5

Rural Water Supply

5.1 BREAKDOWNS AND TECHNOLOGY

At least one in four of the rural water supplies in most developing countries is out of order. Very often the reason why a rural water supply has not been repaired is connected with the organizational problems mentioned in Chapter 4, but there are usually technical reasons why it broke down in the first place. These technical reasons may at first sight appear to be problems of poor standards in workmanship due to a shortage of skilled and supervisory staff. But such problems are almost inevitable in most developing countries, and the engineer who blames high breakdown rates on them is rather like a workman blaming his tools. Good engineering requires designs which can be made to work, *with the labour and materials currently available.*

For instance, the engineer cannot usually rely on high standards of pipe-laying to regular slopes. The slopes on pipelines should be large enough to allow for air locks due to uneven gradient, and for errors in the original survey. This can be turned into an advantage, because if it means the minimum permitted gradient for gravity-fed pipeline is, say, 1 in 50, then the maximum possible size of pipe required for a given flow is only 60% larger than would be required for a very steep slope of 1 in 5. For a given flow capacity, therefore, the pipe required for any likely slope can be chosen from a range of only two or three consecutive sizes. This means that pipe sizes can be chosen from a table like Table 5.1 by a technician who would find a Hazen–Williams pipe flow chart confusing.

Design for maintenance

If it is important for water supply technology to be chosen so that it can be made to work under the existing construction conditions, it is even more important that it should continue to work under the prevailing maintenance conditions. Water treatment plant, for example, generally requires a level of attention and skill in operation quite unattainable in a small community. Since there is

Table 5.1 Diagrams for gravity pipelines (mm)

Flow	Steel		Polythene		Bamboo		PVC	
(l/s)	Flat	Steep	Flat	Steep	Flat	Steep	Flat	Steep
0.10	19	19	12	12	25	19	19	12
0.15	25	19	19	12	32	25	19	19
0.20	25	19	19	12	32	25	25	19
0.30	32	25	25	19	32	25	25	19
0.40	32	25	25	19	37	32	25	25
0.60	37	32	32	25	50	32	32	25
0.80	50	32	32	25	50	37	37	32
1.00	50	37	37	32	62	50	37	32
1.50	62	50	50	32	76	50	50	37
2.00	62	50	50	37	76	62	50	37
3.00	62	50	62	50	76	62	62	50

'Flat' is < 1:15
'Steep' is > 1:15

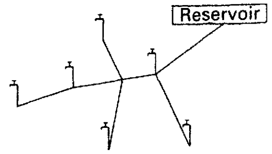
little point in installing water treatment facilities if they will not be reliably operated, it is almost always preferable to find a source of good-quality water and protect it from pollution, rather than to take water from a doubtful source and treat it. Pumps, too, of any kind, frequently break down or fall into disuse in rural areas. Motorized pumps, especially, should only be installed where adequate arrangements have been made to pay for their running costs (see Chapter 4).

It is best to try to build a 'fail-safe' character into rural water supplies so that one small fault is not likely to put the whole system out of action. For example, a ring main is preferable to a 'dendritic' distribution system (Figure 5.1), so that if a pipe is broken the whole community is not necessarily deprived of water. Again, a series of hand pumps on tube wells may have the advantage over a piped supply from a distant water source, because if one pump breaks down the villagers can continue to use the others until it is repaired.

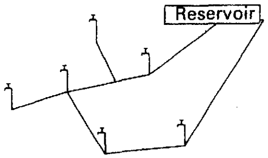
As a general rule the cheaper and simpler the technology, the less maintenance it requires, the more reliable it is in practice, and the easier to repair under village conditions. The major exception is in the choice of hand pumps, where the more robust and reliable pumps are often more expensive and more difficult to repair; here the choice depends not only on technical considerations but also on factors such as whether maintenance is to be carried out by a village caretaker, a local mechanic, or a mobile team. Village Level Operation and Maintenance, known as VLOM, is generally preferable.

5.2 SOURCES OF WATER

Because of the unreliability of treatment plant under most rural conditions, the best sources of water are those which do not need treatment. Rainwater collected from a metal or asbestos cement roof is relatively pure, and is of course available close to the users if the roof is theirs. However, many rural houses are roofed with other materials, such as thatch, and rainfall patterns may require large and expensive storage tanks to guarantee a supply all year round.



(a) Dendritic system



(b) Ring main

Figure 5.1 Alternative village water supply distribution systems

Surface water may be readily available and easy to abstract, but is typically very polluted (Table 3.1). In some sparsely populated upland areas, streams may be of a quality good enough for domestic use, but in most regions streams, lakes, and ponds are subject to substantial faecal pollution.

Where it can be extracted with reasonable ease, ground water is normally preferable to surface water because it is purified by the filtering action of the soil through which it flows. Nevertheless, ground water in some areas may contain iron, manganese, salt, fluoride, or other substances which make its use undesirable or unpleasant, and the use of a surface source—a river, lake, or dam—may be unavoidable. Even in these cases, a well beside the surface source usually gives fresh water and is to be preferred. Where it is not possible to locate a reliable year-round source of water within the village, a more distant source may be supplemented by a 'wet-season well' which, although it may not be in use in the dry season, at least supplies water during the rains, which is usually the period of greatest disease incidence and peak labour demand. Sufficient quantities of ground water to supply a rural community may be collected from a spring or extracted from a well of some kind.

Protected springs

Springs, where they exist and have a reliable flow, can make ideal sources of water for a community water supply. No pumping is required to extract water from them, and all that is usually necessary to obtain water of good quality is to collect it and protect it from pollution. This is done by building a box of brick, masonry, or concrete around the spring so that water flows directly out of the box into a pipe without ever being exposed to pollution from outside (Figure 5.2).

The water emerging at a spring has generally been forced to the surface by an impervious layer of soil or rock; a layer through which water cannot pass. In excavating the foundations for a spring box it is important to avoid digging through this layer, or the water may seep downwards so that the spring disappears or moves downhill.

The point where the water emerges, known as the 'eye' of the spring, should be covered with carefully selected sand or gravel. If this material is too coarse, the spring water may erode the soil behind it, but it should not be finer than the existing soil behind it or it may block the flow. If there is a danger that it too could be washed away, then still coarser gravel should be placed in front of it, with the gravel progressively increasing in size to the stones of the spring box wall. A spring may sometimes flow very strongly for brief periods after rain, and the whole structure must be sound enough to resist erosion.

