POTABLE WATER SUPPLIES IN COSTA RICA

REPORT ON

A SOCIOECONOMIC PILOT STUDY

MADE UNDER THE AUSPICES OF THE OFFICE OF PUBLIC HEALTH

INTERNATIONAL COOPERATION ADMINISTRATION

WASHINGTON, D. C.

By

Alfred H. Wieters
Darwin C. Zobel
John M. Henderson, Chief of Survey Team

July 1959

TABLE OF CONTENTS

Page No.

Page No.

SUMMARY*

I. Introduction

This report covers a nationwide reconnaissance survey and appraisal of potable water supply development in Costa Rica. The appraisal includes physical, technical, administrative and financial aspects of the water supplies within the framework of the entire socio-economic environment of the country.

Many field visits were made and many conferences were held with Costa Rican officials, as well as with American technicians with USOM / Costa Rica, under whose auspices the survey was made.

The objective was to determine insofar as possible the present situation, present and future needs, health and economic benefits which have accrued from past development, and which might result from future activities; the costs; and to suggest criteria which might be useful in determining the best administrative and fiscal machinery to meet present and future needs.

II. Conclusions and General Appraisal

A. Ninety-five per cent of the "urban" population and an estimated 50% of the "rural" population in Costa Rica have piped water into dwellings. However, service has been deteriorating, at least in the past several years.

This deterioration is evidenced by (a) widespread and increasing intermittent service, (b) indications of increasing contamination and decreasing availability, (c) physical deterioration of systems and (d) lack of capital replacements and extensions necessary for a rapidly expanding population.

B. Traditionally, the national government has constructed nearly all potable water supplies, and as a result, the people have no concept of water supply as a utility rather than a governmental function. Extremely low flat rates for maintenance and operation and lax collection of bills has resulted in such serious wastage of water that many systems which are grossly inadequate under present demand conditions would be serviceable under reasonable demand. Water supplies are in sharp competition with other public works financed by the national government. The municipalities are also faced with limited means of raising funds. San José faces a third complication--rapidly increasing population and no cheap additional sources of supply available.

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* Paragraph numeral and letter designations and Section Headings correspond to those used in main body of report.

C. In the long range, water supplies should be administered like other utilities--that is, all costs should be borne by the users.

In Costa Rica this appears feasible since; (a) water is cheap, (b) competition for funds precludes adequate financing from the national treasury, and (c) financing by loans must have a sound financial base. Full payment by users for construction, operation, and maintenance would reduce waste and high demands, and thus reduce costs.

Four organizational plans are under consideration--three involving establishment of some kind of authority and the fourth strengthening the present agencies.

The pros and cons of the various plans are presented and a fifth plan (modified Mexico Plan) is described. The conclusion drawn was that a responsible water authority, metropolitan or national, be established which would place local water supplies on a sound operational, physical, and financial footing with the view of returning the systems to the municipalities as rapidly as they are in position to take over full responsibility. Complete liquidation may require 50 years.

The need for strengthening the Department of Sanitary Engineering of the Ministry of Health is emphasized, to enable it to adequately fulfill those functions essential to control of public water supply quality.

IV. Basic Background Information

A. 1. Costa Rica, area 20,000 square miles, is traversed by two mountain ranges between which lie plateaus and elevated valleys where up to 70% of the population of the country reside, although the area is 10 to 15% of that of the whole country. They also are the most agriculturally productive and contain most of the industry.

2. The climate is temperate in the uplands and tropical in the coastal areas without great seasonal fluctuation. Rainfall is abundant ranging from 70 to 185" annually in various parts of the country.

B. Costa Rica is a republic with an elected president, an appointed cabinet and an elected unicameral legislature. It has seven provinces each with an appointed governor. The principal functions of the provincial governors are responsibility for police and judicial administration throughout the province and as "jefe politicos" of the provincial capitals. Each province is divided into cantóns, which in turn are divided into districts. The cantón government consists of an elected council, and except for the provincial capitals, a "jefe politico" designated by the provincial and national government. The cantón council is responsible for all local affairs. The district

is unimportant as a political subdivision. There are 65 cantóns and 326 districts, the former with populations varying from 3675 to 138,000 and the latter from 21 to 40,000.

The cabinet is composed of two vice-presidents and eight ministries including Economy and Finance, Public Works and Public Health, which have important functions regarding water supplies. There are also nine autonomous authorities with a variety of powers and duties which function outside the ministries.

C. Population censuses have been taken at irregular--but long intervals--the last being in 1950. Subsequent censuses are scheduled for 1960 and every 10 years thereafter. Annual estimates also are made by provinces, cantons and districts. The population in 1958 was estimated at 1.1 million, an increase from 0.8 million in 1950. Two-thirds of the population is rural.

Births and deaths are reported directly to the Census Department. These are included in an annual report which also contains social statistics. An urban dwelling census was taken in 1949, which included among other things, the number of dwellings in each urban cantón with water and sewerage and electric services. This census is to be repeated in 1959.

The decennial census subdivides all population into urban and rural components. Neither is well defined, which resulted in some difficulty in this study.

Since 1864, the population of the four predominantly highland provinces has declined from 87% to 73% of the national population, mainly since 1892, although that of San José Province increased from 31% to 35%. The national population increased nearly sevenfold. The greatest percentage increase was in coastal Puntarenas Province, mainly since 1927.

D. Electricity is widely used in Costa Rica. In 1949, 82% of the urban dwellings were served and this has substantially increased. All but three cantóns had electric service in 1949. The National Power and Light Company reported an average monthly bill of about 30 colones for 42,000 residences served. Analyses of the flat rate for lighting would indicate 4.5 to 5 colones per month to be the absolute minimum. In addition, some people pay for street lighting.

E. 1. The average birth rate (53-57) was 53.1 per thousand population, one of the world's highest and more than twice that of the United States of America.

2. In 1956, the last year for which figures were available, the typhoid death rate was about 1.5 and paratyphoid about 0.5 per 100,000 population. The crude death rate has decreased from 22.3 per thousand in 1921-24 to 10.1 in 1957 (U.S. 9.3 in 1955).

F. The basic nucleus of trained sanitary and civil engineers which would be needed in an expanded water supply program now exists in Costa Rica. The University is graduating 15 to 20 civil engineers annually-- all with training in water supply design and practice.

V. Public Agencies Directly Involved in Public Water Supply

A. Public agencies directly involved in community water supplies are:

1. Ministry of Public Health
2. Ministry of Public Works
3. Inter-American Cooperative Public Health Service (SCISP)
4. Cantón governments
5. Ministry of Economics and Finance
6. Electric Railroad to the Pacific

B. The Ministry of Health is primarily responsible for the design of treatment plants and sanitary aspects of storage and distribution systems.

C. The Ministry of Public Works is primarily concerned with construction, although it also does most of the design.

D. The SCISP has in the past participated in the design and construction of 14 water supply projects. Currently, it is conducting a pitometer survey in a number of communities and also a demonstration well-drilling program.

E. The Cantón governments are responsible for the operation and maintenance of the systems.

F. The Ministry of Economics and Finance is responsible for approval of loans, water and tax rates.

G. The Electric Railway to the Pacific operates the water supply for the port terminus Puntarenas.

VI. Water Resources

Costa Rica has a high average annual rainfall ranging from 64" at Santa Ana in the central plateau to 184" at Golfito on the southern Pacific coast. In the central valley and in the northern Pacific coastal area, there is a pronounced dry season, December through April, with the driest month, February, having less than an inch of rainfall. There is no well-defined dry season on the Atlantic slope, and in the remainder of the country it is less pronounced than for the central plateau.

Population, industry, and agriculture are concentrated in the central plateau relatively near the headwaters of streams. Thus, with small drainage areas upstream and the farily complete utilization of springs, availability of developable water supplies may become a limiting factor to the future development of this area in spite of the abundant rainfall.

In Guanacaste Province, with great seasonal fluctuations in stream flow, future competition for water for various uses may require costly storage and transmission of water from the mountains or development of ground water.

In the southern Pacific coastal area and on the entire Atlantic slope, there is an abundance of rainfall more evenly distributed seasonally and no problem is evident for the foreseeable future.

A ground water investigations program is in an early stage and present information is meager. Prospects do not appear promising in the upper part of the central plateau. In both coastal areas, prospects for substantial ground water supplies appear more promising.

VII. The Community Water Supplies of Costa Rica

A.B. There are approximately 250 community water supplies in the country which serve an estimated 700,000 people, 64% of the population. Only one of the 65 cantons does not have one or more supplies.

C.D. An estimated 95% of the supplies are from springs which furnish an estimated 65% of the total volume of water used. The relatively low cost of construction and operation when the area served is near the supply source, no doubt accounts importantly for the large number of supplies. Approximately 80% of these supplies are in communities under 2500 in population.

E. In the 1949 census, 95% of the urban dwellings were reported to be served from public water supplies. Field review indicates that this percentage would apply at present. In the rural areas of the central plateau, roughly 75% of the dwellings have piped water connections. In both coastal areas where distances to springs are greater and surface water must be treated, most of the rural population is unserved.

F. Information on age of systems, which would give a clue to present conditions, is incomplete. Many systems in the central plateau are old (earliest 1867). Systems in the coastal regions are much newer.

G.H. Several studies, including eight pitometer surveys, indicate an extremely high per capita use of water throughout the country. The pitometer study indicated a range from 74 gcd to 113 gcd. Another earlier study in 34 communities indicated ranges from 24 gcd to 246 gcd with an average of 118 gcd. Analysis of the pitometer data

would indicate wastes and/or leakage account for at least 50% of the demand. Metering, with the existing low rates, and lack of incentive to pay water bills, apparently has little effect on wastage. Much of the wastage is undoubtedly due to the intermittent service resulting largely from fluctuating pressures.

I. The design of water systems, except for San José, is almost entirely by the Department of Public Works. The sources, transmission mains and distribution systems, are generally designed for a consumption of 80 to 100 gcd for an estimated population 20 years in the future and for a maximum hourly demand of 1.8 times the average daily demand. Usually, there is no provision for additional fire or industrial demand. In actual experience, providing for population increase for 20 years has resulted in an increase in per capita demand utilizing the future reserve capacity almost immediately.

J. The bacteriologic and mineral quality of the spring supplies is generally good and the collection structures observed were reasonably satisfactory. All surface supplies are contaminated and require complete treatment--filtration and chlorination. The treatment plants observed (except San José) are not producing satisfactory effluents because of lack of chlorination, by-passing raw water, or poor operation.

With the leaky distribution systems and negative pressures part of the time, the bacteriologic quality of water in most of the distribution systems observed must be regarded as unsatisfactory.

K. Definitive correlation between diarrheal diseases and availability of public water supplies was not established. Due to the few data available, the lack of uniformity in reporting and lack of information on other factors, which might affect the diarrheal disease rate, any conclusions might be erroneous. A special study of the diarrheal problem is now just getting underway. (See Appendix B).

VIII. Financial Considerations Involved in Water Supply

A. In the past, except for San José, practically all of the construction cost has been borne by the national government. Local communities are primarily responsible for operation, maintenance and minor repairs. At present there is a trend towards requiring the municipality to share the costs of replacements and improvements. Except for San Jose, no municipality was found with outstanding bonds or loans on water systems.

B. 1. Based on available data, present construction costs are estimated to average about $30 per capita served. The figure will be higher for the San José metropolitan area and lower in some of the smaller communities. Several factors contribute to these low costs including low labor costs, small lot sizes, short transmission lines, no provision for fire protection, little pumping and elevated storage and few treatment plants. As nearby springs become completely developed

and longer transmission lines, treated surface water or development of ground water supplies are required, costs can be expected to increase.

2. Many existing systems are in need of replacement. To meet these needs, taking care of new population and urbanization and of obsolescence, an estimated annual expenditure of about 20 million colones ($3 million) per year will be required for the next 20 years. This would amount to about 16 colones ($2.40) per person served per year, or 8 colones ($1.20) per month for the average connection.

C. Of 22 supplies on which receipts and expenditure data were collected, 15 operated at a deficit in 1958, with nothing set aside for depreciation. The total receipts were about 65% of the operating expenditures. The Matamoros report also showed that 21 of 23 systems, for which financial data were collected, were also operating at a loss.

D. More than 95% of the water systems are unmetered and none is completely metered. The commonest flat rate encountered was one colon ($0.15) for residential and 1.67 colones ($0.25) for commercial services per month, ranging from 0.5 colones ($0.075) to three colones ($0.45) per month for residential service. Generally minimum meter rates are about the same as the flat rate based on a quantity corresponding to the average usage. Many patterns of flat rates are in vogue, such as numbers of faucets, size of house connection, nature of user. In spite of the fact that meter rates usually increase with increased usage, the minimum rates are so low that meters have had little impact on water demand, especially since payment of water bills is not rigidly enforced.

Only for San José were records of water rates available over a long period of time. The rate in San José (three colones per month) has not increased since 1921. Information concerning 21 other communities show an increase in water rates of 88% from 1930 to 1959, while iron and steel prices increased 429% during the same period and the general retail price index for Costa Rica increased by 325% from 1936 to 1958. Of 118 water systems reviewed the most common rates were only one colon ($0.15) per month, which is additional evidence that water rates have not kept pace with cost of water and other living costs.

E. In spite of the low water rates, delinquent accounts represent a serious problem. It was difficult to obtain much information over a long period of time because most municipalities placed delinquent collections in the general fund. In 23 cantóns studied, less than 75% of the theoretical income (based on all connections paying only the minimum charge) was reported to have been collected in 1958.

F. In the construction of water systems about 60% of the total costs represent imports. Thus, an increased rate of water supply construction might be achieved without disturbing the existing

balance of payments status by (a) increasing exports, (b) decreasing other imports, (c) external loans, and/or (d) local production of more water supply materials and equipment.

Coffee and bananas are the leading exports and neither show certain promise of increase in value in the highly competitive world market. No other developments indicating marked increases in exports are apparent.

Food products (15%), chemical products (12.5%), manufactured articles (27.6%) and machinery (26%) comprise 81% of the total imports. Of these, food products appear to present the best chance for decrease.

External loans, repayable in local currency, would lessen foreign exchange requirements and would stimulate construction.

The national debt is only 406 million colones ($60 per capita), and the exchange rate has been stable for more than 20 years. Loans, backed by national credit should be more easily negotiated because of the fiscal soundness.

It is not likely that metal pipe and fittings, the principal material used in water supply, will be indigenously produced. Cement production is under consideration and is believed to be feasible. Local cement production would reduce import requirements and also might stimulate the local manufacture of asbestos-cement pipe, thus, reducing metal pipe import requirements.

With local manufacture of cement and of larger diameter cement asbestos pipe, possibly import costs could be reduced from 60% to not less than 25%, since small pipe, meters, hydrants, etc. would still be imported.

The local cost component could be theoretically financed by (1) increased appropriation from the national treasury, (2) increased municipal participation, with or without rate increases, (3) by pooling resources, standardizing and increasing rates and improving collections, under a national authority, and (4) by long-term internal loans.

G. Because of scarcity, other investment opportunities, high interest demand and preference for short-term loans, private capital does not seem to be a promising source of internal loans.

Consequently, the only internal sources are the government agencies which generate capital. The three principal agencies involved are:

Social Security Agency -- Part of the resources have been invested in bonds at a rate of 1.36 million colones a year. This rate is, however, increasing and San José is currently seeking a five million colones water loan;

National Banking System - Total investments are 463 million colones, mainly commercial loans, but some bonds;

National Insurance Monopoly - Total assets in 1956 were 98 million colones with a total investment of about 13 million colones in bonds. The principal portfolio is in mortages.

H. The total income of the national government in 1958 was 314.5 million colones of which 55% was from import duties. The national budget was about 16% of the national income. The two largest items of expenditure were for education and social security, accounting for more than 40% of the total. The public works budget was 35 million colones, five million of which was spent for water supplies.

The total income of all municipalities was 33 million colones and expenditures were about the same.

IX. Costs and Benefits

Expressed in monetary value, the total cost of adequate public water supplies in Costa Rica is estimated at $2.40 (16 colones) per person served per year over the next 20 years. The over-all socioeconomic benefits cannot all be expressed in monetary value, because of lack of data and because some are intangible. Among these benefits are increased productivity, better living conditions, stimulation of industry, increased land value and public cleansing.

It is estimated that annual savings in morbidity and mortality for gastroenteritis has been in the magnitude of $1,300,000 and from water-borne diseases (typhoid, paratyphoid and dysentery) in the magnitude of $120,000 annually.

X. Organizational Plans Under Consideration

Changes in existing organizational structure designed to improve the water supply situation are now under consideration by the National Legislature. Three alternatives are under consideration:

1. Establish an autonomous national water supply agency responsible for all aspects of water supply.

2. Establish a semi-autonomous agency similar to (1) within an existing Ministry.

3. Establish an authority for the San Jose metropolitan area, which might become national in scope.

I INTRODUCTION

This report is concerned with the results of a nationwide appraisal of potable water supply development in Costa Rica made in May and June 1959.

The appraisal was concerned not only with the corpus of public water supply systems in Costa Rica, but with the entire socioeconomic environment of past, present and future potable water supply development. It was essentially limited to public water supplies and the original intention was to concentrate attention on urban water supplies. Of special interest were: (a) the broad issue of costs and benefits related to potable water supplies, especially benefits resulting from diarrheal disease reduction, (b) future water supply needs, and (c) the economic, organizational and social resources involved in future water supply development.

As a pilot study for similar water supply appraisals which may be carried on in other countries in the future, determination of what information it is practical to obtain in a brief reconnaissance was also of interest.

During the course of the brief reconnaissance, it became necessary to cut the cloth to fit the pattern, with adjustments made from time to time to conform to the limited time schedule, to new resources of information and conversely to the lack of information in certain areas which became apparent after arrival.

A basic difficulty was the relative lack of specific information on potable water systems which was available in central files in terms of their number, location, extent and related characteristics. Using these data as a baseline, it would have been possible to concentrate on both broader and more specialized interests. For reasons mentioned in a later section of this report, this information was not adequately available and it became necessary to devote much time to taking a census sample in the field. By so doing, insight was obtained on many other conditions within the scope of our appraisal.

A second development was the special current importance of the water supply situation in Metropolitan San José, the capital of Costa Rica. Release of the Rader Report (described elsewhere) immediately preceding the team's arrival together with an unusual drought and other related developments, had generated much public interest, not only in the water supply problems of San José, but also in national legislation pertaining to regional and national water supply agencies. For this reason, the greater part of the time of one team member was spent in obtaining comprehensive information on the water supplies of

metropolitan San José. Because this area was studied in greater detail than any other, observations on the metropolitan San José water supply are contained in an appendix, with references made to some specific conditions in the main text of this report.

Investigations of diarrheal disease conditions in Costa Rica were confined to a statistical study of gastroenteritis mortality and infant mortality and to the collection of limited medical care data. Because of limited time and for other reasons, there was essentially no field contact with local health units, clinics or hospitals on diarrheal disease conditions.

The study was carried out under the auspices of the Servicio Cooperativo Inter-Americano Salud Publica (SCISP) an element of the USOM to Costa Rica. The Servicio is quartered in the central health agency building and engages in special demonstration projects in public health, including water supply. The team is deeply indebted to the Acting Chief of SCISP, Mr. Wilbur Whitsell, for placing at its disposal the full facilities of the Servicio and to several members of the Servicio staff for their valued cooperation, both in San José and in the field. The team is also deeply indebted to the USOM Director, Mr. Wyman R. Stone, to selected members of his immediate staff and to Public Administration and Industry members of USOM who gave valued advice and data on finance, governmental organization, urban planning and industry in Costa Rica.

During the third week of the survey, the staff of SCISP was augmented by the arrival of a resident medical epidemiologist, Dr. Helen Moore, who will undertake intensive studies on some aspects of the epidemiology and treatment of diarrheal diseases in Costa Rica in cooperation with the central health agency. Anticipating her arrival, emphasis was placed on the assembly and analysis of statistical data which it was hoped would be useful to this long-term study as well as to the water supply reconnaissance. She was also given general information on water supplies and other subjects.

At the time of the team's arrival the Director General of the National Health Service was absent and the Minister of Public Health was preparing to join him at World Health Organization meetings in Geneva, Switzerland. However, the team was graciously received by the Minister on the first day of the visit and the full resources of the Ministry were kindly offered. Subsequently, time was spent with the Department of Sanitary Engineering and the available statistical resources of the Department of Biostatistics were utilized. The offices of the Controller General and of Statistics and Census in the Ministry of Economy and Finance and the Office of Hydraulic Works of the National Ministry of Public Works also provided valuable information.

Most of the work was in the general San José area. This was because 70% of the national population is within commuting reach of

San José, of the detailed review made of water systems in metropolitan San José and San José is a central source of nationwide information.

Using San José as a base, field visits were made to many water supplies throughout most of the highlands of Costa Rica, in Alajuela, Cartago and Heredia Provinces. During the fourth week, Puntarenas Province and Guanacaste Province were visited. Information on a total of 115 community water supplies was obtained in the field. These supplies are located in six of the seven provinces (Limón Province excepted).

II CONCLUSIONS AND GENERAL APPRAISAL

A. GENERAL STATEMENT

Review of the history of community water supply development in Costa Rica reveals a situation of outstanding high objectives and past accomplishment. This favorable record has been succeeded however, by deterioration in the over-all situation, at least in the past several years.

As a result of past accomplishments, Costa Rica has reached a unique status among newly developing countries in that some 95% of the "urban" population and an estimated 50% of the "rural" population is served with water piped into dwellings.

Based on mortality statistics at hand, this development has been accompanied by, although not entirely as a result of it, a decline in the crude death rate from an average of 22.3/M in 1921-24 to a present level of around 10. A parallel decline in infant mortality, which accounts for most diarrheal disease deaths, has been predominantly responsible for this improvement. Concurrently, the nation has shown marked progress in other socioeconomic sttributes, as measured by gains in per capita national income adjusted for changes in price level. According to the Rader Report, per capital national income in 1946-54, for example, increased at an average annual rate of 4.9% on a stable price basis.

The present situation of physical retrogression in public water supplies is evidenced by the following:

1) Widespread and increasing occurrence of intermittent service in distribution systems due to inadequate capacity relative to demand, resulting in increasing lack of availability of water.

2) Probable increasing contamination in distribution systems and evident decreasing availability of water for personal hygiene and all other community purposes during daytime hours as a result of a developing intermittent pressure conditions.

3) Commonly, only short-term benefits are realized from new construction in place of the long-term benefits which should be expected, due to expanding per capita demand, present design practices and limited funds. Basically, this is due to excessive water waste resulting from flat rate tariffs.

4) Lack of capital replacement and extensions by the Ministry of Public Works due to lack of funds. The present rate of construction falls short of meeting the needs of new population and thus in effect makes no provision for replacement of existing facilities made necessary by obsolescence and deterioration. The present annually compounded population growth rate of 4% alone require a doubling of facilities every 18 years.

In the face of the apparent need for an expanded water supply construction rate and inadequate national appropriations, the average price of water in Costa Rica has steadily declined relative to general price levels, ability of the consumer to pay and the true costs of operating and maintaining the systems and of replacing them. Thus, no municipality in Costa Rica at the time of this study was known to be making adequate provision for depreciation of its water system in its water tariff and most are not collecting sufficient funds from water charges for operation and maintenance at a minimum level. At the same time, delinquencies in water bill payments by the people are very large, due to lack of sufficient incentive to pay.

The Rader Report (page 71), attributes the following characteristics to the eight existing water supply systems in metropolitan San José, excepting the San José system itself. They are cited in this report because, except for the first item, they are considered to apply to systems generally throughout the nation. We except the water quality item only because unlike the others this condition is more selective in occurrence. Although considered prevalent, poor water quality is apt to be variable in extent and in degree within individual distribution systems. Lack of sanitary control is, however, generalized.

a) Poor quality of water without sanitary control.

b) Deficient operation of the system.

c) Inadequate distribution.

d) Deficient administration.

e) Lack of technical ability for proper operation.

f) Financial deficiency.

g) Lack of coordination between the systems.

h) Political intervention.

B. BASIS FOR PRESENT CONDITIONS

The basic reason for present conditions appears to be the politico-cultural framework under which community water supplies in Costa Rica have been developed and are presently being constructed and operated. A second underlying but less basic condition is considered to be the present division of responsibility for construction on the one hand, and operation, maintenance and water revenues collection on the other hand.

The development of a paternalistic plan whereby the cost of construction of water supply systems is borne by the national government as a subsidy to the people has much validity in political theory in view of the basic importance of water to human existence, economic development and human health. The adoption of this concept by the central government in earlier years probably was responsible in large measure for the high per cent of piped water connections to urban and rural dwellings in Costa Rica, although the team has no knowledge of the history of the role of the central government in water supply back to development of the first public water supply system of record in 1857.

In more recent years, other developments in the name of progress have appeared on the national scene and have competed for national appropriations at the relative expense of those for water supply construction. At the same time, the people had become conditioned to expecting the national government to pay for all water supply construction costs. Encouraged by extraordinarily low flat rate water tariffs and national legislation which practically guaranteed their rights to receive public water without payment of water bills, loss of respect for water as a valuable commodity has become widespread.

The nationwide consequences of the development of this concept has been that, since water is essentially free and a guaranteed right for those connected to water systems, it can be wasted at will.

In the Matamoros Report, an attempt was made to demonstrate that water waste is a function of illiteracy. While there may be some grounds for associating water wastage with illiteracy, the high per capita consumption of water in nearly all Costa Rican public water supplies implies that water waste rests on a broader and more fundamental cultural, psychological and economic base.

Division of responsibility - the second underlying condition - is considered an offshoot from the first. In view of the long established tradition of water supply construction by the national government, not even a single government in Costa Rica has yet established a water rate which provides for financing "the value, depreciation, operation and maintenance of the water supply system", (See 11, General Water Law).

On the other hand, the national government has not been in a position to appropriate, or at least has not appropriated, adequate funds for water supply construction to meet even minimum needs. Water waste - stemming from the basic condition - compounds the problem of engineering design and of raising funds to satisfy water demand in existing systems. At the same time, it is evident that higher water rates are within the capacity to pay of most of the people.

The metropolitan San José problem is complicated by a third factor---the developing high population density and accompanying high total water demand in this area with no cheap new sources available. Currently, this has resulted in water shortage during drought periods which is attributable to the inadequate capacity of presently utilized supply sources. This shortage is in addition to those arising from transmission line and distribution system deficiencies. The ultimate effect of this special problem will be to increase the per capita cost of water in this area to an appreciably higher level than in the rest of the country, due to the heavy investment required in developing more remote and more intrinsically expensive sources of supply and storage.

C. INDICATED SOLUTION

The indicated solution to any complex problem such as Costa Rica's nationwide water problem is best approached by considering the basic principles involved:

The most important principle is that water supplies should be administered in the same manner as any other utility. In the long run, water supplies should be so managed as to pay their own way. As with other utilities, water should be priced in proportion to quantity used. It might further be stated that there is nothing about present water system difficulties which would not apply equally to other utilities if they were managed in the same way. The same problems of excessive demand and wastage and inadequate delivery and financing would exist with electric energy systems, for example, if they too were administered with flat rate tariffs, with divided responsibilities for construction, operation and maintenance and financing and with protection to the consumer against disconnection due to non-payment of bills.

It appears that only by observing the first principle can the use of water be restored to a position of respect by the people which it deserves and which it must have if adequate water supply development to meet the peoples' needs is to be achieved.

The practicality of implementing the first principle is favored by the relative inexpensiveness of water in Costa Rica even under plans of adequate financing. According to the 1949 Dwelling Census, 82% of the urban population was provided with electric service and this percentage has probably increased substantially as indicated by heavy investments by the national government and private enterprise

in additional generating capacity and distribution systems. Many rural people are also served. The prevailing cost for minimum electric service in the poorest rual and urban families served is 4-½ times the prevailing cost of a quantity of water limited only by the hydraulic characteristics of the water supply system.

It is believed that in general water supplies should fully pay their own way in Costa Rica because:

1) Of the intrinsic cheapness of this commodity in Costa Rica.

2) Rising, competing demands on the national treasury will continue to prevent adequate financing for construction from this source.

3) It establishes a basis for internal and external financing of water supply development; a prerequisite to overcoming the present backlog of construction.

4) The application of economic law to water supply provides a basis for solving the problem of water waste with its attendant train of chaotic conditions in engineering design practices, construction requirements and source of supply difficulties.

The full application of this principle is qualified by the reservation "in general" only on two grounds. In the first place, the present construction backlog will require a continuing national subsidy for an interim period until water supply systems as a group can "stand on their own feet". In the second place, further extension of water supply systems to serve additional rural population groups on a selective basis may require limited continuing construction subsidy for this special purpose. It is presumed that such construction would be performed where the per capita construction cost is reasonable and, as a prerequisite condition, where there is local willingness to pay a water rate adequate for future self-financing. It is also evident that, the foreign exchange component in water supply construction will continue through the foreseeable future, for which continuing consideration will be required in national economic planning and development.

Also, in common with established utilities practices, it is imperative that some solution be found to the present impasse in the non-payment of water bills. Under present water law, water service cannot be discontinued for non-payment of water tariffs unless public hydrant facilities are available. San José was the only municipality, in which were found even limited public hydrant facilities in the water system. Under such conditions a high per cent of delinquent water payment could be expected in any society. The obvious choice is either to amend the law or to install public hydrants. There is a real humanitarian basis for the present law. The preferred alternative to amending

the law appears to be the establishment of a small proportion (perhaps 1%) of public hydrants to total connections in each system. Such hydrants, if infrequently spaced, would still provide compelling motivation for payment of water bills due to the inconvenience of carrying water and because of low water rates, and at the same time satisfy basic physiological water needs of the destitute.

The second basic principle involved the type of organization which can best administer all aspects of water supply.

In Section IX, four organizational plans under consideration to improve present conditions were described. Three involved the establishment of some type of authority, the fourth involved strengthening of the present organizational pattern. Since none of these plans is free from possible imperfection, the team members felt that they are not competent to express an opinion favoring any single one. For example, no study was made of the comparative merits, success and effectiveness of the many existing autonomous authorities in Costa Rica. For this reason this discussion is confined to circumscribed coverage of the various plans. A possible fifth plan (Mexico Plan) is also outlined in Item five.

1) Municipal Management

One important aspect involves timetable as regards water supply urgencies versus long-term politico-social objectives in governmental structure. There is widespread agreement that, where local governments are competent to manage their own fiscal affairs and utility systems, the over-all management of water systems is best placed in their hands. This is the prevailing practice in the U.S., for example, and it has been found to be generally satisfactory although far from perfect. Such an arrangement implies not only local competency in operation and maintenance but also in the effective collection of water bills and the general competency of financial management. In addition, credit resources must be available to finance capital construction costs with or without subsidy from higher governmental agencies.

