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WATER COLOUR AND HUMIC CHARGE

FINAL REPORT

by

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SUMMARY

This work was undertaken to examine the relationship between the amount of 'colour' (equivalent to dissolved humic substances) released by organic soils and the net electrical charge on the humic molecules. Bulk analytical and titration data were obtained for 30 soil samples. The charge was calculated using the CHAOS model, which takes into account the interactions of inorganic ions (notably H^+ and Al^{3+}) with the humics. The following conclusions are drawn.

1. Ion-binding over a substantial range of pH (2-5.5) by the 30 soils is explained reasonably well by the CHAOS model, although it appears that the concentration of 'active' humic matter is not directly proportional to soil concentration.
2. The extent of release of dissolved organic carbon (DOC) from the soils increases with net humic change and total extractable DOC. A single-parameter equation has been shown to account reasonably well for the observed behaviour over wide ranges of pH and [DOC]. For most of the soils studied the DOC release characteristics are similar. For two sites, release is substantially greater than average.
3. For restricted ranges of total soil concentration and pH, as would be encountered in the natural environment it is possible to model very precisely the variations of pH, released DOC and 'colour' with added acid or base, suggesting that the CHAOS model is applicable to environmental prediction.
4. The release of 'colour' is more complicated than that of DOC because the 'colour' per unit DOC increases with net humic charge. Thus 'colour' may respond more dramatically than DOC to changes in soil pH etc.

CONTENTS

1. INTRODUCTION

The objective of this work was to investigate the possible relationship between the net electrical charge on soil humic substances (HS) and the concentration of HS dissolved in the soil solution. The starting hypothesis is that the greater is the net charge (Z), the greater is the humic 'solubility'. Preliminary work (Tipping & Hurley, 1988) suggests that there may be a direct relationship between Z and solution [HS]. If so, this relationship might be exploited to make quantitative predictions of concentrations of HS in drainage waters, and how they would change with climate, liming, land-use etc. Since dissolved HS are major contributors to perceived 'water colour', this would be useful in the management of peaty catchments and their reservoirs.

To obtain the data required to test the charge/'colour' relationship, 30 organic soil samples from various locations in England and Wales were taken and subjected to bulk analysis and acid-base titrations (in aqueous suspension). For each titration point (approx. 400 in all) the net humic charge was calculated using the model CHAOS (Complexation by Humic Acids in Organic Soils), and the calculated charges were compared with the concentrations of dissolved organic carbon (DOC) in the supernatant solutions in equilibrium with the soils.

2. SUMMARY OF METHODS

The following determinations and experiments are carried out on each soil sample:

1. Water content of original soil, by drying overnight at 110°C.
2. Preparation of soil suspension: approximately 100 g of wet soil, seived through a 4 mm mesh, suspended in 10^{-3} M NaCl at a final total weight of 350 g. Solids concentration determined by drying sub-samples overnight at 110°C.
3. Loss on ignition of original soil and of sieved soil, determined by heating dried samples at 550°C overnight.
4. Content of extractable (humic) carbon, by extraction with 0.01 M NaOH and analysis of DOC.
5. Content of Al, by extraction with 0.01 M HNO_3/0.1 M $NaNO_3$, and determination of Al with pyrocatechol violet.
6. Content of Fe, by extraction with 1% hydroxylamine, and determination with bathophenanthroline.
7. Content of base cations, by extraction with 0.25 M $BaCl_2$ and determination by AAS.
8. Determination of the C, H, N contents of dried soil, by combustion in a Carlo-Erba instrument.
9. Batch titrations, by suspending the soils in solutions containing 10^{-3} M NaCl together with various concentration of HCl or NaOH, giving final pH ranges of ca. 2-6. After equilibration at 10°C overnight, the suspensions are centrifuged (15,000 rpm, 30 mins) and the supernatants analysed for monomeric Al, pH, absorbance at 340 nm, DOC, total Fe. Absorbances are measured after addition of phosphate buffer (pH 7).
10. Soil water pH, by suspending unsieved soil at a concentration of ca. 50 g per litre of solution, to which NaCl at a total concentration of 10^{-3} M is added. (10°C).

3. RESULTS

3.1 Sampling sites

Tables 3.1 and 3.2 give details of sampling locations and site descriptions. Samples 1-6 were taken from the same place at the same time, and were used to examine local spatial variability and storage effects.

