WATER DISPENSING DEVICES AND METHODS FOR PUBLIC WATER SUPPLY IN DEVELOPING COUNTRIES

INTERIM REPORT

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geen aanhalingen
geen recommendaties

stijl onvoldoende
teksten gegevens summier
afbeeldingen summier
zwak
typen
presentatie verzorgd
als inhoudelijkheid: mager
visie gering

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1. INTRODUCTION

1.1. PUBLIC STANDPIPES

Dispensing of drinking water by means of public standpipes is in many cases the indispensable and useful first stage to realise a reasonably reliable water supply for everybody.

Therefore, the importance of the public standpipes is generally recognized by all those who are concerned with water supply.

However, a number of objections to the public standpipes which are fully realised as well are:

- the lack of a responsible consumer (waterbuyer) with whom contractual arrangements can be made, similar to those with private connections;
- the liability to damage when the installation is not supervised by a guard;
- the risk of contamination;
- wastage.

1.2. OBJECTIVE OF THE STUDY

The objective of the study is to identify ways and means for the dispensing of water at public watering points which avoid the wastage of water and which can be considered for use on or adaptation on systems, both urban and rural, in the developing countries.

The study involves two broad areas of investigation:

a. the identification of all devices currently in use, previously used or suggested for use by designs, ideas, patents or models and which could be used on urban and rural water systems for the public dispensing of water to people.

b. the determination of methods and approaches for the control of public watering points which rely on operational and administration techniques to dispense water to the public.

Public standpipe syphoide type (Libreville, Gabon)

1.3. COLLABORATING AGENCIES

On request of the Worldbank this study is being prepared by the World Health Organization (W.H.O.) International Reference Centre for Community Water Supply (The Hague).

1.4. EXECUTION OF THE STUDY

The main part of the study is executed by International Water Supply Consultants IWACO B.V. (Rotterdam) on request of the International Reference Centre.
Further assistance in the study was provided by:

- Ir. F. Zandvoort Townplanning Office
- The Royal Tropical Institute in Amsterdam

The study consisted of literature reviews, investigation of project reports, discussions with water supply specialists and collecting of information from manufacturers, institutions and water supply authorities.

Based on these preliminary investigations visits have been made to several countries where public water dispensing devices exist and are in operation.

1.5. ACKNOWLEDGEMENT

During the study much collaboration was received from the W.H.O.-Head Office in Geneva, the regional W.H.O. -offices, the local representatives of the W.H.O. in all the countries visited, the Government and Community officials and the Water Supply Companies in all the countries which were visited as well as those who were applied to for information in other ways.

2. ENCOUNTERED TYPES OF WATER DISPENSING DEVICES

2.1. DESCRIPTION OF THE VARIOUS SYSTEMS

During the study a number of different public standpipe systems have been studied. has been
In this chapter an outline of these types will be given in the form of descriptions, drawings and photographs.

Thereby, a distinction has been made between:

1. The faucet mechanism of the standpipe
2. The basic unit of the standpipe (supporting and surrounding structure).

In the faucet mechanism ~~we~~ be can distinguished:

2.1.1.1. Ordinary taps

2.1.1.2. Springloaded taps

2.1.1.3. Self closing valves

2.1.1.4. Float mechanisms

2.1.1.5. Special types

2.1.1. The faucet mechanism (For sketches: see annex 1)

2.1.1.1. Systems with ordinary taps (annex 1; fig. 1 - 7)

These ordinary household taps give water when they are open and go on discharging until they are shut.
Ordinary taps generally have a simple construction, low investment costs and the costs of replacement are low as well.
However, as the taps do not shut automatically after use, the possibility of wastage of drinking water must be considered.
If the system has no adequate waste water discharge, flooding and pollution of the immediate surroundings of the standpipe may happen, thus increasing the risk of contamination of the tapped water.

Another problem encountered with the ordinary tap is that the functioning of the closing mechanism depends on the force with which the tap is closed. There is a lot of wear of the valve and the valvewasher if the tap is closed too forcibly. Badly closing taps will be the result unless there is regular maintenance.

Therefore, a water dispensing system with ordinary taps should preferably be supervised by guards who can also be entrusted with the maintenance of the system. During a study in Dakar [19] in 1968 it was noticed, however, that on approx. 45% of the existing standpipes a tap was put out of operation, in spite of the presence of guards.

Leaking ordinary tap

2.1.1.2. Systems equiped with springloaded taps (annex 1; fig. 12)

These systems are developed as an improvement of the ordinary tap. In order to get water, people have to push a button or pull or turn a handle. The valve closes automatically when the button or handle is released.

Public water dispensing systems equiped with springloaded taps are aimed at reducing wastage because the taps shut automatically after releasing the button or handle. People are very clever in inventing systems to keep the buttons or handles in open position by using ropes or stones. This should be taken into account when designing the construction of these valves.

The investment costs are low, continuous guard-supervision is not strictly necessary; maintenance, however, is still required.

2.1.1.3. Self closing valves (annex 1; fig. 8 - 11 and 13 - 14)

A self closing valve has to be pushed or turned in order to get water. Even when the button or wheel is fixed in position the valve closes automatically after a certain time; a few seconds later the system can again be operated.

Some frequently encountered self closing faucets are:

Aquatrol Valve
Fordilla Valve
Tropicale
Tylor "Waste Not" Valve

The self closing device of the first and last mentioned valves is comprised of a socket and plunger machined to allow a close sliding fit. The side of the plunger has an accurately machined venting groove along its length, thereby allowing the plunger to fall out of the socket at a controlled rate as water flows up the groove. The plunger continues to fall until it reaches the seat and shuts off the flow of water through the valve.

The Fordilla valve (see annex 1, fig.13) operates by means of a piston and piston rod assembly with flow restriction in a separate cylinder filled with silicone fluid.
This system was originally used as a house connection for groups of some 20 persons, thus not really a public standpipe [9, 10] . With this kind of device people are able to get water at any time of the day and do not depend on a system of supervision, while at the same time the waste of water can be reduced to a minimum.
For public standpipe purposes, the self closing system is also elaborated by Bayard ("Tropicale"). However, in order to obtain water, a considerable pressure must be exerted with at least one hand.

2.1.1.4. Systems equiped with reservoir and float mechanism (annex 1; fig. 15 - 17)

The principle of such a system is that the piped drinking water is stored in a tank.

The two main differences to obtain water are:

- by siphoning with a flexible tube (siphoide system)
- by rotating a vaned wheel (bedouin system)

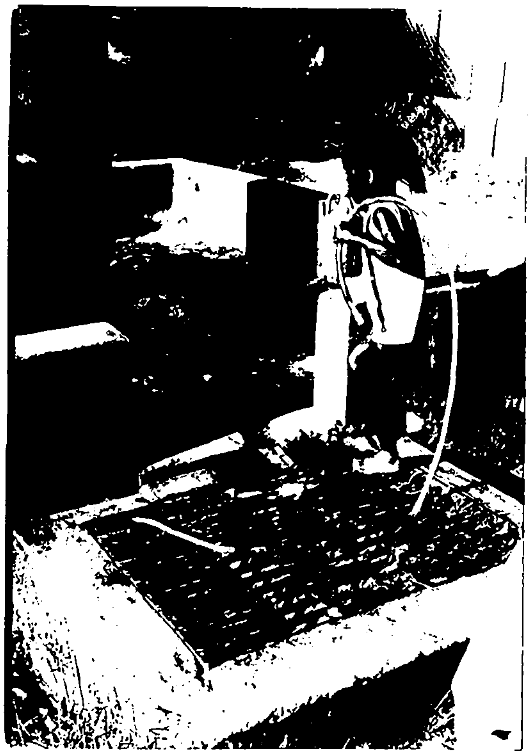
In both systems the inflow of piped water is stopped by means of a float valve when the storage tank is filled.

With the siphoide system drinking water can be obtained by putting a flexible tube on the nipple outside the tank. This nipple is connected to the fixed tube on the inside of the tank. Water is then sucked through the flexible tube. Generally each consumer has his own flexible tube.
With the bedouin type (Cameroon) water can be obtained from the tank by rotating a vaned wheel.
The siphoide system has a high risk of contamination as also the private flexible tube itself is very often contaminated.
The consumers not always only suck on the tube but, especially children, also blow into the tube to produce a "funny noise".

Aber bis wann?

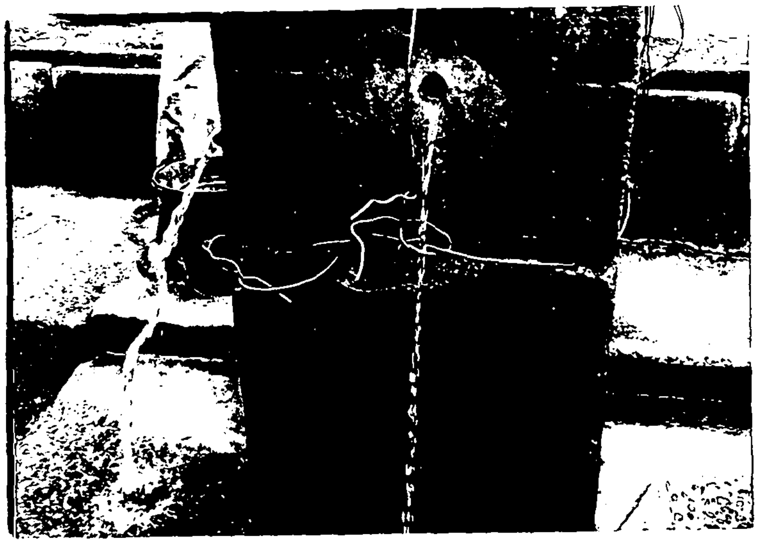
The bedouin system has been studied in Cameroon. It was not possible to find a device functioning as it should.
All bedouin types missed the handle for rotating the vaned wheel.
It appeared that children liked to play with the rotating wheel until the shaft and wheel were completely eroded.

The only remaining possibility to use the watering point is to remove the vaned wheel. The hole, now obtained, can then be used to insert a tube; thus the bedouin type was transferred into a kind of siphoide type.



Siphoide type
Contamination of flexible tube

Bedouin type
used as
siphoide type



The photograph shows a former bedouin type
The float valve is stuck,the standpipe discharges continuously.

Siphoide type
The float valve is stuck, thus continuous discharge by overflow.

It happens very often that the float valves are stuck and the siphon or bedouin goes on discharging.
A flooding of the area around the standpipes is likely.
In some cases this continuous flooding caused erosion and settlements which led to failure of the pipeconnection beneath the concrete floor.

Siphoide type; connection is broken, water is ladled from the ground with a bowl.

Both systems are the only encountered systems where the waterdischarge does not take place because of pressure of the piped water. The storage tank with float valve eliminates this pressure.

2.1.1.5. Special types (annex 1; fig. 18)

With the Pont à Mousson standpipes, type Bayard, a continuous movement has to be made to get water.
The operating mechanism, however, is very attractive for children to play with, which shortens the lifetime of the device.

In many places we found the casing of this system and comparable ones.
Lateron another system was installed in this casing.

2.1.2. The basic unit

The basic unit of the standpipe system can be built up out of several specific components such as:

1. The connection with the distribution system
2. Watermeters and shut-off valves
3. Drainage system with sump
4. Connection on sewerage system
5. Facilities to put pots, pans and buckets on.
6. Protective wall.

Furthermore,attention must be paid to the construction materials of the several components.

The above is limited to the basic standpipe.
It is possible to make combinations of public water dispensing systems with:
- public lavatories
- public showers
- public washing places

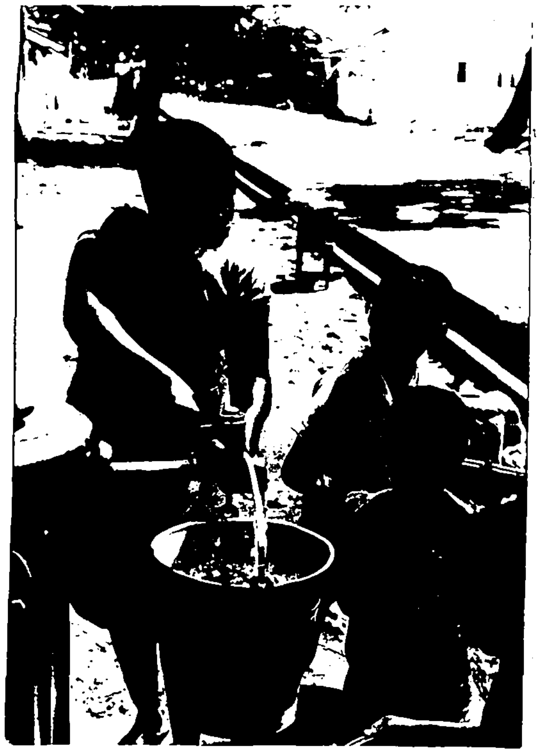
However, these combinations were rarely seen in any of the countries visited.
Upon request it appeared that the Water Supply Companies did not regard this as their responsibility and only supplied them when obliged by the Municipality.

This report, however, is limited to the factual public water dispensing systems.

The composition of the basic unit is essential for the functioning of a standpipe.
Several existing systems were not equiped with an adequate drainage system. Most of the time the (concrete) floor was drained by means of open channels towards a sump. From the sump waste water had to infiltrate into the subsoil. When there is a considerable waste and when the drainage system is not adequate, flooding of the immediate surroundings will occur. Thus pollution and contamination of the tapped water may occur.
Furthermore, such a flooding causes instability of the standpipe foundations, which might lead to failure of pipe connections (see photograph on page 8).

In urban areas, standpipes can easily be damaged by traffic.
Most of the time the basic unit is surrounded by a protective wall.

The basic unit was not always designed in such a way that tapping of water could be done in the most convenient way.
Sometimes buckets etc., had to be hung at the taps.
Also, people had to lift their water containers on their shoulders, thereby using the tap as a temporary support as no other facilities were present.
Both these circumstances effect the lifetime of the tap in a negative way.



Bucket is hung at the tap

2.2. INVESTMENT COSTS OF STANDPIPES

The investment and installation costs of a standpipe depend on:

a. the costs of supplying water on the spot of both adequate quality and quantity

b. the type of tap

c. the basic unit.

Some cost estimates mentioned under b. and c. and based on the price level in Western Africa of 1974 are given in table 2.2.1. on page 12.
The costs of the various mechanisms are indicated separately in the first column. Also the total costs of the standpipes are indicated.
Its starting point has been the various forms of construction as encountered in the field.
The estimate of the details of the basic unit with a minimum adequate solution and the extra costs of some more luxureous types which have been observed will be elaborated in the final report.

2.3. LOCAL MANUFACTURE

When considering the suitability for local manufacture and as already mentioned in par. 2.2., a distinction should be made between tap and basic unit.
Most mechanisms are technically unsuitable for local manufacture. However, when taking into account the costs of the taps (e.g. ordinary, springloaded and self closing taps) as compared to the costs of the basic unit, this fact does not seem to be of major importance.
Particularly as regards the siphoide system, which is expensive compared to the basic unit, it might be interesting to mention the siphoide system with a concrete storage tank, which is in operation in Douala (Cameroon).
Only its valves and watermeter are not very suitable for local manufacture.

