Water for the World

Constructing a Ground Level Storage Tank
Technical Note No. RWS. 5.C.2

For effective water storage and water system operation, ground level storage tanks should be built for sufficient, and even excess, capacity and must be watertight to prevent leakage.

This technical note discusses the basic steps to follow in constructing a ground level storage tank. The actual construction process and materials used will differ with each situation or area. The construction of all storage tanks should be supervised by experienced builders or masons and, whenever possible, engineering assistance should be sought.

Useful Definition

ALGAE - Tiny green plants usually found floating in surface water.

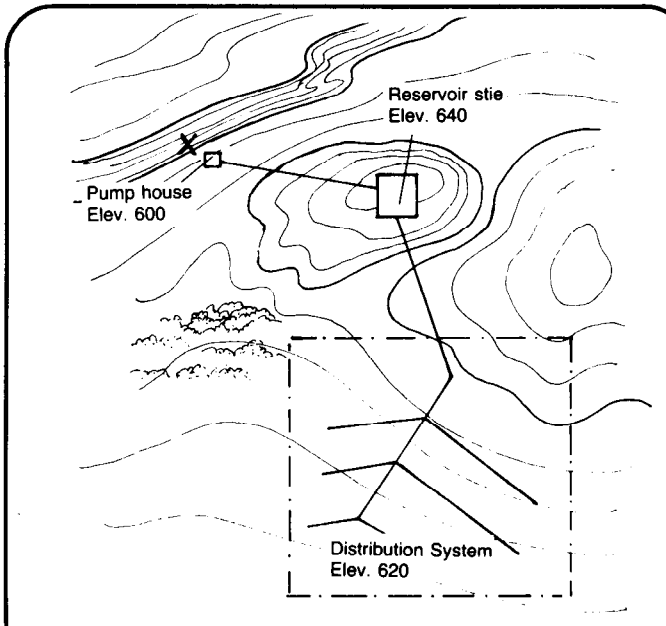

Figure 1. Location Map

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 reservoir, the distribution system, location of users, houses and elevations. Figure 1 is an example of a map showing these reference points.

2. A list of all labor materials and tools needed similar to that shown in Table 1. Ensure that all needed materials are available and at the work site before work begins to prevent construction delays.

3. A plan of the reservoir with all dimensions as shown in Figure 2. This plan shows a top, side and end view.

Table 1. Sample Materials List

Item	Description	Quantity	Estimated Cost
Labor	Foreman		
	Laborers		
Supplies	Portland cement		
	Clean sand and gravel		
	Clean water		
	Reinforcing rod		
	Pipe for inlets, overflow and drain (PVC or steel)		
	Screening and wire mesh for pipes		
	Boards and lumber for forms		
	Lubricating oil		
	Rocks, if masonry tank		
	Float valve (if needed)		
	Cut-off valves		
	Lock for manhole cover		
	Iron for steps in tank		
	Lumber and rafters, if wooden tank		
	Cover structure		
	Shingles		
	Plywood		
	Rope or string		
	Nails, tie wire		
Tools	Shovels, picks and other digging tools		
	Measuring tape		
	Plumb tool		
	Hammer		
	Saw		
	Buckets		
	Carpenters square		
	Level		
	Mixing bin or machine		
	Pipe wrench		
	Adjustable wrench		
	Trowel		
	Hoe		
	Wheelbarrow		
	Sieve		
		Total Estimated Cost =	

