SPATIAL STRUCTURE OF PHYSICAL PROPERTIES OF A TYPIC TORRIFLUVENT

by

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ABSTRACT

The spatial structure of soil properties has been examined at the University of Arizona Experiment Station at Marana. Nine hundred samples from 9 transects were collected in straight lines (100 sites for each transect), 20-, 200-, and 2,000-cm intervals. All samples were at a 50-cm depth. Variables include 0.1- and 15-bar water content, available water, surface area particle size analysis, pH, electrical conductivity, bulk density, and moisture content in the field 7 days after irrigation.

Autocorrelation functions were evaluated for each parameter and the values found to be correlated over space with patterns of three basic types: typical, random, and a large zone of influence.

Generalizations were difficult, but the calculated zone of influence was strongly dependent on distance of lags, with larger lags tending to give greater values. In a few cases, this could partially be explained on the basis of larger standard deviations measured on longer transects. Results indicate future difficulty in assigning scale lengths by parameter or soil.

CHAPTER 1

INTRODUCTION

The inherent variability affects all uses of the soil. For example, knowing the variability of soil is essential to the farmer for deciding management units such as for water and fertilizer application. Likewise, it also can be dominant for high precision laboratory results based on samples collected in the field.

As technology increases, the successful management of the soil and land becomes even more important. Pressures for increased food products, "wise" land utilization, and threats of environmental hazards are all contributing factors.

If a variable at one location is correlated with a value measured at another location, the relationship may be expressed by the covariance or autocorrelation function. Such relationships may be dependent on direction as well as distance. Also, we would anticipate that such relationships would differ according to the parameter as well as the soil under study. We will view such spatial patterns in a somewhat different light than most conventional soil studies. Rather than assume the soil is composed of blocks, areas which are uniform, we will assume there are continuous variations over all space. Also, rather than assume "random" differences, we will assume values are correlated as a function of space. Such an approach has been used in time-series analysis and geostatistics. A close counterpart is the application of such methods for evaluating ore reserves and mining operations.

Objectives

Briefly, the objectives are:

1. To determine the spatial variability of selected soil physical and chemical properties over 3 different spacings in straight lines.
2. To examine the spatial structure of these soil properties as a function of distance.
3. To interpret spatial structure, if practical, in terms of morphology or type of parameter.

Properties considered are: 0.1-bar and 15-bar moisture content, particle size analysis, specific surface, bulk density, moisture content in the field 7 days after irrigation, soil pH, and soil electrical conductivity. These particular properties were chosen to emphasize soil properties related to water and water movement.

In order to achieve the objectives, a total of 900 locations were sampled on 9 transects on the University of Arizona Experimental Farm at Marana. Each transect of 100 samples was a straight line at 20-, 200-, or 2,000-cm intervals. All samples were at a 40-60-cm depth.

CHAPTER 2

LITERATURE REVIEW

Many factors cause the variation of soil properties from one point to another. The amount of variability depends on climate, type and distribution of parent material, and depth. We will examine literature which discusses measuring variability, ramifications, and geostatistics. Philip (1972) and Nielsen, Biggar, and Erh (1973) discussed the importance of variability of soil parameters as a research problem.

Measuring Variability

One of the most comprehensive field studies on variability was on the Panoche in California (Nielsen et al., 1973; Biggar and Nielsen, 1976). The distribution of solute within a soil profile was measured at 6 depths to 182 cm within 20 subplots of a 150-ha field. The estimated pore-water velocities were found to be log-normally distributed and agreed with water infiltration measurements. To estimate the pore-water velocity, 100 observations were found needed to be within ± 50% of its true mean with confidence. The measured values of the apparent diffusion coefficient were also found to be log-normally distributed.

Warrick and Amoozegar-Fard (1980) concluded that the observed variation of soil physical parameters fall into more or less 3 classes. For low variability, with the coefficient of variability less than 20%, they found bulk density and water content at saturation. For medium variability, with the coefficient of variability of about 20-75%, were soil textural classes, field water content, and water content at specified tensions between 0.1-15 bars. For high variability, with coefficient of variability greater than 100%, were saturated and unsaturated hydraulic conductivity, apparent diffucsion coefficient, pore-water velocity, electrical conductivity, and scaling coefficients.

Ryan (1969) studied the spatial variation of soil physical properties in northern Arizona. He determined the moisture retention at 0.33 and 0.66 bars, bulk density, particle size distribution, and organic matter for a sampling study in 4 watersheds comprising several soil series in forested areas. He concluded that the stratification by soil sampling unit on a watershed presented no advantage over simple random sampling.

Guma'a (1978) studied the spatial variation of <u>in situ</u> available water content along with other related parameters over three 16-hectare irrigated fields. Two fields were in Pima County and one field in Pinal County, Arizona. Bulk density, saturated hydraulic conductivity, 0.1-bar and 15-bar moisture content, and soil particle analysis were determined within 56 sampling sites in each field. Samples were collected from each site at 30-, 60-, 90-, 120-, and 150-cm depths. The coefficient of variability for each parameter was determined. Bulk density showed a CV as low as 5%. Available water showed a CV with irregular tendency to increase with depth, but was consistently high in the 150-cm layer. The correlation coefficient for 0.1 bar and sand percentage was found as $r = -0.8$, and 15-bar moisture content and clay percentage showed a coefficient of correlation of $r = 0.5$.

Stockton (1971) and Coelho (1974) studied the soil variability on the 87 hectares of the University of Arizona farm at Marana. Degree and significance of variation within a soil mapping unit were determined. Variables included pore size distribution, bulk density, particle size analysis, and 15-bar moisture content. The variation between samples was found about the same for most of the properties studied. The values of 15-bar moisture content showed a frequency distribution close to the normal with a slight tendency toward skewness. Bulk density showed a normal distribution. The particle size distribution showed a decrease of silt and clay, and an increase of sand with depth. The average percentages of sand, silt, and clay were found at 30 cm to be 23.3, 41.2, and 35.3, and at 150 cm to be 39.7, 35.6, and 24.7, respectively. Bulk density showed a range of 1.42 g/cm^3 at the 30-cm depth to 1.57 g/cm^3 at the 150-cm depth.

Aljibury and Evans (1961) determined the variability of moisture retention values, bulk density, and particle-size distribution for Oregon soils. They found significant differences for 0.1- and 15-bar moisture content and bulk density between soil groups, counties, and depths sampled.

Cassel and Sweeney (1974) and Cassel and Bauer (1975) studied the moisture content of field capacity and wilting point, available water content, and bulk density on several soil series in North Dakota. The moisture content at field capacity, wilting point, and available water was found to be dependent on the amount of water applied, soil texture, soil structure, stratification, and salt content. The moisture content at 15-bar and bulk density were evaluated in samples collected at 5 depths to 152 cm from 3 soil series developed from glacial or glacio-lacustrine deposits. The bulk density values showed normal frequency distribution with less variability, while 15-bar moisture content showed higher variability and following gamma distribution in most of the cases.

Cameron (1978) measured the soil-water retention curves and cores taken from 5 sites at 6 depths in the Bainsville clay loam soil in Canada. He found that the coefficient of variation ranged from 4.2 to 13% in the surface layers and from 2.4 to 6.2% in the deeper layers.

Cameron also concluded that there were no consistent trends in variability with respect to tensions from 0 to 500 cm H_2O.

Wagenet and Jurinak (1978) studied the variability of electrical conductivity (EC) for 35 sampling sites on Mancos shale formation within a 777-km^2 area of the Price River Basin in Utah. The samples were collected at 0-2.5-, 2.5-7.5-, and 7.5-15-cm depths. Whether a 1:1 or saturation extract, it has been found that electrical conductivity values were distributed log-normally about the mean EC values. The coefficient of determination for the log-normal statistical plots was $r^2 = 1.0$ for all the 3 depths at the 35 sites. It also has been found that the variance in the EC values increased with depth.

Lumb (1966) determined the variations in properties of 4 types of natural soils. Random variation about a mean or linear trend related to the "normal" or "Gaussian" statistical distribution was found. Soil properties followed normal, log-normal, and bi-normal distributions. Properties studied included Atterberg limits, grading, and for undisturbed samples, strength and compressibility characteristics.

Andrew and Stearns (1963) concluded that intensive sampling is necessary to obtain a good estimation for the study of moisture retention values at saturation, .015-, .03-bar, bulk density, particle size distribution, and plasticity constants at 0-15- and 15-30-cm depths in samples collected from 4 Mississippi soil series (silt loam) according to an intensive grid-like sampling design.

Raupach (1951) studied the variability in reaction and total soluble salts of a red-brown soil from South Australia. Spatial variations have been found for organic carbon, nitrogen, clay, and exchangeable cations over small areas. Variance of the reaction values about the mean soil reaction is not great. Seasonal changes were discernible for reaction, but were largely masked by spatial variations even over small areas.

Bascomb and Jarvis (1976) and Williams and Rayner (1977) determined the variability of physical and chemical properites of 30 profiles within 3 areas of the Denchworth map unit in South England. They found that the variability of individual properties as indicated by coefficient of variation differed widely. In general, the physical properties were more uniform than the chemical properties. The correlations between 2 pH measurements, and between fine clay and clay, were large at all depths. Linear regression indicated that close predictions of pH in water and fine clay content is possible from pH in $Ca\ Cl_2$ and clay content, respectively. The coefficient of variation for 5 elements samples 1-2 m^2 sites was determined. For 3 such sites the CVs were 1-13% for Ti, 4-20% for Zr, 3-20% for Fe, 5-13% for Ca, and 2-4% for K. The CVs for samples from a total area of 6 km^2 at 2 locations within one depth at a time were 11-16% for Ti, 23-38% for Zr, 60-100% for Ca, and 15-19% for K. The difference for the elements other than Ca were due to the large sampling area. The variation in Ca content is due to the presence of Ca CO_3 accumulation at varying depths.

Blyth and MacLeod (1978) determined the variability of total nitrogen, total phosphorous, and 0.5-M acetic acid extractable nutrients (Ca, Mg, Pb, and K) for forest soil in northeastern Scotland. Thirteen sample plots (0.01 ha) in 6 forests were taken. They found that the average number of top soil samples required per plot to secure 95% confidence limits for a range about the mean of ± 0.1 was 6 for total nitrogen, 9 for total phosphorous, and 29 for extractable nutrients (Ca, Mg, Pb, and K). It has been found that high variability within plots causes large variation in correlation coefficients between tree growth and soil properties. The use of large plot size was recommended.

Bracewell, Robertson, and Logan (1979) studied the variability of organic matter, total cation, nitrogen, and the exchangeable Ca^{+2}, Mg^{+2}, Na^{+}, K^{+}, and H^{+}. For the A2 horizon of the Countess Wells series (iron podzol), analysis of variance has been carried out between soil samples separated by distances of 0.5 m, 10 m, and 0.5-8 m. They found that all properties exhibit considerable variation over short distances and many showed the major proportion of their total variance at a distance of 0.5 m. A variation of similar size over distances of the order of a kilometer was found.

Banfield and Bascomb (1976) studied the correlations among soil properties and used multivariate techniques to investigate similarities between profiles in relation to substrata. They compared laboratory measurements and field observations as a means of characterizing soils. Correlations between pH measurements and between fine clay were found to be large at all depths. Linear regressions indicated that close predictions of pH in water and fine clay content are possible from pH in calcium and clay content, respectively.

Ramifications and Simulations

Warrick, Mullen, and Nielsen (1977) studied ramification of the spatial variation of soil hydraulic properties for drainage processes. They ran Monte Carlo studies using random functions for the soil-water characteristics and unsaturated hydraulic conductivity functions needed to describe water flow in soil.

Rao et al. (1978) studied the application of the empirical distribution function (EDF) to describe the spatial variability of soil properties. They demonstrated use of a Taylor's series to evaluate variation of a function of a random variable.

Bresler, Bielorai, and Laufer (1979) compared data obtained from a controlled irrigation experiment and results obtained from simultaneous water and salt flow models where the spatial variability in hydraulic conductivity and soil-water retentivity have been taken into consideration. The measured data of water content were taken by the neutron probe method. Saturated paste extracts were used to obtain the measured salt data. The measurements were made in 6 replications at each of 3 experimental treatments, and variability in water and salt content observations was expressed in terms of the 45% confidence limits. Bresler et al. concluded that the models have been sufficiently developed for estimating field values of water and salt content with approximate ranges of soil-water retentivity and hydraulic conductivity at a given probability.

Sharma and Luxmoore (1979) represented soil spatial variability on water balance components of a grassland watershed near Chickasha, Oklahoma using a simulation model. Scaling theory, based on the similar media concept, was used. They found that deep drainage increases with an increase in the scaling factor, while the evapotranspiration and surface runoff decrease. Sharma and Luxmoore (1979) also concluded that the soil-plant-weather combination was highly affected by the spatial variability (expressed as coefficient of variation of the scaling coefficient) on water balance.

The effects were more noticeable during the months of high rainfall and low evapotranspiration.

Warrick and Amoozegar-Fard (1979) also used the scaled forms of the moisture flow equation to study soil-water characteristics and unsaturated hydraulic conductivity. They used Monte Carlo simulations in most cases, and demonstrated how the soil-water flow equation could be solved using the scaled-water characteristics and unsaturated hydraulic conductivity. They also concluded that the scaling techniques offer distinct advantages in terms of economy of calculations as well as advantages in synthesizing large volumes of data.

Geostatistics

The values of a variable at different places in space are often related to one another. The correlation value is dependent upon the separation distance.

The methods of autocorrelation and Kriging have entered the earth science primarily from mining engineering. In order to estimate the gold content of ore bodies accurately, Krige (1966) considered spatial dependence of sample values in South Africa. Matheron (1971) developed Krige's empirical method into a general theory of sampling and estimation of spatially dependent values. This procedure is known as "Universal Kriging"--especially among earth scientists.

Autocorrelation and spectral analysis were used by Webster (1977) to study the spatial series along transects of gilgai soils in Australia. Samples at 4-meter intervals over a distance of 1.5 km were collected. Soil properties such as pH, electrical conductivity, and chloride content at 0-10, 30-40, and 80-90 cm showed a recurrent short-range variation associated with the gilgai pattern. If the samples are dense enough, the data from neighboring points were mostly similar, whereas data from distant points were more different. The density at which spatial dependence becomes manifest varies appreciably from one region to another, and also depends on the size of the area surveyed and the soil property of interest.

Two methods for locating soil boundaries from multivariate data were used to compare 2 soil transects in Oxfordshire (Webster, 1978). The methods were split moving window (SMW) and maximum level variance (MLV). The MLV method was found to identify all major changes, but was less reliable for small changes. The SMW method was found to identify all sharp boundaries, even between soil types that are similar. Webster concluded that the SWM method requires less computing than the MLV method.

Smith and Freeze (1979) carried out a stochastic analysis of one-dimensional steady-state ground-water flow through a bounded domain by using Monte Carlo simulation techniques. Hydraulic conductivity values were autocorrelated by assuming the spatial variations in conductivity can be represented by stochastic process neighboring blocks. The Monte Carlo solution showed a similar behavior to the spectral solution of the stochastic flow equation in one dimension, although the direct comparisons could not be made.

Smith and Schwartz (1980) described a modeling concept which accounts for macroscopic dispersion as a mixing caused by spatial heterogeneities in hydraulic conductivity. A two-dimensional spatially autocorrelated hydraulic conductivity field was generated as a first-order nearest-neighbor stochastic process. The analysis of a variety of hypothetical media showed that over finite domains a population of tracer particles connected through this statistically homogeneous conductivity field does not have the normal distribution and does not yield the constant dispersivity that classic theory would predict.

Kriging was applied to a soil salinity problem by Hajrasuliha et al. (1980). Soil salinity levels were analyzed by using both geostatistical and classical statistical methods in three large agricultural fields in Southwest Iran. The fields showed both space and time variability. The variance structures of the salinity observations were spatially dependent in two fields, while they were spatially independent in the third field.

Rogowski (1980) measured sorptivity (S) and A-values in Philip's (1957) infiltration equation in Appalachian mine soil by using large and small infiltration rings in the field. The small rings (0.15-m diameter) gave relatively rapid measurements of S and the A-value, but showed high spatial variability, more than larger rings (0.5-m diameter). The parameters S and A showed poor correlation and varied uniformly within a 20-m diameter neighborhood. Semivariograms of these properties showed no correlation or perhaps slowly increasing linearity for larger distances. Semivariograms of water-table elevations seemed to reach constant values within a 100-m range. Infiltration and its parameters, S and A, were found to be somehow related to the water content and water-table elevation.

CHAPTER 3

STUDY AREA AND SAMPLING

Description of the Study Area

The University of Arizona Branch Experiment Station at Marana is located in the Avra Valley about 20 miles northwest of Tucson, on the west side of Interstate Highway 10. The station is 87 hectares distributed in 20 fields with 10.5 hectares in ditches and roads (Figure 1).

The climate at Marana is characterized by low annual precipitation (254 mm), about evenly divided between summer (July to September) and winter rains (January to March). The temperature extremes range from 44°C during the summer to -14°C during the winter. Low humidity and clear sky occur most of the time.

The most common crops in the area are cotton, alfalfa, wheat, barley and vegetables. The area is mainly dependent on irrigation.

A soil map of the station was recently made by Post, Hendricks, and Pereira (1978). The dominant soil type on the farm is Pima clay loam (93%) which belongs to the fine silty, mixed thermic family of Typic Torrifluvents. The remaining 7% consists of Grabe clay loam in fields C-2 and A-1 which is within the coarse loamy, mixed thermic family of Typic

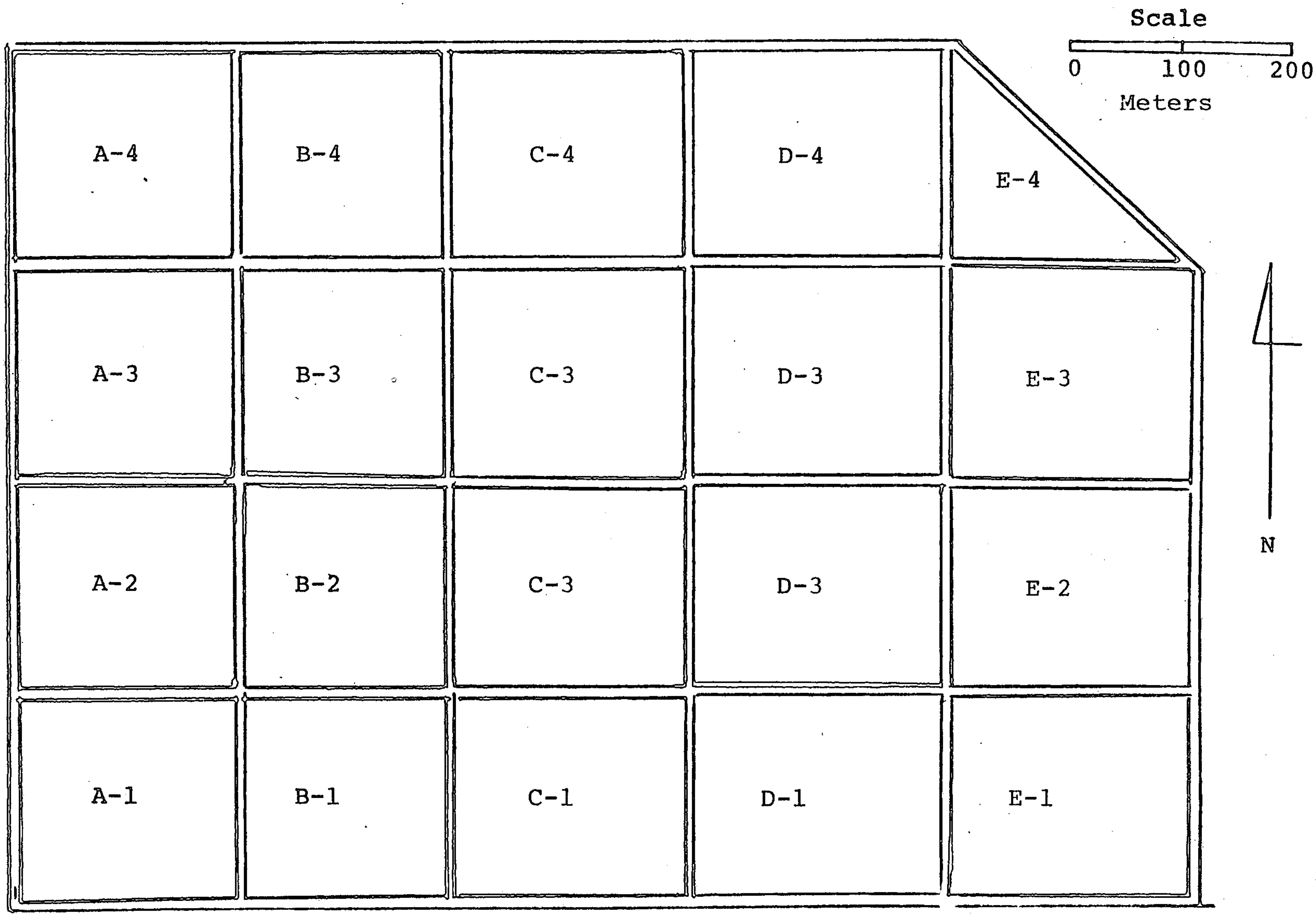


Figure 1. The University of Arizona Branch Experiment Station at Marana

Torrifluvents. These soils are formed in recent alluvium deposited by the Santa Cruz River and are stratified in character. The surface layer is dark, grayish-brown clay loam ranging from 40-80-cm deep. Underlying this layer the soil is usually brown to dark brown loam-textured soil which grades into a sandy loam texture to a depth of 110-115 cm.

Sampling

In June 1979, 900 sites were sampled from 9 transects on straight lines (100 sites per transect), at 20-, 200-, and 2,000-cm intervals. Four hundred sites were sampled at 20-cm intervals, 400 from 200-cm intervals and 100 sites from 2,000-cm intervals. All samples were collected at a 40-60-cm depth. Bucket augers of 7.5 cm diameter were used to collect the 900 disturbed samples.

Transects 1-20 cm and 1-200 cm (i.e., location 1 for 20-cm and 200-cm spacings) were sampled from Field C-2 from a south-to-north direction (Figure 2). Transects 2-20 cm and 2-200 cm were sampled from field E-3 from a south-to-north and north-to-south direction, respectively. Transects 3-20 cm and 4-20 cm were sampled from Field B-4 crossing each other at the exact middle with no common point. Transects 3-200 cm and 4-200 cm were also sampled from field B-4 crossing each other with 15 sites to the south, 85 sites to the north, 30 sites to the west and 70 sites to the east.

Finally the transect at 2,000-cm intervals went from the east to the west side of the farm and into the adjacent, privately owned farm (B.K.W. Farms) giving a total sampling length of 2 kms (Figure 2).

Another 200 undisturbed samples were collected from Transects 3-20 cm and 3-200 cm at the depth of 40 to 60 cm. An "Oakfield probe" was used to collect a 69 cm^3 undisturbed soil sample from each site. Bulk density and gravimetric moisture content in the field 7 days after irrigation was evaluated for the 200 sites.

Some sites were missing due to roads and irrigation ditches. There are 12 sites missing from Transect 1-200 cm, 14 sites from Transect 2-200 cm, 6 from Transect 3-200 cm, 5 sites from Transect 4-200 cm, and 5 sites from the 2,000-cm transect.

The soil samples were air dried in a greenhouse for 24 hours, passed through a mechanical soil grinder, through a 2-mm sieve, and finally stored in plastic bags for analysis.

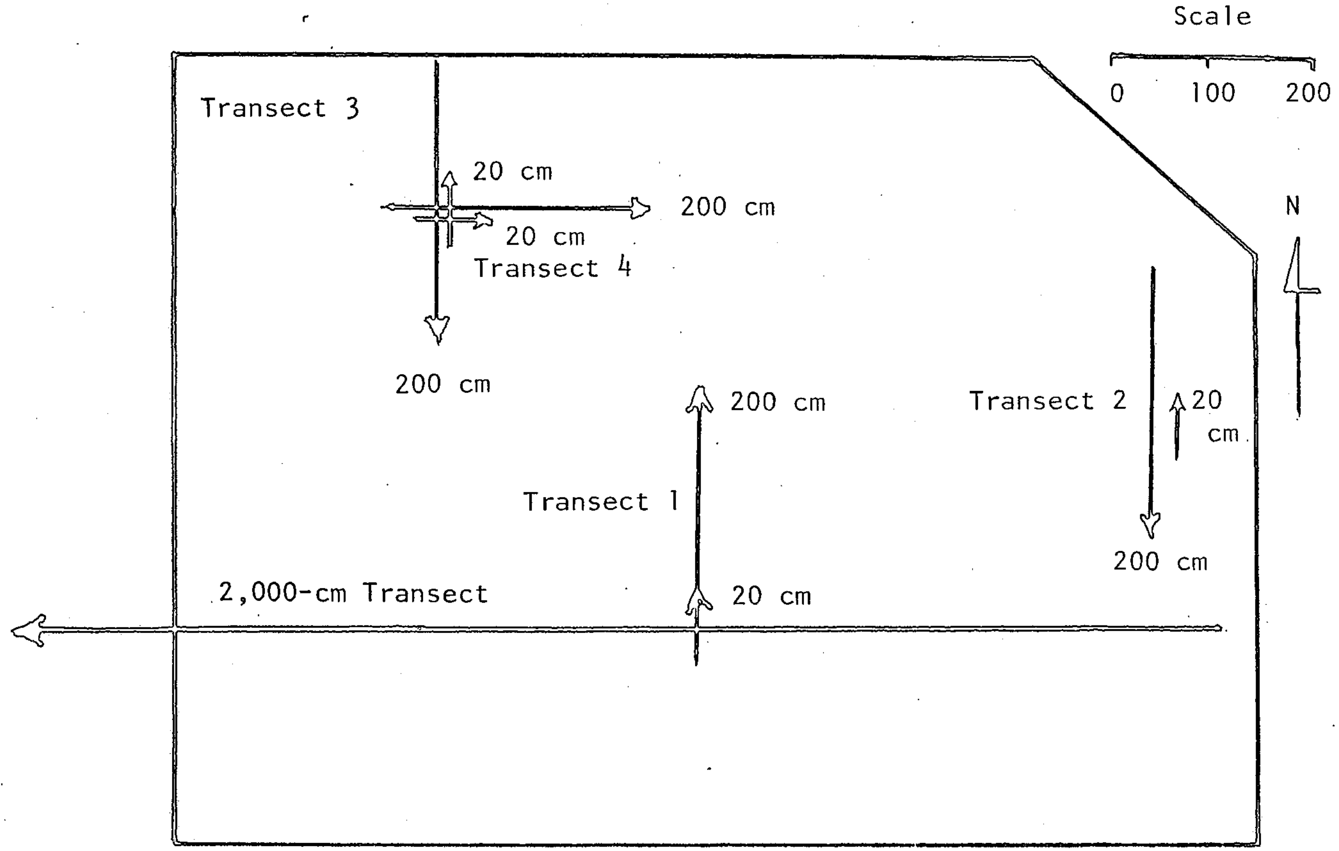


Figure 2. Locations of 9 transects used at the Marana Farm for samples. -- Total area is about 85 hectares.

CHAPTER 4

MEASURED VALUES

Soil-water Characteristics

Moisture retention values at 0.1 bar and 15 bar were evaluated for all 900 soil samples. Pressure cookers and pressure plates were used following procedures outlined by Richards (1965). Available water (0.1-15 bar) was also evaluated for all 900 soil samples.

The experimental mean, standard deviation, and coefficients of variation [(standard deviation/mean)(100)] were evaluated for these and the other parameters by transect, and are given in Table 1. Raw data is given in Appendix A. Coefficients of variation (CV) for 0.1 bar water were found in the range 4.4-8.7% for the 20-cm spacing, 8.1-15.0% for the 200-cm spacing, and 20.6% for the 2,000-cm spacing. The CVs for 15 bar water at 20-, 200-, and 2,000-cm spacing were found in ranges of 6.7-12.9%, 13.1-22.7% and 30.8%, respectively. The CVs for available water at 20-, 200-, and 2,000-cm spacings were found as 8.8-18.5%, 11.7-15.9%, and 20.2%, respectively, using the 0.1 bar water retained minus the 15 bar water.

Table 1. Experimental Means, Standard Deviation, and Coefficients of Variability of 900 Sites

Transect		0.1 Bar (%)	15 Bar (%)	A.W. (%)	pH	EC µmhos/cm	Specific Surface m^2/cc	Mean Diameter (µ)
1-20 cm (Field C-2)	Mean	34.90	18.30	16.70	8.90	223.0	1.10	13.80
	SD	2.80	2.10	3.10	0.12	27.9	0.07	2.20
	CV	8.20	11.40	18.50	1.40	12.5	6.40	15.70
2-20 cm (Field E-3)	Mean	21.00	8.20	12.80	8.80	136.0	0.65	51.40
	SD	1.20	1.10	1.40	0.10	11.6	0.05	4.11
	CV	5.60	12.90	11.10	1.10	8.5	7.70	8.00
3-20 cm (Field B-4)	Mean	36.70	21.10	15.60	8.20	350.0	1.01	20.60
	SD	1.60	1.40	1.60	0.19	74.2	0.08	4.90
	CV	4.40	6.70	10.30	2.30	21.2	7.90	23.50
4-20 cm (Field B-4)	Mean	37.00	17.90	19.10	8.70	186.0	0.88	23.10
	SD	1.90	1.50	1.70	0.11	20.9	0.06	3.80
	CV	5.10	8.50	8.80	1.20	11.2	6.80	16.30
1-200 cm (Field C-2)	Mean	35.30	19.30	16.00	8.80	212.0	1.05	15.40
	SD	2.90	2.52	2.40	0.11	30.3	0.07	3.00
	CV	8.10	13.10	14.90	1.30	14.3	6.70	19.40
2-200 cm (Field E-3)	Mean	29.40	13.30	16.10	8.60	161.0	0.83	36.80
	SD	4.40	3.00	1.90	0.10	23.4	0.13	11.00
	CV	15.00	22.20	11.70	1.10	14.5	15.70	29.90
3-200 cm (Field B-4)	Mean	34.20	19.00	15.10	8.40	234.0	0.96	25.20
	SD	3.60	2.70	2.40	0.12	33.8	0.11	10.40
	CV	10.60	14.30	15.90	1.40	14.4	11.50	41.20
4-200 cm (Field B-4)	Mean	34.00	18.40	15.50	8.50	162.0	0.89	29.10
	SD	3.60	3.00	2.10	0.14	16.3	0.07	6.50
	CV	10.60	16.10	13.60	1.60	10.0	7.90	22.30
2,000 cm (whole field)	Mean	32.60	14.10	18.50	8.80	176.0	0.92	26.30
	SD	6.70	4.30	3.74	0.12	53.4	0.20	10.50
	CV	20.60	30.80	20.20	1.40	30.3	21.70	40.10

Particle Size Analysis and Surface Area (Microtrac)

A Leeds and Northrup Co. "Microtrac" particle size analyzer (Model 7991-0) was used to evaluate particle size and specific surface area for all 900 soil samples. The instrument used was at the Southwest Rangeland Research Center in Tucson. The Microtrac analyzer uses a small angle, forward light scattering of a laser beam to measure soil particles with a diameter ranging from 2-176 μm. Results give percentage of each particle size in both a differential and cumulative form (Hawando et al., 1978). The distribution is expressed in 13 histogram channels, partitioning the fine and very fine sand into 4 of these segments and the silt into the other 9. The microcomputer prints a number of parameters including the volume mean diameter in microns and the specific surface of the sample. The specific surface value is given as m^2/cm^3 and is not identical to the physical surface area measured by polar retention. For preparation, about 4 g of dry soil was wet sieved through a 180 μm sieve. One ml of a mixture of Na-pyrophosphate (53.52 g/L) and Na-carbonate (4.24 g/L) was added to each gram of soil as dispersing agent. The soil suspension was dispersed by an ultrasonic mixer (Sonifier Cell Disruptor Model 350) for 2 minutes. After that, the soil suspension was transferred to the Microtrac, and the results displayed on a LED readout. A digital printer recorded the data.

