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Physical and Chemical Characterization of the Groseclose Soil Mapping Unit

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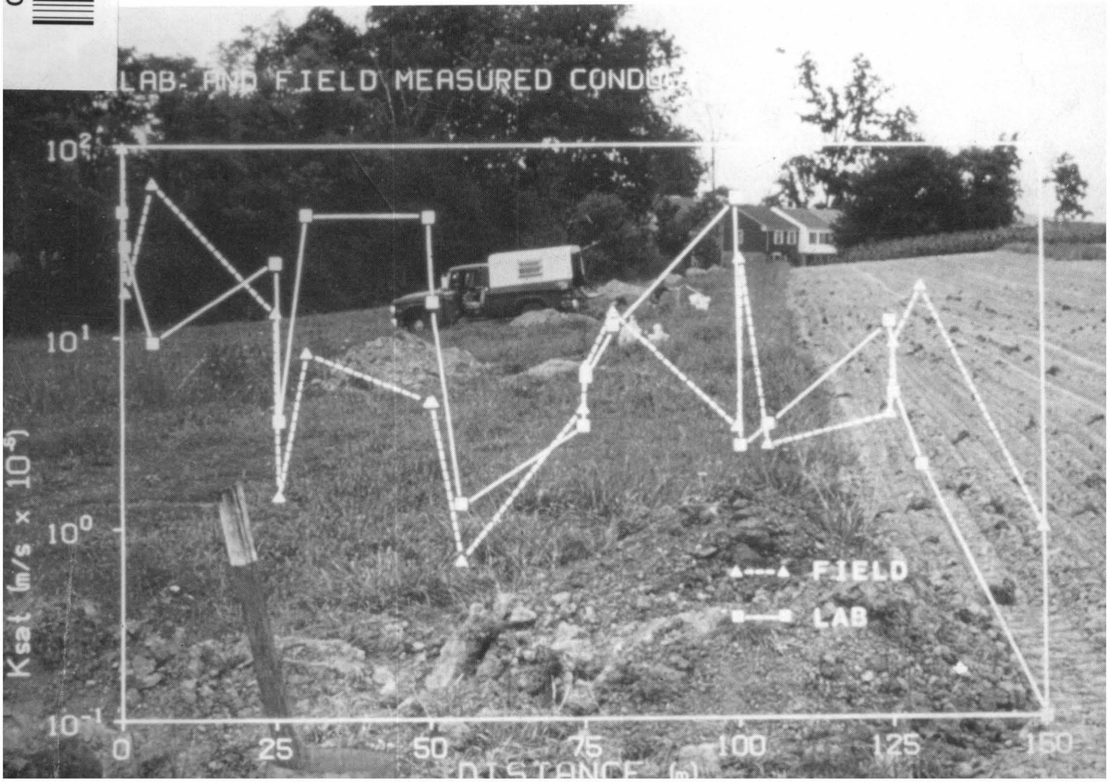

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The Virginia Agricultural and Mechanical College came into being in 1872 upon acceptance by the Commonwealth of the provisions of the Morrill Act of 1862 "to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life." Research and investigations were first authorized at Virginia's land-grant college when the Virginia Agricultural Experiment Station was established by the Virginia General Assembly in 1886.

The Virginia Agricultural Experiment Station received its first allotment upon passage of the Hatch Act by the United States Congress in 1887. Other related Acts followed, and all were consolidated in 1955 under the Amended Hatch Act which states "It shall be the object and duty of the State agricultural experiment stations . . . to conduct original and other researches, investigations and experiments bearing directly on and contributing to the establishment and maintenance of a permanent and effective agricultural industry of the United States, including the researches basic to the problems of agriculture and its broadest aspects and such investigations as have for their purpose the development and improvement of the rural home and rural life and the maximum contributions by agriculture to the welfare of the consumer . . . "

In 1962, Congress passed the McIntire-Stennis Cooperative Forestry Research Act to encourage and assist the states in carrying on a program of forestry research, including reforestation, land management, watershed management, rangeland management, wildlife habitat improvement, outdoor recreation, harvesting and marketing of forest products, and "such other studies as may be necessary to obtain the fullest and most effective use of forest resources."

In 1966, the Virginia General Assembly "established within the Virginia Polytechnic Institute a division to be known as the Research Division . . . which shall encompass the now existing Virginia Agricultural Experiment Station . . . "

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I. INTRODUCTION

Growing concern over potential ground and surface water contamination resulting from land use practices has led to an increasing need for quantitative information on processes of water flow and transport of solutes through soils. Such information is indispensable when assessing contamination hazard and in setting standards for safe practices. Often the only information available on soils in an area is in the form of a soil map. In a soil map, soils are grouped on the basis of genesis and morphology; flow and transport properties are not explicitly considered. Although these properties are often correlated with differential properties, many recent studies show that considerable variation often exists within mapping units, even when the units are consociations that are dominated by one soil series. Among other factors, this variation determines reliability of prediction of field scale behavior based on averaged or indirectly inferred soil properties, e.g. estimated from a soil map. Complete characterization of soil properties over an area of land requires consideration of the number and spatial distribution of observations. The collection and analysis of these data represents a major effort. Although care should be taken in extrapolating results of such characterization studies to other areas, analysis of which properties are most variable and of the correlations among soil properties can be a valuable aid in design of efficient sampling schemes. In practical situations, it may not be feasible to make more than a cursory examination of soil properties at an actual site and any additional information will be valuable, if only to provide an assessment of likely prediction uncertainty.

This bulletin contains results of a study, carried out in 1982-84, to characterize soil physical and chemical properties at two sites in the Groseclose soil mapping unit in Pulaski and Montgomery Counties, Virginia. Generally available soil information is usually represented by just a soil map which delineates mapping units rather than soil series. Different classification systems were used in producing soil maps for the two counties. As a result, the definition of the

Groseclose map unit is not identical for both counties (W. J. Edmonds, pers. communication). We have taken the practical point of view that soils that are assigned to identically named map units and are geopraphically proximate will for most purposes be considered as representing the same map unit. Sampling sites were selected from the Montgomery County soil map (Porter et al., 1973). No attempt was made in this study to determine the actual taxonomic classification at each sampling location. Methods and measured data are reported in this bulletin, together with an analysis of the variability and correlation structures of the various soil properties. Data reduction methods that allow soil variability to be expressed in a reduced number of variables are discussed. A detailed analysis of solute transport parameters and the effects of sample volume is given elsewhere (Albrecht, 1985).

II. METHODS

2.1 Site Description

Undisturbed soil core samples were collected from two locations in the Groseclose soil mapping unit in Pulaski and Montgomery Counties, Virginia. The first site (referred to as Site I) was located in Pulaski County near Radford, Va.; the second site (Site II) ws at the Virginia Polytechnic Institute and State University research farm, just outside Blacksburg in Montgomery County. Site locations are shown in Figure 1. Both sites were under grassland. The dominant soil in the mapping unit is the Groseclose series, classified as a clayey, mixed, mesic Typic Hapludult. Groseclose soils occur on nearly level to very steep convex ridges and sideslopes in the Appalachian Valley, and formed in materials weathered from interbedded limestone, shale, siltstone and sandstone. The soil is deep and well drained with slowly permeable subsoil. The Ap horizon

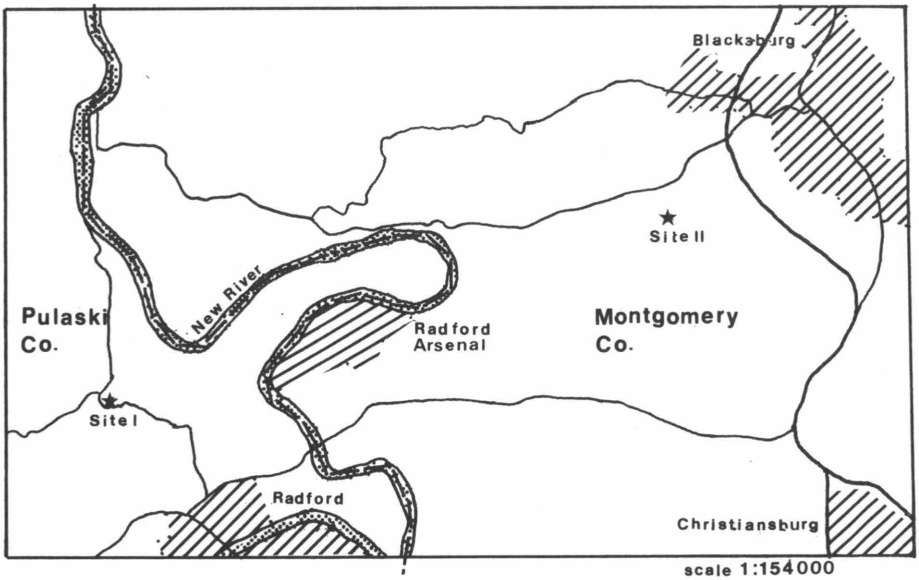

Figure 1. Location of two sampling sites in Pulaski and Montgomery Counties, Virginia.

is typically 0.25 m thick and has a loam texture with moderate fine granular structure. The Bt horizon typically extends from 0.25 - 0.70 m and has a clay texture with moderate very fine and fine subangular blocky structure. Soils at Site II were found to have a high montmorillonite content. Between depths of 0.18 and 0.84 m, the total clay fraction varies between 42 and 76 percent, and one-fourth to one-third of the total clay fraction consists of montmorillonite. Such high montmorillonite contents are not typical of the Groseclose series. An inclusion was probably sampled at this site.

2.2 Field Methods

At both sites, core samples were taken in September 1982 along a 150 m transect, spaced as shown in Figure 2. This particular sampling plan was selected to obtain information on variability at a range of scales with minimal sample number. At each site there were 19 subsites, spaced logarithmically to yield 6 pairs of samples separated by 0.5 m, 6 pairs separated by 5 m, 6 pairs separated by 25 m, etc. The more commonly used fixed-interval transect yields most pairs separated by one sampling interval while the number of sample pairs decreases with increasing separation distance. Undisturbed 40 mm long by 54 mm diameter (volume = 92 mL) core samples were collected at each subsite at depths of 0.0, 0.25, 0.5, 1.0, 2.0, 4.0, and 6.0 m. A hole was augered to the desired depth, and samples were taken using a hydraulic sampler. In addition, loose soil samples were collected at each subsite and depth.

At site II, additional core samples with core volumes of 0.471 L (60 mm long x 100 mm diameter) and 1.77 L (100 mm long x 150 mm diameter), respectively, were collected at each of the 19 subsites at

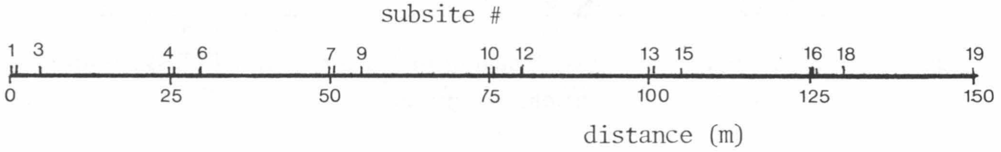

Figure 2. Sampling design showing 19 subsites spaced logarithmically along a 150 m transect.

depths of 0.0 and 0.5 m. For convenience, the three core volumes considered in this study will be referred to as 'small,' 'medium,' and 'large,' in order of increasing size. Medium and large sampling rings were driven into the ground by hand and then carefully dug out. Before any samples were taken at Site II, in-situ infiltration was measured at each subsite, at the soil surface and at 0.5 m depth, using the double-ring ponded infiltration method (Boersma, 1965). Tensiometers were installed at a depth of 0.1 m in the outer ring to measure the hydraulic gradient. The test was run until quasi steady-state was indicated by either a constant flux or a non-negative pressure reading of the tensiometers. A 0.01 M $CaCl_2$ solution was used for the infiltration measurements to reduce soil dispersion. Upon completion of the infiltration tests, inner rings were dug up and used as large cores. All core samples were stored at 4^{o} C prior to laboratory analyses.

2.3 Laboratory Methods

Hydraulic and solute transport properties

Soil cores were assembled in Tempe pressure cells and slowly wet from the bottom over a 1-2 day period. After saturation, the saturated hydraulic conductivity of each core was measured using a falling head method (Klute, 1965) for the majority of the samples. A constant head method was used for some of the medium and large cores with high conductivity. Next, desorption water contents of the cores were determined by stepwise equilibration at increasing gas pressures up to 1 bar (10 m equivalent matric tension). Sorption water contents at 5.0 and 0.5 m tension also were determined on the small cores. Desorption water contents at 30.0 and 150.0 m tension were determined on disturbed samples for all subsites and depths. A solution of 0.01 M $CaCl_2$ with 2 ppm $CuSO_4$ was used in all water retention and conductivity measurements.

Miscible displacement tests were run on small, medium, and large cores taken at 0.0 and 0.5 m depths at Site II. For the 0.5 m depth, a different set of small cores was used for the miscible displacement test than was used for the hydraulic conductivity and water retention measurements. At the start of the miscible displacements tests, the cores were percolated with a 0.01 M $CaCl_2$ + 2 ppm $CuSO_4$ solution. After passing at least one pore volume of solution through the core, or after the flux became constant, the supply was removed and, when the free solution had disappeared from 50% of the surface, a displacing solution containing 0.01 M $MgBr_2$ was applied. Hydraulic gradients during the displacement tests were kept close to unity. Effluent was collected in suitably small fractions over a range of 2-4 pore volumes and the Br^- concentration in each fraction determined with an ion-specific electrode. Average pore water velocities (v) were determined from the measured flow rates and saturated water contents. Dispersion coefficients (D) were determined by least squares fitting of the simple convection- dispersion model (Parker and Van Genuchten, 1984) to measured effluent flux concentrations. After completion of all tests, core samples were oven-dried and dry bulk densities were calculated from the dry weight and volume of soil.

Particle Size Distribution and Chemical Analyses

Particle size and chemical analyses were carried out on the disturbed samples collected at each subsite and depth. Weight fractions of the following particle sizes were determined by the method of Day (1965): very coarse sand (2.0 - 1.0 mm), coarse sand (1.0 - 0.5 mm), medium sand (0.5 - 0.25 mm), fine sand (0.25 - 0.1 mm), very fine sand (0.1 - 0.05 mm), silt (0.05 - 0.002 mm), and clay (<0.002 mm). Chemical analyses consisted of the following: pH in a 1:1 soil:water suspension using a combination calomel-glass electrode; organic matter content for the 0.0, 0.25 and 0.5 m depths, by acid-dichromate digestion (Allison, 1965); exchangeable bases (Ca^{2+}, Mg^{2+}, and K^+) by atomic absorption spectroscopy after N NH_4OAc pH 7.0 extraction; exchangeable Al^{3+} by N KCl extraction (McLean, 1965); and exchangeable acidity (H^+) by $BaCl_2$-TEA, pH 8.2 extraction (Peech, 1965). Percent base saturation was calculated as the sum of exchangeable bases ($Ca^{2+} + Mg^{2+} + K^+$) divided by the cation exchange capacity, i.e. total cations ($Ca^{2+} + Mg^{2+} + K^+ + H^+$) times 100.

2.4 Data Analysis

Principal Component Analysis

Principal Component Analysis (PCA) is a technique of multivariate statistics useful for detecting dependencies among variables and for data reduction. Its application to soils has been mainly in the area of soil classification and survey (e.g. Nortcliff, 1978). A measured data set will generally show some correlations among the variables in the set. Information carried by a variable is, therefore, partly redundant as this same information is contained in correlated variables. PCA takes advantage of this fact by transforming a data set of n correlated variables into a smaller set of uncorrelated variables, called principal components, with minimal loss of information. Principal components (PC's) are linear combinations of the original variables. The value of the i-th principal component for the k-th member of the data set is obtained from:

$$PC_i^k = \sum_{j=1}^{n} x_j^k b_{ij} = x^k b_i \qquad (2.1)$$

where x^k is the vector $(x_1^k \ldots x_n^k)$, that contains all observations made on the k-th member and coefficient vector $b_i = (b_{i1}, b_{i2}, \ldots b_{in})^T$ is called the vector of component loadings. The b_i are obtained by solving the characteristic equation:

$$[C - \lambda I]b = 0 \qquad (2.2)$$

where I is the identity matrix of size n and $C^{n \times n}$ can represent either the variance-covariance matrix or the correlation matrix of the original variables. The present study deals with variables that represent very different scales of measurement, and principal components were, therefore, obtained from the correlation matrix rather than the covariance matrix. The b_i in Eq. (2.1) are the eigenvectors of this matrix and the λ's are the associated eigenvalues. b_1 is the eigenvector associated with the largest eigenvalue; b_2 is associated with the second largest eigenvalue, etc. Since the vectors b_i are orthogonal, the principal components will be uncorrelated. Dependencies among the original variables will be reflected in the composition of the principal components (Timm, 1975). Furthermore, the sum of the eigenvalues equals the trace of

C, which for a variance-covariance matrix equals the sum of the variance of the original variables. The ratio

$$\frac{\lambda_i}{Tr(C)} \tag{2.3}$$

gives the proportion of total variance that is represented by the i-th principal component. While the above holds only for principal components derived from the variance-covariance matrix, the interpretation that each principal component represents a portion of the total variability in the data set is also used when principal components are derived from the correlation matrix (Timm, 1975).

The utility of PCA is at least twofold. In the first place, the principal components are ordered by decreasing importance (eigenvalue) and it will thus often be possible to discard all but the first few principal components for subsequent analyses, while retaining a maximum amount of the information in the original data set. In the second place, the loadings of the original variables onto the principal components reflect the dependencies among the original variables, as correlated variables tend to have similar loadings. Generally, principal components will have high loadings for only a small number of variables and, although the principal components are mathematical constructions, it will often be possible to give a physical interpretation to the principal components from the pattern of loadings.

Procedures from the Statistical Analysis System (SAS, 1982) were used to perform the principal component analyses.

Scaling

Scaling theory (e.g. Peck, 1983) was used to describe variability of water rentention curves in terms of a dimensionless scale factor α. From the equation of capillary rise, it can be readily derived that the macroscopic pressure heads in two geometrically similar capillary media which are at the same water content $\theta*$, differ only by a factor α via

$$h_i(\theta^*)=h_m(\theta^*)/\alpha_{i,m} \tag{2.4}$$

where α is the ratio of characteristic lengths of the two media. If $h_m(\theta)$ is taken to be some mean water retention characteristic, we can describe the retention characteristics of other media, in this case samples collected at different locations, by the mean curve $h_m(\theta)$ and the deviation from this mean curve represented by the value of α for each individual soil sample. Although physically based, Eq. (2.4) only holds approximately for soils. For instance, if soil were an ideal medium, its saturated water content would be constant, whereas in reality it may be quite variable. The value of α for a given soil sample will also depend on the water content θ^* at which it is determined, and different θ^* will yield different values of α. In practice, therefore, α becomes a statistical parameter which yields the best agreement between the mean retention curve $h_m(\theta)$ and the scaled curve $\alpha_i h_i(\theta)$. Published studies on the use of scaling (e.g. Warrick et al., 1977; Rao et al., 1983) have shown that scaling can be an effective tool for describing variability of soil hydraulic properties and can be further extended to modeling spatially variable flow processes (Warrick and Amoozegar-Fard, 1979). In these studies the degree of saturation θ/θ_s has been used in place of θ in Eq. (2.4) to remove the effects of variable θ_s. Scaling has been found to be most successful when applied to sandy and other light-textured soil with simple pore structure. The present study deals with soils that are characterized by a high clay content and exhibit pronounced macro-structure, especially in the Bt horizon. These soil properties were found to somewhat complicate the scaling of experimental retention curves. After some preliminary trials, the following methodology was adopted. Measured equilibrium desorption data for $-10 \leq h \leq 0$ m H_2O were used; i.e., measured 3 and 15 bar water contents were not included. To eliminate effects of variable saturated water content θ_s, the effective saturation, S_e, was used in Eq. (2.4). S_e is given by

$$S_e = \frac{\theta-\theta_r}{\theta_s-\theta_r} \qquad (2.5)$$

where θ_r is the residual water content, i.e., the water content approached at large negative pressure heads. Variations in θ_r mainly reflect differences in clay content with higher values of θ_r corresponding to higher clay contents. Soils in this study showed a distinct variation of clay content and therefore θ_r, with depth. To account for this variation, a mean value of θ_r was used for each depth at each of the two sites. Values of $h(S_e)$ corresponding to S_e=0.5, 0.6, 0.7, 0.8, 0.9, 0.99 were determined by fitting the equation

$$S_e = [1 + |\mu h|^{\beta}]^{1/\beta - 1} \tag{2.6}$$

where μ and β are curve-fitting parameters (van Genuchten, 1980) to the experimental $S_e(h)$ data, and subsequently inverting Eq. (2.6) to yield $h(S_e)$. Only relatively high values of S_e were used, to avoid having to extrapolate much beyond the range of the experimental data $-10 \leq h \leq 0.0$ m H_2O. A separate mean retention curve was determined for each depth at each site as a logarithmic mean:

$$\log h_m(S_{ej}) = N^{-1} \sum_{i=1}^{N} \log h_i(S_{ej}) \qquad ,S_{ej}=0.5,\ldots,0.99 \tag{2.7}$$

The value of α for the i-th core sample was determined by least-squares regression as the value that minimized:

$$SS_i = \sum_{j=1}^{6} [h_m(S_{ej}) - \alpha_i h_i(S_{ej})]^2 \tag{2.8}$$

Spatial Analysis

In recent years, geostatistical theory (Journel and Huybrechts, 1978; Webster, 1985) has been applied widely to analysis of soil spatial variability. The basic tool in such analyses is the semivariogram which relates the average squared deviation between pairs of observations to their separation distance. The sample semivariogram is calculated as

$$\gamma(h) = 1/2N(h)^{-1} \sum_{i=1}^{N(h)} (x_i - x_{i+h})^2 \tag{2.9}$$

where x_i denotes an observation at location i, x_{i+h} denotes an observation at distance h from x_i, and N(h) representes the number of observation pairs at separation distance or lag, h. A plot of $\gamma(h)$ is called a semivariogram. A typical example is shown in Figure 3 and will be used to illustrate some of the terminology. The semivariance is low for small separation distance, or lag, h and

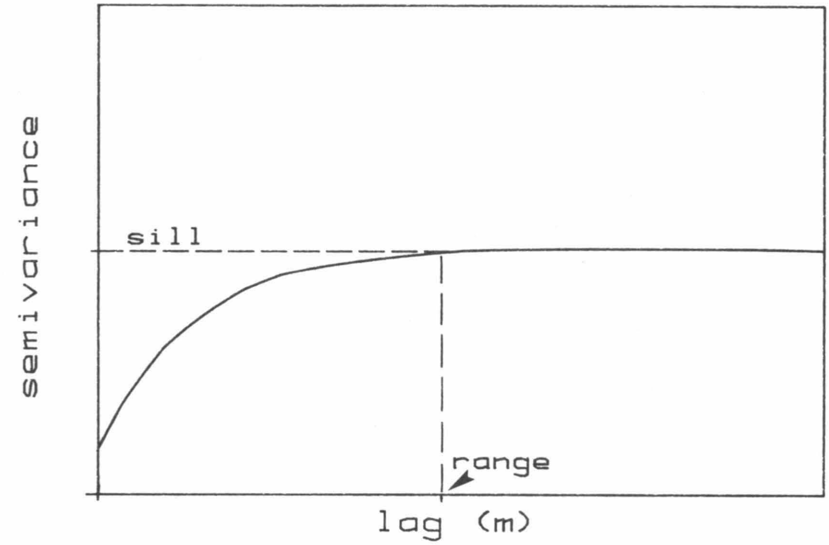

Figure 3. Hypothetical semivariogram.

increases with h, indicating that observations that are taken close together are similar, while their differences increase with distance. The semivariogram typically has a non-zero y-axis intercept. The residual semivariance at distance zero reflects real variation over very small distances plus the effect of random measurement error. In most cases, the semivariogram is observed to reach a plateau as the separation distance or 'lag' exceeds a characteristic value, called the 'range'. The range indicates the average distance over which observations are correlated. If the distance exceeds the range, observations can be considered statistically independent. The plateau value of the semivariance is termed the 'sill' and estimates the population variance.

The theoretical background and application of geostatistics to soils is discussed extensively elsewhere (e.g. Vieira et al., 1983) and will not be repeated here. Instead, we will focus on the aspect of estimation uncertainty which has not received much attention in previous work but is pertinent to the present study. Although frequently used in analyzing spatial data, the interpetation of an experimental semivariogram is complicated by the fact that confidence intervals for the estimated semivariance are not readily available. As a result, it is also not possible to infer what number of observations is required to achieve a specified accuracy in the semivariogram. Common recommendations for the number of observations range from 50-60 (Journel and Huybrechts, 1978) to 100 (Webster, 1985). Obviously, a larger number of observations will mean better accuracy, but exactly how accurate or reliable the semivariogram is is still unknown. Approximate confidence regions for semivariograms can be constructed using Monte Carlo techniques such as boot strapping (Efron, 1982). This technique does not involve any assumptions about the distribution or stationarity of the process being modeled. Alternatively, we can note that the semivariance is just one-half the variance of the differences ($x_i - x_{i+h}$). When these differences follow a normal distribution, as is the case for a second-order stationary process, i.e. constant mean and variance, the semivariance follows a Chi-square distribution with one degree of freedom (Davis and Borgman, 1982; Webster, 1985) and confidence intervals can be obtained from standard statistical tables. As an example, 95% confidence intervals for $\gamma(h)$ as a function of pair number N(h) are given in Table 1. The table clearly illustrates the great uncertainty in $\gamma(h)$ for small sample numbers. Even when N(h) is equal to 100, the confidence interval is still ±25% of the calculated value. In case the process is not really second-order stationary, the confidence region is unknown, but is likely to be even wider than that given in Table 1. It is clear, then, that semivariograms based on only 19 observations, as in the present study, cannot be very reliable. Therefore, the interpretation of semivariograms in this study is tentative and the semivariograms give no conclusive information about the spatial variability at the within-site scale.

