REPORT

of the

PANEL OF EXPERT CONSULTANTS

to the

INTERNATIONAL COOPERATION ADMINISTRATION

on

THE COMMUNITY WATER SUPPLY DEVELOPMENT PROGRAM

Washington, D. C.

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INTRODUCTION

The third in a series of consultant panels convened by ICA, Office of Public Health, for the purposes of obtaining guidance in planning further steps in the Community Water Supply Development Program, and for effecting maximum coordination between WHO, PAHO, and ICA, met in Washington, April 12-14, 1960.

Participants included recognized engineering authorities from educational institutions, professional associates, private practice, equipment manufacturing association, the technical publishing field, and from State, Federal, and International agencies.

Opening the formal sessions of the panel, Dr. Campbell, Director, Office of Public Health, outlined the background and objectives of the meeting. As early as April, 1958, the ICA staff started planning for a Community Water Supply Development Program. It was proposed that the U.S. spearhead a world-wide attack on the gastro-intestinal diseases through the stimulation of national programs to provide safe water supplies for human needs. The purpose of this program is to assist countries develop business-type, self-sustaining and self-generative water supply institutions to plan, aid in financing, construction and management of water supply systems. The program was actually initiated in Fiscal Year 1960 with an allotment of $1,000,000 to ICA out of which grants of $300,000 and $200,000 have been made to WHO and PAHO, respectively.

Dr. Campbell pointed out that safe water supply is a public health cornerstone and that this program admirably meets mutual security program criteria:

1. In terms of feasibility it ranks very high. Community water supplies are popular with cooperating country officials and with the people.

2. Water is not only the key factor in the control of diarrheal diseases but contributes substantially to the reduction of lice, scabies and filth among population groups.

3. For economic progress, safe, potable water is essential to the health and increased efficiency of the labor force and to the establishment and growth of industry.

4. The program is conceived on the basis of maximum utilization of community resources to supply potable water to their people, thus reducing the drain on state and national governments.

5. Perhaps most important of all, this is a positive program which is self-sustaining and self-generating. It has a cumulative and compounding effect on the health, social and economic development of the local community and the nation.

Supporting statements were also made by Mr. Kleine and Mr. Grant of ICA; Mr. Mulliken of OES, State; Mr. Kaplan of U-MSC, State; Mr. Mark Hollis, USPHS; and Dr. Gonzales of PAHO. Mr. Hollis in particular emphasized that this is not a crash program, but that it is long-term and developmental in nature. He went on to say that water is still the key to man's progress and his development -- we cannot afford the expense of being without it.

Mr. Kleine emphasized the self-sustaining principle of water supply development, and the need to "gear this technique to the ability of the area to support it not only financially but through the manpower resources that they will have, to maintain the system after - - - it is built."

Mr. Grant urged positive steps to document the value of water to industry, especially small industry; pointed to the basic need to establish methods for funding water supplies for villages, small towns and medium-sized cities; and in referring to the probable limitations of available capital loans and grants - both external and central government - concluded that "It is for this reason that we have laid such stress on the importance of the development of indigenous, self-sustaining institutions that can cope with this problem. I think it is demonstrated that people are willing to pay for water if an appropriate system can be evolved to secure the payments."

The importance of "the impact of water supply programs upon the economic and the social progress of these communities and countries, and on their stability" was the theme of Mr. Mulliken's remarks.

Dr. Wolman outlined the nature and extent of the problem, pointing out that community water supplies represent a capital investment which will bring a return not only in social, economic and health benefits, but in monetary values as well as in reduced insurance rates and increased property values. Water is a commodity which should pay for itself. In undertaking this program, we should not think of the total capital investment required and then decide we cannot afford it, but rather think about it in terms of monthly rates sufficient to pay the cost of operation and maintenance and to repay capital expenditures.

Dr. Baity, WHO; Mr. Shipman, PAHO and Mr. Board, ICA briefly discussed the planning and implementation to date.

The panel formulated certain fundamental principles and guidelines based on prepared working papers related to four distinct program elements. The four panel sub-groups emphasized the importance of relating their reports to the local conditions encountered.

REPORT OF TASK GROUP A

QUANTITATIVE RELATIONSHIPS BETWEEN ECONOMIC DEVELOPMENT AND COMMUNITY WATER SUPPLIES

INTRODUCTION

Large numbers of community water supply systems can be financed and built only to the extent that they attract investment capital from banks, development funds and individuals of the communities. Greater emphasis must therefore be placed on the total economic advantages of municipal supplies than has heretofore been the case. This will require that the public health as well as industrial, commercial and civic advantages of community water supplies be expressed in terms of economic benefits insofar as this is possible.

This report provides a basis for measuring some of the economic returns that can be expected from community water supplies* in developing areas of the world, it also emphasizes other less tangible ones.

WATER SUPPLY AND ECONOMIC DEVELOPMENT

Economic development in any given country begins when forces are mobilized to control and modify the physical environment in ways which yield productive change. This requires a change from the traditional agricultural economy (common to the underdeveloped areas of the world) to an industrial economy, with increasing capital investments in services and industry. In the development from primitive to highly industrialized economies, the American economic historian W. W. Rustow has classified five stages:

1. Traditional economies,

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*It is important to recognize that many existing community water supplies are inadequate and do not meet the minimum requirements necessary for economic development. These minimum requirements are that the supply:

1. Be reliable,
2. Provide 24-hour service,
3. Provide adequate pressure,
4. Be of good quality,
5. Be adequate in quantity,
6. Be piped into or to the premises of all consumers or made available nearby.

Systems will attain their desired objectives only if they are effectively planned, operated and managed.

2. The transition period,
3. Take-off,
4. The maturing economy,
5. Period of mass consumption.

Each of these stages requires an increasing percentage of industrial workers and a larger capital investment in productive enterprise. Overhead capital investments are essential to provide the service facilities required, which include: ports and docks, railroads, power, police protection, education, irrigation and, importantly, community water supplies.

COMMUNITY WATER SUPPLY AS A CAPITAL INVESTMENT

Water is not only a physiological necessity but provides a service essential to public health and to commercial and industrial development. As well as being a key and essential element in this process, water supply systems can be self-supporting and self-generating. Water is a saleable commodity and it is traditional in the United States and many other countries to pay for it by means of revenues from the consumers and taxes from beneficiaries which cover fixed costs, operation and maintenance. Wherever this custom has been established, the costs of water supply systems are being met by the communities served. Almost without exception, electric light and power services throughout the world are operated on the basis of selling a commodity to the public which pays according to amount used. A much larger number of people in the less developed areas has installed electric services than water services. They also pay a much higher price for electricity. There is no inherent reason why community water supplies cannot be operated on a similar basis.

INDUSTRIAL AND COMMERCIAL DEVELOPMENT

Industrial and commercial development implies specialized labor and urbanization. Community water supply is essential to the development and maintenance of a vigorous, productive urban community and is not merely a service but, in effect, a spearhead of economic development.

While individual supplies can serve an interim need, experience has shown that these cannot meet the wide range of demands (residential, commercial and industrial) which result from an expanding economy. If adequate, reliable supplies of water are not available, there is a definite limit to economic development. Provision must be made not only for immediate needs but for the expanding requirements which have been evidenced in countries such as the United States (approximately 60% of U. S. municipal supply in cities of over 10,000 is sold to commerce and industry). As William Mulholland stated in 1920 in answer to the query as to when Los Angeles would need the increased supply which he was advocating: "If you don't get it, you'll never need it!"

The five essentials for industrial development in a community are: Labor supply; Power; Transportation; Raw Materials; Water Supply.

Water, like power, fulfills not only a service function but has important collateral benefits. In providing water for commerce and industry, the economic base of the water supply system is extended; this permits economies in water production and lowers the cost for all consumers. Community water supplies not only stimulate industry in general but generate a series of specialized industries for the production of pipe, specials, bathroom and kitchen fixtures and plumbing supplies in general. New and improved housing is another important by-product resulting from community water supplies.

The availability of water is routinely used in the United States as an attraction to industry. The New York State Department of Commerce, for example, has a special report which is used to advertise the wide range of ground and surface supplies available for industrial use. The Tennessee Valley Authority actively promotes industrial development in their area and encourages industry to locate where the available supplies best meet their special needs. The Simpsonville-Fountain Inn area in South Carolina developed a new water supply for the primary purpose of attracting industry; a $900,000 bond issue was approved by a ratio of 64:1 by the population of 1290. In two years new industries alone provided employment for some 1500 persons and property values have doubled and in some cases trebled.

In Puerto Rico, the number of industrial customers served by the island-wide Water and Sewer Authority increased from 775 in 1949-50 to 1498 in 1958-59, an increase of approximately -- 200%. Industrial water revenues in 1958-59 amounted to $498,436.00, or about 7% of the total water revenue. The increase in commercial water sales during the same period was even greater and amounted to almost 30% of the 1958-59 revenue. Under the former unreliable municipal systems which existed before 1946, this phenomenal commercial and industrial growth would not have been possible. These customers furthermore reduced the cost of water to residential consumers.

Water supplies were built in key cities in the Rio Doce valley in Brazil about 1945, up to which time economic development had been very slow. The succeeding period, however, has been characterized by a rapid growth in industrial development and population, largely due to the availability of water.

PUBLIC HEALTH

A safe and adequate supply of water for human needs is absolutely essential to a healthy and productive life. One of the major causes of debility and illness in the less developed countries are the diseases commonly transmitted through water or which are widespread due to lack of it. These include a variety of diarrheal and dysenteric diseases and a large group of virus diseases. Community water supply is not only a key element in the control of these diseases but the ready availability of water contributes substantially to the reduction in scabies, lice, and filth-borne disease.

Several investigators have developed guides and approaches to the quantification of these public health benefits.

1 - Campbell & Morehead - "Productive Years"

The authors analyze the population distribution to determine the percentage in the productive age group, those between 20 and 65. The population in this group provides the wealth which supports the remainder, and to a large extent determines the standard of living of the country as a whole.

2 - Weisbrod - "Stream of Earnings Method"

Based on the median income and consumption of high school graduates of the U. S., Weisbrod calculated and plotted curves for the present value of net future earnings by age and sex using annual discount rates of 4% and 10%. Loss of life is considered as the loss of a productive unit.

3 - Direct Methods

Wagner and Wannoni in Venezuela analyzed the cost of community water supplies in terms of fixed costs, operation and maintenance. This cost was compared to the increase in productivity due to the reduction in premature death, illness and medical costs, as well as the savings effected in providing water by other less efficient means. The return on the investment was 800%.

Atkins calculated the entire costs of water supplies and latrines in several countries as compared to the cost of typhoid fever, diarrhea and enteritis. He reported that the entire cost could be recovered in from two to five years.

Many papers are available in the literature showing the direct relationship between the provision of safe water supplies and the reduction in water borne disease.

OTHER BENEFITS

Among the other measurable returns from community water supplies is the increase in property values which inevitably occurs. This increase may be due to the convenience of having an adequate supply of pure water readily available for residential use, or because of the economic value of the water to a business or industry occupying the property.

Another measurable return occurs when water carrying or vending systems are abandoned in favor of a piped supply. The manpower released from carrying water is thus made available for more productive purposes.

A return which is more intangible, but nevertheless very real, is the feed-back which develops as a result of adequate community water supplies. Water triggers the upward spiral of improved health, social and economic development; better health permits more effective education which in turn stimulate increased productivity and a higher standard of living which compounds the upward trend. Concomittantly the availability of water makes possible the development of commerce and industry which, because it also has this important feed-back characteristic provides further impetus to the upward spiral.

RECOMMENDATIONS

1. Develop methodology for a more accurate determination of the cost-benefit ratios of community water supplies.

2. Prepare guidelines for sanitary engineers for the determination of economic benefits of community water supplies.

3. Give wide publicity to the ICA position with regard to community water supplies and economic development.

4. Sponsor or co-sponsor a symposium on the economic impact of community water supplies in order to bring together engineers, economists, bankers and others concerned with economic development and technical cooperation.

BASIC CONSIDERATIONS IN PLANNING LOCAL INSTITUTIONS FOR COMMUNITY WATER SUPPLY DEVELOPMENT AND MANAGEMENT

FOREWORD

Task Group "B" of a panel of Sanitary Engineering Consultants to ICA, which met in Washington, D.C., April 12-14, 1960, revised a working paper on the title subject prepared by Alfred H. Wieters, Sanitary Engineer Consultant to ICA and Paul S. Fox, Sanitary Engineer, ICA. Suggested changes, mostly of a clarifying nature, were accepted by the authors and incorporated in the paper which, as revised, was adopted by the Task Group as its report.

The Task Group recognized the necessity of tailoring organizations to meet specific needs and conditions on a country by country basis.

It is hoped that the report may be useful in developing guidelines for assisting cooperating governments in planning the improvement or establishment of organizations responsible for community water supplies.

INTRODUCTION

It is obvious that no single pattern of governmental structure for the development and management of community water supplies in developing countries can be devised to fit all situations. However there are certain general principles which might apply to all countries upon which individual country organizations, tailored to meet prevailing situations, can be used. Suggested principles are presented for the panel's consideration.

In the developing countries many of the smaller cities have no piped water. In most of the cities, including the largest, the present systems are inadequate, the water quality is questionable, large segments of the population have intermittent or no service, and many older systems, due to obsolescence and deterioration, are in need of replacement. Intestinal disease morbidity and mortality rates (water borne or water connected) are generally high. Usually maintenance and operation are unsatisfactory due to several factors including insufficient funds, poorly trained and underpaid personnel and lack of good administration.

It is not within the scope of this paper to discuss the physical needs but rather discussion will be confined to the organizational needs for development and management of water systems.

PRESENT STATUS OF ORGANIZATIONS

At the present the administration and management of public water supplies varies so widely in developing countries that it is impossible to discuss all the variations in this brief paper. However certain procedures are quite common and are briefly described.

Responsibility for Public Water Supply

The philosophy that some level of government should furnish water and that it should be essentially "free" to the consumer is very general. This philosophy is held not only by the users of water but it is accepted in varying degrees by many governments.

Design

A national or state agency is normally responsible for design of small and medium sized supplies. Sometimes this responsibility is divided between two or more agencies. Design is usually by the staff(s) of the responsible agency(ies) of all but the large systems, where frequently private consulting engineers are employed. In a few of the large cities municipal agencies (usually public works departments) are responsible for design either by their own staffs or by private consulting engineers. Design and construction by the same private company is not uncommon.

Financing

In smaller communities grants from national or state governments for constructions costs, often for 100% of the total cost, are very common. Appropriations made directly to the constructing agency for the construction of specified projects in lieu of direct grants to each municipality is a common procedure for smaller cities. Where a municipality, usually a large city, is responsible for its own construction grants may be made directly to the municipality. Loans by the national or state government are less common than grants. Where made they are frequently from some special fund such as insurance, social security, etc., and at interest rates considerably below the prevailing bank or private investment institution rates.

Finance ministries, central banks or other governmental fianance agencies often exercise considerable influence on appropriations for water supplies by their overall control of budgets, imports, exchange rates, etc.

Fixing rate schedules is usually the responsibility of the municipality, however, this is frequently subject to review and approval by the responsible national or state fiscal agency. Collection of water revenues and disbursements are also usually local responsibilities.

Construction

In the smaller cities construction is by an agency of the national or state government usually a public works department. Larger works are sometimes done by contract under the supervision of the national or state construction agency. In a few of the largest cities construction is carried out by the municipal authorities usually by contract.

Operation and Maintenance

This generally is the responsibility of the municipality with little or no help or supervision from the state or national government.

Coordination

Often there is lack of coordination between the agencies responsible for design, financing, construction, maintenance and operation and for necessary expansion.

Comprehensive Planning

There is usually no comprehensive study of needs, coordinated planning or system of priorities for water works development.

Summary

The most common procedure is for a local government, or a group of interested citizens, to request funds from the state or national legislative body for construction of a water system. Line item appropriations are made for specific projects and the funds are turned over to the national or state construction agency which designs, or supervises design and constructs, or supervises construction of, the project. When construction is completed the project is turned over to the local government for operation and maintenance including the collection of service charges. Ordinarily the municipality makes no provision in its rate structure to provide for any extension of service or for replacements due to obsolescence or deterioration. Therefore when expansion or replacements are needed the municipality must go again to the state or national government for another grant.

Notable exceptions to the above generalized present conditions are programs in Puerto Rico, India, Mexico, Brazil and others.

CONDITIONS AFFECTING PUBLIC WATER SUPPLY PROGRAMS

Among the existing conditions which adversely affect public water supply programs are:

1. The philosophy that water is free and that some

1. (cont.) level of government should furnish water at little or no cost to the consumer is very common.

2. The incomes of the vast majority of the people are very low and hence ability to pay is limited.

3. Revenue from users generally is insufficient to pay for maintenance and operation, to say nothing of debt service, necessary extensions and replacements.

4. Delinquent accounts are generally high with no provision for collection or no effort to collect back accounts.

5. Services are usually unmetered, except in large cities, which results in undue wastage of water, thus increasing costs and/or requiring curtailed services.

6. Many existing systems have deteriorated due to lack of maintenance and repair, with a result that leakage is high in the systems.

7. Where construction funds are from national or state funds no provision is made for operation, or supervision of operation, or for necessary extensions, repairs and maintenance. When the construction organization has completed its work, the system is turned over to the community with no further responsibility on the part of the construction agency.

8. There is lack of comprehensive planning and establishing a system of priorities for the orderly implementation of a nation-wide program.

9. Divided responsibilities for the various aspects of water supply development has resulted in wasteful overlapping competition among agencies and gaps in effective management.