Fine sediment is suspended in the water from most springs. A spring box therefore should be built so as to prevent this sediment from settling over the eye of the spring and blocking its flow. This is best done by ensuring that the overflow pipe is not above the eye (Figure 5.2). It is also important for the spring box to have a removable cover, so that it can be cleaned out from time to time. Alternatively, one or more small springs may be connected to a single 'silt trap' (Figure 5.3), where the silt is allowed to accumulate and is periodically cleaned out.

Care is required to prevent surface water from running into the spring box and polluting the water in it. Puddled clay should be used to backfill behind the box to seal the ground against infiltration. The top of the spring box should be at least 300 mm above the ground,

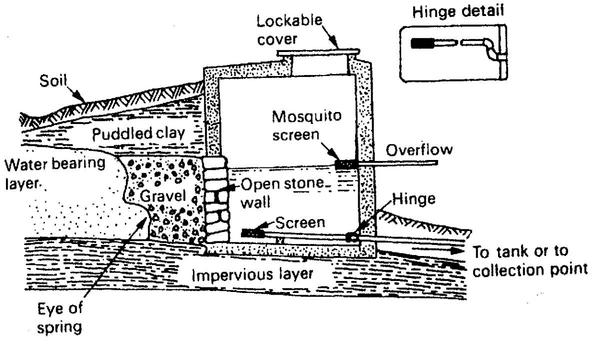


Figure 5.2 A spring box. The inset detail shows a hinge made with two flexible pipe bends, enabling the screen to be lifted above the water for cleaning

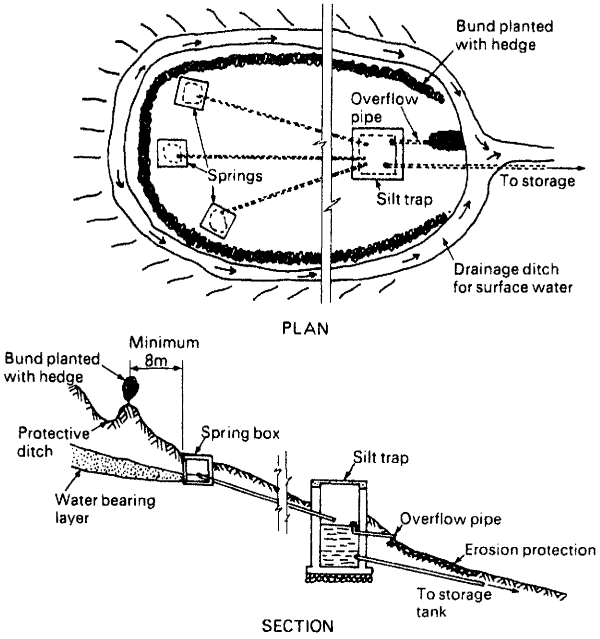


Figure 5.3 Three protected springs connected to a silt trap

and the access hole should have a lip around it and a cover which is not easily removed. In addition, a ditch may be dug on the uphill side of the spring, and the excavated soil thrown up into a bank or 'bund' (Figure 5.3) to divert surface water. Finally, a fence or prickly hedge planted on the bund will help to keep people and animals away.

Wells

Wells can be sunk in a wide variety of ways. The basic methods most suitable for small community water supplies are illustrated schematically in Figure 5.4, and listed below.

(1) *The driven tube well*, in which a specially perforated or slotted tube known as a 'well point' is driven into the ground. The well point is re-usable, but is expensive and normally lasts only about 5 years. Well points can be made locally from galvanized iron pipe (FAO, 1977), but these are more liable to clogging and corrosion than commercial well points.
(2) *The bored tube well*, which can be sunk by hand to depths up to 40 m with an 'auger', a simple tool twisted by hand to drive it into the ground.

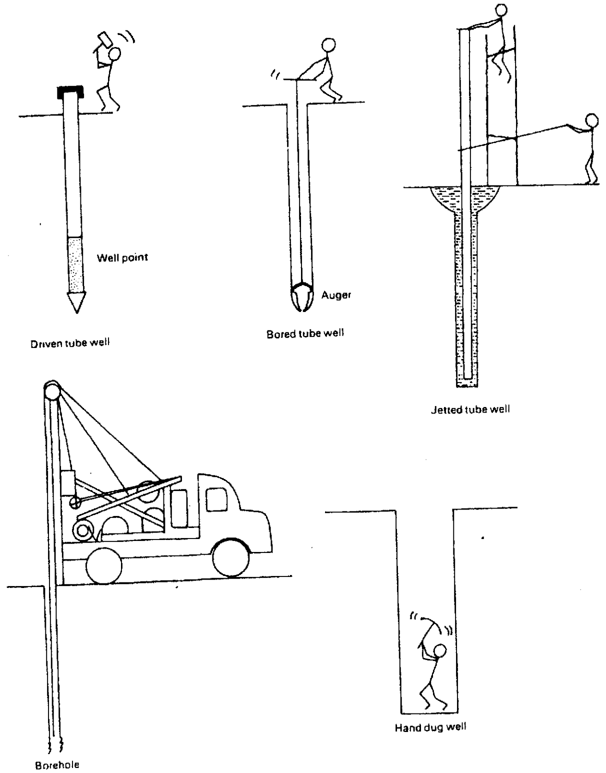


Figure 5.4 Schematic illustration of five basic methods of ground water extraction

(3) *The jetted tube well*, in which a pipe is sunk into soft ground while the soil is loosened and removed by water pumped down (or up) the pipe while the surrounding hole is kept full of water. Figure 5.5 illustrates the simplest method of jetting, known as the 'palm and sludger' method; the pipe is moved up and down by a lever, and a person's hand or a wooden flap on the top of the pipe is used as a valve to pump water upwards, closing as the pipe rises and opening as it falls.

(4) *The hand-dug well*, the most common method of extracting water from the ground. It can be dangerous to build unless the necessary skills are available locally; but, if they are, it can be constructed cheaply with local equipment and materials. The hand-dug well has the very important advantage that water can be drawn from it by bucket and rope if a pump cannot be afforded, or if the pump breaks down.

(5) Various methods of jetting, punching, or drilling a tube well or borehole require a special *drilling rig* which may be trailer- or truck-mounted for use in rural areas. The rigs are expensive, but

many of these methods have equivalents using hand power, or a small motor and pump (FAO, 1977).

