REC-ERC-83-15

THE USE OF DISCRIMINANT ANALYSIS WITH SATURATION EXTRACT DATA TO IDENTIFY DISPERSIVE CLAY SOILS

December 1983

Engineering and Research Center

U. S. Department of the Interior

Bureau of Reclamation

7-2090 (4-81)
Bureau of Reclamation

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO. REC-ERC-83-15	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
4. TITLE AND SUBTITLE The Use of Discriminant Analysis With Saturation Extract Data to Identify Dispersive Clay Soils		5. REPORT DATE December 1983
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Douglas Craft		8. PERFORMING ORGANIZATION REPORT NO. REC-ERC-83-15
9. PERFORMING ORGANIZATION NAME AND ADDRESS Engineering and Research Center Bureau of Reclamation Denver, Colorado 80225		10. WORK UNIT NO.
		11. CONTRACT OR GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Engineering and Research Center Bureau of Reclamation Denver, Colorado 80225		13. TYPE OF REPORT AND PERIOD COVERED
		14. SPONSORING AGENCY CODE DIBR

15. SUPPLEMENTARY NOTES

Microfiche or hard copy available at the Engineering and Research Center, Denver, Colo.

Ed:REC

16. ABSTRACT

Soils from the McGee Creek Project, Farris, Oklahoma, may be classified as dispersive or non-dispersive by substituting selected pore-water data into a discriminant function. The discriminant function was derived from discriminant analysis, a multivariate statistical classification technique, performed on a 28-sample data set. Suggestions for using the derived discriminant function as part of a simple field test and precautions regarding data interpretation are presented. Also presented is a brief description of discriminant analysis.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. *DESCRIPTORS--/* dispersion/ soil chemistry/ soil tests/ statistics

b. *IDENTIFIERS--/* pore-water/ pinhole tests/ discriminant analysis

c. *COSATI Field/Group* 08M *COWRR:* 0813 *SRIM:*

18. DISTRIBUTION STATEMENT *Available from the National Technical Information Service, Operations Division, 5285 Port Royal Road, Springfield, Virginia 22161* (Microfiche and/or hard copy available from NTIS.)	19. SECURITY CLASS (THIS REPORT) *UNCLASSIFIED*	21. NO. OF PAGES 70
	20. SECURITY CLASS (THIS PAGE) *UNCLASSIFIED*	22. PRICE

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by

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December 1983

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UNITED STATES DEPARTMENT OF THE INTERIOR * BUREAU OF RECLAMATION

ACKNOWLEDGMENTS

The author would like to express thanks to the following persons: R. L. McKisson, for his help and assistance with the CYBER-70 and SPSS subprogram DISCRIMINANT, and P. D. Fagan, for help with the asynchronous terminal emulator software. This work was supported with Bureau of Reclamation funds from the McGee Creek Project appropriations. Administrative support by E. L. McAlexander and D. Geary is also gratefully acknowledged.

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SUMMARY

1. Previous studies performed at the Bureau of Reclamation [9],* indicated that the currently accepted method for using pore-water cation data to identify dispersive clay soils does not apply to soils from the McGee Creek Project, Farris, Oklahoma.

2. Discriminant analysis, a multivariate statistical classification technique, may be successfully used to identify McGee Creek dispersive soils. A successful discriminant function was derived from the following pore-water variables in a 28 sample data set: weight percent water in the saturated paste, pH of the pore-water, log of the corrected 25 °C pore-water conductivity (in microsiemens, μS), and the log of the pore-water sodium concentration (in milliequivalents per liter).

3. Verification studies indicated that the discriminant function derived using the above-mentioned variables may be used to classify future soil samples from the McGee Creek Project which were not originally used to derive the discriminant function.

4. Precautions for using the derived discriminant function as a predictive technique are presented. In general, the discriminant analysis should be rerun periodically with new data to account for the changes in the variances and covariances of the dispersive and nondispersive group populations expected to accompany larger data sets.

5. The variables chosen for the discriminant function in this study could be readily measured as part of a simple field test method.

INTRODUCTION

Dispersion is a process whereby a soil will spontaneously deflocculate when exposed to water having little or no hydraulic velocity. Dispersion is generally thought to be caused by electrostatic repulsion between clay or clay-sized soil particles, resulting in the formation of a stable colloidal soil suspension. The implications of this process may be disastrous when dispersive clay soils are used in engineering structures such as earthen dams or canal embankments. The failure of earthen dams from piping caused by dispersive clay soils has been well documented [1], and the loss of life and property resulting from these structural failures has prompted an interest among geotechnical scientists to develop reliable tests to identify dispersive clay soils.

Several physical tests are currently used to identify dispersive clay soils. These tests include the crumb test [2], the SCS (Soil Conservation Service) dispersion test (also called the double-hydrometer test) [3], and the pinhole test [4]. The development and application of these physical tests methods are covered in a literature review by Perry [5] and a methodology summary by Kinney [6]. While providing valuable information regarding dispersion, these tests are not quantitative and thus suffer the uncertainty of operator judgment. In response to the problem of qualitative physical test results, Acciardi [7] suggested modifications to the pinhole test which provides more quantitative data related to dispersion.

Chemical tests on soil saturation extracts have also been used to corroborate physical test results. The currently accepted method, suggested by Sherard, et al., [8], plots pore-water cation data on a control chart (fig. 1). The TDS (total dissolved solids, in milliequivalents per liter) is defined as the sum of the major cations (calcium, magnesium, sodium, and potassium), and percent Na (sodium) is defined as the milliequivalent percentage of Na present in the major cations. According to Sherard, D (dispersive) soils should plot in zone A, and N (nondispersive) soils should plot in zone B. Zone C is a region of uncertainty containing both N and D soils.

Unfortunately, the currently accepted chemical method has failed to adequately corroborate physical test results during dispersive soil testing programs conducted by the Bureau of Reclamation. Recent work by Craft and Acciardi [9] demonstrated that the method suggested by Sherard is not universally applicable and that pore-water data other than the major cations may discriminate between N and D behavior for certain soils. These data provided the background for this study, in which discriminant analysis was used as a basis for a simple chemical test for dispersive soils from the McGee Creek Dam, Farris, Oklahoma.

DISCRIMINANT ANALYSIS AND SPSS[1] SUBPROGRAM DISCRIMINANT

A variety of multivariate statistical methods may be used to classify experimental cases into groups, depending on the variables measured and the values these variables assume. Examples of these classification techniques are factor analysis, principal components analysis, cluster analysis, and discriminant analysis, all of which are used extensively in the social and medical sciences. Except for discriminant analysis, all these methods assume no prior knowledge of membership in a particular group for the

* Numbers in brackets refer to entries in bibliography.

[1] Statistical package for the Social Sciences.

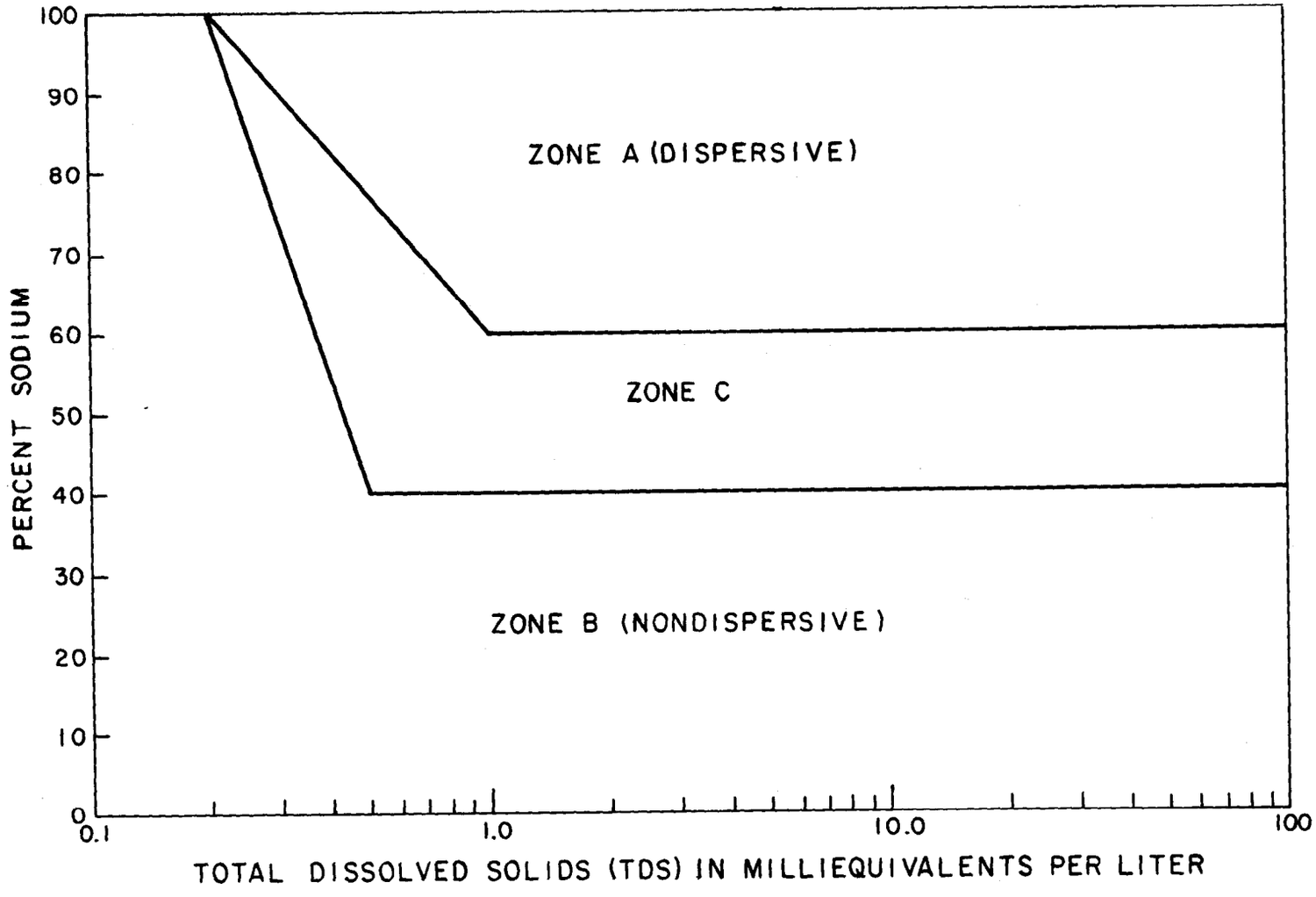

Figure 1.–Control chart for pore-water cation data suggested by Sherard et al. to identify dispersive clay-soils.

cases analyzed; and, thus, the data are used to derive groups based on similarities in the variables. When *a priori* knowledge of group membership is known, as was the situation in this study, discriminant analysis is the appropriate multivariate classification technique. Discriminant analysis is available as a subprogram on the SPSS statistics software [6], as well as other computer packages such as the SAS (Statistical Analysis System) software.

The object of discriminant analysis is to identify the linear combination of variables which will best accentuate differences between defined taxonomic groups. This linear combination is called the discriminant function, and a successful discriminant function will effectively separate the groups into distinct "clusters" in the analysis subspace. The SPSS subprogram DISCRIMINANT will derive an unstandardized discriminant function according to the form:

$$D_i = d_1 V_1 + d_2 V_2 + \ldots + d_i V_i + C \qquad (1)$$

where

d = unstandardized weighting coefficients
V = raw data corresponding to variables chosen for analysis
C = constant
D_i = discriminant score

DISCRIMINANT also derives a standardized discriminant function from data converted to standard (Z) form. The standardized function contains no constant and the coefficients for each V_i correspond to the relative discriminating power of the variables entered into the analysis.

Samples, or cases, are classified into groups by evaluating "how close" the discriminant score is to the respective group discriminant score mean, or centroid. The "distance" of the individual score from the centroid allows DISCRIMINANT to calculate a probability of group membership. Discriminant analysis assumes that the group covariance matrices are similar (an assumption analogous to the requirement of similar variances for two means in a univariate t-test); however, the technique is sufficiently "robust" to tolerate deviations from this assumption [10].

DISCRIMINANT provides several diagnostic parameters which may be used to evaluate the success of a derived discriminant function. These include the eigenvalue and Wilk's lambda. A high eigenvalue and a corresponding low Wilk's lambda indicate a successful discriminant function with group centroids which are well separated. Typically, higher eigenvalues will result in higher calculated probabilities of group membership [labeled as P(G/X) on the DISCRIMINANT output table] for each case.

In addition to an eigenvalue and Wilk's lambda, DISCRIMINANT will also print a classification results table and an all-groups histogram. The histogram is a visual representation of the adequacy of the derived discriminant function and is probably the most obvious diagnostic available with DISCRIMINANT. A successful function will have a histogram which clearly indicates good separation of the two group populations with little or no overlap between populations.

A listing of the SPSS output for the discriminant analysis recommended to be used for future classification of McGee Creek soils is included in appendix II. The SPSS output includes diagnostics related to the individual group and pooled within-group covariance matrices, as well as listing of the classification functions used by DISCRIMINANT to classify soils as N or D.

METHODOLOGY

Soil samples used in this study were obtained from borrow areas located near the McGree Creek Dam. Samples were taken according to methodology outlined in the Bureau of Reclamation *Earth Manual* [11], and representative fractions of each sample were prepared for physical and chemical testing.

Samples were classified as N or D using the pinhole test, and samples which yielded intermediate results were removed from consideration for pore-water analyses.

A total of eight different N samples and seven different D samples were analyzed in replicate according to the USDA (U.S. Department of Agriculture) Agricultural Handbook No. 60 [12] procedures, with the exception that pore-water was separated from the saturated pastes using centrifugation [13]. These 28 pore-water samples were analyzed for the major cations, conductivity, and pH. Sodium was measured using both flame photometry and an Orion Na-specific ion electrode. Calcium and magnesium were determined using an EDTA (ethylenediamine tetraacetate) total hardness titration. An Orion model 801 digital pH/mV meter was used with an Orion combination pH electrode for pH measurements. Conductivity was measured with a Beckman conductivity bridge and results were corrected to 25°C. Potassium was measured using flame photometry.

Preliminary data coding, editing, and statistical analysis were performed using a Hewlett-Packard

HP-9835A desk-top computer with the HP Regression Analysis Methods software. The N samples were coded as −1 and D samples were coded as +1. Data files were transferred from the HP-9835A to a CYBER-70 mainframe computer using modified asynchronous terminal emulator software. Discriminant analysis was performed using the CYBER-70 version of the SPSS subprogram DISCRIMINANT [14]. Method DIRECT, the default analysis method for DISCRIMINANT, was used and classification was based on the individual group covariance matrices rather than the pooled within-groups covariance matrix (the default classification method). Example run card and submit files, and an example of output from SPSS subprogram DISCRIMINANT are presented in appendix II.

The preferred set of variables for predicting dispersive behavior was determined by a series of discriminant analyses on differing combinations of pore-water variables. Additionally, univariate ANOVA (analysis of variance) results from a previous study [9] provided important information regarding the potential discriminating power of both raw pore-water variables and log-transformations of selected variables. Another selection criteria applied to the preferred set of variables was the ease with which the selected variables could be measured in a field situation.

Once an appropriate set of variables was selected, the resulting discriminant function was verified by a series of discriminant analyses on a randomized data set. The data set was randomized with the aid of an HP-BASIC program called RANDOM. Eleven distinct data sets, each with a different subset of eight randomly selected samples, were then created. A modification of RANDOM was used to select the 8 samples for each of the 11 data sets. In each of the data sets, the N or D coding for selected samples (−1 or +1) was changed to 10, which resulted in the selected samples being removed from the discriminant analysis. A listing of program RANDOM, an example output, and a listing of the randomized data set, ØTEST, is presented in appendix III.

The predictive validity of the successful discriminant function was tested by submitting each of the 11 randomly coded data sets for discriminant analysis. A special feature of SPSS subprogram DISCRIMINANT allowed the randomly coded samples to be classified as N or D using the classification functions derived without the coded samples.

RESULTS AND DISCUSSION

A description of the preferred subset of pore-water variables for McGee Creek soils may be found in table 1. Table 2 lists the standardized discriminant function coefficients and eigenvalues for discriminant analyses performed on varying combinations of the variables listed in table 1. While the most successful function was derived with all four preferred variables (eigenvalue equaled 6.96), the deletion of log(Na) yielded successful discriminant function with only slightly reduced discriminating power (eigenvalue equaled 6.84).

Both of these successful functions were subjected to the verification procedures outlined in the methodology. The results of discriminant analysis on the randomized and coded data sets for the two successful subsets of pore-water variables are presented in tables 3 and 4. Table 3 outlines the standardized function coefficients and eigenvalues obtained from discriminant analyses using all four preferred variables. Selected output from subprogram DISCRIMINANT (a discriminant score table and all-groups

Table 1.—*Pore-water variables used to derive a successful discriminant function*

Variable	SPSS designation	Description
Percent H_2O	V2	Weight percent water in the saturated soil paste.
pH	V3	pH of the pore-water.
log(EC)	V5	Log (base10) of the 25 °C, temperature-corrected, pore-water conductivity (originally measured in microsiemens, μS).
log(Na)	V6	Log (base 10) of the pore-water sodium concentration (originally measured by a specific ion electrode in milliequivalents per liter, meq/L).