TABLE 1. 95% confidence limits for γ/γ^*

No. of pairs	Lower	Upper
5	0.42	3.48
10	0.53	2.70
20	0.63	1.88
30	0.68	1.64
40	0.70	1.47
50	0.73	1.41
70	0.76	1.33
100	0.80	1.27

γ is semivariance

γ^* is estimated semivariance

III. RESULTS

Measured data are presented in Tables A1 through A7 of Appendix A. An analysis of hydraulic and solute transport properties and the effect of sample volume on measurements is given by Albrecht (1985) for the surface and 50 cm depths at Site II. In the following sections results of principal component analyses and scaling are discussed.

Principal Component Analysis

Results of the PCA are summarized in Tables 2 and 3 and Figures 4 and 5 The first step of PCA is the construction of a correlation matrix for the measured variables (Table 2). The correlation matrix is based on 242 observations. Corresponding 95% and 99% significance levels for the sample correlation coefficient r are 0.13 and 0.17, respectively. Many of the correlations in Table 2 are thus highly significant. It should be borne in mind, however, that statistical significance does not necessarily imply a direct physical correlation. Two variables may have a high correlation coefficient because they are both correlated with a third variable. As an example, consider the apparent negative correlation between saturated conductivity, K_s, and moisture contents at different pressure heads. In general a positive correlation between K_s and saturated water content would be expected, other factors being constant. The negative correlations between K_s and water contents at saturation as well as at negative heads in Table 2 reflect the systematic variation of K_s and water retention characteristics with soil depth. The subsoil at both sites, i.e. sampling depths of 2 m and lower, is characterized by a high clay content, low bulk density, and very fine pore structure. The high correlation between clay content and saturated water content reflects the generally higher porosity in the finer textured soil. At the same time, the fine pore-size distribution causes low values for saturated conductivity.

TABLE 2. CORRELATIONS BETWEEN MEASURED SOIL PROPERTIES

	SITE	DEPTH	SUB-SITE	BULK-DENSITY	θ_s	$\theta_d(1)$	$\theta_d(3)$	$\theta_d(10)$	$\theta_d(30)$	$\theta_d(150)$
SITE	1.000	0.121	0.059	-.289	0.197	0.154	0.158	0.165	-.070	-.221
DEPTH	0.121	1.000	-.086	-.713	0.674	0.782	0.791	0.743	0.498	0.403
SUB-SITE	0.059	-.086	1.000	0.189	-.196	-.144	-.126	-.106	-.032	-.048
BULKDENS.	-.289	-.713	0.189	1.000	-.823	-.797	-.774	-.671	-.264	-.129
θ_s	0.197	0.674	-.196	-.823	1.000	0.953	0.933	0.883	0.374	0.290
$\theta_d(1)$	0.154	0.782	-.144	-.797	0.953	1.000	0.995	0.943	0.498	0.400
$\theta_d(3)$	0.158	0.791	-.128	-.774	0.933	0.995	1.000	0.962	0.530	0.429
$\theta_d(10)$	0.165	0.743	-.106	-.671	0.883	0.943	0.962	1.000	0.568	0.484
$\theta_d(30)$	-.070	0.498	-.032	-.264	0.374	0.498	0.530	0.568	1.000	0.788
$\theta_d(150)$	-.221	0.403	-.048	-.129	0.290	0.400	0.429	0.484	0.788	1.000
$\theta_w(5)$	0.168	0.748	-.111	-.691	0.895	0.954	0.971	0.997	0.553	0.466
$\theta_w(.5)$	0.183	0.778	-.140	-.778	0.939	0.988	0.989	0.954	0.486	0.399
ln K_s	0.105	-.622	0.059	0.366	-.483	-.608	-.632	-.619	-.488	-.477
MED. SAND	-.203	-.398	0.085	0.322	-.449	-.501	-.522	-.571	-.621	-.455
TOTAL SAND	-.191	-.466	0.051	0.383	-.493	-.550	-.579	-.629	-.695	-.534
SILT	0.187	-.374	-.116	0.223	-.335	-.429	-.452	-.493	-.590	-.675
CLAY	-.077	0.511	0.076	-.340	0.476	0.581	0.612	0.661	0.770	0.774
PH	-.190	-.413	0.312	0.270	-.321	-.367	-.382	-.387	-.216	-.244
CEC	0.026	0.268	0.085	-.370	0.415	0.430	0.444	0.480	0.565	0.475
% BASE SAT.	-.424	-.458	0.278	0.416	-.403	-.431	-.434	-.404	-.107	-.098

	$\theta_w(.5)$	$\theta_w(5)$	LN K_s	MEDIUM SAND	TOTAL SAND	SILT	CLAY	PH	CEC	% BASE SATURATION
SITE	0.168	0.183	0.105	-.203	-.191	0.187	-.077	-.190	0.026	-.424
DEPTH	0.748	0.778	-.622	-.398	-.466	-.374	0.511	-.413	0.268	-.458
SUB-SITE	-.111	-.140	0.059	0.085	0.051	-.116	0.076	0.312	0.085	0.278
BULKDENS.	-.691	-.778	0.366	0.322	0.383	0.223	-.340	0.270	-.370	0.416
θ_s	0.895	0.939	-.483	-.449	-.493	-.335	0.476	-.321	0.415	-.403
$\theta_d(1)$	0.954	0.988	-.608	-.501	-.550	-.429	0.581	-.367	0.430	-.431
$\theta_d(3)$	0.971	0.989	-.632	-.522	-.579	-.452	0.612	-.382	0.444	-.434
$\theta_d(10)$	0.997	0.954	-.619	-.571	-.629	-.493	0.661	-.387	0.480	-.404
$\theta_d(30)$	0.553	0.486	-.488	-.621	-.695	-.590	0.770	-.216	0.565	-.107
$\theta_d(150)$	0.466	0.399	-.477	-.455	-.534	-.675	0.774	-.244	0.475	-.098
$\theta_w(5)$	1.000	0.967	-.618	-.558	-.619	-.479	0.646	-.391	0.467	-.414
$\theta_w(.5)$	0.967	1.000	-.600	-.508	-.559	-.414	0.574	-.385	0.413	-.444
ln K_s	-.618	-.600	1.000	0.292	0.382	0.498	-.570	0.298	-.338	0.291
MED. SAND	-.558	-.508	0.292	1.000	0.884	0.218	-.561	0.166	-.449	0.096
TOTAL SAND	-.619	-.559	0.382	0.884	1.000	0.304	-.679	0.199	-.557	0.147
SILT	-.479	-.414	0.498	0.218	0.304	1.000	-.873	0.235	-.569	0.119
CLAY	0.646	0.574	-.570	-.561	-.679	-.873	1.000	-.278	0.681	-.163
PH	-.391	-.385	0.298	0.166	0.199	0.235	-.278	1.000	-.013	0.819
CEC	0.467	0.413	-.338	-.449	-.557	-.569	0.681	-.013	1.000	0.013
% BASE SAT.	-.414	-.444	0.291	0.096	0.147	0.119	-.163	0.810	0.013	1.000

To focus attention on only the most pronounced correlations, we consider, rather arbitrarily, only correlation coefficients of 0.7 and higher. An r value of 0.7 or higher between two variables means that 50% or more of the variation in one variable can be explained from its correlation with the other variable. Using this criterion, it can be seen that none of the soil properties are highly correlated with either site or subsite, with a possible exception of the variable base saturation which shows lower values at Site II than at Site I. Hydraulic properties, especially water retention characteristics, are strongly correlated with depth. Water contents at a given pressure head increase, and saturated conductivity decreases, with soil depth. Moisture contents, especially near saturation, are strongly correlated with bulk density, as well as with each other. Note that moisture contents at 3 and 15 bar, which were determined on loose soil samples, are not highly correlated with other moisture content measurements which were obtained from undisturbed soil cores. This lack of correlation may be partly due to the difference in measurement technique. Moisture contents at 3 bar and 15 bar are highly correlated with each other and also with clay content. Saturated conductivity is most strongly correlated with sampling depth and with water retention characteristics. Further correlations are between medium and total sand fractions, between silt and clay fractions, between clay content and cation exchange capacity, and between percentage base saturation and pH.

Table 3 shows the loadings for the first four principal components, together with their corresponding eigenvalue, proportion of variance, and cumulative variance explained by the component. PC1 alone accounts for over 50% of the variation in the data set; the first four components combined account for 80% of the variance. From the pattern of component loadings given in Table 3, PC1 can be interpreted to represent variations in hydraulic properties with sampling depth and associated changes in bulk density and particle size distribution, especially clay content. PC2 represents differences between the two sites in silt and clay content, base saturation, and 3 and 15 bar moisture contents, associated with differences in clay content. PC3 reflects differences in percentage base saturation and pH within sites, and PC4 represents differences in sand fraction between the two sites.

TABLE 3. Principal Component Analysis.

	component loadings			
variable	PC 1	PC 2	PC 3	PC 4
SITE	.04592	-.28994	.23484	-.46632
DEPTH	.24996	-.11673	-.06054	.11174
SUB-SITE	-.04071	.19562	.28119	.15078
BULKDENSITY	-.22477	.24726	-.18061	-.12481
θ_s	-.26843	-.18763	.16007	.15278
$\theta_d(1)$	.29145	-.13554	.09417	.15669
$\theta_d(3)$	.29596	-.11600	.08197	.13663
$\theta_d(10)$	.29525	-.06295	.07147	.07378
$\theta_d(30)$	.21676	.30866	-.08195	-.18516
$\theta_d(150)$	.18864	.34801	-.25621	-.07346
$\theta_w(5)$	.29535	-.07932	.07488	.08539
$\theta_w(.5)$	.29078	-.14395	.09249	.13199
ln K_s	-.21164	-.06448	.20203	-.22643
MEDIUM SAND	-.19862	-.13901	-.24466	.45476
TOTAL SAND	-.22278	-.16695	-.20431	.41343
SILT	-.18391	-.30817	.25999	-.18782
CLAY	.24251	.31348	-.11666	-.03619
PH	-.13804	.22059	.53338	.26364
CEC	.17980	.27284	.16887	-.04668
% BASE SAT.	-.13866	.34760	.40004	.24099

	Eigenvalue	Difference	Proportion	Cumulative %
PC 1	10.35583	7.59854	0.51779	51.78
PC 2	2.75729	1.22476	0.13786	65.56
PC 3	1.53253	0.17509	0.07663	73.23
PC 4	1.35744	0.30442	0.06787	80.02

Summarizing the above, we conclude that most of the variation in the data set is due to the effect of soil depth on hydraulic properties, which accounts for over 50% of total variability. The second most important source of variation is differences in particle size distribution between the two sites. Soils at Site I contain more sand and clay, and also have a higher base saturation than soils at

Site II, which are siltier. These differences are reflected by PC2 and PC4, which together account for approximately 20% of overall variability. From a statistical point of view, the first principal component represents an optimal choice for a single parameter to characterize both overall and hydraulic property variability. To use this or other principal components in further analyses, it is first necessary to compute the projection of the individual samples in the data set onto the component axes, i.e. solve Eq. (2.1) for each sample and for each of the desired principal components PCi. The result is called the 'score' of an individual onto the i-th PC. Replacing values of the original variables is equivalent to a change in the coordinate system. Each sample is originally defined by its location in n-dimensional space, where each of the n dimensions corresponds to a specific soil property. The pH value of a sample, for instance, is the projection of that sample onto the pH axis. The projection of a sample onto a principal component corresponds not to a single soil property but to a combination of different properties. In case of the first PC, a high score indicates high clay content, high water retention, and low saturated conductivity. Figure 4 shows a plot of PC1 scores against depth. Scores for the two sites at each depth are averages over subsites. The figure shows a considerable increase of the scores between 0 and 1 m depth, but relatively little change at greater depths. Statistical significance of differences in mean PC1 scores between sites were evaluated using the t-test (Snedecor and Cochran, 1967). Results of these tests are indicated by the asterisks at the right of Figure 4. Significance of the differences between sites decreases with soil depth, due to a larger within-site variability at increasing depths.

Spatial variability within sites was evaluated using geostatistical methods. It is convenient to employ principal components rather than repeat the analyses for each individual soil property. Semivariograms for the first principal component are shown in Figure 5. Straight lines have been drawn through the data using a visual best fit. Because of the great uncertainty in estimated semivariograms with the small number of observations at each soil depth, and because overall shapes of the semivariograms appeared similar for the two sites, the semivariograms shown are averaged over the two sites. Semivariograms for the 2, 4, and 6 m depths were also averaged, since semivariograms for the individual depths were very close.

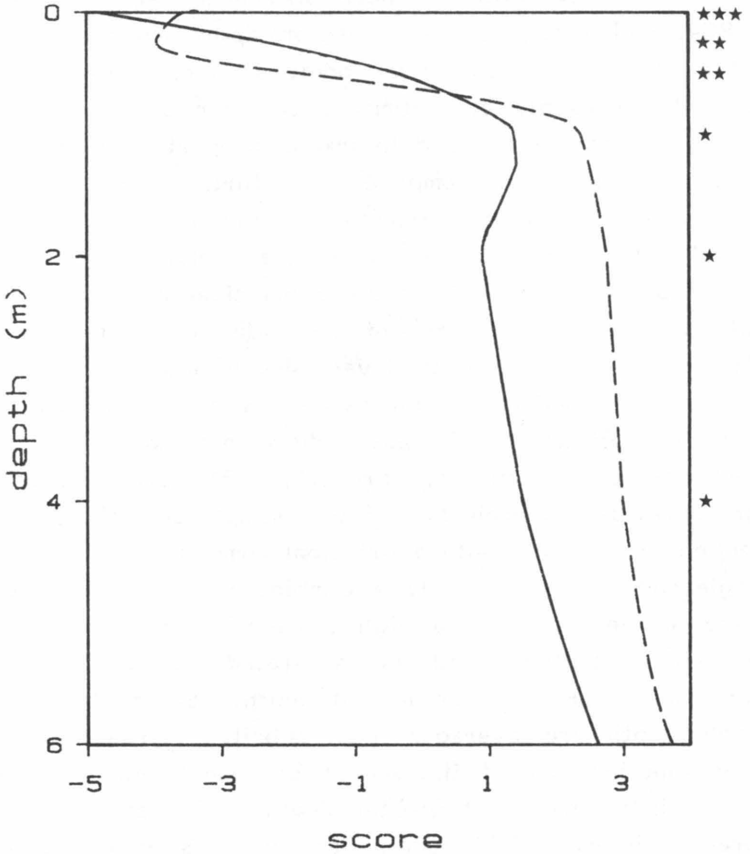

Figure 4. Mean PCI scores versus depth for Site I (——) and Site II (— —). *'s denote level of significance for differences between sites: * p ≤0.05; ** p ≤0.01; *** p ≤0.001.

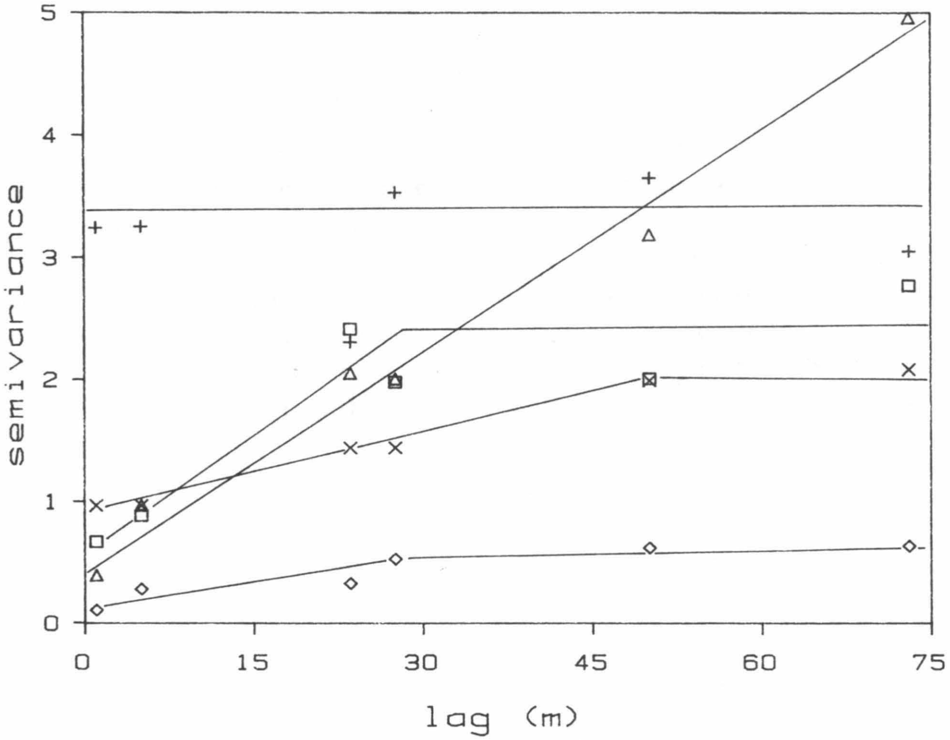

Figure 5. Semivariograms of PC1 scores. Symbols distinguish different sampling depths. ◇ = 0.0 m; □ = 0.25 m; △ = 0.5 m; x = 1.0 m; + = 2-6 m.

Figure 5 shows a correlation distance of approximately 25 m for the 0 and 0.25 cm depths. At 1 m depth there is a range of about 50 m, but also a large proportion of very short distance variability, indicated by the y-axis intercept. At depths of 2 m and greater there appears to be no spatial correlation at all. Finally, the semivariogram for the 0.5 m depth is difficult to interpret; the calculated semivariance keeps increasing with distance, indicating the presence of a trend or other nonstationarity. With the small number of observations, the significance of this nonstationary behavior remains unresolved.

Scaling

Figures 6-12 show mean desorption curves, obtained from Eq. (2.6), for each sampling depth and site. Note that although $S_e(h)$ curves for the two sites may be similar at a given depth, this does not mean that actual retention curves $\theta(h)$ are also similar, since saturated and residual moisture contents are in most cases different for the two sites (Tables 4 and A1). At both sites, the $h_m(S_e)$ curves for depths of 1 m and greater become very steep near saturation reflecting the narrow and very fine pore size distribution of the corresponding soil layers. The soil remains essentially saturated up to pressure heads of several hundred cm at depths of 1 m and more, especially at Site II. Since the abcissa in Figures 6-12

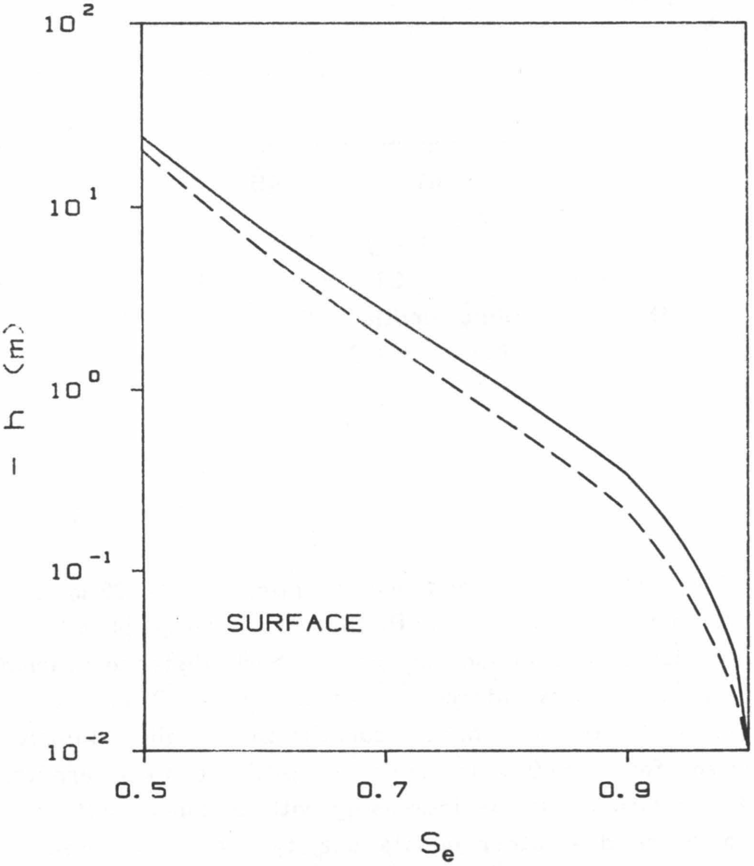

Figure 6. Mean desorption $\theta(h)$ curves for 0.0 m depth at two sites: ———: Site I; — — —: Site II.

represent the effective saturation, S_e, the effect of soil depth on the residual moisture content, θ_r, is not evident from these graphs. In fact, soil depth had a distinct effect on residual moisture contents. θ_r values used for each soil depth in the scaling procedure are given in Table 4. The table indicates very high values for θ_r for soil depths of 0.5 m and greater, reflecting the high clay contents in the Bt and C horizons. Since only measured pressure heads up to h = -10 m were used in obtaining θ_r values, they must be regarded as curve-fitting, rather than physical parameters. In particular, the fitted retention curves should not be extrapolated to pressure heads that are much more negative than -10 m. Values of the scale coefficients α_i are given in Tables 5 and 6 for Sites I and II, respectively. Each column gives the scale coefficients at a given

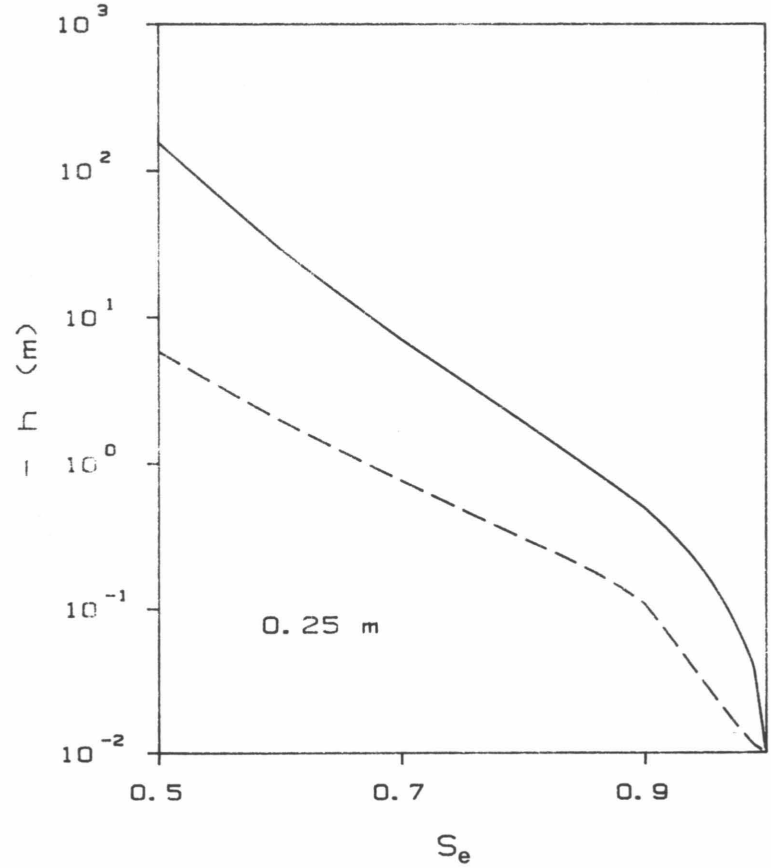

Figure 7. Mean desorption θ(h) curves for 0.25 m depth at two sites: ———: Site I; — — —: Site II.

depth, while rows in Table 5 and 6 give the scale coefficients at different depths for each subsite. The value of the scale coefficient indicates the differences between the retention characteristic for each individual sample and its corresponding mean retention curve. A value of α equal to 1.0 indicates perfect agreement with the mean retention curve, while very large or very small values indicate very different curves. The range of values at a given depth is indicative of the variability of retention characteristics at that depth. The tables show that at both sites the least variability occurs at the soil surface, as was also indicated by the principal component analyses. Ranges in scale coefficients are much greater at other depths, with values of α ranging over several orders of magnitude. It is worth noting that at any soil depth most of the values will be fairly close to

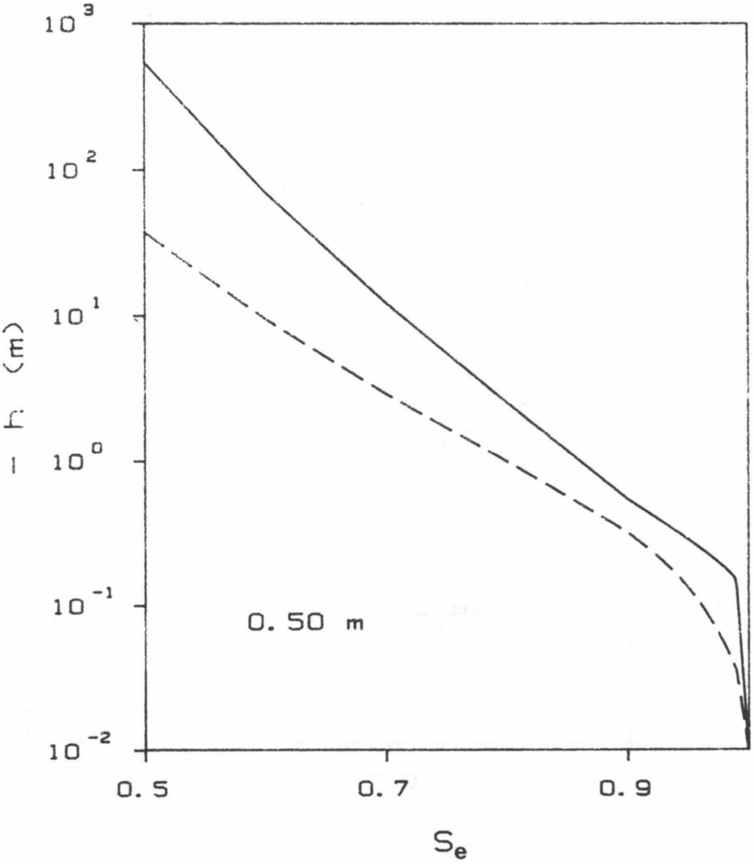

Figure 8. Mean desorption θ(h) curves for 0.5 m depth at two sites: ———: Site I; — — —: Site II.