The construction of the various types of well is described in several technical manuals (FAO, 1977; Watt and Wood, 1977; Brush, 1979; Blankwaardt, 1984; IDRC, 1981) and so is not discussed here.

Figure 5.5 The palm-and-sludger method in use in Bangladesh (Photo: HEED, Dhaka Bangladesh)

Pollution of open wells

Tube wells and boreholes are protected from pollution by a concrete slab, at least 2 m across, used as a base for the pump (see Figure 5.12). Open hand-dug wells, however, are more liable to pollution. An open well can be polluted by any of the following means, but only the first two normally affect tube wells.

(1) *Polluted ground water* This can result from location of the well too close to pit latrines, soakaways, or refuse dumps, whose influence may extend to about 10 m in a typical soil. In fissured strata such as limestone and fractured rock, water may flow in underground streams rather than seeping through the soil, and so carry faecal pollution much longer distances (see Section 8.4).

(2) *Seepage water from the surface* This may enter through the top few metres of the well lining if it is not sufficiently watertight near the surface (Figure 5.6).

(3) *The vessels used for drawing water* However often these may be rinsed out, they can cause some pollution of the well (Figure 5.7). An improvement can be achieved by having a bucket permanently hanging in the well, probably from a windlass, so that it is never taken home and never put on the ground (Figure 5.8). If the bucket is made of collapsible rubber, it is less likely to be put on the ground or stolen. Pollution can only be completely avoided by sealing the well and installing a pump, though this may cost as much as the original construction of the well.

Figure 5.6 This well in Burkina Faso is contaminated by seepage of the pool of water around the well head into the well. The pool is contaminated by pig faeces
(Photo: R. Witlin, World Bank)

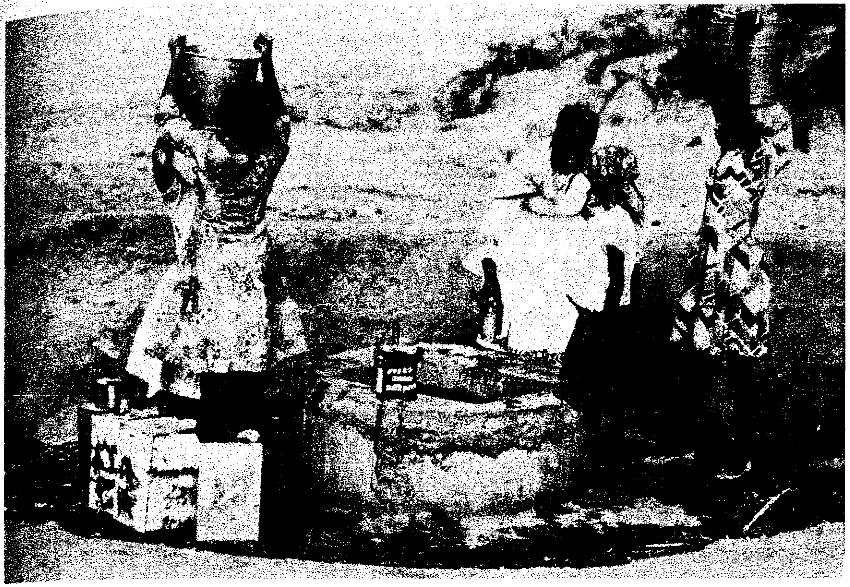


Figure 5.7 This well is polluted by dirt on the tins and buckets that are lowered into it and also by seepage of spilt water and rainwater

(4) *Rubbish thrown down the well* The chance of this may be reduced by preventing children from playing near the well, but the only certain way to prevent it is to fit a permanent cover over the well and install a pump.

(5) *Surface water* This may be washed straight down the well, especially if the ground surface has sunk, as is often the case when the well does not have an adequate lining. It can be prevented by building a headwall (Figure 5.9), which will also help to prevent animals and people from falling into the well.

(6) *Spilt water* If there is no headwall, or if people stand on the headwall to draw water, water which has splashed against their feet can fall back into the well.

Avoidance of pollution by spilt water is particularly important in regions of West Africa where Guinea worm (*Dracunculus* *medinensis*) is endemic (see Chapter 1 and Appendix D). Its cyclopoid intermediate hosts are not often found in very deep, narrow wells; but in a shallow well, water splashed off the legs of infected people drawing water, or washing with it, could maintain transmission of the disease.

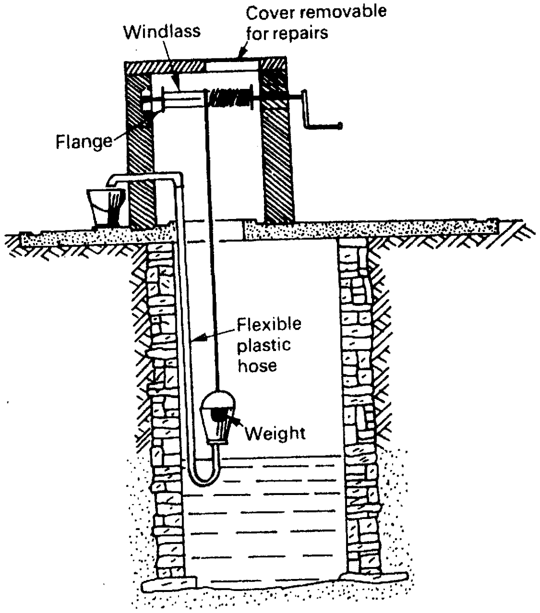


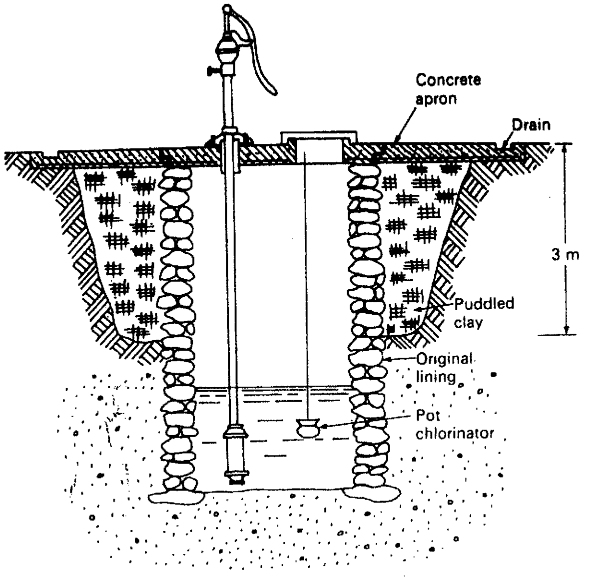
Figure 5.8 One method of protecting a well from pollution Methods of this kind have not yet been adequately tested i the field

