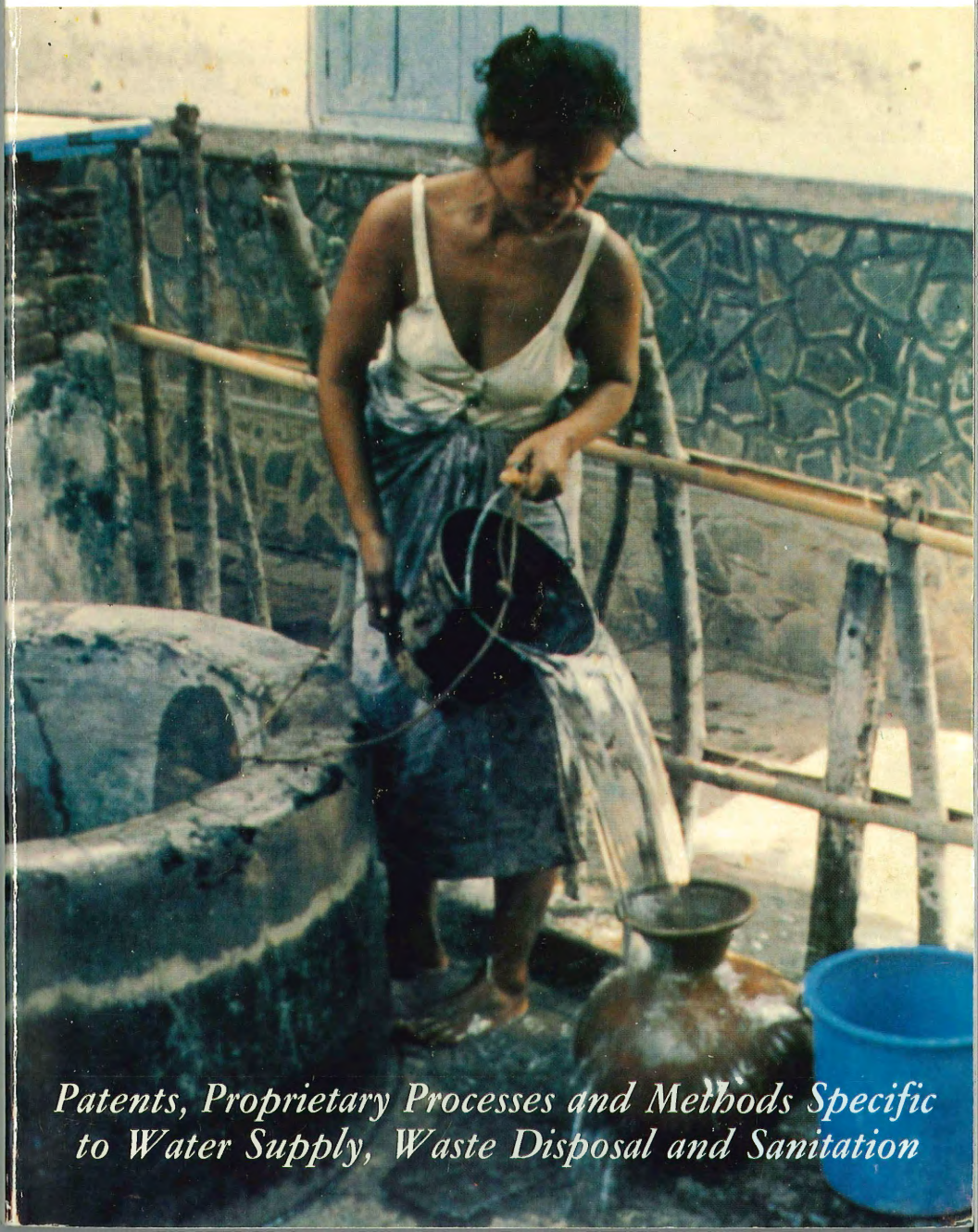
Guidelines for Development of Water/ Sanitation Components of Urban Fringe and Rural Village Projects

Bertram Fountain and Harold Shipman



Patents, Proprietary Processes and Methods Specific to Water Supply, Waste Disposal and Sanitation

Urban Resources Consultants (URC) is a research and development corporation created in 1968 to provide highly specialized services to government, business and industry. URC's speciality areas include: civil/sanitary engineering, social sciences, technology transfer, rural transportation planning, systems engineering, human factors and life sciences, management information systems, health and agricultural sciences. Examples of URC's clients include: U.S. Department of Agriculture, U.S. Agency for International Development, U.S. Department of Transportation, U.S. Department of Health, Education, and Welfare, U.S. Department of Health and Human Services, selected states, cities and service delivery agencies. URC's headquarters is located at Suite 500, 1025 15th Street, N.W., Washington, D.C. 20005, with branch offices in New York, California, Florida, Georgia and Michigan.

The reports contained herein are the results of a study supported by the Office of Urban Development, Bureau for Development Support (DS/UD), Agency for International Development (AID), Contract Number AID/DS/OTR-C-0015/1979. The research in this document does not necessarily reflect the opinions or policies of Urban Resources Consultants, Inc.

Published by:

Urban Resources Consultants, Inc.

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VOLUME I:

GUIDELINES FOR DEVELOPMENT OF WATER/ SANITATION COMPONENTS OF URBAN FRINGE AND RURAL VILLAGE PROJECTS IN DEVELOPING COUNTRIES

VOLUME II:

PATENTS, PROPRIETARY PROCESSES & METHODS SPECIFIC TO WATER SUPPLY, WASTE DISPOSAL AND SANITATION

Bertram Fountain and Harold Shipman

A.I.D. Contract Number: AID/DS/OTR-C-0015

The views and interpretations in this publication are those of the author and should not be attributed to the Agency for International Development or to any individual acting on its behalf.

Foreword

When the idea for this study was conceived in 1977, the United Nations Water Conference had just been completed and preparations were underway for U.S. participation in the United Nations Conference on Science and Technology for Development (UNCSTD) in 1979. The application of science and technology to address the problems of development was being emphasized increasingly.

In addressing the problem of helping poor people gain access to essential services, especially on the fringes of larger cities, in smaller urban centers, and in rural areas, consideration was given to the identification and better use of existing technology. What were the kinds of needs which the appropriate application of technology might address? Stated differently, what were the technological opportunities? The juxtaposition of the two United Nations conferences suggested the focus on water and sanitation.

The services of Urban Resources Consultants, Inc., (URC) were engaged to do a state-of-the-art study which would identify technology in use currently to provide water and sewer facilities and services and would determine the need for and accessibility of new or improved technology. Thereafter, the contractor was to develop and field test a set of guidelines which would assist in planning, developing, and administering water and sanitation services. The goal was to make maximum and appropriate use of technology in order that poor people would have greater access to these services and to the benefits thereof.

These two volumes were prepared by a team of specialists in URC under the leadership of Bertram Fountain. This multidisciplinary team was composed of health and sanitation specialists with many years of experience in this country and overseas. While not eschewing the theoretical, the team leaned towards what it felt was doable and practical and realistic, given the various constraints in developing countries and in the availability of technology.

Volume I is a review of the relevant literature on urban and rural water supplies and sewage systems and of experience in the use of various technologies and methodologies in providing these services. Issues are delineated and strategies are suggested for project development, including types of facilities which are suited for water and sanitation services to urban, urban fringe, and rural areas.

Volume II considers the effective use of patents and proprietary processes and methods and how they might be made more accessible to developing countries. Appended are a classification of relevant patents, a product directory, and a list of patents of particular interest for use in developing water supply and sanitation facilities and services.

The guidelines are especially timely, having been completed on the eve of the International Drinking Water and Sanitation Decade. They will be useful to decision makers as they determine the nature and extent of their participation in this worldwide effort and as they address the needs of specific areas and groups of people for improved water supply and sanitation systems.

William R. Miner
Director
Office of Urban Development
Bureau for Development Support
Agency for International Development

December 1979

Preface

This two-volumed publication has been prepared to assist those who are responsible for helping poor people gain access to and benefit from a safe water supply and improved sanitation facilities. Through the appropriate use of existing and new technologies, it is hoped that the quality of life for poor people in developing countries is improved in a cleaner and healthier environment.

These guidelines are designed specifically to assist: (1) decision makers representing national and local ministries and departments, (2) officials and missions of international assistance agencies, (3) consulting firms and contractors, and (4) other planning and development agencies and organizations in their efforts to increase access to and the benefits from a safe water supply and improved sanitation. Included are steps for project development and types of facilities suited for the provision of water and sanitation services to urban, urban fringe, and rural areas.

The guidelines also cover the effective utilization of patents, proprietary processes and methods as conveyed through experiences drawn from previous efforts. They will be helpful in evaluating alternative technologies, both technically and economically, with respect also to the planning and administration of water and sanitation elements of multi-component housing and development projects in urban fringe and rural areas.

The guidelines are not intended to be a substitute for the required expertise of health professionals, engineers, community planners, and other specialists. These two volumes are a guide, not a textbook. The technologies and experiences contained in the guidelines may appear to be simple. However, the reader should be aware that decisions on the selection of the appropriate technology and on when and how to go about meeting the needs of a particular situation often are very complex. Those who are involved in the initiation of water projects should solicit the assistance of those who are trained and experienced in the art and science of water and sanitation systems.

Acknowledgments

Urban Resources Consultants, Inc., (URC) is grateful to the Office of Urban Development, Bureau for Development Support, Agency for International Development for its sponsorship. URC would like to give thanks to Dr. William R. Miner, Director, Office of Urban Development, who took the initiative in implementing this project, and Dr. John Dickey, Urban Regional Advisor, for his support.

CONTENTS

VOLUME I

GUIDELINES FOR DEVELOPMENT OF WATER/SANITATION COMPONENTS OF URBAN FRINGE AND RURAL VILLAGE PROJECTS IN DEVELOPING COUNTRIES

Page

Introduction 1

Background 2

Purpose of Guidelines 4

Organization of this Report 4

SECTION I

Overview of Water Supply and Sanitation Problems for the Urban Fringe and Rural Areas of Developing Countries

The Present Situation 6

SECTION II

Literature Review

Extent of the Survey 8

General Findings of the Foreign and United States Survey 9

Rural Water Supplies 11

SECTION II (cont'd) Page

Rural Water System Management 12

Some Broad General Views 13

Urban Sewage 14

SECTION III

Urban, Urban Fringe, and Rural Sanitation Technology

Incineration. 17

Disposal to the Soil 18

The Aqua Privy 20

Compost Toilets 21

SECTION IV

Experiences and Success Factors from Past Projects

Types of Projects Previously Carried Out 22

Success Factors of Previous Projects 24

SECTION V

Technology and Methodology

Broad Technological Choices. 27

Water Supply. 28

Conventional Sewage. 28

SECTION V (cont'd) Page

General Comments 29

SECTION VI

Issues in the Development of Urban, Urban Fringe, and Rural Projects having Water and Sanitation Components

Use of Urban Water and Sewer Facilities. 41

Community Participation 42

Sanitation Policies and Financing Issues 42

Institution Building and Manpower Development 43

SECTION VII

The Role of Private Enterprise in the Operation and Maintenance of Water and Sanitation Facilities 44

SECTION VIII

Strategies for Project Development and Implementation

Project Identification 48

Priority of Project Areas 49

Cost Estimated for Preliminary Preparation Work. 52

Preliminary Engineering and Feasibility Study 52

Final Design 53

Staffing. 53

SECTION VIII (cont'd) Page

Project Construction 53

Operation and Maintenance of Water Supplies 54

Operation and Maintenance of Sanitation Facilities 56

Summary 59

VOLUME II

Companion Report

PATENTS, PROPRIETARY PROCESSES AND METHODS SPECIFIC TO WATER SUPPLY, WASTE DISPOSAL AND SANITATION

SECTION I

Methods Employed for this Study 1

Impact of the Patent Code on Exporting United States Technology 3

The Scope and Nature of Patents in the Water/Sanitation Sector 4

Observations on Patent Content 5

Methods and Processes for Water Supply 5

SECTION I (cont'd) Page

Methods and Processes for Sewage Collection and Disposal 6

Methods and Processes for Uses of Pipes, Pumps, Valves, Fittings, Equipment, and Apparatus 7

Summary. 10

SECTION II

The Significance and Feasibility of Making Patented Technologies More Accessible to the Developing Countries

The Significance of Patents to the Developing Countries. 11

Summary. 13

Appendixes

1 Patent Classification as Related to Water, Waste and Sanitary Devices 15

2 Product Directory 65

3 Patents of Particular Interest for Water Supply/ Sanitation Applications. 76

4 Bibliography 85

Introduction

The developing countries of the United Nations organization have designated the period 1980-1990 as the "Drinking Water Decade." Resolutions adopted at both the Habitat Conference in 1976 and the World Water Conference in 1977 took note of the multitude of urban and rural people who live in conditions of poverty and poor sanitation without benefit of a safe and accessible water supply. The resoultion calls upon the world community to join in a unified effort to bring water and improved sanitation to these people by the end of the decade in 1990.

A substantial number of the developing countries have carried out studies which establish the magnitude of the water/sanitation problem and the manpower needs for achieving alternative goals in the next 10 years. With few exceptions these studies confirm the necessity for external assistance in the form of loans, grants, manpower training, and technical assistance.

The framework under which water supplies and sanitary facilities can be provided within countries, while not the same for each will most likely follow fairly standard patterns. In most countries, the national water and sewer authorities, public works and health ministries will have major responsibilities for the provision of such facilities. Urban and rural planning and development agencies will be responsible for sites and services projects, urban fringe and village improvements. Low cost housing projects will have a major role to play. Achievement of goals set for all countries striving to meet the decade target will demand the combined efforts of all national and local departments, agencies, and government. It will need the support of all external assistance organizations using projects in all sectors as vehicles to bring water and improved sanitation to all the people.

BACKGROUND

A little over five years ago a group of scientists met in Paris and identified the problem of bringing water and improved sanitation to the millions of people in need throughout the world as a critical concern. The world's scientific community was asked to make this a priority area for their attention. It was reasoned that the solution to the problem lay in research and the application of new technologies. A scientific resource capable of putting man on the moon could, if given the mandate, provide everyone with safe water, in adequate quantity and within ready access. Further, poor sanitation could be overcome by finding new and cheaper mechanisms for the disposal of human body waste and for the cleaning of bodies and the environment. This would lower costs, overcome operation and maintenance problems, and bring to the latter part of the 20th century a new state of the art which would rapidly close the gap between need and adequacy for these essential services. Unfortunately, this diagnosis of the problem and its solution appears to have been oversimplified.

Engineers and scientists specialized in water supply and sanitation have been engaged over the past several decades with programs of assistance to developing countries. With few exceptions they have seen the solution of the problems as resting less on the development of new revoluntary technologies than on proper application of what is already known. This knowledge must be coupled with the will of nations to do what is necessary politically, and financially to insure that everyone has the benefits of these most basic of human needs. They see the importance and necessity for a reservoir of trained and experienced personnel. Similarly they support transfer of information and knowledge between countries and people on technological matters and successful methodologies. Having supplied these elements, however, and having noted an inability to find the foolproof approach which invariably ensures success, the front line worker in the rural villages and fringe areas of developing countries, views the process of supplying people with water and a cleaner environment as one which is less scientific than political, less a clear cut procedure than an art, and less a matter of external help than one of

self-help and local finances. In the analysis of past and present efforts to help people in developing areas to obtain a safe supply of water and a clean, sanitary place to dispose of wastes, the only formula that has shown promise for success is the formula of people's desire for these amenities and their demonstrated willingness to properly use and support them.

This report presents a number of suggested approaches and guides for the development of projects and policies concerned with bringing pure water and improved sanitation to many of the poor residing in rural, urban fringe and urban slum areas. While believing such suggested approaches and guides are sound, and reflect experiences on a broad front, it has to be repeated that suitable technologies exist. However, proper application of suggested water and sanitation technologies, supported with policies, organization, management and villagers' participation is a formula that has been found to be effective.

In the preparation of these guidelines an emphasis was placed on presenting approaches which village and urban departments and rural and urban developers can use and which will insure a better understanding between them and those whose sole responsibility is water and sanitation. The rationale being that water, and sanitation facilities are commonly provided within projects which are not always administered by water and sewer agencies or departments.

The final point by way of background is that there are a rather large number of projects now in execution, some completed, others in preparation, which can serve as examples of the multi-component type project examined in this report. Many of these are designated as urban development projects; some are for fringe area developments. Resettlement, village and rural development projects while having certain differences in component content when compared with an urban project, are nevertheless similar in format and in the means for project development and execution.

PURPOSE OF GUIDELINES

These guidelines are designed to assist: (1) decision makers representing developing country missions, urban ministries and departments; (2) planning and development agencies; and (3) consulting organizations in their efforts to effectively improve water and sanitation conditions. They should also be helpful in evaluating alternative technologies, both technically and economically, with respect to planning and the administration of water and sanitation elements of multi-component housing and development projects in urban fringe and rural areas.

