Wetland Assessment Information Series

Number 4

WETLAND SCIENCE INSTITUTE

USDA

Natural Resources Conservation Service

Evaluation of the Baumer and Rice (MUUF) Procedures used by NRCS for Estimation of Soil Hydraulic Parameters Used in the Scope and Effect Equations and the Program DRAINMOD

ABSTRACT

The measurement of soil hydraulic properties (soil moisture characteristic curve, unsaturated conductivity, and drainable porosity) is time consuming and expensive. The application of drainage design equations and methodologies however require some of these values for computation. Several procedures have been developed for estimating soil hydraulic properties from more general soil properties that are readily available from the NRCS NASIS soils database.

This paper addresses the methodology used by NRCS (developed by Baumer and Rice(1988)) to estimate soil hydraulic properties used in the Scope and Effect equations (Ellipse, Hooghoudt, and van Schilfgaarde) and the computer model DRAINMOD. The Scope and Effect equations (***http://www.sedlab.olemiss.edu/java/tools_java.html)*** and DRAINMOD are used for the purpose of evaluating the lateral effect of water table drawdown by agricultural drains. The estimation of these soil hydraulic parameters is critical in the application to wetland hydrology analysis, as well as other water table situations.

Also included is a review of an independent evaluation (Master's Thesis) on the accuracy of using these predictive methodologies as opposed to having measured data. The conclusion of that evaluation is that reasonable accuracies can be obtained by estimating soil hydraulic properties from general soils data.

BACKGROUND

Drainage equations were developed for the design of subsurface hydrology drainage systems. Drainage equations such as the Ellipse, Hooghoudt, and van Schilfgaarde equation use soil properties, including horizontal saturated hydraulic conductivity, to estimate water table drawdown by a drainage system. The Ellipse and Hooghoudt equations are steady-state equations and use a drainage rate, normally based on rainfall or irrigation, to determine the flux to the drain. The van Schilfgaarde equation is a non-steady state equation which uses the drainable porosity (f) of the soil to estimate the drainage flux. Drainable porosity is a dimensionless term (cm^3/cm^3 or cm/cm), defined as the water volume drained divided by the volume of soil drained, or the depth of water drained divided by the change in depth to the water table.

The drainable porosity of a soil is used in the van Schilfgaarde equation directly. Drainable porosity is used in conjunction with the water table depth and drawdown time from wetland criteria to estimate the drainage rate in the Ellipse and Hooghoudt equations. The computer model DRAINMOD (USDA, 1994) uses the Hooghoudt equation which requires these same soil hydraulic parameters.

Direct field measurements of soil hydraulic characteristics and procedures required for their measurement in the laboratory are time-consuming and expensive. These properties are often available for soils associated with research sites. However, as one moves across the landscape, hundreds upon hundreds of soils are encountered that do not have such data. Over the years, researchers have developed various algorithms to estimate the soil hydraulic properties from soil properties that are more easily obtained (i.e. texture).

Locations:

USGS,
Patuxent Wildlife
Research Center
Laurel MD

Dept of Agronomy
Louisiana State
University
Baton Rouge LA

ARS, National
Sedimentation
Laboratory &
University of
Mississippi
Oxford MS

USFWS
Hadley
MA

NRCS employees and others use various methodologies such as drainage equations and DRAINMOD to evaluate various water table situations including drainage system design and evaluation, wetland hydrology evaluation, water table management, etc. To utilize these methodologies, soil hydraulic properties are needed. In the absence of measured data, soil hydraulic properties need to be evaluated from more generally available soil data. One method of obtaining these values is by using the program MUUF 2.14.

The MUUF 2.14 program has been demonstrated, as described above, to provide approximate estimates of soil hydraulic parameters based upon general soil information. This allows the use of the Scope and Effect equations and the computer model DRAINMOD on soils that do not have measured soil hydraulic parameters. Estimated parameters should never be used where measured data are available.

MUUF Version 2.14

MUUF 2.14 was the last version (released 12/14/94) of the computer program written by Baumer et al. (1987) to estimate soil hydraulic properties from generally available soils data (Soil Interpretation Record (SIR)). This program was developed to estimate the required soil hydraulic data (drainable porosity, upward flux, etc) used by the computer model DRAINMOD. Some of these same soil hydraulic properties are required in the evaluation of water table fluctuations using drainage equations. The basic data for MUUF is the SIR. This file is the data normally established for each soil series by NRCS soil scientists during a soil survey.

