Water for the World

Constructing Intakes for Streams and Rivers
Technical Note No. RWS. 1.C.3

Several types of intakes can be constructed to give communities access to water from streams and rivers for their water supply needs. A well-designed and constructed intake provides a community with good quality water in abundant quantities and eliminates the chore of carrying water long distances.

This technical note discusses the construction of three basic intake systems for rivers and streams. The three systems are infiltration systems, gravity flow systems, and permanent direct pumping systems. Read this entire technical note before beginning construction.

Useful Definitions

ABUTMENT - A structure supporting a bridge or walkway.

CATWALK - A narrow walkway that passes over water or spaces that cannot be crossed by foot.

LEVER - A device consisting of a bar turning on a fixed point using force at a second point to lift a weight.

VOIDS - Open spaces in a material.

Materials Needed

Before construction begins, the project designer should give you the following items:

(1) A map of the area, including the location of the intake system and related items similar to Figure 1 which shows the location of an infiltration gallery.

(2) A list of all labor, materials and tools needed as shown in Tables 1, 2, or 3.

(3) A detailed plan of the intake system with all dimensions similar to Figure 10.

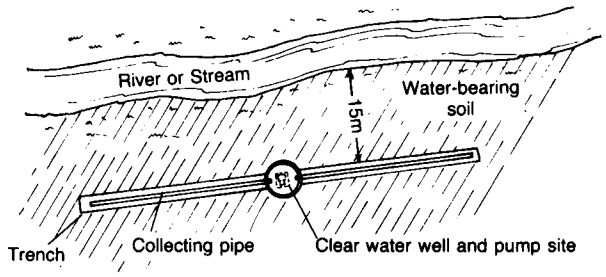

Figure 1. Location Map for Infiltration System

Table 1. Sample Materials List for Infiltration Systems

Item	Description	Quantity	Estimated Cost
Labor	Foreman Laborers	____ ____	____ ____
Supplies	Plastic (PVC) pipe, 50mm, or clay tile or concrete pipe, 10mm Hand or mechanical pump Sand and gravel (for filter beds) String Wooden stakes Sludge pump (if necessary)	____ ____ ____ ____ ____ ____	____ ____ ____ ____ ____ ____
Tools	Shovels, picks, digging sticks (for digging well) Small hand drill Hammer Nails Measuring tape Carpenter's level Measuring rod Bucket	____ ____ ____ ____ ____ ____ ____ ____	____ ____ ____ ____ ____ ____ ____ ____

(NOTE: For additional materials needed, see "Constructing Dug Wells," RWS.2.C.1)

Table 2. Sample Materials List for Gravity Flow System

Item	Description	Quantity	Estimated Cost
Labor	Foreman Laborers	____ ____	____ ____
Supplies	Portland cement Clean sand and gravel, if available, or locally available sand and gravel Water (enough to make a stiff mixture) Reinforcing rod, 8mm Lumber (for forms) Nails Rope and pulley Tripod Tie wire or clamp Wire mesh screen, 10mm Pipe, plastic or galvanized	____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____	____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____
Tools	Shovels, picks, digging sticks Measuring tape Wire cutters Hacksaw Hammer Bucket	____ ____ ____ ____ ____ ____	____ ____ ____ ____ ____ ____

Table 3. Sample Materials List for Permanent Direct Pumping System

Item	Description	Quantity	Estimated Cost
Labor	Foreman Laborers	____ ____	____ ____
Supplies	Bricks - seconds can be used for half bricks Portland cement Clean sand and gravel, if available, or locally available sand and gravel Water (enough to make a stiff mixture) Lumber (2.5cm x 15cm; 5cm x 150cm; 10cm x 10cm) Tripod Rope and pulley Barbed wire Log Mechanical pump Pipe and elbow joint (couplings) Wire mesh screen, 10mm Tie wire Clamp Nails Pipe glue	____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____	____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____
Tools	Shovels, picks, digging sticks	____	____

Infiltration Systems

The construction of infiltration system requires a great deal of physical labor and expertise. The construction of two types of infiltration systems is discussed in this section. These are (a) riverside wells and (b) infiltration galleries.

Before beginning construction, stake out the area where construction will take place with string and wooden sticks or stakes. Follow exactly the location map the project designer gives you.

Construction. Figure 2 shows a well with a hand pump built on a riverbank. Construction steps for this well do not differ from any other dug well although cave-ins are more likely due to the sandy soil found in stream banks. The construction steps to follow are available in "Constructing Dug Wells," RWS.2.C.1.

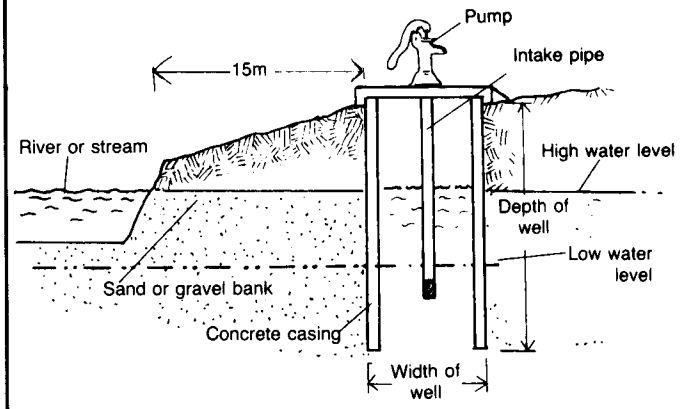

Figure 2. Riverside Well Intake

There are three basic construction components for infiltration galleries: the collecting pipes, the trenches, and the clear well.

1. Dig the clear well. For well construction guidelines, see "Constructing Dug Wells," RWS.2.C.1.

2. Dig the trenches for the collecting pipes. The best time to dig is during the dry season when the water table is low. Dig about 1m below the water table level to collect the maximum amount of water. Extend the trench through the water-bearing layers of soil until the layers end or sufficient quantities of water are being collected. Be sure not to dig deeper than the height of the workers. To avoid accidents from cave-ins, slant the trench walls.

Water will seep into the trenches during excavation. This water must be removed for work to continue. If the flow is slow, water can be bailed out of the trenches during construction.

