Water for the World

Installing Pipes
Technical Note No. RWS. 4.C.1

This technical note provides general information on installing water distribution systems using any type of piping material. It contains specific information on installation using the more common piping materials. The full useful life of trouble-free service from properly selected pipe materials can only be obtained if the pipes are installed in accordance with the manufacturer's instructions and standards of good practice.

Useful Definitions

BACKFILL - Material placed in the trench over the pipe.

BEDDING - Material in the trench on which the pipe is placed; it should be carefully selected and free of rocks, pieces of wood, and other debris.

CONTAMINATE - To make unclean by introducing an infectious (disease-causing) impurity such as bacteria.

DISINFECTION - Destruction of harmful microorganisms present in water through physical (such as boiling) or chemical (such as chlorination) means.

SELECT MATERIAL - Material that is free of rocks or organic material.

STRINGING - Placing pipe sections along one side of the route of the trench to be ready for laying.

Pre-Installation

Precautions must be taken in transporting pipe to the construction site and in storing it. Pipe should arrive on-site with parts that are easily damaged protected by the manufacturer. This could be nothing more than protective tape or a cap or threaded pipe ends or it could be paper wrapping to protect sensitive material from sunlight. Separating pipe by specially formed blocks of wood is also common. The protective packaging material should be left in place up to the time the pipe is installed. Manufacturer's instructions about handling and storing of pipe should be followed. This could involve such items as how to lift the pipe, how to protect the ends from damage, or how to store it. For example, most plastic pipe will be damaged if left in direct sunlight for long periods to time. Lengths of stored pipe should be supported at intermediate points so they will not bend, which could cause them to break or warp. Rubber gaskets should be stored in a cool dark place, out of the direct rays of the sun.

Installation

There are seven steps in installing pipe. These are trenching and stringing pipe, bedding, joining, thrust blocking, pressure testing, backfilling and disinfecting the system. Each step is discussed briefly.

Trenching and Stringing Pipe. As a general rule, do not excavate a trench too far ahead of laying the pipe. Stake the pipe lines and grades as shown in Figure 1 but only stake that portion of the pipeline that can be constructed in a few days. Avodiing long stretches of open trench will minimize the risk of flooding and caving and will reduce hazards that might cause accidents. Trenches should be no wider than necessary to permit workmen easy access to install the pipe. Not only do wide trenches require unnecessary digging, they will add more weight to backfill earth on the installed pipe. Figure 2 shows how to excavate a trench. Table 1 shows recommended trench widths at the top of the pipe.

