Soil Evaluation Techniques

NSFC ENGINEERING SCIENTIST
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Editor's Note: This column is based on calls received over the National Small Flows Clearinghouse technical assistance hotline. If you have further questions concerning soil evaluation, call (800) 624-8301 or (304) 293-4191 and ask to speak with a technical assistant.

National Environmental Services Center staff operate the permeameter.

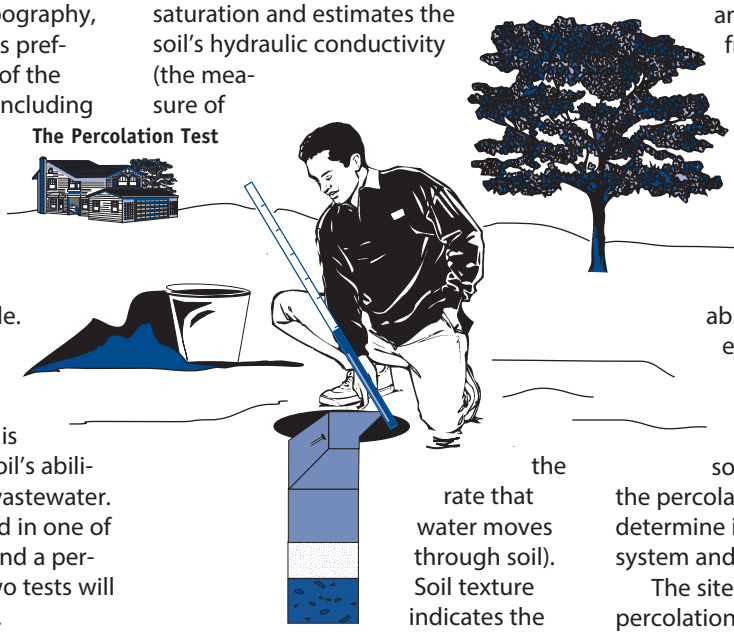
How is the soil on my site determined to be suitable for an onsite wastewater treatment and disposal system?

The site evaluation is the first step toward installing an appropriate wastewater disposal system and entails gathering detailed information about the lot and the surrounding area. This information includes the topography, separation distances, owner's preferences, physical properties of the soil, existing water sources (including groundwater and surface water), the depth to any limiting layer, and other conditions that describe whether wastewater treatment and disposal by the soil is possible.

The most important factor in determining whether an onsite system will work on a particular site is the soil properties and the soil's ability to treat and dispose the wastewater. Typically, the soil is evaluated in one of two ways: a soil evaluation and a percolation test. Often, these two tests will both be performed on a site.

A soil evaluation begins with a simple soil probe or boring, using a hand auger or probe to retrieve samples of the soil at different depths, followed by digging a test pit. The boring will give the experienced soil evaluator a rough idea of what can be expected on the lot. At least one test pit is dug within the perimeter of the proposed absorption area. The test pits must be deep enough for the evaluator to determine that enough unsaturated soil is available below the proposed bottom of the absorption area.

The evaluator will look at the soil texture to estimate permeability, soil structure, and soil color changes that may indicate the influence of groundwater. As far as water movement within the soil is concerned, the evaluator determines any seasonal soil saturation and estimates the soil's hydraulic conductivity (the measure of the rate that water moves through soil). Soil texture indicates the various sizes of solid particles in the soil and the proportion of spaces that exist between those particles. Soil texture analysis provides an estimate of the percent of sand, silt, and clay, with generally higher clay content having lower permeabilities.



The Percolation Test

A soil's physical structure will influence how water will move in the soil. This is determined by looking at the soil structure. The soil evaluation can provide enough information to the evaluator to determine if the site is suitable to treat and dispose wastewater from your onsite system.

The second method for determining the soil's ability to adequately treat and dispose wastewater is through a percolation test. The theory behind the percolation test is that the rate of water absorbed into the soil of an excavated test hole relates to the amount of water flowing through an onsite system and how rapidly the soil can absorb it. Results of the percolation test are used to help determine if a site can accept an onsite system and to size the absorption area.

The site evaluator will perform the percolation test by excavating three to four test holes uniformly spaced within the proposed absorption area. The depth and size of the holes and the percolation test procedure may vary from state to state, and this should be verified with the local or state regulatory authority. The sides of the hole should be roughened to expose the natural soil surface and to make sure that smearing of the sides does not interfere with the testing procedure.

Loose soil is to be removed from the hole, and two inches of one half to three-quarter-inch gravel is placed in the bottom of the hole. This is done to prevent scouring the bottom of the hole when water is added.

The hole is to be filled with at least 12 inches of clear water. In most states, this water depth is to be maintained for at least four hours to achieve saturated conditions within the hole. Only saturated soil conditions will produce an accurate measurement of water movement through the soil. Once these steps have been completed, percolation test measurements are taken by observing the drop in water within the hole over a period of time, measured in minutes per inch. The water level drop is used to calculate the percolation rate. Check with local and state regulatory authorities for the specific procedures to be used in performing the percolation test, as they do vary.

Table 1 Advantages and Limitations to the Testing Methods for Soil Suitability

Soil Evaluation	Percolation Test	Permeameter
Advantages		
Visual identification of soil conditions	Moderately accurate estimation of soil hydraulic capacity (if the procedure is followed completely according to code)	Relatively easy to perform
Easy to learn soil identification techniques	Provides information about the sizing of an onsite systems absorption area	Small volume of water needed to perform the test
		Testing is completed under saturated conditions
		Several readings ensure accuracy in the test procedure
Limitations		
Highly variable; results may vary from personal identification by evaluator	Difficult to determine if saturated conditions have been achieved, particularly in dry soil conditions	Roots or rock fragments can affect test results
Does not reflect compaction effects on permeability	Time consuming	Records hydraulic conductivity only
Translation to soil permeability can vary widely	Large volumes of water needed to complete the percolation test	Calculations will require additional data to estimate site hydraulic capacity and loading rates
	Seriously affected by proximity of water table	
	Highly variable testing method depends on how well the test is conducted	

The percolation test may produce widely varying results depending on the soil's present condition and is best used along with soil boring test results. Detailed soil evaluations and more sophisticated permeability tests are replacing percolation tests in many states because they are more accurate.

There is an alternative testing method that does not replace the need for a soil evaluation, but is complementary. This testing method is performed using a permeameter. A permeameter is a tool that will provide a relatively quick estimation of a soil's hydraulic conductivity, which, as stated earlier, will determine the ability of a site to treat and dispose wastewater. The permeameter, similar to the test pit, soil borings and percolation test, is placed in several augered holes within the perimeter of the proposed absorption area. The depth of the holes should be at least 18 inches. While augering the holes, the evaluator should observe the soil being removed and evaluate the soil texture as a way to confirm the soil permeability found using permeameter testing.

The permeameter is then filled with water and then placed within the hole. The use of the permeameter allows for the soil to become quickly saturated, and testing can begin within 5 minutes of activating the permeameter. Readings on the permeameter are taken every 5–7 minutes for at least 20 minutes. When the minutes-per-inch fall for two consecutive water level readings are consistent, saturated soil conditions around the auger hole have been created, and the test readings can be converted to conductivity values.

Soil suitability for wastewater treatment can thus be determined using a variety of methods, including soil evaluations, percolation tests, or permeameter testing. Ideally, a combination approach involving soil evaluation and a water-based test, such as percolation or permeameter testing, is likely to provide the most reliable prediction of how suitable the soil is for an onsite