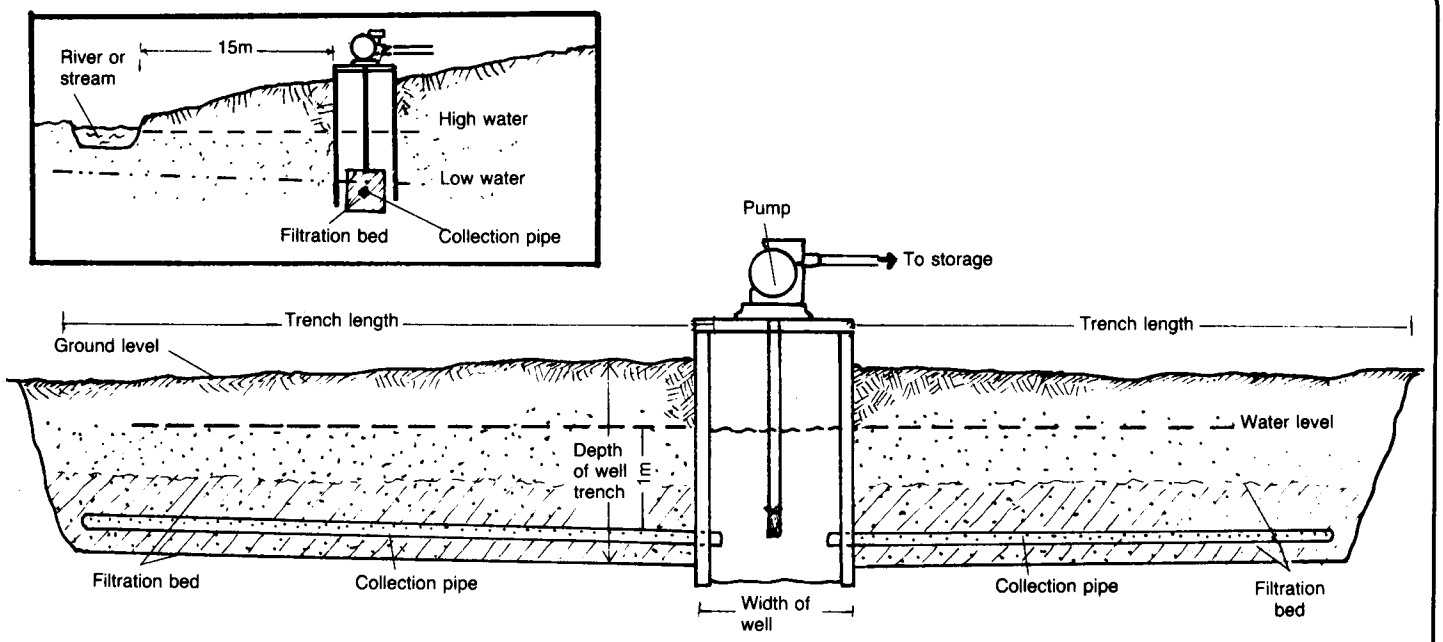

Figure 5. Riverside Infiltration Intake

guidelines. If the location is convenient and the community population using the well is 200 or less, a hand pump can be used.

Where construction of collecting trenches in stream banks is not possible, an alternative method can be used. An infiltration gallery as shown in Figure 6 can be constructed. If the stream flow is relatively slow and soil is not very sandy, a trench in the middle of the stream can easily be constructed by bailing. Generally, the stream should be diverted.

1. Build a small dam and diversion ditch and lead water away from the construction area.

2. Dig a collecting trench approximately 0.5-1.0m deep and line it as described for filter beds. Dig trenches from each end of the filter pipe to each bank. Lay the pipe as shown in the figure. All pipe should be laid so water will flow toward the clear well. The length of the collection pipe chosen depends on the amount of water needed. Several meters of pipe should be installed in the bed to ensure adequate flow.

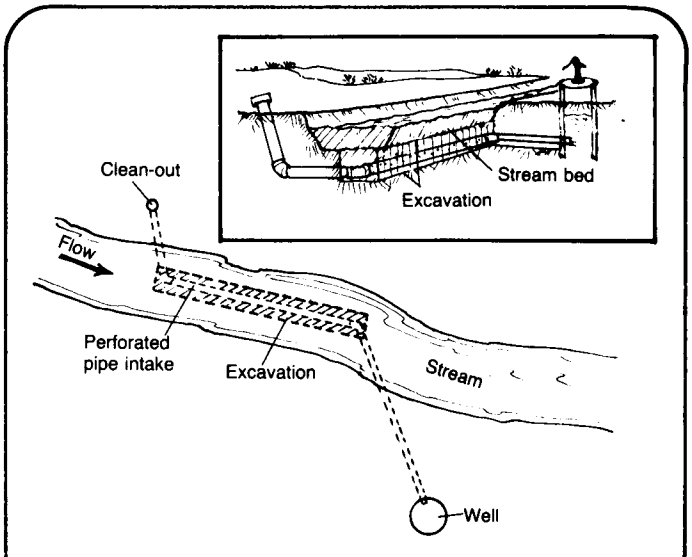

Figure 6. Infiltration System Below Stream Bed

3. On the shore opposite the clear well, install a vertical pipe connected to the main collection system. This pipe acts as the clean-out pipe and should be capped.

4. Connect the other pipe to the clear well. Install a valve in the pipe just above the well so that water flow can be stopped for any needed operation and maintenance.

If appropriate equipment is available an infiltration gallery with collection pipes driven into the stream bed can be constructed. See Figure 7. Follow the construction steps below.

1. Dig a clear well in the stream bank. Make the well about 1.5m in diameter to permit people to work inside.

2. Line the well with concrete rings or bricks and mortar as described in "Constructing Dug Wells," RWS.2.C.1. Leave a section unlined so that the pipes can be driven into the ground. If water enters the well quickly, drain the well using a motorized pump. The well should be kept as dry as possible for work to take place.

3. Lower the necessary tools and equipment into the well. In some cases, the pipe can be driven by han but generally a pneumatic hammer is necessary.

4. Begin to auger a hole into the side of the well. Once the hole has entered the side of the well about 0.5m, place the drive pipe in place.

5. Drive the pipe into the stream bed so that the pipes slope toward the well. If a sledge hammer can be used, the process should be simple. If a pneumatic hammer is used, brace it against the opposite wall for support and drive the pipes into the stream bed. To prevent destruction of the well casing, extra reinforcement shoul be added to the side of the well.

