New FLUTe *Discrete Extraction/Injection Liner* (DEIL)

Background

In response to a question of whether FLUTe can seal a borehole and extract or inject in discrete intervals of the borehole, the answer is yes, now we can. Because extraction or injection procedures usually use larger flow rates than water sampling procedures and more viscous fluids than water, they require larger diameter tubing than our usual designs. Such large diameter tubing cannot be everted in the usual FLUTe installation manner. Therefore we had to develop a new design that allows us to lower the liner down the borehole with the larger tubing interior to the liner and with discrete intervals defined by exterior spacers were the extraction or injection would occur with the rest of the borehole sealed. The liner is then dilated with a water fill or a different fill such as sand for injections. Removal of the fill material allows the liner to be removed.

The geometry of the liner

The geometry of the FLUTe DEIL is shown in Figure 1 for only two extraction intervals. The tube from the port extends to the bottom of the borehole where it connects with the bottom end of a larger diameter tube to the surface. An air injection line connects as shown to the bottom of the larger air lift pump tube. The air injection, at a surprising small rate, causes the large tube to act as an air lift pump carrying the extracted water to the surface where it can be treated as desired. The same tubing can be used to inject remediation fluids into the same intervals.

The air lift pump is essentially gravity driven, it provides a gallon per minute flow from 65 ft at an air flow rate of ~1 standard cubic foot of air per hour. That is a rate that can be supplied by a relatively small compressor as used for common work like spray painting although at far less than the capacity of those inexpensive compressors.

Liners are not normally lowered into open boreholes because of the concern of abrasion of the liner. Therefore a protective sheath is included in the DEIL design. The sheath is removed after the liner has been emplaced on open uncased holes. In PVC cased holes with screens at each extraction level, the sheath is not needed. In open or cased holes the intervals of interest should be well developed.

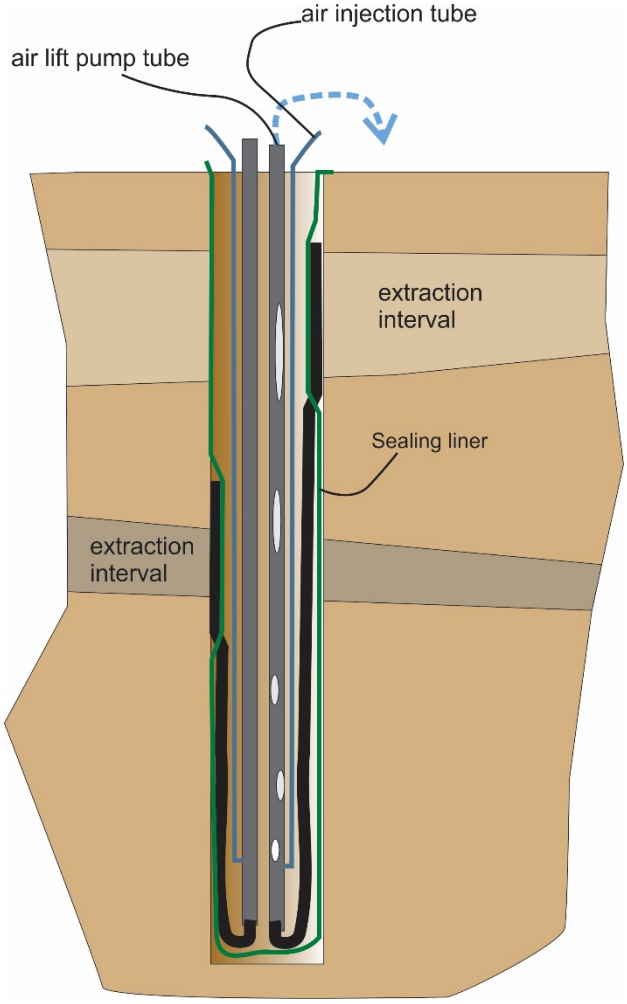

Figure 1. The DEIL geometry showing the large tube from the extraction interval and the larger air lift pump tube. Air injected near the bottom of the pump tube reduces the density of the water column and causes it to be driven to the surface. Water table depth at the port should be less than half the liner depth.

Design limitations

Depth and flow rate limitations are still being assessed, However, the flow rates obtain for the 65 ft deep borehole with the spacer at 25 ft were as high as 2 gal/min.

For extractions, a water fill of the liner is sufficient. For injections, a sand fill will prevent collapse of the liner. A grout fill is also an option. A sand fill can be removed using the same air lift pumping technique. For very high injection pressures, the liner can be sealed and pressurized or grout filled. A grout filled liner can be drilled out for abandonment.

The simplicity of the air lift pumping method and the low cost make this an especially attractive FLUTe design. There are no moving parts. The utility for remediation injections further expands the utility of the system. This design can replace the removable FLUTe multi-level monitoring systems when remediation intervals have been defined. The number of intervals available depends on hole diameter and tubing diameter.

The air lift pumping mechanism is less effective if the water table is relatively deep compared to the borehole depth. A water table more than half the hole depth below the surface begins to be limited in flow rate and has limited ability to function as a pump for water table depths more than half the depth of the pump tube.

The advantages of the DEIL

- The liner can usually be installed or removed by the customer.
- The entire borehole is sealed except for targeted intervals.
- The pumping rate is very efficient
- The cost of the pumping system is not much more than the tubing to the surface and less than most electric pumps.
- One is not treating water that is free of contaminants.
- A water sample is easily drawn from the bottom end of the pump tube to assess contaminant levels unaffected by the aeration of the pumping mechanism.
- It replaces the need or bypass of multiple straddle packers in a borehole.