Siphoide with concrete storage tank

The bedouin type is also suitable for local manufacture. In Cameroon even the vaned wheel was constructed locally. However, it appeared lateron that the materials and construction did not last.
Perhaps it would be possible to make a better construction abroad but then the necessary foreign exchange will be considerable.

Table 2.2.1. ESTIMATED INVESTMENT COSTS FOR STANDPIPES (US $)

	MECHANISM ONLY	INCLUDING BASIC UNIT *
1. Ordinary taps	1 - 3	500 - 1000
2. Springloaded taps		
- Neptune	200	500
3. Self closing valves		
- Tylor	5 - 7	500 - 700
- Fordilla	10 - 12	500 - 700 **
- Tropicale	250	600
4. Float mechanisms		
- Siphoide	1500	2000
- Bedouin	—	—
5. Special types		
- Bayard	300	600

*) Cost estimates based on situations existing in the countries which were visited

**) If Fordilla valve is used as a public standpipe

3. METHODS AND PRICING

3.1. GENERAL REMARKS

Apart from the technical aspects of the various encountered standpipe systems, the way in which management, maintenance and payment takes place is essential for the functioning of the public water supply system.
In fig. 1. an outline is given of the encountered interrelations between the Water Supply Company, the Municipality and the Consumer in relation to capital investments, maintenance, ownership and management, delivery and payment.
These aspects will be discussed in this chapter.

3.1.1. General backgrounds of public standpipes

The problems which have been discussed in relation to methods of administration, must be considered in connection with the general opinion on public standpipes.
In all countries which have been studied the Authorities consider the standpipes as a temporary solution for the water supply.
The ultimate aim of the Local Water Supply Authorities is a private connection for each family or at least the "courtyard" standpipe for a limited group of houses.
General motivations to achieve this aim are:

- the risk of contamination at the public standpipes
- the difficulties to find adequate methods of administration and collecting of payment
- the economical drawbacks of long waits at the standpipes
- by giving the people their own connection, their motivation to go and search for water at other sources such as puddles of rainwater, will be lessened.

watercarrier

In the development of water supply one can distinguish three, not exactly defined, phases:

- first phase: no piped water supply
- second phase: water supply by means of public standpipes
- third phase: private connections mainly

Particularly in the transitional stages of development, people must be able to compare the previous system with the new system.
Therefore, the opinion concerning public standpipes of people living in stage 1 - 2 will be more positive than the opinion of people living in the transitional stage 2 - 3.
An important phenomenon in such a stage is the <u>watercarrier</u>.
(See photograph on page 13)

Watercarrier paying the guard
(Ouagadougou, Upper Volta)

Watercarriers obtain their water at the public standpipes and sell it at the houses, serving people who do not like (or are unable) to get water themselves but like to be served privately.
Watercarriers have been encountered in quarters of some cities supplied by public standpipes as well as in the new quarters, where no water supply system exists at all.
Depending on the distance between the standpipe and the destination some tariffs for delivery by watercarriers are given in the following table on page 15.

Watercarrier, filling his container
(Ouagadougou, Upper Volta)

Water rates when water is delivered by watercarriers

	Costs in US $/m3	
	delivered by water supply company	delivered by watercarrier
Upper Volta	0,3	1 - 1,5
Ghana	0,1 *	1,25 - 2,5 [4]
Senegal	free	1,6 - 2,4 [19]

*) estimated costs based on monthly use and levy, per house

Another phenomenon which has been noticed in quarters which are partly supplied by public standpipes and partly have private connections, is that sometimes the head of the family locks his private connection before leaving for his work. In this way he forces his wife and children to collect water at the public standpipes in the vicinity (where it is free) and thus he economizes on his water bill.

3.1.2. Effects on the rate of consumption at public standpipes

The fact whether people collect water from the public standpipes or not may be caused by several factors:

- the distance between their houses and the nearest standpipe
- the length of waits at the standpipe
- the importance people attach to reliable drinking water
- the presence of other sources of drinking water in the vicinity
- the water tariffs at the standpipes.

In urban centres the first two factors can generally be expressed by one figure: the average number of people who rely on water supply by means of one standpipe.

The presence of other sources of drinking water may depend on the season.

In table 3.6.2(page 26), the seasonal fluctuation (in some countries) is expressed in the quotient maximum/minimum consumption.
Generally this value is between 1,5 - 3, except in Libreville (Gabon) where this factor is extremely high, viz. 7. [2, 3]
This figure coincides with a high average number of persons for one standpipe (3300).
Since in Gabon the water at the tap is free for the consumer, it can be concluded that there is an interrelation between the number of people for one standpipe and the use of other sources.
This interrelation is confirmed by a public inquiry [1] which was held in Libreville (Gabon). The results of the inquiry are represented graphically in fig. 2.
The majority of the people use the public standpipe. But from a distance of more than 550 meters, certain persons do not collect water from the standpipe but only from the other sources. However, others again still use the standpipe even while living more than 800 meters away. Even for drinking water the river is also used by the majority of the people and most people catch rainwater. Only a quarter of the people use the public standpipe as their only source of drinking water.

catching of rainwater

The public inquiry held in Dakar (Senegal) [19], learned that the standpipe has no direct social function. In Dakar people sometimes have servants to collect the water. Collecting of water is generally considered to be an activity which means loss of time.
Most people collect water before they go to school or to work.
The people generally take their water from the nearest standpipe, except in cases where the standpipe is too crowded or when a lack of order exists. In such cases people sometimes look for another standpipe in the vicinity which is less crowded.
Some important results from the inquiry of Dakar are:

1. people like to have more standpipes for each quarter

2. supervision of a guard is considered as essential

It is known that in rural areas the public standpipes, in combination with markets and medical facilities, often form social meeting points.

3.2. INVESTMENTS AND INSTALLATION

The installation of a public standpipe generally takes place on request of the Municipality.
In some cases the installation costs are paid by the Municipality or the Government.
They, in their turn, pay the Water Supply Company or a private firm, or even sometimes through intermediary of the Public Works Department, to execute the work.
This has been the case in Gabon and Cameroon.
In other cases the Water Supply Company takes capital investments for its own account, including interest and depreciation (e.g. Upper Volta, Ghana and Senegal).

3.3. OWNERSHIP AND MANAGEMENT

The public standpipes are often owned and managed by the Water Supply Company. Even when the installation costs have been paid by others (e.g. the Municipality) the ownership is often given to the Water Supply Company without payment.
In other countries it has been noted that the ownership of the standpipes stays with the Municipality.
In Upper Volta in one case the ownership rested with a private organization.

3.4. MAINTENANCE

The maintenance of the standpipes is mostly executed by the Water Supply Company. In Upper Volta, however, the regular maintenance and small replacements are executed by the guards of the standpipes while more extensive maintenance will be done by technicians from the Water Supply Company.
In some other countries the Municipality is responsible for maintenance.
The Municipality, however, may entrust a private firm or the Water Supply Company with the maintenance, as most Municipalities do not have sufficient staff for such activities.

3.5. DELIVERY OF WATER AND PAYMENT

The Water Supply Company delivers the water through public standpipes:

1. At a fixed amound per metered m^3 to:
   a. The Municipality (e.g. Gabon, Cameroon)
   b. The guards who sell it to the consumers (e.g. Upper Volta, Uganda)

2. In other ways:
   a. Directly to the consumers at a certain monthly contribution (e.g. Ghana)
   b. Through guards, to the consumers at a certain amount per unit (bucket, can, pot, etc.)
   c. To the consumers, without payment (e.g. Senegal, The Peoples Republic of Congo)

In some countries where payment takes place according to the second method, a watermeter is sometimes present for statistical reasons or to check on leakage in the distribution system.
Since 1970, the inhabitants of Accra (Ghana) pay at a paying centre in their quarter.

Centre for collecting waterrates in Ghana

In Ghana the standpipes are not supervised by guards. The only way in which the Water Supply Company can give sanctions is to lock the standpipes in the quarters where payment is insufficient.
Before 1970 the payment was arranged differently: in urban areas a general water rate was levied on all properties (regardless of the fact whether they had a private connection or not) of 5% of the ratable value of the property [4] .

The guards who take care of the dispensing of water in Ouagadougou (Upper Volta), are nominated by the Water Supply Company.
Each week the guard has to pay the Water Supply Company for the metered amount of water.
The guard is not paid by the Water Supply Company but earns his wages by selling water at a higher price. His selling price is fixed by the Municipality and is well known by the consumers.

The guard handling the tap in Ouagadougou (Upper Volta).

In Libreville (Gabon) and Douala and Yaoundé (Cameroon) the Municipality has to pay for the metered water to the Water Supply Company.
Here the Municipalities collect their money from the citizens by means of taxes, in combination with taxes for other utilities.
It sometimes happens that the Municipality is unable to pay as the city is not founded as a community and therefore has no municipal taxes. In such cases it happens that the Water Supply Company reduces the consumption by means of closing standpipes in the wet season (some cities in Mali), or charges the consumption of the whole city on the private connections only (e.g. in Timbouctou, Mali, the hotel has to pay for the total water consumption of the city [13]).

3.6. WATER COSTS AND TARIFFS

3.6.1. Effect of the main elements on the costs of water at the standpipe

A general formula is set up to investigate the main effects on the costs of consumed water at the public standpipes:

$$C_c = \frac{1}{1 - W} C_b + \frac{(a + b) I_p + E_o + E_g}{q_c}$$

Explanation of parameters:

C_c = costs of consumed water at standpipe (in US \$ per m^3)

W = wastage factor as part of the produced water at the standpipe.
$W = 0$, no wastage
$W = 1$, all produced water is wasted.
The starting point is that the value of a m^3 wasted water equals the value of a m^3 consumed water.

C_b = The general costs of production, transport and distribution for the entire water supply company (in US \$ per m^3)

I_p = Investment costs of one standpipe (in US \$)

aI_p = Annual costs of depreciation and interest for one standpipe (in US \$)

bI_p = Annual costs of maintenance and spare parts for one standpipe (in US \$)

E_o = Annual costs of operation, management, revenue collecting, etc. for one standpipe (in US \$)

E_g = Annual costs of guard (in US \$)

q_c = Total annual consumption at one standpipe (m^3)

Some relevant information to explain the estimate of the above mentioned factors is given in the tables 3.6.1. and 3.6.2. This information has been found in the visited countries.

In figure 3. a diagram is given of this formula for the following values of C_b, a, b, I_p, E_o, E_g and q_c:

C_b is different for each company and can even be different for several regions supplied by the same company.

This difference will depend on the water resources (groundwater or surface water), the methods of treatment and the distance between the winning and distribution centre as well as on the density of the distribution. Suitable values will stay between 0.1 and 0.5 US \$ per m^3.
In the diagram values of C_b= 0.1, 0.2, 0.3, 0.5 and 0.7 US \$ per m^3 are shown.

a + b, a:depends on the interest which has to be paid and the time available or chosen for depreciation.
a. will normally vary from 0.1 to 0.2
b. depends on the extent of maintenance and may vary widely.
A normal estimate a + b = 0.2 seems reasonable as a first approach.

I_p depends on the construction of the standpipe and the pricelevel in the country. In the visited countries, investments between 200 and 2000 US \$ were estimated.

E_o specific costs of the operation and management of one standpipe.
We estimate E_o= 100 US \$ based on the supposition that an average of 1 staffmember per 10 standpipes is needed for these services and that the annual costs of 1 staffmember would be 1000 US \$.
This is based on the information supplied by several water supply companies.

E_g The costs of one guard are estimated at approx. 500 US \$ per year.

q_c $q_c = (1 - W)\ q_p$ in which q_p is the amount of water which is annually produced by one standpipe.

TABLE 3.6.1.

CAPITAL INVESTMENTS AND WATER TARIFFS

COUNTRY	collecting takes place by:	water tariff to be paid by municipality [US$/m3]	water tariff to be paid by consumers [US$/m3]	capital investments for local type of standpipe [US $]
GHANA	Government	—	0.1 *)	200
UPPER VOLTA	Government (by guard)	—	0.3 - 0.5	1450
CAMEROON	Municipality	0.1 - 0.3	—	2000
GABON overal?	Municipality	0.4	0.5	1250
MAURITIUS	Government	—	0.02	?
SENEGAL	—	—	0.00	500

*) calculated costs per m3 = $\dfrac{\text{waterconsumption per house}}{\text{yearly contribution per house}}$

$$= \frac{15 \text{ cap} \times 25 \text{ lpcd} \times 365 \times 0.001}{\text{US } \$ \ 12} = 0.1 \text{ US } \$$$

Some examples will be given below to show the importance of the various influences on the costs of water at the standpipes.

Case 1. Supposing there is a lot of wastage at the standpipe and assuming that W = 0.5 (A) and that the basic costs of the distributed water are 0.3 \$ per m^3 (B) then the cost factor thus obtained is already C_{c_1} = 0.6 \$ per m^3 (C).

Supposing the investment of the standpipe is \$ 1000 (D) (with a + b = 0.2 and E_o = \$ 100) with no guard, and that the consumption at the standpipe is q_c = 3000 m^3/year (E), then the cost factor of the standpipe is C_{c_2} = 0.1 \$ per m^3 (F).

The total costs of the consumed water at the standpipe are now C_c = 0.7 \$ per m^3 (G).

Case 2. We can now investigate how to reduce C_c.
Reducing wastage causes in case 1. a favorable influence on the costs.
If W is brought back to 0.2 (K), C_{c_1} will be reduced from 0.6 to 0.35 US \$ per m3 (L).
In order to achieve this we suppose that a guard will be necessary (M).
The cost factor of the standpipe is now C_{c_2} = 0.25 \$ per m^3(N).
Total: C_c = 0.6 \$ per m^3.
Little more can be saved by choosing a cheaper standpipe, e.g. I_p = 250 \$; then the value of C_c is reduced to C_c=0.55 \$.
Even by further reducing wastage to e.g. W = 0.1, hardly anything is gained.

If a guard is present the only substantial economization which may be reached is to enlarge q_c which means reduction of the number of standpipes with the same number of inhabitants e.g. the enlargement of q_c of 3000 to 5000 means a reducement of C_c to about 0.50 \$ per m^3.

Some remarks in connection with the total consumption at one standpipe:
q_c = 3000 m3/year may correspond with a daily consumption of approx. 10 l./capita and 800 capita/standpipe; another supposition would be 500 capita/standpipe consuming 16 l. per capita per day.
Extremely low consumption figures result from the combination of few capita per standpipe (e.g. 200) and a low consumption (e.g. 5 l./capita per day) which makes q_c = 360 m^3/year.
At these low values of q_c it is almost impossible to use a guard as this makes the water unpayable; then also a large contribution towards the costs has to be made by using a standpipe with a more expensive construction.

3.6.2. Water tariffs

Generally the water rates will more or less correspond with the costs.
As shown before these costs consist of the costs of production, storage, transport and treatment (costs to be paid by the Water Supply Company), as well as the costs of investments of the standpipes (to be paid either by the Municipality or by the Water Supply Company) and the costs of collecting from the consumers (to be paid by the Municipality or the Water Supply Company).
The political aims of the various local governments, however, are of major importance.
In some countries the Water Supply Companies are subsidized by the Government, which will result in lower prices for the consumer (e.g. Mauritius).
Sometimes also, not every consumer pays for the water and thus increases the charges on the consumer who does pay.
The average number of persons for one standpipe as indicated in table 3.6.2. and the number of persons actually using one standpipe is not necessarily the same. The number calculated is the quotient of the total number of persons without private connections and the number of public standpipes in the city.
Actually, the Water Supply Companies take an average between 300 and 1000.