6. Drive in the number of pipes desired. If plastic pipe is more easily available than steel, drive in large diameter steel pipe. Once the driving process is complete, slide smaller diameter perforated plastic pipe into the steel pipe and slide the steel pipe out. For more specific information on the process of driving, see "Constructing Driven Wells," RWS.2.C.2.

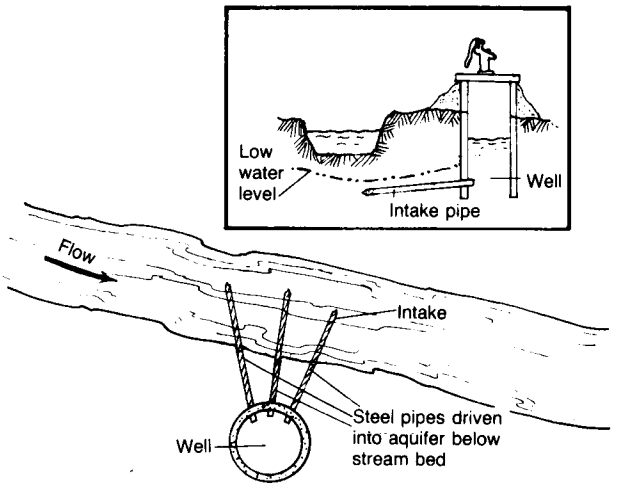

Figure 7. Multiple Pipe Infiltration System

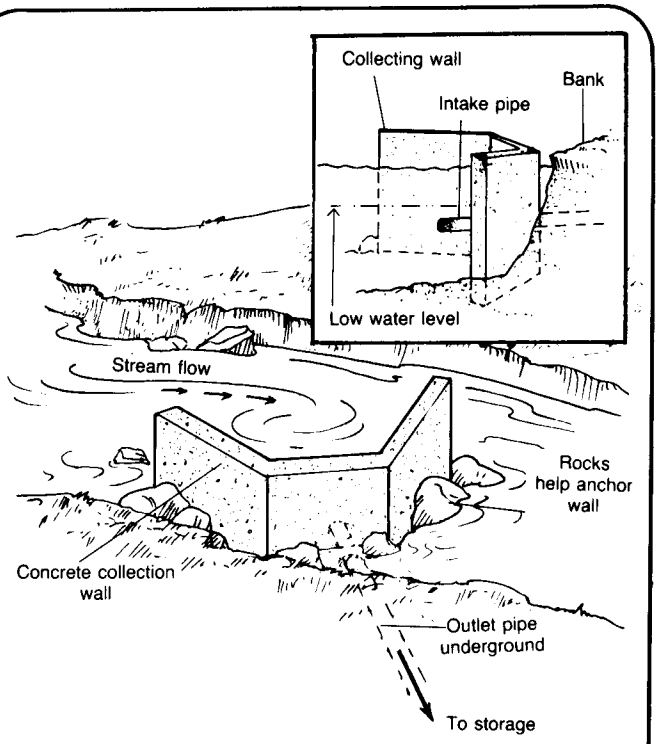

Figure 8. Gravity Flow Intake

4. Connect the other pipe to the clear well. Install a valve in the pipe just above the well so that water flow can be stopped for any needed operation and maintenance.

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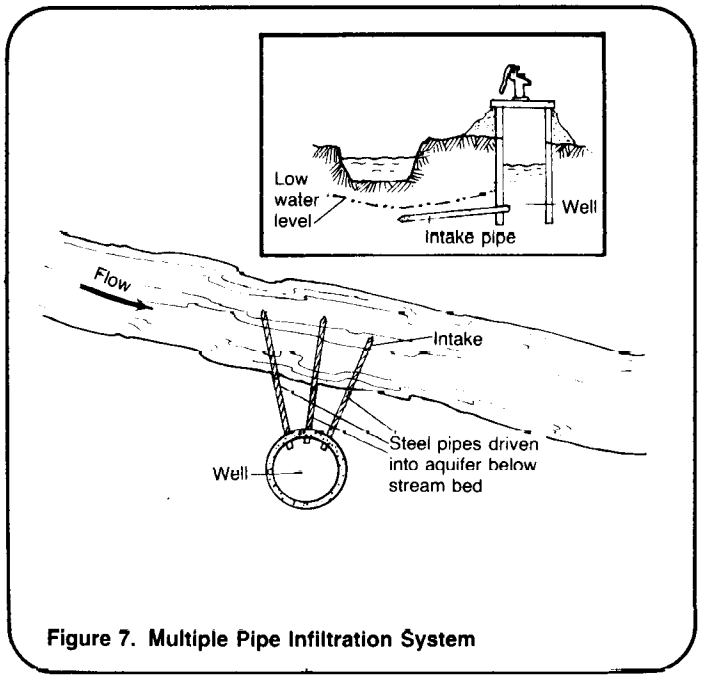

Figure 7. Multiple Pipe Infiltration System

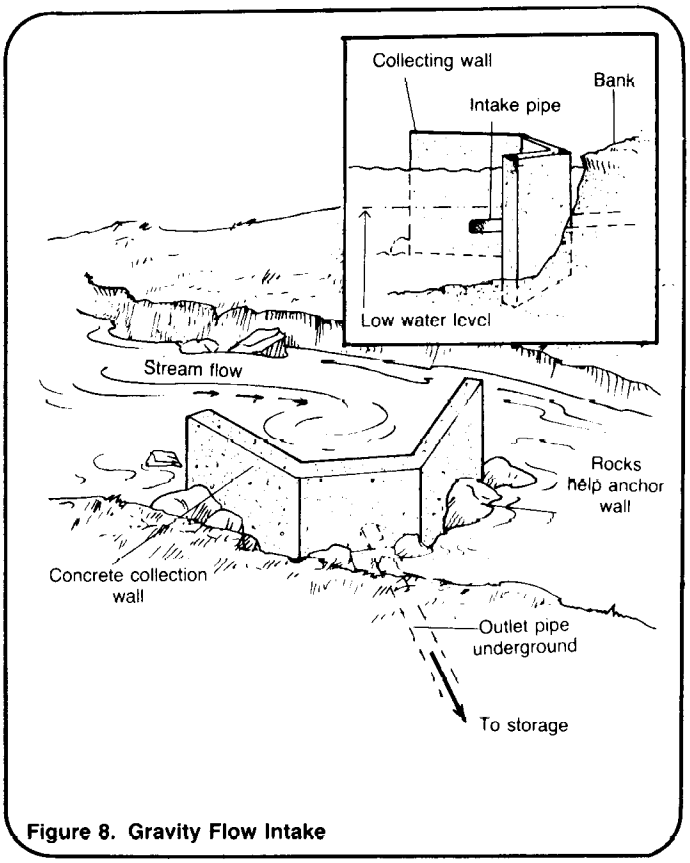

Figure 8. Gravity Flow Intake

Gravity Flow System

In mountains and hilly regions, water from streams and rivers can be collected as shown in Figure 8. This section outlines the construction steps to follow for a concrete intake with winged-walls.

