An overview of:

The Auger Hole Method: A field measurement of the hydraulic conductivity of soil below the water table

By: W. F. J. van Beers

This is just a brief overview of this method. The entire publication can be found at:

http://www2.alterra.wur.nl/Internet/webdocs/ilri-publicaties/bulletins/Bul1/bul1-h1.pdf

for all those interested in reading the theory behind the method.

Introduction

There are 4 distinct parts to this activity

1. Drilling the hole(s) in the location you would like to investigate (probably more than one location would be best)
2. Prepping the hole by removing water (generally using a bailer made from PVC pipe, but could also use a pump)
3. Measuring the rate of water rise (many methods available for this one)
4. Compute the hydraulic conductivity from measurements

Drilling the holes

To get accurate measurements, the hole needs to be as undisturbed as possible, so take your time and don't get carried away. The depth of each hole depends on a bunch of factors, but for practical purposes, 60 to 70 cm (2 to 2.5 ft) below the water table should do it. Note: If you have multiple layers and want to know the conductivity of each one, you will need to refer to the full publication for details.

There are several augers available to use for drilling. They are generally sold with a classification (i.e. clay, stony, mud, general purpose), so consider the application. Also, a 5 cm (2 in) auger or larger would be ideal.

Removing water from the hole

Before this step, make sure the water level in stable so you can measure the surrounding groundwater depth. After this, it is a good practice to bail 2 or 3 times to open any pores that were clogged during drilling, but this depends on how clean the hole is and which type of auger you used. The bailer should be about 2 cm (¾ in) smaller diameter than the augured hole with a check valve on the bottom.

When bailing just before measurement, you want to drop the water level by 20 to 40 cm (8 to 16 in). The deeper you go, the less time the test will take.

Measuring the rising water

The more measurements you take the better, but at least 5 are required to get a good estimate. When measuring, you need to record the time of the measurement and the depth to the water surface. Measurements are taken maybe every 5, 10, 15, or 30 seconds, depending on how quickly the water is rising (could be every couple minutes in really tight soils). The test need to be done before the hole fills up ¼ of the way so, if you bail 40 cm (16 in), you want to stop before it refills to 10 cm (4 in).

Measurements can be made with an audio water sensor, with a float and measuring rod, or with a logging pressure transducer. Of course they all have their benefits (ease, cost, accuracy).

Calculations

The calculations are a bit complicated; however, they can be done with some patients and a calculator. Refer to Figure 1 below for what the terms actually mean. Equation 1 below can be used to calculate the hydraulic conductivity.

Equation 1

$$k = \frac{4000 * r^2 * \Delta y}{(H + 20 * r) * \left(2 - \frac{y}{H}\right) * y * \Delta t}$$

where k is the hydraulic conductivity in meters/day, which we can change, r is the radius of the hole in cm, Δy is the change in your measurement in cm, Δt is the time between your measurements, H is the depth of the hole below the groundwater table, and y is the distance between the groundwater level and the average level of water in the hole during the measurement (see Figure 1 below). There is a spreadsheet setup to do these specific calculations that can be made available if interested.

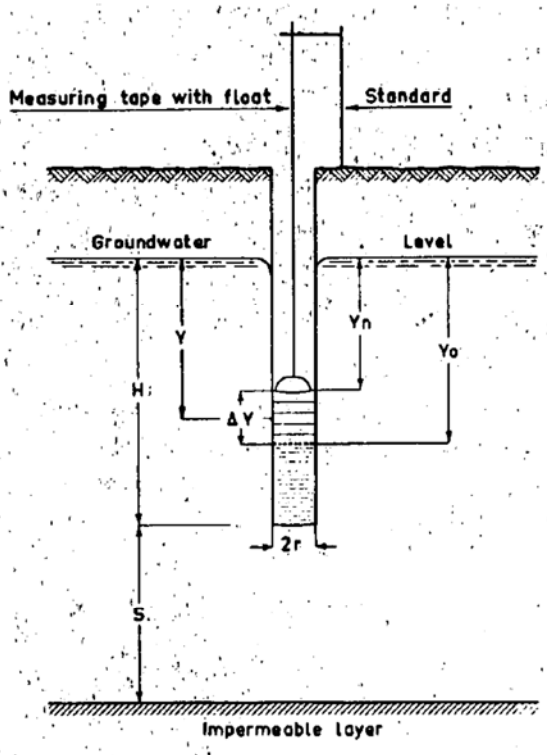

Fig. 2. Diagram of method followed in determining the hydraulic conductivity by the auger-hole procedure.

H = depth of the hole below the groundwater table.

y_o = distance between the groundwater level and the elevation of the water surface in the hole after removal of water at the time of the first reading.

y_n = the same at the end of the measurement. Usually about 5 readings are taken.

$\Delta y = \Sigma \Delta y_t = y_n - y_o$; the rise of water level in the hole during the time of measurement,

y = distance between the groundwater level and the *average* level of the water in the hole during the time of measurement.

$$y = \frac{y_n - y_o}{2} = y_o - \tfrac{1}{2}\Delta y.$$

r = radius of the hole.

Figure 1. Auger hole layout with applicable parameters for hydraulic conductivity calculation.