1.0, with only a small number of extreme values. The pattern is the most erratic at the 0.5 and 1.0 m depth (i.e. Bt horizon) at Site I.

For perfect scaling, the scaled individual retention curves $\alpha_i h_i(\theta)$, will coincide exactly with their corresponding mean curve. In practice, such good results are not expected. The effectiveness of scaling is judged instead from the reduction in deviations between mean and scaled versus unscaled individual retention curves. These reductions are shown in Table 7 for each site and sampling depth. The table gives medians of the sums of squared residuals (See Eq. 2.8) for the 19 subsites at each depth and site. The median rather than the arithmetic mean is given because the distribution of sums of squares at a given depth was found to be very skewed. A result of this skewness is that the arithmetic mean is determined mostly by the

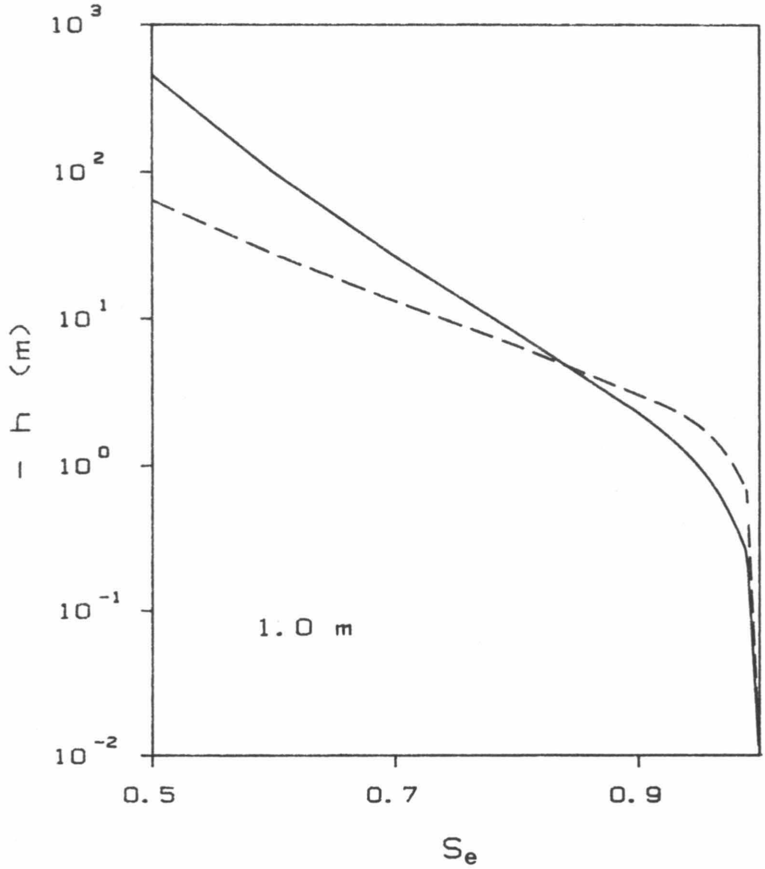

Figure 9. Mean desorption $\theta(h)$ curves for 1 m depth at two sites: ———: Site I; — — —: Site II.

small number of very large values. Table 7 shows that scaling results in an overall 5-10-fold reduction in the sum of squares. The table also indicates that, even after scaling, the sums of squares remain quite high. These high values are partly explained by the fact that the squared deviations are used. Even taking this into account, the table still indicates considerable variation among the individual scaled retention curves. These variations can also be seen from Figures 13-16, in which deviations between mean and individual $h(S_e)$ curves before and after scaling are plotted for the 0.0 and 1.0 m depths.

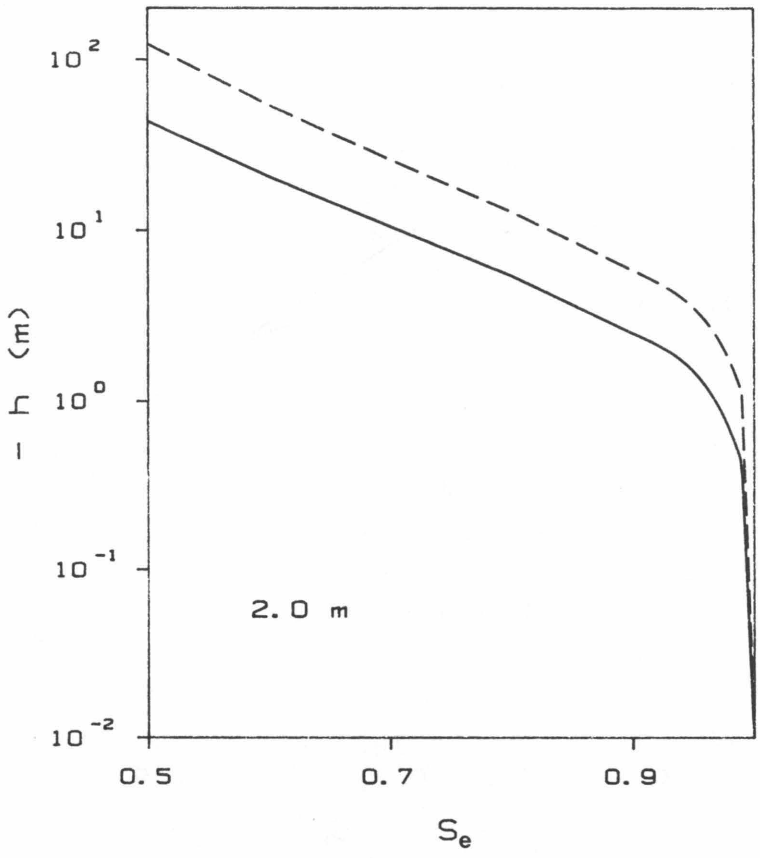

Figure 10. Mean desorption θ(h) curves for 2 m depth at two sites: ——: Site I; — —: Site II.

From Table 7 we note that scaling was most effective for the 0.0 m depth but much less so at 1.0 m. Deviations among samples in Figures 13-16 are plotted as relative deviations, R, given by:

$$R_{unscaled} = \frac{h_m(S_e)-h_i(S_e)}{h_m(S_e)}$$

and (3.1)

$$R_{scaled} = \frac{h_m(S_e)-\alpha_i h_i(S_e)}{h_m(S_e)}$$

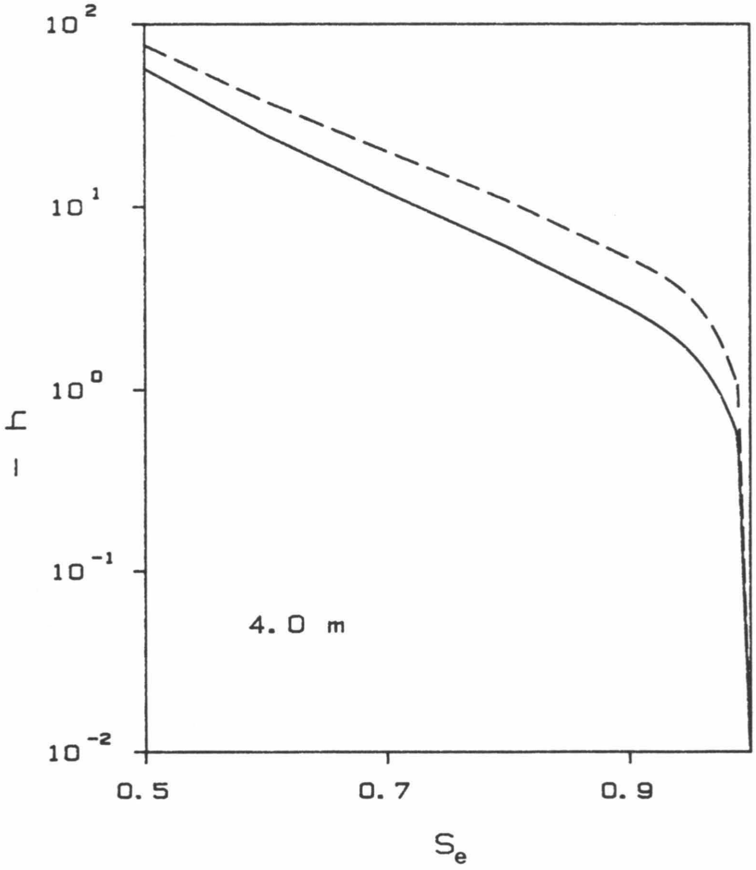

Figure 11. Mean desorption θ(h) curves for 4 m depth at two sites: ———: Site I; — —: Site II.

for unscaled and scaled plots, respectively. Note the difference in scale on the vertical axis between the 0.0 m and 1.0 m plots in Figures 13-16. The total sum of squares before scaling will have highest contributions from high negative pressure heads, where the magnitude of deviations among samples is greatest. Consequently, scaling will be most effective in reducing deviations at these high negative pressure heads. Increased deviations for scaled curves may actually result near saturation, as is clearly shown by the figures. Figures 15a and 16a also show that before scaling at the 1.0 m depth, retention characteristics for most samples are clustered quite closely around the mean curve, and only a small number of samples

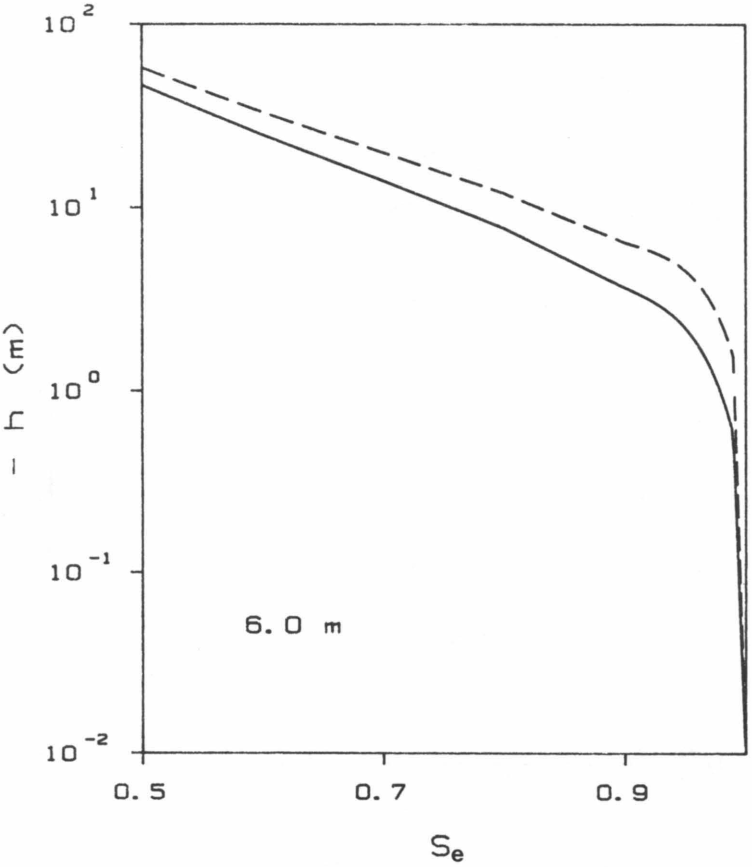

Figure 12. Mean desorption θ(h) curves for 6 m depth at two sites: ———: Site I; — — —: Site II.

Table 4. Values of residual moisture content θ_r for each site and depth.

	Site	
Depth (m)	I	II
0.0	0.020	0.120
0.25	0.151	0.155
0.05	0.305	0.281
1.0	0.304	0.425
2.0	0.287	0.261
4.0	0.228	0.250
6.0	0.324	0.404

TABLE 5. Values of scale coefficient α for site I samples.

	Depth (m)						
sub-site	0.0	0.25	0.5	1.0	2.0	4.0	6.0
1	1.92	21.70	0.91	19.10	2.53	0.05	0.02
2	0.29	0.35	0.47	5.50	0.88	0.10	-
3	1.36	6.09	132.00	$1.1\text{x}10^{-5}$	11.60	-	1.0
4	1.22	-	2.08	- -	-	1.94	1.38
5	2.11	79.40	120.00	$2.1\text{x}10^{-4}$	4.06	0.01	1.1
6	2.80	-	228.00	$1.4\text{x}10^{-4}$	2.86	2.89	0.8
7	2.38	3.42	-	16.50	$1.2\text{x}10^{-3}$	5.42	2.1
8	1.91	0.82	0.02	34.20	0.36	3.55	1.02
9	3.09	1.99	29.50	19.80	1.64	3.42	-
10	1.66	-	-	2.84	-	-	-
11	2.11	10.70	0.02	5.00	5.26	-	-
12	-	-	-	-	-	-	-
13	-	5.47	0.06	0.02	$1.6\text{x}10^{-3}$	0.97	-
14	0.86	0.02	0.03	0.07	3.71	2.30	-
15	0.20	1.50	0.04	17.20	-	-	-
16	0.39	0.05	2.86	33.20	-	-	-
17	0.26	0.01	0.02	11.50	1.95	-	-
18	0.33	0.26	$5.7\text{x}10^{-3}$	26.00	-	-	-
19	0.54	0.08	197.00	13.60	8.95	-	-

TABLE 6. Values of scale coefficient α for site II samples.

sub-site	Depth (m) 0.0	0.25	0.5	1.0	2.0	4.0	6.0
1	3.16	1.32	0.02	0.31	33.30	0.78	1.56
2	4.50	0.62	0.02	58.00	$4.7x10^{-7}$	2.79	-
3	1.69	1.94	0.15	-	0.28	0.16	2.24
4	1.63	2.07	0.02	4.13	3.31	0.98	-
5	2.14	1.20	0.02	-	29.60	1.29	2.16
6	3.14	2.75	2.72	5.16	3.25	0.61	0.99
7	2.70	3.78	2.05	3.34	3.56	3.15	2.79
8	0.64	0.08	73.20	-	7.60	2.54	1.57
9	0.39	4.06	4.04	$4.5x10^{-4}$	4.86	2.90	-
10	1.21	2.41	8.91	-	3.90	0.01	1.39
11	2.54	3.96	21.60	0.43	0.06	$5.7x10^{-5}$	0.0
12	0.88	1.26	17.10	$1.7x10^{-4}$	$8.6x10^{-5}$	3.00	0.5
13	0.36	0.81	1.14	0.13	0.12	7.70	1.39
14	1.01	1.22	1.59	2.60	5.85	2.84	3.3x10
15	0.47	1.99	4.87	1.87	1.71	2.53	7.98
16	0.02	1.68	0.12	5.85	7.93	1.49	2.16
17	1.97	3.10	60.40	6.78	17.10	2.95	1.50
18	-	4.51	$4.8x10^{-3}$	1.77	5.88	14.20	8.82
19	0.26	$5.8x10^{-5}$	0.63	2.77	1.77	0.88	0.17

deviate strongly from this mean, especially at high negative pressure heads and low water contents. Scaling of these few aberrant curves introduces the very low values of α in Tables 5 and 6. No attempt was made to fit probability distributions to the observed α since only 19 or fewer values were available at every site depth. However, the wide range and extreme values of observed α indicate that this distribution cannot be described very well with commonly used distribution functions, e.g., normal or log-normal.

Table 7. Median values of sums of squared deviation between mean and indivudal retention curve, before and after scaling.

	Site			
	I		II	
Depth (m)	Before	After	Before	After
0.0	$2.89\mathrm{x}10^{2}$	$4.55\mathrm{x}10^{0}$	$1.72\mathrm{x}10^{2}$	$3.30\mathrm{x}10^{0}$
0.25	$2.30\mathrm{x}10^{4}$	$3.56\mathrm{x}10^{2}$	$1.71\mathrm{x}10^{1}$	$5.83\mathrm{x}10^{0}$
0.5	$4.02\mathrm{x}10^{5}$	$1.76\mathrm{x}10^{3}$	$1.36\mathrm{x}10^{3}$	$6.88\mathrm{x}10^{1}$
1.0	$2.04\mathrm{x}10^{5}$	$1.10\mathrm{x}10^{4}$	$4.07\mathrm{x}10^{3}$	$9.59\mathrm{x}10^{2}$
2.0	$1.71\mathrm{x}10^{3}$	$2.85\mathrm{x}10^{2}$	$1.49\mathrm{x}10^{4}$	$2.52\mathrm{x}10^{3}$
4.0	$2.61\mathrm{x}10^{3}$	$9.94\mathrm{x}10^{2}$	$3.88\mathrm{x}10^{3}$	$9.10\mathrm{x}10^{2}$
6.0	$1.66\mathrm{x}10^{2}$	$4.15\mathrm{x}10^{1}$	$2.46\mathrm{x}10^{3}$	$5.49\mathrm{x}10^{2}$

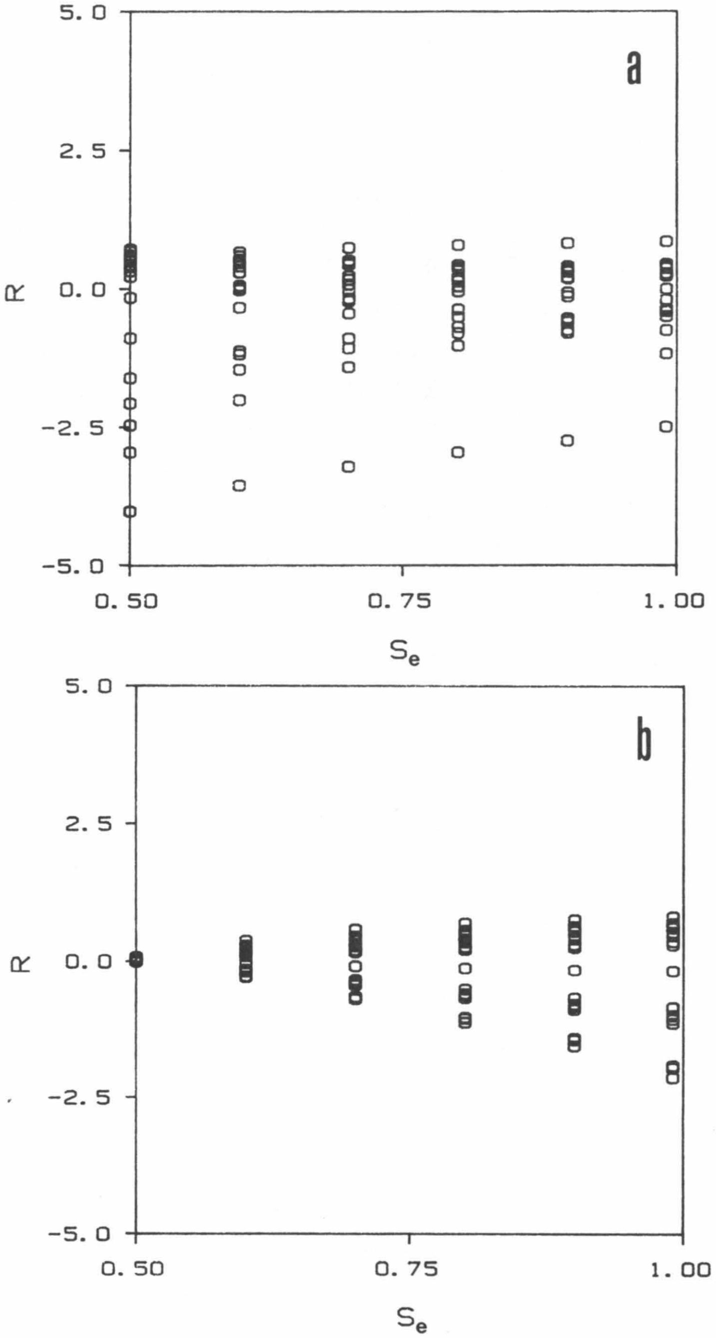

Figure 13. Relative deviation R between mean and indivudual $\theta(h)$ curves before (a) and after (b) scaling for Site I depth and 0.0 m.

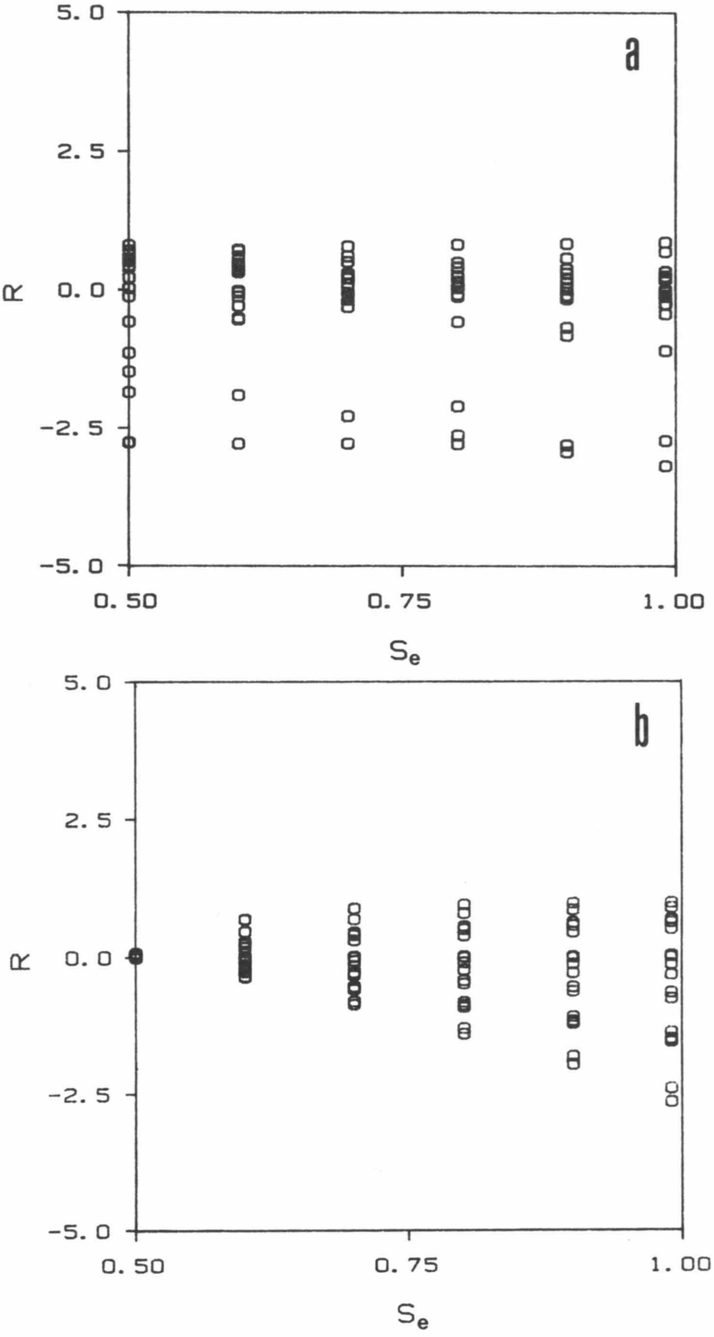

Figure 14. Relative deviation R between mean and individual θ(h) curves before (a) and after (b) scaling for Site II and depth 0.0 m.

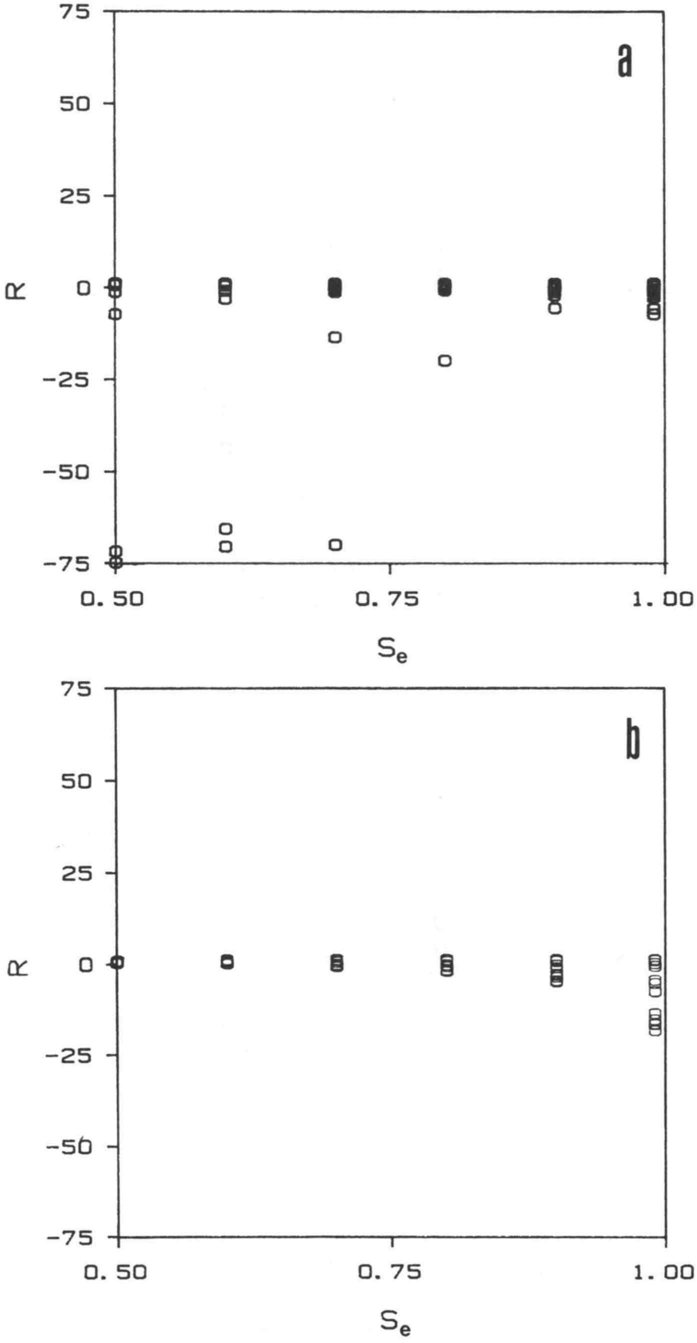

Figure 15. Relative deviation R between mean and individual θ(h) curves before (a) and after (b) scaling for Site I and depth 1.0 m.