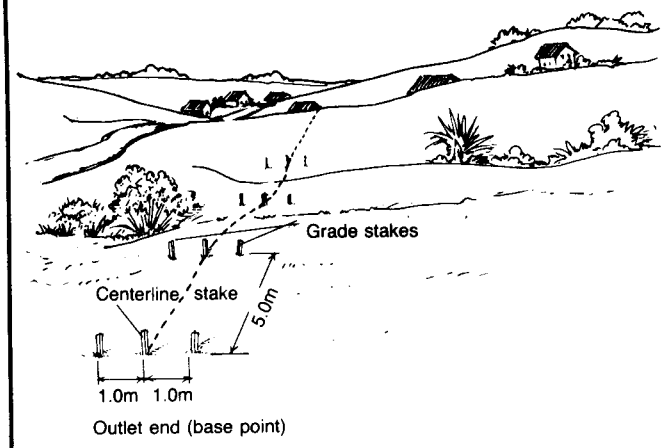


Figure 1. Centerline and Grade Stakes

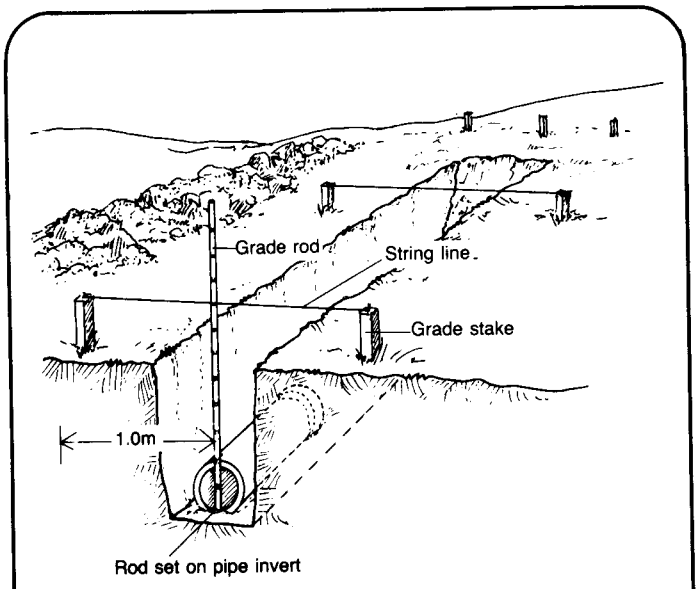


Figure 2. Excavating Trench

Table 1. Trench Width at Top Level of Pipe

Pipe size (mm)	Trench Width (cm)	
	Minimum	Maximum
30-50	15	45
80-100	45	70
150-200	50	80
250-300	60	90
350-400	75	105

Pipe must be buried deep enough to prevent freezing if that ever occurs and to protect it from surface activity, vehicle loads, and high temperatures caused by the sun. Normally a minimum depth cover of 60cm will provide adequate protection. If the trenches are too deep or the soil too unstable, caving may be a problem. If so, some form of sheeting and bracing must be used or the sides of the trench must be sloped. Sloping or widening should be done correctly as shown in Figure 3.

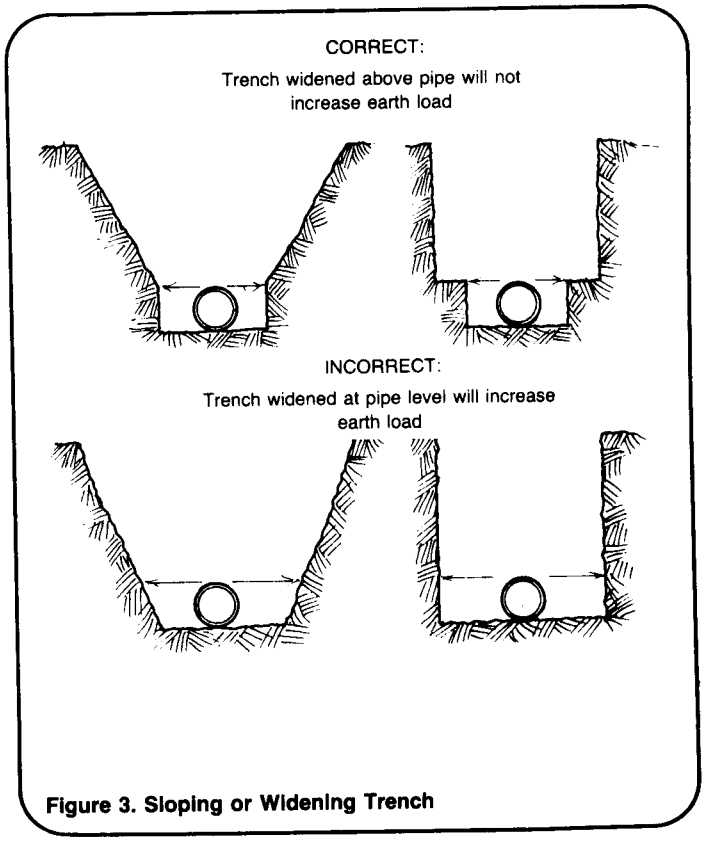


Figure 3. Sloping or Widening Trench

If rock is encountered, the trench will have to be dug deeper than the planned depth of the pipe and brought back to grade using material free from rocks. The pipe must not be laid on rock. Usually, overexcavating 50cm is recommended. Excavated material should be placed to one side of the trench so pipe may be "strung" close to the edge of the opposite side. This makes it easy to lower the pipe from the ground into the trench. Lightweight, small diameter plastic pipe may be assembled on the ground surface next to the trench and then lowered into the trench

as a single long length. Heavier pipe should be handed down by two workers to two other workers as shown in Figure 4. Larger slip and mechanical coupled pipe must be assempled in the trench a length at a time. Where separate slip couplings are used, they should be put on one end of each pipe length above ground to reduce the amount of work that must be done in the trench.

