FLUTe™ Flexible Liner Underground Technologies, Ltd. L.C.
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Use of Pressure Transducers with Water FLUTe System

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Purpose
This guide explains where the pressure transducer is located in the Water FLUTe system and how the formation head is measured at each port both manually and with the pressure transducer. The manual measurement is required to determine the precise depth of the pressure transducer in the borehole. Given the depth of the transducer, all future head measurements can be determined from the transducer measurements.

Geometry
The Water FLUTe multi level sampling system is shown in Fig. 1. The formation water flows from the formation into the spacer interstitial space and via the annular spacer into the port. The water is conducted from the port to the bottom of the hole and upward into the pump tube volume through the first check valve. The water from the port fills the pump tube to the level of the natural head in the formation.

When pressure transducers are part of the design, the pressure transducer is located just below the first check valve on the port to pump tube (Fig 2.). The pressure transducer measures the water pressure in the tube at the elevation of the transducer diaphragm shown in Fig. 2.

The water from the port also fills the sample tube though the second check valve. If the system has been pumped, the sample tube may also be filled to the surface.

Calibration of the pressure transducer
Since the pressure transducer measures the head in the port-to-pump tube which is open to the formation, the pressure measured is the head in the formation at the depth of the transducer diaphragm (Fig 2). If one knows the depth of the transducer below the ground surface, the water table depth below the surface can be calculated directly for that port (WT bgs = depth transducer - head measured by transducer).

Another simple means of measuring the water table depth is to tag the depth of the water in the pump tube (Fig. 2) if the water table is less than 200 ft. (For deeper water tables, contact FLUTe for a special tag line.) If one has measured the depth to the water in the pump tube, he can calculate the depth to the transducer (depth to transducer = WT Depth bgs+ head measured by transducer). Since the actual depth of the transducer is not precisely known when the liner is emplaced due to a variety of factors including the actual depth of the hole, the depth of the transducer is best determined from this manual measurement of the water table in the pump tube. The first check valve has a Teflon ball so as to minimize any perturbation to the equilibration of the water in the pump tube at the actual water table for that port.

However, because of the fact that the check valve will prevent the water flow out of the pump tube to the port, the water level in the pump tube can not follow a dropping water table in time. In order to obtain the correct current water table, the entire contents of the pump tube and sampling tube must be expelled to allow the pump tube to fill to the

current water table level. Therefore, a gas pressure source should be used with the normal water sampling valves to expel all of the water from the system just as described for the purge procedure in the water sampling procedure (Fig. 3). The water sampling procedure is available from FLUTe.

It is important to remember that the pressure transducer is connected directly to the formation and is not measuring through any check valves. Therefore, the transducer follows the head changes in the formation. As the pump refills, the transducer will follow the last portion of the rising head in the pump when the flow velocity of the water in the pump is very low.

Procedure for calibration of the pressure transducer

To obtain the depth of the transducer in the hole, purge the pump of all water and let it equilibrate to a new water level equal to the water table in the formation. Measure the depth of the water table in the pump tube. This is the depth of the water table in the formation for that port (it may not be the water table measured in the open hole). Add the head measured in the pump tube to the head measured by the transducer. The sum is the depth of the transducer below the surface. For all future head measurements in the formation (water table depths below the surface), subtract the transducer head measurement from the transducer depth. This same procedure is used for each port. This will provide the depth to the water table for each port elevation in the formation. For absolute elevations, convert the depths below the surface to elevation values.

Once the depth of each transducer has been determined, it does not need to be remeasured. However, with time the transducer calibration may drift. The manual measurement of the water table allows the transducer effective depth to be determined as often as desired.

FLUTe provides pressure transducers for specified ports as a service to our customers for the retail price of the transducer and cable with appropriate fittings. The transducer calibration information is also provided by FLUTe as received from the manufacturer. The warranty of the transducer and associated hardware is the responsibility of the manufacturer. For information on the transducers, please contact the manufacturer.

For any questions about this procedure, call 888-33-32433.