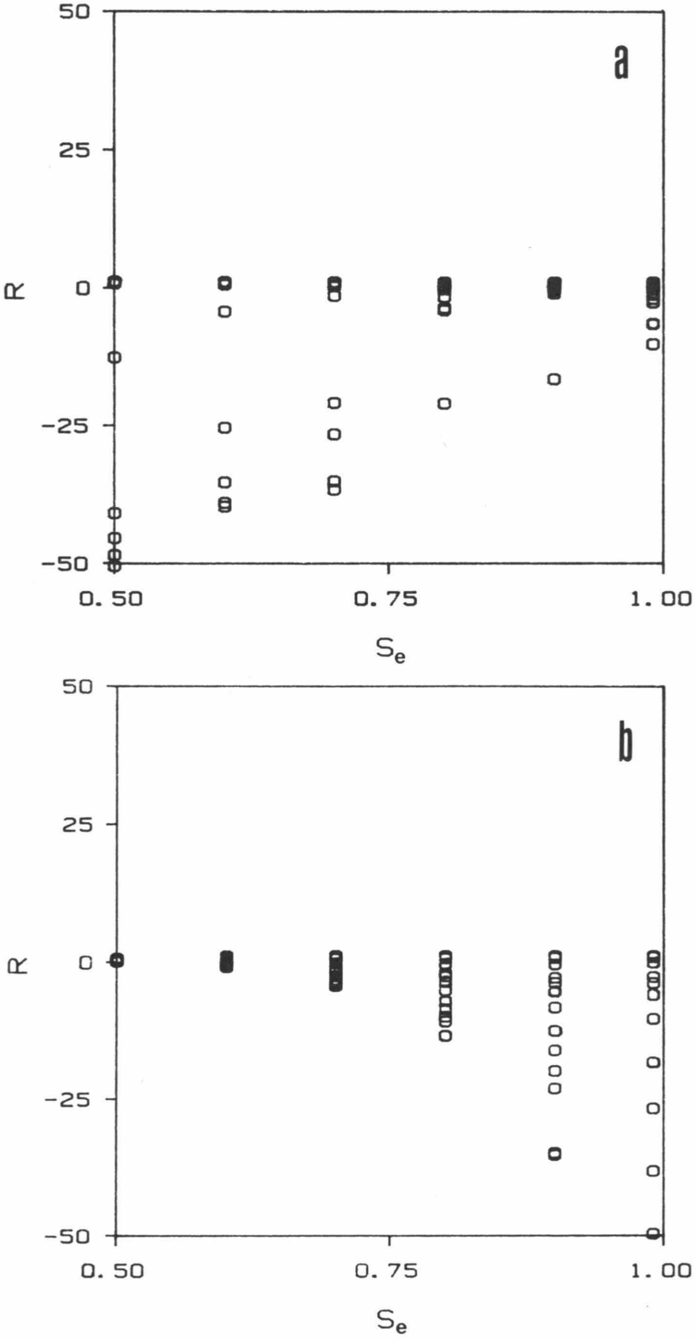

Figure 16. Relative deviation R between mean and individual θ(h) curves before (a) and after (b) scaling for Site II and depth 1.0 m.

IV. SUMMARY AND CONCLUSIONS

In this study a total of 317 soil samples from the Groseclose soil mapping unit were collected and analyzed. Samples were taken from two sites in Pulaski and Montgomery Counties near Blacksburg, Virginia. At each site, undisturbed core samples were taken at 19 subsites, along a 150 m transect and to a depth of 6 m. Samples were analyzed for hydraulic and chemical properties and particle size distribution. A separate study was made of solute transport properties and effects of core volume for the 0.0 and 0.5 m depths at Site II. All measured data are given in the appendix. The analysis of hydraulic, chemical, and particle size distribution properties is discussed in this report. Hydraulic properties --i.e. water retention characteristics and saturated conductivity-- show the most variability. These properties vary strongly with soil depth. Differences between sites were statistically significant, especially in the topsoil, but were still much smaller than depth-related variability. Differences between sites were most pronounced in the particle size distribution, with soils at Site II being siltier than those at Site I. Scaling was applied to the measured desorption water retention data to obtain a succint description of the water retention variability. Effects of between-site and depth-related variation were accounted for by defining separate mean retention curves for each sampling depth at each site. Scaling the retention curves resulted in an overall 5-10 fold reduction in variability. The reduction is not consistent for every depth, but varies from 200x to 2.6x. Most of the scaled retention curves were found to be clustered quite closely around their respective mean curves with, except for the surface samples, a small number of outlying curves. These few aberrant curves significantly reduce the overall effectiveness of scaling. The overall conclusion is that scaling hydraulic properties of the Groseclose soil is not as simple a procedure as other scaling studies have suggested. It was found necessary to define separate mean retention curves for each soil depth and each site. Scaling also had to be restricted to more or less the range of measured pressure heads. Plots of retention curves before and after scaling suggest that a great part of these difficulties are caused by a small number of samples at each depth. These samples have retention characteristics that deviate strongly from the mean curve at high negative pressure heads. These few curves could not be scaled very successfully.

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APPENDIX

Measured data are presented in Tables A1 through A7 of this appendix. In Tables A1A and A1B water retention data and saturated hydraulic conductivity data are given for small cores for each subsite and depth, at Site I and Site II, respectively. Subsites are numbered as shown in Figure 2. The number in parentheses in the subsite column is the distance in meters along the transect for each subsite. Water contents during drying are indicated by θ_d, while θ_w indicates wetting. The value in parentheses gives the absolute pressure head in m H_2O to which these water contents correspond. Particularly at Site I, shallowness of the soil prevented taking samples down to 6 meters at many of the 19 subsites. The maximum depth reached is indicated for each subsite by the depth of auger refusal. Other missing values are indicated by "--". Tables A2 and A3 give particle size distributions and chemical characteristics, respectively, for each subsite and depth. The organization of these tables is the same as for Table A1. Table A4 gives mean and standard deviations of the data presented in Tables A1-A3. Means and standard deviations were calculated over subsites for each site and depth. Numbers of subsites used to calculate these statistics are designated as N. Tables A5 through A7 give hydraulic and transport properties measured on different core sizes at 0 and 0.5 m depths at Site II. To facilitate comparison, values for the small cores that were also given in the previous tables are repeated here with the data for medium and large cores. Table A5 gives the desorption water contents between 0 and 10 meters tension, together with the actual water contents at the time of sampling in the column labelled 'INITIAL'. Table A6 gives saturated hydraulic conductivity, pore water velocity, dispersion coefficient, and bulk density data for the three core sizes. Saturated conductivities, calculated from the in-situ infiltration experiments, are indicated by 'FIELD'. Means and standard deviations of the data presented in Tables A5 and A6 are given in Table A7. N again denotes the number of subsites used in calculating the statistics.

TABLE A1A. WATER RETENTION AND SATURATED CONDUCTIVITY FOR SITE I

SUB-SITE	DEPTH (m)	Θ_s	$\Theta_d(1)$	$\Theta_d(3)$	$\Theta_d(10)$	$\Theta_d(30)$	$\Theta_d(150)$	$\Theta_w(5)$	$\Theta_w(.5)$	K_s
		(m^3/m^3)								(m/s)
1	0.0	0.455	0.358	0.315	0.233	0.194	0.185	0.249	0.336	7.63E-06
	0.25	0.389	0.320	0.295	0.254	0.217	0.227	0.259	0.301	4.58E-06
(0.0)	0.5	0.442	0.433	0.421	0.410	0.297	0.326	0.414	0.431	4.31E-06
	1.0	0.506	0.507	0.502	0.424	0.395	0.411	0.440	0.488	1.06E-08
	2.0	0.600	0.590	0.550	0.470	0.215	0.221	0.480	0.560	2.77E-07
	4.0	0.550	0.530	0.510	0.480	0.283	0.290	0.490	0.520	2.39E-08
	6.0	0.580	0.560	0.540	0.510	0.273	0.275	0.510	0.530	1.94E-08
2	0.0	0.420	0.350	0.300	0.280	0.156	0.150	0.280	0.290	3.74E-06
	0.25	0.394	0.389	0.375	0.355	0.273	0.281	0.359	0.383	6.79E-07
(0.5)	0.5	0.494	0.487	0.481	0.462	0.377	0.348	0.460	0.470	1.14E-08
	1.0	0.570	0.550	0.540	0.490	0.390	0.386	0.510	0.530	7.32E-09
	2.0	0.580	0.580	0.570	0.530	0.310	0.310	0.540	0.570	6.73E-10
	4.0	0.590	0.570	0.550	0.510	0.278	0.284	0.510	0.540	2.57E-09
	6.0	0.548	0.540	0.533	--	0.241	0.216	--	--	6.31E-09
3	0.0	0.477	0.409	0.358	0.266	0.158	0.154	0.286	0.384	1.45E-06
	0.25	0.378	0.321	0.304	0.266	0.146	0.124	0.277	0.311	9.29E-08
(5.0)	0.5	0.378	0.361	0.328	0.287	0.270	0.246	0.295	0.344	4.26E-08
	1.0	0.519	0.497	0.494	0.485	0.400	0.345	0.489	0.496	1.33E-09
	2.0	0.471	0.418	0.400	0.320	0.366	0.319	0.342	0.416	2.93E-06
	4.0	0.524	0.513	0.508	0.502	0.448	0.413	0.509	0.536	3.81E-09
	6.0	0.567	0.581	0.567	0.526	0.479	0.440	0.528	0.527	4.29E-09
4	0.0	0.421	0.354	0.319	0.234	0.140	0.130	0.254	0.331	3.22E-06
	0.25	--	--	--	--	0.205	0.183	--	--	3.04E-06
(25.0)	0.5	0.364	0.356	0.352	0.343	0.302	0.342	0.345	0.355	1.15E-08
	1.0	0.491	0.486	0.484	0.479	0.411	0.388	0.483	0.486	5.76E-10
	2.0	0.592	0.586	0.580	0.571	0.353	0.340	0.578	0.600	2.48E-09
	4.0	0.597	0.599	0.597	0.522	0.319	0.304	0.541	0.584	6.84E-09
	6.0	0.555	0.549	0.540	0.498	0.333	0.312	0.507	0.540	4.40E-08

TABLE A1A. WATER RETENTION AND SATURATED CONDUCTIVITY FOR SITE I

SUB-SITE	DEPTH (m)	Θ_s	$\Theta_d(1)$	$\Theta_d(3)$	$\Theta_d(10)$	$\Theta_d(30)$	$\Theta_d(150)$	$\Theta_w(5)$	$\Theta_w(.5)$	K_s
		(m^3/m^3)								(m/s)
5	0.0	0.439	0.304	0.269	0.225	0.153	0.139	0.243	0.301	3.39E-05
	0.25	0.326	0.251	0.227	0.181	0.179	0.166	0.187	0.231	9.67E-07
(25.5)	0.5	0.355	0.337	0.330	0.326	0.229	0.222	0.329	0.324	4.40E-07
	1.0	0.451	0.437	0.432	0.425	0.364	0.445	0.427	0.435	6.79E-09
	2.0	0.540	0.529	0.496	0.382	0.451	0.441	0.410	0.516	5.31E-07
	4.0	0.573	0.566	0.539	0.524	0.459	0.457	0.551	0.603	5.03E-08
	6.0	0.631	0.632	0.620	0.578	0.503	0.455	0.582	0.621	7.23E-09
6	0.0	0.423	0.329	0.253	0.217	0.163	0.149	0.226	0.279	9.16E-06
	0.25	--	--	--	--	0.144	0.137	--	--	--
(30.0)	0.5	0.359	0.339	0.331	0.318	0.207	0.201	0.320	0.335	2.31E-07
	1.0	0.461	0.449	0.447	0.435	0.384	0.365	0.439	0.445	9.59E-10
	2.0	0.488	0.488	0.461	0.400	0.345	0.335	0.400	0.477	9.95E-09
	4.0	0.569	0.557	0.523	0.431	0.214	0.195	0.439	0.519	1.08E-08
	6.0	0.603	0.616	0.613	0.575	0.354	0.323	0.583	0.614	8.84E-09
7	0.0	0.388	0.296	0.259	0.194	0.169	0.157	0.207	0.275	8.55E-06
	0.25	0.397	0.361	0.340	0.297	0.285	0.278	0.306	0.335	4.64E-07
(50.0)	0.5	0.465	0.457	0.453	0.447	0.323	0.317	0.447	0.453	1.99E-08
	1.0	0.490	0.490	0.476	0.428	0.321	0.305	0.432	0.455	5.75E-08
	2.0	0.507	0.507	0.499	0.491	0.388	0.375	0.491	0.516	7.58E-10
	4.0	0.593	0.486	0.465	0.435	0.308	0.298	0.444	0.478	2.94E-09
	6.0	0.514	0.507	0.492	0.448	0.294	0.293	0.454	0.502	1.42E-06
8	0.0	0.390	0.297	0.266	0.199	0.140	0.128	0.219	0.285	8.34E-06
	0.25	0.432	0.369	0.349	0.331	0.292	0.289	0.337	0.362	2.65E-07
(50.5)	0.5	0.451	0.441	0.434	0.421	0.319	0.311	0.425	0.440	2.26E-06
	1.0	0.510	0.509	0.481	0.367	0.289	0.284	0.376	0.466	1.22E-08
	2.0	0.474	0.472	0.461	0.441	0.369	0.365	0.446	0.463	2.73E-09
	4.0	0.519	0.499	0.484	0.354	0.391	0.339	0.361	0.425	3.06E-09
	6.0	0.550	0.539	0.529	0.487	0.275	0.248	0.501	0.532	1.44E-08

TABLE A1A. WATER RETENTION AND SATURATED CONDUCTIVITY FOR SITE I

SUB-SITE	DEPTH (m)	θ_s	$\theta_d(1)$	$\theta_d(3)$	$\theta_d(10)$	$\theta_d(30)$	$\theta_d(150)$	$\theta_w(5)$	$\theta_w(.5)$	K_s (m/s)
					(m^3/m^3)					
9	0.0	0.418	0.313	0.274	0.197	0.132	0.124	0.216	0.294	1.85E-05
	0.25	0.355	0.326	0.312	0.281	0.256	0.220	0.291	0.319	2.70E-07
(55.0)	0.5	0.395	0.377	0.365	0.354	0.307	0.279	0.363	0.384	4.61E-05
	1.0	0.411	0.400	0.396	0.365	0.437	0.402	0.373	0.390	1.65E-09
	2.0	0.454	0.449	0.437	0.394	0.352	0.312	0.402	0.438	8.50E-10
	4.0	0.501	0.499	0.487	0.464	0.223	0.193	0.473	0.496	2.09E-09
					AUGER REFUSAL AT 5.3 M					
10	0.0	0.402	0.322	0.289	0.213	0.129	0.097	0.234	0.304	1.40E-06
	0.25	0.365	0.353	0.350	0.340	0.224	0.186	0.350	0.350	5.92E-07
(75.0)	0.5	0.463	0.450	0.445	0.438	0.367	0.349	0.442	0.451	1.62E-06
	1.0	0.519	0.513	0.498	0.474	0.412	0.454	0.478	0.488	1.43E-09
					AUGER REFUSAL AT 2.0 M					
11	0.0	0.390	0.312	0.277	0.193	0.121	0.100	0.215	0.288	2.44E-06
	0.25	0.350	0.317	0.303	0.242	0.167	0.219	0.252	0.307	1.27E-07
(75.5)	0.5	0.471	0.474	0.466	0.455	0.328	0.360	0.458	0.465	2.55E-06
	1.0	0.447	0.445	0.437	0.419	0.453	0.495	0.422	0.428	4.31E-08
	2.0	0.579	0.575	0.501	0.266	0.249	0.276	0.272	0.516	7.64E-07
					AUGER REFUSAL AT 3.0 M					
12	0.0	0.407	0.390	0.386	0.309	0.103	0.103	0.347	0.416	2.59E-07
	0.25	--	--	--	--	1.397	0.186	--	--	--
(80.0)					AUGER REFUSAL AT 0.5 M					
13	0.0	0.354	0.283	0.239	0.183	0.178	0.142	0.197	0.254	2.21E-06
	0.25	0.375	0.328	0.308	0.275	0.250	0.300	0.281	0.317	1.73E-06
(100.0)	0.5	0.467	0.434	0.428	0.417	0.374	0.411	0.419	0.424	3.24E-06
	1.0	0.525	0.520	0.519	0.519	0.390	0.425	0.530	0.540	7.78E-09
	2.0	0.479	0.461	0.450	0.421	0.396	0.402	0.425	0.440	1.89E-08
	4.0	0.555	0.563	0.562	0.548	0.410	0.413	0.548	0.559	3.12E-10
					AUGER REFUSAL AT 5.8 M					

TABLE A1A. WATER RETENTION AND SATURATED CONDUCTIVITY FOR SITE I

SUB-SITE	DEPTH (m)	Θ_s	$\Theta_d(1)$	$\Theta_d(3)$	$\Theta_d(10)$	$\Theta_d(30)$	$\Theta_d(150)$	$\Theta_w(5)$	$\Theta_w(.5)$	K_s (m/s)
					(m^3/m^3)					
14	0.0	0.405	0.323	0.293	0.230	0.201	0.157	0.252	0.305	3.58E-06
	0.25	0.480	0.420	0.412	0.392	0.331	0.335	0.395	0.407	2.94E-06
(100.5)	0.5	0.489	0.480	0.473	0.457	0.429	0.432	0.461	0.468	2.07E-07
	1.0	0.537	0.520	0.508	0.491	0.391	0.391	0.498	0.510	1.26E-08
	2.0	0.504	0.499	0.476	0.374	0.363	0.371	0.381	0.488	1.91E-08
	4.0	0.544	0.541	0.540	0.450	0.350	0.354	0.455	0.487	7.27E-10
					AUGER REFUSAL AT 5.5 M					
15	0.0	0.420	0.383	0.353	0.302	0.219	0.164	0.313	0.376	1.23E-06
	0.25	0.502	0.474	0.456	0.400	0.308	0.315	0.403	0.427	2.30E-07
(105.0)	0.5	0.492	0.488	0.482	0.471	0.389	0.390	0.474	0.484	2.31E-07
	1.0	0.515	0.511	0.510	0.434	0.332	0.000	0.450	0.473	1.64E-09
					AUGER REFUSAL AT 1.5 M					
16	0.0	0.417	0.356	0.323	0.270	0.210	0.166	0.280	0.334	2.26E-06
	0.25	0.519	0.458	0.445	0.425	0.341	0.325	0.432	0.447	1.91E-05
(125.0)	0.5	0.540	0.486	0.474	0.448	0.349	0.340	0.454	0.467	5.46E-05
	1.0	0.536	0.495	0.467	0.422	0.371	0.361	0.427	0.441	1.61E-07
	2.0	0.470	0.469	0.455	0.424	0.309	0.296	0.413	0.457	3.70E-07
					AUGER REFUSAL AT 2.4 M					
17	0.0	0.408	0.353	0.319	0.274	0.199	0.159	0.282	0.331	1.94E-07
	0.25	0.513	0.454	0.443	0.422	0.320	0.330	0.426	0.435	2.29E-05
(125.5)	0.5	0.489	0.471	0.462	0.447	0.341	0.337	0.451	0.462	2.73E-06
	1.0	0.458	0.429	0.414	0.393	0.404	0.351	0.397	0.416	1.64E-07
	2.0	0.475	0.462	0.445	0.403	0.306	0.204	0.395	0.439	2.12E-07
					AUGER REFUSAL AT 2.4 M					
18	0.0	0.410	0.350	0.318	0.272	0.223	0.174	0.278	0.321	5.05E-07
	0.25	0.533	0.500	0.484	0.435	0.358	0.073	0.442	0.460	5.01E-08
(130.0)	0.5	0.498	0.480	0.474	0.460	0.396	0.140	0.469	0.480	7.43E-09
	1.0	0.527	0.502	0.482	0.422	0.232	0.234	0.477	0.535	6.92E-08
					AUGER REFUSAL AT 1.5 M					

TABLE A1A. WATER RETENTION AND SATURATED CONDUCTIVITY FOR SITE I

SUB-SITE	DEPTH	θ_s	$\theta_d(1)$	$\theta_d(3)$	$\theta_d(10)$	$\theta_d(30)$	$\theta_d(150)$	$\theta_w(5)$	$\theta_w(.5)$	K_s
	(m)	(m^3/m^3)								(m/s)
19	0.0	0.411	0.325	0.284	0.214	0.156	0.143	0.225	0.293	9.52E-07
	0.25	0.385	0.363	0.349	0.328	0.144	0.346	0.332	0.358	4.04E-07
(150.0)	0.5	0.391	0.359	0.348	0.332	0.212	0.410	0.337	0.365	2.64E-07
	1.0	0.392	0.392	0.382	0.365	0.254	0.187	0.371	0.391	3.43E-09
	2.0	0.355	0.340	0.327	0.313	0.243	0.240	0.311	0.344	2.46E-07
	4.0	0.239	0.235	0.234	0.186	0.306	0.250	0.191	0.222	2.15E-10

AUGER REFUSAL AT 4.9 M

TABLE A1B. WATER RETENTION AND SATURATED CONDUCTIVITY FOR SITE II

SUB-SITE	DEPTH (m)	Θ_s	$\Theta_d(1)$	$\Theta_d(3)$	$\Theta_d(10)$	$\Theta_d(30)$	$\Theta_d(150)$	$\Theta_w(5)$	$\Theta_w(.5)$	K_s
		(m^3/m^3)								(m/s)
1	0.0	0.476	0.370	0.332	0.274	0.218	0.143	0.285	0.336	2.09E-05
	0.25	0.377	0.297	0.275	0.251	0.225	0.140	0.258	0.291	6.13E-06
(0.0)	0.5	0.427	0.398	0.390	0.384	0.265	0.201	0.387	0.402	2.18E-06
	1.0	0.514	0.514	0.503	0.497	0.365	0.299	0.498	0.514	2.43E-08
	2.0	0.470	0.432	0.347	0.275	0.303	0.280	0.286	0.416	1.67E-07
	4.0	0.623	0.613	0.613	0.582	0.310	0.199	0.583	0.583	5.67E-08
	6.0	0.659	0.656	0.655	0.612	0.258	0.143	0.617	0.642	6.89E-09
2	0.0	0.476	0.353	0.319	0.264	0.217	0.214	0.273	0.333	1.84E-05
	0.25	0.417	0.326	--	0.281	0.224	0.193	0.288	0.341	3.57E-06
(0.5)	0.5	0.462	0.424	0.415	0.405	0.274	0.244	0.410	0.419	3.17E-06
	1.0	0.480	0.454	0.444	0.432	0.373	0.377	0.433	0.449	1.41E-09
	2.0	0.947	0.943	0.935	0.918	0.206	0.202	0.920	0.950	3.97E-09
	4.0	0.614	0.606	0.604	0.545	0.284	0.272	0.574	0.660	3.02E-08
	6.0	0.410	0.410	0.402	0.221	0.289	0.292	0.258	0.404	4.40E-08
3	0.0	0.448	0.363	0.332	0.283	0.235	0.225	0.294	0.351	5.86E-06
	0.25	0.392	0.294	0.276	0.253	0.252	0.221	0.255	0.285	1.46E-05
(5.0)	0.5	0.483	0.426	0.417	0.407	0.312	0.298	0.413	0.422	1.68E-05
	1.0	0.540	0.536	0.529	0.528	0.389	0.349	0.529	0.543	1.68E-09
	2.0	0.649	0.637	0.620	0.585	0.359	0.274	0.586	0.600	1.35E-08
	4.0	0.667	0.646	0.625	0.580	0.261	0.127	0.608	0.689	8.68E-07
	6.0	0.674	0.674	0.674	0.607	0.254	0.127	0.626	0.673	6.66E-08
4	0.0	0.493	0.390	0.357	0.309	0.195	0.186	0.315	0.365	1.52E-05
	0.25	0.367	0.281	0.262	0.238	0.216	0.140	0.243	0.271	1.05E-05
(25.0)	0.5	0.461	0.429	0.419	0.406	0.345	0.301	0.410	0.423	9.74E-06
	1.0	0.567	0.565	0.558	0.490	0.341	0.297	0.501	0.554	5.39E-09
	2.0	0.592	0.592	0.588	0.560	0.370	0.260	0.590	0.592	1.03E-09
	4.0	0.649	0.638	0.632	0.590	0.358	0.318	0.595	0.621	3.01E-08
	6.0	0.446	0.446	0.400	0.352	0.312	0.232	0.360	0.438	3.87E-05