Such a concept tends to be visionary, however, where the municipal government structure is weak, often basically because of financial malnutrition with respect to tax revenues. Under such conditions the concept of a special authority to comprehensively manage a particular resource or utility system becomes attractive. This condition existed in Puerto Rico, for example, where the present water supply problems of Costa Rica were replicated and augmented as long as the water systems were under municipal management. Water system and financial management conditions in the insular capital, San Juan, were worse if anything than in the smallest towns. Establishment of an insular water authority

in the late 1940's in Puerto Rico has since transformed conditions; today water bills are collected, water delivery is continuous and operation and maintenance is reliable throughout the island. Without benefit of subsidies from the general treasury for urban water supplies, extensive construction has been financed from current revenues and from internal and external capital raised at low interest rates.

In Costa Rica, local governmental structure appears to occupy an intermediate position of development, in San José, the local water supply management is considered competent and the general structure of this municipal government is, perhaps, potentially competent to effectively collect water bills with amendment to the Water Law or provision of public hydrants. The local governmental structure of some other provincial capitals, although at a somewhat lower general level, seems to be relatively satisfactory. The local governmental structure of all smaller municipalities is at a far lower plane, although on a basis of water bill collections, there are encouraging but rare exceptions even in this group. Also, in the great majority of these systems where springs are the source of supply and flow is by gravity head, no treatment is basically required and the systems are so simple that only a low order of operating skill is needed.

In accordance with a "long timetable" philosophy it might be rationalized that the maintenance and strengthening of municipal responsibility over water systems would bear the following results:

Following the leadership of San José, the adequacy and competency of local governments in water system management and financial management would spread more or less as follows in terms of attainment of a "satisfactory" status.

1959 -	San José
1960 - 1970	All Other Provincial Capitals
1970 - 2010	All Other Municipalities

Since it appears that source of supply development in metropolitan San José can be achieved economically only by serving at least nine municipalities as a unit, the foregoing concept if accepted would still require some sort of "super-organization" at least in this key area. This organization would at least require jurisdictional authority to serve the municipalities on a wholesale basis. However, if the super-organization were to be restricted to a wholesale function, it would not solve the many other water system and financial management problems of the other eight municipalities.

Also, acting as independent entities, there would be little hope for municipalities in Costa Rica other than San José to float internal or external loans on their own credit at any time in the reasonably near future.

2) Authorities

The apparent advantages of an authority under competent management and with adequate powers conferred by legislation are:

a) Water waste and leakage could be curtailed more readily by an organization concerned with all aspects of the water system. Installation of water meters in places requiring them most urgently could be expedited.

b) Water bills would be adequately collected.

c) Singleness of responsibility would make possible elimination of all present basic weaknesses arising from divided responsibilities in construction, operation, and maintenance and, especially, financing.

d) All systems involved would receive the benefit of higher managerial and professional skills which could be recruited and employed only by an authority-type organization (San Jose excepted).

e) Financing of capital improvements both on a pay-as-you-go plan and by long-term loans could be greatly strengthened by stronger financial management, more effective collection of water bills, more realistic water rates, more metering, pooling of financial resources and spreading the credit risk.

f) Concentration of responsibility could simplify present practices and procedures, facilitate overall planning and expedite all action.

The most apparent disadvantage of an authority aside from its adverse effect on the sociologic concept of strengthening municipal governments lies in the possible liability of incurring high overhead costs due to an overelaborate organizational structure and remote supervision. The Ministry of Public Works presently assesses an overhead charge of 25% for construction; in practice, overhead on operation and maintenance is materially higher than on construction.

3) Metropolitan vs Nationwide Authorities

The principal issue involved in choosing between the initial establishment of a metropolitan San Jose water authority and a nationwide authority is one of political strategy. Because of source of supply problems in the metropolitan area which commonly concern nine municipalities, the urgency of need of a metropolitan authority from this standpoint and the articulateness and interest of many consumers are greater than in the rest of the nation.

There is also, however, a significant management issue. It takes time to develop an effective new organization; growing pains of an organization developed to initially serve the metropolitan area would be very much less than those of one established with an initial nationwide jurisdiction over 250 systems. The metropolitan authority could be expanded in jurisdiction after proving its worth while the nationwide authority would be forced to develop service jurisdictionally on a gradual basis anyway to avoid chaos.

4) Strengthening the Status Quo:

The essence of this plan as it is understood, is that the Ministries of Public Health and Public Works would receive more funds to perform their functions. So far as is known, there would be no direct provision for strengthening the role of municipalities in collecting water bills, setting up depreciation accounts and sinking funds or in operation and maintenance.

The effect of this plan on the activities of the Department of Sanitary Engineering of the Ministry of Public Health can not be appraised because of its inactivity in the water supply field. There is no suitable parameter of current performance on which to project an estimate of future accomplishment of those functions with which it is presently charged. The declared reasons for this inactivity are lack of appropriations and staff.

The Ministry of Public Works on its part probably could effectively spend more construction funds since its present expenditure rate is lower than in some previous years. It has a large backlog of projects and past construction has been physically sound. However, such a program would only continue the present division of responsibility between the design and constructing agency on the one hand and the operating and revenue collecting agency and consumer on the other hand. The benefit of physical water supply improvements by the Ministry of Public Works would be rapidly dissipated in many cases by rising per capita wastage of water and the solution to longer-range water needs would be indefinitely postponed.

5) Mexico Plan -- A Fifth Plan

A plan developed and used in Mexico with apparent success will be described in brief outline. Under this plan, municipalities have full control of their public water supplies as long as they wish to retain this authority and to assume full financial responsibility.

Should they wish to obtain a construction subsidy from the national government, however, they are privileged to make application at any time to a national water supply authority. This authority receives national funds for its administrative expenses and for a revolving fund to finance construction.

Under the provisions of this revolving fund, local water supplies which receive a construction subsidy are jointly managed by a commission with both local and national representation, the national representative being a district engineer serving many supplies. Under the provisions of its contract and under national supervision, the local water supply.

a) Must be competently operated

b) Must be self-financing and must reimburse the revolving fund for construction costs over a period of years

c) Can be returned to local control whenever all indebtedness is repaid.

This plan involves the meritorious features of "pay-as-you-go." Since admission of a local water supply into the plan is discretionary with both parties, the admission rate of local systems can be limited to the organizational capacity of the national agency and the financial capacity of the revolving fund to receive them.

6) Conclusion

To the extent that any conclusion to a solution to the organizational aspects of Costa Rica's water supply problems in harmony with politico-economic planning objectives as evidenced by other cultural accomplishments of the nation has been reached either the Mexico Plan or a responsible water authority (metropolitan or otherwise) which would be dedicated on the one hand to placing local water systems on a sound operational, physical and financial footing and on the other hand, to ultimate liquidation (over a 50-year period) and to the year-to-year return of systems to municipality management wherever they are in a position to assume full operational and fiscal responsibility would be favored.

7) Department of Sanitary Engineering - Ministry of Health

It is evident that the development of any logical plan for improvement of the present water supply situation in Costa Rica will require strengthening of the Health Ministry's Department of Sanitary Engineering so that activities of that Department above the level described in Section IV-B of this report will be both possible and assured. The indicated strengthening must extend beyond more increase of Departmental appropriation alone, important as that is, and must be of such a nature as to provide salary scales which will attract and retain a competent full-time engineering staff and which will assure able and competent direction. The major function of the Department in water supply, in our opinion, should be one of stimulating other agencies, including local governments, in the installation and effective management and operation of water facilities, review and approval of plans, and the technical supervision of over-all sanitary conditions.

Of pertinent interest in this connection is the following excerpt from an article in press by Dr. Abel Wolman, consulting sanitary engineer, with which we are in agreement:

"It is desirable to stress again the leadership role which Ministries of Health must accept. This will require a strengthened environmental sanitation division in all Ministries and a new administrative approach in working with other Ministries and agencies of government. It will be difficult in many countries to exercise the influence and exert the pressure necessary to make the water program a dynamic force in those countries where the engineering services of the Health Ministry are maintained at a token level. Ministries of Health must decide if they want to get into this activity and if they decide in the affirmative, they must take immediate action."

III REFERENCES

Many published documents were utilized as sources of information. These were obtained during field visits and conferences in San José, and included office files and memoranda supplied by local, national and private officials.

The published material is too lengthy for listing. It consists mainly of annual reports of agencies of the Government of Costa Rica, including public corporations (autonomous authorities), census publications and statistical yearbooks, as well as reports of the International Monetary Fund, the United Nations and the Pan American Sanitary Bureau.

Specialized reports which had special applicability are:

1. Report on a Water Supply System for the Metropolitan Area of San José, Costa Rica. Prepared for La Oficina de Pleaneaniento Del Area Metropolitania (OPAM). Organizado Por El Instituto Nacional de Vivicenda y Urbanismo (INVU). Rader and Associates, Engineers and Architects, Miami, Fla. April 1959. 88 pp. Pbbd. (Referred to as "The Rader Report").

2. Estudio de Varios Sistemas de Abastacimiento de Agua Potable de la Republica de Costa Rica. By Edgar Matamoros Lizano. Ministerio de Salubridad Publica, November 1954. Typed. 186 pp. (Referred to as "The Matamoros Report").

Unit of Currency

The unit of currency is the colon, with an exchange rate of 6.63 colones per $: roughly 15¢ U. S.

IV BASIC BACKGROUND INFORMATION

A. GEOGRAPHY, CLIMATE, AND HISTORY

1. GEOGRAPHY

Costa Rica, with an area of little less than 20,000 square miles, is located in the central part of the isthmus of the two American continents at Latitude 10 degrees north, Longitude 84 degrees west. It is bordered on the south by Panama and on the north by Nicaragua.

Mountains which form the continental divide and which extend in a northwest-southeast direction constitute a longitudinal axis for Costa Rica. This axis is bordered by coastal plains which extend northeasterly toward Nicaragua and easterly to the Atlantic Ocean (Caribbean Sea). On the Pacific side, the coastal topography is characteristically foothills interspersed with limited plains area.

Plateaus and valleys in which most of the population is located are found in parts of the highlands. The remaining population is almost entirely located in scattered areas along both coasts. Other areas, both coastal and inland, are thinly populated.

Some 60% of the total national population alone is reputed to be in the small "meseta central", comprising elevated agricultural table lands on the Pacific watershed which are devoted chiefly to coffee, corn and truck crops cultivation and dairy farms. Up to 70% are located in all of the elevated land area. The meseta central also includes metropolitan San José, the Capital.

A still higher percentage of the national population is located in all cultivatable highland areas, even though these comprise only a small proportion of the total area of Costa Rica, (10 to 15%). As a rough index, only 28.5% of the estimated population at the end of 1958 lived in the 3 coastal provinces of Limón, Guanacaste and Puntarenas; the remainder lived in the 4 predominantly highland-populated provinces of Alajuela, Cartago, Heredia and San José.

2. CLIMATE

The climate of Costa Rica is modified principally by elevation above sea level. The lowland climate is tropical while that of the highlands, which are in the range of 2000 to 4000 ft. above sea level, is temperate. Due to proximity to the equator (latitude 10° N), there is little seasonal temperature change. The entire country is humid; the annual precipitation varies from about 70 inches to about 185 inches. In the more settled areas, it averages about 90 to 100 inches. The year is divided into a dry season (December-April) and a wet season (May-November). The wettest months are September and October.

3. HISTORY

Discovered early in the 16th Century by Columbus, Costa Rica was under Spanish rule as a distant province under the seat of government in Guatemala until 1824 when it became independent.

B. POLITICAL ORGANIZATION

Costa Rica is a republic, with a president, a cabinet, and a unicameral legislature of 45 members. The president and legislature are popularly elected to 4-year terms. The country is divided into 7 provinces, the governors of which are appointed by the Ministry of the Interior. The provincial governments are concerned with police and judical functions.

The unit of local government in Costa Rica is the cantón, or municipality. As in many other Latin American countries, these municipalities compare more closely with townships in the United States; nearly every cantón being composed of one or more urban areas (generally one), and contiguous rural territory, all under a single government. In three cantóns, however, the population is entirely rural according to Costa Rican census standards, although there is a seat of government.

The cantón government consists of an elected council and a jéfe politico. The jéfe politico, appointed by the provincial governor, is directly responsible for police and judicial functions as an agent of the provincial government. In all but the central cantón of each province, he is also the chief executive officer of the cantón as agent of the cantón council, of which he is a non-voting member. Except for police and judicial functions, the cantón council is responsible for all local affairs, including water and sewerage services. In the central cantón of the province, a chief engineer is directly responsible to the Cantón Council for local utilities functions. The provincial governor serves as jéfe politico for that cantón.

Each cantón is divided into a number of districts. From a standpoint of governmental functions, the district serves little significant purpose except for the election of a representative who attends the Cantón Council member as an observer, serving as a spokesman for his local area.

The number and size of cantóns in each province and of districts in each cantón vary with population density. The most populous province (San José), for example, has 19 cantóns, while the least populous province (Limón) has only 3 cantóns. The number of districts in a cantón ranges from 2 to 14. Cantón pupulations range from 3,675 to 138,000 and district populations from 21 to about 40,000. In thinly populated territory, a cantón may contain as much as a thousand square miles; in densely settled areas, it may be as small as four or five square miles.

The national cabinet is composed of two vice-presidents and eight ministers. The respective ministers are those for: Foreign Affairs, Economy and Finance, Interior, Public Works, Agriculture and Industry, Education,

Public Health and Public Security. Those with functions which directly involve community water supplies are: Economy and Finance (Water rates and capital loans), Public Works (planning, design and construction) and Public Health (planning, design and supervision).

There are also many autonomous authorities which operate as public corporations and which in many cases at least are administered by directors who, although appointed by the President, have staggered terms of office. A brief enumeration of these authorities follows:

1. Costa Rican Institute of Electricity (I.C.E.) established 1948. A national electric energy monopoly except for territory served by a private company (National Power and Light Company).

2. Social Security Agency. Established 1941. Administers old age retirement, survivorship, illness and maternity programs. The illness and maternity programs involve both financial aid and hospitalization.

3. National Insurance Institute. Established 1924. A government monopoly in life, accident, property, and automobile insurance.

4. National Production Authority. Established 1948 as an autonomous agency. Concerned with the economic production and price stabilization of articles of popular consumption. Engages in a wide variety of operations including the marketing of foods and financing of food production.

5. National Housing and City Planning Authority (INVU). Established 1954. Construction of public housing. City planning. As a city planning function representatives of this agency have played an active role in the planning and promotion of a metropolitan water supply in the San José area.

6. University of Costa Rica. Established 1940. Higher education.

7. National Banking System, National Bank of Costa Rica and Central Bank of Costa Rica. Established in 1914, 1948 and 1950 respectively. This complex is a government monopoly in the fields of commercial banking, mortgage loans and agricultural credit as well as performing the functions of a national reserve bank.

8. Electric Railway to the Pacific. First constructed in 1895. Established as an autonomous agency in 1948, law repealed 1950, re established 1954. In addition to operating the railway from San José to the Pacific port of Puntarenas, this authority operates the port facilities in Puntarenas and a major public water supply which serves Puntarenas City and scattered populations.

9. Social Protection Board of San José. Operates the national lottery and administers the central hospital for Costa Rica, (San Juan de Dios), a mental hospital and a tuberculosis sanitorium. Gives financial aid to other medical care institutions.

The establishment of additional autonomous agencies is understood to be opposed in some quarters at present, including the national administration.

C. POPULATION AND DEMOGRAPHY

The first population census of Costa Rica was taken in 1824 or 1825, when the total population was about 50,000. Population censuses were subsequently taken in 1864, 1892, 1927 and 1950. The next general population census is scheduled for 1960. Results of the 1950 Census are available in a detailed publication.

Currently, annual estimates of the population of the nation are made by districts, cantóns and provinces. These annual estimates are published in summarized form in a small brochure. The estimated 1958 year-end population of Costa Rica was about 1.1 million as compared with 0.9 million in May 1950, an increase of 38% in 8-2/3 years, or about 4.4% per year averaged for the period. On an annual compounded basis, the net rate of population increase is about 4%, one of the world's highest. The national population (1958 estimated), was two-thirds rural and one-third urban.

A statistical annual containing rather complete demographic statistics (both vital and social), is also published by the Director General of Statistics and Census of the Ministry of Economics and Finance, which directly receives birth and death certificates and reports.

A census of dwelling and living conditions was first taken in 1949 in all urban areas but not in rural areas. It probably is to be repeated in 1959. Among other things, this census reports by districts the water supply and sewage and excreta disposal facilities of dwellings, type of house construction, type of artificial lighting, number of rooms and occupants and bathing facilities.

A commerce and industry census also is currently taken every five years, the next one being scheduled in 1962.

Since urban and rural areas are not separated in Costa Rica by civil subdivision boundary lines, the definition of rural and urban areas by census takers necessarily is based on subjective cultural criteria. It is said that these criteria include house spacing and the presence of a central nucleus or business district, paved streets, various utility services, etc. Based on limited field observations of localities which have been classified as urban and rural, it seems likely that the presence of a central nucleus may be a ruling criterion for urban areas, since some "rural" localities satisfy urban requirements in all or most other respects.

Based on Census Bureau interpretation of these standards, every cantón in Costa Rica was listed in the 1950 Census as having a rural population and all but three (Turrubares, Pococi and Buenos Aires Cantóns) had an urban population. The maximum and minimum rural and urban populations of any cantón in 1950 are listed below:

	Population in any Cantón	
	Minimum	Maximum
Urban	132*	109,693
Rural	2127	28,293
Total	2801	111,820

* Except for three cantóns with no urban populations.

Except in parts of the urban-suburban complex which forms metropolitan San José, each "urban" area is well separated from any other "urban" area, and the very small urban populations reported in many cantóns do not represent spillover from adjoining larger urban areas.

Classifications of urban populations in Costa Rica by size of city cannot be readily compared with classifications based on conditions in the USA. In the United States, areas included within the boundaries of a city usually are urban and suburban in cultural character, but are seldom rural. In Costa Rica, suburban areas are seldom encountered except in metropolitan San José, but the density of land occupation of rural areas contiguous to an urban area may be as great or greater than that in some U. S. suburban areas within the city limits. The definition of a rural area in this case is based on means of livelihood). On the other hand, inclusion of the entire population of a cantón in an urban category on the grounds that a cantón is a municipality, commonly would involve including residents in very sparsely settled territory.

The three standards (Items one, two and four), which might be followed in determining the populations of Puntarenas City (and the water supply attributes) are given below as an example. (1950 Census).

1.	Urban census population (Central District)	13,272
2.	Total population of Central District	15,660
3.	Remote rural population in Cantón	15,414
4.	Total population of Cantón (Municipality)	31,074

If an "urban" area is considered as being a thickly built-up and densely populated area with a single central nucleus and if the aggregation of communities comprising metropolitan San José is accepted as a single city, there are probably only seven other localities in Costa Rica which might be considered as being in the "10,000 and over" population classification at present. Six of these (Alajuela, Cartago, Heredia, Limón, Puntarenas and Turrialba) are in the 10,000-25,000 group; the first five are provincial capitals. The seventh, metropolitan San José, is in the over 250,000 class. However, if cantón boundaries were to be accepted as the urban area limits, Costa Rica would have 24 cities of over 10,000 population.

Table 1, which follows, gives the population of each province in 1950 and 1958, the percent of urban population to total population by provinces (1950), and the number of districts and cantóns credited with populations in the 1950 census.

Table 1

Population Characteristics and Civil Subdivisions by Provinces

Province	Population 1958 Est. ----Millions----	Population 1950 Census ----Millions----	% Urban	No. of Civil Subdivisions With Urban Pop. Districts	Cantóns	Total Dist.	Cant.
Alajuela	0.206	0.149	19	12	12	76	12
Cartago	0.137	0.101	24	9	8	39	8
Heredia	0.068	0.052	33	8	8	36	8
Guanacaste	0.129	0.088	14	8	8	26	8
Limón	0.056	0.041	28	2	2	10	3
Puntarenas	0.129	0.088	28	6	6	29	7
San José	0.375	0.282	53	30	18	98	19
TOTAL	1.100	0.801	33.5	75	62	314	65

Although metropolitan San José, the capital city, contains about 25% of the national population, local planning authorities state its growth rate is in equilibrium with that of the national population. This is also generally true of all principal urban centers in Costa Rica. The absence of accelerated urbanization relative to total population growth can be attributed to the dominant importance of agriculture in the national economy and especially as a medium of foreign exchange, to the relative lack of improvement in per capita production in agriculture and industry and to the relative lack of industrial development in excess of the national population growth rate.

Coffee and bananas are the principal exports in the order given. Industrial development which has taken place in recent years is all light industry, such as the garment trade industry and food processing industry.

Table 2, which follows, gives the numbers of civil subdivisions in cantóns having urban populations according to population size, based on the 1950 Census. There are also three strictly rural cantóns.

Table 2

Civil Subdivision in Urban Cantóns by Population Size - Urban and Total

Population	Number Districts Urban	Total	Cantóns Urban	Total
Under 2,000	45	200	44	1
2,000-2,500	3	30	3	1
2,500-5,000	8	48	5	13
5,000-10,000	3	16	3	26
10,000-25,000	6	9	6	19
25,000-50,000	0	0	0	4
50,000-100,000	0	0	0	0
Over 100,000	0	0	1	1
TOTAL	65	303	62	65

These numbers do not include the 11 districts of San José Cantón which are contained in a single cantón-wide water system. Also, the City of Alajuela comprises two districts which are 100% urbanized and are served by a single water system. Consolidation of these two districts would decrease urban and total district numbers in the 5,000-10,000 range by two and increase those in the 10,000-25,000 range by one.

According to one historical publication, the population of Costa Rica in 1825 was 50,000. Populations obtained in later censuses are listed in the 1950 Census report, as follows:

	1950	1927	1892	1883	1864
Costa Rica	800,875	471,524	243,205	182,073	120,499
San Jose Province	281,822	153,183	76,718	56,162	37,208
Alajuela Province	148,850	96,577	57,203	45,205	27,171
Cartago Province	100,725	70,198	37,973	30,428	23,064
Heredia Province	51,760	38,407	31,611	25,818	17,791
Guanacaste Province	88,190	51,142	20,049	14,902	10,431
Puntarenas Province	88,168	28,739	12,167	7,700	4,836
Limón Province	41,360	32,278	7,484	1,858	n.a.

Comparing 1950 results with those for 1864, the national population increased nearly seven-fold and there was a large absolute increase in the population of every province. Relative to the national population, that of the four predominantly highland provinces declined from 87% to 73%, indicating a net migration into the lowland provinces. Nearly all of this decline took place since 1892. The populations of three provinces increased relative to the total population: San José (from 31% to 35%, Guanacaste (from 9% to 11%) and Puntarenas (from 4% to 11%). The greatest percentage increase was in Puntarenas Province; this occurred mainly since 1927.

D. RESIDENTIAL ELECTRIC SERVICE

Electric distribution systems are rather highly developed in Costa Rica. Service is provided by a private utility (Compania Nacional de Fuerza y Luz, S. A.), which is headquartered in San José and which serves the Meseta Central, and by a public authority known as I. C. E., with a nationwide network. Some municipalities also purchase electric energy at wholesale rates and retail it to urban and rural customers within their jurisdictions. Due to the availability of stream flows with favorable gradients and dry weather flows and a lack of indigenous fossil fuels, most of this energy is generated at hydro plants.

Early in the course of field travel, the widespread availability of electric service was noted in rural areas and small communities. While electric facilities were not within the immediate scope of our study, it was apparent that the presence of such service in areas of low economic income provided one yardstick of ability to pay for other utilities, including water.

The 1949 Dwelling Census provides information on electric service in urban dwelling units. As mentioned previously, this census did not extend into what were considered to be rural areas, but the urban category did include some communities with populations of 200 or less. According to this census, 43,606 of the 53,455 urban dwelling units in Costa Rica had electric lights (82% served). Since 1949, electric distribution systems have been extended in both urban and rural areas. The national installed electric generating capacity increased from 324,000 kilowatts in 1948 to 810,000 kilowatts in 1956 and capacity has been further increased since 1956.

Electric light facilities in dwelling units are reported xxx by cantóns in the 1949 Dwelling Census. Sixty two of the 65 cantóns in Costa Rica had dwellings with electric lights, including one cantón which, according to the 1950 Census, had no urban population (Pococi Cantón in Limón Province). Of the three excluded cantóns (Turrubares in San José Province, Buenos Aires in Puntarenas Province and Siquirres in Limón Province), only the last had any urban population.

The number and percent of urban dwellings provided with electric lights are shown below by provinces:

Province	Total Number Urban Dwellings	Number With Electric Lights	Percent Served
Alajuela	4837	4062	83%
Cartago	4843	3581	80%
Guanacaste	2337	1155	50%
Heredia	3256	2441	75%
Limón	3995	3015	76%
Puntarenas	5794	4569	79%
San José	25323	24513	96%
TOTAL	53445	43606	82%

Inquiries were made in areas visited as to electric light facilities in dwellings, especially where the economic status appeared to be relatively low. In the great majority of such cases, it was stated that the minimum number of light bulbs per dwelling was three in a few cases the figure reported was two.

The published tariff of the Compania Nacional de Fuerza y Luz, in effect November 1, 1956, was reviewed. The tariff for residental service where energy is supplied only for lights is quite complicated--for other types of service it is even more complicated. For lighting, there is both a service charge and an energy charge and also a minimum charge in the energy charge category. The service charge is 1.45 colones per month per light bulb up to 50 watts for intermittant service from 5 PM to 6 AM. The premium for 24 hr., service is 50%. Each increment of up to 50 watts per bulb above a 50 watts base capacity is counted as an additional bulb.

The minimum energy charge is 0.4 colon per month per room. The scaled energy charge is in 5 kw hr., steps, starting at 0.215 colon per hr., for the first increment, 0.14 colon for the 2nd step, and 0.077 colon for the rest.

Under this schedule, the minimum bill for a two room house with two lights, but no energy consumption, would be 3.7 colones per month or 11.1 colones per trimester. If two - 50 watt bulbs are each used three hrs. daily in such a dwelling, the electric bill would be 4.5 colones per month or 13.5 colones per trimester. Under similar conditions the bill for a three room house with three light bulbs would be 6.4 colones per month or 19.2 colones per trimester. These figures are for intermittent service.

The Compania Nacional de Fuerza y Luz advises that in 1958 the average electric energy bill for the 42,000 residential customers on its system which it directly serves at retail rates in the Meseta Central, was 29.65 colones per month. However, the area served includes metropolitan San Jose where energy consumption probably is well above the national average. It is noted in passing, however, that the light bill shown by a young lady serving as Treasurer in a small municipality in Puntarenas Province (Esparta), amounted to 29.5 colones a month. She was served by I. C. E., the public electric authority.

In addition to the light bills rendered either by municipalities or by electric utilities for service within buildings, some municipalities also make a property charge for street lights. In a random check of 72 water services in Esparta central district, 51 (71%) were billed for street lights. This charge varied from 1.05 to 7.10 colones per trimester. The water rate (flat rate) was three colones per trimester.

E. DISEASE AND GENERAL VITAL STATISTICS

1. Birth Rates and Crude Death Rates

The birth rate per thousand population for Costa Rica in 1957 was 55.5, one of the world's highest. The average rate for the five - year period 1953-57 was 53.1 per thousand, more than twice that of the USA.

The crude death rate per thousand population declined from 22.3 in 1921 - 24 to 9.6 in 1956 and 10.1 in 1957, and is at the same general level as that of the USA (9.4 in 1956).

Because of its high birth rate and favorable death rate, the population of Costa Rica is expanding at an annually compounded rate of about 4%.

2. Diarrheal Disease Morbidity and Mortality

Adequate data on diarrheal disease morbidity for rate determination are not available. Information is available on the total number of hospital and clinic admissions for this cause and is given in Appendix B. Such information necessarily represents only a very small proportion of the actual morbidity among infants and young children, among whom clinical illness and mortality from this cause is largely concentrated.

Mortality from diarrheal disease as measured by reported deaths from gastroenteritis and total infant mortality is at an intermediate level

in Costa Rica. The nationwide infant mortality rate under one year of age has fallen from 179 per thousand live births in 1931 to 70 in 1957, but it is still nearly three times that of the USA. Gastroenteritis as a stated cause of death leads all other causes for the total population as well as among infants, and was responsible for 1221 deaths in 1956 (rate 124 per 100,000). To these figures should be added an unknown proportion of the 1001 deaths (rate 101 per 100,000), attributed to "ill-defined deaths during early infancy" plus 51 deaths attributed to "dysentery"

Comparative data for infant mortality under two years of age is available for nearly all of the western hemisphere nations for 1953-55, as well as for earlier periods. Costa Rica has close to the top rate in this list. However, validity of such comparative statistics is discounted due to the wide differences which are known to exist in the adequacy of reporting infant deaths among the countries involved. As a result, some of the least developed countries from the standpoints of economic income, nutrition, medical service and sanitary conditions, may report among the lowest infant mortality rates due to sheer failure to register infant deaths with the civil authorities. Under such conditions, comparative statistics for gastroenteritis mortality can be even more misleading.

A detailed analysis of these two causes of death by certain civil subdivisions in Costa Rica has been prepared and appears in Appendix B.

3. Water-Borne Disease Morbidity and Mortality

In the following discussion differentation is made between those parameters which relate most directly to what is currently referred to as "diarrheal disease" and specific infections which are more likely to be actually transmitted by water.

It is generally recognized that diarrheal disease among infants (excluding the new-born) and in older age groups is predominantly caused by Shigella and secondarily by some organisms in the Salmonella group, neither of which are likely to be endemically transmitted by water. The water relationship in such cases is one of availability (or the reverse) of water for general domestic use, including personal hygiene.

While typhoid and paratyphoid are acknowledged to have many modes of transmission other than water, typhoid is classically employed as a principal index of water-borne disease transmission. Where typhoid fever morbidity and mortality is high, water is generally considered to be an important mode of transmission; where it is low, widespread gross contamination of public water supplies is unlikely to be present because of the high effectiveness of public water supplies as a mass transmission mechanism under such conditions.

Reported mortality from typhoid and paratyphoid fever for Costa Rica has not been systematically reviewed over a period of years. However, in the latest year for which this information is at hand (1956), of the 9518 deaths reported in the nation, only 16 were attributed to typhoid, and only six to paratyphoid fever.

F. TECHNICAL MANPOWER RESOURCES

There are 15 Costa Rican engineers with graduate training in sanitary engineering obtained mostly in the U.S. Presently three are working in the Ministry of Health, two in the Department of Public Works and one in SCISP. Two are working outside the country and the remaining seven are engaged in work other than sanitary engineering. There are no consulting engineers who design sanitary works since all such work is carried on by engineers at some level of government.

The Engineering School of the University of Costa Rica opened in 1941. Only civil engineering is taught. The course extends over six years with students attending half time. During the last two years, the curriculum includes eight hours a week on water and sewerage design and practice. The students get little in instruction in sanitary chemistry, biology or sanitary science. The course in sanitary engineering has been taught for six years. The first-year class now averages about 70 students of whom 15-20 are expected to complete the sixth year.