ORGANIZATION OF THIS REPORT

This report is organized as follows:

- Overview of Water Supply and Sanitation Problems for the Urban Fringe and Rural Areas of Developing Countries;
- Literature Review;
- Technology and Methodology;
- Urban, Urban Fringe, and Rural Sanitation Technology;
- Issues in the Development of Urban, Urban Fringe, and Rural Projects having Water and Sanitation Components;

- Strategies for Project Development and Implementation; and

- Patents, Proprietary Processes and Methods Specific to Water Supply, Waste Disposal and Sanitation.

The facts covering Patents, Proprietary Processes and Methods Specific to Water Supply, Waste Disposal and Sanitation are presented in a separate companion report (Volume II). This document was prepared in conjunction with the Guidelines and presents the results of the findings on the review and search of United States and foreign patents concerned with water/sanitation devices, equipment and processes applicable to developing countries. The report includes the following objectives:

- To examine the scope and nature of patents and proprietary processes specifically concerned with water/sanitation application;

- To evaluate the feasibility and significance of selected efforts directed at insuring that appropriate patented technologies are more accessible to developing countries; and

- To investigate the question of how developing countries can best gain access to the use of patents, proprietary processes and methods specific to water supply, waste disposal and sanitation, after once identifying those of promise, economic benefit and applicability.

SECTION I

Overview of Water Supply and Sanitation Problems for the Urban Fringe and Rural Areas of Developing Countries

THE PRESENT SITUATION

Unlike the suburban development which occurs in industrialized countries, the urban fringe of most cities in the developing countries is made up of the poor and the destitute. Illegal shanty towns--congested settlements made up of sheet metal huts and box shelters; characterized by poor drainage, narrow foot paths and a few peripheral mud roads--are the substances of the urban fringe. Sanitary facilities and a clean, accessible source of water for drinking and cooking are normally absent. A place for washing and bathing seldom exists. Even space to provide such facilities is at a minimum. To many, the situation appears almost hopeless. Everyday new arrivals attracted primarily by work opportunities come to the city from rural areas and continually add to the city's and the nation's dilemma.

There is usually need for piped water at some point where the family can get it without transporting it over great distances. If piped water is unavailable, people commonly pay someone to bring it in from sources of questionable safety at prices usually exceeding those paid by homeowners having piped supplies.

Rural areas have lagged far behind urban areas in the provision of both water and sanitation facilities for the people. An estimated 1.1 billion rural people in the world (excluding China) are in need of a good water supply and an acceptable means to dispose of body wastes. One basic difference between the rural poor and those in urban settings is that normally the urban poor do not have any source of water except the community system. Only as the village population outgrows the capacity of the water source, or as droughts dry it up, is the village faced with the hard-

ship of transporting water from great distances. The supply of pure water to villages has encountered a number of problems. Water normally available is accepted even though it may be polluted. It has therefore not been easy to convince the villagers to use a new, safe source if the water tastes or appears different and/or if they have to pay to get it.

In developing countries today, not only is there a lack of water, there is also a paucity of sanitary facilities. Both the rural and urban poor get along with few if any sanitary facilities for the disposal of human body wastes. For the rural dweller, open space is usually not at the premium that it is in the urban setting. Motivations for use of latrines such as privacy, absence of odors, cleanliness, and convenience are easily met by nature in the rural areas. Those engaged in farming prefer the field to even a clean, well ventilated latrine at the house. In neither the urban nor rural areas, are public health considerations, much of a motivational factor. All people and all classes are repelled by unclean, unsightly, foul toilets and toilet areas. Therefore, all will revert to the open space and the ground whenever the opportunity presents, even though they may be creating a problem for someone else. This is the reason why public toilets for urban, urban fringe and rural areas, have seldom proven successful. Therefore if any success is to be achieved, individual home facilities are required. However, the home latrine is also the cause of a major problem in most urban situations because there is usually no space available at the shanty to build even the smallest of toilets.

Furthermore, cultural factors can seriously affect acceptance or rejection of sanitation facilities. For example, seat units are not acceptable to people accustomed to squatting. Toilet paper cleansing is of little use in most developing countries. Thus, the means by which cleansing is accomplished is of fundamental importance in the selection of design. Multiple units for more than one family may or may not be acceptable. Modesty and superstition surround the use of toilet facilities to such a great extent that no design should be decided on in advance without testing acceptability and use for any area not currently served by excreta disposal facilities.

SECTION II

Literature Review

EXTENT OF THE SURVEY

This survey has concentrated on the English literature and of this, primarily United States and British publications. A number of Spanish and Portugese documents have been reviewed, and a few French, German, Chinese, Japanese and Malaysian references have been noted. Appendix 4 presents the bibliography.

The following seven criteria have been used to screen approaches to water/sanitation problems presented in the literature. They are believed relevant to the evaluation of technologies proposed for use in all developing country projects:

1. Is the initial cost low?

2. Is the operational cost low?

3. Can it be fabricated locally with a maximum of imported materials and equipment?

4. Is it simple enough to be operated and maintained by the local people?

5. Is it durable, long lasting and dependable?

6. Will it provide an acceptable degree of protection to the public health?

7. Will it be acceptable to the people who use or will benefit from it?

The published literature covering water supply and sanitation, using the definition of sanitation applied in the previous section, covers five broad topics:

- Urban water
- Rural water
- Public sewage
- Private sewer systems
- Excreta disposal.

The literature on desalination processes and operations is extensive. However, this aspect is not included since employment under economically favorable conditions would be possible in only the most unusual of circumstances.

While a mass of publications exist on sewage treatment, only stabilization pond applications have been included in the present survey. Most developing countries are investing what little they are able, on collection systems to remove the sewage from underfoot and transport it away from the densely populated areas. Given present financial constraints, this is a sound social, public health and environmental initiative. Treatment of the sewage by conventional processes is necessary but must come at a later stage. In the meantime, low cost and easily operated stabilization pond techniques exist and can be employed to afford treatment equivalent to conventional secondary processes when needed, provided that open land areas are available.

GENERAL FINDINGS OF THE FOREIGN AND UNITED STATES SURVEY

Urban Water Supply

In technologies covered in the literature, no major differences exist between foreign and United States practices. Differences do exist in policies, design standards, and service levels. Where wells are employed as the source of water, designs are based on the nature and characteristics of the aquifers. Dis-

tances between wells and points of pollution regarded as safe as established by the type of soils, do not vary substantially between countries. Minimum distances have been based on early studies such as those reported in the Rockefeller Monographs (Caldwell) and confirmed by other studies. Construction employed to exclude surface contamination varies widely and reflects differences in available materials, types of pumps, construction methods, climate, and accessibility of spare parts and sources of service.

Water standards reflect acceptable levels of chemical, physical, radiological and biological contaminants and are usually referenced or are similar to the World Health Organization (WHO) recommended standards. If recent requirements on chlorinated hydrocarbons and trace substances are disregarded, older United States Treasury Standards (later United States Public Health Services and currently Environmental Protection Agency standards) do not depart far from WHO standards. WHO standards published as of this writing, do not cover chlorinated hydrocarbons and trace substances. For most developing countries trace substances will not be a major concern for the immediate future. Where good ground waters are available, it is unusual to find disinfection of any kind employed routinely by countries other than the United States. Experience in rural areas for most countries indicates that few chlorinators continue in use for more than the period required to exhaust the initial supply of chlorine powder. It is therefore prudent from a public health standpoint to emphasize location and construction of wells and the exclusion of pathogens, than on disinfection and other treatment to remove such organisms after they have gained access to the water.

No major departure from time tested techniques are evident in the treatment of surface water sources supplying urban systems. Mostly, conventional practice consists of chemical mixing, flocculation, precipitation, filtration and disinfection of the surface water sources. Much is said in the literature about the advantages for developing countries to employ simple equipment, with a minimum of complex valving and controls. Emphasis is placed on use of straightforward designs--avoiding processes that involve im-

ported chemicals, coagulant aids, complex instrumentation and controls.

RURAL WATER SUPPLIES

Types and Designs

In most literature rural water systems are classified in two ways: (a) whether the system is piped or not, and (b) whether the water source is ground water or surface water. It is of course possible to combine these classifications where found useful. The literature confirms the desirability for health, economic and operational reasons for using ground water sources where aquifers are in consolidated formations as contrasted with cavernous limestone. Since contamination can travel long distances in cavernous limestone these water sources have to be regarded in the same way as surface sources. To reach all ground water sources, wells are drilled or dug, except where springs exist.

Wells are universally similar in style and are based on the depth to, and characteristics of, the aquifer. Drilled wells which tap deep aquifers are minimal in diameter. Dug wells are much larger in diameter and are of use only to limited depths. Drilled wells are cased in part or entirely with steel casing that ranges from 2 inches to 24 inches or larger in diameter. The literature confirms use of plastic pipe for casing where driving is not required. It appears unusual to use casing larger than 8" diameter on rural wells. The most common size is the 4" to 6" casing. Drilled wells of 2 inch to 5 inch size are commonly referred to in the United States literature as tubular where the outer casing serves as the eduction pipe. No drop pipe is provided for tubular construction as is the case with conventional drilled wells.

Shallow aquifers are usually tapped by digging, driving, or boring. Bored wells may be lined with tile or corrugated steel pipe. Such construction is not favorably regarded by public health engineers. Where these types of linings are used, most require that concrete be poured around the curbings to make the well watertight to a depth of at least ten feet. This prevents surface contamination from entering the well.

Dug and bored wells seldom go beyond 40 to 50 feet in depth but dug wells have been constructed to depths exceeding 80 feet. Obviously such construction is extremely hazardous because most digging is done by hand. Where proper concrete curbing is used such wells are costly because of the large diameter. However, dug well use is required where (a) aquifers are very limited in water yield and (b) there is need for the well to act as a collection and storage facility.

Driven wells are common throughout the world. They are usually limited in use to areas where water is within 15 feet to 20 feet of the surface. They are constructed by driving a perforated point, usually covered by a fine screen, until the point penetrates the ground water. Such wells are usually equipped with suction pumps. They are comparatively cheap, and simple to maintain. If properly located, they can yield high quality water.

Jetted wells are common in some countries. Usually the jetting process is combined with a lightweight percussion drilling rig and if hard rock is not encountered, depths of 100 to 200 feet can be easily reached with a 2 or 3 inch hole. In Bangladesh such wells have gone down over 1,000 feet. A PVC or other type casing and well screen are installed after the aquifer is reached.

RURAL WATER SYSTEM MANAGEMENT

The literature is in general agreement concerning problems of operation and maintenance of rural water systems. Most authors support the view that communities must be involved in the important decisions. Communities must financially support both the installation of the system and the operation and maintenance costs. However, worldwide, there are too few success stories. In most cases, the cause of failure has been the inability of villages to collect the funds needed to pay for maintenance and repair. We conclude that a regional or national organization must financially stand behind most local systems to insure successful water management. Otherwise the failure rate for rural water projects will continue high. The problem of poor maintenance

is probably not one of shortage of trained personnel. Complex equipment, automobiles, tractors, etc., are being maintained by local mechanics. Most wells and most pumps are simple by comparison. Lack of money to pay for the operator/repairman and for the repair parts seems to be at the heart of the problem.

SOME BROAD GENERAL VIEWS

Numerous papers make the following points:

1. Urban water systems pose less of a financial risk than rural systems. Urban owners keep systems running and collect money from those who benefit to repay loans and cover costs of operation and maintenance more consistently than rural owners.

2. Water systems technology whether urban or rural does not vary substantially from one country to another. Modification of a few basic methods or processes exist everywhere; changes in the fundamental technologies vary little.

3. Because of its importance to life and the differences in the way people regard water from country to country, superstition, old wives tales, and misinformation abound. Further, experienced workers differ drastically on the policies to be followed, how projects should be developed, and how to overcome these problems. Judgment, sensitivity, and experience in local customs of the developing country must temper decisions. Technologies, methodologies and project design have to fit the unique requirement of each developing locale.

A substantial number of opinions expressed by experienced professionals support these conclusions.

URBAN SEWAGE

Urban Sewage Situation

The most reliable worldwide statistical information in the field of urban sewage has been collected by WHO. The last report, published in 1977 and covering the period 1970-75, shows that for Latin America a smaller percentage of urban residents were served by municipal sewers in 1975 than at the beginning of the period in 1970 because the urban population was increasing faster than sewer connections. This occurred in every country despite the fact that Latin America had established goals and planned for improvement of sewer services during this period.

In addition, there exists in the region a much larger reservoir of personnel trained in Sanitary Engineering than in nearly any other area of the developing world. This pattern of a smaller percentage of population served by municipal sewers in 1970 than in 1975 is the same in most other areas of the world. It seems likely that a much greater percentage of urban dwellers will be without sewer service in year 2000 than today. It is anticipated that the poor and the lower middle class of those countries will be most affected.

The literature continues to emphasize the public health problems existent today in the rural areas of developing countries which are without properly constructed excreta disposal facilities. These are also the problems today in city after city of the third world. It will be more intense as a problem in year 2000, and it will certainly be more widespread unless the trend is reversed.

During the past ten years, the major reason for the lack of progress in the construction of public sewage disposal facilities has been the cost. Per capita costs today for conventional sewage disposal units can vary from an amount equivalent to urban water supply to several times that amount. Such costs do not include the added amounts needed for house connections and house plumbing. This is the reason that most recent literature in the field

is devoted to discussion of, and proposals for alternate technologies directed at reducing costs.

The most likely alternative will be a merging of several methods on a district-by-district basis within cities. For example, high rise commercial centers in the heart of cities will have to be served by a conventional, piped sewer system. A fringe, middle class, disperse housing area might be served by individual sewer systems. An area set aside for low income, self-help housing can be designed for pit latrines, etc. Decisions and plans for resolving growing urban sewer problems will increase in complexity as time goes on. At present, most efforts to attack the problem are only thinly hinted at in the literature.

Urban sewage disposal without doubt is of lower priority than urban water supply, and urban fringe sewage is even lower in priority. Nevertheless, as density of population increases the disposal of body and liquid wastes becomes increasingly a vexing problem. The literature offers little guidance on the means to be employed for making a decision on when to invest in a sewer system or its alternatives. Most standard texts indicate that when water is provided, sewage should be installed simultaneously. Even in the United States such a policy was not followed in the early stages of the country's development. The simultaneous installation of a water supply and sewage disposal system is out of the question for most developing country urban areas today. Even providing water usually taxes resources to the limit. A pragmatic approach appears to lie in prevention of the problem in new areas while whittling away at it in the older sections.

Urban Sewage Technology

There is not a great difference in technology between countries in the collection of sewage by public systems.

Given the "social" nature of water supply and sewage, the basic objective in their development is usually to provide the maximum number of people with safe water in adequate quantities,

and to collect and dispose of wastes in a manner that will avoid public health, environmental and aesthetic problems, at the minimum unit cost. In most cases, full satisfaction of these needs is not a realistic short-term goal; therefore development programs represent a selection among alternatives--i.e., levels of funding, degree of emphasis on urban versus rural development, quality of service, technical options, and the like. These judgments must be based on both qualitative and quantitative factors, but more and more emphasis is being given "social" factors, by governments and lending institutions. For example, social effects have to be considered when deciding the urban versus rural emphasis, pricing policies, alternative tariff structures, the effects of programs on government revenues, and the degree of sewage treatment. These are largely political choices and must therefore be made by the government. However, they should be made in the full knowledge of the financial and economic, as well as the social consequences of the decisions.

SECTION III

Urban, Urban Fringe, and Rural Sanitation Technology

Epidemiological case studies along with national and regional studies related to vital statistics for infants, children and people of all ages consistently show poor sanitation to be the major cause of high morbidity and mortality rates in most developing countries. In the broad sense of the meaning, however, poor sanitation as a major factor in morbidity and mortality rates, actually means also poor water supply, poor environmental and body cleanliness, poor food and food storage, as well as unsatisfactory excreta and solid waste disposal. For this discussion the word "sanitation" will be used in the limited sense to mean only practices surrounding disposal of body waste, and we will speak of latrines, privies, excreta disposal, night soil and sewage as the terminology of sanitation.

A review of the United States and foreign literature reveals that there are basically only three ways to satisfactorily dispose of human body waste: to incinerate it; to bury it; or to transport it by pipes, vehicle, or container to a place removed.

Certain side mechanisms for disposal such as composting, treatment and soil absorption, treatment and reuse, biogas production and sewage irrigation are only modifications of the basic technologies.

INCINERATION

While incineration is not uncommon it is a technology which is limited in the literature to: (1) disposal of sludge cake in large municipal sewage treatment plants; (2) processes which mix excreta with fuel oil for disposal as part of the heating process in arctic huts and military installations; (3) recently patented and expensive units operating on gas, fuel oil or electricity that have yet

to be proven in even the developed areas; and (4) patented designs employed in a few early buildings and units where waste was deposited in a covered trench or vault and incinerated by the addition of kerosene and other combustibles, then vented up a stack at the end of the combustion chamber. The last process turned out to be a disaster when used in buildings. The other three processes are workable and quite usable. However, they have little relevance to the objective of this discussion, primarily because of cost and complexity. Application of incineration to sludge disposal in urban treatment plants may be considered in a few large urban situations but usually the economics and availability of more appropriate alternatives will render it of little concern.

