

## INSTALLING PROBES and CABLES

Probes may be installed either by direct burial or by pushing the probe rods into the soil. The former method is straightforward. However, installation by pushing the probe into the soil requires some attention to detail in order to avoid air gaps between the rods and soil. Provided with your probes are two clear plastic spacers. Push a spacer over a probe's rod ends leaving about 2 cm of free rod. Begin to insert the probe by pushing the rod tips into the soil. When the spacer reaches the soil surface remove the spacer and continue pushing the probe into the soil until the handle makes firm contact with the soil. Pack soil around the probe handle and bury the cable. The plastic spacer will ensure that the rod spacing at the point of entry into the soil is the same as the rod spacing at the handle of the probe. As long as the probe is pushed straight into the soil no air gaps will be formed.

Burial of the cables is recommended for two reasons. First, the buried cable undergoes less diurnal temperature variation and thus the cable insulation's dielectric constant changes very little. Cables left on the soil surface may undergo wide temperature changes which induce dielectric constant changes in the cable insulation (similar to the temperature dependency of water's dielectric constant). The changing dielectric constant will cause the travel time of the TDR signal in the cable to vary and thus cause a change of position of the wave form on the cable tester screen. Under extreme conditions this can cause important parts of the wave form to shift off the screen. The second reason for burial of the cables is that buried cables are much less prone to damage by rodents or other animals, tillage operations, etc. If cables cannot be buried they can be protected somewhat from temperature extremes by wrapping with pipe insulation held in place with white tape. The pipe insulation comes in pre-slit foam tubes at most hardware stores. White tape will reflect solar radiation and thus help prevent heat buildup. The reflective Al foil tape used to install heating duct insulation can also be used to hold in place and cover the pipe insulation.

We recommend that cables be protected where they leave the soil to enter a multiplexer enclosure or other opening. This protection can be afforded by a length of 1 inch diameter polyethylene (e.g. Tygon) tubing. Slit the tubing along its length and insert the cables. Then tape the tubing closed over the cables with electrician's plastic tape.

## USING THE PROBE PLACEMENT JIG

### Introduction

The TDR probe placement jig (Fig. 4-1) is designed for placing probes horizontally (parallel to the soil surface). Since horizontal probe placement is most critical near the soil surface the jig provides for placement of probes at depths arbitrarily near the surface and on down to 30 cm depth. Below 30 cm horizontal placement is not so critical since in most soils water content does not change so quickly with depth below 30 cm. The jig consists of a 9 inch square base of 3/4 inch plywood which rests on the soil surface, a similar plywood backplate which is attached perpendicularly to the base, and two steel legs graduated in millimeters with centimeter enumeration which extend in the opposite direction from the backplate, i.e. perpendicular to the base and into the soil pit. Included are five 8 inch by 3/4 inch aluminum cross straps with fasteners for fixing the straps to the jig legs at the depth(s) at which probes are to be installed. Also included are a plastic square for leveling the probes and two plastic leveling guides which fit onto the 3 stainless steel probe rods.

## Use

Dig a pit in the soil slightly deeper than 32 cm and wide enough to accommodate the jig legs as well as a horizontal TDR probe. Flatten the soil on one face of the pit so that it is vertical and smooth to make a smooth fit with the probe handle. Attach the appropriate number of aluminum cross straps to the jig legs leaving the top edge of each strap just below the depth at which each TDR probe is to be installed (additional straps are available if needed). Place the jig base on the horizontal soil surface just above the smooth face of the pit with the legs extending vertically into the pit. Place a weight on the jig base to hold the jig firmly in place. Attach the two plastic leveling guides to the probe rods by snapping them on. Place the ends of the probe rods on the bottom-most of the cross straps and hold the probe horizontally. Place the wide edge of the plastic square against the cross straps above the probe or against the jig back plate as may be appropriate and slide the square down to touch the leveling guides. Move the handle of the probe up or down as needed to square the probe with the jig (both leveling guides touching the bottom of the square). Slide the probe into the soil, removing the square and leveling guides as needed, until the handle is about 1 inch from the cross strap. Loosen the wing nuts on the cross strap and rotate the backing washers until the cross strap comes free from the jig legs. Remove the cross strap and push the probe into the soil until the handle comes firmly into contact with the face of the pit. Repeat this process for any other probes to be placed, moving from the bottom to the top of the pit. Moving from the bottom to the top insures that there will always be cross straps above the probe currently be installed. These are needed for the square to rest against. The bottom to top procedure also guarantees that already installed probes and their attached cables will be out of the way of probes that are to be installed later.



**Fig. 4-1.** The probe installation jig in use. The square is used to ensure that the probe is horizontal to the soil surface.