MUUF provides a series of tools for generating soil properties and the soil data produced may be used with several different modeling programs. Soil properties can be based on the Soils-5 name and surface texture information, on Map Unit Use File searches, or on user generated data. The retrieved data from either type of search can be modified to more closely match the user's specific case. Once the soil data is established, the various soil hydraulic values are calculated. The program generates output for use by DRAINMOD and other models but can be used more generally where soil hydraulic values are needed and soil survey information is known.

MUUF 2.14 can use data in several different formats (STATSGO, SUURGO, Soils-5), however the most readily available in the past was the Soils-5. The Soils-5 was a tabular format for recording and storing soils data. With advances in computers, databases, etc. this format has been replaced within the NRCS Soil Survey Division. Therefore, Soils-5 records are "historic" (the Soils-5 data was frozen on January 1, 1994), and are not updated. However, they still represent one of the most widely available soil databases, and one of the formats for which the program MUUF 2.14 is set-up to read.

Availability of MUUF 2.14

The National Water and Climate Center has made the MUUF program and data available as downloadable files on their server (***ftp://ftp.wcc.nrcs.usda.gov/water_mgt/muuf/***). There is no technical support for MUUF or its data.

The user will have to download the MUUF program and the soils data by state. Directories and paths will have to be correctly established for the program to operate. Figure 1 represents a typical MUUF 2.14 data input file. This file can be created manually using the MUUF 2.14 program.

Once the input data set is ready, the program can be run for the desired output type (DRAINMOD, WEPP, general, etc). Figure 2 provides an example of output from MUUF 2.14 for DRAINMOD. This file would then serve as the input soils data file for DRAINMOD.

Availability of MUUF 2.14 Output Data

The Wetland Science Institute, in a cooperative project with the Agricultural Research Service National Sedimentation Laboratory, will make available the DRAINMOD output file (Figure 2) from MUUF 2.14 on the Internet at ***http://www.sedlab.olemiss.edu/java/tools_java.html*** . This eliminates the need to download the program and run the individual data sets. This has been provided as a temporary measure until NASIS is fully developed to provide these data. Soils will be added to the site on a request basis. Submit a request for a soil to be added to ***rodrigue@sedlab.olemiss.edu*** .

Also, for those only needing the drainable porosity and saturated hydraulic conductivity for the Scope and Effect equations, this provides easy access to needed input data.

VALIDATION OF PROCEDURE

Mohammad (1989) evaluated the NRCS method of predicting soil hydraulic properties by comparing the computed volume drained and upward flux using the predicted soil hydraulic properties and measured soil hydraulic properties for 53 and 34 soils, respectively.

The NRCS procedure was found to provide good results for estimated volume drained across all soil types except sandy loam. The program tended to under predict the volume drained by about 13%. Also the error was less for estimations at deeper water table depths (>50 cm).

The NRCS procedure was found to provide good results for maximum upward flux across all soil types, but tended to under predict the upward flux by about 11%, although the method over predicted maximum upward flux at shallower water table depths (<75 cm).

DETERMINATION OF DRAINABLE POROSITY

Drainable Porosity (f, dimensionless) is the volume of water that will be released per unit volume of soil by lowering the water table a unit depth. Drainable porosity can be measured in the lab or can be calculated from soil water retention data calculated by the MUUF program as discussed in this paper. It is used in the van Schilfgaarde equation directly and can be used indirectly in the Ellipse and Hooghoudt.

Drainable porosity is calculated by dividing the depth of water drained by the amount the water table is lowered (e.g. difference in drained depth of water/change in water table depth). Table 1 shows the calculated drainable porosity using the data of Figure 2 for Commerce soil, a silty clay loam found in Louisiana.

Table 1. Drainable Porosity for Commerce Soil

Water Table Depth (cm)	Depth of water Drained (cm)	Drainable Porosity $_{0\text{ - Depth}}$ (cm/cm)
.0000	.0000	N/A
10.0000	.0582	0.00582
20.0000	.1819	0.00910
30.0000	.4054	0.01351
40.0000	.7358	0.01840
50.0000	1.1632	0.02326
60.0000	1.6767	0.02795

As can be seen from Table 1, when the water table is near the surface, a small removal of moisture lowers the water table significantly. The removal of only .4054 cm of water lowers the water table 30 cm, from 0 cm to 30 cm. However, 1.2713 cm of water must be removed to lower the water table the next 30 cm, from 30 cm to 60 cm.