Table 2.—*Standardized discriminant function coefficients and eigenvalues for several discriminant analyses on different subsets of the optimum set of pore-water variables*

Variables in the analysis	Standardized discriminant function coefficients				
	Percent H_2O (V2)	pH (V3)	log(EC) (V5)	log(Na) (V6)	Eigenvalue
Percent H_2O, log(EC), log(Na)	−0.503	–	−0.537	−0.550	4.05
pH, log(EC), log(Na)	–	−0.193	−0.175	−0.816	3.36
log(EC), log(Na)	–	–	0.113	0.895	3.24
Percent H_2O, pH, log(Na)	0.886	0.722	–	1.03	5.40
Percent H_2O, pH, log(EC)	1.20	0.969	1.17	–	6.84
Percent H_2O, pH	1.14	1.25	–	–	0.535
Percent H_2O, log(EC)	0.564	–	1.09	–	3.88
Percent H_2O, log(Na)	0.434	–	–	1.04	3.90
pH, log(Na)	–	0.185	–	0.980	3.35
pH, log(EC)	–	0.244	0.978	–	3.03
Percent H_2O, pH, log(EC), log(Na)	−1.30	−1.05	−1.55	0.375	6.96

Table 3.—*Standardized discriminant function coefficients and eigenvalues for verification discriminant analyses using percent H_2O, pH, log(EC), and log(Na) as the analysis variables*

Number of samples withheld		Standardized function coefficients				
N	D	Percent H_2O (V2)	pH (V3)	log(EC) (V5)	log(Na) (V6)	Eigenvalue
0	0	−1.30	−1.05	−1.55	0.375	6.96
4	4	−1.30	−1.06	−1.29	0.021	9.37
5	3	−1.17	−0.916	−1.18	0.089	6.85
4	4	−1.05	−0.957	−1.40	0.264	6.03
5	3	−1.30	−0.904	−1.70	0.448	7.58
2	6	−1.74	−1.48	−2.28	0.835	8.56
5	3	−1.12	−1.12	−1.15	−0.077	8.04
3	5	−1.23	−0.782	−1.32	0.150	8.16
3	5	−1.42	−1.06	−1.58	0.386	8.82
3	5	−1.24	−0.845	−1.20	0.157	8.34
4	4	−1.09	−0.966	−1.66	0.556	5.66
2	6	−1.54	−1.23	−1.89	0.734	9.25
Coefficient means		−1.29	−1.03	−1.51	0.324	7.88
Standard deviation		0.207	0.197	0.351	0.295	1.24
Percent relative standard deviation		16.1	19.1	23.2	91.2	15.7
Percentage of total function discrimination		37.1	29.6	36.4	7.80	–

Table 4.—*Standardized discriminant function coefficients and eigenvalues for verification discriminant analyses using percent H_2O, pH, and log(EC) as the analysis variables*

Number of samples withheld		Standardized function coefficients			
N	D	Percent H_2O (V2)	pH (V3)	log(EC) (V5)	Eigenvalue
0	0	1.20	0.969	1.17	6.84
4	4	1.29	1.06	1.27	9.37
5	3	1.14	0.893	1.09	6.84
4	4	0.976	0.903	1.13	5.97
5	3	1.17	0.805	1.23	7.41
2	6	1.44	1.22	1.38	7.86
5	3	1.14	1.14	1.23	8.03
3	5	1.20	0.742	1.17	8.14
3	5	1.34	0.948	1.19	8.67
3	5	1.21	0.798	1.05	8.31
4	4	1.04	0.955	1.11	5.54
2	6	1.37	0.990	1.15	8.76
Coefficient means		1.21	0.950	1.18	7.72
Standard deviation		0.140	0.147	0.093	1.19
Percent relative standard deviation		11.6	15.5	7.87	15.4
Percentage of total function discrimination		36.2	28.4	35.3	–

histogram) for each of the four variable verification analyses are presented in appendix IV. The standardized function coefficients and eigenvalues for the percent H_2O, pH, and log(EC) analyses are presented in table 4. All samples withheld from analysis were correctly classified by discriminant analysis on each of the randomly coded data sets for both sets of analysis variables. Several important comparisons between the verification results seen in tables 3 and 4 deserve comment. First, while the eigenvalues for the four variable analyses were slightly higher than the three variable eigenvalues, a one-way ANOVA indicated that the eigenvalue means for the two sets of verification analyses were not significantly different (even at $\alpha = 0.50$). Second, the log(Na) in the four-variable verification accounted for an average of only 7.80 percent of the total function discrimination. These data suggest that a field classification technique could be based on the three variable discriminant function. Additionally, neither Na nor log(Na) data appeared to represent strong N and D discriminating variables for the 28-sample data set used in this study.

It is important to consider factors related to the variances and covariances of the N and D populations as more samples are analyzed before using discriminant analysis as a predictive technique. Since soils are heterogeneous, the variances of the discriminant score populations for N and D groups will likely increase as the overall number of samples is increased. Even though the 28 sample data set used to derive the successful functions contained replications on all but two samples, it would be unwise to assume that all future samples will exhibit the same multivariate behavior.

Thus, a conservative approach is recommended in using discriminant analysis with a field test. Even though log(Na) does not appear to be a strong discriminating variable, it is probably wise to include this parameter in a field measurement method. The relative discriminating power of the four preferred variables may possibly differ with discriminant analysis performed on a larger data set. Additionally, as more samples are included in the total data set, the discriminant analysis should be run again using the updated function as a basis for N and D classification. If the verification method used in this study is a reasonable test of the predictive ability of the derived discriminant function, then applying discriminant anlysis to field-generated data as a means to classify N and D soils is justified.

The four preferred variables can be measured in a field laboratory using standard chemical measurement techniques. A suggested procedure for these chemical methods is presented in appendix V. Once the specified pore-water variables have been

measured, these data may be substituted into the unstandardized classification functions (the Fisher's linear discriminant functions, one each for the N and D groups), to classify the sample as N or D. Appendix V lists an HP-9835A desk-top computer BASIC program (along with example output) which allows for input of raw pore-water data and the appropriate calculations for classification. An alternative would be to include new samples, coded as for the verification data sets with the original 28 sample data set. A new discriminant analysis would then be performed and the new, coded samples would be classified as N or D and assigned a probability of group membership [called P(G/X) in the SPSS output table].

If SPSS subprogram DISCRIMINANT is used to classify the new samples, it is recommended that the P(G/X) value be used as a criterion for determining the necessity for repeated chemical or physical testing. The P(G/X) values less than 0.95 for samples classified as D should warrant retesting. Since the "penalty" for misclassifying a D sample as N would be higher with respect to structural safety, the P(G/X) tolerance for soils classified as N should be high. Thus, samples classified as N should have P(G/X) values greater than or equal to 0.98.

It is not recommended that the methods suggested in this study be used as the sole means for classifying N and D soils at the McGee Creek Dam. Since the original *a priori* classification of samples used to derive a successful discriminant function was based on pinhole test results, it is recommended that the derived discriminant function be used to corroborate the results of a well-planned pinhole testing program.

In conclusion, it should be noted that the preferred set of pore-water variables do not relate to a physiochemical mechanism. Discriminant analysis has merely identified these variables as having the ability to discriminate between N and D soils previously classified by physical tests. Additionally, it has been observed that different soils exhibit unique sets of pore-water discriminating variables [9], so the discriminant function presented in this study should not be applied to other soils. Discriminant analysis represents an interim solution to the lack of success observed using the pore-water chemical method suggested by Sherard et al. [8]. Hopefully, future research on chemical techniques will provide a more direct and universal technique for identifying dispersive clay soils.

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APPENDIX I

Data set and basic statistics summary

```
*****************************************************************************
*                              DATA MANIPULATION                            *
*****************************************************************************
                          McGee Creek Dispersive Soil

Data file name: X1SOIL:H8
Number of observations: 28
Number of variables: 15

Variables names:
   1. Soil ID
   2. % H2O
   3. pH of Ext
   4. EC(25) uS
   5. E Na meq/L
   6. K meq/L
   7. Ca + Mg
   8. E Sum
   9. E % Na
  10. SAR
  11. D/N or I
  12. log EC
  13. log E Na
  14. log Ca+Mg
  15. log E Sum

Subfile name      beginning observation--number of observations
 1. NON DISP                          1                        14
 2. DISPERSIVE                       15                        14


                          McGee Creek Dispersive Soil


     Variable # 1   Variable # 2   Variable # 3   Variable # 4   Variable # 5
        Variable # 6   Variable # 7   Variable # 8   Variable # 9   Variable #10
     Variable #11   Variable #12   Variable #13   Variable #14   Variable #15
OBS#
   1
         61.00000       32.75000        5.53000      163.00000         .74000
              .10000         .48000        1.32000       56.10000        2.25000
         -1.00000        2.21219        -.13077        -.31876         .12057
   2
         61.00000       30.30000        6.58000      126.00000        1.02000
              .01000         .18000        1.21000       84.30000        3.79000
         -1.00000        2.10037         .00860        -.74473         .08279
   3
         81.00000       29.14000        7.46000       39.10000         .20000
              .01000         .24000         .45000       44.40000         .76000
         -1.00000        1.59218        -.69897        -.61979        -.34679
   4
         86.00000       46.41000        5.68000       28.70000         .16000
              .03000         .32000         .51000       31.40000         .46000
         -1.00000        1.45788        -.79588        -.49485        -.29243
   5
         65.00000       27.93000        5.45000      123.00000         .29000
              .08000         .87000        1.24000       23.40000         .91000
         -1.00000        2.08991        -.53760        -.06048         .09342
   6
         65.00000       29.46000        6.06000       73.90000         .49000
              .04000         .42000         .95000       51.60000        1.22000
         -1.00000        1.86864        -.30980        -.37675        -.02228
   7
```

	66.00000	31.24000	6.33000	132.00000	1.07000
	.02000	.24000	1.33000	80.50000	3.31000
	-1.00000	2.12057	.02938	-.61979	.12385
8					
	66.00000	32.76000	6.54000	133.00000	1.07000
	.03000	.26000	1.36000	78.70000	3.30000
	-1.00000	2.12385	.02938	-.58503	.13354
9					
	81.00000	29.53000	6.38000	39.30000	.20000
	.01000	.24000	.45000	44.40000	.85000
	-1.00000	1.59439	-.69897	-.61979	-.34679
10					
	100.00000	34.84000	6.44000	56.90000	.36000
	.03000	.18000	.57000	63.20000	1.49000
	-1.00000	1.75511	-.44370	-.74473	-.24413
11					
	95.00000	20.68000	7.04000	190.00000	1.02000
	.05000	1.01000	2.08000	49.00000	1.67000
	-1.00000	2.27875	.00860	.00432	.31806
12					
	86.00000	36.50000	6.36000	29.50000	.20000
	.01000	.24000	.45000	44.40000	.72000
	-1.00000	1.46982	-.69897	-.61979	-.34679
13					
	100.00000	41.43000	5.64000	56.20000	.21000
	.08000	.30000	.59000	35.60000	.80000
	-1.00000	1.74974	-.67778	-.52288	-.22915
14					
	96.00000	20.52000	7.53000	147.00000	.95000
	.05000	.55000	1.55000	61.30000	2.22000
	-1.00000	2.16732	-.02228	-.25964	.19033
15					
	62.00000	37.10000	6.45000	211.00000	1.74000
	.03000	.48000	2.25000	77.30000	3.53000
	1.00000	2.32428	.24055	-.31876	.35218
16					
	94.00000	26.60000	7.89000	413.00000	2.39000
	.04000	2.10000	4.53000	52.80000	2.26000
	1.00000	2.61595	.37840	.32222	.65610
17					
	94.00000	20.43000	8.13000	497.00000	2.87000
	.06000	3.15000	6.08000	47.20000	1.98000
	1.00000	2.69636	.45788	.49831	.78390
18					
	103.00000	34.98000	7.33000	760.00000	5.65000
	.02000	1.03000	6.70000	84.30000	7.66000
	1.00000	2.88081	.75205	.01284	.82607
19					
	103.00000	34.97000	7.32000	752.00000	6.31000
	.02000	1.21000	7.54000	83.70000	7.02000
	1.00000	2.87622	.80003	.08279	.87737
20					
	62.00000	38.98000	7.42000	254.00000	2.35000
	.22000	.97000	3.54000	66.40000	3.28000
	1.00000	2.40483	.37107	-.01323	.54900
21					
	107.00000	40.32000	6.32000	397.00000	3.31000
	.04000	.18000	3.53000	93.80000	9.01000
	1.00000	2.59879	.51983	-.74473	.54777
22					
	108.00000	38.41000	6.36000	1291.00000	10.87000
	.11000	.63000	11.61000	93.60000	18.37000
	1.00000	3.11093	1.03623	-.20066	1.06483
23					
	107.00000	42.58000	6.70000	408.00000	3.57000
	.03000	.48000	4.08000	87.50000	6.01000

	1.00000	2.61066	.55267	-.31876	.61066
24					
	118.00000	35.45000	6.41000	672.00000	5.22000
	.09000	.44000	5.75000	90.80000	9.26000
	1.00000	2.82737	.71767	-.35655	.75967
25					
	118.00000	36.47000	5.70000	556.00000	4.65000
	.08000	.38000	5.11000	91.00000	8.66000
	1.00000	2.74507	.66745	-.42022	.70842
26					
	135.00000	29.76000	7.85000	806.00000	7.66000
	.11000	1.43000	9.20000	83.30000	7.87000
	1.00000	2.90634	.88423	.15534	.96379
27					
	135.00000	29.93000	7.51000	997.00000	7.66000
	.07000	.44000	8.17000	93.80000	13.42000
	1.00000	2.99870	.88423	-.35655	.91222
28					
	108.00000	38.86000	5.26000	1250.00000	10.66000
	.08000	.61000	11.35000	93.90000	16.59000
	1.00000	3.09691	1.02776	-.21467	1.05500

```
*****************************************************************************
*                          SUMMARY STATISTICS                               *
*                             ON DATA SET:                                  *
*                       McGee Creek Dispersive Soil                         *
*****************************************************************************
```

Subfile: NON DISP

BASIC STATISTICS

VARIABLE	# OBSERVATIONS	# MISS. VALUES	SUM	MEAN
Soil ID	14	0	1109.00000	79.21429
% H20	14	0	443.49000	31.67786
pH of Ext	14	0	89.02000	6.35857
EC(25) uS	14	0	1337.60000	95.54286
E Na meq/L	14	0	7.98000	.57000
K meq/L	14	0	.55000	.03929
Ca + Mg	14	0	5.53000	.39500
E Sum	14	0	14.06000	1.00429
E % Na	14	0	748.30000	53.45000
SAR	14	0	23.75000	1.69643
D/N or I	14	0	-14.00000	-1.00000
log EC	14	0	26.58073	1.89862
log E Na	14	0	-4.93875	-.35277
log Ca+Mg	14	0	-6.58267	-.47019
log E Sum	14	0	-.76578	-.05470

VARIABLE	VARIANCE	STANDARD DEV.	COEF OF SKEWNESS	COEF OF KURTOSIS
Soil ID	223.87363	14.96241	.11477	-1.54246
% H20	48.09794	6.93527	.34922	.12288
pH of Ext	.43981	.66318	.34169	-.76737
EC(25) uS	3017.10571	54.92819	.17474	-1.39402
E Na meq/L	.14735	.38387	.27205	-1.71004
K meq/L	.00087	.02947	.78322	-.56146
Ca + Mg	.06593	.25678	1.44100	.84188
E Sum	.26264	.51249	.44795	-.74504
E % Na	343.18885	18.52536	.26141	-.86575
SAR	1.22358	1.10615	.72200	-.87629
D/N or I	0.00000	0.00000	---------	---------
log EC	.08466	.29096	-.27531	-1.45576
log E Na	.10905	.33022	.00051	-1.71000
log Ca+Mg	.05583	.23629	.80344	-.47587
log E Sum	.05521	.23496	-.06256	-1.52653

VARIABLE	COEF VARIATION	STANDARD ERROR OF THE MEAN	95 % CONFIDENCE INTERVAL ON MEAN LOWER LIMIT	UPPER LIMIT
Soil ID	18.88852	3.99887	70.57305	87.85552
% H20	21.89311	1.85353	27.67254	35.68318
pH of Ext	10.42977	.17724	5.97556	6.74158
EC(25) uS	57.49063	14.68018	63.82021	127.26551
E Na meq/L	67.34508	.10259	.34831	.79169
K meq/L	75.02320	.00788	.02226	.05631
Ca + Mg	65.00693	.06863	.24670	.54330
E Sum	51.02989	.13697	.70831	1.30026
E % Na	34.65923	4.95111	42.75106	64.14894
SAR	65.20492	.29563	1.05759	2.33527
D/N or I	0.00000	0.00000	-1.00000	-1.00000
log EC	15.32478	.07776	1.73059	2.06666
log E Na	93.60831	.08826	-.54348	-.16206

log Ca+Mg	50.25481	.06315	-.60666	-.33372
log E Sum	429.56171	.06280	-.19040	.08100