Figure 5.9 A well with a headwall and rollers in Nigeria. Th arrangement preve surface and spilt water running into the well and also prevents Guinea wo transmission at the (Photo: R Feachem)

Because of this, and because of the importance of surface and spilt water in causing well pollution, the most important single improvement which can be made to an existing well is the construction of a well head consisting of a headwall and drainage apron to take spilt water to a soakaway. This single measure can completely prevent Guinea worm transmission at a well, and considerably reduce other health risks. It can only be done on its own in solid ground where there is no danger of the well shaft collapsing. Where the ground is unstable, it is necessary to build a well lining first.

The headwall can be fitted with rollers, a pulley, or a windlass to help people to pull up the bucket (Figures 5.8 and 5.9). Better protection from pollution can be gained by covering the well with a concrete slab and fitting a hand pump (Figure 5.10). This increases the cost of the well, and a pump should not be installed in any water supply unless arrangements have been made to maintain it.

A well itself requires maintenance too. Dust, rubbish, and dead animals can accumulate remarkably quickly in the bottom of an open well. Apart from polluting the water, the accumulation of rubbish or wind-blown dust in a well may be sufficient to reduce its depth or block it up. Ideally, any open well should be cleaned once a year in the dry season when the water level is low, and then heavily disinfected before being put back into service.



5.10 Improving existing well by ding a hand pump, cover slab, an apron drain, and a puddled clay barrier seepage of water After Wagner Lanoix (1959)

5.3 RAISING WATER

Methods of lifting water are numerous and varied. The simplest mechanisms are often the cheapest, and can more easily be made and repaired with local materials. However, they are sometimes less durable, and usually require more maintenance by the local community. The main methods are described below, roughly in order of increasing complexity and cost. Which of these is most appropriate will depend on the local conditions, the funds available, and the probability of regular maintenance in the future.

Hand power

The first decision to make is whether to use hand power for raising water. Hand power is suitable for a supply where water is drawn straight from the source, such as a well, and the person drawing water operates the device. If water is to be pumped to a storage tank some other type of power will have to be used, such as wind, diesel, or electricity, unless an institutional framework (school, hospital, commune, etc.) exists to organize the work of pumping by hand.

The simplest method of raising water is a bucket of some kind on the end of a rope. It is best to use rollers (Figure 5.9), a windlass (Figure 5.8) or a shaduf (Figure 5.11) so that people do not have to lean over the well headwall to raise the bucket. If the shaduf is designed to balance with the empty bucket in the air, this will help to prevent the bucket from being put down on dirty ground.

However, these devices are not suitable for tube wells, or for very deep hand-dug wells, and for these a hand pump may be required. A hand pump also enables the water to be protected from pollution until it enters the user's bucket, but it cannot usually be made in the village, and may have to be imported. It also requires regular maintenance (Figures 5.12 and 5.13). Most hand pumps employ a piston with leather washers which moves up and down inside a cylinder, rather like a bicycle pump, and the washers must be regularly replaced. Simple hand pumps can be made locally from wood and plastic, but they tend to wear out quickly.

Hand pumps are of two kinds. Shallow-well pumps are cheaper and easier to maintain because the pumping mechanism is above ground level, but they can only work when the water level is less than 8 m deep. In deep-well pumps, the pumping mechanism is immersed in the water at the bottom of the well (Figure 5.12). The 'open cylinder' type of deep-well pump has a riser pipe larger than the cylinder, so that the piston can be pulled up for maintenance using the pump rod, without having to winch up the heavy riser pipe full of water. This makes maintenance by villagers much easier, as the leather washers may have to be replaced as often as four times a year.

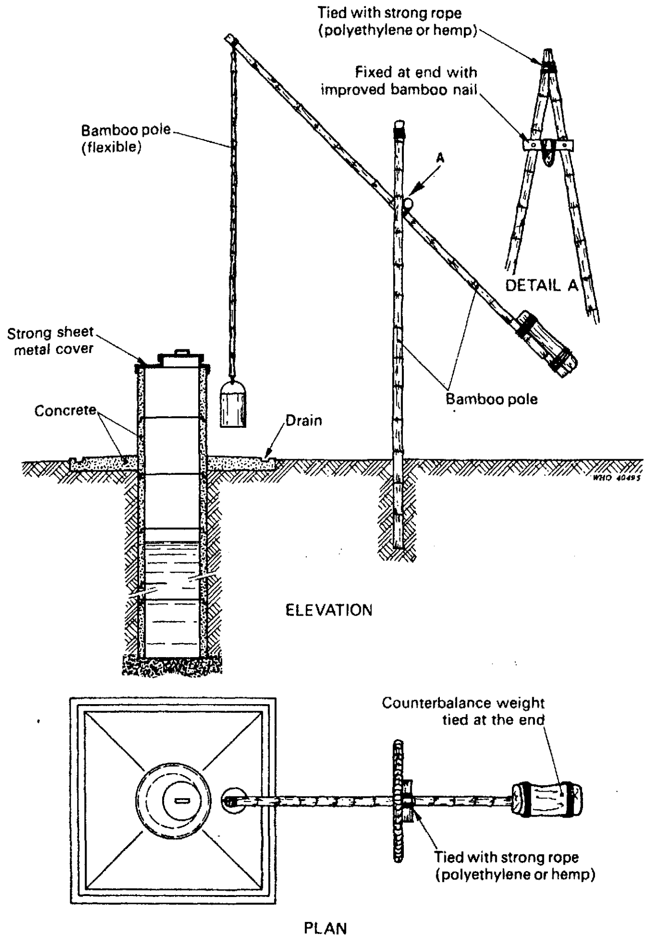


Figure 5.11 A shaduf used over a hand-dug well
Source: From Rajagopalan and Shiffman (1974)

When choosing a hand pump, the following criteria should be borne in mind:

(i) the pump should be as simple as possible and easy to repair;
(ii) the maintenance required must be easy to carry out and preferably not required too frequently;
(iii) manufacture should not present major quality control problems, and should preferably be undertaken in the country where the pump is to be installed;

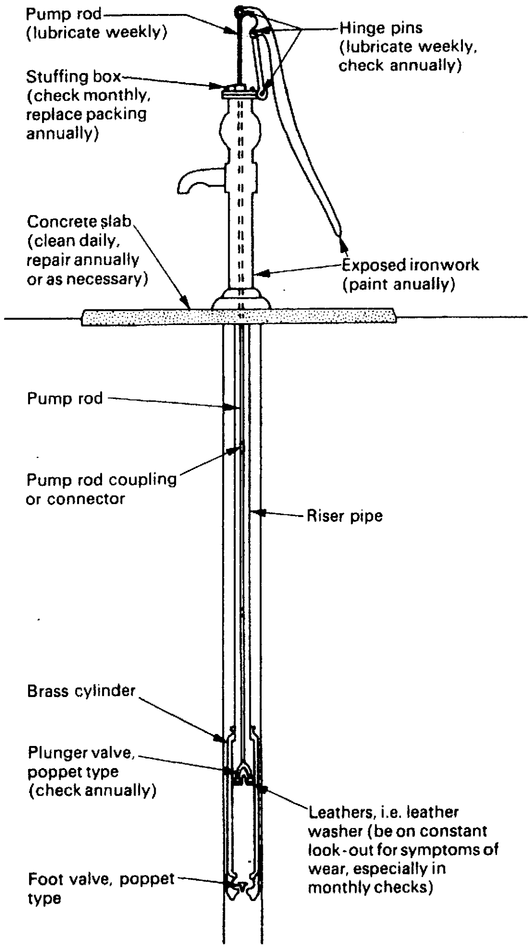


Figure 5.12 Maintenance points on a simple hand pump
Source: From Pacey (1977)

(iv) the pump must be reliable;
(v) the pump should be resistant to abuse, vandalism, and theft of parts;
(vi) the pump should be acceptable to users, easy to use, and produce water at a reasonable rate;
(vii) the pump should be suitable for the local hydrogeological conditions—depth of water table, corrosiveness of ground water, etc;
(viii) the pump should be accompanied by clearly illustrated installation and maintenance instructions and a basic tool kit;

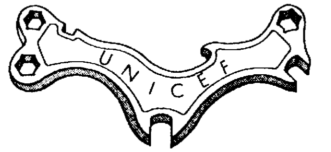


Figure 5.13 The UNICEF all-purpose hand-pump tool

(xi) the price should be as low as possible, consistent with the other criteria being satisfied.

Three brands of hand pump which meet some of these criteria are illustrated in Figures 5.14–16. A comprehensive guide to handpump selection is given by Arlosoroff *et al.* (1987), who developed the concept of Village Level Operation and Maintenance (VLOM).

Natural sources of power

Wind power may also be used for raising water, with the advantage that wind is free. However, a windmill is necessary to harness wind power, and windmills are usually rather expensive. A large and expensive storage tank is also necessary to ensure a reasonably reliable supply over windless periods. Even in a quite windy region, storage capacity for seven days' water may be required. Alternatively, a wind pump may be installed which is designed to be operated as a hand pump when there is no wind.

Two other types of pump, the hydraulic ram and the solar pump, use naturally occurring sources of energy. A hydraulic ram uses the energy of flow of a large volume of water, to pump a small proportion of that volume. It therefore requires a much larger flow of water of suitable quality than would be necessary for the community's needs alone. It also requires careful adjustment (Watt, 1975). Solar pumps are suitable for arid areas, they can pump as much as 10 l/s, but they involve sophisticated technology. Several have been installed, with mixed results, in rural areas of francophone West Africa and in Somalia.

Motor pumps

Pumps may also be driven by diesel or electric motors. Electric motors need less maintenance and are usually more reliable than diesel engines, so that they are preferable where electricity is available. Unfortunately, electricity supplies themselves are not always reliable in rural areas.

The simplest motorized well pump works like a hand pump, but a mechanism called a 'forcehead' is used at the top to turn the motor's rotation into the vertical motion necessary for pumping, which is

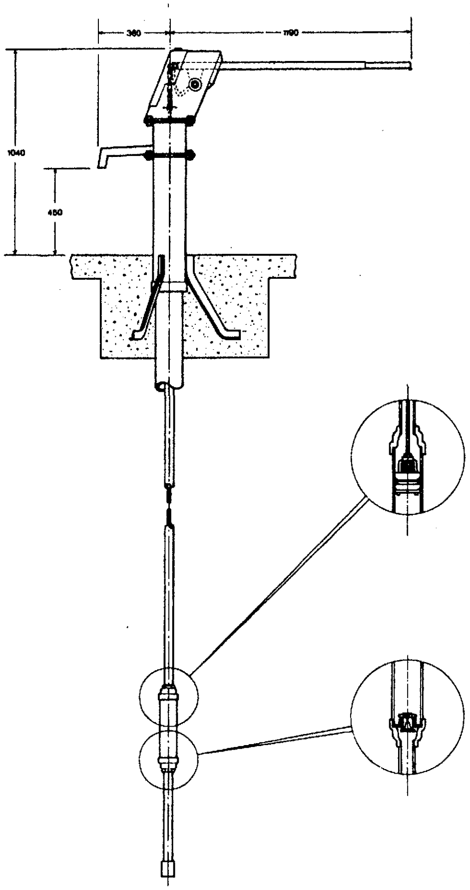


Figure 5.14 The India Mark II pump: a hand-operated deep-well lift pump. It is manufactured in several developing countries (dimensions are in millimetres)
(Photo and drawing: Consumers' Association)

transmitted down the well by a steel rod. In general, it is best to have the motor above the ground where it is accessible for maintenance but to keep the pump mechanism below the water level to avoid the need for 'priming'. Ejector or 'jet' pumps are particularly suitable for boreholes, as both motor and pump are above ground and there are no moving parts down the hole.

There are particular points to note when choosing pumps for village water supplies. Spare parts should be readily available; this can be helped by standardization on one or two basic designs. Motors should be simple to maintain, and be able to run with locally available lubricants and local fuel or electricity. The water pumped for a village water supply may be quite silty; if so, a pump should not be liable to wear out too quickly under these conditions. Finally, in view of the difficulty of assessing village demand, it will help if the pump cylinder or, on a centrifugal pump, the impeller, can be changed for a larger one if necessary.

