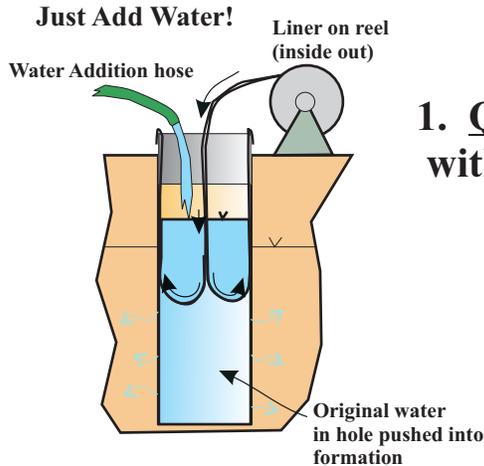


Problem: You need a borehole for measurements, but boreholes spread the contamination.

Solution: *The FLUTE[®] Trio*



1. Quickly Seal the borehole with an everting FLUTE liner.



2. Measure all significant flow paths at the same time with the Hydraulic Conductivity Profiler



3. Swap the sealing liner for a Water FLUTE multi level system. Measure the head profile and water quality profile, more easily than any other system.

Well proven
High quality water samples
Seals the entire borehole

For the facts and references: www.flut.com and 888-333-2433

FLUTE[™]: Flexible Liner Underground Technologies, 6 Easy St., Santa Fe, NM 87506

for a medley of innovative designs

The FLUTE® Blank liner

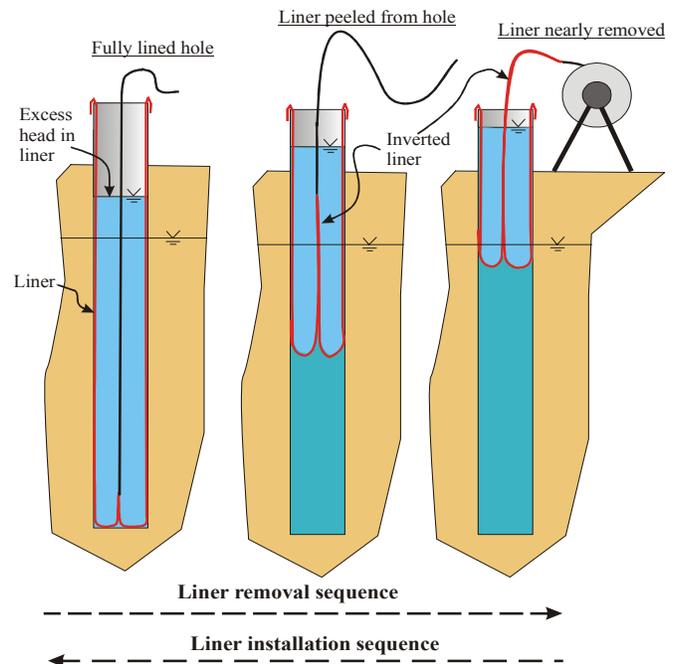
Method: The FLUTE blank liner is a tubular urethane coated nylon borehole liner which is normally everted into place as shown in Fig. 1. It is easier to understand the everting process if one starts with the lined hole of Fig. 1a. The excess head inside the liner, above the water table in the formation, forces the liner out against the hole wall and forms a continuous seal of the hole much like a continuous packer. By pulling up on the tether shown in the figure, the liner inverts and can be peeled from the hole wall as the tether and then the liner are wound on a reel at the surface (Fig. 1b-1d).

The installation procedure for the blank liner is the reverse procedure (Fig. 1d-1a). The inside-out liner is pulled from the reel and clamped to the top of the casing. The liner is pushed down into the casing to form an annular pocket. Water is added to the interior of the liner forcing the liner against the hole wall and down the hole, pulling the liner from the reel. As the liner “everts” down the hole (the reverse of peeling it out of the hole), the water in the borehole is forced into the formation. The liner will continue to descend in the borehole until it reaches the bottom of the hole or until all flow paths in the borehole are sealed by the liner and the water beneath the liner can not be forced into the formation.

