2805D20 OPERATING INSTRUCTIONS

2805D20 Pressure Infiltrometer Attachment Assembly — March 2009

Figure 1 - 1.) Reservoir Carrying Case (MML009),
2.) Guelph Permeameter Reservoir Assembly (2800-100CR)
3.) Pressure Infiltrometer Foot Assembly (2805D20),
4.) Vacuum Hand Pump (2005G2)
5.) 2-1/2 Gallon Folding Jug (2038V3).

These instructions are helpful for operating the Pressure Infiltrometer. Making readings using the Guelph Permeameter Reservoir Assembly is as simple as recording the change in reservoir water level outflow (R (cm/T)) as water infiltrates into the soil. The Guelph reservoir assembly is two reservoirs in one. When both reservoirs are combined, the reservoir valve notch is in the 12:00 o'clock position, which is useful when infiltration rates are rapid (i.e., in sand and loam textured soils). The inner reservoir provides better resolution when making readings in slow infiltration soils (i.e., clay loam and clay textured soils). The inner reservoir is engaged when the reservoir valve is turned so the notch is in the 6:00 o'clock position. To calculate flow rate (Q (cm^5/T)), simply multiply by the appropriate reservoir calibration factor: X= for the combined reservoirs, and Y= for the inner reservoir only.

SOILMOISTURE EQUIPMENT CORP.
P.O. Box 30025, Santa Barbara, CA 93105 U.S.A.
Telephone 805-964-3525 - Fax No. 805-683-2189
Email: sales@soilmoisture.com - Website: http://www.soilmoisture.com

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AQUAINT YOURSELF WITH THE PARTS

Figure 2 - Pressure Infiltrometer Foot Assembly, Disassembled

NOTE: Please see page 6 for details and replacement parts for the Pressure Infiltrometer. Please see page 7 for details and replacement parts for the Guelph Permeameter Reservoir Assembly.

ASSEMBLY

The Pressure Infiltrometer (PI) Attachments for the Guelph Permeameter (GP) consist of two major components. They are:

1. Guelph Permeameter Reservoir Assembly
2. Pressure Infiltrometer Foot Assembly

NOTE: The Reservoir has a factory calibration that is shown (labeled) on the face of the reservoir valve. Record the cell constants x= and y= and the Serial Number. Place these in a safe location for future replacement reference in case the reservoir valve is lost or misplaced.

The PI Foot Assembly comes completely assembled except for the Installation Ring, which is easily detachable *(see Figure 2)*. Prior to complete assembly, use the Installation ring to insert the cutting ring/foot assembly into the soil. Once the foot assembly is inserted into the soil, the Pressure Infiltrometer can be completely assembled and made ready for use. Insert the support tube of the reservoir assembly into the foot assembly and make sure the double “O” ring support tube is securely seated. The reservoir can now be filled with water in preparation for making measurements (see the following operating instructions).

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PI Foot Installation

To install the pressure Infiltrometer foot assembly into the soil, use the detachable installation ring. The installation ring is heavy gauge plated steel and rests on the support ring during installation, see *(Figure 2*). It is designed to take the abuse of repeated blows from a rubber mallet while inserting the cutting ring into the soil. To achieve a vertical installation in the soil, strike the installation ring directly with a mallet at opposite sides (i.e., at 3:00, then 9:00, 2:00 and 6:00 o'clock) while driving the cutting ring into the soil. As an alternative, a block of 2" x 4" wood can be placed over the installation ring and struck with a mallet or hammer. Repeat the process on opposite sides of the foot assembly until the desired insertion depth is obtained. The cutting ring insertion depth should be between 3 and 5 cm. The depth is shown by the depth indicator rings grooved onto the cutting ring exterior surface.

Installation Techniques for Well Structured Soils

It is advisable to insert the cutting ring into moist soil, especially for well-structured soils that have a large shrink-swell potential. This is not always possible given ambient soil moisture conditions. The problem encountered in dry soil is the shattering of the soil peds during installation. In this case ponded water will preferentially flow down the fractured ped faces. Considerable quantities of water will be required to bring the soil water content to a workable condition. Wet season measurements are preferred, but are not mandatory. After site selections have been made, it is advisable to pond water on the study site to swell the clays. This can be done a day or two prior to cutting ring insertion. (This technique is intended for use on highly structured clays that have saturated hydraulic conductivity of 10^{-6} cm/s or less.) Ponding to a depth of 6 cm should be adequate, but may be difficult to achieve initially as water fills the many cracks between ped faces. Building a border around the site approximately a meter in diameter to a depth of about 6-cm is helpful.