None of the current bibliographies, United States or foreign, covering excreta disposal practices and technology mention incineration other than as a method of disposing of treatment plant sludge. None of the international agencies have recognized excreta incineration as a suitable technology for developing countries.

DISPOSAL TO THE SOIL

The latrine designs adopted in the 1930's in the United States under the Works Project Administration, (WPA), Farm Security Administration (FSA), and state sponsored sanitation programs remain as models for low cost, simple sanitary privy design. They are applicable with only slight modification to developing country conditions and to any climate. Description of these designs continue to exist in the bulletins of many state health and agriculture departments. The WHO monograph on Excreta Disposal for Rural Areas describes such designs. The differences between early and late designs concern mainly size and shape of vaults, methods of curbing, vault ventilation, and whether seat or squat slab configuration is to be employed.

The scientific basis for the location and design of vault latrines is contained in the 1920 Monographs of the Rockefeller Foundation and extending through the 1937 studies of Caldwell

and Parr. Numerous epidemiological studies covering the period from 1937 to the present have supported the findings that bacterial and parasitic contamination introduced into dry vaults constructed in consolidated earth formations, will travel only very short distances (usually less than 10 feet even in sand). This confirms the fact that latrines with vaults constructed in a manner which prevents caving and discourages the entrance of flies and rodents, will provide a sound public health means for excreta disposal. There appears to be no country in the world which has published information on various methods of excreta disposal, that has not shown the vault latrine as an acceptable technology. It is certainly the one most widely used worldwide. With all its crudeness and frequently foul smells, the vault latrine remains as the method of choice wherever conventional sewage cannot be employed.

A considerable number of papers have been prepared on the bore hole latrine. The Rockefeller Foundation tested this design in a number of foreign countries and it is described in WHO, Canadian and World Bank publications. It is without doubt one of the cheapest and simplest designs available. Because of its depth, a bore hole latrine will penetrate shallow aquifers requiring particular caution in locating wells which may use or penetrate the aquifer. Once the bore hole is filled, like the vault latrine, it has to be either cleaned or a new hole constructed. The old hole is filled in with earth and after a year or two the contents become completely stabilized. The major objection to bore hole latrines besides the hazard of penetrating the aquifer is their short life. Three years is about the maximum life before cleaning or moving.

Properly designed vault and bore hole latrines function without regard to the superstructure. While the literature tends to emphasize structural details of the shelter, this is of no importance from the public health standpoint and serves only to allow privacy. Consequently, any materials available which can serve to make the screen or the structure, are appropriate. The easier the shelter or structure is to move the better, since this facilitates cleaning or moving to a new location when the vault or bore hole becomes full.

Although vault and bore hole latrines are primitive and simple, they remain as a very satisfactory public health tool to be employed whenever a low cost, easily adaptable technology is required and where adequate space is available.

THE AQUA PRIVY

The United States literature is lacking much description of aqua privies and so far as can be determined, such units have not been employed in the United States of America. This may be attributed to several factors of which culture, climate, and operational problems are the most likely.

In the cold areas of northern United States and Canada, outdoor unheated latrines whose design requires a water trap seal, will experience freezing of the trap and the unit will no longer function. Body wastes deposited in the bowl cannot be flushed down even if the water for flushing were available and not frozen.

Aqua privies are essentially designed for areas which use squat slabs. No seat-type modifications are shown in any of the literature although it should not be too difficult to develop such a design if the occasion required. Two problems need to be overcome with built-in trap units. First, it is difficult to scour and clean the bowls with the limited amount of water usually available for flushing. Secondly, the need for water for flushing the latrine increases problems of poor operation and also increases costs.

Culturally, in countries such as India and Shri Lanka where water seal latrines had their early beginning, it has been written that people object to looking into the vault and that a trap which shields the vault is a necessity.

Recent proposals such as those published by the World Bank and others advocate aqua privies as an intermediate stage which will permit connection of the trap outlet to a piped system at a future time, thus avoiding costly modifications. Under this

proposal the vault which serves as a form of septic tank with overflow to a dry well in the original phase will be abandoned upon connection with the system. Whether such a sequence and approach will prove feasible remains in doubt.

COMPOST TOILETS

Compost latrines also called Malaysian Latrines, are the subject of great interest to a few who are intrigued with the concept of recycling and compost utilization. However, problems of operation and functional design encountered with such units should not be ignored.

The compost toilet discussed in the WHO Excreta Disposal Manual needs to be built as a double unit to permit one side to stabilize while the other is in use. The multrum and similar sloping chute type units developed by the Swedes do not employ a double facility. Instead, gravity moves the soil/excreta mixture downward to replace the stable compost that is periodically removed at the bottom. Such privies require intelligent and informed maintenance. They require considerable space, are not cheap, and need to be kept in a condition favorable to composting, i.e., some moisture but not too much, and at temperatures well above freezing. Of these requirements, cost, informed maintenance and prevention of flooding by heavy rain are the most serious deterrents for developing country application. The compost obtained from such units will be useful agriculturally but it will have to be regarded as a possible source of disease. Therefore use on vegetable crops should be avoided. Farmers and workers will also need to wear shoes to avoid hookworm problems in soil which receives the compost. In view of their shortcomings, few projects will likely wish to employ compost toilets on a wide scale.

SECTION IV

Experiences and Success Factors from Past Projects

TYPES OF PROJECTS PREVIOUSLY CARRIED OUT

Some of the earliest international assistance in the fields of water and sanitation was initiated in 1942-43 in Latin America by the Coordinator for the Office of InterAmerican Affairs. This assistance represents some of the most impressive accomplishments ever achieved if measured by the numbers of people served by safe water and sanitary facilities; by the building of institutions capable of carrying on under the complete management of national personnel; by the numbers of trained personnel; and by the policies adopted and continued on to this day. These programs were directed at both urban and rural populations.

The United States Agency for International Development (USAID) and its predecessor agencies have supported many water and sanitation projects in a host of countries. In most cases such projects were sponsored by Ministries of Health, Public Works, or National Authorities for Water and Sewage rather than by Urban Affairs Ministries. These projects have commonly concentrated on urban and/or the rural areas. Seldom were both included in the same package. This has resulted in the neglect of fringe areas under either format since rural officials believed the fringe belonged to the cities and the urban officials felt that the fringe was a rural problem. It is not uncommon to observe these differences in many countries today. Somewhat different but equally vexing problems can be observed today in the industrial countries where political boundaries between cities and suburbs cause numerous disputes. Noneconomic solutions often occur where water and sewage facilities become involved in these jurisdictional difficulties.

Previous projects in rural settings have commonly incorporated water and sanitation components with rural health service

activities. Those in the urban field have, more often than not, been specifically for water and/or sewage. In recent years, the World Bank, USAID, the Swedish Development Agency, and a few others have assisted rural development projects which covered a number of sectors including Education, Roads, Agriculture, Health, Water and Sanitation and Rural Credit. These and other agencies have also assisted projects in urban low cost housing, urban development, and slum and fringe area improvement. Such projects have commonly included water and sanitation components. In some instances where municipal water or sewer systems were unable to cope with the added demand imposed by a new urban development project, provision was made to simultaneously expand the municipal water/sewer facilities. Sites and services projects have almost always included provisions for water and sanitation facilities. These have included public watering points (sometimes with bathing facilities adjacent), water to the property for an outside tap, or to a basic plumbing system installed on a slab to be included within the structure. The sanitary facilities (sewage/excreta disposal unit and the wastewater arrangement) have posed the most difficult and usually most costly part of the basic facilities group.

Most of the urban, urban fringe, and rural development projects presently supported by external agencies and geared to helping the poor, are in an early stage of operation. Therefore, insufficient data is available from these efforts for guidance in either policy or technological matters. However, one of the most recent evaluations of fringe and rural projects* is specially concerned with the water/sanitation aspects of eight projects in Latin America. Throughout the eight case studies, the importance of cultural, economic, and political factors on the attitudes toward, and acceptance of facilities is emphasized. Technical decisions were also found to be interrelated with the other factors.

* Eight Case Studies of Rural and Fringe Areas in Latin America, World Bank, May 1979.

SUCCESS FACTORS OF PREVIOUS PROJECTS

Running throughout the literature and the statements made concerning experiences on rural and urban projects for the supply of water and sanitation services to the poor, is the warning that problems of operation, maintenance, collection of charges, and proper usage of facilities are universal. These problems have been responsible in countless projects for the failure of the system or at least the loss of many long ranging benefits from investments.

A major oversight has been the failure to properly involve communities in which possible projects might be located. This involvement must occur at the outset, and continue throughout the construction period. A major education process has usually been required to establish the care and use of the facilities. Differences in cultures and motivations make community organization and involvement one of the most difficult project elements. Qualified local people willing to do such work are usually in short supply. Experienced and competent technicians in this field have been in even shorter supply externally.

In some cases operation and maintenance problems for water systems have been overcome by having a national/regional organization whose responsibility it is to supervise the systems in its jurisdiction. Without the existence of such organizations, projects have frequently failed.

In fringe areas, water supplied from extension of existing urban systems has usually proven to be the most effective arrangement. Problems have occurred in attempting to collect money for the water used at public hydrants and watering points. House connections have shown to be advantageous by facilitating the collection of funds to cover water use.

In view of the cultural factors involved in the design, installation, use, and maintenance of excreta disposal facilities, many problems have occurred in areas where facilities of this type were not in widespread use. It will be well to study any new areas to insure that all relevant cultural factors have been properly addressed.

Many questions have occurred concerning the policy to be followed on payment for water supply service and for latrines. The place of village contributions, village involvement, and fringe area organizations have also been the subject of continuing differences of opinion. One cost efficient formula for potential success is the sweat equity concept.**

In rural, and some fringe areas, it has been common to find that several agencies of government have been involved in the provision of water/sanitation facilities. For example, on some projects these facilities have been under the responsibility of one of the following: the Ministry of Health, the Ministry of Agriculture, the Water Authority or the Water Department. This has resulted in different objectives and policies being followed in the same country. As a result, serious problems arose for external agencies interested in strengthening organizations and improving management.

In certain countries it has been possible to effect an arrangement between Ministries whereby the Ministry with prime responsibility for water supply has carried out the work and followed up with continuing assistance to the area. This has insured some consistency and while no guarantee for future investment, it does give some hope that operation and maintenance of the facilities will not be neglected.

Many sources of external assistance to the developing countries in the fields of urban and rural development and in the provision of water and sanitation facilities have been available. It has been the rule rather than the exception that each external agency has had its own ideas as to what is best for the country. On numerous occasions these ideas were in direct conflict with another advisory group working in a different part of the country. Countries should be encouraged to decide what policy they wish to follow and all external agencies should support this position

** For purposes of this section, sweat equity means the exchange of villagers' labor for their share of the capital costs of water and sanitation services.

to the maximum extent possible. Ideally, external agencies should have a forum in which they could exchange information and learn what has transpired on various projects in given countries. Much time and money have been wasted and countries further confused because of the inability of external agencies to find common ground in their assistance efforts.

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SECTION V

Technology and Methodology

A common objective of those concerned with the selection of technologies to be applied to any given project has been to find cost-effective solutions which are acceptable to the people, which can be operated and maintained by the personnel available, and which can be upgraded whenever the people so decide. The literature is voluminous on the technologies to be considered and the methodologies for the installation and operation of water and sewage/excreta disposal systems. These can be rather simply broken down into a few broad categories for easy understanding. They are as follows:

Broad Technological Choices

1. Urban and Fringe Area Systems

   a. Those easily connected to existing urban water systems.

   b. Those easily connected to existing urban sewer systems.

   c. Those not easily serviced by either of the urban systems.

2. Rural Areas

   a. Those which can be supplied by a simple expansion of an existing water system.

   b. Those which have to be supplied by a new water system or systems.

c. Those which will be supplied by a community sewer system.

d. Those which will be supplied by individual home sewage or excreta disposal units.

WATER SUPPLY

The guides on selection of technologies for the supply of water as shown in Table 1 are presented with the admonition that they may be oversimplified. Final decision on project design should be taken only after involvement of experienced sanitary engineers from both local agencies and those of USAID. Caution is therefore recommended in the application of Table 1.

CONVENTIONAL SEWAGE

Much has been written in recent years on the ecological and economic shortcomings of conventional sewer systems. The arguments are essentially concerned with the lost of nutrients when body waste is mixed with water for flushing, with the pollutional aspects of discharging large volumes of sewage to water courses, and with the high cost associated with providing high quality water for flushing and the treatment required to remove the contaminants. Unfortunately, solutions to removal of body wastes and sullage water (bath and kitchen waste water) from populated areas do not always lend themselves to ecologically optimal solutions even though economically one approach may be more favorable than another in any given situation. Table 2 lists various methodologies of sewage disposal.

Liquid waste emanating from household kitchens and bathing facilities are not readily disposed of by composting and similar ecologically favored methods applicable to solid wastes. Decisions on the most appropriate technology and methodology to employ for sewage and excreta disposal are consequently complicated by the additional need to properly dispose of the sullage water.

The conventional sewer system, therefore, with all its faults, must always be included in the array of options open to those who finally decide on the means by which various areas are to be served. When solutions are sought on hcw best to dispose of the sewage/excreta produced by any housing area, practices used for the past century will continue to apply for many years into the future. These will entail connection to existing sewer systems, construction of new systems, provision of household septic tank systems, and the use of vault or other types of latrines depending on the economics, the geology, the topography, and the culture of the areas concerned. Almost universally in cities where sewers do not exist sewage ends up being discharged to drains and storm sewers initially constructed to reduce flooding and to remove surface run-off.

If caution were in order in using Table 1 guide for water supply, it is doubly needed for the sewage/excreta disposal guide presented in Table 2. Experienced professionals should be consulted before final decisions are taken.

GENERAL COMMENTS

In all of the above applications and those shown in Table 2, reference has not been made to compost toilets, or chemical toilets. The reason is that none of these units is likely to function without giving trouble under day-to-day conditions encountered in urban, fringe and rural housing projects. There will probably be a few situations where one of these alternatives might be considered but there will not be many. Aqua privies have been listed as an alternative for certain applications but experiences to date lead to the conclusion that this technology is extremely limited in its application.

TABLE 1

WATER
(Urban)

TYPE OF AREA	TYPE OF WATER CONNECTIONS WHICH CAN BE CONSIDERED	WATER SOURCES TO BE CONSIDERED
Urban	(a) Public fountains (b) Courtyard connections (c) House connections (d) Combinations of a, b, c.	1. Only the municipal system should be used unless very unusual circumstances prohibit this arrangement. --- REMARKS 1. Check on capacity of existing municipal system. If inadequate, it must be expanded before project connection is made.

TABLE 1 - Continued

WATER
(Urban Fringe)

TYPE OF AREA	TYPE OF WATER CONNECTIONS WHICH CAN BE CONSIDERED	WATER SOURCES TO BE CONSIDERED
Urban Fringe	(a) Public fountains (b) Courtyard connections (c) House connections (d) Combinations of a, b, c. (e) Hand pumps	1. Municipal system extension. 2. Compare discounted cost of supply by connection to municipal system against discounted cost of a new supply for project area only. Select least cost solution. 3. Shallow or deep wells. REMARKS 1. Check on capacity of existing municipal system. If inadequate, it must be expanded before project connection is made. 2. If comparison of discounted costs between two solutions is reasonably close, always select the one involving connection to existing urban system.

TABLE 1 - Continued

WATER
(Rural Village)

TYPE OF AREA	TYPE OF WATER CONNECTIONS WHICH CAN BE CONSIDERED	WATER SOURCES TO BE CONSIDERED
Rural Village	(a) Hand pump(s) (b) Limited distribution to: ---Public fountains ---Courtyard connections ---House connections (c) Extensive distribution: ---Public fountains ---Numerous house and courtyard connections	1. Springs 2. Protected shallow wells 3. Protected deep wells 4. Infiltration galleries 5. Small treatment plants 6. Rain water collectors REMARKS Sources listed in order of cost effectiveness, safety, dependability and serviceability. Gravity systems which can eliminate need for pumping have many advantages. Treatment plants need to be avoided if possible because of difficulties experienced with operation.

TABLE 2

URBAN
(Sewage/Excreta Disposal)

TYPE OF AREA	OBJECTIVE OF THE PROJECT	TYPES OF DISPOSAL WHICH CAN BE CONSIDERED
Urban 1. Highly congested slum - Little permanent housing. Shacks usually back-to-back, and side by side.	Improvement of living conditions with no new housing and with little slum clearance.	a. Bore hole or vault latrine at each shanty 1/ b. Public latrines 2/ c. Conventional sewerage by connection to existing urban system 3/ d. Waste water thrown onto road or any accessible area, or to drainage ditches and channels 4/

COMMENTS CONCERNING SELECTION OF DISPOSAL TYPE

1/ Depends on space around house. Cannot be placed inside shanty.