Fig. 1 Water FLUTe Port and Pump System

(Single port system shown for clarity)

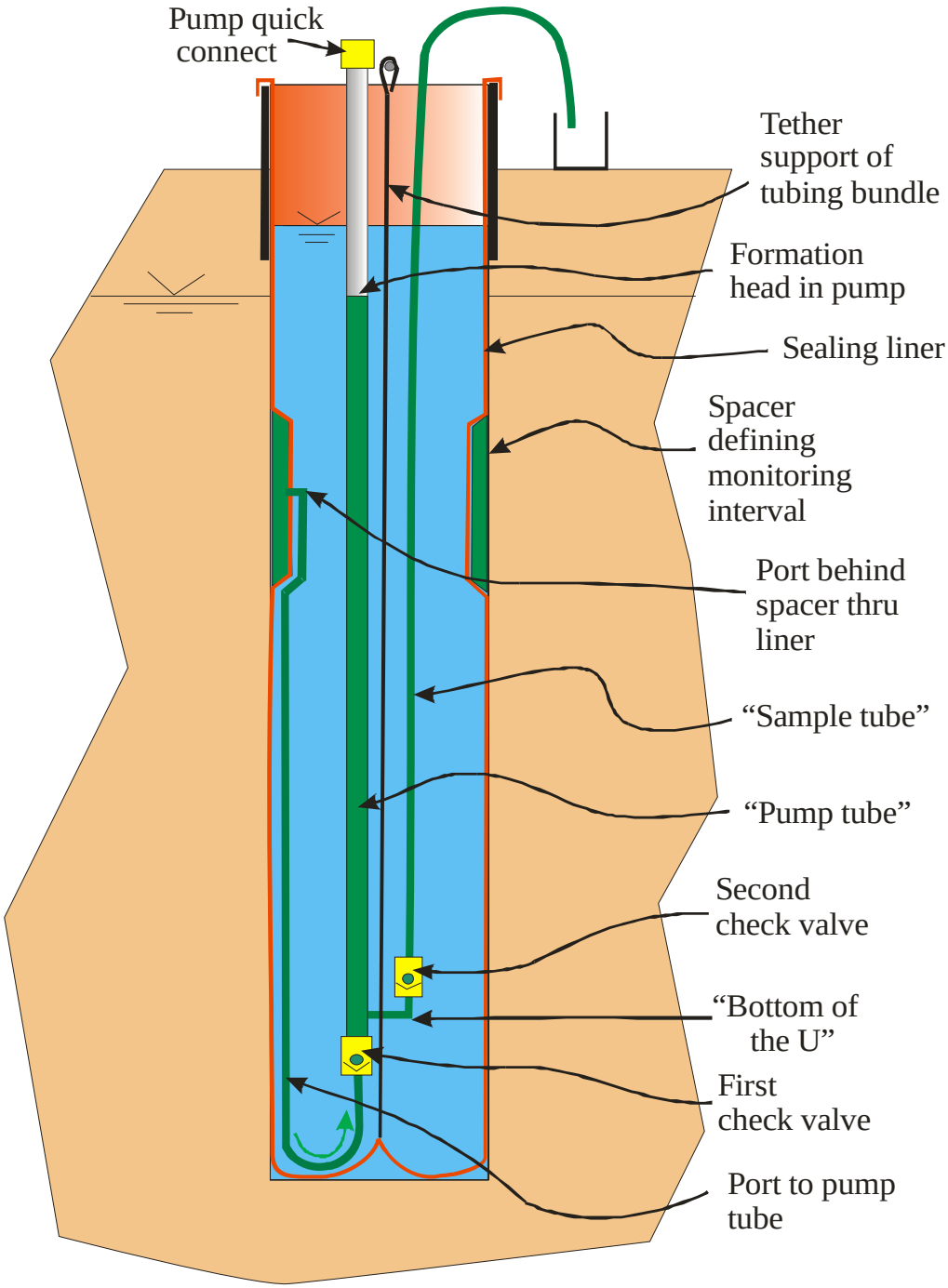