3.2 Bulk soil properties

Results of bulk soil analyses are given in Table 3.3. In nearly all cases the moisture content and loss-on-ignition were high, as expected for organic soil samples in winter. Soils 8, 11, 22 and 28 had relatively low organic contents. Soil suspensions in 10^{-3} NaCl gave pH values in the range 3.4-4.4, with the majority of values being <4. Amounts of NaOH-extractable (dissolved) organic carbon varied from 19 to 167 mg g $soil^{-1}$, representing ca. 10-30% of the total carbon present. The content of extractable Al varied from 11 to 257 µmol g $soil^{-1}$, that of extractable Fe from 1 to 163 µmol g $soil^{-1}$. Total contents of $BaCl_2$-extractable base cations varied from 18 to 193 µeq g $soil^{-1}$.

3.3 Batch titrations

For each soil, two batch titrations (8 points each) have been carried out. For logistic reasons, the first of the titrations was routinely begun at the same time as the bulk soil analysis, with the result that the soil concentration was not known until the titration had been completed. Initially the aim was to perform all titrations at or near a single soil concentration, and it was hoped that this could be achieved on the basis of wet weights. However the large amounts of root material present in most of the soil samples made sieving essential before titrations could be carried out; unfortunately the soil samples have been found to differ with respect to their sieving behaviour, giving stock suspensions of varying solids contents. As a result the soil concentrations for the first titrations have varied (2.6-49.4 gl^{-1}). However the second titrations have all been carried out at nearly the same soil concentration (2.6-3.1 gl^{-1}). The data at different soil concentrations have yielded important information on humic 'solubility', as discussed below.

3.3.1 Fitting the titration results with CHAOS

The titration data were analysed using the CHAOS model (Tipping and Hurley, 1988), restricting the range of pH to <5.5 because higher pH's are unlikely in organic soils, even after liming. To fit the data for a given soil, all model parameters were kept fixed at the values given by Tipping and

Hurley (1988) for Mosedale Beck humic acid, while different trial values of the weight fraction of soil that is 'active' humic matter (in the sense of ion-binding) were taken. The optimal value of the active humic fraction (FH) was taken to be that which gave the smallest value of $\Sigma(pH_{obs}-pH_{calc})^2$ where pH_{obs} is the observed pH and pH_{calc} that calculated with CHAOS. The results of this analysis are summarized in Table 3.4 and fuller details are shown in Tables 3.5.1-3.5.30. Also tabulated in Table 3.4 are values of 2x the extractable dissolved organic carbon contents of the soils, which are expected to approximate to the content of humic matter. The average ratio of extractable humic matter to the optimal humic content is 0.68. This may indicate that functional groups (COOH, phenolic OH) associated with insoluble ("non-humic") organic matter contribute to the ion-binding. Alternatively, the (assumed fixed) parameters may not be appropriate to the soils. Nonetheless the agreement between observed and calculated pH values is reasonable, given a single adjustable fitting parameter and bearing in mind that the range of pH considered is much wider than would be expected for soils in situ. Inspection of the data for individual soils shows that pH is systematically underestimated at the higher soil concentrations and systematically overestimated at the lower soil concentrations. A possible explanation is that the fraction of 'active' humic matter varies with total soil concentration, perhaps due to mutual interference between molecules. This effect might be incorporated into CHAOS in order to improve the match between observed and calculated values. When only a single soil concentration was used, (soils 1-3), the agreements between observed and calculated pH are excellent. (See also section 3.3.3).

3.3.2 Charge/'colour' relationships : general analysis

In calculating ion distributions with CHAOS, the net electrical charge on the humic molecules is computed (see Tables 3.5.1-3.5-30), and the reason for carrying out the present work was to test for a direct relationship between this charge and the amount of humic matter in the solution in equilibrium with the organic soils. If supernatant concentrations of DOC are taken to represent released humic substances, it is seen from inspection of Tables 3.5.1-3.5.30 that $[DOC_{SN}]$ does indeed invariably increase with $|Z|$ (the modulus of Z). However, it is also apparent that $[DOC_{SN}]$ depends on the total concentration of soil, behaviour not expected if humic solubility, with the implied notion of a solid phase of constant activity, were the controlling mechanism. The results show that $[DOC_{SN}]$ increases with $[DOC_{solid}]$, i.e. the concentration of NaOH-extractable DOC that remains in the solid phase, and/or with $[DOC_{total}]$.