Engineers and surveyors are licensed in Costa Rica. Two hundred and forty-four are now licensed to practice--about equally divided between engineers and surveyors.

Only five water works operators have attended water works short courses held in other countries. There are two private schools, partially supported by industry, which conduct short courses for training sub-professional technicians, principally in surveying. The impression left by the Ministry of Public Health and SCISP engineers was that these private schools, with the cooperation of the University, could meet any future needs for training water plant operators.

It was the concensus of those with whom the matter was discussed that at least the basic nucleus of well-trained engineers which might be needed for the purely technical aspects of a greatly expanded water supply program now exists and that future needs could be met to a great degree by the University.

Since most of the construction in the past has been by some level of government, there are no contractors who specialize in construction of sanitary works. However, one official stated that there are now more general contractors in Costa Rica than the volume of construction warrants, and should the occasion demand, there would be no problem in placing contracts for an expanded water supply program.

V. PUBLIC AGENCIES DIRECTLY INVOLVED IN COMMUNITY WATER SUPPLY

A. GENERAL STATEMENT

The public agencies which are directly involved in community water supply in Costa Rica are:

1. Ministry of Public Health - Sanitary Engineering Department
2. Ministry of Public Works
3. Inter-American Cooperation Public Health Service (SCISP)
4. Canton Governments
5. Ministry of Economics and Finance - Comptroller General
6. Electric Railroad to the Pacific

Under the provisions of the general water law of 1953:

1. The Ministry of Public Health is responsible for making studies and surveys to determine the need for construction of new water supplies and for expansion, replacement, and betterment of existing water supplies, and for making recommendations to the Ministry of Public Works. Technically, this is interpreted to include the design of all treatment plants and the sanitary aspects of storage and distribution systems (including adequate capacities) and supervision of operation, maintenance and quality control.

2. The Ministry of Public Works is responsible for carrying out the construction in accordance with the recommendations of the Ministry of Public Health, if a municipality is not able to carry out such recommendations.

3. Each municipality is responsible for maintenance, operation, minor repairs, establishing rates for service, billing and collection of service charges all in accordance with the recommendation of the Ministries of Public Health and Public Works and, in the case of water rates and financial management, under the jurisdiction of the National Comptroller General.

Other important features of the law - A Municipality:

1. Must keep water revenues in a separate account and use such funds only for maintenance, operation, repairs and betterment of the system.

2. May not discontinue service unless it provides a public hydrant within a reasonable distance.

3. May charge a penalty of 2% per month for delinquent accounts.

4. May borrow money for expansion or betterments

5. May require builders in new real estate subdivisions to install water mains, sewers and streets, to be built under the supervision of the city engineering department, before building permits are issued.

In actual practice, the functions of the municipalities and the Ministry of Public Health are quite different than contemplated under the law.

B. MINISTRY OF PUBLIC HEALTH

The Ministry of Health has two principal functions: all aspects of prevention, and medical assistance, which includes the curative aspect, i.e. operation of hospitals. Each function is administered by a Director-General who reports to the Minister of Health.

Under the Director General of Public Health are 19 separate departments, sections or offices, one of which is the Department of Sanitary Engineering. There are five sections in this department; potable water, sewerage, construction, environmental sanitation, and surveying. Insect control, chemical and biological laboratories are in other departments. The chemical laboratory of the Ministry examines potable water, food and drinks, and also is responsible for food sanitation.

There is keen competition for budget among the various departments and sanitary engineering has a very small budget.

The Department of Sanitary Engineering staff consists of a Chief who is a trained sanitary engineer, two other sanitary engineers (one each in charge of sewerage and potable water), and one sanitarian. The Construction Section has been primarily engaged in design of health centers. None of these employees work full time.

Thus with a small staff of part-time technical personnel and a very limited budget little effective work is being done at this level to insure the people of Costa Rica ample water supplies of acceptable quality.

In 1954, the Department of Sanitary Engineering made a detailed study of some 34 water supplies (Matamoros Report), but the work has not been continued. No studies of water supply needs or planning of new works or extensions are currently underway.

The last design of any consequence was a rapid sand filter plant for Guadalupe constructed in 1958. Although this plant is now in partial operation, the original design was radically changed by the contractor who constructed it. Nothing is being done in the review of plans prepared by the Ministry of Public Works or by municipal engineers.

All field investigations are made by a sub-professional employee who has had no training in water supply. His principal function is to investigate complaints and collect samples. No routine system of inspections or sample collections is in operation.

The Ministry of Public Health maintains a central laboratory, which makes chemical and sanitary water analyses of samples collected by the inspector. Except for the laboratory of the Water Department of San José, this is the only water laboratory in the country. Only 89 and 44 water samples were analyzed during 1958, and 1959 to date, respectively. Most of these were taken from spring sources or treatment plant effluents, very few being from distribution systems.

Since the provincial governments have no technical staffs in the water supply field, all of the smaller communities and most of the larger ones are dependent upon untrained personnel without any supervision by trained personnel for the operation and maintenance of the water systems.

C. MINISTRY OF PUBLIC WORKS - HYDRAULIC WORKS

The Ministry of Public Works is responsible for the design and construction of highways, public buildings, schools and for the construction of water supplies.

Within the Ministry of Public Works is the Department of Hydraulic Works which is responsible for the construction of all new water supplies (exception San José) and also major repairs and extensions in all of the smaller communities and most of the larger ones with funds appropriated by Congress. Largely by default, this Ministry also designs most of the systems (exception San José, Guadalupe and possibly a few others).

The Ministry has a central drafting and design office. However, each department has a small engineering staff and is responsible for the design of works coming under its particular specialty. The Ministry also maintains a central equipment pool, repair and maintenance shops and a material stock pile.

Each water supply project of the Ministry of Public Works is financed by a specific appropriation by the Congress. No master plan has been developed nor has a system of priorities been established. Pressure from a community is reportedly a big factor in determining which projects are to be constructed.

Good records of existing water supplies are not available since all records of construction prior to 1948 were destroyed in a fire. Currently, a questionnaire survey is underway to secure information on existing water supplies. This survey is about 70% complete.

The Ministry has no reliable estimates on needs to meet backlog, population increases, urbanization and obsolescence. More than

300 requests for new water systems, replacements and extensions, estimated to cost 18 million colones, are now awaiting action by the Congress. The Department estimates that these requests represent only a portion of the actual needs.

Most of the projects are carried out by force account, only six having been built under contract in the past five years. One of these, Guadalupe, was a large project costing over 9 million colones.

Budgets for Ministry of Public Works (Colones)

	Total	Water Supply*
1956	45 million	7,816 million **
1957	35 million	5,434 million
1958	35 million	4,355 million ***
1959	28 million	Very small - total not yet allocated
1960	Budget request contains an item of 20 million for pipe purchase.	

* Materials and labor only
** High because of purchase of pipe in 1955
*** Guadalupe 9.4 million not included

D. INTER-AMERICAN COOPERATIVE PUBLIC HEALTH SERVICE (SCISP)

Since the SCISP activities are confined to demonstration projects, a principal activity in the field of water supply is the well-drilling project.

Prior to 1956, there were no municipal well water supplies in Costa Rica. Particularly in both coastal regions, the distances to spring supplies are great and transmission lines were expensive. River waters are turbid and polluted and require expensive treatment to produce a safe and attractive potable supply. To meet needs in these areas, consideration was given to local ground water resources which previously had been practically unexplored, as possible sources of potable water supply. Accordingly, SCISP inaugurated a demonstration well-drilling program in 1956.

At that time, there was only one well driller in Costa Rica, engaged in drilling private wells and irrigation wells. Therefore, the first phase of the program was largely one to train well drillers. A civil engineer with well drilling experience was placed in charge, and during 1956, fifteen wells were drilled, using one rig. Emphasis was placed on training drillers, although as a by-product, useful wells were completed. Presently, the SCISP program is in charge of an engineer with a staff comprising an engineering assistant, four drillers, four assistant drillers and one mechanic.

Although the Ministry of Public Works owned two well-drilling rigs, neither had been used, and these were turned over to SCISP when the program was inaugurated. SCISP now has four rigs--two percussion and two rotary type-with a trained crew for each rig.

The purpose of this program is twofold: (1) to demonstrate exploratory drilling necessary to map the underground water resources of the country, and (2) to demonstrate the feasibility of developing ground water supplies - particularly for small communities in areas where use of springs or surface water is prohibitive in cost.

To this end three programs are now operating as follows:

1. Municipal Supplies

Thirty-six producing wells have been drilled for municipal purposes in Guanacaste Province, mostly in the western part. Five of these are in the Santa Cruz area, two of which have been developed and are used as a source of supply for a new water supply system. The wells are 100 feet deep with a static level of 13' to 15'; at 600 gpm pumping rate there is little drawdown and no interference although the wells are quite close together. The water bearing gravel apparently is in an old river bed. Five wells were also drilled for the Nicoya system, in the same general section of the province. These are in sandy clay and produce only 50 gpm each. Indications are encouraging for abundant water in coarse alluvium which is believed to occur at unknown but frequent intervals in this entire region.

In the central plateau, principally in the San José area, 22 producing wells were drilled in an effort to find sources of water to augment the San José metropolitan area during the recent severe drought. The wells are mostly small producers (15-50 gpm at depths varying from 100' - 200'). These small quantities of water are apparently from lenses in the volcanic ash (see Section V). One exceptional condition was encountered while test-drilling for a dam site. An artesian flow was encountered in coarse gravel, apparently an old river bed. Six wells are now producing about 1000 gpm which augments the San José supply.

Three wells were drilled for Limón and finished in a fine sand formation. Although difficulty has been encountered with clogging, it is believed that with proper screens and/or gravel treatment, good yields can be obtained in this area.

2. School Program

As a part of a school sanitation program 25 producing wells have been drilled in lower San José Province and adjoining Puntarenas Province. These are equipped with hand pumps. The wells were built primarily for the schools but in some instances serve a few houses. A second school program is just getting started east of the city of Puntarenas. Five wells have been completed.

3. A new program of well points to serve small communities in the west coastal area of the Gulf of Nicoya is under consideration. It is believed that well points will prove adequate to meet the needs there.

Under the present program, SCISP completes the well and the municipality furnishes and installs the pumping equipment and elevated storage. Distribution systems are built in the usual manner by the Ministry of Public Works with or without local financial participation.

In summary, community wells have been completed as follows:

1956 -	24 wells	serving 19,000 people
1957 -	20 wells	serving 16,000 people
1958 -	29 wells	serving 18,000 people
1959 -	12 wells	serving 29,000 people
Total	85	82,000

The figure of 85 wells does not represent an equal number of communities served since in some cases many wells serve a single community. Furthermore, as explained above, the nature of water supply development on this program is such that only a portion of the 82,000 persons listed are believed to be served by water piped into dwellings. In other cases, such as San José, wells serve primarily as a limited emergency supply during droughts.

There are three private well contractors in Costa Rica operating a total of six rigs. They drill irrigation wells chiefly and have drilled no municipal wells.

SCISP has participated in the design and construction of 18 water supply systems, most of which were in the first period (1943-1947) of SCISP operation. Unfortunately, records of this activity have not been located since the Servicio reopened in 1951. Currently, SCISP is not engaged in any water supply design or construction activities.

A second important activity is the pitometer flow surveys in a number of municipalities. Seven surveys have been completed and several more are under way. These reports will be valuable for future water programs in pointing up the consumption characteristics and indicating the magnitude of wastage and leakage that is occurring. Results of the pitometer surveys are given in Section VII-G.

The engineering staff of SCISP consists of one US engineer, four Costa Rican engineers and three surveyors. One of the engineers and one surveyor devote full time to the well drilling program and one engineer is primarily a construction engineer. One engineer and one surveyor are primarily engaged in the pitometer survey. In addition to the two major projects mentioned above, the SCISP engineers are frequently consulted by the Ministry of Public Works and the City of San José, but apparently there is little cooperative activity with the Department of Sanitary Engineering of the Ministry of Health. The Chief Engineer of SCISP also teaches at the University of Costa Rica.

E. CANTÓN GOVERNMENTS

Local water supply management in the capital city is described in Appendix A. The San José Water Department is more adequately and more completely staffed than that of any other municipality.

From a water supply viewpoint at least, the governments of provincial capitals also present atypical conditions compared with the rest of the nation and occupy an intermediate position. The principal apparent distinction between them and other municipalities is the presence, of a chief engineer who is responsible for all municipal public works and utilities, and of more able municipal treasurers. As a result, there is evidence of some local planning in management and engineering. Water bills also are more adequately collected. The improved collection of water bills in these municipalities should perhaps be more basically credited to the cantón council and to the politico-socioeconomic structure of the community since it is evident that failure to collect water bills and other accounts in other municipalities mainly is due to more fundamental factors than the caliber of the occupant of the Municipal Treasurer's office.

The operating staffs of the water departments in most provincial capitals, on the other hand, appear similar in composition and quality to those of smaller cantóns. This, apparently, is due to the simple character of the systems in those provincial capitals which were visited.

The operating staffs of the municipal water departments in all cantóns where no treatment is involved (98% or more of the total number), are remarkably similar in composition. They consist of a "fontanero" (plumber) who serves as superintendent, a watchman for the source of supply and a watchman for the ground reservoir (usually located near the distribution system). As will be described in more detail in Section III.B, cantóns in highland provinces have an estimated average of five water systems, those in coastal provinces have fewer. These multiple systems may have either separate or joint sources of supply, generally each has its own storage reservoir. There is a separate watchman for each source of supply and for each storage reservoir. Up to a certain population size, one fontanero serves the entire cantón. A single fontanero generally serves up to about 1,000 connected services, beyond that he has one or more assistants. In most such cases, his services appear to be confined largely to the central district, the other districts being mainly self-operating. He is usually assisted by several unskilled laborers.

The salary of a fontanero varies in the range of 100 to 600 colones/month ($15 to $90). The salaries of watchmen range from 10 to 125 colones/month ($1.50 to $18.75). The watchmen and the lower paid fontaneros are presumably part-time employees. In two highland cantóns visited, the prevailing unskilled labor wage scale was nine colones/day (8 hr. day for light work, 6 hr. day for heavy work). Those employed by the month presumably are paid at a lower rate.

In Information on the financial details of local water supplies relative to organization and operating staff is provided by the following

data for Alajuela Cantón for 1958. This is one of the few partly metered supplies. Of 7178 connections in the cantón, 323 are metered (4.5%), of which all but 16 are in the central district. The meters are read once each trimester. Alajuela Cantón has 13 separate water systems, all with springs as sources of supply.

1958 Operating Costs - Alajuela Cantón (Colones)

	Central Dist.	All Others	Cantón
No. Connections	3,600	3,578	7,178
No. Meters	307	16	323
Salaries	24,603	-	-
Labor	12,418	-	-
Water Meters - Purchase Payment	16,470	-	-
Maintenance Materials	29,345	-	-
Administrative Overhead	8,284	-	-
Total	91,120	39,874	130,994
Ann. Cost/Service	25	11	18
Less Meter Purchase Payments	4	11	-
Ann. Net Cost/Service Operation and Maintenance	21	-	-

The approximate installed cost of a residential size meter in Costa Rica is 100 colones ($15.00). Except to the extent payment is spread over several years, the meter cost item is mainly a non-recurring expense under the foregoing conditions. Further details on municipal water supply management and practices appear in other parts of this report, especially in Section VII.

F. MINISTRY OF ECONOMICS AND FINANCE

Under the laws of Costa Rica, the Ministry of Economics and Finance is charged with the responsibility of acting on applications by municipalities for approval to borrow money and to change utility rates, tax rates, license fees, etc. Municipalities in turn are required to obtain this approval before taking action.

If a municipality wishes to borrow more than 250,000 colones, Congressional action is also required. Up to the present time, the issue of obtaining approval for long-term loans in any amount is mainly academic, since the only municipality with any long-term debt is San José.

Jurisdiction over municipal water rates in the Ministry is by the Office of the Comptroller General. Within that office it was formerly administered by a Section of Municipalities and Autonomous Institutes. It has recently been transferred to a newly established Office of Economic Studies of the Comptroller General.

A visit to this ministry was of special interest in view of the very low water rate structure in Costa Rica and statements made by a number of municipal officials that the Ministry would oppose applications to raise water rates on policy grounds. This was contradicted in some other municipalities where water rates had been raised, although with considerable delay in some cases. One specific case of disapproval was encountered which was changed to approval two years later. There is also some discussion of interest on National Government policy on water rates in the Rader Report.

As a first step in this visit, legal and jurisdictional aspects were first discussed.

It was pointed out by one official interviewed that under the Water Law of Costa Rica, the Ministeries of Public Works and Public Health are responsible for analyzing the annual expenses of local supplies, on basis of which an application can be filed by the municipality with the "Controleria General" if a change of rate is indicated. According to the Law, this "tariff" should take into consideration the "local resources that assure the value, depreciation, operation, and maintenance of the system of water supply under its control" (Article 11, General Law of Water Supply).

It was considered by the persons interviewed that such service by the other two ministeries is essentially nil. However, neither the former office nor the present one in charge of water tariffs in the Ministry of Economics and Finance was acquainted with the Matamoros Report, which among other things analyzed costs on the basis specified in the Law and which almost consistently found a major deficit.

At the present time, it was explained that municipalities prepare such applications "on their own". Because most of the municipal officials are not qualified to prepare such applications, delay results and the Office of Economic Studies is obliged to render field service. Applications for water rate changes are relatively few in number.

Other laws governing the Office of the Controlleria, of which the Office of Economic Studies is an element, specify that water rates "shall not exceed the effective cost of the service" (page 119, Codified Laws of Costa Rica).

Review of applications for water rate revisions by the Ministry of Economics and Finance involves political as well as technical considerations, since proposed rate changes must be published for eight consecutive days for the purpose of determining local public reaction. In the known case where disapproval action was taken, local officials advised that the people objected. Later, with construction of a new system by the Ministry of Public Works, the objections disappeared or diminished and approval was granted.

In discussing the general policy of the Office of Economic Studies, it was stated by the official interviewed that in nearly all cases in Costa Rica water supplies were operated at less than cost. This was considered desirable in principle, or rather that central government subsidy was considered desirable. However, it was considered that the fears of some municipalities that the central office would arbitrarily disapprove requests for water rate increase were groundless.

Following considerable discussion on whether water should "pay its own way", whether a water authority was warranted, and on the present decrepit condition of local water supplies in Costa Rica, the general viewpoint of the official interviewed on water policy was as follows:

The political objective of Government subsidization, a general principle of government in Costa Rica, is for the more prosperous areas to subsidize the less prosperous areas. In accordance with this principle, some 50% of the cost of local government is provided by direct or indirect subventions from the national government. On present form of national assistance is the arrangement whereby the Ministry of Public Warks constructs and improves local water supplies at national expense. This principle is good and should be continued in force. However, it is recognized that funds appropriated for this purpose are insufficient.

A theoretically ideal arrangement would be for:

1. The Ministry of Public Works to be responsible for constructing all new systems and for additions and betterments in special cases where needs exceeded capital accumulation in the water accounts of municipalities.

2. The water rates charged by municipalities should be adequate to cover replacement needs as well as operation and maintenance. When the system wears out, it should be replaced at municipal expense. Water should be metered to avoid waste.

Other points of interest which were discussed are:

3. In view of the high percentage of delinquent water accounts in many municipalities, the question was posed whether the CES would approve an application to double water rates in a situation where the actual water income amounted to only half of expenses, but where half of the water customers bills were unpaid. It was stated that approval would not be granted because this would place an unfair burden on those who were paying their water bills.

This situation appears to create a theoretical impassé to water rate increases in most municipalities, in view of the high percentage of delinquent accounts.

4. Up to about 30 years ago, there was a law which permitted water to be cut off when water bills were unpaid. This was superseded by another law which prohibited discontinuance of service for non-payment. This law was then amended in 1950 to permit discontinuance of service to the house provided

(in effect) public hydrants are provided in the general area, (Article 8, page 218, Codified Laws of Costa Rica).

At present the cut-off provision of this law is generally not utilized because of the prevailing lack of public hydrants.

In Naranjo Canton, however, where the municipality furnishes electric energy to houses as well as water and a joint bill is rendered, the lights are cut off if payment is delinquent on any portion of the joint bill.

G. ELECTRIC RAILROAD TO THE PACIFIC

The Electric Railroad to the Pacific is concerned with community water supplies only to a limited extent. The City of Puntarenas, the western terminus of this railroad, is remote from a water supply source. The railroad operates a gravity transmission line leading from the famous Ojo de Agua Spring to Puntarenas City (80 kilometers away) and also manages and operates the port facilities and the water distribution system serving the City. Enroute, the transmission line serves two small rural communities and may also supply water for domestic and limited agricultural purposes to a few farms.

The role of this railroad in water supply activities is mainly of interest because it is an autonomous institute (see description in Section IV-B) and its water management policies and practices differ substantially from those of the municipal governments which operate all other supplies.

VI. WATER RESOURCES

The average annual rainfall in Costa Rica is high ranging from 1628mm (64 in.) (Santa Ana) to 4680mm (184 in.) (Golfito) (Records from ten selected stations). There are, however, great variations seasonally in some sections of the country.

In the central plateau and the drainage area of the Gulf of Nicoya, there is a well-defined dry season extending roughly from December through April. February has only a fraction of an inch of rain whereas the wettest month, October, has an average rainfall in the magnitude of 330mm (13 in.).

The central and lower Pacific coastal areas have the greatest rainfalls with less pronounced dry seasons occurring during the same months as in the central plateau. Here, the driest month, January, has an average of 160mm (6 in.), and the wettest month, October, 729mm (29 in.).

On the Atlantic slope, there is no well-defined dry season. The average annual rainfall is in the magnitude 3500mm (138 in.), however, with monthly averages fluctuating from 132 (5") to 505 (20 in.). In Limón, for instance, October is the driest month and December the wettest month.

The northern slope of the Cordillera, which drains into the Atlantic, has an average rainfall in the magnitude of 3205mm (126 in.), and wet and dry seasons following the same pattern as in the central plateau, but with less pronounced difference. Monthly ranges here are of the magnitude of 20mm (1 in.) for the driest month and 470mm (18 in.) for the wettest month.

Surface Water

There would appear at first glance to be ample surface water to meet all foreseeable needs. However, the heaviest concentration of population, of industry and of agriculture is in the meseta central, the area of lowest rainfall and most pronounced dry seasons. Furthermore, many of the sources, both domestic and agricultural, are at relatively high elevations with the result that the drainage areas are quite small above the place of present and potential future use. Another characteristic of this area is the steep grades of the stream beds, which result in rapid concentration of rainfall and very rapid run-off. Thus, stream flows fluctuate greatly not only seasonally, but also daily. As an example, some of the water supplies visited with river sources near the head waters, which were very turbid during and immediately following a rain would be flowing clear a few hours later.

Another complicating factor is agriculture. Coffee, the principal crop, also is most intensely cultivated in the upland region. A considerable quantity of water is used in processing coffee and unfortunately this occurs during the driest months when the supplemental irrigation of crops,

principally coffee, is at its peak. Coffee processing also produces a strong polluting organic waste and many of the processing plants discharge this waste above existing water intakes.

Not only are the flows of surface streams affected by the dry seasons, but also some springs at higher elevations fluctuate substantially during the year.

Unfortunately, stream gagings are practically non-existent in the central plateau. Outside of the area, a few records are available from studies made for hydroelectric development.

In the drainage area of the Gulf of Nicoya, which constitutes most of Guanacaste Province, the pattern of stream flows is the same as in the central plateau. That is, they fluctuate greatly from wet to dry seasons. Much of the land in this region, particularly in the foothills, was at one time heavily forested, however, it has been denuded. This has caused more rapid run-off and less opportunity for replenishing ground water which feeds the springs and rivers. The inevitable result has been greater floods and lower minimum flows in the streams. The area is largely rural with no large concentrations of population and consequently, the quantity of water needed for domestic purposes is not large. There is very little industry. Much of the land is uncultivated or in pasture although this area is said to have good agricultural potential. Some rice, which requires irrigation, is grown in this area. It is understood that a study was made on a proposed irrigation project in this area to be supplied from reservoirs in the mountains, but was found to be economically infeasible at this time. However, with an increasing population in the country and a corresponding increase in need for food and fibre, competition for water in this area is a definite possibility.

In the central and southern Pacific areas, there are many streams and with the very heavy and more uniformly spaced rainfall, there seems to be no problem in the foreseeable future. The area is sparsely populated, there is little industry and no need for water for irrigation.

Likewise, the Atlantic coastal area presents no foreseeable problem for domestic, industrial or agricultural needs.

Ground Water

The many large springs in the mountainous area might indicate large underground water resources. Little is known of these resources since only a start has been made on test drilling (SCISP Program decribed elsewhere).

The Central plateau lies between two mountain ranges, the one to the north being of volcanic origin, with that to the south resulting from upheaval. During eruptions, the prevailing winds were from the northeast carrying the volcanic ash into the plateau. In the

San Jose area, lava, alluvium, volcanic mud and rock from slides were also deposited resulting in a non-uniform deposit of various materials. The lava bed is uneven and therefore the cover is of varying depths up to as much as 700 feet. The volcanic ash, presumably in lenses, is porous and provides a water reservoir believed to extend throughout the valley. The ash is relatively fine and therefore the wells generally produce small yields. The depth of ash also affects the yield of the wells. Generally the yields of wells drilled so far are in the range of 15 to 50 gpm.

An exception is the one instance mentioned elsewhere where an old river bed was tapped and a well producing 1000 gpm was developed. There are no surface indications as to where these underground rivers may occur. Only test drilling will reveal how extensive these formations may be. The Chief geologist at the University believes that main reliance for additional supplies of water for this area will have to be placed upon surface waters and that wells will be useful only to augment the main sources of supply during dry periods such as have been experienced last year and this year. He estimates that the visible supply of surface and underground water from this area may support a population, with accompanying industrial development, not to exceed one million people.

The entire Guanacaste Province is covered with volcanic ash, more uniformly deposited and with much less other material than in the San Jose Area. Drilling to date has indicated water in this ash and in the water-bearing alluvium below the ash. For instance, in Santa Cruz, a well producing 500 gpm (potential yield higher) was developed. Over the entire western part of the province, the layer of ash is quite thick and the potential for ground water supplies is good.

In the eastern and higher portions of the province the water supply prospect is not as favorable. Extensive cutting of forests has had a deleterious effect on springs and dry season river flows as well as on ground water recharge.

The central and south Pacific areas have many streams and water supply should be no problem in the foreseeable future. The only drilling that has been done has been for school supplies. These wells are in alluvium.

The eastern slope presents no problem. The rainfall is heavy and there are many streams. In the areas near the coast, thick alluvial deposits occur which are potentially good aquifers. Limón, the only community of any size on the eastern slope, has a well supply. Some difficulty has been encountered with fine sand. It is believed, however, that with proper development, screens and/or gravel treatment, good yields can be expected in this area. Since there is ample surface water for all purposes, drilling will be resorted to largely where distances to springs or costs of treating surface waters are such that ground water will be cheaper.

The agricultural potential is said to be good in the area, however, irrigation is not in the picture. In fact, drainage appears to be the greatest water problem, insofar as agriculture is concerned.

Under the water Law, the title of all water is in the name of the nation. The agency which controls the use of water is the National Electric Institute. Water for domestic use has the first priority. The Institute grants water use rights and has the power to extend, modify, or rescind such permits for irrigation, power and industry.

In the central plateau the principal users of water, other than municipalities, are the coffee growers and processors. While the processing of coffee is not a consumptive use of water per se., waste waters from processing are sometimes returned to the land for irrigation and then it does become a consumptive use. Because of the importance of the coffee industry to the country's economy, there is apparently considerable reluctance on the part of the Institute to exercise much control over this water use.

VII THE COMMUNITY WATER SUPPLIES OF COSTA RICA

A. SOURCE OF SUPPLY

The present and historic sources of public water supply in Costa Rica are almost exclusively springs. Due to topography, geology and relatively heavy precipitation, the elevated lands of Costa Rica possess a very great number of small, medium and large springs which are utilized for individual, public and agricultural water supplies. Because population development in Costa Rica has been mainly concentrated in the highland areas, both rural and urban communities have generally developed one or more springs as a source of supply.

Even in the foothill and lowland areas, small and large communities have tended to favor springs as a source of supply, though frequently it has been necessary to go relatively long distances to tap a spring source. In coastal Puntarenas Province, for example, the water supply for Esparta Cantón (460 connections) is obtained from a spring reported to be 18 miles distant. In Miramar Cantón (200 connections), it is obtained from a spring about six miles distant, while in Puntarenas City with 3100 connections the source of supply is a very large spring about 50 miles away.

An estimated 95% of the community water systems obtain the water exclusively from springs. Also, San José City and several others obtain their supply from springs, streams, and wells, or springs and streams. In terms of volume of supply, an estimated two-thirds is from springs with most of the rest from streams, and some from wells.

In cases where remote spring sources have been developed, nearer stream sources and ground water resources for well development commonly are available. Under such conditions, the preference for spring sources can be attributed to the following:

1. Tradition. Historically, the bulk of the population has lived in land areas where nearby spring sources are generally available. The more sparsely settled lowland areas were largely settled by highland emigration as highland population density increased and spring water probably has been culturally accepted as more salubrious and more palatable.

2. Wells. Ground water exploration and deep well development appear to have been very recent activities, with demonstration deep well development a current SCISP project.

3. Operation and Maintenance. Spring supplies represent the ultimate in simplicity of operation and maintenance. The typical spring supply consists of a protected spring source, a transmission line, a hillside storage reservoir for equalizing supply and demand, and a distribution system. The source is at a higher elevation than the distribution system and flow is by gravity. There are no pumps and no treatment.

4. Economics. While the economy of a spring source is open to question in some extreme situations, the negligible operating and maintenance costs of spring fed systems and the fact that transmission lines commonly operate under high gravity heads with consequent small pipe diameters, tends to place water even from remote sources in economic equilibrium with more nearby water supply sources. (As one index of high available head, the springs serving the principal system of Sto. Domingo Cantón are 1700 ft. above the town and the average gradient of the conduction main is 4.6%.)

5. Practicability. In all but the larger urban areas, operation of systems requiring treatment and/~~xxx~~ or pumping is of questionable practicability because of labor skill factors, at least under present organizational conditions.

The few non-spring systems appear to have sought other supply sources for the following two basic reasons: (a) full prior utilization of spring resources in the area (metropolitan San José) and (b) obvious prohibitive cost due to remote lowland location (Limón and Golfito). In general, however, the principal effect of lack of available spring resources up to the present may have been to (c) discourage development of community water supplies (in coastal Puntarenas, Limón and Guanacaste Provinces, for example, the percentage of total population served much lower than in the highland provinces) and (d) (probably discourage population development and land occupancy.