Installation Techniques in Sand or Loam Textured Soils

The installation of the PI ring in sand, silt or loam textured soils presents no problem, except when there is considerable rock content. Situations with high rock content should be avoided when using the Pressure Infiltrometer. If the cutting ring on the Pressure Infiltrometer becomes severely damaged due to rocks in the profile, the cutting ring can be replaced. *(2805D20-200)*

For measuring hydraulic conductivity on sites with high rock content, a surface disk Permeameter and appropriate techniques are recommended. A disk-type Infiltrometer, the Guelph Tension Infiltrometer, is available from Soilmoisture Equipment Corp.

Filling the Reservoir and Preparation to Make Measurements

Once the cutting ring is inserted, the Guelph Permeameter Reservoir Assembly may be attached using the support tube. Push the air tip (attached to the air tube) down to the air tip seat located in the foot cover. Turn the reservoir valve so the notch is pointing to a 3:00 or 9:00 o'clock position. The two steps outlined above should be double-checked prior to filling the reservoir with water to prevent accidental water spillage.

In preparation for making a measurement, the air tip (attached to the air tube) should be lifted to an appropriate height to establish a pressure head (hydraulic gradient) (cm) at the soil surface. Appropriate pressure heads are listed for various textured soils in Table 1.

The head height applied using the well height indicator on the Guelph Permeameter Reservoir

Filling the Reservoir and Preparation to Make Measurements (cont.)

Assembly differs from the actual head height applied at the soil surface. The variability in the ring insertion depth and the configuration of the PI Foot Assembly must be accounted for in determining the actual head height. The actual head height may be determined by using an algorithm that converts the well height indicator value (cm) to actual well height (cm) dependent on the cutting ring insertion depth (Eq. 1). Head height (cm) may also be independently verified using a “sight tube” attached to one of the access ports on the PI foot cover and then physically measuring the height from the water level in the “sight tube” to the soil surface.

$$\text{Actual Well Height (cm)} = (7.5 - 1) + WH \qquad \text{Eq.1}$$

Where: 1 = the cutting ring insertion depth (cm)
WH = the well height indicator value (cm)

Lift the air tip to provide an appropriate pressure head. The inner or outer reservoir should be selected with the reservoir valve. The inner reservoir should be selected for those situations where measurements are made on clay textured soils
(i.e., K_{fs} >= 10^{-6} cm/s). The outer reservoir can be used for all other situations.

If measurements require the use of the inner reservoir, the reservoir valve should be turned to the outer reservoir first (turn the reservoir valve to the 12:00 o’clock position). This will allow water from the reservoir to quickly fill the ponded head space above the soil within the foot assembly. After air bubbles have been dislodged from the ponded head, air tube, and support tube, the reservoir valve may be turned to the inner reservoir (6:00 o’clock position). The inner and outer reservoirs will initially be the same level, but the inner reservoir will drop as infiltration bubbles from the air tip begin to relieve the increasing vacuum in the air space of the reservoir. This process assures a steady head condition. The inner reservoir may be refilled by turning the reservoir valve to the outer reservoir (12:00 o’clock position) and turning again to the inner reservoir. (This procedure introduces a loss of data for the immediate timed measurement interval and requires recording the new water level and time.)

Measurement Techniques

To make measurements with the PI, you should objectively decide on an appropriate technique to use. They could be:

1. Transient flow (early time measures)
2. Steady flow techniques.

Under steady flow techniques, values can be obtained using single head or multiple head approaches. In the multiple head approach, two or more water potentials (heads) are sequentially applied. Appropriate hydraulic conductivity and flux potential values
(k_{fs} and $o_{ß}$) are solved using either simultaneous equations (2 heads applied sequentially), or least squares regression (2 or more head applied sequentially). For a complete discussion of appropriate techniques, please review pertinent publications by D. E. Elrick and/or W. D. Reynolds and others. A short list of review articles is included in section IV References.

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Measurement Techniques (cont.)

When making multiple head measures, it is important to use successively larger heads rather than using a decreasing head approach. The effect will be saturating a profile rather than draining it. The saturating condition simulates infiltration.

TABLE 1 Appropriate Pressure Heads Vs Soil Textural Classification For Measuring Saturated Hydraulic Conductivities, Flux Potential Values, And Other Soil Hydraulic Properties.

TEXTURAL CLASSIFICATION	PRESSURE HEAD (CM)
Sands, Sandy Loam, Silt, Loam	5 – 10
Sandy Clay Loam, Silty Clay Loam	10 – 15
Clay	15 – 30

Measurements in Very Slow Infiltrating Soils

When making measurements of very slow infiltration rate soils ($<10^{-0}$ cm/s) it may be difficult to obtain steady state values. These difficulties may be experienced, in part, because of:

1. The length of time necessary to obtain steady state (many hours in the worst case)
2. The dynamic physics of the ambient environment
3. The physics of the instrument construction.