2/ Difficult to keep clean. People do not like; odors and problems for neighbors.

3/ Very costly; depends on space in or around shanty; should involve water line to each house.

4/ Limited amounts of waste water can usually be disposed of without need for facilities. Rain water and surface drains commonly used without too many problems. Depends on topography. Disposal of solid waste to drains and ditches commonly creates added problems.

TABLE 2

URBAN - Continued
(Sewage/Excreta Disposal)

TYPE OF AREA	OBJECTIVE OF THE PROJECT	TYPES OF DISPOSAL WHICH CAN BE CONSIDERED
Urban 2. Highly congested slum - Little permanent housing. Shacks usually back-to-back, and side by side.	To improve conditions by removing many shanties, with or without new housing.	a. Vault latrines. One vault serving two units may be feasible in some places 1/ b. Aqua privies and septic units 2/ c. Conventional sewerage 3/ d. Waste water 4/

COMMENTS CONCERNING SELECTION OF DISPOSAL TYPE

1/ Space outside house should permit room for a second vault to be built after five years.
Space to be provided needs to allow separation between dwelling units and vault latrines, both to permit servicing and to reduce odor nuisance.

2/ Require space outside shanty. Soil needs to be porous, problems of operation and maintenance likely, more costly than vault units. Require water to function.

3/ Very costly, depends on space in or around shanty; should involve water line to each house.

4/ Limited amounts of waste water can usually be disposed of without need for facilities. Rain water and surface drains commonly used. Depends on topography.

TABLE 2

URBAN - Continued
(Sewage/Excreta Disposal)

TYPE OF AREA	OBJECTIVE OF THE PROJECT	TYPES OF DISPOSAL WHICH CAN BE CONSIDERED
Urban 3. Highly congested slum - Little permanent housing. Shacks usually back-to-back, and side-by-side.	New low cost housing area	a. Sewage system connected to urban system 1/ b. Vault latrines 2/ c. Multiple unit latrines of various types 3/

COMMENTS CONCERNING SELECTION OF DISPOSAL TYPE

1/ Project design will probably provide water to house. If so, economics of combined sewers versus sanitary, and community versus individual sewer systems needs study. Usually private systems unsuited to congested, urban sites.

2/ Spacing around and between houses should be ample.

3/ Units of two or four can be constructed to serve as many families. Preferably conventional sewerage should be used unless economically very much out of line.

TABLE 2

URBAN FRINGE AREAS
(Sewage/Excreta Disposal)

TYPE OF AREA	OBJECTIVE OF THE PROJECT	TYPES OF DISPOSAL WHICH CAN BE CONSIDERED
Urban Fringe Existing low income fringe shanty area with high congestion and few permanent houses.	a. To improve living conditions in the fringe area with a minimum of slum clearance and little new housing.	a. Vault latrines. Single or dual units 1/ b. Soakage pits 2/

COMMENTS CONCERNING SELECTION OF DISPOSAL TYPE

1/ Latrines should be apart from dwellings. Dual units to serve two families can be considered.

2/ Where waste water disposal to roads, paths or open areas creates problems, a soakage pit can be considered for each one or two housing units.

TABLE 2

URBAN FRINGE AREAS - Continued
(Sewage/Excreta Disposal)

TYPE OF AREA	OBJECTIVE OF THE PROJECT	TYPES OF DISPOSAL WHICH CAN BE CONSIDERED
Urban Fringe (continued)	b. To improve living conditions in the fringe area by provision of extra space around houses and with some new open areas to be added.	a. Vault latrines 1/ b. Soakage pits 2/

COMMENTS CONCERNING SELECTION OF DISPOSAL TYPE

1/ Latrines should be apart from dwellings. Dual units to serve two families can be considered.

2/ Where waste water disposal to roads, paths or open areas creates problems, a soakage pit can be considered for each one or two housing units.

TABLE 2

URBAN FRINGE AREAS - Continued
(Sewage/Excreta Disposal)

TYPE OF AREA	OBJECTIVE OF THE PROJECT	TYPES OF DISPOSAL WHICH CAN BE CONSIDERED
Urban Fringe (continued)	c. To develop new living areas by providing water and sanitation infrastructure to new land areas.	Conventional sewage to nearby waste stabilization pond 1/

COMMENTS CONCERNING SELECTION OF DISPOSAL TYPE

1/ Most fringe areas of developing country cities will not have access to urban systems for sewer connection. Decisions on whether to undertake a public system for the project area will have to be taken with full appreciation of the cost which will be high.

TABLE 2

RURAL VILLAGES
(Sewage/Excreta Disposal)

TYPE OF AREA	OBJECTIVE OF THE PROJECT	TYPES OF DISPOSAL WHICH CAN BE CONSIDERED
Rural Village	To improve living conditions by providing certain water and sanitation facilities.	a. Vault latrines 1/ b. Septic tank systems 2/ c. Community sewer system 3/

COMMENTS CONCERNING SELECTION OF DISPOSAL TYPE

1/ Well suited to areas where housing is not congested.

2/ Much more costly than vault latrines, require a porous soil or point of disposal isolated from human contact. Tanks can be designed to serve one or a number of houses.

3/ Combination drain lines and sewers are used in some rural areas. Few villages can afford such systems.

TABLE 2

DISPERSED RURAL HOUSING
(Sewage/Excreta Disposal)

TYPE OF AREA	OBJECTIVE OF THE PROJECT	TYPES OF DISPOSAL WHICH CAN BE CONSIDERED
Dispersed Rural Housing		a. Either vaul latrines or septic tank systems suited to disperse housing application 1/ b. Septic tank systems 2/

COMMENTS CONCERNING SELECTION OF DISPOSAL TYPE

1/ Well suited to areas where housing is not congested.

2/ Much more costly than vault latrines, require a porous soil or point of disposal isolated from human contact. Tanks can be designed to serve one or a number of houses.

SECTION VI

Issues in the Development of Urban, Urban Fringe, Rural Projects Having Water Sanitation Components

All of the technical and administrative options as well as all of the problems and issues which confront projects directed only at water and sanitation are encountered in multi-sectoral and multi-component projects. In addition, a few other problems will likely be added.

In a guideline directed at the latter types of projects, it is desirable to identify as many of these difficulties as possible. A discussion of some of the more important of these together with comments on how these have been dealt with on past projects, is presented in the following paragraphs.

USE OF URBAN WATER AND SEWER FACILITIES

Developers of projects requiring water and sanitation facilities almost always find that the easiest way out of this problem is to connect to the urban systems whenever possible and feasible. The problem most frequently overlooked is that most city water and sewer systems of the developing countries are commonly already overloaded. While connecting pipes to these systems may pose no problems, the ability to serve these pipes does. In such cases, the most advantageous solution is to expand the urban systems, and to then use them to serve the fringe or new housing areas. Urban water supply and sewage, more often than not, are the responsibility of other agencies of government as well as other departments of the external agency concerned with urban development. It may be that other external aid and financing agencies will also be involved. In the long run, attempting to resolve the water/sanitation problems of a particular housing area while ignoring water and sewage capacity problems already facing the city may do more harm than good.

COMMUNITY PARTICIPATION

Communities tend to misunderstand their role in water system development. Many have understood that they were to make initial contributions of money, goods, services, or all three, but have failed to understand that they had a continuing obligation, following project completion, for the payments necessary to cover operation and maintenance costs. Everyone inside and outside of the community should be aware of this problem and be prepared to consider what position the government should be advised to take on such matters. Ideally, the communities, urban fringe settlements and inner city project areas should cover not only an initial contribution but the operation and maintenance costs after completion. If the costs are not going to be covered, the investment will have been largely wasted unless the government by other ways is prepared to cover them. The economic implications to the country's development plans have to be weighed under whatever arrangements are finally decided.

SANITATION POLICIES AND FINANCING ISSUES

Without question the provision of a safe and accessible water supply is of the highest priority as a public health measure. Proper disposal of human body waste, while of less significance, remains important both as a public health measure and as a means of preventing the despoilage of the living environment. As the density of population increases the need for convenient and properly designed facilities also increases both for water and sanitation.

Whether a public sewer system exists or is to be extended to the area, or whether individual, privately-owned facilities are proposed, questions of financial and project policy will arise and have to be answered. For connection to a public sewer, the question is whether the cost of house service pipes and, in some cases, the house plumbing should be included in the project cost. For septic tank systems and vault latrines, the question will likely be whether all, part, or none of the costs should be included in the project. If the answer is that all or part of the costs for service con-

nections, plumbing, septic tank systems, and latrines should be financed as part of a project, the question must then be asked on what policy to follow vis-a-vis cost recovery.

While there are no clear answers to the many questions that can be raised concerning project policy among which are those just noted, it seems logical, in the face of scarce capital in the developing countries, that if improvements are to occur in sanitation facilities, whether public or private, these will have to be financed under the project. Similarly it seems necessary that policies be adopted which encourage the greatest amount of cost recovery from the homeowners affected. It also appears equitable to recover a major part of the cost of septic tank systems such as plumbing and service connections to public sewers, while recovering only the cost of materials from those installing vault latrines. These are issues on which the people affected and those responsible for arranging the finance will have to come together and reach an agreed position.

INSTITUTION BUILDING AND MANPOWER DEVELOPMENT

The trained manpower to insure operation and maintenance of facilities after construction can be best realized within the the framework of the sector agencies responsible for water and sanitation. Provision can be made in urban, urban fringe, and rural projects to strengthen the operation and maintenance functions through support of national training programs now being studied and developed in many water and sanitation agencies of the developing areas.

SECTION VII

The Role of Private Enterprise in the Operation and Maintenance of Water and Sanitation Facilities

Private enterprise has always played a major part in the activities surrounding project preparation and project construction for water and sewer facilities. Engineering firms, and contractors, local and foreign, have designed, provided supplies and equipment, and carried out the civil works required to place facilities into operation. However, it has been common that for smaller communities where hand pump water installations and simple vault latrines could meet the needs, technical inputs for both design and construction have more often than not come from the staff and personnel of governmental agencies. Also, with only a few exceptions, operation and maintenance of public facilities have been performed by staff and employees of the water/sewer sanitation agencies or municipal departments.

Generally, private enterprise is involved only in the supply of spare parts, replacements, and the complex repairs. The exception to such action can be noted in some places where water meters are being repaired under private contract rather than by an in-house meter repair shop; where water and sewer extensions and house service connections are being executed under contract; and where certain complex activities such as leak detection, rate analysis and rate making, and computer services may be undertaken by contract with private companies. In some African countries, entire systems are being operated under a blanket contract.

In the area of operation and maintenance, except for the few exceptions noted above which lightly touch on day-to-day operations, private enterprise has had almost no part.

It has been asked by a few over the years during which the United States has been providing assistance to developing coun-

tries, why aid directed, for example, at water supply and sanitation should result in projects that tend to bypass the private sector. There are a number of sound reasons for this. However, the most important reason is that water and sewage have to function essentially as a monopoly and, therefore, the public utility approach is appropriate. Privately-owned utilities are almost a thing of the past in the United States and operation of systems by private contract in other countries of the world is extremely limited. These facts support the conclusion that ownership of such facilities and responsibility for control will continue to be vested in government agencies either at national, state, or local levels depending on circumstances. This is not to say, however, that a number of the functions now carried by the staff of these agencies should continue to be exercised by them and that there is no room for change.

In the areas of operation and maintenance it has previously been noted that rural water projects are high risk because of early failures due to poor maintenance. More often than not, existing facilities for sewage and excreta disposal are privately owned and privately maintained. While one solution to these difficulties rests with the existence of a strong, well staffed national agency capable of properly operating or controlling all systems, experience indicates that the building of such strong agencies is a long-range, gradual process. Even with soundly conceived programs of institution building, many failures are likely to occur. While every effort needs to be continued toward the strengthening of the water/sanitation agencies at all levels, this should be no deterrent to exploration of other approaches among which the most promising is that of greater involvement by private enterprise.

Many of the functions that can be performed by private contractors in the field of urban fringe and rural water supply include the following:

- Managing the system
- Reading of water meters

- Billing and collecting for water used
- Maintenance of accounts
- Operation and maintenance of treatment plants, pump stations, and control equipment
- Planning and construction of extensions and improvement
- Making new connections
- Finding and repairing of leaks.

For rural water supply, the following functions could be contracted for:

- Operation of pumps, treatment facilities, and storage;
- Maintenance of pumps, treatment facilities, and storage;
- Management of systems of facilities;
- Collection of bills; and
- Planning of extensions and expansions.

For urban sewage the list of functions which might be contracted for are similar to those shown for water. Where sewers are not present, but local government has certain obligations concerning transport of night soil or pumping of septic tanks, private contractors can be considered.

For rural latrines and private sewer systems, aside from a few countries where health department sanitarians give advice on maintenance details, few resources exist for either construction of

new latrines or maintenance of old units. The feasibility of greater private business involvement in these activities appears warranted.

To whatever extent private enterprise is stimulated to play a greater role in the management and operation of water and sewer systems, it should not be forgotten that there will always be a need by the government, at whatever level, to insure that standards are met, service is maintained, and broad supervision exercised in the interest of the public.

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SECTION VIII

Strategies for Project Development and Implementation

This section is concerned with project identification, project development and project implementation and only with those projects of a multi-sectoral nature which have water and/or sanitation components. It will stress that these guidelines are for the purposes of project identification and "early project development" activities. They are not intended to cover in detail the work normally done by a consultant firm which prepares a preliminary engineering and feasibility study. The administrative details which relate to the internal machinery of countries and agencies responsible for the work have been avoided since procedures and policies differ among governments, and over time within agencies. Such details should not seriously affect the action to be taken in developing and completing sound projects.

Primarily we are concerned here with projects for slum upgrading, fringe area housing, settlement improvement, sites and services operations, rural development and rural village improvement. The technologies and methodologies described in previous sections and relevant to this section are the same as would be employed whether water and sanitation facilities were to be provided alone or as a part of a multi-component project. The major differences between the two types of projects is that the water/sanitation facilities for the multi-component project are likely to serve a more limited area or may not be the major element in the project mix.

PROJECT IDENTIFICATION

There are few, if any countries in the world that do not have housing problems, and that do not have areas which are substandard in water and sanitation facilities. There are usually so

many such areas, and the task is so great that the problem is one of deciding where to begin, and what area to establish as priority one.

Every country should have a development blueprint which presents in a broad way the means by which it plans not only to deal with present problems, but also prevents similar ones from occurring in the future. These guidelines are directed only at water and sanitation components of such plans. At first glance, it appears that this ought not be the place to discuss the long range planning of urban growth. However, on the matter of disposal of body and household wastes, there is simply no satisfactory and economically viable solution for urban slums and fringe areas under the congested housing conditions which prevail. Therefore, it becomes evident that the single factor of waste disposal can be critical to the entire national approach. Only advanced planning and the setting aside of areas subdivided in a manner to give a little space around houses, offers any hope for the future in many developing country situations.

PRIORITY OF PROJECT AREAS

A number of countries have attempted to classify villages, regions and areas according to certain economic and social criteria and to establish a list which reflects priorities. Most countries appear to use political factors as the main method of selection. Even systems using formal classification methods commonly encounter political pressures in application of this selection. As a matter of policy for external agencies, it appears that to the maximum extent possible, country selection methods should be accepted. Where these are grossly distorted, efforts should be made to influence selection of other project areas.

Among the technically, socially and economically significant items to be considered in evaluating priorities, the following are among those usually included on the list:

1. Population and location of the area.

2. Nature of the area and principal sources of income of the people.

3. Per capita and family income of the area.

4. Is the area a political entity; i.e., incorporated? With recognized officials? With a boundary? With income?

5. Approximate number of houses.

6. Number of schools, stores, public buildings, house connections, public wells with hand pumps and meters of distribution piping.

7. Water supply - source(s).

8. Source of power.

9. Financial policies on water/sanitation followed in the past.

10. Average distance between houses and water point(s).

11. Quality of water.

12. Dependability.

13. Major problems and needs.

14. Views of community on its needs.

15. Evidence of community interest for a project.

16. Health information from Ministry of Health.

17. Other social/political factors.

18. Technical solutions, time period covered.

19. Rough cost of proposed project and per capita cost of proposed water supply.

20. Capacity to pay by the areas.

21. Importance of community to future development plans of the government.

Similar relevant data to the above will be required for sanitation facilities.

Depending on other elements in the project coverage such as numbers of new sites, new housing units, new schools, new industry, etc., additional data would be needed and other criteria required for determining importance of any area for project selection.

Out of the data and information collected and analyzed, the project area or areas selected as highest priority are decided by the government. These become the areas which will be used for project development. Some areas may be dropped or others added as work proceeds. Some idea of the amount of money likely to be invested by both the government, USAID and others, is required at the outset of preliminary preparation work. Without a "ball park" figure there is no way to know whether one small area is to be selected or several large ones; whether the facilities will be minimal or broad; and whether provision can be made for adding additional land areas, to thin out congested sections, or whether the project must live with most of its existing physical conditions.