10. Often appropriations for individual projects are grossly inadequate and the money thus spent is largely wasted.

11. Little provision is made for quality control.

12. It is difficult to economically serve an entire metropolitan complex by a group of independent

12. (cont.) water systems, in cases of cities with contiguous independent political subdivisions.

13. Original construction costs, and major extensions or replacements are usually financed wholly or in part by national or state grants. Appropriations are frequently made for individual municipalities as a result of political pressure.

14. Water works projects are in a highly competitive position with other necessary public works projects at all levels of government. Total budgets for public works are very limited in light of the overall needs.

15. Many countries must import large percentages of equipment, material and supplies.

16. In spite of cheap labor construction costs are often relatively high due to cost of material and equipment, import requirements and restrictions, use of hand labor and general inefficiency.

17. Public funds available for loan to municipalities are very limited in amount and the market is highly competitive. Where interest rates on loans from public funds are low, these rates in effect represent government subsidies.

18. Money available for loans from private sources is limited in amount, the market is also highly competitive, and the interest rates are very high.

19. Comparatively little money from international or foreign government lending agencies has been available for water supplies. The few loans that have been made for water supplies have been to large cities.

20. Little, if any, foreign private capital has been available for water supply loans.

21. Where grants are made by the national or state governments no special tax or other revenues are earmarked for water supply and thus there is no assurance of continuity of the program.

From information available there will be a continuing need for subsidies in the form of grants or low interest loans, or a combination of the two in most instances, for some time in the future.

GENERAL PRINCIPLES

While there are many variations in governmental philosophy and structure in the developing countries, certain general principles which have been applied successfully in the more developed countries might be useful in considering organizational structures for the development and management of water systems in the developing countries. The following broad principles are suggested:

1. Water supply should be considered a utility, the same as electricity, gas, or telephone, and the users and beneficiaries should pay the full cost of supplying water.

2. Community water supply development and management should be the responsibility of a single agency of government with full legal authority.

   A single agency at the municipal or metropolitan area level is best adapted to carry out this responsibility in more developed countries. In less developed countries complete development and management at this level of government is generally not now feasible in smaller cities.

   In countries where municipal management is not feasible a single autonomous national state or regional authority or a combination thereof would appear to be the best solution.

3. National state or regional programs should be so designed that the municipalities would undertake responsibilities as rapidly as possible with the aim of ultimately taking over the complete management of water supplies. These might be accomplished in steps in the following order:

   a. Operation and maintenance

   b. Extension of service and replacements

   c. Major new construction

4. Until community water systems become self-liquidating a long term financing plan should be adopted, under the national or state plan, to assure a source of annual grant and/or loan funds sufficient to meet the needs within a reasonable period of time.

5. The agency responsible for community water supply, at whatever level of government, should be fully staffed with well trained, competent, full-time

5. personnel to carry out the necessary technical, administrative and management functions. Available man-power resources of the country, including professional and technical personnel engaged in private practice should be effectively utilized.

6. Since water, or lack of water, in most underdeveloped countries constitutes one of the most important public health problems, the national (or state) public health agency should have a basic responsbilility in any water supply program regardless of the type of organization. It should be the primary agency of government responsible for the promotion of community water supplies. Likewise it should have a basic responsibility as to water quality control.

7. Where water resources agencies have been or will be established, community water supply should have first priority in the allocation of water and responsibility for community water supply management should be in a separate agency, outside the water resources agency.

ORGANIZATION

The best type of organization to develop and manage water supply programs, under the existing conditions in developing countries, will vary widely from country to country depending upon several factors including:

1. Size and population of country.

2. Dispersal of populations and degree of, and trend towards urbanization.

3. Basic structure of government.

   a. Degree of autonomy of subdivisions of national government, (states, municipalities and other local governments).

   b. Authority and ability to impose taxes of various types and collect revenues at each level of government.

   c. Trends towards giving greater responsibility and authority to state and/or local governments for self-rule including authority to levy taxes and raise revenue.

4. Philosophy of the government and the people as to responsibility for furnishing water.

5. Attitude of the people and the government officials toward changes from status quo.

6. Water resources of the country.

7. Economic resources of the country.

8. Industrialization and trends.

Municipal Management

In most countries the ultimate goal should be the complete management of the water systems, including responsibility for design, financing and construction and operation and maintenance by municipalities or metropolitan areas. Financing should be on an equitable basis and might include realistic service charges, front foot or square foot assessments, and ad valorem taxes. In a few large cities, which have reasonably good basic water systems at the present time but need extensions, replacements and improved operation, this plan may be feasible within the reasonably near future.

This plan does not appear to be feasible however in the near future for the vast majority of smaller cities and many larger ones for the following reasons:

1. Inability and/or unwillingness of the majority of the people to pay full costs.

2. Lack of trained personnel to design, construct, or to supervise design and construction, and to manage a water system.

3. Lack of powers (from national or state governments) to carry out these responsibilities.

4. Taxing powers and other means of raising revenue preempted by the national and/or state governments.

5. Inability to borrow money at reasonable interest rates and for sufficiently long terms.

6. Restrictions on imports.

7. Lack of stocks of supplies, materials and equipment necessary for adequate maintenance, operation and expansion, and/or lack of suppliers of such commodities.

8. Relative high cost of construction due to lack of local manufacture of supplies, materials and equipment and to inefficient methods, labor and supervision.

In addition to the above reasons, the concept of ultimate complete administration of a water system by a municipality is likely to face obstacles in many countries. For the most part the national governments have a greater degree of sovereignity than, for instance, in the USA and other federations of sovereign states. There is a wide variation in powers of states or provinces ranging from very few functions (Costa Rica) to countries where the states or provinces enjoy a great deal of authority for self government in many matters (Brazil).

Likewise, powers delegated to municipalities for home rule vary widely. Where the state or province is weak a municipality is actually a creature of the national government. Where the state is relatively strong most of the powers of the municipality stem from the state.

There is likely to be resistance to granting municipalities power over administration of water supplies, together with the power for raising necessary revenues, without broadening municipal power generally. To strengthen municipal government generally is not within the scope of a community water supply program and thus the attainment of the above concept may be quite limited.

Autonomous National State or Regional Agency

With the difficulties noted above it would appear that some type of autonomous national agency would be the best interim approach. In some countries, with widely varying economic and social conditions, and where the states (or provincial governments) have a sufficient degree of sovereignity, autonomous state or regional authorities may be preferable. In any case the authority should be at the lowest level of government which can effectively administer the program.

A National state or regional authority:

1. Would be better able to impose adequate rates and collect water revenues than would local authorities.

2. Could more economically, build and maintain a trained staff competent to administer such a program than could individual municipalities, and would be able to train and supervise local personnel who would ultimately take over certain aspects of the program, such as maintenance and operation.

3. Could study the entire structure of government, the inter-relationships between different levels of government, insofar as water supply is concerned and recommend changes to give the municipalities the needed autonomy to carry out greater responsibilities and the authority to provide financing.

4. Could study the inter-relationships at different levels of government and recommend changes in tax structures which would better enable municipalities to carry a greater part of the financial load.

5. Could, with the financial backing of the entire country (or state), secure internal and external loans at much more advantageous interest rates and terms. Where indicated they would re-loan money from this central fund to individual communities.

6. Could better seek relaxation of restrictions on necessary imports.

7. Could more economically maintain stockpiles of materials, supplies and equipment needed for construction, repair and maintenance.

8. Could survey the needs, the potentialities and encourage the development of industry for the local manufacture of water supply needs in the country and better develop a competent labor force for construction.

9. Would be better able than individual municipalities to economically administer water services in a large metropolitan complex.

10. Could be of assistance in developing a plan for eventual administration of a metropolitan supply by a metropolitan authority.

A national, state or regional authority should preferably be autonomous. If a semi-autonomous authority is established within an existing ministry such an authority should have broad powers and its functions should be entirely separated from other functions of the ministry.

The authority might have complete responsibility for all aspects of community water supply development and management throughout the entire country (or state or regional) or it might have limited responsibilities. Where a competent construction agency exists a country might wish to continue utilizing such an agency. The same might apply to engineering design, quality control, operation and maintenance or supervision therof. There should be, however, a national (or state or regional) authority with the responsibility for comprehensive planning, establishing priorities, preparing and submitting budgets, issuing bonds and borrowing money, making loans or grants to communities and exercising general control over other agencies to whom certain functions may have been delegated thus assuring an integrated program. Even where substantial segments of the work have been delegated to other agencies of government, the national authority should have sufficient staff to carry out its responsibilities and not be dependent upon staffs of other agencies.

Water Resources

In some countries, particularly those with short supply of water, agencies with broad authority over all water resources have been established or are being considered.

Ordinarily the principal function of a water resources agency is to develop and implement a comprehensive plan for the best use of water to meet the needs of the people in a nation or water basin. In water-short areas there is frequently conflict between water uses and thus it becomes necessary to allocate available water for various uses. It is a generally accepted concept that public water supply is the highest water use and that therefore in a water allocation program, public water supply should receive priority consideration in any water allocation program.

In the majority of cases in the more developed countries, development of community water supplies has been for a single purpose--domestic and industrial use--even in water-short areas. Therefore the actual development and management of such supplies should not be placed within a water resources agency. If the design and construction of multi-purpose impoundments are to be carried out by a water resources agency, then of course, storage for public water supply purposes would become a part of the project. Likewise the construction of a conduit or aqueduct carrying water for multiple purposes, including water for public supplies, might be a function of the water resources agency. However, from the point of take-off for municipal purposes the design, construction and management should be the responsibility of a separate public water supply authority.

BASIC CONSIDERATIONS IN PLANNING LOCAL INSTITUTIONS FOR COMMUNITY WATER SUPPLY DEVELOPMENT AND MANAGEMENT

Summary of Recommendations:

It is obvious that no single pattern of governmental structure for the development and management of community water supplies in developing countries can be devised to fit all situation. However, there are general principles which might apply to all countries and upon which individual country organizations can be tailored to meet prevailing situations. They are as follows:

1. Water supply should be considered a public utility.
2. Development and management should be the responsibility of a single agency of government with full legal authority.
3. The responsible agency should be staffed with competent full-time personnel.
4. Public health agencies should be responsible for promotion of community water supplies and for quality control.
5. Community water supply should have first priority in the allocation of water and the responsibility for management should be separate from any water resources agency.

In planning an organization to develop and manage a water supply program consideration should be given to: the size and population of the country; the dispersal of the population; the basic structure of government; the water and economic resources; and the industrialization trends.

Some type of autonomous national agency appears to be the best interim approach to the problem. It could impose and collect adequate water rates; build and maintain a competent staff; secure external and internal loans with the backing of the national government; maintain or supervise the maintenance of adequate stockpiles of equipment and supplies; encourage the local manufacture of needed items; and develop plans for the eventual administration of metropolitan supplies by a metropolitan authority.

REPORT OF TASK GROUP C

UTILIZATION OF WATER SUPPLY AND SANITARY ENGINEERS IN DEVELOPING COUNTRIES

BASIC ASSUMPTIONS

The implementation of the Community Water Supply Program is dependent upon effective utilization and training of engineering personnel. The following basic assumptions appear justified.

(a) The action of the Twelfth World Health Assembly and the Directing Council, Pan American Health Organization, reflect a world-wide desire for this program, which is a cornerstone of public health and economic development, to move forward as rapidly as possible. Widespread support of the special funds necessary by several of the member nations would substantiate this desire.

(b) Many of the facets of this program are engineering in nature. This will necessitate a well-qualified corps of sanitary and water supply engineers both at the international and country levels.

(c) It will be necessary to train new sanitary engineers in addition to reorienting engineers now in practice both at the international and national levels.

(d) In most cases, the program will have to be adapted to existing organizational patterns at the local, national, and international levels, even though steps will be taken to assist in the developing of more effective water supply organizations.

ORGANIZATIONAL PATTERN

The Community Water Supply Program would ordinarily be a segment in the over-all field of water resources. A successful program can be achieved only through the coordinated efforts of several agencies -- on the international level, WHO, PAHO, and ICA; on the national or country level, ministries of development, finance, public health, public works, and water resources to cite the most obvious. The assignment, training, and orientation of engineers for this program will have to be in accordance with the organizational pattern in which the engineer will work.

To illustrate the administrative complexity of the problem, the situation facing the engineer working for an international multilateral agency such as WHO may be analyzed. In its entire program WHO is geared to dealing with national governments through national ministries of health. It is the voice of health ministries which determines WHO policies and the Secretariat of WHO is extremely sensitive to those voices. Yet in a majority of the countries of the world the planning, financing and construction of community water supplies is not primarily the function of the health ministry. Much more frequently, this is a function of the ministry of public works. It is rather naive to assume that a minister of public works will consent to deal with an international agency through a minister of health. (The minister of public works is on the same level as the minister of health and they both have independent agencies.) He might deal through a minister of foreign affairs. The sanitary engineer must be prepared to function in this type of situation.

An agency such as ICA which is carrying on bilateral programs is better fitted to deal administratively with the several ministries which may be involved in a community water supply development program. Theoretically, the USOM country director can call upon his various staff and they can deal with the appropriate national ministry. However, also in this situation the engineer must be able to cope with a sometimes difficult administrative situation. Very obviously, both at the Washington level and at the overseas country level, a number of units of ICA have interest in the water program. It impinges on the work of the health group, the agriculture group, the economic group and the utility group; and this is probably not a complete list. Currently, most of the sanitary engineering competence in ICA resides in the health group. It is essential that the competence of the other disciplines concerned be brought to bear on the water supply program.

EDUCATION AND TRAINING

It is essential that engineering staffs on all levels be capable of understanding not only the technical aspects of engineering, but the socio-economic implications of the program as well. They should be able to advise on financing schemes and on essential governmental administration. In addition to engineering skills, they should have some competence in management, economics, political science, sociology, environmental health, and public health education. They should have the ability both in the form of adaptability and imagination to utilize local materials and labor to the fullest extent, and to encourage establishment of local manufacturing of essential equipment and materials.

Both short-term and long-term educational programs will be needed. Short-term programs such as seminars and specialized short courses can be used to orient engineers who are now practicing. The recent short course on financing held at the Robert A. Taft Sanitary Engineering Center and the ten-week Ground Water Development Course held at the University of Minesota are examples of educational efforts which have increased the ability of engineers to work in the community water development program. Similar courses conducted on a regional basis should be inaugurated as soon as possible. It is unrealistic to think that large numbers of engineers can be brought to the United States for short-term training of this type. To reach the necessary numbers the courses must be organized on a national or regional basis.

On this long-term basis, national educational programs should be established. These should utilize to the fullest extent the potentials of the existing educational resources. The conduct of a successful water supply program will be largely dependent upon the development of sound sanitary engineering education. This educational program should be carried on within the confines of the country. If this is impracticable, training institutions in the same region should be utilized and developed. In most cases, the training should be in a school of engineering.

Sanitary engineering education cannot yield maximum benefits unless it is associated with an adequate research and development program. The water supply problems peculiar to a country or region demand this type of research. Training in the country or region may be implemented by supporting and strengthening local institutions such as by the assignment of foreign sanitary engineering professors to the local institutions. In order to prevent the exodus of trained engineers, it is essential that, insofar as possible, they be trained in their own country or region. However, in many cases a few well-selected faculty members will benefit particularly from training outside their country.

Since it is not practical in many cases to use foreign textbooks or the translations thereof, it is necessary to develop new texts as required by problems and state of development in a particular country or region. One of the principal deficiencies of sanitary engineering instruction throughout the world is the absence of engineering laboratory instruction. One of the objectives of any educational program should be the demonstration of sanitary engineering methods and the utilization of laboratory experiments. This training should stimulate the imagination and ingenuity of the country engineers in utilizing effectively local materials and equipment.

As a means of disseminating technical information in other languages, particularly with the view of keeping the engineer up-to-date on developments, consideration should be given to the use of local and international media. The Spanish-language PAHO Boletin and AIDIS Journal, and the WHO French-language publications are but a few examples.

UTILIZATION OF ENGINEERING PERSONNEL

In order to utilize effectively the available engineering manpower, it will be necessary to provide qualified engineers both at the international and national levels to any of several agencies with specific responsibilities for the implementation of community water supplies. Ordinarily the responsibility for water quality control is vested in health ministries because of their concern with health protection and promotion. Health agencies should be expected to stimulate community water supply development and to participate in establishing minimum guidelines to be followed in design, construction, and maintenance. Such guidelines should be available to the ministry, agency, or local entity responsible for the actual design, construction, maintenance, and operation of the facilities. It is essential that engineers in the health ministry should have competence and understanding in the many areas of the water supply field in order to command the respect and acceptance of the other ministries.

Public works or water resource ministries ordinarily have the responsibility for the planning, financing, design, construction, and maintenance of water supplies. Engineers, both at the international and national levels with the necessary competence should be assigned to those ministries. In the orientation and training of engineers for assignments to health or non-health agencies, the respective functions of each agency should be made clear.

In order to attract qualified engineers to work in water supply programs, steps should be taken to assure full-time employment and salaries commensurate with the responsibilities of the positions as compared with engineering positions in other agencies of the government. It is very important that the water supply engineer have professional and social status equal to his contemporaries in other professions.

In order to make maximum possible use of local resources, a roster should be prepared listing all trained engineers in a country. Frequently, there are engineers working in non-engineering jobs. There are also many sanitary engineers who are working in other fields of engineering. It should be possible to recapture some of these engineers for water supply engineering.

ICA, WHO, and PAHO should maintain a roster of recognized specialized consultants who would be available for short periods of consultation in various areas of the world as the need arises.

It is recommended that engineers should be utilized strictly at professional levels, and that maximum use should be made of other professional and technical personnel. Subprofessionals, such as engineering aides and overseers should be utilized to follow through on the routine aspects of the program.