CORRELATION MATRIX

	% H2O	pH of Ext	EC(25) uS	E Na meq/L	K meq/L	Ca + Mg
Soil ID	.0842902	.3161651	-.3006255	-.3263848	-.0257909	.0569614
% H2O		-.6198763	-.6376881	-.5300174	-.0228886	-.5508288
pH of Ext			.1473503	.3532592	-.5191395	-.0221793
EC(25) uS				.8538542	.4480872	.6097861
E Na meq/L					.0265161	.1993931
K meq/L						.5666495

	E Sum	E % Na	SAR	D/N or I	log EC	log E Na
Soil ID	-.2174150	-.3324785	-.4904698	----------	-.3559645	-.3533301
% H2O	-.6743038	-.2487289	-.3101759	----------	-.6350800	-.5747123
pH of Ext	.2236327	.3811178	.2220109	----------	.1108411	.3093070
EC(25) uS	.9708606	.4283048	.6634009	----------	.9773005	.8785404
E Na meq/L	.8504588	.7949459	.9029147	----------	.8531391	.9837359
K meq/L	.3612877	-.3528425	-.1015405	----------	.4599920	.1109479
Ca + Mg	.6829825	-.3943670	-.1463116	----------	.5386641	.2374476
E Sum		.3775509	.5971616	----------	.9353745	.8621992
E % Na			.9202711	----------	.4831442	.7829942
SAR				----------	.7124625	.8866928
D/N or I					----------	----------
log EC						.8963114

	log Ca+Mg	log E Sum
Soil ID	.0237397	-.3350825
% H2O	-.4973037	-.6221251
pH of Ext	-.0829238	.1253445
EC(25) uS	.5810992	.9717157
E Na meq/L	.1646213	.8666022
K meq/L	.6522169	.4067982
Ca + Mg	.9729545	.6140249
E Sum	.6483075	.9801586
E % Na	-.4408762	.4326432
SAR	-.1878565	.6679064
D/N or I	----------	----------
log EC	.5137362	.9689831
log E Na	.2080976	.8933527
log Ca+Mg		.5968785

ORDER STATISTICS

VARIABLE	MAXIMUM	MINIMUM	RANGE	MIDRANGE
Soil ID	100.00000	61.00000	39.00000	80.50000
% H2O	46.41000	20.52000	25.89000	33.46500
pH of Ext	7.53000	5.45000	2.08000	6.49000
EC(25) uS	190.00000	28.70000	161.30000	109.35000
E Na meq/L	1.07000	.16000	.91000	.61500
K meq/L	.10000	.01000	.09000	.05500
Ca + Mg	1.01000	.18000	.83000	.59500
E Sum	2.08000	.45000	1.63000	1.26500

E % Na	84.30000	23.40000	60.90000	53.85000
SAR	3.79000	.46000	3.33000	2.12500
D/N or I	-1.00000	-1.00000	0.00000	-1.00000
log EC	2.27875	1.45788	.82087	1.86832
log E Na	.02938	-.79588	.82526	-.38325
log Ca+Mg	.00432	-.74473	.74905	-.37020
log E Sum	.31806	-.34679	.66485	-.01436

Subfile: DISPERSIVE

BASIC STATISTICS

VARIABLE	# OBSERVATIONS	# MISS. VALUES	SUM	MEAN
Soil ID	14	0	1454.00000	103.85714
% H2O	14	0	484.84000	34.63143
pH of Ext	14	0	96.65000	6.90357
EC(25) uS	14	0	9264.00000	661.71429
E Na meq/L	14	0	74.91000	5.35071
K meq/L	14	0	1.00000	.07143
Ca + Mg	14	0	13.53000	.96643
E Sum	14	0	89.44000	6.38857
E % Na	14	0	1139.40000	81.38571
SAR	14	0	114.92000	8.20857
D/N or I	14	0	14.00000	1.00000
log EC	14	0	38.69322	2.76380
log E Na	14	0	9.29004	.66357
log Ca+Mg	14	0	-1.87263	-.13376
log E Sum	14	0	10.66700	.76193

VARIABLE	VARIANCE	STANDARD DEV.	COEF OF SKEWNESS	COEF OF KURTOSIS
Soil ID	468.74725	21.65057	-.64747	.06146
% H2O	36.07747	6.00645	-.98791	.30045
pH of Ext	.74149	.86110	-.32529	-.89310
EC(25) uS	115170.52747	339.36784	.57171	-.67385
E Na meq/L	8.85625	2.97595	.64674	-.70418
K meq/L	.00280	.05289	1.57730	2.43589
Ca + Mg	.65856	.81152	1.59655	1.81905
E Sum	8.36266	2.89183	.51314	-.75801
E % Na	236.69670	15.38495	-1.25255	.24765
SAR	25.35661	5.03554	.68429	-.39900
D/N or I	0.00000	0.00000	---------	---------
log EC	.05668	.23807	-.26543	-.77275
log E Na	.06303	.25106	-.06066	-1.11576
log Ca+Mg	.10831	.32910	.22253	-.41460
log E Sum	.04269	.20661	-.24140	-.67405

VARIABLE	COEF VARIATION	STANDARD ERROR OF THE MEAN	95 % CONFIDENCE INTERVAL ON MEAN LOWER LIMIT	UPPER LIMIT
Soil ID	20.84649	5.78636	91.35330	116.36099
% H2O	17.34394	1.60529	31.16252	38.10033
pH of Ext	12.47320	.23014	6.40626	7.40088
EC(25) uS	51.28616	90.69987	465.71934	857.70923
E Na meq/L	55.61773	.79535	3.63202	7.06941
K meq/L	74.05196	.01414	.04088	.10198
Ca + Mg	83.97093	.21689	.49775	1.43510
E Sum	45.26562	.77287	4.71846	8.05869
E % Na	18.90375	4.11180	72.50045	90.27098

SAR	61.34484	1.34580	5.30040	11.11674
D/N or I	0.00000	0.00000	1.00000	1.00000
log EC	8.61379	.06363	2.62631	2.90129
log E Na	37.83383	.06710	.51858	.80857
log Ca+Mg	246.04019	.08796	-.32382	.05631
log E Sum	27.11673	.05522	.64260	.88125

CORRELATION MATRIX

	% H20	pH of Ext	EC(25) uS	E Na meq/L	K meq/L	Ca + Mg
Soil ID	-.1486472	-.0509274	.5951304	.5900432	-.1657193	-.1633793
% H20		-.7130502	.0148569	.1356286	.1081964	-.8459592
pH of Ext			-.2671109	-.3310023	.0253813	.7220089
EC(25) uS				.9810651	.0454911	-.1503848
E Na meq/L					.1143926	-.2458400
K meq/L						-.0412683

	E Sum	E % Na	SAR	D/N or I	log EC	log E Na
Soil ID	.5583273	.5285130	.5426468	----------	.7395526	.7275779
% H20	-.0958445	.6805860	.3621985	----------	-.0881505	.1101966
pH of Ext	-.1375526	-.6757420	-.5712398	----------	-.1718860	-.2781098
EC(25) uS	.9682333	.5144312	.8910230	----------	.9643682	.9540000
E Na meq/L	.9621922	.5964480	.9091006	----------	.9318296	.9685935
K meq/L	.1244302	-.0745541	.0986635	----------	-.0461103	.0559244
Ca + Mg	.0268791	-.8743702	-.5288659	----------	-.0712113	-.2498059
E Sum		.3670640	.7889368	----------	.9381082	.9276897
E % Na			.7699031	----------	.4901716	.6417553
SAR				----------	.8139691	.8694588
D/N or I					----------	----------
log EC						.9661392

	log Ca+Mg	log E Sum
Soil ID	-.1790930	.6574976
% H20	-.7416082	-.1961849
pH of Ext	.7276291	-.0298258
EC(25) uS	-.0243427	.9370728
E Na meq/L	-.0942280	.9123219
K meq/L	.0610253	.0946223
Ca + Mg	.9239591	.1107623
E Sum	.1634334	.9716736
E % Na	-.7956905	.3168545
SAR	-.4539157	.7149877
D/N or I	----------	----------
log EC	.0280237	.9655064
log E Na	-.1108949	.9301943
log Ca+Mg		.2327388

ORDER STATISTICS

VARIABLE	MAXIMUM	MINIMUM	RANGE	MIDRANGE
Soil ID	135.00000	62.00000	73.00000	98.50000
% H20	42.58000	20.43000	22.15000	31.50500
pH of Ext	8.13000	5.26000	2.87000	6.69500
EC(25) uS	1291.00000	211.00000	1080.00000	751.00000

E Na meq/L	10.87000	1.74000	9.13000	6.30500
K meq/L	.22000	.02000	.20000	.12000
Ca + Mg	3.15000	.18000	2.97000	1.66500
E Sum	11.61000	2.25000	9.36000	6.93000
E % Na	93.90000	47.20000	46.70000	70.55000
SAR	18.37000	1.98000	16.39000	10.17500
D/N or I	1.00000	1.00000	0.00000	1.00000
log EC	3.11093	2.32428	.78664	2.71760
log E Na	1.03623	.24055	.79568	.63839
log Ca+Mg	.49831	-.74473	1.24304	-.12321
log E Sum	1.06483	.35218	.71265	.70851

APPENDIX II

Sample output from the SPSS subprogram DISCRIMINANT

```
S P S S - - STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES

VERSION 8.0 -- JUNE 18, 1979

BRASS -- NDS1.4  501/498  JANUARY 1980


        RUN NAME            DOUG CRAFT --DISP.NONDISP
        FILE NAME           DATA
        VARIABLE LIST       V1 TO V7
        INPUT MEDIUM        DISK
        N OF CASES           UNKNOWN
        INPUT FORMAT        FREEFIELD
        RAW OUTPUT UNIT     XX
        DISCRIMINANT          GROUPS = V4(-1,1)/
                          VARIABLES=V2,V3,V5,V6/
                          ANALYSIS=V2,V3,V5,V6/
                          METHOD=DIRECT/
                                    FIN=1.0/
        OPTIONS              4,5,6,7,10,11,12,14
        STATISTICS          1,2,3,4,5,6,7,8,9
        READ INPUT DATA

   00100300 CM REQUIRED FOR DISCRIMINANT ANALYSIS
   00101100 CM REQUIRED FOR DISCRIMINANT CLASSIFICATION

   OPTION - 1
   IGNORE MISSING VALUE INDICATORS
   (NO MISSING VALUES DEFINED...OPTION 1 WAS FORCED)

   OPTION - 4
   SUPPRESS STEPWISE SUMMARY TABLE

   OPTION - 5
   PRINT CLASSIFICATION RESULTS TABLE

   OPTION - 6
   PRINT DISCRIMINANT SCORES AND CLASSIFICATION INFORMATION

   OPTION - 7
   PRINT A SINGLE PLOT OF CASES

   OPTION -10
   PRINT TERRITORIAL MAP

   OPTION -11
   PRINT UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS
```

```
OPTION -12
PRINT CLASSIFICATION FUNCTIONS

OPTION -14
USE INDIVIDUAL GROUP COVARIANCE MATRICES FOR CLASSIFICATION



END OF FILE ON FILE DATA
AFTER READING     28 CASES FROM SUBFILE DATA
```

FILE DATA (CREATION DATE = 83/03/28.)

- D I S C R I M I N A N T A N A L Y S I S -

ON GROUPS DEFINED BY V4

28 (UNWEIGHTED) CASES WERE PROCESSED.
0 OF THESE WERE EXCLUDED FROM THE ANALYSIS.
28 (UNWEIGHTED) CASES WILL BE USED IN THE ANALYSIS.

NUMBER OF CASES BY GROUP

V4	NUMBER OF CASES UNWEIGHTED	WEIGHTED	LABEL
-1	14	14.0	
1	14	14.0	
TOTAL	28	28.0	

GROUP MEANS

V4	V2	V3	V5	V6
-1	31.67786	6.35857	1.89862	-.35277
1	34.63143	6.90357	2.76380	.66357
TOTAL	33.15464	6.63107	2.33121	.15540

GROUP STANDARD DEVIATIONS

V4	V2	V3	V5	V6
-1	6.93527	.66318	.29096	.33022
1	6.00645	.86110	.23807	.25106
TOTAL	6.54145	.80360	.51197	.59216

POOLED WITHIN-GROUPS COVARIANCE MATRIX WITH 26 DEGREES OF FREEDOM

	V2	V3	V5	V6
V2	42.08771			
V3	-3.269512	.5906497		
V5	-.7037891	-.6923877E-02	.7066752E-01	
V6	-.5750070	.3807142E-02	.7193153E-01	.8603720E-01

POOLED WITHIN-GROUPS CORRELATION MATRIX

	V2	V3	V5	V6
V2	1.00000			
V3	-.65575	1.00000		
V5	-.40809	-.03389	1.00000	
V6	-.30217	.01689	.92250	1.00000

CORRELATIONS WHICH CANNOT BE COMPUTED ARE PRINTED AS 99.0.

WILKS LAMBDA (U-STATISTIC) AND UNIVARIATE F-RATIO
WITH 1 AND 26 DEGREES OF FREEDOM

VARIABLE	WILKS LAMBDA	F	SIGNIFICANCE
V2	.94715	1.451	.2392
V3	.88075	3.520	.0719
V5	.25962	74.15	.0000
V6	.23628	84.04	.0000

COVARIANCE MATRIX FOR GROUP -1

	V2	V3	V5	V6
V2	48.09794			
V3	-2.851034	.4398132		
V5	-1.281519	.2138767E-01	.8465782E-01	
V6	-1.316186	.6773723E-01	.8611809E-01	.1090453

COVARIANCE MATRIX FOR GROUP 1

	V2	V3	V5	V6
V2	36.07747			
V3	-3.687990	.7414863		
V5	-.1260595	-.3523543E-01	.5667723E-01	
V6	.1661719	-.6012295E-01	.5774497E-01	.6302907E-01

TOTAL COVARIANCE MATRIX WITH 27 DEGREES OF FREEDOM

	V2	V3	V5	V6
V2	42.79057			
V3	-2.731090	.6457803		
V5	-.1522038E-01	.1155791	.2621146	
V6	.2245442	.1472715	.2972386	.3506529

FILE DATA (CREATION DATE = 83/03/28.)

- D I S C R I M I N A N T A N A L Y S I S -

ON GROUPS DEFINED BY V4

ANALYSIS NUMBER 1

DIRECT METHOD- ALL VARIABLES PASSING THE TOLERANCE TEST ARE ENTERED.

MINIMUM TOLERANCE LEVEL..... .00100

CANONICAL DISCRIMINANT FUNCTIONS

MAXIMUM NUMBER OF FUNCTIONS..... 2
MINIMUM CUMULATIVE PERCENT OF VARIANCE... 100.00
MAXIMUM SIGNIFICANCE OF WILKS LAMBDA.... 1.0000

PRIOR PROBABILITY FOR EACH GROUP IS .50000

CLASSIFICATION FUNCTION COEFFICIENTS
(FI^''ER*S LINEAR DISCRIMINANT FUNCTIONS)

V4 =	-1	1
V2	9.767880	10.78421
V3	72.76225	79.70037
V5	485.1063	514.7654
V6	-347.6127	-354.1110
(CONSTANT)	-908.5681	-1056.403

CANONICAL DISCRIMINANT FUNCTIONS

FUNCTION	EIGENVALUE	PERCENT OF VARIANCE	CUMULATIVE PERCENT	CANONICAL CORRELATION	AFTER FUNCTION	WILKS LAMBDA	CHI-SQUARED	D.F.	SIGNICANCE
1*	6.95664	100.00	100.00	.9350502	0	.1256812	49.776	4	.0000

* MARKS THE 1 FUNCTION(S) TO BE USED IN THE REMAINING ANALYSIS.

STANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
V2	-1.29710
V3	-1.04899
V5	-1.55107
V6	.37498

UNSTANDARDIZED CANONICAL DISCRIMINANT FUNCTION COEFFICIENTS

	FUNC 1
V2	-.1999390
V3	-1.364912
V5	-5.834732
V6	1.278401
(CONSTANT)	29.08306

CANONICAL DISCRIMINANT FUNCTIONS EVALUATED AT GROUP MEANS (GROUP CENTROIDS)

GROUP	FUNC 1
-1	2.54160
1	-2.54160

TEST OF EQUALITY OF GROUP COVARIANCE MATRICES USING BOX*S M

THE RANKS AND NATURAL LOGARITHMS OF DETERMINANTS PRINTED ARE THOSE OF THE GROUP COVARIANCE MATRICES.