Uses: The blank liner is a convenient method for sealing the borehole to prevent contaminant transport in the hole. Many geophysical measurements can be performed inside the liner, with the liner sealing the hole. Those measurements are: gamma and gamma-gamma logs, induction coupled electric log (resistivity), sonic logs of several kinds, temperature logs, radar measurements, and neutron moisture logs in the vadose zone. A very attractive use of the blank liner is the measurement (i.e., location and flow rate) of all significant flow paths in the borehole while the liner is descending into position. For details on this *Hydraulic Conductivity Profiling Technique*, visit www.flut.com, or call us at 888-333-2433.

The blank sealing liner is also used to prevent the leakage of grout from the borehole while sealing the annulus between a casing and the hole wall, or while simply grouting a borehole in a karst formation. FLUTE blank liners are manufactured to the borehole dimensions and come in a variety of tensile strengths and coatings for the particular application. After the blank liner seals the borehole and the flow paths measured, the *Water FLUTE®* allows multi level water sampling.

Fig. 1. Blank liner installation and removal sequence

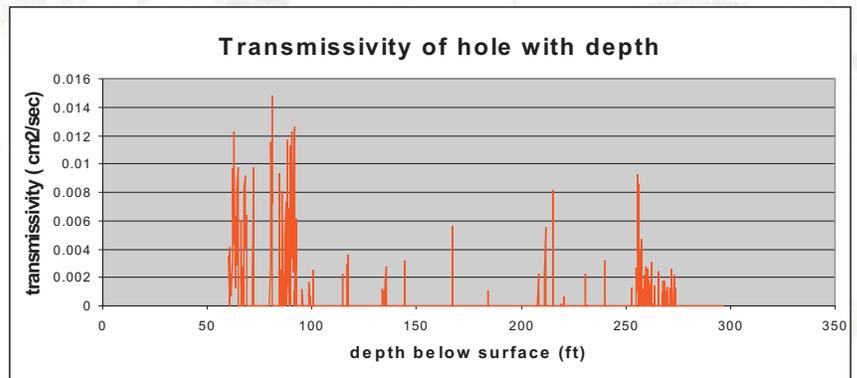


Another *FLUTE*TM “Revolutionary Concept” has evolved to a “Proven Concept”

Map and flow test all significant flow paths in a borehole in a few hours



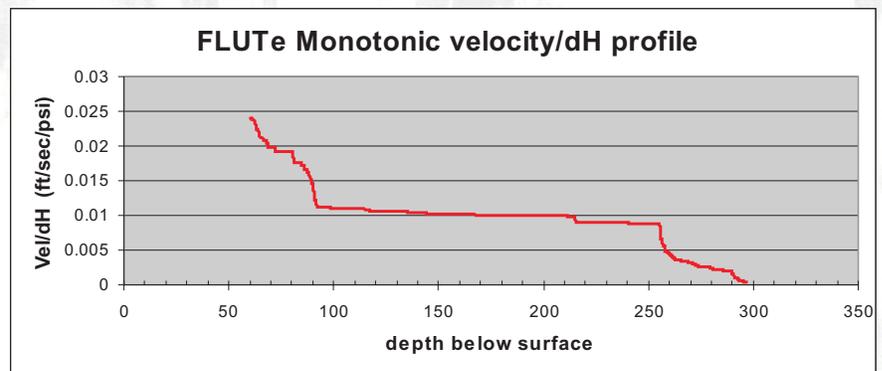
The result: amazing detail



How it works:

A flexible liner is everted down a borehole. As the liner descends, it pushes the water from the borehole into all the fractures in the hole. But the descending liner sequentially seals the flowing fractures from the top down. As each flow path is sealed, the velocity of the descending liner drops according to the flow rate into the fracture.

The velocity plot yields the flow path measurement for the hole. Each step in the velocity is due to a fracture sealed by the liner.



The entire mapping of the flow paths takes 1-4 hours regardless of the hole depth. Once in place, the liner seals the entire borehole.

