

Water for the World



Constructing an Elevated Storage Tank Technical Note No. RWS. 5.C.3

Elevated storage tanks provide storage capacity for community water systems where water is distributed to the users through hand pumps or distribution pipes. A storage tank provides both needed storage capacity and sufficient head to deliver water to all parts of the distribution system.

This technical note discusses various construction procedures that can be followed for constructing elevated storage tanks of different capacities. Construction of most tanks requires a certain amount of expertise and should be overseen by an engineer or someone with a great deal of construction experience.

Useful Definitions

HEAD - Difference in water level between the inflow and outflow ends of a water system.

SLURRY - A watery mixture of cement used on the outside of tanks as a finish.

Materials Needed

Before construction begins, the project designer should provide the following items:

1. A map of the area including the location of the storage facilities and the distribution system. The map should include all water points and distribution lines. All elevations should be marked. Figure 1 is a sample location map.

2. A list of all labor, materials and tools needed similar to the sample shown in Table 1. Ensure that all needed materials are available and can be at the work site before work begins. Make sure that adequate quantities of materials are available to prevent construction delays.

3. A plan of the storage tank showing all dimensions. Figure 2 shows an example of a small capacity elevated storage tank with standpipes distribution.

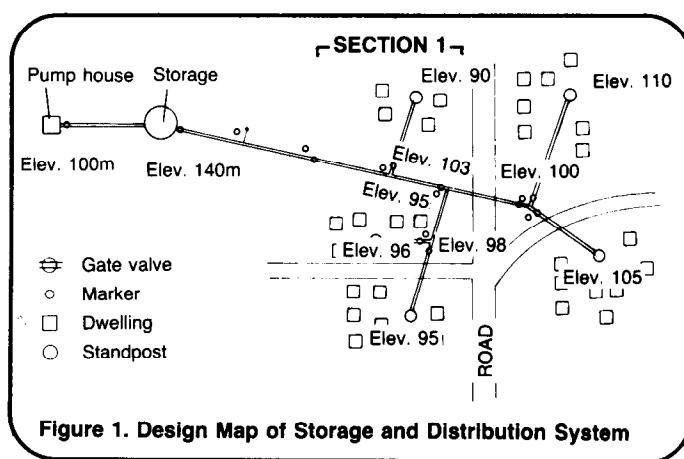
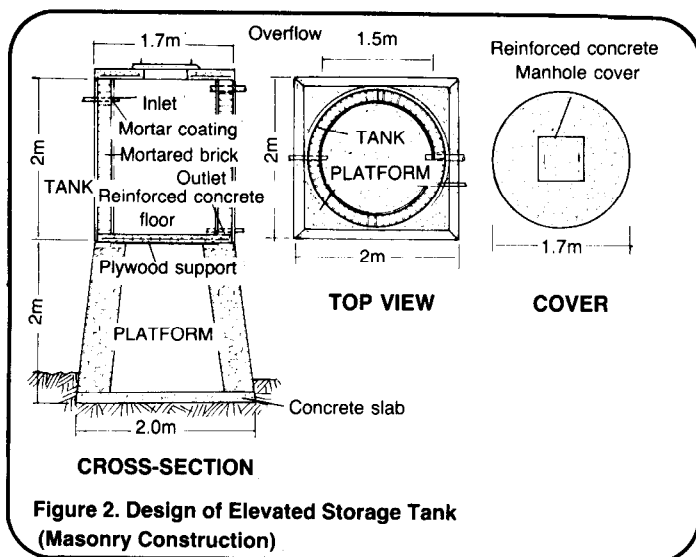


