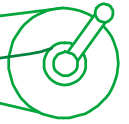


FLUTE™

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Brief Description of Installation Procedure

for

Water FLUTES

Installation procedure for Water FLUTEs

Purpose

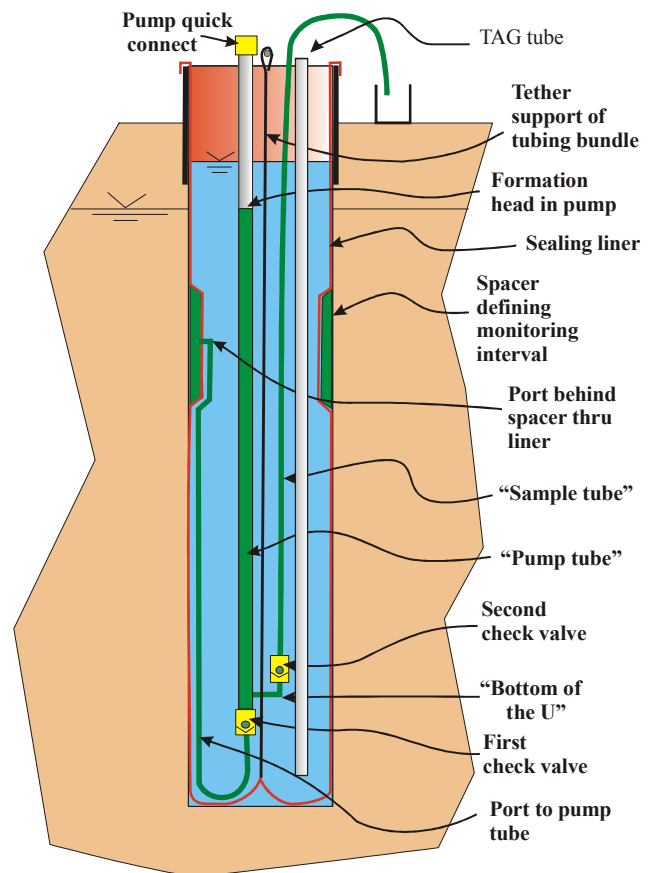
This is intended as a brief general description of the procedure and the equipment used for the Water FLUTE installation method.

The Water FLUTE system

The Water FLUTE system is a multi level ground water sampling system as is described in detail in Cherry, et al¹. The system consists of a flexible borehole liner composed of a urethane coated nylon fabric with attachments for the purpose of drawing water from the formation and for measurement of the depth of the water table at each sampling interval. Figure 1 depicts the liner as fully installed in a borehole with only one sampling interval shown for clarity. The external annular spacer defines an interval of the borehole that is not sealed by the liner. The ground water sample is drawn from that interval and conducted to the pump system shown in the center of the borehole. The long pump tubing allows a relatively large (~1 gal.) sample to be displaced to the surface by nitrogen gas pressure. The pumping procedure allows a thorough purge of the pumping system and a water sample can then be obtained with essentially no risk of aeration of the sample. The water level at the port is measured with a manual electric tag liner lowered into the pump tube. Pressure transducers are often incorporated into the system to allow a continuous recording of the head variations in the formation.

Fig. 1. Water FLUTE pump system

(Single port system shown for clarity)



The installation procedure

The Water FLUTE system is everted into the borehole as is normally done for many flexible liner systems. Figure 2 shows the main components of the installation procedure (the pumping system is omitted from the drawing). The liner is positioned on a shipping reel near the wellhead. The liner is inside-out relative to its final state in the borehole.

¹ *A New Depth-Discrete Multilevel Monitoring Approach for Fractured Rock*, Ground Water Monitoring & Remediation 27, no. 2/ Spring 2007/pages 57-70.

