Surface water abstraction

Surface water supplies are those which use rivers, lakes or ponds as their source. Surface water often needs treatment before it is delivered to the user, as it may be contaminated by faecal and organic material and may carry a large silt load.

Surface water is often used for large urban water supply systems, as rivers and lakes can supply a large, regular volume of water. For small community supplies, other forms of water supply, such as wells or spring fed gravity systems, are generally preferred to surface water. This is because the cost of treatment and delivery of surface water is likely to be high, and operation and maintenance less reliable.

There are a number of ways of abstracting surface water. Water may have to be pumped or piped from the intake structure to a treatment plant or storage tank unless the intake is at a higher elevation than the plant or tank.

Rivers

In many countries rivers and streams have a wide seasonal variation in flow, and this affects water quality. In wet periods, water may carry a very high silt load. There is a high risk of faecal contamination in wet periods, particularly at the start, as faeces are washed into the river. As the flow increases, however, the wastewater will be diluted and the risk to health should decrease. In dry periods, the silt load will be lower but the dissolved solids much more concentrated.

River water can be drawn off either directly from the river or by tapping into sub-surface water near to rivers.

Abstraction of sub-surface water

The cheapest and, for small supplies, the most appropriate way to abstract river water is to sink a well near to the river to tap the sub-surface flow. This requires sufficient permeable material, such as gravel, between the river and the well site. It has the advantage that the water is filtered through the bank material and may not require further treatment. Wells of this type should usually be situated approximately 50 m from the river to ensure that the water has been well filtered.

The wells can be dug by hand, drilled, jetted or augered, and should be extended some way below the river bed to ensure a continuous supply of water. The top of the well should be above the flood level of the river and sealed to prevent surface floodwater from entering the well. A lifting mechanism, such as a handpump or rope and bucket, will be needed to take the water from the well. Figure 1 shows a river bank well.

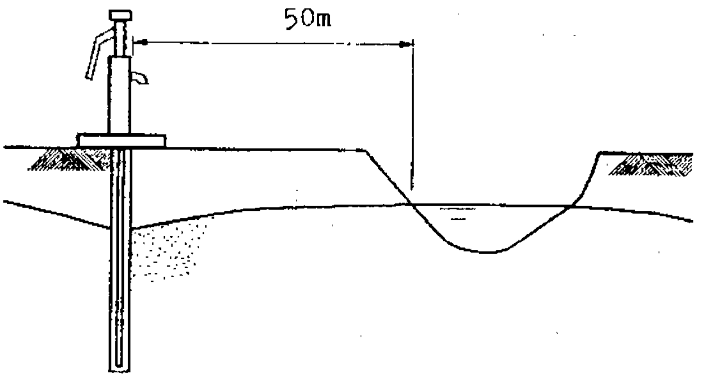

Figure 1. A river bank well

An alternative method of river water abstraction which also relies on the collection of sub-surface flow is the construction of infiltration galleries, (described in Fact Sheet 2.5).

An infiltration gallery is an open jointed or perforated drain pipe which is laid below the level of the river bed to collect water. An infiltration gallery can be constructed by digging a trench and laying a pipe alongside a river. The water flows along the drain into a collection chamber or sump, from which it is withdrawn by a pump or bucket, or pumped into a distribution network. The drain should be surrounded by gravel to increase the flow and prevent blockage of the pipe by fine material. This method is most appropriate in river beds of medium to coarse sand, where there is no sediment accumulation.

Direct abstraction of river water

In some areas, water is taken directly from a river into the water supply system. When mountain streams are tapped well above permanent human habitation, the water may only require filtration and terminal disinfection before it is used. When water is abstracted from rivers where there is permanent human habitation or activity upstream, the water must be treated before it is used. ***If this water is not treated it represents a major health risk to the users.***

Direct intakes from rivers require a minimum depth of water all year round to ensure a permanent water supply. A weir may have to be constructed downstream of the intake to ensure that a sufficient depth of water is available.

Where a river transports no boulders or rolling stones that would damage the intake, an unprotected intake may be adequate. An example is shown in Figure 2.