Construction. Move all construction materials to the work site. The winged-wall intake should be built at the site, following exactly the location map and detailed drawings the project designer has given you. See Figures 9 and 10.

1. Build the forms for the structure. For strength, the thickness of the wall should be 15cm. Be sure to oil and brace all forms before pouring the concrete.

2. Cut a 50mm hole in the forms for the intake pipe. Place a small piece of steel pipe in position before pouring the cement.

3. Mix the concrete in a proportion of one part cement, two parts sand and three parts gravel. Add water to make a thick paste.

4. Place reinforcing rod in the forms as shown in Figure 11. The rod should be placed two-thirds the distance from the side receiving the weight of the water.

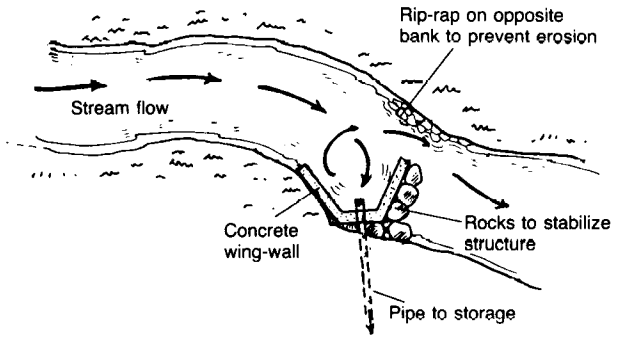

Figure 9. Location Map for Gravity Flow Intake

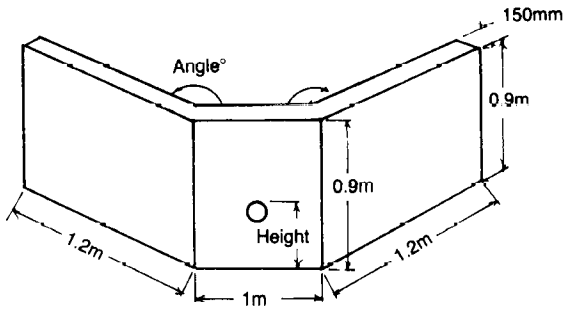

Figure 10. Design of Typical Wing-Wall Collector

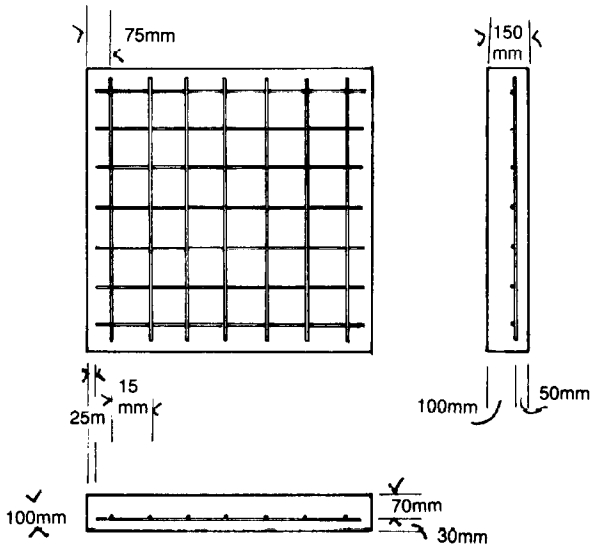

Figure 11. Placement of Rebar in Concrete Slab

5. Pour concrete into the forms making sure to tamp it down to fill any voids or air pockets. After pouring, smooth the top of the walls and cover with canvas, a plastic sheet, or straw to protect it. Wet the structures at least once a day for good curing. Curing produces strong concrete.

6. Allow the concrete to cure for seven days and then remove the forms.

Installation. The placement of the winged-wall structure must be done carefully. Because the structure is heavy, it is difficult to move. If it falls against the rocks in the stream it could break apart. Follow these basic steps when installing the structure.

1. Take out the pipe left in the structure to form the inlet hole and put in a new length of either galvanized or plastic pipe which can be attached to the distribution system. Seal around the pipe and wall with mortar. The pipe length should not be any longer than about 0.5m so that it does not interfere with the installation.

2. Place a piece of 10mm wire mesh over the intake pipe and clamp or tie it in place.

3. Determine where the pipe meets the bank and dig out a trench so that the pipe rests securely in the bank.

4. With logs or heavy duty metal poles, build a tripod on the bank of the stream. Bury a 0.30m length of each pole in the ground to make it secure. Tie the poles together with heavy rope.

5. Install a pulley at the top of the tripod. If the structure is very heavy, a double pulley or two pulleys may have to be installed.

6. Tie the rope around the structure to secure it well and to let it swing freely in the air. Place two or three men at the rope to lift the structure and two others to guide it into place in the stream. See Figure 12.