In the following table 3.6.2. the rate of consumption with the seasonal fluctuations in some visited countries as well as the water tariffs, are given.

TABLE 3.6.2.

RATE OF CONSUMPTION AND WATER TARIFFS AT THE STANDPIPES

COUNTRY (city)	average monthly production per standpipe [m3]	maximum and minimum production [m3]	quotient maximum/ minimum	average number of persons for one standpipe	average production [lpcd]	watertariff at standpipe [US$/m3]
UPPER VOLTA						
(Ouagadougou)	375	500/220	2.27	1850	6.5	0.3
(Bobodioulasso)	247	300/150	2.00	1550	5	0.3
GABON						
(Libreville)	711	1754/235	7.46	3300	7	0.5
(Port Gentil)	236	283/200	1.41	750	10	0.5
(Lambarene)	71	120/ 39	3.07	1200	2	0.5
CAMEROON						
(Douala)	393	484/291	1.65	1450	8.5	0.2
(Yaoundé)	487	—	—	2250	7	0.26

4. DISCUSSION AND EVALUATION

4.1. STANDPIPE MECHANISM

Apart from the methods of management, administration and payment, a technical evaluation of the encountered systems is made.
This evaluation is based on the following criteria:

1. Ability to dispense water without contamination
2. Required maintenance
3. Costs of investment; foreign exchange
4. Total costs of investment
5. Costs of exploitation
6. Effectiveness in reducing wastage
7. Ability to withstand vandalism
8. Durability
9. Flowrate
10. Possibility of local manufacture
11. Amount of energy necessary to get water.

The evaluation is given in table 4.1. (page 28) and is based on the observation of the installations in operation.

Quite often one may find large differences in the way of use of the same installation but in different places. The estimates given in this report may be considered an average of our observations or of the observations made by others.

Furthermore, it has been supposed that the installation always consists of a minimum necessary basic unit which is composed of:
- a concrete (hardened) floor which is sufficiently large with a drainage for wastage
- a place on which to put buckets etc., while drawing water
- a solid support on which conduit and tap are well-attached
- a solid support above, or at least higher than the tap on which to put buckets etc. so as to be able to take them along (e.g. on the head).

The above provisions are the minimum requirements for proper functioning (if also well-tended) for each mechanism.

TABLE 4.1.

TENTATIVE EVALUATION OF TECHNICAL ASPECTS OF THE DIFFERENT TYPES OF PUBLIC STANDPIPES.

	Ordinary tap	Ordinary tap + guard	Tyler Waste not	Neptune	Fordilla	Tropicale	Siphoide	Bedouin	Bayard				
1. Ability to dispense water without contamination	+	++	+	+	+	+	–	□	+				
2. Required maintenance	–	+	□	□	□	□	□	–	–				
3. Costs of investment	+	+	+	–	□	–	+	+	–				
4. Costs of investment + exploitation	+	– –	+	□	+	□	□	□	□				
5. Effectiveness in reducing wastage	–	++	+	□	+	+	□	□	□				
6. Ability to withstand vandalism	–	+	–	–	–	–	□	–	–				
7. Durability	–	++	+	+	+	+	+	–	–				
8. Flow rate	++	++	+	+	+	+	□	□	□				
9. Possibility of local manufacture	+	+	+	–	+	–	+	+	–				
10. Degree of energy necessary to get water	+	+	–	□	–	–	□	– –	– –				

Significance of symbols:

- ++ very positive/cheap
- \+ positive/cheap
- □ moderate/average
- – poor/expensive
- – – very poor/expensive

The following remarks are made concerning the various criteria:

ad 1. The most important object of the public water supply is the ability to dispense water without contamination. It has been taken for granted that the installation is fed by means of a main pipe with water of a good quality.
Until the tap, all systems are equal then.
With the siphoide and bedouin type, however, there is a risk of contamination of the water in the reservoir. With the siphoide type moreover, there is a risk of contamination of the flexible tube. (Although it has been noted with ordinary taps also that people attach flexible tubes).
Moreover, there might be a risk of contamination of the water which is taken away if the surroundings of the standpipe are more or less polluted.
In practice, large differences are noticed in connection with wastage (the larger the wastage, the more pollution) and also in connection with the construction of the discharge of leakage which is quite often insufficient. Another important factor is the extent of neatness of the consumers.

There is hardly any or even no connection between the above mentioned factors and the faucet.
A guard, however, if present, may strongly lessen wastage as well as take care of maintenance and regular inspection.

ad 2. Additional maintenance is necessary if the construction has any rotating parts.
In the case of an ordinary tap being used without supervision, it will require regular maintenance (e.g. replacement of valve washer). But a guard may reduce maintenance to a minimum as well as take care of it himself mainly.

ad 3. The costs of investment in table 4.1. (page 28) have been assessed, based on the provisions which are thought to be necessary for the basic unit.

ad 5. The most important way of reducing the wastage can only be achieved by means of a guard.

ad 6. Vandalism is a criterium which is hard to evaluate as almost everything can be damaged.

ad 7. Durability: a normal tap which is well-used (e.g. by a guard) will last longest while all constructions used by the consumers show a lot of wear.

ad 9. In many countries everything can generally be made locally with the exception of the tap and the pipeconduits. However, there are some systems which form a unit of tap and encasement and therefore have to be imported as a whole.

4.2. COSTS AND TARIFFS.

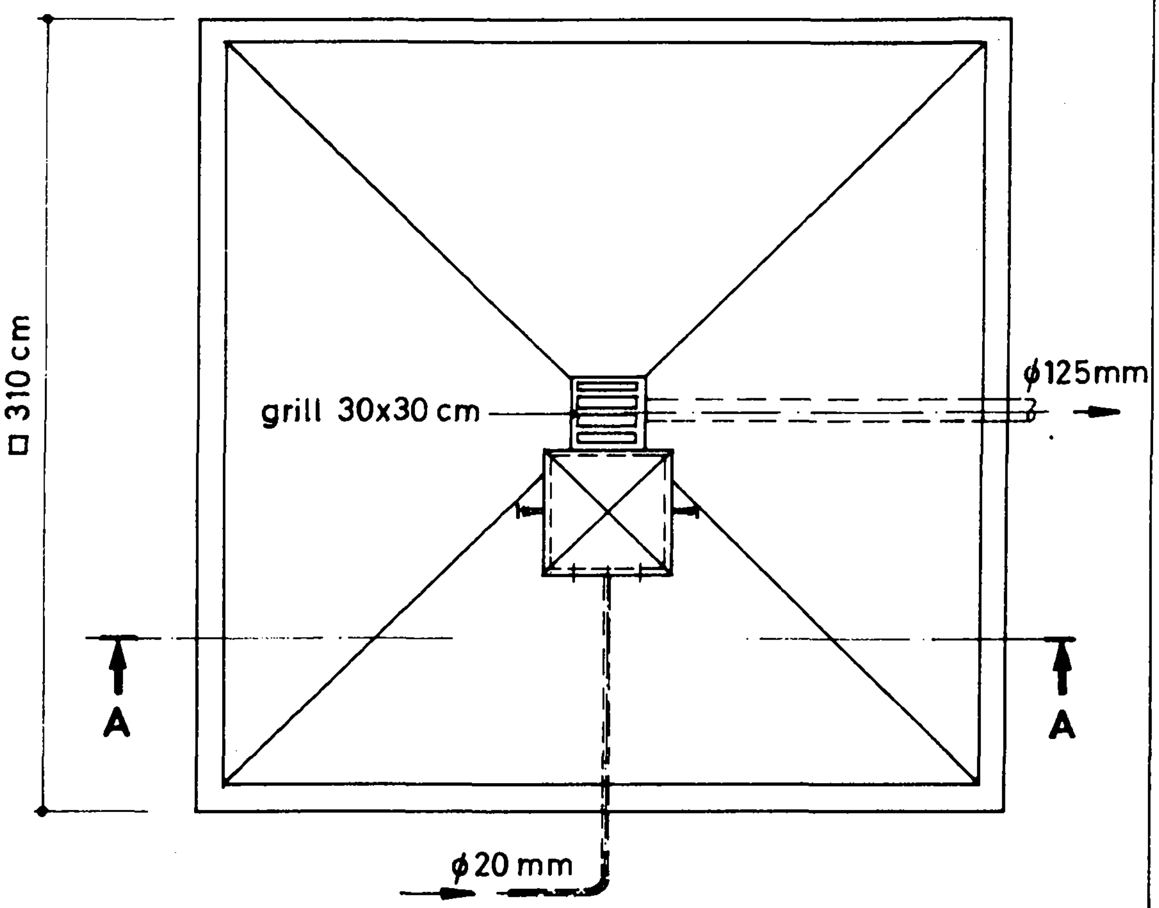
With our estimates, which are based on field investigations, and information of the watersupply companies concerned we have calculated some values of C_c with help of figure 3 and the following table.
The waterrates , which are really paid, are shown as well.

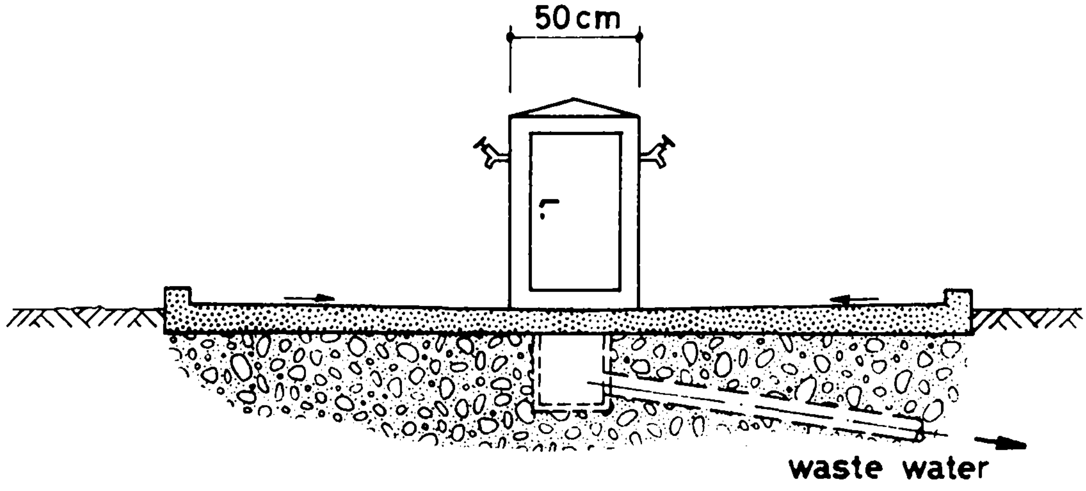
		UPPERVOLTA OUAGADOUGOU	GABON LIBREVILLE	CAMEROON DOUALA
ESTIMATES AND INFORMATION:				
I_p	$	1450	1250	2000
E_o	$	100	100	100
E_g	$	500	0	0
a + b		0,2	0,2	0,2
q_p	m^3/y	5000	8500	5000
W		0	0,5	0,3
q_c	m^3/y	5000	4250	3500
C_b	$	0,3	0,3	0,2
READ FROM FIGURE 3:				
C_{c1}		0,3	0,6	0,29
C_{c2}		0,17	0,1	0,15
C_c		0,47	0,7	0,44
WATERRATES IN US $ PER:				
m^3 produced water		—	0,5 (paid by community)	0,20 (paid by community)
m^3 consumed water		0,40 (paid by consumer)	1,0	0,29

It is still too early for conclusions. After completion of the field investigations this chapter will be written for the final report.

ANNEX 1 PUBLIC STANDPIPES. FIG. 1
SKETCHES OF MECHANISMS.

SYSTEMS WITH ORDINARY TAPS.



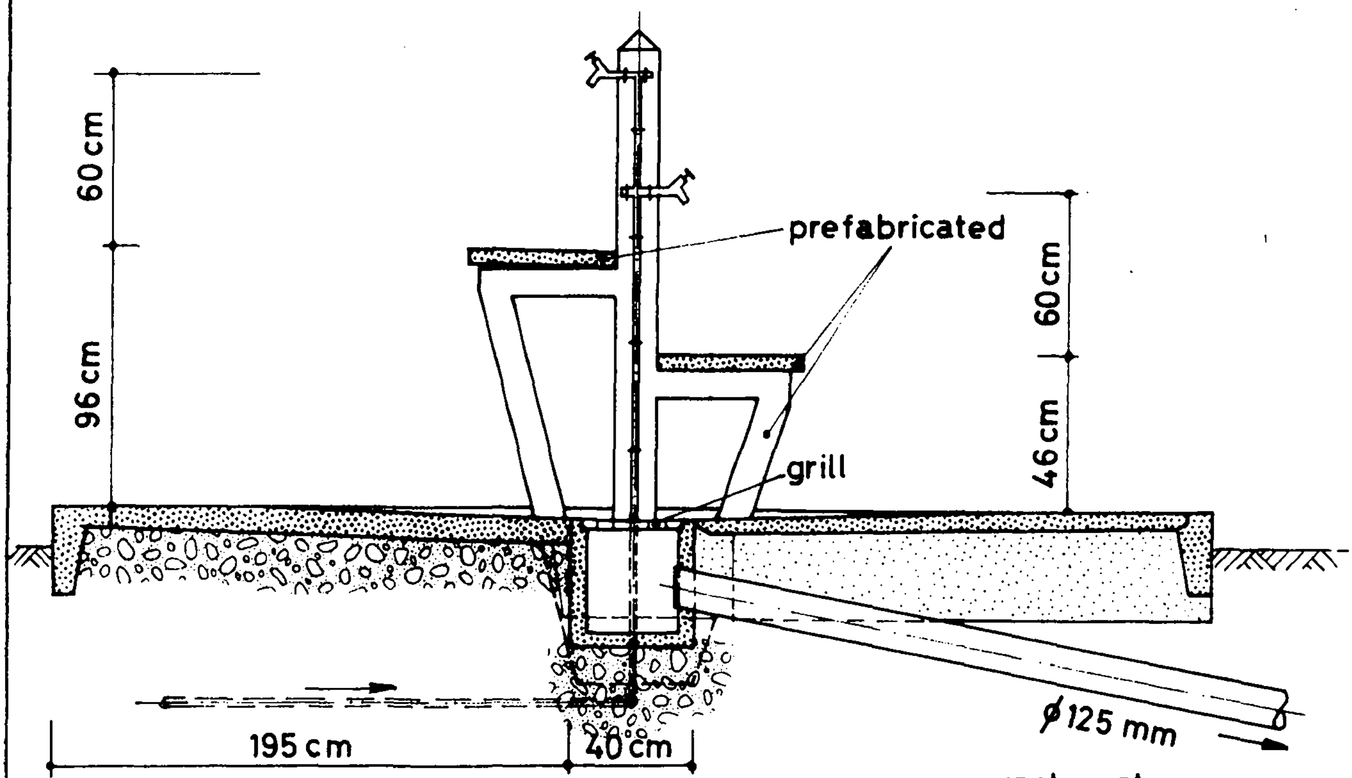


Cross section A-A

in operation in: Senegal (Dakar)

ANNEX 1 PUBLIC STANDPIPES. FIG. 2
SKETCHES OF MECHANISMS.