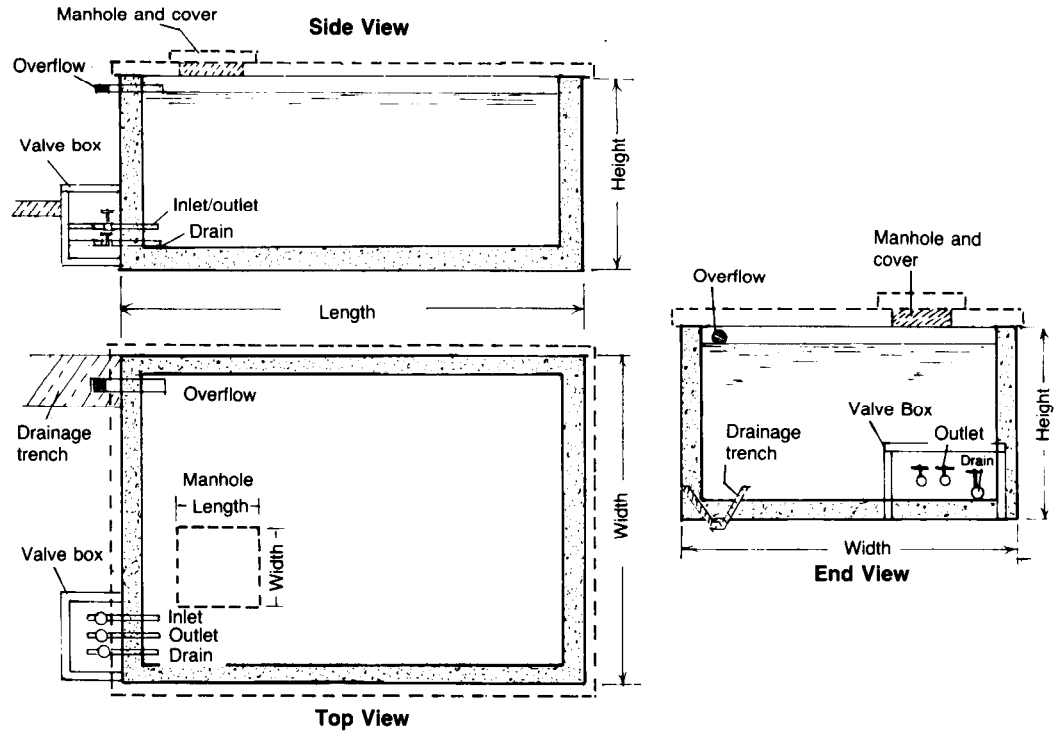

Figure 2. Storage Tank Design

General Construction Steps

Decide on the construction method to use. The reservoir can be completely built into the ground, partially in the ground, or completely above ground. Choice of the construction method will depend heavily on soil conditions and the desired height of the tank. If soil can easily be excavated, it may be best to at least partially bury the tank in order to provide support for the walls. A buried tank is effective as long as the height of the water does not fall below the minimum required to provide adequate pressure in the water system.

Follow the construction steps below. Refer to diagrams as indicated. Remember that the diagrams and construction steps are suggestions that should be adapted to local conditions.

1. Using measuring tape, cord and wooden stakes, mark out the construction site as shown in Figure 3.

2. Clean the area and begin excavation down to the level desired for the tank. If the tank is to be built above ground, or a steel tank is used, then a shallow excavation which serves as foundation should be sufficient. For deeper excavations, walls can be excavated to slope or be built in a step form as shown in Figure 4. This type of design should be used when combined concrete and masonry are used as construction materials.

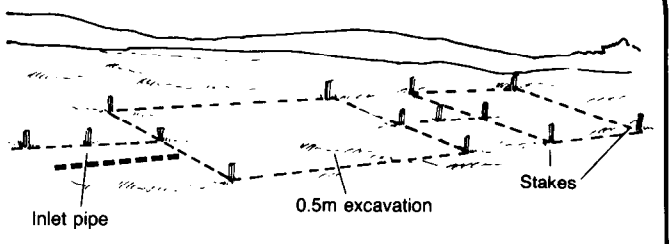

Figure 3. Stakes Marking Site of Storage Tank

Once the level for the bottom of the tank is reached, dig out the area for the foundation. For both concrete and masonry tanks, a concrete foundation and floor is recommended. Make sure the excavation is level around the entire foundation and that plans are made to slope the floor three percent.