First, we attempt a general empirical description of the relationships. Graphical analysis of the data suggests a relationship of the form

$$[DOC_{SN}] = \alpha(|Z|+\epsilon)^{\beta 1} [DOC_{solid}]^{\beta 2} \quad (3.1)$$

where α, $\beta 1$, $\beta 2$ and ϵ are constants, ϵ being a threshold value to allow for the possibility of humics even with zero net charge having an appreciable tendency to pass into solution. Non-linear least squares analysis of the data in Tables 3.5.1-3.5-30 showed that $\beta 1$ and $\beta 2$ were often close to unity for a given soil, and that ϵ was close to zero. To keep things simple, it is therefore reasonable to adopt the relationship:

$$[DOC_{SN}] = \alpha |Z| [DOC_{SN}] \quad (3.2)$$

This expression has but a single parameter, which can be used to characterise the different soils. Values of α, its asymptotic standard error, the root-mean-square deviation between observed and calculated values of $[DOC_{SN}]$, the range of observed $[DOC_{SN}]$, and the correlation coefficient for each soil are shown in Table 3.6. The fairly large positive correlation coefficients and relatively small root-mean-square deviations in Table 3.6 support the use of equation (3.2) over a wide range of [DOC]. The values of α are well-estimated, as shown by the relatively small standard errors.

At the outset of this work it was hypothesized that the relationship between $[DOC_{SN}]$ and $|Z|$ would be the same for all organic soils, i.e. that 'colour' release would be a function only of the interactions between inorganic ions (especially H^+ and Al^{3+}) and the soil humic molecules. Were that the case, α would be the same for all soils. The data in Table 3.6 show that α is in fact variable, although if soils 1-6 and 26 are excepted, the variation is quite small, having a range of 20-67 and a mean of 41. (If data for all 23 'similar' soils are taken together we obtain $\alpha = 37$, $r = 0.75$). Soils 1-6 and 26 evidently release more DOC under a given set of conditions (humic charge and concentration of solid phase DOC). It will be recalled that soils 1-6 were all taken from the same site (Table 3.1) and in that sense represent only a single soil. Thus only two of the samples (combined 1-6 and 26) release 'abnormally' large amounts of DOC.

It was remarked in the interim report of this project that the relationship between solution 'colour' and [DOC] varied with pH and among soils. The general trend is for the ratio of 'colour' to [DOC] to increase with pH, and therefore in most cases, with $|Z|$. For preliminary analysis the following approximation can be tried:

$$\frac{A340nm}{[DOC_{SN}]} = \beta |Z| + \gamma \quad (3.3)$$

where β and γ are constants, the latter being the ratio as $|Z|$ tends to zero. Combination of equations (3.2) and (3.3) then gives

$$A340nm = (\beta|Z|+\gamma)\ \alpha|Z|[DOC_{solid}] \quad (3.4)$$

and we have an expression for water 'colour', which predicts a quadratic dependence of 'colour' on $|Z|$. The increase in A340nm/$[DOC_{SN}]$ with $|Z|$ most likely arises by a fractionation of the heterogeneous coloured humic molecules : at any given average net humic charge, the molecules with a higher charge than average will most readily pass into solution. When $|Z|$ is low the most 'soluble' molecules will probably be the lowest molecular weight/highest acidity molecules, corresponding to the fulvic acid fraction. Such molecules usually are the least intensely coloured. As $|Z|$ increases, larger molecules with less total acidity and stronger colour can be released.

From inspection of the data in cases where A340nm and $[DOC_{SN}]$ are each sufficiently large to allow reliable estimation of their ratio at low $|Z|$, a value of γ of approximately 0.01 (with $[DOC_{SN}]$ in mg l^{-1}) can be estimated. Thus we require only to find values of β for equation (3.4), in order to predict the variation of A340 nm with $|Z|$ and $[DOC_{solid}]$. Since this approach is somewhat speculative, β was estimated only for a sub-set of 6 soils (Table 3.7).

The results in Table 3.7 offer considerable encouragement, with large positive values of r in 5 out of 6 cases and reasonably small root-mean-square deviations. The actual values of β are useful in that they provide comparisons among soils. It appears for example that soils 5 and 10 contain humic molecules of, on average, less 'colour' (lower A340nm/[DOC] ratio) than those of soils 15, 20, 25 and 30.