The drainable porosity is calculated using the initial and final depth of water drained and the initial and final water table depths. The following examples use the data from Table 1 for Commerce soil.

Calculation of Drainable Porosity.

The drainable porosity if the water table is lowered from Depth 1 to Depth 2 is

$$\text{Drainable Porosity}_{\text{Depth 1 - Depth 2}} = \frac{(\text{Drained Volume}_{\text{Depth 1}} - \text{Drained Volume}_{\text{Depth 2}})}{(\text{Depth 1} - \text{Depth 2})}$$

Example 1. The drainable porosity if the water table is lowered from 0 cm to 30 cm is

$$\begin{aligned}\text{Drainable Porosity}_{0\text{-}30} &= (0.0 \text{ cm} - .4054 \text{ cm})/(0 \text{ cm} - 30 \text{ cm}) \\ &= (-0.4054 \text{ cm})/(-30 \text{ cm}) \\ &= 0.0135 \text{ cm/cm}\end{aligned}$$

Example 2. The drainable porosity if the water table is lowered from 10 cm to 30 cm is

$$\begin{aligned}\text{Drainable Porosity}_{10\text{-}30} &= (0.0582 \text{ cm} - .4054 \text{ cm})/(10 \text{ cm} - 30 \text{ cm}) \\ &= (-0.3472 \text{ cm})/(-20 \text{ cm}) \\ &= 0.01736 \text{ cm/cm}\end{aligned}$$

Example 3. The drainable porosity if the water table is lowered from 0 cm to 20 cm is

$$\begin{aligned}\text{Drainable Porosity}_{0\text{-}20} &= (0.0 \text{ cm} - .1819 \text{ cm})/(0 \text{ cm} - 20 \text{ cm}) \\ &= (-0.1819 \text{ cm})/(-20 \text{ cm}) \\ &= 0.0091 \text{ cm/cm}\end{aligned}$$

Notice that drainable porosity is specific to the initial and final water table depths being evaluated.

Drainable Porosity Use in Scope and Effect Equations

As mentioned previously, drainable porosity is used directly in the van Schilfgaarde equation. However, in the ellipse and Hooghoudt equations it is used as follows.

For wetland purposes, drainage rate is used as the average rate water must be removed for the water table to fall below 12" below the surface for more than 14 consecutive days taking into account rainfall, evapotranspiration (ET) and soil water storage. Twelve inches (12") and 14 days are specific to current soil saturation wetland criteria for non-sandy soils and are used for example purposes only. Therefore this value is often the combination of drainable porosity, depth water table is lowered, time to lower water table, and the amount of water from rainfall that must be removed. The appropriate value to use for q should be based on

$$q = \frac{(f^*\text{depth water table lowered}) + \text{rainfall} - \text{evapotranspiration}}{\text{time to lower water table for most critical period during the growing season}}$$

The drainage rate (q) is a function of climate and should be evaluated locally. Long-term continuous simulation models could be used to evaluate area, state or regional drainage rate values. Appropriate values for drainage rate need to be evaluated by climate region and soil type.

On the internet site with the programmed Scope and Effect equations (***http://www.sedlab.olemiss.edu/java/tools_java.html***), "q" can be entered directly, or calculated from "c" (depth to water table), "f" (drainable porosity, and "t" (time to lower water table).

NRCS Use

Each NRCS State Office sets the technical guidance for any procedure to be utilized in that state (documented in the Field Office Technical Guide (FOTG)). NRCS employees in any state must follow the guidance established in that state. The information in this paper may be adopted or modified as the individual state technical authority deems appropriate. Best professional judgement is used in the selection of appropriate parameters.

Other agencies should consult with NRCS for the individual state adopted procedure and a copy of the appropriate section of the state FOTG.

Presence of Water Table

It is critical that the user of this information, before applying it to a site, affirm that the site does support a water table situation. The Scope and Effect equations and DRAINMOD apply to unconfined aquifers where a free water surface, a water table, can be found. Often this water table will be a perched water table, created by a restrictive layer that prevents the continued downward flow of soil moisture. MUUF will calculate the soil hydraulic properties for any valid input soil data set. It is the responsibility of the user to ascertain if a water table is present, the timing, extent, and duration of the water table, and that no measured data exists for the soil.

Application to Irrigation

The soil hydraulic parameters generated by MUUF 2.14 also have an application to the irrigation water management arena. The soil moisture characteristic curve (soil moisture tension versus soil moisture content) is important in the scheduling of irrigation, especially in computer scheduling and modeling programs.