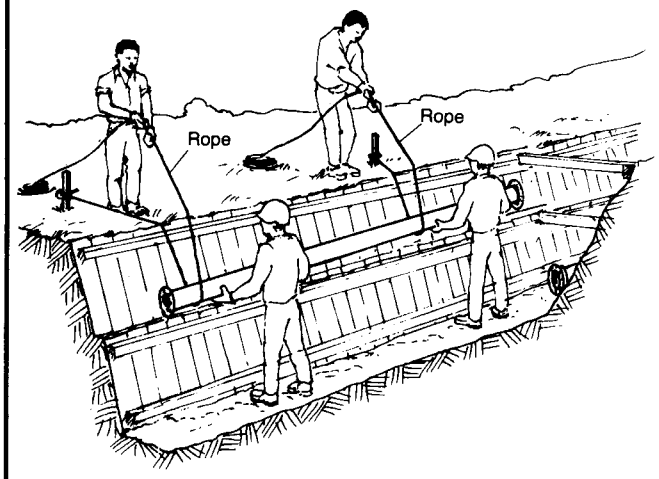


Figure 4. Lowering Heavy Pipe

Bedding. Most pipe materials need to be protected from direct contact with rocks that could be forced against the pipe and cause a facture. Most pipe should be uniformly supported along the underside so it will not have to "bridge" low spots. For these reasons, trench bottoms should be level, free of rocks and preferably of loose material that can easily conform to the shape of the pipe. At couplings and fittings, a small depression in the trench bottom should be made to ensure the pipe will not "bridge" from coupling to coupling. See Figure 5.

If the excavated material has rocks, a "select" material must be used to lay the pipe on a bed of soil and to backfill the trench. Select material may be obtained by screening out the rocks or by bringing material from another location.

Joining. In joining pipe lengths and fittings, manufacturer's instructions should be followed. While they are no longer commonly used, pay close

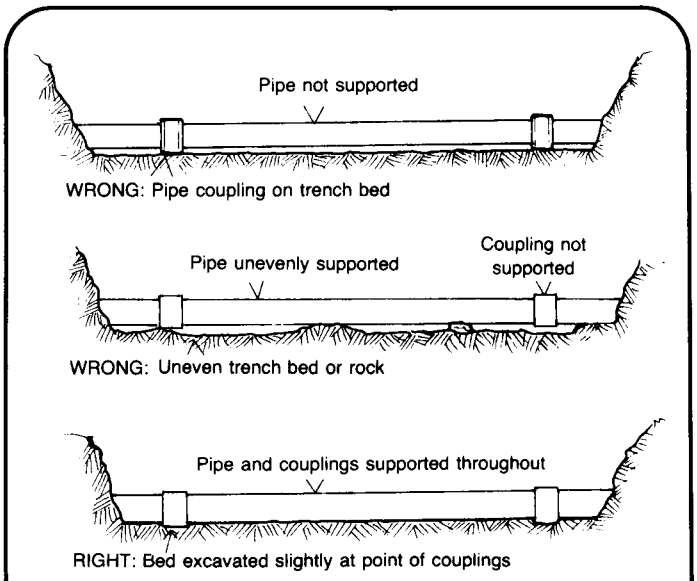
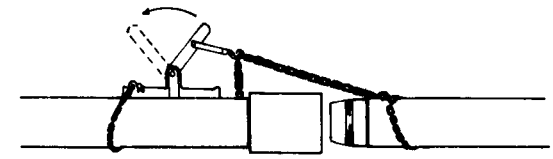


Figure 5. Prevention of Bridging

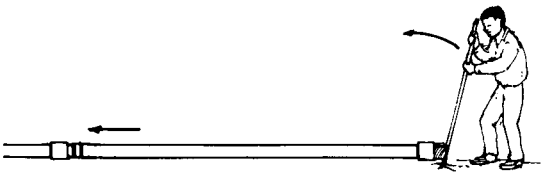
attention to the types of solvents or "glues" to be used on plastic pipes should you encounter them. They are not all the same. Gaskets used in various slip type couplings and mechanical joints may look similar, but they may not be interchangeable. Use the ones that were furnished with the pipe and fittings. Be sure pipe ends, gaskets, and couplings are clean before assembly. A few grains of sand under a gasket can result in a leak. Grease can prevent a plastic pipe solvent from sealing tightly. Keep the inside of the pipe as clean as possible while assembling. This will shorten the flushing time and lessen the chance of material plugging valves and small diameter water lines.