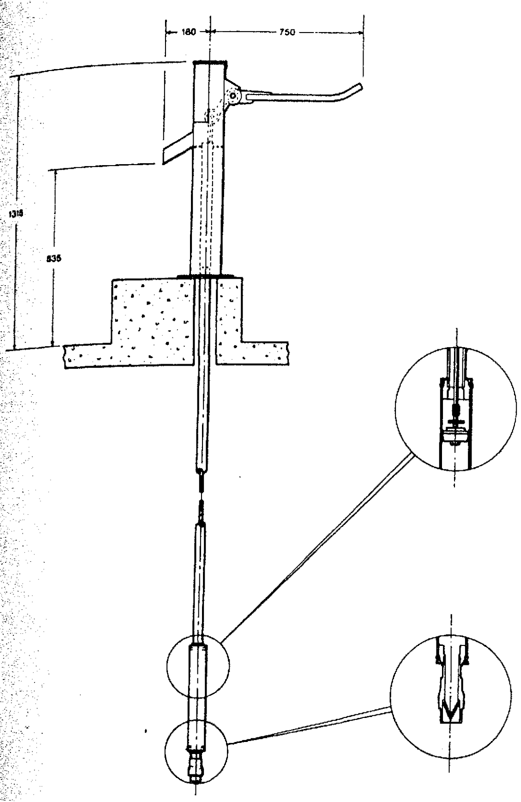


Figure 5.15 The Consallen LD5 pump: a hand-operated deep-well lift pump (dimensions are in millimetres)
(Photo and drawing: Consumers' Association)

5.4 STORAGE

When designing storage tanks for village water supplies, it is often tempting to use familiar materials such as reinforced concrete or

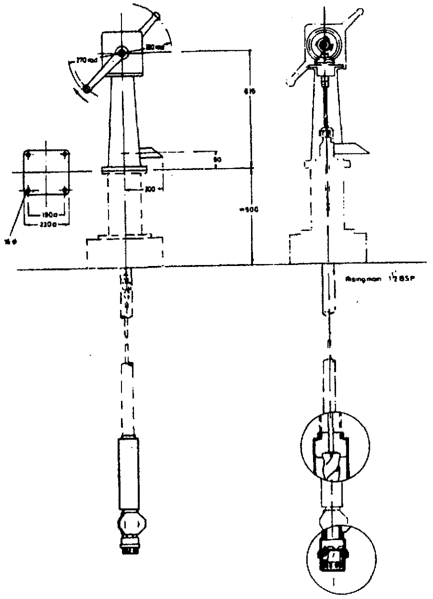


Figure 5.16 A Mono ES30 pump: a hand-operated, rotary helical-screw pump. It is several times more expensive than those shown in Figures 5.14 and 5.15 (dimensions are in millimetres) (Drawing: Consumers' Association. Photo: Mono Pumps Ltd.)

corrugated steel sheet, as these are easier to make reliably watertight. But a few small leaks in a tank above ground may not be serious in village circumstances, and perfectly adequate tanks may be built of local building materials such as brick or masonry, especially if galvanized wire is laid between courses to give the walls horizontal reinforcement. Watt (1978) describes simple methods for building water tanks by plastering cement mortar on to reinforcement of chicken mesh and steel wire (ferrocement).

Small earth dams, too, do not need to be of sophisticated design, being made with clay core walls and rip-rap, although certain basic safety requirements are of course necessary. A good account of small dam construction is given by Wagner and Lanoix (1959).

Care should be taken to prevent tanks and reservoirs from becoming breeding places for malaria mosquitos, especially in seasonally arid areas where malaria transmission decreases during the dry season. The creation of any permanent water surfaces accessible to mosquitoes may promote their breeding in the dry season, unless special precautions are taken. Storage tanks should therefore be covered, ventilation pipes screened with mosquito-proof mesh, and steps taken to avoid the creation of breeding sites downstream from the overflow. Ponds and dams may need special measures to prevent their banks becoming overgrown with weeds, for instance by paving them at water level (compare Figure 10.5).

5.5 TREATMENT

Unfortunately, there is no such thing as a simple and reliable water treatment process suitable for small community water supplies. Therefore it is preferable to choose a source of naturally pure water, and then to collect that water and protect it from pollution so that treatment is unnecessary. Treatment of village water supplies should only be considered if it can be afforded and reliably operated in the future.

Storage

The simplest method of treating water is to store it in a covered tank. Some treatment may be obtained by careful design of storage tanks to ensure a slow and even movement of water from the inlet to the outlet, as in a sedimentation tank. This will permit some silt to settle out, and allow time for some pathogens to die off. If water is stored for at least forty-eight hours, for instance, any schistosome cercariae in it will become non-infective before they leave the tank.

Sedimentation

For larger communities it may be useful to build a small sedimentation tank like that shown in Figure 5.17, although it will not usually be possible to arrange for coagulant chemicals to be added to the water to assist the sedimentation. Sedimentation does not remove many of the harmful organisms from polluted water, but it helps to clarify water for treatment by filtration or chlorination.

Filtration and chlorination

Filtration and chlorination are discussed in Chapter 6, as they are not usually suitable for village conditions. If filtration is unavoidable, it should be by slow sand filters.

One method of chlorination can be used in village wells. It involves a pot containing a mixture of coarse sand and bleaching powder, which is hung underwater in a well (see Figure 5.10). Figure 5.18 shows two types of pot chlorinator.