Table 1. Sample Materials List for Elevated Ferrocement Storage Tanks

| Item | Description | Quantity | Estimated Cost |
|-----------|---|----------|----------------|
| Labor | 1 Foreman 6-10 Workers | _____ | _____ |
| Supplies | Cement | _____ | _____ |
| | Weld mesh 0.15m, 5mm diameter, 4m x 2m sheets | _____ | _____ |
| | Woven mesh 0.2m openings, 30m long, 1m high | _____ | _____ |
| | Sand | _____ | _____ |
| | Gravel | _____ | _____ |
| | Timber and plywood for roof | _____ | _____ |
| | Bricks | _____ | _____ |
| | Lime | _____ | _____ |
| | Pipe, PVC or steel for inlet and outlet | _____ | _____ |
| | Wire screening | _____ | _____ |
| | Valves | _____ | _____ |
| | Nails | _____ | _____ |
| Pipe glue | _____ | _____ | |
| Tools | Shovels | _____ | _____ |
| | Pliers | _____ | _____ |
| | Wire cutters | _____ | _____ |
| | Wrenches, adjustable and open | _____ | _____ |
| | Mortar box | _____ | _____ |
| | Hoes | _____ | _____ |
| | Hack saw | _____ | _____ |
| | Hammer | _____ | _____ |
| | Screwdriver | _____ | _____ |
| | Measuring tape | _____ | _____ |
| Plumb bob | _____ | _____ | |

Total Estimated Cost *



3. Mix concrete in a 1:3 proportion; that is, one part cement by volume to one part sand. Begin laying the brick by usual methods of brick work. Make sure each row is plumb and level. Vertical joints should not line up from one course to that above.

4. Build the platform to the desired height. Scaffolding of some type will be needed to reach the upper platform and to build the tank at the top. Scaffolding can be made of wood or other available materials.

Platform Construction

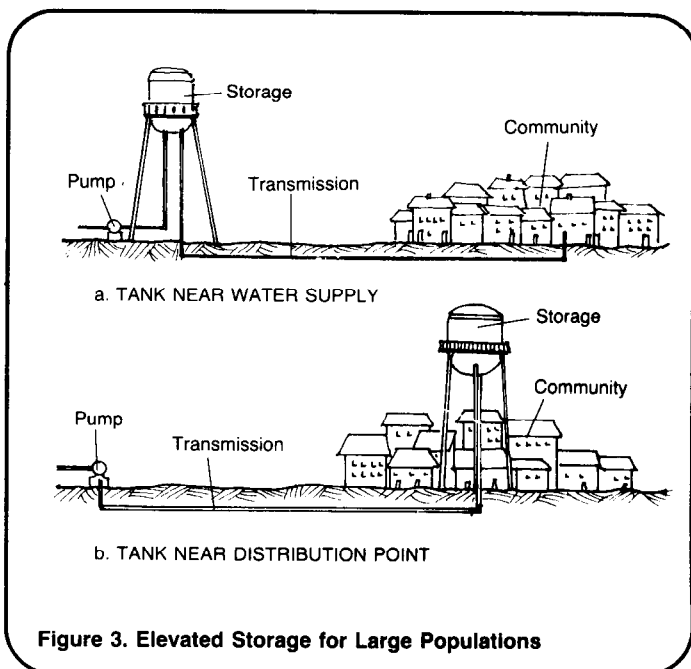
In very small communities, a single elevated storage tank may be sufficient, whereas in more heavily populated areas or those with widely dispersed populations, several tanks may be needed. Alternate tank locations are shown in Figure 3.

There are several types of tanks and support structures. If steel tanks and platforms are used, assembly of the structure is all that is necessary. Instruction for assembly should be provided by the manufacturer.

Supporting platforms can be made from wood, brick, reinforced concrete, or masonry. All platforms must be well constructed to withstand the weight of the tank when full of water. The following section discusses the construction of a brick platform built to support a circular masonry tank of 1.5m diameter.

1. First dig out an area in the ground the diameter of the base. Dig down approximately 0.2-0.4m. Lay a base of concrete and bricks.

2. Begin building up the walls. If wide bricks are available, the walls can be built to a one brick thickness, otherwise a two brick thickness is recommended.



Small Tank Construction

A brick masonry tank is constructed as a continuation of the platform. Lay the bricks in a circular pattern. Place both mortar and some small gravel in the spaces between the cracks to ensure a good bond. Lay the bricks in the tank until a height of approximately 2m is reached.