If the infiltration rate is approximately 1.0 cm/min or less, if the Pressure Infiltrometer is in a warming environment (i.e., air temperature is increasing in bright sun), and if there is an air gap above the water level in the reservoir, a pressure increase can be expected due to the rapidly expanding gases in the air space above the water level in the reservoir. This situation can occur if the bubbling rate (related to the infiltration rate) does not exceed the rate of expansion of gases in the air space. Several suggested methods to alleviate the problem are:

1. Maintain as much water as possible in the upper reservoir to minimize the air space;
2. Shield the upper reservoir assembly from direct sun light;
3. Use an access port of the foot assembly to install a horizontal burette assembly at a fixed head height and eliminate the use of the upper reservoir assembly. A 5 to 10 ml burette is sufficient;
4. Use a “prior ponding” technique to bring the site to near saturation prior to establishing a fixed steady head with the Pressure Infiltrometer Assembly. This will minimize the time necessary to achieve steady state. The major concern is that the “prior ponding” head cannot exceed the steady state head established during the latter measurement period.

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Calculations

See References:

Constantz, J., W.N. Herkelrath and F. Murphy, 1988. Air Encapsulation During Infiltration, Soil Sci. Soc. Am. J. 52:10-16

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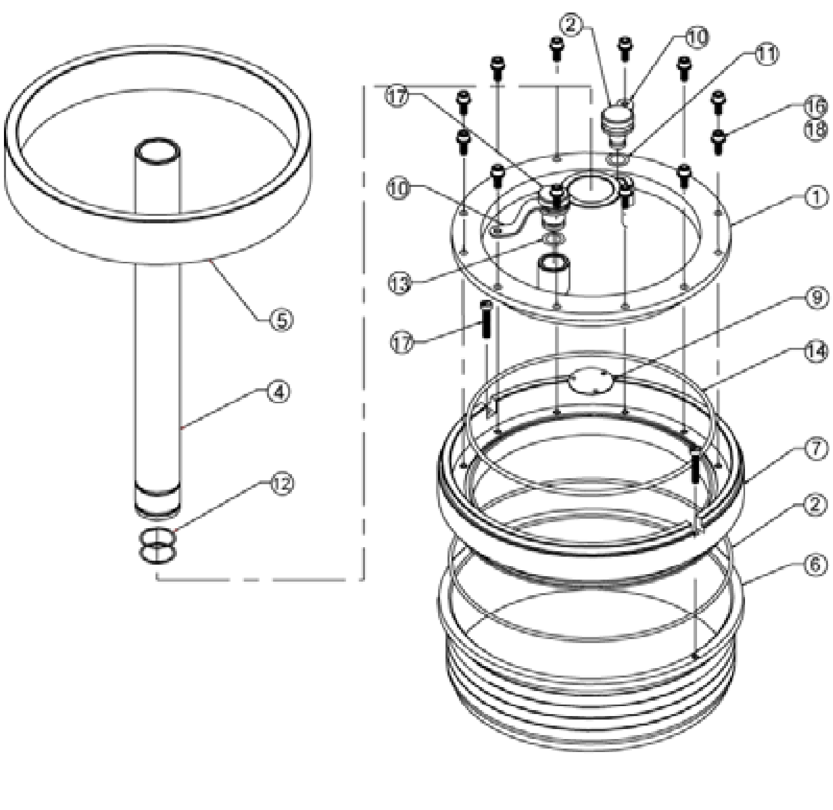
REPLACEMENT PARTS FOR PRESSURE INFILTROMETER



	ITEM PART #	DESCRIPTION
1.	2800K3-003SK	FOOT ASSY. TOP CAP, I.M.
2.	2800K3-009	PORT PLUG
3.	2800K3-010	BUBBLER PLUG
4.	2805D10-005	SUPPORT TUBE
5.	2805D20-001	INSTALLATION RING
6.	2805D20-002	CUTTING RING
7.	2805D20-003	SUPPORT RING
8.	2805D10-005	PRESSURE INFILTROMETER SUPPORT TUBE
9.	2805D20-005	SPLASH GUARD
10.	2805D20-006	PLUG STRAP
11	M802X012	O-RING
12.	M802X020	O-RING
13.	M802X111	O-RING
14.	M802X166	O-RING
15.	M802X169	O-RING
16.	Q1024CAF08	SCREW10-24 x1/2" SKT HD
17.	Q1024CAP16	SCREW10-24 x 1" SKT HD
18.	RW010CAR	FLAT WASHER #10
19.	0234HAMR	SHOCK ASSEMBLY HAMMER