FUTURE STATUS

Work is currently underway which will allow the resources of the NASIS database to be utilized in the MUUF 2.14 program that currently exists, either as input to MUUF 2.14 or including the algorithms in NASIS to produce a DRAINMOD input file.

AUTHORIZED USE OF DRAINMOD

DRAINMOD is a computer program that was developed to simulate the performance of drainage, subirrigation and controlled drainage systems. DRAINMOD was developed by Dr. R.W. Skaggs of North Carolina State University (NCSU). DRAINMOD is licensed for use within NRCS and the USDA-SCS DRAINMOD User's Guide (USDA, 1994) should be referenced for detailed instructions in running the program. NRCS personnel interested in DRAINMOD should contact Pat Willey (***pwilley@wcc.nrcs.usda.gov***) at the National Water and Climate Center.

Others should contact NCSU to obtain the program and to learn about formal training available (***http://www.bae.ncsu.edu/bae/research/soil_water/www/watmngmnt/drainmod/***).

ACKNOWLEDGEMENTS

Dr. Ron Bingner, Research Scientist, USDA-ARS National Sedimentation Laboratory, for development of the MUUF Internet site and Vera Sasanova, Research Scientist Assistant, for programming the site.

The assistance, comments, and suggestions of the following reviewers contributed to this paper: Pat Willey, Wetland and Drainage Engineer, NWCC; Sonia Jacobsen, NRCS Hydraulic Engineer, MN; Bob Nielsen, Soil Scientist, NSSC; Wetland Science Institute Director and Staff.

FOR ADDITIONAL INFORMATION CONTACT:

Wetland Science Institute
Paul B. Rodrigue, Hydrologist
PO Box 1157
Oxford MS 38655
662-232-2973
rodrigue@sedlab.olemiss.edu

REFERENCES

1. Baumer, Otto W. and John W. Rice. 1988. Methods to predict soil input data for DRAINMOD. ASAE Paper No. 88-2564.
2. Baumer, O.W., R.D. Wenberg and J.W. Rice. 1987. The use of soil water retention curves in DRAINMOD. Technical paper, USDA, Soil Conservation Service, Mid-West National Technical Center.

3 Mohammad, Agita Tjandra. 1989. Evaluation of USDA-SCS Methods for Predicting Soil Hydraulic Properties. Master's Thesis. Department of Biological and Agricultural Engineering, North Carolina State University, Raleigh, North Carolina, USA.

4. US Department of Agriculture, Soil Conservation Service. 1994. DRAINMOD User's Guide. USDA, SCS, Washington, D.C.

5. US Department of Agriculture, Natural Resources Conservation Service. 1997. Hydrology Tools for Wetland Determination, Chapter 19, Engineering Field Handbook, edited by Donald E. Woodward. USDA, NRCS, Fort Worth, TX.

The United States Department of Agriculture (USDA) prohibits discrimination in its programs on the basis of race, color, national origin, sex, religion, age, disability, political beliefs and marital or familial status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint, write the Secretary of Agriculture, U.S. Department of Agriculture, Washington, DC 20250 or call 1-800-245-6340 (voice) or (202) 720-1127 (TDD). USDA is an equal employment opportunity employer.