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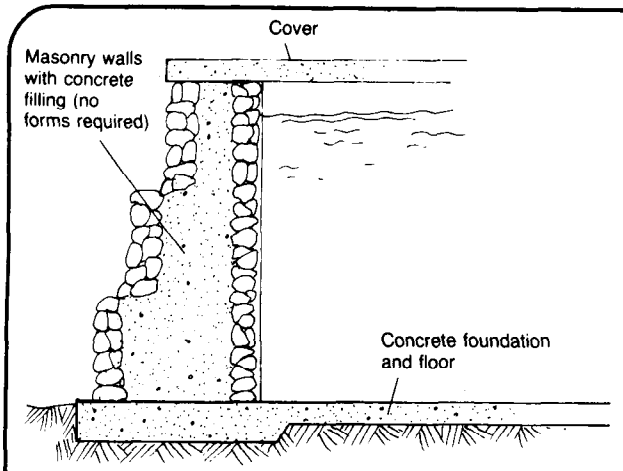

Figure 4. Example of Mass Concrete Wall Construction

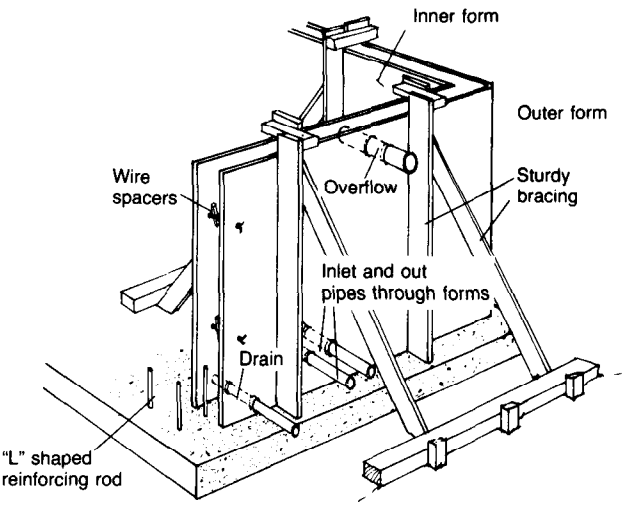

Figure 5. Detail of Forms for Walls Construction

Tank Construction

1. Once the foundation area has been dug out, begin preparing the formwork. Be sure to nail together the forms and secure them well at both top and bottom. It is especially important to brace the inside form, as the outside section will already be braced against the ground. The concrete will push out from the wall toward the inside and adequate pressure against this movement should be applied. See Figure 5.

2. Set up the reinforcing rod as shown in Figure 6. A raft foundation should be used for the structure. Install the rod so that a short length extends into the wall section. This is done by bending the rod at the base where the wall meets the floor. Before pouring the concrete:

- Make sure that all rods are tied together with wire at points of intersection;