The experimental mean, standard deviation, and coefficients of variation were evaluated and are given in Table 1. The results of volume mean diameter expressed in μm and specific surface expressed as m^2/cm^3 are given in Appendix A for all 900 soil samples. The coefficients of variation for volume mean diameter were 8.0-23.5%, 19.4-41.2%, and 40.1% at 20-, 200-, and 2,000-cm spacing, respectively (see Table 1). The specific surface showed CVs of 6.4-7.9%, 6.7-15.7%, and 21.7% at 20-,200-, and 2,000-cm spacing, respectively.

Soil pH (1:5 Soil-Water Suspension)

The pH for a 1:5 soil-water suspension was measured for all 900 soil samples. For the extract, 250 ml of distilled water was added to a 50-g air-dried soil, and left to shake for 1 hour in a mechanical shaker. A pH meter (Model 5996, Horizon Ecology Company) was used to measure pH for the 1:5 suspension following procedures outlined by Peech (1965).

The experimental mean, standard deviation, and coefficients of variation were evaluated and are given in Table 1. The results of soil pH for all 900 soil samples are given in Appendix A. The coefficients of variation at 20-,200-, and 2,000-cm spacing were 1.1-2.3%, 1.1-1.6%, and 1.4%, respectively. Soil pH showed the lowest coefficients of variation of any of the measurments made.

Soluble Salts by Electrical Conductivity (1:5 Soil-water Extract

A conductivity meter (Model 1484, Horizon Ecology Company) was used to measure the electrical conductivity (EC) for a 1:5 soil-water extract for all 900 soil samples. The soil-water suspension used for pH measurements was extracted, and the EC measured for all the samples following procedures outlined by Bower and Wilcox (1965).

The experimental mean, standard deviation, and coefficients of variation are given in Table 1. The results of the EC expressed as μmhos/cm at 25°C for all 900 soil samples are given in Appendix A. The coefficients of variation of the EC at 20-, 200-, and 2,000-cm spacings were 8.5-21.2%, 10.0-14.5%, and 30.3%, respectively.

Bulk Density and Moisture Content in the Field

The bulk density (g/cm^3) and moisture content in the field 7 days after irrigation (g/g) were evaluated for 200 soil samples taken from Transects 3-20 cm and 2-200 cm, Field B-4. The Oakfield probe was favored over an "undisturbed" core for expediency and because the variability of measurement is relatively small. The bulk volume of soil taken from each site was 69 cm^3 for a diameter of 2 cm and length of 22 cm.

The experimental mean standard deviation and coefficients of variation are given in Table 2. The raw data

Table 2. Experimental Mean, Standard Deviations, and Coefficients of Variation for Bulk Density and Moisture Content in the Field (7 days after Irrigation), and Percentage of Sand, Silt, and Clay

Transect Number	Value Labeled	Bulk Density (g/cm^3)	Moisture Content (g/g)	Sand (%)	Silt (%)	Clay (%)
3-20 cm (Field B-4)	Mean	1.38	14.70	17.3	50.9	31.8
	SD	0.20	2.40	5.5	9.4	5.2
	CV	14.50	16.30	31.8	18.5	16.4
3-200 cm (Field B-4)	Mean	1.25	20.70	---	---	---
	SD	0.10	4.90	---	---	---
	CV	8.00	23.70	---	---	---

of bulk density in g/cm^3 and moisture content in the field 7 days after irrigation in g/g are given in Appendix A. The CVs for bulk density at 20- and 200-cm spacings were found to be 14.5% and 8.0%, respectively. The moisture content in the field 7 days after irrigation showed coefficients of variation of 16.3% and 23.7% at 20- and 200-cm spacing, respectively.

Soil Particle Analysis (Hydrometer)

A standard hydrometer (152H-68°F) was used to determine the particle size analysis of 100 soil samples from Transect 3-20 cm, Field B-4. Sodium-pyrophosphate was used as a dispersing agent (50 g/l). Readings were taken at 0.5, 1, 3, 10, 90, and 720 minutes (Day, 1965) with sand, silt, and clay defined using the USDA classification scheme.

The experimental mean, standard deviation, and coefficients of variation are given in Table 2. The CVs for percentage of sand, silt, and clay found were 31.8%, 18.5%, and 16.4%, respectively. The results of particle size analysis expressed as percentage of sand, silt, and clay of 100 sites at 20-cm spacings are given in Appendix A.

Precision of Determination

Replicated measurements for 0.1- and 15-bar water content, pH, EC, and percentage of sand, silt, and clay were conducted to evaluate laboratory errors and determine precision of measurements. The replicates were taken by splitting samples.

For 0.1-bar water content, 6 plates were used to determine the moisture content of 6 replicates of each of two different samples and repeated for two different dates. The mean, standard deviation, and coefficients of variation of each sample were evaluated (Table 3). A coefficient of variability was found within the range of 1.3-2.0% and 1.4-2.2% for sample 1 and sample 2, respectively. We can test for significance in the mean values for the two dates of comparison using a "t" statistic (Miller and Freund, 1977, pp. 218-219):

$$t = \frac{|\bar{x}_1 - \bar{x}_2| - \delta}{\sqrt{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}} \sqrt{\frac{n_1 n_2 (n_1 + n_2 - 2)}{n_1 + n_2}}$$

For our results of Sample 1, 1.1-bar water $\bar{x}_1 = 34.75$, $\bar{x}_2 = 35.82$, $s_1 = 0.7$, $s_2 = 0.46$, $n_1 = n_2 = 6$ and we test $\delta = 0$ or no difference in the mean. The result is

$$t = \frac{|34.75 - 35.82|}{\sqrt{(5)(0.7)^2 + (5)(0.46)^2}} \sqrt{\frac{36(10)}{12}} = 3.13$$

Table 3. 0.1-bar Water Content--Replicated Measurements

Plate Number	Sample 1		Sample 2	
	9-12-79	9-13-79	9-12-79	9-13-79
	Percentage			
11375	35.17	35.70	32.99	35.00
2976	35.18	35.60	32.94	34.40
3229	34.66	35.60	32.55	33.75
3230	35.11	36.10	34.43	33.90
3231	33.37	35.30	33.14	34.40
3226	34.98	36.60	32.40	34.70
Mean	34.75	35.82	33.08	34.36
SD	0.70	0.46	0.72	0.47
CV	2.00	1.30	2.20	1.40

For $\alpha = 0.01$, t from the table for $n_1 + n_2 - 2$ degrees of freedom is t = 3.17. Thus, the null hypothesis that the means are the same is rejected at the 1% probability level.

Thus, we expect some difference due to the plates and dates of running. All 6 plates were used in 0.1-bar moisture analysis and the procedure standardized insofar as practical.

For 15-bar water replicated measurements, 6 plates were also used to measure the moisture content of 6 replicates of each of 2 samples at 2 different dates. The mean standard deviation and CVs were evaluated for each case and are given in Table 4. The coefficients of variability were found to be within the range of 6.8-7.2% and 9.0-9.5% for Sample 1 and Sample 2, respectively. Three plates were selected out of the 6 plates: Nos. 9161, 9349, and 9355.

Replicated measurements were also conducted for pH and EC. Five replicates of one sample were used to determine pH in 1:5 soil water suspension and EC in 1:5 soil water extract at 2 different dates. Mean, standard deviation, and CV were evaluated for each variable at each time (Table 5). The CV was found to be within the range of 0.4-0.5% and 1.6-2.7% for pH and EC, respectively.

The replicated measurements were also conducted for percentages of sand, silt, and clay. Four replicates of

Table 4. 15-bar Water Content--Replicated Measurements

Plate Number	Sample 1		Sample 2	
	9-18-79	9-24-79	9-18-79	9-24-79
	Percentage			
9161	13.00	13.30	11.40	12.20
9315	12.70	16.00	11.50	15.00
9316	11.50	14.40	11.10	13.60
9346	12.80	16.20	12.40	15.40
9349	13.70	13.40	13.10	12.80
9355	11.30	13.90	11.10	13.10
Mean	12.50	14.50	11.80	13.70
SD	0.90	1.30	0.80	1.30
CV	7.20	9.00	6.80	9.50

Table 5. Replicated Measurements for pH and EC (1:5 Soil Water)

Replicate Number	pH of 1:5 Suspension		pH of 1:5 Extract		EC of 1:5 Extract	
	10-1-79	10-11-79	10-1-79	10-11-79	10-1-79	10-11-79
1	8.65	8.7	7.9	7.3	310	270
2	8.65	8.7	8.2	7.2	330	280
3	8.65	8.7	8.3	7.6	330	270
4	8.60	8.7	8.2	7.5	330	275
5	8.70	8.8	8.2	7.1	325	270
Mean	8.65	8.72	8.16	7.34	325	273
SD	0.035	0.045	0.152	0.207	8.66	4.47
CV	0.4%	0.5%	1.9%	2.8%	2.7%	1.6%

each of 3 sites were used to determine percentages of sand, silt, and clay by hydrometer. Mean, standard deviation, and coefficients of variation were evaluated (Table 6). The CV was found to be within the range of 3.9-16.4%, 1.1-1.7%, and 3.5-6.8% for percentages of sand, silt, and clay, respectively.

Table 6. Replicated Measurements for Percentages of Sand, Silt, and Clay by Hydrometer

Replicates	Sand	Silt	Clay
	Percentage		
	Sample 1 at 280-cm Spacings		
1	30.0	37.3	32.7
2	27.0	37.3	35.3
3	28.0	36.7	35.3
4	28.0	36.7	35.3
Mean	28.2	37.0	34.7
SD	1.3	0.4	1.3
CV	4.6	1.0	3.8
	Sample 2 at 1,060-cm Spacings		
1	13.0	54.2	32.8
2	13.0	54.2	32.8
3	12.0	53.8	34.2
4	13.0	55.6	31.4
Mean	12.8	54.5	32.8
SD	0.5	0.8	1.1
CV	3.9	1.5	3.5
	Sample 3 at 1,580-cm Spacings		
1	12.0	52.8	35.2
2	12.0	55.4	32.6
3	16.0	52.7	31.3
4	16.0	54.0	30.0
Mean	14.0	53.7	32.3
SD	2.3	1.3	2.2
CV	16.4	2.4	6.8

CHAPTER 5

AUTOCORRELATION

We expect measurements made close together in the field to be approximately the same value, while measurements farther apart differ considerably. This is an example of spatial dependence and can be quantified using an autocorrelogram, or semivariogram, to be defined shortly. To assume samples are interrelated in terms of their separation distance is counter to the underlying assumptions of many conventional statistical analyses for which sample values are assumed independent of each other. Methodology for dealing with such spatially dependent systems has been developed extensively in mining engineering, particularly in France and South Africa (Journel and Huijbregts, 1978).

By definition, the autocorrelation r_k is

$$r_k = C_k/s^2 \qquad [1]$$

where C_k is the estimated covariance of sample values k "lags" apart

$$C_k = \left(\frac{1}{n-k-1}\right) \sum_{i=1}^{n-k} (x_i - s)(x_{i+k} - s) \qquad [2]$$

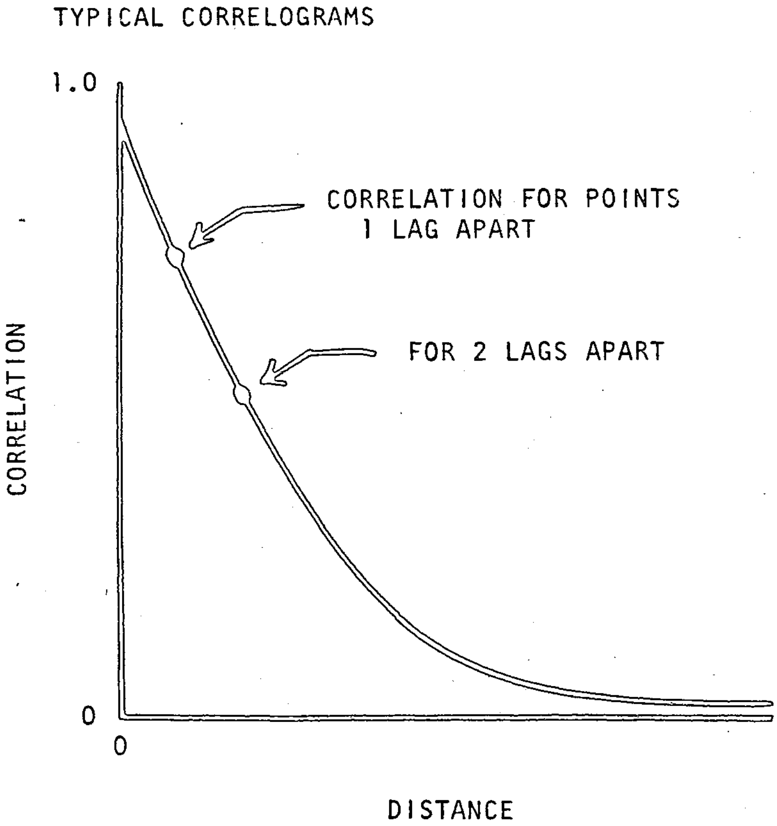
with s^2 the estimated population variance

$$s^2 = C_0 = \left(\frac{1}{n - 1}\right) \sum_{i=1}^{n} (x_i - \bar{x})^2 \qquad [3]$$

and x_i the parameter value from 1 to n.

The autocorrelogram is a plot of r_k as a function of distance or the lag k (Figure 3). The maximum value is 1 at zero lag (k = 0) and the values tend to decrease with increasing k. In fact, when k = 0, C_k reduces to s^2, giving the autocorrelation $r_0 = 1$. When k = 1, and points 1, 2, . . ., n are evenly spaced, we correlate x_1 with x_2, x_2 with x_3, . . ., x_{n-1} with x_n. For k = 2, we correlate x_1 with x_3, x_2 with x_4, . . ., x_{n-2} with x_n.

Some other possible types of correlograms are shown as Figure 4. The distribution may be "typical" (Figure 4A), independent (Figure 4B), dependent over long range (Figure 4C), or cyclic (Figure 4D). In case of the typical distribution, the autocorrelation decreases gradually with increase of lags and approaches zero. In case of the independent distribution, the autocorrelation decreases sharply from 1.0 to zero within the first lag. In case of the dependent distribution, the autocorrelation decreases slowly and approaches zero only over a long range. Finally, the cyclic distribution shows a decrease in autocorrelation with increase of lags until it gives negative



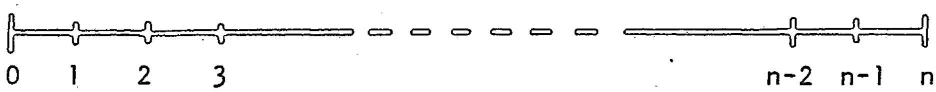


Figure 3. Autocorrelation plot of r_k as a function of lag k

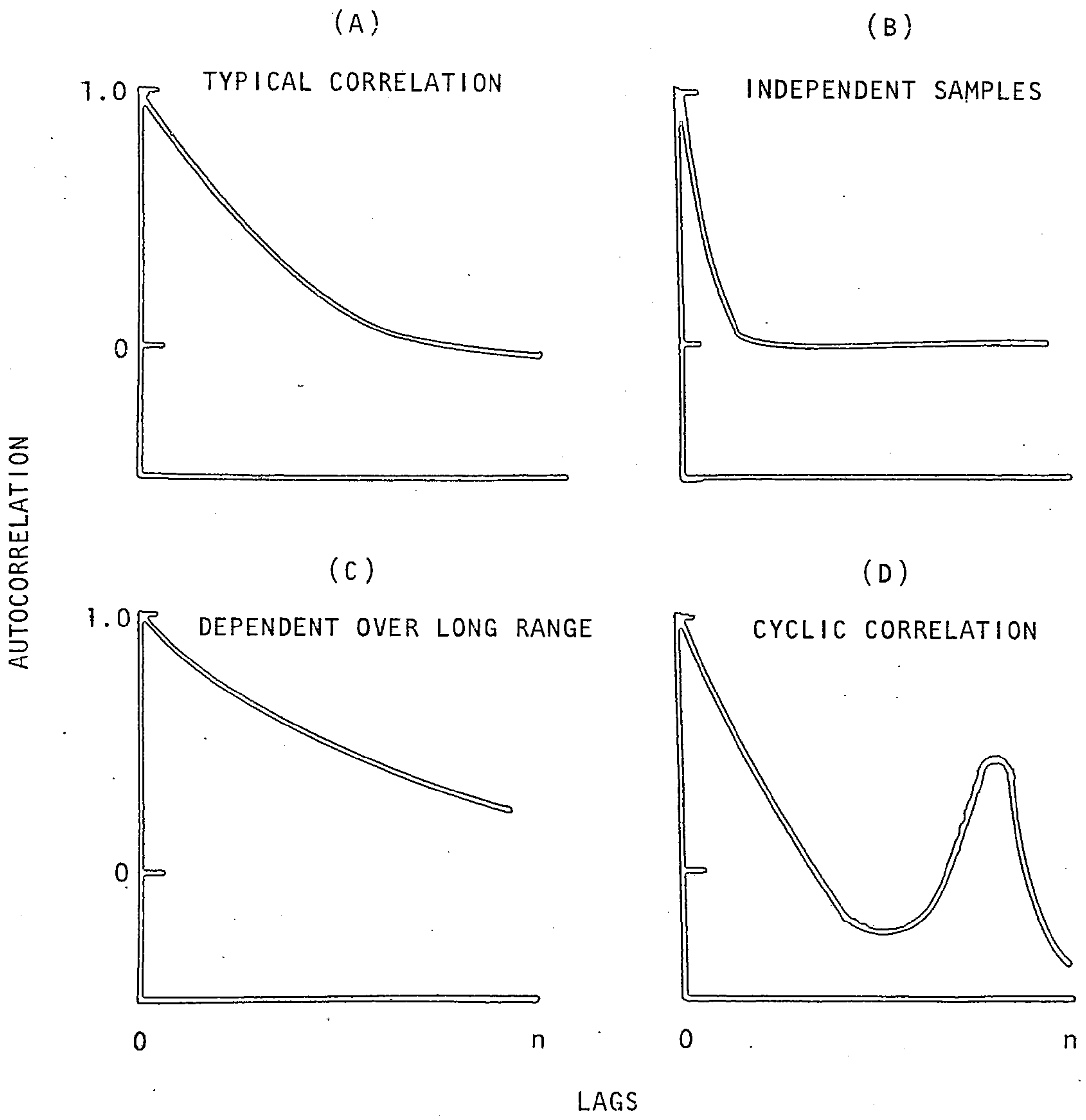


Figure 4. Different types of correlations

values and then increases and decreases with further increase of lags.

We now examine the development of a correlogram using the 100 samples collected on a straight line from the 20-cm spacing of Transect 1, Field C-2. We examine the water content retained at 0.1-bar tension values arranged in order of collection from left to right (Table 7). They have a maximum value of 43% and a minimum of 29%. The experimental mean, standard deviation, and coefficient of variation are 35, 2.8, and 8%, respectively. The 100 values are plotted in Figure 5. There are more large values toward the left section, smaller values in the middle, and somewhat larger values toward the end.

Autocorrelation coefficients r_k were evaluated using Equation [1] and are given in Table 8. A plot of the autocorrelation is given in Figure 6. The maximum is 1 at zero lag (k = 0) and the values tend to decrease for larger lags. Figure 6 indicates that the values are indeed correlated over space. If the samples were independent, the autocorrelation values should be all zero, but this was not the case.

Correlograms were prepared for the 70 transect-parameter combinations. We first examine results of 0.1-bar and 15-bar water in Figure 7 for Transects 3-20, 3-200, and the 2,000-cm transect. For both 0.1 and 15 bar, Transect 3-20 shows a rather erratic pattern--in fact, nearly

Table 7. Sequence of 100 Values for Percentage of Water (g/g) Retained 0.1 Bar. -- Samples were at 50-cm depth, 20-cm apart on Pima Clay Loam, Transect 1.

Values are ordered left to right

37.5	37.6	36.7	39.0	35.0	36.0	36.8	36.5
37.1	36.6	37.9	38.8	40.0	40.6	37.6	38.7
37.9	42.1	35.9	38.0	38.5	38.3	37.4	37.1
41.8	37.2	35.4	39.1	35.3	34.0	39.0	35.5
35.0	35.7	35.1	34.1	34.0	34.7	34.2	35.2
31.7	30.7	32.7	33.7	35.3	32.6	33.5	31.4
30.9	31.4	35.5	34.2	32.5	30.5	28.9	33.0
30.0	31.7	32.0	30.9	42.8	31.0	34.3	31.2
30.9	31.7	32.9	32.1	32.8	32.2	34.4	32.2
32.2	32.4	33.3	34.3	31.8	36.9	33.9	35.2
36.4	34.7	38.9	35.0	35.6	36.9	35.3	36.4
33.7	34.2	30.9	34.3	33.2	35.3	35.6	35.1
34.4	34.0	33.6	36.6				

Table 8. Autocorrelation Coefficients for 0.1 bar Water Data of Table 7

Lag Position	Autocorrelation Coefficient	Lag Position	Autocorrelation Coefficient
0	1.00	14	.35
1	.52	15	.28
2	.58	16	.25
3	.54	17	.30
4	.45	18	.15
5	.55	19	.14
6	.47	20	.13
7	.53	21	.06
8	.47	22	.14
9	.44	23	0
10	.49	24	-.01
11	.38	25	-.03
12	.40		
13	.31		

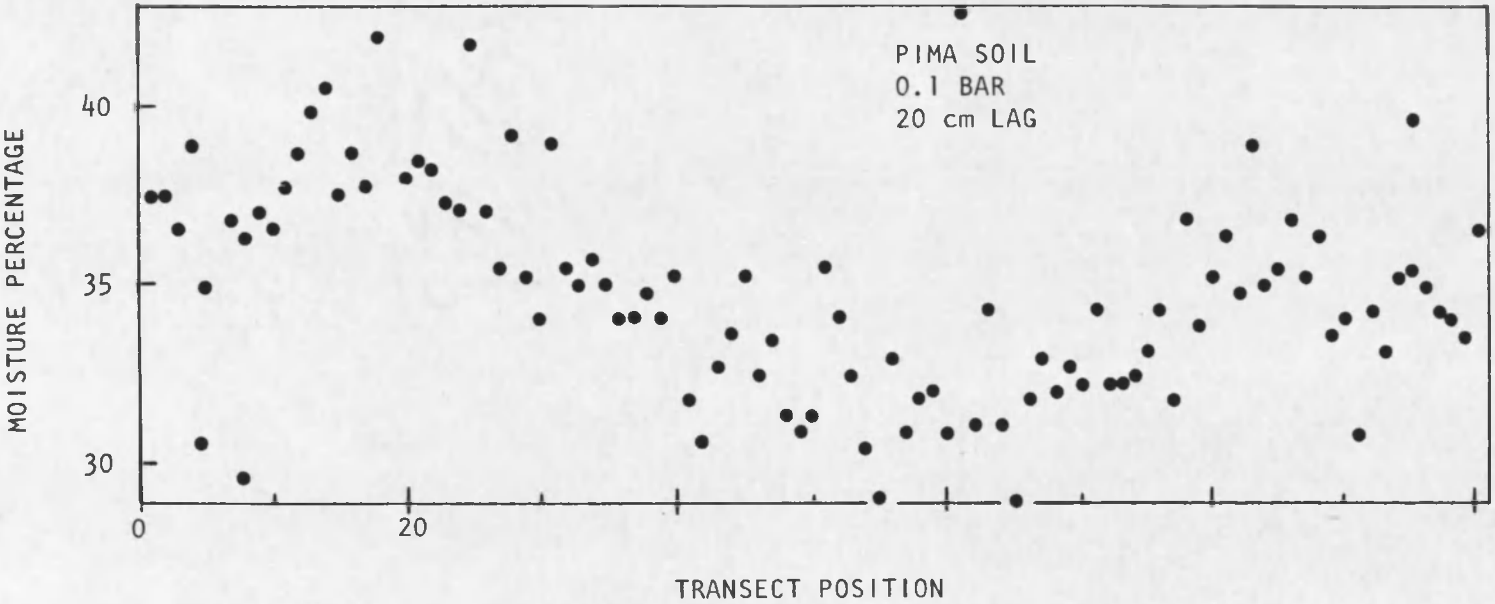


Figure 5. Plot of 0.1-bar water of Pima clay loam

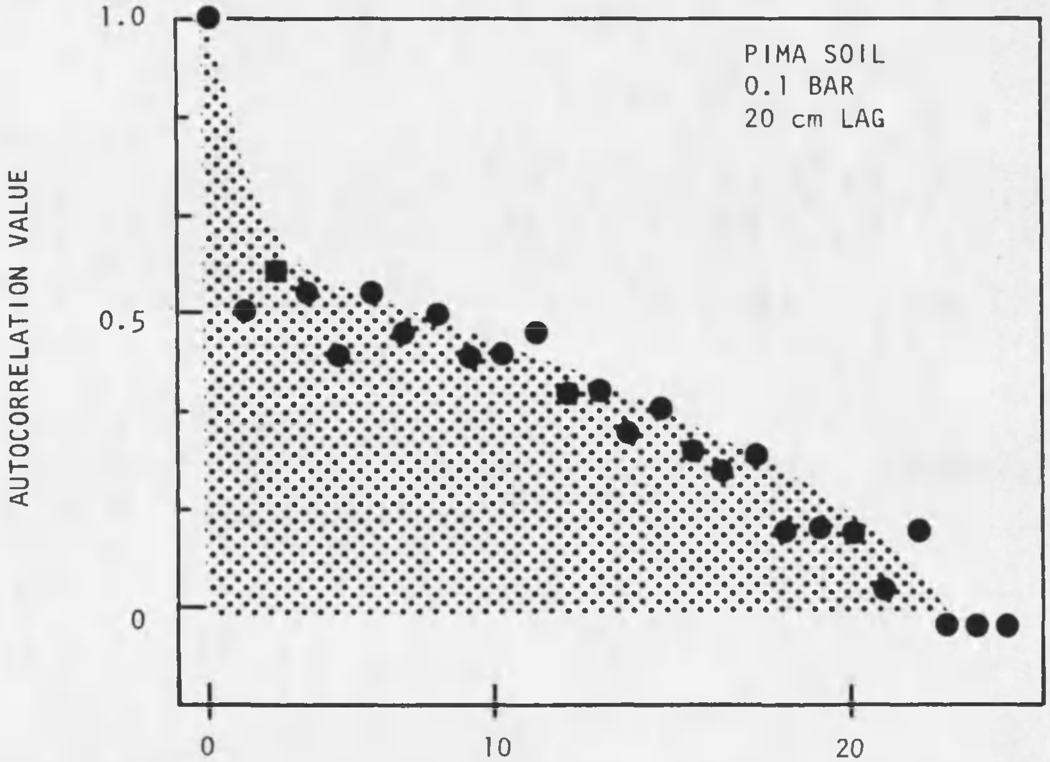


Figure 6. Autocorrelation for 0.1-bar water of Pima clay loam

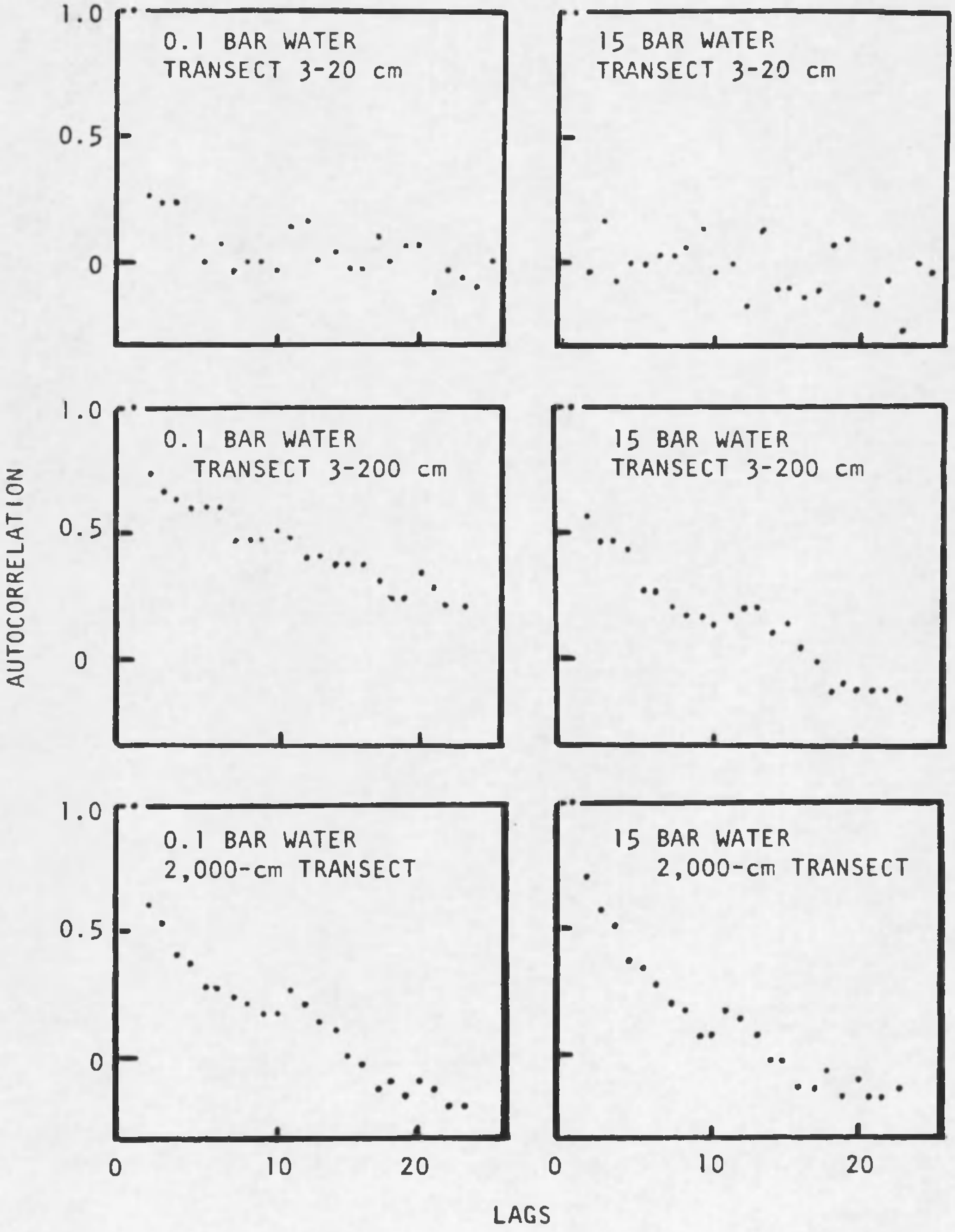


Figure 7. Autocorrelation for 0.1- and 15-bar water at 20-, 200-, and 2,000-cm intervals

random--which is considerably different from the 1-20-cm transect of Figure 6. For the large transects, however, the results apparently are correlated. The 0.1 bar results for the 3-200-cm transect are considerably above zero even at 20 lags, indicative of a long correlation length similar to Figure 4C. The last 3 figures are more like Figure 4A.

The results of available water (0.1-15 bar) for the same 3-20-, 3-200-, and the 2,000-cm transects are given in Figure 8. The available water results for the 3-20-cm transect showed a random pattern similar to that shown in Figure 4B. The results for the 3-200-cm transect is considerably above zero even at 23 lags, which is indicative of a long correlation similar to that shown in Figure 4C. The results for the 2,000-cm transect correlated similar to our typical example in Figure 4A.

The results of pH and EC are given in Figure 9 for the same 3-20-, 3-200-, and the 2,000-cm transects. Except for the 2,000-cm transect of EC, all plots are similar to the typical example given in Figure 4A. The EC results for the 2,000-cm transect appear to be randomly related.