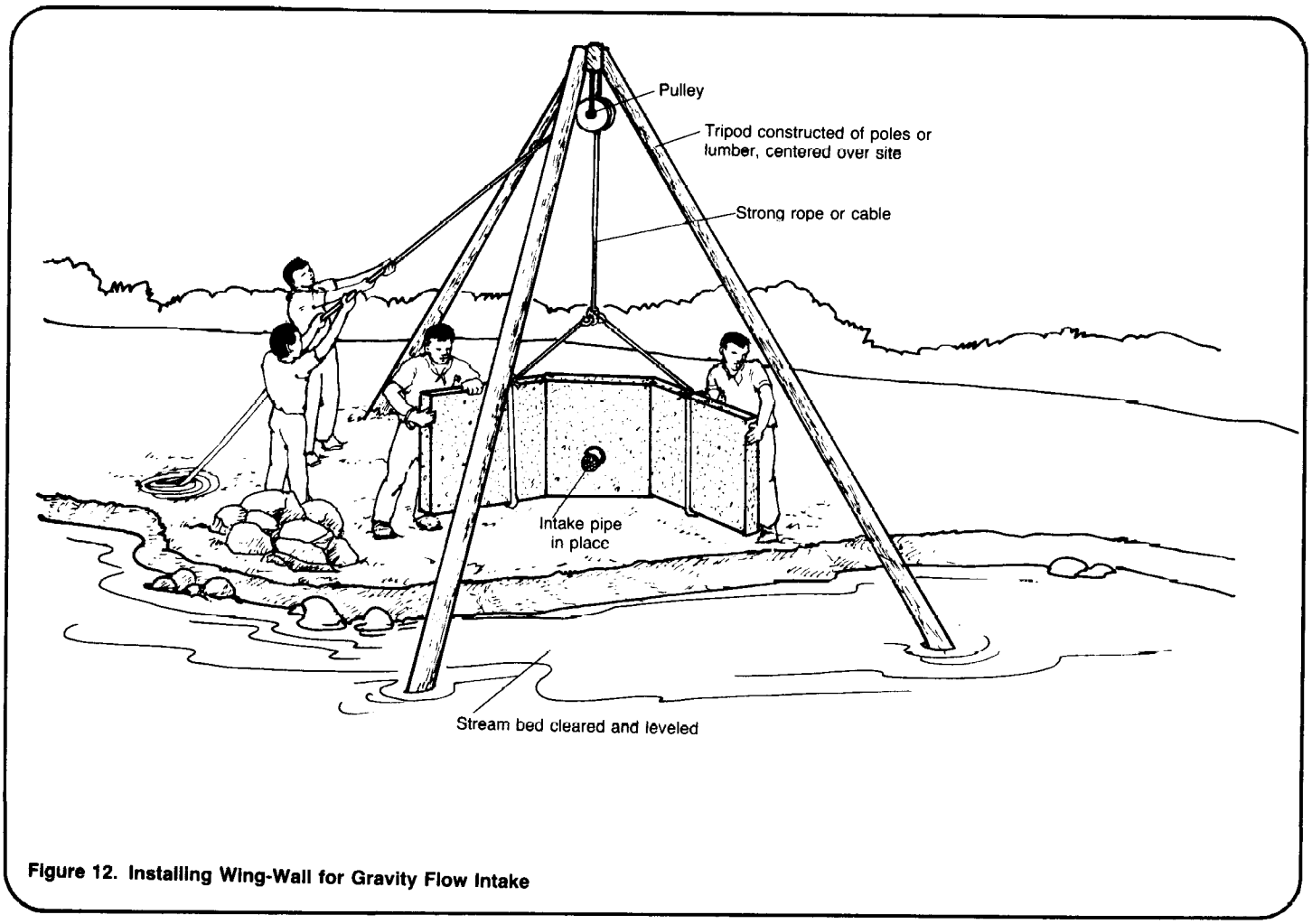

Figure 12. Installing Wing-Wall for Gravity Flow Intake

7. Before placing the structure in the stream, dig out about 10mm on the stream bed to place the structure. Flatten a spot on the shore where the front of the structure can fit tightly. It may be necessary to dig deep and add rip-rap if there is evidence of erosion.

8. Lower the structure into the stream so that the front is flat against the bank. Pile large rocks against the downstream side so that a fast flow does not wash it away. Be sure that the water completely covers the intake pipe.

9. Dig a trench to bury the outlet pipe. The trench should be at least 200mm deep to adequately secure the pipe.

10. Place rip-rap on the shore opposite the structure in order to prevent erosion of the bank.

If the concrete structure is large, it may be too heavy to easily lower into the stream. In such cases, and if the stream flow is not very strong, the forms can be built and the structure cast directly in the water. This technique should only be attempted by someone with a great deal of experience in working with concrete.

Permanent Direct Pumping System

This system is the most difficult to build and requires a construction team of skilled workers. Figure 13 shows an example of an intake for direct pumping. It is a well standing in the stream.

Select a firm area on a river bank about 2-3m from the stream and stake it out for a work area. The site should be in a straight stretch of the bank. Using the location map, find a firm, flat section of the stream or river bed where water is at least 1m deep during the dry season.

Also, stake out the pipeline trench and a foundation for the catwalk support on the river bank. Follow carefully the detailed drawings the project designer has given you.

Construction. Construct or purchase a reinforced concrete ring 1.5m in diameter and 1m in height. Concrete rings are more difficult to cast and it might be easier to buy a concrete ring. Rings, however, can be built using bricks and mortar.