Figure 1. Soils-5 Data File for use in MUUF 2.14

```
1 Soil Records
MUUF ENTRIES FOR MAP UNIT , COMPONENT NUMBER
Soils5 Record Only---MUUF Not Used.
COMMERCE                    Component/Soil Name
LA         State Fips
           Survey Code
           Map Unit Symbol
           Sequence Number
SOILS-5         !Data Source
                                      Map   Unit    ::
                                        Name        ::
  VFSL     Comp. Surface Texture
           MLRA
           Kind of Map Unit
           Prime Farmland
           Number of Components
           Component Number
           Kind of Component
           Soils 5 Number
   0       Percent Composition
    0      Acreage of Map Unit
           Flooding
   0       Slope (lower)
   0       Slope (upper)
   1         2         3         4         5         6      !MUUF Layer Number
                                                             Fips County Code
                                                             Acreage of Map Unit
   0         0         0         0         0         0       MUUF Depth (upper)
   0         0         0         0         0         0       MUUF Depth (lower)
ESTIMATED SOIL PROPERTIES FROM SIR ENTRIES
131                         MLRA's
COMMERCE                    S5 Soil Name
5          Unit Kind Code
LA         S5 State Fips
0041       S5 Record Number
JLD        Author
9-91       Date
X          Revision
           Unit Modifier
EAQFL      Great Group
AE         Sub Group Modifier
106        Particle Size Code
34         Minerology
12         Reaction Code
18         Temperature
02         Other Code
SP         Drainage Class 1
           Drainage Class 2
A          Property Note
  60.0      70.0     Annual Air Temp. (lo/hi)
 200.0     350.0     Frost Free Days  (lo/hi)
  45.0      65.0     Annual Precip.   (lo/hi)
   0.0     120.0     Elevation (ft)   (lo/hi)
 0.000     5.000     S5 Slope (pct)   (lo/hi)
   0         0         0        10        36         0       S5 Depth upper     (in)
  10        10        10        36        60         0       S5 Depth Lower     (in)
                                          SR                 Modifier 1
SICL      SIL       L         SICL                           Texture  1
                                                             Modifier 2
          VFSL                SIL       VFSL                 Texture  2
                                                             Modifier 3
                              L         SIC                  Texture  3
CL        CL-ML     CL-ML     CL        CL-ML                Unified 1
          CL        CL                  CL                   Unified 2
          ML        ML                  ML                   Unified 3
```

Figure 1 (continued)

						Unified 4
A-6	A-4	A-4	A-6	A-4		AASHO 1
A-7-6			A-7-6	A-6		AASHO 2
				A-7-6		AASHO 3
						AASHO 4
0.000	0.000	0.000	0.000	0.000	0.000	> 10 Inch lower (pct)
0.000	0.000	0.000	0.000	0.000	0.000	> 10 Inch upper (pct)
0.000	0.000	0.000	0.000	0.000	0.000	3 to 10 Inch lower (pct)
0.000	0.000	0.000	0.000	0.000	0.000	3 to 10 Inch upper (pct)
100.000	100.000	100.000	100.000	100.000	0.000	Passing Sieve 4 lower
0.000	0.000	0.000	0.000	0.000	0.000	Passing Sieve 4 upper
100.000	100.000	100.000	100.000	100.000	0.000	Passing Sieve 10 lower
0.000	0.000	0.000	0.000	0.000	0.000	Passing Sieve 10 upper
100.000	100.000	100.000	100.000	100.000	0.000	Passing Sieve 40 lower
0.000	0.000	0.000	0.000	0.000	0.000	Passing Sieve 40 upper
90.000	75.000	75.000	85.000	75.000	0.000	Passing Sieve 200 lower
100.000	100.000	100.000	100.000	100.000	0.000	Passing Sieve 200 upper
27.000	14.000	14.000	14.000	14.000	0.000	Clay Percent lower
39.000	27.000	27.000	39.000	39.000	0.000	Clay Percent upper
32.000	30.000	30.000	32.000	23.000	0.000	Liquid Limit lower
50.000	0.000	0.000	45.000	45.000	0.000	Liquid Limit upper
11.000	0.000	0.000	11.000	3.000	0.000	Plasticity Index lower
25.000	10.000	10.000	23.000	23.000	0.000	Plasticity Index upper
1.250	1.350	1.350	1.350	1.350	0.000	Moist BD (g/cm3) lower
1.450	1.650	1.650	1.650	1.650	0.000	Moist BD (g/cm3) upper
0.200	0.600	0.600	0.200	0.200	0.000	Permeability low.(in/hr)
0.600	2.000	2.000	0.600	2.000	0.000	Permeability upp.(in/hr)
0.150	0.210	0.200	0.200	0.200	0.000	Available Water Cap. low
0.190	0.230	0.220	0.220	0.230	0.000	Available Water Cap. up
5.600	5.600	5.600	6.100	6.600	0.000	Soil Reaction (pH) lower
8.400	8.400	8.400	8.400	8.400	0.000	Soil Reaction (pH) upper
0.000	0.000	0.000	0.000	0.000	0.000	Salinity lower
0.000	0.000	0.000	0.000	0.000	0.000	Salinity upper
0.000	0.000	0.000	0.000	0.000	0.000	SAR lower
0.000	0.000	0.000	0.000	0.000	0.000	SAR upper
10.000	5.000	5.000	10.000	10.000	0.000	CEC (me/100g) lower
25.000	15.000	15.000	30.000	40.000	0.000	CEC (me/100g) upper
0.000	0.000	0.000	0.000	0.000	0.000	CaCO3 (pct) lower
0.000	0.000	0.000	0.000	0.000	0.000	CaCO3 (pct) upper
0.000	0.000	0.000	0.000	0.000	0.000	Gypsum (pct) lower
0.000	0.000	0.000	0.000	0.000	0.000	Gypsum (pct) upper
0.500	0.500	0.500	1.000	1.000	0.000	Organic Matter (pct) low
4.000	4.000	4.000	0.000	0.000	0.000	Organic Matter (pct) up
0.370	0.430	0.370	0.320	0.370	0.000	Erosional K
5.000	5.000	5.000	0.000	0.000	0.000	Erosional T
7	6	8				Wind Erode Group
3	2	2	3	2		Shrink-Swell Potential