We also examine the results of the mean diameter and surface area (Microtrac) in Figure 10. Mean diameter results for the 3-20-cm, 3-200-cm, and 3-2,000-cm transects are correlated the same as the example in Figure 5. Surface area results for the 3-20-cm transect are a bit more

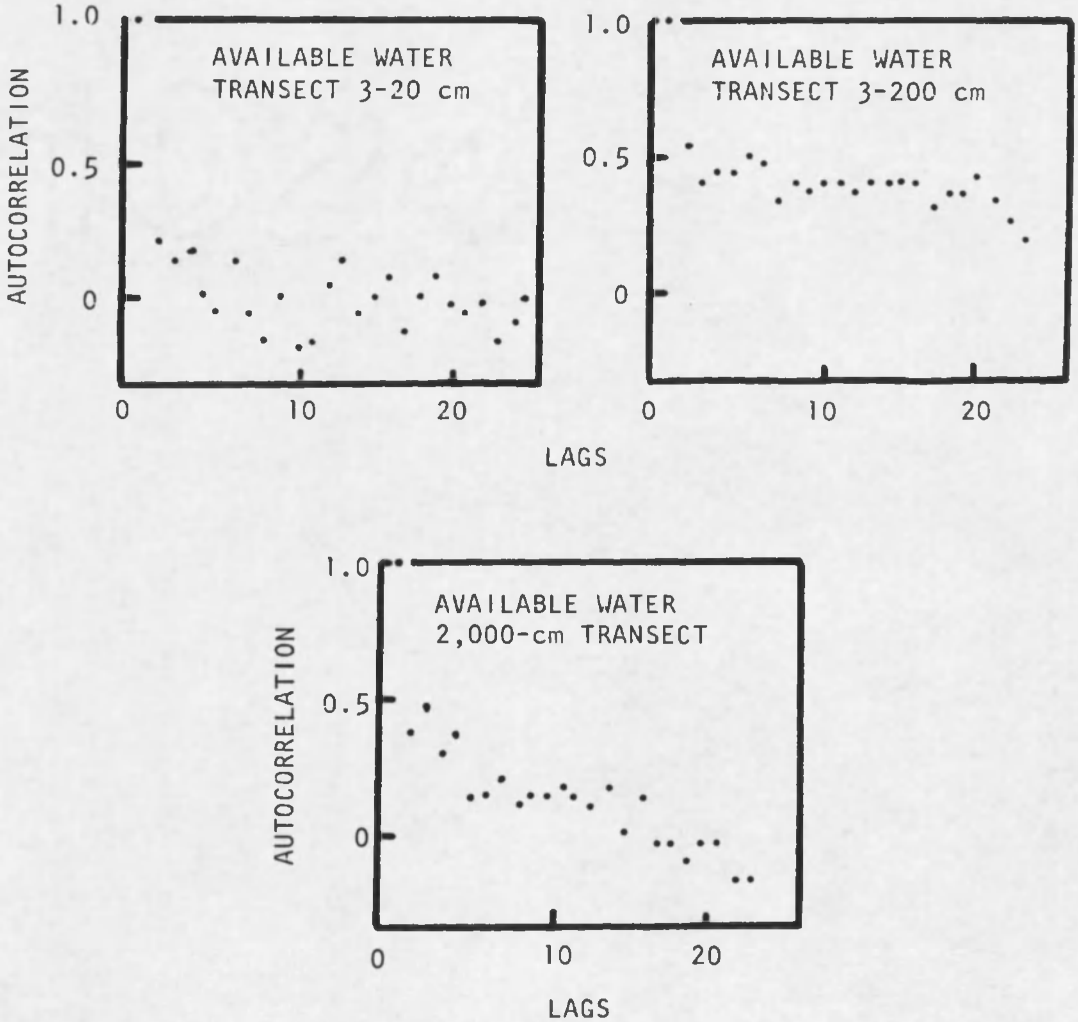


Figure 8. Autocorrelation for available water at 20-, 200-, and 2,000-cm intervals

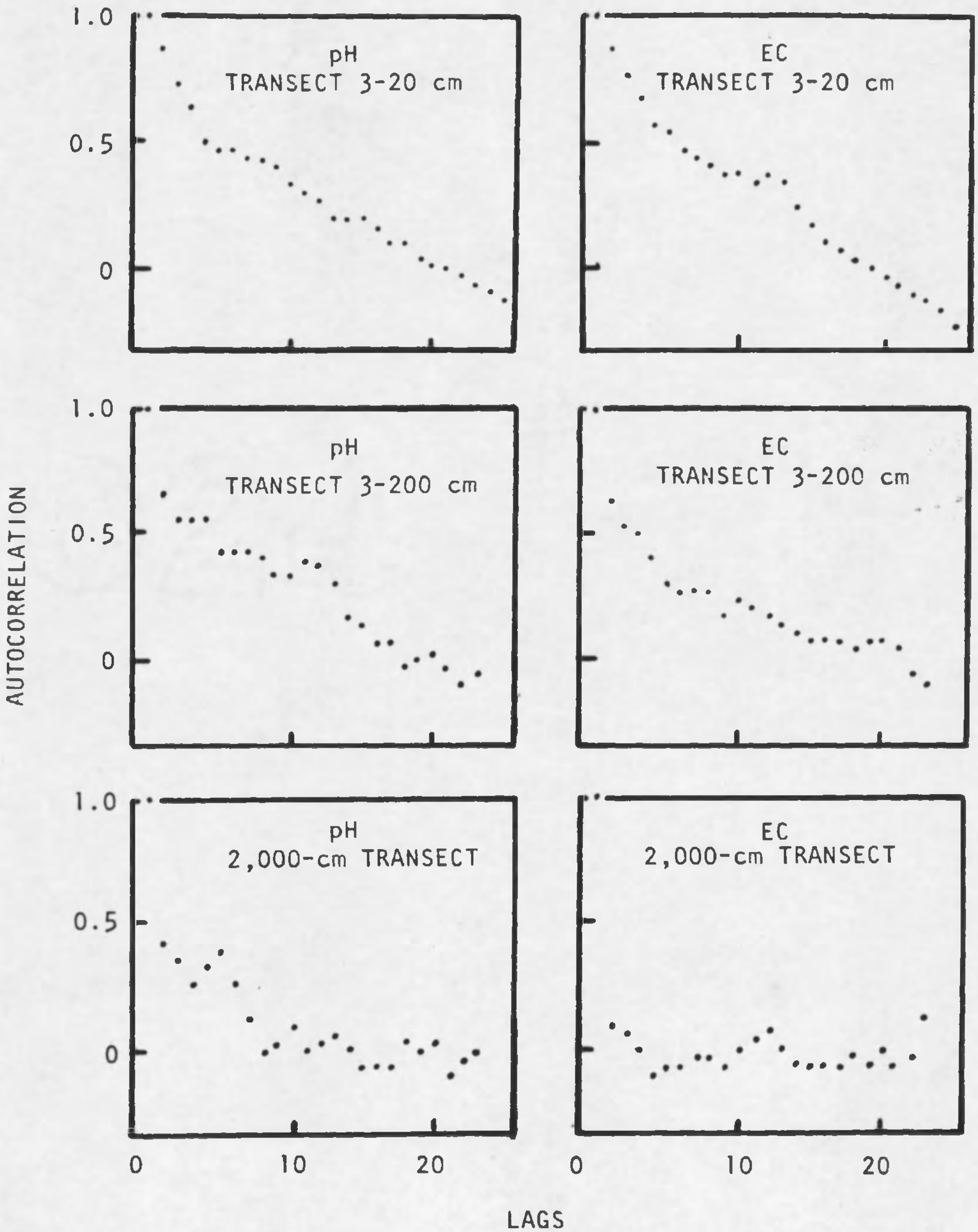


Figure 9. Autocorrelation for pH and EC at 20-, 200-, and 2,000-cm intervals

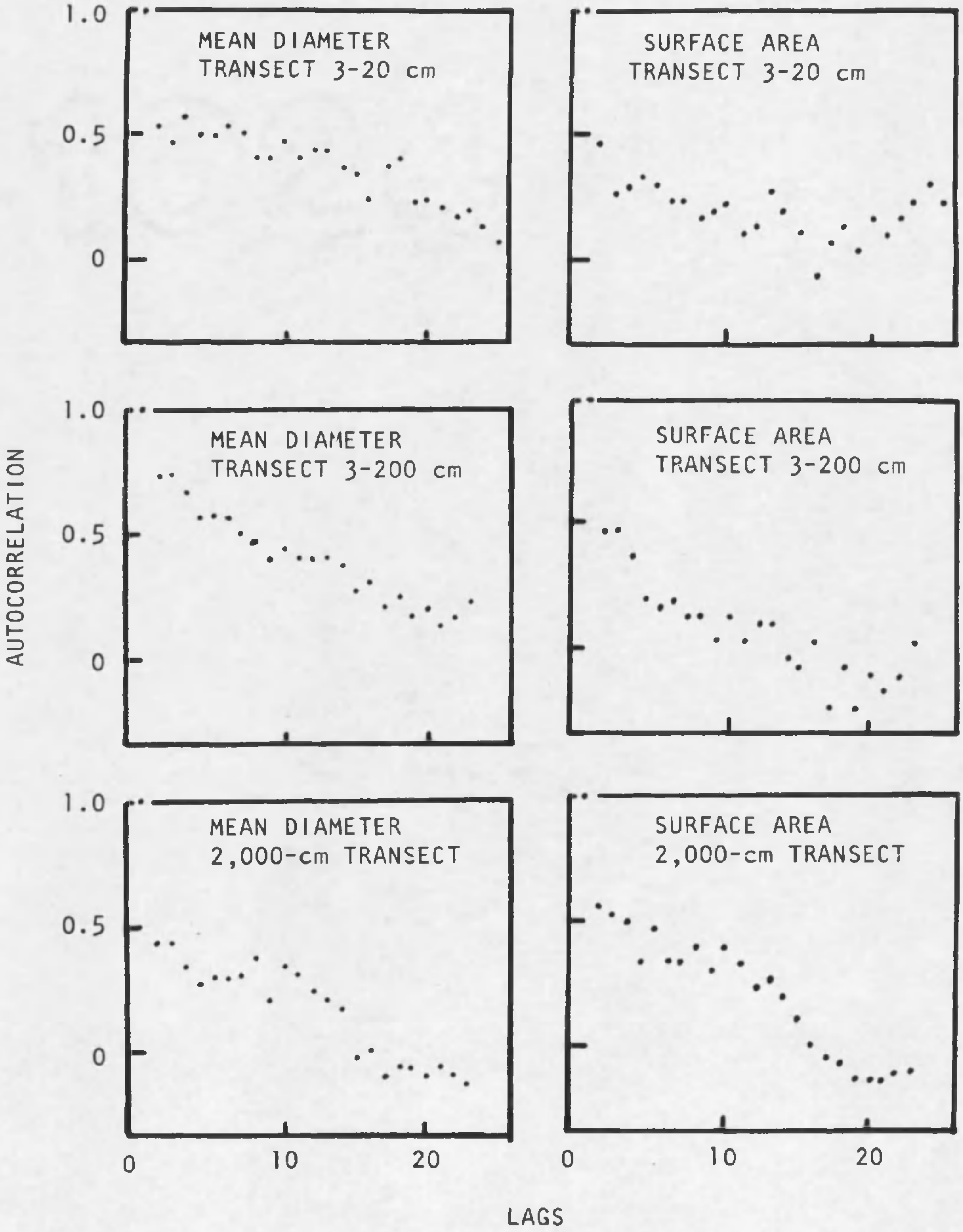


Figure 10. Autocorrelation for mean diameter and surface area (Microtrac) at 20-, 200-, and 2,000-cm intervals

erratic. The surface area results for the other two transects apparently are correlated similar to the example shown in Figure 4A.

For bulk density and moisture content in the field 7 days after irrigation, the results are examined in Figure 11 for the 3-20-cm and 3-200-cm transects. The bulk density and the moisture content results for the 3-20-cm transect are correlated in the same manner of the example given in Figure 6, and is similar to that in Figure 4A. The bulk density results for the 3-200-cm transect indicate a random pattern similar to Figure 4B. The moisture content results for the 3-200-cm transect are considerably above zero even at 23 lags, indicative of a long correlation similar to that presented in Figure 4C.

Finally, the results of sand, silt, and clay percentages for the 3-20-cm transect are examined in Figure 12. The results of the 3 parameters for the 3-20-cm transect are considerably above zero even at 25 lags--indicative of a long correlation similar to that shown in Figure 4C.

Correlograms for the rest of the 70 transect-parameter combinations are given in Appendix C. In Table 9 we summarize all of the results in terms of type of distribution. Of the total 70 transects, we have 30 of Type A, 11 of Type B, 15 of Type C, and 14 which we label as not clearly any of the common types. Although several

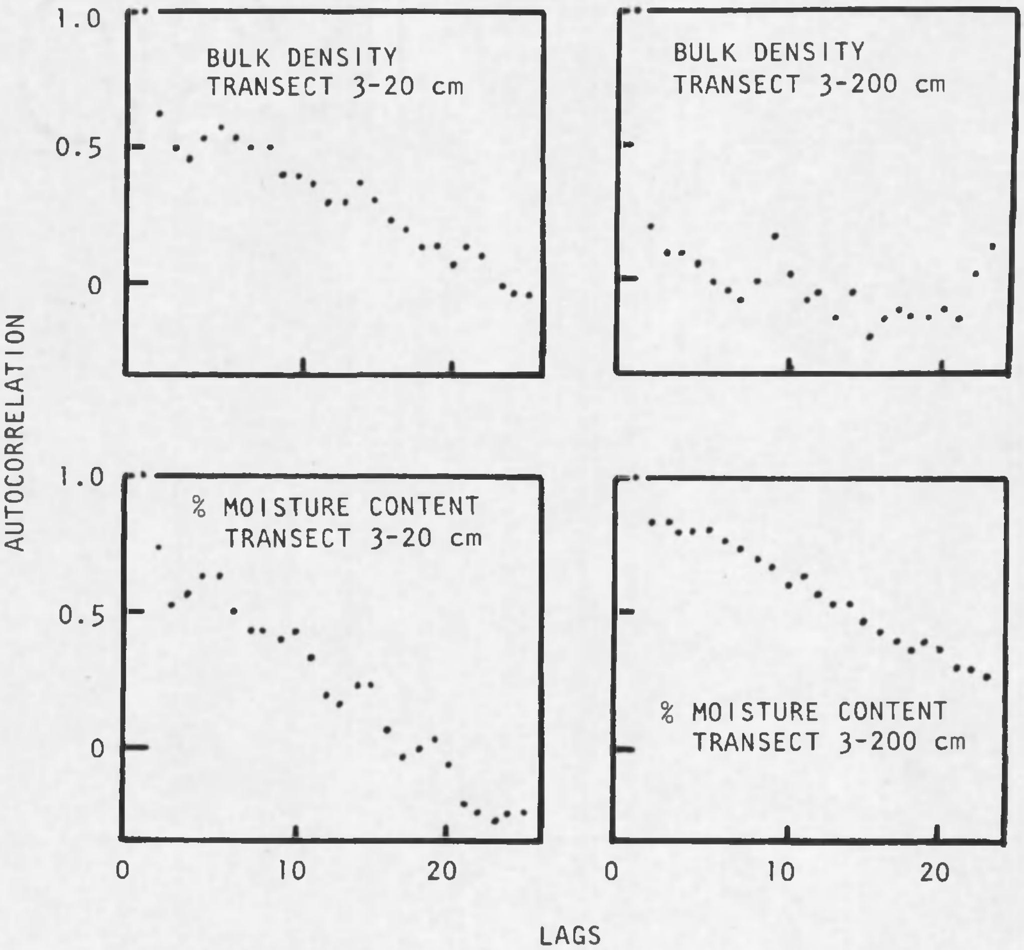


Figure 11. Autocorrelation for bulk density and moisture content 7 days after irrigation at 20- and 200-cm intervals

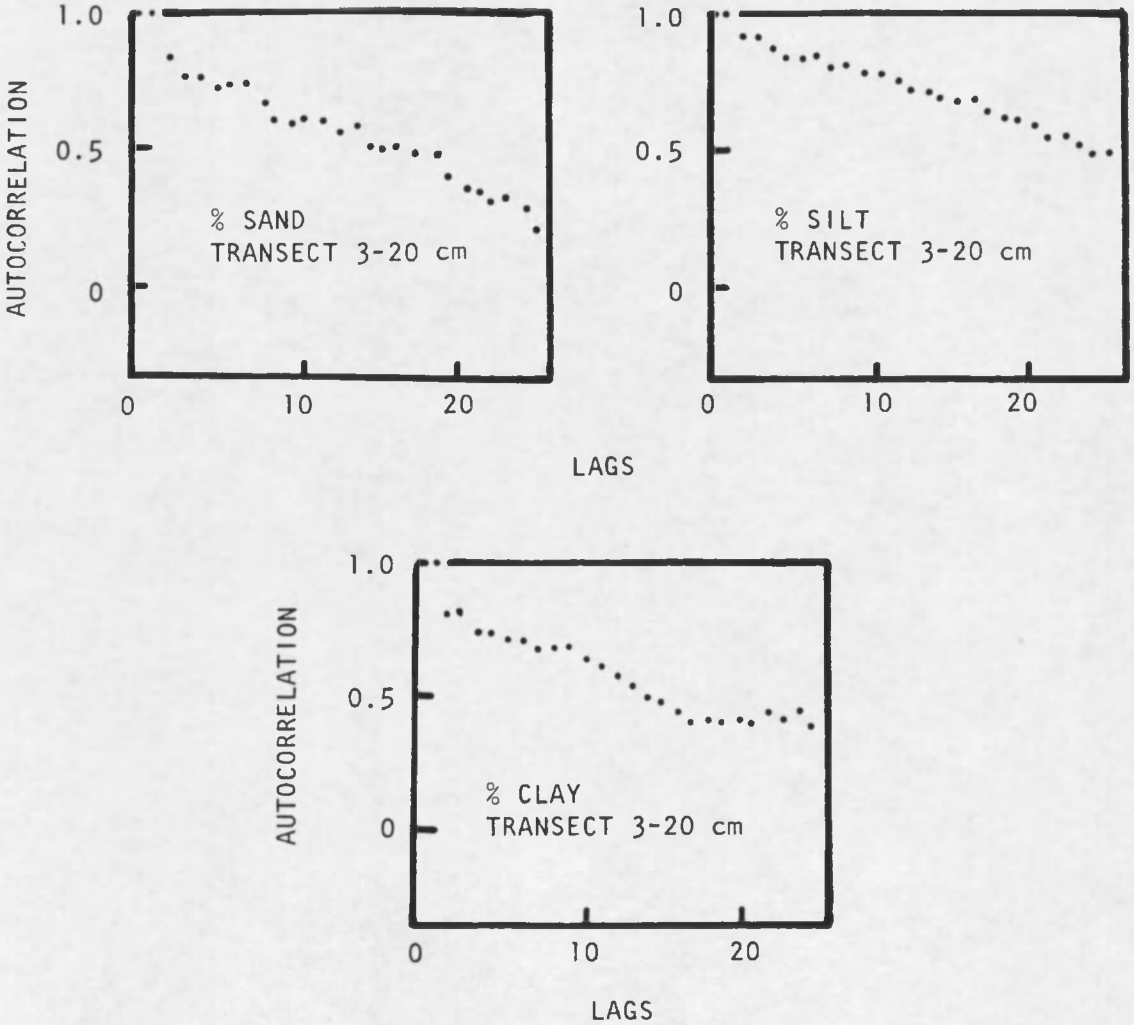


Figure 12. Autocorrelation for percentages of sand, silt, and clay at 20-cm intervals

Table 9. Type of Distribution, Z-values at 10 and 20 Lags, Zone of Influence (cm), and Integral Scale (cm)

Parameter	Type of Distri-bution	Z_{10}	Z_{20}	Zone of** Influence (cm)	Integral*** Scale (cm)
		Transect 1-20-cm Intervals, Field C-2			
0.1 bar	A	4.56*	1.16	350	158
15 bar	A	1.04	1.07	170	88
Available Water	C	5.03*	2.24*	>400	>214
Surface Area	A	1.33	0.72	140	70
Mean Diameter	A	0.38	0.27	120	50
pH	A	0.85	0.89	160	77
EC	B	2.09*	2.68*	0	27
		Transect 2-20-cm Intervals, Field E-3			
0.1 bar	Indefinite	2.47*	0.45	100	38
15 bar	Indefinite	0.76	0.45	60	27
Available Water	B	1.04	0.09	20	14
Surface Area	A	1.90*	0.09	60	61
Mean Diameter	A	3.42*	0.54	80	83
pH	Indefinite	0.76	2.50*	120	62
EC	Indefinite	0.95	0.18	120	57
		Transect 3-20-cm Intervals, Field B-4			
0.1 bar	B	0.28	0.80	60	28
15 bar	B	0.19	0.89	0	21
Available Water	B	1.80*	0.27	20	24
Surface Area	Indefinite	2.28*	1.61	160	82
Mean Diameter	C	4.46*	2.24*	400	>153
pH	A	3.42*	0.18	260	141
EC	A	3.51	0.09	300	143
Bulk Density	A	3.98*	0.89	340	153
Moisture Content	A	4.08*	0.54	240	138
Clay	C	5.98*	3.67*	>500	>276
Silt	C	7.40*	5.28*	>500	>352
Sand	C	5.90*	3.49*	>500	>284

*Significant at 95% level
**See Equation 4
***See Equation 5

Table 9. -- Continued

Parameter	Type of Distri-bution	Z_{10}	Z_{20}	Zone of Influence (cm)	Integral Scale (cm)
		Transect 4-20-cm Intervals, Field B-4			
0.1 bar	B	4.27*	3.04*	0	56
15 bar	Indefinite	0.00	2.06*	0	33
Available Water	Indefinite	0.10	1.43	0	25
Surface Area	Indefinite	0.66	1.52	0	38
Mean Diameter	Indefinite	3.32*	2.77*	0	54
pH	B	0.47	0.54	40	39
EC	A	0.38	1.25	40	26
		Transect 1-200-cm Intervals, Field C-2			
0.1 bar	Indefinite	0.00	1.65*	1,000	505
15 bar	C	2.74*	1.65*	4,000	>1,319
Available Water	Indefinite	0.62	0.5	200	269
Surface Area	A	0.09	0.33	400	325
Mean Diameter	B	0.79	0.91	0	289
pH	A	0.79	0.33	1,200	562
EC	Indefinite	0.79	1.32	1,600	954
		Transect 2-200-cm Intervals, Field E-3			
0.1 bar	C	5.16*	1.68*	4,000	>2,300
15 bar	A	4.99*	1.04	3,600	>2,030
Available Water	C	3.10*	1.20	3,400	>1,690
Surface Area	A	4.40*	0.64	2,800	1,775
Mean Diameter	A	4.04*	0.48	2,600	1,653
pH	A	1.38	1.12	1,400	582
EC	C	4.90*	2.64*	>4,000	2,098

Table 9. -- Continued

Parameter	Type of Distri-bution	Z_{10}	Z_{20}	Zone of Influence (cm)	Integral Scale (cm)
		Transect 3-200-cm Intervals, Field B-4			
0.1 bar	C	4.67*	2.92*	>4,600	>1,980
15 bar	A	1.37	0.95	1,400	>1,100
Available Water	C	3.94*	3.96*	>4,600	>1,970
Surface Area	A	1.37	0.77	800	615
Mean Diameter	C	4.03*	1.81*	>4,600	>1,830
pH	A	3.30*	0.26	2,800	1,340
EC	A	2.20*	0.77	1,800	996
Bulk Density	B	0.64	0.86	200	121
Moisture Content %	C	5.77*	3.27*	>4,600	>2,800
		Transect 4-200-cm Intervals, Field B-4			
0.1 bar	C	4.15*	2.94*	>4,000	>1,820
15 bar	C	4.43*	3.46*	>4,000	>2,270
Available Water	Indefinite	0.28	1.13	0	687
Surface Area	B	0.55	0.95	200	169
Mean Diameter	A	0.46	0.43	600	241
pH	A	3.32*	0.43	3,200	1,270
EC	Indefinite	1.30	1.30	600	462
		Transect 2000,cm Intervals, Whole Field			
0.1 bar	A	1.84*	0.78	16,000	8,030
15 bar	A	0.74	0.87	15,000	7,510
Available Water	A	1.48	0.17	12,000	7,960
Surface Area	A	3.78*	1.04	28,000	12,655
Mean Diameter	A	3.32*	0.87	26,000	7,713
pH	A	1.01	0.35	13,000	6,187
EC	B	0.18	0.17	2,000	723

correlograms showed some negative values and even showed signs of cycling, we did not judge any to be of the cyclic type (Figure 4D).

Zone of Influence

Questions naturally arise as to whether the autocorrelation is significantly greater than zero and, if so, over what length the dependence exists. With regard to the first question, a conservative test for the hypothesis that an autocorrelation r_k is zero is to use the statistic (Davis, 1973, p. 236),

$$Z_k = |r_k|\sqrt{n - k} \qquad [4]$$

where n is the length of the sequence and k the lag. The value for Z_k is calculated and compared to the tabulated, one-tailed normal deviate. Thus, at a 5% probability level the tabulated value $Z^*_{.05} = 1.645$ would be compared against Z_k, above. If Z_k is greater than 1.645, we reject the null hypothesis and accept the hypothesis that the correlation is greater than zero at a lag of k. If less than 1.645, we accept the hypothesis that $Z_k = 0$ (assuming here that r_k is positive). Assumptions are that n is large and k is small. Probably n should exceed 50 and k should be no greater than n/4.

For the example of Table 8, the calculated Z_k for 10 and 25 lags gives:

$$Z_{10} = 0.49 \sqrt{100 - 10} = 4.65$$

(significant at 5% level)

$$Z_{25} = .03 \sqrt{100 - 25} = 0.26$$

(not significant at 5% level).

These results would indicate a zone of influence between 10 and 25 lags (i.e., between 20-500 cm). In fact, we can solve for a precise zone of influence by solving for k which Z_k is just equal to the tabulated Z^*_α. Doing this for $\alpha = 0.05$, we find k = 17 or 340 cm as the zone of influence.

The zone of influence as well as Z_k for 10 and 20 lags are given in Table 9. The zone of influence ranged from apparently zero to greater than the full length of the 2-km transect. For 59 of the 70 cases, 10 were significantly greater than zero at 10 lags. On the other hand, 44 of 70 were significantly greater than zero at 20 lags.

In Table 10, the zone of influence is tabulated alongside the standard deviation for all transects and all variables. If we have a variance which grows according to the distance at which samples are taken, we would expect the larger transects to have larger s^2.

Table 10. Summary Table (Zone of Influence and Standard Deviation) for Transect-parameter Combination

		20-cm Spacing		200-cm Spacing		2,000-cm Spacing	
Parameter	Transect Number	Zone of Influence	Standard Deviation	Zone of Influence	Standard Deviation	Zone of Influence	Standard Deviation
0.1 bar	1	350	2.8	1,000	2.9	16,000	6.7
	2	100	1.2	4,000	4.4	---	---
	3	60	1.6	>4,600	3.6	---	---
	4	0	1.9	>4,000	3.6	---	---
15 bar	1	170	2.1	4,000	2.5	15,000	4.3
	2	60	1.1	3,600	3.0	---	---
	3	0	1.4	1,400	2.7	---	---
	4	0	1.5	>4,000	3.0	---	---
Surface area	1	140	0.07	400	0.07	28,000	0.20
	2	60	0.05	2,800	0.13	---	---
	3	160	0.08	800	0.11	---	---
	4	0	0.06	200	0.07	---	---
Mean diameter	1	120	2.2	0	3.0	26,000	10.5
	2	80	4.1	2,600	11.0	---	---
	3	400	4.9	4,600	10.4	---	---
	4	0	3.8	600	6.5	---	---
pH	1	160	0.12	1,200	0.11	13,000	0.12
	2	120	0.10	1,400	0.10	---	---
	3	260	0.19	2,800	0.12	---	---
	4	40	0.11	3,200	0.14	---	---

Table 10. -- Continued

Parameter	Transect Number	20-cm Spacing: Zone of Influence	20-cm Spacing: Standard Deviation	200-cm Spacing: Zone of Influence	200-cm Spacing: Standard Deviation	2,000-cm Spacing: Zone of Influence	2,000-cm Spacing: Standard Deviation
EC	1	0	27.9	1,600	30.3	2,000	53.4
	2	120	11.6	> 4,000	23.4	---	---
	3	300	74.2	1,800	33.8	---	---
	4	40	20.9	600	16.3	---	---
Bulk density	1	---	---	---	---	---	---
	2	---	---	---	---	---	---
	3	340	0.2	200	0.1	---	---
	4	---	---	---	---		---
Moisture content	1	---	---	---			
	2	---	---	---	---	---	---
	3	240	2.4	>4,600	4.9	---	---
	4	---	---	---	---	---	---
Clay (%)	1	---	---	---	---	---	---
	2	---	---	---	---	---	---
	3	>500	5.2	---	---	---	---
	4	---	---	---	---	---	---
Silt (%)	1	---	---	---	---	---	---
	2	--	---	---	---	---	---
	3	>500	9.4	---	---	---	---
	4	---	---	---	---	---	---
Sand (%)	1	---	---	---	---	---	---
	2	---	---	---	---	---	---
	3	>500	5.5	---	---	---	---
	4	---	---	---	---	---	---

The bulk density and moisture contents of Transect 3-20 appear to be well-behaved and easily explainable. The zone of influence for the bulk density is about 340 cm for the short spacing and is hardly discernible (200 cm is only 1 lag) for the larger 200-cm spacing. This would indicate a short range of influence, detectable only when using the short spacing. The short transect gives a similar range (240 cm) for the moisture content. However, we find a much larger value (> 4,600 cm) for the 200-cm water content. This large value can be rationalized easily by adding the fact that the irrigation was from south to north. The slope was such that more water infiltrated at the head of the furrow. (The original data is in Appendix A.) The standard deviations, 4.9 for the long spacing and 2.4 for the short spacing, also are consistent.

Transect 4-20 also is interesting and would seem explainable on the basis of management. This short transect was the only one going perpendicular to the rows. The furrows were on a standard spacing of 103 cm. Results show Transect 4-20 to be nearly random with a short range of influence in nearly every case, whereas the north-south transect 3-20 was a value up to 300 or 400 cm on some of the same parameters (i.e., surface area, mean diameter, pH, and EC).

The rest of the values for zone of influence are much harder to explain and offer few clear patterns other than that we have bigger values for the larger transects. Most of the parameters on the 20-cm transect have zones of influence in the 100-300-cm range. Most of the 200-cm transects show values in the 2,000-4,000 range, approximately the same number of lags. For all parameters, the long transect shows values between 20-280 m.

An alternative to the above zone of influence is the "integral scale", λ, as used by Bakr et al. (1978):

$$\lambda = \int_0^\infty r(x)\,dx \qquad [5]$$

where r(x) is the autocorrelation at a distance x. The quantitative interpretive is that the values are autocorrelated at a distance less than integral scale and are independent for larger distances. When r(x) is exponential, the length, λ, will be the inverse of the decay constant.

An approximation of the integral scale is made for our 0.1 bar water example by determining the area under the smoothed curve of Figure 6. The area of the curve shown is multiplied by the lag length of 20 to give a result of $\lambda = 158$ cm.

Integral scales for all the parameters and transects were estimated and are shown in Table 9. In each case the autocorrelogram was smoothed, and area similar to the shaded area of Figure 6 found with a planimeter. For cases in which the smoothed curve could not readily be extrapolated to zero, we simply indicate that the integral scale is greater than the area to the limiting length of the plot.

A scattergram for integral scale and zone of influence is given as Figure 13. For the most part, the zone of influence (as estimated by $Z^*_{.05}$) is larger than the integral scale. The relationship is approximated by the power relationship

$$ZI = 0.874\ \lambda^{1.097} \qquad [6]$$

when we ignore the values assumed to be zero or off-scale.

Semivariogram

The semivariogram can also be used to quantify spatial dependence. When the population variance is finite, the semivariogram function is given by

$$\gamma_k = C_0 - C_k \qquad [7]$$

In Equation [7], C_0 is the population variance and C_k is the estimated covariance given in Equation [2].