When assembling asbestos cement pipe, a light coating of special lubricant, supplied by the manufacturer, must be applied to the tapered end of the pipe. Do not use, common grease or other substitutes that could contaminate the water. A gasketed coupling can be pushed onto the pipe, or sections of pre-belled pipe can be pushed together, using a bar and wood block or a special lever type puller. See Figure 6.

Plastic pipe can be assembled using gasketed couplings or integral bell couplings as shown in Figure 7. Again a special lubricant is used, but the coupling can usually be installed by hand without the use of bars or other devices.

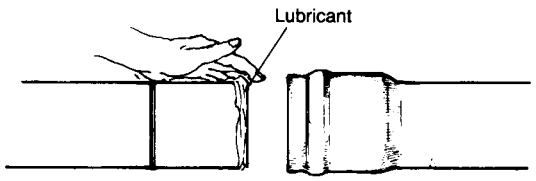


a. Lever-Type Puller

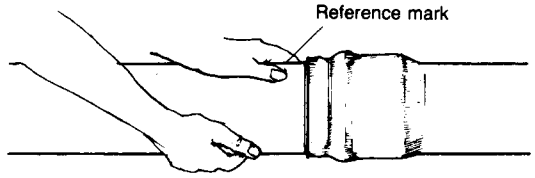


b. Assembly with Bar and Wood Block

Figure 6. Jointing A/C Pipe



a. Lubricate Pipe End



b. Push Pipe In Until Reference Mark is in The Bell

Figure 7. Joining Plastic Pipe

Thrust Blocking. Water under pressure in a pipe will not only exert a force against the sides of the pipe, but along its length as well. For this reason, joints must resist the force of being pulled apart. Thrust blocks are needed for all pipe material and joints, particularly when a slop coupling and gasket is used. Thrust blocks should be used at fittings, bends and pipe ends to prevent pipe movement due to water pressure. A thrust block consists of concrete that is placed between the fitting and the solid, undisturbed face of the trench. The size of the thrust block is determined by the pipe size, type of fitting, water pressure, and soil stability. Manufacturer's literature should be consulted for design information. For most rural systems, it will be sufficient if a concrete block is poured which provides a full bearing surface to the fitting and extends to undisturbed earth. Typical placement of thrust blocks are shown in Figure 8.

Longitudinal forces can result from thermal expansion or contraction of pipe material. An extreme case may occur when polyethelyene pipe is installed on a very hot day and then filled with cold water. The force of contraction could pull joints apart. It is common, therefore, particularly for polyethelyene pipe, to "snake" the pipe in the trench so the force of contraction will merely straighten the pipe rather than cause joint failure. Lay the pipe in a slight wavy pattern, rather than straight. See Figure 9.

Pressure Testing. After a pipeline has been installed, but before completing of backfilling, the pipe should be tested for leaks. This can be done by filling the section to be tested with water under pressure and, after several hours, looking for a drop in pressure and/or leaks. When filling the lines with water, valves at the far ends should be opened to allow air to escape and then close when water begins to flow. It is desirable to raise the pressure in the pipe to 50 percent above the normal working level, but not above the rated strength of the pipe, by use of an auxiliary pump. This will show leaks that may occur at a later date when there are pressure surges in the line. Prior to pressure testing, it is essential that thrust blocks be installed and allowed to harden. The line should be partially backfilled, leaving the joints exposed. This will prevent the pipeline from moving under the pressure from the water.

Backfilling. Proper backfilling is essential in order to protect the pipe, prevent erosion, and avoid too much settlement of the filled trench. Dry soil, that is free of rocks and organic material should be used. If the excavated materials is not free of rocks, then a "select" material should be