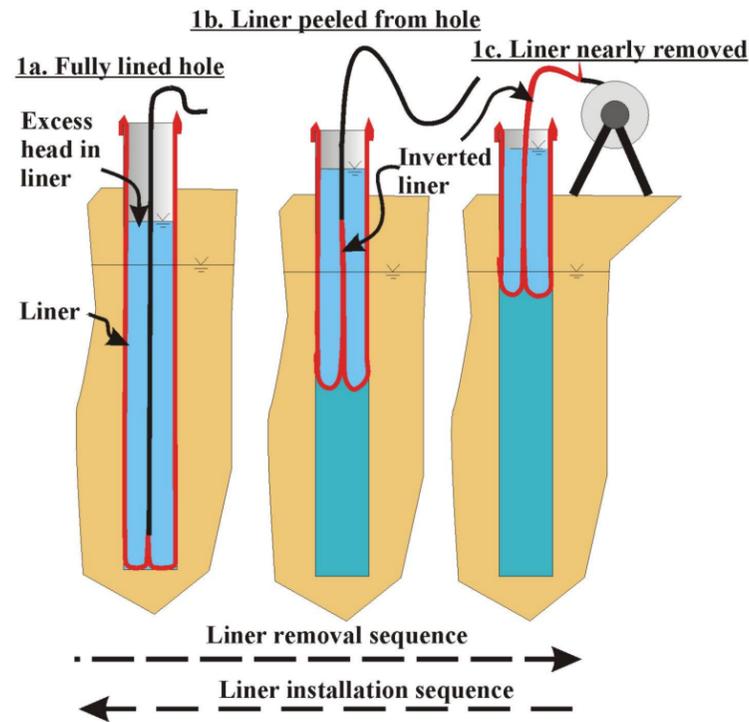
Comparison with traditional methods show excellent agreement. We call it the *FLUTE*TM *Hydraulic Conductivity Profiler*.

**Flexible Liner Underground Technologies (*FLUTE*TM), 6 Easy St., Santa Fe, NM 87506.
www.flut.com. Phone: 888-333-2433, or info@flut.com.**

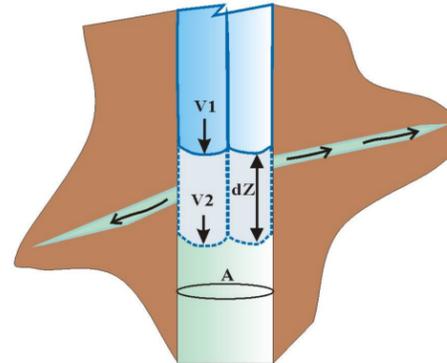
Measuring all significant flow paths in a borehole in 1-3 hours

Carl Keller, Flexible Liner Underground Technologies (FLUTE™)