TABLE A1B. WATER RETENTION AND SATURATED CONDUCTIVITY FOR SITE II

SUB-SITE	DEPTH (m)		(1)	(3)	(10)	(30)	(150)	(5)	(.5)	K
		----------	----------	----------	(m /m)	----------	----------	----------	----------	(m/s)
5	0.0	0.442	0.357	0.320	0.274	0.240	0.230	0.292	0.335	3.66E-06
	0.25	0.385	0.294	0.278	0.260	0.207	0.161	0.264	0.287	9.84E-06
(25.5)	0.5	0.461	0.461	0.459	0.451	0.375	0.366	0.456	0.464	1.09E-05
	1.0	0.598	0.596	0.593	0.592	0.342	0.336	0.597	0.603	3.14E-09
	2.0	0.567	0.528	0.347	0.219	0.395	0.319	0.246	0.507	1.91E-06
	4.0	0.659	0.619	0.603	0.511	0.387	0.320	0.529	0.590	6.22E-08
	6.0	0.656	0.656	0.647	0.606	0.258	0.230	0.618	0.656	5.07E-08
6	0.0	0.494	0.374	0.339	0.290	0.172	0.162	0.302	0.357	2.63E-05
	0.25	0.395	0.292	0.267	0.238	0.203	0.168	0.247	0.288	4.18E-06
(30.0)	0.5	0.432	0.389	0.376	0.355	0.307	0.302	0.359	0.375	6.22E-05
	1.0	0.595	0.593	0.586	0.424	0.303	0.298	0.483	0.625	4.26E-09
	2.0	0.624	0.615	0.601	0.541	0.313	0.276	0.558	0.638	4.23E-08
	4.0	0.663	0.662	0.657	0.644	0.389	0.377	0.648	0.651	9.05E-09
	6.0	0.700	0.700	0.702	0.682	0.273	0.261	0.682	0.711	1.47E-08
7	0.0	0.461	0.331	0.312	0.286	0.229	0.223	0.296	0.342	2.67E-05
	0.25	0.432	0.304	0.273	0.226	0.176	0.159	0.239	0.297	1.19E-05
(50.0)	0.5	0.424	0.379	0.369	0.366	0.329	0.253	0.375	0.389	1.14E-05
	1.0	0.561	0.561	0.555	0.508	0.401	0.363	0.515	0.566	2.44E-09
	2.0	0.479	0.475	0.464	0.425	0.397	0.254	0.428	0.437	3.93E-08
	4.0	0.636	0.631	0.630	0.535	0.358	0.257	0.544	0.579	1.69E-08
	6.0	0.670	0.667	0.654	0.577	0.367	0.215	0.593	0.665	2.78E-07
8	0.0	0.446	0.370	0.343	0.304	0.263	0.158	0.308	0.345	9.58E-06
	0.25	0.390	0.363	0.340	0.314	0.313	0.219	0.312	0.346	5.27E-07
(50.5)	0.5	0.421	0.381	0.372	0.357	0.313	0.260	0.360	0.374	2.15E-05
	1.0	0.580	0.580	0.576	0.552	0.367	0.341	0.556	0.567	2.22E-09
	2.0	0.553	0.549	0.534	0.418	0.263	0.258	0.438	0.519	1.99E-08
	4.0	0.650	0.653	0.628	0.552	0.168	0.148	0.567	0.616	5.23E-08
	6.0	0.600	0.601	0.601	0.571	0.276	0.202	0.576	0.612	6.84E-09

TABLE A1B. WATER RETENTION AND SATURATED CONDUCTIVITY FOR SITE II

SUB-SITE	DEPTH (m)	Θ_s	$\Theta_d(1)$	$\Theta_d(3)$	$\Theta_d(10)$	$\Theta_d(30)$	$\Theta_d(150)$	$\Theta_w(5)$	$\Theta_w(.5)$	K_s (m/s)
		(m^3/m^3)								
9	0.0	0.431	0.394	0.365	0.318	0.232	0.230	0.326	0.378	8.25E-07
	0.25	0.437	0.310	0.278	0.226	0.179	0.121	0.237	0.301	1.46E-05
(55.0)	0.5	0.406	0.361	0.351	0.343	0.299	0.249	0.348	0.362	1.04E-05
	1.0	0.541	0.541	0.538	0.534	0.364	0.343	0.538	0.554	1.26E-09
	2.0	0.534	0.534	0.529	0.458	0.387	0.334	0.456	0.530	1.05E-08
	4.0	0.582	0.574	0.570	0.507	0.367	0.289	0.512	0.539	2.37E-08
	6.0	0.615	0.611	0.609	0.591	0.336	0.290	0.593	0.613	1.10E-08
10	0.0	0.406	0.347	0.312	0.279	0.229	0.220	0.282	0.336	2.13E-06
	0.25	0.412	0.311	0.281	0.232	0.158	0.108	0.247	0.316	1.90E-05
(75.0)	0.5	0.360	0.339	0.310	0.260	0.195	0.150	0.272	0.307	8.17E-08
	1.0	0.404	0.346	0.325	0.293	0.346	0.306	0.298	0.356	6.81E-08
	2.0	0.593	0.593	0.577	0.519	0.355	0.301	0.522	0.582	4.79E-08
	4.0	0.695	0.682	0.671	0.639	0.360	0.317	0.644	0.665	1.77E-08
	6.0	0.600	0.601	0.597	0.583	0.341	0.300	0.583	0.588	2.37E-06
11	0.0	0.444	0.361	0.318	0.271	0.232	0.170	0.277	0.345	3.90E-06
	0.25	0.449	0.317	0.284	0.225	0.181	0.107	0.239	0.304	2.28E-05
(75.5)	0.5	0.439	0.368	0.339	0.290	0.169	0.107	0.310	0.371	6.75E-07
	1.0	0.553	0.552	0.540	0.528	0.322	0.286	0.532	0.540	2.96E-09
	2.0	0.592	0.592	0.591	0.579	0.400	0.348	0.582	0.586	2.50E-09
	4.0	0.633	0.618	0.609	0.583	0.394	0.310	0.588	0.610	1.17E-07
	6.0	0.595	0.594	0.588	0.576	0.267	0.239	0.580	0.599	1.91E-07
12	0.0	0.439	0.363	0.335	0.298	0.218	0.166	0.304	0.352	7.08E-06
	0.25	0.438	0.334	0.317	0.270	0.178	0.126	0.285	0.345	1.77E-05
(80.0)	0.5	0.385	0.343	0.325	0.300	0.277	0.116	0.310	0.341	2.72E-07
	1.0	0.539	0.525	0.521	0.517	0.339	0.312	0.520	0.538	1.51E-09
	2.0	0.629	0.629	0.618	0.610	0.340	0.317	0.611	0.619	6.26E-09
	4.0	0.449	0.446	0.440	0.397	0.144	0.188	0.401	0.436	9.51E-09
	6.0	0.527	0.527	0.518	0.496	0.282	0.269	0.500	0.524	5.43E-09

TABLE A1B. WATER RETENTION AND SATURATED CONDUCTIVITY FOR SITE II

SUB-SITE	DEPTH (m)	Θ_s	$\Theta_d(1)$	$\Theta_d(3)$	$\Theta_d(10)$	$\Theta_d(30)$	$\Theta_d(150)$	$\Theta_w(5)$	$\Theta_w(.5)$	K_s
		(m^3/m^3)								(m/s)
13	0.0	0.406	0.333	0.313	0.285	0.249	0.254	0.288	0.313	3.28E-05
	0.25	0.381	0.316	0.293	0.256	0.218	0.204	0.268	0.324	5.81E-06
(100.0)	0.5	0.330	0.327	0.319	0.313	0.292	0.272	0.316	0.326	4.12E-05
	1.0	0.464	0.462	0.459	0.456	0.167	0.375	0.457	0.476	1.02E-09
	2.0	0.580	0.580	0.575	0.556	0.314	0.373	0.559	0.566	4.00E-09
	4.0	0.357	0.530	0.526	0.311	0.377	0.148	0.354	0.495	2.19E-07
	6.0	0.616	0.616	0.616	0.606	0.178	0.247	0.625	0.638	5.52E-10
14	0.0	0.424	0.355	0.325	0.286	0.224	0.189	0.290	0.332	1.67E-06
	0.25	0.401	0.324	0.298	0.246	0.188	0.130	0.259	0.320	9.66E-06
(100.5)	0.5	0.334	0.330	0.324	0.312	0.275	0.110	0.316	0.334	1.40E-04
	1.0	0.500	0.499	0.491	0.464	0.184	0.371	0.478	0.484	3.88E-08
	2.0	0.398	0.398	0.385	0.348	0.281	0.216	0.354	0.360	1.71E-08
	4.0	0.792	0.790	0.773	0.657	0.164	0.102	0.696	0.790	1.52E-07
	6.0	0.606	0.606	0.600	0.594	0.379	0.302	0.597	0.610	2.75E-09
15	0.0	0.425	0.355	0.332	0.298	0.241	0.177	0.299	0.353	2.16E-06
	0.25	0.397	0.306	0.275	0.240	0.187	0.126	0.247	0.299	1.21E-05
(105.0)	0.5	0.362	0.335	0.327	0.320	0.246	0.145	0.324	0.337	4.23E-05
	1.0	0.517	0.516	0.509	0.490	0.461	0.385	0.492	0.500	1.85E-07
	2.0	0.530	0.528	0.522	0.492	0.369	0.284	0.500	0.526	4.51E-07
	4.0	0.553	0.551	0.534	0.472	0.224	0.187	0.478	0.528	3.98E-09
	6.0	0.615	0.615	0.612	0.604	0.353	0.239	0.610	0.630	6.66E-09
16	0.0	0.411	0.368	0.342	0.325	0.229	0.164	0.333	0.368	7.44E-06
	0.25	0.407	0.305	0.286	0.262	0.171	0.088	0.277	0.334	2.24E-05
(125.0)	0.5	0.419	0.394	0.386	0.376	0.243	0.170	0.379	0.390	5.35E-06
	1.0	0.463	0.461	0.460	0.426	0.297	0.245	0.428	0.453	6.97E-10
	2.0	0.531	0.531	0.511	0.416	0.207	0.198	0.456	0.573	7.90E-07
	4.0	0.570	0.568	0.560	0.515	0.400	0.382	0.521	0.543	4.86E-09
	6.0	0.595	0.587	0.580	0.569	0.336	0.319	0.572	0.595	1.73E-09

TABLE A1B. WATER RETENTION AND SATURATED CONDUCTIVITY FOR SITE II

SUB-SITE	DEPTH (m)	Θ_s	$\Theta_d(1)$	$\Theta_d(3)$	$\Theta_d(10)$	$\Theta_d(30)$	$\Theta_d(150)$	$\Theta_w(5)$	$\Theta_w(.5)$	K_s
		(m^3/m^3)								(m/s)
17	0.0	0.417	0.339	0.308	0.263	0.215	0.146	0.277	0.334	3.15E-06
	0.25	0.393	0.293	0.262	0.209	0.171	0.155	0.219	0.285	1.98E-05
(125.5)	0.5	0.406	0.338	0.327	0.314	0.254	0.239	0.319	0.334	7.68E-05
	1.0	0.477	0.474	0.464	0.413	0.313	0.300	0.425	0.481	1.33E-09
	2.0	0.456	0.440	0.404	0.340	0.231	0.223	0.366	0.423	1.73E-05
	4.0	0.530	0.533	0.530	0.460	0.229	0.220	0.466	0.507	2.19E-09
	6.0	0.600	0.611	0.608	0.579	0.341	0.287	0.586	0.596	3.24E-09
18	0.0	--	--	--	--	0.128	0.103	--	--	1.60E-06
	0.25	0.423	0.295	0.256	0.211	0.170	0.114	0.221	0.286	5.93E-05
(130.0)	0.5	0.395	0.387	0.378	0.373	0.234	0.164	0.377	0.392	9.94E-05
	1.0	0.508	0.508	0.507	0.500	0.349	0.297	0.502	0.521	3.31E-09
	2.0	0.504	0.482	0.481	0.403	0.426	0.370	0.407	0.424	1.09E-09
	4.0	0.545	0.495	0.445	0.304	0.242	0.198	0.324	0.447	3.07E-06
	6.0	0.465	0.465	0.448	0.415	0.387	0.330	0.421	0.446	1.05E-08
19	0.0	0.398	0.365	0.343	0.301	0.264	0.215	0.314	0.352	4.69E-08
	0.25	0.468	0.418	0.412	0.398	0.401	0.345	0.404	0.416	1.08E-05
(150.0)	0.5	0.482	0.482	0.482	0.456	0.408	0.367	0.459	0.468	1.26E-06
	1.0	0.512	0.510	0.506	0.483	0.344	0.303	0.488	0.496	1.37E-09
	2.0	0.485	0.485	0.480	0.458	0.212	0.187	0.460	0.462	1.17E-09
	4.0	0.551	0.551	0.549	0.541	0.345	0.318	0.541	0.546	7.28E-08
	6.0	0.600	0.600	0.600	0.591	0.381	0.349	0.596	0.600	8.40E-10

TABLE A2A. PARTICLE SIZE DISTRIBUTION AND BULKDENSITY FOR SITE I

SUB-SITE	DEPTH (m)	BULK-DENSITY (g/cm)	SAND							
			VERY COARSE	COARSE	MEDIUM	FINE	VERY FINE	TOTAL	SILT	CLAY
			%							
1	0.0	1.24	3.5	6.0	5.2	6.3	4.9	25.8	59.4	14.8
	0.25	1.39	2.7	2.6	3.0	4.9	5.5	18.7	50.0	31.3
(0.0)	0.5	1.45	2.9	3.8	3.6	2.9	3.0	16.1	36.0	47.9
	1.0	1.31	1.1	1.7	1.4	2.8	3.4	10.5	29.1	60.4
	2.0	0.98	5.2	3.6	3.3	4.6	6.6	23.4	40.8	35.8
	4.0	1.17	3.6	3.7	3.5	5.1	6.9	22.9	32.0	45.1
	6.0	1.10	1.4	2.0	2.3	3.2	5.0	14.0	48.9	37.1
2	0.0	1.35	6.1	4.7	5.2	5.5	5.2	26.9	60.5	12.6
	0.25	1.67	2.1	2.7	2.9	4.5	4.2	16.5	52.7	30.7
(0.5)	0.5	1.41	1.6	1.4	1.4	1.7	2.5	8.6	34.5	56.9
	1.0	1.33	1.5	1.6	1.8	2.9	4.0	11.7	20.1	68.2
	2.0	1.09	4.3	4.7	4.1	5.2	4.9	23.3	18.8	57.9
	4.0	1.11	4.2	3.4	2.9	4.9	6.0	21.4	30.4	48.2
	6.0	1.07	4.3	3.6	3.7	4.7	5.5	21.7	41.5	36.8
3	0.0	1.25	6.1	4.5	4.9	6.5	3.0	25.1	60.9	13.9
	0.25	1.63	2.8	4.1	4.4	6.5	5.6	23.5	61.8	14.8
(5.0)	0.5	1.57	1.9	2.0	2.5	3.7	4.3	14.4	51.3	34.2
	1.0	1.22	1.7	1.9	1.8	2.1	2.7	10.4	30.5	59.1
	2.0	1.24	5.4	3.2	2.4	3.1	4.6	18.7	35.0	46.4
	4.0	1.21	3.8	3.1	2.2	1.7	2.6	13.4	42.8	43.7
	6.0	1.09	0.5	0.6	0.5	1.1	2.4	5.1	41.2	53.7
4	0.0	1.34	10.3	4.3	4.6	4.8	4.7	28.9	60.0	11.1
	0.25	1.58	2.3	2.3	2.1	3.7	3.4	14.0	60.8	25.2
(25.0)	0.5	1.66	2.6	2.7	2.3	3.0	4.0	14.7	39.5	45.8
	1.0	1.34	1.0	1.7	1.6	2.5	2.8	9.6	22.3	68.2
	2.0	1.08	1.0	1.6	1.9	2.3	2.4	9.2	32.0	58.8
	4.0	1.09	1.9	2.5	3.0	3.8	3.5	14.7	36.1	49.2
	6.0	1.09	3.7	3.5	2.8	2.8	2.1	15.1	53.5	31.5
5	0.0	1.48	8.0	4.2	3.9	5.9	5.1	27.1	59.2	13.7
	0.25	1.71	8.2	3.6	3.2	4.5	5.7	25.2	59.7	15.1
(25.5)	0.5	1.71	3.5	2.2	2.3	4.0	4.7	16.8	58.1	25.1
	1.0	1.46	3.1	2.5	1.9	2.5	3.2	13.1	37.5	49.4
	2.0	1.22	0.7	2.2	2.8	2.8	2.4	10.8	31.3	58.0
	4.0	1.07	2.0	1.9	1.7	1.9	2.3	10.0	38.5	51.6
	6.0	1.09	0.3	0.5	0.5	1.5	2.6	5.5	60.3	34.2
6	0.0	1.51	11.0	5.1	4.8	6.1	5.1	32.0	56.1	11.9
	0.25	1.58	12.8	4.7	4.0	6.0	5.7	33.2	55.1	11.7
(30.0)	0.5	1.66	2.8	2.2	2.7	4.3	5.8	17.3	59.3	23.4
	1.0	1.41	1.9	1.3	1.1	1.5	2.1	8.1	34.4	57.6
	2.0	1.28	3.2	3.5	3.1	3.0	3.8	16.5	31.6	51.9
	4.0	1.09	0.7	1.2	1.3	2.2	18.9	24.4	57.2	18.4
	6.0	1.09	0.9	1.3	1.0	1.6	2.8	7.7	54.3	38.0
7	0.0	1.57	9.8	4.3	4.1	4.7	5.2	28.2	56.4	15.3
	0.25	1.49	1.7	1.5	1.6	2.8	3.9	11.6	49.2	39.2
(50.0)	0.5	1.39	0.3	0.8	0.9	1.5	3.2	6.8	43.5	49.8
	1.0	1.30	1.4	1.6	1.0	1.2	1.7	7.0	44.4	48.6
	2.0	1.30	0.4	0.6	0.6	1.3	1.9	4.8	38.1	57.0
	4.0	1.26	4.1	2.9	2.0	2.2	3.1	14.4	50.6	35.0
	6.0	1.09	0.8	1.4	2.0	3.1	4.1	11.5	39.7	48.8

TABLE A2A. PARTICLE SIZE DISTRIBUTION AND BULKDENSITY FOR SITE I

SUB-SITE	DEPTH (m)	BULK-DENSITY (g/cm)	SAND							
			VERY COARSE	COARSE	MEDIUM	FINE	VERY FINE	TOTAL	SILT	CLAY
			%							
8	0.0	1.32	7.6	4.8	4.0	4.7	4.9	26.2	61.8	12.1
	0.25	1.49	1.3	1.5	1.5	2.3	3.2	9.9	52.0	58.1
(50.5)	0.5	1.41	0.9	1.4	1.1	1.4	2.6	7.5	48.2	44.3
	1.0	1.21	1.9	2.0	1.6	1.8	2.0	9.2	44.3	46.5
	2.0	1.38	0.4	0.9	0.8	1.0	1.6	4.8	45.8	49.4
	4.0	1.18	2.9	2.0	1.2	1.3	1.8	9.3	36.2	54.5
	6.0	1.09	1.1	1.7	1.8	3.7	5.1	13.5	43.8	42.7
9	0.0	1.37	12.8	4.6	3.9	4.8	5.2	31.1	57.9	11.0
	0.25	1.59	1.5	1.5	1.9	2.8	3.5	11.4	60.1	28.5
(55.0)	0.5	1.49	0.3	0.5	0.8	1.6	2.1	5.4	54.7	39.9
	1.0	1.48	0.2	0.3	0.3	0.7	2.5	4.0	46.7	49.2
	2.0	1.39	4.6	2.9	1.5	1.3	2.3	12.7	46.0	41.4
	4.0	1.32	3.9	3.5	3.3	5.9	9.3	26.0	49.3	24.7
			AUGER REFUSAL AT 5.4 M							
10	0.0	1.43	9.7	6.2	3.9	4.4	3.2	27.4	61.7	10.9
	0.25	--	3.3	3.3	2.2	2.9	4.5	16.3	57.8	25.9
(75.0)	0.5	1.39	2.8	1.9	1.5	1.8	2.2	10.3	30.4	59.3
	1.0	1.38	0.8	0.8	1.1	2.4	2.9	8.1	34.2	57.7
			AUGER REFUSAL AT 2.0 M							
11	0.0	1.39	9.0	6.7	4.0	3.9	4.5	28.1	61.3	10.6
	0.25	1.62	8.9	5.3	4.0	3.9	4.3	26.5	57.9	15.6
(75.5)	0.5	1.42	1.2	1.7	1.4	2.4	3.5	10.2	36.7	53.1
	1.0	1.45	0.3	0.6	0.9	1.8	2.5	6.2	31.6	62.2
	2.0	1.05	2.2	1.6	1.4	1.3	3.7	16.3	43.1	46.6
			AUGER REFUSAL AT 3.0 M							
12	0.0	1.47	8.1	6.9	4.4	5.2	4.7	29.2	60.0	10.9
	0.25	1.61	8.4	6.6	4.3	4.7	4.1	28.2	60.2	11.7
(80.0)			AUGER REFUSAL AT 0.5 M							
13	0.0	1.49	7.4	4.7	4.2	4.1	4.3	24.6	56.0	19.5
	0.25	1.61	3.3	3.2	2.6	3.2	3.5	16.0	56.5	27.5
(100.0)	0.5	1.38	1.2	1.7	1.3	1.3	1.5	7.2	30.6	62.2
	1.0	1.30	0.3	0.9	1.1	1.9	2.1	6.3	25.5	68.2
	2.0	1.40	0.6	0.7	0.8	0.7	1.4	4.3	48.9	46.8
	4.0	1.25	3.8	2.8	2.0	2.1	2.4	13.0	12.8	74.2
			AUGER REFUSAL AT 5.8 M							
14	0.0	1.42	6.3	4.4	4.0	4.8	4.3	23.7	56.7	19.6
	0.25	1.33	2.1	1.8	1.9	2.5	3.6	11.8	34.3	53.9
(100.5)	0.5	1.39	0.9	1.6	1.8	2.9	2.4	9.5	24.5	65.9
	1.0	1.25	1.1	1.2	1.0	1.5	0.9	5.8	38.5	55.7
	2.0	1.30	0.7	0.4	0.4	0.7	1.2	3.5	38.9	57.6
	4.0	1.20	2.7	2.6	2.4	2.6	2.5	12.8	24.3	63.0
			AUGER REFUSAL AT 5.5 M							
15	0.0	1.48	5.2	3.8	3.6	4.1	3.5	20.0	59.0	20.9
	0.25	1.24	0.4	0.9	1.2	2.4	3.2	8.1	44.6	47.3
(105.0)	0.5	1.34	1.0	1.0	1.3	2.1	2.8	8.3	33.1	58.6
	1.0	1.14	0.3	0.4	0.5	0.6	0.9	2.8	49.2	48.0
			AUGER REFUSAL AT 1.5 M							

TABLE A2A. PARTICLE SIZE DISTRIBUTION AND BULKDENSITY FOR SITE I

			SAND							
SUB-SITE	DEPTH (m)	BULK-DENSITY (g/cm)	VERY COARSE	COARSE	MEDIUM	FINE	VERY FINE	TOTAL	SILT	CLAY
			%							
16	0.0	1.45	5.3	4.8	3.2	5.5	4.1	22.8	55.6	21.6
	0.25	1.20	2.4	2.3	1.6	1.8	1.7	9.6	31.1	59.3
(125.0)	0.5	1.16	1.7	1.1	1.0	1.5	1.5	6.8	31.8	61.5
	1.0	1.15	1.4	1.8	1.0	1.0	1.7	6.9	25.9	67.2
	2.0	1.37	1.0	1.1	1.5	2.1	2.7	8.5	49.3	42.3
			AUGER REFUSAL AT 2.4 M							
17	0.0	1.49	5.1	4.4	3.6	4.9	4.0	21.9	56.6	21.6
	0.25	1.25	1.0	1.5	1.4	2.2	2.0	8.1	34.7	57.2
(125.5)	0.5	1.33	2.0	1.6	1.5	1.8	1.6	8.3	33.9	57.8
	1.0	1.43	0.6	1.3	1.1	1.2	1.9	6.2	54.6	39.2
	2.0	1.32	1.2	1.9	1.3	2.8	3.2	10.4	45.2	44.3
			AUGER REFUSAL AT 2.4 M							
18	0.0	1.50	5.3	3.9	3.8	4.7	3.9	21.4	55.0	23.5
	0.25	1.24	0.6	0.5	0.5	0.5	0.7	2.9	37.0	60.1
(130.0)	0.5	1.31	1.2	0.7	0.4	0.4	0.7	3.5	47.7	48.8
	1.0	1.21	1.8	1.5	0.7	0.7	0.0	4.7	55.6	39.6
			AUGER REFUSAL AT 1.5 M							
19	0.0	1.42	8.5	6.2	4.7	5.1	5.7	30.2	59.3	10.6
	0.25	1.54	4.8	4.8	4.6	5.9	6.0	26.2	58.1	15.6
(150.0)	0.5	1.51	2.6	7.6	4.1	4.3	5.4	24.0	47.5	28.5
	1.0	1.55	1.7	2.0	1.5	1.6	1.7	8.6	77.3	14.1
	2.0	1.62	7.9	7.1	4.7	4.8	5.2	29.7	44.4	25.8
	4.0	1.24	1.7	2.2	2.0	4.1	8.6	18.6	38.7	42.7
	6.0	--	3.8	2.8	2.0	2.7	2.6	--	--	--