GROUP LABEL	RANK	LOG DETERMINANT
-1	4	-5.092758
1	4	-6.840988
POOLED WITHIN-GROUPS COVARIANCE MATRIX	4	-4.990562

BOX*S M	APPROXIMATE F	DEGREES OF FREEDOM		SIGNIFICANCE
25.384	2.1107	10,	3231.9	.0213

GROUP COVARIANCE MATRICES OF THE CANONICAL DISCRIMINANT FUNCTIONS

NOTE FOR COMPARISON THAT THE POOLED WITHIN-GROUPS COVARIANCE MATRIX OF THE CANONICAL DISCRIMINANT FUNCTIONS IS AN IDENTITY MATRIX.

GROUP -1.

	FUNC 1
FUNC 1	.74869

GROUP 1.

	FUNC 1
FUNC 1	1.25131

TEST OF EQUALITY OF COVARIANCE OF THE CANONICAL DISCRIMINANT FUNCTIONS

THE RANKS AND NATURAL LOGS OF DETERMINANTS PRINTED ARE THOSE OF THE GROUP COVARIANCE MATRICES OF THE CANONICAL DISCRIMINANT FUNCTIONS.

GROUP LABEL	RANK	LOG DETERMINANT
-1	1	-.289424
1	1	.224187
POOLED WITHIN-GROUPS COVARIANCE MATRIX (AN IDENTITY MATRIX)	1	0

BOX*S M	APPROXIMATE F	DEGREES OF FREEDOM		SIGNIFICANCE
.84808	.81662	1.	2028.0	.3664

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP	HIGHEST PROBABILITY GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
DATA	1			-1.	-1	.5734	.9998	1	.0002	2.0544
DATA	2			-1.	-1	.0452	1.0000	1	.0000	4.2743
DATA	3			-1.	1	.4320	.9995	1	.0005	1.8617
DATA	4			1.	1	.6169	1.0000	-1	.0000	-3.1012
DATA	5			1.	1	.9429	1.0000	-1	.0000	-2.6218
DATA	6			1.	1	.1625	1.0000	-1	.0000	-4.1042
DATA	7			-1.	-1	.9869	1.0000	1	.0000	2.5274
DATA	8			1.	1	.2749	1.0000	-1	.0000	-3.7629
DATA	9			1.	1	.3178	1.0000	-1	.0000	-3.6592
DATA	10			1.	1	.2466	.9998	-1	.0002	-1.2456
DATA	11			1.	1	.4381	1.0000	-1	.0000	-3.4090
DATA	12			1.	1	.4983	1.0000	-1	.0000	-1.7841
DATA	13			-1.	-1	.5530	.9998	1	.0002	2.0283
DATA	14			1.	1	.0547	.9746	-1	.0254	-.3924
DATA	15			1.	1	.2142	.9997	-1	.0003	-1.1522
DATA	16			-1.	-1	.1361	.9926	1	.0074	1.2520
DATA	17			-1.	-1	.2116	1.0000	1	.0000	3.6224
DATA	18			1.	1	.8523	1.0000	-1	.0000	-2.3333
DATA	19			-1.	-1	.9795	1.0000	1	.0000	2.5193
DATA	20			-1.	-1	.3912	.9994	1	.0006	1.7997
DATA	21			-1.	-1	.6863	1.0000	1	.0000	2.8911
DATA	22			-1.	-1	.4671	.9996	1	.0004	1.9124
DATA	23			-1.	-1	.4616	1.0000	1	.0000	3.1787
DATA	24			1.	1	.8960	1.0000	-1	.0000	-2.3954
DATA	25			1.	1	.3828	1.0000	-1	.0000	-3.5178
DATA	26			-1.	-1	.2064	1.0000	1	.0000	3.6349
DATA	27			-1.	-1	.5511	.9998	1	.0002	2.0257
DATA	28			1.	1	.6953	1.0000	-1	.0000	-2.1034

SYMBOLS USED IN PLOTS

SYMBOL	GROUP	LABEL
1	-1	
3	1	

ALL-GROUPS HISTOGRAM

-- CANONICAL DISCRIMINANT FUNCTION 1 --

```
              4 +                                                                          +
                .                                                                          .
                .                                                                          .
F               .                                                                          .
R             3 +                                                                          +
E               .                                                                          .
Q               .                                                                          .
U               .                                                                          .
E             2 +                     3     3     3             1   1    1                 +
N               .                     3     3     3             1   1    1                 .
C               .                     3     3     3             1   1    1                 .
Y               .                     3     3     3             1   1    1                 .
              1 +                 3 3333  333 3  3   3       1  1   11 1 1  1               +
                .                 3 3333  333 3  3   3       1  1   11 1 1  1               .
                .                 3 3333  333 3  3   3       1  1   11 1 1  1               .
                .                 3 3333  333 3  3   3       1  1   11 1 1  1               .
               OUT.........+.........+.........+.........+.........+.........+.........+.........OUT
                          -6        -4        -2         0         2         4         6
 CLASSIFICATION 3333333333333333333333333333333333333333111111111111111111111111111111111111111
GROUP CENTROIDS                                3                         1
```

CLASSIFICATION RESULTS -

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP -1	1
GROUP -1	14	14	0
		100.0	0
GROUP 1	14	0	14
		0	100.0

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED - 100.00

CLASSIFICATION PROCESSING SUMMARY

28 CASES WERE PROCESSED.
28 CASES WERE USED FOR PRINTED OUTPUT.

CPU TIME REQUIRED.. .6550 SECONDS

FINISH

TOTAL CPU TIME USED.. .7160 SECONDS

RUN COMPLETED

APPENDIX III

The HP-BASIC program RANDOM and data set, ØTEST

```
10   ! ************************** PROGRAM "RANDOM" **************************
20   ! *********** PROGRAMMED BY ANDY MURPHY AND DOUG CRAFT 05/04/83 ***********
30   ! ***************** US BUREAU OF RECLAMATION/ E&R CENTER *****************
40   ! ******************** PO BOX 25007/ MAIL CODE D-1523 ********************
50   ! ************************ DENVER, COLORADO 80225 *************************
60   ! ************************** FTS-303-234-4020 **************************
70   !
80   !
90   ! ************** FOR HEWLETT/PACKARD 9835A DESKTOP COMPUTERS **************
100  !
110  !
120  ! This program may be modified to pick a random sample from a given range
130  ! of integers, or to sequence a range of integers different than 1 to 28.
140  ! Alter lines 210,270,300, and 500 to change the program function.
150  !
160  !
170  PRINTER IS 7,1
180  PRINT "RANDOM SEQUENCE OF INTEGERS FROM 1 TO 28"
190  !  PRINT LIN(1),"CUMULATIVE VALUES OF STRING A$:"
200  PRINT
210  DIM A$[56]  ! dimension A$ to have 2X the number of integers in range
220  A$=""
230  B$="0"
240  !
250  !
260  !
270  FOR I=1 TO 28   ! choose I to reflect number of integers you want selected
280  ! FOR I=1 TO 8
290     RANDOMIZE          ! selects a random seed integer
300     Z=INT(28*RND+1)    ! 30: upper value of range, 1: lower value of range
310     IF Z=0 THEN 290
320     C$=VAL$(Z)
330     IF LEN(C$)<2 THEN C$=B$&C$
340     E=LEN(A$)
350     IF E=0 THEN 430
360        FOR J=1 TO E
370            IF POS(A$[J,J+1],C$)>0 THEN 390
380            IF POS(A$[J,J+1],C$)<=0 THEN 410
390            J=J+1
400            GOTO 290
410            J=J+1
420            NEXT J
430     A$=A$&C$
440     ! PRINT A$
450  NEXT I
460  PRINT
470     !
480     !
490     !
500     FOR M=1 TO 56   ! M=56: twice the number of integers selected
510     ! FOR M=1 TO 16 ! if 8 integers are desired
520         V=.5*(M+1)-1+1
530         IF V=0 THEN V=1
540         IMAGE DD,5X,2A
550         PRINT USING 540;V,A$[M,M+1]
560         M=M+1
570     NEXT M
580  PRINT
590  PRINT
600  END
```

```
*****************************************************************************
*                              DATA MANIPULATION                            *
*****************************************************************************
                          McGee Creek Dispersive Soil

Data file name: 0TEST:H8,0,1
Number of observations: 28
Number of variables: 7

Variables names:
   1. Soil ID
   2. % H2O
   3. pH of Ext
   4. D/N or I
   5. log EC
   6. log E Na
   7. RANDOM #

Subfiles:  NONE
```

McGee Creek Dispersive Soil

OBS#	Variable # 1	Variable # 2	Variable # 3	Variable # 4	Variable # 5	Variable # 6	Variable # 7
1	95.00000	20.68000	7.04000	-1.00000	2.27875	.00860	1.00000
2	81.00000	29.53000	6.38000	-1.00000	1.59439	-.69897	2.00000
3	66.00000	31.24000	6.33000	-1.00000	2.12057	.02938	3.00000
4	107.00000	42.58000	6.70000	1.00000	2.61066	.55267	4.00000
5	108.00000	38.86000	5.26000	1.00000	3.09691	1.02776	5.00000
6	108.00000	38.41000	6.36000	1.00000	3.11093	1.03623	6.00000
7	86.00000	46.41000	5.68000	-1.00000	1.45788	-.79588	7.00000
8	103.00000	34.98000	7.33000	1.00000	2.88081	.75205	8.00000
9	103.00000	34.97000	7.32000	1.00000	2.87622	.80003	9.00000
10	94.00000	20.43000	8.13000	1.00000	2.69636	.45788	10.00000
11	135.00000	29.76000	7.85000	1.00000	2.90634	.88423	11.00000
12							

	94.00000	26.60000	7.89000	1.00000	2.61595
	.37840	12.00000			
13					
	96.00000	20.52000	7.53000	-1.00000	2.16732
	-.02228	13.00000			
14					
	62.00000	37.10000	6.45000	1.00000	2.32428
	.24055	14.00000			
15					
	118.00000	36.47000	5.70000	1.00000	2.74507
	.66745	15.00000			
16					
	66.00000	32.76000	6.54000	-1.00000	2.12385
	.02938	16.00000			
17					
	65.00000	29.46000	6.06000	-1.00000	1.86864
	-.30980	17.00000			
18					
	118.00000	35.45000	6.41000	1.00000	2.82737
	.71767	18.00000			
19					
	100.00000	34.84000	6.44000	-1.00000	1.75511
	-.44370	19.00000			
20					
	61.00000	30.30000	6.58000	-1.00000	2.10037
	.00860	20.00000			
21					
	81.00000	29.14000	7.46000	-1.00000	1.59218
	-.69897	21.00000			
22					
	61.00000	32.75000	5.53000	-1.00000	2.21219
	-.13077	22.00000			
23					
	65.00000	27.93000	5.45000	-1.00000	2.08991
	-.53760	23.00000			
24					
	62.00000	38.98000	7.42000	1.00000	2.40483
	.37107	24.00000			
25					
	135.00000	29.93000	7.51000	1.00000	2.99870
	.88423	25.00000			
26					
	86.00000	36.50000	6.36000	-1.00000	1.46982
	-.69897	26.00000			
27					
	100.00000	41.43000	5.64000	-1.00000	1.74974
	-.67778	27.00000			
28					
	107.00000	40.32000	6.32000	1.00000	2.59879
	.51983	28.00000			

APPENDIX IV

Discriminant score and classification tables and all-group histograms for verification discriminant analyses.

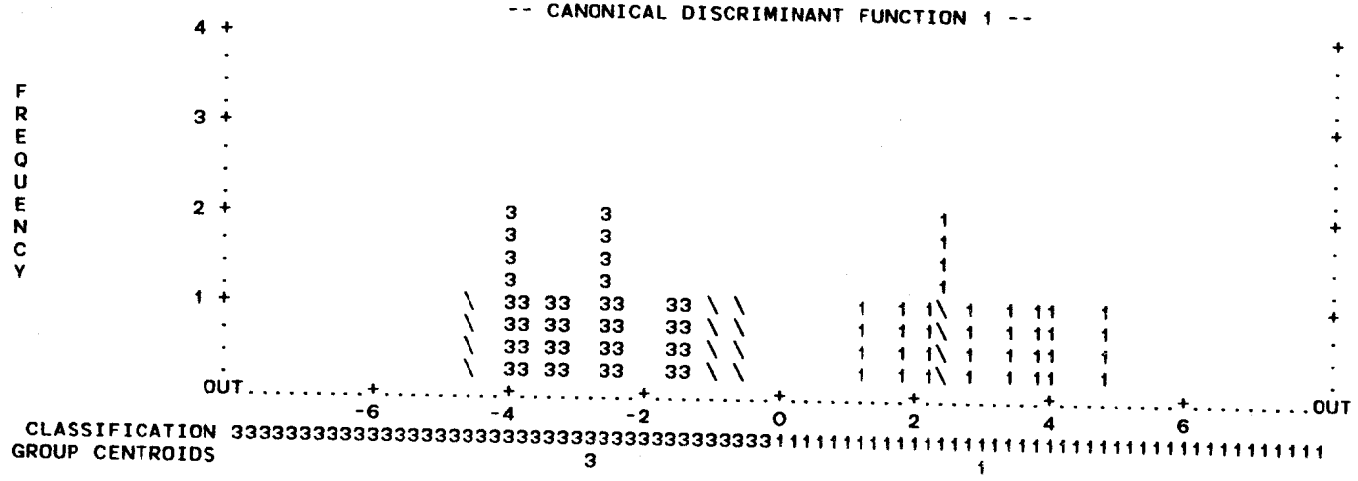
CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP	HIGHEST PROBABILITY GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
DATA	1			UNGRPD	-1	.6412	1.0000	1	.0000	2.3957
DATA	2			-1.	-1	.0833	1.0000	1	.0000	4.7913
DATA	3			-1.	-1	.3537	1.0000	1	.0000	1.8929
DATA	4			1.	1	.5543	1.0000	-1	.0000	-3.4367
DATA	5			1.	1	.7740	1.0000	-1	.0000	-3.1625
DATA	6			UNGRPD	1	.0612	1.0000	-1	.0000	-4.5911
DATA	7			-1.	-1	.9363	1.0000	1	.0000	2.8166
DATA	8			1.	1	.2217	1.0000	-1	.0000	-4.0051
DATA	9			1.	1	.2398	1.0000	-1	.0000	-3.9632
DATA	10			UNGRPD	1	.0415	.9914	-1	.0086	-1.0661
DATA	11			1.	1	.3744	1.0000	-1	.0000	-3.7041
DATA	12			1.	1	.1670	.9997	-1	.0003	-1.6581
DATA	13			-1.	-1	.6062	1.0000	1	.0000	2.3418
DATA	14			UNGRPD	1	.0082	.8369	-1	.1631	-.5214
DATA	15			1.	1	.1163	.9992	-1	.0008	-1.4882
DATA	16			-1.	-1	.1354	.9999	1	.0001	1.2763
DATA	17			-1.	-1	.3734	1.0000	1	.0000	3.8738
DATA	18			1.	1	.7544	1.0000	-1	.0000	-2.6217
DATA	19			UNGRPD	-1	.9192	1.0000	1	.0000	2.7930
DATA	20			UNGRPD	-1	.3393	1.0000	1	.0000	1.8623
DATA	21			-1.	-1	.6112	1.0000	1	.0000	3.4577
DATA	22			-1.	-1	.4929	1.0000	1	.0000	2.1563
DATA	23			UNGRPD	-1	.3741	1.0000	1	.0000	3.8723
DATA	24			1.	1	.7357	1.0000	-1	.0000	-2.5993
DATA	25			UNGRPD	1	.3439	1.0000	-1	.0000	-3.7567
DATA	26			-1.	-1	.3291	1.0000	1	.0000	3.9672
DATA	27			-1.	-1	.6856	1.0000	1	.0000	2.4625
DATA	28			1.	1	.5743	1.0000	-1	.0000	-2.3973

SYMBOLS USED IN PLOTS

SYMBOL	GROUP	LABEL
1	-1	
3	1	
#		ALL UNGROUPED CASES

ALL-GROUPS HISTOGRAM

-- CANONICAL DISCRIMINANT FUNCTION 1 --



CLASSIFICATION RESULTS -

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP -1	1
GROUP -1	10	10 100.0	0 0
GROUP 1	10	0 0	10 100.0
UNGROUPED CASES	8	4 50.0	4 50.0