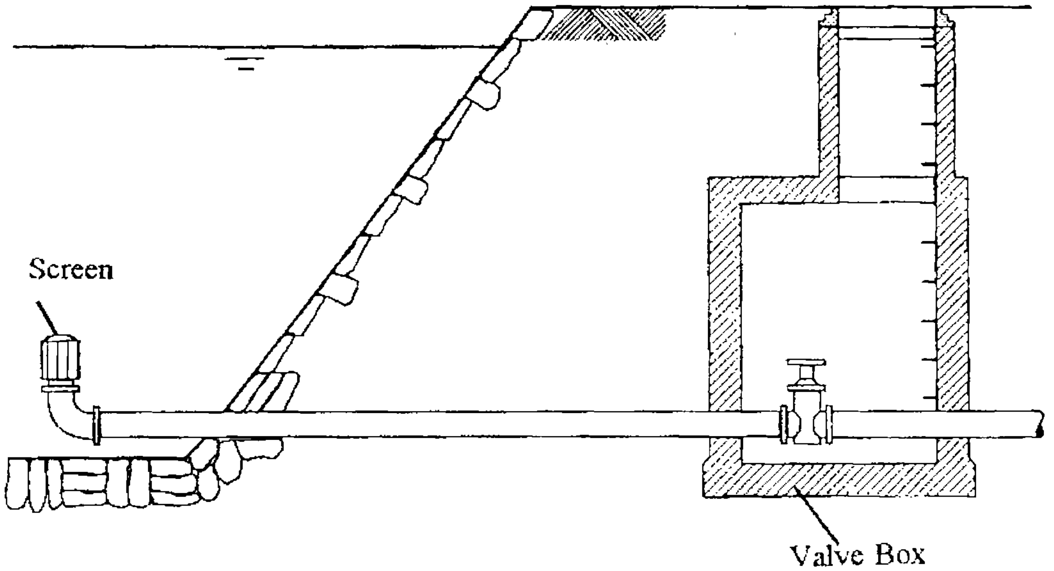

Figure 2. An unprotected river intake

Most rivers will, however, transport large material sometimes, even if only during occasional floods. It is therefore a good idea to provide some protection for the intake.

An intake may be protected as shown in Figure 3. In this case the water is abstracted through an intake built into the river bank. The intake is protected by wing walls extending from the bank and large stone pitching against floods and scour.

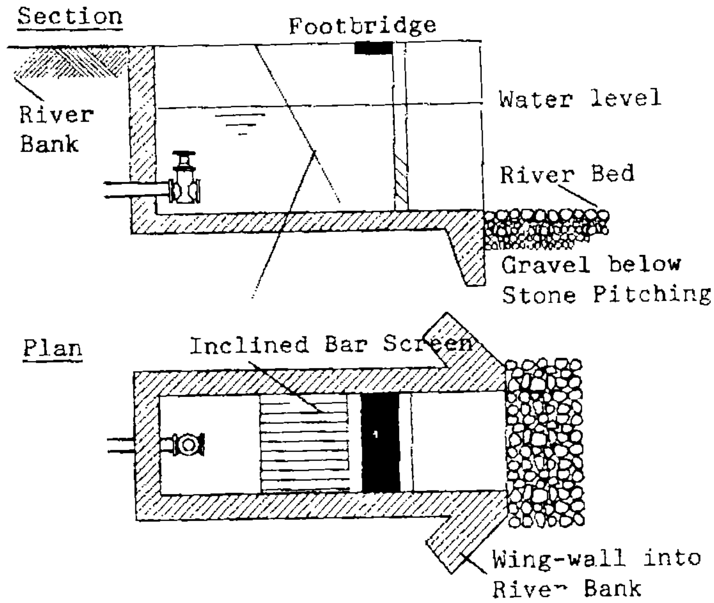

Figure 3. A protected river intake

Screens are used to prevent debris and large stones from entering the intake. The screen consists of a row of 25 mm bars inclined at 60 - 75 degrees to the horizontal and spaced about 100 mm apart. The bars are sized to ensure that the velocity of the water entering the intake is about 0.5 - 0.7 metres per second. Above this velocity, soft deformable material may be swept through the screen. The screen can be cleaned by hand or mechanically. Cleaning should be done regularly to ensure that an adequate flow is maintained.

Except in hilly areas where water can be transported from the intake by gravity, water will have to be pumped up to a storage tank or treatment works. This can be done by pumping directly from the river or using a pump at the start of the supply line. In deeper intakes, a sump can be used from which water is pumped, with an inlet pipe running through the river bank. This has the advantage of the sump acting as a silt trap, thus removing potentially damaging debris from reaching the treatment plant or the supply line.