TABLE A2B. PARTICLE SIZE DISTRIBUTION AND BULKDENSITY FOR SITE II

SUB-SITE	DEPTH (m)	BULK-DENSITY (g/cm)	SAND							
			VERY COARSE	COARSE	MEDIUM	FINE	VERY FINE	TOTAL	SILT	CLAY
			%							
1	0.0	1.24	3.8	2.8	2.0	2.7	2.6	14.0	66.3	19.6
	0.25	1.52	3.3	2.5	2.6	3.0	3.8	15.3	68.3	16.4
(0.0)	0.5	1.39	0.5	0.7	0.9	1.8	2.3	6.3	57.5	36.2
	1.0	1.29	0.7	0.3	0.2	0.6	2.1	3.9	43.2	52.9
	2.0	1.29	2.6	2.1	3.5	2.2	3.8	14.1	46.7	39.2
	4.0	0.90	1.2	0.7	1.2	2.9	5.3	11.4	52.0	36.7
	6.0	0.85	0.2	1.1	1.1	1.4	1.8	5.7	57.8	36.5
2	0.0	1.16	4.6	2.5	2.1	2.7	3.4	15.5	62.2	22.3
	0.25	1.41	3.0	2.1	1.7	2.9	4.2	14.0	64.2	21.8
(0.5)	0.5	1.37	0.9	0.9	1.0	2.0	3.4	8.2	56.6	35.1
	1.0	1.35	0.3	0.3	0.3	0.6	1.6	3.2	34.5	62.3
	2.0	1.03	3.8	3.6	2.8	4.0	7.2	21.3	41.5	37.2
	4.0	0.90	0.2	0.3	0.3	0.9	4.1	5.8	64.5	29.6
	6.0	0.85	11.5	8.6	2.7	1.1	1.1	25.0	56.4	18.6
3	0.0	1.32	7.5	4.0	2.4	2.3	3.1	19.4	63.3	17.3
	0.25	1.50	4.9	2.4	2.3	3.3	3.2	16.2	67.4	16.5
(5.0)	0.5	1.33	1.2	0.7	0.8	1.2	2.6	6.5	46.8	46.7
	1.0	1.23	1.0	1.0	0.7	0.7	1.8	5.3	26.5	68.3
	2.0	0.92	0.1	0.3	0.6	1.6	2.3	4.9	45.9	49.2
	4.0	0.80	0.4	0.5	0.5	0.9	1.7	4.1	72.7	23.2
	6.0	0.80	0.2	0.1	0.3	1.0	2.2	3.0	77.8	20.4
4	0.0	1.16	4.0	2.3	2.0	2.2	2.0	12.6	68.9	18.5
	0.25	1.53	5.4	2.9	2.6	2.9	3.8	17.8	65.4	16.9
(25.0)	0.5	1.31	0.9	0.8	0.5	0.9	2.0	5.1	38.4	56.5
	1.0	1.12	0.2	0.2	0.2	0.6	2.4	3.6	32.8	63.6
	2.0	1.12	0.5	0.8	1.1	1.7	2.0	6.2	48.2	45.7
	4.0	0.93	0.2	0.3	0.8	1.8	4.4	7.6	50.4	42.0
	6.0	0.85	0.9	0.8	0.8	1.3	2.1	5.9	58.9	35.2
5	0.0	1.43	3.1	2.5	1.9	2.1	1.7	11.5	70.0	18.5
	0.25	1.45	3.8	2.3	2.4	2.8	3.0	14.4	69.7	15.9
(25.5)	0.5	1.56	0.6	0.6	0.5	1.1	2.0	4.9	42.5	52.5
	1.0	1.11	0.5	0.4	0.6	1.6	3.3	6.4	43.4	50.2
	2.0	1.11	1.7	2.1	1.0	1.2	2.2	8.2	60.9	30.9
	4.0	0.92	0.0	0.3	1.2	3.1	6.3	11.0	55.7	33.3
	6.0	0.85	0.8	0.8	0.8	1.9	1.3	5.7	61.2	33.1
6	0.0	1.01	6.9	2.0	1.7	1.6	2.6	14.9	65.6	19.6
	0.25	1.43	3.7	2.7	2.6	3.6	2.8	15.6	69.1	15.4
(30.0)	0.5	1.40	1.2	1.0	0.9	1.2	0.1	4.5	52.8	42.6
	1.0	1.05	3.3	2.7	1.5	1.4	1.9	10.8	34.0	55.2
	2.0	1.02	0.0	0.1	0.1	0.5	1.3	2.0	68.2	29.7
	4.0	0.95	0.1	0.3	0.8	2.1	1.3	4.7	25.5	69.9
	6.0	0.90	0.8	0.6	0.8	2.4	3.7	10.4	52.2	39.4
7	0.0	1.31	3.3	2.6	2.2	3.2	3.2	1.1	--	--
	0.25	1.30	1.4	1.3	1.4	2.5	3.3	14.7	70.5	24.9
(50.0)	0.5	1.43	0.4	0.2	0.5	1.6	2.2	10.0	55.0	35.0
	1.0	1.13	0.1	0.0	0.0	0.2	0.9	4.9	27.6	67.5
	2.0	1.14	0.7	0.6	0.6	0.8	1.8	1.2	71.5	27.3
	4.0	0.95	0.9	0.9	1.2	2.7	3.5	4.6	53.4	41.9
	6.0	0.90	3.0	2.3	2.6	4.6	6.8	9.3	61.6	29.0

TABLE A2B. PARTICLE SIZE DISTRIBUTION AND BULKDENSITY FOR SITE II

SUB-SITE	DEPTH (m)	BULK-DENSITY (g/cm)	SAND VERY COARSE	SAND COARSE	SAND MEDIUM	SAND FINE	SAND VERY FINE	TOTAL	SILT	CLAY
			%							
8	0.0	1.28	3.0	2.3	2.6	4.6	6.8	19.4	61.5	19.1
	0.25	1.56	4.0	2.9	2.1	4.1	3.3	16.6	70.3	13.1
(50.5)	0.5	1.35	0.7	1.3	1.2	1.4	3.1	8.3	49.2	42.5
	1.0	1.16	0.1	0.1	0.3	0.5	1.7	2.7	28.8	68.
	2.0	1.12	0.3	0.3	0.1	0.2	0.7	1.6	72.1	26.3
	4.0	0.90	7.9	4.8	3.1	2.8	5.1	23.8	44.5	31.7
	6.0	0.85	3.1	1.3	0.7	0.7	0.1	5.9	57.6	36.4
9	0.0	1.34	1.7	1.3	1.5	2.7	4.8	12.1	68.2	19.
	0.25	1.32	3.7	2.6	2.7	4.2	2.6	16.0	72.7	17.3
(55.0)	0.5	1.46	1.5	1.5	1.4	2.6	3.8	10.9	57.3	31.8
	1.0	1.23	0.1	0.2	0.2	0.6	0.9	2.0	29.8	68.1
	2.0	1.23	0.6	0.4	0.3	0.4	1.4	3.2	53.7	43.1
	4.0	1.09	0.3	0.1	0.1	0.5	1.1	2.2	54.2	43.7
	6.0	0.95	0.3	0.3	0.4	0.7	2.0	3.8	43.2	53.
10	0.0	1.47	2.1	2.3	2.8	6.0	9.2	22.5	57.0	20.5
	0.25	1.35	3.1	2.8	2.7	5.4	5.0	19.2	68.9	11.9
(75.0)	0.5	1.63	2.8	2.4	2.7	4.4	7.0	19.4	64.7	15.
	1.0	1.38	0.5	0.3	0.5	1.3	2.9	5.5	43.3	51.
	2.0	1.12	0.2	0.3	0.4	1.0	1.5	3.5	48.3	48.
	4.0	1.00	0.3	0.2	0.3	1.2	2.8	4.8	37.9	57.
	6.0	0.95	0.3	0.4	0.3	0.8	0.6	2.5	25.6	72.
11	0.0	1.35	1.1	1.0	1.4	4.3	7.8	15.7	68.0	16.
	0.25	1.33	2.7	2.8	2.7	5.7	7.0	20.9	69.2	9.9
(75.5)	0.5	1.48	3.3	3.3	3.2	5.3	7.6	22.8	62.9	14.
	1.0	1.30	0.8	0.6	0.8	1.8	3.1	7.2	43.7	49.
	2.0	1.09	0.0	0.2	0.5	1.4	3.5	5.5	35.3	59.2
	4.0	1.00	0.4	0.6	1.2	3.2	6.7	12.2	38.4	49.4
	6.0	0.95	0.4	0.1	0.2	0.6	1.7	3.0	26.7	70.
12	0.0	1.40	2.4	1.5	2.1	4.7	7.7	18.5	64.1	17.
	0.25	1.38	2.4	2.3	2.4	5.0	4.5	16.6	72.7	10.
(80.0)	0.5	1.59	11.8	3.3	2.4	3.6	6.6	27.8	56.8	15.5
	1.0	1.23	3.5	1.5	1.0	1.4	0.4	7.9	31.5	60.
	2.0	0.99	0.3	0.4	1.6	3.7	5.0	1.0	36.4	52.
	4.0	1.00	8.9	7.2	4.6	3.8	4.2	28.6	30.6	40.9
	6.0	0.95	5.5	3.4	2.5	1.8	1.7	14.8	39.0	46.
13	0.0	1.46	2.5	2.8	2.9	7.6	9.5	25.4	50.8	23.8
	0.25	1.47	2.4	2.0	2.9	5.8	6.2	19.4	67.6	13.
(100.0)	0.5	1.66	3.8	1.8	1.9	3.6	6.4	17.6	57.9	24.
	1.0	1.40	1.2	0.8	0.9	1.1	2.3	6.4	35.8	57.8
	2.0	1.11	1.2	0.6	0.2	0.4	0.9	3.4	41.7	54.9
	4.0	1.00	2.5	2.5	4.4	2.1	3.7	25.3	62.7	22.
	6.0	0.95	2.6	1.8	1.0	1.6	2.1	9.0	31.2	59.8
14	0.0	1.37	4.2	2.5	2.6	7.5	10.3	27.2	49.9	22.9
	0.25	1.41	3.5	2.4	2.4	5.3	5.3	19.5	66.6	14.
(100.5)	0.5	1.65	5.4	2.3	2.3	3.8	0.3	14.2	65.2	20.5
	1.0	1.39	0.6	0.5	0.4	0.8	1.2	3.6	31.3	65.
	2.0	1.46	--	--	--	--	--	--	--	--
	4.0	1.00	1.9	1.2	1.0	1.2	2.9	8.2	70.7	21.
	6.0	0.95	1.3	2.3	1.8	1.6	1.4	8.3	34.9	56.8

TABLE A2B. PARTICLE SIZE DISTRIBUTION AND BULKDENSITY FOR SITE II

SUB-SITE	DEPTH (m)	BULK-DENSITY (g/cm)	SAND							
			VERY COARSE	COARSE	MEDIUM	FINE	VERY FINE	TOTAL	SILT	CLAY
						%				
15	0.0	1.40	1.6	1.2	1.7	4.2	6.9	15.7	62.8	21.5
	0.25	1.40	2.3	2.1	2.3	5.4	6.4	18.5	68.2	13.3
(105.0)	0.5	1.61	4.2	2.1	2.1	3.5	5.8	17.8	57.7	24.4
	1.0	1.31	0.5	0.3	0.4	0.8	2.3	4.3	30.7	65.0
	2.0	1.23	2.5	1.3	1.1	1.2	1.1	7.3	33.4	59.3
	4.0	1.00	4.5	4.2	3.0	2.9	6.3	20.9	35.8	43.3
	6.0	0.95	0.2	0.2	0.1	0.3	0.2	1.0	43.0	56.0
16	0.0	1.42	3.2	1.7	1.7	4.5	2.1	13.3	72.2	14.5
	0.25	1.42	4.2	3.4	4.4	6.5	5.6	24.2	62.0	13.8
(125.0)	0.5	1.41	3.0	2.5	2.0	2.9	5.1	15.6	50.8	33.6
	1.0	1.35	7.6	6.9	4.4	4.0	3.5	26.4	25.2	48.4
	2.0	1.16	1.3	1.9	1.8	2.8	7.4	15.3	50.5	34.2
	4.0	1.13	2.5	1.0	0.7	0.3	0.7	5.3	31.3	63.4
	6.0	1.00	0.9	0.6	0.2	0.3	0.6	2.7	27.6	69.7
17	0.0	1.38	2.1	2.0	2.8	6.4	7.9	21.3	63.3	15.4
	0.25	1.40	2.4	2.7	3.3	6.7	8.7	23.9	63.0	13.1
(125.5)	0.5	1.49	6.2	2.2	2.5	3.6	6.0	20.5	46.8	32.7
	1.0	1.33	3.6	2.7	1.6	2.0	4.2	14.1	39.5	46.4
	2.0	1.14	9.6	5.3	3.3	3.5	4.6	26.2	34.6	39.1
	4.0	1.10	6.3	3.7	2.1	1.6	0.5	14.2	48.3	37.4
	6.0	1.08	0.8	0.7	0.3	0.3	0.4	2.6	39.4	58.0
18	0.0	0.95	3.2	4.0	5.3	11.3	11.3	35.0	48.1	16.9
	0.25	1.40	1.6	1.9	2.5	5.8	7.3	19.1	67.0	13.9
(130.0)	0.5	1.62	3.2	1.7	2.0	3.9	7.5	18.4	60.1	21.5
	1.0	1.29	1.8	1.4	1.3	1.5	2.0	8.0	33.9	58.1
	2.0	1.25	1.4	1.2	0.8	0.6	0.6	4.7	24.3	70.9
	4.0	1.11	3.6	2.3	1.2	1.1	3.0	11.2	46.4	42.9
	6.0	1.42	2.4	1.9	1.2	1.6	2.4	9.5	49.3	41.1
19	0.0	1.49	2.3	2.2	2.5	3.9	4.5	25.5	54.1	30.5
	0.25	1.39	1.4	1.4	0.8	1.0	1.4	6.2	35.4	58.4
(150.0)	0.5	1.38	8.2	3.1	2.0	2.0	2.0	17.2	26.9	55.9
	1.0	1.30	5.4	2.8	1.5	1.8	1.4	13.0	34.9	52.1
	2.0	1.37	10.1	11.9	9.0	8.4	4.4	43.8	6.1	27.1
	4.0	1.21	3.8	2.0	1.2	1.2	1.2	9.5	30.5	60.0
	6.0	1.11	1.1	0.6	0.6	1.0	2.4	5.8	25.7	68.5

TABLE A3A. SOIL CHEMICAL PROPERTIES FOR SITE I

SUB-SITE	DEPTH (m)	pH	ORGANIC MATTER %	-- EXCHANGEABLE	CATIONS	(me/100 gr)	--		BASE SATURATION %
				Ca	Mg	K	H	Al	
1	0.0	6.4	5.5	7.20	2.60	1.40	4.98	0.05	69.2
	0.25	6.5	1.3	3.36	2.00	1.20	12.28	0.05	31.8
(0.0)	0.5	5.1	0.7	2.70	2.00	0.70	7.33	0.85	42.4
	1.0	5.0		1.49	1.38	0.34	11.68	4.85	21.6
	2.0	4.8		0.52	0.54	0.13	4.75	1.65	20.0
	4.0	4.5		0.22	0.30	0.06	7.13	3.25	7.5
	6.0	5.9		0.07	0.11	0.04	14.45	2.55	1.5
2	0.0	6.6	4.5	4.84	2.00	0.90	3.58	0.05	68.4
	0.25	6.0	0.9	2.90	1.74	1.00	14.85	0.05	27.5
(0.5)	0.5	5.2	0.4	2.38	1.75	0.49	9.95	4.35	31.7
	1.0	4.0		1.12	1.24	0.21	23.76	6.05	9.8
	2.0	4.1		0.42	0.82	0.09	22.18	5.15	5.7
	4.0	4.9		0.25	0.25	0.05	9.31	4.35	5.6
	6.0	5.1		0.11	0.19	0.04	6.73	2.75	4.8
3	0.0	6.5	5.2	6.83	2.40	1.10	4.98	0.10	67.5
	0.25	6.3	1.0	2.08	1.14	0.30	3.96	0.05	47.1
(5.0)	0.5	5.3	0.3	2.01	1.59	0.27	8.32	1.05	31.8
	1.0	5.0		0.66	0.92	0.11	14.85	4.65	10.2
	2.0	4.8		0.53	0.51	0.15	18.02	1.19	6.2
	4.0	5.4		0.04	0.16	0.10	18.02	2.35	1.4
	6.0	5.4		0.07	0.36	0.09	10.10	3.95	4.9
4	0.0	6.4	3.8	3.81	1.65	0.45	4.38	0.05	57.4
	0.25	5.1	0.2	1.29	0.85	0.12	6.14	1.35	26.9
(25.0)	0.5	5.1	0.1	1.50	1.02	0.12	8.12	2.35	24.5
	1.0	4.4		0.65	0.90	0.17	22.77	5.15	7.0
	2.0	5.0		0.34	0.81	0.11	22.18	5.25	5.4
	4.0	5.1		0.09	1.51	0.03	8.71	3.85	15.8
	6.0	5.4		0.04	1.14	0.08	4.55	0.15	21.7
5	0.0	6.3	3.3	3.40	1.20	0.70	5.17	0.05	50.6
	0.25	5.5	0.4	1.27	0.90	0.07	3.76	0.15	37.3
(25.5)	0.5	5.2	0.3	1.01	0.73	0.28	5.54	1.65	26.7
	1.0	4.8		0.65	0.88	0.11	10.49	3.95	13.5
	2.0	4.9		0.18	0.84	0.06	9.90	5.05	9.8
	4.0	5.6		0.08	1.43	0.09	5.74	2.05	21.8
	6.0	5.5		0.12	3.40	0.21	5.35	1.15	41.1
6	0.0	6.6	4.5	4.63	2.00	0.46	4.38	0.05	61.8
	0.25	5.8	1.0	1.39	1.12	0.26	4.75	0.10	36.8
(30.0)	0.5	4.9	0.2	1.10	0.77	0.16	5.74	1.35	26.1
	1.0	5.0		1.27	1.52	0.27	12.47	3.45	19.7
	2.0	5.1		0.42	1.41	0.17	10.89	5.45	15.5
	4.0	5.4		0.08	2.70	0.14	4.55	0.85	39.1
	6.0	5.9		0.35	9.80	0.39	3.56	0.75	74.8
7	0.0	6.6	3.3	3.63	1.90	0.46	4.18	0.05	58.9
	0.25	5.6	0.4	2.47	2.20	0.14	8.12	1.05	37.2
(50.0)	0.5	4.8	0.2	1.97	2.40	0.10	5.74	2.95	43.8
	1.0	4.8		0.86	2.20	0.10	10.30	2.95	23.5
	2.0	5.3		1.74	6.10	0.19	6.53	0.65	55.2
	4.0	6.1		1.84	3.80	0.19	4.16	0.10	58.4
	6.0	6.3		5.07	4.80	0.22	5.35	0.05	65.4

TABLE A3A. SOIL CHEMICAL PROPERTIES FOR SITE I

SUB-SITE	DEPTH (m)	pH	ORGANIC MATTER %	-- EXCHANGEABLE CATIONS (me/100 gr) --					BASE SATURATION %
				Ca	Mg	K	H	Al	
8	0.0	6.3	3.2	3.42	1.42	0.45	3.98	0.10	57.1
	0.25	5.8	0.4	2.80	2.40	0.09	6.73	0.45	44.0
(50.5)	0.5	4.8	0.3	2.27	2.70	0.10	10.89	2.15	31.8
	1.0	5.1		1.18	2.50	0.11	9.70	2.45	28.1
	2.0	5.6		1.46	5.40	0.13	6.73	0.45	51.0
	4.0	6.0		2.59	6.70	0.23	4.55	0.05	67.7
	6.0	6.3		3.98	4.70	0.21	4.95	0.10	64.2
9	0.0	6.3	2.9	3.40	1.12	0.25	3.38	0.05	58.5
	0.25	6.3	0.5	2.20	1.87	0.25	2.38	0.05	64.5
(55.0)	0.5	5.8	0.4	2.96	3.20	0.12	4.36	0.35	59.0
	1.0	5.8		2.96	6.40	0.22	6.93	0.35	58.0
	2.0	6.2		2.55	6.00	0.17	2.38	0.10	78.6
	4.0	6.1		1.98	3.10	0.15	3.76	0.05	58.2
				AUGER REFUSAL AT 5.3 M					
10	0.0	5.7	3.1	1.80	0.61	0.52	6.77	0.35	30.2
	0.25	5.8	0.3	1.93	1.19	0.07	4.75	0.55	40.2
(75.0)	0.5	5.8	0.3	4.58	7.50	0.24	7.73	0.35	61.5
	1.0	6.4		7.00	10.80	0.29	5.54	0.10	76.6
				AUGER REFUSAL AT 2.0 M					
11	0.0	5.8	3.2	2.25	0.98	0.44	7.36	0.15	33.3
	0.25	5.4	0.8	1.47	0.76	0.08	5.74	0.45	28.7
(75.5)	0.5	5.4	0.3	3.46	5.20	0.15	4.95	0.45	64.0
	1.0	6.5		7.00	13.40	0.34	6.14	0.05	77.2
	2.0	6.6		5.80	4.80	0.25	5.35	0.05	67.0
				AUGER REFUSAL AT 3.0 M					
12	0.0	6.0	3.2	3.18	1.01	0.80	6.97	0.15	41.7
	0.25	6.2	0.6	1.52	0.64	0.21	2.97	0.10	44.4
(80.0)				AUGER REFUSAL AT 0.5 M					
13	0.0	5.5	4.7	4.92	1.71	0.70	5.97	0.10	55.1
	0.25	5.8	0.6	2.62	2.00	0.60	3.76	0.15	58.1
(100.0)	0.5	5.9	0.5	4.84	7.00	0.32	7.13	0.10	63.0
	1.0	5.6		5.16	7.60	0.31	6.73	0.05	66.0
	2.0	6.6		8.20	9.40	0.43	4.95	0.10	78.5
	4.0	6.6		7.50	6.40	0.31	7.13	0.05	66.6
				AUGER REFUSAL AT 5.8 M					
14	0.0	6.1	4.3	6.00	2.00	0.60	6.97	0.10	55.2
	0.25	6.4	0.7	5.09	5.80	0.19	4.38	0.05	71.7
(100.5)	0.5	6.3	0.8	6.20	8.40	0.33	7.76	0.00	65.8
	1.0	6.6		8.00	11.80	0.37	4.58	0.00	81.5
	2.0	6.6		8.40	7.60	0.34	3.96	0.05	80.5
	4.0	6.3		9.50	7.70	0.34	4.95	0.10	71.0
				AUGER REFUSAL AT 5.5 M					
15	0.0	5.7	3.7	3.80	1.75	0.41	7.16	0.15	45.4
	0.25	6.5	1.0	5.38	6.80	0.21	6.34	0.10	66.2
(105.0	0.5	6.7	0.8	7.10	9.60	0.38	5.77	0.05	74.8
	1.0	6.9		10.80	14.00	0.26	2.38	0.10	91.3
				AUGER REFUSAL AT 1.5 M					

TABLE A3A. SOIL CHEMICAL PROPERTIES FOR SITE I

SUB-SITE	DEPTH (m)	pH	ORGANIC MATTER %	-- EXCHANGEABLE CATIONS (me/100 gr) --					BASE SATURATIO %
				Ca	Mg	K	H	Al	
16	0.0	6.0	4.2	4.14	1.90	0.50	8.36	0.15	43.9
	0.25	6.4	1.0	5.40	9.40	0.35	8.12	0.15	65.1
(125.0)	0.5	6.4	1.1	5.90	11.50	0.30	5.54	0.10	76.2
	1.0	7.0		8.30	12.40	0.31	6.14	0.10	77.4
	2.0	7.1		7.50	6.80	0.14	2.38	0.05	85.9
				AUGER REFUSAL AT 2.4 M					
17	0.0	5.7	3.4	3.33	1.53	0.70	6.97	0.25	44.4
	0.25	6.0	1.0	4.97	7.70	0.43	7.72	0.45	62.9
(125.5)	0.5	6.2	1.1	5.30	9.00	0.36	6.73	0.15	68.5
	1.0	6.9		9.80	12.00	0.28	2.18	0.05	91.0
	2.0	7.0		7.50	6.10	0.16	2.38	0.05	85.3
				AUGER REFUSAL AT 2.4 M					
18	0.0	5.8	3.4	3.48	1.88	0.50	6.97	0.35	45.7
	0.25	6.1	0.8	5.11	9.50	0.34	8.71	0.05	63.2
(130.0)	0.5	6.6	0.6	5.84	11.60	0.30	5.54	0.05	76.2
	1.0	7.1		1.98	1.74	0.06	0.20	0.05	95.0
				AUGER REFUSAL AT 1.5 M					
19	0.0	5.5	2.6	1.80	0.60	0.30	5.37	0.25	33.5
	0.25	5.7	1.0	1.52	0.49	0.27	3.38	0.35	40.3
(150.0)	0.5	5.4	0.0	1.12	1.44	0.15	5.15	0.35	34.4
	1.0	6.0		1.10	2.80	0.19	4.98	0.25	45.1
	2.0	5.9		0.71	2.70	0.13	3.17	0.05	52.8
	4.0	6.7		4.04	6.80	0.25	4.36	0.05	71.8
				AUGER REFUSAL AT 4.9 M					