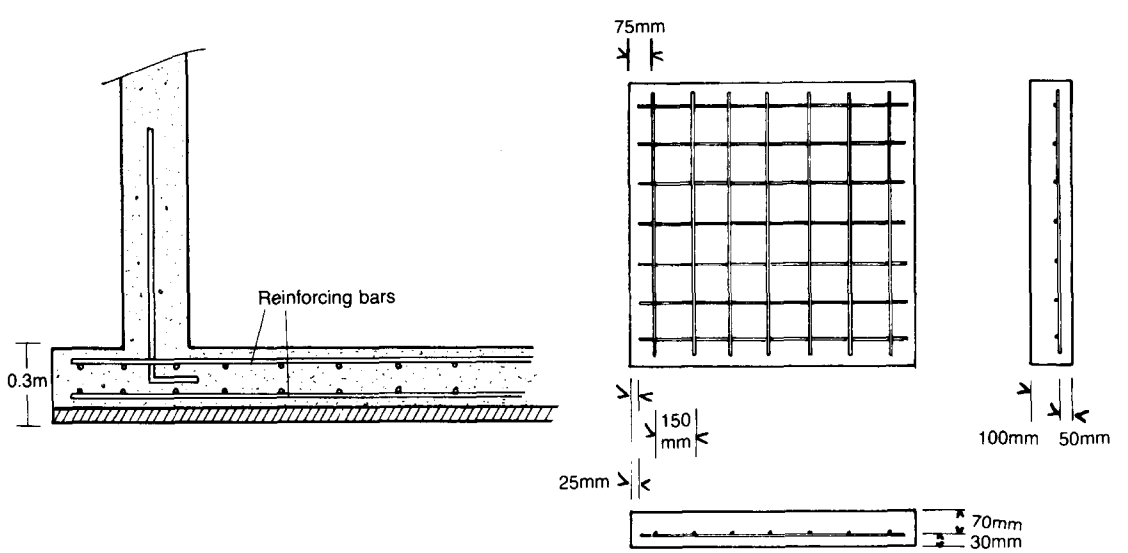

Figure 6. Placement of Rebar in Foundation and Walls

- Place small pebbles or stones under the reinforcing rod grid so that it does not rest on the ground;

- Oil the forms with a lubricant such as old motor oil;

- Cut holes and place pieces of pipe through the forms so that the intake and drain pipe can be installed.

3. Mix the cement in the proportion of one part cement, two parts sand and three or four parts gravel. Pour the entire foundation in a day so that the pour is smooth and drying is even. Smooth the top layer of cement to form the floor. At this time, build up the floor so there is a three percent slope. Hollow out a small channel for the drain pipe. The pipe should range in diameter between 40-70mm.

If structure is reinforced concrete, finish building the forms to the desired height. Remember all forms should be sturdily braced to withstand the force of the concrete. Wire placed in the forms and tightened helps in bracing. Wood braces and cross-pieces should be attached to the forms to provide adequate support. Lubricate all forms before pouring the concrete. Make a hole in the forms for a pipe ranging in size from 40-70mm in diameter. The larger the flow, the larger the pipe diameter should be. The holes in the forms should be located 150mm above the floor. Place the pipe directly into the forms before pouring. Follow the same technique for an overflow pipe. See Figure 5.

When stone masonry is used as construction material, no forms are required but skilled builders are needed. Adequate care should be taken to ensure that walls are straight (plumb) and are at least 300mm thick. A useful technique is to build the outside walls and fill the center of the wall with concrete. When building this type of structure use a step formation.

For both reinforced concrete and masonry-concrete tanks prepare a 1:2:3 or 1:2:4 concrete mixture and pour it evenly around the structure. If possible, use a portable cement mixer which will make the work move much more quickly than if the cement is mixed by hand.

Try to avoid making joints in the concrete. Leakages often occur in joints where a new layer of cement has been poured on a previous day's cement. When pouring from one day is over, leave the edge rough. The next day, clean the surface and paint over it with water and cement to form a good bond.

Once the concrete is poured, 10-14 days are needed for curing. During this time, the cement should be kept moist. A daily wetting of the structure is recommended. If cement dries too quickly, it may crack and leakage will be likely. Forms can be removed after the third or fourth day of curing. To ensure watertightness, the walls of the structure should be roughened with a trowel or a wire brush and painted with a mixture of mortar (one part cement to four parts sand).

Roof Structure

All reservoirs should be covered to prevent the entrance of contaminants, growth of algae and possible accidents. Covers can be made from reinforced concrete or lumber and shingles.

Covers cast in place are both expensive and difficult to construct. Very sophisticated formwork is needed for construction. A better method of construction using concrete is to cast sections as shown in Figure 7. Make several sections and place handles in the top so that they can be lifted into place. Construction of the slabs requires reinforcing rod and a 1:2:3 mixture of cement.

An access hole should be left in one of the covers and a lip built up to allow a cover to be secured to it. Possibly half a hole can be cut from two slabs. Once the slabs are in place, seal the joints between them with mortar to make them watertight.