Fig. 2 Water FLUTe port/pump with Transducer

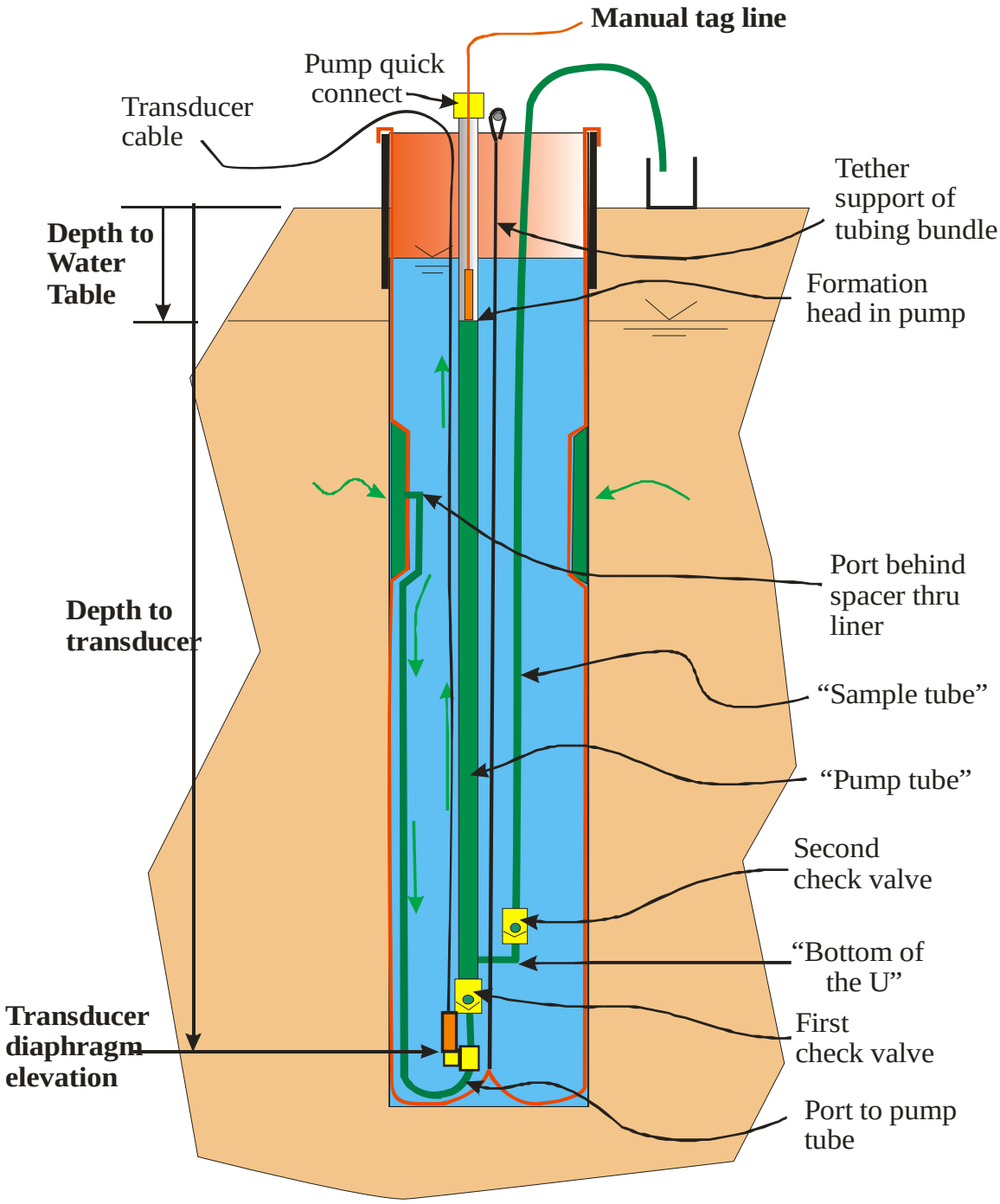

Fig. 3. Purge Pumping Procedure