SYSTEMS WITH ORDINARY TAPS.



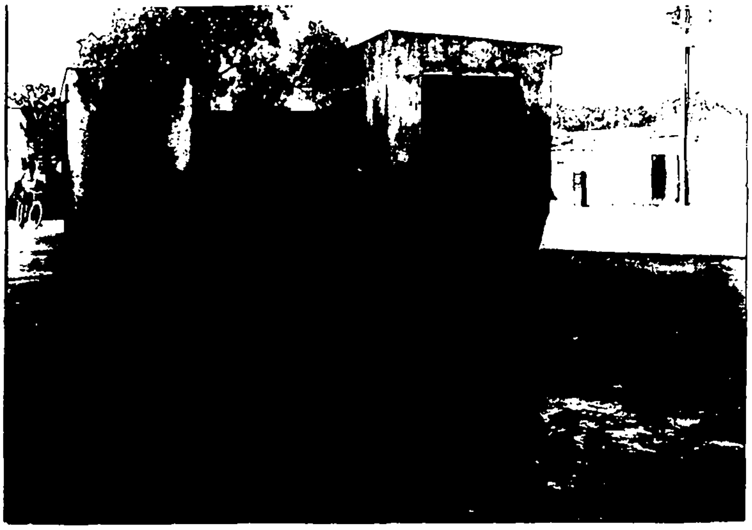
Cross section

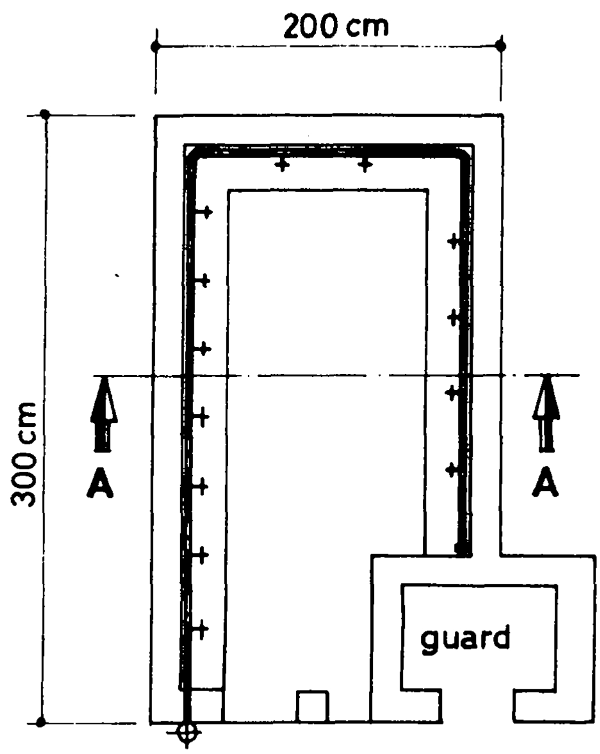
proposed for: Senegal (Dakar)

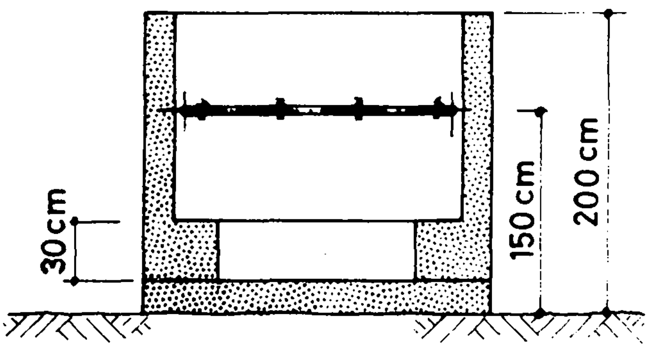
ANNEX 1 PUBLIC STANDPIPES. FIG. 3

SKETCHES OF MECHANISMS.

SYSTEMS WITH ORDINARY TAPS.







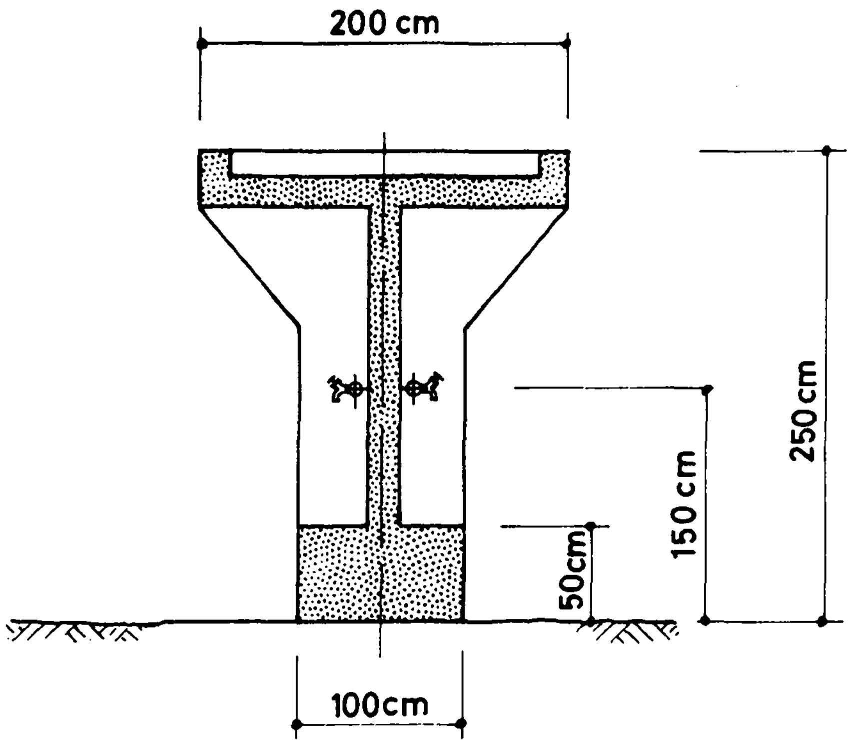
Cross section **A-A**

in operation in: Upper Volta (Ouagadougou)

ANNEX 1 PUBLIC STANDPIPES. FIG.4

SKETCHES OF MECHANISMS.

SYSTEMS WITH ORDINARY TAPS.

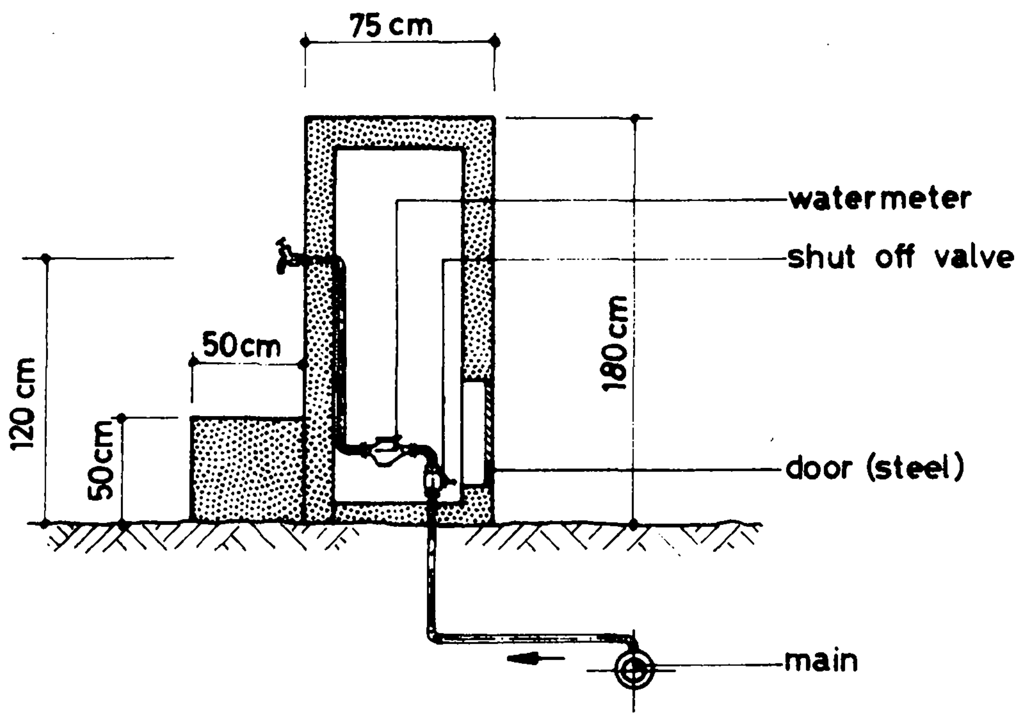


Cross section

in operation in: Upper Volta (Ouagadougou)

ANNEX 1 PUBLIC STANDPIPES. SKETCHES OF MECHANISMS. FIG. 5

SYSTEMS WITH ORDINARY TAPS.



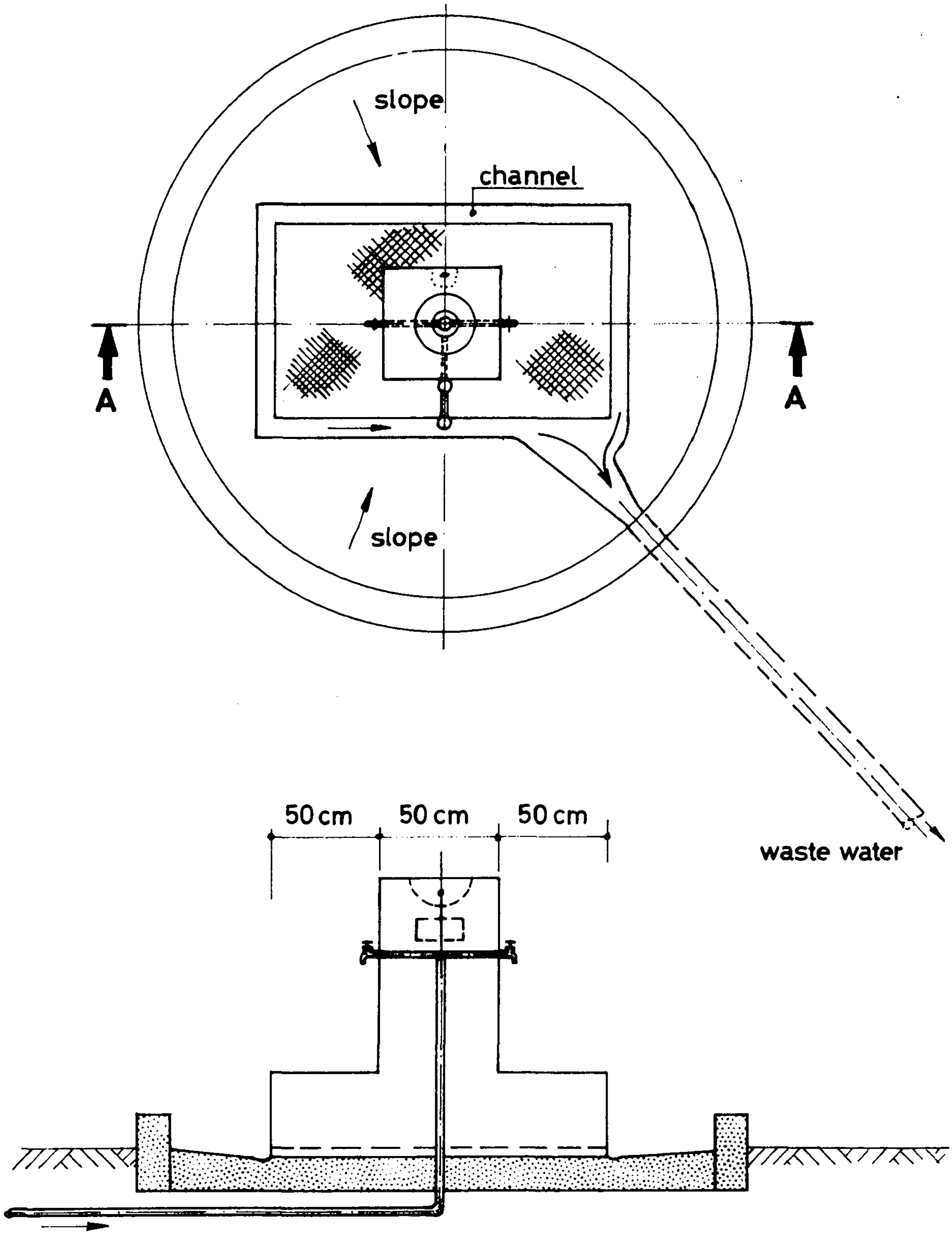
Cross section

in operation in: Upper Volta (Ouagadougou)

ANNEX 1 PUBLIC STANDPIPES. **FIG. 6**

SKETCHES OF MECHANISMS.

SYSTEMS WITH ORDINARY TAPS.