3.3.3 Charge/'colour' relationships : analysis in relation to modelling

The parameter-fitting exercises described in sections 3.3.1 and 3.3.2 show that the CHAOS model together with the empirical equations relating [DOC] and 'colour' to $|Z|$ account reasonably well, in a quantitative sense, for the observed trends, and reveal useful information about the ion-binding and dissolution properties of organic soils. However the fits are not good enough for modelling the responses of organic soils to changing environmental conditions. This is because in analysing the laboratory data we are attempting to account for humic behaviour over wide ranges of values of total soil concentration and pH. The validity of the present approach for environmental modelling is much better judged by considering data obtained at only 1 soil concentration, and over a narrower pH range. Preliminary steps in this direction were taken by analysing the data for soils 5, 10, 16, 20, 25 and 30, taking data only for the higher soil concentration in each case. By doing this, it was immediately found that the pH titration data were better fitted (Figs. 3.1 - 3.6) than when 2 soil concentrations were taken together. Equations (3.2) and (3.4) also yielded closer agreement between observed and calculated values of $[DOC_{SN}]$ and A340nm, but still were not sufficiently precise. Marked improvements were obtained by adopting the equations.

$$[DOC_{SN}] = \alpha' \exp(\sigma Z^2 [DOC_{solid}] \qquad (3.5)$$

$$A340nm = (\beta' |Z| + 0.01)\alpha' \exp(\sigma Z^2)[DOC_{solid}] \qquad (3.6)$$

For single soil concentrations - i.e. for nearly fixed values of $[DOC_{solid}]$ - these give excellent descriptions of the variations of $[DOC_{SN}]$ and A340nm with added base or acid in the titration (Figs. 3.1-3.6, Tables 3.8 and 3.9). This type of analysis would form the basis of the predictive environmental model that might be developed in the future.

4. SUGGESTIONS FOR FURTHER WORK

The present study shows that the release of coloured matter from organic soils can be related to the chemical interactions of ions (especially H^+ and Al^{3+}) with soil humic substances. The indications are that, for a given net humic charge and content of extractable DOC, most organic soils release DOC similarly, although for 2 sites (soil 1-6 and 26) the release was substantially greater than for the majority. On the basis of these findings we suggest that the following work might be undertaken:

1. Setting up a predictive model of the release of coloured matter in catchments

The analysis in section 3.3.3 suggests that the CHAOS model can now be extended in order to predict the response of soil water concentrations of DOC to changes in rainfall composition, liming and land-use changes. Such a model would enable changes in colour over relatively long periods (decades) to be predicted, using average soil parameters. It could be extended to deal with shorter-term behaviour, although that would require information about possible seasonal changes in the soil contents of leachable coloured matter, and about catchment hydrology.

2. Studies of spatial and temporal variations in soil contents of leachable coloured matter

The results of the present study show that contents of leachable coloured matter vary to some extent among soils. All the samples studied were taken during the winter months, but in all cases probably after the major 'autumn flush' of coloured organic matter. It would be useful to know the extents to which leachability varies in space and time. This could be done by determining the parameter α (equation 3.2) or α' and σ (equation 3.5) for samples taken from a number of sites in a single catchment at different times. It would not be necessary to perform full-scale analyses, as done in the present work; pH and DOC measurements on a soil sample suspended at 3 or 4 different concentrations, together with determinations of total Al and base cations would suffice. Calculations would be done with the CHAOS model.

5. ACKNOWLEDGEMENTS

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6. REFERENCE

E. Tipping & M.A. Hurley (1988) A model of solid-solution interactions in organic soils, based on the complexation properties of humic substances. J. Soil Sci. in press.