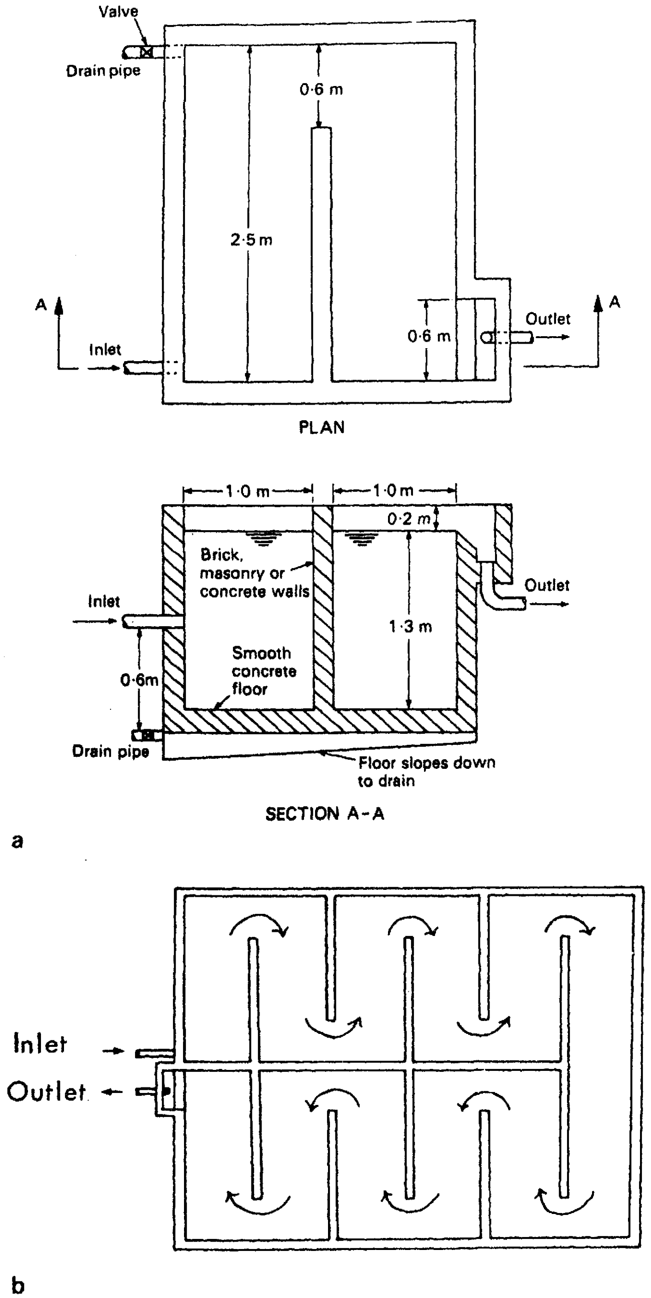
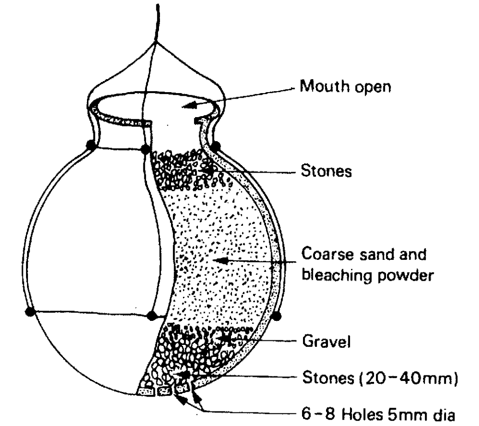
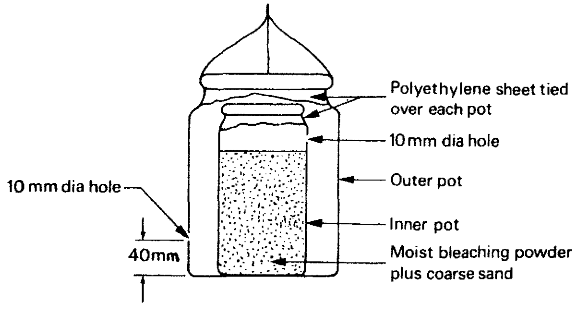


Figure 5.17 (a) A simple sedimentation tank for flows of up to 2000 l/h. (b) A method of combining six small sedimentation tanks to take a flow six times the capacity of each



(a) Single pot system



(b) Double pot system

Figure 5.18 Pot chlorinators for disinfecting wells. Two alternative designs

The double pot is suitable for a well serving up to twenty people, and needs to be refilled with 1 kg of bleach and 2 kg of sand every three weeks. The single pot will serve up to sixty people if it contains 50% more bleach and sand, but it requires replenishing every two weeks. The trouble with these pots is that they tend to make the water taste unpleasant for the first few days after refilling. There is no point at all in using a water disinfection process if it drives people to use water of worse quality, or if it is not reliably operated. Nevertheless, chlorination of a rural water source may be a worthwhile temporary measure during an epidemic which is suspected to be water-borne (Figure 5.19).

Figure 5.19 Emergency well chlorination in Burma (Photo: H Page, WHO)

Removal of minerals and salts

In a few areas, heavy concentrations of dissolved iron and manganese in the ground water can give it an unpleasant taste, and give a brownish colour to food and clothes. These chemicals can be a serious nuisance, and may even prevent people from using the water. If so, they can often be removed by aeration, for instance when the water falls into a storage tank from the inlet. Aeration causes the iron and manganese to become insoluble so that they form a fine dark sediment which is more easily removed.

Figure 5.20 shows a simple unit for the aeration of water, which will also remove the iron and manganese sediment produced. It is made of four cylinders, the top three of which each have a mesh or sieve in the base, and ventilation slots in the side. The top two have a layer of stones 150 mm deep, and the third has a 50 mm layer of small stones, covered with 300 mm of coarse sand. The unit stands on a solid brick or concrete platform. Water is sprayed over the stones at the top and is collected in the bottom cylinder, to be withdrawn through a tap at the bottom. The water is exposed to the air as it trickles down through the stones, and the sediment is deposited on the sand lower down. The sand requires replacement roughly once a month.

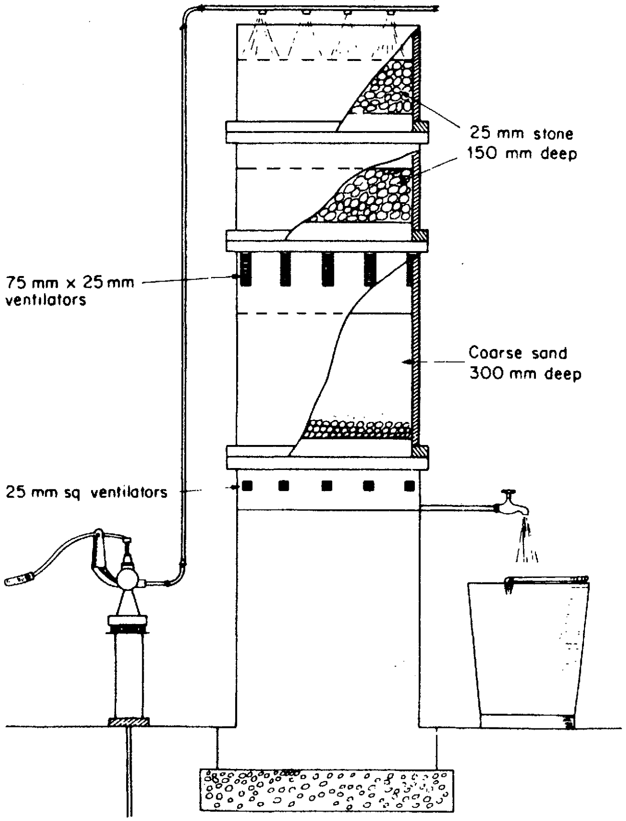


Figure 5.20 A hand-operated unit for iron and manganese removal
Source: From Pickford (1977)