B. NUMBER OF SYSTEMS

Neither the Ministry of Public Works or the Sanitary Engineering Department of the Health Ministry have a comprehensive list of public water systems in Costa Rica. SCISP, however, had an incomplete list of districts above 2500 population where water service is provided. During the initial stages of the study, the nearest approach to such a list was in the Matomoros Report (see References), which gives a detailed description of 34 public water supply systems as of 1954. This list was known to be grossly incomplete in view of the omission of many urban areas with residents reported as being connected to public water supplies in the 1949 Dwelling Census of Costa Rica. It was also in disagreement with an estimate of 250 supplies contained in ICA project files.

Toward the end of the visit, a partial list of existing public water supplies was obtained from the Office of Hydraulic Studies of the Ministry of Public Works. This list is currently being compiled from replies which have been received so far over a period of several months from municipalities in response to a questionnaire. While this compilation does not show the number of water supply systems in local areas, it does provide partial information on the number of connections in certain districts and on the percent of the population served. Replies have been received so far from 34 of the 65 cantóns (52%), of which all but one have at least one public water system.

In the course of field work, specific information on 115 public water systems in 23 of the 65 cantóns and in six of the seven provinces (Limón excepted) was collected. This includes every cantón in Cartago

Province, nine of the 19 cantóns in San José Province, three of seven in Puntarenas Province, two of eight in Heredia Province and one of four in Alajuela Province and two of eight in Guanacaste. The number of systems per cantón varied from one in Puntarenas Province and in San José Cantón to 13 in the central cantón of Alajuela Province. Based on detailed scrutiny of the results, it was estimated that there is an average of five systems per cantón in the four highland provinces and one system per cantón in the lowland provinces. An approximation of the total number of public water systems in Costa Rica is arrived at below. It is in almost exact agreement with the round number of 250 in SCISP files.

Estimated No. Public Water Systems

Province	No. Cantóns	Av. per Cantón	Total
1. Alajuela	12	5	60
2. Cartago	8	5	40
3. Guanacaste	8	1	8
4. Heredia	8	5	40
5. Limón	3	1	3
6. Puntarenas	7	1	6 *
7. San José	19	5	91 **
TOTAL			248

* Reflects 1 unserved cantón
** Reflects 1 cantón-wide system

About five percent of the 115 systems in the enumeration were actually semi-public community supplies, developed at private expenses primarily to serve the resident employees of large farms. However, it was not considered practical to separate these from the public supply category since they were larger than some public supplies, and some supplies developed at public expense for small communities are under private maintenance and operation to the extent such services are provided. On the other hand individual deep-well systems developed by SCISP in lowland provinces to serve rural schools, which may also have served a very few houses in the immediate school area, were not included in the enumeration.

In one case, a single system served nearly all of an entire Cantón (San José Cantón), although there were many district-wide-systems. In all but three cases involving urban supplies, rural as well as urban populations were served. On the other hand, many systems served only rural populations.

C. NUMBER OF SUPPLIES BY SIZE OF COMMUNITY

Following a different procedure, the number of supplies according to size of community was determined on a basis of all sources of information. The principal sources consisted of the field notes on the 115 system reviewed in the field and the partial questionnaire returns of

the Ministry of Public Works. Since these information sources in toto did not cover the entire nation, the 35 systems listed in the Matamores report were reviewed for possible additions. These combined sources are still imcomplete for the nation.

Of principal interest in this compilation was the classification of supplies in accordance with ICA Reports Control U-902, a water supply questionnaire sent to the Public Health Offices of USOMs in March 1959. The population groupings in this questionnaire were: Under 2,500; 2500 - 10,000; 10,000 - 50,000; 50,000 - 100,000 and over 100,000. Since the number of supplies serving communities of over 10,000 population in Costa Rica was readily determinable, the practical objective was to distinguish between supplies serving communities of less than 2500 and those serving communities of 2500 to 10,000. For reasons mentioned previously, (Section III-C), it was not considered that the size of a community from a water supply standpoint could be rationally determined in the foregoing two population ranges by using census data in the form of (a) the urban component of a municipality (cantón), (b) the total population or (c) district populations, as sole criteria.

The procedure actually followed was to base the size of community on the reported number of connections to water systems. This procedure was possible as a basis for estimating community populations because the "urban" population component is nearly 100% connected in most of the communities and because of the relatively high per cent-connected of tributary "rural" population.

The Ministry of Public Works at the present time uses a factor of six persons per dwelling in estimating the number of persons served by a house connection. This figure slightly exceeds the national average of five persons per house based on dividing the national "urban" population of 268,286 reported in the 1950 census by the 53,435 "urban" dwellings reported in the 1949 Dwellings Census, but is more likely to be correct than the lower figure because of the probable slightly higher occupancy resulting from a 40% population increase since that time. There is some evidence, however, that both figures are higher than actual occupancy in some suburban areas in metropolitan San José and lower than actual occupancy in some "rural" areas. However, the figure of six was adopted in this procedure.

On this basis, it was arbitrarily assumed that a community in the 2500 - 10,000 size range consisted of an area with 400 to 1600 connections, (three systems with 393 to 398 connections were also admitted). This standard was rigorous compared with those which might occur in other countries where the boundaries of an urban community may be more clearly defined. A community of 2500 population in such an area might be only 50% connected (about 200 connections).

Other conventions and assumptions adopted were:

1. A district was considered as a minimum community unit. That is, if two or three separate water systems served a single district, the number of communities involved was counted as one.

2. Where a single system within the boundaries of a municipality (cantón) served more than one district, the community was considered to be the population group served by the water supply system.

On these bases, it was determined that there were 29 communities of 2500 - 10,000 population in Costa Rica served by a public water supply and 128 communities of less than 2500 population which were similarily served. There was only one city above 100,000 (San José) and none in the 25,000 to 100,000 range. Those in the 10,000 - 25,000 range are listed below. Population figures given are those for the central district except for Tibás Cantón in metropolitan San José where the entire cantón population is presently considered urban and is also served by a single water system. In determining the indicated connected population, 10% of the reported number of connections was assumed to be commercial and industrial since communities in this size range have central business districts of significant proportions. In comparing the indicated connected population with the 1958 census estimate, it should be kept in mind that these estimated populations are subject to considerable revision after the 1960 Census is taken and are materially higher that the known 1950 census results. In the case of Cartago City, this water system also serves a portion of adjoining El Carmen and San Francisco Districts. These two districts had an aggregate estimated population of 5216 in 1958 and were also partially served by two independent systems with 491 connections (2946 equivalent population). The system serving Heredia City is cantón-wide and partially serves an additional census population of over 10,000 outside of the central district.

Number and Location of Public Water Supplies 10,000 - 25,000 Population

City	No. Connections	Indicated Connected Pop.	1958 Population
Alajuela	3600	19,440	17,265.
Cartago	3778	20,400	16,767
Heredia	4130	24,780	16,538
Puntarenas	3270	19,620	20,349
Tibás Canton	2600	14,040	14,106
Limón	*	14,000	21,421

* Number of Connections Unknown. Connected Population in 1954 was estimated in the Matamoros Report at 14,000 in a total population of 16,384 at that time.

Communities in the 2500-10,000 population range (400 to 1600 connections) are listed in a following table. The census populations given is the total (urban and rural) population of the principal district served; some systems served parts or all of one or two other districts and the number of connections is considered to be more valid in these cases than the census estimate as an index of the population of the community served. The entire Escazú Cantón (San José Province) is served by two systems and the cantón census population is listed.

Number and Location of Public Water Supplies - 2500 - 10,000 Population

	Province	Cantón	District	Number Connections	Indicated Connection Pop.	1958 Pop.
1.	Alajuela	Atenas	Atenas	547*	3282	2933
2.		Grecia	Grecia	1036*	6216	5704
3.		Palmares	Palmares	620*	3720	2306
4.		San Carlos	Ciudad Quesada	500*	3000	9613
5.		San Ramon	San Ramon	1045	6270	5596
6.		Naranjo	Naranjo	878	5408	6497
7.		Central	San Isidro	814	4884	3611
8.		Central	San Jose	819	4914	2743
9.		Central	San Rafael	509	3054	2940
10.	Cartago	Oreamuno	San Rafael	685	4110	2940
11.		El Paraiso	El Paraiso	744	4464	5683
12.		La Unión	Tres Ríos	819	4914	4069
13.		Turrialba	Turrialba	1324	7944	19493
14.		Central	San Nicolas	1384	5544	4574
15.		Jimenez	Jaun Vinas	490	2940	5858
16.		El Guarco	El Tejar	537	3222	3603
17.	Heredia	San Rafael	San Rafael	768	4608	2079
18.		Flores	San Joaquin	578	3468	1870
19.		Sto Domingo	Sto Domingo	988	5928	3059
20.		Belen	San Antonio	398	2388	2149
21.	Guanacaste	Central	Liberia	483	2898	7145
22.		Nicoya	Nicoya	393	2358	17493
23.	Puntarenas	Esparta	Esparta	460	2760	3601
24.	San José	Moravia	San Vicente	1204	7224	5880
25.		Escazú	--	1200	7200	9405
26.		Desamparadoes	Desamparados	1324	7944	5321
27.		Desamparadoes	San Miguel	398	2388	3371
28.		Alajuelita	Alajuelita	588	3528	2299
29.		Curridabat	Curridabat	640	3840	3461

* Connections as of 1954 (Matomoros Report)

Summary of No. of Community Water Supplies by Size of Community

Size of Community	No. of Supplies
Under 2500	128
2500 - 10,000	29
10,000 - 25,000	6
25,000 - 100,000	0
Over 100,000	1
Total	164

Partial List Based on Available Records, Total No. of Systems estimated at 250, serving districts in 64 of a total of 65 cantons.

D. INDUSTRIAL AND AGRICULTURAL WATER SUPPLIES

This section deals with industrial and agricultural water supplies separate from community water supplies. Industrial and agricultural water supplies are further considered in Section VI.

Costa Rica has no heavy industry and but little other industry with substantial industrial water requirements. Nation-wide, indigenous food processing accounts for the greatest number of business establishments, with substantial water use in agricultural areas by coffee "beneficios." San José is characterized by light industry, notably the garment trades.

Because of its very humid climate, there is no need for irrigation to meet the basic water needs of principal crops. However, limited supplemental irrigation of coffee bushes is carried on in the central plateau. Some rice is grown without irrigation, due to the humid climate. There is also limited rice irrigation in the lowland.

The processing of coffee beans in rural highland areas represents the outstanding agricultural water use up to the present time. In some of the areas visited, there was much evidence of spring supply sources being used in large quantity by coffee "beneficios". In contrast with community water supplies, where development is at the source and conduction is by pipeline, the agricultural processing water is commonly conveyed by artifical open channels.

E. PERCENTAGE OF POPULATION AND TOTAL POPULATION SERVED BY PUBLIC WATER SUPPLIES

The 1949 Census of Dwellings for Costa Rica among other things lists the total number of urban dwellings in each district and the number served by public water supplies. Of a total of 53,435 urban dwellings, 50,521 in the nation (95%) were reported as being provided with piped public water connection into the home. The remaining five percent were reported as being served by individual or communal wells (shallow) or by individual or communal flowing stream sources, or public hydrants.

The reported percent connected is so high there is little point in detailing this information by cantón. By province, the percent connected was highest in the four highland provinces (range 97% to 100%), and lowest in the three coastal provinces (59% in Guanacaste, 87% in Limón and 94% in Puntarenas Provinces. It was, accordingly, only in Guanacaste Province that a very appreciable percentage of the urban population was not connected to public water supplies. The sources of water supply for those not connected to public water systems differed materially in the three lowland provinces. On the Pacific Coast (Puntarenas and Guanacaste) there were about two users of shallow wells for each user of a stream or ditch source of supply, while on the Caribbean coast (Limón), about 95% used streams and ditches. In San José Province, nearly all of those residing in dwelling units not connected to a public water supply (709 of 866 dwelling units), were in the central cantón (San José City). Of 709,612 of these were in the mixed category of streams, ditches and public hydrants. It is believed the occupants of these 612 dwelling units obtained their water from public hydrants and represented the only users of water from

public hydrants at that time in the entire country. Currently, San José City was the only system reviewed in the field which had public hydrants, and these were few in number.

The field review of public water supplies confirms that this high percentage of connected urban population still prevails in spite of a population increase of around 40% during the ensuing decade. Field inspections, testimony of municipal officials and records of connections, all confirm this conclusion. Furthermore, from best information only one cantón in the nation does not presently have a public water supply (Buenos Aires). Although it had an estimated population of 7,685 at the end of 1958, none of the population was classed as urban in the 1950 Census.

Considerably more surprising, however, is the high proportion of the rural population connected to public water supplies in many areas, especially in the central plateau. The central plateau, which is reported to have 60% of the national population, contains heavily developed rural areas as well as urban areas since it is the main coffee growing area. While the percent of the rural population served with piped connections to public water systems cannot be precisely determined, it is probably about 75% for the central plateau and in some rural districts in the order of 95% to 100%. This area includes all of the highly developed rural areas of Alajuela, Heredia and San José Provinces. In Cartago Province, the fourth highland province, where agricultural development is extensive and land occupancy is high in the valleys, but the topography is more irregular, around 50% of the rural population is believed to be connected to piped public water supplies. Even in mountainous areas it is not unusual to see small diameter mains (as small as one-half inch) along roadsides which, operating under high pressure heads, serve primitive dwellings scattered over considerable distances.

The general rule is that, as long as spring sources of supply are abundant in number and accessible, the rural populations are extensively served with piped public water systems provided the houses are strung along roads or clustered into "caserios."

When spring sources of supply become scarce and remote, however, the rural population served with piped public water systems becomes nil or negligible, a condition which appears to prevail in coastal Guanacaste, Limón and Puntarenas Provinces. In Puntarenas Cantón, for example, which has one urban and six rural districts, five of the six rural districts are totally unserved, while the sixth has a system serving only a small central nucleus. A similar situation applies in Esparta and Montes de Oro Cantóns of Puntarenas Province. Although other cantóns in this province were not investigated, the situation with respect to spring sources of supply is considered relatively unfavorable.

Although rural populations in the cited cantóns are generally unserved, it is noted that even in these cantóns the central or "urban" areas of Esparta and Montes de Oro Districts for example, have piped public water systems. According to the 1950 Census, the "urban" populations were 1925 and 899 respectively, which from one viewpoint places them in a rural category.

Although inquiry into public water supply availability in rural areas is perhaps a side issue from the point of view of a program concerned mainly with the development of urban water supplies, it has special applicability in

Costa Rica from a standpoint of evaluating diarrheal disease conditions. Since there are no urban areas without water supplies and practically all of the urban population in the served communities is actually connected, rural populations provide the only control of comparison group from a water supply standpoint. However, rural populations cannot be selected at random for this purpose, because of the high variation in percent served for this group.

In addition to information on "percent served" which was collected, this factor is included in the current questionnaire census being carried on by the Ministry of Public Works, with listings on a canton wide basis. It was also included in the Matamoros Report, generally on a district basis for individual systems.

Within the past year SCISP gathered information available at central sources in San José on the number of districts in Costa Rica with populations of 2500 or more which were served by public water supplies. The districts were classified: a) known to have public water supplies, b) known to be without public water supplies, c) status unknown. It was concluded that 690,000 people reside in districts in this size range which have public water supplies. This figure includes population unserved. On the other hand, many districts with less than 2500 population, including districts with "urban" populations, are known to have public water supplies.

Based on the analysis of more complete data, including the results of field visists and the 1949 Dwelling Census, it is estimated that not less than 700,000 persons (64% of the total population), are actually served by piped water connection in this predominantly rural nation.

F. AGE OF WATER SYSTEMS

The Matamoros Report contains information on the ages of the specific water supply systems covered in that report. In most cases, information was not gathered on the ages of most of the systems visited.

Age of system has significance in two respects. The years in which systems were first constructed in localities in provinces and in the nation provides historical perspective on public water supply development. On the other hand, the years in which these systems were most recently rebuilt or replaced provides information physical condition and adequacy of supply.

Information available is not altogether satisfactory in satisfying either of these points of inquiry. Much of the information in the Matamoros Report was obtained by questionnaire and it is not possible to evaluate the adequacy and accuracy of the replies. Also, many systems have been improved by the Ministry of Public Works since preparation of the Matamoros Report in 1954. Furthermore, the nature of this replacement and betterments work varies greatly in different supplies. In some systems, it may involve only minor repairs, in others, it may consists of complete replacement of the entire system, as in Heredia City where the old system is now used as a non-potable system.

The oldest system of record in the Matamoros Report is that of San José (1867). The next oldest is that of Heredia City (1870). The system in Cartago City was build in 1872. While it may be surmized that the original system in Alajuela City was built about the same time, the earliest available record is that it was reconstructed in 1936-40. Major additions and betterments are currently under way (1959). The water systems of many smaller communities in the central plateau appear to have been built 50 to 60 years ago, such as those in Alvarado (1900) Tres Rios (1903), Oreamuno (1906), San Isidro (1907), Belen (1909) and Grecia (1907). Others show more recent dates (1930 to 1955); in many cases this may represent reconstruction, replacement or other improvements.

The water systems of communities in the coastal provinces appear to have been built more recently (1930-1955), than those in the highland areas except for Liberia* (1904) and probably those of the long established port towns of Limón and Puntarenas. The Limón** system is reported to have been reconstructed in 1928. The present Puntarenas City system dates from 1936.

G. PER CAPITA WATER USE

1. Flat Rate Use

Matamoros Report. Per capita water use was reported in the Matamoros report for the 34 public supplies reviewed. In most cases these figures appear to have been obtained by measuring or estimating the flows captured at the spring sources of supply and dividing these by the populations served. The municipalities supplied information on the number of connected houses and may have supplied it for the population served. However, of 15 supplies checked in the report, the population served equaled 5.6 times the number of connected houses in 10 of them, indicating that a standard factor was applied in most cases. It is not known how this standard factor was obtained for 1954 conditions. (If urban populations from the 1950 Census are applied to the number of urban dwelling units reported in the 1949 Dwelling Census, a national average of 5.0 persons per dwelling is obtained. The range by provinces is from 2.9 in (Limón to 6.0 in Alajuela).

In these 34 supplies, the maximum per capita consumption in municipalities was 932 lpcd (246 gcd) in Abangares and the minimum was 90 lpcd (24 gcd) in San Rafael (Heredia). The average was 447 lpcd or 118 gcd.

The 1950 Census reports an urban population of 803 for Abangares and the population served in 1954 was 835. There is no idication of industrial water use in this community and but little commercial or public buildings use (only 12 of the 161 connections were non-residential). It was a

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* Liberia distribution system rebuilt in 1956 - 444,734 colones 3620 m of pipe serving 8000 people.

** Limón-350,936 colones reconstruction involving 2,086 m pipe serving 23,000 people reported by the Ministry of Public Works, 1956.

relatively new system at the time, having been constructed in 1942 and substantially improved in 1954.

Abangares is in a coastal area while San Rafael is in a highlands area. However, other communities with very high per capita use rates are in highlands areas and some with low rates are in coastal areas.

Pitometer Survey. The pitometer surveys of SCISP provide further information on per capita water use. Beginning late in 1957, and continuing through or beyond 1959, SCISP is determining flow characteristics in transmission mains with recording pitometric equipment in a number of carefully selected local water systems. The principal objective appears to be to obtain data which can be applied in future design to these and other similar systems.

Continuous records are taken for a 28-day period in each supply, using 24-hour recording charts. Converted into flow rates, these results are plotted on daily graphs, and the maximum, minimum, average and total flows are also listed. Average daily flows are also plotted on a 28-day graph to show diurnal and weekly variations.

In order to obtain data on per capita water use, a current census of the number of connections, class of connected establishment and the number of persons in each house is made if not available from other sources. All studies completed to date are for flat rate systems.

The communities on which studies have been completed so far are intermediate in size, ranging from 300 to 1000 connections. Currently, a study is underway in part of a large system (San José).

As a sample of national conditions, the study unavoidably is somewhat biased. The pitometer equipment can operate satisfactorily only where the sampling point is under pressure (full flow); it is not designed to function under open channel flow conditions. To insure avoidance of open channel flow conditions in the transmission mains, supplies where major parts of the distribution systems provide intermittent service are avoided. As a result, the communities selected for study generally are those where additions and betterments to the systems have been recently completed by the Ministry of Public Works and where all or most of the distribution system is providing continuous 24-hour delivery.

Results are currently available for eight systems located in four provinces (three highland and one coastal). In all but one of these (San José) there is no significant use of industrial water. Per capita consumption ranged from 74 to 113 gcd in these systems, averaging 95 gcd. This is slightly lower than the average of 118 gcd in the Maloney Report.

The nature of these small water systems is such that there should be essentially no consumption of water for useful purposes around 2 AM, which is in the period when flow was at a minimum in all the supplies studied. That is, in supplies where delivery to all services is continuous, these minimum flows provide an index of water loss from waste and leakage. Where delivery is intermittent, a portion of the 2 AM flows may represent the filling of private storage tanks for use in daytime hours.

The results reported for these eight systems from this standpoint were analyzed. The ratio of minimum (2 AM) flow to average flow in the seven flat rate systems varied from 0.1 (El Paraiso) to 0.65 (Guadalupe), with a median of 0.50. In San Jose (42,000 persons sample), the average per capita consumption was 95 gcd and the ratio of minimum to average flow was 0.4.

The median result of 0.5 indicates that, theoretically, 50% of the water supply is lost to waste and leakage in these seven supplies. If the minimum consumption rate in the supply having the lowest ratio (0.1), is arbitrarily charged to leakage, and applied to the other seven systems, the factor of waste in the median supply represents 40% of average flow. This the lowest ratio (0.1) was widely separated in scale from all others, the next lowest ratio being 0.35.

Subtraction of minimum flow from average flow as a technique toward estimating net useful consumption yielded the following results:

System	PER CAPITA CONSUMPTION (GAL)				
	Gross	Rank	Net	Rank	Ratio
Tres Rios	113	1	57	2	-
Sto. Domingo	106	2	48	6	-
San Rafael	98	3	49	5	-
El Paraiso	96	4	85	1	-
San José	95	5	57	2	-
Canas	81	6	53	4	-
Tilaran	74	7	44	7	-
Guadalupe	n.a.	-	-	-	0.65

The system with the lowest minimum flow had the highest net per capita flow. With the exception of this system, all other supplies were closely grouped in net per capita flow (range 44 to 57 gcd).

It would be misleading, however, to imply that in the order of 50 gcd is actually consumtively used or needed. All but two of the communities involved were visited in the field. San Rafael is a rural community without a central nucleus in which the houses are stretched along a road for several miles. The system has a connected population of 2112. It is an agricultural community with farming carried on in very small parcels. There are no flush toilets in the houses and minimum plumbing of any type. In some houses, the plumbing consists of a single faucet on a porch, in others, there may be two or possibly three faucets. It is doubtful if much water is used for stock raising. Under these conditions, a figure of 20 gcd is considered a liberal estimate of actual net water need for personal hygiene and general household purposes. If the water had to be carried into the house from a nearby source, it is more likely that actual water use would not exceed 25 gpd for a family of five, or five gcd. This, of course, would represent less than optimum use for diarrheal disease control purposes.

However, the gross water use in this community was 98 gcd and the net water use was 49 gcd after deducting minimum flow.

2. Metered Water Use

As described in more detail in another section, a few water systems in Costa Rica are wholly or partially metered. In two cases, data on water use based on meter readings were obtained.

In Puntarenas City, which is entirely, or almost entirely metered, the Electric Railroad to the Pacific (owner and manager of the system), published figures on per capita water consumption in 1956. This system sells a considerable quantity of water to ships and commercial establishments, as well as to residences.

Gross per capita consumption based on transmission main flow measurements amounted to 111 gcd, based on 3092 connections, a population of 15,917 and an average of 5.2 persons per family. Average use by residential premises amounted to 500 gpd per connection or 95 gcd. It is possible that the true average per capita residential consumption was somewhat less since there is no evidence that commercial services were excluded from the calculations and it is noted that where meters are installed in Costa Rica, two or more adjoining houses owned by the same person may be served by a single metered connection.

Information was also furnished on water consumption for 323 metered premises for the trimester ending in March 1959 in Alajuela Cantón. Using a factor of six persons per connection, as suggested by this municipality, per capital consumption in residential services was:

	Number Meters	Per Capita Consumption (gcd)
Central District Residential	211	103
Public Housing (Urban)	51	71
Other Districts	8	70
	270	

The remaining 53 meters were for commercial and industrial premises. Daily consumption per service was:

Location	Number Meters	Daily Consumption per Service (gpd)
Central District (City)	45	1190
Other Districts	8	3540
	53	

Average daily consumption per service in the 53 commercial and industrial services was about twice that of the residential services.

Alajuela Cantón is in the early stages of a phased program of metering. It was stated that the premises now metered were specially selected on suspicion that they were high users of water.

H. INTERMITTENT SUPPLY IN DISTRIBUTION SYSTEMS

Intermittent service in distribution systems is a common occurrence in Costa Rica and is closely linked with water waste. That is, in the absence of water waste and to a lesser extent leakage, as indicated by excessive per capita consumption relative to true need, there are few if any supplies in Costa Rica which are not capable of continuously supplying water throughout all parts of the distribution system. To the extent these deficient systems may exist, they would tend to be special cases, such as where there has been phenomenal recent population growth (Metropolitan San José), or a few houses in a community located on very high ground compared with that of the storage reservoir.

There is also a tendency, for a vicious cycle to develop in many cases, although there is no clear cut correlation. Waste creates intermittent supply conditions, these conditions in turn encourage people to store water on the premises in oil barrels or otherwise. When the water flows from the faucets only at night, the faucets are turned on before retiring and left open all night. The water stored in this manner is generally only a very small fraction of that which overflows to waste. This increased waste in turn generates longer lasting and more extensive intermittent pressure conditions. To a minor extent, this cycle may be partly offset by curtailment of leakage as a result of low pressure conditions and by reduced flows through faucets and other outlets which may be left continuously open under all sets of conditions.

A consistent relationship between intermittent service and the history of improvement projects by the Ministry of Public Works was noted in many outlying supplies. Largely, the supplies where satisfactory pressures were reported currently were supplies where additions to capacity had been recently carried on by the Ministry.

Due to marked differences in elevation within the area served by some systems, localization of intermittent service to higher parts of the system was common. Thus, it was possible to obtain two different answers to inquiries about pressure conditions from local residents, depending on place of residence.

The presence of oil barrels for water storage was employed as one index of intermittent delivery conditions. In more prosperous areas, inquiry was also made as to elevated storage facilities and lift pumps within dwellings. These private storage facilities did not always provide satisfactory indices. In a rural community with intermittent service in some parts of the system but with few or no oil barrels, cost was an inhibitant. The cost of an oil barrel is 30 colones and the in-place cost including modification of house plumbing is about 40 colones ($6.00); equal to the water bill for nearly 3-1/2 years.

Use of any water storage facility was prohibited by ordinance in some small communities. These ordinances were enforceable because the water supply manager was a one-man plumber monopoly. While this did not prevent storage tanks from being filled by hand it did serve as an effective curb.

Intermittent service in outlying areas was reported or observed in the following communities during field investigations:

Alajuela Province

1. San Rafael de Alajuela Cantón (Some houses have no water all day in spite of recent improvements to capacity).

Cartago Province

2. Cartago City, (Extensive intermittent service areas--many oil barrels).

3. Oreamuno Cantón, (Intermittent service in high part of central district and in Potrero Cerrado and Sta. Rosa).

4. El Guarco Cantón (Very poor delivery conditions in main system serving El Tejar, San Isidro and part of Tobosi. Service only at night in one-half of El Tejar).

5. Turrialba City (Intermittent service in higher parts of city. Half of population is without water four hours per day. Twenty-five percent of entire city uses oil barrels).

Heredia Province

6. Sto Domingo Cantón (Intermittent service from 7 AM to 2 PM in dry season and two hours in mid-morning in wet season in Sto. Domingo Dist., Sta. Rosa, Sto. Tomas and upper San Vicente. High demand in dry season may be largely due to many flower and vegetable gardens.)

Puntarenas Province

7. Puntarenas City (A long narrow city with no flow in mid-morning at ground level faucets during field visit in fartherest half of system).

Guanacaste Province

8. Liberia: (Flat topography and low elevation of distribution tank result in low pressures throughout the city during dry season when water use is high.)

9. Cañas: (Pressures low during peak daily use throughout the year and aggravated during dry season.)

10. Information on pressures in the nine systems in the San José Metropolitan District will be found in Appendix "A".

11. The Matamoros Report also reported on delivery conditions as they existed in 1954 in the supplies surveyed. Of a total of 30 supplies responding to this item in the questionnaire, 17 reported deficient delivery and 13 reported satisfactory or "regular" service.

Average consumption in the 13 deficient supplies was 103 gcd, in the 17 other supplies it was 134 gcd, or about one-third greater. In view of the high per capita rate for the intermittent delivery supplies, the principal effect of providing continuous delivery appears to be to substantially increase waste and leakage. However, it is likely there is also some increase in the quantity of water used for personal hygiene as well.

I. DESIGN CRITERIA

All of the water supply design in Costa Rica is by engineers employed at some level of government. There are no private consulting engineers in the waterworks field in Costa Rica.

In San José, the City Engineers Office is responsible for design. In nearly all other communities, designs have been made by the Ministries of Public Health and Public Works, mainly by the latter. The relationship between these ministries has been discussed elsewhere. In a few other larger cities, some extensions have been designed by the city engineering departments.

Distribution Systems:

The distribution systems generally are designed for a consumption of 80 to 100 gcd for the estimated population in 20 years and a maximum hourly demand of 1.8 times average daily demand. Ordinarily, there is no added quantity for fire protection. Fire hydrants are common in only the larger systems (10,000 population and up), but they are very small in size and are served only by street mains sized for domestic demand. Guadalupe's new system has a fire hydrant in each block in the commercial area, and hydrants are two blocks apart in the entire residential area. This is the most complete system in the country insofar as fire hydrants are concerned. Usually no added quantity is provided for industrial demand. In San José, limited provision is made for industry by zoning. Adequate water supply is a prerequisite for industrial location, even though there is no evidence that industrial demand is considered in system design.

The difficulty of following rational design principles under prevailing water use practices is exemplified by conditions discussed in the Matamoros Report. The actual effect of designing water systems to serve population requirements 20 years in the future in Costa Rica is to increase per capita water consumption to a level where a large part of the future reserve capacity is utilized by present excess consumption. This situation is further illustrated by the fact that, while per capita water use is excessive in systems with intermittent delivery, it is 30% higher in supplies with continuous delivery (Section VI-K of this report). This incremental increase alone is considered adequate to satisfy net community water needs before making allowance for waste and leakage.