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED - 100.00

CLASSIFICATION PROCESSING SUMMARY

28 CASES WERE PROCESSED.
28 CASES WERE USED FOR PRINTED OUTPUT.

CPU TIME REQUIRED.. .6660 SECONDS

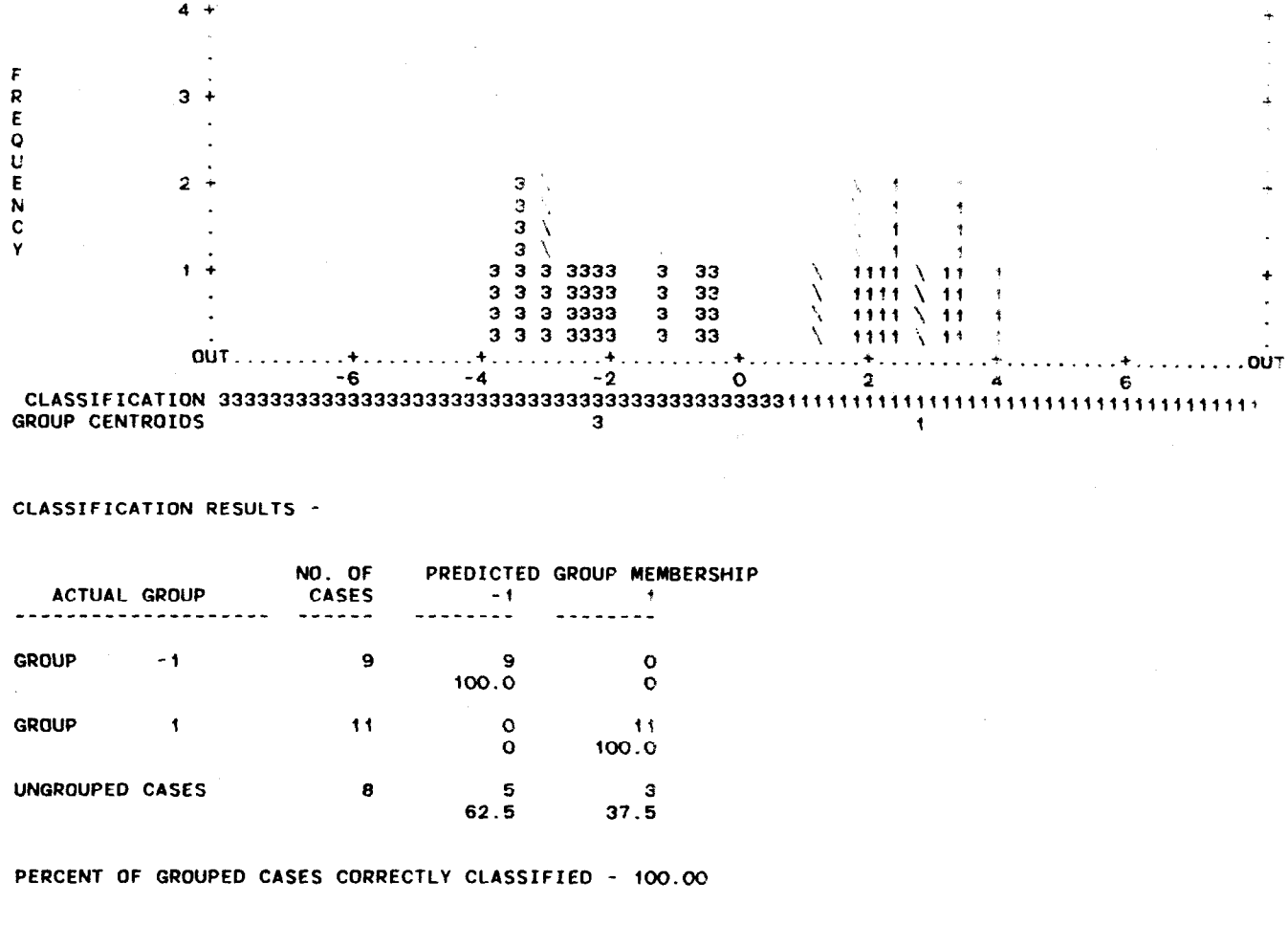
CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP	HIGHEST PROBABILITY GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
DATA	1			-1.	-1	.6201	.9998	1	.0002	2.3408
DATA	2			-1.	-1	.0979	1.0000	1	.0000	4.0931
DATA	3			UNGRPD	-1	.2122	.9969	1	.0031	1.7281
DATA	4			1.	1	.4829	1.0000	-1	.0000	-3.0360
DATA	5			1.	1	.8160	1.0000	-1	.0000	-2.5077
DATA	6			1.	1	.1661	1.0000	-1	.0000	-3.8056
DATA	7			UNGRPD	-1	.3829	.9992	1	.0008	2.0338
DATA	8			1.	1	.3244	1.0000	-1	.0000	-3.3558
DATA	9			1.	1	.3466	1.0000	-1	.0000	-3.3058
DATA	10			1.	1	.1477	.9992	-1	.0008	-.6150
DATA	11			UNGRPD	1	.5146	1.0000	-1	.0000	-2.9798
DATA	12			UNGRPD	1	.3851	1.0000	-1	.0000	-1.2672
DATA	13			-1.	-1	.5518	.9997	1	.0003	2.2599
DATA	14			1.	1	.1108	.9977	-1	.0023	-.4493
DATA	15			1.	1	.3179	1.0000	-1	.0000	-1.1206
DATA	16			UNGRPD	-1	.0498	.9495	1	.0505	1.1466
DATA	17			-1.	-1	.4091	1.0000	1	.0000	3.4173
DATA	18			1.	1	.9078	1.0000	-1	.0000	-2.1153
DATA	19			-1.	-1	.5892	.9998	1	.0002	2.3048
DATA	20			-1.	-1	.2002	.9965	1	.0035	1.7009
DATA	21			UNGRPD	-1	.8723	1.0000	1	.0000	2.8756
DATA	22			-1.	-1	.3181	.9988	1	.0012	1.9312
DATA	23			-1.	-1	.4040	1.0000	1	.0000	3.4247
DATA	24			1.	1	.9461	1.0000	-1	.0000	-2.3218
DATA	25			UNGRPD	1	.4981	1.0000	-1	.0000	-3.0088
DATA	26			-1.	-1	.5517	1.0000	1	.0000	3.2297
DATA	27			UNGRPD	-1	.2798	.9983	1	.0017	1.8640
DATA	28			1.	1	.8756	1.0000	-1	.0000	-2.0694

SYMBOLS USED IN PLOTS

SYMBOL	GROUP	LABEL
1	-1	
3	1	
#		ALL UNGROUPED CASES

ALL-GROUPS HISTOGRAM

-- CANONICAL DISCRIMINANT FUNCTION 1 --



CLASSIFICATION RESULTS -

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP -1	1
GROUP -1	9	9	0
		100.0	0
GROUP 1	11	0	11
		0	100.0
UNGROUPED CASES	8	5	3
		62.5	37.5

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED - 100.00

CLASSIFICATION PROCESSING SUMMARY

28 CASES WERE PROCESSED.
28 CASES WERE USED FOR PRINTED OUTPUT.

CPU TIME REQUIRED.. .6810 SECONDS

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP	HIGHEST PROBABILITY GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
DATA	1			-1.	-1	.3329	.9960	1	.0040	1.5222
DATA	2			-1.	-1	.0769	1.0000	1	.0000	3.8027
DATA	3			UNGRPD	-1	.3400	.9962	1	.0038	1.5340
DATA	4			UNGRPD	1	.7470	1.0000	-1	.0000	-2.6975
DATA	5			1.	1	.8552	1.0000	-1	.0000	-2.5374
DATA	6			1.	1	.1979	1.0000	-1	.0000	-3.8003
DATA	7			-1.	-1	.7307	.9999	1	.0001	2.6156
DATA	8			1.	1	.3234	1.0000	-1	.0000	-3.4575
DATA	9			UNGRPD	1	.3577	1.0000	-1	.0000	-3.3800
DATA	10			1.	1	.4379	.9999	-1	.0001	-1.4423
DATA	11			1.	1	.4112	1.0000	-1	.0000	-3.2679
DATA	12			1.	1	.6289	1.0000	-1	.0000	-1.7765
DATA	13			UNGRPD	-1	.3340	.9961	1	.0039	1.5241
DATA	14			1.	1	.0863	.9694	-1	.0306	-.3684
DATA	15			1.	1	.3183	.9997	-1	.0003	-1.1884
DATA	16			-1.	-1	.1219	.9697	1	.0303	1.0404
DATA	17			-1.	-1	.3449	1.0000	1	.0000	3.1157
DATA	18			UNGRPD	1	.9284	1.0000	-1	.0000	-2.2262
DATA	19			-1.	-1	.9832	.9998	1	.0002	2.3113
DATA	20			-1.	-1	.3061	.9952	1	.0048	1.4763
DATA	21			-1.	-1	.7185	.9999	1	.0001	2.6291
DATA	22			UNGRPD	-1	.3941	.9973	1	.0027	1.6189
DATA	23			-1.	-1	.6283	1.0000	1	.0000	2.7322
DATA	24			1.	1	.8252	1.0000	-1	.0000	-2.0765
DATA	25			1.	1	.3607	1.0000	-1	.0000	-3.3734
DATA	26			UNGRPD	-1	.2051	1.0000	1	.0000	3.3844
DATA	27			-1.	-1	.7316	.9995	1	.0005	2.0431
DATA	28			UNGRPD	1	.6930	1.0000	-1	.0000	-1.8778

SYMBOLS USED IN PLOTS

SYMBOL	GROUP	LABEL
1	-1	
3	1	
#		ALL UNGROUPED CASES

ALL-GROUPS HISTOGRAM

-- CANONICAL DISCRIMINANT FUNCTION 1 --

```
              4 +                                                                  +
                .                                                                  .
                .                                                                  .
F               .                                                                  .
R             3 +                                          \                       +
E               .                                          \                       .
Q               .                                          \                       .
U               .                                          \                       .
E             2 +                       3                  \     1                 +
N               .                       3                  \     1                 .
C               .                       3                  \     1                 .
Y               .                       3                  \     1                 .
              1 +                     3 \3  3 \33 33   3      1 11  1 111  1\  1   +
                .                     3 \3  3 \33 33   3      1 11  1 111  1\  1   .
                .                     3 \3  3 \33 33   3      1 11  1 111  1\  1   .
                .                     3 \3  3 \33 33   3      1 11  1 111  1\  1   .
               OUT.........+.........+.........+.........+.........+.........+.........+.........OUT
                          -6        -4        -2         0         2         4         6
 CLASSIFICATION 3333333333333333333333333333333333333333311111111111111111111111111111111111111
GROUP CENTROIDS                                3                     1
```

CLASSIFICATION RESULTS -

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP -1	1
GROUP -1	10	10	0
		100.0	0
GROUP 1	10	0	10
		0	100.0
UNGROUPED CASES	8	4	4
		50.0	50.0

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED - 100.00

CLASSIFICATION PROCESSING SUMMARY

28 CASES WERE PROCESSED.
28 CASES WERE USED FOR PRINTED OUTPUT.

CPU TIME REQUIRED.. .6870 SECONDS

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP	HIGHEST PROBABILITY GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
DATA	1			UNGRPD	-1	.4222	.9998	1	.0002	2.2080
DATA	2			-1.	-1	.0669	1.0000	1	.0000	4.4375
DATA	3			-1.	-1	.2654	.9993	1	.0007	1.9446
DATA	4			1.	1	.5317	1.0000	-1	.0000	-3.0549
DATA	5			1.	1	.5636	1.0000	-1	.0000	-3.0019
DATA	6			UNGRPD	1	.0879	1.0000	-1	.0000	-4.2528
DATA	7			-1.	-1	.7100	1.0000	1	.0000	2.5724
DATA	8			1.	1	.2410	1.0000	-1	.0000	-3.6611
DATA	9			1.	1	.2863	1.0000	-1	.0000	-3.5433
DATA	10			1.	1	.2021	.9999	-1	.0001	-.9489
DATA	11			UNGRPD	1	.4673	1.0000	-1	.0000	-3.1674
DATA	12			UNGRPD	1	.4491	1.0000	-1	.0000	-1.5238
DATA	13			-1.	-1	.5157	.9999	1	.0001	2.3371
DATA	14			1.	1	.0672	.9951	-1	.0049	-.3346
DATA	15			1.	1	.3629	1.0000	-1	.0000	-1.3542
DATA	16			UNGRPD	-1	.0744	.9876	1	.0124	1.3772
DATA	17			UNGRPD	-1	.3463	1.0000	1	.0000	3.6841
DATA	18			1.	1	.9648	1.0000	-1	.0000	-2.4111
DATA	19			-1.	-1	.8068	1.0000	1	.0000	2.6802
DATA	20			-1.	-1	.2639	.9992	1	.0008	1.9417
DATA	21			-1.	-1	.6360	1.0000	1	.0000	3.2876
DATA	22			UNGRPD	-1	.1708	.9979	1	.0021	1.7283
DATA	23			-1.	-1	.9610	1.0000	1	.0000	2.9285
DATA	24			1.	1	.8379	1.0000	-1	.0000	-2.1356
DATA	25			1.	1	.3498	1.0000	-1	.0000	-3.3980
DATA	26			-1.	-1	.2530	1.0000	1	.0000	3.8545
DATA	27			UNGRPD	-1	.2660	.9993	1	.0007	1.9458
DATA	28			1.	1	.8413	1.0000	-1	.0000	-2.1403

SYMBOLS USED IN PLOTS

SYMBOL	GROUP	LABEL
1	-1	
3	1	
#		ALL UNGROUPED CASES

ALL-GROUPS HISTOGRAM

-- CANONICAL DISCRIMINANT FUNCTION 1 --

```
              4 +                                                                  +
                .                                                                  .
                .                                                                  .
F               .                                                                  .
R             3 +                                                                  +
E               .                                                                  .
Q               .                                                                  .
U               .                                                                  .
E             2 +                     3  3   3                   1  1              +
N               .                     3  3   3                   1  1              .
C               .                     3  3   3                   1  1              .
Y               .                     3  3   3                   1  1              .
              1 +                  \  33\3  33  \3 3  3        \ \\\11 11 \1  1     +
                .                  \  33\3  33  \3 3  3        \ \\\11 11 \1  1     .
                .                  \  33\3  33  \3 3  3        \ \\\11 11 \1  1     .
                .                  \  33\3  33  \3 3  3        \ \\\11 11 \1  1     .
               OUT.........+.........+.........+.........+.........+.........+.........+.........OUT
                         -6        -4        -2         0         2         4         6
 CLASSIFICATION 3333333333333333333333333333333333333333331111111111111111111111111111111111111
GROUP CENTROIDS                                 3                          1
```

CLASSIFICATION RESULTS -

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP -1	1
GROUP -1	9	9	0
		100.0	0
GROUP 1	11	0	11
		0	100.0
UNGROUPED CASES	8	5	3
		62.5	37.5

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED - 100.00

CLASSIFICATION PROCESSING SUMMARY

28 CASES WERE PROCESSED.
28 CASES WERE USED FOR PRINTED OUTPUT.

CPU TIME REQUIRED.. .6610 SECONDS

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP	HIGHEST PROBABILITY GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
DATA	1			-1.	-1	.4817	1.0000	1	.0000	1.5542
DATA	2			-1.	-1	.0377	1.0000	1	.0000	4.3692
DATA	3			UNGRPD	-1	.5743	1.0000	1	.0000	1.6978
DATA	4			1.	1	.3942	1.0000	-1	.0000	-4.2349
DATA	5			1.	1	.8565	1.0000	-1	.0000	-3.5767
DATA	6			UNGRPD	1	.0332	1.0000	-1	.0000	-5.4875
DATA	7			-1.	-1	.8130	1.0000	1	.0000	2.5057
DATA	8			UNGRPD	1	.0588	1.0000	-1	.0000	-5.2524
DATA	9			1.	1	.0902	1.0000	-1	.0000	-5.0606
DATA	10			1.	1	.3714	1.0000	-1	.0000	-2.5231
DATA	11			UNGRPD	1	.1583	1.0000	-1	.0000	-4.7828
DATA	12			1.	1	.7603	1.0000	-1	.0000	-3.1003
DATA	13			-1.	-1	.4967	1.0000	1	.0000	1.5783
DATA	14			UNGRPD	1	.0142	.9019	-1	.0981	-.9954
DATA	15			1.	1	.1155	.9992	-1	.0008	-1.8560
DATA	16			-1.	-1	.1925	.9999	1	.0001	.9472
DATA	17			UNGRPD	-1	.1447	1.0000	1	.0000	3.7425
DATA	18			1.	1	.9959	1.0000	-1	.0000	-3.4045
DATA	19			-1.	-1	.9018	1.0000	1	.0000	2.3911
DATA	20			-1.	-1	.5050	1.0000	1	.0000	1.5916
DATA	21			-1.	-1	.7483	1.0000	1	.0000	2.5911
DATA	22			-1.	-1	.4683	1.0000	1	.0000	1.5322
DATA	23			-1.	-1	.6773	1.0000	1	.0000	2.6876
DATA	24			1.	1	.9673	1.0000	-1	.0000	-3.4396
DATA	25			UNGRPD	1	.1030	1.0000	-1	.0000	-4.9985
DATA	26			-1.	-1	.1273	1.0000	1	.0000	3.8096
DATA	27			-1.	-1	.5347	1.0000	1	.0000	1.6379
DATA	28			UNGRPD	1	.7090	1.0000	-1	.0000	-3.0336

