

<b>Cornell Soil Health Laboratory 2022</b>	<b>Code:</b> CSH 05
	<b>Date:</b> 1/6/2022
<b>Title:</b> <b>Available Water Capacity</b>	<b>Page:</b> 1 of 3
	<b>Location:</b> Leland 120
<b>Final revision:</b> Bob Schindelbeck, Kirsten Kurtz, Steven Dunn	

## Available Water Capacity



### Background / References:

Available water capacity (AWC) reflects the quantity of water that a disturbed sample of soil can store for plant use. AWC is determined in the lab by measuring the soil water content at both field capacity and permanent wilting point using air pressure chambers and ceramic pressure plates. AWC is defined as the difference between water stored at field capacity and the wilting point.

In the field, a soil is at the upper end of soil water storage when water that it cannot hold against the force of gravity has drained – this is called ‘field capacity.’ We define the field capacity in the laboratory as 0.1 bar of pressure (10kPa) in the pressure cells. The lower end of the range of water storage is referred to as the ‘permanent wilting point,’ which occurs when only hygroscopic water remains (i.e., water tightly held so tightly onto soil particle surfaces so tightly that it is inaccessible by plant roots). The permanent wilting point is defined in the laboratory using 15 bars of pressure (1500kPa).

Reynolds, W. D., & Topp, G. C. (2008). Soil water desorption and imbibition: tension and pressure techniques. Soil sampling and methods of analysis. 2nd ed. CRC Press, Boca Raton, FL, 981-997.

### Scope/Objective:

Soil is air dried and sieved past 2mm prior to placing on a pressure plate apparatus for one week to remove soil water. Each sample has a subsample equilibrated to 0.1 bar (10 kPa) and a subsample equilibrated to 15 bar (1500 kPa).

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	<b>Date:</b> 1/6/2022
<b>Title:</b> <b>Available Water Capacity</b>	<b>Page:</b> 2 of 3
	<b>Location:</b> Leland 120
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**NOTE: For Quarantined soils, see labeled procedures in italics at the bottom of each section.**

### **Materials and Equipment:**

1 bar and 15 bar pressure plates  
 Rubber rings (to hold soil on the plate, approx. 1.5cm tall and 5cm in diameter)  
 Pressure chambers- 5 bar and 15 bar  
 Compressor  
 Pressure regulation system  
 Analytical balance  
 One liter beakers  
 Spatula  
 Wash bottle  
 Spoon  
 Tared weighing cups  
 Drying oven  
*Bleach/10% Bleach solution in spray bottle*

### **Procedure:**

1. Saturate 1 bar plates and 15 bar plates using a wash bottle to deliver water. To ensure the plates are saturated, they can be stored for up to 2 weeks in tubs of clean water after each use. Place 14 rubber rings on each plate in a predetermined and prerecorded order. *Work inside a large plastic tub to collect any water run-off. Add bleach tablets to create a 10% bleach solution and soak for 30 minutes before discarding. Clearly label throughout test as quarantine with a sign or a large "Q" on samples.*
2. Fill a rubber ring on each of two plates (one 1 bar and one 15 bar) with about 15 g of soil (as much as will fit into each ring). Place soil from the first sample into each of the number one position rings on the 1 and 15 bar plates and so on until all 14 positions on each plate are filled. Add enough water to the plate surfaces to saturate the soil samples. Note that some dry soils can be hydrophobic and resist wetting. In these cases, place 2 tablespoons of sample into a clean plastic cup, add 2 tablespoons of water to create a slurry. Pour this slurry into the designated position. Keep plates with samples flooded for at least 3 hours to fully saturate. *Bleach any laboratory equipment that comes into contact with quarantined soil with 10% bleach solution for 30 minutes before discarding.*
3. Beginning with plate 3, stack pressure plates into the appropriate pressure chamber ensuring that the plates do not contact the soil samples below and the outflow tubes are not restricted. Spacers placed on the plate surface can be used to support the next plate above it. Connect outflow tubes of plates to pressure chamber outlet tubes, set pressure chamber outlet tubes into beakers. *Bleach all water in beakers with 10% bleach solution for 30 minutes before discarding water.*
4. Tighten lids down using the appropriate bolts.
5. Bring both chambers up to pressure slowly over 2 minutes.

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	<b>Date:</b> 1/6/2022
<b>Title:</b> <b>Available Water Capacity</b>	<b>Page:</b> 3 of 3
	<b>Location:</b> Leland 120
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6. Equilibration requires ~1 week.
7. After equilibrium, the samples are placed in tared moisture cans and weighed.  
*Bleach pressure plates and any equipment that comes into contact with quarantined soil with 10% bleach solution for 30 minutes before rinsing.*
8. These cans are placed in an oven at 105C and dried to constant weight.  
*Bleach cans with quarantined soil with 10% bleach solution for 30 minutes before rinsing. Discard soil into autoclave bags and autoclave as soon as possible.*

**Calculations for each subsample which has been equilibrated to 0.1 bar and 15 bar:**

Theta M = ((wt. wet soil + can) - (wt. dry soil + can)) / ((wt. dry soil + can) - wt. of can)

Units are g water / g oven dry soil

For sample X :

$$AWC_{\text{sample x}} = \text{Theta M}_{0.1 \text{ bar}} - \text{Theta M}_{15\text{bar}}$$

**Table 1. Lima silt loam soil standard Quality Control soil (QC) descriptive statistics for the Available Water Capacity test 2020**

ID	Theta M	Theta M		Theta M	Theta M
	10 kPa	1500 kPa		10 kPa	1500 kPa
1	0.375	0.099	Mean	0.366	0.103
2	0.386	0.100	Standard Error	0.001	0.001
3	0.381	0.101	Median	0.365	0.100
4	0.381	0.099	Standard Dev.	0.009	0.007
5	0.376	0.099	Range	0.034	0.020
6	0.376	0.107	Minimum	0.351	0.094
7	0.377	0.100	Maximum	0.386	0.114
8	0.374	0.101	Count	34	34
9	0.370	0.099	<b>mean</b>	<b>0.366</b>	<b>0.103</b>
10	0.371	0.101	<b>mean MINUS 3 SD</b>	<b>0.340</b>	<b>0.082</b>
11	0.364	0.112	<b>Mean PLUS 3 SD</b>	<b>0.392</b>	<b>0.124</b>
12	0.368	0.111			
13	0.366	0.112			
14	0.358	0.113			
15	0.351	0.112			
16	0.360	0.113			
17	0.363	0.112			
18	0.354	0.114			
19	0.362	0.112			
20	0.355	0.113			
21	0.358	0.111			
22	0.358	0.096			
23	0.365	0.098			
24	0.367	0.098			
25	0.364	0.098			
26	0.356	0.094			
27	0.355	0.095			