1	Corrosivity-Steel
2	Corrosivity-Concrete
31	Flood Frequency
12	Flood Duration
DEC	Flood Month Begin
JUN	Flood Month End
1.5	Hi Water Depth Upper ft.
4.0	Hi Water Depth Lower ft.
1	High Water Table Kind
DEC	High Water Table Begin
APR	High Water Table End
	Cem. Pan Depth Upper(in)
-	Cem. Pan Depth Lower(in)
	Cemented Pan Hardness
60	Bedrock Depth Upper (in)
>	Bedrock Depth Lower (in)
	Bedrock Special Flag
	Bedrock Hardness

Figure 1 (continued)

	Subsidence Init Low (in)			
-	Subsidence Init Upr (in)			
	Subsidence Total Low(in)			
	Subsidence Total Upr(in)			
C	Hydro Group			
-	Potential Frost Action			
Land Capability	--- Slope --- Other Nirr Irr			
4	Number of Land Classes			
0	1	2	2W	Class 1
0	1	4	2W	Class 2
1	5	2	2E	Class 3
1	5	4	2E	Class 4

Figure 2. Output from MUUF in DRAINMOD input format (COMMERCE.SIN).

COMMERCE — Soil Name

2121 — # of Entries in Soil Moisture (1st two digits) and Drained Volume (2nd two digits) Tables

.44547	.0
.43906	-5.0
.43107	-10.0
.41520	-20.0
.40090	-30.0
.38837	-40.0
.36778	-60.0
.35162	-80.0
.33853	-100.0
.31427	-150.0
.29720	-200.0
.27394	-300.0
.26703	-340.0
.25827	-400.0
.23755	-600.0
.21385	-1000.0
.18589	-2000.0
.15552	-5000.0
.13678	-10000.0
.12681	-15300.0
.09343	-102000.0

Soil Moisture Characteristic Curve Data (21 entries)

Column 1	Column 2
Moisture Content	Matric Potential
(cm^3/cm^3)	(cm)

.0000	.0000	.2000
10.0000	.0582	.2000
20.0000	.1819	.1229
30.0000	.4054	.0790
40.0000	.7358	.0508
50.0000	1.1632	.0339
60.0000	1.6767	.0239
70.0000	2.2670	.0172
80.0000	2.9257	.0116
90.0000	3.6458	.0091
100.0000	4.4214	.0071
120.0000	6.1197	.0046
140.0000	7.9880	.0031
160.0000	10.0017	.0022
200.0000	14.3934	.0012
250.0000	20.4605	.0006
300.0000	26.9986	.0000
400.0000	41.1890	.0000
500.0000	56.5111	.0000
700.0000	89.5809	.0000
1000.0000	143.3694	.0000

Water Volume Drained - Upward Flux Table (21 entries)

Column 1	Column 2	Column 3
Water Table	Depth of Water	Upward
Depth	Drained	Flux
(cm)	(cm)	(cm/hr)

10 — # of entries in Green-Apmt Table

.00	.00	.00
20.00	.20	1.61
50.00	.50	1.83
80.00	.71	1.88
120.00	.91	1.91
160.00	1.05	1.93
250.00	1.27	1.95
400.00	1.48	1.96
700.00	1.71	1.97
1000.00	1.84	1.97

Green-Ampt Infiltration Parameters (10 entries)

Column 1	Column 2	Column 3
Depth	A	B
(cm)	(cm^2/hr)	(cm/hr)

3 — # of Horizons in Ksat Table

5.	2.78
13.	.88
30.	1.61

Column 1	Column 2
Horizon Depth	Ksat
(cm)	(cm/hr)

.12681 — Wilting Point Moisture Content (cm^3/cm^3)