SYMBOLS USED IN PLOTS

SYMBOL	GROUP	LABEL
1	-1	
3	1	
#		ALL UNGROUPED CASES

ALL-GROUPS HISTOGRAM

-- CANONICAL DISCRIMINANT FUNCTION 1 --

```
              8 +                                                                  +
                .                                                                  .
                .                                                                  .
F               .                                                                  .
R             6 +                                                                  +
E               .                                                                  .
Q               .                                          1                       .
U               .                                          1                       .
E             4 +                                          1                       +
N               .                                          1                       .
C               .                                          1    1                  .
Y               .                                          1    1                  .
              2 +                       3                  1    1                  +
                .                       3                  1    1                  .
                .             \\3\  3  333\ 3   3   \         1  \   11     1  1   .
                .             \\3\  3  333\ 3   3   \         1  \   11     1  1   .
               OUT........+.........+.........+.........+.........+.........+.........+.........OUT
                        -6        -4        -2         0         2         4         6
 CLASSIFICATION 3333333333333333333333333333333333331111111111111111111111111111111111111111111111
GROUP CENTROIDS                         3                                  1
```

CLASSIFICATION RESULTS -

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP -1	1
GROUP -1	12	12	0
		100.0	0
GROUP 1	8	0	8
		0	100.0
UNGROUPED CASES	8	2	6
		25.0	75.0

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED - 100.00

CLASSIFICATION PROCESSING SUMMARY

28 CASES WERE PROCESSED.
28 CASES WERE USED FOR PRINTED OUTPUT.

CPU TIME REQUIRED.. .6960 SECONDS

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP	HIGHEST PROBABILITY GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
DATA	1			UNGRPD	-1	.2758	.9996	1	.0004	2.0364
DATA	2			UNGRPD	-1	.0403	1.0000	1	.0000	4.7347
DATA	3			-1.	-1	.1731	.9988	1	.0012	1.8022
DATA	4			1.	1	.4790	1.0000	-1	.0000	-3.2109
DATA	5			1.	1	.5814	1.0000	-1	.0000	-3.0387
DATA	6			UNGRPD	1	.0609	1.0000	-1	.0000	-4.4935
DATA	7			UNGRPD	-1	.7283	1.0000	1	.0000	3.2714
DATA	8			1.	1	.1542	1.0000	-1	.0000	-3.9992
DATA	9			1.	1	.1602	1.0000	-1	.0000	-3.9766
DATA	10			1.	1	.3808	1.0000	-1	.0000	-1.4686
DATA	11			UNGRPD	1	.1809	1.0000	-1	.0000	-3.9036
DATA	12			1.	1	.6080	1.0000	-1	.0000	-1.8682
DATA	13			-1.	-1	.2313	.9994	1	.0006	1.9444
DATA	14			1.	1	.0704	.9976	-1	.0024	-.4429
DATA	15			1.	1	.3627	1.0000	-1	.0000	-1.4314
DATA	16			UNGRPD	-1	.0426	.9767	1	.0233	1.2302
DATA	17			-1.	-1	.3533	1.0000	1	.0000	3.7705
DATA	18			1.	1	.8822	1.0000	-1	.0000	-2.5953
DATA	19			-1.	-1	.8943	1.0000	1	.0000	2.8587
DATA	20			UNGRPD	-1	.1515	.9984	1	.0016	1.7405
DATA	21			-1.	-1	.6402	1.0000	1	.0000	3.3745
DATA	22			-1.	-1	.3760	.9998	1	.0002	2.2122
DATA	23			-1.	-1	.2858	1.0000	1	.0000	3.8900
DATA	24			1.	1	.9535	1.0000	-1	.0000	-2.4965
DATA	25			UNGRPD	1	.1776	1.0000	-1	.0000	-3.9148
DATA	26			-1.	-1	.1975	1.0000	1	.0000	4.0802
DATA	27			-1.	-1	.8617	1.0000	1	.0000	2.8232
DATA	28			1.	1	.8522	1.0000	-1	.0000	-2.2274

SYMBOLS USED IN PLOTS

SYMBOL	GROUP	LABEL
1	-1	
3	1	
#		ALL UNGROUPED CASES

ALL-GROUPS HISTOGRAM

-- CANONICAL DISCRIMINANT FUNCTION 1 --

```
              4 +                                                                  +
                .                                                                  .
                .                                                                  .
F               .                                                                  .
R             3 +                                                                  +
E               .                                                                  .
Q               .                                                                  .
U               .                                                                  .
E             2 +                   3           3                   1    1         +
N               .                   3           3                   1    1         .
C               .                   3           3                   1    1         .
Y               .                   3           3                   1    1         .
              1 +                 \ 3   33 333 3 3    3       \  111  1 \1 11   \   +
                .                 \ 3   33 333 3 3    3       \  111  1 \1 11   \   .
                .                 \ 3   33 333 3 3    3       \  111  1 \1 11   \   .
                .                 \ 3   33 333 3 3    3       \  111  1 \1 11   \   .
               OUT........+.........+.........+.........+.........+.........+.........+.........OUT
                         -6        -4        -2         0         2         4         6
 CLASSIFICATION 3333333333333333333333333333333333333333333111111111111111111111111111111111111111
GROUP CENTROIDS                            3                           1
```

CLASSIFICATION RESULTS -

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP -1	1
GROUP -1	9	9	0
		100.0	0
GROUP 1	11	0	11
		0	100.0
UNGROUPED CASES	8	5	3
		62.5	37.5

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED - 100.00

CLASSIFICATION PROCESSING SUMMARY

28 CASES WERE PROCESSED.
28 CASES WERE USED FOR PRINTED OUTPUT.

CPU TIME REQUIRED.. .6560 SECONDS

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP	HIGHEST PROBABILITY GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
DATA	1			UNGRPD	-1	.9391	1.0000	1	.0000	2.3797
DATA	2			-1.	-1	.0406	1.0000	1	.0000	4.3767
DATA	3			-1.	-1	.4727	.9999	1	.0001	1.7763
DATA	4			1.	1	.8285	1.0000	-1	.0000	-3.2280
DATA	5			1.	1	.9479	1.0000	-1	.0000	-3.0662
DATA	6			1.	1	.2348	1.0000	-1	.0000	-4.2673
DATA	7			-1.	-1	.8477	1.0000	1	.0000	2.2709
DATA	8			1.	1	.5659	1.0000	-1	.0000	-3.6105
DATA	9			1.	1	.6050	1.0000	-1	.0000	-3.5497
DATA	10			UNGRPD	1	.0300	.9545	-1	.0455	-.6748
DATA	11			1.	1	.8769	1.0000	-1	.0000	-3.1620
DATA	12			UNGRPD	1	.1193	.9988	-1	.0012	-1.3298
DATA	13			-1.	-1	.9691	1.0000	1	.0000	2.4151
DATA	14			1.	1	.0201	.8933	-1	.1067	-.5091
DATA	15			UNGRPD	1	.1501	.9994	-1	.0006	-1.4566
DATA	16			-1.	-1	.1858	.9991	1	.0009	1.2072
DATA	17			-1.	-1	.2404	1.0000	1	.0000	3.5554
DATA	18			UNGRPD	1	.5953	1.0000	-1	.0000	-2.4280
DATA	19			-1.	-1	.9474	1.0000	1	.0000	2.5136
DATA	20			-1.	-1	.4788	.9999	1	.0001	1.7856
DATA	21			UNGRPD	-1	.3879	1.0000	1	.0000	3.2633
DATA	22			-1.	-1	.4940	1.0000	1	.0000	1.8084
DATA	23			-1.	-1	.3558	1.0000	1	.0000	3.3198
DATA	24			UNGRPD	1	.5321	1.0000	-1	.0000	-2.3277
DATA	25			1.	1	.7865	1.0000	-1	.0000	-3.2861
DATA	26			UNGRPD	-1	.2331	1.0000	1	.0000	3.5727
DATA	27			-1.	-1	.5846	1.0000	1	.0000	1.9375
DATA	28			1.	1	.5077	1.0000	-1	.0000	-2.2875

SYMBOLS USED IN PLOTS

SYMBOL	GROUP	LABEL
1	-1	
3	1	
#		ALL UNGROUPED CASES

ALL-GROUPS HISTOGRAM

-- CANONICAL DISCRIMINANT FUNCTION 1 --

```
              4 +                                                                  +
                .                                                                  .
                .                                                                  .
F               .                                                                  .
R             3 +                        3                       1                 +
E               .                        3                       1                 .
Q               .                        3                       1                 .
U               .                        3                       1                 .
E             2 +                      3 3   \     \             1                 +
N               .                      3 3   \     \             1                 .
C               .                      3 3   \     \             1                 .
Y               .                      3 3   \     \             1                 .
              1 +                  3   3 33  \3    \   3     1   11111  \11   1     +
                .                  3   3 33  \3    \   3     1   11111  \11   1     .
                .                  3   3 33  \3    \   3     1   11111  \11   1     .
                .                  3   3 33  \3    \   3     1   11111  \11   1     .
               OUT........+.........+.........+.........+.........+.........+.........+.........OUT
                        -6        -4        -2         0         2         4         6
 CLASSIFICATION 3333333333333333333333333333333333333311111111111111111111111111111111111111111
GROUP CENTROIDS                          3                         1
```

CLASSIFICATION RESULTS -

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP -1	1
GROUP -1	11	11	0
		100.0	0
GROUP 1	9	0	9
		0	100.0
UNGROUPED CASES	8	3	5
		37.5	62.5

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED - 100.00

CLASSIFICATION PROCESSING SUMMARY

28 CASES WERE PROCESSED.
28 CASES WERE USED FOR PRINTED OUTPUT.

CPU TIME REQUIRED.. .6750 SECONDS

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP	HIGHEST PROBABILITY GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
DATA	1			-1.	-1	.8070	1.0000	1	.0000	2.7787
DATA	2			-1.	-1	.0477	1.0000	1	.0000	4.4126
DATA	3			-1.	-1	.5575	1.0000	1	.0000	1.9965
DATA	4			1.	1	.6345	1.0000	-1	.0000	-3.6232
DATA	5			1.	1	.6510	1.0000	-1	.0000	-2.6315
DATA	6			1.	1	.2970	1.0000	-1	.0000	-4.2296
DATA	7			UNGRPD	-1	.3627	.9999	1	.0001	1.6918
DATA	8			1.	1	.4928	1.0000	-1	.0000	-3.8481
DATA	9			1.	1	.5561	1.0000	-1	.0000	-3.7442
DATA	10			UNGRPD	1	.0174	.9270	-1	.0730	-.5729
DATA	11			1.	1	.9080	1.0000	-1	.0000	-3.2386
DATA	12			UNGRPD	1	.1249	.9996	-1	.0004	-1.4749
DATA	13			-1.	-1	.8933	1.0000	1	.0000	2.6750
DATA	14			1.	1	.0185	.9358	-1	.0642	-.5967
DATA	15			UNGRPD	1	.0645	.9971	-1	.0029	-1.1390
DATA	16			-1.	-1	.1730	.9995	1	.0005	1.2659
DATA	17			UNGRPD	-1	.1646	1.0000	1	.0000	3.8570
DATA	18			UNGRPD	1	.4658	1.0000	-1	.0000	-2.3356
DATA	19			-1.	-1	.8335	1.0000	1	.0000	2.3508
DATA	20			-1.	-1	.5285	1.0000	1	.0000	1.9554
DATA	21			UNGRPD	-1	.7016	1.0000	1	.0000	2.9094
DATA	22			-1.	-1	.6201	1.0000	1	.0000	2.0820
DATA	23			-1.	-1	.2472	1.0000	1	.0000	3.6380
DATA	24			1.	1	.7898	1.0000	-1	.0000	-2.8301
DATA	25			1.	1	.8673	1.0000	-1	.0000	-3.2937
DATA	26			-1.	-1	.4123	1.0000	1	.0000	3.3206
DATA	27			-1.	-1	.2937	.9999	1	.0001	1.5603
DATA	28			UNGRPD	1	.5260	1.0000	-1	.0000	-2.4374

SYMBOLS USED IN PLOTS

SYMBOL	GROUP	LABEL
1	-1	
3	1	
#		ALL UNGROUPED CASES

ALL-GROUPS HISTOGRAM

-- CANONICAL DISCRIMINANT FUNCTION 1 --

```
              4 +                                                                                  +
                .                                                                                  .
                .                                                                                  .
F               .                                                                                  .
R             3 +                                                   1                              +
E               .                                                   1                              .
Q               .                                                   1                              .
U               .                                                   1                              .
E             2 +                     3  3   \                      1                              +
N               .                     3  3   \                      1                              .
C               .                     3  3   \                      1                              .
Y               .                     3  3   \                      1                              .
              1 +                   3 33 3 33\    \\  3        1 1 1 111\ 11\  1                   +
              .  .                  3 33 3 33\    \\  3        1 1 1 111\ 11\  1                   .
                .                   3 33 3 33\    \\  3        1 1 1 111\ 11\  1                   .
                .                   3 33 3 33\    \\  3        1 1 1 111\ 11\  1                   .
             OUT.........+.........+.........+.........+.........+.........+.........+.........OUT
                       -6        -4        -2         0         2         4         6
 CLASSIFICATION 3333333333333333333333333333333333333311111111111111111111111111111111111111111
GROUP CENTROIDS                          3                                1
```

CLASSIFICATION RESULTS -

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP -1	1
GROUP -1	11	11	0
		100.0	0
GROUP 1	9	0	9
		0	100.0
UNGROUPED CASES	8	3	5
		37.5	62.5

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED - 100.00

CLASSIFICATION PROCESSING SUMMARY

28 CASES WERE PROCESSED.
28 CASES WERE USED FOR PRINTED OUTPUT.

CPU TIME REQUIRED.. .6610 SECONDS

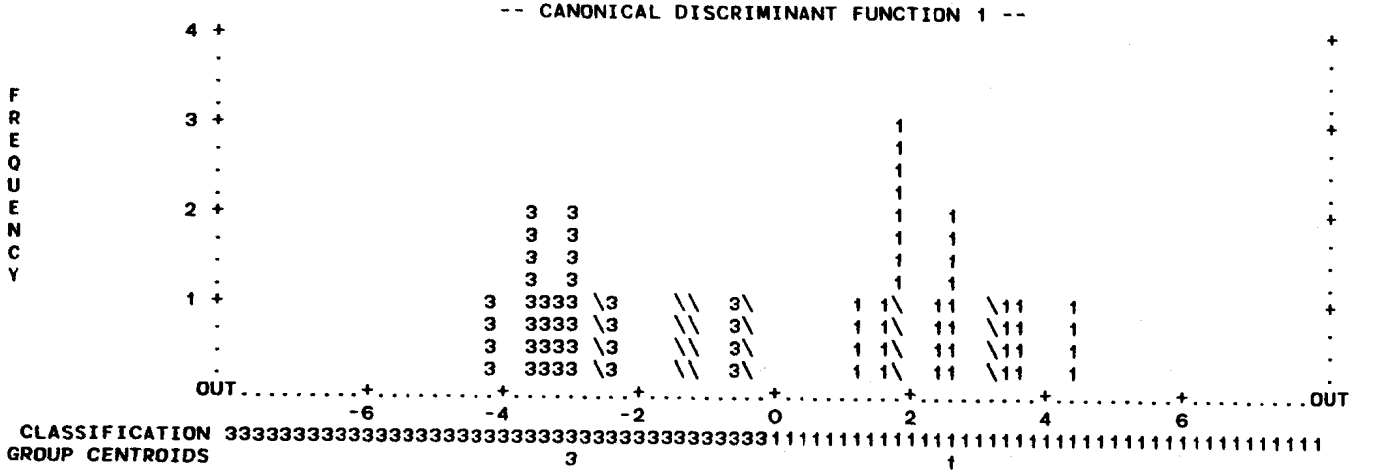
CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP	HIGHEST PROBABILITY GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
DATA	1			-1.	-1	.8800	1.0000	1	.0000	2.6246
DATA	2			-1.	-1	.0548	1.0000	1	.0000	4.3380
DATA	3			-1.	-1	.4784	1.0000	1	.0000	1.7920
DATA	4			1.	1	.6900	1.0000	-1	.0000	-3.4434
DATA	5			1.	1	.9866	1.0000	-1	.0000	-3.0118
DATA	6			1.	1	.2294	1.0000	-1	.0000	-4.2770
DATA	7			UNGRPD	-1	.5096	1.0000	1	.0000	1.8399
DATA	8			1.	1	.5553	1.0000	-1	.0000	-3.6416
DATA	9			1.	1	.5974	1.0000	-1	.0000	-3.5776
DATA	10			UNGRPD	1	.0124	.7898	-1	.2102	-.4329
DATA	11			1.	1	.9541	1.0000	-1	.0000	-3.0890
DATA	12			UNGRPD	1	.0845	.9970	-1	.0030	-1.2380
DATA	13			-1.	-1	.8865	1.0000	1	.0000	2.6167
DATA	14			1.	1	.0201	.9118	-1	.0882	-.6160
DATA	15			UNGRPD	1	.1232	.9990	-1	.0010	-1.4289
DATA	16			-1.	-1	.1768	.9994	1	.0006	1.1705
DATA	17			-1.	-1	.2509	1.0000	1	.0000	3.5904
DATA	18			UNGRPD	1	.5531	1.0000	-1	.0000	-2.4135
DATA	19			-1.	-1	.9094	1.0000	1	.0000	2.3683
DATA	20			-1.	-1	.4861	1.0000	1	.0000	1.8041
DATA	21			UNGRPD	-1	.4825	1.0000	1	.0000	3.1584
DATA	22			-1.	-1	.5116	1.0000	1	.0000	1.8429
DATA	23			-1.	-1	.3179	1.0000	1	.0000	3.4456
DATA	24			UNGRPD	1	.6337	1.0000	-1	.0000	-2.5344
DATA	25			1.	1	.8814	1.0000	-1	.0000	-3.1841
DATA	26			UNGRPD	-1	.3689	1.0000	1	.0000	3.3485
DATA	27			-1.	-1	.4038	1.0000	1	.0000	1.6700
DATA	28			1.	1	.5590	1.0000	-1	.0000	-2.4226