Assuming that agreement is finally reached between the government and all parties concerned on the project areas to be studied, and the broad outline of the elements to be covered, actual work on project development can begin.

The final output of project identification work will be a proposal which indicates what needs to be done; how it is to be done; what the study will cost; and how long it will take. This proposal will serve as the basis for decision by government and USAID on whether to proceed with project preparation and what funds are to be provided and by whom.

COST ESTIMATES FOR PRELIMINARY PREPARATION WORK

After a work statement has been prepared, proposals may be sought from competent consulting firms to help in the identification and preliminary project development activities. Arrangements between the government and the external agency will have to be made to select and pay for the firm submitting the most favorable proposal.

PRELIMINARY ENGINEERING AND FEASIBILITY STUDIES

This phase of work is not covered by these guidelines since it is the work normally carried out by contract with consultants (foreign or local) specialized in the field after the preparatory work discussed in the previous paragraphs has been done. It has prepared the groundwork for preparation of a term of references for employment of the consultants. The end result of the consultants' work will be a preliminary engineering and feasibility study which describes a proposed project and presents cost estimates of sufficient accuracy to permit the government and the external financing agency to reach decisions on whether to proceed.

Since this phase of the work comes after that of project identification and early preparation, it is not discussed further in these guidelines.

FINAL DESIGN

It is customary in the case of many water and sanitation projects to complete the preliminary design stage before costing out the facilities and reaching decisions on whether to proceed. The cost of final engineering work under this arrangement is included in the total project cost and provided for in the financing plan. It is likely that on multi-component projects, at least some of the facilities, such as roads and service unit sites, will require final design as part of the project preparation effort in order to permit accurate costing. A decision will therefore be required for each identified project as to whether final design will be required for all elements or only for certain ones.

STAFFING

Water and sanitation components for multi-purpose projects, as well as those for roads, markets, health centers, schools, etc., will normally be covered by specialized professional staff specific to the sector and separate from those responsible for the other components. A team approach will therefore be required with interchange and consultation between all of the sector specialists on a continuing basis. Most developing countries will lack the expertise and experience to permit independent coverage of all aspects of the preliminary project development. Use of local professionals and technicians should be anticipated to cover as much of the project identification work as possible. There will be cases where the water supply portion of the project can be fully assigned to the local engineers. Decisions on the extent of dependence will have to be made when the decision is made to proceed. This will have to be a decision made between government and the external agency concerned. For the implementation of these guidelines, it is proposed that in addition to local staff involvement, external specialists will be needed to allow possible revisions of the draft.

PROJECT CONSTRUCTION

Decisions on whether to package all elements of a project

under one prime contractor or to bid each separately will need to be resolved during the period of preliminary design. This will be done after the preparatory work covered by these guidelines. Nevertheless, even in the very early stages of the project development some thought should be given to this topic. On complex projects which require very close coordination between contractors to prevent claims and counter-claims of obstruction, advantages appear to lie with a prime contract. Costs at the time of bidding may be higher with the prime contract than with individual contracts. Supervision of construction by experienced consultants representing the government and the external agency is required with almost no exceptions.

Local consultants can be used if they have demonstrated competence and experience. Affiliation with a foreign firm sometimes provides the best of both arrangements.

The biggest single cause of project construction delay is the inability of governments to make rapid decisions. This is particularly true in the award of contracts to evaluated low bidders. Few projects start on schedule and fewer projects are being completed on schedule. Any delay increases cost due to inflation. This needs to be recognized in the planning of projects. For multi-sectoral projects of the type envisaged for fringe area communities, considerable attention needs to be given on how best to overcome problems which are likely to be more numerous than normal.

OPERATION AND MAINTENANCE OF WATER SUPPLIES

Of the studies, evaluations and investigations directed at past projects, the most common conclusion appears to be that where poor performance of water supplies has occurred, community participation was inadequate or non-existent. More recent information obtained in part during the course of this study, leads to the opinion that for many rural areas, and likely for many fringe situations, communities tend to deliver on their commitments for provision of labor and materials. On occasion, they have made cash contributions. However, when the construction has been completed and the facilities placed into operation, further

support to cover the costs and to maintain the system has not been forthcoming. This has been particularly so where water was supplied from public standpipes. The reasons probably vary with localities but one explanation is that people believe they have fulfilled their obligation through the labor/materials/money contributions to construction. As a result, the responsibility then falls on central government to operate and maintain the facilities. This belief, appears to be widespread in African countries and probably prevails in others where highly centralized governments exist. With few exceptions these beliefs appear to hold even though there is clear evidence that each community was informed of its continuing obligations.

Failures have occurred in the operation and maintenance of water systems because of the lack of funds to pay the cost of the operator's salary, of energy, of spare parts, and of specialized labor needed to repair the system. One solution has been to provide all of the needed resources from the central organization and its district offices. There are two problems inherent in this solution. The first is that it assumes a well staffed, competent and mobile, central organization that is dependable and responsive to calls for assistance. The second is that the cost of operation and maintenance is usually borne from the central budget with little or no input from the communities. This is one of the prime reasons why progress in supplying more rural people with water is moving ahead so slowly. Not only is a major portion of the capital costs of water systems being financed by central budgets but also most or all of the operation and maintenance expenses. The result is that governments are unable to find funds needed to build new systems at the pace needed and to then finance their operation.

When considering policies to be applied to rural and fringe areas and to slum areas of cities, the issues which most countries need to confront are:

1. Whether and/or how much to charge for water;

2. How to charge;

3. How to collect; and

4. How best to administer, operate and maintain the facilities.

Good organizations with good management and adequate freedom for independent decisions and actions have demonstrated that water supplies can be properly operated and maintained. The question is, what to do when the evidence suggests that after construction, the organization responsible for rural water or fringe area supplies is not likely to have the staff nor the administrative authority needed to insure that the facilities will continually provide the benefits for which they were intended. Three choices are available. Increase staffing proficiency (i.e., recruit, reassign, and train staff), and provide technical assistance for developing good management procedures. [Note: This is time consuming, costly, but probably needed whether either of the other two options are selected.]

A second option for attempting a solution to the operation and maintenance problem is to place much greater emphasis on local control and in the preparation of the community to assume its financial obligations after the facilities are constructed. [Note: This also may be a desirable option along with the first, regardless of what is done concerning the third choice.]

A third option involves the use of private enterprise to take over all or part of the operation and maintenance tasks. This option was discussed in some detail in Chapter VII.

OPERATION AND MAINTENANCE OF SANITATION FACILITIES

Sewage and excreta disposal for rural and most fringe areas will normally be on a house-by-house basis through use of privately-owned and maintained facilities. In the case of urban slums, urban fringe areas or large rural concentrations served by public sewers, operation and maintenance of such systems will encounter

most of the problems and require decisions or policies similiar to those discussed for water supply. Therefore, this dicussion is directed at the operation and maintenance problem surrounding privately-owned facilities whether septic tank and soil absorption type systems or vault/bore hole latrines.

Operation and maintenance of private sewage and excreta disposal facilities are the responsibilities of the owner in almost every country. Local ordinances and public health regulations exist nationally and locally in some countries to insure adequate protection of the public interests. Where trained engineers exist and the statutes are enforced, advice can be given and extended to correct conditions which may adversely affect the public health. Knowledge of how their systems operate and the recognition of the need for periodic cleaning and maintenance of home sewer systems is extremely limited among householders in even the most highly industrialized countries.

The poor and uneducated masses living in urban fringe and rural areas of most developing countries are unlikely to take much initiative, or assume the financial obligations for having latrine vaults cleaned and/or units moved to new vaults. Based on observations in a number of urban areas, it also appears unlikely that even the better educated and financially favored householders will do much to have septic tanks cleaned or systems repaired. When sewage overflows to the surface of the ground the situation is often ignored unless the resulting conditions create a major odor or flooding problems which seriously annoy the occupant.

The foregoing observations present a rather discouraging outlook for good operation and maintenance of private sewage and excreta disposal facilities and raise the question as to what line of approach should be followed with respect to insuring a better experience than has previously been noted? As with water supply, emphasis can be placed on strengthening the national institutions and building the manpower resource. However, in view of the private ownership of most individual latrines and septic systems, the likely outcome of this approach is not very encouraging. The third option proposed for water seems to be

particularly suited to the handling of operation and maintenance of private facilities, that is, the employment of private enterprise for the task. This option was discussed in Chapter VII.

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SUMMARY

This study proposes approaches which can be considered to help improve the quality of life for the poor in developing countries through the transfer and productive use of improved water/sanitation technologies and their associated operating procedures. The conclusions emerged from this study include the following:

- Technology transfer, to be effective, must include technical considerations as only one component of a larger system or package which takes into account the constraints imposed by local cultural practices, beliefs, and administrative requirements. Benefits and goals, must be carefully delineated to prove a rational framework for comparing different technological options. Any investigation of "needs" must consider administrative, managerial, technical and cost requirements.

- Host country objectives will vary. While community participation may not be needed to install water and waste disposal facilities, without the participation of beneficiaries, proper use and proper maintenance are unlikely.

- USAID is in a good position to build on what has already been accomplished in the field of water supply and waste disposal for the urban fringe and rural village areas of developing countries. USAID's unique field presence also places country missions, urban ministries and departments, planning and development agencies in a good position to gain the commitment of host country planners and administrators in the utilization of "appropriate" technologies.

- There is a need to evaluate projects now in process and to profit from past successes and failures.

- The project design phase of new projects must have host country involvement from the very beginning of the planning process, commencing with demonstration projects and activities. Some attempt should be made to disseminate on a broad scale copies of these "Guidelines" in order that USAID mission officers can begin to stimulate projects for low income areas, both urban and rural to more rapidly improve the living conditions and health of the world's poor.

The next actions on project development leading to the financing of construction will commonly require external technical assistance and external financing. It is for governments and for external assistance agencies such as USAID to decide whether the proposed project should take another step toward construction, by financing the preliminary engineering and feasibility studies. Hopefully, the initial information and basic framework derived from the work outlined in this "Guideline" will prove helpful in deciding whether to proceed.

PATENTS, PROPRIETARY PROCESSES AND METHODS SPECIFIC TO WATER SUPPLY, WASTE DISPOSAL AND SANITATION

COMPANION REPORT

The development of this companion report was prepared under a contract provided by the Office of Urban Development, Bureau for Development Support (DS/UD), Agency for International Development (AID), Contract Number AID/DS/OTR-C-0015/ 1979. The research described in this document does not necessarily reflect the opinions of policies of Urban Resources Consultants, Inc.

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December 1979

Abstract

This companion report presents a listing of the primary classes and subclasses of equipment, devices and processes covered by United States and foreign patents and which can be employed in some way in the supply of water and the disposal of waste. The role which patents may play in restraining the transfer of technology to developing countries is examined and the conclusion reached that patents are of almost no importance in preventing countries from gaining access to technologies which they need.

SECTION I

Patents, Proprietary Processes and Methods Specific to Water Supply, Waste Disposal and Sanitation

A few scientists and officials concerned with overcoming problems of the developing countries have expressed the thought that lack of access to certain technologies because of patent restrictions may be a major obstacle needing attention. They have suggested that finding ways to overcome the constraints and to make the technologies readily available might do much to help the countries in resolving a number of problems related to inadequate water supply and poor sanitation.

The conclusion of this report is that no technologies are currently being withheld from any developing country because of restrictions placed as the result of United States patents. It will be pointed out that patent laws do not, and were not intended to operate beyond the limits of the United States.

The discussion which follows is intended to present broadly the coverage, content, and nature of patents and proprietary processes concerned with the water and sanitation sector.

METHODS EMPLOYED FOR THIS STUDY

The United States Patent Office has on file a complete record of all United States Patents, Methods and Processes and an extensive record of foreign patents. These records are maintained under a classification system which attempts to group inventions by functional application. Cross-referencing is widely used. Where both a device and a method may be involved, the patent will show under both classifications.

For purposes of this study the general classification index was scanned and all items extracted which were judged to be of

interest to the water, waste and sanitation fields. The items, their class and subclass, are presented in Annex 1. As a check against omissions which might occur through errors of judgment, classification of equipment items and processes normally used by the water and waste industry for product advertising and promotion were selected from the publication "Water and Sewage Works," and are produced as Annex 2. A comparison of the items occurring in Annexes 1 and 2 shows that each covers essentially the same equipment, processes and devices as the other. It is therefore believed reasonable to conclude that the patent search as conducted has not resulted in major errors of omission. Nevertheless, because of the near impossible task of determining from around five million items which have direct or indirect application to a multifaceted sector as water, waste disposal and sanitation, some disparaties and omissions will no doubt be found.

The decision to retain or reject a subclass, or a particular patent or proprietary process from further consideration was taken by using three assumptions: First, that where non-patented means are now available for carrying out water, waste disposal and sanitation, there is no need to complicate matters by employing a patented device; Second, that for those countries at an early stage of development, there is no need to employ patented processes applied in industrialized countries to meet standards not applicable at this stage to a developing area. (For example, tertiary sewage treatment processes); and Third, that patents directed at labor saving need to be given a second look only if important tasks will be done better and more economically than is possible by the use of workmen normally available in developing areas.

The patent search was initiated by a review of the classification index and all items of interest tabulated along with the appropriate subclasses. The class indexes were then entered and the specific subclasses believed to be of interest were listed. After the subclass listing was completed, a short list was prepared which included only those subclasses left in because they are currently applicable. Many older inventions are covered by patents which have long since expired.

Using the short list of special interest subclasses, a search of individual patents was made and only those found worthy of final listing retained. The "special interest" subclass list is shown as Annex 3.

A separate legal study has been conducted to bring out the aspects of the United States Patent Code which relate to the export of technologies. The results of this study are presented in the section which follows.

IMPACT OF THE PATENT CODE ON EXPORTING UNITED STATES TECHNOLOGY

The patent code which was enacted by Congress in 1925 should have little if any effect on exporting United States technology to other countries. 35 U.S.C. Section 154 sets the term and jurisdiction of products patented in the United States. It states that "every patent shall contain a short title of the invention and a grant to the patentee, his heirs or assigns, for the term of seventeen years, of the right to exclude others from making, using, or selling invention throughout the United States, referring to the specification for the particulars thereof..." And 35 U.S.C. Section 100 defines United States as the United States of America, its territories and possessions.

Moreover, the Supreme Court has cleared up any ambiguity that might have existed concerning the jurisdiction of the patent code, when it stated in Deepsouth Packing Company versus Laitram Corporation, 92 Section Ct. 1700, 406 U.S. 518, 32 L. Ed. 2d 273 that the patent system makes no claim to extraterritorial effect, and patent laws do not and were not intended to operate beyond the limits of the United States.

Since most countries have patent laws of one fashion or another, and there generally is no prohibition against United States inventors securing patent rights in all countries where their inventions might be used, the question of whether the patent laws of the host country would place some restraint on exporting the technology should be considered. If such barriers should exist, they could possibly be circumvented.

The underlying reasons for enacting patent laws are, generally, to grant licensing privileges for making, using, and selling an invention and to prevent others from infringing upon one's own invention or creative design. However, the individual inventor may set a fee so exorbitant for allowing others to use his patent rights, that he remains the sole possessor of this technology at the expense of the underdeveloped country. In that event, it would become more of a political question than a legal one. Patent laws are enacted by political bodies. These same bodies also have powers to amend the laws to ensure that the people of their country are not denied important and necessary technology.

There are other possible ways of getting around the problem. For example, most machines come in multiple parts which may be covered by a combination patent. If the completely assembled machine were exported to another country this would constitute a patent infringement. However, if each individual part were manufactured in the United States and shipped disassembled to the foreign country, this would not constitute a patent infringement. It would then be necessary to set up a plant in the developing country to assemble the machine. Therefore, although the United States patent code would not create a restraint on exporting United States technology to developing countries, the patent laws of the host country might. But these can be overcome, as previously noted.

THE SCOPE AND NATURE OF PATENTS IN THE WATER/SANITATION SECTOR

It will be noted from Annex 1 that methods, processes and equipment and devices which are of direct concern to the water and sanitation fields have been granted patents in great number and that they are listed under many classifications. Every industrialized country has recorded patents for these purposes, many of which go back to the mid-nineteenth century.

In the field of water supply, patents range from processes for manufacturing basic materials such as pipe, metallic alloys, treatment chemicals, and plastics to processes for treatment which

make water safe, or non-corrosive, or soft, or suited for specific uses. For human waste disposal, processes and methods range from simple means of excreta collection and disposal to advance systems providing high degrees of treatment of waste for reuse. In between, are processes and methods involving devices, equipment, tools, supplies and appurtenances that claim to make tasks easier, operations better, solutions cheaper, and designs more effective.

Observations on Patent Content

A conceptual view of the current scope of patents related to water and sanitation systems can be gained through a survey of commonly employed focus areas such as:

- Methods and processes for water supply;
- Methods and processes for sewage collection and disposal; and
- Uses of pipes, pumps, valves, fittings, meters, controls and instrumentation.