Table 3.1 Details of sampling/1

Soil			NGR	date sampled	date analysed
1	Scar House Pasture	N. Yorks	SE 069763	3.11.87	9.11.87
2	"	"	"	"	"
3	"	"	"	"	"
4	"	"	"	"	24.11.87
5	"	"	"	"	"
6	"	"	"	"	19.1.88
7	Ladyclough	Derbys	SK 090934	27.11.87	8.12.87
8	"	"	"	"	"
9	Wrynose	Cumbria	32775028	14.12.87	15.12.87
10	"	"	32755033	"	"
11	Dark Peak	Derbys	SK 145921	5.1.88	12.1.88
12	"	"	SK 143918	"	"
13	"	"	SK 145921	"	19.1.88
14	Elan Valley	Dyfed	SN 845740	25-28.1.88	2.2.88
15	"	Powys	SN 917713	"	"
16	"	Dyfed	SN 851747	"	9.2.88
17	"	"	SN 865745	"	"
18	"	"	SN 858752	"	16.2.88
19	"	"	SN 858752	"	"
20	"	"	SN 846736	"	23.2.88
21	"	"	SN 846737	"	"
22	Llyn Brianne	Dyfed	SN 774574	8.3.88	15.3.88
23	"	"	SN 814483	9.3.88	"
24	"	"	SN 768578	9.3.88	"
25	North Grain	Derbys	SK 106930	18.4.88	19.4.88
26	"	"	SK 110935	"	"
27	"	"	SK 107937	"	"
28	"	"	SK 103934	"	26.4.88
29	Crowden Brook	"	SK 098871	"	"
30	"	"	SK 105859	"	"

Table 3.2 Details of sampling/2

Soil	site details
1	hill top, blanket peat
2	"
3	"
4	"
5	"
6	"
7	hill top (plateau) exposed peat
8	hill top (plateau) peat from beneath heather
9	sloping ground, ca. 10 cm of organic matter, under Nardus
10	flat bog, moss covering, ca 30 cm of organic matter
11	sloping ground, 10 cm of organic matter above sandy sub-soil, under heather
12	level site, beneath heather
13	as 11, less 'contaminated' with sand
14	Hafren peat phase (ferric stagnopodzol). Sample depth: 1-10 cm
15	" "
16	Crowdy flush zone phase (peat). Sample depth: 5-15 cm
17	" "
18	area of eroding Crowdy flush zone phase (peat). Sample depth 1-10 cm
19	" " " " 2-30 cm
20	Crowdy interfluve phase (peat). Sample depth: 5-15 cm
21	area of eroding Crowdy interfluve phase (peat). Sample depth: 20-30 cm
22	Ah horizon (0-5 cm) of a brown podzol
23	O horizon (0-5 cm) of a stagnopodzol
24	upland peat bog
25	sloping ground, 10 cm organic layer beneath bilberry and Nardus
26	hill top, 20 cm organic layer beneath Nardus
27	blanket peat beneath heather, top 20 cm
28	steep slope, 10 cm organic layer beneath Nardus
29	" " " " " " " and bilberry
30	valley bottom, 20 cm organic layer beneath bracken

Table 3.3 Bulk analyses of soil samples. The pH values are for suspensions in 0.001 M NaCl.

soil	% H_2O	% LOI orig.	% LOI sieved	elemental analysis % C	elemental analysis % H	elemental analysis % N	pH	DOC $mg\ g^{-1}$
1	88	98	97	52.4	6.2	1.6	3.54	110
2	87	98	97	53.2	6.1	1.4	3.53	143
3	88	97	97	53.6	6.2	1.6	3.51	123
4	88	-	98	52.9	6.0	1.4	3.45	132
5	88	-	97	54.1	5.9	1.1	3.44	167
6	89	99	98	52.1	5.5	0.8	3.79	77
7	85	94	95	49.8	6.0	1.6	3.57	113
8	62	35	59	34.7	3.9	1.0	3.51	104
9	69	57	70	36.7	4.5	2.9	4.40	71
10	89	92	93	55.0	6.5	2.5	4.09	72
11	50	34	37	28.9	3.0	0.7	3.70	62
12	77	93	90	53.3	5.4	0.9	3.52	119
13	75	66	60	38.9	4.0	0.9	3.97	70
14	71	86	85	51.4	5.6	2.2	3.80	126
15	70	68	63	36.4	4.7	2.1	4.13	70
16	84	91	90	49.3	6.6	3.6	3.73	73
17	84	80	81	46.1	5.5	2.1	3.99	90
18	84	98	98	54.4	5.8	1.4	3.74	68
19	91	99	98	53.4	5.9	1.5	3.89	82
20	90	97	97	52.7	6.4	1.8	3.80	55
21	80	97	97	52.8	6.0	1.5	3.52	46
22	57	32	33	16.3	2.3	1.2	4.41	19
23	74	85	85	46.5	5.5	2.1	3.77	70
24	93	90	86	45.6	5.8	2.7	4.32	64
25	80	89	90	51.6	5.4	1.7	3.55	64
26	88	97	94	48.9	5.4	1.0	3.54	46
27	84	94	95	50.9	5.9	1.4	3.41	59
28	44	24	27	19.4	1.9	0.8	4.08	32
29	72	79	65	36.6	3.8	1.6	3.90	63
30	75	67	70	39.3	4.2	2.1	3.72	68