The semivariogram function is zero for k = 0. As k increases, C_k approaches zero and $\gamma_k = C_0$. Figure 14 shows an idealized semivariogram along with the autocorrelation C_k. The value C_0 is the "sill" and "range a" is defined as the distance for which γ becomes within a predefined value of sill. Semivariograms have an advantage

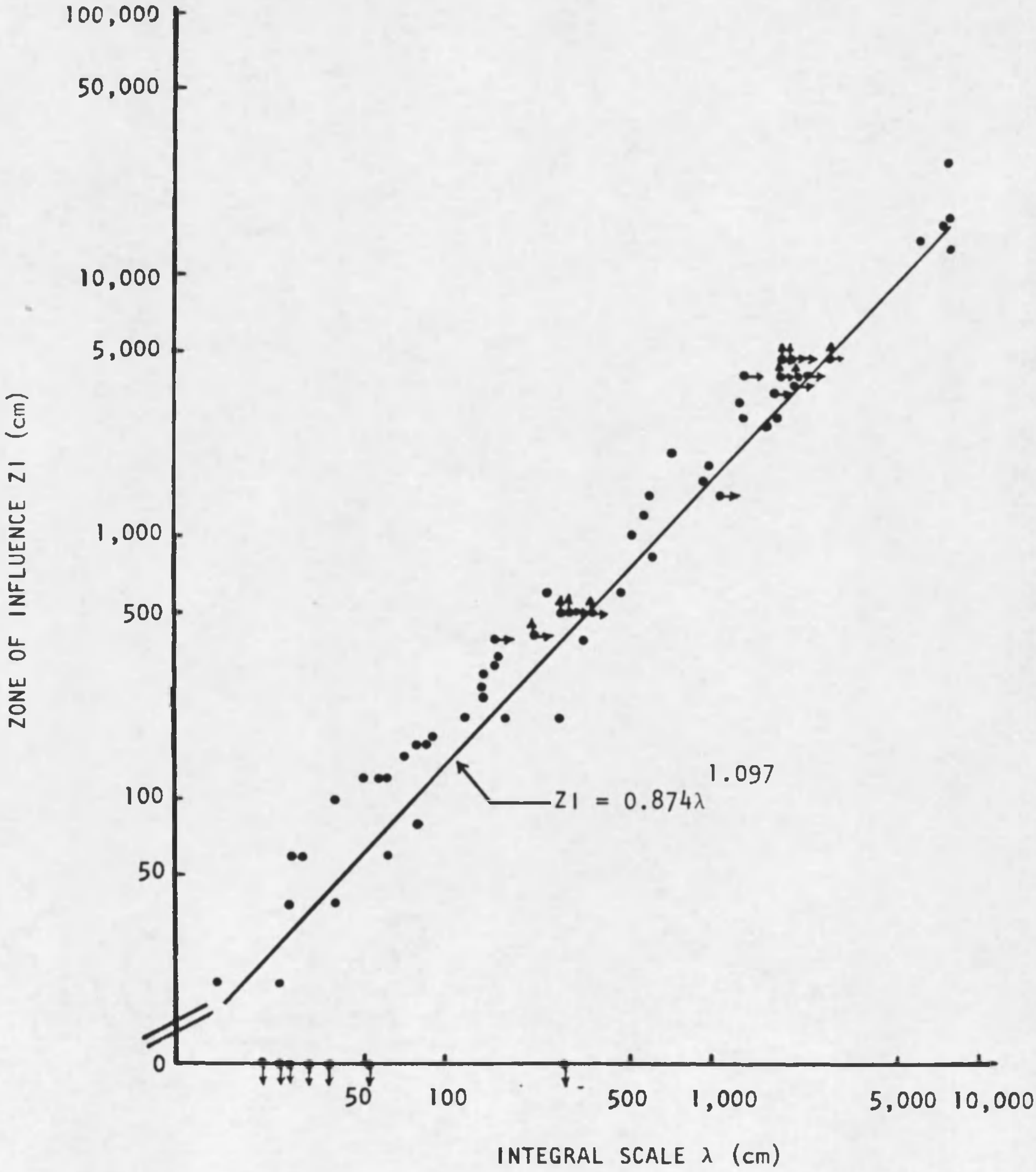


Figure 13. Scattergram for "zone of influence" and integral scale. -- Arrows on data points indicate values are greater than those plotted by an unknown amount.

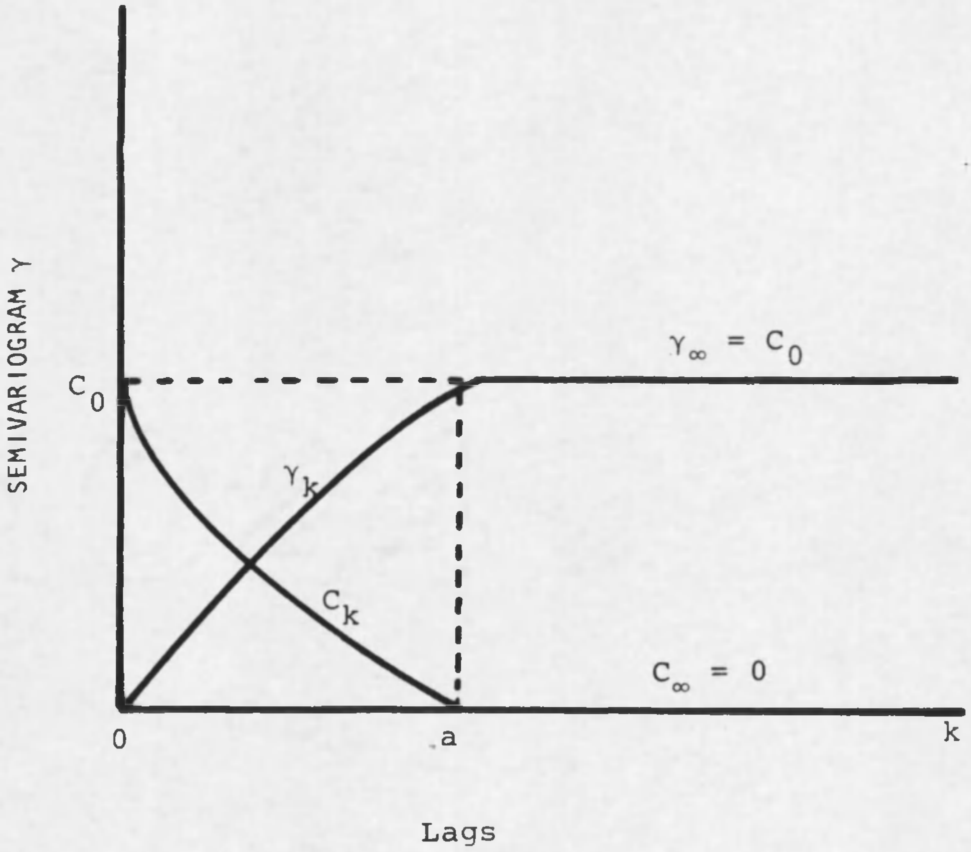


Figure 14. Covariance and semivariance as a function of lag separation

over the correlation in that they exist in some cases for which the population variance is undefined.

Four samples of semivariograms are given as Figures 15, 16, 17, and 18 for 0.1-bar water (Transect 1-20 cm), moisture content (Transect 3-200), bulk density (Transect 3-20 cm), and percentage of silt (Transect 3-20 cm). The ordinate is γ/s^2. The first 3 are all roughly equivalent to Figure 14 and beginning at zero and approaching a more or less constant value after 20 or 30 lags. The semivariogram for silt, however, shows a different pattern. The value continually climbs over the entire 50 lags. This is consistent with its correlogram (Type C) and is expected if the zone of influence is large.

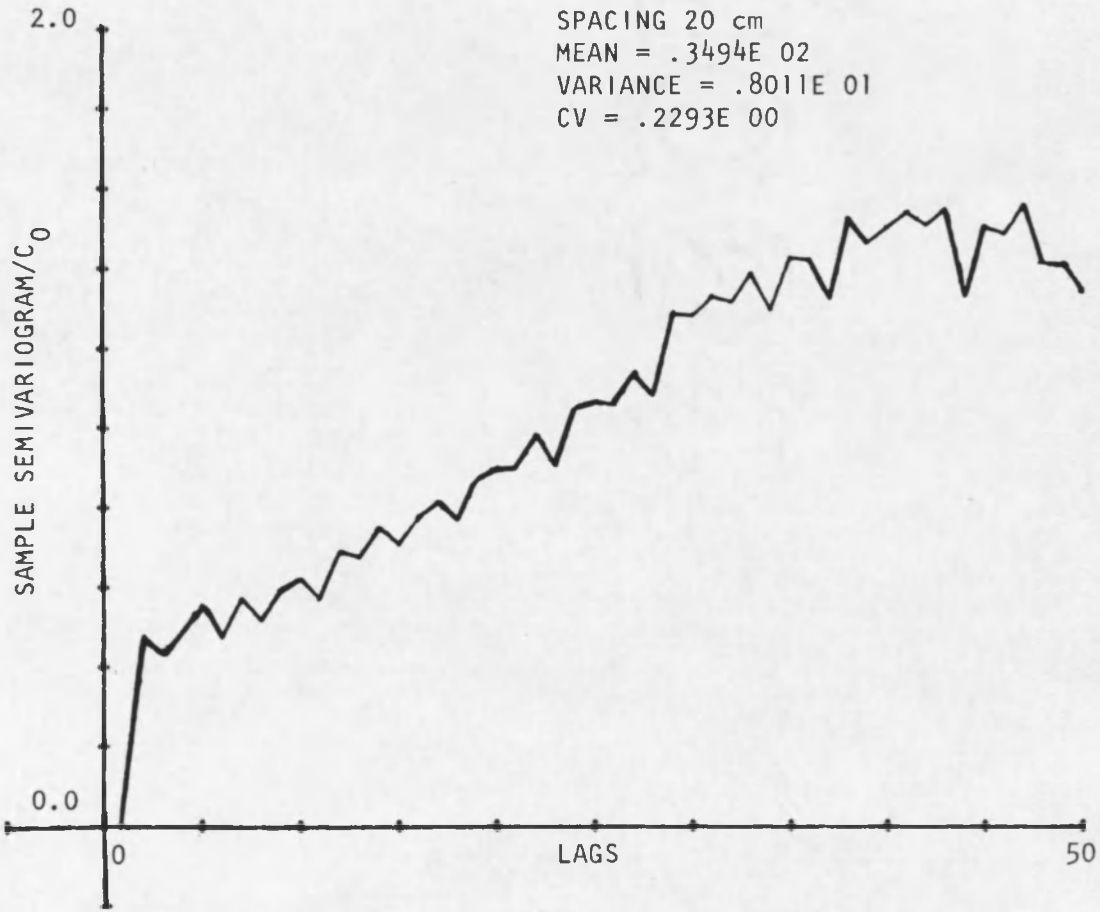


Figure 15. Sample semivariogram for 0.1 bar, Transect 1-20-cm spacing, Field C-2

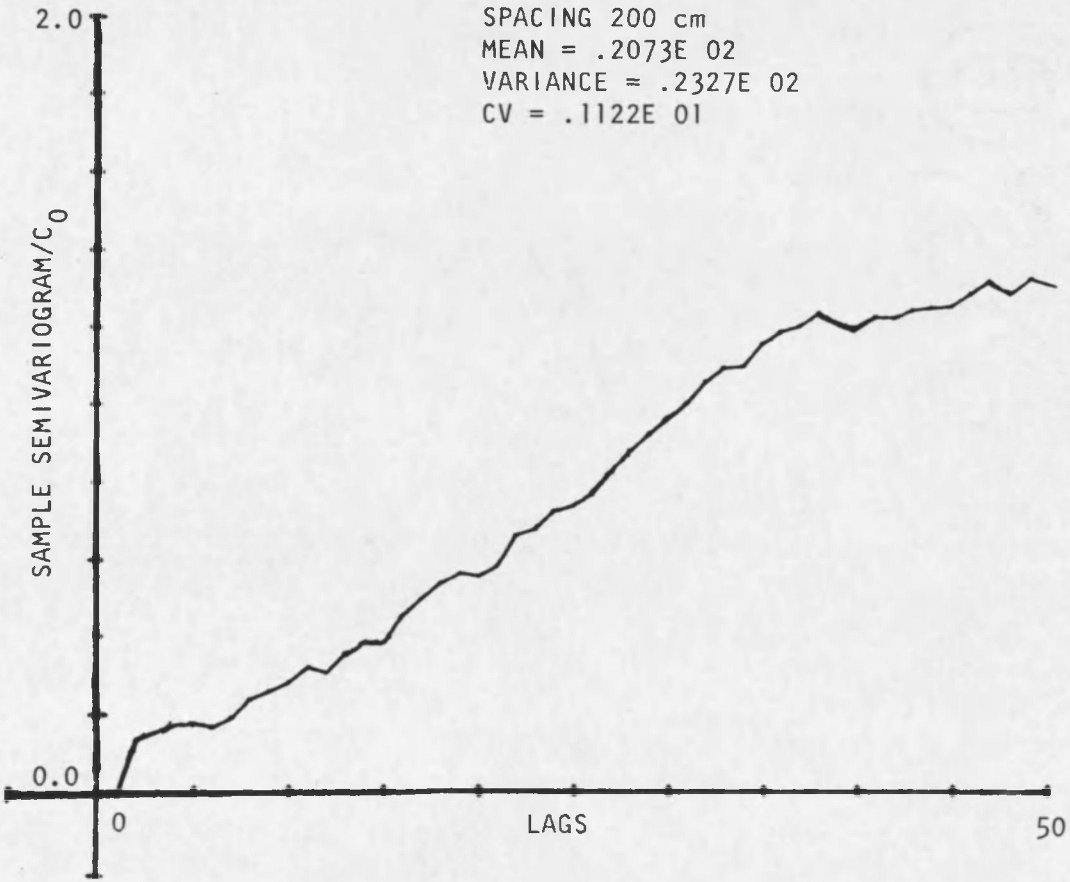


Figure 16. Sample semivariogram for moisture content--Transect 3-200-cm spacing, Field B-4

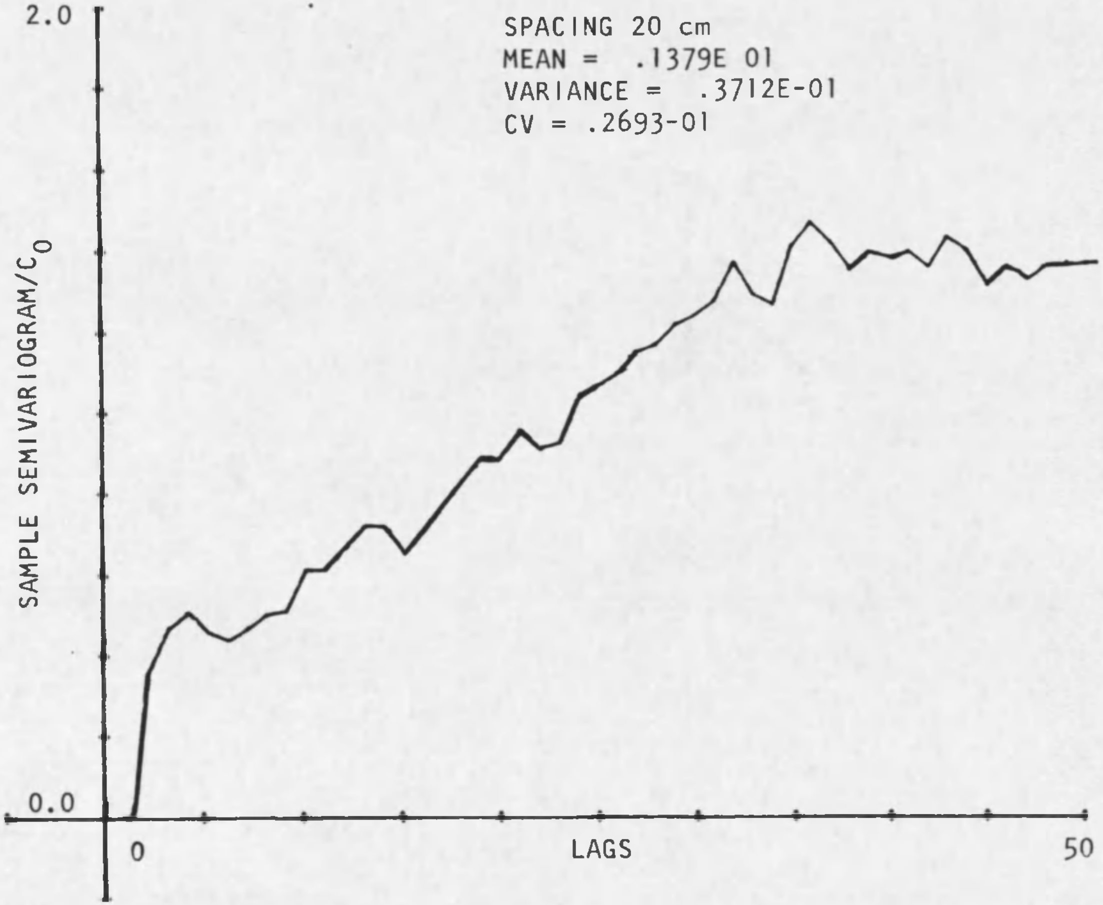


Figure 17. Sample semivariogram for bulk density--Transect 3-20-cm spacing, Field B-4

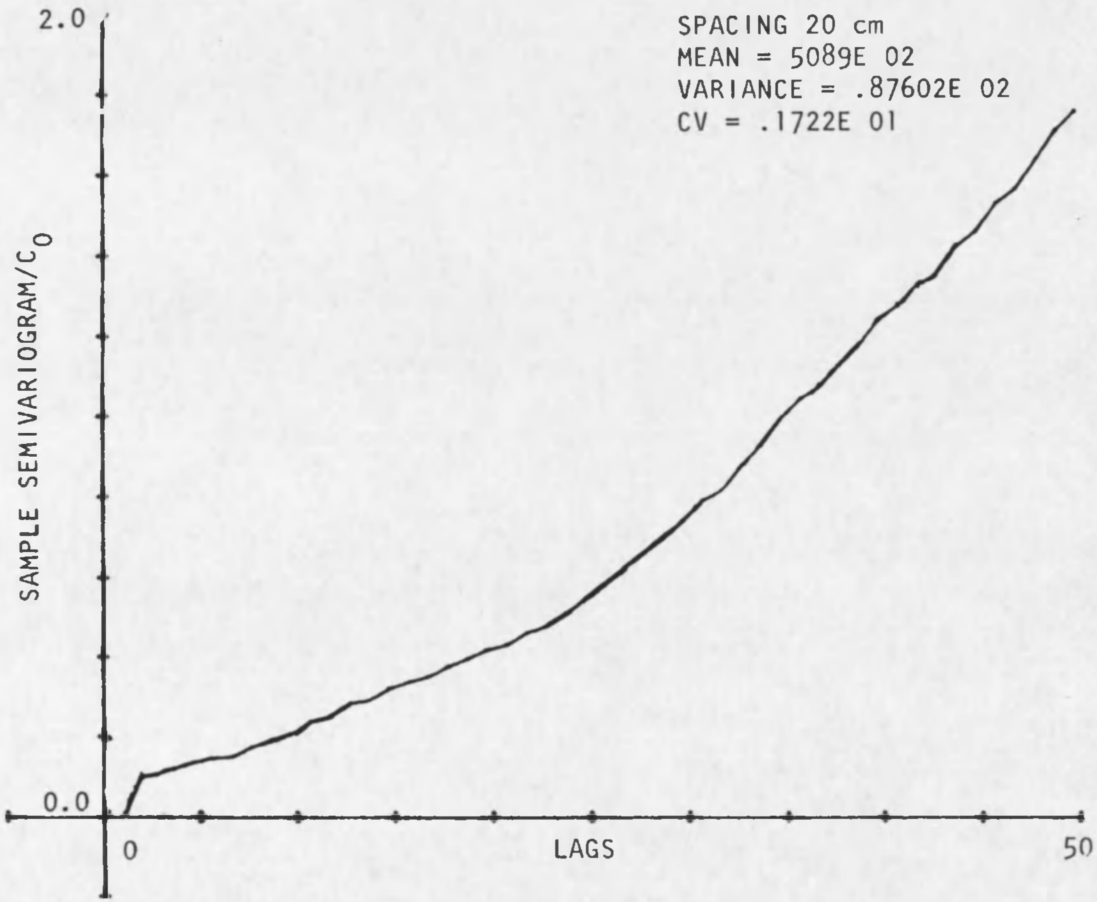


Figure 18. Sample semivariogram for percentage of silt--Transect 3-20-cm spacing, Field B-4

CHAPTER 6

SUMMARY AND CONCLUSIONS

The spatial variability and autocorrelation functions were studied for 11 physical parameters of the Pima clay loam soils. The parameters were 0.1- and 15-bar water content, specific surface area, volume mean diameter, pH, EC, bulk density, moisture content in the field 7 days after irrigation, and percentages of sand, silt, and clay. Four 20-cm interval transects along with four 200-cm transects and one 2,000-cm transect were chosen for most of the first 6 parameters.

Table 11 below shows average values of the standard deviation, approximate precision of measurement and zone of influence for measured values. Both the standard deviations and zone of influence increase with spacing. We define "Precision" as

$$\text{Precision} = \left(\frac{s^2 - s_m^2}{s^2}\right) (100\ \%)$$

where s_m^2 is a measurement variance as given in Tables 3, 4, 5, and 6. If the laboratory measurement is without scatter, the precision is 100%. If the laboratory measurement is large, the precision factor drops in relation to the overall variable which is measured in the field.

Table 11. Average Value of Standard Deviation, Precision, and Zone of Influence (cm)

Parameter	20-cm Spacing			200-cm Spacing			2,000-cm Spacing		
	SD	Precision %	Influence	SD	Precision %	Zone of Influence	SD	Precision %	Zone of Influence
0.1 bar Water	1.88	89.8	127.5	3.63	97.3	>3,400	6.7	99.2	16,000
15 bar Water	1.53	48.7	57.5	2.80	84.6	>3,250	4.3	93.5	15,000
Surface Area	0.07	---	90	0.10	---	1,050	0.2	---	28,000
Mean Diameter	3.75	---	150	7.73	---	1,950	10.5	---	26,000
pH	0.13	90.4	145	0.12	88.7	2,150	0.12	88.7	13,000
EC	33.65	95.8	115	25.95	93.0	2,000	53.4	98.3	2,000
Bulk Density	0.2	---	200	0.1	---	200	---	---	---
Moisture Content	2.4	---	240	4.9	---	>4,600	---	---	---
Clay %	5.2	90.4	>500	---	---	---	---	---	---
Silt %	9.4	99.1	>500	---	---	---	---	---	---
Sand %	5.5	92.0	>500	---	---	---	---	---	---

For the 20-cm spacing, the range of the zone of influence is 57.5 to over 500 cm with the lowest value for 15-bar water and highest value for percentage of sand, silt, and clay. For the 200-cm spacing, the range of zone of influence is 200 to greater than 4,600 cm with the lowest value for bulk density and highest value for moisture content in the field. Such a large variation can only partially be explained on the basis of the larger variances. One possibility is lack of stationarity of the underlying system. There was also strong indication of non-isotropy in Transects 3 and 4-20 cm. The effects of the furrowing probably dominate over "natural" effects. The study would caution against over generalizing for results collected on one set of measured values and assuming the range of influence to be unique.

The moisture content for Transects 3-20 and 3-200 are particularly interesting in that the measurements reflect the irrigation efficiency. For the 200-cm, the measured trend of south to north is more a function of how the water was added than soil variation. For the 20-cm spacing the effects of watering are less important and the variation in soil more dominant (although uniformity in land preparation is still a factor).

The study suggests several possibilities for further studies. Included are:

1. Spatial structure for additional parameters such as soil nutrients.
2. Spatial structures for genetically contrasting soils such as for a soil formed in place as opposed to the alluvially deposited Pima clay loam.
3. Application of Kriging (and co-Kriging) to more soils data in order to best estimate amounts of soil constituents.

More general applications include relationships to soil mapping, remote sensing, and soil management. The technique of Webster (1977) would seem to warrant more attention in the United States in terms of quantifying soils information. The technique of co-Kriging would seem to have outstanding possibilities to matching remote sensing data to ground truth. Lastly, the profitable operation of a mine using regionalized variables would seem to have a lot in common with operating a farm profitably or a waste disposal site optimally. The practicality or potential deserves more attention.

APPENDIX A

RAW DATA*

The raw data of 0.1 bar and 15 bar water content in g/g, available water (0.1 bar-15 bar), surface area (Microtrac) in m^2/cc, mean diameter (Microtrac) in microns, pH (1:5 soil-water suspension), EC (1:5 soil-water extract) in (μmhos/cm), bulk density in (g/cm^3), moisture content in the field 7 days after irrigation in (g/g), and particle size analysis as % clay, silt and sand.

*Missing values are given as -1.0.

TRANSECT NO. 1 FIELD (C-2) 20 CM SPACING

SITE NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC
1	37.50	16.10	21.40	.92	19.10	8.80	180.00
2	37.60	18.00	19.60	.97	16.20	8.90	197.00
3	36.70	16.70	20.00	.97	18.20	9.00	210.00
4	39.00	19.70	19.30	1.11	14.50	9.00	200.00
5	35.00	15.30	19.70	.94	18.80	9.00	200.00
6	36.00	15.40	20.60	.95	19.00	8.90	200.00
7	36.80	15.20	21.60	.99	16.20	8.90	205.00
8	36.50	14.70	21.80	.91	20.10	9.00	200.00
9	37.10	17.00	20.10	.97	16.70	9.00	200.00
10	36.60	16.90	19.70	1.03	16.40	9.10	194.00
11	37.90	16.80	21.10	1.00	15.40	8.90	205.00
12	38.80	18.40	20.40	1.11	13.10	8.80	205.00
13	40.00	17.70	22.30	1.07	14.80	8.60	200.00
14	40.60	18.50	22.10	1.09	14.70	8.70	200.00
15	37.60	18.30	19.30	1.05	17.00	8.80	200.00
16	38.70	18.40	20.30	1.08	13.90	8.80	210.00
17	37.90	17.50	20.40	1.04	15.90	8.70	200.00
18	42.10	20.90	21.20	1.26	10.50	8.70	205.00
19	35.90	15.90	20.00	.99	15.20	8.80	250.00
20	38.00	19.70	18.30	1.07	13.10	8.80	240.00
21	38.50	16.40	22.10	1.00	14.20	8.90	210.00
22	38.30	17.70	20.60	1.09	13.00	8.80	230.00
23	37.40	17.60	19.80	1.09	13.10	8.80	255.00
24	37.10	17.10	20.00	1.09	13.30	8.80	194.00
25	41.80	18.90	22.90	1.08	13.80	8.70	240.00
26	37.20	18.30	18.90	1.16	12.10	8.80	220.00
27	35.40	17.90	17.50	1.13	12.50	9.00	195.00
28	39.10	19.90	19.20	1.22	11.50	9.00	200.00
29	35.30	18.70	16.60	1.15	12.70	9.00	200.00
30	34.00	17.80	16.20	1.17	12.60	9.00	194.00
31	39.00	20.40	18.60	1.22	11.70	8.90	200.00
32	35.50	18.30	17.20	1.15	13.20	9.00	210.00
33	35.00	17.50	17.50	1.20	11.30	9.00	220.00
34	35.70	17.70	18.00	1.14	13.30	8.70	215.00
35	35.10	19.60	15.50	1.13	13.40	9.00	240.00
36	34.10	16.90	17.20	1.16	12.20	9.00	180.00
37	34.00	17.00	17.00	1.11	14.80	8.80	200.00
38	34.70	17.30	17.40	1.10	14.40	8.90	225.00
39	34.20	17.20	17.00	1.13	14.70	8.90	310.00
40	35.20	18.10	17.10	1.09	17.30	8.90	250.00

TRANSECT NO. 1 FIELD (C-2) 20 CM SPACING (Continued)

41	31.70	15.70	16.00	1.16	12.80	9.00	250.00
42	30.70	15.80	14.90	1.15	12.70	9.10	230.00
43	32.70	17.80	14.90	1.11	12.60	9.00	205.00
44	33.70	17.30	16.40	.85	23.00	9.00	210.00
45	35.30	17.20	18.10	1.10	12.40	8.90	260.00
46	32.60	16.70	15.90	1.12	12.50	8.70	290.00
47	33.50	16.90	16.60	1.13	12.30	8.90	225.00
48	31.40	16.00	15.40	1.14	12.10	9.00	200.00
49	30.90	17.30	13.60	1.12	12.00	8.80	200.00
50	31.40	18.50	12.90	1.11	12.80	8.80	185.00
51	35.50	17.70	17.80	1.11	11.80	8.90	210.00
52	34.20	17.50	16.70	1.11	13.30	8.80	275.00
53	32.50	18.00	14.50	1.13	11.50	8.80	250.00
54	30.50	15.90	14.60	1.08	13.90	8.90	210.00
55	28.90	13.90	15.00	1.10	13.50	9.00	195.00
56	33.00	19.50	13.50	1.10	12.80	8.80	245.00
57	30.90	17.10	13.80	1.06	14.20	8.90	260.00
58	31.70	20.00	11.70	1.05	14.80	8.90	250.00
59	32.00	19.88	12.20	1.11	13.70	8.90	260.00
60	30.90	18.80	12.10	1.03	15.20	8.90	250.00
61	42.80	19.40	23.40	1.07	12.80	8.80	265.00
62	31.00	16.90	14.10	1.07	15.20	8.80	275.00
63	34.30	21.20	13.10	1.06	15.30	8.80	280.00
64	31.20	19.50	11.70	1.08	14.70	8.90	290.00
65	29.10	16.60	12.60	1.13	12.30	8.90	270.00
66	31.70	16.80	14.90	1.08	14.40	9.00	210.00
67	32.90	19.30	13.60	1.06	14.80	9.00	200.00
68	32.10	16.50	15.60	1.06	13.60	8.90	180.00
69	32.80	16.10	16.70	1.11	12.40	8.80	230.00
70	32.20	16.00	16.20	1.08	14.10	8.90	200.00
71	34.40	16.40	18.00	1.07	14.10	8.80	260.00
72	32.20	16.60	15.60	1.08	12.80	8.90	230.00
73	32.20	14.00	18.20	1.11	12.20	8.90	210.00
74	32.40	16.90	15.50	1.11	14.20	8.90	192.00
75	33.30	16.30	17.00	1.09	13.50	9.00	200.00
76	34.30	16.90	17.40	1.09	13.80	8.90	210.00
77	31.80	17.60	14.20	1.17	11.40	8.90	280.00
78	36.90	17.30	19.60	1.14	11.20	8.90	230.00
79	33.90	17.70	16.20	1.17	12.40	8.80	210.00
80	35.20	17.90	17.30	1.13	13.10	8.80	230.00
81	36.40	18.70	17.70	1.16	11.60	8.70	200.00
82	34.70	19.90	14.80	1.03	19.20	8.80	210.00
83	38.90	23.10	15.80	1.15	12.50	8.70	230.00
84	35.00	20.90	14.10	1.10	13.40	8.70	240.00
85	35.60	20.40	15.20	1.10	13.60	8.60	250.00
86	36.90	24.80	12.10	1.25	10.10	8.60	240.00
87	35.30	20.30	15.00	1.10	13.50	8.70	220.00
88	36.40	21.40	15.00	1.16	13.60	8.70	230.00
89	33.70	21.40	12.30	1.12	13.20	8.70	220.00
90	34.20	21.20	13.00	1.24	9.53	8.80	245.00
91	30.90	21.60	9.30	1.15	12.10	8.60	225.00
92	34.30	21.70	12.60	1.19	12.30	8.70	210.00
93	33.20	22.30	10.90	1.12	13.30	8.60	210.00
94	35.30	20.90	14.40	1.14	13.30	8.70	260.00
95	35.60	19.80	15.80	1.09	13.40	8.70	180.00
96	35.10	20.80	14.30	1.14	13.60	8.60	230.00
97	34.40	20.80	13.00	1.15	12.60	8.70	240.00
98	34.00	21.40	12.60	1.12	13.20	8.70	225.00
99	33.60	21.20	12.40	1.13	13.00	8.70	225.00
100	36.60	22.60	14.00	1.13	12.80	8.70	245.00