Methods and Processes for Water Supply

Wells

While patents exist on the means for drilling, augering and construction of wells and for many items of equipment employed for the purpose, the universal practice of constructing a hole from the surface down to a depth which penetrates the aquifer is as old as civilization. It is not patentable.

Current practices employed for well construction in most developing countries range from simple to sophisticated depending largely, on depth of the well. Simple tools, high labor input, and very limited imported equipment characterize most shallow wells. No patents were identified as of major concern for these operations. Drilled wells of large diameter and considerable depth usually require imported equipment, parts of which are covered by

patents. The number of well drilling machines in most developing countries is so limited that there is seldom economic justification for local fabrication even though no costs are attached to patent rights and even though no obstacles to use of the technologies is assumed.

Water Treatment

There are many patents relating to water treatment processes. Many plants incorporating these patents can be found in developing countries worldwide. The cost of tooling up to produce the equipment or the materials involved is the constraint for increased usage of these processes rather than the patents. Slight modification of patented processes can be observed in many countries where local engineers have taken patented water treatment units and introduced a few changes. Such modifications have permitted cost savings through use of local materials.

For such processes as desalination, softening and demineralization and certain industrial water processes, proprietary considerations will have relevance to situations in developing countries only to the extent that equipment and processes are imported and the costs include payments for patent rights. Limited demand will usually discourage much local fabrication.

Methods and Processes for Sewage Collection and Disposal

The patent review did not identify any major innovations in methods for disposal of human waste. Most of the patents concern devices and designs. Methods which include composting, incineration, collection and hauling, flushing down a pipe, or disposal into a hole or vault, do not lend themselves to patent coverage. Many have been employed since Biblical time. Most developing countries employ one or more modifications of these methods. As will be noted under the discussion on Sanitation Devices, hundreds of patents have been granted on devices and installations for applications but none apply to the basic methods.

Sewage Treatment and Disposal

Many patents exist and many more are being issued in the field of sewage treatment. Many can be said to involve methods. Most are currently concerned with Advanced Waste Treatment and attempt to provide a high degree of treatment in order to permit compliance with standards. A substantial number of patents relate to secondary treatment processes and have the potential for possible application in developing country situations.

Methods and Processes for Uses of Pipes, Pumps, Valves, Fittings, Equipment, and Apparatus

Pipes

A review of the various types of pipes used in water and sanitation installations indicates that the following are the most common: cast iron, ductile iron, steel, asbestos cement (AC), plastics, concrete clay, and coal tar impregnated fiber. Each has been, and many continue to be covered by patents usually applying to the means of fabrication. Numerous patents exist on equipment for lining all types of pipe, some individually, some after laying.

Currently, a majority of developing countries manufacture some kinds of pipe in various sizes. Asbestos cement pipe in diameters to 24" (600mm) and plastic pipe (PVC, PE) to 6" (150mm) are among the more common. Concrete pipe of various types and sizes (unreinforced, reinforced, steel cylinder, and prestressed) and clay pipe up to 24" (600mm) are made in a number of countries depending on demand and on local clays. Steel, cast iron and ductile are currently being made in only a few of the more advanced developing areas although spirally welded steel pipe is being produced from imported sheet in several places. Patent rights to fabricate particular types of pipe are normally part of the transaction which makes the equipment available. Thus plastic pipe extruding equipment as used by many developing country firms is covered by patents. Patent rights cover the equipment and seldom have created, in themselves, any major obstacles for the use of United States patent equipment in the third world countries.

Clay pipe has been produced in many countries for centuries. This is evident in the channels of the Roman viaducts and in the water conveyance systems of many Turkish baths. Where patents may exist, they apply to molds, glazing compounds, and ovens and handling equipment. While quality and quantity aspects may be improved through application of certain patents, nothing stands in the way of countries with the proper clay and fuel for kilns, to produce clay pipe in whatever size proved desirable without concern for outside patent rights.

In many developing countries, large diameter prestressed concrete pipe, both cylinder and non-cylinder, has been manufactured under license or under joint venture arrangements for the past quarter century. Because of the technological problems associated with proper use of equipment and because of the high costs of failure associated with using large diameter pipe, existing practices on providing equipment, patent entitlements, and technical expertise as a package to developing countries have demonstrated an effective means to assure the countries of a workable, economical and sound arrangement.

Pipe Linings

Numerous patents have been granted for equipment designed to line pipes of various types, both at the factory and after laying. Only a few of the many patents appear to have been assigned and found their way into current usage. Nevertheless, a number of different makes are currently in use. Research indicates that pipe lining is a sizable industry. Whether there is a sufficient market in most developing countries to justify the manufacture of equipment after obtaining information on the patent, is another matter. In most instances, this market will be very limited.

Pumps

Next to pipes, pumps are probably the most common item of equipment used on water and sewer systems. Even the simplest of water systems requires a pump, and large systems commonly

require pumps built specifically for the task. Many types of pumps, designs, and patents apply. Basic concepts on the functioning of rotary impellers, turbines, air lifts, centrifugal and reciprocating phenomenon are not patentable. Particular devices and technological means for application of the principles however, have been developed and patented. The search for pump patents of possible interest to developing countries concentrated on smaller units which might have the greatest application on rural systems. Only a few were identified which seem to be worth following up. These concern the hydraulic ram and air lift installations.

Valves and Fittings

Along with pipes and pumps, valves and fittings make up the core of supplies for the water and waste disposal industry. They are included on every system, large and small, in every developing country.

Both valves and fittings, while comparatively simple, are covered by many patents, and although most are not complex, there is considerable precision required in their manufacture. In a number of instances, arrangements have been made to use patented designs and local manufacture of valves. However, a high rate of rejects and costly repairs is not uncommon, which suggests that obtaining access to United States patented technology is the easiest part of the process. Fittings are usually not as complex as valves in their demand for manufacturing precision, but the processes for their production which carry patents will likely encounter some difficulties in the proper application.

Nevertheless, valves and fittings belong to a group where greater emphasis on local fabrication, and proper slection of patented designs may prove justified.

Meters, Controls and Instrumentation

Many patents, both United States and foreign, are held on water flow meters, controls and instrumentation. All are used on larger water systems and certain simple controls and gauges may be involved on small private supplies. Patented types of controls and gauges applicable to small system may be of interest to some countries. Complex instrumentation and controls for large systems may employ advanced electronics and are covered with patents ranging from transistors to the software areas of computerized control. Specialized and very selective use of these complex devices even if justified in certain applications will seldom be in sufficient demand to support the procurement of technologies, and the effort needed to manufacture in the developing countries.

Water meters are another matter. Some can be produced from patents now expired and others may require access to the technology. In view of the continuing controversy on the best type and mechanism to use in water meter design, countries having a sufficient market to justify local production may wish to consider the merits of assembly of imported parts versus complete fabrication. In either case, proven units following old and new designs will help ensure proper decisions to be made.

Summary

From a review of the patent literature, it is apparent that the number of devices, processes, and methods covered by patents in the water supply and sanitation fields is almost overwhelming. The problem is finding a means to quickly dispose of the irrelevant material and to concentrate on the subclasses holding promise. The foregoing brief discussion of the principle elements found on these systems and the probable usefulness of pursuing patents as the avenue of greatest returns, may prove of some help to those who wish to separate some of the wheat from the chaff. Once equipment, designs and processes have been found which appear to hold promise for application in a developing area, information on the technology involved should be reasonably simple to obtain.

SECTION II

The Significance and Feasibility of Making Patented Technologies More Accessible to the Developing Countries

Much has been written about economic development theory and practice. With few exceptions there appears to be reasonable agreement that developing countries should not enter into the manufacture of goods which can more economically be imported, military defense considerations aside. In the field of water supply and sanitation, a wide range of items and goods are required in the construction, operation and maintenance of systems, large and small, public and private. Depending on the country, a number of these items will lend themselves to national production. Of these items, only a few will likely be covered by patents. Few of these will likely be reflected in the patent codes of the developing country under consideration. The issues needing clarification and which are discussed in this section, concern the significance of local patent restrictions to the water/sanitation sector in developing countries today, and the need and feasibility of making certain patented technologies more accessible than is now the case.

The Significance of Patents to the Developing Countries

A review of the elements which enter into the cost of water and sanitation projects would commonly show a breakdown somewhat as shown in Figure 1 for a rural water system in a developing country.

The list of items as shown in Figure 1 is typical of most water projects which use an infiltration system or well water source. If any part of the cost of these items represents royalties on patents, it is next to impossible to determine the amount because initial purchase price usually includes such payments. On most such equipment now purchased, patent rights will have expired and no amount would apply against royalty payments.

FIGURE 1

COST OF A TYPICAL VILLAGE WATER SYSTEM 1/
POPULATION 2500

Preparatory Works	$ 1,682
Intake	292
Pumphouse	1,700
Pumps	5,536
Rising Main	4,950
Storage Tank	2,835
Distribution System	15,930
Hydrants	758
Construction Plant	1,264
Transportation	3,886
	$38,833*

1/ Village Water Supply - World Bank, 1976
Prices adjusted using 10% annual inflation rate.

* In 1979 dollars.

Where certain new innovations such as bearing seals, corrosion resistant metals, and higher efficiency configurations for pump impellers are encountered, the items against which patent claims might be applied will surely be a small part of the total cost of the pump. If the item is imported to a developing country, the purchase price will include some amount for patent use. Patent claims against older pipe types will have long since expired. For pipe such as plastic and the newer reinforced fiberglass products, patents exist which will reflect on the purchase price of the product or the equipment for fabrication. The extent of the total cost likely to be attributed to the patent holders' claims varies between products but will normally be insignificant on water and sanitation items.

On sewer systems and for sanitation projects consisting of home latrines and home sewage disposal systems, most of the same comments which were made concerning patents on the various elements of a water system, equally apply. For home latrines, there is nothing that concerns patent rights. For sewer systems, both private and public, pipe is the major construction material together with some pumps and some fittings. There is no evidence that lack of access to the technologies involved in sewage and sanitation facilities, is a cause of concern in any of the developing countries today. Certainly no problem can be ascribed to restraints caused by patent rights.

Summary

Use of older methods, materials and designs will usually avoid costs built into imported equipment covered by patents, because the patents will have expired. Where new materials and new equipment occur which will involve patents, the price of imported items can be expected to include payments for patent usage. Costs for payment of patent rights will occur for items manufactured within a developing country only if a patent has been granted by the government of that country. In most cases such patents will not have been granted.

It is concluded that there is little basis for concern over the lack of access of technologies suited for use in developing countries. Most methods and means for providing water and sanitation services are not patentable; where patents have been involved most are now outdated but where found of use and still valid, no restraints exist to their use within the country except as the country itself may wish to issue patents covering manufacture in the country.

The remainder of this report is presented in the following annexes:

- Annex 1 - Patent Classification as Related to Water, Waste and Sanitary Devices;
- Annex 2 - Product Directory; and
- Annex 3 - Patents of Particular Interest for Water Supply/Sanitation Applications.

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ANNEX 1

Patent Classification as Related to Water, Waste and Sanitary Devices

Table 1 is an abstract of the Patent Office Classification System which presents only those classes and subclasses pertinent and specific to the water and sanitation field. While there are other classes and subclasses that have a broad relationship to such things as construction materials, devices for surveying; transportation; calculations; surveillance, etc., these have been intentionally omitted because they are not specific to the water and sanitation sectors.

In the Patent Office System, as shown in Table 1, the class carries a number under which all patents are filed. Each class is broken into subclasses. When searching the stacks for patents on water or dry type closets (latrines) for example, most of the information will be found under Class 4, a class which covers Baths, Closets, Sinks and Spittoons. Subclasses will focus on one of these, and for closets, numbers will be assigned for various types and functional attributes. Because of overlaps with features more characteristic of another class, all closets are not classified under Class. For example, in Table 1, it will be noted that "Bowls," "Toilet," "Closure," and "Seat Combined," are shown as Class 4. "Water Closet," "Design," however is shown as D23, subclass 65. It will also be noted under "Closet," "Dry Closet and Furnance Combined," this carries a Class 110 number and a 9 subclass. It is therefore difficult to insure complete coverage of existing patents applicable to any device or process by searching under only one name or class. The problem is that, after a comprehensive search of all classes and subclasses, there is no assurance that something has not been overlooked.

The + sign behind many of the subclass numbers in Table 1, means that other subclasses in the successively numbered sequence will also relate to the subject under search.

TABLE 1

CLASSIFICATION OF PATENTS COVERING WATER AND SANITATION DEVICES AND PROCESSES

	CLASS	SUBCLASS
ACTIVATED SLUDGE		
Collector and remover	210	523+
Gas and liquid contact devices	261	75+
Processes	210	2+
Submerged fluid treating apparatus	210	220+
Surface contact aeration apparatus	210	150+
ACTIVATING CARBON		
AERATION		
Aerator	D23	35
Agitation mixers	259	
Dispensing with gas agitating	222	195
Liquid purification		
Contact surface means	210	150+
Process	210	63
Pumping by aerating liquid column	417	108+
Sewage Processes	210	2+

TABLE 1 - Continued

	CLASS	SUBCLASS
AGITATING		
Agitating Processes	51	313+
AGRICULTURE AND AGRICULTURAL		
Wells	166	
AIR		
Pumps	D23	14+
Design, manually operated	417	118+
ANAEROBIC		
Sewage treatment	210	2+
ANIMAL		
Stop in sewage system	210	131
ANTI LEAK JOINT	105	424

TABLE 1 - Continued

	CLASS	SUBCLASS
BAILER		
Well	166	162+
BALL		
Cocks toilet tank	137	409+
BATHTUB		
Design	D23	55+
Fitting	4	191+
Water cutoff device	4	191+
BOWLS		
Toilet		
Closurer	4	253
Water Closets		
Design	D23	65+
Seat combined	4	234+

TABLE 1 - Continued

	CLASS	SUBCLASS
BOWLS		
Water Closets (continued)		
Tank combined	4	300+
Urinal	4	311+
Valved	4	434+
Wash out	4	420+
CLOCK VALVE	251	298+
CLAMP DESIGN	D8	72
CLEANING		
Well	166	170+
CLOSET		
Sanitary	4	9+
Dry closet and furnace combined	110	9

TABLE 1 - Continued

	CLASS	SUBCLASS
CLOSET (continued)		
Dry type	4	111+
Dry type with dryer or burner	4	131+
Flushing tanks	4	353+
COUPLING		
Rod, Pipe and Shaft		
Pipe type	285	
Valve type	60	530+
COVER		
Seat toilet	4	242+
CULTER		
Pipe and rod	30	92+
Reamers	408	222
Tube culters for well tubing	166	55
Pipe hand tools	30	165+

TABLE 1 - Continued

	CLASS	SUBCLASS
DESALTING SEA WATER		
Distillation	203	10
Fractional crystalization	62	532
Reverse Osmosis	210	23
Direct contact refrigeration	62	533+
Electrolysis		
DRAIN OR DRAINAGE		
Sewerage	210	163+
DRYER AND DRYING		
Garbage and Sewerage furnace	110	15+
DRINKING FOUNTAIN		
Animal Watering Devices	119	72+
Design	D30	13+

TABLE 1 - Continued

	CLASS	SUBCLASS
DRINKING WATER		
Chemical purification	210	198+
Process	210	59+
Filtering	210	340+
Decanting combined	210	294+
EJECTOR		
Jet pump	417	151+
ELECTROMAGNET		
Liquid separation	210	222+
or purification process	210	42+
EXPRESSING		
Die		
Plastic molding (extruding)	425	381.2

TABLE 1 - Continued

	CLASS	SUBCLASS
FAUCETS		
Fixture	D23	23+
Spigot joint means	285	8
FEEDERS		
Dispersing	222	
Automatic weighers	177	116+
Liquid		
Purification, material feed controlled	196	135
Purification, treating material addition	210	199
Self proportioning systems	137	87+
Water purification chemical	210	198+
FILTER		
Liquid		
Design treatment	D23	4
Purification or separation	210	500+

TABLE 1 - Continued

	CLASS	SUBCLASS
FILTERING		
Electrolytic water or sewage treating combined	204	152
Liquid purifying	210	
Mode	333	98
Polarization	333	98
FITTINGS		
Making		
Gas and water	29	157+
Pipe		
Design fluid distribution	D23	1+
FLOCCULATION		
Liquid separation	210	42+
Solid separation	209	5

TABLE 1 - Continued

	CLASS	SUBCLASS
FLOW		
Meters		
Fluid	73	194+
Regulators		
General utility type	138	37+
FLUID		
Treatment		
Ultraviolet	250	432+
FORCE PUMPS	4	255+
FOUNTAIN DRINKING		
Design	D15	118
HOUSE		
Plumbing	4	211+