TABLE A3B. SOIL CHEMICAL PROPERTIES FOR SITE II

SUB-SITE	DEPTH (m)	pH	ORGANIC MATTER %	-- EXCHANGEABLE CATIONS (me/100 gr) --					BASE SATURATION %
				Ca	Mg	K	H	Al	
1	0.0	5.9	5.7	5.38	2.40	1.30	7.96	0.15	53.3
	0.25	5.6	1.5	2.26	0.45	0.05	6.73	0.65	29.1
(0.0)	0.5	5.6	0.3	3.17	1.23	0.11	7.72	2.65	36.9
	1.0	5.2		1.71	1.91	0.29	15.60	8.15	20.0
	2.0	5.1		1.77	1.53	0.27	12.20	6.05	22.6
	4.0	5.1		0.94	1.66	0.23	14.40	9.65	16.4
	6.0	5.4		0.44	1.00	0.18	8.60	5.15	15.9
2	0.0	6.0	4.8	5.05	2.00	0.90	8.36	0.10	48.7
	0.25	--	--	--	--	--	--	--	--
(0.5)	0.5	5.7	0.2	2.70	1.02	0.12	8.71	3.05	30.6
	1.0	5.6		1.88	1.84	0.34	15.40	7.45	20.9
	2.0	5.6		0.57	0.79	0.20	10.60	4.85	12.8
	4.0	5.3		0.43	1.06	0.20	12.60	6.95	11.8
	6.0	5.0		0.47	1.13	0.22	11.00	8.95	14.2
3	0.0	6.5	3.7	4.98	2.30	0.50	5.37	0.10	59.2
	0.25	6.0	1.8	3.60	1.60	0.16	2.77	0.05	65.9
(5.0)	0.5	5.2	0.3	3.90	1.42	0.13	10.49	3.55	34.2
	1.0	5.4		1.57	1.55	3.00	19.21	7.95	15.1
	2.0	5.3		0.61	1.63	0.28	22.60	16.45	10.0
	4.0	5.3		0.29	0.85	0.15	11.20	7.45	10.3
	6.0	5.1		0.42	1.45	0.10	10.40	7.95	15.9
4	0.0	6.5	3.7	5.20	2.10	0.80	4.98	0.05	61.9
	0.25	5.8	1.9	3.08	0.82	0.08	5.94	0.15	40.1
(25.0)	0.5	5.9	0.5	7.60	1.76	0.13	6.73	0.43	58.5
	1.0	5.6		4.46	2.60	0.22	18.61	9.25	28.1
	2.0	5.5		1.24	1.04	0.45	13.27	7.25	17.1
	4.0	5.4		0.68	1.80	0.26	15.44	8.35	15.1
	6.0	5.4		1.57	2.60	0.20	16.80	12.65	20.6
5	0.0	6.6	4.0	5.26	2.30	0.90	4.98	0.05	63.0
	0.25	5.8	2.1	2.84	0.90	0.08	6.53	0.25	36.9
(25.5)	0.5	6.0	0.5	5.55	1.42	0.10	7.33	0.75	49.1
	1.0	5.4		2.66	2.10	0.32	18.61	11.35	21.4
	2.0	5.4		1.32	1.25	0.38	15.40	9.55	16.1
	4.0	5.1		0.82	2.30	0.24	20.79	14.35	13.9
	6.0	5.4		1.08	2.00	0.17	18.41	12.95	15.0
6	0.0	6.6	3.0	4.40	2.00	0.90	5.57	0.05	56.7
	0.25	5.6	1.9	2.40	0.71	0.09	6.14	0.45	34.3
(30.0)	0.5	5.2	0.3	2.02	1.02	0.11	9.50	5.05	24.9
	1.0	5.6		0.36	1.37	0.24	17.80	10.55	10.0
	2.0	5.3		0.12	0.35	0.08	8.40	5.45	6.1
	4.0	5.3		0.35	1.21	0.20	22.18	9.85	7.4
	6.0	5.3		0.30	1.08	0.14	13.60	10.35	10.1
7	0.0	6.4	4.4	5.40	2.50	0.45	5.57	0.05	60.0
	0.25	4.7	2.4	3.11	0.92	0.07	6.93	0.15	37.2
(50.0)	0.5	5.8	0.6	3.06	0.78	0.13	6.34	1.35	38.5
	1.0	5.1		0.98	1.02	0.24	18.61	9.25	10.7
	2.0	5.5		0.14	0.26	0.08	11.68	8.95	4.0
	4.0	4.9		0.15	0.52	0.17	19.40	12.25	4.1
	6.0	5.5		0.82	1.75	0.23	17.40	12.95	13.9

TABLE A3B. SOIL CHEMICAL PROPERTIES FOR SITE II

SUB-SITE	DEPTH (m)	pH	ORGANIC MATTER %	-- EXCHANGEABLE CATIONS (me/100 gr) --					BASE SATURATION %
				Ca	Mg	K	H	Al	
8	0.0	6.1	4.5	5.44	2.40	0.44	6.77	0.15	55.2
	0.25	5.8	2.0	2.54	0.64	0.08	6.93	0.25	32.0
(50.5)	0.5	5.8	0.6	3.54	0.94	0.13	8.51	2.00	35.1
	1.0	5.3		1.64	1.26	0.28	16.00	7.95	16.6
	2.0	5.1		0.10	0.24	0.08	8.80	8.15	4.6
	4.0	5.4		0.06	0.29	0.10	8.40	4.35	5.1
	6.0	5.4		0.85	1.70	0.16	18.20	12.95	13.0
9	0.0	6.8	3.8	6.23	2.60	0.36	5.37	0.05	63.1
	0.25	5.6	1.8	2.16	0.38	0.08	6.14	0.55	29.1
(55.0)	0.5	5.4	0.6	3.17	0.66	0.09	6.73	1.85	36.8
	1.0	5.4		0.93	0.89	0.21	9.80	5.95	17.2
	2.0	5.5		0.20	0.32	0.13	13.20	6.05	4.7
	4.0	5.1		0.08	0.67	0.19	19.00	12.75	4.7
	6.0	5.1		0.67	2.00	0.25	28.00	24.45	9.4
10	0.0	6.6	2.9	4.50	2.00	0.29	5.57	0.05	54.9
	0.25	5.7	1.9	2.25	0.37	0.06	7.33	0.25	26.8
(75.0)	0.5	5.8	0.5	1.73	0.24	0.15	3.96	0.65	34.9
	1.0	5.2		4.19	2.10	0.32	8.40	1.95	44.0
	2.0	5.0		1.48	1.17	0.29	11.80	6.25	20.0
	4.0	4.8		0.25	0.91	0.36	19.40	10.35	7.3
	6.0	5.3		0.37	1.07	0.29	20.00	11.45	8.0
11	0.0	6.6	4.2	5.53	2.60	0.80	6.37	0.05	58.4
	0.25	5.7	2.0	2.19	0.50	0.14	8.12	0.25	25.8
(75.5)	0.5	5.6	0.4	1.66	0.19	0.11	2.77	0.25	41.4
	1.0	5.3		4.19	2.00	0.29	9.20	2.25	41.3
	2.0	4.9		0.82	0.83	0.31	19.60	10.25	9.1
	4.0	5.2		0.34	0.99	0.33	15.60	10.05	9.6
	6.0	5.1		0.29	1.06	0.32	22.20	12.85	7.0
12	0.0	6.6	3.9	6.00	2.50	0.36	4.18	0.05	67.9
	0.25	5.6	2.2	2.32	0.76	0.15	8.12	0.25	28.5
(80.0)	0.5	5.9	0.3	1.51	0.20	0.07	2.18	0.25	45.0
	1.0	5.5		1.88	1.40	0.32	15.00	6.75	19.4
	2.0	5.3		0.50	0.80	0.32	18.80	10.45	7.9
	4.0	5.3		0.21	0.41	0.13	8.40	3.85	8.2
	6.0	5.3		0.68	1.36	0.32	19.20	12.75	11.0
13	0.0	6.4	3.4	5.87	2.40	0.70	5.17	0.05	63.4
	0.25	5.6	1.9	3.07	0.75	0.14	6.93	0.25	36.4
(100.0)	0.5	5.9	0.2	3.27	0.90	0.15	4.16	0.35	50.9
	1.0	5.7		2.20	1.66	0.26	15.00	6.15	21.5
	2.0	5.4		0.82	1.12	0.21	20.20	10.45	9.6
	4.0	6.0		0.39	0.61	0.11	4.00	3.25	21.7
	6.0	5.3		4.30	3.30	0.31	11.00	1.95	41.8
14	0.0	6.6	3.0	5.76	2.40	0.60	3.78	0.05	69.9
	0.25	5.7	1.9	2.91	0.60	0.11	6.34	0.25	36.4
(100.5)	0.5	5.8	0.3	2.88	0.72	0.12	3.96	0.45	48.4
	1.0	5.1		1.02	1.19	0.22	16.40	10.45	12.9
	2.0	--		--	--	--	--	--	--
	4.0	5.3		0.50	0.69	0.09	7.20	2.85	15.1
	6.0	5.3		10.50	6.80	0.50	8.40	1.85	67.9

TABLE A3B. SOIL CHEMICAL PROPERTIES FOR SITE II

SUB-SITE	DEPTH (m)	pH	ORGANIC MATTER %	-- EXCHANGEABLE CATIONS (me/100 gr) -- Ca	Mg	K	H	Al --	BASE SATURATION %
15	0.0	6.8	3.7	6.43	2.40	0.70	3.98	0.05	70.5
	0.25	5.7	1.8	3.50	0.51	0.06	5.54	0.15	42.4
105.0)	0.5	5.8	0.4	2.52	0.54	0.11	4.36	0.15	42.1
	1.0	5.0		2.09	3.00	0.38	18.60	8.95	22.7
	2.0	5.5		0.38	0.81	0.21	13.00	7.85	9.7
	4.0	5.4		0.20	0.71	0.17	10.60	4.85	9.3
	6.0	5.4		2.19	2.40	0.33	20.40	14.55	19.4
16	0.0	6.6	3.6	4.85	1.68	0.80	6.17	0.10	54.3
	0.25	5.9	1.4	2.26	0.40	0.11	5.94	0.25	31.8
125.0)	0.5	5.8	0.3	3.06	1.21	0.23	6.14	1.25	42.3
	1.0	5.8		1.74	1.43	0.35	12.20	4.65	22.4
	2.0	5.3		0.34	0.45	0.19	7.00	3.25	12.3
	4.0	5.3		0.73	1.14	0.41	20.00	12.15	10.2
	6.0	5.2		0.95	1.12	0.34	18.60	10.05	11.5
17	0.0	6.4	3.7	5.02	1.84	0.60	5.17	0.10	59.1
	0.25	5.6	1.4	1.69	0.31	0.15	6.73	0.65	24.2
125.5)	0.5	5.6	0.4	3.08	0.82	0.18	8.32	1.05	32.9
	1.0	5.7		1.12	1.07	0.34	12.40	4.05	17.0
	2.0	5.3		0.43	0.54	0.22	9.40	4.35	11.2
	4.0	5.6		0.30	0.47	0.18	8.80	4.95	9.7
	6.0	5.5		1.12	1.20	0.29	17.80	10.85	12.8
18	0.0	6.6	2.3	4.46	1.79	0.70	3.98	0.05	63.6
	0.25	5.9	1.5	2.82	0.69	0.13	5.15	0.15	41.4
130.0)	0.5	5.7	0.3	2.44	0.53	0.14	4.55	0.75	40.4
	1.0	5.9		3.01	1.90	0.36	11.00	3.95	32.4
	2.0	5.4		0.63	1.04	0.30	15.20	7.25	11.5
	4.0	5.8		0.09	0.28	0.11	8.40	4.35	5.4
	6.0	5.1		0.55	0.86	0.21	12.60	7.55	11.4
19	0.0	6.5	2.8	5.46	1.85	1.20	4.98	0.05	63.1
	0.25	5.8	0.8	7.60	2.60	0.30	10.30	0.45	50.5
150.0)	0.5	5.2	0.4	3.02	2.40	0.24	14.45	4.05	28.2
	1.0	5.7		1.16	1.26	0.24	13.80	5.45	16.2
	2.0	--		--	--	--	--	--	--
	4.0	5.5		0.61	1.18	0.23	17.80	10.95	10.2
	6.0	5.3		2.45	3.30	0.37	19.40	9.25	24.0

TABLE A4. MEANS AND STANDARD DEVIATIONS OF SOIL PROPERTIES FOR SITES I AND II

		SITE I				SITE II		
VARIABLE	DEPTH (m)	N	MEAN	STANDARD DEVIATION	DEPTH (m)	N	MEAN	STANDAR DEVIATI
BULK-DENSITY (gr/cm)	0.0	19	1.42	0.089	0.0	19	1.31	0.15
	0.25	18	1.49	0.166	0.25	19	1.42	0.07
	0.5	18	1.44	0.139	0.5	19	1.48	0.11
	1.0	18	1.33	0.118	1.0	19	1.26	0.10
	2.0	15	1.27	0.167	2.0	19	1.15	0.13
	4.0	12	1.18	0.080	4.0	19	0.99	0.09
	6.0	8	1.09	0.008	6.0	19	0.95	0.13
Θ_s	0.0	19	0.413	0.026	0.0	18	0.441	0.03
	0.25	16	0.418	0.068	0.25	19	0.408	0.02
	0.5	18	0.445	0.056	0.5	19	0.415	0.04
	1.0	18	0.492	0.047	1.0	19	0.522	0.05
	2.0	15	0.505	0.065	2.0	19	0.564	0.11
	4.0	12	0.529	0.096	4.0	19	0.601	0.09
	6.0	8	0.569	0.036	6.0	19	0.592	0.07
$\Theta_d(1)$	0.0	19	0.337	0.034	0.0	18	0.360	0.01
	0.25	16	0.375	0.069	0.25	19	0.315	0.03
	0.5	18	0.428	0.057	0.5	19	0.384	0.04
	1.0	18	0.481	0.044	1.0	19	0.515	0.06
	2.0	15	0.495	0.070	2.0	19	0.556	0.11
	4.0	12	0.513	0.094	4.0	19	0.600	0.07
	6.0	8	0.566	0.042	6.0	19	0.592	0.07
$\Theta_d(3)$	0.0	19	0.300	0.039	0.0	18	0.330	0.01
	0.25	16	0.360	0.071	0.25	18	0.290	0.03
	0.5	18	0.419	0.059	0.5	19	0.373	0.04
	1.0	18	0.470	0.044	1.0	19	0.509	0.06
	2.0	15	0.474	0.065	2.0	19	0.532	0.13
	4.0	12	0.500	0.091	4.0	19	0.589	0.07
	6.0	8	0.554	0.044	6.0	19	0.585	0.08
$\Theta_d(10)$	0.0	19	0.237	0.039	0.0	18	0.289	0.01
	0.25	16	0.327	0.075	0.25	19	0.255	0.04
	0.5	18	0.405	0.061	0.5	19	0.357	0.05
	1.0	18	0.435	0.046	1.0	19	0.480	0.06
	2.0	15	0.413	0.081	2.0	19	0.480	0.15
	4.0	12	0.450	0.099	4.0	19	0.522	0.10
	6.0	7	0.517	0.047	6.0	19	0.549	0.10
$\Theta_d(30)$	0.0	19	0.165	0.035	0.0	19	0.223	0.03
	0.25	19	0.307	0.273	0.25	19	0.211	0.05
	0.5	18	0.323	0.063	0.5	19	0.285	0.05
	1.0	18	0.368	0.060	1.0	19	0.335	0.06
	2.0	15	0.334	0.063	2.0	19	0.323	0.07
	4.0	12	0.332	0.081	4.0	19	0.303	0.08
	6.0	8	0.344	0.098	6.0	19	0.309	0.05
$\Theta_d(150)$	0.0	19	0.143	0.025	0.0	19	0.188	0.03
	0.25	19	0.238	0.081	0.25	19	0.159	0.05
	0.5	18	0.320	0.077	0.5	19	0.227	0.08
	1.0	18	0.346	0.115	1.0	19	0.325	0.03
	2.0	15	0.320	0.067	2.0	18	0.275	0.05
	4.0	12	0.316	0.084	4.0	19	0.246	0.08
	6.0	8	0.320	0.086	6.0	19	0.256	0.05

TABLE A4. MEANS AND STANDARD DEVIATIONS OF SOIL PROPERTIES FOR SITES I AND II

		SITE I				SITE II		
VARIABLE	DEPTH (m)	N	MEAN	STANDARD DEVIATION	DEPTH (m)	N	MEAN	STANDARD DEVIATION
$\theta_w(.5)$	0.0	19	0.316	0.041	0.0	18	0.346	0.015
	0.25	16	0.359	0.063	0.25	19	0.312	0.034
	0.5	18	0.422	0.055	0.5	19	0.381	0.045
	1.0	18	0.467	0.046	1.0	19	0.517	0.061
	2.0	15	0.483	0.066	2.0	19	0.543	0.127
	4.0	12	0.497	0.099	4.0	19	0.584	0.087
	6.0	7	0.552	0.046	6.0	19	0.592	0.083
$\theta_w(5)$	0.0	19	0.253	0.039	0.0	18	0.297	0.017
	0.25	16	0.333	0.074	0.25	19	0.264	0.041
	0.5	18	0.409	0.060	0.5	19	0.363	0.052
	1.0	18	0.445	0.048	1.0	19	0.488	0.064
	2.0	15	0.419	0.081	2.0	19	0.491	0.147
	4.0	12	0.459	0.101	4.0	19	0.535	0.098
	6.0	7	0.524	0.046	6.0	19	0.558	0.104
K_s (m/s)	0.0	19	7.25E-06	9.86E-06	0.0	19	9.97E-06	1.02E-05
	0.25	17	3.44E-06	6.77E-06	0.25	19	1.45E-05	1.16E-05
	0.5	18	6.60E-06	1.60E-05	0.5	19	2.92E-05	3.93E-05
	1.0	18	2.84E-08	5.18E-08	1.0	19	1.84E-08	4.39E-08
	2.0	15	2.19E-06	7.10E-06	2.0	19	1.06E-06	3.96E-06
	4.0	12	8.99E-09	1.46E-08	4.0	19	2.54E-07	7.09E-07
	6.0	8	2.16E-07	5.31E-07	6.0	19	2.20E-06	8.86E-06
VERY COARSE SAND (%)	0.0	19	7.6	2.40	0.0	19	3.3	1.66
	0.25	19	4.7	5.19	0.25	19	3.1	1.11
	0.5	18	1.7	0.95	0.5	19	3.1	3.02
	1.0	18	1.2	0.75	1.0	19	1.7	2.08
	2.0	15	2.6	2.36	2.0	18	2.1	3.02
	4.0	12	2.9	1.14	4.0	19	2.4	2.76
	6.0	9	1.9	1.59	6.0	19	1.9	2.70
COARSE SAND (%)	0.0	19	5.0	0.94	0.0	19	2.3	0.80
	0.25	19	2.9	1.64	0.25	19	2.4	0.52
	0.5	18	2.0	1.60	0.5	19	1.7	0.96
	1.0	18	1.4	0.60	1.0	19	1.2	1.65
	2.0	15	2.4	1.82	2.0	18	1.9	2.85
	4.0	12	2.7	0.74	4.0	19	1.7	1.96
	6.0	9	1.9	1.15	6.0	19	1.5	1.94
MEDIUM SAND (%)	0.0	19	4.2	0.56	0.0	19	2.3	0.85
	0.25	19	2.6	1.23	0.25	19	2.5	0.73
	0.5	18	1.8	0.98	0.5	19	1.6	0.83
	1.0	18	1.2	0.45	1.0	19	0.9	0.98
	2.0	15	2.0	1.31	2.0	18	1.6	2.13
	4.0	12	2.3	0.75	4.0	19	1.5	1.32
	6.0	9	1.8	1.06	6.0	19	1.0	0.84
FINE SAND (%)	0.0	19	5.1	0.75	0.0	19	4.4	2.44
	0.25	19	3.6	1.58	0.25	19	4.3	1.57
	0.5	18	2.4	1.14	0.5	19	2.7	1.30
	1.0	18	1.7	0.73	1.0	19	1.2	0.85
	2.0	15	2.5	1.49	2.0	18	2.0	2.00
	4.0	12	3.2	1.54	4.0	19	1.9	1.03
	6.0	9	2.7	1.15	6.0	19	1.3	0.99

TABLE A4. MEANS AND STANDARD DEVIATIONS OF SOIL PROPERTIES FOR SITES I AND II

		SITE I				SITE II		
VARIABLE	DEPTH (m)	N	MEAN	STANDARD DEVIATION	DEPTH (m)	N	MEAN	STANDARD DEVIATIO
VERY FINE SAND (%)	0.0	19	4.5	0.74	0.0	19	5.7	3.14
	0.25	19	3.9	1.44	0.25	19	4.6	1.90
	0.5	18	3.0	1.40	0.5	19	4.0	2.42
	1.0	18	2.2	0.97	1.0	19	2.1	0.98
	2.0	15	3.2	1.58	2.0	18	2.9	2.12
	4.0	12	5.7	4.92	4.0	19	3.4	1.98
	6.0	9	3.6	1.34	6.0	19	1.8	1.51
TOTAL SAND (%)	0.0	19	26.3	3.35	0.0	19	17.9	7.36
	0.25	19	16.7	8.28	0.25	19	17.3	3.96
	0.5	18	10.9	5.24	0.5	19	13.5	6.89
	1.0	18	7.7	2.71	1.0	19	7.3	5.70
	2.0	15	13.0	8.05	2.0	18	9.6	11.11
	4.0	12	16.7	5.71	4.0	19	11.3	7.86
	6.0	8	11.8	5.58	6.0	19	7.1	5.56
SILT (%)	0.0	19	58.6	2.23	0.0	18	58.9	15.02
	0.25	19	51.2	10.09	0.25	19	66.2	8.00
	0.5	18	41.2	10.42	0.5	19	52.9	9.58
	1.0	18	39.0	14.28	1.0	19	34.2	5.93
	2.0	15	39.3	8.34	2.0	18	45.5	16.68
	4.0	12	37.4	12.05	4.0	19	47.7	13.97
	6.0	8.	47.9	7.53	6.0	19	45.7	15.04
CLAY (%)	0.0	19	15.1	4.51	0.0	18	19.7	3.71
	0.25	19	33.1	17.73	0.25	19	17.4	10.56
	0.5	18	47.9	13.14	0.5	19	33.6	13.38
	1.0	18	53.3	13.54	1.0	19	58.5	7.62
	2.0	15	48.0	9.42	2.0	18	43.0	12.96
	4.0	12	45.9	15.24	4.0	19	41.6	13.81
	6.0	8	40.4	7.56	6.0	19	47.4	16.88
pH	0.0	19	6.1	0.38	0.0	19	6.5	0.23
	0.25	19	6.0	0.40	0.25	18	5.7	0.27
	0.5	18	5.6	0.62	0.5	19	5.7	0.25
	1.0	18	5.7	0.99	1.0	19	5.5	0.26
	2.0	15	5.7	0.95	2.0	17	5.3	0.20
	4.0	12	5.7	0.69	4.0	19	5.3	0.28
	6.0	8	5.8	0.47	6.0	19	5.3	0.14
OM (%)	0.0	19	3.8	0.81	0.0	19	3.7	0.77
	0.25	19	0.7	0.31	0.25	18	1.8	0.36
	0.5	18	0.5	0.32	0.5	19	0.4	0.12
Ca (me/100g)	0.0	19	3.99	1.48	0.0	19	5.33	0.57
	0.25	19	2.88	1.53	0.25	18	2.92	1.27
	0.5	18	3.46	1.99	0.5	19	3.15	1.41
	1.0	18	3.89	3.60	1.0	19	2.04	1.18
	2.0	15	3.09	3.32	2.0	17	0.68	0.51
	4.0	12	2.35	3.17	4.0	19	0.39	0.26
	6.0	8	1.23	2.06	6.0	19	1.58	2.37
Mg (me/100g)	0.0	19	1.59	0.56	0.0	19	2.21	0.29
	0.25	19	3.08	3.07	0.25	18	0.77	0.54
	0.5	18	4.86	3.88	0.5	19	0.95	0.55
	1.0	18	5.76	5.20	1.0	19	1.66	0.55
	2.0	15	3.99	3.03	2.0	17	0.83	0.43
	4.0	12	3.40	2.83	4.0	19	0.93	0.53
	6.0	8	3.06	3.36	6.0	19	1.96	1.39

TABLE A4. MEANS AND STANDARD DEVIATIONS OF SOIL PROPERTIES FOR SITES I AND II

		SITE I				SITE II		
VARIABLE	DEPTH (m)	N	MEAN	STANDARD DEVIATION	DEPTH (m)	N	MEAN	STANDARD DEVIATION
K (me/100g)	0.0	19	0.61	0.28	0.0	19	0.70	0.27
	0.25	19	0.33	0.30	0.25	18	0.11	0.06
	0.5	18	0.27	0.16	0.5	19	0.13	0.04
	1.0	18	1.48	5.31	1.0	19	0.43	0.62
	2.0	15	0.18	0.10	2.0	17	0.24	0.11
	4.0	12	0.162	0.103	4.0	19	0.20	0.09
	6.0	8	0.160	0.120	6.0	19	0.26	0.10
H (me/100g)	0.0	19	5.68	1.49	0.0	19	5.50	1.24
	0.25	19	6.26	3.21	0.25	18	6.59	1.50
	0.5	18	6.79	1.77	0.5	19	6.68	3.00
	1.0	18	8.01	5.50	1.0	19	14.82	3.47
	2.0	15	8.38	6.96	2.0	17	13.60	4.49
	4.0	12	6.86	3.96	4.0	19	13.87	5.48
	6.0	8	6.88	3.64	6.0	19	16.42	5.11
Al (me/100g)	0.0	19	0.13	0.10	0.0	19	0.07	0.04
	0.25	19	0.30	0.36	0.25	18	0.30	0.18
	0.5	18	1.04	1.22	0.5	19	1.57	1.45
	1.0	18	1.73	2.08	1.0	19	6.97	2.75
	2.0	15	1.69	2.26	2.0	17	7.82	3.12
	4.0	12	1.43	1.66	4.0	19	8.08	3.62
	6.0	8	1.43	1.47	6.0	19	10.60	4.95
BASE-SATURATION (%)	0.0	19	97.4	2.57	0.0	19	99.1	0.42
	0.25	19	94.0	7.17	0.25	18	91.7	5.99
	0.5	18	87.2	12.97	0.5	19	75.9	15.65
	1.0	18	84.6	17.99	1.0	19	38.4	16.48
	2.0	15	82.4	20.17	2.0	17	18.5	9.04
	4.0	12	80.0	21.46	4.0	19	16.5	6.36
	6.0	8	77.7	21.49	6.0	19	26.2	21.93