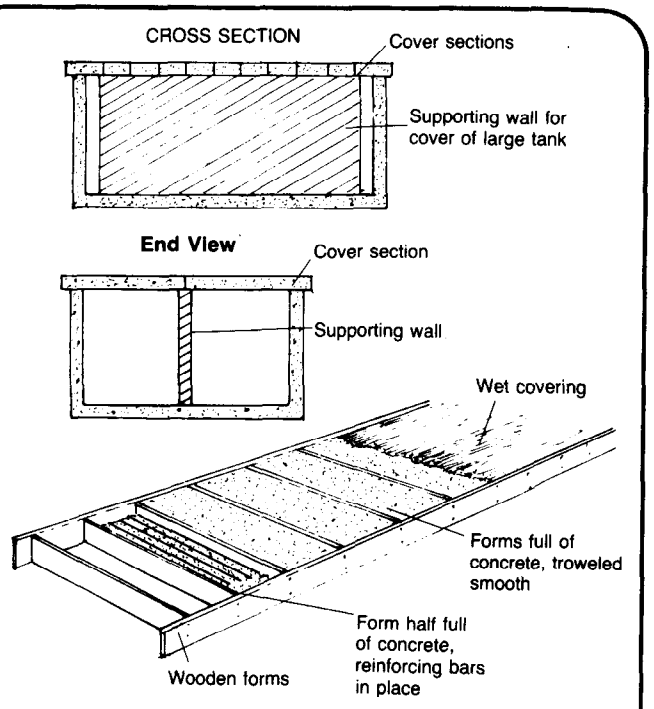

Figure 7. Casting Cover Sections

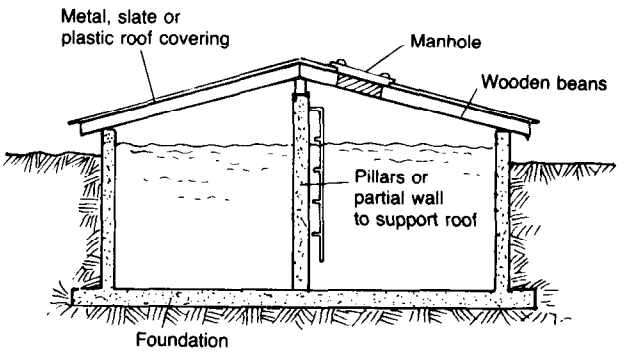

Figure 8. Cover for Large Storage Tank

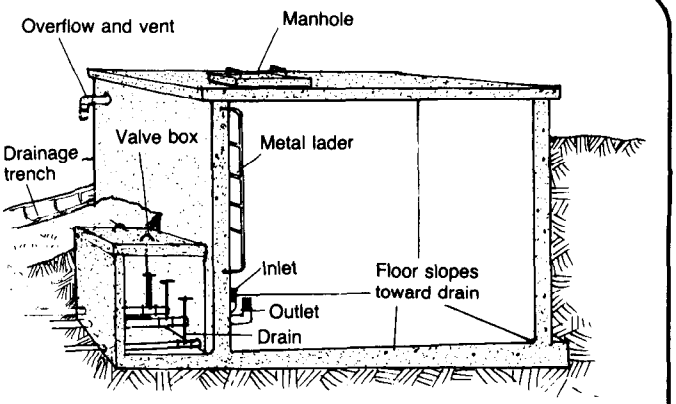

Figure 9. Ground Level Storage Tank

Another alternative is to build a roof structure as shown in Figure 8. The construction should be done by someone experienced in putting roofs on houses. The slope of the roof need not be as great as for a house but should be steep enough to allow water to run off it easily. The most important consideration is that the roof be watertight. Do not cover the roof with thatch or tile which are likely to leak. Use aluminum sheeting or slate or tar shingles for best results. Build up to the earth around the tank so that rainwater drains away from the storage area.

Valve Box

A small box to protect the valves that control inflow and outflow should be constructed at the side of the reservoir. The box can be made from stone masonry, reinforced concrete or wood. The box should have a cover and should be buried. The cover should both protect the valves and provide easy access to cut-off valves installed on the inlet and drain pipes. See Figure 9.

The valve box should be approximately 350-500mm high and can vary in length and width between 750-1500mm. Small globe and gate valves should be installed. The small box should not be difficult to construct. Construction steps can be similar to those followed for the large tank. Make sure that all valve covers are tight so that no water is wasted through leakage.