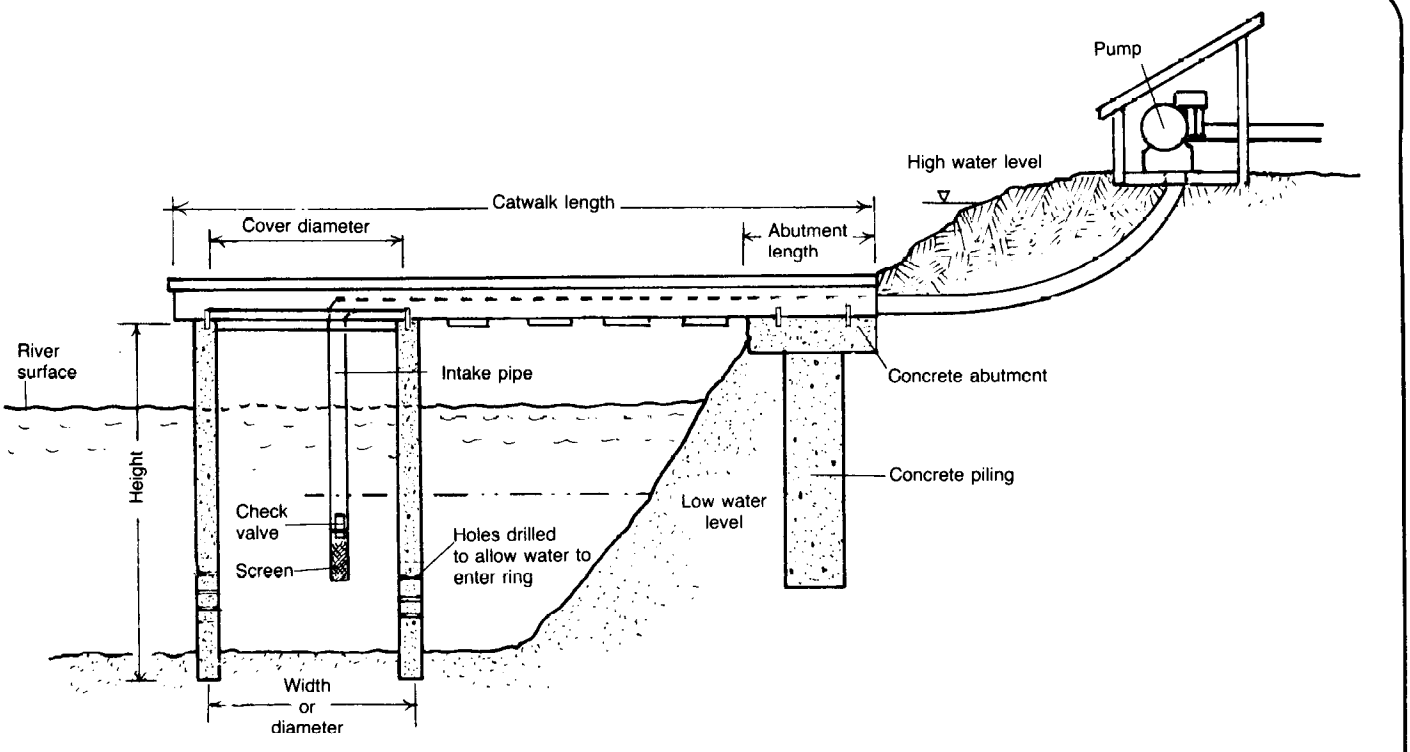

Figure 13. Direct Intake

To make a ring from half bricks and mortar follow these steps:

- Trace the diameter of the ring on the surface where the ring will be constructed.

- Lay the half-bricks around the outside diameter of the traced ring. Fill in the cracks with small loose gravel and mortar, mixed with four parts sand and one part cement.

- Build the ring to the desired height using normal brick-laying techniques.

- Wrap the finished ring with wire. Old barbed wire is useful.

- Cover the wire-wrapped ring with mortar and let it cure for 10 days before installation.

Place two bolts on the top edge of the concrete ring so that they face upwards. One bolt should be located on each side of the ring and should be at least 15cm long in order to anchor the catwalk. To permit the flow of water into the ring, place 5-7mm diameter holes around the side of the ring below the expected low water level. See Figure 14.

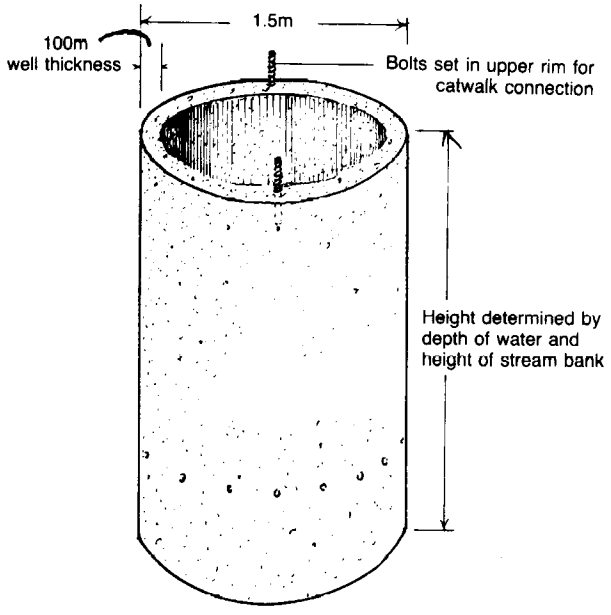

Figure 14. Concrete Ring for Protected Intake

Installation. The first step is the placement of the ring in the stream.

1. Build a skid to help lower the ring into the river. An example of a skid which can be used is shown in Figure 15.

2. Lay the skid on the bank and secure it on the stream bed. Then, place a log or other suitable bracing device on the skid and loop rope around each end.

3. Place the concrete ring on the skid as shown and lower it into the stream by sliding the log down the skid and guiding the ring.

4. To stand the ring upright, use tripod with a pulley placed in the stream bed. Tie a rope around the ring and lift it into place. A long strong piece of wood can be used as a lever to lift the ring. Place the lever inside the ring and with several workers lift it into place. It may be necessary to tie a rope to the top of the lever so that people standing on the bank can pull the ring into an upright position. See Figure 16. Be sure to dig down at least 0.5m to sink and anchor the ring. Level the ring in the stream bed by removing debris below it. The bolt in the ring must be in line at a right angle to the bank.

5. Once the ring is in place, dig the pipe trench in the bank. To support the catwalk build a concrete abutment attached to a concrete piling as shown in Figure 17.

6. Attach catwalk beams with attached lower planks to the top of the concrete ring and abutments by tightening nuts on the pre-placed bolts.

7. Lay the pipe into the trench and under the catwalk. Backfill the trench up to the last 0.60m of the connection to the pump as shown in Figure 18.

8. Connect a union joint to the end of the pipe so that a straight piece of pipe extends down from the catwalk into the water in the concrete ring. See Figure 19. Place a check valve at the end of the intake pipe. Be sure that the end of the pipe rests below the water level, but not close to the flow of the stream.