Much small diameter pipe, 1/2" to 4", has been used in distribution systems in the past. However, the trend is towards larger pipe. Guadalupe has a minimum main size of 4" and San Jose is using a minimum pipe size of 4" on all replacements and new construction. Pipes of 4" diameter and greater

have usually been cast iron. Smaller pipe is usually galvanized steel. Cement asbestos was used in the new Guadalupe transmission main. This is only a year old and therefore, there has been practically no experience with this type of material. Since cement-asbestos pipe costs about the same as cast iron and both must be imported, there has been little interest in it. The oldest record of cement-asbestos pipe in Costa Rica is of two kilometers of 6" diameter transmission main installed in the El Paraiso system in 1951. Its present condition is not known. San José and Liberia have used a small amount of reinforced concrete in transmission mains.

House connections are usually one-half inch galvanized steel with rigid connections to the main. Guadalupe and San José are now using flexible connections on all new mains.

Storage

There are no well-defined standards on storage. Guadalupe has about seven hours of storage with an assured flow into storage sufficient for ordinary peak flows. San José has a total of four hours storage which is inadequate for peak flows.

As previously mentioned in Section VII-A, about 95% of the systems have springs as sources of supply. The systems consist of a source of supply, a gravity transmission main leading to a ground storage reservoir at an elevated site near the distribution system and a distribution system. Delivery through and from the distribution system is provided by hydrostatic head in the ground storage reservoir. Systems with surface sources of supply also operate without pumps in most cases and are similar to the spring systems except for the source of supply.

In some systems with intermittent delivery, inspection of the ground reservoirs during late morning hours revealed that they were often empty and that supply to the distribution system was limited at such times to direct flow from the transmission main. Since the transmission mains are often quite long and the ground reservoirs are relatively small and hence economical to construct, provision of adequate reservoir storage capacity in such cases can be more economical than providing increased capacity in the transmission main. Also, improvements in distribution system capacity under "empty reservoir" situations can only lengthen the duration and frequency of intermittent delivery conditions.

For this reason, the systems reported on in the Matamorous Report also were reviewed with respect to the per capita storage volume provided by ground reservoirs in: a) systems with satisfactory and b) with unsatisfactory distribution system delivery characteristics. In some of these systems, auxiliary storage was also provided at the source of supply; this was not included in the tabulation which follows. For reference purposes, the indicated volume of storage which should be provided for most economical transmission main design is estimated to be in the general order of 33 gcd for systems with an average per capita water consumption of 100 gcd, or about 40 gcd rounded off after providing a small amount of reserve storage. For a system with a water consumption of 200 gcd, the required storage volume would be twice as

much. These figures are based on the assumptions that the daytime 12 hour consumption rate is twice the average 24 hour consumption rate and that the rate of flow in the transmission main is uniform.

Delivery Conditions	Number of Systems	Average Reservoir Storage Volume Gallons Per Capita
Satisfactory	12	50
Unsatisfactory	11	21
Unclassified	3	5
Incomplete Data	4	-
Total	30	--

These data demonstrate a correlation between intermittent delivery and lack of reservoir storage capacity and indicate that in some inadequate systems at least, more adequate delivery could be achieved at economical cost by providing more storage reservoir capacity. However, it is noted that two of the 12 "satisfactory" systems had reservoir storage capacities of only 8.5 and 9 gallons per capita, indicating a large capacity of,and possibly a short length of transmission main. Conversely, one of the "unsatisfactory" systems had a reservoir capacity of 47 gcd indicating excessive water waste or leakage, a grossly inadequate distribution system and/or lack of reservoir flow elevation. In this particular case (Puntarenas City), the per capita consumption rate is believed to have been normal at the time the Matamoras Report was prepared. The distribution system, on the other hand, is known to be unusually long and narrow and the storage reservoir is probably remote.

Treatment

Because of high turbidities at times, plain sedimentation tanks precede slow sand filters and usually are designed for four to six hours theoretical detention. With no collecting weirs and lack of baffling, actual detention time in deep basins is much less. Outlets are usually simple orifices or pipes.

Slow sand filters are designed for rates of 4-6 mgad. The minimum sand depth is 12" and the maximum usually is 18". Either local river sand or beach sand from the Pacific Coast is used with effective sizes ranging from .25 to .40 mm. Little attention is paid to the uniformity coefficient.

Only one rapid sand filter plant has been built (Guadalupe 1958). Following are the design features:

Flash mix

Mechanical floculator 30 min. detention.

Settling basins - theoretical detention four hours. These have short overflow weirs.

Filtration rate 1.9 g/ft^2/min.

Sand-24" depth, effective size .35mm.

Air and water wash-0.47 mg of clear water is required to wash the filters. Under present operating conditions this is more than 13% of the plant output.

J. WATER QUALITY

The three generally recognized indices of water quality in potable water systems may be classified as:

a. Evaluation based on appraisal of: physical characteristics and facilities, operations and maintenance practices and sources of supply. Where the source of supply is polluted, design and operation of treatment methods and practices is involved.

b. Presence, adequacy and reliability of disinfection equipment, with or without other treatment.

c. Results of bacteriological and chemical analyses.

1. Physical Facilities

The 95% of Costa Rica's potable water systems which have springs as a source of supply probably merit high ranking in freedom from contamination hazard. The springs are generally at high elevations with few or no habitations above them and those visited were well protected against entrance of contaminated surface and shallow subsurface waters. There are no pumps or suction lines in these systems. Storage reservoirs tend to be either entirely above ground or only partially depressed in shallow excavations on hillsides. Depths of cover of transmission mains and distribution systems tend to be shallow, with consequent lessening of ground water contamination hazards.

While it is not intended to imply that all elements other than the distribution systems are structurally perfect from a standpoint of contamination hazard, the principal weakness in terms of water quality lies in the distribution systems and house plumbing systems. While these might be generally satisfactory from a sanitary standpoint under continuous pressure conditions, the wide-spread prevalence of intermittent pressures in distribution systems and, in some municipalities, of consequent underground storage tanks in buildings as elements of pneumatic pressure systems, introduces physical contamination hazards which are difficult to appraise. To these are added back siphonage hazards, especially those within multifamily dwellings and urban commercial structures, which are also created by negative pressure conditions in distribution lines and building plumbing systems.

The fact that intermittent delivery and negative pressures are seldom systemwide, that plumbing hazards vary from building to building and that the age and condition of distribution lines, exposure to leaky sewers and contaminated ground water conditions, can vary widely within different parts of a single distribution system, indicates that contamination of the water supply is likely to be sporadic in occurrance and scattered in location. As a result, it is possible for limited bacteriologic sample collections to be made

over long periods of time at favorable locations, or even at random, without revealing serious contamination in unsampled elements of the system.

The conclusion, based on physical appraisal of typical systems, is that localized portions of many distribution systems are highly suspect, but that definitive evidence is lacking as to prevalence and importance of this contamination.

As far as known, there are no proven records of water-borne disease outbreaks arising from these distribution lines and house plumbing system defects, but it is questionable whether adequate investigations of this subject have been performed.

2. Disinfection Equipment

Only four systems are known where chlorination is actually being carried on. (San José, Desamparadoes, Guadalupe and a company-owned water system at Golfito). All four rely partly or wholly on surface supply sources and chlorination is carried on at the treatment plant at low dosage rates (combined residuals). Except in San José, there is no evidence of free available chlorine residuals which might provide some protection within distribution systems.

Ten systems are reported to have chlorination equipment, but due to breakdown or lack of chlorine, six chlorination systems are not in operation.

3. Results of Bacteriological and Chemical Analyses

San José maintains a laboratory for quality control (See Appendix "A"). The only other water laboratory in the country is that of the Ministry of Health. There is no regular schedule of sampling and with the very few samples examined for bacteriological quality (89 and 44 in 1958 and in 1959 to date), there are insufficient data for making a general appraisal of sanitary quality of water. The Ministry of Health makes no analyses on supplies where past records have shown heavy contamination. Thus, most of the current sampling is from springs or treatment plant effluents.

The surface water supplies visited all require complete treatment to make them potable. Most of them carry a high bacterial content and all are turbid following rains. All carry colloids which pass through the settling basins preceding slow sand filtration, and in some cases even pass through the filters. No surface supply, after filtration, is deemed satisfactory by the Ministry of Health without effective chlorination.

Data on mineral quality also are limited. The surface waters and spring supplies for which analyses are available are generally of good mineral quality from the standpoint of alkalinity and hardness. Sulfates are rather high in a few instances. Some of the ground waters which have been analyzed are highly mineralized, however, most were of usable quality.

K. CORRELATION BETWEEN DIARRHEAL DISEASE AND AVAILABILITY OF PUBLIC WATER SUPPLIES

It was impossible to establish any definitive correlation between the availability of public water supplies and diarrheal disease levels during the course of our brief, reconnaissance study.

In the three provinces (of a total of seven provinces in the nation) which have the highest percent of total population served, the five year average mortality rates for gastroenteritis and for total infant deaths were significantly lower than in the other four provinces (See Appendix B). The "low rate" provinces were Alajuela, Heredia and San José.

However, the rates were disproportionately high in Cartago Province, which occupies an intermediate position in "percent served". The provinces where the total population is much more inadequately served (Limón and Puntarenas), had only slightly higher rates than Cartago, although materially higher than in the "low three" provinces. The province which appears to be most inadequately served (Guanacaste), had the lowest reported gastroenteritis rate and had essentially the same infant mortality rate as the most favorable province.

The only cantón of 65 in Costa Rica which is unserved by a public water supply (Buenos Aires), had the lowest gastroenteritis and infant mortality rates amont the seven cantóns in its province (Puntarenas). The gastroenteritis mortality rate in this cantón was less than half the provincial average and was materially lower than the national rate (106 vs 138). The infant mortality rate also was materially lower than the national rate. These results are for the five year period 1953-57.

Results obtained from this limited comparison indicate that the establishment of any clear cut relationship between diarrheal disease and availability of water based on piped connections to dwellings places demands a far more precise study with primary reliance on morbidity rates, obtained by special study. The fact that virtually all urban populations are connected to public water supplies, that about half of the rural population is similarly served and that the unserved population is mainly scattered and hot segregated in vital statistics records, precludes the possibility of developing a large enough comparison group for satisfactory statistical analysis of mortality records (See Appendix B).

VIII. FINANCIAL CONSIDERATIONS INVOLVED IN WATER SUPPLY

A. PRESENT FINANCIAL STRUCTURE

The established financial pattern of community water supply development in Costa Rica is for all or most of original cost of construction and for principal replacements and additions and betterments to be paid from general funds of the National Treasury on a basis of line items in appropriation acts. The work is performed by the Ministry of Public Works. It is understood that each line item covers specific work in a specific community and that projects are selected on a basis of community interest, technical judgement of the Ministry of Public Works, and the interest and prestige of individual congressmen.

Local communities, on the other hand, are basically responsible for the management of existing systems, including operation and maintenance and minor repairs. These management costs are paid from general funds of the municipality as received from water revenues, local tax collections, and subventions from the national government.

Due, perhaps, to steadily retrogressing physical conditions in community water supplies, and to lack of increased appropriations to the Ministry of Public Works to cope with these conditions, there appears to be an increasing tendency on the part of the Ministry of Public Works to expect municipalities to shoulder a part of the replacement and additions and betterments burden. This includes not only direct local participation in the cost of specific projects financed primarily with national appropriations, but also a tacit understanding that some types of improvements (such as installation of water meters) are a 100% local responsibility. Analysis of records of the Ministry of Public Works for water system improvements completed in 1954-57 shows that local contributions were involved in 26 of 102 projects. These contributions amounted to 532,924 colones (about $80,000), or 4% of the total cost of 12.6 million colones (about $1.9 million). Since the water revenues received by most municipalities in their general fund accounts amount to less than outlays for operation and maintenance, these local contributions were derived essentially from other than water system receipts.

In all systems visited with phased programs of water meter installations, scheduled financing was from local funds.

Except for the City of San Jose, there appear to be no local bond issues or other long-term debt liabilities for water system improvements or any other public improvements. Availability of short-term credit, in the form of deferred payment agreements in connection with materials and equipment for water system improvements, especially for water meters and their appurtenant parts, was noted. However, the indicated cost of such credit was high.

SCISP also has paid part of the construction cost of some public water system improvements. Its role in this respect, however, has

been minor relative to total need and total activities over the gross period of 17 years in its history.

B. CONSTRUCTION COSTS -- PER CAPITA AND FUTURE

Per Capita Cost

Detailed construction costs were difficult to obtain. Practically all of the water works construction is done by the Ministry of Public Works; hence, this is the only source of information available. Detailed breakdowns were not available; therefore, in most cases, this discussion must be in generalities. As stated elsewhere, the vast majority of the water supplies are simple, consisting essentially of a spring, collection tank or box, a transmission main, a storage reservoir, and a distribution system. The spring, collection tanks, and storage reservoirs are of concrete and are relatively inexpensive. By far the greatest part of the cost is in the distribution system and, occasionally, in the transmission main. The cost of the latter fluctuates widely, depending upon length, and thus materially influences any per capita cost figures.

In 1956 the Public Works Ministry constructed 19 "new" distribution systems at a cost of 2,760,000 colones to serve a population of 56,811 at an average per capita cost of 71 colones.

In 1957, 23 systems serving 44,451 people, were built at a total cost of 4,511,000 colones, or about 102 colones per capita.

In 1958, 19 systems were built to serve 46,049 people which cost 6,007,320 colones, or 130 colones per capita.

The above represents costs of labor and material only, and the Ministry of Public Works estimates that to reflect true costs, 25% should be added to cover engineering administration, maintenance, depreciation of equipment, transportation of material, and other costs.

Many of the foregoing projects represent extensions of existing systems to serve new districts. Another group represents practically new systems replacing inadequate and deteriorated existing systems, while still another group represents new systems serving previously unserved small communities. An analysis was made of the 1957 projects as follows:

1957 Ministry of Public Works
Projects - All Types

22 Projects -- Cost per Capita -- Colones

Under 50	--- 2	Lowest 34 colones
50 - 100	--- 6	
100 - 150	--- 5	
150 - 200	--- 3	
200 - 300	--- 4	
Over 300	--- 2	Highest 336 colones

Average 102 colones

25 Projects -- Colones per Meter of Pipe

Under 10	-- 2	Lowest 8 colones
10 - 19	-- 4	
20 - 29	-- 9	
30 - 39	-- 2	
40 - 49	-- 5	
50 - 59	-- 2	
60 - 69	-- 0	
70 - 79	-- 1	Highest 75 colones

Average 30 colones

Range of Population Served -- 22 Projects

Under 500	-- 6
500 - 1000	-- 3
1000 - 1500	-- 6
1500 - 2000	-- 2
2000 - 2500	-- 2
4200	-- 1
10,000	-- 1
12,000	-- 1

Lowest Population - 203
Highest Population - 12,000

Meters of Pipe per Capita -- 22 Projects

Under 2.5	-- 3	Lowest .67 meters
2.5 - 4.9	-- 4	
5.0 - 7.4	-- 6	
7.5 - 9.9	-- 5	
10.0 - 12.4	-- 2	
12.5 - 15.0	-- 1	
Over 15.0	-- 1	Greatest 15.2 meters

Average 8.65 meters

The wide fluctuation in per capita costs reflects the varying lengths of transmission mains, the nature of the community, i.e., whether closely built up or with houses relatively farther apart, and the degree to which the project provided a complete system. It will be noted, however, that over half the projects fell in the range of 50-150 colones per capita and that the average per capita cost of all projects was 102 colones. Adding 25% for administration and overhead, the average per capita cost is 127 colones ($49. U.S.).

Since the costs are for material and labor only and a standard minimum wage prevails, the costs per meter of pipe in place reflect mainly differences in pipe sizes for individual projects.

Populations served range from 203 to 12,000 with 15 of the 22 projects in communities having populations under 1500.

The 1956 averages are influenced by two larger projects with very low costs per capita. These represent partial reconstruction of existing systems and do not reflect true per capita costs. Eliminating these two projects, the net cost per capita would be about 90 colones.

The 1958 figures are greatly influenced by one large project, which had nearly 45% of the population served by all projects, and with relatively high per capita costs. This project represents a complete replacement of an old system. If this project were eliminated, the net per capita cost would be 111 colones.

The per capita cost of providing water in Costa Rica is very low compared with U.S. costs. This is to be expected for several reasons: (1) Little or no provision is made for fire protection and industrial use. This permits smaller pipe sizes. (2) Source of supply development is relatively inexpensive. (3) Treatment is seldom required. (4) In the more populous areas, sources of supply up to the present have been relatively nearby and the transmission mains are relatively inexpensive. (5) Except for a few recent small well supplies, all systems are supplied by gravity, and there are also no elevated storage tanks. In most cases, the difference in elevation between source and consumer is large, permitting small pipe sizes. (6) In the more populous areas the lots are small and houses are close to each other, making the number of persons served per connection high. This permits smaller pipe sizes. (7) Labor is cheap.

As an illustration of the cost advantage of the simple spring gravity systems, following is an example of a recent well supply:

Santa Cruz --- Constructed in 1958
Population 6,649 (1958) - Design Population 8,000 - Costs in Colones

		% Total
Elevated Tank	82,000.	18
Distribution System	250,000.	56
Pumping Equipment	65,200.	14
Wells (2)	52,200.	12
	449,400.	100

While the distribution system is a replacement and does not represent a completely new system, the above illustrates the appreciable added cost (44%) where wells with elevated storage are used.

In making an estimate for the future, higher costs must be anticipated as follows: (1) Additional sources will be farther from the municipalities than present sources, necessitating longer and larger transmission mains. (2) More well supplies will be used, particularly in the coastal areas. (3) Streams will be used to a greater extent,

necessitating expensive treatment plants. As a basis for estimating costs for future work, it therefore seems reasonable to assume substantially greater per capita costs, and the following discussion is based upon a 50% greater per capita cost than was indicated by the analysis of the three years -- namely, 200 colones ($30.) per capita (rounded off value). This figure is, if anything, a little less than that suggested by the Ministry of Public Works.

Future Cost Requirements

Estimates of future construction requirements in this section are for the twenty-year period, 1959 - 79. Compounded at an annual increase rate of 4%, the population of Costa Rica is expected to increase from the present figure of 1.1 million to 2.5 million in 1979, or 2.3 times the present figure. The greater part of future construction requirements is expected to be due to this population growth.

Total water system construction requirements for the 20-year period may be classified as follows:

1. Present backlog of overdue construction.

2. Added requirements of presently served areas due to population growth.

3. Increase in percent of total population served due to:

   (a) Moderate increase in the urban proportion of the total population (from about 35% to about 40%);

   (b) An average two-fold increase in the density of rural populations which may be presently unserved because of population sparseness.

4. Deterioration and obsolescence of existing systems.

Toward assigning a price tag to future construction costs, the following assumptions have been made:

5. Backlog - present replacement and betterment needs - 50% of value of existing systems serving 700,000 people.

6. Per capita cost for new and replaced systems and major additions - $30.00.

7. Percent Served: 1959 (700,000/[illegible] million . 64%
   1979 . . . . . 75%

8. Population Served: 1979 (75% of 2.5 million) . . 1.87 million

9. Average life of systems . . . . . 30 years

The following estimate of future construction costs has been derived from the foregoing estimates and assumptions:

10. Present backlog -- .7 x .5 x 30 . . . . . $10.5 million

It is realized that it is probably not feasible to meet all these needs immediately. However, they are so urgent that it is not realistic to spread this part of the construction over a 20-year period. Therefore, to arrive at a realistic annual cost figure, the computations are based upon immediate construction, the cost of which is to be amortized over 20 years at 8% annually. The annual cost becomes 10.5 x .08 or $0.840 million.

11. Additional population to be served over a 20-year period (1.875 - 0.7 million . . . . . 1.175 million.

12. Total construction cost of item (11)1.175 million x 30 - $35 million.

13. Deterioration and obsolescence of remaining 50% of present systems over 20-year period:

$$\frac{20}{30} \times 0.7 \text{ million} \times \$30 \text{ million} \times .5 \quad \$ 7 \text{ million}$$

Average annual cost of items (12) and (13):

$$\frac{35 + 7 \text{ million}}{20} \quad \$ 2.1 \text{ million}$$

Annual cost of item (11) .84

Total annual costs . $2.94 million

Average population served:

$$\frac{1.875 + .7 \text{ million}}{2} = 1.23 \text{ million}$$

Average annual per capita construction cost over 20 years:

$$\frac{\$2.94 \text{ million}}{1.23 \text{ million}} = \$2.40 \text{ (16 colones)}$$

Remarks: 1. Except for immediate replacement needs, costs have been shown on a "pay as you go" basis.

2. Immediate construction of present replacement needs is obviously more costly than spreading such construction over 20 years. Near term future requirements materially exceed the foregoing 20-year average per capita cost, due to the present backlog and imminent need for large scale development

of a metropolitan San José water supply to meet future requirements (first stage cost - 133 colones or $20 per person served).

3. Appendix A contains detailed information on construction cost requirements for metropolitan San José, derived from the Rader Report. These costs are considered to be more precise for the particular area involved, than the foregoing national averages. Including distribution system costs, per capita construction cost requirements in metropolitan San José are expected to be higher than national average costs, primarily because of more costly source of supply development.

The annual capital expenditures for water supply by the national government have been in the magnitude of 6,000,000 colones ($900,000.) for the entire country for several years or about $1.30 per capita served. It is significant that the increase above present expenditures for future needs appears to be within the realms of possible achievement.

The foregoing figures represent capital costs only. Past maintenance and operating costs have been very low and operating costs on some of the simple supplies can be expected to remain low. However, in the future more supplies will require treatment which will increase operating costs substantially. Maintenance in the past has been seriously deficient and to provide proper maintenance, increased costs should be anticipated.

It is difficult to arrive at estimates for operation and maintenance costs since conditions are so variable. Obviously, such costs will be higher in the San José metropolitan area than the average for the rest of the country. Assuming that these costs will be 50% of San José's proposed rates of three colones per month per connection($0.45), the total cost per connection would be:

Amortized construction cost

$2.40 per capita per year or $20¢ per month
Per connection 20¢ x 6 or $1.20 per month

Maintenance and operation	$ .45
Total cost per connection per month	$1.65 or
11 colones (rounded off)	

C. OPERATING AND MAINTENANCE COSTS

Data were obtained on total water receipts and expenditures for 1958 from most of the systems visited. These are listed below by cantóns (municipalities). For all practical purposes, the expenditures are for operation and maintenance, plus a 10% indirect charge for administration.

Receipts primarily represent charges for water consumed, but also include in some cases a variety of other charges, such as for water connections and meter rental. Receipts and expenditures are given in colones.

Local Water System Expenditures and Receipts -- 1958

Item No.	Province	Cantón	Receipts	Expenditures
1.	Alajuela	Alajuela	130,994	243,281
2.	Cartago	Alvarado	1,848	3,350
3.	Cartago	Cartago	60,074	54,468
4.	Cartago	El Guarco	3,375	17,289
5.	Cartago	El Paraiso	11,955	23,162
6.	Cartago	Jimenez	5,339	2,930
7.	Cartago	La Unión	3,971	14,790
8.	Cartago	Oreamuno	7,705	11,890
9.	Guanacaste	Liberia	6,000	8,500
10.	Guanacaste	Canas	8,500	8,000
11.	Heredia	Heredia	45,895	66,411
12.	Heredia	Sto. Domingo	21,017	44,379
13.	Puntarenas	Esparta	5,031	13,238
14.	Puntarenas	Montes de Oro	2,018	1,430
15.	Puntarenas	Puntarenas	265,540	213,133
16.	San José	Alajuelita	3,759	11,368
17.	San José	Curridabat	16,784	10,605
18.	San José	Desamparados	5,918	76,780
19.	San José	Escazú	18,700	16,159
20.	San José	Goicoechea	120,000	253,000
21.	San José	Montes de Oca	42,239	104,013
22.	San José	Moravia	12,576	18,495
23.	San José	San José	984,861	1,500,000
24.	San José	Tibas	24,706	52,800
			1,808,805	2,769,471
		Operating Deficit		960,666

% Income to Expenditures 54%

Remarks: Figures on expenditures furnished by the cantóns of provincial capitals included an overhead charge of 10% to cover costs of administration, but this charge was not included by other cantóns. In the interest of consistency, a 10% overhead charge has been provided for all cantóns in the foregoing table.

Except for Puntarenas City, where the system is owned and managed by the Ferrocarril Electrica al Pacifico, a public agency, and for San José, none of the cost figures included provision for depreciation. In the interest of consistency, depreciation costs have been omitted for these two systems in the foregoing table. On a cash basis, the Puntarenas

system shows a profit; with depreciation in the amount of 103,411 colones included, it shows an operating deficit of 51,000 colones.

On the 22 cantons in this table, 15 operated on a cash deficit basis in 1958, without provision for depreciation and usually without adequate provision for repairs, operation and maintenance.

Matamoros Report

In the Matamoros Report, an attempt was made to evaluate the financial condition of 23 of the 35 systems surveyed. The evaluation was on a capitalized cost basis. The annual cost of maintenance, multiplied by the age of the system, was added to the initial cost of construction. This total was compared with annual receipts, multiplied by the age of the system. Credit was allowed for the collection of delinquent accounts. In the case of Cartago City, for example, this credit amounted to about 7.5 times annual receipts. In one case (such as El Guarco Cantón), depreciation was capitalized and added to the cost of construction. The reasoning behind this is difficult to understand.

Twenty-one of the 23 systems were found to be operating at a loss; two were operating at a profit. In one case, the annual cost was about 10 times the annual income.

The deficit was greatly under estimated in many cases. It is likely that this was because of inadequate information. The cost of construction of the system in Cartago City, for example, was reported as 100 thousand colones and the age as 82 years as of 1954. The estimated population served was 16,280, representing a capital cost of about six colones per person (about $1.) for the system. While the original cost of this system actually may have been 100 thousand colones; it is apparent that the system as it existed in 1954 included many additions and betterments made since 1872. The cost of additions and betterments was not added to the initial cost.

At a per capita cost of $20 to $30 (Ministry of Public Works nation-wide average estimate), the capital value of the Cartago system on a present worth basis before depreciation, may be approximated at $325,000 to $500,000 or 2-3/4 to 4-1/4 million colones vs. the 100,000 colones value used.

D. WATER RATES

1. Flat Rate Systems

More than 95% of the 250 water systems in Costa Rica are unmetered and are on a flat rate basis. All of the metered systems also have flat rates since they are less than 100% metered.

The commonest flat rate tariff is three colones per trimester for residential services and five colones per trimester for commercial

services. However, there are many exceptions. The lowest residential flat rate encountered was 1.5 colones per trimester and the highest was nine colones per trimester. Since the minimum rate of metered services represents the lowest water charge to any metered service, this figure may be used in comparing metered rate schedules with flat rate schedules, although the flat rate tariff represents the maximum charge as well. On this basis, the highest charge for water was in the Puntarenas City system, owned and operated by an autonomous national authority, where the minimum charge for water was 11.5 colones per trimester.

These rates have been converted to a monthly, a per capita and a dollar basis, as follows. The per capita conversion factor used was six persons per service.

	Lowest	Median & Typical	Highest
Charge per Service per Month - Colones	.5	1.0	3.8
Charge per Capita per Month - Colones	0.084	0.17	0.63
Charge per Service per Month - Dollars	$0.075	$ .15	$0.57
Charge per Capita per Month - Dollars	$0.0125	$ .025	$0.095

Although there was insufficient data for definitive proof, the figure of 1¼ cents per capita per month is believed to represent the lowest public water rate in the world for water piped into the house, except where it may be completely free. The minimum average and median costs of water per service per month are a small fraction of the minimum cost of electric lights in areas of low economic level in Costa Rica. Even the highest water rate is only 13% of the average electric energy bill for all residential customers of the Compañía Fuerza y Luz.

Many interesting patterns in flat rate charges were encountered. In some cantóns, the rate varied in different districts. In some of these, differences in economic level were offered as an explanation. In one cantón with a rate of three colones per trimester in three districts and 1.5 colones in three other districts, it was stated that the systems in the three low-rate districts were inferior, with intermittent supply. The commercial rate in this cantón also varied, being 3.5 colones in the second class systems and five colones in the districts with more satisfactory systems. The houses connected to the water systems in the low-rate districts were reported to be totally connected to power lines and to have a minimum of three light bulbs per house. (Minimum indicated light bill six colones per month).

In some cantóns the flat rate was determined by the number of faucets per service and by the size of house connection line. In one cantón the minimum flat rate was 4.5 colones per trimester for up to three faucets, provided the house connection line was not over 1/2 inch in diameter and provided a 3/16 inch nipple was placed in the house connection line. Without the 3/16 inch nipple, a penalty rate of 24 colones was charged for up to

three faucets. The charge for each additional faucet where the reducing nipple was installed was 0.75 colones, without the nipple it was 7.5 colones. In another canton, the flat rate tariff was in equal increments per 1/4 inch of diameter of house connection line, starting with 1/4 inch in size.

In some other areas, higher flat rate charges are made for special water uses. In Oreamuno Cantón, for example, the residential rate is three colones per trimester for ordinary residential services and 10 colones for farmers with potato washing equipment. In Sto. Domingo Cantón, where the residential rate is three colones per trimester, farmers who use the public water supply for cattle watering facilities pay the commercial rate of four colones per trimester.

All of the partially metered systems are located in provincial capitals or in metropolitan San José. Known metered supplies up to the present time are listed below. Heredia, a provincial capital about five miles from San José, also is planning to install meters on a phased program. At least three of these supplies (San José, Goicocechea, and Alajuela) have plans for 100% metering. The plan for San José is very firm and should be achieved within three years.

Community Water Supplies With Meters in Costa Rica

Cantón 1/	Total No. Connections	No. of Metered Connections	% Metered
Alajuela (D)	3,600	392	10%
Goicoechea (C)	5,000	4,500	90%
Grecia (D) 2/	1,036	?	?
Monte de Oca (D)	3,107	349	12%
Puntarenas (D) 3/	3,270	--	87%
San José (C)	22,000	4,400	20%
Desamparados 4/	3,331		

1/ Data reported are for particular metered supplies which variously may be either cantónwide (C) or districtwide (D), as indicated.

2/ Presence of meters in 1954 noted in Matamoros Report. No other details known.

3/ Percent metered calculated from flat rate and metered service revenues in 1958.

4/ 400 meters ready for installation.

2. Metered Water Rates

Information on metered water rates is available for all of the foregoing supplies except Grecia. In all five of the remaining supplies,

meter registration is on a cubic meter basis and all rates are on a trimestral basis.

Four of the five supplies have minimum charges of seven and nine colones per trimester. The quantity of water which can be used without exceeding the minimum charge is 43,500 gal., 52,800 gal., and 71,300 gal., per trimester respectively for the four communities. Using a figure of six persons per house, these are equivalent to 80 gcd, 90 gcd and 132 gcd respectively. These consumption rates would be 20% greater if a figure of five persons per house were used.