ca. 50 g 1-1

Extractions					
Al $\mu mol\ g^{-1}$	Fe $\mu mol\ g^{-1}$	Na $\mu eq\ g^{-1}$	K $\mu eq\ g^{-1}$	Mg $\mu eq\ g^{-1}$	Ca $\mu eq\ g^{-1}$
15	10	11	1	62	21
16	19	12	2	64	28
16	15	12	2	76	27
14	13	12	1	58	13
20	20	12	1	71	33
12	9	11	3	57	10
32	28	8	1	35	33
72	23	4	4	7	10
195	14	7	4	4	6
104	40	7	6	36	36
39	11	2	2	22	6
40	16	6	2	17	29
54	44	3	3	10	14
120	33	4	3	14	5
159	80	6	5	13	9
33	82	7	4	22	19
119	21	6	1	24	15
11	3	13	1	92	22
15	1	14	1	94	6
12	12	14	3	142	34
16	7	10	3	77	29
30	53	6	9	12	6
128	64	11	1	16	10
257	163	10	2	27	12
45	68	6	2	19	34
28	52	9	2	28	34
37	18	10	3	26	46
61	37	3	5	5	5
70	41	4	4	11	15
59	72	7	4	14	37

Table 3.4 Fitting soil titration data with CHAOS. FH is the optimized fraction of soil that is 'active' humic matter. The rmsd pH is the root-mean-square deviation between observed and calculated pH values.

soil	no. of titration points	FH	rmsdpH	2x extractable DOC g/gsoil
1	6	0.31	0.02	0.22
2	6	0.33	0.05	0.29
3	5	0.37	0.02	0.25
4	16	0.27	0.12	0.26
5	16	0.43	0.31	0.33
6	16	0.24	0.18	0.15
7	16	0.25	0.16	0.23
8	15	0.22	0.23	0.21
9	13	0.17	0.30	0.14
10	15	0.24	0.18	0.14
11	14	0.16	0.24	0.12
12	16	0.30	0.16	0.24
13	14	0.16	0.26	0.14
14	15	0.26	0.21	0.25
15	14	0.21	0.31	0.14
16	14	0.19	0.25	0.15
17	14	0.21	0.24	0.18
18	15	0.26	0.15	0.14
19	15	0.22	0.15	0.16
20	16	0.32	0.14	0.11
21	16	0.30	0.15	0.09
22	13	0.07	0.40	0.04
23	15	0.26	0.20	0.14
24	12	0.26	0.19	0.13
25	15	0.26	0.20	0.13
26	16	0.27	0.14	0.09
27	16	0.31	0.15	0.12
28	13	0.09	0.34	0.06
29	14	0.18	0.28	0.13
30	15	0.24	0.18	0.14

TABLE 3.5.1 SOIL NUMBER 1

NO. OF TITRATION POINTS, PH < 5.5 = 6

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	.837	.000113	.001034	.416E-04	.0153	1.92	3.4
2	.837	.000113	.001034	.416E-04	.00386	2.62	7.9
3	.837	.000113	.001034	.416E-04	.00243	2.93	13.3
4	.837	.000113	.001034	.416E-04	.00157	3.37	18.8
5	.837	.000113	.001034	.416E-04	.001	4.05	21.1
6	.837	.000113	.001604	.416E-04	.001	5.3	38.7

OPTIMUM FRACTION THAT IS HA = .31

RMS DEV. IN PH = .178306E-01

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.155636E-01	-.014266	1.92	1.9008	-.108049E-03	3.4
2	.403805E-02	-.002826	2.62	2.60963	-.215055E-03	7.9
3	.256912E-02	-.001396	2.93	2.92583	-.270545E-03	13.3
4	.16639E-02	-.000536	3.37	3.33539	-.352935E-03	18.8
5	.104626E-02	.000034	4.05	4.04727	-.539865E-03	21.1
6	.103801E-02	.000604	5.3	5.31443	-.114222E-02	38.7