TRANSECT NO. 1 FIELD (C-2) 200 CM SPACING

SITE NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC
1	37.50	16.10	21.40	.92	19.10	8.80	180.00
2	38.00	16.80	21.20	1.00	15.40	8.90	205.00
3	38.50	16.40	22.10	1.00	14.20	8.90	210.00
4	39.00	20.40	18.60	1.22	11.70	8.90	200.00
5	31.70	15.70	16.00	1.16	12.80	9.00	250.00
6	33.50	17.70	15.80	1.11	11.80	8.90	210.00
7	42.80	19.40	23.40	1.07	12.80	8.80	265.00
8	34.40	16.40	18.00	1.07	14.10	8.80	260.00
9	36.40	18.70	17.70	1.16	11.60	8.70	200.00
10	30.90	21.60	9.30	1.15	12.10	8.80	225.00
11	37.60	21.00	16.60	1.18	11.80	8.60	205.00
12	32.20	18.00	14.20	1.14	13.40	8.70	200.00
13	31.10	16.90	14.20	1.18	11.50	8.80	166.00
14	30.10	15.50	14.60	1.25	10.30	8.80	210.00
15	26.70	12.90	13.80	1.08	21.30	8.80	154.00
16	32.70	17.70	15.00	1.15	12.30	8.80	200.00
17	27.00	12.80	14.20	1.02	16.00	8.90	161.00
18	35.70	17.00	18.70	1.06	14.30	8.70	190.00
19	33.30	16.90	16.40	1.07	13.30	8.80	197.00
20	35.40	17.70	17.70	1.10	12.70	8.80	190.00
21	33.60	18.80	14.80	1.11	14.30	8.80	200.00
22	31.00	18.50	12.50	1.01	16.50	8.80	180.00
23	34.70	18.00	16.70	1.01	14.40	8.70	172.00
24	35.90	17.90	18.00	1.04	13.60	8.80	169.00
25	33.10	20.30	12.80	1.12	12.70	8.80	197.00
26	36.90	19.40	17.50	1.07	12.60	8.70	199.00
27	36.60	18.90	17.70	1.12	13.20	8.70	250.00
28	31.80	17.90	13.90	.95	22.60	8.80	192.00
29	36.30	22.60	13.70	1.14	12.70	8.70	192.00
30	33.40	17.50	15.90	1.09	13.00	8.70	184.00

TRANSECT NO. I FIELD (C-2) 200 CM SPACING (Continued)

31	31.70	15.80	15.90	1.04	16.00	8.80	181.00
32	36.00	18.10	17.90	1.02	15.90	8.70	220.00
33	34.20	15.40	18.80	.91	18.20	8.80	200.00
34	34.30	17.50	16.80	.92	19.90	8.68	192.00
35	31.80	20.60	11.20	1.09	13.80	8.80	195.00
36	34.10	16.10	18.00	1.00	15.10	8.80	175.00
37	34.00	15.80	18.20	.91	18.00	8.90	189.00
38	34.30	20.20	14.10	1.08	19.40	8.80	200.00
39	32.50	16.10	16.40	.98	20.50	8.80	186.00
40	29.90	14.50	15.40	.99	16.80	9.00	181.00
41	33.70	16.90	16.80	1.06	14.90	8.90	190.00
42	33.60	18.70	14.90	1.10	13.70	8.90	200.00
43	36.90	20.70	16.20	1.02	15.90	8.90	185.00
44	38.90	18.30	20.60	1.00	15.10	8.80	167.00
45	36.00	19.80	16.20	1.04	14.60	8.80	184.00
46	32.80	18.40	14.40	.98	20.40	8.90	190.00
47	35.60	19.60	16.00	1.08	13.10	8.80	200.00
48	35.60	18.70	16.90	1.07	13.80	8.80	200.00
49	36.40	19.50	16.90	1.14	13.00	8.80	200.00
50	33.10	17.20	15.90	1.01	16.40	8.70	260.00
51	38.00	18.50	19.50	.98	16.80	8.90	200.00
52	37.80	19.10	18.70	1.00	16.90	8.90	220.00
53	35.90	19.90	16.00	1.03	14.90	8.70	230.00
54	36.30	22.70	13.60	1.06	13.70	8.80	210.00
55	35.50	21.10	14.40	1.03	16.50	8.70	225.00
56	37.90	22.00	15.90	1.03	15.50	8.70	250.00
57	36.80	20.90	15.90	.99	15.70	8.80	250.00
58	38.70	22.50	16.20	1.07	14.80	8.80	200.00
59	35.00	20.90	14.10	1.03	14.40	8.80	250.00
60	34.80	23.30	11.50	1.14	13.30	8.70	250.00
61	35.70	20.80	14.90	1.14	13.10	8.70	225.00
62	34.60	19.90	14.70	1.05	20.00	8.70	250.00
63	31.80	18.60	13.20	1.01	23.70	8.80	210.00
64	36.40	20.40	16.00	1.11	14.40	8.70	260.00
65	35.50	21.40	14.10	1.06	15.30	8.50	220.00

TRANSECT NO. 1 FIELD (C-2) 200 CM SPACING (Continued)

66	36.60	21.90	14.70	1.05	14.60	8.50	250.00
67	35.60	22.80	12.80	1.07	13.20	8.60	200.00
68	37.90	21.10	16.80	1.03	15.80	8.50	230.00
69	38.00	23.40	14.60	1.06	14.60	8.50	200.00
70	36.10	23.10	13.00	1.01	16.10	8.50	240.00
71	35.50	20.20	15.30	1.01	14.90	8.60	210.00
72	36.60	22.10	14.50	1.02	16.80	8.60	250.00
73	37.60	23.70	13.90	1.00	20.50	8.60	240.00
74	37.50	21.30	16.20	1.02	16.20	8.60	240.00
75	38.20	22.30	15.90	1.04	15.30	8.70	215.00
76	38.20	23.40	14.80	1.06	14.50	8.90	200.00
77	39.20	23.10	16.10	1.10	14.20	8.70	250.00
78	38.80	23.40	15.40	1.07	14.30	8.80	220.00
79	37.50	21.00	16.50	1.07	16.50	8.80	250.00
80	37.80	20.40	17.40	1.07	13.80	8.80	230.00
81	38.30	19.70	18.60	1.09	12.90	8.80	250.00
82	40.00	19.50	20.50	1.05	13.50	8.80	210.00
83	33.50	16.80	16.70	1.04	15.50	8.80	225.00
84	33.70	20.00	13.70	.94	22.70	8.90	200.00
85	31.50	15.80	15.70	.91	26.80	8.90	200.00
86	35.60	21.10	14.50	1.06	18.00	8.70	220.00
87	37.40	21.10	16.30	1.10	17.20	8.60	210.00
88	40.30	22.30	18.00	1.06	14.50	8.50	350.00
89	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
90	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
91	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
92	38.50	19.30	19.20	1.01	15.90	8.60	190.00
93	38.50	19.00	19.50	1.09	12.40	8.20	480.00
94	38.70	25.25	13.50	1.12	13.80	8.20	930.00
95	38.50	24.30	14.20	1.13	11.70	8.50	350.00
96	36.80	24.20	12.60	1.08	14.80	8.50	410.00
97	37.20	23.00	14.20	1.09	14.20	8.50	340.00
98	38.90	24.70	14.20	1.09	12.70	8.60	330.00
99	38.30	22.40	15.90	1.04	13.50	8.70	335.00
100	38.40	23.30	15.10	1.10	13.20	8.60	425.00

TRANSECT NO. 2 FIELD (E-3) 20 CM SPACING

SITE NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC
1	21.40	9.00	12.40	.54	60.90	8.90	140.00
2	19.60	9.20	10.40	.59	59.20	8.90	134.00
3	20.00	9.00	11.00	.56	57.80	8.90	136.00
4	25.40	11.40	14.00	.82	38.80	8.80	170.00
5	22.60	8.30	14.30	.67	48.40	8.90	146.00
6	19.20	9.10	10.10	.61	54.00	8.90	135.00
7	20.80	9.50	11.30	.63	54.30	8.90	147.00
8	21.70	9.50	12.20	.63	53.50	8.90	143.00
9	21.20	8.10	13.10	.64	55.10	8.90	142.00
10	20.60	7.90	12.70	.64	53.60	8.90	143.00
11	20.50	8.70	11.80	.56	59.70	9.00	130.00
12	19.80	6.90	12.90	.55	59.90	8.90	134.00
13	20.00	8.70	11.30	.58	59.80	8.80	145.00
14	19.30	8.00	11.30	.56	58.40	8.80	144.00
15	20.20	8.70	11.50	.53	54.00	8.80	142.00
16	19.90	9.10	10.80	.61	54.90	8.70	146.00
17	21.20	8.10	13.10	.55	53.30	8.70	167.00
18	21.30	9.40	11.90	.66	51.40	8.80	156.00
19	20.60	7.60	13.00	.59	55.50	8.70	145.00
20	20.30	9.40	10.90	.62	54.90	8.80	140.00
21	19.60	7.30	12.30	.60	55.60	8.80	134.00
22	18.90	7.40	11.50	.58	56.80	8.90	134.00
23	20.20	8.00	12.20	.62	55.40	8.90	123.00
24	21.60	9.20	12.40	.62	55.20	8.90	133.00
25	20.30	8.00	12.30	.63	52.60	8.80	133.00
26	20.80	6.30	14.50	.58	57.90	8.90	122.00
27	20.40	7.50	12.90	.63	54.50	8.90	116.00
28	20.40	7.60	12.80	.62	53.70	8.90	137.00
29	21.90	8.40	13.50	.67	51.20	8.90	140.00
30	19.80	7.50	12.30	.63	52.60	8.90	134.00
31	20.70	8.10	12.60	.65	53.70	8.90	135.00
32	20.80	8.20	12.60	.66	50.30	8.90	135.00
33	22.00	8.40	13.60	.67	49.40	8.90	141.00
34	20.40	8.50	11.90	.66	50.80	8.90	130.00
35	20.10	9.00	11.10	.64	52.00	8.90	139.00
36	21.10	9.20	11.90	.68	51.20	8.70	133.00
37	20.30	7.70	12.60	.63	51.80	8.70	124.00
38	19.50	9.50	10.00	.67	48.50	8.80	129.00
39	22.10	7.90	14.20	.69	48.70	8.70	128.00
40	21.30	7.90	13.40	.64	51.00	8.90	117.00

TRANSECT NO. 2 FIELD (E-3) 20 CM SPACING (Continued)

41	21.50	7.60	13.90	.63	51.80	8.90	118.00
42	20.80	9.40	11.40	.67	47.60	8.80	120.00
43	21.90	8.70	13.20	.68	50.50	8.90	125.00
44	21.60	8.00	13.60	.64	54.20	8.90	122.00
45	20.60	11.10	9.50	.68	49.00	8.90	117.00
46	20.70	11.00	9.70	.69	46.50	8.80	123.00
47	22.90	9.60	13.30	.73	46.90	8.80	134.00
48	21.00	8.60	12.40	.57	52.50	8.90	126.00
49	22.10	8.50	13.60	.69	48.20	8.80	129.00
50	22.20	7.60	14.60	.66	48.30	8.90	129.00
51	22.10	10.00	12.10	.66	51.80	8.80	127.00
52	22.60	7.90	14.70	.65	49.20	8.90	120.00
53	22.40	8.00	14.40	.64	52.00	8.90	120.00
54	23.60	9.50	14.10	.71	49.00	8.90	123.00
55	23.60	8.70	15.10	.73	46.60	8.90	126.00
56	21.10	6.50	15.40	.59	54.00	8.80	128.00
57	21.60	8.70	12.90	.67	50.50	8.80	132.00
58	21.30	8.30	13.00	.67	49.80	8.80	133.00
59	23.60	8.70	14.90	.73	45.80	8.80	134.00
60	20.60	9.50	11.10	.75	42.80	8.80	138.00
61	22.30	9.00	13.30	.66	52.90	8.90	140.00
62	21.40	9.00	12.40	.66	51.10	8.80	135.00
63	22.20	8.20	14.00	.66	49.80	8.80	138.00
64	21.30	7.90	13.40	.62	53.80	9.00	137.00
65	20.40	8.00	12.40	.64	53.50	9.00	140.00
66	22.70	6.90	15.80	.66	50.50	8.90	137.00
67	21.20	8.50	12.70	.68	50.70	8.90	145.00
68	20.60	7.90	12.70	.65	51.70	8.80	130.00
69	22.60	7.40	15.20	.68	48.10	8.90	130.00
70	19.40	7.20	12.20	.66	52.00	8.90	125.00
71	21.00	7.10	13.90	.61	53.60	8.90	126.00
72	21.90	7.00	14.90	.65	52.50	8.80	133.00
73	22.20	6.90	15.30	.59	54.60	8.90	135.00
74	21.60	7.90	13.70	.63	53.50	8.80	124.00
75	19.30	8.30	11.00	.64	52.20	8.80	130.00
76	22.20	7.30	14.90	.71	45.50	8.80	135.00
77	21.30	7.00	14.30	.67	50.10	8.80	139.00
78	20.40	6.40	14.00	.59	54.90	8.80	137.00
79	21.20	8.10	13.10	.71	43.60	8.70	155.00
80	18.70	7.10	11.60	.58	54.70	8.70	139.00
81	19.70	8.20	11.50	.69	48.10	8.70	144.00
82	20.00	8.60	11.40	.68	47.80	8.80	136.00
83	21.10	6.40	14.70	.66	51.10	8.80	136.00
84	22.00	7.60	14.40	.75	44.60	8.70	142.00
85	21.00	8.40	12.60	.69	47.00	8.70	142.00
86	23.00	8.10	14.90	.83	37.40	8.80	131.00
87	19.80	8.10	11.70	.70	46.20	8.90	118.00
88	20.30	7.30	13.00	.68	49.30	8.90	114.00
89	20.50	11.00	9.50	.65	48.30	8.70	145.00
90	20.30	6.20	14.10	.64	51.30	8.80	142.00
91	20.30	7.60	12.70	.65	50.00	8.70	142.00
92	19.90	6.30	13.60	.65	51.30	8.70	161.00
93	20.30	6.80	13.50	.66	48.00	8.70	146.00
94	18.90	8.10	10.80	.69	46.40	8.70	156.00
95	20.60	7.80	12.80	.66	50.20	8.70	148.00
96	20.60	9.60	11.00	.66	49.90	8.70	153.00
97	18.80	7.30	11.50	.62	51.50	8.70	142.00
98	20.30	7.60	12.70	.62	55.00	8.60	155.00
99	21.20	7.60	13.60	.64	50.50	8.60	167.00
100	20.70	6.50	14.20	.64	50.10	8.60	165.00

TRANSECT NO. 2 FIELD (E-3) 200 CM SPACING

SITE NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC
1	33.80	15.10	18.70	.90	31.10	8.60	183.00
2	33.40	15.30	18.10	.86	33.80	8.70	185.00
3	33.00	14.40	18.60	.89	31.20	8.70	160.00
4	33.00	14.90	18.10	.87	32.50	8.70	185.00
5	33.30	14.20	19.10	.90	32.10	8.70	161.00
6	33.20	13.70	19.50	.90	31.60	8.70	174.00
7	32.70	14.30	18.40	.86	36.00	8.70	176.00
8	33.00	14.90	18.10	.86	33.20	8.80	173.00
9	30.90	14.60	16.30	.83	38.30	8.80	169.00
10	31.80	14.90	16.90	.86	34.30	8.80	187.00
11	31.20	13.70	17.50	.83	38.30	8.70	183.00
12	31.60	17.30	14.30	.84	39.10	8.70	220.00
13	30.70	14.10	16.60	.83	37.70	8.60	198.00
14	31.80	14.80	17.00	.83	37.40	8.60	198.00
15	31.80	14.40	17.40	.86	36.40	8.60	194.00
16	32.80	14.30	18.50	.83	38.10	8.60	200.00
17	29.60	13.60	16.00	.86	35.40	8.70	190.00
18	30.40	14.40	16.00	.86	34.60	8.60	182.00
19	31.30	15.00	16.30	.86	35.60	8.60	180.00
20	31.40	14.30	17.10	.85	34.00	8.60	195.00
21	31.90	14.90	17.00	.85	32.80	8.60	197.00
22	32.40	14.40	18.00	.88	30.70	8.50	197.00
23	33.70	15.00	18.70	.88	29.20	8.50	198.00
24	31.30	18.40	12.90	.84	32.60	8.70	196.00
25	32.60	14.40	18.20	.88	30.30	8.50	163.00
26	32.10	16.60	15.50	.86	32.20	8.50	171.00
27	31.70	15.10	16.60	.91	31.80	8.50	179.00
28	31.70	14.90	16.80	.87	33.00	8.60	164.00
29	33.30	15.30	18.00	.96	25.80	8.50	174.00
30	31.10	14.70	16.40	.92	32.90	8.60	164.00

TRANSECT NO. 2 FIELD (E-3) 200 CM SPACING (Continued)

31	31.20	14.70	16.50	.93	31.20	8.50	177.00
32	30.40	14.40	16.00	.90	35.20	8.50	165.00
33	30.20	14.30	15.90	.87	37.90	8.50	169.00
34	31.60	15.00	16.60	.92	33.10	8.50	176.00
35	32.10	15.60	16.50	.92	28.40	8.50	166.00
36	31.40	15.00	16.40	.93	34.30	8.60	164.00
37	31.50	14.00	17.50	.94	29.30	8.50	161.00
38	33.30	15.70	17.60	.95	28.80	8.50	176.00
39	32.20	14.60	17.60	.89	31.90	8.60	155.00
40	31.80	14.40	17.40	.94	26.20	8.60	163.00
41	34.80	14.90	19.90	.95	20.00	8.50	160.00
42	34.40	15.80	18.60	.96	23.00	8.60	150.00
43	34.60	15.90	18.70	.89	26.30	8.50	172.00
44	34.20	16.80	17.40	.90	25.80	8.60	172.00
45	33.70	17.30	16.40	.96	25.10	8.60	142.00
46	34.60	16.20	18.40	.93	23.70	8.60	163.00
47	31.90	14.40	17.50	.93	31.70	8.60	157.00
48	34.00	15.10	18.90	.99	26.50	8.60	163.00
49	31.80	17.00	14.80	.95	30.70	8.60	158.00
50	32.30	14.10	18.20	.95	26.90	8.60	159.00
51	30.40	16.20	14.20	.91	30.30	8.60	154.00
52	28.60	13.40	15.20	.92	30.50	8.70	143.00
53	28.30	12.80	15.50	.80	36.80	8.60	158.00
54	32.10	14.70	17.40	.93	26.10	8.60	160.00
55	32.30	14.70	17.60	.97	24.80	8.60	150.00
56	27.30	11.90	15.40	.88	32.00	8.70	148.00
57	28.00	12.40	15.60	.90	31.50	8.70	147.00
58	27.10	12.00	15.10	.78	43.90	8.70	150.00
59	32.90	15.80	17.10	.96	26.10	8.70	160.00
60	31.70	16.10	15.60	.98	26.90	8.70	164.00
61	31.90	17.90	14.00	1.02	21.70	8.50	175.00
62	26.70	12.40	14.30	.90	30.20	8.70	157.00
63	30.00	14.60	15.40	.96	26.70	8.60	165.00
64	28.70	12.60	16.10	.88	30.00	8.60	161.00
65	27.30	13.10	14.20	.82	35.00	8.70	161.00

TRANSECT NO. 2 FIELD (E-3) 200 CM SPACING (Continued)

66	25.10	11.00	14.10	.74	41.80	8.70	144.00
67	22.20	8.80	13.40	.71	46.80	8.70	139.00
68	22.00	8.60	13.40	.66	51.70	8.70	128.00
69	25.10	9.90	15.20	.67	48.50	8.60	142.00
70	27.00	11.50	15.50	.80	37.80	8.70	160.00
71	24.10	9.70	14.40	.76	41.40	8.70	149.00
72	23.20	9.10	14.10	.69	46.10	8.70	137.00
73	23.50	8.90	14.60	.62	55.60	8.50	134.00
74	19.60	7.00	12.60	.57	57.70	8.50	106.00
75	19.00	6.60	12.40	.55	61.90	8.60	109.00
76	20.30	7.40	12.90	.56	60.20	8.60	114.00
77	20.90	7.60	13.30	.58	57.80	8.70	115.00
78	22.80	8.70	14.10	.64	52.20	8.50	135.00
79	21.80	8.10	13.70	.61	57.30	8.60	124.00
80	22.30	8.30	14.00	.63	54.40	8.60	125.00
81	21.40	8.30	13.10	.60	57.80	8.70	130.00
82	20.90	8.10	12.80	.61	57.10	8.90	125.00
83	20.00	6.80	13.20	.47	65.90	8.90	114.00
84	23.10	8.40	14.70	.55	58.80	8.60	132.00
85	24.20	9.50	14.70	.59	58.40	8.60	165.00
86	23.00	9.00	14.00	.60	55.00	8.60	143.00
87	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
88	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
89	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
90	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
91	28.50	13.80	14.70	.88	39.30	8.60	160.00
92	27.50	13.80	13.70	.90	38.10	8.70	140.00
93	29.10	13.80	15.30	.86	40.70	8.50	136.00
94	29.40	13.80	15.60	.85	39.90	8.50	142.00
95	29.10	14.10	15.00	.90	35.30	8.60	131.00
96	29.80	14.70	15.10	.91	34.10	8.60	145.00
97	27.70	14.00	13.70	.84	37.70	8.60	139.00
98	29.70	14.90	14.80	.92	33.00	8.60	147.00
99	28.90	13.80	15.10	.87	34.40	8.50	155.00
100	32.70	14.30	18.40	.83	38.10	8.60	146.00

TRANSECT NO. 3 FIELD (B-4) 20 CM SPACING

SITE NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC	BULK DENSITY	WATER CONTENT	CLAY	SILT	SAND
										-----PERCENT-----		
1	39.20	22.00	17.20	1.19	13.1	8.5	290.0	1.34	15.60	36.8	49.2	14.0
2	33.90	18.30	15.60	1.00	27.9	8.5	280.0	1.26	13.47	35.5	38.5	26.0
3	35.90	22.50	13.40	1.09	24.7	8.4	275.0	1.31	14.69	36.8	41.2	22.0
4	37.80	21.50	16.30	1.31	10.8	8.4	300.0	1.38	15.45	36.8	44.2	19.0
5	37.30	21.50	15.80	1.16	22.0	8.4	300.0	1.29	16.33	39.5	40.0	20.0
6	35.90	18.00	17.90	.98	21.8	8.4	275.0	1.31	16.68	34.2	49.8	16.0
7	38.40	18.90	19.50	1.01	19.5	8.4	265.0	1.37	15.69	32.9	54.1	13.0
8	36.40	20.10	16.30	1.21	15.4	8.4	270.0	1.43	14.19	36.8	40.2	23.0
9	35.50	20.90	14.60	1.06	23.7	8.4	260.0	1.39	14.16	35.5	42.5	22.0
10	36.20	20.00	16.20	1.07	24.0	8.4	260.0	1.06	14.52	38.2	39.8	22.0
11	37.40	21.40	16.00	1.11	19.8	8.6	250.0	1.36	14.42	38.2	43.8	18.0
12	36.10	21.60	14.50	1.07	23.8	8.5	265.0	1.46	11.83	36.8	43.2	20.0
13	36.90	21.20	15.70	1.09	23.5	8.4	290.0	1.38	13.42	39.5	40.5	20.0
14	36.20	20.70	15.50	1.09	21.1	8.4	300.0	1.38	14.50	36.8	43.2	20.0
15	33.80	19.00	14.80	.98	29.4	8.4	285.0	1.56	12.41	34.2	38.8	27.0
16	36.60	20.90	15.70	1.10	22.1	8.4	280.0	1.35	14.94	38.0	44.0	18.0
17	37.40	21.60	15.80	1.11	23.4	8.4	290.0	1.33	13.49	38.0	43.0	19.0
18	37.70	22.30	15.40	1.24	13.2	8.5	280.0	1.21	15.02	39.0	39.0	22.0
19	33.70	19.30	14.40	1.07	22.6	8.4	275.0	1.44	14.13	35.0	40.0	25.0
20	33.90	19.70	14.20	.92	32.9	8.3	290.0	1.26	12.32	34.0	38.0	28.0
21	33.80	19.40	14.40	.98	29.8	8.4	265.0	1.59	12.79	35.0	38.0	27.0
22	35.10	21.40	13.70	1.01	26.5	8.4	280.0	1.49	12.90	35.0	39.5	25.5
23	35.10	19.50	15.60	1.03	26.7	8.3	285.0	1.35	13.11	36.0	41.0	23.0
24	35.30	20.40	14.90	.99	27.6	8.3	300.0	1.23	15.42	34.0	42.0	24.0
25	34.90	20.40	14.50	1.00	27.7	8.0	455.0	1.44	14.64	35.0	41.0	24.0
26	35.00	19.40	15.60	1.04	26.9	8.0	440.0	1.22	15.02	30.3	42.7	27.0
27	35.40	21.10	14.30	.94	33.2	8.0	440.0	1.56	11.89	36.5	40.0	23.5
28	36.10	19.70	16.40	1.06	25.2	8.0	415.0	1.39	11.88	35.0	45.0	20.0
29	37.30	21.90	15.40	1.08	22.0	8.0	410.0	1.61	12.98	38.0	42.5	19.5
30	36.70	21.90	14.80	1.05	23.9	8.0	405.0	1.47	14.14	34.5	45.0	20.5

TRANSECT NO. 3 FIELD (B-4) 20 CM SPACING (Continued)

31	36.50	21.80	14.70	1.19	17.9	8.0	400.0	1.01	18.12	38.0	38.5	23.5
32	36.80	22.40	14.40	1.08	24.2	8.1	380.0	.92	18.86	36.5	42.0	21.5
33	35.60	21.70	13.90	1.01	28.2	8.3	300.0	1.06	17.08	36.0	39.0	25.0
34	36.60	19.40	17.20	1.04	22.9	8.3	300.0	1.32	15.97	37.5	42.0	20.5
35	37.40	22.30	15.10	1.08	24.0	8.3	280.0	1.16	17.23	38.5	38.5	23.0
36	36.80	22.40	14.40	1.07	23.8	8.3	290.0	1.04	18.82	36.0	41.0	23.0
37	36.60	22.10	14.50	1.09	21.9	8.1	390.0	1.06	18.11	37.5	42.5	20.0
38	36.00	21.90	14.10	1.06	26.0	8.1	370.0	1.28	16.26	37.0	41.5	21.5
39	35.30	21.10	14.20	1.00	25.7	8.1	380.0	1.19	16.57	34.5	42.5	23.0
40	36.80	21.90	14.90	1.07	24.1	8.1	375.0	1.02	18.23	38.0	37.5	24.5
41	36.20	21.80	14.40	1.10	22.6	8.1	370.0	1.15	16.42	36.5	38.5	25.0
42	36.80	22.10	14.70	1.06	26.8	8.1	380.0	1.03	17.67	38.5	38.0	23.5
43	36.90	21.90	15.00	1.07	24.1	8.1	310.0	1.14	16.66	36.0	43.0	21.0
44	36.00	21.10	14.90	1.00	29.6	8.1	375.0	1.27	15.43	36.0	40.0	24.0
45	36.20	21.20	15.00	1.05	26.0	8.1	360.0	1.14	18.09	35.0	39.5	25.5
46	35.80	24.20	11.60	1.05	25.5	8.1	360.0	1.15	19.05	36.0	40.5	23.5
47	37.30	21.50	15.80	.95	22.3	8.1	340.0	1.12	16.14	32.0	48.0	20.0
48	34.80	19.90	14.90	.95	23.0	8.2	340.0	1.25	15.67	30.0	48.0	22.0
49	36.90	19.20	17.70	.92	21.4	8.1	450.0	1.24	19.31	28.0	53.0	19.0
50	36.30	20.70	15.60	.92	22.8	8.0	480.0	1.27	18.51	27.0	54.0	19.0
51	35.70	19.30	16.40	.96	18.8	8.1	450.0	1.30	17.76	31.0	53.0	16.0
52	37.30	20.50	16.80	.96	18.1	8.0	440.0	1.33	15.94	32.0	55.0	13.0
53	37.90	19.70	18.20	.95	20.3	8.0	450.0	1.31	18.54	30.0	58.0	12.0
54	39.50	20.60	18.90	.97	16.9	8.1	450.0	1.24	17.78	32.0	56.0	12.0
55	38.70	21.10	17.60	.94	19.9	8.1	450.0	1.25	16.88	32.0	57.0	11.0
56	38.00	21.20	16.80	1.00	19.5	8.0	440.0	1.18	18.41	34.5	56.5	9.0
57	40.10	21.80	18.30	1.00	16.4	8.1	450.0	1.27	17.27	34.0	54.0	12.0
58	34.40	20.20	14.20	.87	21.7	8.1	450.0	1.29	16.55	26.0	60.0	14.0
59	34.60	23.20	11.40	.94	21.8	8.0	440.0	1.21	17.76	30.0	54.5	15.5
60	36.30	20.20	16.10	.96	16.2	8.1	430.0	1.27	18.42	28.0	57.0	15.0
61	39.10	19.70	19.40	.97	17.1	8.0	435.0	1.19	19.89	31.0	57.0	12.0
62	34.40	21.80	12.60	.93	24.6	7.9	450.0	1.40	15.46	30.0	56.0	14.0
63	36.10	19.10	17.00	.91	18.3	7.9	440.0	1.46	12.30	28.0	60.0	12.0
64	37.30	24.90	12.40	1.09	17.0	7.9	430.0	1.22	17.28	34.0	54.0	12.0
65	36.90	23.50	13.40	1.09	18.5	7.9	460.0	1.16	17.43	35.0	51.5	13.5

TRANSECT NO. 3 FIELD (B-4) 20 CM SPACING (Continued)