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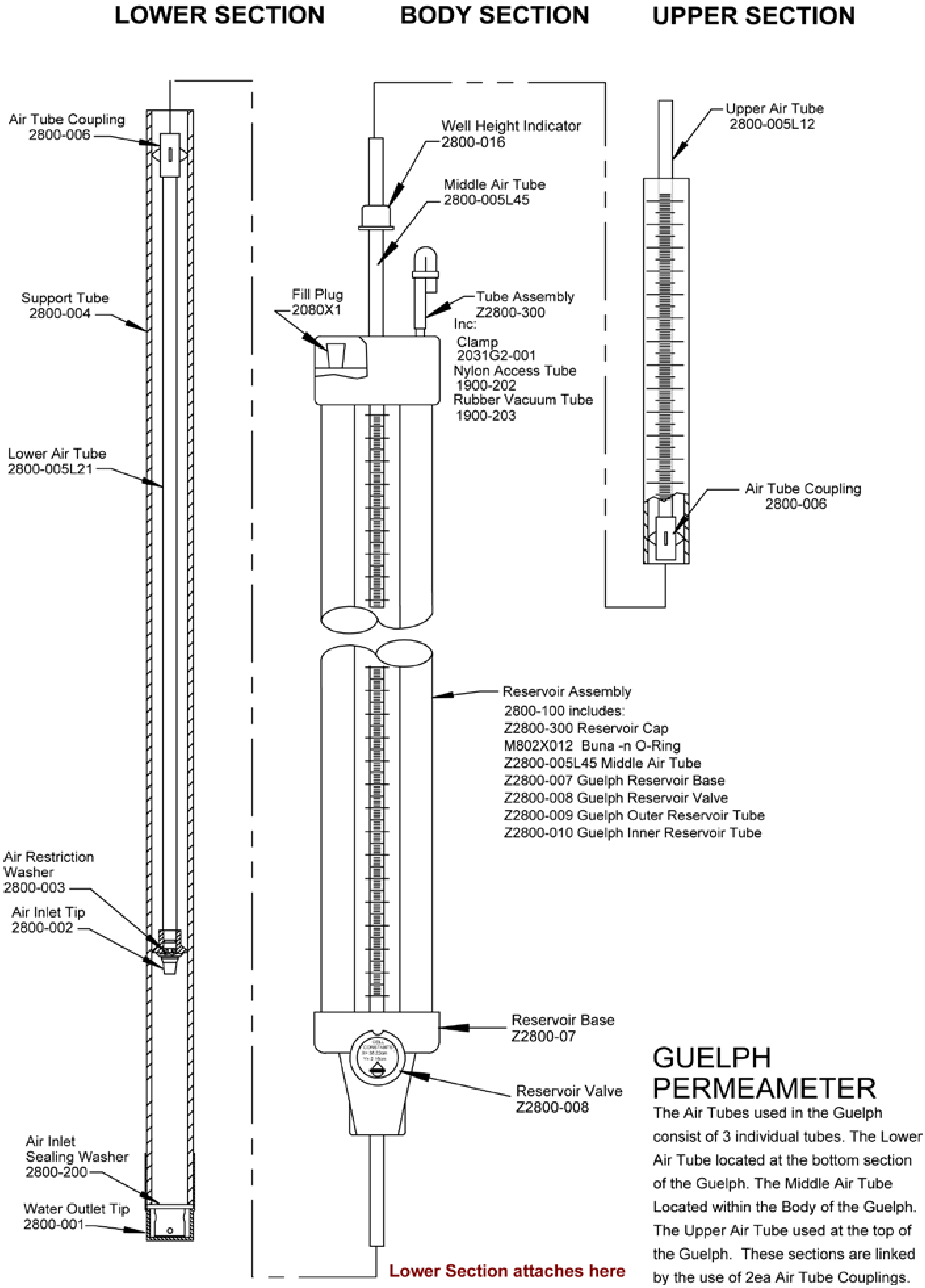
REPLACEMENT PARTS FOR GUELPH PERMEAMETER



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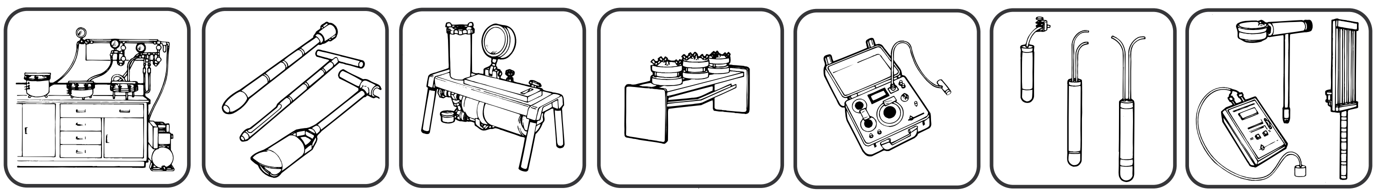

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