An air vent tube is first located in the borehole to allow the air above the water table to escape as the liner is installed. A second tube called a pump tube is lowered to the bottom of the hole to allow the water to escape beneath the liner as the liner is everted into the hole (eversion is the opposite procedure to inversion). The top end of the liner is fastened to the surface casing with a large hose clamp. Then the liner is pushed into the casing by hand for a depth of ~3 ft to form an annular pocket. Water is added to the annular pocket which pressurizes the liner and drives it down the hole, pulling itself off the shipping reel. The liner passes through itself and is said to be everting down the borehole. The water level inside the liner is well above the water level in the formation so that the liner interior pressure is higher than the formation pressure, causing a seal of the borehole. As the liner descends, it pushes the borehole water into the formation. If the formation is of low transmissivity, the water must be pumped from beneath the liner via the pump tube. When the liner reaches the bottom of the hole, the tether supporting the pump tubing is tied to a strong bar at the wellhead to prevent any further descent of the tubing bundle.

Fig. 2. Typical Water FLUTE Liner Installation

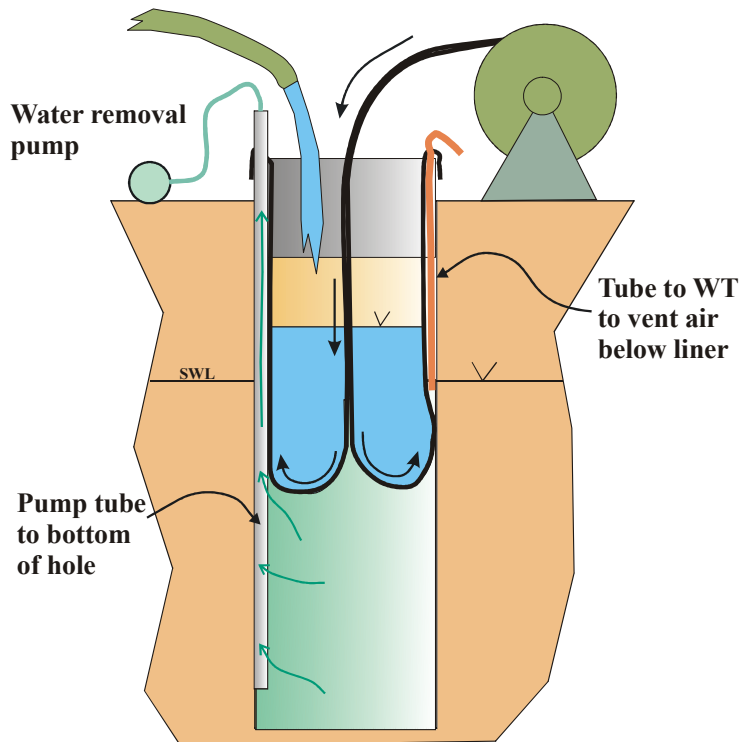


Figure 1 shows the liner fully everted and sealing the borehole. The individual pumping systems are tested to assure that they are fully functional before the pump tube is removed. In order to remove the pump tube, a pump is lowered inside the liner and the water is removed from the liner until the liner begins to collapse. (Sometimes a large tube built into the tubing bundle, called a tag tube, is used as an air lift pump to remove the water from the interior of the liner.) The pump tube is then pulled out of the hole and the liner is refilled to a level about 10 ft above the water table in the formation so as to pressurize the liner and seal the borehole. The sealing liner isolates each sampling interval in the hole to allow a discrete water sample to be drawn from that interval defined by the length of the annular spacer on the exterior of the liner.

The quick connect fittings are added to the top of the pump tubing for connection of the gas source. A nitrogen bottle is used to expel the water from the pumping system as shown in Figure 3.

Special circumstances

If the water table is very near the surface, a temporary extension of the casing is added to develop a higher driving pressure for the installation of the liner. When the liner is fully

installed, a weighted mud is used as a filling of the liner from the bottom to the top to better pressurize the liner. The mud still allows the liner to be removed by the reverse of the installation process.

In karst formations, a device called an eversion aid can be used inside the bottom end of the liner to cause it to propagate more nearly vertically than a liner driven with water alone. This allows the liner to propagate through large caverns intersected by the borehole.

Water FLUTE liners can be installed equally easily in angled holes or even horizontal holes using the same eversion procedure.

Fig. 3. Pumping Procedure