66	38.90	22.40	16.50	1.23	11.0	7.9	450.0	1.52	11.70	36.0	54.0	10.0
67	36.30	20.30	16.00	.98	14.5	7.9	440.0	1.67	10.20	30.0	60.0	10.0
68	36.60	20.90	15.70	.97	15.5	7.9	440.0	1.70	11.00	30.0	60.0	10.0
69	39.80	21.30	18.50	1.00	15.1	7.9	440.0	1.51	12.38	32.0	58.0	10.0
70	36.40	18.20	18.20	.95	16.5	7.9	460.0	1.46	13.02	26.0	62.0	12.0
71	36.50	22.70	13.80	1.01	16.5	7.9	480.0	1.66	11.28	30.5	57.5	12.0
72	39.80	23.40	16.40	.96	17.4	7.9	495.0	1.52	11.19	28.5	61.5	10.0
73	39.30	23.30	16.00	1.01	15.4	8.1	380.0	1.64	11.87	32.5	52.5	15.0
74	36.90	21.00	15.70	.97	16.0	8.2	350.0	1.62	13.18	28.5	58.0	13.5
75	40.20	25.00	15.20	.98	14.5	8.1	380.0	1.65	14.47	30.5	62.5	7.0
76	36.70	18.80	17.90	.94	14.8	8.2	320.0	1.38	12.35	26.0	64.5	9.5
77	38.60	24.10	14.50	1.04	13.4	8.2	310.0	1.63	9.85	32.0	58.5	9.6
78	35.10	20.10	15.00	.89	20.1	8.2	320.0	1.62	11.68	25.0	64.5	10.5
79	36.30	20.40	15.90	.99	13.4	8.3	320.0	1.58	12.96	28.0	62.0	10.0
80	37.20	21.40	15.80	.94	20.0	8.2	325.0	1.49	13.92	30.0	59.0	11.0
81	38.70	20.70	18.00	.94	16.3	8.2	335.0	1.56	12.12	28.5	63.5	8.0
82	37.70	20.90	16.80	.93	16.3	8.3	315.0	1.65	11.59	26.0	62.0	12.0
83	41.00	23.20	17.80	1.00	14.1	8.2	350.0	1.51	12.58	28.5	62.0	9.5
84	38.50	21.60	16.90	.99	14.3	8.2	340.0	1.52	13.90	22.0	65.0	13.0
85	39.60	21.70	17.90	.91	18.9	8.2	370.0	1.67	12.80	23.0	65.0	12.0
86	37.60	21.40	16.20	.98	16.5	8.1	320.0	1.40	12.95	24.5	61.5	14.0
87	36.10	20.90	15.20	1.00	14.7	8.1	300.0	1.79	11.64	24.5	60.5	15.0
88	36.00	20.80	15.70	1.00	14.9	8.2	335.0	1.74	12.40	24.5	62.0	13.5
89	35.00	20.70	14.30	.99	19.2	8.3	330.0	1.48	12.36	24.5	60.5	15.0
90	35.10	21.90	13.20	1.01	14.5	8.3	310.0	1.62	13.71	24.5	59.5	16.0
91	34.20	21.10	13.10	.97	20.6	8.4	300.0	1.25	12.67	23.5	60.0	16.5
92	36.30	21.20	15.10	.97	16.2	8.3	295.0	1.55	13.38	23.5	64.5	18.0
93	33.00	20.10	12.90	.98	19.3	8.2	300.0	1.54	12.82	22.0	57.0	21.0
94	36.70	20.00	16.70	.89	20.4	8.1	295.0	1.60	13.39	22.0	65.0	13.0
95	36.10	19.70	16.40	.95	17.4	8.1	315.0	1.71	13.08	24.5	60.5	15.0
96	35.80	21.00	14.80	.97	17.1	8.2	310.0	1.50	13.89	27.0	60.0	13.0
97	39.00	23.40	15.60	1.01	17.6	8.5	220.0	1.37	13.62	24.5	60.5	15.0
98	35.70	19.30	16.40	.88	21.4	8.6	200.0	1.49	15.15	20.5	64.5	15.0
99	36.20	22.80	13.40	.93	20.5	8.6	200.0	1.69	13.09	24.5	61.5	14.0
100	37.80	20.70	17.10	.92	19.6	8.6	200.0	1.44	14.70	22.0	63.0	15.0

TRANSECT NO. 3 FIELD (B-4) 200 CM SPACING

SITE NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AR	MEAN DIAMETER	PH	EC	BULK DENSITY	MOISTURE CONTENT
1	25.10	12.30	12.80	.68	53.20	8.60	159.00	1.31	12.29
2	32.50	18.40	14.10	.97	33.80	8.60	176.00	1.02	16.68
3	30.30	17.80	12.50	.87	40.90	8.50	200.00	1.22	14.64
4	28.90	14.90	14.00	.82	42.80	8.60	199.00	1.21	14.34
5	30.60	16.30	14.30	.88	39.80	8.60	210.00	1.12	13.37
6	30.80	16.90	13.90	.90	37.00	8.60	225.00	1.10	14.38
7	29.90	16.00	13.90	.86	38.40	8.60	225.00	1.24	13.21
8	30.50	16.60	13.70	.89	36.00	8.60	225.00	1.44	12.39
9	29.50	16.00	13.50	.83	41.60	8.70	200.00	1.36	12.37
10	28.90	15.60	13.30	.93	33.20	8.60	230.00	1.30	12.43
11	28.90	15.40	13.50	.83	40.80	8.60	200.00	1.07	13.44
12	29.10	15.10	14.00	.83	42.90	8.60	200.00	1.24	13.19
13	28.10	15.20	12.90	.85	41.00	8.60	200.00	1.28	12.68
14	28.90	15.50	13.40	.90	36.90	8.60	189.00	1.02	14.49
15	29.30	16.00	13.30	.83	41.80	8.60	200.00	1.17	13.27
16	29.70	16.70	13.00	.98	28.30	8.70	198.00	1.02	15.02
17	26.70	15.90	10.80	.79	43.20	8.60	186.00	1.35	14.06
18	28.50	15.90	12.60	.84	39.90	8.60	200.00	1.33	15.88
19	28.60	16.00	12.60	.68	44.50	8.60	191.00	1.37	13.00
20	29.80	16.80	13.00	.87	40.30	8.60	200.00	1.36	13.61
21	29.70	16.50	13.20	.66	42.40	8.60	205.00	1.37	16.61
22	31.70	19.90	11.80	1.03	26.50	8.60	197.00	1.38	15.14
23	33.60	20.70	12.90	1.10	23.30	8.80	230.00	1.22	19.18
24	32.30	18.90	13.40	.96	30.30	8.50	200.00	1.30	15.58
25	31.50	17.80	13.70	1.05	24.70	8.30	245.00	1.31	16.10
26	32.10	21.90	10.20	.97	29.10	8.30	320.00	1.31	17.40
27	32.80	21.40	11.40	.94	27.30	8.40	240.00	1.39	16.64
28	34.70	18.80	15.90	1.00	22.00	8.20	249.00	1.26	18.29
29	33.70	19.20	14.50	.99	25.90	8.30	265.00	1.28	16.77
30	34.30	19.50	14.80	.97	26.50	8.40	240.00	1.46	15.82

TRANSECT NO. 3 FIELD (B-4) 200 CM SPACING (Continued)

31	27.60	14.00	13.60	.76	41.00	8.50	200.00	1.06	15.64
32	31.90	19.30	12.60	.90	34.50	8.40	225.00	1.31	18.60
33	30.20	16.90	13.30	.87	34.10	8.40	215.00	1.36	16.22
34	31.10	17.60	13.50	.90	36.20	8.30	205.00	1.10	20.13
35	33.60	21.60	12.00	1.00	26.90	8.40	225.00	1.29	21.70
36	36.30	20.00	16.30	1.10	16.00	8.40	250.00	1.33	24.01
37	31.50	21.70	9.80	.85	32.90	8.30	235.00	1.00	17.39
38	37.90	24.30	13.60	1.12	12.60	8.40	235.00	.93	25.45
39	38.00	25.50	12.50	1.08	17.40	8.30	249.00	1.19	24.78
40	37.40	24.80	12.60	1.03	15.70	8.30	249.00	1.14	25.93
41	38.20	22.30	15.90	1.13	12.50	8.40	235.00	1.16	25.07
42	35.60	22.10	13.50	1.13	13.70	8.40	225.00	1.18	22.96
43	37.60	24.00	13.60	1.12	13.90	8.40	255.00	1.27	24.95
44	38.80	21.60	17.20	1.10	14.00	8.50	250.00	1.23	24.65
45	37.50	22.30	15.20	1.06	14.40	8.40	245.00	1.10	24.07
46	34.50	20.00	14.50	1.02	16.90	8.30	250.00	1.10	23.36
47	37.90	22.90	15.00	1.02	15.90	8.40	245.00	1.21	28.03
48	39.30	19.40	19.90	1.08	13.00	8.50	270.00	1.20	24.97
49	38.80	20.10	18.70	1.02	15.90	8.20	235.00	1.36	26.12
50	36.70	17.30	19.40	.92	18.00	8.30	225.00	1.14	25.56
51	36.70	22.70	14.00	1.16	11.20	8.40	228.00	1.28	22.13
52	36.40	21.20	15.20	1.06	18.30	8.40	240.00	1.31	24.16
53	35.90	19.60	16.10	.97	19.80	8.30	225.00	1.40	23.82
54	37.60	19.60	18.00	1.05	15.90	8.40	225.00	1.13	26.00
55	36.50	22.70	13.80	.78	27.90	8.40	250.00	1.23	25.51
56	31.20	16.60	14.60	.88	29.80	8.30	225.00	1.18	19.76
57	27.20	13.80	13.40	.76	41.80	8.40	250.00	1.31	14.69
58	33.00	17.30	15.70	.88	27.70	8.30	260.00	1.34	22.20
59	36.10	19.30	16.80	1.01	17.10	8.30	265.00	1.26	23.85
60	36.50	18.60	17.90	.92	23.30	8.40	260.00	1.19	23.69
61	35.00	17.40	17.60	.87	23.90	8.30	225.00	1.13	24.97
62	34.50	17.90	16.60	.96	26.90	8.30	200.00	1.22	19.23
63	34.00	17.40	16.60	.91	24.60	8.30	200.00	1.28	23.39
64	39.40	20.50	18.90	1.02	22.10	8.30	215.00	1.18	23.77
65	38.60	19.80	18.80	1.01	15.30	8.40	215.00	1.30	24.48

TRANSECT NO. 3 FIELD (B-4) 200 CM SPACING

66	34.90	20.70	14.20	.96	23.60	8.40	200.00	1.16	23.94
67	34.80	18.30	16.50	.94	19.30	8.50	245.00	1.37	23.97
68	37.00	19.60	17.40	.94	18.20	8.50	225.00	1.35	23.40
69	37.30	18.90	18.40	.96	22.70	8.30	230.00	1.37	25.18
70	35.30	18.80	16.50	.98	18.10	8.40	200.00	1.24	21.43
71	37.00	20.00	17.00	1.01	20.00	8.50	235.00	1.37	23.11
72	37.30	18.70	18.60	1.08	11.90	8.50	240.00	1.30	23.70
73	37.40	23.30	14.10	1.12	11.70	8.20	205.00	1.27	24.87
74	37.90	21.90	16.00	1.19	9.64	8.30	210.00	1.24	24.09
75	39.00	21.90	17.10	1.18	9.51	8.30	240.00	1.28	25.55
76	34.90	19.50	15.40	1.06	20.30	8.40	225.00	1.31	20.63
77	35.50	19.80	15.70	1.09	12.80	8.30	249.00	1.27	24.89
78	34.60	17.80	16.80	.92	21.50	8.60	260.00	1.24	24.35
79	33.20	16.90	16.30	.92	27.10	8.50	230.00	1.23	23.18
80	36.60	20.90	15.70	1.03	16.00	8.50	275.00	1.25	24.78
81	34.70	17.60	16.90	.96	19.00	8.40	235.00	1.28	21.99
82	38.80	19.30	19.50	1.00	14.60	8.50	260.00	1.31	26.69
83	37.60	18.70	18.90	1.00	16.70	8.50	245.00	1.26	25.39
84	36.00	18.70	17.30	.94	18.30	8.50	250.00	1.31	24.97
85	39.30	19.10	20.20	.90	20.10	8.40	290.00	1.18	26.92
86	36.80	23.10	13.70	.95	20.20	8.40	300.00	1.29	25.18
87	35.60	21.80	13.80	.98	17.00	8.50	260.00	1.32	24.94
88	39.50	23.50	16.00	1.07	14.00	8.40	335.00	1.27	24.90
89	36.50	20.10	16.40	.95	19.70	8.50	275.00	1.22	25.57
90	38.90	17.90	21.00	.91	22.80	8.50	290.00	1.27	24.92
91	37.70	19.40	18.30	1.00	16.70	8.50	275.00	1.36	24.99
92	36.60	23.90	12.70	.96	21.80	8.40	350.00	1.32	23.77
93	34.90	16.80	18.10	.88	22.60	8.30	305.00	1.41	25.54
94	35.20	16.80	18.40	.80	26.40	8.30	275.00	1.28	26.22

TRANSECT NO. 4 FIELD (B-4) 20 CM SPACING

SITE NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC
1	37.20	18.50	18.70	.94	22.60	8.50	280.00
2	38.00	19.60	18.40	.96	21.40	8.40	280.00
3	37.00	19.60	17.40	.94	22.40	8.50	240.00
4	36.20	17.80	18.40	.84	26.80	8.50	210.00
5	35.20	16.00	19.20	.82	24.70	8.70	170.00
6	35.90	16.90	19.00	.88	22.30	8.60	180.00
7	37.70	17.00	20.70	.86	23.70	8.70	160.00
8	38.70	18.80	19.90	.86	24.20	8.80	160.00
9	36.70	19.20	17.50	.95	27.30	8.60	170.00
10	37.70	19.80	17.90	.94	19.80	8.70	175.00
11	40.40	18.10	22.30	.87	20.80	8.60	180.00
12	38.10	18.50	19.60	.86	23.30	8.60	155.00
13	34.90	16.30	18.60	.90	21.50	8.70	150.00
14	36.10	17.90	18.20	.94	17.50	8.70	170.00
15	39.10	18.00	21.10	.88	22.30	8.60	167.00
16	38.10	21.00	17.10	.92	22.70	8.60	180.00
17	36.30	17.80	18.50	.80	27.00	8.60	179.00
18	35.90	17.80	18.10	.91	22.60	8.80	210.00
19	38.50	17.80	20.70	.86	22.20	8.70	174.00
20	39.10	19.60	19.50	1.00	15.40	8.50	185.00
21	38.20	19.70	18.50	.96	16.70	8.60	182.00
22	37.30	20.60	16.70	.90	18.10	8.70	171.00
23	35.90	20.20	15.70	.88	24.80	8.70	182.00
24	37.00	18.10	18.90	.87	21.00	8.60	160.00
25	39.90	20.50	19.40	.96	16.90	8.60	190.00
26	39.00	18.90	20.10	.90	15.40	8.70	200.00
27	38.80	20.20	18.60	.90	21.70	8.70	220.00
28	38.10	19.60	18.50	.89	23.50	8.80	200.00
29	37.70	18.10	19.60	.89	21.20	8.80	200.00
30	37.60	17.60	20.00	.94	16.20	8.60	185.00
31	40.40	18.10	22.30	.90	17.30	8.60	195.00
32	38.70	17.10	21.60	.88	19.50	8.60	200.00
33	37.10	18.30	18.80	.90	21.40	8.70	180.00
34	37.90	17.50	20.40	.86	23.70	8.70	168.00
35	38.10	18.50	19.60	.97	16.00	8.60	192.00
36	38.30	19.40	18.90	.91	23.40	8.60	200.00
37	37.30	17.70	19.60	.90	22.00	8.60	191.00
38	37.60	17.00	20.60	.86	21.90	8.50	184.00
39	36.90	18.80	18.10	.94	23.00	8.50	200.00
40	37.50	19.30	18.20	1.00	18.40	8.60	195.00

TRANSECT NO. 4 FIELD (B-4) 20 CM SPACING (Continued)

41	37.60	18.80	18.80	.92	19.30	8.70	200.00
42	37.60	17.20	20.40	.90	19.00	8.70	175.00
43	37.20	18.40	18.80	.95	25.60	8.60	172.00
44	39.40	18.30	21.10	.90	22.20	8.60	174.00
45	39.40	18.20	21.20	.84	22.70	8.60	170.00
46	38.00	17.60	20.40	.83	23.40	8.80	172.00
47	38.10	16.80	21.30	.85	22.90	8.70	170.00
48	35.90	16.40	19.50	.84	25.30	8.70	192.00
49	37.00	17.00	20.00	.82	26.00	8.70	182.00
50	39.20	21.70	17.50	.93	21.40	8.60	200.00
51	37.70	17.50	20.20	.91	22.60	8.60	195.00
52	37.50	17.90	19.60	.88	24.50	8.70	168.00
53	35.70	17.40	18.30	.93	24.90	8.60	170.00
54	34.90	16.80	18.10	.88	26.20	8.70	165.00
55	37.30	21.60	15.70	.93	23.10	8.70	193.00
56	37.40	17.60	19.80	.69	24.40	8.70	192.00
57	35.30	16.50	18.80	.95	19.10	8.70	161.00
58	32.90	17.20	15.70	.93	26.50	8.60	163.00
59	37.00	17.60	19.40	.85	24.90	8.60	168.00
60	39.60	19.20	20.40	.92	21.00	8.70	180.00
61	40.10	19.70	20.40	.92	18.30	8.60	197.00
62	39.20	19.60	19.60	.94	23.00	8.50	186.00
63	36.60	17.00	19.60	.89	23.00	8.60	178.00
64	39.40	20.20	19.20	1.03	20.20	8.60	175.00
65	39.20	17.60	21.60	.82	25.00	8.50	175.00
66	36.10	16.40	19.70	.75	27.50	8.60	181.00
67	35.50	15.00	20.50	.72	29.90	8.60	165.00
68	31.40	14.90	16.50	.79	30.90	8.70	180.00
69	36.20	16.20	20.00	.83	25.00	8.60	181.00
70	37.10	16.60	20.50	.79	26.00	8.70	167.00
71	38.90	15.60	23.30	.70	28.10	8.60	192.00
72	36.40	16.30	20.10	.80	27.00	8.70	181.00
73	37.00	16.10	20.90	.81	27.60	8.70	191.00
74	38.40	16.50	21.90	.80	26.70	8.70	178.00
75	38.40	19.70	18.70	.88	24.30	8.50	170.00
76	37.50	16.20	21.30	.79	25.50	8.50	175.00
77	34.00	16.30	17.70	.84	25.30	8.70	160.00
78	35.40	18.40	17.00	.87	28.90	8.70	183.00
79	35.60	20.40	15.20	.95	23.10	8.70	186.00
80	34.90	17.00	17.90	.88	24.00	8.90	183.00
81	35.40	17.30	18.10	.85	25.50	8.90	184.00
82	37.00	22.40	14.60	1.04	17.20	8.90	193.00
83	35.80	18.80	17.00	1.01	19.50	8.90	177.00
84	35.90	17.20	18.70	.89	24.30	8.80	186.00
85	33.90	16.60	17.30	.88	31.20	8.70	180.00
86	36.40	17.50	18.90	.90	21.90	8.80	189.00
87	34.20	16.90	17.30	.88	25.70	8.90	200.00
88	32.10	15.90	16.20	.87	28.30	9.00	195.00
89	35.00	17.10	17.90	.90	20.60	8.60	170.00
90	38.40	17.60	20.80	.93	17.50	8.50	195.00
91	39.60	18.00	21.60	.82	22.70	8.60	185.00
92	35.50	15.90	19.60	.85	24.30	8.80	178.00
93	34.90	16.70	18.20	.88	26.40	8.70	192.00
94	37.40	17.70	19.70	.81	27.00	8.70	200.00
95	35.50	15.80	19.70	.74	29.40	8.60	200.00
96	37.00	18.00	19.00	.85	23.90	8.60	194.00
97	33.00	15.70	17.30	.90	22.10	8.70	200.00
98	30.40	15.40	15.00	.63	35.50	8.70	210.00
99	36.40	16.80	19.60	.82	26.90	8.60	210.00
100	38.40	18.20	20.20	.96	16.00	8.50	240.00

TRANSECT NO. 4 FIELD (B-4) 200 CM SPACING

SITE NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC
1	35.10	19.20	15.90	.88	33.90	8.50	164.00
2	34.40	19.00	15.40	.84	36.80	8.50	168.00
3	34.70	18.50	16.20	.79	35.00	8.50	147.00
4	35.40	19.20	16.20	.79	33.20	8.50	146.00
5	35.20	20.40	14.80	.89	33.40	8.50	163.00
6	34.80	22.50	12.30	.87	30.70	8.50	165.00
7	34.30	18.60	15.70	.79	36.00	8.50	166.00
8	33.90	19.60	14.30	.87	31.00	8.60	165.00
9	33.40	21.30	12.10	.83	38.80	8.50	155.00
10	36.40	19.90	16.50	.91	28.90	8.50	182.00
11	36.30	20.70	15.60	1.01	27.90	8.50	157.00
12	35.30	22.70	12.60	.74	39.70	8.60	146.00
13	34.80	20.40	14.40	.97	33.30	8.50	153.00
14	34.00	18.20	15.80	.81	37.00	8.50	151.00
15	36.40	22.80	13.60	.79	34.50	8.60	151.00
16	35.30	16.90	18.40	.84	28.60	8.60	162.00
17	35.80	22.00	13.80	.96	26.30	8.50	160.00
18	35.80	20.60	15.20	.90	32.40	8.60	161.00
19	36.00	22.60	13.40	.85	35.40	8.50	171.00
20	38.00	20.20	17.80	.87	31.00	8.60	175.00
21	30.40	19.80	10.60	.92	38.90	8.60	145.00
22	38.50	22.00	16.50	.85	26.30	8.60	147.00
23	35.10	21.00	14.10	.82	37.20	8.70	156.00
24	39.40	22.40	17.00	.98	25.10	8.70	164.00
25	37.80	23.20	14.60	.96	22.50	8.40	173.00
26	39.40	23.00	16.40	.97	22.20	8.40	154.00
27	39.20	25.80	13.40	1.00	25.60	8.40	163.00
28	38.60	22.40	16.20	.93	27.40	8.50	160.00
29	38.00	22.30	15.70	.90	29.30	8.40	168.00
30	37.20	21.90	15.30	.86	27.70	8.40	184.00

TRANSECT NO. 4 FIELD (B-4) 200 CM SPACING (Continued)

31	41.30	20.90	20.40	.96	19.30	8.30	188.00
32	38.80	22.60	16.20	.93	27.70	8.50	175.00
33	37.90	19.00	18.90	.90	26.10	8.50	165.00
34	37.30	22.00	15.30	.86	29.50	8.40	200.00
35	37.90	19.00	18.90	.89	32.80	8.40	180.00
36	37.50	21.40	16.10	.94	27.90	8.40	160.00
37	34.60	17.30	17.30	.79	37.30	8.30	160.00
38	35.20	19.60	15.60	.77	36.60	8.50	165.00
39	39.50	20.50	19.00	.93	29.70	8.40	160.00
40	29.70	13.70	16.00	.70	50.00	8.50	143.00
41	36.30	18.10	18.20	.86	31.30	8.50	150.00
42	38.20	18.60	19.60	.89	28.50	8.50	156.00
43	36.20	17.90	18.30	.94	27.40	8.50	170.00
44	34.90	18.20	16.70	.99	25.30	8.40	180.00
45	41.30	22.50	18.80	1.12	14.60	8.50	183.00
46	37.60	17.60	20.00	.92	18.80	8.60	142.00
47	37.30	24.00	13.30	.97	19.10	8.50	165.00
48	35.90	18.80	16.70	.88	20.90	8.60	153.00
49	38.30	21.00	17.30	.95	21.00	8.30	193.00
50	33.00	16.60	16.40	.88	35.00	8.20	170.00
51	34.70	20.60	14.10	.96	19.10	8.40	159.00
52	35.50	17.30	18.20	.92	21.90	8.40	181.00
53	32.70	19.00	13.70	.91	26.00	8.40	168.00
54	34.30	17.10	17.20	.86	26.00	8.40	168.00
55	31.10	17.10	14.00	.89	31.10	8.30	175.00
56	32.40	17.40	15.00	.86	26.50	8.40	168.00
57	34.00	17.60	16.40	.87	27.70	8.40	171.00
58	33.80	16.60	17.20	.90	25.70	8.40	181.00
59	32.00	15.60	16.40	.88	27.10	8.50	200.00
60	31.10	16.10	15.00	.92	21.50	8.50	182.00
61	31.30	16.40	14.90	.91	27.70	8.50	173.00
62	32.60	15.90	16.70	.86	25.60	8.50	164.00
63	29.30	14.70	14.60	.82	32.70	8.50	168.00
64	34.00	16.20	17.80	.94	20.60	8.50	173.00
65	34.90	18.20	16.70	.86	29.90	8.30	172.00

TRANSECT NO. 4 FIELD (B-4) 200 CM SPACING (Continued)

66	33.80	15.00	18.80	.83	27.80	8.40	168.00
67	26.70	11.10	15.60	.64	52.60	8.50	143.00
68	29.50	14.20	15.30	.86	32.90	8.40	160.00
69	31.80	14.90	16.90	.86	27.90	8.60	162.00
70	26.50	13.10	13.40	.81	38.10	8.70	132.00
71	29.40	14.40	15.00	.81	36.80	8.70	149.00
72	28.00	13.50	14.50	.83	34.10	8.70	137.00
73	31.40	15.10	16.30	.87	26.70	8.70	150.00
74	30.60	15.70	14.90	.89	31.90	8.80	145.00
75	27.40	17.40	10.00	.62	33.80	8.70	140.00
76	26.70	17.10	9.60	.93	28.40	8.70	144.00
77	34.20	17.00	17.20	.94	26.70	8.70	142.00
78	32.30	17.20	15.10	.92	25.20	8.80	150.00
79	32.80	15.50	17.30	.84	28.20	8.70	145.00
80	27.10	12.70	14.40	.79	32.90	8.80	147.00
81	32.70	15.60	17.10	.81	25.10	8.60	145.00
82	32.30	19.70	12.60	.96	25.40	8.70	147.00
83	32.30	17.30	15.00	1.04	19.90	8.60	170.00
84	32.50	18.20	14.30	.91	22.00	8.70	148.00
85	34.40	17.60	16.80	.89	22.20	8.60	149.00
86	29.60	15.20	14.40	.87	32.70	8.60	149.00
87	32.60	16.80	15.80	.91	24.50	8.80	148.00
88	30.10	15.90	14.20	.94	23.70	8.70	165.00
89	30.10	15.50	14.60	.91	27.30	8.70	143.00
90	26.60	13.90	12.70	.85	35.50	8.70	145.00
91	27.70	14.70	13.00	.88	32.20	8.70	149.00
92	26.40	13.90	12.50	.86	33.40	8.80	133.00
93	27.70	15.50	12.20	.88	30.20	8.70	166.00
94	34.90	19.80	15.10	.98	15.00	8.90	200.00
95	39.10	19.20	19.90	.95	22.20	8.50	225.00
96	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
97	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
98	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
99	39.50	19.00	20.50	.88	21.30	8.80	195.00
100	35.30	17.70	17.60	.83	24.90	8.70	173.00

2,000-CM SPACING TRANSECT

SITE NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC
1	43.70	18.00	25.70	1.15	11.00	8.90	200.00
2	33.40	15.00	18.40	.88	28.60	8.80	124.00
3	31.90	13.80	18.10	.79	36.40	8.90	128.00
4	26.30	10.40	15.90	1.10	22.50	9.00	125.00
5	29.20	8.10	21.10	.52	51.50	9.00	123.00
6	29.30	12.60	16.70	1.11	30.60	8.90	127.00
7	25.30	10.40	14.90	.92	44.30	8.80	121.00
8	34.30	11.50	22.80	.80	24.40	8.90	118.00
9	25.60	11.00	14.60	1.03	27.10	8.90	126.00
10	21.10	9.20	11.90	.97	31.20	9.10	149.00
11	28.30	11.90	16.40	1.10	19.60	9.10	182.00
12	29.90	12.60	17.30	1.00	26.10	8.40	600.00
13	19.60	8.00	11.60	.76	47.10	8.90	128.00
14	27.60	12.10	15.50	.99	26.90	8.90	158.00
15	30.00	16.10	13.90	.94	24.10	9.00	161.00
16	28.60	13.60	15.00	.96	27.60	8.90	144.00
17	35.50	21.60	13.90	1.00	19.40	8.80	154.00
18	34.00	15.50	18.50	1.01	18.80	8.80	155.00
19	31.40	16.40	15.00	.97	21.30	8.80	152.00
20	32.00	15.30	16.70	.94	19.30	8.90	155.00
21	33.00	14.10	18.90	1.00	18.90	8.90	150.00
22	37.90	14.00	23.90	.92	17.40	8.90	180.00
23	31.10	13.90	17.20	.83	23.60	9.00	146.00
24	25.70	9.60	16.10	.99	17.60	9.10	193.00
25	19.10	7.40	11.70	1.05	27.20	8.90	155.00
26	21.60	7.70	13.90	.90	27.20	8.90	143.00
27	20.80	8.10	12.70	1.00	24.60	8.90	150.00
28	29.60	11.70	17.90	1.00	20.10	8.90	182.00
29	33.80	17.80	16.00	1.12	12.00	8.80	166.00
30	35.80	16.10	19.70	1.10	12.40	8.70	200.00
31	37.40	15.80	21.60	.99	16.50	8.70	184.00
32	42.90	20.60	22.30	1.20	12.00	8.60	198.00
33	42.60	19.20	23.40	1.19	12.90	8.70	167.00
34	44.30	23.10	21.20	1.30	9.97	8.60	200.00
35	48.30	24.30	24.00	1.30	8.77	8.60	275.00
36	36.80	18.20	18.60	1.00	14.00	8.80	185.00
37	42.30	23.30	19.00	1.16	11.20	8.60	210.00
38	41.90	20.90	21.00	1.17	12.10	8.70	200.00
39	35.70	16.20	19.50	.92	25.90	8.70	170.00
40	37.40	19.30	18.10	.91	28.80	8.70	175.00

2,000-CM SPACING TRANSECT (Continued)

41	42.10	24.00	18.10	1.21	12.40	8.70	180.00
42	46.90	26.10	20.80	1.42	6.80	8.70	220.00
43	48.30	23.90	24.40	1.34	8.20	8.70	250.00
44	44.70	22.40	22.30	1.29	9.23	8.70	245.00
45	38.10	21.70	16.40	1.01	24.80	8.80	265.00
46	41.60	17.50	24.10	1.05	13.50	8.70	159.00
47	43.00	18.00	25.00	1.03	13.10	8.70	165.00
48	35.30	11.50	23.90	.80	31.40	8.80	160.00
49	36.10	13.60	22.50	.88	29.30	8.80	155.00
50	38.70	13.50	25.20	.70	30.20	8.80	190.00
51	33.00	10.70	22.30	.66	36.60	8.80	174.00
52	39.90	15.70	24.20	.89	24.90	8.80	220.00
53	35.30	13.90	21.40	.77	31.10	8.80	174.00
54	36.60	13.90	22.70	.85	29.00	8.80	165.00
55	36.80	14.20	22.00	.81	27.20	8.90	210.00
56	34.20	13.10	21.10	.80	30.75	8.80	165.00
57	31.80	16.50	15.30	1.29	15.10	8.80	167.00
58	32.90	14.50	18.40	.76	33.60	8.70	145.00
59	25.00	9.60	15.40	.76	39.80	8.80	135.00
60	33.90	11.80	22.10	.63	35.50	8.70	153.00
61	17.50	6.00	11.50	.47	64.10	8.90	119.00
62	31.30	10.30	21.00	.58	37.60	8.60	138.00
63	30.70	12.40	18.30	.72	37.80	8.60	149.00
64	38.50	14.40	24.10	.87	20.90	8.60	177.00
65	32.20	12.00	20.20	.68	36.20	8.70	155.00
66	35.40	12.20	23.20	.68	28.00	8.70	173.00
67	31.60	10.40	21.20	.61	38.10	8.70	155.00
68	27.70	10.70	17.00	.67	33.20	8.70	162.00
69	32.40	11.10	21.30	.63	37.70	8.70	164.00
70	34.00	13.40	20.60	.88	22.20	8.70	168.00
71	31.50	11.00	20.50	.67	34.80	8.80	161.00
72	21.80	6.50	15.30	.57	50.20	8.80	163.00
73	30.00	10.40	19.60	.68	38.90	8.80	167.00
74	37.10	13.30	23.80	.88	21.30	8.70	195.00
75	31.10	16.50	14.60	.71	36.90	8.70	178.00
76	38.00	13.60	24.40	.84	21.60	8.70	198.00
77	28.70	11.50	17.20	.72	40.10	8.70	170.00
78	33.50	13.00	20.50	.90	21.40	8.80	180.00
79	21.80	8.30	13.50	.76	36.10	8.90	149.00
80	20.80	8.10	12.70	.80	37.90	8.90	149.00
81	29.00	11.60	17.40	.90	22.50	8.90	193.00
82	35.00	18.20	16.80	1.00	20.80	8.70	190.00
83	32.00	13.50	18.50	.98	19.80	8.90	176.00
84	25.20	10.10	15.10	.87	34.70	8.80	155.00
85	31.40	11.80	19.60	.87	31.30	8.90	200.00
86	26.90	12.30	14.60	.91	27.60	8.80	190.00
87	27.50	12.60	14.90	.92	29.80	8.70	195.00
88	25.10	13.20	11.90	.95	28.70	8.70	179.00
89	32.40	15.00	17.40	.88	24.20	8.80	200.00
90	26.70	12.80	13.90	1.00	24.90	8.80	195.00
91	29.80	13.40	16.40	.91	26.70	8.80	195.00
92	28.00	11.90	16.10	.95	29.00	8.80	185.00
93	34.20	19.70	14.50	.89	26.70	8.70	191.00
94	28.80	13.00	15.80	.84	33.70	8.80	179.00
95	29.40	13.20	16.20	.82	34.40	8.70	183.00

APPENDIX B

AUTOCORRELATION COEFFICIENTS AS A FUNCTION OF DISTANCE LAGS

For all transect-parameter combinations.