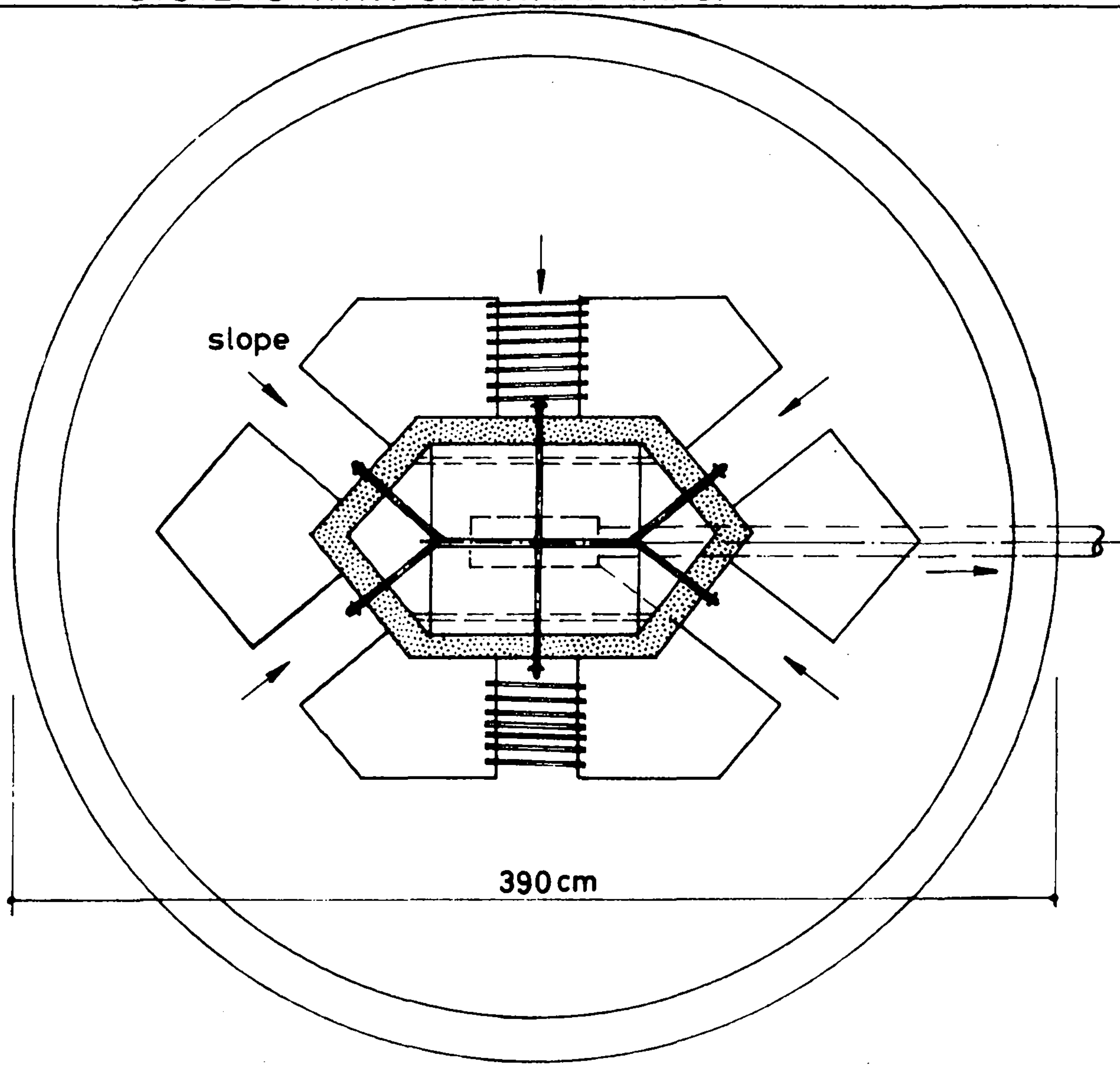


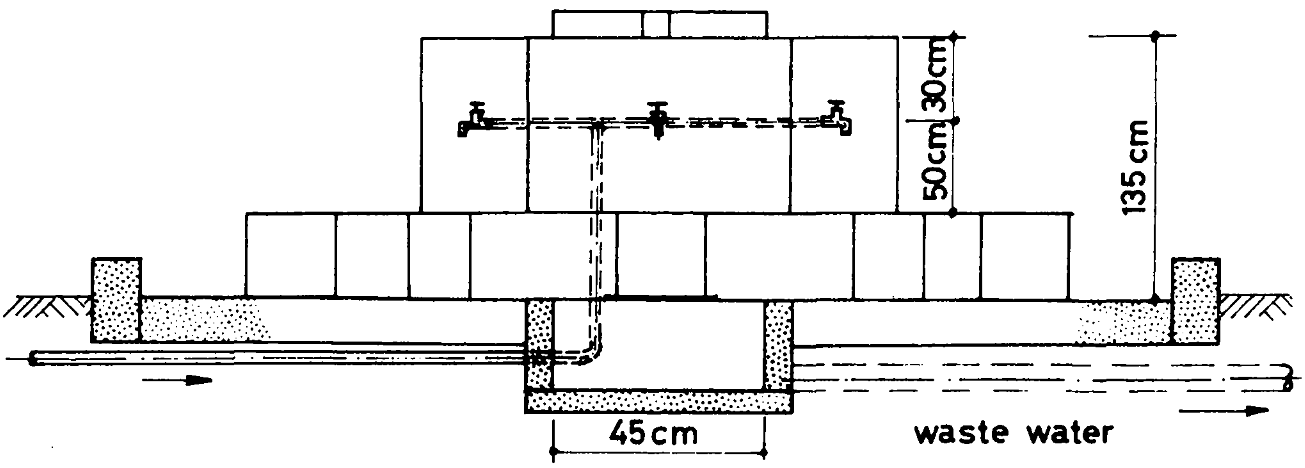
Cross section A-A

in operation in: Kenya (Zaina Region)

ANNEX 1 PUBLIC STANDPIPES. SKETCHES OF MECHANISMS. FIG. 7

SYSTEMS WITH ORDINARY TAPS.





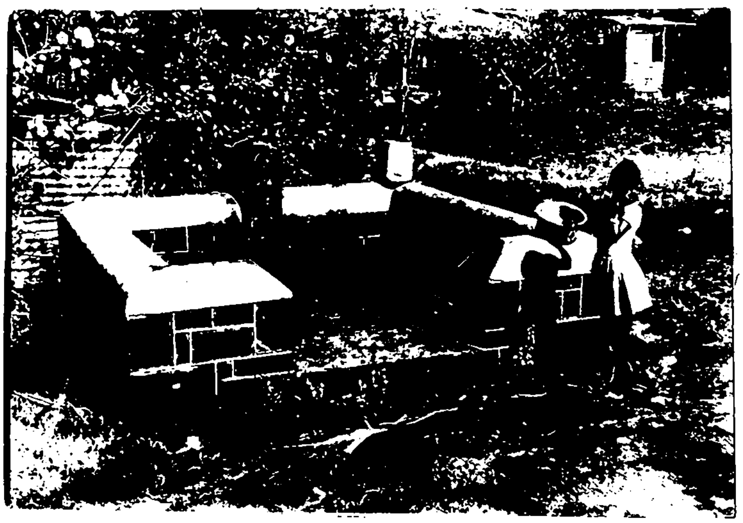
Cross section

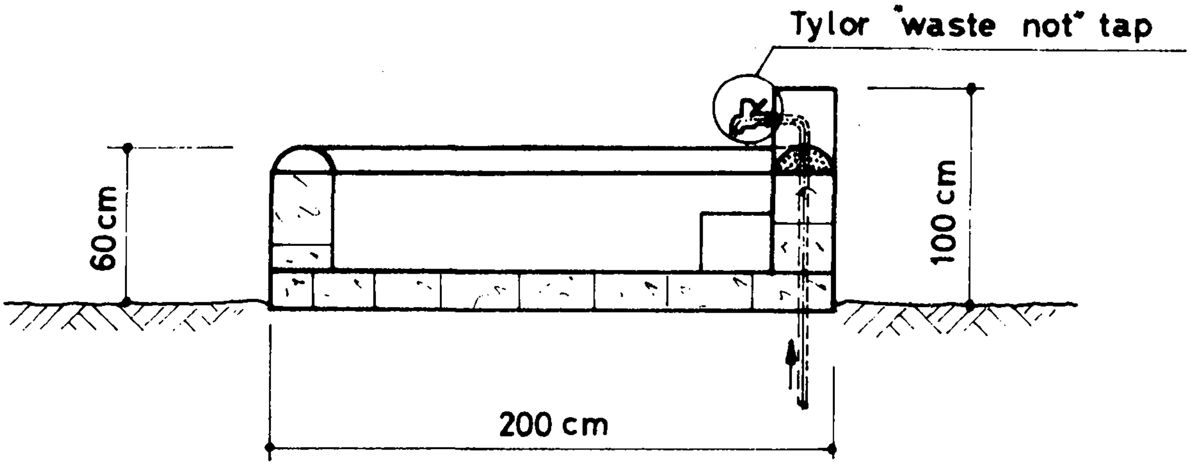
in operation in: Kenya (Zaina Region)

ANNEX 1 PUBLIC STANDPIPES. FIG. 8

SKETCHES OF MECHANISMS.

SYSTEMS WITH SELF CLOSING TAPS.





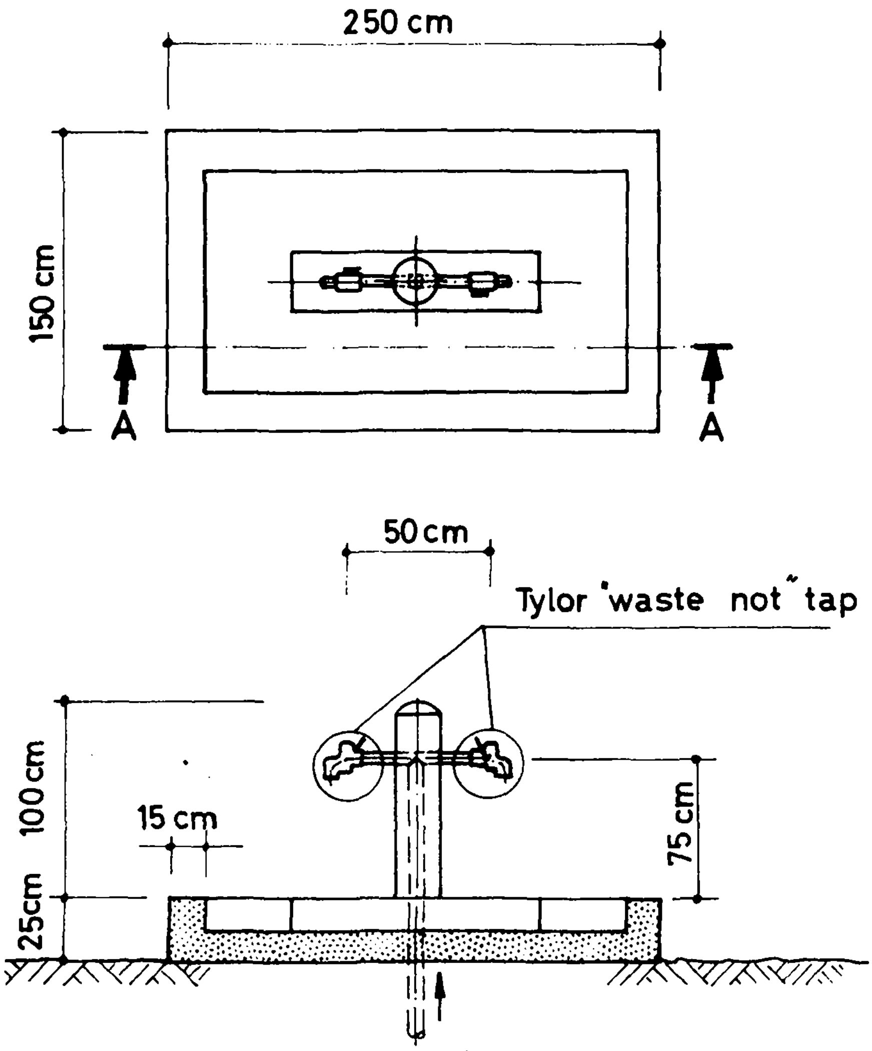
Cross section

in operation in: Mauritius

ANNEX 1 PUBLIC STANDPIPES. FIG. 9

SKETCHES OF MECHANISMS.

SYSTEMS WITH SELF CLOSING TAPS.



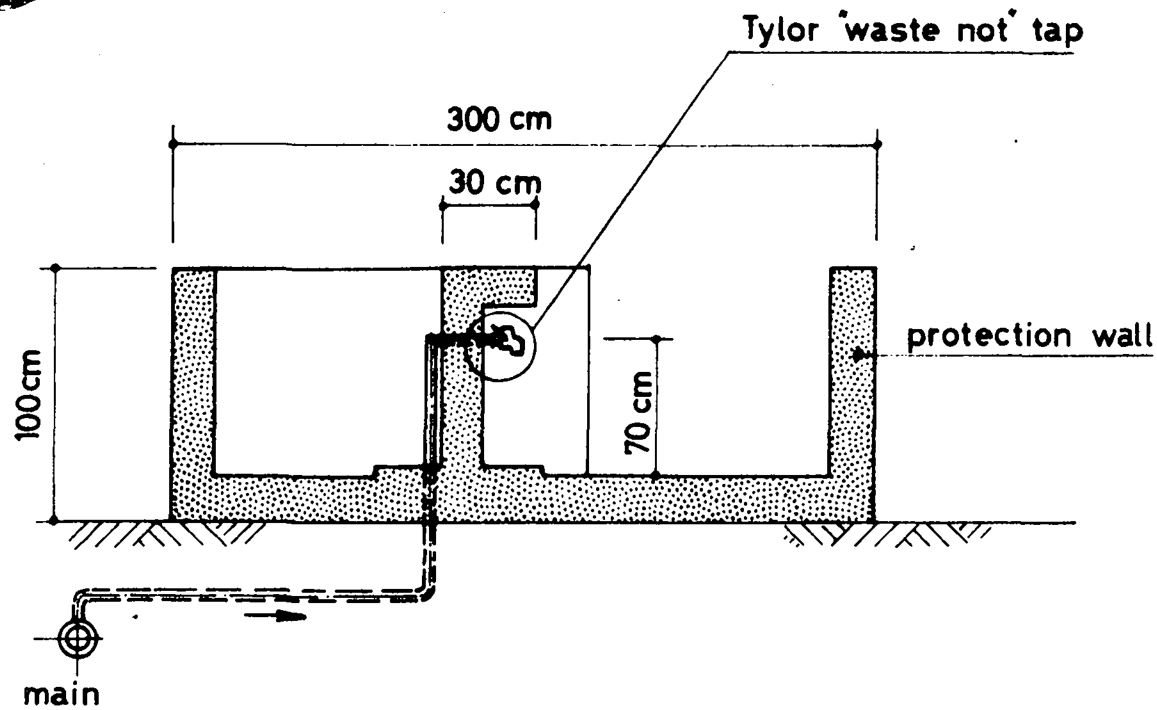
Cross section A-A

in operation in: Ghana (Rural area)

ANNEX 1 PUBLIC STANDPIPES. FIG.10

SKETCHES OF MECHANISMS.

SYSTEMS WITH SELF CLOSING TAPS.

