

# Instrument Construction and Installation

## Instructions for Making and Installing a Frost Tube to Measure Depth of Frozen Ground

### Materials

- Inner tube: 6 - 7 mm diameter (1/4" outside diameter) clear tubing, at least 2 m long
- Outer tube: 20 mm diameter (1/2" inside diameter) PVC tube, at least 2 m long
- 1 PVC cap to fit on 20 mm PVC tube
- 1 PVC end plug or cap, for the bottom of the 20 mm (1/2") PVC tube (epoxy putty may be used if cap is too large)
- PVC Cement
- Gas burner, alcohol lamp, or lighter to seal inner tube
- Pliers for pinching heated inner tube
- Gloves for applying PVC cement
- Food coloring and water
- Bowl for mixing food coloring with water
- Wash bottle with spout or funnel
- Black waterproof marker
- Meter stick with cm markings
- Soil probe or steel rod, 20 mm or 3/4" diameter, 1.5 m (60") in length.
- Flag
- [Frost Tube Site Definition Data Sheet](#)

### Directions for Construction

The Frost Tube consists of two layers:

- The innermost tube is a piece of clear tubing sealed on both ends, which holds colored water.
- The outermost tube is a piece PVC pipe, sealed with a PVC end plug secured with PVC cement on bottom and fitted with a removable cap on top.

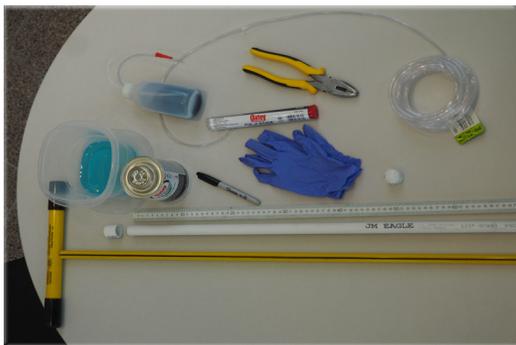


Figure 1a. Parts of Frost Tube



Figure 1b. Assembled Frost Tube

1. Estimate the below-ground length of the Frost Tube.

*In areas of seasonally frozen ground:* The length of the Frost Tube should be a little longer than the depth to which the ground freezes in winter. The suggested length is 2 meters (1 meter above and 1 meter below the ground surface). Frost and thaw depth tables for your area will help you estimate the length.

- At your site, pound or turn the probe vertically into the ground until you reach 1 meter or the estimated depth. You may need to push the probe deeper in sandy soils, which tend to have deeper frost penetration. Mark the hole with a flag.

*In high latitudes and altitudes with permafrost:* The below-ground length of the Frost Tube depends on the depth of the active layer. Permafrost can be variable, so probing the ground is necessary.

- Check the thickness of the active layer using a steel stick or rod (thaw probe) at the end of the summer. Write down this depth.
- Pound the probe into the ground until you hit permafrost. It will feel like you have hit rock or something very hard. Your Frost Tube should extend to this depth. Flag this location for later installation.

2. Determine the length of the entire Frost Tube by adding 1 meter to the estimated below-ground length. Cut both tubes (inner and outer tubes) to the final length. Write this down on the [Frost Tube Site Definition Data Sheet](#). The height of 1 m above ground allows the top of the Frost Tube to stick out of the snow (in most areas), be protected from runoff and animals, and be accessible.

3. Use a PVC end plug or cap to seal the bottom of the outer tube. A plug fits inside the tube, while a plug fits over the outside of the tube. Following the manufacturer's instructions and wearing gloves (latex, vinyl, or nitrile), coat the bottom 1 cm of the outer tube with the PVC cement and place the cap or plug. If you have wet soils, epoxy putty as a

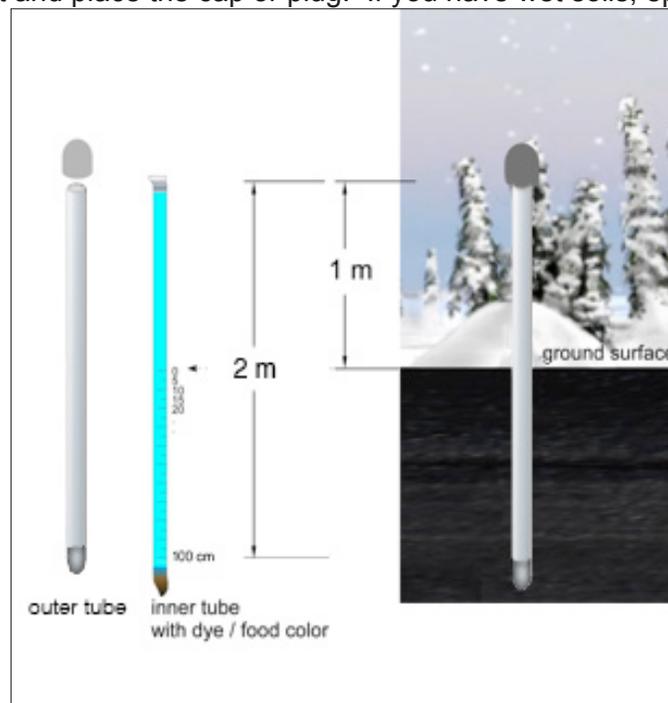


Figure 2. Frost Tube assembly showing liquid-filled inner tube (both ends sealed) and outer tube as well as the assembled frost tube placed in the ground.

plug with a cap over will keep water from infiltrating into the tube. If using epoxy putty, allow it to cure (harden) according to the instructions from the manufacturer.