TRANSECT NO. 1 FIELD (C-2) 20 CM SPACING

LAG NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	.52	.58	.70	.40	.27	.66	.49
2	.58	.61	.67	.48	.38	.47	.17
3	.54	.58	.62	.32	.26	.45	.03
4	.45	.49	.60	.40	.32	.32	.05
5	.55	.45	.64	.32	.28	.29	.10
6	.47	.38	.61	.35	.24	.34	.34
7	.53	.37	.65	.20	.18	.27	.27
8	.47	.27	.55	.21	.12	.16	.00
9	.44	.17	.54	.11	.04	.15	-.25
10	.49	.11	.53	.14	.04	.09	-.22
11	.38	.12	.38	.08	-.03	.14	-.08
12	.40	.01	.41	.08	.04	.25	.10
13	.31	.01	.33	.11	-.01	.09	.21
14	.35	.06	.38	.16	.07	-.04	.07
15	.28	-.07	.33	.02	-.05	.01	-.08
16	.25	-.00	.29	.02	-.00	-.04	-.03
17	.30	-.11	.34	-.05	-.11	-.09	.06
18	.15	-.07	.23	.02	.02	-.10	.14
19	.14	-.08	.25	-.00	.02	-.09	.34
20	.13	-.12	.25	-.08	.03	-.10	.30
21	.06	-.10	.22	-.15	-.11	-.09	.10
22	.14	-.06	.23	-.17	-.02	-.04	-.00
23	-.00	-.04	.23	-.12	.01	-.00	.16
24	-.01	-.04	.25	-.13	-.02	.04	.15
25	-.03	.06	.17	-.21	-.01	.04	.23

TRANSECT NO. 1 FIELD (C-2) 200 CM SPACING

LAG NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	.36	.56	.28	.39	.32	.63	.29
2	.35	.53	.07	.22	.07	.50	.45
3	.21	.49	.07	.11	-.03	.45	.25
4	.24	.39	.14	.14	-.06	.35	.26
5	.26	.30	.12	.22	.11	.32	.26
6	.14	.36	.16	.24	.19	.18	.24
7	.20	.30	.11	.10	.09	.10	.32
8	.06	.27	-.10	-.08	-.10	.05	.21
9	.15	.39	-.20	.06	-.06	.07	.31
10	.00	.31	-.07	-.01	.09	-.09	.09
11	.03	.35	-.07	.13	.19	-.02	.27
12	-.00	.32	-.04	-.01	.16	-.01	.03
13	.01	.36	.03	-.02	.12	-.10	.17
14	-.01	.32	-.12	-.01	-.09	-.08	.16
15	.01	.27	-.08	.05	-.10	-.04	.17
16	.03	.33	-.08	.13	.09	-.05	.15
17	.10	.28	.03	.05	.07	-.05	.07
18	.11	.30	-.05	.00	.01	.02	.17
19	.06	.30	-.06	-.07	-.07	-.05	.04
20	.20	.20	-.06	-.04	-.11	-.04	.16
21	.10	.14	-.16	-.12	.00	.03	.05
22	.21	.28	-.28	-.01	.25	-.05	.23

TRANSECT NO. 2 FIELD (E-3) 20 CM SPACING

LAG NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	.24	.21	.15	.28	.44	.63	.65
2	.13	.27	.11	.32	.30	.48	.46
3	.27	.20	.11	.17	.26	.38	.42
4	.23	.13	.05	.18	.22	.31	.36
5	.24	.14	.12	.31	.33	.27	.25
6	.09	.04	-.01	.10	.20	.18	.19
7	.27	.31	.29	.19	.28	.09	.12
8	.18	.06	.10	.20	.27	.05	.10
9	.04	.17	.02	.21	.25	.11	.06
10	.26	.08	.11	.20	.36	.08	.10
11	.04	-.02	-.03	.07	.18	.06	.11
12	.16	.13	.06	.10	.17	.08	.12
13	.11	.10	.07	.04	.20	.06	.25
14	.13	.22	.26	.13	.14	.06	.27
15	.11	.09	.14	.06	.07	.07	.25
16	-.01	.10	.04	.13	.06	.08	.21
17	-.02	.02	.11	.06	.16	.22	.15
18	-.08	-.08	-.05	.01	.06	.19	.13
19	.02	-.13	.03	.01	.04	.25	.05
20	.05	-.05	-.01	.01	.06	.28	-.02
21	-.23	-.05	-.04	-.00	.06	.34	-.07
22	.03	.08	.22	.02	.00	.22	-.18
23	-.09	-.19	-.04	-.01	-.03	.23	-.25
24	-.09	-.14	.08	.10	.10	.06	-.23
25	-.10	-.09	-.05	.12	.09	-.09	-.17

TRANSECT NO. 2 FIELD (E-3) 200 CM SPACING

LAG NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	.91	.86	.64	.90	.89	.54	.84
2	.86	.84	.67	.85	.84	.39	.80
3	.82	.77	.55	.78	.75	.28	.76
4	.81	.75	.57	.73	.72	.28	.70
5	.78	.72	.56	.69	.68	.28	.68
6	.75	.69	.53	.67	.66	.33	.69
7	.70	.63	.53	.65	.62	.20	.66
8	.66	.60	.41	.61	.57	.13	.64
9	.65	.59	.48	.58	.55	.07	.59
10	.60	.58	.36	.51	.47	.16	.57
11	.54	.51	.33	.44	.39	.16	.50
12	.48	.45	.39	.34	.27	.22	.44
13	.44	.34	.32	.26	.22	.05	.36
14	.41	.35	.37	.22	.18	.02	.36
15	.41	.33	.33	.20	.18	.05	.37
16	.37	.31	.32	.15	.15	-.01	.34
17	.34	.28	.23	.12	.13	-.12	.36
18	.32	.22	.25	.05	.06	-.10	.29
19	.28	.19	.20	-.00	.02	-.21	.31
20	.21	.13	.15	-.08	-.06	-.14	.33
21	.18	.10	.20	-.11	-.10	-.27	.31

TRANSECT NO. 3 FIELD (B-4) 20 CM SPACING

LAG NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC	BULK DENSITY	WATER CONTENT	CLAY	SILT	SAND
										---------	PERCENT	---------
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	.27	-.01	.21	.47	.55	.88	.88	.63	.75	.83	.91	.85
2	.25	.19	.14	.29	.49	.74	.77	.52	.57	.82	.90	.80
3	.25	-.05	.19	.33	.58	.64	.68	.49	.59	.75	.88	.77
4	.13	.01	.00	.36	.53	.51	.59	.55	.66	.75	.87	.75
5	.02	.00	-.06	.32	.51	.48	.55	.58	.64	.72	.86	.76
6	.08	.05	.16	.25	.54	.49	.48	.55	.53	.71	.86	.76
7	-.02	.05	-.06	.26	.53	.47	.44	.52	.44	.68	.83	.69
8	.02	.09	-.16	.19	.43	.43	.40	.52	.45	.60	.82	.63
9	.02	.14	.01	.23	.40	.42	.38	.42	.42	.67	.80	.63
10	-.03	-.02	-.19	.24	.47	.36	.37	.42	.43	.63	.78	.62
11	.15	.01	-.16	.13	.42	.30	.36	.37	.35	.61	.75	.63
12	.20	-.15	.03	.14	.44	.27	.30	.32	.21	.58	.73	.60
13	.03	.14	.14	.28	.46	.23	.34	.32	.19	.55	.72	.59
14	.05	-.08	-.06	.23	.38	.20	.25	.37	.26	.52	.70	.53
15	-.02	-.07	.01	.13	.35	.21	.18	.32	.24	.49	.60	.52
16	-.01	-.10	.09	-.05	.24	.17	.12	.26	.09	.45	.67	.50
17	.10	-.09	-.11	.07	.38	.13	.09	.21	-.03	.43	.64	.48
18	.01	.09	.02	.14	.41	.10	.05	.16	.02	.41	.62	.47
19	.08	.13	.08	.06	.24	.05	.02	.16	.05	.42	.60	.43
20	.09	-.10	-.03	.18	.25	.02	-.01	.10	-.06	.41	.59	.39
21	-.13	-.14	-.04	.12	.21	.01	-.03	.14	-.17	.42	.56	.35
22	-.00	-.05	-.02	.10	.10	-.01	-.08	.13	-.22	.44	.55	.33
23	-.05	-.25	-.15	.26	.21	-.06	-.12	.03	-.26	.42	.52	.31
24	-.07	.02	-.07	.30	.15	-.09	-.16	-.00	-.22	.46	.50	.20
25	.03	-.02	.01	.26	.10	-.12	-.21	-.02	-.22	.40	.47	.22

TRANSECT NO. 3 FIELD (B-4) 200 CM SPACING

LAG NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC	BULK DENSITY	WATER CONTENT
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	.75	.57	.53	.48	.75	.68	.64	.21	.86
2	.68	.48	.42	.47	.74	.58	.56	.12	.84
3	.66	.48	.46	.39	.60	.59	.51	.13	.82
4	.63	.44	.46	.22	.60	.58	.42	.08	.82
5	.62	.29	.50	.19	.58	.44	.30	.03	.82
6	.60	.29	.47	.23	.57	.45	.28	-.01	.79
7	.49	.20	.36	.14	.51	.45	.27	-.06	.74
8	.47	.19	.43	.16	.50	.42	.27	.00	.71
9	.49	.18	.38	.06	.43	.36	.17	.18	.68
10	.51	.15	.43	.15	.44	.36	.24	.07	.63
11	.47	.18	.43	.06	.41	.40	.21	-.07	.64
12	.41	.23	.39	.10	.40	.39	.18	-.08	.59
13	.41	.21	.40	.13	.40	.31	.16	-.11	.55
14	.39	.12	.40	-.00	.38	.19	.11	-.02	.56
15	.38	.13	.40	-.05	.29	.16	.08	-.17	.49
16	.38	.04	.42	.06	.33	.09	.08	-.12	.45
17	.31	-.00	.30	-.20	.22	.08	.09	-.08	.41
18	.25	-.10	.39	-.04	.24	-.03	.06	-.12	.40
19	.26	-.08	.38	-.22	.19	.01	.07	-.12	.40
20	.34	-.11	.46	-.09	.21	.03	.09	-.10	.38
21	.29	-.10	.36	-.14	.15	-.03	.04	-.13	.31
22	.23	-.12	.27	-.08	.20	-.09	-.04	.04	.30
23	.23	-.16	.21	.04	.23	-.04	-.07	.14	.27

TRANSECT NO. 4 FIELD (B-4) 20 CM SPACING

LAG NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	.46	.33	.32	.43	.38	.51	.60
2	-.00	.13	.12	.19	.09	.16	.32
3	-.01	.13	.07	.22	.20	.09	.09
4	.18	.18	.18	.28	.28	.18	-.02
5	.26	.19	.13	.11	.21	.23	-.01
6	-.01	.08	-.02	.02	.20	.12	-.10
7	-.15	.06	-.11	.11	.21	-.03	-.05
8	.02	-.03	-.25	-.09	.10	-.04	-.03
9	.34	.05	-.11	-.20	.14	-.03	-.00
10	.45	.00	.01	-.07	.35	.05	-.04
11	.25	.04	-.12	-.08	.21	-.02	-.13
12	.10	-.02	-.23	-.30	-.00	-.18	-.08
13	.06	-.07	-.06	-.26	.09	-.06	-.07
14	.14	.12	.01	-.11	.13	.09	-.06
15	.22	.01	.00	-.13	.08	-.02	-.05
16	.11	-.11	-.11	-.34	-.01	-.21	-.04
17	.07	.04	-.11	-.06	.08	-.26	-.06
18	.07	.13	-.02	.18	.12	-.09	-.11
19	.25	.21	.12	.15	.19	-.10	-.11
20	.34	.23	.16	.17	.31	-.06	-.14
21	.11	.15	-.06	.27	.14	-.13	-.11
22	-.16	.08	-.17	.28	.09	-.13	-.11
23	-.22	.09	-.09	.13	-.06	-.02	-.04
24	-.03	.18	-.01	.18	.00	.05	.07
25	.14	.24	.13	.27	.15	-.04	.13

TRANSECT NO. 4 FIELD (B-4) 200 CM SPACING

LAG NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	.62	.64	.10	.25	.34	.70	.49
2	.60	.71	.32	.14	.32	.66	.25
3	.56	.63	.07	.07	.18	.58	.18
4	.60	.62	.31	.08	.19	.53	.20
5	.47	.54	-.06	.03	.10	.52	.24
6	.48	.58	.29	.08	.06	.47	.14
7	.49	.53	.11	-.05	-.04	.41	.13
8	.49	.49	.19	.02	-.07	.40	.03
9	.41	.52	.08	-.11	-.06	.32	.06
10	.45	.48	.03	-.06	-.05	.36	.14
11	.41	.46	.05	-.05	-.07	.28	.03
12	.46	.47	.03	-.04	-.03	.30	-.02
13	.47	.48	.15	-.03	-.04	.28	-.11
14	.39	.36	-.04	-.03	-.09	.28	.04
15	.40	.38	.29	-.08	-.03	.24	.02
16	.43	.34	-.04	-.10	-.08	.25	-.16
17	.45	.46	.19	.01	.12	.13	-.14
18	.32	.39	-.12	.09	-.04	.18	-.18
19	.39	.44	.03	.06	.06	.07	-.13
20	.34	.40	-.13	-.11	-.05	.05	-.15
21	.30	.38	.09	-.11	.03	-.03	-.22
22	.19	.32	-.15	-.24	-.19	-.08	-.21
23	.22	.28	.02	-.14	-.05	-.07	-.29

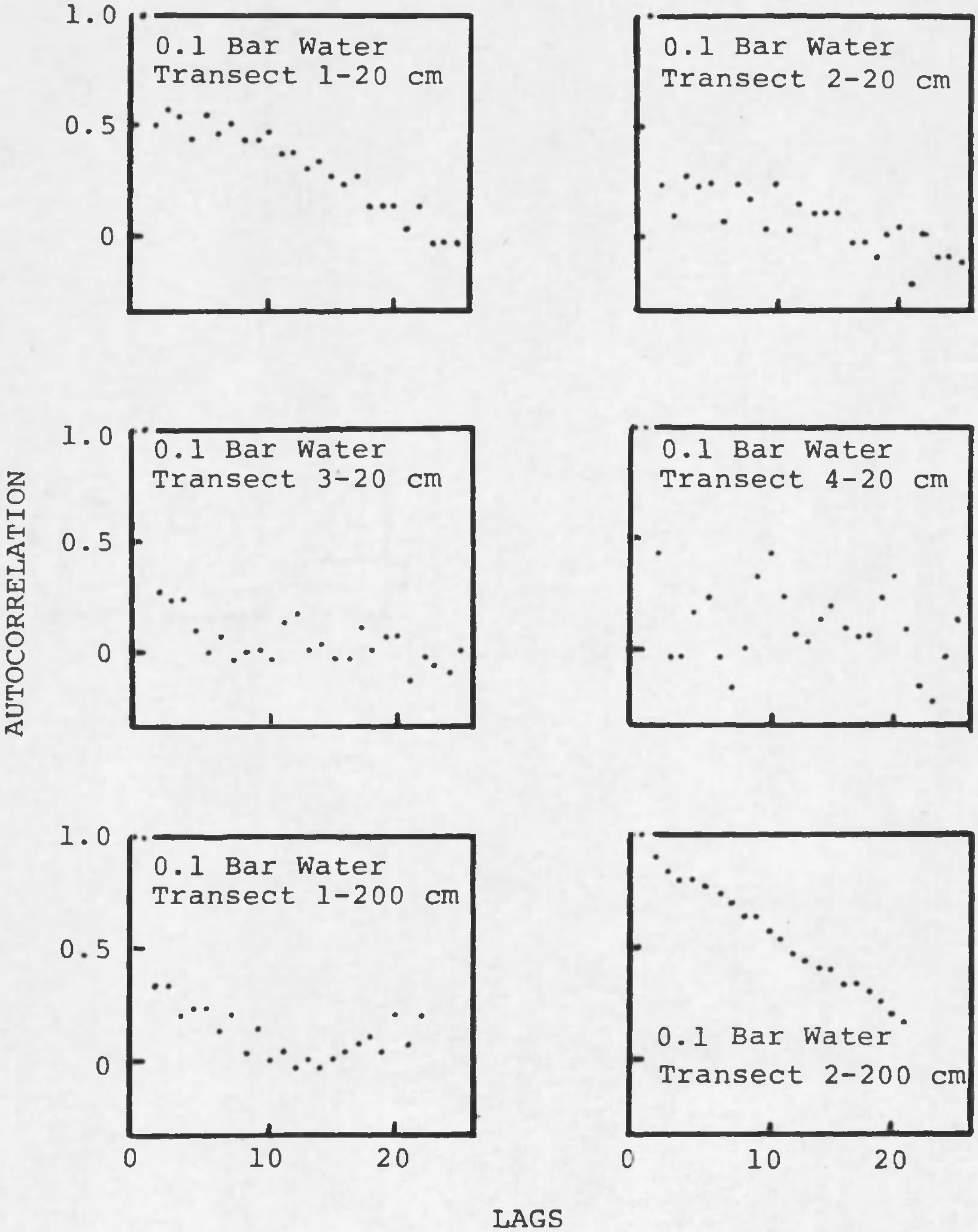
2000 CM SPACING TRANSECT

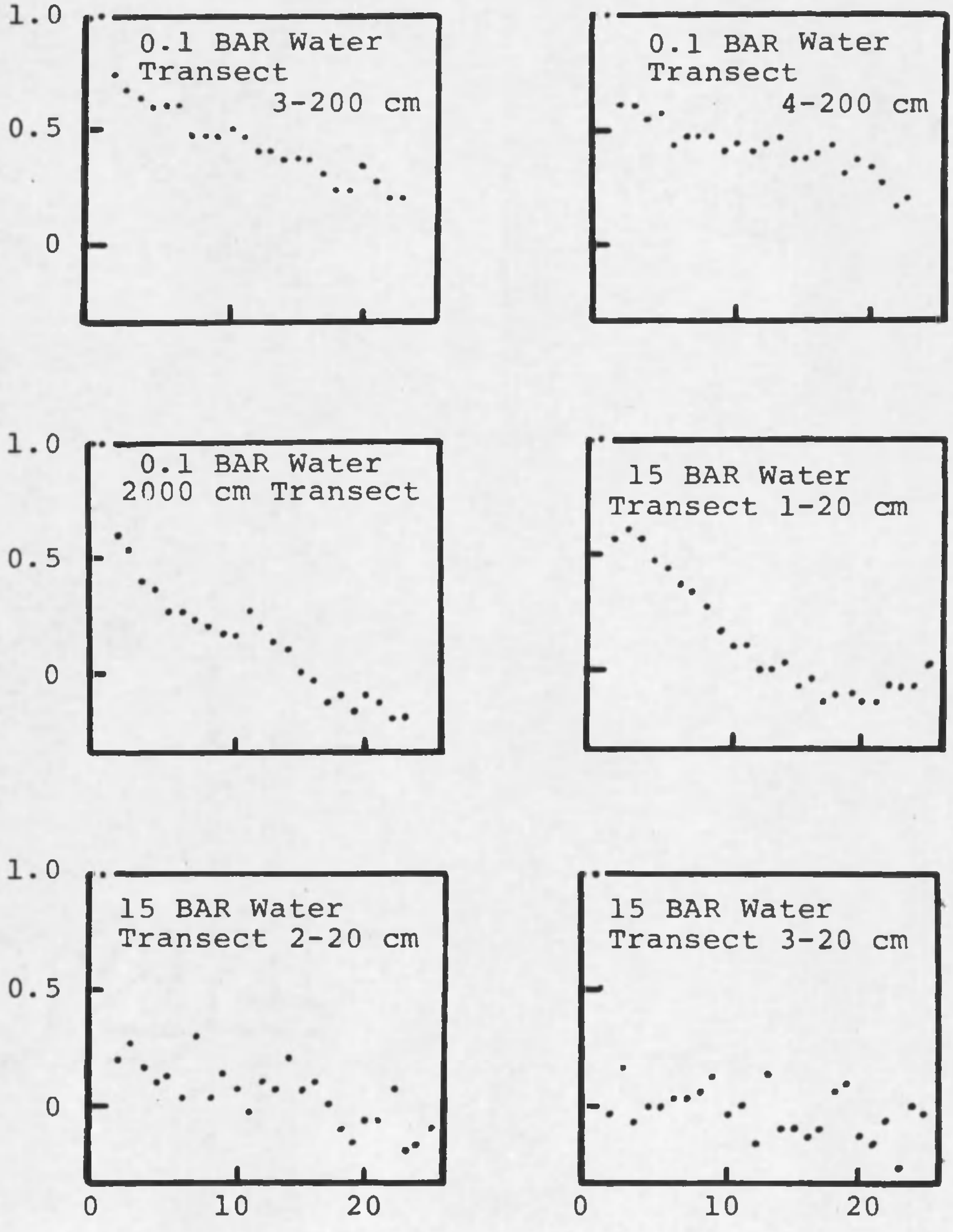
LAG NUMBER	0.1 BARS	15 BARS	AVAILABLE WATER	SURFACE AREA	MEAN DIAMETER	PH	EC
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	.62	.72	.37	.57	.45	.45	.12
2	.55	.59	.47	.54	.45	.37	.09
3	.43	.50	.30	.50	.36	.29	.01
4	.38	.38	.40	.36	.28	.34	-.07
5	.28	.36	.15	.47	.32	.41	-.04
6	.27	.29	.15	.36	.30	.30	-.05
7	.26	.23	.22	.36	.33	.16	-.02
8	.20	.19	.12	.42	.39	.02	-.02
9	.19	.10	.13	.33	.23	.07	-.06
10	.20	.08	.16	.41	.36	.11	.02
11	.27	.17	.19	.34	.32	.01	.05
12	.23	.15	.16	.26	.26	.06	.07
13	.14	.08	.11	.28	.22	.09	.01
14	.12	-.00	.17	.21	.17	.01	-.06
15	.02	-.02	.01	.12	-.01	-.06	-.07
16	-.02	-.12	.14	.03	.02	-.05	-.05
17	-.11	-.11	-.03	-.00	-.08	-.04	-.06
18	-.09	-.07	-.01	-.06	-.04	.04	-.01
19	-.14	-.15	-.08	-.10	-.06	.02	-.04
20	-.09	-.10	-.02	-.12	-.10	.04	.02
21	-.12	-.15	-.03	-.11	-.06	-.07	-.04
22	-.18	-.15	-.14	-.10	-.10	-.01	-.03
23	-.20	-.11	-.15	-.10	-.10	.02	.15

APPENDIX C

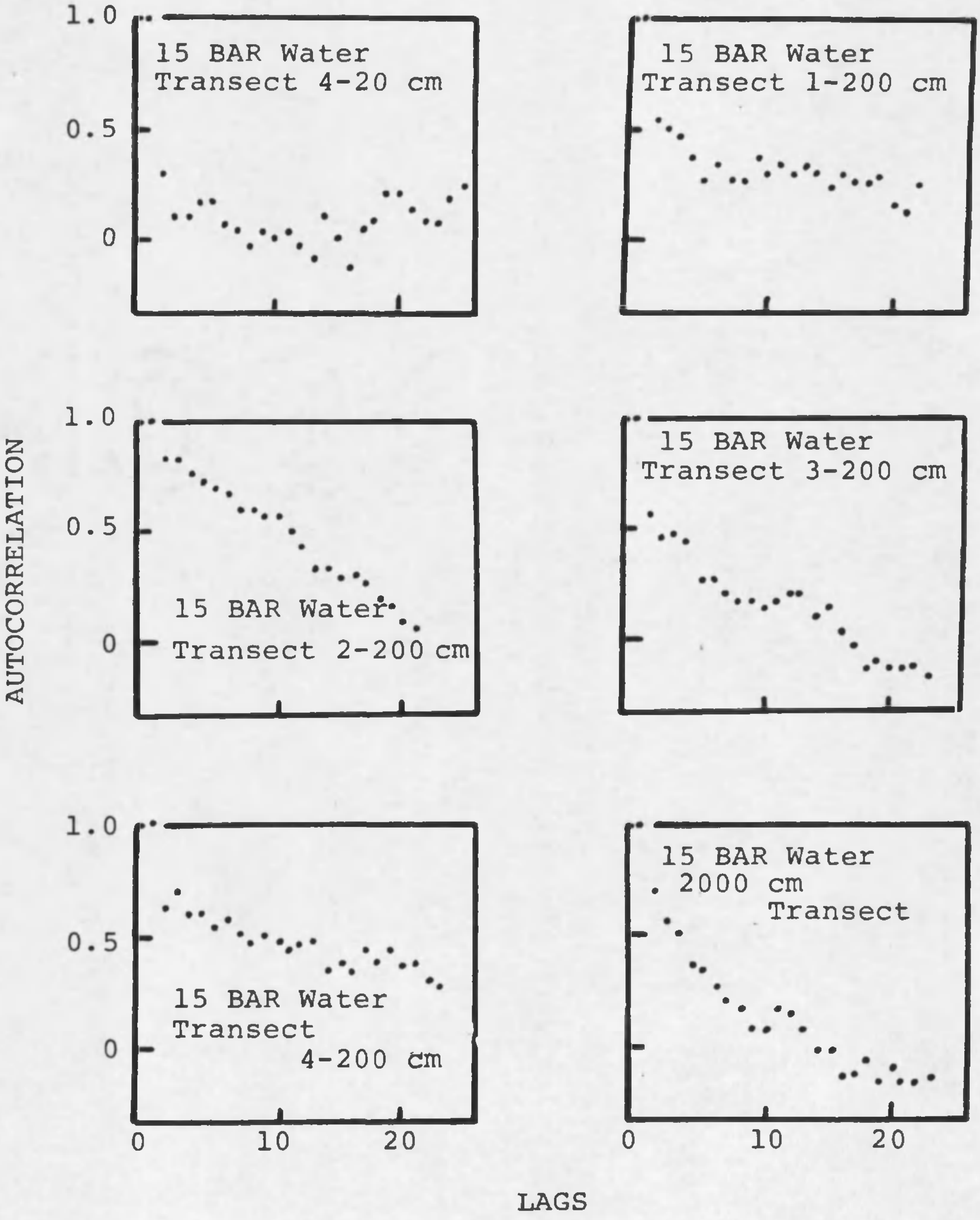
CORRELOGRAMS

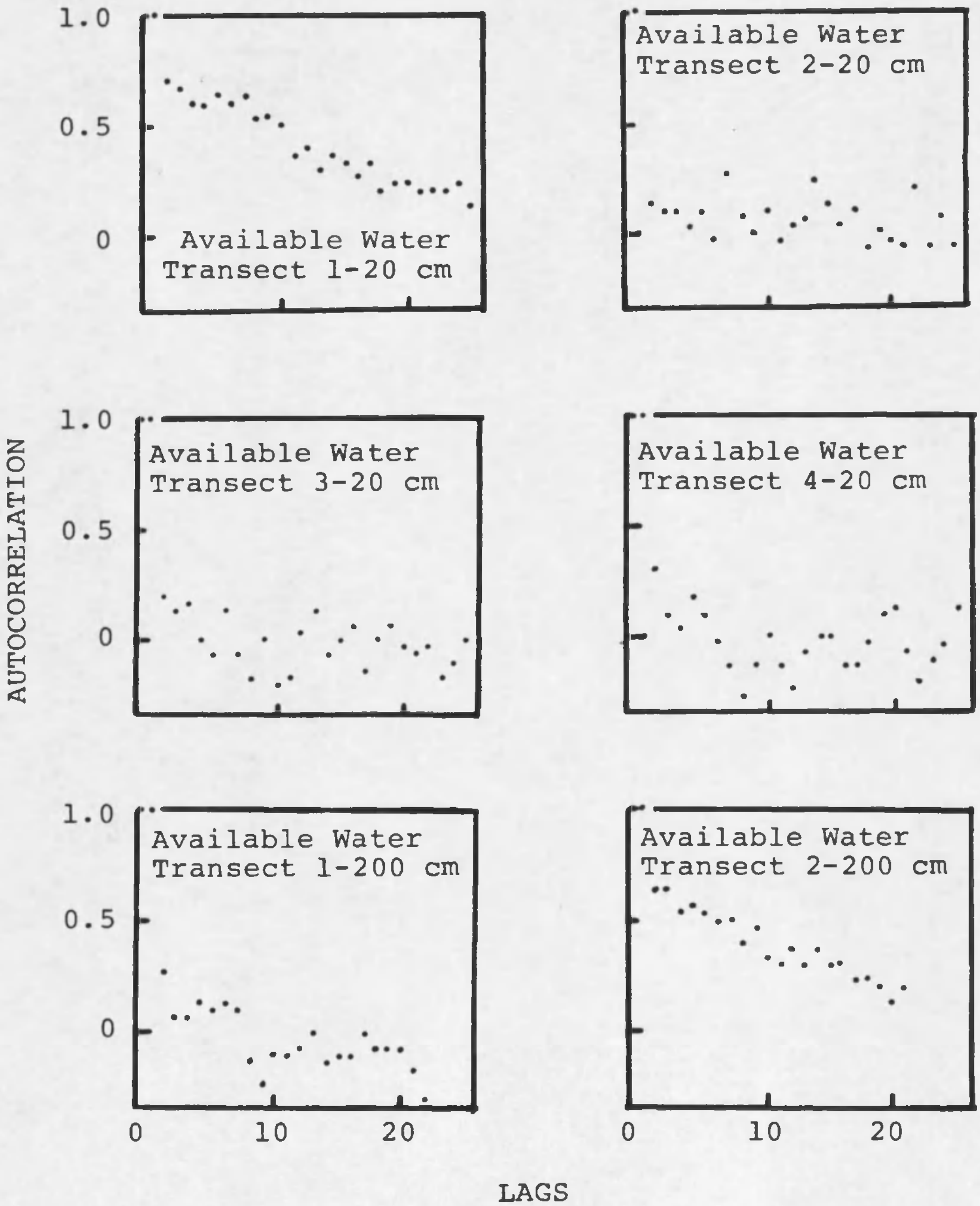
For all 70 Transect-parameter combinations.