The following quotation from the Second Report of the Expert Committee on Environmental Sanitation of the World Health Organization is particularly applicable to the Community Water Supply Program:

> "The assumption, perhaps too widely made, that underdeveloped regions are not prepared for the services of the best-trained specialists in environmental sanitation can readily be contested. Countries of minimum resources are most in need of the highest expert service available, both for diagnosis of need and for planning solutions. The relegation of these functions to less-adequately prepared persons results from a great misunderstanding of the complexity of the problems in environmental sanitation encountered in areas of low economic level. These problems require for their solution the impact of high intelligence, training, and experience, even when the number of persons possessing such qualifications is necessarily a minimum. It is unsound practice literally to send a boy to do a man's job."

UTILIZATION OF WATER SUPPLY AND SANITARY ENGINEERS IN DEVELOPING COUNTRIES

Summary of Recommendations:

1. A panel to develop specific guidelines for the education and training aspects of the Community Water Supply Program should be convened at an early date. An important allied matter to be considered by this panel might be the question of achieving and maintaining adequate professional and social status by water supply and sanitary engineers as a means of attracting qualified engineers to work in this field.

2. Short-term and long-term training should be provided for water supply and sanitary engineers at all levels. This training should be carried out in the home country or in the same regional area.

3. Any sanitary engineering instruction, existing or to be developed, should be provided with adequate laboratory facilities, both for research and for developmental activities, as an integral part of advanced training and instructions.

4. Text books should be developed to meet the particular needs in sanitary and water supply engineering in individual countries or regions with the same basic problems.

5. Sanitary engineers in the health ministries must have competence in the many areas of the water supply field and should be available for assignment to other ministries which have responsibilities for community water supply development.

6. Promotion and stimulation of community water supply development should be a prime and priority responsibility of health agencies.

7. Guidelines for design construction and operation of community water supply systems should be developed by the health agencies. Quality control of water served by community water supplies should be a particular responsibility of the health agencies.

8. Water supply and sanitary engineers should be utilized strictly at professional levels with a maximum use being made

of other professional and technical personnel, as well as subprofessional aides.

9. Rosters listing all trained engineers should be developed and maintained for each country to serve as a possible source of technical manpower.

10. ICA, WHO, and PAHO should maintain a roster of recognized consultants which can be drawn upon as the need arises.

REPORT OF TASK GROUP D

REALISTIC DESIGN AND QUALITY CRITERIA AS ELEMENTS IN THE ECONOMICS OF COMMUNITY WATER SUPPLY DEVELOPMENT

I. INTRODUCTION

A. GENERAL

The present interest and joint program of various agencies in the urban water supply problems of developing countries stems largely from the very large backlog of unsatisfied, acute need which has accumulated in this field, that is, from lack of physical plant. Although many valid reasons can be advanced in support of urban water supply development, and although solution of the problem is multi-faceted, it is a truism that most of them are significant because of widespread existing deficiencies in plant which are increasing each year.

Wolman has pointed out, for example, that more then 29 million people of a total urban population of some 75 million in 19 Latin American countries were estimated to be without water service in 1958. The natural increase rate in one of these countries is at the annually compounded rate of 4.4% and the average for the area probably is in the order of 3%. The annual rate of urban population increase is probably at least 5%, including some metropolitan areas with a much higher growth rate than the average.

In one of these countries (Costa Rica), the estimated per capita cost of needed future construction is $30. This low figure by comparison with U. S. experience reflects not only factors which Costa Rica possesses in common with many other Latin American countries, such as low labor wages and modest hydraulic design values, but also low average costs in source of supply development and limited treatment requirements due to predominantly ground water resources. Whether this per capita cost figure is valid for the 19-country area is open to question, but it probably is not excessive as an average figure under resonable design and present water conditions. It is probably high for many relatively small urban areas with adequate ground water resources, just as it is low for some large metropolitan areas faced with the heavy cost of developing remote new surface supply sources as well as treatment facilities and major improvements to distribution systems. However, if it is applied to the 19 Latin American countries surveyed, the annual cost of construction needed to keep up with urban population increase and to overcome the present backlog over a 10 year period would be:

1. Backlog Cost - 29 million x $30/10			$87 million
2. Growth Cost -			
1958 Urban Population	74.7 million		
1960 " " (5% Annual Increase)	81. "		
1970 " "	120. "		
Av. Ann. Increase-1961-70	3.9 "		
Av. Ann. Growth Cost 3.9 million x $30			117 "
Total Annual Cost			$204 million

This estimate is based on the desirable objective of providing each urban resident with piped water service by 1970. It contemplates not a 50-year program, but a perpetual program, with the present backlog cleared in 10 years in order to make way for annually expanding growth requirements. If the present backlog were to be cleared in 15 years, rather than 10, the annual backlog cost would be reduced to $58 million but the average annual growth cost would rise to $144 million, and the total annual construction cost would be essentially the same. Any program of coping with this backlog over a still longer time period would entail a greater total annual construction cost if creation of new backlogs is to be avoided and if urban growth continues at its present rate or at an accelerated rate. These figures represent construction cost, net debt service, which could be higher or lower but certainly would be different.

The foregoing figures merely represent a crude approximation of the construction cost needs of 19 countries, mainly located in a single continent, and are only minor fractions of the global water supply needs of developing countries especially in Asia. There is little point in carrying these calculations further in view of the insecure base on which they rest and because the purpose they serve in this paper is more qualitative (i.e. to demonstrate general order of magnitude), than quantitative.

B. OVER-ALL FINANCING PLANS

One fundamental premise of this program is that water largely should pay its own way, i.e. that the urban consumer should pay most, and preferably all, of the operating and overhead costs of urban water systems. There seems to be common agreement outside of the immediately affected countries at least, that only on this basis can water supply development catch up with accumulated needs and satisfy continuing needs.

A second seemingly equally fundamental premise is that construction cost will be financed mainly with soft currencies, or more precisely with the currencies and credit resources of the benefited areas. This premise in effect stems from the principle that urban water supplies should be self-supporting. However, it does not preclude the need for and desirability of substantial outside support in the form of hard and soft currency loans and credits repayable either in hard currency or preferably in the firm-to-soft currencies of the benefited countries.

Conversion of these two premises into terms of practical application requires on the one hand:

1) That the obviously needed higher water prices in most of the urban water systems involved be held within limits of socioeconomic feasibility by exercising economy in design and materials specifications and by making capital funds available at favorable interest and repayment rates.

and on the other hand:

2) That maximum use be made of national resources in addition to the obvious and assumed principal use of native labor; this would be mainly in the form of materials, supplies and to a lesser extent equipment, produced by native companies and local branches of outside private enterprises. In addition, the principal use of national raw materials for such manufactured products would be indicated. The term "national" would be applied to regional blocs of countries in some instances.

From the standpoint of sheer use of these materials, the role of engineering specifications is apparent. Design considerations, on the other hand, determine the volume of materials used and hence ability to supply. Both have an important impact on the required volume, and method, of financing.

The alternative to national and regional production as a primary base in meeting the logistic needs of expanded community water supply development needs in newly developing countries is the importation of the bulk of these requirements from industrially developed (i.e. hard currency) nations. This procedure would require primary financing by one or more of the following procedures:

1) By currency inflation - a self limiting device.
2) By hard currency grants.
3) By hard currency loans and credits repayable in soft currencies.
4) By exporting gold and/or hard currency assets.
5) By reducing imports, especially soft goods and luxury items.
6) By increasing exports and/or increasing tourism.

It is not within the scope of this paper to make a detailed review of these alternatives. Suffice it to say that each of these methods is being presently employed in varying degree by or on behalf of individual countries and all but the first are potentially applicable in theory for support of long range water supply development needs. However, as a substitute for placing primary reliance on national and regional production they are assigned a secondary, supportive role.

It would be unrealistic, however, to assume that it will be economically feasible for every developing country, regardless of size or status, to develop internal production facilities in the reasonably near future to meet its principal needs in expanded water supply development. To some extent, developing regional commerce may fill this void, but not uncommonly the developing countries of a given region are exporters of the same principal commodities, and the foregoing alternatives appear to provide the only solution in such cases. Nor should it be assumed that the development of national production to meet expanded water supply construction needs would result in a net loss in exports of water supply items from industrialized countries. Tripling the present construction rate in developing countries, for example, could result in tripled imports of water supply equipment and specialized materials items, even though basic materials components were produced locally.

II. DESIGN*

A. INTRODUCTION

Consideration of broad design values is especially significant in the over-all planning of a water supply program because the process of establishing basic design norms involves converting program objectives from the area of principles toward the area of application. In reviewing the many values, norms and end-use objectives which are involved in design, it has seemed best to confine this report to three paramount factors with respect to socioeconomic objectives, construction costs and financial feasibility. These three factors are:

1. the extent to which the prople of an urban community will be served with water and the location of the point of service.

2. the continuity of water service.

3. the quantity of water to be supplied.

A fourth important factor (water quality) is covered in a following section. Water quality however, is also involved in item (2) above and health benefits aside from water quality are also involved in all 3 of the foregoing items since they all bear directly on the availability of an adequate supply of water for hygienic purposes.

Much of the following discussion is presented with one qualification in mind. The strengthening of existing systems calls for design practices which are individually tailored for each community. This is somewhat less the case where completely new systems are involved. In the present program, new systems are rarely involved except to the extent that some existing systems may require complete replacement. The great majority of the urban communities in developing countries are already provided with a piped water supply; the problem is rather one of inadequate supplies. Under such circumstances, each individual system tends to be a special case, with relatively greater emphasis placed on actual conditions in the community and system, including system operating experience, and relatively less on predetermined factors based on other communities.

B. EXTENT AND LOCATION OF WATER SERVICE

One program concept under which this report is developed is that potable water should be made available to all residents of an

* This section is concerned primarily with design considerations for urban water systems covering a wide range of population. However, some parts of the text are not applicable to small community systems since these systems have their own special characteristics in operation, financing and design.

urban community through a single piped distribution system to meet full domestic requirements. The extent to which commercial and industrial water needs are met from private supply sources and the extent to which certain industrial and public water uses are met by non-potable distribution systems, will necessarily vary with individual systems. In general however, it is anticipated that the system supplying domestic water requirements usually will also serve all or most commercial and public requirements, all or most light industry needs and a lower and more variable proportion of the needs of industries which are moderate-to-heavy water users.

It is also considered that piped water service into all habitations or their immediate premises should be an objective in the development of every urban water supply and that this objective should be met wherever and whenever it can be achieved within the limits of fiscal, physical and socioeconomic feasibility. However, it is recognized that the economic and housing conditions under which a minor-to-large proportion of the population of a given city may live will in many cases dictate service to yards (as contemplated above), and also at times to neighborhood facilities, such as public hydrants (fountains). Such neighborhood facilities are indicated in some slum areas, often large in extent, with makeshift temporary housing occupied by squatters without property rights or defined premises. They are also indicated in some cities having large populations of destitute people where even major subsidization of water bills by general government would not result in payment of the residual amounts owed by individuals. Some slum housing conditions lack living facilities to such a degree that there is negligible opportunity for families to use significantly more water at the dwelling place than that needed to satisfy physiologic requirements even if piped water service were provided.

A limited number of strategically placed public hydrants (fountains) in an urban community also may be indicated as an aid to maintaining the economic validity of a water supply. Experience in some areas indicates the practical difficulty of disconnecting water service in low income areas where these disconnected are left without a supply of water to meet physiologic needs. If water supply is put on a business basis and treated as a commodity, as has been advocated, it is important that each customer with piped water service pay his water bill (either on a full value or subsidized basis), except in special cases where general government may directly pay the water bills of indigents from welfare funds. The threat of disconnection is vital if water bills are to be paid. The provision of a few public hydrants (fountains), at relatively inconvenient locations does not compete with the attractiveness of piped water service at reasonable water rates but does make disconnection for non-payment sociopolitically feasible.

As is the practice in some areas, the cost of free public hydrants (fountains), should be borne by general government from welfare funds and not from water revenues. In special situations where these neighborhood facilities serve as dispersal points for water in substantial quantity for commercial purposes, including supply to water vendors, it is logical for such bulk water to be sold at these facilities by a water supply attendant. In other areas where bulk withdrawal of water is attempted by commercial enterprises for their own use and without valid reason, such practices have been feasibly controlled in some cases by volunteer wardens and police follow-up.

C. CONTINUITY OF SERVICE AND PRESSURE

Continuity of service 24 hours daily and at all seasons of the year is considered essential in an urban water system on both quality and usability grounds. This criterion does not preclude service interruptions due to emergency failures, unusual fire demands etc.

Toward achieving this goal, a minimum pressure of 5 psi. in street mains under maximum season, peak hourly domestic demand conditions might be employed in design for delivery to outlets at very low elevations in minimum flow-rate services, with upward adjustment for all other conditions.

D. PER CAPITA WATER USE VALUES

1. General Considerations and Practices

In the earliest day of man's history, food, water and air were free. With the establishment of an organized society, including community development, it soon became necessary to create a pricing system for one of these essentials (food), with payment in the form of personal services, by barter, and later through the use of a medium of exchange. It is likely that almost from the beginning, the cost of any given food in the market place was in direct proportion to the quantity purchased, rather than on some other unit of measurement, such as the amount a man could carry away in a given period of time. The fact that this market practice presently prevails facilitates orderly planning in food marketing, since per capita demand can be predicted on the bases of ability to pay, nutritional requirements and price.

It is also probable that a second essential of life (water) was price-based in some communities in arid areas at about the same time in history as was food. However, the spread of this practice into other parts of the world proceeded much more gradually and even today free water is provided in some urban communities. Nevertheless, the prevailing worldwide practice is to charge the consumer for water delivered to the premises by vendor or by pipe.

Unlike food, however, water is not sold to most urban consumers in developing countries strictly on a quantity basis, even though use of water meters is quite widespread. Since the sale of water on a period-of-time (flat rate) basis provides no incentive to the consumer to avoid waste, water abuse, as distinguished from valid water use, variously is or would become the controlling design criterion, depending on whether water is continuously or intermittently supplied, Since the economic resources which are available in developing countries for community water supply construction and operation are rarely sufficient to warrant the design of systems under a flat rate schedule which will satisfy water waste potentialities in addition to useful needs, a number of practical "solutions" have been devised. A common characteristic of these measures is the establishment of undesirable pressure conditions in water distribution and building supply systems and the limitation of water availability to consumers for useful as well as for non-useful purposes.

Perhaps the commonest procedure is to design systems which on the one hand conform to ceilings imposed by budgetary and capital resources limitations and on the other hand provide a resonably ample supply of water to consumers before taking water waste into account. When placed in operation, systems designed under this procedure are characterized by intermittent service to the more adversly situated customers during high water demand periods. Interruption of service can be seasonal or daily and can vary from one or two hours to 12 or more hours daily. This problem may not develop immediately where the design provides for large future population growth.

Another common procedure at least in the eastern hemisphere is to deliver water into the distribution system only during a few designated hours of the day. This limits leakage and waste since these are a function of time as well as pressure and permits inadequate source of supply production to be stored to satisfy distribution system demand during operating hours.

A third procedure is the installation of tubular or disc orifices in building service connections to limit flow rates. A related procedure is the establishment of a rate schedule having flat rates proportioned to the diameters of building connections lines, starting with a minimum size of pipe of as small as three-sixteenths inches.

A common characteristic of water systems having intermittent delivery is the use of storage containers on consumer's premises. These include ground storage reservoirs and lift pumps, roof tanks, open barrels at ground level and on porches, buckets and pots and pans. Even bathtubs are put to use where they exist. These facilities are sometimes supplemented by private wells. The adequacy and nature of such storage tends to be proportioned along economic lines, with the more prosperous members of the community put to little or no inconvenience by intermittent delivery in the street mains.

Occasionally, water storage on the premises is directly or indirectly involved in the fiscal and hydraulic planning of community water supply improvements. Deliberate provision for premises storage in hydraulic design is exemplified by special situations involving small communities where it is anticipated that every customer will provide himself with a sizable roof storage tank. By use of orifices in each building service line, the maximum demand rate in the distribution system and gross waste in individual services are held in check. While the cost of the water system on public property can be reduced by such arrangements, the total capital investment is almost certainly higher than that of a system where demand is controlled by meters and an adequate rate schedule.

The fact that so much of the available information on per capita water use in terms of actual experience and design norms used in developing countries is based on special practices and conditions (such as water waste, budgetary limitations, intermittent and interrupted delivery), rather than on the objective determination of true consumptive use requirements, invites exploration into a hypothetical and theoretical approach to per capita water use needs. This approach is suggested as a baseline toward determining "true" need, and not as an actual basis for a per capita design value.

According to Rich, Ingram and Berger/1 in a recent article on space travel, the indicated total water intake of a 146 lb. man under temperature and humidity conditions of optimal comfort is 2800 grams. Under certain assumed food-water content conditions, one liter would be consumed as drinking water. So far as is known, the closest approach to this value in water supply practice is cited by Lamoureux /2 as "less than one gallon per capita per day" in many countries of the Near East. This is corraborated by the experience of a member of this panel in Kuwait (1948), a city on the Persian Gulf with over 100,000 at the time, where water use was less than 6 lcd. The amount used was determinable since the public water supply was obtained from the remote Shatt-al-Arab River by sailing dhows of the public water monopoly. The male population also had access to the seashore for ablutions. Due to the hot, dry climate, drinking water intake must have comprised a substantial part of total water use.

Another reference base is to estimate water use requirements based on the type and number of plumbing fixtures in habitations. Probably a substantial-to-great majority of the urban residential services which might be connected to a piped water supply under the objectives outlined previously in this report would be provided with either one or two faucets, commonly located in the yard or back porch or occasionally in a kitchen or what may serve as a bathroom. Sewer service to this "majority" group is conspicuously absent, as are also water flush toilets and piped bathtubs. Fixed-in-place sinks and lavatories are present in slightly greater numbers but are relatively rare.