The indicated objective in setting metered water rates appears to be to establish a tariff and a minimum water quantity which will not penalize any metered water user compared with the amount paid and the quantity of water used by the average flat rate user. The Puntarenas water supply management, for example, issued a public statement in 1956, demonstrating that the minimum metered rate of nine colones per trimester permitted water use at a rate of 112 gcd, as compared with an average use of 95 gcd by all consumers, flat rate and metered. The flat rate charge was the same as the minimum metered charge. Thus, the objective so far in installing meters has not been to discourage the prevailing liberal use of water, including substantial wastage, or to increase revenues significantly, but rather to penalize only the gross waster of water.

The concept of discouraging gross waste is further exemplified by the adoption of an ascending scale of unit water rates in all five of the metered supplies. The lowest rate per gallon is for the minimum quantity used. In Puntarenas, for example, the cost per cubic meter for the first 200 units is 0.45 colones, the next 150 units cost 2-1/4 times as much, the next increment costs 4-1/4 times as much and all consumption beyond that costs nearly seven times as much.

The low cost of water in Costa Rica is demonstrated by metered rates as well as by flat rate charges. In the four metered systems with minimum rates, the cost of 1,000 gallons of water in the minimum increment varies from 0.13 to 0.23 colones (2¢ to 3½¢).

San José is preparing a tariff at the present time which will double the minimum metered charge from nine to 18 colones per trimester). A base rate of 0.15 colones per trimester will apply for the first 260 cubic meters of water used (equivalent to 127 gcd consumption and 8.5¢ per thousand gallons). This proposed rate schedule is based on engineering estimates of operating and maintenance costs, including installation of meters, but exclusive of construction costs.

In Puntarenas City, there is a meter rent charge of 2.5 colones per trimester in addition to the water quantity rate schedule. Consumers who wish to have their meters tested for accuracy of registration by the water supply management must deposit five colones. If the meter is found to be accurate, the deposit is retained; if the meter is inaccurate, the deposit is refunded.

3. Trend of Water Rates in Relation to Other Prices

Inquiry was made into the historic trend of water rates relative to living costs and the cost of water supply materials. Mr. Francis M. Dimond, USOM City Planning Advisor supplied a large part of the Costa Rica data collected in this phase of our survey. As an index of living costs, the Index of Retail Prices supplied by the Department of Economic Studies of the Central Bank of Costa Rica has been used since it was impossible to obtain annual figures for this index over a longer time span (1936-58), than for any other index. However, the "Price Index for the Average Consumer and Worker in San José" was obtained for the period 1952-58 and it is noted these two indices are in agreement for the comparable period. This latter index is prepared by the Dirección General de Estadistica y Censos. Information on employee income by occupational category was obtained from the same office, but only for the 1954-57 period. Average wages and salaries of non-governmental employees increased by 18% for the lowest increase by category to 70% in the highest.

As an index of water supply materials prices, the composite prices of finished steel at Pittsburgh, Pa., USA, and of cast iron pipe FOB N.Y. City were averaged together by years for the period 1932-1959, using 1932 as the base year (value 100). For 1930 and 1931, the curve is based on the steel price only. This combined index provides a measure of the price of galvanized steel pipe and cast iron pipe, the principal cost items in water supply construction in Costa Rica. The 1959 price level of cast iron pipe (532) was considerably greater than that of finished steel (326). The retail price index provides a measure of cost of living and hence an index of the relative price of water and of the cost of water supply operation and maintenance. The price index also provides one measure of replacement costs, which is potentially significant in Costa Rican municipal water rates because, by law, depreciation is an allowable charge in setting these rates.

A long term record of water rates (minimum domestic flat rate) was available only for one supply (San José). The San José figures are:

Year	Minimum Domestic Flat Rate (Colones per Trimester)
1901	4.0
1914	6.0
1921	9.0
1959	9.0
1959 (proposed)*	18.0

* Metered Rate

The fact that the present median rate encountered in our review of 115 water systems was only three colones per trimester (15¢ per month) per service, probably provides stronger evidence than any other that water rates in Costa Rica have not kept pace with living costs.

As another approach, the records of the Office of Economic Studies of the Ministry of Economics and Finance (see Section IV.D) were consulted for information on approval action on municipal applications for water rate changes. This information was supplemented by direct inquiries made of municipalities in the metropolitan San José area for information on water rates in previous years.

By these two procedures, it was possible to obtain data for the period 1930-1958. Data from the first source represents the new rate adopted in a given year rather than the former rate. For 21 of the cantons from which past rate information was obtained, we also had information on the current 1959 rate, obtained by field visitation. The average for these 21 municipalities was used as a plotting point for the year 1959 in Figure 1. Records for previous years were grouped into five-year periods with the following results:

Domestic Flat Water Rates by Five-Year Periods

Five-Year Period	Number of Municipalities	Rate Per Trimester (Colones)
1930-34	18	2.4
1935-39	17	2.8
1940-44	20	3.7
1945-49	53	3.4
1950-54	24	4.6
1955-58	12	6.75
1959*	21	4.5

* Actual Present Rate

The rate data for 1930-58 are baised on the high side in two respects. Most of the data for this period are for municipalities which made application to change their rates, generally for an increase. The true average rate, however, would include municipalities which did not apply for a rate increase during the period. Consequently, the 1959 rate figure, which is a composite of municipalities which have changed their rates recently, and also of other municipalities which have not changed their rates recently, more correctly represents the present average rate.

The other measure of bias is the over-representation of metropolitan San José municipalities in the averages presented. Municipalities

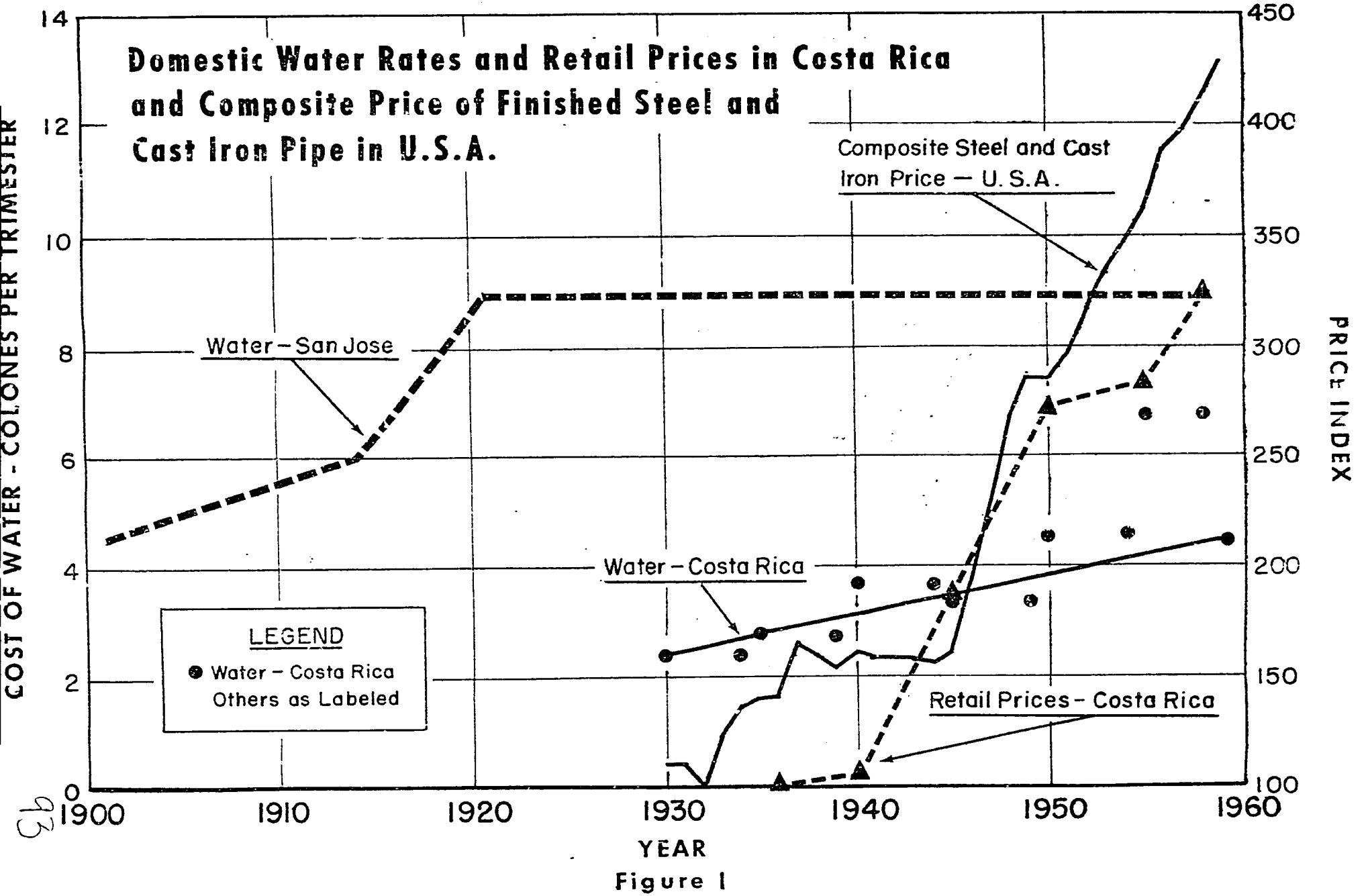
Domestic Water Rates and Retail Prices in Costa Rica and Composite Price of Finished Steel and Cast Iron Pipe in U.S.A.
COST OF WATER - COLONES PER TRIMESTER
PRICE INDEX
YEAR
Composite Steel and Cast Iron Price — U.S.A.
Water – San Jose
Water – Costa Rica
Retail Prices – Costa Rica
LEGEND
Water – Costa Rica
Others as Labeled
0
2
4
6
8
10
12
14
100
150
200
250
300
350
400
450
1900
1910
1920
1930
1940
1950
1960

Figure 1

in this area tend to have higher rates and to apply more frequently for rate increases.

In order to correct for the first error, the curve has been smoothed in Figure 2 by extending a straight line from the initial five-year period to the actual 1959 rate plotting point for the municipalities involved. This line also approximates a "line of best fit" and represents an 88% increase over a 29-year period.

A comparison of water rates, retail prices and iron pipe and steel prices follows:

Non-Governmental Employee Income	Period	% Increase In Water Rates	Retail Prices	Iron Pipe and Steel
	1932-59	77%	--	429%
	1936-58	58%	225%	-
	1930-59	88%	--	-
18% to 70%	1954-57			

E. COLLECTION OF WATER BILLS

During the process of collecting information on number of water connections, water rates, receipts and expenditures from various canton governments, data was also furnished on the amount of unpaid bills. In some cantons where there was a separate water account card for each customer, random samples of cards also were individually inspected. The tabulation by cantons which follows lists the: a) actual water income for 1958, b) amount of delinquent accounts as reported, c) theoretical minimum annual income and, d) percent of actual income to the theoretical minimum income.

The theoretical minimum annual income was obtained by multiplying the number of connections by the residential flat rate on an annual basis. In a few cases where the number of commercial sources was known, adjustment was made for this item in the theoretical income. In all cases, the theoretical income as computed understates the true theoretical income since this income includes supplementary income from commercial and industrial connections (an additional income for most of the supplies listed), charges for connections and disconnections, penalties for late payment, charges for additional faucets and for house connection lines above the base number and size and, in the case of metered connections, consumption above the minimum quantity. Thus, the "percent collected" column in the table would be in excess of 100% in all cases if there were no delinquent accounts.

Generally, the amount of delinquent accounts reported, was for the year 1958. In three cases, however, it was stated they represented "several years accumulation." In most cases, payments made in 1958 on

water charges incurred in the last quarter of 1957 and earlier, were credited to 1958 income. This counteracts the effect in the 1958 income statement of 1958 billings paid in 1959.

Water accounts are payable every three months at the end of the trimestral period. It was said by one central government representative that the delinquent account item mainly represented water bills which had become due at the end of the last trimester of the preceding year and which would be paid during the first trimester of the following year. That this is not the case in many supplies is evidenced by the fact that far less than 75% of the minimum theoretical income (in itself an understatement) was reported as having been collected in 1958.

In reviewing a random sample of individual water bill cards for 72 customers in Esparta Cantón, for example, it was noted that as of June 8, 1959, 27 had paid their bills due April 1 for the first trimester of 1959 and two had made back payments on 1958 accounts. These represented the total payments received since January 1, 1959. In El Paraiso Cantón, a list of delinquent accounts was scanned; one property owner owed water bills for a total of 78 continuous trimesters (19-1/2 years), and was still receiving water in the absence of a public hydrant; service could not legally be discontinued. It was explained that the account was "good" since the bill constituted a lien against the property.

In some cantóns, it was stated that the one water bill item which was invariably collected was the charge for making a new connection since this work was performed by the "fontanero" and was done only on a prepayment basis. In communities in which recent extensions have been made to the distribution system, this item can be an appreciable part of the total income and expenses reported. In Heredia Cantón Central, for example, the charge for a water connection on a paved street is 75 colones plus the cost of materials and labor.

In a few cantóns, several utilities services are furnished by the municipality (including water, sewers, garbage collection and electric service). This is mainly confined to the central districts of provincial capitals. The individual charges for each utility service are combined into a common account. At the end of the year, unpaid bills for all utilities are sometimes placed in a general delinquent account with any subsequent payments credited to this general account. Under such conditions, payments on delinquent water bills are not credited to water income for the current year.

The proportion of delinquent accounts varied considerably by districts within some cantóns. In Alajuela Cantón, for example, where about 50% of the connections are in the central district, and the payment record is outstandingly favorable (94% of theoretical minimum), delinquent accounts in the central district were only 3% of payments, but ranged up to 43% of payments in the rural districts.

1958 DATA ON COLLECTION OF WATER BILLS

Cantón	Actual Income	Unpaid Water Bills	Number Connections	Min. Rate	Theoretical Min. Income	Percent Collected
Alajuela	243,261	33,856	7178	9	258,508	94%
Alajuelita	3,759	4,800	1037	3	12,444	30%
Alvarado	1,848	-	399	3	4,788	39%
Cartago	60,074	-	6215	3	74,580	81%
Curridabat	16,784	8,658	941	4	15,056	112%
Desamparados	5,918	-	3223	4	51,568	11%
El Guarco	3,375	-	611	3	7,332	46%
El Paraíso	11,955	13,998 1/	1445	3	17,340	81%
Escazú	18,700	16,159	1200	4.5	21,600	87%
Esparta	5,031	-	460	3	5,520	91%
Goicoechea	120,000	120,000	5000	10	200,000	60%
Heredia	41,312 3/	14,544	4130	4.5	74,340	56%
Jimenez	5,339	513	577	2	4,616	116%
La Union	3,971	-	1380	1.5 & 3	15,346 2/	26%
Montes de Oca	42,239	98,812	3050	7	85,400	49%
Montes de Oro	2,018	-	200	1.8	1,440	140%
Moravia	11,433	21,627 1/	1438	2.5 & 3.5	19,832	58%
Oreamuno	7,705	-	1168	3	15,716 2/	49%
Puntarenas	223,219 4/	-	3092	11.5	142,232	156%
San José	984,000	985,000	22348	9	804,528	122%
Sto. Domingo	21,016	61,688 1/	2006	3	24,400 2/	86%

(Cont'd)

Cantón	Actual Income	Unpaid Water Bills	Number Connections	Min. Rate	Theoretical Min. Income	Percent Collected
Tibas	24,706	12,676	3,025	4	48,400	51%
Turrialba	22,361	-	1,622	4.5	29,196	77%

FOOTNOTES

1/ Accumulated for more than one year.

2/ Includes minimum income from commercial and industrial services.

3/ Specifically excludes known income of 4583 colones for installation work. No. of connections listed excludes 46 public buildings receiving free water.

4/ Net income for water furnished to domestic and commercial services. No. of connections are as of 1956. Supply operated by an autonomous authority.

F. FOREIGN EXCHANGE AND EXTERNAL CAPITAL SOURCES

1. General Statement

In considering the subject of financing the costs of construction and reconstruction of community water supplies in Costa Rica, either at the present rate or at an accelerated rate, the central fact is that a majority of these costs under present conditions is in the form of imported materials and equipment.

According to the Ministry of Public Works, imported materials and installed equipment comprise 70% of the net cost of water system construction, with labor and indigenous materials making up the 30% remainder. A surcharge of 25% is added to this net cost figure for overhead costs incurred in planning, design, construction, supervision, administration and possibly for overhead on some construction equipment. Certain elements of this surcharge represent imported materials and equipment although the bulk is in the form of personal services. Examples of imported requirements are vehicles, fuel and office machines. It has been arbitrarily assumed in the following computations that one-fifth of this 25% surcharge represents imported requirements.

Imported requirements in relation to total cost for a 100,000 colones net cost project are, accordingly, as follows:

	Imported	Indigenous	Total
Net Cost	70,000	30,000	100,000
Surcharge	5,000	20,000	25,000
Total	75,000	50,000	125,000

Imported requirements - - - 60%

Thus, an increased rate of water supply development could be achieved with maintenance of present status in the balance of payments account only by: a) increasing exports, b) decreasing other imports, c) external loans, d) indigenous production of more water supply equipment and materials, or by two, three, or all four of these measures in combination.

The ICA Master Program Book for FY 1959-60 presents at length the economic structure of Costa Rica. Published documents of the United Nations and the International Monetary Fund also provide much detail on balance of trade, import and export and other financial and general economic statistics for all nations.

In this report, there is little point in repeating this information in detail. The remarks are confined to a brief summary of the previously stated four "potential avenues of opportunity," plus such more detailed comments as may be pertinent to the water supply aspects.

2. Increased Exports

From a value standpoint, coffee is the leading export, ($40.628 million in 1957), followed by bananas ($32.287 million and cocoa ($7.35 million). These three items made up 92% of the total exports. At the present time, the volume of coffee production in Costa Rica and the volume of coffee exports is up; the price is down. The value of banana exports in 1957 was about 50% greater than in 1956. So far as is known, there are no developments in prospect for other crops or industrial products to supplant the leading roles of coffee and bananas. The trend of meat exports to the USA is understood to be on the upgrade. However, the value of total exports on a per capita basis projected into the future is believed to be highly unpredictable and it is doubtful if predictions could be made which would possess any reasonable validity. This subject was not investigated in any detail while in Costa Rica.

3. Decreased Imports

In the three latest years (1955-57) reported in the 1958 United Nations Statistical Yearbook, imports exceeded exports in the last two years by a wide margin. This was partly due to the after effects on crop production of floods in 1955. Figures below are in $ million.

	Exports	Imports	Deficit
1955	80.9	87.5	6.6
1956	67.5	91.2	23.7
1957	83.8	102.8	19.0

The value of (imports) in 1957 approximated $100. per capita..

The Industry and Mining Division, USOM to Costa Rica, has prepared an import reference list for the benefit of persons interested in developing indigenous production. The sources of this information are the 1955 and 1956 editions of "Comercio Exterior de Costa Rica," published by the Dirreccion de Estadistica y Censos of Costa Rica.

Averaged for the two years 1955-56, imports by principal categories were:

		Value $ Million	Percent
1.	Food Products (33 classes)	12.8	15.1
2.	Alcoholic beverages and tobacco (five classes)	0.7	0.8
3.	Inedible Crude Materials (five classes)	0.5	0.6
4.	Mineral Fuels and Lubricants (nine classes)	5.4	6.4
5.	Oils and Fats (seven classes)	0.5	0.6
6.	Chemical Products (32 classes)	12.5	14.8
7.	Manufactured Articles (64 classes)	23.4	27.5
8.	Machinery, parts & supplies (64 classes)	22.0	26.0
9.	Various Manufactured Articles (40 classes)	6.9	8.2
	Total	84.7	100.0

Of the four major categories (nos. 1, 6, 7, 8 and 9), the highest single class item in Category 1 was wheat flour ($3.2 million), followed by lard and lard substitutes ($1.5 million).

In Category 6, the highest class item was fertilizer ($2.8 million), followed closely by copper sulfate ($2.7 million) and medicinal and pharmaceutical products ($2.7 million).

In Category 7, textiles and yarns of all types were the highest class item ($7.4 million), followed by cement ($1.6 million). The cement import rate was increasing. The aggregate value of all metal construction products, however, materially exceeded that of cement, although the individual class items did not. The average value of cast iron water pipe and fittings was $783,000, total $1.07 million (about 7 million colones). Cast iron water pipe is used to some extent in Costa Rica as building columns. Conversely, most water pipe in Costa Rica is galvanized steel pipe since all pipe up to three inches in diameter is of that type.

In Category 8, items exceeding $1 million in value were buses ($2.95 million), passenger automobiles, including jeeps ($2.4 million), airplanes and parts ($1.1 million) and tractors ($1.8 million).

In Category 4, the value of gasoline, kerosene and diesel oil was $3.3 million.

The total potentiality of internal resources development from a balance of trade standpoint was estimated in the Master Program Book at $10 to $12 million annually. These figures represent the value of "imported consumer goods which could be produced efficiently from locally available imported raw materials and or raw materials produced within the country."

4. External Loans

There exist at present a number of international and U. S. public lending agencies concerned with developmental loans to newly developing countries, as well as loans for other purposes. They include the World Bank, the Export-Import Bank and the Development Loan Fund. These are in addition to the private capital market in the U. S. and European countries and such credits as may be extended by manufacturers. There are no counterpart funds in Costa Rica on the ICA program. An Inter-American public lending agency is also under consideration.

Up to the present, loans for community water supply development have not been favored by these public lending agencies, even though such development is basic to any other community development. Some water loans, however, have been made, especially by the Development Loan Fund.

The members of the survey team are obviously not qualified to evaluate the eligibility of Costa Rica for community water supply development loans from the several points of view of these lending agencies. There are a few principles, however, which are basic to all banking operations, irrespective of whether internal or external loans are involved.

In the interest of assuming repayment and that socioeconomic benefit will be realized by the loan, enterprises which will yield a profit or at least pay their own way and which will be effectively operated and maintained, are favored as loan recipients. The principle of basic soundness of enterprise still applies even when loan repayment is a general obligation of government as well as an encumbrance against revenues of the enterprise. A second principle is that larger governmental units, and in the loan amounts which are involved in this case, larger loans, are preferred to smaller units and smaller loans. This suggests that loans would be more readily granted to nationalor metropolitan water agencies than to individual municipalities for community water supply development. Furthermore, the pooling of resources which would result from some water agency plans would spread the risk as well.

Any external loans of a development type which might be repayable in national currency would lessen the foreign exchange requirements in financing water supply development.

5. Indigenous Production of Water Supply Materials

The principal materials used in Costa Rica water supplies are cast iron and steel pipe and fittings. In the smaller municipalities, use of galvanized steel pipe is primary; in the larger municipalities, cast iron pipe probably leads. It is unlikely that indigenous production of either type of pipe will be found economically feasible in the reasonably near future, even though production of cast iron pipe by processes which are now out moded would be possible under present conditions.

The third most important material is probably cement. At present, cement is used in concrete for storage reservoirs, spring development and for a variety of boxes to house valves and meters and in some cases for access to transmission lines. Use of cement probably will increase materially in the future with the construction of storage dams for the water supply of metropolitan San José.

Average cement imports in the three-year period 1955-57 amounted to $1.6 million per year in value for an average of 60,000 tons annually. This was nearly twice the quantity imported in 1949 and 1951, and it is believed this uptrend has continued. Indigenous production of the material should further increase consumption. In the joint interest of decreasing other imports and of increasing the indigenous production of water supply materials, construction of a cement plant appears to offer the best prospects.

With respect to water supply, indigenous cement production would:

a. Permit substituting indigenous cement for imported cement in present types of uses.

b. Favor the indigenous manufacture of cement asbestos pipe as a substitute for imported iron pipe.

Construction of a cement plant has been proposed and under consideration since 1947. It is said there are two plans--one for a plant in Puntarenas Province, the other for a plant in Cartago Province. The one in Cartago Province would be developed at private expense by a U. S. manufacturer and would not involve outlay by the Government of Costa Rica. So far as is known, there are no immediate prospects for the construction of either plant.

6. National Debt

The public debt of the national government as of December 31, 1957 totaled 405.9 million colones as follows:

	Million Colones
Domestic long-term debt	220.7
Domestic short-term debt	38.7
Subtotal domestic debt	259.4
Foreign debt	146.5
Total	405.9

7. Exchange Rate (Free)

The colon has had a very stable dollar exchange rate for at least 23 years, except for one year (1950). According to the 1958 United Nations Statistical Yearbook, the exchange rate in 1937 was 5.62; it is now 6.63 (1959) and has been at this rate since 1952.

8. Tourism

According to the cited Yearbook, international tourism showed a sharp gain in 1957 (from 19,300 persons in 1956 to 31,600 in 1957). More recent figures are not yet available. However, the impact of tourism on Costa Rica is not yet very noticeable.

9. International Economic Aid from the USA

The cited Yearbook lists $10.9 million in grants and $5.5 million in loans for 1954-57, total $16.4 million.

C. INTERNAL CAPITAL SOURCES

a. General Statement

As stated in the preceding section, about 40% of the present total cost of community water supply development comes from indigenous resources. The detailed data needed to estimate what this percentage would be with indigenous production of cement and of cement asbestos pipe, is not available. Bearing in mind, however, that the smallest size of cement asbestos pipe produced in the U. S. is 2-1/2 inches, and the large proportion of small diameter pipe used in Costa Rica water supplies, it is estimated that the highest proportion of total construction cost which could be expected from indigenous resources under these conditions would be in the order of 75%. It is assumed that under these future conditions, at least all services in principal urban centers would be provided with imported meters but, counterbalancing this, availability of indigenous pipe only in the larger diameters would tend to raise present design standards with respect to pipe sizing.

On this basis, internal capital sources would rationally be expected to directly finance the total indigenous cost element (40% to 75%). From an annual payment standpoint, of course, water revenues plus subsidies from local and national treasuries as might be provided, would necessarily finance 100% of the cost of construction and operation.

The indigenous resource component of augmented community water supply development could theoretically be financed in the following ways, separately or in combination:

1. By increased appropriations from the National Treasury for water supply construction and by continuance of the present arrangement whereby the national government pays for nearly all of the costs of construction and reconstruction on a nation-wide basis.

2. By increased appropriations from Municipal Treasuries for such work, with or without change in present water rates.

3. By pooling resources under a "pay as you go" plan. There are some 250 public water systems in Costa Rica. With improved collection of water bills and increased water rates in all supplies and under the nation-wide management of a national water agency, surplus operating income could be applied each year to construct or reconstruct X number of supplies each year. Over a period of 10, 15, or 20 years, depending on the time schedule adopted and water rates, the water supplies of the entire nation might be rehabilitated.

4. By internal loans, predominantly long-term.

b. Specific Sources

Indications are that private capital cannot be viewed as an internal capital source for water supply bonds due to its relative scarcity. The fact is that it is attracted by short-term, rather than long-term offerings and the high interest rates which would have to be offered. Private investment appears to be heavily concentrated in real estate, where there is much opportunity for speculative profits at least in the metropolitan San José area. Compared with investment and speculative opportunities and interest in land and improved properties, there is considered to be negligible interest in long-term bonds. The going interest rate for "street" money is around 12%; the yield rate on national bonds is in the order of 8.75 to 9% at market prices. There are said to be essentially no private institutional funds as capital sources, due to the nationalization of institutions of a capital-generating nature. The banking and insurance systems as well as the social security agency are government institutions.

As a result, those instrumentalities of government which generate capital are considered to provide essentially the only sources for long-term (20 years or more) loans, especially at reasonable interest rates. Loans for community water supply development from these agencies would be granted in competition to the interests of other capital-seeking public agencies, such as the national power and light monopoly (ICE) and the national public housing authority (INVU).

It is understood that such inter-agency loans have not been the practice in the past, but one precedent is provided by a loan approved by the National Assembly in July 1958 from the Social Security Agency to the Power and Light Authority (ICE). This loan, which is in the amount of 26 million colones, is serial refunding, with a coupon rate of 7% and is for construction of a hydroelectric plant on the Macho River. This coupon rate is appreciably lower than the yield rate on national government bonds. The loan is being made partly in money and partly in negotiable bonds which presumably will be marketed by ICE as needed to meet its capital needs.

A resume of the financial resources of the three principal public capital-generating agencies follows. Further description of these agencies is given in Section IV-B.

Social Security Agency (Caja Costarricense de Seguro Social)

Part of the resources of this agency is invested in bonds which in 1954 amounted to 6.374 million colones and in 1955 to 7.742 million colones, an annual investment rate of 1.363 million colones. This investment rate has been expanded since then in view of the foregoing 1958 loan of 26 million colones to ICE, part of which, however, was in bonds. The City of San José is currently seeking approval of the National Assembly for a loan of five million colones from the Social Security Agency for community water supply development purposes.

National Banking System

The year end statement for 1957 reported total assets of 1.069 billion colones, a gain of 18% over 1956. Total investments of all types amounted to 463 million colones. These investments were not classified, but presumably were mainly commercial loans. However, the portfolio contains some bonds. As a statutory reserve item, there is an investment of 65 million colones in non-negotiable national government bonds.

National Insurance Monopoly (Instituto Nacional de Seguros)

Total assets in 1956 amounted to 98 million colones, a gain of 10 million colones over 1955.

The same rate of gain was maintained in 1957 over 1956. As a more accurate index of capital generation available for investment, the annual increase in reserves in 1957 amounted to 5 million colones. The gross investment in bonds at the end of 1956 was 12.927 million colones. The principal investment was in mortgages (54 million colones).

H. OTHER FINANCIAL INFORMATION

a. National Government Budget

The budget of the national government for 1958 is detailed below:

	Million Colones	
	Expenditures	Receipts
Direct Taxes		52.6
Export Duties		15.8
Import Duties		174.5
Other Indirect Taxes		32.9
Other Receipts		38.7
Total		314.5
Debt Service	46.9	
Social Services		
Education	61.7	
Public Health	7.2	
Social Security	74.3	
Defense	12.1	
Public Works	35.0	
Other	77.3	
Total	314.5	

Per Capita: 286 colones or $43.
National Income (1957) 1900 million colones.
Percent National Budget to National Income - about 16.5%.

Remarks

Conspicuous features of the national budget are the high proportion of import duties to total receipts (more than 50%), the relatively favorable total national tax bill (about 16% of the national income), which includes about 50% of the costs of municipal governments as well, high expenditures for education and low expenditures for defense. Debt service is a considerable item. The level of subvention to municipal governments, although not listed as a budget item, is high.

b. Municipal Governments Budget

A printed summary sheet of municipal income and expenditures for 1958 was obtained from the National Controller General's office. Rounded off, current receipts amounted to 32 million colones, and current expenditures were 33 million. Forty-six percent of the total municipal expenditures for the nation were made by municipalities in San José Province with 34% of the national population. Receipts and expenditures were not classified in detail, but it is presumed they included receipts and expenditures for all utilities, including water.