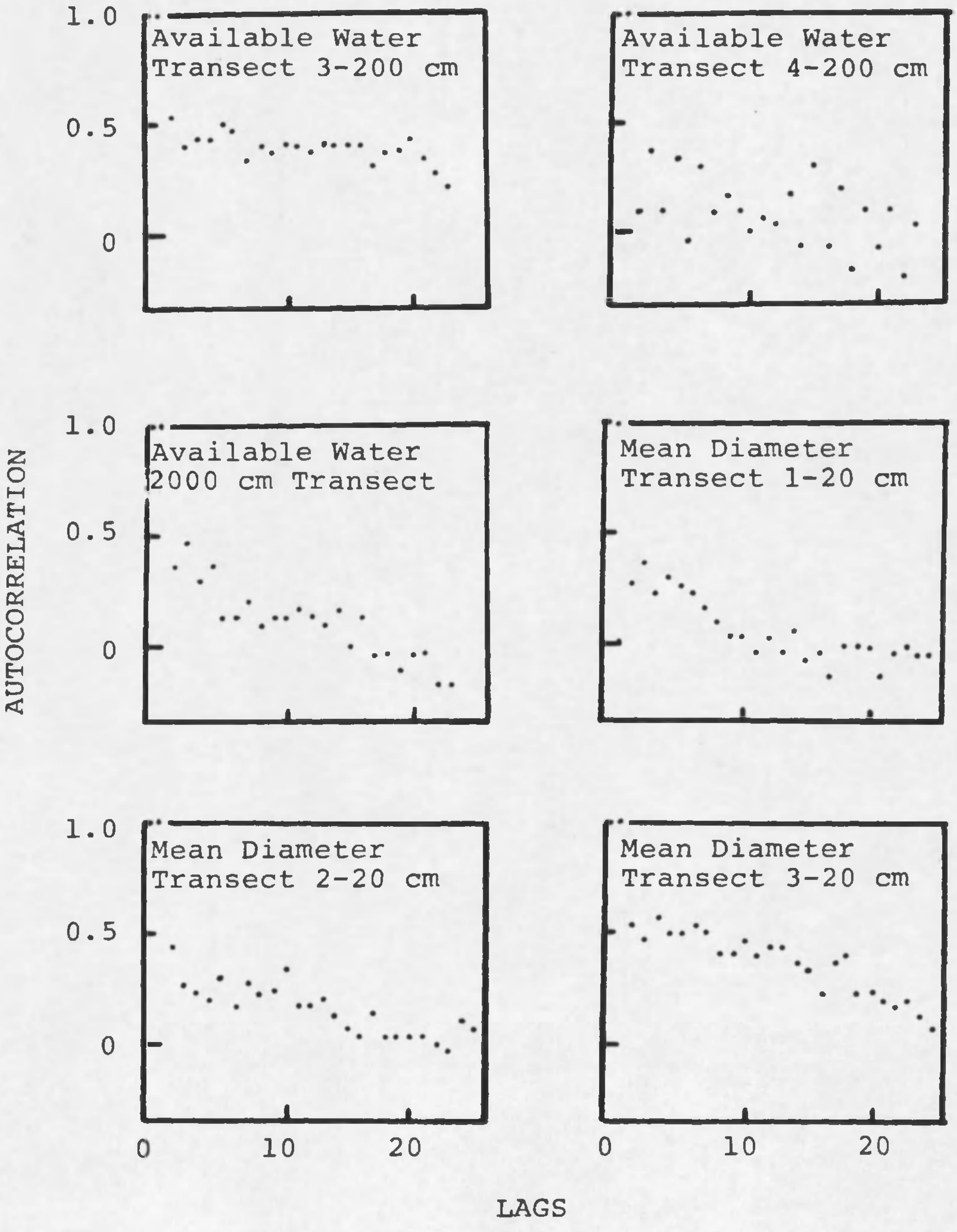

1.0
0.5
0
0.1 Bar Water
Transect 1-20 cm
0.1 Bar Water
Transect 2-20 cm
0.1 Bar Water
Transect 3-20 cm
0.1 Bar Water
Transect 4-20 cm
0.1 Bar Water
Transect 1-200 cm
0.1 Bar Water
Transect 2-200 cm
AUTOCORRELATION
0
10
20
LAGS

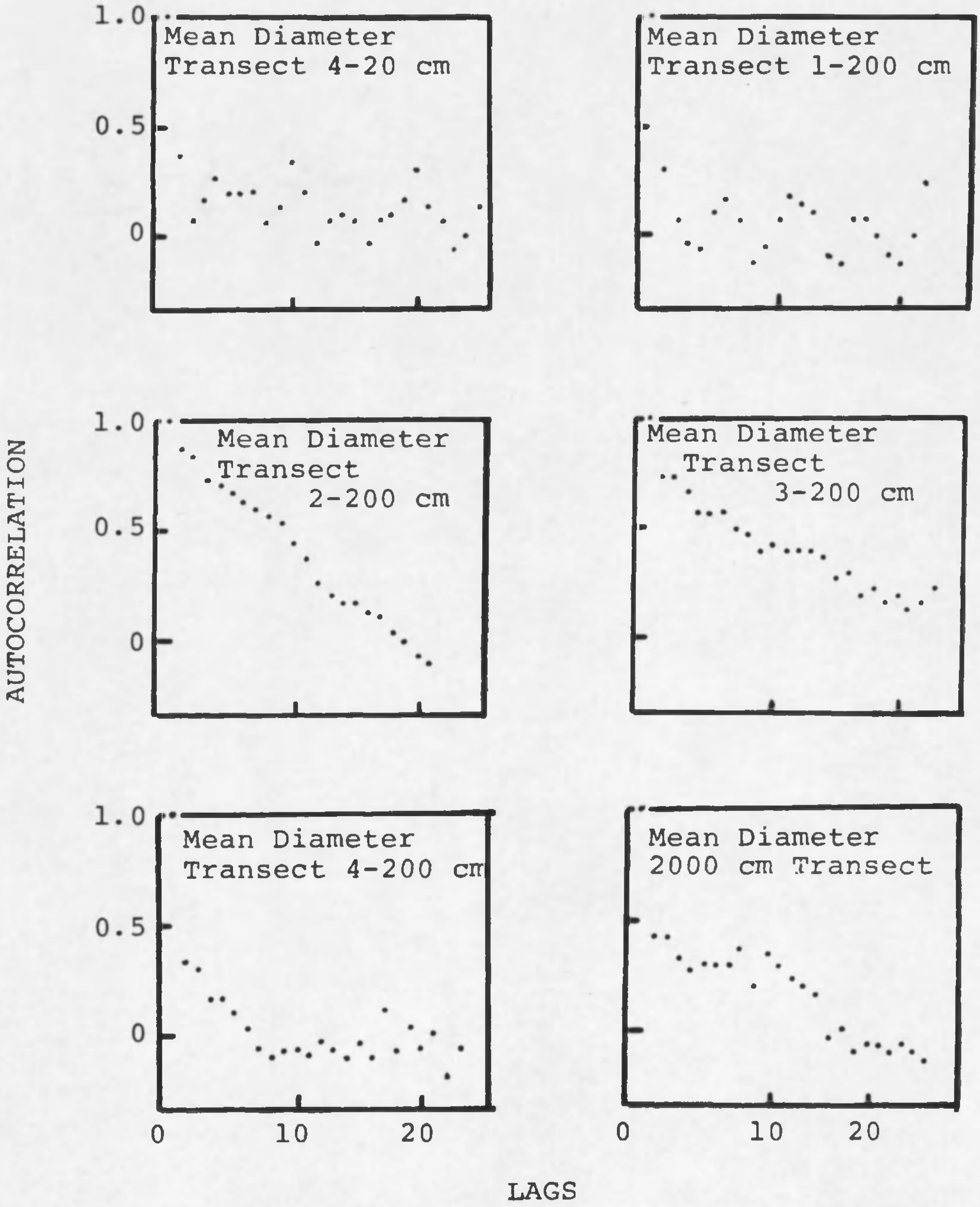


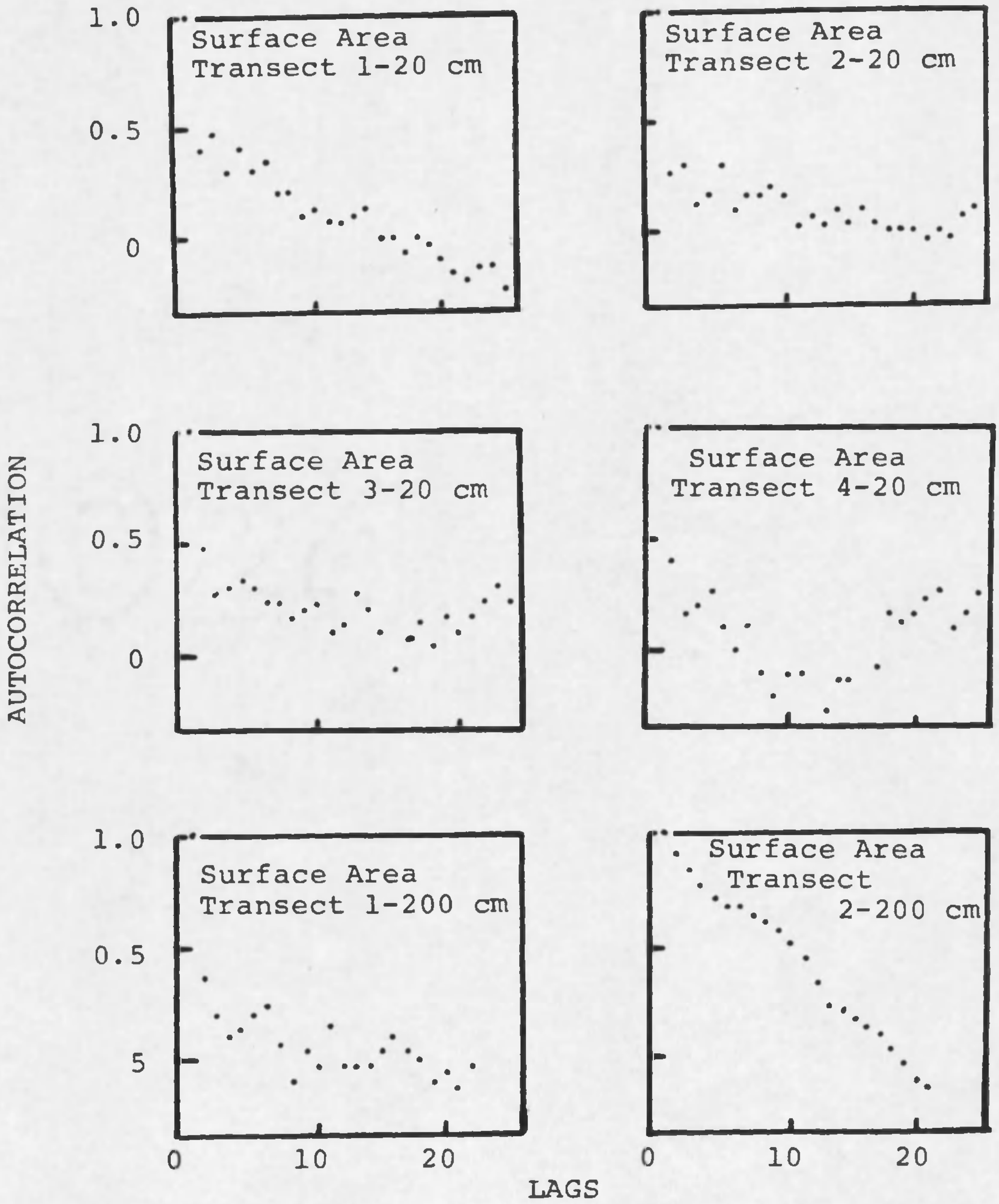
1.0
0.5
0
0.1 BAR Water Transect 3-200 cm
0.1 BAR Water Transect 4-200 cm
0.1 BAR Water 2000 cm Transect
15 BAR Water Transect 1-20 cm
15 BAR Water Transect 2-20 cm
15 BAR Water Transect 3-20 cm
0
10
20


AUTOCORRELATION
1.0
0.5
0
15 BAR Water
Transect 4-20 cm
15 BAR Water
Transect 1-200 cm
15 BAR Water
Transect 2-200 cm
15 BAR Water
Transect 3-200 cm
15 BAR Water
Transect
4-200 cm
15 BAR Water
2000 cm
Transect
0
10
20
LAGS

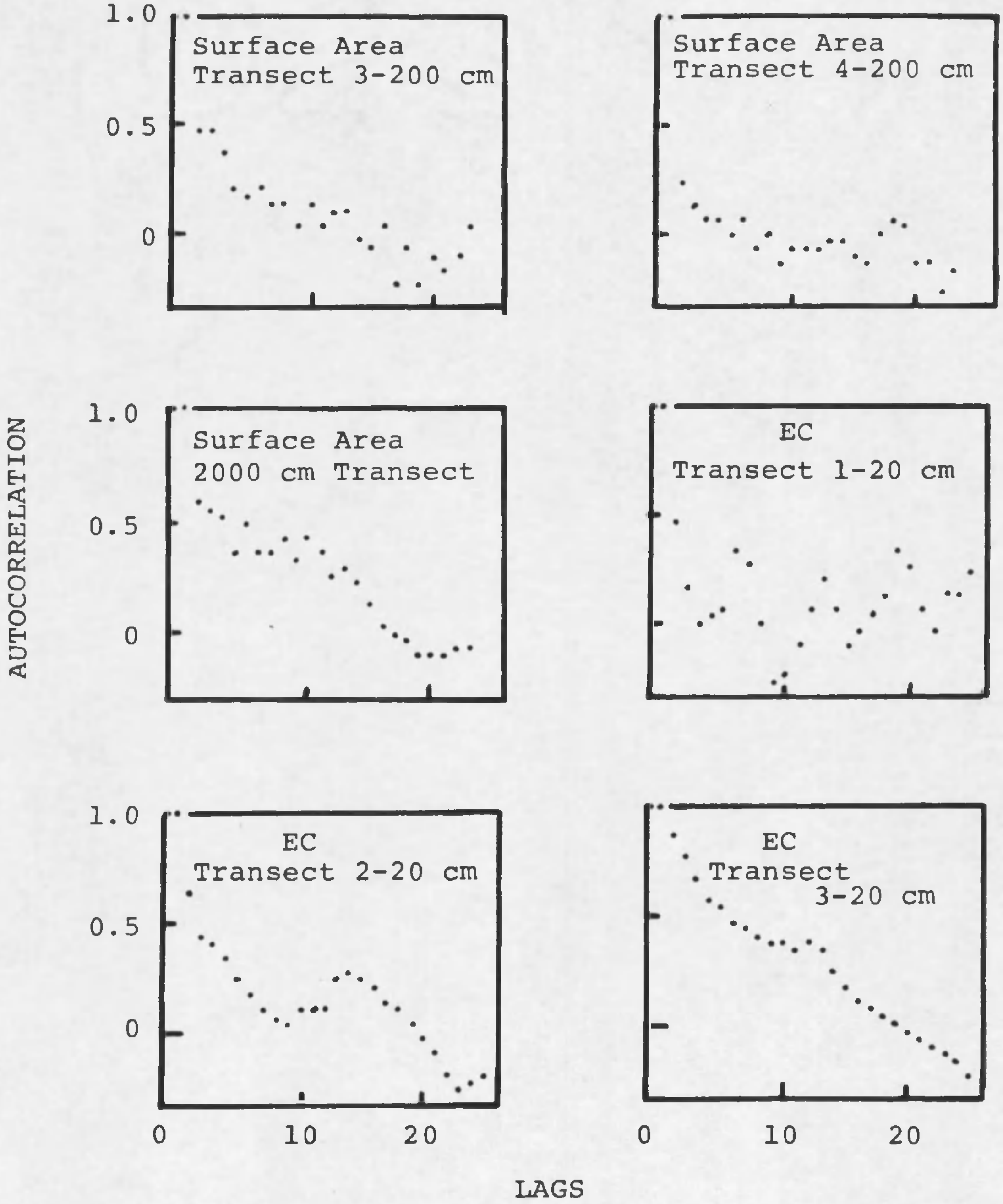

1.0
0.5
0
Available Water
Transect 1-20 cm
Available Water
Transect 2-20 cm
Available Water
Transect 3-20 cm
Available Water
Transect 4-20 cm
Available Water
Transect 1-200 cm
Available Water
Transect 2-200 cm
AUTOCORRELATION
0
10
20
LAGS

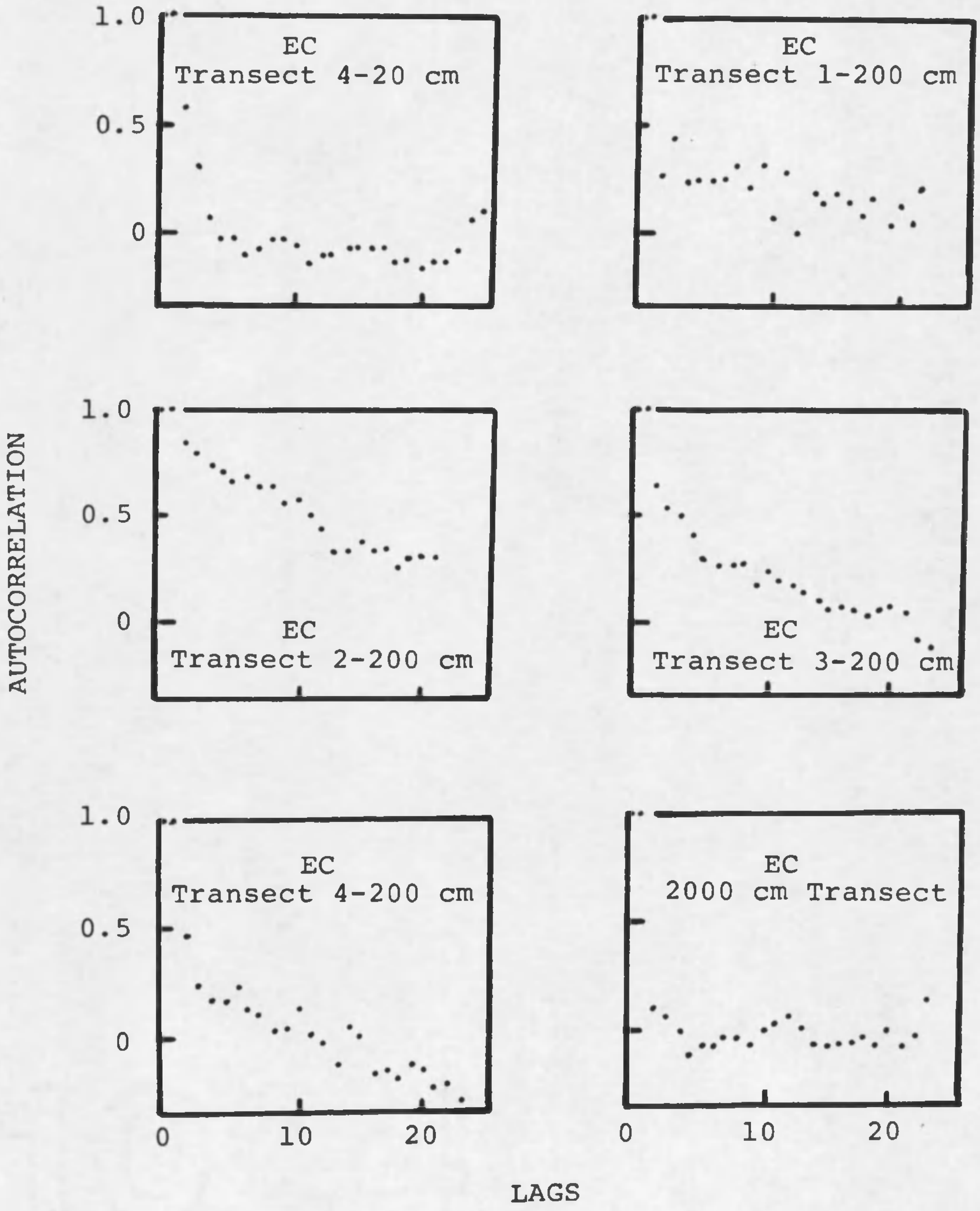

Available Water
Transect 3-200 cm
Available Water
Transect 4-200 cm
Available Water
2000 cm Transect
Mean Diameter
Transect 1-20 cm
Mean Diameter
Transect 2-20 cm
Mean Diameter
Transect 3-20 cm
AUTOCORRELATION
1.0
0.5
0
0
10
20
LAGS

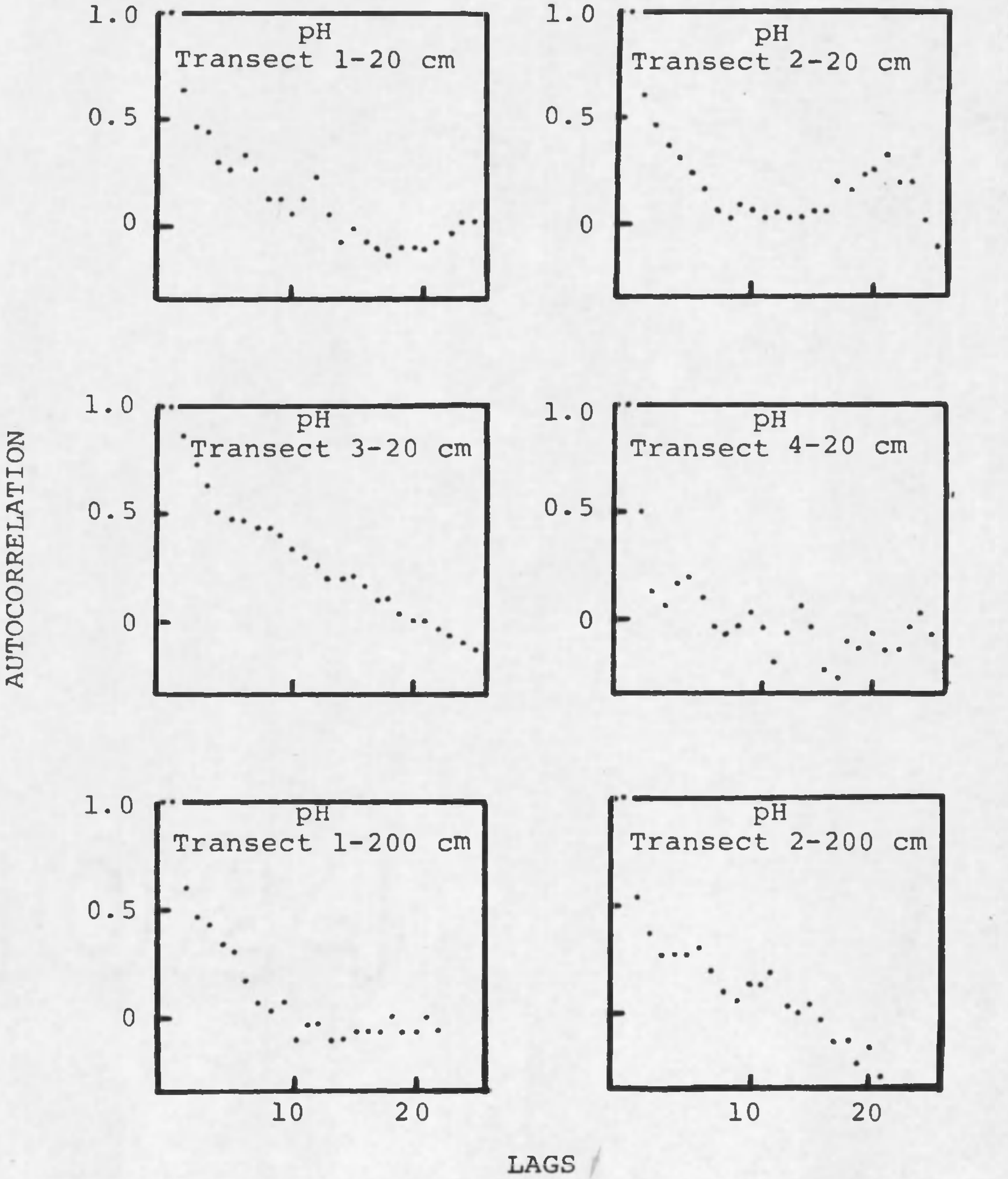

1.0
0.5
0
Mean Diameter
Transect 4-20 cm
Mean Diameter
Transect 1-200 cm
Mean Diameter
Transect
2-200 cm
Mean Diameter
Transect
3-200 cm
Mean Diameter
Transect 4-200 cm
Mean Diameter
2000 cm Transect
AUTOCORRELATION
0
10
20
LAGS

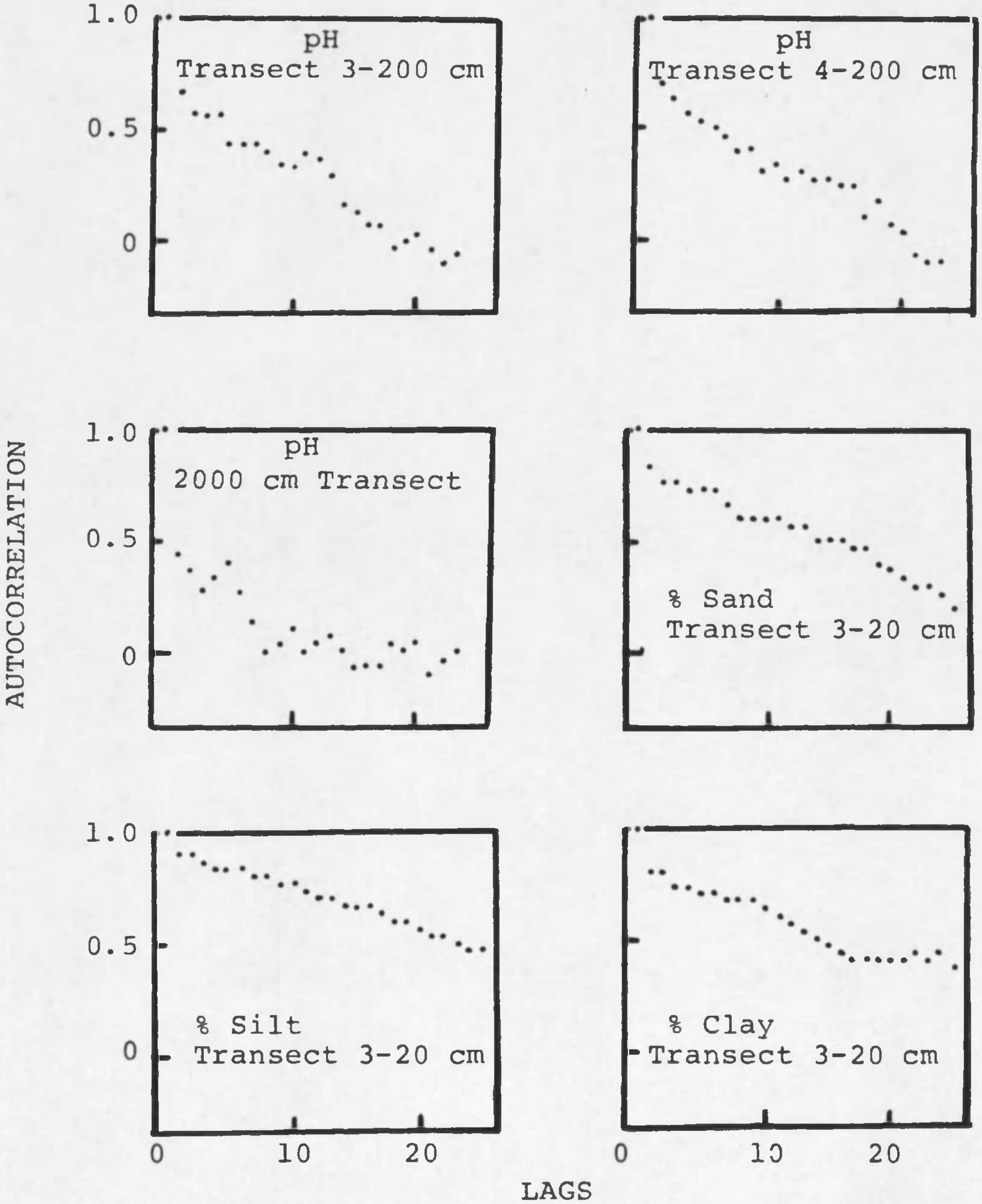


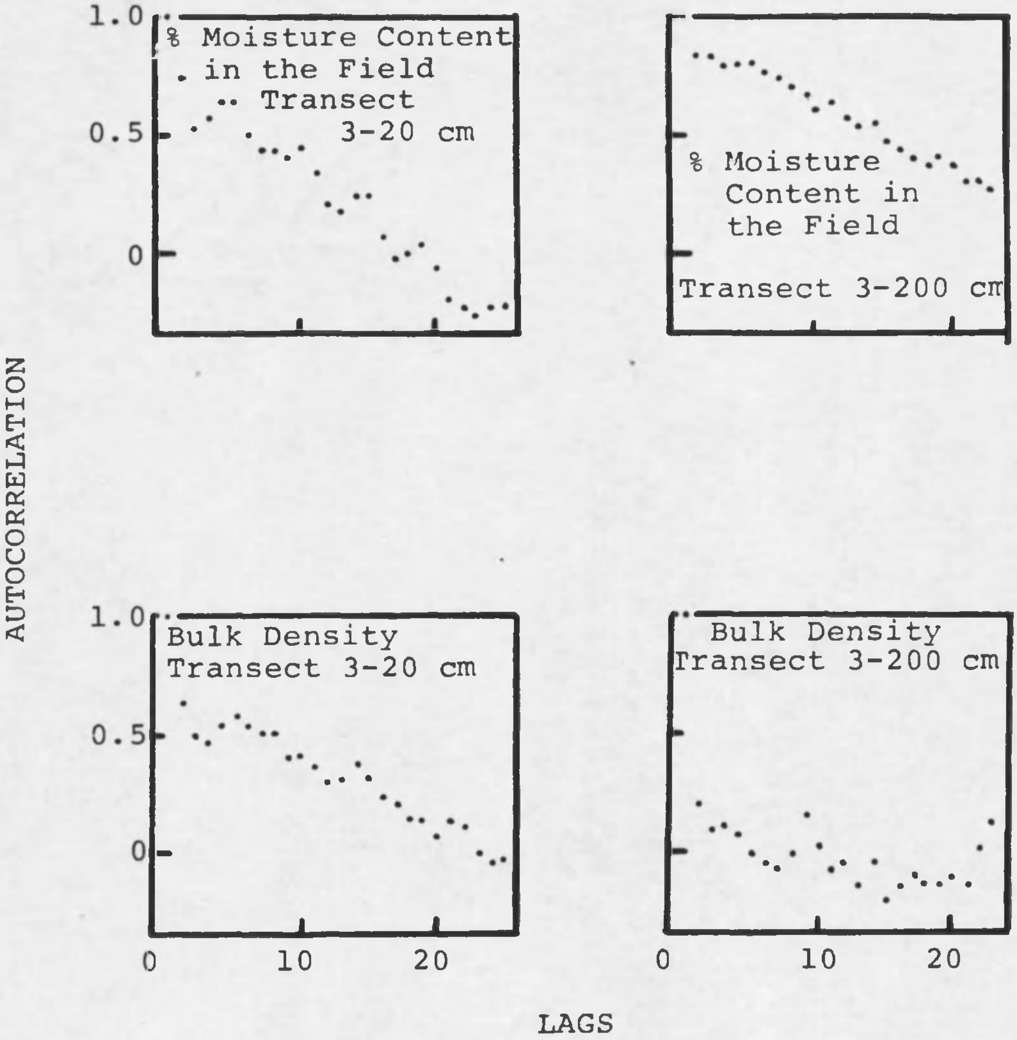
Surface Area
Transect 1-20 cm
Surface Area
Transect 2-20 cm
Surface Area
Transect 3-20 cm
Surface Area
Transect 4-20 cm
Surface Area
Transect 1-200 cm
Surface Area
Transect
2-200 cm
1.0
0.5
0
5
AUTOCORRELATION
0
10
20
LAGS


Surface Area
Transect 3-200 cm
Surface Area
Transect 4-200 cm
Surface Area
2000 cm Transect
EC
Transect 1-20 cm
EC
Transect 2-20 cm
EC
Transect
3-20 cm
1.0
0.5
0
0
10
20
AUTOCORRELATION
LAGS


1.0
0.5
0
EC
Transect 4-20 cm
EC
Transect 1-200 cm
EC
Transect 2-200 cm
EC
Transect 3-200 cm
EC
Transect 4-200 cm
EC
2000 cm Transect
AUTOCORRELATION
0
10
20
LAGS


1.0
0.5
0
pH
Transect 1-20 cm
pH
Transect 2-20 cm
pH
Transect 3-20 cm
pH
Transect 4-20 cm
pH
Transect 1-200 cm
pH
Transect 2-200 cm
AUTOCORRELATION
10
20
LAGS


pH
Transect 3-200 cm
pH
Transect 4-200 cm
pH
2000 cm Transect
% Sand
Transect 3-20 cm
% Silt
Transect 3-20 cm
% Clay
Transect 3-20 cm
AUTOCORRELATION
1.0
0.5
0
LAGS
0
10
20


1.0
0.5
0
% Moisture Content
in the Field
Transect
3-20 cm
% Moisture
Content in
the Field
Transect 3-200 cm
AUTOCORRELATION
1.0
0.5
0
Bulk Density
Transect 3-20 cm
Bulk Density
Transect 3-200 cm
0
10
20
0
10
20
LAGS

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