Other chemicals in water, particularly salt, fluorides, and nitrates, are less easily removed under village conditions. The simplest fluoride-removal process, for example, requires the regular addition of alum (aluminium sulphate) to the water, and some kind of settling process. Alum is not always available, and since the fluoride is usually present only in imperceptible amounts the villagers are not strongly motivated to treat the water or aware if it has not been treated. When harmful or unpalatable chemicals are dissolved in the water, it is usually preferable to look for alternative sources of water. For instance, when ground water is salty in flat coastal areas, it is sometimes possible to find sweet water lower down, by sinking deep boreholes.

5.6 WATER DISTRIBUTION

Some aspects of pipeline design for rural water supplies are discussed in Section 5.1. In this section we discuss the design of rural water points.

Individual connections

Many of the potential health benefits from rural water supplies come from an increased use of water. There is therefore good reason for designing water points so as to encourage the maximum possible water use, particularly for hygiene. Ideally, water should be provided inside or near each house, as this usually leads to an increase by several times in the volume of water used, even if only a single tap is installed. The cost of a water supply with such individual connections depends on the density of village housing. It is possible to raise revenue from private subscribers, a thing very difficult to do with public water points.

Public water points

When individual connections cannot be afforded, the alternative is to provide public water points, also known as standpipes, from which the public may collect their water. In addition, showers, clothes-washing facilities, and possibly toilets may be constructed beside the water points and connected to the piped water supply. These would be provided on a communal basis, but if one shower and toilet cubicle is reserved for each family, this will help to encourage good maintenance by the users.

The best design for a public water point may depend upon traditional methods of carrying water. Where water is carried on the head, it may help if buckets can be stood on a platform at shoulder height to be filled (Figure 5.21). In that case, a lower tap should also be provided to allow clothes-washing under the tap and to permit water collection by children and old people. In designing a water point, provision should be made for the disposal of spilt water and waste water used for washing at the water point. Areas on which water will be spilt should be paved, preferably with concrete, and the waste water taken to a soakaway, such as a pit filled with stones and covered over with a layer of soil.

One serious problem is damage to water points through heavy use, or sometimes through vandalism. The most common component to break is the tap, and this should be as durable as possible. But it should not be too hard to operate; much 'vandalism' to rural water supplies is in fact the product of frustration. In any case, arrangements should be made for the regular inspection and maintenance of public water points, and for villagers to report faults they cannot repair themselves.

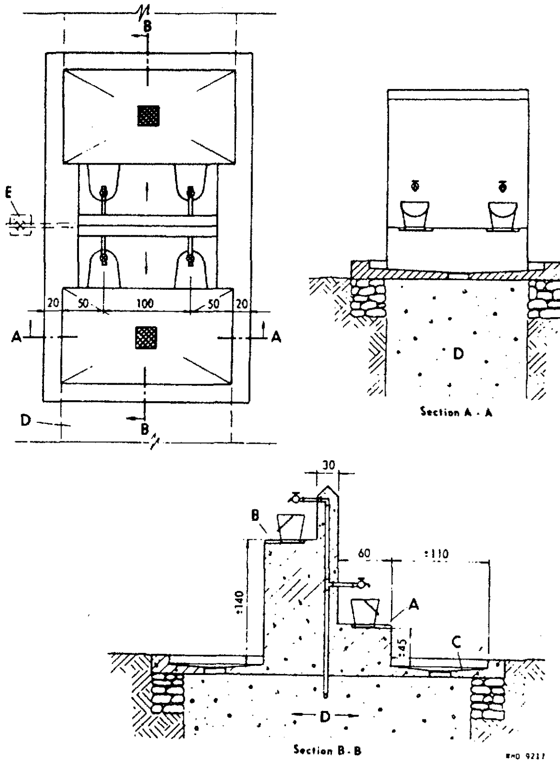


Figure 5.21 Possible design of a public water point (dimensions are in centimetres)
Source: From Wagner and Lanoix (1959)

Measures are in centimetres.
A = Platform level at about knee height
B = Platform level at about shoulder height
C = Hard-surface floor
D = Soakage pit : length may extend beyond limits of fountain
E = Control valve

5.7 REFERENCES AND FURTHER READING

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6

Urban Water Supply and Water Treatment

6.1 INTRODUCTION

Most of the technology suitable for urban water supply in developing countries is similar to that used in the developed countries, and is described in conventional textbooks on water supply such as Twort *et al.* (1985). However, by no means all of the systems used in Europe and North America are appropriate for conditions in the Third World. For example, some pumping and treatment plants could not cope with the very silty water of many tropical rivers. More importantly, some equipment is too difficult to operate, to maintain, and to repair due to difficulties of importing spare parts, shortage of trained staff, and a lack of sufficient continuity of staffing and record-keeping to ensure that the correct procedures are carried out throughout the life of the equipment. In general, therefore, the technology appropriate for urban water supply in developing countries must be chosen in such a way as to make it easily understandable by its operators, and easy to operate and repair without too much technical knowledge or need for imported materials.

Treatment is usually necessary for town water supplies. Sufficient water for a whole town is not always available from the ground, and so polluted surface sources often have to be used. The larger scale of a town water supply makes the quality of the water more important than for a small village supply. A single source of pollution in an urban supply could cause a water-borne epidemic in the whole town, so that the consequences of poor water quality are more serious. Treatment is of little use if it is only erratically applied, and yet it is a major problem to ensure continuous and reliable operation of water treatment works in many countries. Various possible methods are discussed below.