Although municipalities in Costa Rica for the most part have very limited income, their position in this respect is believed to be more favorable then that of municipalities in some other Latin American countries. The minimum income of any municipality (cantón) in Costa Rica was about 46,000 colones (Dota Cantón, San José Province (population 3,675). Municipal income including carried over unexpended balances has increased from 7.6 million colones in 1946 to 40.2 million 1958. The percent increase of income from 1950 to 1958 amounted to about 150% compared with a population increase of about 38%.

c. Ministry of Public Health Budget

As reported in the PASB Summary of Health Conditions in the Americas (June 1958), the Ministry of Public Health Budget in 1957 was largely spent for hospitals (70%). The budget for the category "Environmental Health Services" was 83,865 colones or about $12,650 annually. It is noted that a larger budget category of "Other" included "sanitary engineers" along with "nurses, social workers, health education, mental hygiene, pharmacy, leprosy and legal."

IX. COSTS AND BENEFITS

A. GENERAL STATEMENT

Cost-benefit calculations in water resources development planning characteristically are presented as opposing items, in the same manner as assets and liabilities in financial statements. In this study and report it is impossible to prepare such a balance sheet because of the problem of developing reasonably valid cost estimates with the limited data available and because the more important benefit factors can be expressed more readily qualitatively than quantitatively.

B. COSTS

The average annual amortized cost of constructing, operating and maintaining adequate public water supplies in Costa Rica over a 20-year period is given in Section VIII B. This estimate does not include provision for change in price level. It amounts to $2.40 (16 colones) per capita per year for an average of 1.23 million persons served.

C. BENEFITS

Benefits arising from adequate public water supply facility development in Costa Rica are of two classes: 1) generalized over-all socioeconomic benefits and 2) specific losses and costs due to inadequate water supply which would be eliminated by adequate development.

1. Generalized Over-all Socioeconomic Benefits

Since water is basic to all plant and animal life, including human life, it is theoretically appropriate to credit the value of all human development and property development in a nation to the availability of water as a resource.

Without development of the resource by means of water systems, the resource possesses only limited useful value except among sparse primitive populations. Such credit theoretically is fully as defensible, for example, as crediting the full value of irrigated farming in previously non-arable land to irrigation water as a resource.

The population of Costa Rica is two-thirds "rural," as subjectively defined by census takers. Most of this population lives in densely settled rural upland areas of the country, with springs or streams of adequate capacity for low per capita consumption within maximum water hauling distance. From a standpoint of water resources development (i.e. water supply systems), a society in Costa Rica completely without water supplies can be visualized along the following lines:

a) A greatly curtailed urban population (the size of urban communities would be limited to areas within walking distance of surface and spring sources and to the economic equilibrium of cost of water hauling and ability to pay). Ground water resources in most urban areas in Costa Rica would not permit extensive development of private shallow well and spring supplies.

b) A rural population smaller than the present rural population, which is presently two-thirds of the total population.

c) A practically stable population following a gradual decline from the present level to a "no public water supply" level. The initial decline and subsequent equilibrium condition would be due to greatly increased mortality rates and lowered productivity and food supply.

In Costa Rica itself, there is a correlation between rural population density and potable water availability as well as between urban population and the availability of gravity sources of supply, especially those which do not require treatment. Arable highland areas, where water has been adequate in supply and accessible and the systems highly developed, have many times the population density of the lowland areas. While it is understood that climate and soil fertility provided the most compelling motivation for the historic early settlement of these areas, the importance of abundant clear water sources as an attractant to population settlement at that time should not be disregarded. In any event, agricultural and population development in these areas following settlement probably would have been severaly restricted in the absence of public water supply development.

With regard to urban development, a much smaller population would be expected in San José in the absence of a public water supply, than the 1958 estimated population of 138,000, with a somewhat lower proportionate decline in metropolitan area urban populations. This is based on a society dependent on water supply by door-to-door vendors and the carrying of water by householders for residential, commercial and industrial establishments or the development of private wells under "no public water supply conditions."

The most comprehensive over-all economic measure of benefits accruing from public water supply development is the gain in gross national product and in per capita income resulting from conditions under the present status of public water supply development as compared with conditions which would prevail in a more primitive society and with a smaller population under "no public water supply" conditions. Likewise, the value of certain urban physical assests, such as the value of property improvements in business districts and of urban land, not only indirectly reflects benefits accruing from public water supplies (i.e. larger and more prosperous urban populations), but also directly reflects the improved usability and occupancy conditions resulting from the availabilty of public water supplies.

While no special provision is made for industrial supply, industry has been encouraged to locate in portions of the cities with ample water

supplies and in fact, under zoning provisions, industry must locate in areas where ample water will be available. Again there are many other factors in choosing the location of an industry, but an ample supply of good water is an important one.

2. Diarrheal Disease Morbidity and Mortality Prevented by Availability of Piped Water Supplies

The average death rate from gastroenteritis during the five years 1953-1957 was 133 per 100,000. (Appendix B) Based on an average population in this period of 973,000, the average number of deaths reported from this cause was 1343 per annum.

There were 5882 patients hospitalized with this complaint in 1958, with an average stay of 11 days, or 65,080 patient-days. An additional 1859 patients with this complaint were treated in rural centers and clinics, a grand total of 7741 patients.

The earliest year for which gastroenteritis deaths are available at the time and place this report is being prepared is 1940. The mortality rate in that year was 282.4 per 100,000 for "diarrhea and enteritis."

Between 1951 and 1952 Costa Rica adopted the broader category of "gastroenteritis" in its mortality reporting practices, with a consequent 39% increase in rate in 1952. The infant mortality rate was constant during 1951-52, indicating that the increase in reported mortality rate for this enteric disease complex was mainly due to change in reporting practice. After adjustment for this factor, the 1940 rate becomes 392 per 100,000.

Available information on infant mortality rates, however, goes back to 1927 by individual years and to 1921 for groups of years. The infant mortality rate was relatively constant from 1921 through 1933 (median rate 165 per 1000 live births), when a gradual irregular decline set in. Information in Appendix B indicates there was a correlation between gastroenteritis and total infant mortality rates in 1953-57, partly because 71% of the reported deaths from gastroenteritis were among infants.

The median infant mortality rate of 165 extending back to 1921, was 25% higher than the rate in 1940 (132). If this factor is used to transpose the gastroenteritis rate back to a 1920 base, the adjusted mortality rate from this cause becomes 490 per 100,000, or 4.9 per 1000. By comparison, the crude death rate in 1921 was 22.3 per 1000 vs. 9.6 in 1957, which tends to support this adjusted gastroenteritis rate (490 per 100,000 vs. 138 in 1953-57).

It is manifestly impossible with the information available to accurately estimate how much of the reduction in gastroenteritis mortality and morbidity can be attributed to piped water supplies.

Not only is corroborating data lacking on present comparative rates for populations served and unserved with piped water (see Section VII K), but information is equally lacking on the rate of piped water supply development in earlier years with respect to number of persons served. These rates tend to be quite different in character from the age of water systems per se, since all or most of the distribution systems evolved in size from the original embryonic systems.

However, the earliest years for which crude death rate figures are available are 1911-13, when the average rate was 25.0/1000 vs. 22.3 in 1921. Presumably it was even higher in earlier years before piped water supplies were extensively developed. (The first system was constructed in 1867). Likewise, the gastroenteritis mortality rate in 19th Century and early 20th Century baseline years for water supply development probably was substantially higher than 490/100,000. For this reason, a baseline figure of 600/100,00 is aribitrarily adopted in making a rough approximation of gastroenteritis savings for the 30-year period 1921-59, on a hypothetical basis of "pre-water supply gastroenteritis conditions."

The present population of 1.1 million is about one-third urban (95% served with piped water) and about two-thirds rural (about 50% served), an over-all average of about 65% served. (700,000 served).

The approximate population in 1920 was 400,000, at which time we estimate that 40% of the population was served with piped water (160,000 served). It is estimated that the present figure of 65% served was reached by 1940, since postwar water supply development is believed to have barely kept pace with population growth. The estimated population in 1940 was 650,000 (425,000 served). Using 1920, 1940 and 1959 as base-points, the average population served during the 30-year period 1920-59 is calculated at 427,500 (rounded off at 425,000).

Field epidemiological studies in some other countries indicate that gastroenteritis incidence is reduced by 30 to 60% by providing adequate piped water service. In some studies, the control group had access to nearby hydrants and private wells, and we estimate that, under Costa Rican water availability conditions, there would be a 50% reduction in gastroenteritis for the "served" population compared with the "unserved" population.

On this basis, there would be an average reduction in gastroenteritis mortality of 231/100,000 (600-138)x50% per annum in an average population of 425,000 under the assumed "pre-water supply conditions", an annual saving of 959 lives annually. Over a 30-year period, (1920-59), a total of 28,770 lives would be saved according to this calculation procedure, almost entirely among infants and young children.

Although the case-fatality rate from gastroenteritis morbidity is often very low in older age groups, it tends to be high in infants and very young children. The reported case fatality rate among infants and

young children admitted to medical care at the San Juan de Dios Hospital was 8.7%. Two-thirds of these had gastroenteritis and this hospital treats about two-thirds of all patients in Costa Rica for this cause.

Assuming an average case fatality rate of 4% for unhospitalized and hospitalized cases with frank clinical illness, the indicated average number of gastroenteritis cases prevented annually during this period due to piped water supplies is approximated at 24,000 cases of significant clinical illness plus a much larger number of milder infections.

Further benefit calculations for gastroenteritis reduction follow:

Morbidity Saving -

Total Cases Saved Annually	----	24,000	
Percent Hospitalized - 20%			
Average Illness - 11 days			
Cost per patient day - $2.50			
Annual Cost - hospitalized patients	---		$132,000
Cost per day - unhospitalized patients $1.00			
Annual Cost - unhospitalized patients	--		211,200

Mortality Saving -

*Av. Value per human life	$1,000*		
Annual No. lives saved	959		
Total Av. Annual value		--	959,000
Total Av. Annual Saving			$1,302,200
Thirty-year Saving		--	$39,000,000

or 255 million colones

3. Water-Borne Disease Cases and Deaths Prevented by Superior Quality of Piped Water Supplies.

The category of water-borne diseases includes typhoid and paratyphoid fever and the dysenteries, especially bacillary dysentery. Because reporting of dysentery mortality and incidence has been so erratic in Costa Rica, only typhoid and paratypoid fever are considered herein.

Available records of reported mortality due to typhoid and paratyphoid fevers dates back to 1935. For the three-year period (1935-37) the average mortality rate from these causes was 13.1/100,000. This is adopted as a baseline, although it is presumed to have been higher in earlier years when piped

* This low value which includes burial costs reflects the high proportion of infant deaths from this cause.

water supplies served a smaller proportion of the population. This rate has gradually declined since 1937 and currently (1957) is 2.5/100,000, a reduction of 81% or 5.3/100,000, averaged over the period.

If this average rate saving is applied to the full 30-year period 1920-59, and 50% of it is credited on a nationwide basis to water supply improvement, the following results are obtained:

Average Rate Saving Due to Water Supply	2.75/100,000
Average Total Population - 1920-59	700,000

Mortality Benefit

Lives Saved per Year	19
Average Value per Life Saved	$5,000
Total Benefit per Year	$95,000

Morbidity Benefit

Case Fatality Rate During Period	10%
Cases Prevented per Year	190
Av. Duration of Illness	50 days
Av. Cost per Patient-Day	$2.50
Av. Cost per Illness	$125.
Total Benefit per Year	$23,750

Total Annual Mortality and Morbidity Benefit	$118,750
Thirty-Year Benefit	$3,562,500

or 23.25 million colones

Remarks -

Reflecting the older average age at death for these diseases compared with gastroenteritis, the value of a human life has been increased. Although the case fatality rate is currently much lower than 10%, this rate is considered applicable for the 30-year period. There is reason to believe these results greatly understate the probably benefit realized in typhoid and paratyphoid fever reduction from water supply development. Primarily, this is believed due to lack of available data on mortality rates from these causes before 1935.

Some of the assumptions in the computations of gastroenteritis, typhoid and paratyphoid fever benefits are necessarily arbitrary and the reader is free to adopt his own in the computation procedure.

4. Additional Specific Costs

a. The following specific benefits representing current identifiable costs as a result of inadequate service:

1. Oil Drum Water Storage Facilities.

Provision of these facilities in individual urban areas ranges from 0 to 50%. Estimated national average 10% of 700,000/6 services or 11,670 facilities. Estimated cost in place (including plumbing) 50 colones. Total estimated costs $87,500. Estimated life, 10 years.

Av. Annual cost $8750.

2. Elevated Storage Facilities in Premises on Intermittent Delivery Systems.

These are believed to be limited almost exclusively to San José and environs. In one metropolitan system with 3100 connections, 900 elevated tanks with an average installation cost of $100 each were reported. Total $90,000. The total number in the San José area is not known. See Appendix A.

3. Underground Storage Tanks and Hydro Pneumatic Lift Stations in Premises on Intermittent Delivery Systems.

Same distribution as for Item 2. In the above community there were 450 of these with an average installation cost of $300, plus operating cost. Total number not determinable but a considerable number is known to exist in San José proper. See Appendix A.

4. Private Wells on Premises Served by Intermittent Delivery Systems.

A considerable number is known to exist in San José and environs, but they are fewer than facilities in Items 2 and 3. No accurate estimate available. Average construction cost $900. See Appendix A.

5. Municipal Trucks for Hauling Water in Intermittent Delivery Systems.

San José had eight trucks for this purpose in 1959, supplemented by at least one other truck provided by SCISP. This practice is believed to be confined essentially to San José and San Pedro. Cost about $3800 per annum. See Appendix A.

X. ORGANIZATIONAL PLANS UNDER CONSIDERATION

Since the present water supply situation is due no doubt in some degree to present division of responsibility between several national government agencies as well as local governments, changes in governmental structure as it relates to water supply are under consideration. Actually two types of problems exist. One involves only the San José metropolitan area. San José Cantón is by far the largest and most dominant cantón in the country as well as in the metropolitan complex. This area has 25% of the population of the entire country. The second involves the rest of the urban cantóns which have problems more or less in common, but different from those in the San José area. These problems have been discussed in detail elsewhere. (Chapter VII and Appendix A)

During our visit various organizational plans to improve the public water supply situation were being actively discussed and committee hearings were being held by the National Assembly. Although the area of discussion was not limited to plans involving only metropolitan San José, a large part of the impetus for attracting attention to water supplies was due to current water shortages in that area as a result of delivery and source of supply problems, including an unusual drought.

In summary, four alternatives to the present organizational arrangement were reported to be under consideration. These were:

1. Establishment of an autonomous national water supply agency responsible for nationwide operation, maintenance, construction, and probably, collection of water bills.

2. Establishment of an agency similar to Item 1 but "semi-autonomous" rather than "autonomous" in authority. This agency would operate under the aegis of the Ministry of Public Health; it would be politically responsible to the national President through the Minister of Public Health. It was said that this plan was sponsored by the Ministry of Public Health and supported by the Ministry of Public Works.

3. Establishment of a "Department of Sanitary Works of the Metropolitan Area of San José", as proposed in the Rader Report. As discussed in that report, this would be an authority patterned after similar water authorities in Puerto Rico and Venezuela. Initially it would serve the San José metropolitan area with the implication that it "will eventually become national in scope."

4. Maintenance of the status quo with respect to the present jurisdictional responsibilities of municipal governments and the Ministries of Public Health and Public Works, but with strengthened programs in the two ministries. Details of this "strengthening" procedure are not known. It is said this plan has the support of the national President and of some elements of the central government.

No doubt the most pressing water problem facing the country is in the San José Metropolitan area. (See Appendix A) While conceivably

San José Cantoń could develop and operate a satisfactory system to meet its needs it is difficult to see how the satellite cantóns can economically meet their needs on an individual basis. This problem will become worse in time. It would appear, as a minimum, that some type of central organization will be required to develop an adequate supply for the entire area and construct transmission mains to deliver water to individual water distribution systems. For a most economical solution the central organization should probably go much farther, in the absence of a national authority.

In the case of a national autonomous authority, it could serve in place of a metropolitan authority, in providing the necessary coordination of existing or future systems.

Among the advantages of a metropolitan sanitary authority with full power to design, construct, maintain and operate, and finance a metropolitan system are:

1. San José's urgent needs might receive prompter attention under an area authority than under a nationwide authority.

2. Proponents of greater autonomy in local affairs would likely prefer a metropolitan authority.

3. Because San José has unique problems an authority concentrating on these problems might be expected to solve them more expeditiously than if it were concerned with more diverse and scattered problems, particularly in the field of financing.

4. San José has contributed to water system expansion and betterments to a much greater degree than other communities in the country, and could therefore be expected to continue the trend towards greater self sufficiency in financing and thus establish a financing pattern for other communities.

5. San José Cantón has a reasonably effective engineering, administrative and fiscal establishment which could be expanded to serve the metropolitan area with minimum delays.

6. The San José metropolitan area appears to be more capable of financing an area water supply than would the individual cantóns in the area.

A nationwide autonomous authority would have the following advantages:

1. It would be less vulnerable politically, i.e., all municipalities in the country would receive equal consideration for national assistance. This would not be valid if the metropolitan area completely financed its system, which seems unlikely.

2. A national authority could develop a master plan for meeting the nation's needs, both present and future, establish priorities, and implement the program under a comprehensive plan.

3. A national authority would probably obtain favorable loans more readily by virtue of pledging the resources of the entire country.

4. Few municipalities have competent technical staffs or stock piles of material and supplies. This type of service can be better and more economically supplied by a national authority than by individual municipalities.

5. A national authority would bring together all aspects of water supply -- design, construction, operation and maintenance, financing -- under one organization which should result in more effective and economical service.

Advantages of retaining the present organizations are:

1. Since health is a major consideration in water supply, the Ministry of Health in carrying out its broad responsibilities, must have a major interest in both quantity and quality of water. However, this ministry would need strengthening to carry out its present legal responsibilities.

2. Since the Ministry of Public Works now has a staff (engaged in design and construction of public works, including water systems) equipment, supplies, etc., they would probably move more readily and rapidly in an expanded water supply program than a new agency. Substantial additional funds would be needed for construction.

3. Water supply is basically a local function and therefore municipalities should be encouraged and assisted in ultimately taking full charge of their water supplies.

APPENDIX A

METROPOLITAN SAN JOSÉ WATER SUPPLIES

San José is located in the central plateau of Costa Rica at approximately Latitude 10° N. and Longitude 84° W. It is the national capitol and the capitol of San José Province, the most populous in the country. It is in the center of a prosperous agricultural (coffee) area; is the hub of rail, highway, and air transportation; and is the commercial and industrial center of the country. San José lies in a high valley (av. elev. 3800 ft), between two mountain ranges, which slopes rather sharply towards the Pacific Ocean.

Approximately 60% of the population of Costa Rica (1,100,000) live in the central plateau (less than 10% of the total area of Costa Rica) and almost 25% of the population of the country lives in the San José metropolitan area (64 square miles).

The San José metropolitan area as defined by the Department of Statistices and Census consists of nine cantóns or parts of cantóns in San José Province as follows:

Central (San José)	11 of 11	districts
Tibas	3 of 3	"
Moravia	1 of 3	"
Goicoechea	5 of 6	"
Montes de Oca	4 of 4	"
Curridabat	4 of 4	"
Desamparados	4 of 9	"
Alajuelita	2 of 5	"
Escazú	3 of 3	"
Total	37 48	

The above includes only those districts which because of topography can readily be integrated into the metropolitan area. The true metropolitan area is considered larger by us, since the foregoing territory has been arbitrarily limited to San José Province and there are many commuters living only a few minutes away in Alajuela and Heredia Provinces.

Average montly temperatures vary only from 21° C. to 18° C.; the maximum and minimum temperatures are 28° C. and 14° C., respectively. However, there are two well defined seasons, wet and dry, which occur annually, the former from May through November and the latter from December through April. The average rainfall is about 78 inches ranging from a low of a fraction to an inch to over 15 inches monthly.

Although the city of Cartago in the central valley was founded in 1564 and became the colonial sub capital, the city of San José was not founded until 1823, two years after independence from Spain.

The following tabulation shows the population of the metropolitan area by cantóns:

Cantón	1927	1950	1958 Estimated
San José	60,600	112,200	138,025
Tibas	4,600	10,600	14,106
Moravia	1,900	4,500	5,880
Goicoechea	6,200	20,800	25,599
Montes de Oca	3,700	10,000	13,283
Curridabat	2,600	4,600	5,658
Desamparados	4,600	8,500	11,171
Alajuelita	1,000	2,300	3,081
Escazú	5,300	7,300	9,405
Metropolitan Area	90,500	180,800	226,208
- % Increase (1927-1950)			150%
Costa Rica	471,524	800,875	1,100,000
- % Increase (1927-1950)			134%

San José, Escazú, Desamparados and Curridabat Cantóns have had a fairly uniform growth since 1927 while the others have shown a greatly accelerated rate of growth since 1945.

The Department of Statistics and Census of Costa Rica and Rader and Associates have made estimates of future populations of the metropolitan area as follows:

	Department of Census	Rader and Associates
1960	254,787	
1965	309,805	
1970	373,104	389,800
1975	444,504	
1980	524,065	550,600
2000		927,100

Economy

The economy of Costa Rica is discussed elsewhere. It should be noted, however, that the metropolitan area is in the heart of the area of highest value of agricultural products. It had 28.1% of the industrial establishments and 33.8% of the commercial establishments of the entire country in 1952 and predictions are that these percentages will increase. Another indication of the rapid development is that the total number of new buildings constructed in 1950 was 372 with a total value of 14,805,731 colones. This increased to 791, with a value of 32,047,958 colones in 1956. The total construction during the seven-year period was 3,997 buildings (71% single family dwellings) valued at 170,530,304 colones.

Government

Basically, local governments in the area are the same as in other cantóns of the country. San José city, however, has a much larger

and more diversified staff of trained and specialized municipal employees than any other cantón. This will be discussed in more detail insofar as water supply administration is concerned. While there is now no legal or administrative machinery to coordinate the functions of local governments within the area, studies are under way to determine the best methods of accomplishing this. INVU activities in this regard have been discussed elsewhere. It appears that the first attempt to secure the necessary coordination will be in the water field.

Present Water Supply Situation

There are currently ten water systems serving the 37 districts of the nine cantóns within the metropolitan area, namely:

1. San José - serving ten of the 11 districts in the central cantón and part of San Pedro in Monte de Oca Cantón.
2. Alajuelita - serving two districts in the cantón.
3. Curridabat - serving all four districts of the cantón.
4. Desamparados - serving three of the nine districts in the cantón.
5. San Rafael-Desamparados - serving San Rafael, and San Antonio Districts in Desamparados Cantón.
6. Escazú - serving Escazú District.
7. San Rafael-Escazú - serving San Rafael and San Antonio Districts in Escazú Cantón and Pavas District of San José Cantón.
8. Guadalupe - serving four of five districts in Goicoechea Cantón.
9. Moravia & Tibas - serving San Vincente District in Moravia Cantón and all three districts of Tibas Cantón.
10. Montes de Oca - serving all three districts of the cantón.

In some limited instances such as the Moravia-Tibas system, two adjacent cantóns are using the same source of supply, and in a few instances, a district is getting its supply from an adjoining cantón (... (Ex. Pava in San José from S. Rafael, Escazú). Furthermore, two systems in metropolitan San José also serve adjoining districts outside of the metropolitan area and which are not listed in this appendix. This undoubtedly stems from the fact that most of the water supplies were built by the national government. However, to complicate matters further, collections, disbursements, maintenance and operation of the distribution systems is by the cantón government. For example, San José operates the San Rafael-Escazú plant in return for using this source for the Pavas

TABLE 1

San José Metropolitan Area

	San José	Alajuelita	Curridabat	Desamparados	San Rafael - Desamparados	Escazu	San Rafael Escazú	Guadalupe (Goicoechea)	Moravia Tibas	Montes de Oca
Source	2-Springs River	River	Spring	River	River	Spring	River	River	River	Spring
Treatment	Cl. Set.-SF-Cl	None	None	Set-SF-Cl-CS	None	None	Set-S.F. Cl, C.S.	Co-Set-RF-Cl	Set-SF-C.S.	None
Capacity-Plant or source l.p.s.	540 dry weather	15	7	27	26	12	20	150	60	28
	760 wet "									
Capacity-Plant or source M³/da	46600 dry "	1300	600	1810	2250	1040	1730	13000	5900	2400
	67500 wet "									
Consumption l.c.d.	470	300	345	450	450	330	330	377	356	430
Total req. Max da. M³	67500	1080	1100	3150	1940	1670	3300	10500	7850	9150
Transmission main length Km	1.5	5.4	0.5	1.0	1.3	3.0	2.5	2.5	3.5	9.0
Storage M³	12500 (3 Reservoirs)	385	200	450	115	175	230	3500	650	670
Storage-El. above high	19	137	0	50	5	230**	105	56	52	13
Point Distrib. System M. El. above low	94	187	67	70	55	150**	145	111	157	115
Point distribution M.										
Pressures distrib. system	0-55 p.s.i.	U	U	U	U	U		S	U	U
Pop. served *	143500	3600	3200	7000	4300	3700		37500	8200	19400
Adequacy										
Supply	I - dry weather	A	I	I	A	I	A	A	I	I
Treatment Main	A - except peaks			I		I	I			I
Storage	A - " "									I
Treatment	A	I	-				Generally inadequate for present max. consumption			
Dist. system	Grossly I	I	I	I	I	-	I (By pass)	I	I (By pass)	-
Operation	A			I		I	I	A	I	I
				I			I	I	I	

U - Unsatisfactory
S - Satisfactory
A - Adequate
I - Inadequate

Treatment Symbols
Cl - Chlorination
Set - plain sedimentation
S.F. - Slow sand filters
C.S. - Copper Sulfate
Co. - Coagulation
R.F. - Rapid Sand Filters

*From Roder Report
**Storage at 2 elevations
l.p.s. - liters per second
l.c.d. - liters/capita/day
M - meters
M³ - cubic meters
Km - Kilometers

-123-

T A B L E 2

	1958 Pop (Est)	Population Urban--U Rural--R	No. Connections	% Pop. Served	No. Elev. Tanks	No. Tanks and Pumps	Cost Water Delivered By Truck (Colones)	Remarks
San José	138025	138025 U	22000	97%	6600	Few	12350	97% water in house 3% public hydrant within 100m
Escazú	9405	9405 U	1200	Almost 100%				
Desamparados	21092	21092 U	3331	Almost 100%				
Alajuelita	5164	3080 U 2084 R	708 387	98% 75%				
Tibas	14106		2600	99%	1000	75		
Goicoechea	26232	22593 U 3639 R	5000	100% 100%				
Curridabat	5658	5052 U 626 R	954	97% 0.5%	285			One Rural Dist. 626 Pop has only 3 Connections
Montes de Oca	13282	13282	3107	100%	900	450	12420	
Moravia	7554	--	1438	100%	-	-	-	

District in San José. However, in San Rafael and San Antonio Districts in Escazú Cantón - served by this same plant - operation and maintenance of the distribution system and collections and disbursements are by Escazú Cantón.

Table 1 gives some pertinent information on the physical characteristics of systems serving San José and the metropolitan area. All of the systems were visited as were the cantón business offices to obtain basic information. Also, much information was taken from the Rader Report. Populations served in Table 2 are estimates from the Rader Report and represent only those districts in the metropolitan area served by the ten supplies covered by that report. These figures vary from those shown in Table 2 since the latter represent figures obtained from the cantón business offices and represent water services on a cantón basis regardless of source. This will be discussed later.

Elevations of storage above high points of the distribution system should generally be sufficient to produce satisfactory pressures (exception Curridabat) if volume of storage and capacities of transmission lines and distribution systems were satisfactory.

The per capita consumption and total requirements for maximum day use are taken from the Rader Report. The former are based on a pitometer survey made in San José (1945) and on subsequent surveys by SCISP (1958-59) in two supplies in the metropolitan area and in six other Costa Rican cities. The maximum day is based on 1.2 times the average daily flow.

It will be noted that the per capita flows (ranging from 470 lcd or 114 gcd in San José to 300 lcd or 79 gcd in Alajuelita) appear excessive and indicate a very considerable loss through wastage and leaks.

With present usage, only four of the nine systems outside of San José have sources of supply adequate for the maximum day. In San José, the sources are adequate during the wet season and inadequate during the dry season. However, a great factor in inadequate source is the very high per capita flow of water. If waste and/or leakage were reduced to reasonable amounts, it appears that only in Curridabat and Montes de Oca would the sources be inadequate.

The transmission mains were indicated to be deficient in San José and two other supplies. However, again with reasonable use only Escazu appears to be deficient.

Storage is generally inadequate for peak consumption. Storage ranges from 1.4 hours (San Rafael-Desamparados) to 8.5 hours (Guadalupe and Alajuelita) for maximum day consumption. Again reduction of wastage would greatly reduce or eliminate these deficiencies.

San José and Guadalupe have adequate treatment. Alajuelita and Desamparados use raw river water and San Rafael-Escazú and Moravia-Tibas have filter plants of inadequate capacity, necessitating by-passing raw

river water to the distribution system. Also, the chlorinators in these plants and in Desamparados were inoperative. Consequently, these supplies must be considered non-potable. Curridabat and Escazú have protected spring supplies and are considered potable at the source. Guadalupe has a new rapid sand filter plant which has been in operation about a year. However, because of mechanical difficulties, lack of chemicals, poor coagulation and inadequate chlorination, it is not producing a satisfactory effluent.

Inquiries revealed that with the exception of Guadalupe, pressures are low or non-existent part of the time in all systems. Only in San José have studies been made to obtain an accurate picture. A block-by-block pressure study in San José indicated that under average consumption conditions, roughly 20% of the system had pressures of 0-5 psi; 60% had pressures in the range of 5 to 25 psi and 20% had pressures of 25-30 psi. With negative pressures, leaks in the distribution system, poorly protected underground tanks and opportunities for back-siphonage, it must be concluded that there is no completely satisfactory potable water supply in the metropolitan area. This is in spite of the fact that in San José maintenance of a minimum residual chlorine of 0.1 ppm. is attempted throughout the system and the declaration (apparently no records are kept on satisfactory analyses) of the water-works chemist that 99+% of the samples from the distribution system (four daily from different parts of the system) are satisfactory.

Availability of Water

Table No. 2 represents data gathered in the field and is based upon cantóns rather than systems previously described, since ordinarily each cantón operates and maintains all water systems for the entire cantón. In several cantóns - notably Desamparados, Alajuelita and Moravia, outlying districts are served from other sources - springs - which supply groups of houses. Consequently, the populations shown do not coincide with those indicated in previous tables (from Rader Report). The principal purpose of this table is to show the availability of piped water to the residents of the various cantóns, partly or totally within the metropolitan district (San José, Escazú, Tibas, Montes de Oca and Curridabat are entirely within) other cantóns have one or more districts, usually rural, outside the area.