/1 A balanced Ecological System for Space Travel. 1959. Rich, L.G., Ingram, W., & Berger, B.B., Jnl. San. Eng. Div., ASCE Proceedings. 85 (SA 6).

/2 Sanitary Engineering Programs of the ICA in the NEA Area. 1956. Lamoureux, V.B. Jnl. San. Eng. Div., ASCE Proceedings. 82(SA 1): Paper 885.

The prevailing method of water use is to fill pans, tubs and buckets from a faucet for washing purposes and pots for cooking. Body bathing is by sponging or by dousing the body with water from a bucket for rinsing purposes. Clothes laundering is by use of a tub, commonly in the porch or yard.

Due to the general absence of building plumbing systems and fixtures, opportunities for "valid" consumptive water use for hygienic and other residential purposes are obviously limited. One committee member in reviewing this subject, estimated that a family of 5 persons obtaining its water by bucket from an off-premises source, would likely carry in the order of 56 liters of water daily. This figure incidentially, is in close agreement with a measured water use of 11 to 13 lcd (55 to 65 lpd/family) from public fountains at Paramaibo, Surinam, where fountains are rather widely spaced. With on-premises delivery of water, it was estimated that the inherent lack of plumbing systems and fixtures would limit "valid" water use to about twice this figure or 112 lpd/family. This amounts to about 22 lcd or about 6 gcd in U. S. gallons.* After an allowance of 2 lcd for drinking and cooking water, it represents the equivalent of about ten 2-liter pans of water/capita/day for over-all washing purposes, or 50 pans/family/day.

It is apparent that the adoption of such a value for design purposes even in small cities with low-income populations and limited commercial establishments and industries might be unrealistically low except where water is in very short supply. This calculation however, lends support to the India Committee recommendation (listed in a later table) of 15 Imperial gcd (68 lcd) as a design goal for urban areas of up to 5000 population, a figure 3 times that indicated above. The committee preparing this report is of the opinion that 20 gcd (75 lcd) might serve as a useful baseline for small cities where there is need to limit capital and operating costs by effective water use control and where there is effective management. This figure incidentially is the India Committee recommended norm for cities of 5000 to 20,000 population. It is obvious that where water use in some comparable communities in another developing country is over 10 times this figure, adoption of such a norm without drastic change in management practices and in public attitude would only result in the collapse of water supply service.

a) Principal Factors Affecting Per Capita Water Use. Listed below more or less in descending order of frequency in our opinion are the principal factors affecting per capita water use for purposes of design. The assumed conditions are adequacy of developable supply source and continuous delivery of water in the distribution system. (Where the source of supply is inadequate or delivery is interrupted or intermittent, these may establish a ceiling on water use irrespective of other factors, although some systems may have excessively high per capita rates in spite of intermittent delivery conditions).

* Lcd = liters/capita/day. Gcd = gallons/capita/day.

1. The "policy" climate of water distribution and sale, including community and general governmental attitudes and status, character of water supply management, use of meters and related water rates.

2. Lawn and garden irrigation practices

3. Presence and Adequacy of Plumbing Systems and Fixtures

4. Socioeconomic Level of Community

5. Presence and Adequacy of Public Sewerage

6. Size of City

7. Climate, especially precipitation and temperature.

8. Cultural Attributes of the Population

9. Degree of Commercialization

10. Extent and Nature of Water-Using Industries

11. Extent and Nature of Public Water Uses.

12. Physical Condition of Water Distribution System

13. Method of Source of Supply Treatment.

2. Per Capita Water Use In Some Countries

The following scattered data provides limited information on actual per capita water use and on design values used in some countries. The annual per capita national incomes in 1957 or 1958 of the countries involved are listed immediately below for reference purposes.

Annual Per Capita National Income

Nation	$(U. S. A.)
Costa Rica	$328.
India	about $60
Puerto Rico (Commonwealth)	$480
Surinam	$280
U. S. A.	$2057
Venezuela	$760.

a) U. S. A.

More information on water use is available to this committee for the U. S. than for any other country. Much information on this subject has been collected by state and federal health agencies and by the American Water Works Association (AWWA). For rule of thumb purposes, per capita water use in the U. S. is commonly assumed at about 150 gcd or 580 lcd. Of this quantity, about one-third or 50 gcd (190 lcd) is attributed to basic residential demand and the other two-thirds to mixed commercial, industrial and public demands and line losses. This total per capita consumption figure is confirmed by data collected by the U. S. Public Health Service in 1954 from 1474 systems serving 94.8 million people. Per capita total municipal consumption was 143 gcd (540 lcd), and per capita water use has been subsequently increasing at an annual rate of 2%.

Factors which importantly influence per capita water use in the U. S. include climate (especially precipitation and temperature), size of city and extent of metering. The principal water use directly related to climate are lawn and garden irrigation, followed by water cooled air-conditioning. Mainly on account of these uses, per capita residential use east of the 100th meridian (humid area) is approximated at 50 gcd (190 lcd), and twice this amount west of this meridian (semi-arid area)/3, the latter figure representing one part of basic use and one part of supplemental use due to climate. Data collected by the U. S. Public Health Service from 1474 communities indicate that per capita total municipal consumption declines from 210 gcd (790 lcd) in communities where the annual precipitation is less than 15 inches to 119 gcd where it exceeds 45 inches./4

Information available from/4 on the effect of metering on per capita water use indicates that total municipal water use is reduced about 25% by 100% metering. (from 174 gcd or 660 lcd to 143 gcd or 540 lcd). The per capita reduction was substantially greater in cities of less than 100,000 population than in those above this figure. However, these results are misleading for 2 reasons. Due to the fact that use of meters in urban systems is so extensive in the U. S., there was an insufficient number of unmetered systems among the 1474 communities surveyed to provide a baseline. For this reason, communities which were from "0 to 50% metered" were used as a base. In the second place, the relationship between water rates and water-use in metered systems was not analyzed and water rates in some completely metered systems may have been too low to discourage water waste.

According to data presented by /4, per capita water use increases moderately with population size in those communities which are predominantly metered (50 to 100%). The range was from 121 gcd

/3 Study of Domestic Water Use. Task Group Report. Jnl. AWWA 50 (11): 1408-17 (Nov. 1958).

/4 Porges, Ralph. Factors Influencing Per Capita Water Consumption. Water & Sewer Works. 104 (5): 199-204 (May 1957).

(490 lcd) for cities of 5000-10,000 population to 148 gcd (570 lcd) in cities of over 100,000 population. In cities which were only 0 to 50% metered however, per capita consumption was lower in cities of over 100,000 population than in smaller cities.

Maximum Day and Maximum Hour Demands. Data collected for 51 metered systems over 16 years by the American Water Works Service Co./3, indicate a peak maximum day demand of 157% of average day demand when data for the 51 systems were averaged. Data presented by/5 for an average size city with an appreciable lawn irrigation and air conditioning load in hot weather, indicate a maximum hour non-fire flow demand rate of 177% of maximum day demand. Combining these 2 results gives a maximum hourly demand rate of 278% of average daily demand. This is offered as an example and is only one of many different values which might be cited.

b) Venezuela

A paper prepared in 1956/6 presents data on water consumption for 13 communities in Venezuela with a population range of 395 to 4333. These communities were served with piped distribution systems leading to habitations (one-third of population), and to public fountains (two-thirds). The sources of supply and the public fountains were metered during the observation period but the water was either free or on a flat rate basis to the consumer.

The following data were reported:

	Range	Average
No. of Persons/House	4.4 - 8.0	5.97
Population Served/Public Fountain	50 - 520	135.
Per Capita Consumption-Public Fountain	2.2 - 23.4 lcd	10.3 lcd
" " " -House Connections	35 - 436 lcd	187 lcd

c) Surinam

The following information/7 from a developing country is of particular interest because it involves a city (Paramaribo) of substantial size (100,000 population), in which piped water services to premises are 100% metered. As the capital and metropolis of the country and as a port city, Paramaribo has appreciable commercial water use. Results reported are for December 1958, in the rainy season, and are based on meter records for connected customers and special studies made at public fountains.

The average per capita value of 90 lcd cited for the total population does not fully reflect system production because the method of data collection used does not reflect system leaks or unregistered flows through meters.

/5 Davis, A. R., Meter Records at Austin. Jnl. AWWA. 50(11):1404-7 (Nov. 1958)

/6 Rivas Mijares, G & Kollar, K. L., A Study of Rural Water Supplies in Venezuela. Presented at the Fifth Inter-American Congress of Sanitary Engineers. Lima, Peru. March 1956.

/7 R. Brewer. Personal Communication.

The Paramaribo water supply is privately owned and the source of supply is from well fields 25 miles away. The system has continuous delivery.

Percent with water service within houses	33%
" " " " in courtyards	49
Subtotal	82
Percent served by public fountains	18
Total	100

Total No. of Public Fountains	36
Total Population/Fountain	2780
Population Actually Served/Fountain	500

Per Capita Consumption-Connected Services	106 lcd
" " " -Public Fountains	13 lcd
" " " -Total Population	90 lcd

The per capita water use figure of 106 lcd at connected services is equivalent to 28 gcd. Paramaribo water is priced at U. S. 13¢/cu. m. or 49¢/1000 gal. Based on this consumption rate, the annual per capita water bill for connected services is $5.05 or about 1.8% of the annual per capita income. Allowing for an increased consumption rate in dry months, the per capita water bill is probably somewhat over 2% of per capita income. The low per capita use value, in combination with the price and cost of water, indicates that this metered rate schedule is a deterrent to water waste and excessive use.

Table I, which follows, contains a summary of water supply design norms for 3 areas (Costa Rica, India and Puerto Rico), for which considerable detailed information is available. The general setting under which these criteria have been developed and are used is given below for each country.

d) Costa Rica

Services almost totally unmetered. Average flat rate water bill 15¢/month. Water waste and total per capita water use very high (av. 118 gcd (4457 lcd), max. 246 gcd (930 lcd). Intermittent delivery very common. Percent piped water services - probably highest in world. Very little light industry water use. Essentially no public fountains. Cost of operation and source of supply development - very low for most existing systems.

e) India

Per capita income about $60. Up to 40% of population destitute in large cities - 1 public fountain recommended/150 users. Meters in limited use and other flow conservation devices in greater use, with most residential connections on flat rate. Distribution systems designed for low pressures. Interrupted and intermittent delivery very prevalent in existing systems, which generally do not meet recommended norms in Table I. Limited light industry water use in urban systems.

f) Puerto Rico

Per capita income $480., second highest in Latin America. Urban services well over 90% metered. Average residential water bill $1.71/month. Limited use of public fountains, percent urban connected estimated at 86%. Substantial industrial water use by light industry. Per capita consumption 59 gcd, including the capitol (San Juan) with 87 gcd, which consumes 57% of total insular-wide water supply.

Scattered information on water consumption rates and design values is also available for municipal water systems in a number of other developing countries and in one industrialized country (Japan). They are listed separately from the preceding list since adequate baseline information is lacking on the conditions which serve to determine the water use characteristics of these communities. Gallonage values are given in U. S. gallons.

TABLE I

FIRE FLOW AND PER CAPITA DOMESTIC DESIGN NORMS FOR THREE AREAS.

Domestic Flow	India: Central Com. Recommendation '57	India: Andhra State Practice	Puerto Rico	Costa Rica
1. Future Population	40 yrs	30 yrs.	25 yrs	20 yrs
2. Rural Supplies-previous present			15 gcd 25 "	
3. Urban up to 5000	15 gcd		45 "	
4. Urban - 5000-20,000	20 "			
5. Urban-5000-25,000			60 "	
6. Urban-over 25,000			75 "	
7. Urban-20,000-50,000	25 "			
8. Urban-50,000-200,000	40 "			
9. Urban - unclassified		5 to 25 gcd*		80-100 gcd.
10. Fire Flow	About 25% of U.S.	Dist. system not designed for fire demand	33% to 67% of U.S.	No Provision

* Examples are cited of 1 city of 50,000 with 5 gcd., another of 70,000 with 10 gcd, one of 45,000 with 15 gcd. and one of 225,000 with 25 gcd. - all future population values. Design value reported as depending on value of local contribution made to supplement state and possible national funds.

g) Principal Japanese Cities /8

	Population Served (million)	Maximum Day Demand LCD	GCD
Tokyo	4.91	348	92
Osaka	2.24	418	110
Nagoya	0.86	310	82
Kyoto	0.83	285	75
Tokahoma	0.80	448	118
Kobe	0.73	402	116

h) Asuncion, Paraguay /9

(Estimated Population 1960 - 0.205 million)

New system, no previous water consumption experience. Based on consumption in North Argentina cities, design values adopted were maximum daily consumption rate of 250 lcd domestic plus 50 lcd allowance for industrial, schools, hospitals, fire and leakage. Total 300 lcd or 79 gcd.

i) Selected Argentine Cities /10

City	No. Services	Consumption LCD	GCD
San Nicolas	1173	380	100
Santa Fe	13236	310	82
Parana	6569	342	91
Correntes	2876	380	100
Cordoba	18422	233	62
Santiago del Estero	2815	352	93
Mendosa	11152	260	69
San Juan	7418	310	82
Tucuman	13000	356	94

j) South American & West Indian Cities/11

City	Year	Population Served	Percent Metered	Consumption LCD	GCD
Cartagena, Columbia	1957	135,000	100	132	35
Barranquilla, Columbia	1957	370,000	15	240	63
Kingston, Jamaica	1956	265,000	0	500	132
Kingston, Jamaica			82	274*	72
Correntes, Argentina	1954	58,000	1.4	296	78
Resistencia, Argentina	1954	58,000	--	143	38

* 500 gcd before metering

/8 Reference Data in Relation to Water Works Law. National Ministry of Welfare of Japan. 1957.

/9 Report on Water Supply for City of Asuncion, Paraguay, Rader Engineering Co., Miami, 1955.

/10 Obras Sanitatias de la Nacion, Govt. of Argentina. 1935.
/11 Report on Water Supply System for Metropolitan Area, San Jose,

k) Saigon, Vietnam /12

(Estimated Population 1958 - 1.8 million)

	LCD	GCD
Metered Population (5 Saigon Districts)	350	93
" " (Chalon)	300	80
Public Fountains	40	11

Maximum Demand 135% of Average Daily Demand

Percent of Total Water Use by Category

Metered Supply	Percent
Domestic	38.5
Administrative, Military, Institutional & Resale	16.2
Industrial	3.5
Unmetered Supply	
Public Fountains, Fire & Parks	26.5
Losses	15.3
TOTAL	100.

l) Venezuela /13

Design Standards of National Department of Public Works of Venezuela.

Population	Municipal System Design Criteria	
	LCD	GCD
Under 2000 Metered	200	53
Unmetered	400	106
20,000 - 50,000 metered	250	66
Unmetered	500	132
Over 50,000 metered	300	79
Unmetered	600	158

/12 Water Supply Improvement Project, Saigon Metropolitan Area. Hydrotechnic Corp., N.Y., 1958

/13 Abastecimiento de Agua y Alcantarilla. Riva Mijares, N. Nueyo Gracias Madrid, 1959.

m) Guayaquil, Ecuador /14

Population - 1950: 226,000

Percent Metered - Estimated at 44% of total volume.

	Water Consumption	
	LCD	GCD
Metered Services	200	53
Unmetered Services	300	79

n) Scattered Locations /15

DESIGN VALUES

	Average Daily				Peak Ratios	
	Population Under 10,000		Population Over 10,000		Daily	Hourly
	LCD	GCD	LCD	GCD		
San Paulo State, Brazil	200	53	300-400	79-95	1.25	1.50
Phillippines	230	61	450	119		
Honduras	200	53	235	62		
Columbia	150	40	300	79	1.50	1.75
Costa Rica	240	64	400	95	1.50	2.50
Ceylon	180	48	340	90		
Peru	100	26	200-300	53-79	1.40	2.00
Jamaica	180	48	500	132		2.00
Panama City	---	--	---			1.75
Pakistan	115-130	30-34	270	71		2.50
Haiti	115-130	30-34	380	100		
Tunisia	200	53	300	79		
Venezuela	--	-	250	66	1.80	2.50
Formosa	180	48	180	48		2.50
Guatemala	--	-	500	132		

o) Sao Paulo, Brazil /16

Population -over 3 million. A highly industrialized city.
Peak Day Consumption - 150% of average daily

Consumption Breakdown

	LCD	GCD
Domestic	140	38
Commercial and Industrial	100	27
Public	15	4
Losses	45	12
TOTAL	300	79

/14 Presentation by Hugo Ramerez, Director Provincial de Obras Publicas del Guayas, Ecuador, at First Seminar of Sanitary Engineers in Caracas, Venezuela, May, 1954.

/15 Data collected by Edmund G. Wagner from participants in Ground Water Development Course at University of Minnesota. 1959.

/16 From a published article by Ministry of Public Works in D.A.E. (Brazilian engineering magazine) December, 1958.

p) Rangoon, Burma /17

Estimated Present Consumption

	LCD	GCD
Industrial	23	6
Domestic-Commercial	90	24
Waste	57	15
	170	45

Design consumption value: 75 gcd in 1965 for 850,000 population with maximum day demand of 110% of average daily.

q) Tiapai, Taiwan /18

Total Population - 1958	1.02 million
Population Served	0.86 "
Percent Served	85%
Consumption - Present	133 lcd (35 gcd)
- Design	310 lcd (82 gcd)

/17 Report on Water Supply and Transmission for Rangoon, Burma. Malcolm Pirnie Engineers, N. Y.

/18 Report on Taipai Regional Project. J. G. White Engineering Corp., N. Y., 1959.