TABLE A5. DESORPTION WATER RETENTION DATA FOR THREE CORE SIZES

SUB-SITE	VOLUME	DEPTH (m)	--------- WATER CONTENTS (m^3/m^3) --------				
			INITIAL	θ_s	$\theta_d(1)$	$\theta_d(3)$	$\theta_d(10)$
1	SMALL	0.0	0.335	0.476	0.370	0.332	0.274
		0.5	0.374	0.427	0.398	0.390	0.384
(0.0)	MEDIUM	0.0	0.231	0.477	0.398	0.391	0.352
		0.5	0.335	0.396	0.362	0.354	0.335
	LARGE	0.0	0.382	0.494	0.402	0.359	0.298
		0.5	0.381	0.494	0.425	0.406	0.383
2	SMALL	0.0	0.267	0.476	0.353	0.319	0.264
		0.5	0.391	0.462	0.424	0.415	0.405
(0.5)	MEDIUM	0.0	0.215	0.538	0.394	0.370	0.318
		0.5	0.392	0.454	0.421	0.411	0.388
	LARGE	0.0	0.318	0.516	0.372	0.334	0.269
		0.5	0.374	0.421	0.399	0.383	0.364
3	SMALL	0.0	0.321	0.448	0.363	0.332	0.283
		0.5	0.349	0.483	0.426	0.417	0.407
(5.0)	MEDIUM	0.0	--	0.503	0.383	0.377	0.356
		0.5	0.350	0.432	0.391	0.382	0.361
	LARGE	0.0	0.406	0.495	0.407	0.387	0.333
		0.5	0.367	0.476	0.399	0.384	0.364
4	SMALL	0.0	0.358	0.493	0.390	0.357	0.309
		0.5	0.402	0.461	0.429	0.419	0.406
(25.0)	MEDIUM	0.0	0.506	0.532	0.462	0.427	0.368
		0.5	--	0.455	0.424	0.413	0.391
	LARGE	0.0	--	0.471	0.413	0.373	0.298
		0.5	0.403	0.479	0.433	0.413	0.378
5	SMALL	0.0	0.194	0.442	0.357	0.320	0.274
		0.5	0.393	0.461	0.461	0.459	0.451
(25.5)	MEDIUM	0.0	0.182	0.447	0.382	0.375	0.337
		0.5	0.426	0.476	0.442	0.435	0.418
	LARGE	0.0	0.409	0.485	0.428	0.385	0.305
		0.5	0.407	0.473	0.419	0.405	0.389
6	SMALL	0.0	0.317	0.494	0.374	0.339	0.290
		0.5	0.351	0.432	0.389	0.376	0.355
(30.0)	MEDIUM	0.0	0.206	0.496	0.371	0.361	0.321
		0.5	0.316	0.473	0.376	0.356	0.318
	LARGE	0.0	0.413	0.500	0.379	0.375	0.331
		0.5	0.371	0.445	0.397	0.380	0.359
7	SMALL	0.0	0.332	0.461	0.331	0.312	0.286
		0.5	0.354	0.424	0.379	0.369	0.366
(50.0)	MEDIUM	0.0	--	0.451	0.331	0.323	0.294
		0.5	0.335	0.405	0.369	0.355	0.334
	LARGE	0.0	0.362	0.448	0.385	0.372	0.327
		0.5	0.338	0.402	0.353	0.335	0.309
8	SMALL	0.0	0.348	0.446	0.370	0.343	0.304
		0.5	0.362	0.421	0.381	0.372	0.357
(50.5)	MEDIUM	0.0	0.242	0.469	0.343	0.329	0.290
		0.5	0.339	0.408	0.376	0.364	0.338
	LARGE	0.0	0.363	0.435	0.377	0.342	0.279
		0.5	0.350	0.442	0.333	0.310	0.288

TABLE A5. DESORPTION WATER RETENTION DATA FOR THREE CORE SIZES

SUB-SITE	VOLUME	DEPTH (m)	WATER CONTENTS (m^3/m^3) INITIAL	θ_s	$\theta_d(1)$	$\theta_d(3)$	$\theta_d(10)$
9	SMALL	0.0	0.368	0.431	0.394	0.365	0.318
		0.5	0.334	0.406	0.361	0.351	0.343
(55.0)	MEDIUM	0.0	0.254	0.448	0.375	0.363	0.332
		0.5	0.368	0.419	0.397	0.386	0.361
	LARGE	0.0	0.434	0.471	0.393	0.376	0.313
		0.5	0.311	0.386	0.340	0.320	0.294
10	SMALL	0.0	0.300	0.406	0.347	0.312	0.279
		0.5	0.173	0.360	0.339	0.310	0.260
(75.0)	MEDIUM	0.0	0.320	0.439	0.385	0.378	0.338
		0.5	0.251	0.318	0.271	0.258	0.232
	LARGE	0.0	0.432	0.456	0.416	0.376	0.315
		0.5	0.276	0.346	0.291	0.272	0.241
11	SMALL	0.0	0.287	0.444	0.361	0.318	0.271
		0.5	0.194	0.439	0.368	0.339	0.290
(75.5)	MEDIUM	0.0	0.280	0.396	0.330	0.318	0.288
		0.5	0.248	0.349	0.282	0.272	0.246
	LARGE	0.0	0.432	0.483	0.430	0.374	0.303
		0.5	0.261	0.400	0.306	0.275	0.215
12	SMALL	0.0	0.326	0.439	0.363	0.335	0.298
		0.5	0.245	0.385	0.343	0.325	0.300
(80.0)	MEDIUM	0.0	0.283	0.408	0.364	0.349	0.311
		0.5	0.337	0.360	0.344	0.330	0.303
	LARGE	0.0	0.329	0.450	0.339	0.324	0.288
		0.5	0.351	0.389	0.365	0.350	0.318
13	SMALL	0.0	0.306	0.406	0.333	0.313	0.285
		0.5	0.330	0.330	0.327	0.319	0.313
(100.0)	MEDIUM	0.0	0.277	0.390	0.343	0.335	0.290
		0.5	0.296	0.367	0.329	0.316	0.293
	LARGE	0.0	0.306	0.390	0.326	0.300	0.260
		0.5	0.280	0.332	0.299	0.282	0.256
14	SMALL	0.0	0.331	0.424	0.355	0.325	0.286
		0.5	0.327	0.334	0.330	0.324	0.312
(100.5)	MEDIUM	0.0	0.267	0.425	0.359	0.336	0.308
		0.5	0.313	0.387	0.318	0.307	0.282
	LARGE	0.0	0.340	0.425	0.347	0.317	0.269
100.5		0.5	0.278	0.362	0.305	0.288	0.267
15	SMALL	0.0	0.321	0.425	0.355	0.332	0.298
		0.5	0.341	0.362	0.335	0.327	0.320
(105.0)	MEDIUM	0.0	0.270	0.429	0.380	0.369	0.331
		0.5	0.309	0.387	0.341	0.331	0.311
	LARGE	0.0	0.356	0.450	0.394	0.362	0.308
		0.5	0.275	0.362	0.301	0.284	0.255
16	SMALL	0.0	0.350	0.411	0.368	0.342	0.325
		0.5	0.384	0.419	0.394	0.386	0.376
(125.0)	MEDIUM	0.0	0.242	0.407	0.365	0.332	0.264
		0.5	0.302	0.378	0.285	0.270	0.250
	LARGE	0.0	0.332	0.443	0.363	0.331	0.272
		0.5	0.306	0.380	0.281	0.263	0.239

TABLE A5. DESORPTION WATER RETENTION DATA FOR THREE CORE SIZES

SUB-SITE	VOLUME	DEPTH (m)	WATER CONTENTS (m^3/m^3)				
			INITIAL	θ_s	$\theta_d(1)$	$\theta_d(3)$	$\theta_d(10)$
17	SMALL	0.0	0.326	0.417	0.339	0.308	0.263
		0.5	0.336	0.406	0.338	0.327	0.314
(125.5)	MEDIUM	0.0	0.244	0.432	0.374	0.367	0.337
		0.5	0.319	0.366	0.348	0.336	0.313
	LARGE	0.0	0.355	0.441	0.354	0.340	0.295
		0.5	0.254	0.335	0.260	0.241	0.218
18	SMALL	0.0	--	--	--	--	--
		0.5	0.322	0.395	0.387	0.378	0.373
(130.0)	MEDIUM	0.0	0.217	0.393	0.333	0.322	0.286
		0.5	0.282	0.344	0.305	0.296	0.280
	LARGE	0.0	0.271	0.403	0.324	0.280	0.230
		0.5	0.307	0.361	0.310	0.293	0.257
19	SMALL	0.0	0.253	0.398	0.365	0.343	0.301
		0.5	0.482	0.480	0.482	0.480	0.456
(150.0)	MEDIUM	0.0	0.228	0.378	0.337	0.325	0.293
		0.5	0.440	0.505	0.483	0.470	0.444
	LARGE	0.0	0.369	0.422	0.379	0.351	0.301
		0.5	0.443	0.464	0.436	0.420	0.386

TABLE A6. SATURATED CONDUCTIVITY, TRANSPORT PARAMETERS, AND BULKDENSITY FOR THREE CORE SIZES

SUB-SITE	VOLUME	DEPTH (m)	K_S (m/s)	PORE-WATER VEL. (m/day)	DISP. COEFF. (m /day)	BULK-DENSITY (gr/cm)
1	SMALL	0.0	2.09E-05	6.482	2.91E-01	1.194
		0.5	2.18E-06	0.001	3.40E-04	1.403
	MEDIUM	0.0	6.53E-05	0.976	1.19E-01	1.358
(0.0)		0.5	5.00E-07	0.175	4.08E-03	1.540
	LARGE	0.0	7.91E-05	6.206	3.03E+00	1.145
		0.5	7.03E-05	0.314	1.10E-02	1.145
	FIELD	0.0	9.76E-05			
		0.5	3.14E-07			
2	SMALL	0.0	1.84E-05	2.249	1.76E-01	1.211
		0.5	3.17E-06	0.001	1.00E-05	1.405
	MEDIUM	0.0	1.01E-04	15.448	6.60E+00	1.293
(0.5)		0.5	6.24E-08	0.073	2.44E-03	1.586
	LARGE	0.0	2.20E-04	8.187	1.36E+01	1.241
		0.5	1.00E-05	0.034	2.18E-03	1.538
	FIELD	0.0	1.72E-05			
		0.5	7.27E-08			
3	SMALL	0.0	5.86E-06	0.094	2.50E-03	1.418
		0.5	1.68E-05	0.017	5.30E-04	1.158
	MEDIUM	0.0	2.07E-04	9.942	3.95E+00	1.317
(5.0)		0.5	7.19E-07	0.052	1.62E-03	1.531
	LARGE	0.0	1.54E-04	51.106	8.89E+01	1.330
		0.5	6.64E-05	0.743	4.75E-02	1.421
	FIELD	0.0	6.30E-05			
		0.5	4.42E-07			
4	SMALL	0.0	1.52E-05	4.632	1.45E+00	1.365
		0.5	9.74E-06	0.008	9.00E-05	1.438
	MEDIUM	0.0	6.41E-06	3.849	2.19E+00	1.520
(25.0)		0.5	1.59E-06	0.281	4.93E-02	1.392
	LARGE	0.0	9.98E-05	12.335	7.76E+01	1.380
		0.5	1.18E-04	1.191	8.14E-01	1.393
	FIELD	0.0	1.33E-05			
		0.5	4.24E-06			
5	SMALL	0.0	3.66E-06	9.267	1.57E+00	1.400
		0.5	1.09E-05	0.007	1.50E-04	1.314
	MEDIUM	0.0	3.12E-04	0.972	6.84E-02	1.447
(25.5)		0.5	1.86E-06	0.065	4.00E-03	1.467
	LARGE	0.0	3.68E-05	1.233	3.25E-01	1.290
		0.5	9.09E-05	1.396	5.24E-01	1.443
	FIELD	0.0	1.46E-06			
		0.5	7.88E-07			
6	SMALL	0.0	2.63E-05	1.118	4.05E-02	1.406
		0.5	6.22E-05	0.001	2.80E-04	1.281
	MEDIUM	0.0	4.99E-05	8.270	4.39E+00	1.355
(30.0)		0.5	3.55E-05	5.870	1.58E+00	1.421
	LARGE	0.0	1.24E-04	0.832	3.33E-01	1.232
		0.5	5.92E-05	2.015	3.14E-01	1.463
	FIELD	0.0	8.24E-06			
		0.5	3.53E-07			

TABLE A6. SATURATED CONDUCTIVITY, TRANSPORT PARAMETERS, AND BULKDENSITY FOR THREE CORE SIZES

SUB-SITE	VOLUME	DEPTH (m)	K_s (m/s)	PORE-WATER VEL. (m/day)	DISP. COEFF. (m /day)	BULK-DENSITY (gr/cm)
7	SMALL	0.0	2.67E-05	4.248	1.83E+00	1.238
		0.5	1.14E-05	0.014	1.70E-04	1.193
	MEDIUM	0.0	3.34E-04	23.412	1.61E+01	1.455
(50.0)		0.5	8.26E-06	0.548	1.59E-01	1.612
	LARGE	0.0	1.38E-05	10.445	2.10E+01	1.377
		0.5	1.15E-04	5.085	2.09E+00	1.504
	FIELD	0.0	4.54E-06			
		0.5	3.71E-06			
8	SMALL	0.0	9.58E-06	0.073	6.25E-03	1.503
		0.5	2.15E-05	0.358	8.89E-02	1.215
	MEDIUM	0.0	6.80E-05	10.384	6.77E+00	1.391
(50.5)		0.5	4.31E-06	0.506	6.83E-02	1.475
	LARGE	0.0	2.79E-05	8.390	1.07E+01	1.430
		0.5	6.08E-05	2.573	9.22E-01	1.480
	FIELD	0.0	4.53E-06			
		0.5	3.75E-06			
9	SMALL	0.0	8.25E-07	3.096	7.36E-01	1.432
		0.5	1.04E-05	0.002	1.20E-04	1.361
	MEDIUM	0.0	4.73E-05	5.950	3.82E+00	1.430
(55.0)		0.5	4.48E-06	5.263	5.99E+00	1.577
	LARGE	0.0	5.05E-05	0.127	1.13E-02	1.347
		0.5	1.17E-04	4.092	4.59E+00	1.581
	FIELD	0.0	6.72E-07			
		0.5	1.29E-05			
10	SMALL	0.0	2.13E-06	1.407	6.35E-02	1.437
		0.5	8.17E-08	0.018	2.10E-04	1.601
	MEDIUM	0.0	2.09E-05	13.970	1.14E+01	1.488
(75.0)		0.5	4.64E-06	0.486	1.65E-02	1.677
	LARGE	0.0	1.19E-04	1.571	4.93E-01	1.368
		0.5	9.57E-05	1.551	4.44E-01	1.574
	FIELD	0.0	4.16E-06			
		0.5	4.24E-06			
11	SMALL	0.0	3.90E-06	1.177	6.65E-02	1.515
		0.5	6.75E-07	0.101	4.34E-02	1.619
	MEDIUM	0.0	1.16E-04	4.279	2.69E+00	1.545
(75.5)		0.5	4.39E-07	0.132	4.78E-03	1.738
	LARGE	0.0	9.78E-05	5.560	2.60E+01	1.441
		0.5	1.66E-04	6.145	1.10E+00	1.433
	FIELD	0.0	6.97E-06			
		0.5	9.26E-07			
12	SMALL	0.0	7.08E-06	0.011	1.60E-04	1.586
		0.5	2.72E-07	0.002	2.80E-04	1.547
	MEDIUM	0.0	1.88E-05	0.334	3.06E-02	1.501
(80.0)		0.5	6.09E-06	0.001	2.90E-04	1.712
	LARGE	0.0	8.54E-05	2.293	2.03E+00	1.330
		0.5	4.94E-06	0.143	5.15E-02	1.547
	FIELD	0.0	1.33E-05			
		0.5	5.39E-07			
13	SMALL	0.0	3.28E-05	0.170	9.90E-03	1.625
		0.5	4.12E-05	0.111	5.38E-03	1.519
	MEDIUM	0.0	6.36E-05	5.374	4.83E+00	1.633
(100.0)		0.5	8.86E-07	0.425	8.75E-03	1.685

TABLE A6. SATURATED CONDUCTIVITY, TRANSPORT PARAMETERS, AND BULKDENSITY FOR THREE CORE SIZES

SUB-SITE	VOLUME	DEPTH (m)	K_S (m/s)	PORE-WATER VEL. (m/day)	DISP. COEFF. (m /day)	BULK-DENSITY (gr/cm)
	LARGE	0.0	7.10E-05	6.599	4.30E+00	1.551
		0.5	6.04E-05	2.275	5.38E-01	1.628
	FIELD	0.0	3.33E-06			
		0.5	6.61E-08			
14	SMALL	0.0	1.67E-06	0.045	9.70E-04	1.571
		0.5	1.40E-04	0.065	2.35E-03	1.644
	MEDIUM	0.0	5.84E-06	9.923	7.42E+00	1.514
(100.5)		0.5	3.10E-06	2.165	4.94E-01	1.668
	LARGE	0.0	1.93E-05	87.930	6.94E+01	1.670
		0.5	5.75E-05	7.993	6.01E+00	1.609
	FIELD	0.0	2.54E-05			
		0.5	3.91E-07			
15	SMALL	0.0	2.16E-06	4.653	2.19E+00	1.568
		0.5	4.23E-05	0.000	1.01E-03	1.445
	MEDIUM	0.0	1.68E-05	3.436	1.56E+00	1.414
(105.0)		0.5	4.32E-06	9.216	6.43E+00	1.666
	LARGE	0.0	3.75E-05	1.655	4.56E-01	1.487
		0.5	8.31E-05	3.289	1.39E+00	1.637
	FIELD	0.0	2.69E-06			
		0.5	1.47E-07			
16	SMALL	0.0	7.44E-06	7.337	1.80E+00	1.499
		0.5	5.35E-06	0.000	4.63E-03	1.457
	MEDIUM	0.0	4.47E-06	10.545	3.41E+00	1.478
(125.0)		0.5	2.88E-05	0.356	1.28E-02	1.642
	LARGE	0.0	7.61E-05	51.013	1.10E+02	1.325
		0.5	5.25E-05	0.396	1.76E-01	1.645
	FIELD	0.0	3.90E-06			
		0.5	8.20E-07			
17	SMALL	0.0	3.15E-06	2.669	5.29E-01	1.407
		0.5	7.68E-05	0.000	4.00E-04	1.453
	MEDIUM	0.0	1.81E-05	5.425	5.70E+00	1.468
(125.5)		0.5	1.48E-06	0.317	3.88E-02	1.607
	LARGE	0.0	2.03E-04	11.614	3.09E+01	1.287
		0.5	6.78E-05	1.384	7.14E-01	1.667
	FIELD	0.0	9.11E-06			
		0.5	3.51E-06			
18	SMALL	0.0	1.60E-06	0.545	2.83E-02	1.575
		0.5	9.94E-05	0.000	1.64E-03	1.443
	MEDIUM	0.0	8.10E-05	7.873	6.93E+00	1.611
(130.0)		0.5	2.96E-06	0.151	2.50E-02	1.722
	LARGE	0.0	1.34E-04	3.329	2.03E+00	1.450
		0.5	1.60E-04	3.436	2.12E+00	1.643
	FIELD	0.0	1.82E-05			
		0.5	--			
19	SMALL	0.0	4.69E-08	0.199	1.70E-02	1.564
		0.5	1.26E-06	0.002	3.10E-04	1.325
	MEDIUM	0.0	2.45E-06	0.023	2.87E-03	1.637
(150.0)		0.5	9.51E-07	0.041	9.70E-04	1.285
	LARGE	0.0	1.72E-04	4.067	4.07E+00	1.530
		0.5	5.37E-06	0.391	6.51E-02	1.343
	FIELD	0.0	9.69E-07			
		0.5	1.06E-06			

TABLE A7. MEANS AND STANDARD DEVIATIONS OF SOIL PROPERTIES FOR THREE CORE SIZES

VARIABLE	DE (m)		SMALL	MEDIUM	LARGE
BULKDENSITY (gr/cm)	0.0	N	19	19	19
		MEAN	1.448	1.466	1.380
		STANDARD DEV.	0.129	0.099	0.125
	0.5	N	19	19	19
		MEAN	1.412	1.579	1.510
		STANDARD DEV.	0.141	0.125	0.131
INITIAL Θ	0.0	N	19	17	18
		MEAN	0.313	0.263	0.367
		STANDARD DEV.	0.042	0.071	0.047
	0.5	N	19	18	19
		MEAN	0.336	0.331	0.333
		STANDARD DEV.	0.065	0.052	0.056
Θ_s	0.0	N	19	19	19
		MEAN	0.447	0.445	0.457
		STANDARD DEV.	0.040	0.047	0.034
	0.5	N	19	19	19
		MEAN	0.412	0.404	0.408
		STANDARD DEV.	0.048	0.051	0.053
$\Theta_d(1)$	0.0	N	18	19	19
		MEAN	0.360	0.369	0.380
		STANDARD DEV.	0.017	0.031	0.032
	0.5	N	18	19	19
		MEAN	0.378	0.361	0.350
		STANDARD DEV.	0.039	0.057	0.057
$\Theta_d(3)$	0.0	N	18	19	19
		MEAN	0.330	0.355	0.350
		STANDARD DEV.	0.016	0.029	0.030
	0.5	N	18	19	19
		MEAN	0.367	0.350	0.332
		STANDARD DEV.	0.042	0.058	0.059
$\Theta_d(10)$	0.0	N	18	19	19
		MEAN	0.289	0.317	0.294
		STANDARD DEV.	0.018	0.028	0.026
	0.5	N	18	19	19
		MEAN	0.352	0.326	0.304
		STANDARD DEV.	0.049	0.058	0.062

TABLE A7. MEANS AND STANDARD DEVIATIONS OF SOIL PROPERTIES FOR THREE CORE SIZES

VARIABLE	DE (m)		SMALL	MEDIUM	LARGE	
PORE WATER VELOCITY (m/day)	0.0	N	19	19	19	
		MEAN	2.604	7.389	14.447	
		STANDARD DEV.	2.797	5.926	23.175	
	0.5	N	19	19	19	
		MEAN	0.037	1.375	2.339	
		STANDARD DEV.	0.085	2.552	2.204	
DISP. COEFFICIENT (m^2/day)	0.0	N	19	19	19	
		MEAN	0.568	4.629	24.459	
		STANDARD DEV.	0.772	4.116	34.804	
	0.5	N	19	19	19	
		MEAN	0.008	0.784	1.154	
		STANDARD DEV.	0.022	1.948	1.612	
SATURATED CONDUCTIVITY (10^{-5} m/s)	0.0	N	19	19	19	19
		MEAN	1.00	7.32	6.36	1.57
		STANDARD DEV.	1.02	10.01	4.39	2.44
	0.5	N	19	19	19	18
		MEAN	2.92	0.360	4.78	0.207
		STANDARD DEV.	3.93	0.595	2.79	0.304

Virginia's Agricultural Experiment Stations

1—Blacksburg
Virginia Tech, Main Station
Dairy, Poultry, and all other topics

2—Steeles Tavern
Shenandoah Valley Agricultural Experiment Station
Beef, Forages, Fruit, Insect and Pest Control, Sheep

3—Orange
Northern Piedmont Agricultural Experiment Station
Alfalfa, Corn, Crops, Small Grains

4—Winchester
Winchester Agricultural Experiment Station
Fruit, Insect and Pest Control

5—Middleburg
Middleburg Agricultural Experiment Station
Beef, Forages

6—Warsaw
Eastern Virginia Agricultural Experiment Station
Field Crops, Insect and Pest Control

7—Holland Station, Suffolk
Tidewater Agricultural Experiment Station
Corn, Peanuts, Pest Control, Small Grains, Soybeans, Swine

8—Blackstone
Southern Piedmont Agricultural Experiment Station
Forages, Horticulture Crops, Small Grains, Tobacco, Turfgrass

9—Critz
Reynolds Homestead Agricultural Experiment Station
Aquaculture, Forestry, Wildlife

10—Glade Spring
Southwest Virginia Agricultural
Experiment Station
Beef, Burley Tobacco, Sheep

11—Hampton
Virginia Seafood Agricultural Experiment Station
Seafood

12—Virginia Beach
Hampton Roads Agricultural Experiment Station
Ornamentals, Vegetables, Insect and Pest Control

13—Painter
Eastern Shore Agricultural Experiment Station
Fruit, Field Crops, Herbs, Insect and Pest Control, Vegetables