How a liner works



How a liner travels past a flow path

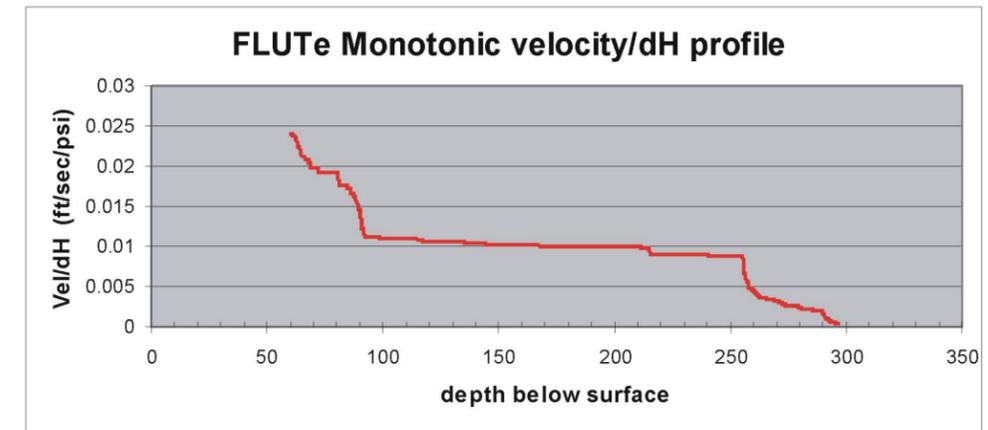


Flow rate into the fracture, $Q_f = A(V_1 - V_2)$, where $V_1 > V_2$

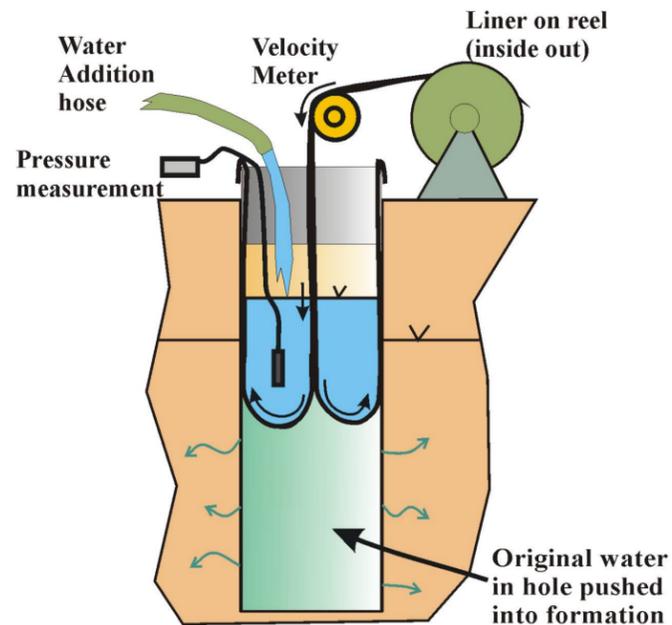
Average flow rate into the hole wall over the interval dZ is:
 $Q/(dZ \pi D) = \text{fctn}(C, dP, D, \dots)$

The results

The velocity drops at each fracture



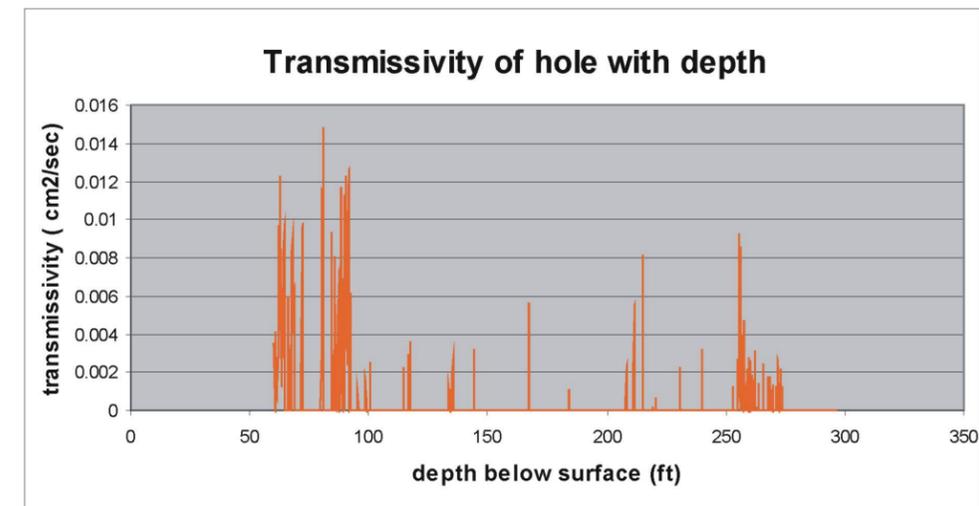
The profiling essentials



The Machine



Transmissivity calculated from velocity



Far better resolution than a straddle packer

www.flut.com

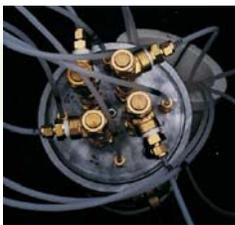
Indeed: “A medley of innovative designs”

Note the Harmony:

1. **GREAT SEAL:** A strong, urethane-coated Nylon liner seals the entire hole, like a continuous packer, isolating typically 5-15 ports per hole.
2. **INERT:** All PVDF tubing (as good or better than Teflon, per L. Parker and T. Ranney 1996 CRREL report).
3. **TESTED:** Proof tested in the factory to 300 psi fully assembled, as shipped.
4. **FAST:** 5-10 port system installed to 300 ft; fully operational in less than 3 hrs.
5. **AMPLE SAMPLE:** Sample size of 1-2 gal/stroke of each dedicated sample pump, yet fully compatible with low flow sampling criteria at each port.
6. **KARST SOLUTION:** Works great in Karst formations. No grout seal required. Seals wherever seals are possible. (T. Kafka, D. Graves (GeoSyntec) paper comparing multi-level systems for karst)
7. **REMOVABLE:** Fully removable for reuse of the hole, or for any other reason.
8. **UNCASED HOLE:** Works equally well in uncased or cased holes. Normally in uncased holes.
9. **WARRANTED:** Fully warranted against any defects. And, it is repairable.
10. **BETTER:** Drives one of our competitors to half truths and innuendo. When you hear that doleful refrain, ask us for the facts. Would you talk to Ford about Chevrolets?
11. **RESPECTED:** We stand behind our claims. Our customers include some of the best known consulting experts in the field, plus the EPA and many States. References available.
12. **ECONOMICAL:** Combine the above features and the life cycle costs are very competitive.