3. Effect of Meters on Per Capita Consumption

The effect of meters (vs flat rate) on per capita water use necessarily varies in different areas of the world and even among different communities in the same country. For this reason, citation of USA experience in metered and unmetered systems has perhaps limited applicability to experience and expectancy in developing countries.

Reference to the data presented earlier in this section indicates that substantial savings in per capita water use can be achieved in developing countries of the western hemisphere at least by the use of water meters. While the data presented on this subject is admittedly scanty, it includes the low water use in Paramaribo (100% metered), a reduction in water use in Kingston, Jamaica from 500 lcd to 274 lcd (45% reduction), following the installation of meters in 82% of the services, /11 the 50% reduction in design value credited to metered services in Venezuela/13 and the estimated 33% saving in Guayaquil, Ecuador in metered services. /14

In all but very small urban systems, it can resonably be assumed that per capita use savings of the magnitude indicated by these results would not only economically justify the installation of meters but would simplify logistics and financing problems in system construction, and in the case of many existing systems, would bring continous pressures to distribution systems with intermittent and interrupted supplies.

However, justification for metering does not rest solely on economic grounds nor will per capita water use be reduced by metering in all cases. In some systems having continuous pressure only a few hours daily (of which there are many), the effect of meter installation would be to tend to restore continuous pressure without reducing average daily per capita consumption. Metering has special significance in this respect where source of supply resources are limited.

Of special interest in appraising the role of meters in water system design and management is information obtained from special areawide studies and program reviews made in 1954 and 1959 in Costa Rica and Puerto Rico. In 1959, more than 240 of the 250 public water systems in Costa Rica were totally unmetered and in only two systems were a majority of the services metered. In Puerto Rico, every public urban water system is metered and 89% of the total connected rural and urban premises are metered. The percentage of urban customers metered is not precisely known but is substantially higher than the over-all average of 89%.

Per capita water consumption in 34 public water systems in Costa Rica was studied by Matanoros/19 in 1954. They included very

/19 Estudio de Varios Sistemas de Abastecimiento de Agua Potable de la Republica de Costa Rica. Matamoros Lizano, Edgar. 186 pp. 1954.

small to medium size communities (835 to 20,000 population), as well as different climatic zones. All systems were flat rate. Average per capita consumption was 447 lcd (118 gcd).

Islandwide per capita water consumption in Puerto Rico in 1958-1959 was 59 gcd, including metropolitan San Juan (over 500,000 population), which had a per capita consumption rate of 87 gcd and used 57% of the total water provided. The very much lower per capita water use which necessarily exists in the remaining 70 municipalities involves cities of up to 125,000 population.

By most yardsticks, Puerto Rico should have an appreciably higher intrinsic water use rate than Costa Rica. Puerto Rico has a materially higher annual per capita income (about 45% greater), a higher proportion of industrial water customers, is more adequately served with sanitary sewers and plumbing fixtures and has substantially less precipitation than Costa Rica. All public water systems in Puerto Rico provide water on a continuous pressure basis; a majority of the systems in the Matamoros study were intermittent supply systems.

The relationship of metering to the provision of continuous water pressures in distribution systems is illustrated by the history of development of the Puerto Rico Aqueduct and Sewer Authority. When this authority was established in 1946 to take over the management of 75 municipal water systems, only 6 systems were on a continuous pressure basis. Although 44% of the services were metered, many meters were not operating and many others were not read. Water rates were low and delinquencies high. During the early years of the Authority's existence, emphasis was placed on maintenance and operating reforms, rather than source of supply development, in order to restore all systems to a continuous pressure basis. This was achieved mostly by a program of water main cleaning, metering, higher water rates and leak detection and correction. By 1950-51, 96% of the insularwide water services were served with operating meters.

Difficulty in designing unmetered water systems and impaired investment in such systems in Costa Rica is indicated by the Matamoros Report. The highest per capita water use in the 34 systems studied was 246 gcd (932 lcd); this was in a system with only 161 services, of which only 12 were non-residential. This figure is about 3 times the design norm in Costa Rica for systems of this size. It was pointed out that the principal effect of constructing distribution system improvements in another flat rate town to serve population requirements 20 years in the future was the rapid increase of an already ample per capita water use rate, this preempting most of the future reserve capacity.

Results of a recording pitometer survey carried on in Costa Rica in 1957-59 in seven relatively small flat rate systems provides information on the combined effect of water waste and leakage in such systems. These systems had 300 to 1000 services each and an average per capita consumption rate of 95 gcd (359 lcd) over a 28-day observation period. The socioeconomic circumstances of these communities was such that there should be essentially no valid water demand at 2 AM. Also substantially they were continuous pressure systems, with little or no filling of storage containers at this time of night. Yet the median value of the 2 AM flows for these 7 systems was 0.5 of the average 24 hour flows. Extended over the 24 hours this represents a value of 50% of the total water use being lost through leaks and wastage from outlets which were open at 2 AM. Additions and betterments to all or most of these systems had been completed shortly prior to the study by the Ministry of Public Works, and street main leakage presumably was responsible for only a minor part of the water loss.

The beneficial effect of meters in permitting interrupted supply systems to be placed on a continuous supply basis is further indicated by the following excerpt from an India water supply report. /20

"One of the practices common to much of India is that of providing an intermittent or less than a constant 24-hour supply of water throughout the distribution system. Not only does this practice compel the water user to provide facilities to store water during the period that water is not available from the tap, but of more serious significance from a health standpoint, the intermittent draining of distribution piping creates a real danger of pollution by backsiphonage and seepage of polluted water into the distribution system during the period that the pipes are not under pressure. One reason given for intermittent service appears to be a conviction that 24-hour continuous service would increase the per capita consumption. However, it has been amply demonstrated in at least one State that with the use of meters it is possible to provide continuous service to individual customers without an increase in per capita use".

Conversely however, and as might be expected, continuous pressure in flat rate systems increases per capita water demand. In the Matamoros study, 13 systems had "regular" delivery and 17 systems had intermittent delivery. Per capita water use in the "regular" systems was 134 gcd (505 lcd), some 30% higher than in the intermittent supplies.

/20 Review of the National Water Supply and Sanitation Program. Boyce, Earnest, Lieberman, Morton W., Metzler, Dwight F., May, 1960.

4. Water Meters as an Element of Design and Water Use.

The concept that water should be treated as a commodity and should pay its own way, and that water supplies should be placed on a business basis implies in principle that the sale of water should be on a unit quantity basis (i.e. by volume in this case). Adoption of the criterion that water should be available for continuous delivery at some indicated minimum positive pressure also implies that demands on source of supply facilities and distribution systems must be maintained within reasonably predictable limits and that water marketing practices should be such as to insure a sufficient flow of money into water system coffers to cover expanding operating costs and continuing systems development costs to meet rising water demands.

The indicated expansion in rate of water system construction needed to satisfy the accumulated backlog and to keep pace with increasing rates of urban growth further suggests that economy of design is essential in order to satisfy the needs of the greatest number of people with the limited capital funds available for system construction, and where applicable for expanding national production facilities for water system construction materials.

The conversion of these several objectives into terms of practical application leads to the conclusion that the extensive use of water meters is essential.

This group notes that water, an essential commodity, is presently sold largely on an unmetered basis at most services in developing countries. By contrast food, another essential commodity, is in effect marketed on a metered basis and electric energy, a non-essential commodity, is also almost entirely metered in urban areas above minimum size.

Electric meters can be observed at low income residential services in some developing countries where energy consumption is limited to a single or very few, low-wattage light bulbs and where the operating and overhead costs of meter reading and billing are obviously uneconomic. Yet, as a matter of marketing policy, meters are installed in all urban services and many rural services in some countries, even where there is a heavily subsidized government electric monopoly.

As a result of the difference in marketing practice between water on the one hand and food and electric energy on the other hand, piped water is more commonly unavailable to consumers than food. Electric energy systems can nearly always out-compete water systems in obtaining capital funds because electric energy systems are operated on a more businesslike basis. This applies not only to the private capital market but also to governmental agencies with credit resources available for long term loans, such as social security agencies.

In localities where it is considered impractical to meter water because the staff is untrained or inadequate, or because the public is considered unaccustomed to metering, electric energy managements in the same communities may carry on a 100% meter reading and billing program.

After weighing the merits of metering, this group endorses 100% metering in principle as an essential element towards placing water systems on a self-sustaining and business basis, reducing financing and logistics problems and providing continuity of service.

It considers however, that there is need and opportunity for technical development of water meters and for changes in manufacturing design based on present knowledge, in order to encourage greater use of meters in developing countries. It further recognizes that metering by itself serves little purpose unless coupled with a realistic rate structure which seeks to place water on a paying basis, limit capital costs to available capital resources and keep water in needed quantities within the financial reach of low income customers.

It is noted that effective water system management is the cornerstone on which virtually all prospects for expanded water supply development rests, including the feasibility of metering. A metering program requires personnel competent and adequate for necessary maintenance, and for meter reading, billing and collecting, generally not less than 4 times a year.

In systems where such management does not exist or is not a near-term prospect, the use of other water conservation devices, such as orifices, may be warranted. These might be installed in flat rate systems on a systemwide or on a more selective basis, or occasionally as a element of a system metering program. One-quarter gpm or about one lpm is considered the lowest acceptable residential orifice-flow value for design, with larger orifices for other services. Since at this low rate it should logically be assumed that an outlet of one type or another would be kept open at all times in each service, orifices have the design potentiality of curtailing residential consumption to 360 gpd/service or 72 gpd (272 lpd), for a family of 5. Additional provision for other water uses and water losses might permit a system design value as low as 100 gcd (378 lcd) in some small systems. Such savings in system construction cost as may be achieved by use of orifices are offset in varying degrees by consequent private investment in water storage facilities within buildings or by lowered availability of water for hygienic purposes among that portion of the population which is financially unable to provide storage as an element of the house plumbing system.

In some cases involving very small systems and adequate, cheap source of supply resources, it may be found more economical to design systems for an above average per capita water use rate than to go to the expense of metering. Reliable data on an appropriate design value is not readily available for continuous service-all-piped water systems of this type; the selection of a suitable value is subject to the cultural attributes and socioeconomic status of the community to be served and there may be wide differences of opinion on design values. In small flat rate systems where socioeconomic circumstances or actually enforced regulations result in small diameter house service lines, few outlets and/or flow-constricting devices, sustained maximum demand rates can be expected to equal the hydraulic capacity of the house connection systems to capture water from the street mains. Where adequate sizing of house service lines, many outlets and ample pressures exist, hydraulic capacity of services no longer determines average demand rates, although water use increases. Water used for lawn and garden irrigation may be the controlling factor in such cases and occasionally the use of water-cooled air-conditioners may be important. In some flat rate U. S. communities up to 30,000 population, for example, water consumption rates of 2500 gpd (9450 lpd), per service, peak season, average daily demand, are not unusual. However, this amounts to only about 1.8 gpm/ for services with a hydraulic capacity of perhaps 20 gpm under prevailing pressures.

III. QUALITY CRITERIA

Appendix A attached, provides a philosophical and administrative approach to the overall question of water quality standards. This appendix distinguishes between goals and realities, It is apparent that the diversity of factors involved in the water supply situation in developing countries precludes pat answers to this complex problem. These factors include great variation in size of city, quality of source of supply, technical development and organizational status of water supply designing, supervisory and operating personnel and ability to pay financial costs.

In those areas where gross sanitary defects are present in existing water supplies and there is great need for expansion in new and existing systems, the immediate goal would appear to be to provide urban populations with a limited, but dependable supply of water under pressure which is protected against gross sanitary defects at all points. This implies that primary attention to be paid to physical factors, including adequacy of supply, rather than on quality control through bacteriological sample collections. This is especially the case with the generally predominanting ground water supplies. In the case of surface water supplies, it implies that selection of source of supply and of intake points in the interest of obtaining water relatively free of fresh, heavy sewage pollution is more to be prized than providing the high degree of operating skill and treatment facilities which would be required to cope with partially avoidable pollution loads, This principle, of course, is neither novel nor confined to developing countries. It should be applied in balance with costs of construction and operation and the degree of pollution avoided in choosing between alternative sources.

The tendency of some designing engineers in some underdeveloped countries to design and specify treatment processes, plant facilities and equipment which are either over-elaborate or which are beyond the capacity of local water supply management to operate, is perhaps well known and may require no further comment.

In selecting treatment processes, simple reliable treatment methods should be favored over methods requiring complicated mechanical equipment, imported chemicals and highly skilled operators.

Criteria of chemical quality employed in highly industrialized countries should be judiciously modified. Those for certain toxic chemicals, such as lead, should be rigidly maintained. Others, such as hardness, which involve asthetic conditions and domestic, commercial and industrial usability, might be relaxed in the interest of avoiding high operating costs and expensive treatment plants where source of supply resources are unfavorable and there is reason to believe consumers will accept or tolerate the water. Water which is very acid or alkaline should be coped with by selecting suitable materials, treatment, or both.

END

APPENDIX A

STANDARDS OF QUALITY FOR POTABLE WATERS

The term "standard" has a number of connations, and thus confusion has resulted when the term is used loosely. For instance, professional societies have issued "standard specifications," which are guides to practice to be followed at the discretion of each individual when preparing specifications for a specific project of design. Other standards of practice have developed minimum acceptable practice such as in the design of water supply systems. Guides or goals of practice are freely developed and freely used by professional groups. For instance, one professional guide states that filter effluents should have a turbidity under 1.0 unit, and another that filter plants should be so operated that coliform organisms are absent at all times from all portions examined of filter effluents. The temporary presences of coliform organisms then would initiate action by the operating staff, but not necessarily action by the health department in prohibiting the use of the supply by interstate carriers.

Frequently the quality of potable water is considered in the light of some single criterion, such as bacteriological quality as shown by M.P.N. of coliform organisms, without due regard to many potential defects which influence the over-all, reliable quality characteristics of a supply as a whole. Also, M.P.N. values frequently are assigned intrinsic significance, whereas there is no presently available technique which provides a definite and universal value which would distinguish between an unsafe and a safe water supply, inasmuch as the routine bacteriological examination of water does not disclose the presence or absence of water-borne pathogens.

Furthermore, the present coliform "standards" used in practice in the U.S.A. represent not a threshold value established from epidemiological evidence, but rather standards which it has been found empirically can feasibly be met by representative municipal water supplies using filtered surface water, under the design and operating conditions prevailing in this country. The epidemiological evidence points rather to the presence of a substantial safety factor in these standards under present concentrations of water-borne pathogens in polluted sources of supply of this country.

In view of the above, it is desirable to review the chain of factors which effect the quality of water as delivered to the public. Briefly, these may be listed as: (a) the incidence of water-borne diseases in the population contributing sewage pollution to any given source of supply; (b) the effectiveness of sewage treatment and self-purification processes; (c) the characteristics of the water, especially its degree of pollution, range of fluctuations in the degree of pollution, and the ease of treatment by acceptable and economically feasible processes; (d) the size of any water treatment plant to the extent that it reflects the reliability, size, and facilities of the operating staff; (e) the extent of laboratory control over treatment and quality; (f) the type of storage facilities for treated water; and (g) the chances for exposure to pollution of the water in the distribution system and on the premises of consumers. These factors, therefore, are those which should be reviewed in the sanitary survey and which should be disclosed by records of operation and by analytical data. In other words, one must have sufficient knowledge of a supply to permit analytical data to be interpreted as to their public health significance. Such a conclusion then is the result of the exercise of professional judgement, and not solely that of comparing analytical data for any given period with norms established in standards of quality. This administrative attitude is established in the Preface to the "Drinking Water Standards" of the U. S. Public Health Service.

In this connection, it should be emphasized that only the U.S. Public Health Service as the "certifying agent" has been given power by law to enforce its standards, and then only in regard to the water supplies serving interstate carriers. State Departments of Health, as "reporting agencies," follow the provisions of the standards when reporting to the U.S. Public Health Service on supplies serving carriers, and use them as guides in their water supply control programs. This policy has received the support of the American Water Works Association.

This situation is not realized by many who read the text of the standards but not the preface, because the main text is worded in the manner of the governmental code it actually is, whereas the preface outlines the broad administrative policy.

It follows, therefore, that norms established by standards must be based upon experience over the years, relating each norm or quality factor with the potability of water. This situation has justified specific norms when certain toxic substances are involved, such as the upper limit of 0.1 p.p.m. for the concentration of lead. Even here, however, the permissible concentration of any given toxic substance is subject to the variability in the resistance of individuals, the volume of water used for potable and food preparation purposes, etc. Witness the problem of selecting the dose of fluoride to be added to a supply in the light of climatic and social factors affecting water consumption, so that the concentration will be such that the desired total amount of fluorine will be consumed by growing children for teeth nutrition without adverse effects.

The situation is still more complex with norms as to the bacteriological quality of potable water, for the reasons outlined above. It is significant, therefore, that the "Drinking Water Standards" of the U.S. Public Health Service establish no precise value as to the permissible bacterial content, but rather provide statistical guides for appraising the results of the examination of monthly series of samples, together with other factors affecting quality. These guides have been selected as the result of experience in the United States, which for years has disclosed that water supplies meeting the over-all conditions of the standards are not responsible for water-borne diseases.

The development over the years of the "Drinking Water Standards" of the U.S. Public Health Service has been accompanied by advances in the design, operation and laboratory control of public water supplies, and also in the degree of supervision over water quality exercised by water departments and by State Departments of health. Therefore, the interpretation of analytical data in the light of all pertinent local factors surrounding a given supply has been feasible and standards have served to make the practice uniform. In the final analysis, the success and applicability of such control measures are indicated by the very low incidence of water-borne diseases in the United States.