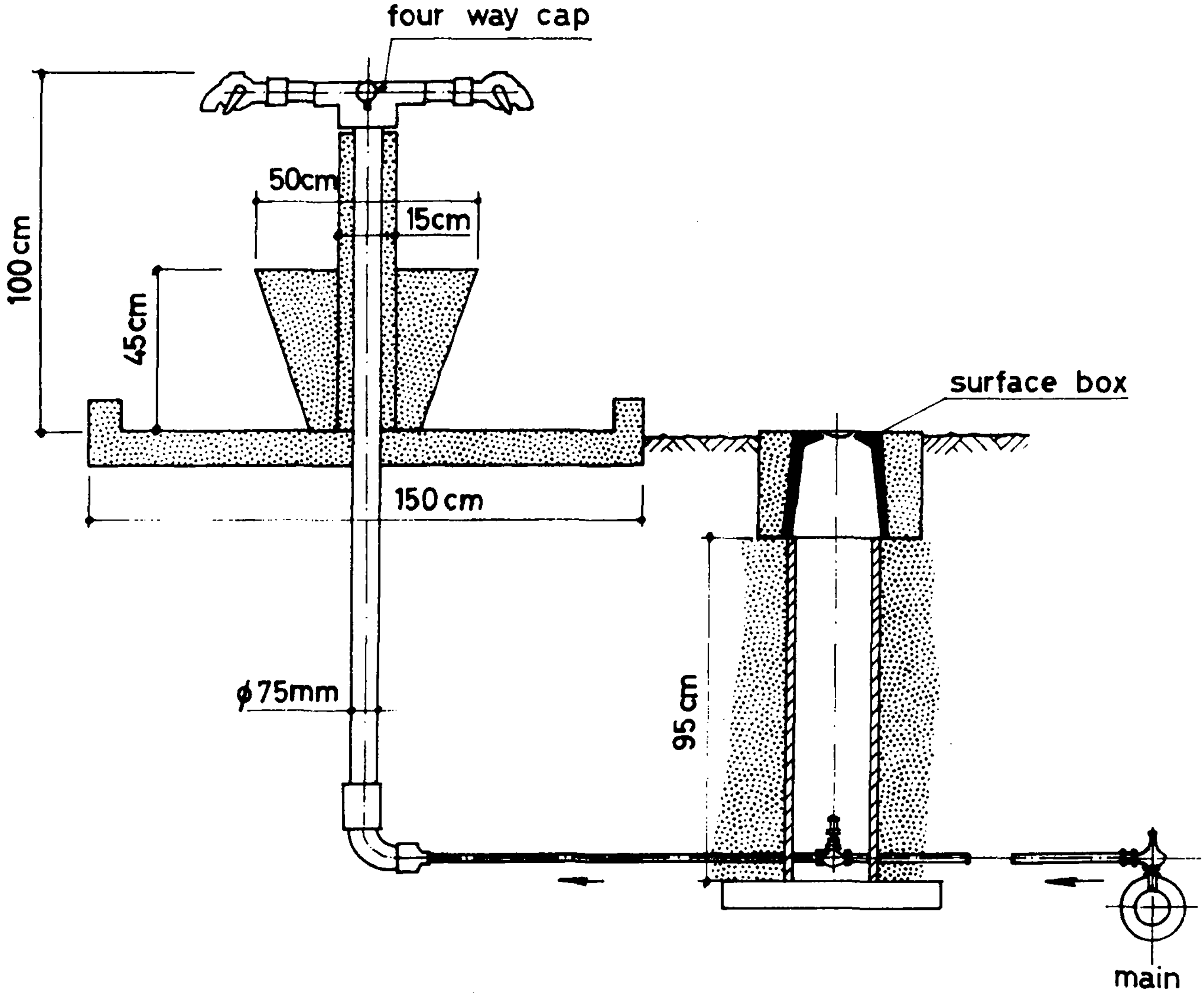


Cross section

in operation in: Ghana (Accra)

ANNEX 1 PUBLIC STANDPIPES. SKETCHES OF MECHANISMS. FIG. 11

SYSTEMS WITH SELF CLOSING TAPS.

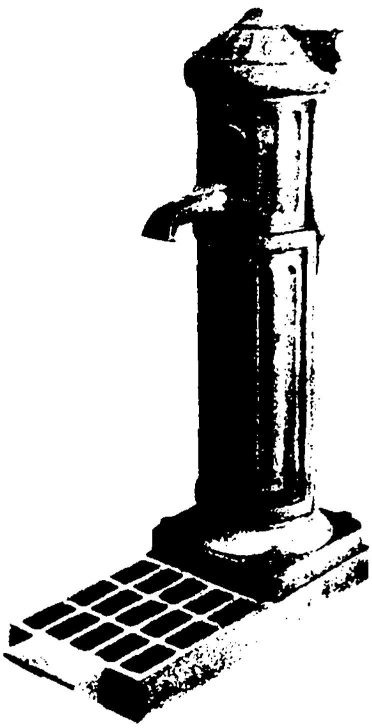


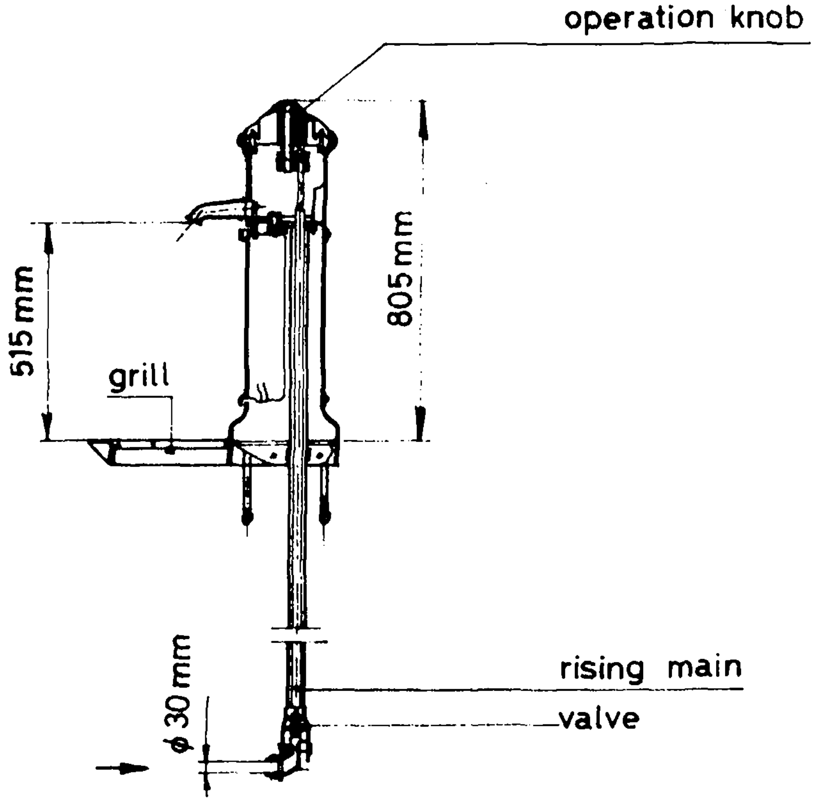
Cross section

in operation in: Ghana (Sekondi - Takoradi)

ANNEX 1 PUBLIC STANDPIPES. SKETCHES OF MECHANISMS. FIG.12

SYSTEMS WITH SPRINGLOADED TAPS.





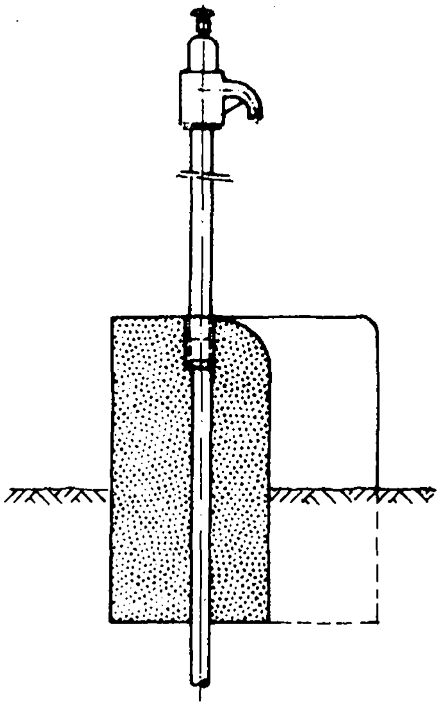
Cross section

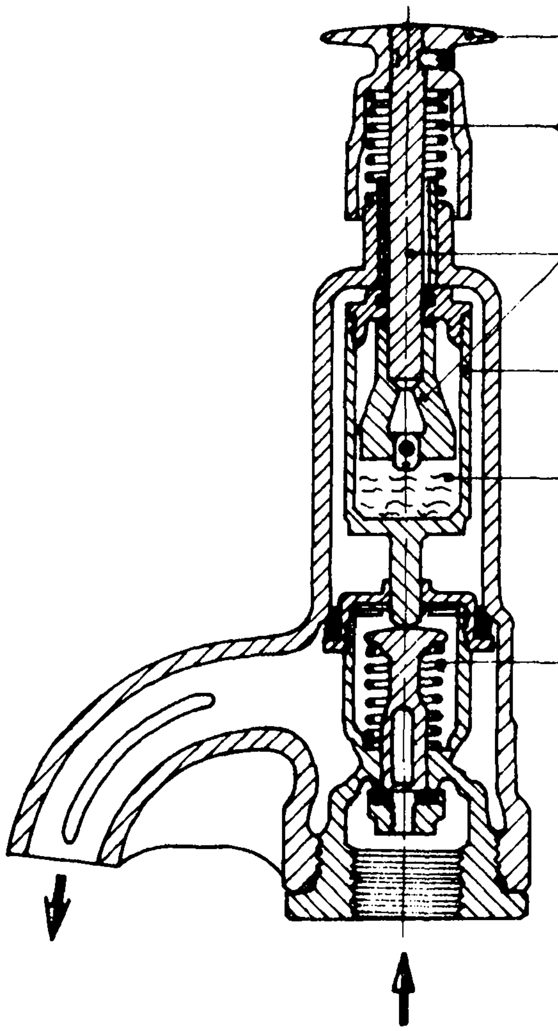
- Neptune type.
- opening of the valve by means of turning a small, smooth knob

in operation in:

ANNEX 1 PUBLIC STANDPIPES. SKETCHES OF MECHANISMS. FIG. 13

SELF CLOSING TAPS.





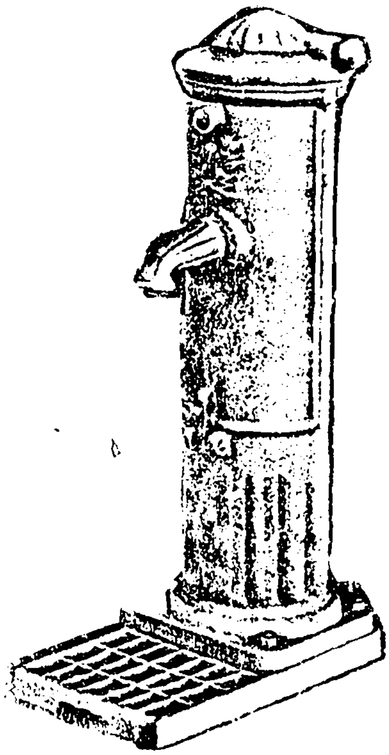
- Fordilla valve.
- is generally used as water supply unit serving a limited group of persons (15–25).

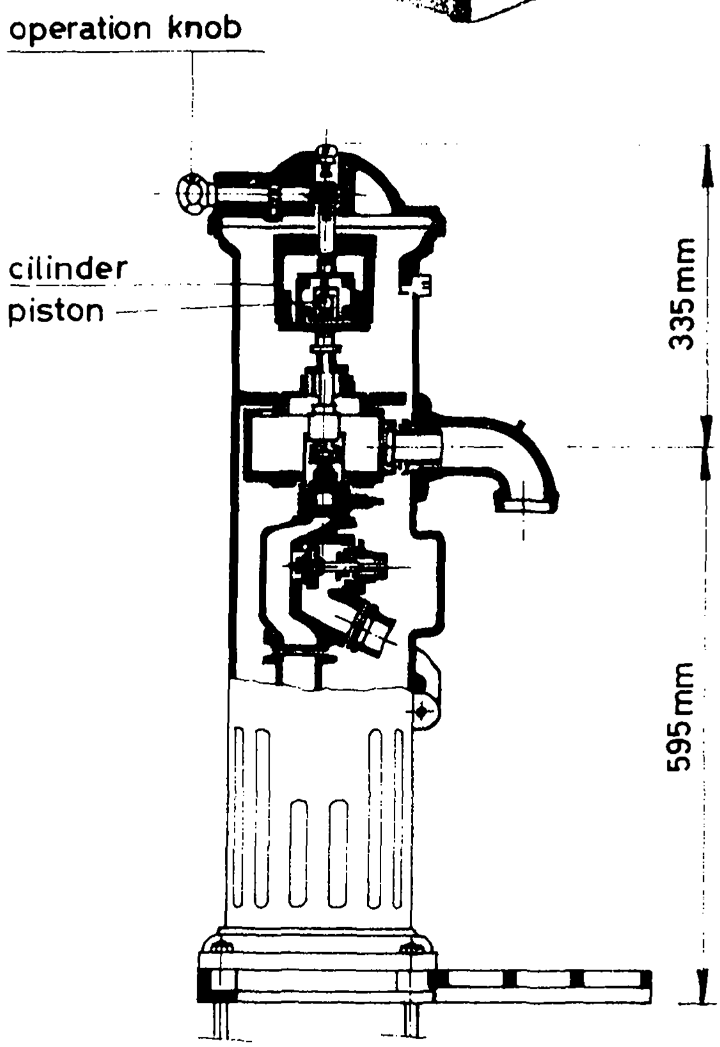
in operation in: Paraguay (Asuncion)
Guatemala
Surinam
St. Lucia

ANNEX 1 PUBLIC STANDPIPES. FIG. 14

SKETCHES OF MECHANISMS.

SELF CLOSING TAPS.



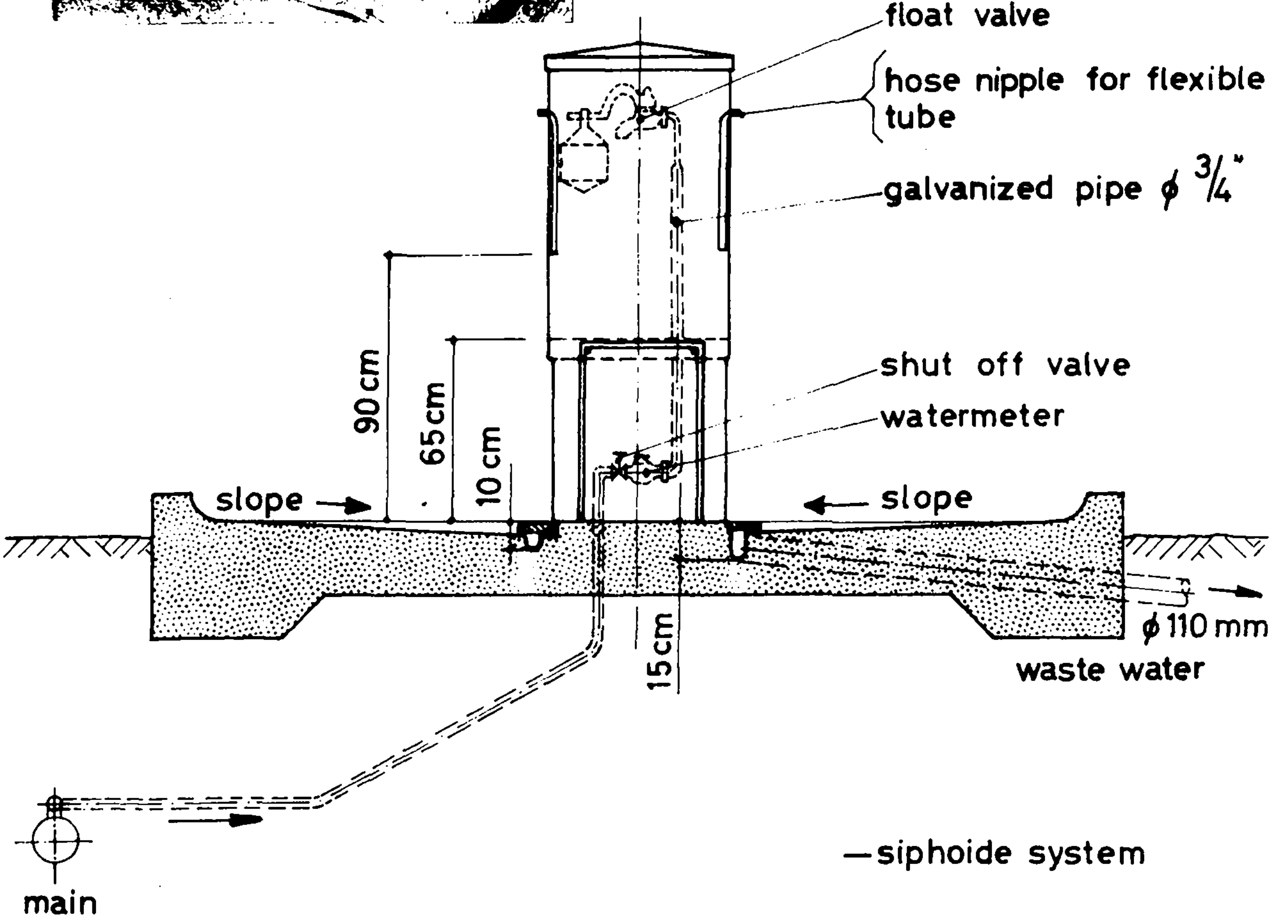


- Tropicale.
- discharges when knob is turned
- flow stops when knob is released
- flow stops after certain time when knob is fixed