The total equals a modern, well tested, and very effective multi-level ground water sampling system called a ***Water FLUTe™***.

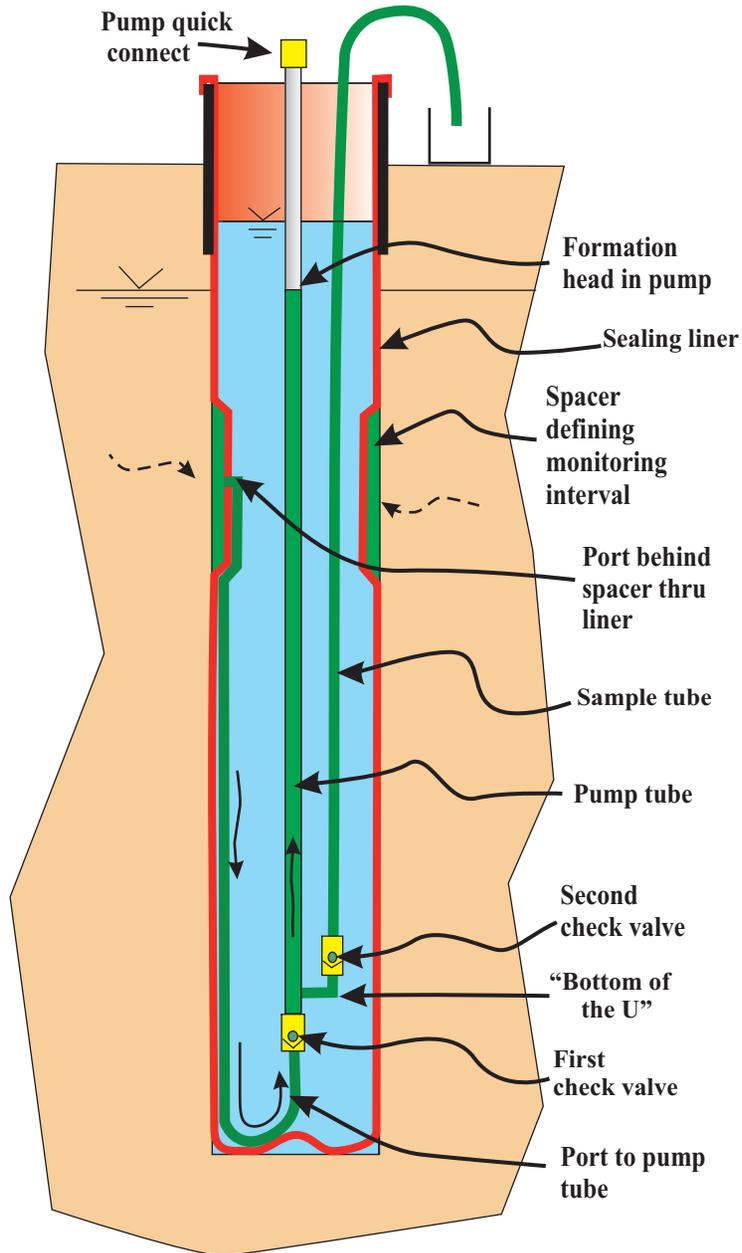
A TRIO: add our sealing borehole liner, and hydraulic conductivity profiling while installing the blank liner, and you have a very nice solution to your site characterization and monitoring needs. Too good to be true? Talk to our customers.



Water FLUTE[®] Multi-Level Sampling System

(Single port system shown for clarity)

Filling from Formation



Pumping Procedure