1. Leave an opening in the bricks for an intake pipe and outflow pipe near the uppermost part of the tank. The outlet pipe is placed at the base of the tank as shown. It should be screened so that sediment is filtered out. Make sure to seal around the pipe with a thick mortar paste.

2. Prepare a cover for the tank. A reinforced cover should be made using scrap wire, cement and sand. Mark out a circle on the ground which represents the size of the cover and place bricks around the outside as shown in Figure 4. Place bricks or wood in a square pattern near the middle to construct an access hole for tank maintenance. Lay down paper or plastic on the ground to prevent the cement from sticking. Pour in the 1:3 mixture to cover the bottom, placing scrap strips of wire in the mold as shown. Finally finish the cover by pouring in the concrete. Let it cure for 10 days. Sprinkle water on the cover during the curing process to prevent the formation of cracks, and to allow the cover to gain strength.

3. When construction of the tank is complete, prepare a mixture of mortar. Mortar should be used to line both the inside and outside of the water tank to make it watertight. The layer of mortar should be about 150mm thick to prevent leaking.

4. When the tank is finished, the pipes should be connected to the water source. In some cases, the inlet will be connected to the gravity-fed pipeline from a spring or other source. In other cases, the connection will be to a pump installed in a community well. Figure 5 shows a completed system with a windmill pump and brick masonry storage tank. Several standpipes can be serviced from a single storage tank if there is sufficient capacity.

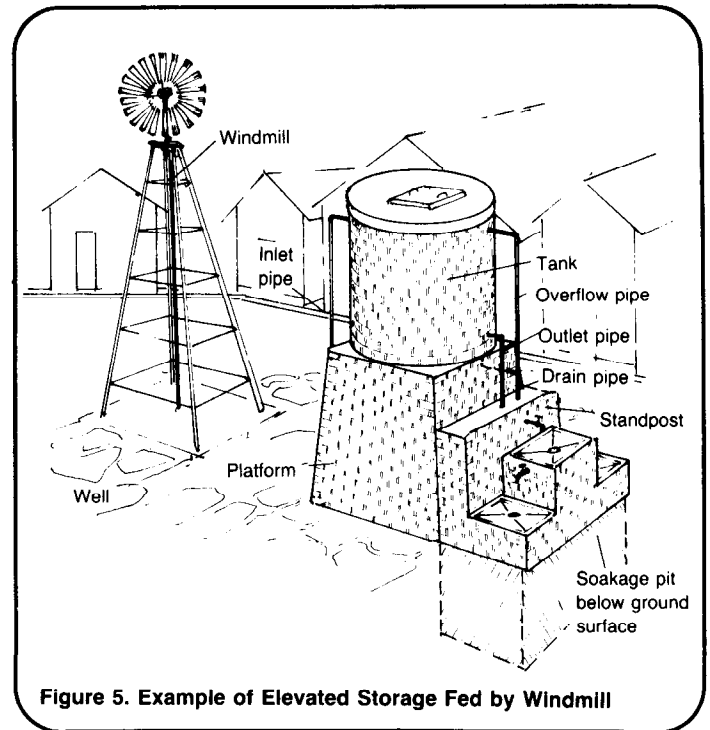


Figure 5. Example of Elevated Storage Fed by Windmill

Storage tanks can be made of rock masonry or ferrocement. Ferrocement requires the use of bricks and wire mesh reinforcement. A weld mesh frame and chicken wire to form and support the walls are used.

1. Build the ferrocement tank by building up from the platform with bricks and wire as shown in Figure 6. Add the weld mesh for walls and add the chicken wire to it. Chicken wire should be placed both inside and outside of the wire mesh. Be sure to leave places for the appropriate piping before applying the mortar.

2. Mix cement in a 1:3 mixture. Apply the prepared mortar to the walls being sure to line both the inside and the outside of the frame.