SYMBOLS USED IN PLOTS

SYMBOL	GROUP	LABEL
1	-1	
3	1	
#		ALL UNGROUPED CASES

ALL-GROUPS HISTOGRAM

-- CANONICAL DISCRIMINANT FUNCTION 1 --



CLASSIFICATION RESULTS -

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP -1	1
GROUP -1	11	11	0
		100.0	0
GROUP 1	9	0	9
		0	100.0
UNGROUPED CASES	8	3	5
		37.5	62.5

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED - 100.00

CLASSIFICATION PROCESSING SUMMARY

28 CASES WERE PROCESSED.
28 CASES WERE USED FOR PRINTED OUTPUT.

CPU TIME REQUIRED.. .6470 SECONDS

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP	HIGHEST PROBABILITY GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
DATA	1			-1.	-1	.4114	.9962	1	.0038	1.5792
DATA	2			-1.	-1	.0573	1.0000	1	.0000	3.8249
DATA	3			-1.	-1	.4987	.9976	1	.0024	1.6987
DATA	4			UNGRPD	1	.7376	1.0000	-1	.0000	-2.6417
DATA	5			1.	1	.8980	1.0000	-1	.0000	-2.4040
DATA	6			1.	1	.2010	1.0000	-1	.0000	-3.7256
DATA	7			-1.	-1	.7061	.9999	1	.0001	2.5678
DATA	8			1.	1	.3025	1.0000	-1	.0000	-3.4412
DATA	9			UNGRPD	1	.3560	1.0000	-1	.0000	-3.3171
DATA	10			1.	1	.4714	.9999	-1	.0001	-1.4294
DATA	11			1.	1	.4412	1.0000	-1	.0000	-3.1415
DATA	12			1.	1	.6913	1.0000	-1	.0000	-1.8006
DATA	13			UNGRPD	-1	.4486	.9969	1	.0031	1.6318
DATA	14			1.	1	.0826	.9441	-1	.0559	-.2627
DATA	15			1.	1	.2935	.9992	-1	.0008	-1.0500
DATA	16			-1.	-1	.1909	.9810	1	.0190	1.1780
DATA	17			-1.	-1	.2312	1.0000	1	.0000	3.2442
DATA	18			UNGRPD	1	.9241	1.0000	-1	.0000	-2.1474
DATA	19			-1.	-1	.9002	.9998	1	.0002	2.3602
DATA	20			-1.	-1	.4521	.9970	1	.0030	1.6365
DATA	21			-1.	-1	.6768	.9999	1	.0001	2.6006
DATA	22			UNGRPD	-1	.4182	.9963	1	.0037	1.5889
DATA	23			UNGRPD	-1	.7633	.9999	1	.0001	2.5051
DATA	24			1.	1	.8214	1.0000	-1	.0000	-1.9974
DATA	25			1.	1	.3570	1.0000	-1	.0000	-3.3150
DATA	26			UNGRPD	-1	.1443	1.0000	1	.0000	3.4609
DATA	27			-1.	-1	.6454	.9988	1	.0012	1.8772
DATA	28			UNGRPD	1	.6912	1.0000	-1	.0000	-1.8003

SYMBOLS USED IN PLOTS

SYMBOL	GROUP	LABEL
1	-1	
3	1	
#		ALL UNGROUPED CASES

ALL-GROUPS HISTOGRAM

-- CANONICAL DISCRIMINANT FUNCTION 1 --

```
              4 +                                                                  +
                .                                                                  .
                .                                                                  .
F               .                                                                  .
R             3 +                                          1                       +
E               .                                          1                       .
Q               .                                          1                       .
U               .                                          1                       .
E             2 +                     3                    \    1                  +
N               .                     3                    \    1                  .
C               .                     3                    \    1                  .
Y               .                     3                    \    1                  .
              1 +                   3 \3  \3\33 3 3   3    1 \1  1\  1\ 1          +
                .                   3 \3  \3\33 3 3   3    1 \1  1\  1\ 1          .
                .                   3 \3  \3\33 3 3   3    1 \1  1\  1\ 1          .
                .                   3 \3  \3\33 3 3   3    1 \1  1\  1\ 1          .
               OUT.........+.........+.........+.........+.........+.........+.........+.........OUT
                         -6        -4        -2         0         2         4         6
 CLASSIFICATION 3333333333333333333333333333333333333333311111111111111111111111111111111111111111
GROUP CENTROIDS                              3                      1
```

CLASSIFICATION RESULTS -

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP -1	1
GROUP -1	10	10	0
		100.0	0
GROUP 1	10	0	10
		0	100.0
UNGROUPED CASES	8	4	4
		50.0	50.0

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED - 100.00

CLASSIFICATION PROCESSING SUMMARY

28 CASES WERE PROCESSED.
28 CASES WERE USED FOR PRINTED OUTPUT.

CPU TIME REQUIRED.. .6340 SECONDS

CASE SUBFILE	SEQNUM	MIS VAL	SEL	ACTUAL GROUP	HIGHEST PROBABILITY GROUP	P(X/G)	P(G/X)	2ND HIGHEST GROUP	P(G/X)	DISCRIMINANT SCORES
DATA	1			-1.	-1	.8318	1.0000	1	.0000	2.5412
DATA	2			-1.	-1	.0378	1.0000	1	.0000	4.1674
DATA	3			-1.	-1	.6939	1.0000	1	.0000	2.0127
DATA	4			1.	1	.7224	1.0000	-1	.0000	-3.9508
DATA	5			UNGRPD	1	.2531	1.0000	-1	.0000	-2.1932
DATA	6			1.	1	.5270	1.0000	-1	.0000	-4.2762
DATA	7			UNGRPD	-1	.2702	.9998	1	.0002	1.3944
DATA	8			1.	1	.4970	1.0000	-1	.0000	-4.3307
DATA	9			1.	1	.5913	1.0000	-1	.0000	-4.1638
DATA	10			UNGRPD	1	.0479	.9978	-1	.0022	-1.2131
DATA	11			1.	1	.8813	1.0000	-1	.0000	-3.7092
DATA	12			UNGRPD	1	.2414	1.0000	-1	.0000	-2.1596
DATA	13			-1.	-1	.9502	1.0000	1	.0000	2.3015
DATA	14			1.	1	.0173	.9601	-1	.0399	-.7422
DATA	15			UNGRPD	1	.0240	.9831	-1	.0169	-.8860
DATA	16			-1.	-1	.1666	.9993	1	.0007	1.1495
DATA	17			UNGRPD	-1	.0743	1.0000	1	.0000	3.9124
DATA	18			UNGRPD	1	.3350	1.0000	-1	.0000	-2.4029
DATA	19			-1.	-1	.7487	1.0000	1	.0000	2.0766
DATA	20			-1.	-1	.5848	1.0000	1	.0000	1.8794
DATA	21			-1.	-1	.8526	1.0000	1	.0000	2.1939
DATA	22			-1.	-1	.8111	1.0000	1	.0000	2.1475
DATA	23			-1.	-1	.1814	1.0000	1	.0000	3.5216
DATA	24			1.	1	.9012	1.0000	-1	.0000	-3.3884
DATA	25			1.	1	.8803	1.0000	-1	.0000	-3.7106
DATA	26			-1.	-1	.4276	1.0000	1	.0000	3.0479
DATA	27			-1.	-1	.1977	.9996	1	.0004	1.2325
DATA	28			UNGRPD	1	.4099	1.0000	-1	.0000	-2.5673

SYMBOLS USED IN PLOTS

SYMBOL	GROUP	LABEL
1	-1	
3	1	
#		ALL UNGROUPED CASES

ALL-GROUPS HISTOGRAM

-- CANONICAL DISCRIMINANT FUNCTION 1 --

```
              4 +                                                                  +
                .                                                                  .
                .                                                                  .
F               .                                                                  .
R             3 +                                                                  +
E               .                                                                  .
Q               .                                                                  .
U               .                                                                  .
E             2 +                  3 3       \                1   11               +
N               .                  3 3       \                1   11               .
C               .                  3 3       \                1   11               .
Y               .                  3 3       \                1   11               .
              1 +                 3333 3   \\\    \ 3         1\ 11111 1  1 \1      +
                .                 3333 3   \\\    \ 3         1\ 11111 1  1 \1      .
                .                 3333 3   \\\    \ 3         1\ 11111 1  1 \1      .
                .                 3333 3   \\\    \ 3         1\ 11111 1  1 \1      .
               OUT........+.........+.........+.........+.........+.........+.........+.........OUT
                        -6        -4        -2         0         2         4         6
 CLASSIFICATION 3333333333333333333333333333333333333311111111111111111111111111111111111111111111
GROUP CENTROIDS                        3                                  1
```

CLASSIFICATION RESULTS -

ACTUAL GROUP	NO. OF CASES	PREDICTED GROUP MEMBERSHIP -1	1
GROUP -1	12	12	0
		100.0	0
GROUP 1	8	0	8
		0	100.0
UNGROUPED CASES	8	2	6
		25.0	75.0

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED - 100.00

CLASSIFICATION PROCESSING SUMMARY

28 CASES WERE PROCESSED.
28 CASES WERE USED FOR PRINTED OUTPUT.

CPU TIME REQUIRED.. .6510 SECONDS

APPENDIX V

Procedures for field measurements of the pore-water variables, classification parameters, and HP-BASIC program SCORE.

Introduction

This procedural outline has been prepared as a basic guide for persons responsible for soil pore-water analyses at the McGee Creek Project, Farris, Oklahoma. The parameters outlined here are those which will classify the sample as N or D when data are entered into a discriminant function. This outline is only intended to demonstrate the possible application of the techniques suggested in this study. No attempt has been made to cover all the technical details which would be involved in using this procedure as part of an officially approved test program.

Instrumentation

1. pH/millivolt meter (0.01 pH unit accuracy).

2. Combination pH electrode.

3. Sodium specific ion electrode with appropriate reference electrode.

4. Conductivity meter.

5. Conductivity cell (cell constant = 1), immersion type.

6. Pan balance (0.01-g accuracy).

7. Electronic calculator (scientific functions).

Glassware and Other Equipment

1. 30-mL plastic sample cups (graduated).

2. 125-mL glass Erlenmeyer flasks with rubber stoppers.

3. 500-mL plastic sample bottles.

4. Magnetic stirrer with Teflon stirring bars.

5. Vacuum pump, filter flasks, and vacuum hose.

6. 0.45-μm millipore filters and filter apparatus.

7. Centrifuge with disposable tubes or Buchner funnels with qualitative filter paper (Whatman No. 41).

8. 5-, 10-, and 50-mL, class A glass pipets.

9. 100-mL buret (1-mL accuracy).

10. 200-μL Eppendorf pipet with disposable tips.

11. Polyethylene washing bottles.

12. Spatulas – Kimwipes.

13. Four-cycle, semilog graph paper (for Na calculations).

14. Laboratory notebook.

15. Celsius thermometer (0.2 °C accuracy).

16. 500-mL volumetric flasks.

17. 1,000-mL stainless steel beakers.

18. Watchglasses or plastic food wrap to cover stainless steel beakers.

Reagents and Standards

1. d.i. (*deionized*) water (at least 1 megohm/cm purity).

2. 200 meq/L NaCl (*sodium chloride*) stock solution.

3. 0.01 M KCl (*potassium chloride*) conductivity standard.

4. Electrode filling solutions for all electrodes used.

5. ISA (*Ionic Strength Adjustor*) solution for Na electrode.

6. pH 4, 7, and 10 buffer solutions.

Saturation Extract

Follow the methods outlined in the USDA Handbook 60 [12] to prepare the saturated paste, using an approximately 300-g representative sample weighed into a stainless steel beaker. Volume of water added to soil may be quantified by buret or by weighing soil before and after adding water. Saturation extract or pore-water may be separated from the paste after a period of time not to exceed 8 hours. Be sure the paste is covered with a watchglass or plastic wrap to prevent contamination and evaporation. Make sure the paste is still at saturation prior to separating the pore-water.

A vacuum filtration where the paste is transfered to a Buchner funnel (with suitable sized 41 filter paper, or equivalent) may be used; however, if a centrifuge capable of 10,000 r/min is available, the separation step will take much less time. If a centrifuge is used, be sure to balance the filled plastic (preferably

disposable) tubes before spinning the soil paste. After both filtration and centrifuge, the pore-water should be filtered through a 0.45-μm membrane filter (such as Millipore) to remove colloidal suspended matter which may remain. Centrifuge the sample no longer than 10 minutes, and if stainless steel tube covers (which would not collapse into the tube when centrifuged) are available, use them. If the centrifuge is unusually noisy, or vibrates excessively during operation, cut the power immediately and rebalance the tubes.

After separation and 0.45-μm membrane filtration, store the pore-water in 125-mL stoppered Erlenmeyer flasks. Be sure that you label the flasks legibly with an indelible marker. For a 300-g soil sample, expect to get 10 to 75 mL of the pore-water after separation.

Use the following expression to calculate the weight percent water at saturation (percent H_2O):

$$\text{percent } H_2O = \frac{V}{W + V} \times 100$$

where:

V = volume (mL) or weight (grams) of water added to soil
W = weight (grams) of soil sample

Conductivity Measurements

Follow the measurement technique outlined in the instrument operating manual. On all samples and standards, measure the solution temperature using a thermometer prior to taking readings. Before measuring the sample pore-water resistance (ohms), check the cell constant value (which should be around 1.0) by measuring the resistance of the 0.01 M KCl standard at 25.0 °C. This temperature may be achieved using a crude water bath with hot and cold tapwater as the temperature controller. Take care not to contaminate the standard KCl with tapwater. The temperature need not be exactly 25 °C, but should be within 0.3 °C. Rinse the cell three times in the KCl standard and then measure the resistance. Calculate the cell constant, C, by the following formula:

$$C(\text{cm}^{-1}) = (0.001413)(R_s)[1 + 0.0191(t-25)]$$

where:

R_s = resistance of the standard KCl in ohms
t = KCl solution temperature, °C

The cell constant is used to calculate the conductivity of samples, and the checking of the cell constant should be performed prior to analyzing a batch of pore-waters, or anytime a new cell is used.

Good conductivity measurements require that the cell be rinsed three times with deionized H_2O between samples or standards and the cell should be rinsed three times with sample (or standard) before a reading is taken. If your pore-water volume is low (and this is common), you need not waste the sample after the first rinse. Keep in mind that you will need at least 10 mL for a sodium determination and also will need to measure the pH, so use common sense. If your sample volume is too low, make another saturation paste using 500 g of soil.

After you measure the sample pore-water resistance, calculate the EC (electrical conductivity) in microsiemens, corrected to 25 °C, with the following formula:

$$EC(\mu S) = \frac{1{,}000{,}000\,(C)}{R[1 + 0.0191(t-25)]}$$

where:

R = sample resistance, ohms
C = calculated cell constant
t = sample temperature, °C

Sodium Measurements

Sodium may be measured using a specific ion electrode with an appropriate reference electrode. It is important to follow all instructions provided with the electrodes and the pH-mV meter. Generally, sodium is quantitated by comparing mV readings for samples to a standard curve. The standard curve is usually obtained by measuring the mV response for a series of dilutions from an Na stock solution (200 meq/L is recommended). Since the Na-specific ion electrode response will vary, a standard curve determination should be performed each time that samples are analyzed.

Specific instructions, which vary for different electrode manufacturers, are omitted here. In general, it is important to realize that most specific ion electrodes are very fragile and that failure to follow recommended maintenance procedures will degrade electrode sensitivity and shorten electrode life.

pH Measurements

The pore-water remaining after EC and Na measurements is now used for pH determinations. The pH

should be measured after *EC* and *Na* since pH electrodes will leak filling solution into the sample, thus altering the *EC* and *Na* levels. Refer to the electrode manual for care and maintenance of the pH probe.

Measuring pH is simple, and the following outline will apply to most commercially available meters.

1. Calibrate the meter using a pH equals 4 and pH equals 10 buffer. Follow the meter manual, and if a temperature compensation circuit is in the meter, use it.

2. Drop a magnetic stirring bar into the sample and make sure that the pH electrode is immersed to the proper depth for accurate and stable readings. The meter should be in "standby" mode.