proposed for: Gabon

ANNEX 1 PUBLIC STANDPIPES. SKETCHES OF MECHANISMS. FIG. 15

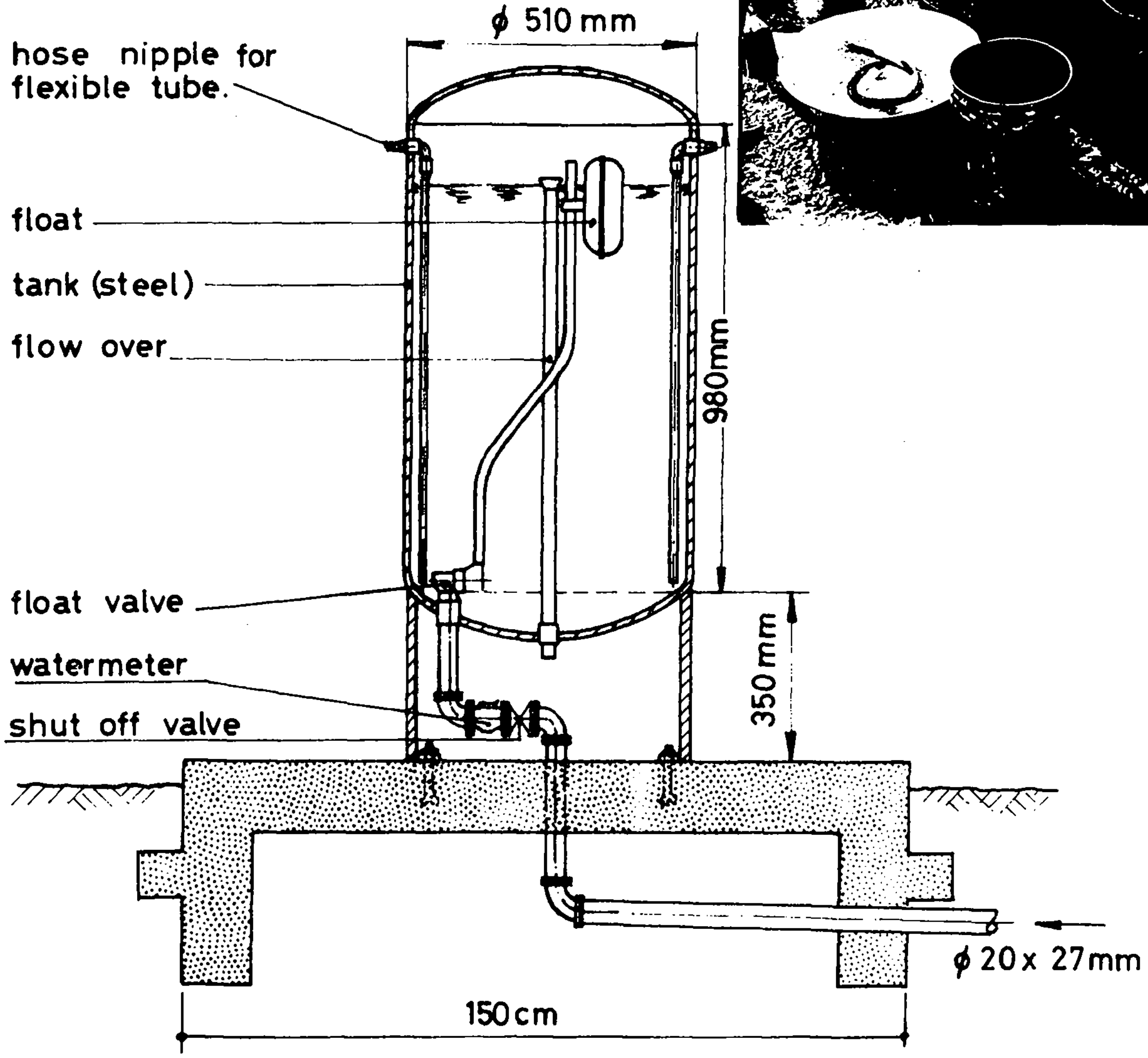
SYSTEMS WITH FLOAT MECHANISMS.



in operation in: Cameroon (Yaounde)

ANNEX 1 PUBLIC STANDPIPES.
SKETCHES OF MECHANISMS. FIG.16

SYSTEMS WITH FLOAT MECHANISMS.



Cross section

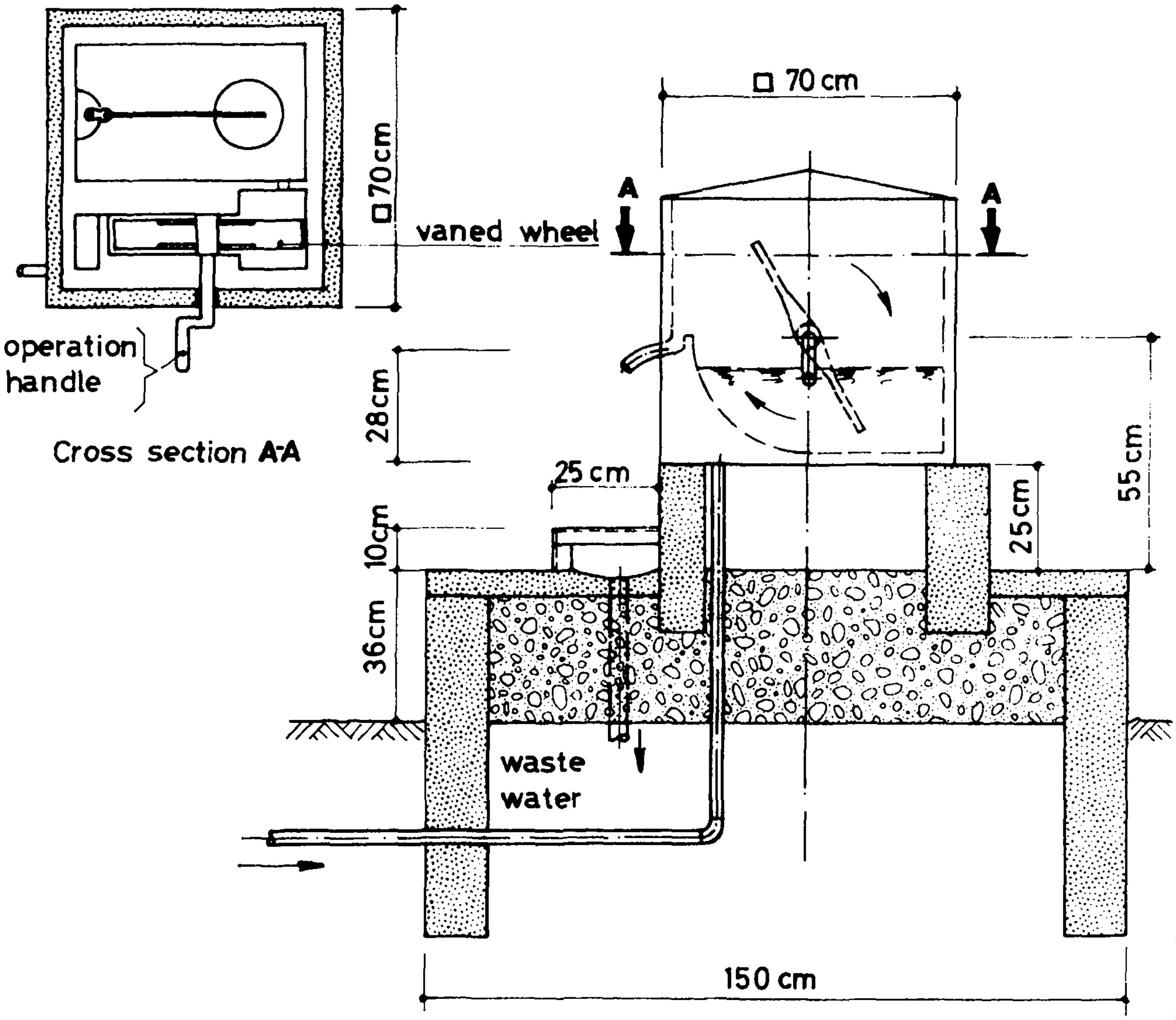
–siphoide system

in operation in: Cameroon (Yaounde)
Gabon (Libreville)
Central African Republic (Bangui)

ANNEX1 PUBLIC STANDPIPES. SKETCHES OF MECHANISMS. FIG. 17

SYSTEMS WITH FLOAT MECHANISMS.

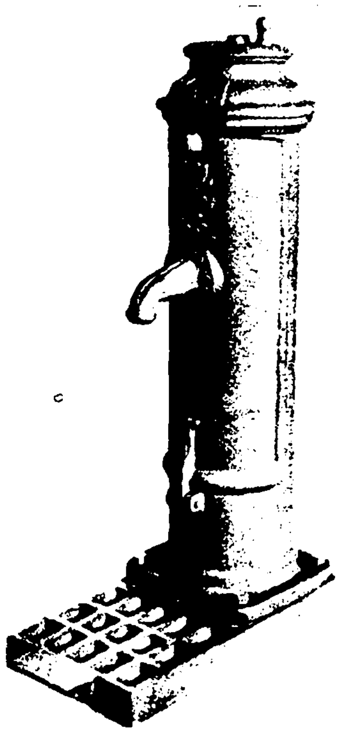
— bedouin type



in operation in: Cameroon (Yaounde)

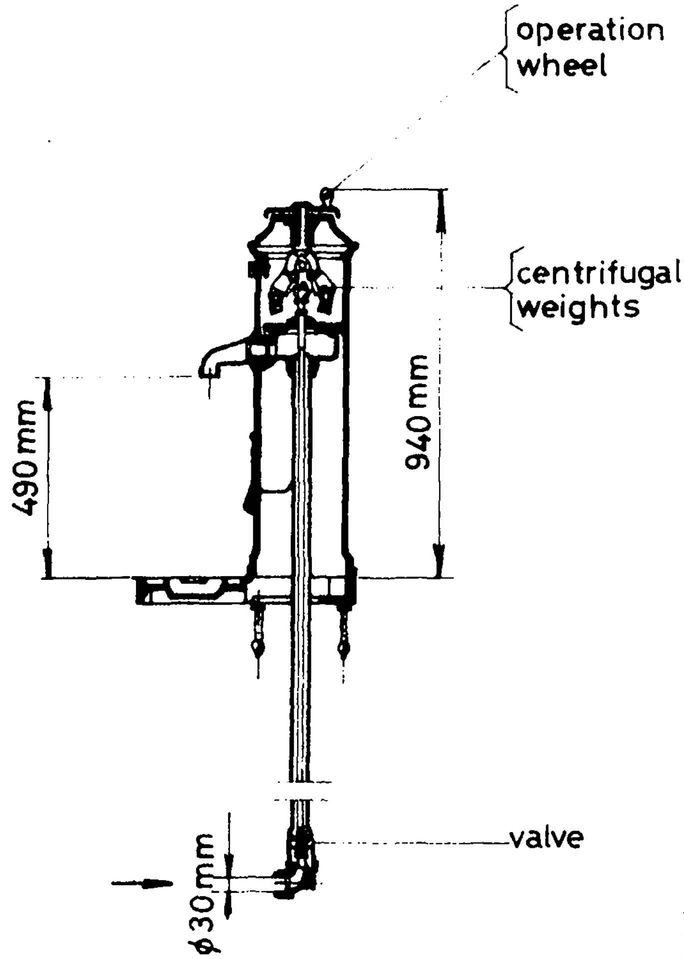
ANNEX 1 PUBLIC STANDPIPES. FIG 18
SKETCHES OF MECHANISMS.

SPECIAL TYPES.



– system Bayard

– continuing rotation of the wheel induces a centrifugal force which maintains opening of the valve



Cross section

in operation in: Gabon (Libreville)

REFERENCES

1. Projet d'aménagement et d'entretien des bornes fontaines dans les quartiers non urbanisés de Libreville. Société d'Energie et d'Eau du Gabon - 1972

2. SEEG. Statistiques Analytiques d'Eau du Gabon - 1973

3. Statistiques Générales Electricité et Eau au Gabon - 1973 SEEG - 1974

4. Seven Urban Water Supply Schemes in Ghana. Howard Humphreys & Sons, 1970. Prepared for the World Health Organization.

5. Informations et Documents BCEOM - 1973 - no. 10 Les bornes fontaines en milieu tropicale Africain.

6. World Health Statistics - W.H.O.- Geneva. Vol. 26, No. 11, 1973

7. Village Water Supply and Sanitation in Less Developed Countries. R.J. Saunders and J.J. Warford.

8. Water Supply for Rural Areas and Small Communities. E.G. Wagner and J.N. Lanoix, WHO Geneva 1959.

9. The hydraulic design of Fordilla pods. Richard V. Ford.

10. New concept in Water Service for Developing Countries. E.K.G. Borjesson and C.M. Bobeda. Journal of American Waterworks Association, Vol. 56, No. 7 - 1964.