This favorable situation does not imply, however, that equally spectacular results would follow elsewhere, were official standards of quality to be adopted prior to the availability of well designed and operated water supply systems, with adequate supervision and quality control by health authorities. Nor is it feasible to compromise with more lenient standards just because they might be considered as facilitating control programs during an intervening period when less satisfactory supplies have to be used in a developing country. In fact, one may expect that pathogenic organisms are more likely to accompany coliform organisms in defective supplies in areas where supervision is limited and water-borne diseases are more prevalent, so that any given concentration of coliform organisms in such supplies would have a proportionately greater public health significance than in supplies located in the United States and similar areas.

Accordingly, progress in water quality control in developing countries must be comprehensive, with equal emphasis on deisgn, construction, operation and maintenance, technical supervision and laboratory control. During the period of progress and development, standards of quality and other technical guides serve as goals. In the meantime, first things must come first in realistic programs designed to provide piped water supplies to an ever-increasing proportion of the world's population.

The incidence of diarrheal diseases is so high in many parts of the world that initial steps in providing water service will usually reduce the incidence of these diseases to a greater extent than will refinements in practice at a later date. Therefore, there would be a lesser total public health gain were the construction of water supplies in developing areas to be delayed until technical facilities, supplies, and funds become available for a technically more advanced program, including the enforcement of standards.

This, of course, does not imply that water quality can be ignored during the early stages of water development programs. Rather it focuses attention on the need for intermediate goals leading eventually to the technically advanced position where acceptable standards of quality can be applied as a part of an integrated control program.

Finally, it is evident that the limited funds and technical facilities in developing areas place a premium upon ground water resources and development. This is because of the lower capital costs of wells, and usually the absence of treatment, involving technical complexity, need for chemicals, and dependence upon effective operation to produce water of safe, sanitary quality.

In summary, this statement of policy supports the use of the "Drinking Water Standards" of the U.S. Public Health Service as one of the factors in integrated water quality control programs. Their full application, however, should wait upon the equally important availability of standards of design, construction, operation, and technical supervision. Pending such an integrated program, the standards can serve as goals which should be looked upon as guideposts established by practice and epidemiological evidence. No lowering of the goals is technically justified during such a transition period, inasmuch as there are no acceptable ways of quantitatively expressing any compromise with quality, which would indicate a water of "partly safe, sanitary quality". Rather, all available data pertaining to a supply should be examined to establish defects, which then become avenues of progress towards the goal of delivering water of reliable, safe and sanitary quality at all times. Many of the water supply projects in the developing world will have such defects, including absence of adequate technical supervision. This of course implies that appreciable periods frequently must elapse between the inauguration of water service in an underdeveloped community, intended to be the first step in elevating the habits of cleanliness in the fight against diarrheal diseases, and the time when technical advances will establish the background for the enforcement of quality standards. The compromise, then, is not with the standards themselves, but rather the acceptance of the realistic situation that municipal water supply development are not and should not be delayed until technical and financial resources permit an integrated, advanced program of design, construction, operation, and technical supervision, and the application of quality standards. In fact, any delay would only continue the practice of the public's purchasing from vendors water of more inferior quality, in quantities inadequate for healthful living.

The "International Standards for Drinking Water", developed by WHO may differ in technical detail with those of the U. S. Public Health Service, such as statistical implications of the respective sections on bacteriological quality. The provisions of both standards, however, can be met by advanced water supplies, and both can serve as goals for water supply programs in developing countries.

References:

"Drinking Water Standards" - Public Health Reports - 61:11 (1946), Reprint #2697.

"International Drinking Water Standards", WHO(?)

"Water Quality and Treatment", Chapter 3, pp. 29-78, American Water Works Association.

C. R. Cox and
J. M. Henderson

APPENDIX I - PANEL ORGANIZATION

LIST OF PARTICIPANTS
INVITED TO ATTEND
COMMUNITY WATER SUPPLY PANEL
April 12-14, 1960

PANEL MEMBERS

Mr. Herbert M. Bosch, Prof. of Sanitary Engineering
School of Public Health
University of Minnesota
Minneapolis, Minn.

Mr. Waldo G. Bowman, Editor
Engineering News-Record
New York, N. Y.

Mr. Raymond J. Faust, Secretary
American Water Works Association, Inc.
New York, N. Y.

Mr. Richard V. Ford
Vice-President, Ford Meter Box Co.
Representing Water and Sewage Works Manufacturers Association, Inc.
New York, N. Y.

Mr. Wesley E. Gilbertson
Chief, Engineering Services Division
USPHS, DHEW
Washington, D. C.

Mr. John M. Henderson, Consulting Engineer
Savannah, Ga.

Mr. Richard R. Kennedy, Consulting Engineer
Representing The Sanitary Engineering Division
American Society of Civil Engineers
San Francisco, Calif.

Dr. John A. Logan, Chairman and Professor
Civil Engineering Department
Northwestern University
Evanston, Ill.

Mr. F. W. Montanari, Sanitary Engineer
Ohio River Valley Water Sanitation Commission
Cincinnati, Ohio

Mr. Walter L. Picton, Director of Water & Sewerage
Industries & Utilities Division
Business and Defense Services Administration
U. S. Department of Commerce
Washington, D. C.

PANEL MEMBERS

Mr. M. Allen Pond, Assistant Surgeon General
Office of Special Assistant for Health & Medical Affairs, USPHS
Washington, D.C.

Mr. Blucher A. Poole, Director
Bureau of Environmental Sanitation
State Board of Health, Indianapolis, Indiana

Mr. Clarence I. Sterling, Jr.
Director and Chief Engineer
Massachusetts Water Resources Commission
Boston, Mass.

Mr. Alfred H. Wieters, Special Sanitary Engineer Consultant, ICA

Dr. Abel Wolman, Consulting Sanitary Engineer and Emeritus Head at Sanitary Engineering, Johns Hopkins School of Public Health
Baltimore, Md.

OTHER PARTICIPANTS

World Health Organization
Dr. H. G. Baity, Director, Division of Environmental Sanitation, WHO, Geneva

Pan-American Sanitary Bureau
Dr. Carlos Luis Gonzales, Assistant Director
Mr. Harold Shipman, Chief, Environmental Sanitation Branch
Mr. Renato Pavenello, Assistant Chief, Environmental Sanitation Branch

Department of Health, Education and Welfare
Mr. Mark D. Hollis, Assistant Surgeon General, Chief Sanitary Engineer, USPHS

Mr. Frederick F. Aldridge, Chief, Sanitary Engineering Services, INH, USPHS

Department of State

Mr. Otis Mulliken, Acting Director, Office of International Economic and Social Affairs (OES)

Mr. Jacob J. Kaplan, Assistant Coordinator for Programming, U/MSC

International Cooperation Administration

Dr. D. A. Fitzgerald, Deputy Director for Operations
Mr. James P. Grant, Deputy Director for Program and Planning
Dr. Hale T. Shenefield, Office of Deputy Director for Operations
Mr. Carl A. Cramer, O/IND
Mr. Malcolm Jones, O/FOOD
Dr. Eugene P. Campbell, O/PH

International Cooperation Administration (continued)

F. J. Brady, M.D.,	O/PH
E. Harold Hinman, M.D.	O/PH
Mr. Leonard M. Board	O/PH
Mr. E. G. Wagner	O/PH
Mr. Paul S. Fox	O/PH
Mr. V. Lamoureux	O/PH
Mr. R. C. Parsons	O/PH
C. A. Pease, M.D.	O/PH
A. C. Curtis, M.D.	O/PH
Dr. F. J. Vintinner	O/PH
Mr. James D. Caldwell	O/PH
Mr. Jas. D. Williams,	USOM/Brazil
Mr. Chas. S. Pineo,	USOM Costa Rica
Mr. Roger D. Lee,	USOM/Ecuador
Mr. John H. Burgess,	USOM/Guatemala
Mr. Wm. A. McQuary,	USOM/Bolivia
Mr. Eloy A. Barreda,	USOM/Honduras
Mr. Joseph Haratani,	USOM/Nicaragua
Mr. Robert Sikorski,	USOM/Panama
Mr. Frank Tetzlaff,	USOM/Peru
Mr. Ryan B. Salley,	USOM/Surinam
Mr. Robert Brewer,	USOM/Salvador
Mr. Charles R. Cox,	USOM/Jamaica

APPENDIX I - PANEL ORGANIZATION

TASK STUDY GROUPS

Group A

Mr. Bowman, Chairman
Dr. Logan, Author
Mr. Wagner, Recorder
Mr. Barreda
Mr. Gilbertson
Mr. Haratani
Dr. Shenefield
Mr. Williams

Group B

Mr. Tetzlaff, Chairman
Mr. Wieters, Author
Mr. Fox, Recorder
Mr. Lee
Mr. Pavanello
Mr. Pineo
Mr. Salley

Group C

Mr. Montanari, Chairman
Mr. Bosch, Author
Mr. Aldridge, Recorder
Dr. Baity
Mr. Caldwell
Mr. Cox

Group D.

Mr. Kennedy, Chairman
Mr. Henderson, Author
Mr. Board, Recorder
Mr. Brewer
Mr. Burgess
Mr. Ford
Mr. Kollar
Mr. Shipman
Mr. Sikorski
Dr. Vintinner

APPENDIX I - PANEL ORGANIZATION

AGENDA
FOR
COMMUNITY WATER SUPPLY PANEL
April 12-14, 1960

Tuesday, April 12

Dr. Campbell Presiding

9:00 -- Introductions. . . . . .Dr. Campbell, ICA

9:15 -- Background and Objectives of Meeting . .Dr. Campbeell

Statements from:. . . . . Mr. Kleine, ICA
Mr. Kaplan, U/MSC
Mr. Mulliken, OES
Mr. Hollis, USPHS
Dr. Gonzales, PAHO
Mr. Grant, ICA

10:00 -- Nature and Extent of Problem . . . . . .Dr. Wolman

10:45 - 12:00 -- Planning and Developments to Date:

. . . . Dr. Baity, WHO
. . . . Mr. Shipman, PAHO
. . . . Mr. Board, ICA

Mr. Pond Presiding

1:30 -- Presentation of Special Problem Areas

"Quantitative Relationship Between Economic Development and Community Water Supplies"

For Task Group (A). . . . . Dr. Logan

Discussion

2:15 -- "Basic Considerations in Planning Indigenous Institutions for Community Water Supply Development and Management"

For Task Group (B) . . . . .Mr. Wieters
Mr. Fox

Discussion

3:00 -- "Utilization of Water Supply Engineers and Sanitary Engineers in Underdeveloped Countries"

For Task Group (C)..........................Prof. Bosch

Discussion

3:45 -- "Realistic Design, Standards Practices and Encouragement of Indigenous Production as Elements in the Economics of Community Water Supply Development"

For Task Group (D)..........................Mr. Henderson

Discussion

4:30 -- Working Arrangements for Task Study Groups

6:30 -- 8:30 -- Social Buffet - Walter Reed Hospital, Officers Club

Wednesday, April 13

9:00 - 12:00 and 1:30 - 4:30

Task Group Chairmen Presiding:

Individual Task Study Group Meetings

(1) Discussion of Subject in accordance with author's presentation and suggested topics

(2) Recommended action

(3) Development of Task Group reports

4:30 -- Typing and Duplication of Reports

Thursday, April 14

Dr. Baity Presiding

9:00 -- Group Session

Presentation of Individual Task Group Reports, A, B, C, and D

9:00 -- A. "Quantitative Relationship Between Economic Development and Community Water Supplies". . . Group Chairman

Comments and Corrections

Approval of Report A

9:45 -- B. "Basic Considerations in Planning Indigenous Institutions for Community Water Supply Development and Management". . . . . Group Chairman

Comments and Corrections

Approval of Report B

10:45 -- C. "Utilization of Water Supply Engineers and Sanitary Engineers in Underdeveloped Countries" . . . . Group Chairman

Comments and Corrections

Approval of Report C

11:30 - 12:15

D. "Realistic Design, Standards Practices and Encouragement of Indigenous Production as Elements in the Economics of Community Water Supply Development" . . . . .Group Chairman

Comments and Corrections

Approval of Report D

Dr. Baity Presiding

1:30 -- Group Discussion

Implementation of: Group Report Recommendations for Action

3:30 -- Summary and Conslusions. . . . . .Mr. Shipman

APPENDIX II

A STATEMENT

AT THE OPENING SESSION

OF THE

COMMUNITY WATER SUPPLY DEVELOPMENT

CONSULTANT PANEL-APRIL 12, 1960

BY

DR. ABEL WOLMAN
Professor Emeritus of Sanitary Engineering
The Johns Hopkins University
Baltimore, Maryland

REMARKS BY DR. ABEL WOLMAN

DR. WOLMAN: Thank you very much, Dr. Campbell.

I am not at all sure at this stage of the program whether I can be anything more than repetitive. Practically every individual who has so far spoken has not borrowed but restated some of the general and basic principles to which I want to revert.

I am interested, Dr. Campbell, in the repetition which comes from almost every speaker -- I might say a heartening repetition -- that they would look to the development of water supply throughout the world as a self-supporting fiscal operation.

This is heartening because it is the only way in which water on a global basis is likely to reach the bulk of the people.

The more rapidly we depart from the grant and gift principle in this field and the more rapidly we depart from central government grant and gift the more rapidly we are likely to put the water supply business of the world on a self-supporting, continuing and prospectively widely distributed basis.

This is not shocking to my associates in this field of activity who are sitting around this table. They have all, throughout their years, participated in this kind of an effort.

What is striking in moving outside of our own country is that the lessons which our own country can teach over a period of at least a century are lessons which have not been transmitted as effectively in other countries as all of us would like.

As a piece of diagnosis, therefore, it is interesting, Dr. Campbell, to determine why these lessons have not been as effectively transmitted as we would like.

In order to attack this, which I think would be the most profitable comment to make, I should like to redefine what I consider to be a community water supply. Perhaps, negatively, it is not what most countries provide for most of their communities. Positively, it is a system of water service which reaches either into the house or to the place of living.

Such a definition encompasses far more than the service of water at remote standpipes, fountains, and the like, where you have merely reduced the energy of carriage. You have not from either the economic or the public health standpoints delivered water to the individual family or to their constituents.

So that for my purposes this basic definition is the one which is anterior to almost anything that I may say from this point on.

It is well to recall the WHO resolution in Minneapolis and the vote thereon. This was a resolution of profound significance to all of us here and I hope to the rest of the world.

There was one dissenting vote on the resolution. It came from a country of great distinction, and it has particular pertinence in our discussions here.

This dissenting vote against the resolution was because it included in it, aside from the pious declaration which we've always passed that water is desirable, a very significant ingredient, namely, that those people responsible for programming should concern themselves with methods of financing and management.

And this dissenting voter -- incidentally, a medical officer of high distinction -- objected to the World Health Organization interesting itself in money, and, secondly, in administration and management.

I was interested to see, of course, that there was only one dissenting vote, which was tremendous progress from my point of view, because at the first meeting of WHO at its initiation some 11 or 12 years ago a resolution of this sort would have been voted down, if not unanimously, at least on a 90 to 10 vote, because it included a philosophy of financial management.

This is tremendous progress, and this, incidentally, gives a cue to the kind of effort with which we are confronted almost everywhere.

I may take the liberty, Dr. Campbell, of pointing out as a salesman of water supplies first in my own state, secondly in my own country, and thirdly in other countries, that I abandoned the public health aspect, excepting for dinner conversation, as a sales item. It does not sell water supply. I abandoned it very early in the State of Maryland, of which you may recall I was the Chief Engineer for a good many years, because I found that, like Congress and like the State Department, I could arouse no enthusiasm in a mayor and city council for getting a new water system because typhoid fever at that time was tremendous. This had little or no appeal. It did have if the child of the mayor or a member of the city council had recently died. But aside from that the statistical table was a singularly inadequate promotional device.

For a period of some 25 years we rarely mentioned it, but we most often sold water systems on the basis of the reduction in fire insurance rates.

This was not only effective but it was understood. And it had, of course, a highly significant economic value.

In general, at least in our own country, where we burn up, as you know, more per capita than any other country in the world -- this is another distinction we have -- we could pay for the fixed charges on water bond issues through the reduction annually of the insurance rates because of the introduction of a water system.

I mention this because this was an acknowledgment, at least on our part, that something other than the public health significance was important.

Of course, in my own depth of heart I share your view, obviously, that this to me is the most significant reason for having a water supply, that it does reduce disease. But I kept it relatively quiet as a salesman.

I will not repeat the public health implications of water supply development throughout the world. They have been hinted at. You have reams of statistical evidence that this is important.

I need hardly point out that the public health aspect of water of poor quality and of insufficient quantity throughout the rest of the world is about on a par with where we were perhaps 50 years ago in our own country.

In other words, you have, if you want to use this reason, public health significance, on as profound a base as one would like. It carries no major convinction to Congressional committees or to banks or to lenders of money.

The economic aspect I do want to stress again. The water supply provision in the rest of the world should be put on a commodity basis and not on a social basis. I re-emphasize this all the time. Until it is, I am sure it is not going to have the rapidity of extension we would all like to see.

And by "commodity basis" I mean something which is salable and therefore possible of reimbursal, either in whole or in part.

I look at it as an essential economic need.

It seems rather interesting that we have to stress this fact. But there is an assembly of examples where industry has been left out of a community. In some communities it has been suggested to industry that they do not come or that they do not expand because water facilities are either unavailable or scarce and cannot be extended. This to me is an interesting vicious cycle, where we have many of our own agencies moving wisely toward industrialization of countries, while simultaneously, without the knowledge of most people, the chief engineer or general manager of the water system is telling the industry not to double its plant or, if it intends to come anew, to go some place else.