Table 2 shows a remarkably high percentage of the total population with piped water in the homes. Except for a few rural districts the percent of population connected in the adjacent cantóns is as high or higher than that of the city of San José. The adequacy of service, however, is another story as discussed in previous sections. Inadequacy of service is striking in Montesde Oca, which is a high value residential area contiguous to San José. It will be noted that of 3,107 connections, there are 450 underground tanks with pneumatic pressure pumps and 900 elevated tanks - either on towers or in attics fitted with float valves. These are filled only when the pressure is adequate - usually at night. The average cost of an underground tank and pump is about 2,000 colones or $300 and that of an elevated storage tank is in the neighborhood of

1,670 colones or about $100. Thus, 450 services have an added private capital investment of about $75.00 per capita and another 900 an investment of $25.00 per capita though they theoretically have municipal water service. Wells are not uncommon in this area, although the exact number is not known. An average well with pump costs about 6,000 colones or $900. Operation and maintenance costs must of course be added to the consumer costs. In addition to the above, there are literally thousands of containers, usually steel drums, in the area which are placed under a convenient faucet to be filled at night when pressure is available. These cost about 50 colones each, in place. While this amount is small, it equals the water bill for 9 to 12 trimesters ($2\frac{1}{2}$ - 3 years) in most of the area outside San José. Even in San José, it represents nearly a two years water bill. What is perhaps more serious is the tremendous waste of water from these installations. Faucets ordinarily remain open much of the time, consequently, at night when pressures are best, after the drum fills, the overflow is wasted until the pressure is again reduced by rising demand.

Financing

With the exception of San José, almost all of the major construction, extensions and major repairs has been financed by the national government and water revenues are used only for operation and maintenance.

The following discussion applies to the area outside of San José cantón:

In Table 3, it will be noted that in most cases expenditures greatly exceed revenues in spite of the simplicity of operation and consequently relatively low costs. This stems from the very low charges for service and also from the very high delinquencies in payment. Under the law, water service may be cut off only when a public hydrant is available. In view of the very high percentage of house connections, there are relatively few public hydrants and water is very seldom cut off for non-payment of charges. The water and other service charges may also become a tax lien against the property, but this provision is likewise believed to be seldom if ever invoked.

Stock piles of major repair materials are not ordinarily carried by the various cantóns nor are supplies. Usually there is no technical supervision (except Guadalupe and Montes de Oca) and dependence is placed upon the National Ministry of Public Works for any other than minor repairs and routine operating costs.

Administration

Outside of Guadalupe and San José, operation and administration of water supplies systems are very simple. Where the water is from springs, the operating organization consists of a plumber, laborers and watchmen. The plumber is responsible for general supervision of the system, making minor repairs and installing new house connections. The watchmen supervise the intake or spring structure. In smaller cantóns, one crew is

TABLE 2

	REVENUES (COLONES)	EXPEND (COLONES)	DELINQUENCY (COLONES)	NO. METERS	METER RATES (COLONES)	FLAT RATE COLONES PER/TRIMESTER	COST WATER HAULED BY TRUCK (COLONES)
San José	984000	2000000	985000	4400 (20%)	9-1st-165M³ 0.12-165-300M³ 0.18-300-450M³ 0.30-450M³ +	9.0	12350
Puriscal	18000	14700	12800	None	--	4.5	
Desamparados	28000	79800	25000	400 to be installed	--	4.00	
Alajuelita	3757	10335	--	None	--	3.00	
Tibás	24706	12676	45000	None	--	4.00	
Goicoechea	120000	240000	120000	4500 (90%)	4.50 for 1st 45M³ 0.11 per M³ 45 to 135M³ Excess 0.15 per M³	4.50	
Curridabat	16784	13241	8658	None	--	3.0 Res 4.5 Comm 5.0 Ind	
Montes De Oca	42239	94557	98812	549 12%	Residence 7.0 min for 1st 165M³ Excess 0.20M³ Comm'l 10 min for 1st 165M³ Excess 0.30M³	7.0 res 10.0 Comm	12420
Moravia	12576	18495	21627	None	--	3.50	

responsible for the water systems of the entire cantón. In others, each large district may have a separate crew, administratively responsible to the cantón government. Where there are slow sand filters, additional employees consist of a chief operator and the necessary labor to manipulate valves, scrape filters, wash and replace sand, etc.

Collections and disbursements are made on a cantón basis and accounts are kept in a central office. In some cantóns, delinquent accounts are carried indefinitely, in others, the books are closed each year. Generally speaking, current water revenues are kept in a separate account, as required by law, but disbursements are made from whatever municipal funds are available.

In Table 3, it will be noted that costs generally exceed revenues and commonly costs are greater than delinquencies and revenues. This, of course, reflects the very low water charges as the operation and maintenance charges are generally very low.

In Guadalupe, the situation is as follows: About a year ago, a new rapid sand filter plant--the only one in Costa Rica--was placed into operation; the distribution system was almost completely rebuilt, most of the funds--9,500,000 colones--coming from the national government; 4,500 meters have been installed--the remaining 500 are being installed. This will be first fully metered supply in the central plateau; technical supervision has been provided; service charges have been increased. Due to a heavily polluted source, mechanical failures, lack of sufficient chemicals, poor coagulation and faulty operation, the plant has yet to produce water of satisfactory quality. The financial picture is: operating costs currently are at the rate of 250,000 colones per year, collections at the rate of 120,000 colones per year and delinquencies at the rate of 120,000 colones per year. The above costs include little for normal maintenance and insufficient funds for necessary chemicals, yet current costs exceed collections plus delinquencies.

San José is by far the largest and the dominant cantón of the metropolitan area and now has a well organized water department, which undoubtedly will be the base upon which any coordinated program will be built. A more detailed description of the San José water supply seems pertinent.

San José (except Pavas District) is supplied from two large springs and the Tiribi River. The river water is treated in two settling and slow sand filtration plants. The mixed plant effluent and spring supply is further treated by chlorination. A chemist is employed for plant operation and quality control.

Bacteriological analyses are made daily from four points on the distribution system as well as the plant effluent. An attempt is made to maintain a chlorine residual throughout the system and a daily check is made of chlorine residuals. The filter plants are well operated and maintained and the springs and storage reservoirs appear to be well protected. Were it not for a leaky distribution system and negative pressures,

the water would undoubtedly be of satisfactory quality. The sources are adequate during the wet season, however, serious shortages have been encountered during the past two dry seasons. As elsewhere, the per capita consumption is high, 470 liters daily (124 gcd), indicating excessive waste and/or leakage.

The present water distribution system was built in four major construction projects 80, 50, 30, and 20 years ago. The last was primarily to serve the southwest section of the city, however, it gave some relief to the central part of the city. Within the past four years, a betterment program of extensions, replacements, etc. involving an expenditure of 12 million colones has been carried out (4 million from the national government and 8 million from bank loans to the city). The present system for the most part is considered obsolete due to the size and condition of the mains and inadequacy of storage. Many of the mains are of small diameter (under 4") galvanized pipe which due to acid soil conditions are badly corroded. A complete survey of pressures has been made, block-by-block. Results indicate that under average use conditions roughly 20% of the system has pressures of 0 - 5 psi and roughly 20% pressures of 25 - 30 psi, the remaining 60% having pressures in the range of 5 to 25 psi.

An elaborate house to house census is now being made, which will give an accurate picture of connections. Results will not be available until the end of this year. Based on number of connections, it is estimated that 95% of the houses have piped water into the house. Frequently, one connection may serve two or more houses; usually these are owned by the same person. This accounts for an additional 2% of the houses having piped water. The remaining 3% get water from public hydrants. These are mostly low-standard houses in the fringes of the city. The maximum distance of any house from the public hydrant is about 100 meters. Many of these houses are on land not owned by the occupant and under the law, a clear title is required before a water connection permit can be issued.

Because of low pressures an estimated 30% of the houses have some type of storage tank, usually in the attic. These are equipped with float valves and overflows. Relatively few houses in the city have pumps, but depend upon filling their tanks at night when the pressure permits.

The drought of the past year resulted in the city acquiring eight owned or rented trucks to supply water to homes without water. The trucks fill storage tanks where available. In the poorest sections of the city, the people come to the trucks in the street and get water in whatever type of container they have. In the past year, the rainfall has been the lowest in 60 years and this has been the first time it has been necessary to haul water in trucks.

Administration

Administration of the water department is in the City Engineering Department. The Engineering Department has four sections, each headed by a chief. The chief engineer for the city, as well as the chief of the Water Section, are nominated by the City Council and appointed by the Governor.

The chief of the Water Section reports to the Chief of the Engineering Department who in turn reports to the Governor through the City Council. The Water Section is subdivided into four subsections, each with a chief, as follows: 1) Plants and springs, 2) Distribution system, 3) Meter reading and inspections, 4) Meter repairs.

The distribution system subsection is further divided into three units: 1) Minor repairs and new services, 2) Maintenance and Operation, 3) Extension and new works.

The city Engineering Department has a design and construction section, which is responsible for all public works, however, water design is delegated to the Water Department.

Thus, the Water Department is essentially responsible for studies, surveys, design, construction, maintenance and operation of the entire water system. As stated, the Water Department also reads meters, however, the meter readings are turned over to a central accounting department, which is responsible for billing and collections.

Meters are read and bills rendered quarterly. All water collections are kept in a separate account although a single bill is rendered for all services including water, sewerage, garbage collection, street cleaning and street lighting. No bills are presented directly to the consumer. A notice is published in a newspaper designating a due date and the consumer goes to the branch bank in the district in which he lives and pays his bill. The meter readers also inspect house systems for leaks or wastage and make minor repairs, such as replacing faulty faucet washers.

Finances

Water revenues total about 984,000 colones (1958) annually, whereas the annual expenses are about 2 million colones per year. The total revenue of the city is about 13 million colones, which represents all municipal sources (service taxes, commercial licenses, taxes on entertainment, municipal stamps, etc.) and that portion of certain national taxes (principally ad valorem property tax, liquor tax, certain import and export taxes) which are returned to the city. At the end of 1958, there were 2.5 million colones delinquent general service taxes of which 985,000 colones were water service charges. Since then, a special drive resulted in the collection of 750,000 colones (stimulated no doubt by the water shortage). It is contrary to law to shut off water service for non-payment of bills unless a public hydrant is available. Delinquent general service charges by law also constitute a lien against the property. Neither procedure, however, is often carried out. The law provides for a penalty for delinquent bills, however, in practice this is not collected.

New Construction Financing

It has been the past practice for all new construction to be financed by the national government. However, in recent years, the national government has expected San José, and to a lesser extent a few other

principal municipalities, to pay for an increasing proportion of the cost of water system improvements. In recent years, it has been the rule for San José to finance extensions to the systems mainly from local funds, with modest contributions from the national government. In new real estate developments, extensions are required to be built by developers (under city supervision) before building permits are issued.

Under the law, a municipality may borrow not to exceed 500,000 colones from any single lending institution, but there is no limit on the number of institutions from whom loans are obtained, provided approval of the National Controller is obtained. Any loan exceeding 0.5 million colones must be approved by the Congress. In effect, the only limitation on borrowing is the disapproval of the Controller and/or Congress or the maximum which an institution will lend. San José presently pays 6% interest on six-year water supply loans from banks. All bonds or loans are, in effect, general obligations of the city.

Referring to the previous discussions, all water supplies in the metropolitan area are inadequate either as to quantity, treatment, storage and distribution, administration, technical supervision, operation and maintenance, or financing. Many are deficient in two or more respects, a few in all respects, and all in respect to financing.

Rader and Associates, Engineers and Architects of Miami, Florida, have recently submitted a report prepared for INVU on the water supply system of metropolitan area of San José. This report deals primarily with the sources of supply, treatment, financing and a central organization to plan, administer and finance a metropolitan water supply for the entire area. The study did not cover the existing distribution systems.

It is not within the scope of this study to make a detailed review of the Rader report nor to incorporate detailed recommendations from the Rader report.

Briefly, the Rader Report recommends that the proposed work be carried out in three major stages:

<u>First Stage</u>

1. Create a new organization to be in complete charge of the water supply for the metropolitan area.

2. Reduce excessive leakage and waste of water.

3. Construct a new reservoir and treatment plant on the Tiribi River.

4. Enlarge the existing Guadalupe treatment plant.

5. Increase capacity of several existing plants, develop new spring supplies, strengthen storage and distribution systems and install interconnections. This work is to be carried out in 1960 and 1961.

Second Stage

Construct a storage reservoir in the Virilla River and the necessary treatment plant (to be in service by 1969).

Third Stage

1. Enlarge Curridabat plant.

2. Divert water from the Atlantic slope (to be in service by 1985).

Estimate of operating costs from the Rader Report are shown in Table 4. These estimates include operation and amortization costs for the period 1960-1985. These costs do not include necessary improvement to the distribution systems.

It is estimated (Rader) that the following rates will finance the construction, operation and maintenance, exclusive of distribution system additions, betterments, and replacements. From 1960 - 68: 9150 colones ($1.40) per month minimum for 50 M^3 with a reducing rate per M^3 in four steps from 0.25 colones ($0.0375) to 0.12 colones (0.018) for excess above 50 M^3. From 1969 - 1985: 12.00 colones ($1.80) per month minimum for 50 M^3. From 0.33 colones ($0.05) to 0.12 colones/$M^3$ ($0.018) for excess above 50 M^3.

These rates are markedly higher than any existing rates in Costa Rica, but still seem quite reasonable compared with U. S. water rates.

Because of the nature of the area, the present administrative and governmental structures, the available sources of water, the inevitable growth and other factors, the need for some type of coordinated water supply program seems obvious.

The Rader Report recommends a change in present water laws to authorize establishing a Sanitary Authority which would have full powers to design, construct, maintain, operate and administer coordinated water systems for the area. Administration would include fixing rates, borrowing money and making and enforcing general rules for water services.

Another proposal now being considered by the national government is to establish an autonomous or semi-autonomous national water agency which would have similar powers and functions for the entire nation. This has been discussed in more detail elsewhere.

Both approaches to the problem seem to have advantages and disadvantages. A national authority would be less vulnerable politically; i.e., all municipalities in the country would receive equal consideration. This would not be a valid argument if the metropolitan area completely financed its own system (which seems unlikely). It probably would be easier to secure loans--both external and internal if such loans were secured by the financial resources of the entire country. Most communities outside the metropolitan area do not have technical staffs or stock piles of material and supplies.

TABLE 4

ESTIMATE OF OPERATING COSTS SAN JOSÉ METROPOLITAN AREA (RALEY REPORT)

	1960	1963	1968	1970	1985
Population	262,000	308,000	364,000	413,000	647,000
Annual Operation Costs-Colones	2,194.000	2,999.000	3,898,000	4,861.000	6,828.000
Bond Issues (Colones)	8,000,000	36,700,000	4,300,000	68,000,000	-6,000,000***
Amortization* - Colones	615,000	3,440,000	3,770,000	8,990,000	8,360,000
Average Monthly Cost** per connection (Colones)	5.86	11.00	11.20	17.60	12.10
Average Monthly Cost** per connection (Dollars)	0.88	1.65	1.68	2.64	1.82
Average Cost per cubic meter - Colones	0.104	0.198	0.200	0.310	0.215
Average Cost per cubic meter (Dollars)	.0156	.0297	0.0300	0.0465	0.0323
Average Cost of 1000 Gallons (Dollars)	.059	0.112	0.113	0.176	0.122

* Computed at 4-1/2 interest - 7.688% of construction cost per year.
** Based on 95% total connections.
*** Reduction due to retirement of 1960 Bond Issue.

Such services could better be supplied by a central authority than by individual communities. On the other hand, the San José area is in more immediate need of extensive major improvements than most other cities of the country, (especially in source of supply development), and such needs might receive prompter attention under an area authority than under a nationwide authority. Proponents of greater autonomy in local government would likely prefer an area authority. The problem in the San José area is quite different than in most of the cities and therefore, an authority concentrating on these specific problems might be expected to solve them more expeditiously than if it were concerned with the more diverse and scattered problems. An authority could be established in the metropolitan area and its powers extended to the rest of the country if a trial seemed to indicate the desirability of such an extension. The city of San José has contributed to water system betterments and extensions to a much greater degree than other communities and with it as a nucleus, the area could be expected to continue this trend toward greater local financing. Thus, this area might establish a pattern for a nationwide program.

Suggested Areas for Studies - San José Metropolitan Area

1. Continuation of pitometer surveys

2. Continued studies of San José distribution system and extension of such studies to the distribution systems of other communities in the metropolitan area.

3. Continuation of ground water explorations.

4. Expansion of stream gaging program.

5. Further studies of possible impoundment sites.

6. Pollution studies, particularly with a view to the economics of impoundments downstream from existing and some of the presently planned developments, thus making possible utilization of larger drainage areas above impoundments. Pollution may be the governing factor. Pumping may also be an important economic factor.

7. Continuing study of administrative machinery which will best meet the needs.

8. Continued study of orderly and sound financing including long-range financing plans to take care of needed expansions, new population and industrial growth and obsolescence.

9. Study of water resources of the area with particular reference to the present and future competition for water for various uses--domestic, industrial, agricultural, power, etc.

APPENDIX B

BIOSTATISTICAL STUDY RESULTS

By: Don C. Zobal
Statistical Consultant

I. INTRODUCTION

This visit was made for the purpose of working as a member of a team on a reconnaisance survey of diarrheal diseases and water supply in Costa Rica. The survey is intended to produce information which will be of value in the development of community water supply programs and the control of water-borne diseases. The other members of the team were John M. Henderson and Alfred H. Wieters, consulting engineers, assigned to Costa Rica for a four week period.

After a brief general orientation, discussions of available statistical data were held with the Director of Biostatistics Department of the Ministry of Public Health, the Director of Statistics of the Medical Assistance Office of the Ministry, the Chief of the Vital Statistics Section of the Census, and the Chief of the Statistics Office of the principal hospital of the country, as well as members of the USOM staff. It appeared that the best approach would be to summarize available data on infant mortality and deaths from gastroenteritis and colitis, by province and cantón, so that information on water supplies might be related to the disease data. Similarly, special investigation might be made of the data, such as of the water supply systems in places having high death rates, for the purpose of improving the situation as necessary.

The following sections concern the data obtained on gastroenteritis death, infant deaths, and hospitalization for treatment of gastroenteritis.

II. MORTALITY FROM GASTROENTERITIS

Mortality rates per 100,000 population from gastroenteritis and colitis (Code 571, International Statistical Classification) have been prepared for each cantón and province in Costa Rica for the years 1953 - 1957. Due to the small number of deaths involved, rates per cantón are of limited value; it is expected they may be of use in pinning down situations within a province. Because of the wide variations from year to year, it appeared that five year over-all figures would be more valuable for place to place comparison, and these were therefore computed.

Rates for Costa Rica between 1953 and 1957 have ranged from 119.5 (1956) to 149.1 (1957). The average rate over the five year period is 138.0 per 100,000 population. Deviations are so great that no trend over the period is discernible. A graph for Costa Rica for the five years follows the shape of a W, with the three high points around 149, the low points around 120. Generally speaking, 1956 appears to be a low year,

being the lowest year for five of the seven provinces. Although 1957 is the highest year for all of Costa Rica, it is the high year only in two provinces, San José and Heredia. The year 1953 was the high mark in three other provinces.

A province comparison shows the lowest rates to be in Guanacaste (94.8) and San José (97.0). Guanacaste is the least urban province, and San José the most urban (1950 population census). It has been suggested that infant deaths of gasteroenteritis may be low in Guanacaste as the population is more Indian than the other provinces, and the mothers there tend to nurse their children. This is less true in the other parts of the republic. The low rate in San José Province, which includes the capital of the country, is very likely due at least in part to a water supply system with individual house connections in 97% of the dwellings in the urban areas and in 90 to 95% of those in the rural areas. The rate of deaths in San José is no doubt somewhat higher than the death rate only for San José residents, as about 20% of the 10,000 children hospitalized each year at the San Juan de Dios Hospital come from other provinces. Seven per cent of the children admitted to the Hospital in 1958 died. In 1957, deaths were slightly over 8% of admissions.

The highest gastroenteritis death rates are found in Limón (223.5), Puntarenas (215.6), and Cartago (204.2). The total rate for Costa Rica over this five year period is 138.0. It is expected that further investigations into the water supply systems of these provinces may indicate a relationship with the high rates of the provinces, just as the low rate of San José relates to the province with the best water supply system in Costa Rica.

The ranges of the 5-year gastroenteritis death rates for the cantóns of each province are presented below:

PROVINCES		CANTÓNS			
Name	Rate	Lowest	Rate	Highest	Rate
San José	97.7	San José	69.6	Alajuelita	185.1
Alajuela	132.2	Alfaro Ruiz	46.2	Valverde Vega	186.6
Cartago	204.0	La Unión	98.6	El Guarco	283.9
Heredia	113.0	Sta. Barbara	55.9	Barba	133.0
Guanacaste	94.7	Nicoya	63.8	Canas	223.9
Puntarenas	215.0	Buenos Aires	105.9	Golfito	367.3
Limón	220.4	Pococí	173.4	Limón	238.2

It may be noted that the lowest rate in Limón (173.4) is quite high, in fact considerably above the highest rate in Heredia. It should be remembered that Limón has only 3 cantóns, while all of the others have 7 or more. However, even excluding Limón, a great deal of variation is seen, ranging from 46.2 to 105.9 among the "low" rates, and from 133.0 to 367.3 among the "high" rates, representing vast differences in the disease picture among the provinces.

III. INFANT MORTALITY IN COSTA RICA

The number of infant deaths per 1,000 live births registered per year has been declining more or less regularly in Costa Rica. The rate has fallen from 178.7 in 1931 to 71.6 in 1956, which amounts to 60% decrease. Despite this general downward trend, annual variations are such that it is helpful to use an average of data for the latest five available years for the purpose of a place to place comparison.

The resulting rates range from 69.5 per 1,000 in San José to 100.1 per 1,000 in Puntarenas. Rates for Heredia and Guanacaste were almost as low as that for San José, while that for Limón approached the high rate for Puntarenas. These data are somewhat in accord with those for gastroenteritis, where the lowest rates were found for Guanacaste and San José, and the highest for Limón and Puntarenas. Such a relationship is, of course, to be expected, as 27% of infant deaths are due to gastroenteritis, and 71% of the gastroenteritis deaths are those of infants.

Similar rates have been prepared for each cantón of Costa Rica by year and for the 5-year period. Where it appears desirable to have greater detail within cantóns, use may be made of the worksheets which show the number of infant deaths by province, cantón and district for 1955, 1956 and (with the fourth quarter estimated) 1958.

Tabulations for 1957 and final 1958 data on infant mortality were not available at the time of this study. It appears that the required 1957 tapes had not been sent by the Census Office to the Ministry of Health, probably through an oversight, they had not been requested. Final tabulations for 1958 are being processed, and data for both years are expected shortly. Because of the small numbers involved, rates have not been computed for districts, but such figures could be obtained for study, if desired. A review of the 5 year rates for cantóns within each province indicates the following ranges.

PROVINCES		CANTÓNS			
Name	Rate	Lowest	Rate	Highest	Rate
San José	69.5	San José	56.5	Aserri	121.4
Alajuela	76.8	Alfaro Ruiz	49.5	Valverde Vega	113.3
Cartago	89.8	Cartago	81.1	Oreamuno	115.1
Heredia	70.1	Sta. Barbara	36.2	San Rafael	87.9
Guanacaste	70.6	Santa Cruz	50.4	Carrillo	109.5
Puntarenas	100.1	Buenos Aires	70.8	Golfito	115.8
Limón	96.9	Limón	91.3	Siquirres	119.6

In some instances it will be noted that the central cantóns of the provinces (e.g., San José, Cartago, Limón) are those with the lowest infant mortality rates. Some of the rates (e.g., Santa Cruz in Guanacaste) may be suspected of being low because of under-reporting. Although we have been informed that registration of deaths is very good in Costa Rica, such a rate as 50.4 in this area compared with 81.1 as the lowest in Cartago suggests the possibility that some infant deaths in this rural cantón may have gone

unregistered. This, of course, is a general problem, and a larger one, requiring intensive effort to bring about improvements in death registration, as has been done in Venezuela.

IV. CERTIFICATION OF DEATH

In those instances where the death was not attended by a physician, efforts are made to have the cause of death diagnosed by a physician. If this is not possible, the civil authority prepared the death certificate, registering the cause of death as indicated by the family or friends of the deceased.

There were 3685 infant deaths registered in Costa Rica during 1956. Of this number 45.9% had been attended by a physician; an additional 9.4% had been certified by a physician after death. The remaining 44.7% were diagnosed by civil officials, based on explanations of the family.

Comparable figures for infants who die because of gastroenteritis are as follows:

TOTAL FOR 1956	-	871 deaths
With medical attendance	-	56.6%
Without medical attendance	-	43.4%
With medical certificate	-	8.3%
Without medical certificate	-	35.1%

It is of interest to consider the differences in medical death certification by province. This is shown in the following table relating to 1957:

Provinces	Total Deaths Registered	Per Cent With Medical Attendance	Per Cent Without Medical Attendance	
			With Medical Certificate	Without Medical Certificate
TOTAL	10,471	51.6	11.3	37.1
San José	3,238	64.8	11.2	24.0
Alajuela	1,844	53.2	17.7	29.1
Cartago	1,497	47.3	13.2	39.5
Heredia	563	81.6	10.1	8.3
Guanacaste	1,043	21.5	1.9	76.6
Puntarenas	1,592	37.0	10.1	52.9
Limón	694	49.6	8.8	41.6

Slightly surprising is the high percentage with medical attendance in Heredia; this is one of the least populated provinces (66,000), with urban concentration mainly near the metropolitan area of the capital of the republic.

Second to Heredia, the province of San José presents the best picture of medical certification, about 2 of every 3 deaths being attended by a physician, and 3 of every 4 death certificates signed by a physician. The poorest showing is that of Guanacaste Province, the most rural of all, where only a little more than 1 out of 5 deaths was with medical attendance, and only an additional 2 per cent had medical certification. With a limited number of doctors and a sparse population of low economic status, this is not unexpected.

V. HOSPITALIZATION DATA

Data on hospital stays for the principal hospital of each province show the following numbers of patients discharged during 1958 after care for gastroenteritis:

	4 Weeks to 2 Years		2 Years and Over	
Provinces	Patients	Days	Patients	Days
TOTAL	3750	44576	2132	20504
San José	2378	30175	862	10021
Alajuela	263	3712	241	2233
Cartago	340	3780	347	3376
Heredia	271	2401	276	1659
Guanacaste	142	1710	62	675
Puntarenas	119	694	166	881
Limón	237	2104	178	1259

Totals for all hospitals, rural centers and clinics for Costa Rica are:

	4 Weeks - 2 Years	2 Years and More
1957		
Patients	4,233	3,508
Days	44,187	30,906
Days per patient	10.4	8.8
1958		
Patients	4,747	3,056
Days	52,028	27,671
Days per patient	11.0	9.1

Complete figures on cost per patient day have not been obtained. However, the following figures were published in the 1957 annual report of

the Dirección General de Asistencia Medico Social:

Cost per patient - day in regional hospital

	Colones
Cartago	13.09
Heredia	17.45
Alajuela	16.12
Puntarenas	12.57
Guanacaste	21.56

For San Juan de Dios Hospital, an estimate was provided of 20.00 Colones per patient day. The regional hospital at Limón began to function at the end of August, 1957, and no cost estimate has been obtainable.

In addition to the amount of hospitalization provided for gastro-enteritis, in the year 1957 out-patient consultation was provided at the unidades sanitarias of Costa Rica for 3,945 children suffering from gastro-enteritis. For 9,946 other children, and for 1,236 adults, care was classified as due to diarrheal conditions.

Data obtained from San Juan Dios Hospital, the principal hospital of Costa Rica, shows that in 1958 there were 7,628 children admitted to medical care (this excludes 2,574 admitted to surgery). Of this total, 3,607 were infants, and 3,206 were between 1 and 2 years of age. There were 662 deaths, or a death rate of 8.7%. A total of 120,065 patient days represents an average stay of 15.7 days. (The hospital tabulation shows 15 days). This is an unusually long stay, and further information on it would be of interest. Distribution by province of residence of the children during 1958 is as follows:

Province of Residence	Per Cent
San José	81.0
Alajuela	4.5
Cartago	3.2
Heredia	1.6
Guanacaste	2.0
Puntarenas	4.0
Limón	3.7
TOTAL	100.0

The total relates to 10,202 children under 14 years of age receiving in-patient service in either the medical or surgical pediatrics department of the hospital.

VI. USE OF THE DATA

The following sets of tables have been prepared:

1. Infant mortality in Costa Rica, by Cantón, 1952-1956. Deaths and rates per 1,000 live births for each year and 5-year total.

2. Gastroenteritis Death Rates per 100,000 population, by Cantón. Deaths and rates for 1953 - 1957 annually and 5-year total.

3. Infant Mortality by Districts in 1953.

4. Infant Mortality by Districts in 1956.

5. Infant Mortality by Districts in 1958.
(4th quarter estimated)

6. Worksheet - Deaths by Cantón for Gastroenteritis, etc. Includes data by cantón for 571.0 (gastroenteritis and colitis, except ulcerous colitis, for ages 4 weeks to 2 years). 571.1 (for two years and over, and for the years 1953 - 1955 764.0 (diarrhea of the newborn).

7. Worksheet - Infant mortality in 1952 caused by gastroenteritis and total infant mortality. Includes numbers of deaths by cantóns.

8. Worksheet - Data from San Juan de Dios Hospital. Includes for 1957 and 1958 number of patients, days stay, and deaths for various services of the hospital.

The tables on infant mortality by district contain numbers of deaths, but not rates. Because of the small size of districts and the relatively few deaths per district per year, there appeared to be no value in computing rates. However, within the brief time of this assignment, it was not possible to obtain the special tabulations by district that would permit the preparation of 5-year rates. This appears to be a desirable step that would help localize areas of high infant mortality.

Further tabulations of hospital data were requested that would give details on hospital stays of children treated for gastroenteritis, according to their residence. This would eliminate the bias of having those children who may have developed disease from a poor water supply classified in another area where they have been hospitalized. These tabulations should be completed in the near future and can be consolidated with the data of the project.

It is felt that the data obtained, although the best available, may contain inaccuracies due to improper reporting of cause of illness or death, or to under-reporting. However, as the rates may tend to understate rather than overstate the situation, the higher rates will serve to indicate areas requiring investigation as to the reason why. If a sufficient quantity of statistics on water supplies can be classified, for instance according to quality of water, or per cent of house connection, further comparisons can be made which may be useful in helping to prove the value of public water supply projects. At present, very few such comparisons could be made. It is hoped that the work begun here will be utilized to give a clearer picture of the public water supply problem in Costa Rica and help to diminish gastroenteritis, the number one killer of the country, now causing more than 1 of every 4 infant deaths.