TABLE 1 - Continued

	CLASS	SUBCLASS
HYDRAULIC		
Pumps	417	226+
Ram		
INTAKE		
Pump rotary center	415	206
Filter for pipe	210	460+
Channel	405	127
INTERMITTENT		
Feed and or discharge		
Disinfecting	21	77
Disperser type	222	
ION EXCHANGE		
Liquid purification	210	24+

TABLE 1 - Continued

	CLASS	SUBCLASS
JET		
Pump	417	151
Pneumatic displacement combined	417	86
JOINTS		
Pipe	285	
LABORATORY APPARATUS	23	259
Laboratory equipment	D24	
LANDFILL	405	129
LASER		
Instruments with	33	Dig. 21
LATRINES	4	116

TABLE 1 - Continued

	CLASS	SUBCLASS
LEAK		
Detectors		
Fluid pressure apparatus	73	40+
Pipe joint	285	13
System in situ	137	455+
Preventers		
Pipe joint	285	171+
LEAKAGE		
Disposal		
Pipe joint	285	13
Electric current testing	324	54
LINE AND LINING		
Earthenware pipe	118	4+
	118	105
	118	125

TABLE 1 - Continued

	CLASS	SUBCLASS
LINE AND LINING (continued)		
Earthenware pipe	118	404
	425	110
	425	262
LIQUID		
Comminuting and solidifying	425	6+
Processes	264	5+
Level control		
Float valves	137	409
Tanks	137	386
Meters	73	194+
Seals		
Pipe joint	285	10
Sewer trap	137	247.11
Water closets	4	300+

TABLE 1 - Continued

	CLASS	SUBCLASS
LIQUID (continued)		
Separation		
Contact	261	2+
Deaerating	55	159
Deaerating processes	55	86+
Liquid meters	73	200
Liquid solid	4	Dig. 19
Treatment		
Electrolyte sewage and water	204	149+
MAGNET AND MAGNETIC		
Separation		
Liquid	210	222
METER AND METERING		
Design	D10	46+
Flow meters	73	194+

TABLE 1 - Continued

	CLASS	SUBCLASS
MIXER		
Fluid or vapor		
Agitating device	259	
Chemical feeders, water purification	210	198+
NOZZLE		
Flow meter		
Pressure differential type	73	211
Weir type	73	216
Flow regulating or modifying	239	533.1
Fluid handling	137	801
Jet pump		
Regulator pump	417	182+
Structure pump	417	151+
ORIFICE IN CONDUCT	138	40+

TABLE 1 - Continued

	CLASS	SUBCLASS
OUTLET		
Water Closet valve		
Syphon	4	368+
Valve	4	378+
OVERFLOW		
Water closet		
Outlet valve	4	390+
Outlet valve float	4	395+
Siphon bowl	4	327+
Water control gate	405	101
PIPE		
Cleaner		
Process	134	22+
Closurers or plugs	138	89+

TABLE 1 - Continued

	CLASS	SUBCLASS
PIPE (continued)		
Connections		
Closet bowls	4	252
Couplers and connectors		
Valved	251	142+
Coupling	285	
Culters for pipe and rods	30	92+
Design	D27	2+
Disinfection of flush	4	225
Fittings	285	120+
Making	29	157
Flexible		
Coupling	285	238+
Valve coupling	251	150
Fluid distribution type	D23	1+
Hydraulic ram	417	226+

TABLE 1 - Continued

	CLASS	SUBCLASS
PIPE (continued)		
Joints	285	
Making	29	428+
Making	29	157
Valved	251	142+
Laying pipe and cable	405	154+
Submarine	405	158+
Making		
Bending	72	367+
Earthenware machine	425	376+
Earthenware mold	249	136+
Fittings	29	157
Flanging	72	317
Foundry mold making	164	176+
Laminated	156	
Metal carting	164	
Apparatus	164	421+
Metal joint mold	249	89

TABLE 1 - Continued

	CLASS	SUBCLASS
PIPE (continued)		
Reamer	408	227+
Repairing	138	99
External	72	126
Patches	90	114+
Riveting	227	52
Strainers	4	Dig. 13
Structure	138	177
End combined	138	109
Swaging	72	399+
Thread protectors	138	96
Threading		
Cutting	408	
Milling	138	
Rolling	138	98
Trimming	408	28+
Waste	4	191+

TABLE 1 - Continued

	CLASS	SUBCLASS
PIPE (continued)		
Well		
Cleaner combined	166	173+
Cutter or perforator	166	55
Destroying	166	315
Expansible	166	207
Joining	166	315
Plural concentric	285	138+
Screen combined	166	227+
Structure	166	242
Weakening	166	55
Wrenches	81	53+
PIPELINE		
Filters	210	435+
Intake	210	460+
PITOT METER	73	212

TABLE 1 - Continued

	CLASS	SUBCLASS
PLASTICS	425	
Coating	106	
PLUG		
Dispensing flow control		
Axial discharge stationary	222	521
Cap carried axial	222	546
Closure	222	563
Rotary	222	334
Rotary screw	222	552
Flow meter with orifice and tapered plug	73	210
Pipe conduit	138	89+
Pipe coupling solid type	285	242
Valve		
Bath or basin outlet type	4	204
Bath float operated	4	205+
Bath with inside operator	4	204+
Combined with strainer	4	287+

TABLE 1 - Continued

	CLASS	SUBCLASS
PLUG		
Valve (continued)		
Head	251	356+
Hydrant type	137	272+
Liquid filter with screen	210	429+
Moveable liquid filter with screened type	210	390
Multiple outlet nozzle rotary	239	392
Nonstop reciprocating	137	528+
Reciprocating	251	318+
Rotary	251	309+
Well		
Cementing or plugging	166	285+
Closing port	166	141
Handling	166	313
Preset	166	114
Preset conduit carried	166	116
With expanding anchor	166	118+

TABLE 1 - Continued

	CLASS	SUBCLASS
PLUG		
Well (continued)		
With outward pressure means	166	101
With pump or plunger	166	106
PLUMBING		
Baths and closets	4	
Design	D23	1+
House fittings	4	Dig. 7
Sewerage	137	356+
Snake	15	104.3
Water flow control	137	
Water pressure regulator	137	505+
PLUNGER		
Pump having	417	437+
Vegetable comminuters having	241	
Water closet having	4	300+

TABLE 1 - Continued

	CLASS	SUBCLASS
PNEUMATIC		
Pump		
Air jet combined	417	86
Jet type pump	417	151+
POINTS AND POINTS		
Well casing	175	19+
PRESS		
Molding		
Metal forging	173	
Plastic block and earthenware	425	381.2
PRESSURE		
Filter	210	348+
With pump	210	416
Fluid pressure regulator	D23	21
Pump	417	279+

TABLE 1 - Continued

	CLASS	SUBCLASS
PROTECTION		
Drill rod (continued)		
Guide or slide for	308	4
Object against corrosion by		
Electrical neutralization	204	147+
Electrical current apparatus	204	196+
Magnetic apparatus	250	529+
Protective coating compositions	252	381+
PUMP		
Bath, closet and sink combined	4	
Bearing lubrication	300	78
Centrifugal	415	120+
Suction	415	
Chain	198	
Fluid pressure dispensing	222	401
by collapsible wall pump	222	209

TABLE 1 - Continued

	CLASS	SUBCLASS
PUMP (continued)		
Fluid transmission combined		
Pressure fluid source and rate	60	325+
Pneumatic	60	329
Jet type	417	157+
Manual	D23	14+
Purification units	210	258
Suction	415	
Well structure combined	81	2
REAMERS		
Earth boring	175	406
Expansible	175	263+
REGULATOR		
Fluid flow meter	73	230

TABLE 1 - Continued

	CLASS	SUBCLASS
REGULATOR (continued)		
Pumps	417	279+
Jet	415	
REPAIRING		
Coating processes	427	140+
Fluid handling systems or devices	137	315+
Liquid purification or separation apparatus	210	232+
Pipe joint	285	15+
Pipe and conduits	138	97
SAMPLER		
Well		
Packer and valve type	166	142+
Processes	166	264

TABLE 1 - Continued

	CLASS	SUBCLASS
SCREEN		
Well screen	166	227
Earth boring means combined	175	314
Making	29	163.5
SCREW		
Pump	415	71+
SEAL AND SEALING		
Bearing		
Ball combined	308	187.1
Liquid		
Sewerage boring	137	247.11+
Valve	137	251+
Valve interface	137	246+

TABLE 1 - Continued

	CLASS	SUBCLASS
SEPARATOR AND SEPARATING		
Liquid		
from solids separators	4	Dig. 19
SETTLING TANKS AND CHAMBERS		
Liquid separation and purification		
Decanter or settler	210	513+
Decanter and filter	210	295+
Liquid suspension type of separation of solids	209	155+
Solid separation combined	209	12+
SEWAGE		
Electrolytic treatment	204	149+
Fertilizer making	23	259.1+
Processes and products	71	12+
Furnaces burning	110	8+
Purification apparatus	210	
Purification processes	210	1+

TABLE 1 - Continued

	CLASS	SUBCLASS
PRESSURE (continued)		
Regulator and control		
Volume or rate of flow meters combined	73	199
Water purification by chemical feeders	73	199
Relieving devices		
Fluid	137	98+
Tanks or chambers	220	3
PROPORTIONAL		
Feeding		
Automatic	431	90
Water purification	210	101
Measuring		
Flow meter	73	202+
PROTECTION		
Drill rod		
Applying well protector to	29	236

TABLE 1 - Continued

	CLASS	SUBCLASS
SEWERAGE	137	
Manholes	52	19+
Pipe cleaners	15	104.3+
Design	D15	47
Sewage purification	210	
Sewer reamer design	D15	47
Sewer ventilation	112	
With cover	52	20
SHEET AND SHEET MATERIAL		
Making		
Plastic sheet shaping	425	
Metal structures and articles	405	276+
Treating		
Coating	118	

TABLE 1 - Continued

	CLASS	SUBCLASS
SLUDGE		
Treatment		
Fat etc. recovery from	260	412.5
Mineral oils	208	13
SNAKES		
Plumber	15	104.3
SOFTENING		
Water	210	
Ion exchange process	210	24+
SOLVENT		
Well		
Cleaning with	166	304
Solid material recovering	299	5

TABLE 1 - Continued

	CLASS	SUBCLASS
SPRINGS		
Valve		
Head	251	356
Parts	251	337
STAND		
Standpipe	137	593
STARTER AND STARTING		
Fluid flow	4	368+
Pump regulator	417	1+
STERILIZING		
Water	210	
STORAGE		
Tank	D23	2

TABLE 1 - Continued

	CLASS	SUBCLASS
STRAINERS		
Sinks	4	190
Sewerage trap	210	435+
STRUCTURED ELEMENTS		
Pipe	138	177
SUPPORT		
Pipe		
Conduit	248	49+
Coupling	285	61+
Joint	285	61+
Valve	251	143+
TANK		
Water wagon	280	5
Depth guages	73	290+

TABLE 1 - Continued

	CLASS	SUBCLASS
TANK (continued)		
Masonry and concrete	52	264
Curved	52	245
Material separating		
Liquid separating	210	
Solids separating	209	
Swimming pool		
Purification water	210	169
Tower	52	40
Underground	405	53+
Volume or rate of flow meter	73	217+
Water closet and urinal flushing	4	353+
Disinfection	4	222
TAPPING		
Drilling	408	
Fluid handling system	137	317+
Mains under pressure	137	317

TALBE 1 - Continued

	CLASS	SUBCLASS
TAR		
Coating or plastic	106	
TELEMETERING	340	177+
THETHERS		
Pipe joint parts	285	119
Tool	279	119
THAWING		
Pipes	138	32+
THREADED DEVICES		
Tapping-making	408	215+
Pipe joint	285	390+
TIME		
Urinal flushing	4	302

TABLE 1 - Continued

	CLASS	SUBCLASS
TIME (continued)		
Valve	137	624.11
Valve with fluid timer	251	48+
Valve with indicator	137	552.7
TOILET		
Anaerobic decomposing	4	Dig. 12
Deformable traps	4	Dig. 12
Disinfection	4	222
Electric flushing	4	Dig. 3
Electrolytic	4	Dig. 17
Heated seats	4	Dig. 6
Oil toilet	4	Dig. 11
Water additive or substitute	4	Dig. 1
TOOLS		
Earthworking		
Boring or drilling	175	

TABLE 1 - Continued

	CLASS	SUBCLASS
TOWER		
Wheeled water	169	25
TRASH		
Burners - Furnace structure for garbage and sewage	110	7+
TRICKLING FILTER		
Liquid purification	210	15+
Processes	210	15+
TUBE		
Making		
Plastic molding	425	72+
Rolling apparatus	72	95+
Welding process	228	101+

TABLE 1 - Continued

	CLASS	SUBCLASS
TURBINE		
Hydraulic	60	330+
Pump device	417	405+
Fluid supply	60	643+
UNDERGROUND		
Water locator	181	
URINALS		
Design	D28	68
Dry closet	4	119+
Water closet	4	301+
UTILITY		
Meter	D10	99+

TABLE 1 - Continued

	CLASS	SUBCLASS
VACUUM		
Pumps	417	
Design	D15	7+
VALVE		
Pneumatic displacement pumps	417	118+
Pump controlled	417	510+
Automatic		
Sewerage catch basin	210	109+
Sewerage trap	137	247.15+
Butterfly	251	305+
Check		
Flow meter	73	276
Pivoted	137	527+
Pump	417	559+
in wells	166	325+
Design	D23	19+
Diagram	350	266+

TABLE 1 - Continued

	CLASS	SUBCLASS
VALVE (continued)		
Dispensing	222	344+
Pressure operated	222	491+
Resilient type	222	490
Electrically activated	251	129+
Liquid pump	417	505
Fluid pressure regulating	137	505+
Fluid pressure relief	137	455+
Float	137	409+
Automatic dispenser	222	67+
Water closet	4	395+
Water purifier	210	97+
Flush		
Actuation	251	15+
Actuation closet combined	4	249+
Syphon bowl	4	422+
Water closet bowl	4	435+

TABLE 1 - Continued

	CLASS	SUBCLASS
VALVE (continued)		
Gate		
Pivoted	251	298+
Pivoted check	137	527
Reciprocating	251	326+
Learner Johnson type hydraulic/internal	137	219+
Pipe	251	
System	137	
Pressure reducing and regulating	137	505+
Pressure relief	137	455+
Rotary or Oscillating		
Disk	251	304+
Fluid flow meter	73	265+
Plug	251	309+
Well closures	166	316+

TABLE 1 - Continued

	CLASS	SUBCLASS
VALVED DEVICES		
Fluid flow meter		
Diaphragm	73	265
Piston	73	248
Proportional	73	203
Piston		
Flow meter	73	248
Pump	417	545+
Pump	417	559
Diaphragm	417	480
Regulator	417	279+
Traps		
Sewerage	137	247.13+
VENTURI		
Flow meters	73	213
Restrictor type	138	44
Variable venturi	261	Dig. 56

TABLE 1 - Continued

	CLASS	SUBCLASS
VOLUME METERS		
Fluid	73	194+
Liquid level	73	290+
Volumetric control measuring	73	149
WASHING DEVICES		
Implement with water supply	401	
Well screen with washing joint or shoe	166	157+
WASTE		
Disposal in soil	405	128+
Electrolytic treatment	204	149+
Fertilizer from	71	25+
WATER		
Aeration	261	
Flotation processes	210	44

TABLE 1 - Continued

	CLASS	SUBCLASS
WATER		
Aeration (continued)		
Processes	210	63
Separation apparatus	210	198+
Waste water processes	210	34+
Closets		
Closet design	D23	65+
Pipe joint	285	56
Conditioner or softener	D23	3+
Control hydraulic engineering	405	52+
By valve in closet conduit	137	219+
Distribution		
Design	D23	1+
Systems	137	561+
Electrolytic production	204	101
Faucet attachment	239	428.5
Filter	D23	4
Meter	73	194+

TABLE 1 - Continued

	CLASS	SUBCLASS
WATER (continued)		
Pipe		
Carrying RF telephone signal	179	15.55
Purification	210	
Softeners	252	175+
Towers	169	25
Underground detectors		
Acoustic type	181	
Borehole and drilling study	73	151+
Electric	324	1+
Water culture	47	59+
Wheels		
Current operated	416	
WEIR		
Chemical feeder control	137	101.27
Flow meter	73	215+
Overflow discharge	239	193+

TABLE 1 - Continued

	CLASS	SUBCLASS
WELLS	166	
Cleaning	166	170+
Borehole study	73	151+
Coupling valve	137	515+
Pumps		
Aerated column	417	108+
Reciprocating piston	417	437+
Reciprocating valved piston	417	545+
Rotary centrifugal	415	206
Rotary screen	415	71+
Well structure combined	166	165+
Screen making	29	163.5
Tubing culter	166	55
Valves and closures	166	316+
Wiper	15	210

TABLE 1 - Continued

	CLASS	SUBCLASS
X RAY		
Tube systems	250	202+
Tubes	313	55+
Manufacture	29	25.1
Repair	316	

ANNEX 2

Product Directory

As a check against the Patent Office Classification, a comprehensive directory of water and waste equipment, processes, and devices has been taken from a prominent publication which carries advertising for the water and waste equipment dealers of the United States. The broad headings carried in that product list are shown below as Table 2. They can be compared with the classification and subheadings used by the Patent Office in Table 1. It is concluded that the items selected for particular scrutiny in the Patent Office list reasonably represent the items in the Product Directory which are of significance to the water and sanitation sectors and as applied to developing country needs.