Lakes

Water can be abstracted for drinking water supplies either from artificial (where there is a dam) or natural lakes. The quality of lake water varies widely. Human and animal faecal pollution is a major health hazard near the shore. In small lakes and ponds there is a high risk of faecal pollution, and if water from such a source is used it will require treatment.

In deep lakes, the intake should be set 3 - 5 metres below the surface, although in some cases this may need to be deeper - usually because of excessive algal growth on the lake surface, sometimes called an algal bloom. In shallow lakes, the intake should be sufficiently high above the lake floor to prevent the entrance of silt.

For small community water supplies, where the quantity of water needed is small, very simple intake structures can be used. If, for example, 30 litres of water per person per day is to be supplied and the peak intake is 4 times the average hourly water demand, 1000 people would require an intake capacity of 1.4 litres per second. A 150 mm diameter pipe would be sufficient to keep the entrance velocity in the pipe to 0.02 metres per second. If an entrance velocity of up to 0.12 metres per second is allowed, then a 60 mm diameter pipe can be used.

For small capacity intakes, simple arrangements using flexible pipe can be employed (see Figure 4).

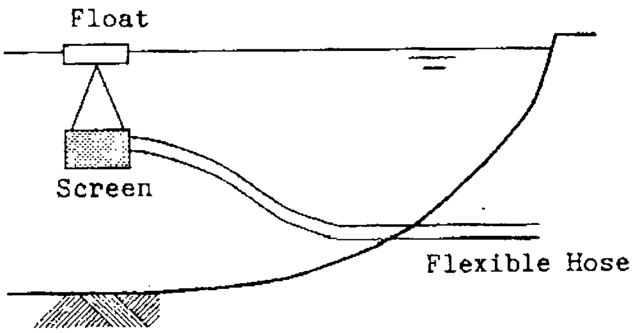

Figure 4. Simple water intake

Small dams

Dams are structures that are built across a river or stream to block the flow of water and create an artificial lake. Artifical lakes may be used as a source of drinking water. Ideally, the dam should be constructed upstream of any permanent human habitation or activity, to reduce the risk of contamination of the lake water. Generally, water from a dam and lake will require treatment, as for any other surface water source.

This Fact Sheet is only concerned with small dams of up to 6 m in height. Dams above this size require specialist construction techniques and experienced engineers to design them. In hot climates, the evaporation from the lake, or reservoir, will be very high ; in these circumstances, the dam should thus be at least 3 m high to provide a year round water supply. Small dams may be constructed from a number of materials, but are most commonly made from earth. Figure 5 shows a simple small earth dam.

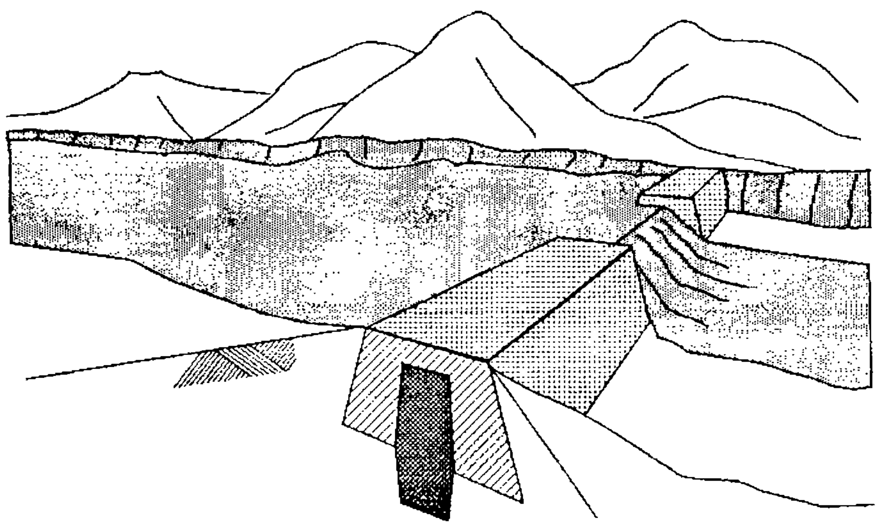

Figure 5. A simple small earth dam

The following points are essential to the design of a small earth dam :

- The dam must have a secure foundation to support the dam weight under all conditions.

- The dam should have an impermeable core of puddled clay, or concrete, to prevent water from seeping through it.