This is a very curious set of circumstances. New housing is being built sometimes with grants in aid or loans on the part of the United States and others which are then without either water or sewerage connections. Large amounts of capital investment have gone into some of these areas and they are still uninhabited because of the absence of water service.

Almost without exception nobody knows what the fire insurance rate is in the country on the part of the people who sell water systems. That includes, incidentally, our own people.

This is one of the misfortunes of not canvassing the totality of the economic aids to water supply extension.

For example, in Calcutta the insurance people who insure most of industrial and private housing in Calcutta indicate that their insurance rates were all high, and deliberately so, for an interesting reason. They said, "We cannot give any of these industries or private homes a reasonable insurance rate because continuity of service by the water system is absent."

In the case of Calcutta continuity of service is almost non-existent.

And, therefore, the insurance company maintains, very much as in our own country, the position that until you make water available, and they all have sprinkler systems in many of the industrial plants, they gain no fiscal return on it because of the inadequacy of service.

I won't overstress the fire protection aspect. In Japan, for example, where there is a great deal of fire loss, it is unusual to find anyone in our particular occupation selling water systems who is aware either of what that fire loss is or what the insurance penalty is, and in turn -- and this is the significant point -- how that could be used in assisting the selling on a financial basis of water supply systems.

Now, may I restate something which is familiar to all of you here, as to what the extent of this problem is throughout the world.

We are prone, as Mark Hollis commented on a moment ago, to assume that our own country and the Western world does not have a water problem. This is not true. The backlog of need in our own country, with which we are most familiar, is tremendous measured either financially or in pipe or in people that require to be served.

The phenomenon of urbanization and of industrialization is not restricted to the Western world. Anyone who gets around can see this very clearly. The metropolitan problem which we ourselves have not solved in this country is one of the plaguing aspects of every country in the world.

It does not make any difference where it is, whether it's Tokyo, Bangkok, Hong Kong, Santiago, Chile or Caracas. In Caracas, of course, as many of you know, there are some 400,000 people that are unsupplied with water.

Now, this has many familiar characteristics in common with some of our own areas in this country and in many other countries of the world. Need for piped water into homes is a universal, global need. It has its variations. It has its differences in intensities, of course.

It has been said that to meet this need would require something of the order -- I think, Dr. Baity, this is your calculation -- for the rest of the world, and by the rest of the world I mean other than, say, the strictly defined Western world, a capital investment of $25 billion.

I look at such figures with a jaundiced eye, for this reason: I just try to put myself back in the year 1900 or 1880 in our own country. We have spent up to 1958 for water supply purposes in the United States a little short of $30 billion.

If we had said to ourselves in 1880, as we might have said, that this will cost us $30 billion, everybody would have gone home with tremendous chagrin and misfortune and said, "Well, it's too big to handle. It's not only too big, it's probably impossible."

Now, these figures are large. I would suggest, and I hope my financial friends would agree with me, that we forget capital investment as a figure and concern ourselves with how capital investment may be obtained and how it may be paid for annually and validly in interest and amortization.

We have always stressed in our own sales operations throughout a hundred years that capital investment merely implies that you must have a banker willing to lend you money. But you must have a community that has the sense and obligation of repayment.

Fixed charges are what our communities throughout the world must learn to understand rather than initial capital investment.

I share Dr. Campbell's view, and I certainly share Dr. Gonzales' view, that lack of resources is not always the reason for the delay in the institution of global water supply. It obviously is the reason in many places.

My prime example, of course, is in our much more intensive review of Calcutta this fall where I had the benefit of Dr. Gulick's very astute financial inquiries and administrative inquiries.

Two things are apparent in the Calcutta area. One is that nobody is adequately taxed. No. 2, that there is a great deal of ad volorem taxable property under-assessed for many years. This is an indoor sport which is not uncommon and, incidentally, is not restricted to outside the United States.

But it does give a cue that gradually this may be lifted to the point of some accurate determination.

Secondly, payment for water, as in most other places, is token in nature, token first in the magnitude of the charge and, more important from my standpoint, in the fact that it is not collected. There is no incentive for collection.

I am sure that if the penalty tax for default in water collections were eliminated in Baltimore tomorrow, our collections would drop at least 50 per cent. This is human and universal. We know this to be the case in some of our States where we have studied it ... that where there is no penalty on the failure to collect a tax, some of our counties never pay.

In the depression period they have a very sound reason, they think, for not paying. And in the prosperity period, the highest prosperity we have ever had, they do not want to pay.

In an adjacent county where the penalty for non-payment is high, with the same economic status, they pay, because they are shown that there is no better use for that money than to pay the tax.

This is the kind of an ingredient which I think we have got to sell rather than typhoid fever. This is slow -- I'll grant that -- but it's the only hope of ever coming to grips with an expansion of water development of any size.

There is a third ingredient in Calcutta which is particularly interesting to you, Mark, in relation to the problem of finance. There has been in the bank in Calcutta unexpended water bond issue money. The bonds have been sold, so interest is being paid, but no tangible return is at hand because nothing is being built. Still millions of dollars are in the bank waiting for construction to begin.

This is a flagrant example and not certainly by any means common.

This is the reason I stress and perhaps overstress, the fact we have to reorient the guideposts in our programming. By that I mean that we have to become masters of fiscal administration, not because Congress or the State Department says to us, "Well, what's your justification," but because if we were selling automobiles we would determine on the best way of selling automobiles from a financial standpoint -- on the vast procedures which the automobile industry has built up of borrowing money and repaying it slowly. This is a device which we use in the water business.

For that purpose we need a lower interest rate than prevails in most countries. We will never get a lower interest rate until we have a banking facility which can lend money at a lower interest rate and have some form of repayment of more than five to ten years. The life of this development is not five to ten years. It certainly is 25 to 35 or 50 years from a fiscal standpoint. Such money is not going to become apparent any more than it did in our own country until the waterworks business in each country has an example of fine management and standing so that banks will not only lend it money, but will in turn begin to lend to other communities of equal stature. This means putting the fiscal house in order in many of the countries.

There are more subtle difficulties that restrain us. I know that Dr. Campbell is aware of the fact, because he has a team at the moment in India. Why has not the money that was available in India been used? We are not talking about a global water supply program to be done in the next five years. But you could have all the work conceivable in the next five years that you could do if you were to make use of the fiscal and manpower resources which in many instances are already available.

There must be some reason for that. This comes into the problem as to whether the central government had too many restrictions or too many restraints. Your team probably will disclose what it is, and it will be extremely interesting to know their findings.

I come to another guidepost which we must ultimately discard. It is coupled with the self-support aspect of water supply. Namely, we must get away from the central government grant or gift.

I asked the people in India, for example, to make a comparison for me, 25 years ago and today. Twenty-five years ago the central government of India was called upon to provide money for three functions: defense, postal operations, and a kind of subsidy for transport. Today they have over 30, and water supply, of course, finds itself in that competitive and growing list.

I would like to extricate it from that competitive position, because, first, it does not belong there. The water supply business has one excellent characteristic. It can and ultimately should pay for itself. This distinguishes it from the highway system, the hospitals, the preventoria, relief, flood control payments and the like.

It has that characteristic. We must capitalize upon it, so that it is removed from the area of central government competition, where its position is going to become weaker and weaker, simply because central government is going to have more and more gift necessities rather than less and less.

The great water systems in most places where they exist are elementary in nature, and in most instances, even where they are elementary in nature, collections are often almost zero. When the chief sanitary engineer, one of the very well informed individuals in a Latin country of large size and great wealth, does not know what his water bill is and then is chagrined to find he has not paid it for three years, he is in no psychological state to provide the kind of leadership which this program needs unless he readjusts himself.

I cannot avoid any other conclusion.

And this is not restricted to him. The director of public works in the same community, who did not volunteer this information, probably has not paid the water charge for four or five years.

There are local financial resources already indicated. There are excellent examples throughout the world. In the same country with the same people some do it very well in one place and persistently very badly in another.

One of the ingredients we have on our side -- is wherever you go you do not have to sell water to people. People are some decades ahead of us. They want water.

It is rather surprising, incidentally, in many of the areas that they will pay for it when they are shown how they can. They may not pay for all, and again here you have a high degree of variability.

It is difficult to understand in some countries of considerable wealth why one does not pay anything for water, and in an adjacent community in the same country you pay for it all. There is something lacking in the pressure or the orientation towards a fiscal program of logical characteristics.

Most of our activities, by and large, have been via the ministries of health. It is rare in most countries that they are the responsible agents for execution in this field. There is a kind of separation in point of view, in attitude, and even in physical relationships, where the ministry of health engineers rarely have anything to do with the director of public works' engineers. In fact, in many instances they do not know each other.

Yet, on the one hand, it is the public works group that does the work, raises the money, operates the systems. The ministry of health has the philosophy and to my mind has a supreme educational value. But the two never come together, or rarely.

Although the pattern of water development in many countries is by the central government, quite unlike our own, there are enough exceptions to it in almost every country to hearten you in the assumption that you may and probably will make your greatest progress on the local level at least with the major municipalities. I'm not speaking now of the population groups of 2,500 or under.

The opportunities for rehabilitation, fiscally and administratively, say in a metropolitan area such as Mexico City are very high. I am under no illusion that they can be corrected -- and they need correction -- overnight. But I feel that the energies have to be devoted toward that correction if you are really going to get water service in that vast area.

In Caracas you have 400,000 that are not served. In Santiago, Chile you have something between 250,000 and 300,000 that are just outside the area.

It is said, and I think there is evidence for it, that in some of those areas the fiscal problem could be very well met if the central government would take its hands off the situation and would permit the local group to develop its own habits and processes and do its own money-raising. Incidentally, it can raise its own money.

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This is a scattered kind of a comment, Dr. Campbell, but from the standpoint of diagnosis as to where we may go from here it is these normally unorthodox principles, normally these departures from our familiar public health emphasis that seem to me to be the key or the promise of an increasing rapidity of furnishing water to people.

DR. CAMPBELL: Thank you, Dr. Wolman.

It's good sometimes to get the facts of life in this business, you know.

DR. CURTIS: Mr. Chairman, I would like to suggest maybe even a few doctors might learn something from this presentation this morning, and if it's in order at all in our geographical area I'd like to have Dr. Wolman's address reprinted for circulation to our missions.

DR. WOLMAN: I hope with editing.

DR. CAMPBELL: We'll certainly do that. I think so too. It's been a very stimulating session, and we're very deeply grateful to you, Dr. Wolman, for taking this time for us.

I would like to thank also Mark for participating with us, and Otis, and Dr. Gonzales, Mr. Kleine, Mr. Kaplan, and Mr. Grant. We certainly do appreciate all that you have said to us.

APPENDIX III

TITLE: QUANTITATIVE RELATIONSHIPS BETWEEN ECONOMIC DEVELOPMENT AND COMMUNITY WATER SUPPLIES

AUTHOR: John A Logan, Chairman, Civil Engineering Department
Northwestern University

In accordance with modern theories of economic development, investment in community water supplies should be considered as a part of the social-overhead capital needed to develop and maintain a technologically-based society.

While supplies can have little justification from an economic point of view in the so-called traditional economies, such as large parts of Africa and Asia, where the population is primarily rural and is engaged in agriculture, they are needed when development begins. This, according to Dr. W. W. Rostow of M.I.T., is when a country decides that its physical environment is not determined solely by nature and providence, but that it is rather: "an ordered world that can be manipulated in ways which yield productive change" (1). In other words, in areas where the physical environment dominates, man is in effect the slave of his environment. Planned progress begins only when he realizes that his physical environment can be controlled and decides to make use of science and technology for that purpose.

In the development upward from the traditional economies of countries such as those of central Arfica to the mass consumption economies of Canada, the United States and Great Britain, Rostow has categorized three intermediate stages:

1. transition
2. take-off
3. the maturing economy

Social-overhead capital is particularly important in the transition period, the time when a country makes its first conscious attempt to break away from primitive agriculture and makes the changes in investment and labor necessary for the use of modern mass-production techniques. Overhead capital includes not only the investment needed for municipal water supplies, but also for other service facilities such as highways, power, railroads, irrigation, police protection, education, etc.

All of these services have both social and economic implications; investment in municipal water supply, for example, brings returns in health and comfort as well as economic growth. While it is difficult, if not impossible, to translate comfort and convenience into economic terms, public health and economic development are more amenable to evaluation in terms of dollars and cents. It will be the purpose of this paper to indicate approaches to these latter problems.

COMMERCIAL AND INDUSTRIAL DEVELOPMENT

The problem of determining the precise role of municipal water supplies in commercial and industrial development is difficult. As with other social-capital investments there is no general agreement on measures of effectiveness or on the importance of water as compared to other factors such as power or education. There is, however, a growing interest on the part of economists in development and a sizeable background of research and investigational work. Because of their philosophy of a planned economy, Russian economists have been paying particular attention to economic development, but reports reaching the United States as late as 1958 (2) show no agreement as to indices of capital effectiveness.

There are, however, a great many statements which support the importance of municipal water supply to industry, and in the absence of exact analysis economists have been willing to accept these as indicative or as illustrative examples. Typical of these is a recent advertisement of the New York State Department of Commerce (3) which appeared in the Wall Street Journal entitled: NOW...MOST COMPLETE REPORT ON WATER EVER ASSEMBLED. The advertisement stresses the importance of water quality and quantity in plant location and the fact that New York State is uniquely endowed with water resources and can meet any demand for either ground or surface supplies.

A United Nations publication, WATER FOR INDUSTRIAL USE (4), states in part:

> Water supply is gaining in importance as a location factor and is playing a decisive role in the location of an increasing number of new or expanding industries and even in the relocation of existing ones experiencing the problems of inadequate quantity or quality of water and rising costs---In the United States, by 1975, access to good water may become the most important factor in deciding where to locate industries---Information (concerning water quantity and quality)...may have important implications for underdeveloped areas of the world now embarking on a program of industrial development.

The Tennessee Valley Authority has recognized the importance of municipal water supplies in the overall development of the Valley and has stressed the necessity of making adequate provision for industrial consumption in planning. In a recent report they state in part (5):

> The use of water for municipal water supply directly effects more people in the Tennessee Valley than any other use. In addition to supplying water for domestic and commercial uses, these systems are used as primary sources of water for most small industries and many large industries...
>
> The economic well-being of this region is, of course, directly related to continued industrial development in the area. The part that is played in this economic picture by water resources is being realized more each day... New industries have an enviable opportunity in site

> planning as related to water supply. Among the variety of sites available can be found water tailored to meet any need---Many industries use several sources of water. For instance, it is quite common in industry to obtain potable water from a nearby municipality, cooling water from an adjacent stream and process water from a well drilled on the plant grounds.

Some of the figures for consumption in the Valley should be of particular interest to newly developing areas. For example, in 1945 the domestic use of water in Chattanooga was 55 GPCD, industrial use was 122 GPCD; in 1956 the comparative figures were 70 GPCD domestic and 150 GPCD industrial. In Columbia, Tenn. in 1945, water use was 22 GPCD domestic and 35 GPCD industrial; in 1956 the figures were 50 domestic and 145 industrial. A breakdown of water-use in Columbia and in Decatur, Alabama, for 1955 is shown in Tables 1 and 2.

Texas has recognized the vital importance of water supply in the development of its resources and has made plans to utilize all of the water available in connection with state development. The State philosophy can be summed up from a statement made in their 1958 Water Development Report (6):

> (Assuming that adequate water supplies of acceptable quality will be made available at a reasonable cost...) In view of the tremendous economic benefits arising from the projected urban and industrial growth, it is apparent that control and development of water constitutes that state's most important economic problem.

There is no lack of examples of how adequate, safe, economical and reliable municipal supplies can attract industry. South Bend, Indiana, has added 36 new industries and has had an expansion of 26 old ones in the three years since developing their new supply (7). in the Simpsonville-Fountain Inn area in South Carolina, the so-called Golden Strip, a water district was organized for the primary purpose of attracting industry; a $900,000.00 bond issue was approved by a ratio of 64:1 by the population of 1290. In two years new industries alone have provided employment for some 1500 persons and property values have doubled and in some cases trebled (8).

Besides its importance as a service, water can play an important role in stimulating the wide variety of industries which are needed for the water supply systems themselves; the manufacture of pipe, plumbing and bathroom fixtures, pumps, etc. Although there is little published data on this, it is none the less real and has been reported in widely scattered areas, from the Amazon Valley to India.

Dr. John M. Henderson, in a personal cummunication following a recent visit which he made to Puerto Rico, stated that the number of industrial consumers served by the Puerto Rico Water and Sewer Authority had increased from 775 in 1949-50 to 1498 in 1958-59, an increase of approximately 200%, with an increase in consumption of over 400% (9). The 1498 industrial customers comprised only 0.6% of the total number of connected services, but industrial-customer water revenues amounted to $498,436.00 under the graduated rate schedule, or about 7% of the total 1958-59 water revenues of $7,350,000.00. Average receipts per industrial customer were about $3,325.00 per year. Total industrial water use in that period was 2200 million gallons, or 7% of the total water produced. Mr. Henderson states that "the contribution (of the authority to industry) is particularly impressive. While this growth was not due to Acueductos' activities alone, it is also obvious that substantial growth of industries served by public water supplies would have been impossible under the conditions which existed when Acueductos was established."