TABLE 2

PRODUCT DIRECTORY*

- Activated Carbon
- Activated Carbon Equipment
- Activated Carbon Regeneration
- Aeration, Chemical
- Aeration Equipment and Systems
- Aeration, Mechanical
- Aftercoolers Compressed Air
- Agitators
- Alarms
- Algaecides
- Alternators Electric
- Ammonia, Anhydrous
- Arrestors, Slude
- Asphalt Liners
- Backflow Preventers
- Bacterial Culture for Waste Disposal
- Bentonite
- Block, Concrete, Glaze, Building Construction
- Blowers, Air
- Bod, Bottles
- Boiler Feedwater Equipment
- Boiler Tube Cleaner
- Bombs, Smoke
- Brass, Goods, Fittings, etc.
- Briquetters
- Bromine Generators
- Cable, Cable Fittings
- Catch Basic Cleaners
- Cathodic Protection Equipment
- Cements, Acid and Alkali Proof
- Centrifuges
- Chains, conveying, etc.
- Chemical Processing Systems and Equipment
- Chemicals, Aluminum Sulfate
- Chemical Feeders
- Chemical Flocculants
- Chemical, Coagulant Aids
- Chemical, Copper Sulfate
- Chemicals, Hydrogen Peroxide
- Chemicals, Iron Removal

*Scranton Gillette Communications Inc.

TABLE 2 - Continued

- Chemicals, Manganese Removal
- Chemicals, Potassium Permanganate
- Chemicals, Soda Ash
- Chemicals, Root Killers
- Chemicals, Rust Removal
- Chemicals, Tablet Copper Sulfate Root Killer
- Chemicals, Water Treatment, Other
- Chlorinators
- Chlorine Dioxide Generators
- Chlorine and Compounds
- Chlorine Handling Equipment
- Chlorine Leaks Detectors
- Chlorine Transportation
- Clarifier Equipment
- Cleaning Equipment, Treatment Plants
- Cleaning Services, Treatment Plants
- Coatings, Corrosion Resistant
- Coatings and Linings
- Cocks, Curb, Meter Corporation, etc.
- Colorimeters

- Comminuting Equipment
- Compressors, Air
- Condensers, Steam
- Construction Equipment and Supplies
- Control Equipment, Automatic
- Control Panels
- Controllers, Flow
- Controllers, Level
- Controllers, PH
- Controllers, Pressure
- Controllers, Pump
- Controllers, Temperature
- Converters, Phase
- Conveyors
- Cooling Towers
- Corrosion Control
- Corrosion Control Chemicals
- Covers, Vault
- Crushers, Bottle, Tube
- Curb Boxes
- Data Transmission Systems

TABLE 2 - Continued

- Deaerators
- Dechlorinating Equipment
- Defoamers
- Degasifiers
- Degreasers
- Degritters
- Demineralization Equipment Water
- Denitrification Equipment
- Desalting Equipment
- Diffusers
- Distillation Units
- Distributors, Sewage Filter
- Dome Covers
- Doors, Pit, Sidewalk, Floor
- Drafting Machines, Portable
- Drains, Gutters, Floor
- Dredging Equipment
- Dredging Services
- Drive Couplings
- Drives, Right Angle
- Drives, Variable Speed

- Dryers
- Dust Removers
- Ejectors Sewage
- Electrodes, PH Analyzers
- Elevated Tank Pump Controls
- Emission Control Equipment
- Enclosures
- Engine Controls, Automatic
- Engines
- Engineering, Drafting and Design Equipment
- Environmental Control Systems
- Enzyme Mixtures
- Erosion Control
- Evaporation Control
- Evaporators
- Extraction Columns
- Feedwater Treatment Equipment
- Fiberglass Structures
- Filter Bottoms
- Filter Media

TABLE 2 - Continued

- Filter Plates and Tubes
- Filter Underdrains
- Filters, Air
- Filters, Diatomite
- Filters, Gravity
- Filters, Membrane
- Filters, Pressure
- Filters, Rotary Biological
- Filters, Sand, Gravel
- Filters, Trickling
- Filters, Trickling Media
- Filters, Vacuum
- Flash Mixers
- Flexible Hose, Metal and Rubbber
- Flocculating Equipment
- Floor Patching
- Floation Equipment
- Flow Measuring Equipment
- Flumes
- Fluoridation Equipment
- Fly-ash Recovery Systems

- Gantries, Portable
- Gas Indicators and Detectors
- Gaskets
- Gates
- Gauges
- Generators, Electric
- Generators, Emergency
- Generators, Rotary Phase
- Grating
- Gratings, Aluminum
- Gratings, Steel
- Grease Control Equipment
- Grease Incinerators
- Grease Removal Equipment
- Grit Removal Equipment
- Grouting Services
- Heat Exchangers
- Heating Devices, Pipe and Vessel
- Humidity Control, Humidifiers
- Hoses, Electrically Heated
- Hydrants

TABLE 2 - Continued

- Hydraulic Tools
- Imhoff Tanks, Cleaners
- Incubators
- Indicators
- Infiltration Control
- Institutional Advertisement
- Instrumentation, Automatic Quality Control Analyzer
- Instrumentation Automation and Supervisory Control Equipment
- Instrumentation BOD Analyzers
- Instrumentation, Chlorine Residual Analyzers
- Instrumentation, Chlorine Test Equipment
- Instrumentation, COD Analyzers
- Instrumentation, Conductivity Analysis
- Instrumentation Dissolved Oxygen Analyzers
- Instrumentation, Hydrogen Sulfide Analyzers
- Instrumentation, TOC Analyzers
- Instruments
- Ion Exchange, Continuous
- Ion Exchange Resins
- Iron Removal Equipment
- Laboratory and Testing Chemicals
- Laboratory Equipment
- Laboratory Equipment, Chromatography
- Laboratory Services
- Ladder Safety Devices
- Leak Detectors
- Leak Sealing, Sewers
- Leak Tracing Dye
- Lift Stations
- Lime and Limestone
- Lime Slakers
- Lime Stopping Equipment
- Lining, Reservoir and Holding Pond
- Lubricants
- Manhole Assemblies
- Manometers

TABLE 2 - Continued

- Meteorological Instruments
- Meter, Automatic Reading, Billing System
- Meter Couplings, Yokes
- Meter Repair Parts
- Meter Testing Equipment
- Meters, Compound
- Meters, Direct Reading Remote Registration
- Meters, PH
- Meters, Venturi
- Meters, Water
- Meters, Water Current
- Microstrainers
- Mixers and Mixing Equipment
- Motor Speed Control
- Motor, Electric
- Motors Phase Controllers
- Nephelometer
- Nozzels, Flow, Mixing Spary
- Odor Control

- Oil Spill Control Equipment
- Ozonators
- Packing Pumps and Valves
- Pelletizers
- Pipe, Asbestos
- Pipe, Bituminous
- Pipe, Cast Iron
- Pipe, Clay
- Pipe Cleaning Equipment
- Pipe Cleaning Services
- Pipe, Concrete
- Pipe Cutters
- Pipe, Ductile Iron
- Pipe, Fiberglass
- Pipe Fittings Main
- Pipe Fittings Service
- Pipe, Flanged Coupling Adapters
- Pipe Handling Grabs
- Pipe Inspection Equipment & Services
- Pipe Joint Restraint
- Pipe Joints

TABLE 2 - Continued

• Pipe Linings, Inserted	• Pulverizers
• Pipe Locators	• Pumping Systems, Standby
• Pipe, Plastic Lined	• Pump Stations, Factory Built
• Pipe, Plastic	• Pumps, Acid Handling
• Pipe Polybuthylene	• Pumps, Air Lift
• Pipe, Polyethylene	• Pumps, Boiler Feed
• Pipe, Plastic Coated Steel	• Pumps, Centrifugal
• Pipe, Pushers and Pullers	• Pumps, Chemical Feed
• Pipe, Restrainers	• Pumps, Diaphragm
• Pipe, Rubber	• Pumps, Grinder
• Pipe, Sleeves and Repair Clamps	• Pumps, Drum
• Pipe, Tapping Machines	• Pumps, Plunger
• Pipe, Steel	• Pumps Peristaltic
• Pipe Tools	• Pumps, Portable
• Pipe Vises	• Pumps, Rotary
• Plastic Curb Boxes	• Pumps, Screw Lift
• Plastic Meter Boxes Pits	• Pumps, Scum
• Plastic Valve Boxes	• Pumps, Self-Priming
• Pollution Abstracts Literature	• Pumps, Progressive Cavity
• Power Drives	• Pumps, Submersible
• Precipitators, Dust	• Pumps, Sump

TABLE 2 - Continued

- Pumps, Test
- Pumps, Turbine
- Pumps, Vacuum
- Rain Gauges
- Railings
- Recarbonation
- Reactors
- Recorders, General
- Recorders, Flow, Solids
- Level Recorder/Indicator
- Recorders, PH
- Recorders, Temperature
- Reverse Osmosis Equipment
- Safety Equipment
- Samplers
- Scales
- Screens, Sewage
- Screens, Water Well
- Scum Removers
- Separators
- Separators, Oil Removers
- Separators, Sand
- Septic Tank, Fiberglass
- Sewage Systems Pneumatic
- Sewage Systems, Vacuum
- Sewer Flushers
- Sewer Stoppers
- Sewer Testing Equipment
- Shoring Trench
- Shutoff Tools for Plastic and Copper Pipe
- Sludge Collectors
- Sludge Conditioning
- Sludge Dewatering Equipment
- Sludge Digester Floating Covers
- Sludge Digester Cleaning Services
- Sludge Digestion
- Sludge Flowmeters
- Sludge Incinerators
- Sludge Oxidation Units
- Sludge Removal Equipment and Services
- Sodium Hypochlorite Generators

TABLE 2 - Continued

- Solvent Recovey Systems
- Spraying Equipment
- Sterilizers, Liquid Ultraviolet
- Strainers
- Surge Controls
- Swimming Pool Chemicals
- Tank Covers Floating
- Tank Linings
- Tank Painting and Repair
- Tanks, Chemical Storage
- Tanks, Pressure
- Tanks, Septic
- Tanks, Water Storage
- Taste and Odor Removal
- Television Inspection
- Thermometers, Thermocouples, and Temperature Sensing
- Tile, Building, Quarry, Ceramic, Glazed and Unglazed
- Toilets
- Toilets, Low Flush
- Toilets, Electric Incinerating
- Transmitters Pneumatic Electric
- Trenches Precast concrete
- Spreading Land Application
- Turbidimeters
- Turbines
- Ultrafiltration
- Valve Actuators
- Valve Box Locators
- Valve Boxes
- Valve Operators
- Valve Operators Portable
- Valve, Air Relief
- Valves Altitude
- Valves Automatic
- Valves, Ball
- Valves, Butterfly
- Valves Check
- Valves, Cone
- Valves, Diaphragm
- Valves, Float

TABLE 2 - Continued

• Valves, Foot • Valves, Gate • Valves, Globe • Valves, Hydrant • Valves, Inserting • Valves, Needle • Valves, Pinch • Valves, Plug • Valves Pressure Regulating • Valves, Pump Control • Valves, Rubber Lined • Valves, Sludge Draw-Off • Valves Solenoid • Valves, Tapping	• Washing Troughs • Waste Disposal Sprinkler Irrigation • Waste Treatment Equip, Packaged • Waste water reuse • Waste water Treatment Systems • Water Analyzing Equipment • Water Conditioning Equipment • Water Softeners • Water Treatment Systems • Weed Killing Chemicals • Weir Plates • Well Casing • Well System • Wrenches, Hand Tools, Hardware

ANNEX 3

Patents of Particular Interest for Water Supply/Sanitation

During the course of searching the patent lists for items of interest in the fields of water supply, human waste disposal, and general sanitation, certain subclasses and a few specific patents were encountered which could be of possible interest for developing country application. The items shown in this annex represent a few such subclasses and patents. It would appear that further examination of these and other items might be warranted.

ANNEX 3

PATENTS OF PARTICULAR INTEREST
FOR WATER SUPPLY/SANITATION APPLICATIONS

	CLASS	SUBCLASS	REMARKS
CLOSETS, LATRINES, TOILETS	4	135	1-1500 - These data date back to 1860 and include foreign and U.S. patents. All of receptacle type.
Receptacle types	4	135	
South Africa; French and foreign latrines	4	116	
Incinerator	4	Dig 9	
Oil or fluid recirculated	4	Dig 9	
Oil incinerator	4	Dig 11	
Water closet having plunger	4	300+	
Chemical	4		
Recirculation	4		
Portable	4		
Anaerobic decomposing toilet	4	Dig 12	Some possible applications for specialized situations.
Water addition or substitute	4	Dig 1	
Fluid fuel burner	4	111.4	
Electrolytic toilets	4	Dig 17	
Flushing tanks	4	353+	

	CLASS	SUBCLASS	REMARKS
FLUID FLOW METERS			
Diaphragm	73	265	
Piston	73	248	
Pressure differential type	73	211, 210	
Flow meter with orifice	73	210, 211 202, 199	
Orifice in conduit	138	40	
Fluid flow meter	73	230	
Volume meters	73	149	
Public utility meter	D10	99+	
Water meter	73	194+	
Pipe carrying F. F. telephone signal	179	15.55	
PIPES			
Design	D27	2+	
Pipe laying, submarine	405	158+	

	CLASS	SUBCLASS	REMARKS
PIPES (continued)			
Pipeline intake	210	460+	
Plastic	425		
Earthenware	118	+4, 105 125, 404	
Seamless AC	118	110	
System for laying	4	121	
Pipe making	425	376	
Standpipes	137	593	These should be studied in detail.
Plastic tube making	425	72	
Anti leak pipe joints	105	424	
PIPE LINING	118	105+	
Plastic coating	106		
Lining	425	262	

	CLASS	SUBCLASS	REMARKS
PUMPS			
Pumps	417	152, 182 226	
Bearing lubrication	308	78	
Centrifugal (suction)	415		
Chain	198		
Design	D15	7+	
Drinking fountain combined	239	24	
Ozonize combined	250	538	
Purification units	210	258	
Rotary kinetic fluid	415		
Well structure, combined	166	105 also 81 2	
Aerated column	417	108+	
1. Airlift pump with valving baffler			All airlift pumps and rams need detailed review for developing country usage.
2. Pumping by aerated column			
3. Adjustable airlift pump			
4. Continuous hydraulic ram			
5. Air injection pump			

	CLASS	SUBCLASS	REMARKS
PUMPS (continued)			
Pneumatic displacement	417	118+	
Screen making	29	163.5	
Valves and closures	166	316+	
Screen pump	415	71	
Hydraulic ram	417	226	All airlift pumps and rams need detailed review for developing country usage.
Manual fluid pump	D23	14	
SEWAGE AND PLUMBING	137	356	
Systems for laying pipe	210	2	
	110	9	
Waste disposal in soil	405	128+	
Sewage and drainage	210	163+	

	CLASS	SUBCLASS	REMARKS
SEWAGE AND PLUMBING (continued)			
Anaerobic sewage treatment	210	2+	
Sewer traps	110	15	
Plumbing traps	210	59	
Plumbing	4	301, 211	
Settling tank	210	295	
Solid separate	209	12+	
Sewage purification apparatus	210		
Sewage purification processes	210	1+	
Trickling filter processes	210	15+	
Water flow control plumbing	137		
Vacuum method of sewage Collection - Swedish			#3686693
Bathroom fixtures	4	Dig.	
VALVES			
Hydrant type valve	137	272	

	CLASS	SUBCLASS	REMARKS
VALVES (continued)			
Basin outlet valve	4	204	
Valves and water storage	137	593	
Flush valves	4	Dig. 3	
Water flow control	137		
Valves	251	304	
Butterfly valve	251	305	
Valves	73	309	
Fluid flow meter valves	73	203	
		248	
		265	
Faucet	D23	234	
WATER			
Electrolytic water treatment combined	204	149, 152	
Pressure filter	210	349	
Pressure filter with pump	210	416	

	CLASS	SUBCLASS	REMARKS
WATER (continued)			
Underground water locater	181		
Water distribution design	D23	1+	
Water filter	D23	4	
Water purification	210		
Drinking water process	210	59+	
Drinking water chemical purification	210	198+	
Drinking water filtering	210	348+	
Drinking water filtering and decanting combined	210	294+	
WELLS, WELL SCREENS, WELL POINTS			
Well casing	175	19+	
Well screen	166	105, 227	
Well structure	166	242	
Well weakening	166	55	
Well screen making	29	163.5	

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