- The sides of the dam embankment should slope at an angle which will provide a stable structure. Commonly, a figure of 2 :1 (horizontal : vertical) is used for the upstream side and 1.5 :1 on the downstream side. The upstream side should bę covered with a stone pitching (sometimes called a " rip-rap ").

- The top, or crest, of the embankment must be at least 2 m wide. The crest of the dam should be at least 1 m above the maximum anticipated water level under extreme flood conditions. This safety margin is called the freeboard.

- The dam should have an overflow channel to divert excess water under flood conditions. Water must never be allowed to flow over the top of the dam, as this will erode the downstream side of the embankment and weaken the dam.

- The means of abstracting water should be as simple and accessible as possible. Usually water is abstracted just upstream of the dam using a pump. Outlet pipes may be built through the dam, but this is difficult to do successfully and there is always likely to be seepage along the outside of the pipes. Figure 6 shows a simple outlet arrangement.

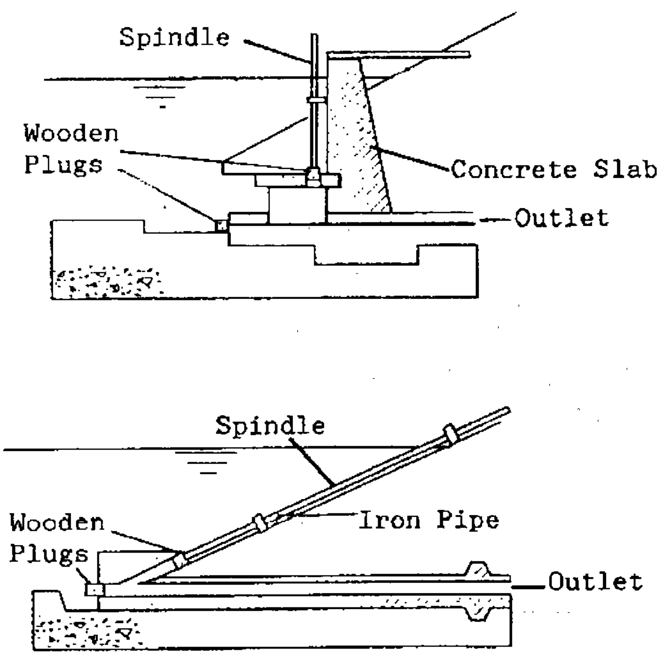

Figure 6. Outlet and drain

- Where the river water is used downstream, there should be an outlet for water to flow from the reservoir to the river bed downstream of the dam. This is called compensation flow. The amount of water discharged should be agreed upon by all the downstream communities which use the river.

Screens

Intakes from surface water often need a screen or a series of screens for two main purposes :

- Removal of floating and suspended matter of a size that might clog pipes, damage pumps or interfere with treatment processes.

- Clarification of water by removing suspended matter, even of small size. This is done to prevent clogging of any filtration systems and helps to make subsequent treatment more effective.

Bar screens normally consist of parallel steel bars spaced at 0.5 to 5 cm. The screens are angled at 60 - 75° for small material and 30 to 45° for large material. The screens can be cleaned manually or mechanically. Water flow to the screen should be low (0.1 to 0.2 metres per second). Once the water has passed the screen, it should have a velocity of at least 0.3 to 0.5 metres per second, to prevent any further settlement of suspended solids. The water flowing through the screen should flow no faster than 0.7 metres per second, otherwise soft deformable material can be forced through the screen.

Summary of maintenance tasks

Every storm

- Unless there is an automatic way of diverting the first flush of water away from the storage tank, disconnect the inflow pipe from the tank.
- Reconnect the pipe 15-20 minutes after the rain begins to fall.

Every week

- Check the water level in the storage tank using a stick (which should be kept in a clean place and not used for any other purpose).
- If water level falls faster than normal there may be a leak. Check the tank for wet areas and repair.

Every month

- Clear roof or other collection surface, pipes and gutters of bird droppings, leaves and other rubbish.

Every year

- Repair leaks (replaster the inside of the tank if leaks are hard to find).
- Check and repair roof and other collection surface, and all gutters and pipes.
- Check mosquito net and screen on tank, and replace or repair if damaged.
- Drain the tank and clean out any sediment from the bottom.
- If work has been done on the tank, for example repairs, disinfect the tank with chlorine solution (see Fact Sheet 2.26 for information about disinfection of tanks).