Data on the commercial use of water in Puerto Rico is equally impressive, as can be seen from the following table (Table III):

TABLE I

MUNICIPAL WATER USE
Columbia, Tennessee, 1955
Population Served - 18,500

	Mean Use (Gal/Day)
Industrial Customers:	
Foremost Dairies	70,900
Kraft Cheese Co.	18,100
Parks-Harris Packing Co.	7,500
Borden Milk Co.	7,100
Oakes Chair Factory	3,100
Tennessee Knitting Mill	11,000
Columbia Rock Products	1,600
Shea Chemical Co.	634,400
National Carbon Co.	307,700
E. I. duPont deNemours Co.	315,800
Industrial Customers Total	1,377,200
Commercial Customers	757,800
Domestic Customers	585,000
TOTAL USE	2,720,000

(Source, TVA)

TABLE II

MUNICIPAL WATER SUPPLY
Decatur, Alabama, 1955
Population Served - 26,000

	Mean Use (Gal/Day)
Industrial Customers:	
Wolverine Tube Co.	1,708,000
Chemstrand Corp.	339,000
Decatur Iron & Steel Co.	33,900
Farm Industries, Inc.	145,000
Ingall's Shipbuilding Corp.	28,900
Southern Cotton Oil Co.	13,000
Alabama Flour Mill	38,700
Worthington Corp.	52,600
Alabama Hosiery Mill	11,300
Goodyear Mills	101,200
Industrial Customers Total	2,471,600
Commercial Customers	202,600
Domestic Customers	2,325,800
TOTAL USE	5,000,000

(Source, TVA)

TABLE III

PUERTO RICO WATER AND
SEWER AUTHORITY (9)

Comparison of Commercial and Industrial Water use During 1958-59

	Commercial	Industrial
No. of Customers	22,255	1498
Water Revenue in Millions	$2.17	$0.5
Percent of Total Water Revenue	30%	7%
Average Annual Revenue/Customer	$98.00	$344.00
Total Water Consumption	N.A.	2200 M.G.
Annual Consumption/Customer	N.A.	1.52 M.G.

In the AWWA survey made in 1955, of the 497 U.S. water supplies serving populations of 10,000 or more, slightly less than 50% of their revenue came from residential sales; about 20% was commercial and roughly 31% industrial (10). However, there are certain misconceptions as to the use of municipal water supplies as a key factor to economic development in the United States; the largest quantities of water used are by the heavy industries from sources other than municipal supplies. Five per cent of industrial plants use about 80% of the total water consumption, mostly for the generation of electric power from steam, for steel mills, petroleum refineries, pulp and paper mills, etc. The plants in this category use more than 10,000,000 gallons of water per day, practically all of it from private sources; on the other hand, 67.3% of the plants surveyed (those using less than 250,000 gallons per day) use only 1.2% of the water used by industry as a whole. It is this latter group of plants to whom municipal supplies must cater.(11).

A study of industrial water use made by the Bureau of the Census in 1954 confirms the above relationships (12). Manufacturers with a gross water intake of 20 M.G. per year and over (approximately 75000 G.P.D.), or 3.6% of 286,817 manufacturers, use 97.4% of the total. Of this total 16.4% is from public supply.

Water is a unique commodity. Its role in industrial development is more as a catalytic agent and a service rather than a raw material, and only a relatively small amount of the water used by industry enters the final manufactured product. It must, however, be safe from a health point of view, it must meet minimum standards of quality, it must be available in adequate quantities and it must be reliable. It must be sold at an attractive price, for although large industrial users can adjust the cost of water through the practice of conservation and reuse, small industries have very little scope for this practice.

The price of water depends on circumstances; if it is very scarce, it is priceless, but, on the other hand, in order to use it as dilution water in waste disposal it has to be very cheap. Municipal water systems in the United States are able to deliver treated water for about 10 cents per ton, and this is a reasonable guide for costs anywhere.

The problem of actually determinig the role of municipal water supplies in economic development is both difficult and complicated. It has been grossly neglected by the public health profession, not so much because of its difficulty but because few have seen its importance. In view of the fact that the future of municipal water supply development throughout the world will depend in a large measure on being able to emphasize its key role in economic development, it behooves engineers in the international field to collect all of the facts that can be obtained and make them available for further study.

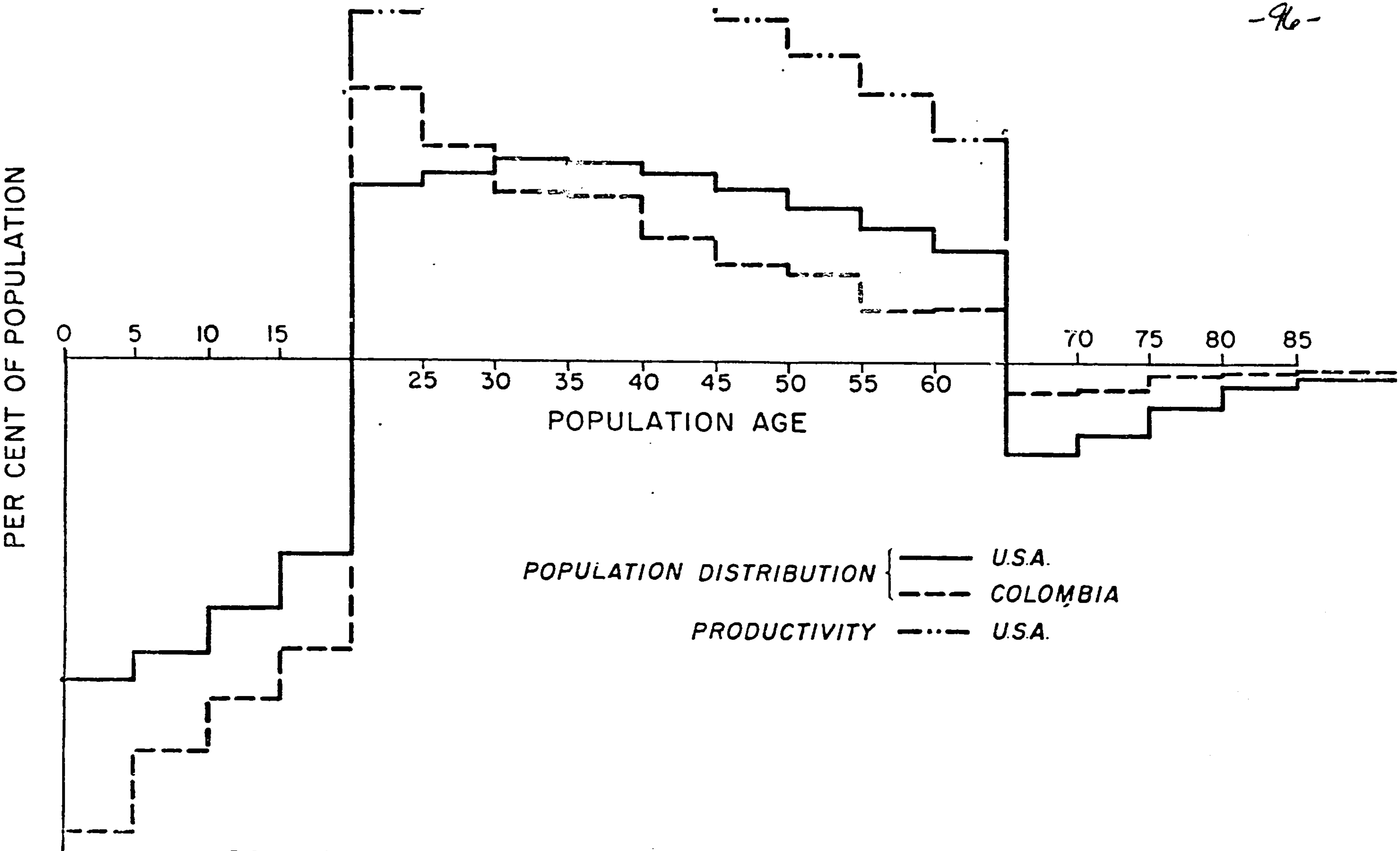
PUBLIC HEALTH

Public water supply is "the foundation on which rests the health and economic progress of the community" (13). Its importance to public health varies, however, with individual communities and different countries, and must be evaluated on the basis of the prevalence and severity of water-borne and filth-borne disease. Because of the indivisibility of water and health it is perhaps best to first attempt an evaluation of the economic importance of public health, and then to determine which portion of this is due to water.

Campbell and Morehead, in 1952 (14), suggested as an approach to the effectiveness of public health in Brazil, an analysis of the working population (men and women between the ages of 20 and 65) per million total population. They recognized that a comparison with the population distribution in developed countries such as the United States would reveal a major difference; a higher percentage of working population in the developed areas and a higher percentage of dependents in the developing countries, The age group between 20 and 65 provide the basic wealth which supports both the young (below 20) and the aged (over 65), and determines the standard of living of the country as a whole.

The high percentage of manpower is the productive age group in the United States (55 per cent), is primarily due to past investments which have been made in public health. In the illustration shown (figure 1), comparing the population of Colombia with that of the United States, approximately 10% more of the population of the U.S. (100,000 more per 1,000,000) lies in the 20-65 age group. On an annual basis this means that the United States has 100,000 more man-years of productive potential per million people than Colombia.

To this should be added an efficiency factor. U.S. workers are among the most productive in the world, partly, at least, because of their standards of health and the absence of chronic debilitating diseases such as malaria, enteritis, tuberculosis, etc. Conservatively, this has been estimated at 100% (U.S. workers are estimated to be twice as efficient as Colombians). This widens the margin (the 100,000 difference per million is effectively 200,000); 44 % of Colombians fall into the productive age group, the U.S. percentage is 55, but it has a relative effectiveness of 110, an overall advantage over Colombia of almost 300 per cent per million people. This manpower advantage is highly significant; if you multiply it by the power (HP) available to individual workers in the United States and Colombia, the disparity in the productive power of the two countries is



COMPARATIVE PRODUCTIVITY OF WORKING POPULATIONS
U.S.A. AND COLOMBIA PER MILLION PEOPLE - (1957)

SOURCE - U.N. DEMOGRAPHIC YEARBOOK

further evident.

Economists have been reluctant to recognize the importance of investments in health as a factor in capital development. Professor Schultz of the University of Chicago recently pointed out, however, that measures to increase the strength and energy of people and to improve their health and vitality should be considered as investments in human capital. These "may go a long way in explaining the kind of economic growth that we have been achieving and that poor countries everywhere would like to understand with a view to using this experience to improve their economic lot" (15).

In order to present a detailed analysis of the investment potential of public health projects, particularly of municipal water supplies, additional data are needed. These include accurate data on the capital investment required and a breakdown of the resulting effect on morbidity, mortality and public health.

There is no standard cost for the production of "units" of public health, as there is, for example, in the production of power or irrigation. Some of the basic requirements for health in certain countries can be met very cheaply, for example, as low as five cents per capita for the eradication of yaws and two dollars per capita for the eradication of malaria.

A big difference in comparing public health costs in different countries depends on the extent to which the program includes the provision of routine medical care for the individual. Winslow (16) has reported on the cost of preventive and curative health services and is of the opinion that in the developed areas of the world, a purely preventive program can be financed at a cost of about 0.5% of the national income, while a curative program will cost about ten times this amount.

Overall public-health expenditures in the United States are estimated at about $5.00 per capita per year, but this does not include the costs of water, sewerage, solid-waste disposal, etc. Public water supplies require an annual expenditure in the order of from $8.00 to $30.00 to cover both first cost and operations; the cost in developing countries is substantially lower.

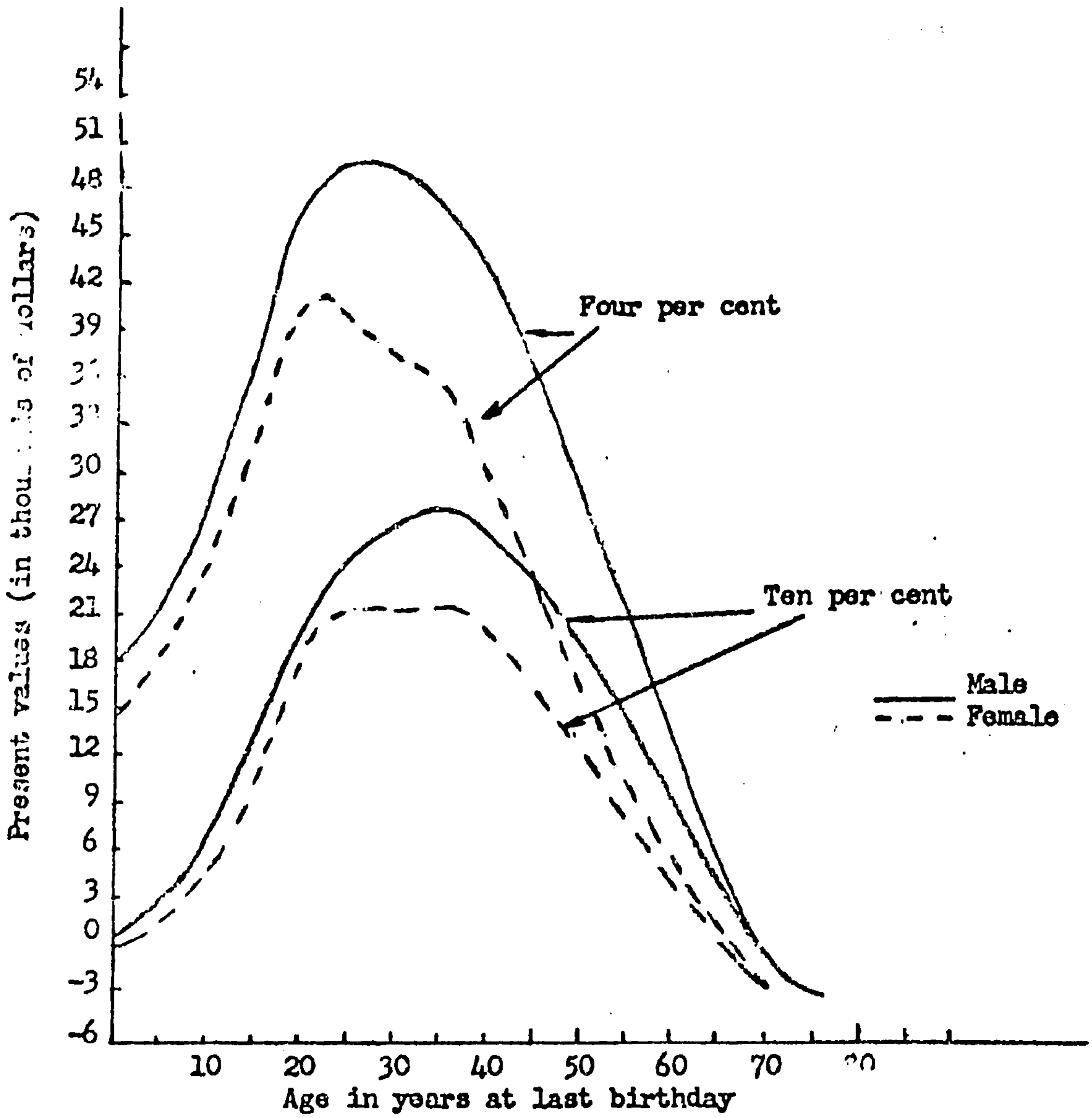
The effect of water supply on morbidity and mortality has been amply demonstrated. Vital statistics are usually broken down into categories which make it possible to evaluate the importance of water-borne disease to death rates in any given country (mortality by age and sex for typhoid; cholera and dysentery; gastritis, duodenitis, enteritis and colitis--- International Categories B4; B5-6; B36). There are a number of excellent sources of information on the effect of water-borne disease on morbidity, such as Verhoestraete and Puffer (17) and the WHO (18).

The problem of translating the benefits of public health into dollars and cents has been explored by a number of economists; one of the most promising studies is that recently completed by Weisbrod (19). Using the stream-of-earnings method, based on the reported median income and consumption of high-school graduates and their probability of life, he obtains the present value of net future earnings by age and sex, using discount rates of both 4 and 10 per cent (see figure 2).

Weisbrod's analysis is based on the thesis that, from an economic point of view, loss of life means the loss of a productive unit (and of a consuming unit as well). He assumes that earnings are a reasonably adequate

FIGURE 2

PRESENT VALUES OF NET FUTURE EARNINGS, BY AGE AND SEX, AT TEN, AND AT FOUR PER CENT DISCOUNT RATES



(Source - Weisbrod)

measure of the value of the marginal product of a worker, but not of a housewife, whose measure is computed differently.

Using this same approach Weisbrod states that it would be practical to obtain present-value curves for the developing countries and that these, in turn, could provide a basis for assessing the benefits of their public health programs, including the effect of municipal water supply.

A more direct approach to the economic justification of public water supplies was taken by Wagner and Wannoni in Venezuela in 1958 (20). They calculated that for an annual expenditure of approximately $6,500,000.00, to cover the amortization and operation of small municipal supplies, Venezuela could obtain an annual return of some $50,000,000.00 or a return on the money invested of 800%. These figures were based on the provision of safe water to an additional 2,000,000 people in the rural area of Venezuela (75 liters per capita per day); the economic benefits were calculated on the man-days of time which would be saved by avoiding premature death and sickness and the savings in medicine and medical service. The calculations are conservative.

C. H. Atkins of the United States Public Health Service has also calculated the economic benefits of water supplies in a number of different countries, the calculations based on the cost of typhoid fever, diarrhoea and enteritis. Atkins reports the entire cost of water supplies and latrines in many countries could be recovered from savings in from two to five years (21).

Perhaps the economies of health can be summed up best by a statement made by Dr. E. Ross Jenney (22) in his terminal report on leaving Brazil in 1959. Dr. Jenney wrote:

> In the complicated network of economic deficiencies (in the underdeveloped areas), the improvement of a man's health is an achievement that will neither create a new need, nor in turn depend upon another capital investment for its success. It is unique in that it is a successful and in itself, economically basic, politically unquestionable, and in most cases technically negotiable. Sometimes, as in the eradication of a disease, it is a single investment, ended forever, a paid-up endowment for the infinite future. We are living on such an endowment; the underdeveloped areas are not, and this most acute difference is reflected in every facet of economic and cultural contrast.

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