11. Individual household water supplies in Rural St. Lucia as a control measure against Schsitsoma mansoni. G.O. Unrau (concept report)

12. World Health Organization - "The village tank as a Source of Drinking Water".

13. Projet d'Eau et d'Assainissement au Mali. Balfour & Sons and ACWA - 1973 (Prepared for W.H.O.) L'étude Sectorielle d'Eau Projet d'Adduction d'Eau de Sikasso, Koutiala, San

14. Alimentation en Eau Potable de la Ville de Ségou (Mali) Prepared by SEURECA for the FED. Rapport socio-économique - Avant Projet Technique

15. Rural Sanitation in the Tropics. The Ross Institute. Bulletin no. 8 - 1965

16. Les Approvisionnements Publics en Eau. Rapport d'un Comité d'experts de l'O.M.S. Série de Rapports Techniques no. 420 - 1969

17. Small Water Supplies The Ross Institute. Bulletin no. 10 - 1964

18. A progress Report on the Zaina Environmental Sanitation Scheme.
K.W.H. Fenwick, Nyeri (Kenya) - 1966

19. République du Sénégal - Projet 22 - préparé pour l'O.M.S.
Plan Directeur de l'Approvisionnement en Eau de Dakar.
Etudes Sociologiques

20. World Health Organization - Community and Rural Water Supply,
Sewerage and Water Pollution Control.
Report No. 2 - 1972 - Government of Kenya

21. Drawers of Water.
G.F. White, D.J. Bradley, A.U. White. - 1972

22. Water Supply, Sewerage, Drainage and Solid Waste Systems for
Greater Kabul, Republic of Afganistan.
W.H.O. - U.N.D.P. - Proctor & Redfern

23. Survey of the distribution systems of the Greater Kathmandu
and Bhaktapur - 1973 - W.H.O. - U.N.D.P. Project Nepal.
Binnie & Partners

24. Masterplans for Water Supply and Sewerage for the Greater
Kampala and Jinja Areas, Republic of Uganda.
W.H.O. - U.N.D.P. - 1971 - Resources Group

25. Pakistan Water Supply and Sewerage Sector Study.
I.B.R.D. - I.D.A. - W.H.O. - 1974

26. India, Water Supply and Sanitation Sector Surveys - 1972 I.O.A./WHO

27. Peoples Republic of Bangladesh.
Water Supply and Sewerage Sector Study - 1973
I.B.R.D./I.D.A./W.H.O.

28. India, Madhya Pradesh, Rural Water Supply. Masterplan - W.H.O.

29. Iraq, Rural Water Supply Development Plan.
U.N.D.P./W.H.O. - 1974 - Ward, Ashcroft & Parkman.

30. W.H.O. - Visit Reports:
- Venezuala 1972
- Columbia 1972
- Peru 1972
- Argentinia 1972
- Upper Volta 1972

31. W.H.O. - Sector Briefs:
- Costa Rica 1974
- El Salvador 1974
- Honduras 1974
- Nicaragua 1974
- Sudan 1973

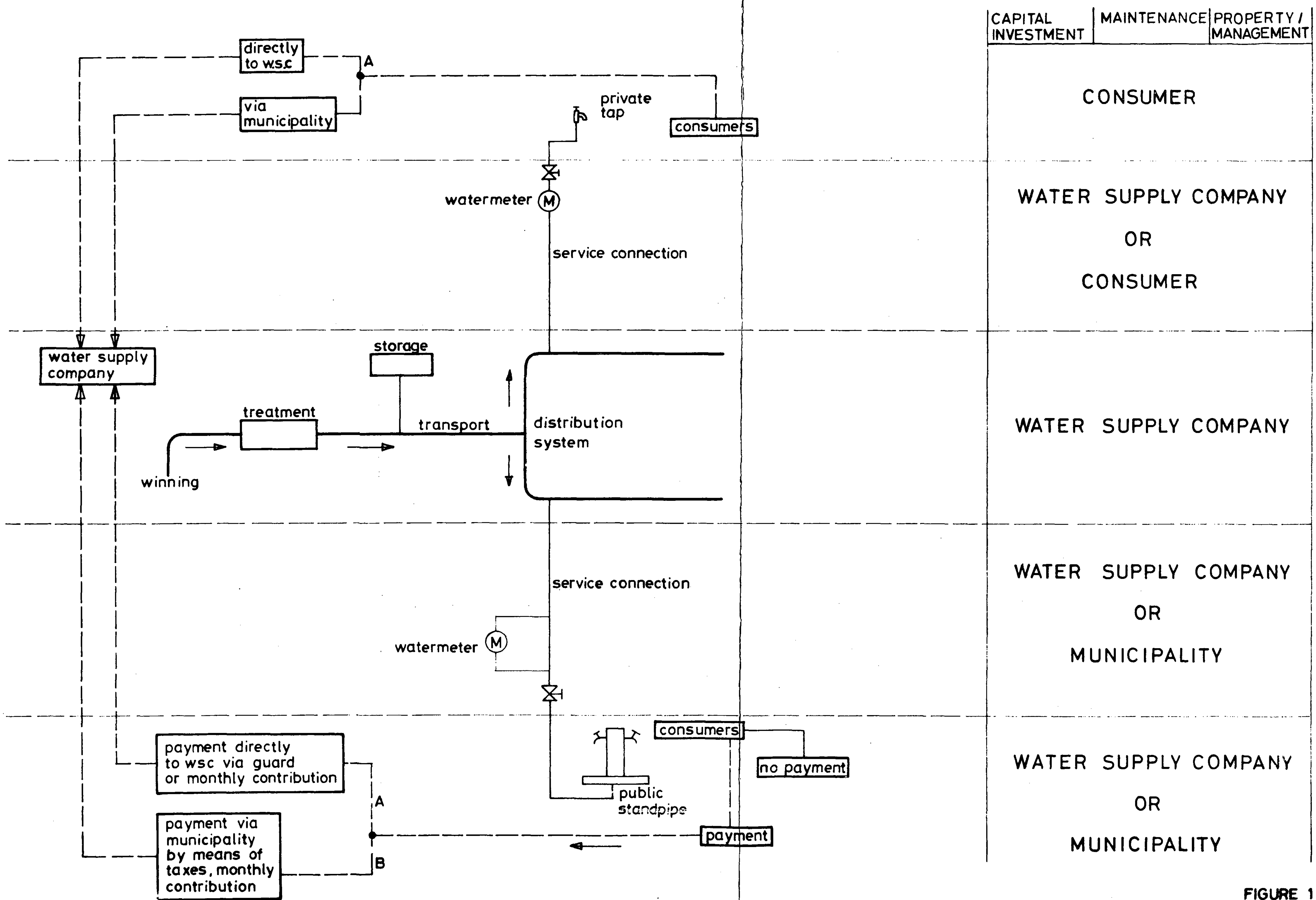

directly to w.s.c
A
via municipality
private tap
consumers
watermeter
M
service connection
water supply company
storage
treatment
transport
distribution system
winning
service connection
watermeter
M
consumers
no payment
public standpipe
payment
payment directly to wsc via guard or monthly contribution
A
payment via municipality by means of taxes, monthly contribution
B
CAPITAL INVESTMENT
MAINTENANCE
PROPERTY / MANAGEMENT
CONSUMER
WATER SUPPLY COMPANY
OR
CONSUMER
WATER SUPPLY COMPANY
WATER SUPPLY COMPANY
OR
MUNICIPALITY
WATER SUPPLY COMPANY
OR
MUNICIPALITY

FIGURE 1

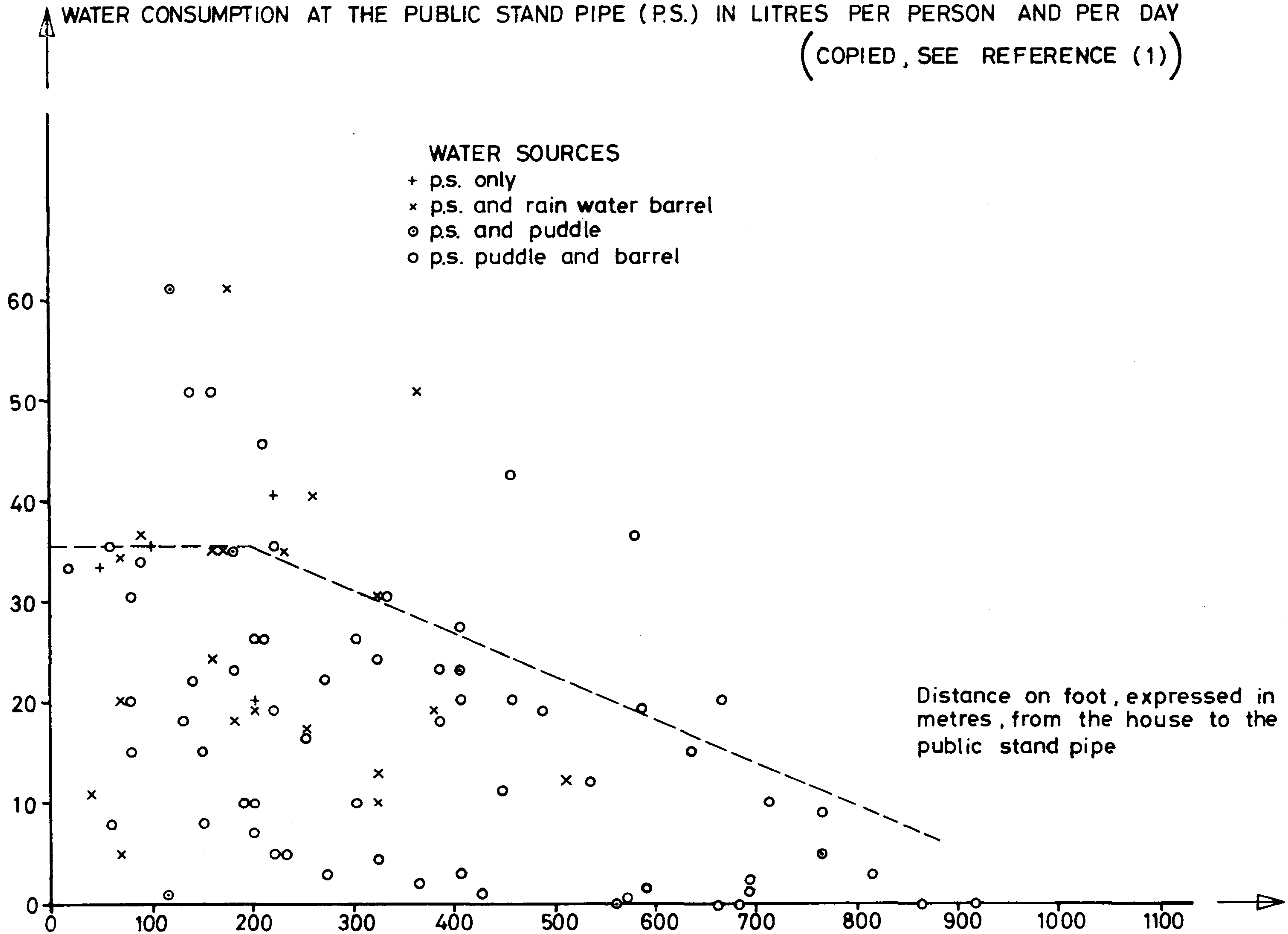

WATER CONSUMPTION AT THE PUBLIC STAND PIPE (P.S.) IN LITRES PER PERSON AND PER DAY
(COPIED, SEE REFERENCE (1))
WATER SOURCES
+ p.s. only
× p.s. and rain water barrel
⊙ p.s. and puddle
o p.s. puddle and barrel
60
50
40
30
20
10
0
0
100
200
300
400
500
600
700
800
900
1000
1100
Distance on foot, expressed in metres, from the house to the public stand pipe

FIGURE 2

MEANING OF PARAMETERS

C_c = costs of consumed water
C_b = general production costs
I_p = capital investment for standpipe
a } factors for interest, deprecation
b } maintenance and replacement
E_o = operation costs and revenue collecting
E_g = annual costs of a guard
q_c = annual consumption per standpipe
w = waste factor

for further explanation of parameters :
the reader is referred to page 21 through 24

EXPLANATION OF SCALES 1, 2 AND 3

costs of consumed water at a standpipe in \$ per m3

$$C_c = \frac{1}{1-w} C_b + \frac{(a+b)\,I_p + E_o + E_g}{q_c}$$

exploitation costs of one standpipe :

scale 1 = $(a+b)\,I_p + E_o + E_g$ all values are variable

scale 2 in $(a+b)\,I_p + E_o + E_g$

is I_p variable and $\begin{cases} a+b = 0{,}2 \\ E_o = 100\,\$ \\ E_g = 0 \end{cases}$

scale 3 in $(a+b)\,I_p + E_o + E_g$

is I_p variable and $\begin{cases} a+b = 0{,}2 \\ E_o = 100\,\$ \\ E_g = 500\,\$ \end{cases}$

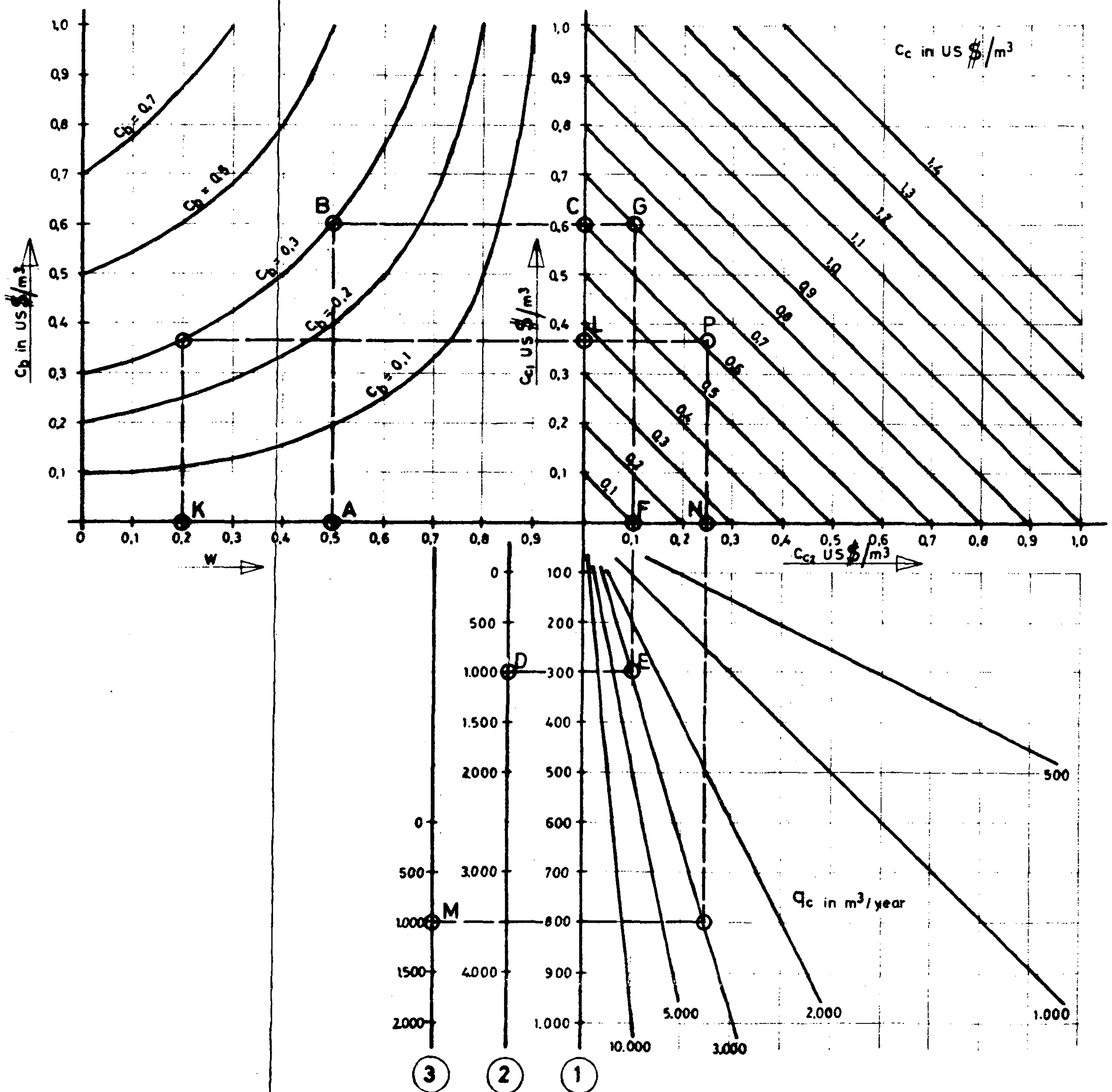


FIGURE 3