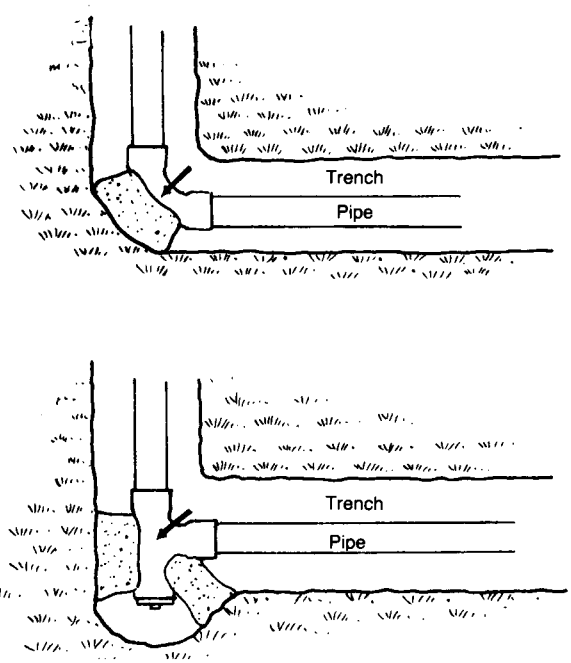


Figure 8. Examples of Thrust Blocking

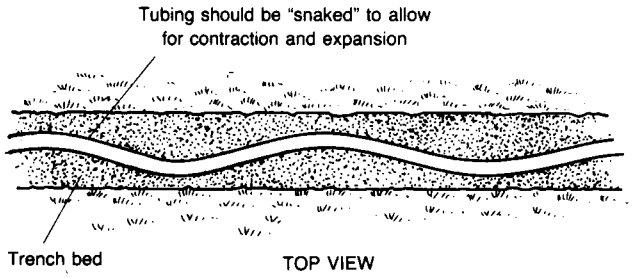


Figure 9. Installing Polyethelene Tubing

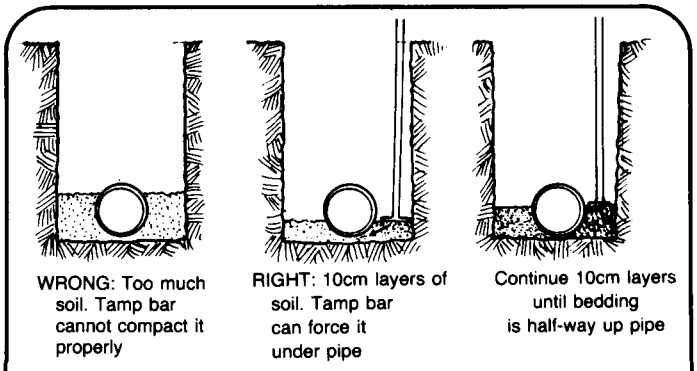


Figure 10. Backfilling the Trench

used. This can be obtained by screening out the rocks before backfilling or by ringing material from a nearby source. Sand or sandy loam is considered excellent for this purpose. A small amount of the backfill material should be placed on both sides of the pipe and tamped into place. This process is continued in layers of about 10-12cm until there is about 30cm of fill over the top of the pipe. Backfilling can then be completed with common excavated material and the surface left mounded to allow for eventual settlement. Figure 10 shows right and wrong ways of backfilling.

Disinfecting the System. When installation has been completed, the entire system should be flushed with clean water to remove dirt and sediment and then disinfected. This can be done by filling the system with water containing at least 50 mg/liter of chlorine and leaving it in the main for 24 hours. A properly adjusted hypochlorite solution can be injected into the main with a hypochlorinator. However, on a small system with a storage tank, add chlorine directly to the tank and then let it flow into the system. Table 2 can be used to calculate the quantity of chlorine compounds to add to yield of 50 mg/liter solution.

Table 2. Amount of Chlorine Needed to Produce a 50 mg/liter Solution

Chlorine Compound	Amount per 1000 liters of water
5% Chlorine bleach	1 liter
12-17% Chlorine solution	.3 liter
25-30% Chlorine powder	200 g
65-75% Chlorine powder	75 g

During the 24 hour period of time, valves and hydrants should be opened to assure the chlorine solution reaches all surfaces. Following this period, no less than 25 mg/liter of chlorine residual should remain. The main should then be flushed and the bacteriological quality of the water checked at several points in the system.

Post Installation

Once a distribution system is installed, it should not be forgotten. Its location should be indentified with markers in the field and on "as-built" maps. This will help to prevent damage to the pipe from subsequent construction activities and to locate the pipe if it is necessary to repair or extend it. Pipelines in open country should be identified by posts or stone markers at bends, intersections, valves, and along the pipeline at 1000m intervals. In populated areas, these points can be identified in relation to their distance to three existing points, such as corners of buildings. An "as-built" drawing should be prepared showing the lines, the markers, the tie points, and the depth of bury. It is important that these be prepared as the pipe is being installed. Remember that a valve in the system is of no use if it cannot be located when needed.