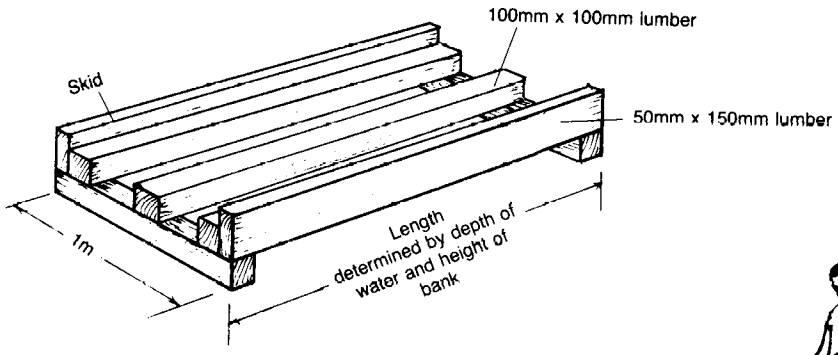

Figure 15a. Design of Skid

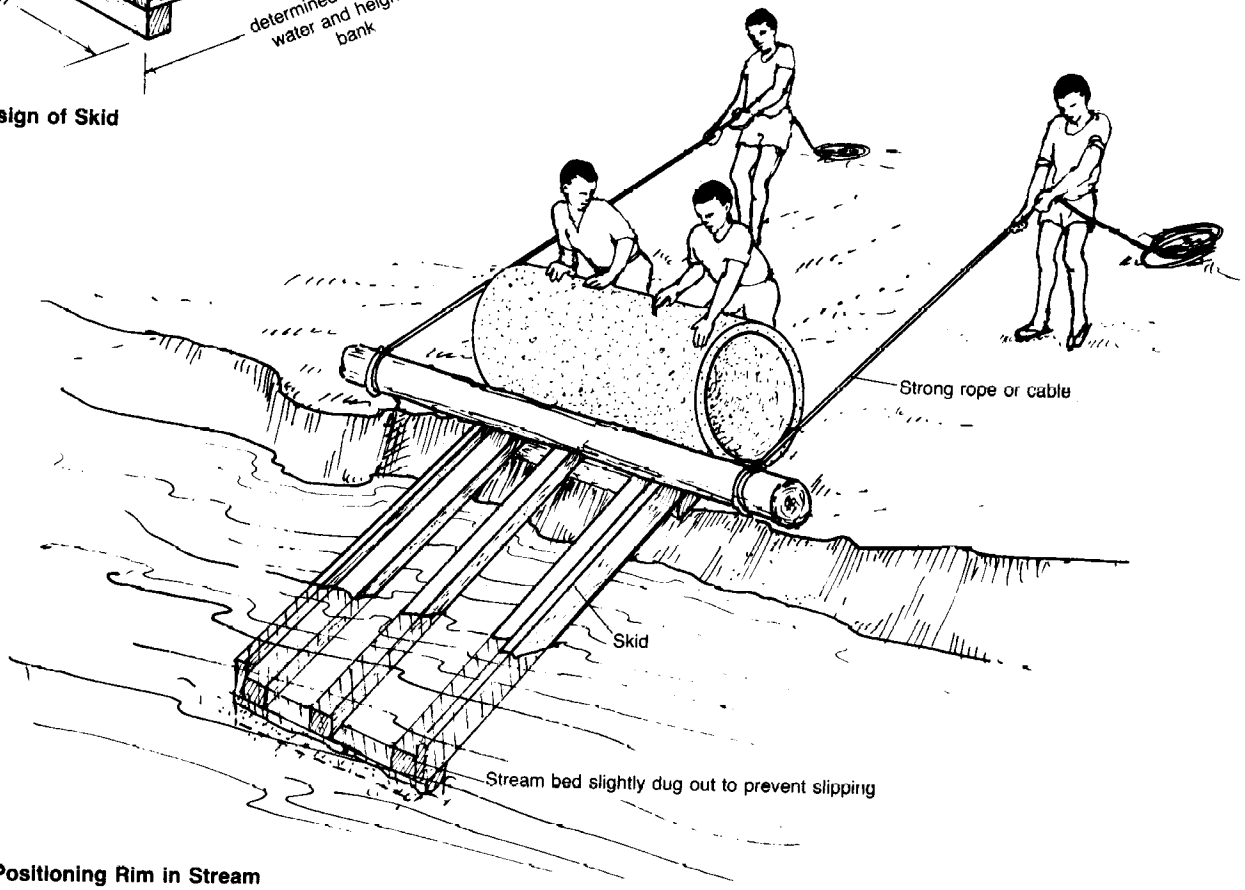

Figure 15b. Positioning Rim in Stream

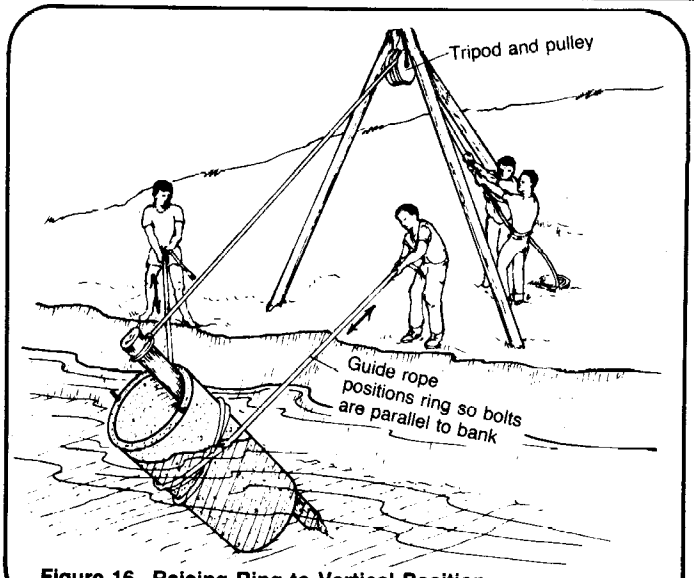

Figure 16. Raising Ring to Vertical Position

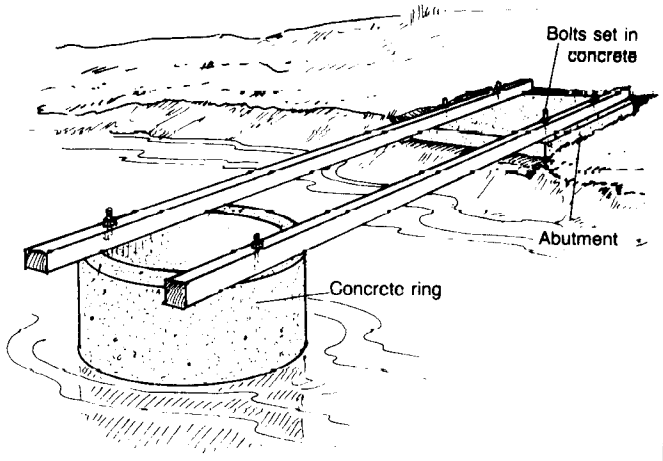

Figure 17. Catwalk and Abutment

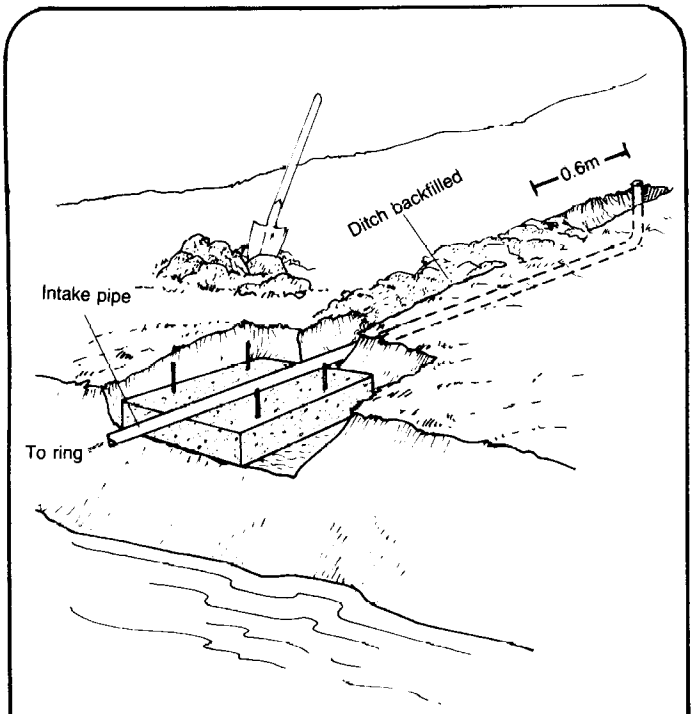

Figure 18. Installing Pipe

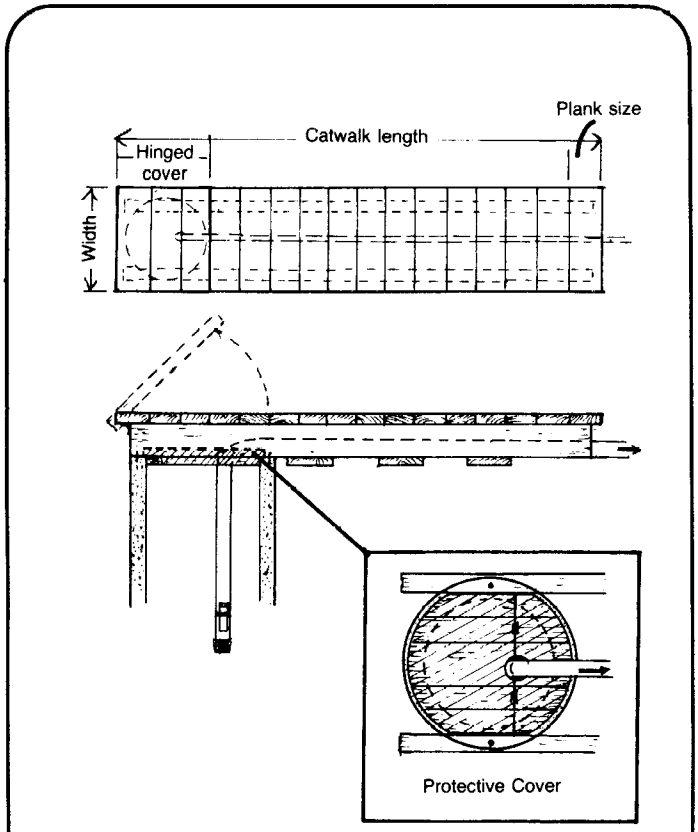

Figure 19. Catwalk and Cover Design

9. To complete the installation, attach the pipe to a mechanical pump as detailed in "Installing Mechanical Pumps," RWS.4.C.2.

Another simpler direct intake design is shown in Figure 20. To construct this intake follow these steps:

1. First, build forms for the intake base. A square base 0.6m x 0.6m should be large and heavy enough. The height should be sufficient to enclose a length of pipe to which the vertical intake can be attached.

2. Place a length of steel pipe in the forms. Make sure that the pipe is in place and that the forms are oiled and braced before pouring the cement. Mix and pour the cement and allow it to cure for at least seven days.

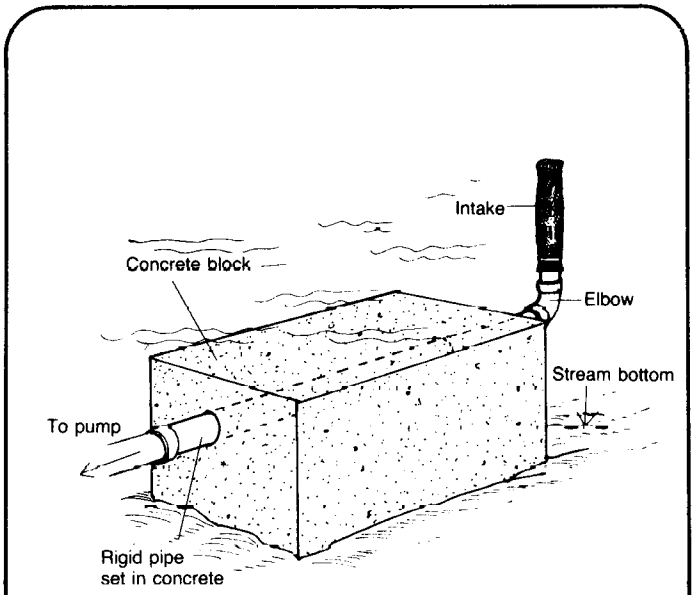

Figure 20. Rigid Pipe Intake

- Once the cement is dry, the intake can be installed. Attach an elbow joint and a length of screened vertical pipe to one end of the base. Attach the pipe leading to the pump to the other.

- Lower the intake into the stream. Mark its location by attaching ropes with floats to its base. The intake can be lifted from the water for maintenance by these ropes.