4. In a bowl, mix water and enough food coloring to make bright but transparent color. Using the wash bottle or a funnel, fill the clear tube with the colored water up to 15 cm from the top being careful to keep it from pouring out the other end. (Eventually you will seal both ends of the inner tube but for now leave both ends unsealed. If you seal one end, the water will not go into the tube since it will not displace the air present.)

5. Light the gas burner. **Use ventilation and be careful not to burn yourself.** Seal one end of the clear tubing by heating it with the burner and press the ends together with pliers. This becomes the bottom end. Make sure that the seal does not distort the bottom of the tubing so it slides easily down into the outer PVC tube. Make sure that you do not stretch the inner tube because it must be the same length as the outer tube.
6. Seal the top end of the clear (inner) tubing by heating it with the burner. **Use ventilation and be careful not to burn yourself.** Flatten this end so that it is just wider than the diameter of the outer tube, but can still fit under the cap. This way, the top of the clear (inner) tube can be retrieved for measuring depth of freezing (Figure 1b).
7. Slip the clear inner tube, now filled with the colored water and sealed on both ends, into the outer tube so that it extends to the sealed bottom of the outer tube.
8. Place the cap on top of the outer tube.

### **Directions for Installation**

1. Return to the flagged location where you inserted the soil probe into the soil. Begin the [Frost Tube Site Definition Data Sheet](#).
2. Insert the soil probe into the hole to the estimated depth. The hole should be just deep enough to accommodate the below-ground portion of the outer tube. If necessary, move the probe side to side and up and down to widen the hole.
3. Place the entire Frost Tube assembly into the hole. It should fit snugly in the hole and reach the estimated depth.
4. Mark the soil surface on the outer tube. Use a meter stick to measure the distance between the soil surface and the top of the outer tube. Subtract this measurement from the total length of the outer tube to get the below-ground depth of the Frost Tube. Record these lengths on the [Frost Tube Site Definition Data Sheet](#).
5. Pull the inner clear tubing out and hold it close to the outer tube, lining up the top of the inner tube with the top of the outer tube. Clearly mark where the soil surface occurs with a permanent marker on the outside of the inner tube. Label the soil surface as 0 cm.
6. Lay the inner tube on a flat surface. Mark 5 cm increments from the 0 cm line to the bottom of the inner tubing using a meter stick and permanent marker. Write in the number next to every 10 cm interval (i.e., 10, 20, 30, 40, etc.). Place hash marks 1 cm apart so there are 4 evenly placed hash marks between each 5 cm mark (Figure 3).
7. Return the inner tubing to the installed outer tube of the Frost Tube assembly.
8. Cover the top of the Frost Tube with the PVC cap (*do not glue!*) to minimize the chance of snow, water, debris, and/or ambient air getting down inside (Figure 4). You may need to bend the top of the inner tube to get the cap to fit snugly.

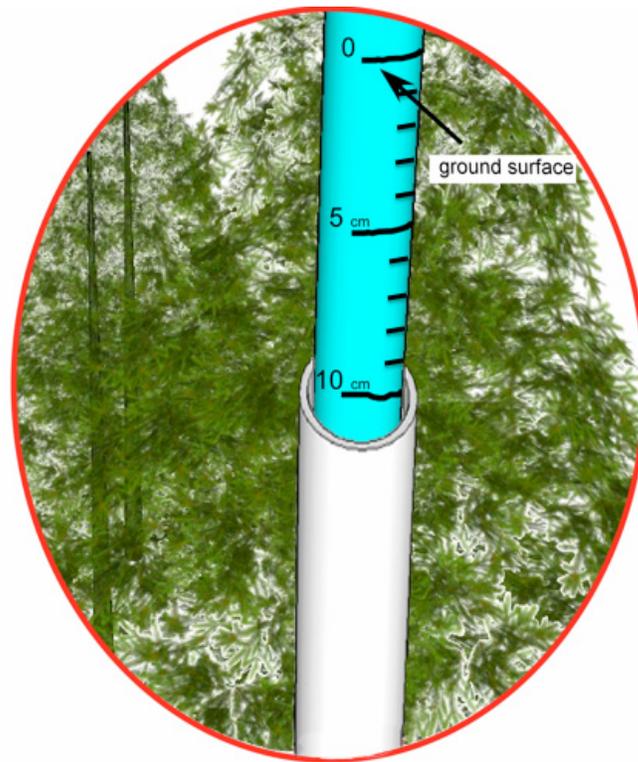


Figure 3. Ground surface and 5 cm below-ground increments with 1 cm hash marks on inner tube



Figure 4. Assembled frost tube on left with a meter stick on the right