3. Set the selector to "pH" and wait until the pH reading is stable. Stir the sample magnetically during this process.

4. Record the sample pH.

Proper Use of Discriminant Analysis

Once the percent H_2O, pH, *EC*, and *Na* have been determined, these data may be substituted into the appropriate classification and discriminant functions. Classification scores and discriminant scores may be calculated manually using the following procedure:

1. Calculate the discriminant score by substituting the appropriate raw data into the following unstandardized discriminant function:

$$D_s = -0.200\,(\textit{percent}\ H_2O) - 1.37\,(pH) - 5.83\,[\log(EC)] + 1.28\,[\log(Na)] + 29.1$$

2. Calculate a classification function score for both of the following expressions; one for nondispersive (C_N) and one for dispersive (C_D):

$$C_N = 9.77\,(\textit{percent}\ H_2O) + 72.8\,(pH) + 485\,[\log(EC)] - 348\,[\log(Na)] - 909$$

$$C_D = 10.8\,(\textit{percent}\ H_2O) + 79.7\,(pH) + 515\,[\log(EC)] - 354\,[\log(Na)] - 1{,}056$$

If C_D is greater than C_N, the sample should be classified as *D*. If C_N is greater than C_D, the sample should be classified as *N*. The discriminant score, D_s, should be used to determine whether or not the sample should be retested. Samples classified as *N* should be retested if D_s is less than +1.10. Samples classified as *D* should be retested if D_s is greater than −0.300.

Alternatively, sample classification calculations may be performed using the HP-9835A BASIC program listed at the end of this appendix. This program will calculate the appropriate parameters and print out a formatted table, indicating which samples should be retested.

As previously mentioned, the new sample data may be coded and included with the original data set and discriminant analysis may then be used to classify samples. This method may be preferable since SPSS subprogram DISCRIMINANT will also calculate a probability of group membership [P/(G/X)] for each new coded sample. The P(G/X) values are a more statistically sound criteria for deciding whether or not samples should be retested.

```
10   ! ************* DISCRIMINANT SCORE CALCULATOR PROGRAM "SCORE" *************
20   ! ***************** PROGRAMMED BY DOUGLAS CRAFT 05/04/83 *****************
30   ! **************** US BUREAU OF RECLAMATION, E&R CENTER ******************
40   ! ******************* PO BOX 25007, MAIL CODE D-1523 *********************
50   ! ********************** DENVER, COLORADO 80225 **************************
60   ! *************************** FTS-303-234-4020 ****************************
70   !
80   !
90   ! ************** FOR HEWLETT/PACKARD 9835A DESKTOP COMPUTERS **************
100  !
110  !
120  PRINTER IS 16
130  PRINT PAGE,SPA(20)," DISCRIMINANT SCORE CALCULATION PROGRAM "
140  PRINT LIN(1),"This program allows you to calculate discriminant scores from
"
150  PRINT "raw data on samples not used to derive the discriminant function. Yo
u"
160  PRINT "must enter the name of each variable used to derive the function and
"
170  PRINT "the coefficients obtained from the unstandardized discriminant fun
ction."
180  PRINT "A maximum of six variable coefficients plus a constant may be entere
d,"
190  PRINT "and coefficients for the two classification functions (the Fisher'
s"
200  PRINT "linear discriminant functions) must also be input in order for the"
210  PRINT "program to classify the samples in one of the two groups."
220  PRINT LIN(8),"PRESS  CONTINUE  TO START PROGRAM."
230  PAUSE
240     FOR B=1 TO 20
250        WAIT 80
260        PRINT
270     NEXT B
280  !
290  !
300  !
310  ! ******* INPUT OF PROJECT AND DISCRIMINANT ANALYSIS PARAMETERS *******
320  !
330  !
340  !
350  DIM Proj$[30],Comm$[80]
360  INPUT "WHAT PROJECT IS THIS FOR?",Proj$
370  INPUT "WHAT IS THE NATURE OF THESE SAMPLES?",Comm$
380  INPUT "NUMBER OF SAMPLES USED TO DERIVE THIS DISCRIMINANT FUNCTION?",Ns
390  INPUT "WHAT IS THE EIGENVALUE FOR THIS FUNCTION?",Ev
400  INPUT "CONSTANT FOR THIS DISCRIMINANT FUNCTION?",C
410  INPUT "CONSTANT FOR THE NONDISPERSIVE CLASSIFICATION FUNCTION?",Cn
420  INPUT "CONSTANT FOR THE DISPERSIVE CLASSIFICATION FUNCTION?",Cd
430       INPUT "1ST VARIABLE NAME?",V1$
440       INPUT "DISCRIMINANT COEFFICIENT #1?",V1
450       INPUT "NONDISPERSIVE COEFFICIENT #1?",Vn1
460       INPUT "DISPERSIVE COEFFICIENT #1?",Vd1
470  INPUT "2ND VARIABLE NAME?",V2$
480  INPUT "DISCRIMINANT COEFFICIENT #2?",V2
490  INPUT "NONDISPERSIVE COEFFICIENT #2?",Vn2
500  INPUT "DISPERSIVE COEFFICIENT #2?",Vd2
510       INPUT "3RD VARIABLE NAME?",V3$
520       IF LEN(V3$)=0 THEN 710
530       INPUT "DISCRIMINANT COEFFICIENT #3?",V3
540       INPUT "NONDISPERSIVE COEFFICIENT #3?",Vn3
550       INPUT "DISPERSIVE COEFFICIENT #3?",Vd3
560  INPUT "4TH VARIABLE NAME?",V4$
570  IF LEN(V4$)=0 THEN 710
580  INPUT "DISCRIMINANT COEFFICIENT #4?",V4
590  INPUT "NONDISPERSIVE COEFFICIENT #4?",Vn4
```

```
600  INPUT "DISPERSIVE COEFFICIENT #4?",Vd4
610       INPUT "5TH VARIABLE NAME?",V5$
620       IF LEN(V5$)=0 THEN 710
630       INPUT "DISCRIMINANT COEFFICIENT #5?",V5
640       INPUT "NONDISPERSIVE COEFFICIENT #5?",Vn5
650       INPUT "DISPERSIVE COEFFICIENT #5?",Vd5
660  INPUT "6TH VARIABLE NAME?",V6$
670  IF LEN(V6$)=0 THEN 710
680  INPUT "DISCRIMINANT COEFFICIENT #6?",V6
690  INPUT "NONDISPERSIVE COEFFICIENT #6?",Vn6
700  INPUT "DISPERSIVE COEFFICIENT #6?",Vd6
710  INPUT "WHAT IS THE CENTROID FOR GROUP 1?",Cg1
720  INPUT "WHAT IS THE CENTROID FOR GROUP 2?",Cg2
730  M=(Cg1+Cg2)/2
740  !
750  !
760  !
770  ! ******************* DISCRIMINANT PARAMETER DATA CHECK *******************
780  !
790  !
800  !
810  FIXED 4
820  PRINT PAGE,"DISCRIMINANT FUNCTION COEFFICIENTS:"
830  PRINT LIN(2),"VARIABLE 1..........";V1;" (";V1$;")"
840  PRINT "VARIABLE 2.........";V2;" (";V2$;")"
850  IF LEN(V3$)=0 THEN 930
860  PRINT "VARIABLE 3.........";V3;" (";V3$;")"
870  IF LEN(V4$)=0 THEN 930
880  PRINT "VARIABLE 4.........";V4;" (";V4$;")"
890  IF LEN(V5$)=0 THEN 930
900  PRINT "VARIABLE 5.........";V5;" (";V5$;")"
910  IF LEN(V6$)=0 THEN 930
920  PRINT "VARIABLE 6.........";V6;" (";V6$;")"
930  PRINT "CONSTANT...........";C
940  PRINT "N CENTROID.........";Cg1
950  PRINT "D CENTROID.........";Cg2
960  PRINT "EIGENVALUE.........";Ev
970  PRINT
980  PRINT "N FUNCTION V1.......";Vn1;"    D FUNCTION V1.......";Vd1
990  PRINT "N FUNCTION V2.......";Vn2;"    D FUNCTION V2.......";Vd2
1000 PRINT "N FUNCTION V3.......";Vn3;"    D FUNCTION V3.......";Vd3
1010 PRINT "N FUNCTION V4.......";Vn4;"    D FUNCTION V4.......";Vd4
1020 PRINT "N FUNCTION V5.......";Vn5;"    D FUNCTION V5.......";Vd5
1030 PRINT "N FUNCTION V6.......";Vn6;"    D FUNCTION V6.......";Vd6
1040 PRINT "N CONSTANT..........";Cn;"    D CONSTANT..........";Cd
1050 Y$="Y"
1060 INPUT "IS THE ABOVE INFORMATION CORRECT (Y/N)?",Y$
1070 IF Y$="N" THEN 380
1080    FOR Z=1 TO 20
1090       PRINT
1100       WAIT 80
1110    NEXT Z
1120 !
1130 !
1140 !
1150 ! ************************* PRINT REPORT HEADING ************************
1160 !
1170 !
1180 !
1190 PRINTER IS 7,1
1200 PRINT PAGE,"*****************************************************************
*****************"
1210 PRINT SPA(25),"DISCRIMINANT SCORE CALCULATOR"
1220 PRINT "*********************************************************************
************"
1230 PRINT LIN(1),"PROJECT: ";Proj$
```

```
1240 PRINT "COMMENTS: ";Comm$
1250 PRINT LIN(2),"COEFFICIENTS FOR THE UNSTANDARDIZED FUNCTION AND CLASSIFICATI
ON FUNCTIONS"
1260 PRINT
1270 PRINT "-----------------------------------------------------------------
------------"
1280 PRINT "VARIABLE";SPA(10);"DISCRIMINANT";SPA(10);"NONDISPERSIVE";SPA(10);"DI
SPERSIVE"
1290 PRINT "  NAME  ";SPA(10);"COEFFICIENTS";SPA(10);"COEFFICIENTS ";SPA(10);"CO
EFFICIENTS"
1300 PRINT "-----------------------------------------------------------------
------------"
1310 PRINT
1320 IMAGE 8A,12X,MDDZ.DDDD,14X,MDDDZ.DDDD,13X,MDDDZ.DDDD
1330 PRINT USING 1320;V1$,V1,Vn1,Vd1
1340 PRINT USING 1320;V2$,V2,Vn2,Vd2
1350 IF LEN(V3$)=0 THEN 1430
1360 PRINT USING 1320;V3$,V3,Vn3,Vd3
1370 IF LEN(V4$)=0 THEN 1430
1380 PRINT USING 1320;V4$,V4,Vn4,Vd4
1390 IF LEN(V5$)=0 THEN 1430
1400 PRINT USING 1320;V5$,V5,Vn5,Vd5
1410 IF LEN(V6$)=0 THEN 1430
1420 PRINT USING 1320;V6$,V6,Vn6,Vd6
1430 PRINT USING 1320;"CONSTANT",C,Cn,Cd
1440 PRINT "-----------------------------------------------------------------
------------"
1450 FIXED 0
1460 PRINT LIN(1),"This discriminant function derived using ";Ns;" samples."
1470 FIXED 4
1480 PRINT "The Eigenvalue for this function is ";Ev
1490 PRINT "The nondispersive centroid is ";Cg1
1500 PRINT "The dispersive centroid is ";Cg2
1510 PRINT LIN(2),"==========================================================
==================="
1520 PRINT "SAMPLE ID            DISCRIMINANT SCORE      GROUP   CLASSIFIED GROUP
"
1530 PRINT "=================================================================
============"
1540 PRINT
1550 !
1560 !
1570 !
1580 ! ***************************** RAW DATA INPUT ****************************
1590 !
1600 !
1610 !
1620 IMAGE 7A,18X,MDZ.DDDD,13X,1A,13X,1A,1X,3A
1630 PRINTER IS 16
1640 PRINT PAGE,SPA(34)," DATA INPUT "
1650 PRINT CHR$(27)&"1"
1660 DIM Id$[7]
1670 INPUT "NUMBER OF SAMPLES TO BE CALCULATED?",N
1680     FOR I=1 TO N
1690        PRINTER IS 16
1700        FIXED 0
1710        PRINT LIN(5),"SAMPLE ";I
1720        FIXED 4
1730        A$="   "
1740        INPUT "SAMPLE ID:",Id$
1750        INPUT "PHYSICAL TEST CLASSIFICATION FOR THIS SAMPLE (N,D or U[unclas
sified])?",G$
1760        INPUT "RAW DATA FOR V1=",Dv1
1770        INPUT "RAW DATA FOR V2=",Dv2
1780        IF LEN(V3$)=0 THEN 1890
1790        INPUT "RAW DATA FOR V3=",Dv3
```

```
1800        IF LEN(V4$)=0 THEN 1890
1810        INPUT "RAW DATA FOR V4=",Dv4
1820        IF LEN(V5$)=0 THEN 1890
1830        INPUT "RAW DATA FOR V5=",Dv5
1840        IF LEN(V6$)=0 THEN 1890
1850        INPUT "RAW DATA FOR V6=",Dv6
1860        !
1870        ! ****************** INDIVIDUAL SAMPLE DATA CHECK ******************
1880        !
1890        PRINT PAGE,LIN(1),"SAMPLE ";I;" DATA CHECK"
1900        PRINT LIN(1),"ID= ";Id$,"GROUP= ";G$
1910        PRINT LIN(1),"V1= ";Dv1,"V2= ";Dv2,"V3= ";Dv3
1920        PRINT LIN(1),"V4= ";Dv4,"V5= ";Dv5,"V6= ";Dv6
1930        Yy$="Y"
1940        INPUT "IS THE ABOVE SAMPLE DATA CORRECT (Y/N)?",Yy$
1950        IF Yy$="N" THEN 1700
1960        !
1970        ! ********* CALCULATION OF DISCRIMINANT ANALYSIS PARAMETERS ********
1980        !
1990        Cfn=Vn1*Dv1+Vn2*Dv2+Vn3*Dv3+Vn4*Dv4+Vn5*Dv5+Vn6*Dv6+Cn
2000        Cfd=Vd1*Dv1+Vd2*Dv2+Vd3*Dv3+Vd4*Dv4+Vd5*Dv5+Vd6*Dv6+Cd
2010        IF Cfn>Cfd THEN P$="N"
2020        IF Cfn<Cfd THEN P$="D"
2030        IF Cfn=Cfd THEN P$="*"
2040        S=V1*Dv1+V2*Dv2+V3*Dv3+V4*Dv4+V5*Dv5+V6*Dv6+C
2050        IF G$="U" THEN GOTO 2070
2060        GOTO 2080
2070        IF (S<1.1) AND (S>-.3) THEN A$="!!!"
2080        IF (G$<>P$) AND (G$<>"U") THEN A$="***"
2090        IF (S<1.1) AND (S>-.3) AND (G$<>"U") THEN A$="*!*"
2100        PRINTER IS 7,1
2110        FIXED 4
2120        PRINT USING 1620;Id$,S,G$,P$,A$
2130     NEXT I
2140 PRINT LIN(1),"==========================================================
==================="
2150 PRINT "Triple astericks indicate incorrect classification by discriminant f
unction"
2160 PRINT "on samples previously classified by physical testing. Triple exclama
tion marks"
2170 PRINT "indicate a sample which should be retested due to a low expected pro
bability"
2180 PRINT "of group membership. Samples previously classified by physical testi
ng which"
2190 PRINT "also indicate low group membership probabilities are indicated by '*
!*'."
2200 PRINT CHR$(27)&"m"
2210 END
```

****
DISCRIMINANT SCORE CALCULATOR
****

PROJECT: McGee Creek Dam
COMMENTS: Verification of discriminant analysis

COEFFICIENTS FOR THE UNSTANDARDIZED FUNCTION AND CLASSIFICATION FUNCTIONS

VARIABLE NAME	DISCRIMINANT COEFFICIENTS	NONDISPERSIVE COEFFICIENTS	DISPERSIVE COEFFICIENTS
%H2O	-0.1999	9.7679	10.7840
pH	-1.3649	72.7620	79.7000
log(EC)	-5.8347	485.1100	514.7700
log(Na)	1.2784	-347.6100	-354.1100
CONSTANT	29.0830	-908.5700	-1056.4000

This discriminant function derived using 28 samples.
The Eigenvalue for this function is 6.9600
The nondispersive centroid is 2.5416
The dispersive centroid is -2.5416

SAMPLE ID	DISCRIMINANT SCORE	GROUP	CLASSIFIED GROUP
56C-95	2.0551	N	N
56C-81	2.8921	N	N
56C-66	1.8628	U	N
56C-107	-2.1030	U	D
56C-108	-4.1024	N	D ***
56C-108	-2.6200	D	D
56C-103	-3.7613	D	D
56C-103	-3.6576	U	D
56C-86	2.5291	N	N
56C-61	1.9136	U	N

Triple astericks indicate incorrect classification by discriminant function on samples previously classified by physical testing. Triple exclamation marks indicate a sample which should be retested due to a low expected probability of group membership. Samples previously classified by physical testing which also indicate low group membership probabilities are indicated by '*!*'.

GPO 841-758