3. Build up a roof structure of weld mesh and chicken wire. Pieces of plywood shuttering should be propped up from the bottom to support the roof structure. The mortar can then be applied to the roof structure to complete the construction of the tank.

After the tank dries, apply a coat of cement slurry, 1 part cement to 2 parts sand. This mixture is applied to the tank to finish the construction. The slurry ensures that the tank is watertight.

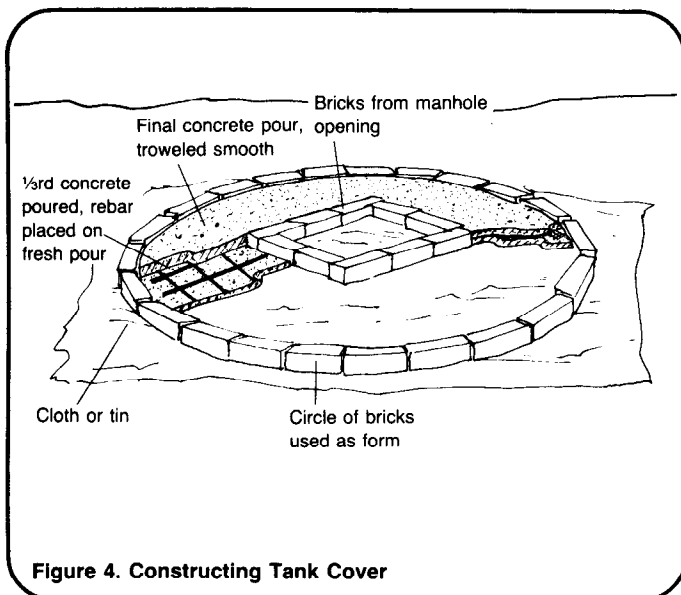


Figure 4. Constructing Tank Cover

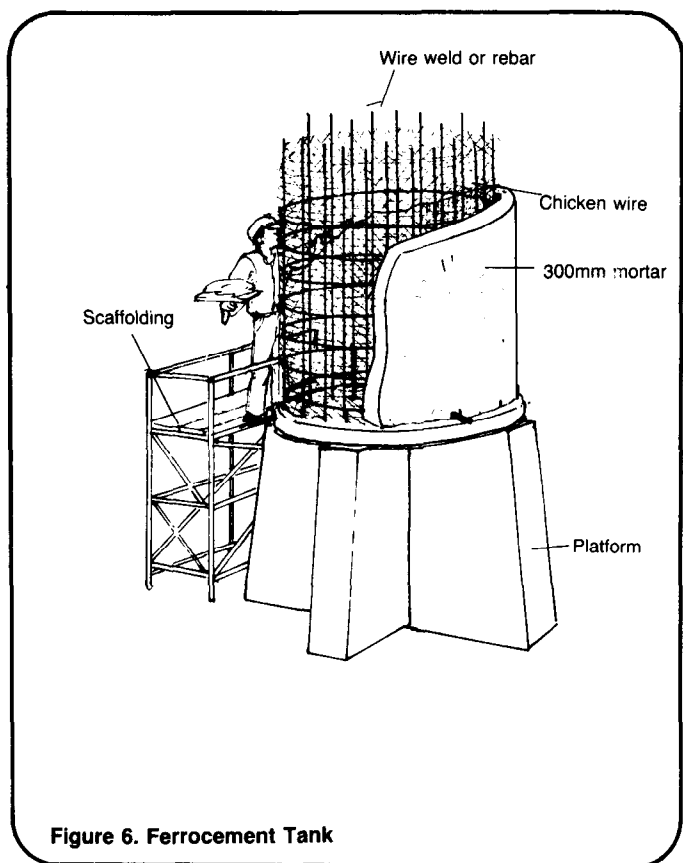


Figure 6. Ferrocement Tank

If a large capacity elevated tank is needed, use "Designing an Elevated Storage Tank," RWS.5.D.3, to determine the amount of storage capacity needed. Discuss plans with the local water development agency or sanitation service. Seek expert advice. Then, obtain cost estimates for the project and determine its feasibility.

In many cases the best choice may be to purchase prefabricated steel tanks and towers. These have the advantage of easy installation and no construction delays. Unfortunately, they are expensive and may not be available in some countries. Many countries prefer to use reinforced tanks in order to save money or to reduce imports. Construction of reinforced concrete tanks requires large quantities of sand, cement, gravel and reinforcing bar, which may be scarce or very expensive.

Large Tank Construction

Large capacity storage tanks, over 5m³ in capacity, may be required in towns with fairly large concentrated populations. The construction of large elevated tanks is very expensive because of the large quantities of materials needed for construction. Large elevated tanks are very complicated to build, requiring engineering expertise. An example of a 200000 liter tank with a tower made from reinforced concrete is shown in Figure 7. Under no circumstances should construction of large capacity elevated storage tanks be undertaken without both technical advice from a competent engineer and engineering supervision throughout the entire construction process. Poor design and construction procedures could result in a waste of money and serious damage due to tank collapse or failure.

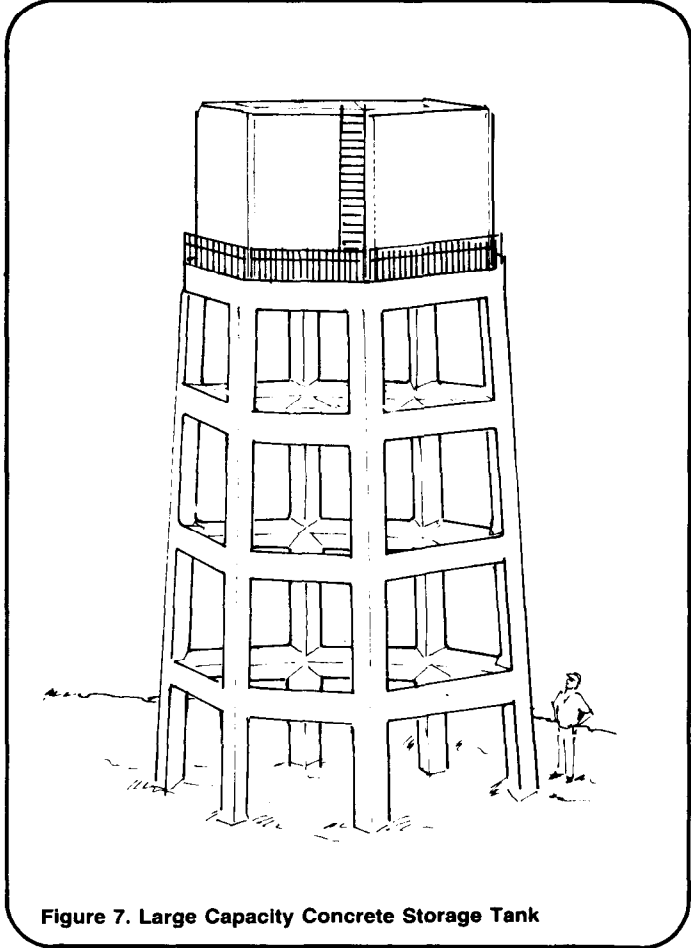


Figure 7. Large Capacity Concrete Storage Tank

Where water tank construction is part of a national plan, costs will generally be lower. Forms can be re-used and construction expertise is gained and passed on. Construction costs are lowered and construction delay reduced.

Summary

Elevated storage tanks are important both for providing storage and for creating sufficient water pressure. Small elevated storage tanks are good for water from gravity flow systems where springs are sources or where water is pumped from community wells by

windmills or small power pumps. The advantage of these tanks are that they can be constructed using local workers. Many communities can afford such tanks for their water supply.

Large elevated storage tanks are much more complicated in design and costly to build than small ones. Their construction by local people is not recommended unless expert advice is available. Their cost is high and they are only economical when there are many users. The better alternative may be to purchase and install a prefabricated steel tank.