TABLE 3.5.2 SOIL NUMBER 2

NO. OF TITRATION POINTS, PH < 5.5 = 6

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	.858	.000119	.001036	.426E-04	.0153	1.94	9.4
2	.858	.000119	.001036	.426E-04	.00386	2.61	19.4
3	.858	.000119	.001036	.426E-04	.00243	2.93	25.3
4	.858	.000119	.001036	.426E-04	.00157	3.43	30.2
5	.858	.000119	.001036	.426E-04	.001	3.99	34
6	.858	.000119	.001606	.426E-04	.001	5.31	55

OPTIMUM FRACTION THAT IS HA = .33

RMS DEV. IN PH = .049419

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.155861E-01	-.014264	1.94	1.90084	-.107999E-03	9.4
2	.404803E-02	-.002824	2.61	2.61104	-.215403E-03	19.4
3	.257295E-02	-.001394	2.93	2.92928	-.271281E-03	25.3
4	.166482E-02	-.000534	3.43	3.34139	-.353991E-03	30.2
5	.104744E-02	.000036	3.99	4.04463	-.5388E-03	34
6	.103787E-02	.000606	5.31	5.26222	-.111318E-02	55

TABLE 3.5.3 SOIL NUMBER 3

NO. OF TITRATION POINTS, PH < 5.5 = 5

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	.960	.000138	.001036	.000044	.0153	1.92	9.4
2	.960	.000138	.001036	.000044	.00386	2.6	15.3
3	.960	.000138	.001036	.000044	.00243	2.92	23.4
4	.960	.000138	.001036	.000044	.00157	3.29	27.4
5	.960	.000138	.001036	.000044	.001	3.97	32.3

OPTIMUM FRACTION THAT IS HA = .37

RMS DEV. IN PH = .232129E-01

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.156074E-01	-.014264	1.92	1.90185	-.108102E-03	9.4
2	.405323E-02	-.002824	2.6	2.61439	-.215947E-03	15.3
3	.257717E-02	-.001394	2.92	2.93168	-.272491E-03	23.4
4	.166796E-02	-.000534	3.29	3.33261	-.353147E-03	27.4
5	.104973E-02	.000036	3.97	3.95566	-.510609E-03	32.3

TABLE 3.5.4 SOIL NUMBER 4

NO. OF TITRATION POINTS, PH < 5.5 = 16

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	1.360	.00018	.001065	.722E-04	.00386	2.67	24.1
2	1.360	.00018	.001065	.722E-04	.00243	2.98	35.8
3	1.360	.00018	.001065	.722E-04	.00157	3.33	45.6
4	1.360	.00018	.001065	.722E-04	.00129	3.55	49.8
5	1.360	.00018	.001065	.722E-04	.001	3.93	51.6
6	1.360	.00018	.001205	.722E-04	.001	4.12	55.5
7	1.360	.00018	.001355	.722E-04	.001	4.35	64.5
8	1.360	.00018	.001635	.722E-04	.001	4.75	75.2
9	.818	.000108	.001039	.433E-04	.00386	2.57	16.4
10	.818	.000108	.001039	.433E-04	.00243	2.9	25.1
11	.818	.000108	.001039	.433E-04	.00157	3.3	33.5
12	.818	.000108	.001039	.433E-04	.00129	3.54	35.3
13	.818	.000108	.001039	.433E-04	.001	3.99	38.5
14	.818	.000108	.001179	.433E-04	.001	4.3	40
15	.818	.000108	.001329	.433E-04	.001	4.66	46
16	.818	.000108	.001609	.433E-04	.001	5.28	56.6

OPTIMUM FRACTION THAT IS HA = .27

RMS DEV. IN PH = .116221

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.411942E-02	-.002795	2.67	2.63173	-.219328E-03	24.1
2	.261535E-02	-.001365	2.98	2.95321	-.275345E-03	35.8
3	.168647E-02	-.000505	3.33	3.33736	-.351743E-03	45.6
4	.137468E-02	-.000225	3.55	3.54639	-.398076E-03	49.8
5	.105763E-02	.000065	3.93	3.83883	-.470372E-03	51.6
6	.105097E-02	.000205	4.12	3.98286	-.516667E-03	55.5
7	.104622E-02	.000355	4.35	4.13873	-.571833E-03	64.5
8	.104219E-02	.000635	4.75	4.42326	-.684343E-03	75.2
9	.403648E-02	-.002821	2.57	2.61029	-.215088E-03	16.4
10	.256776E-02	-.001391	2.9	2.92698	-.270501E-03	25.1
11	.166078E-02	-.000531	3.3	3.34005	-.353218E-03	33.5
12	.135921E-02	-.000251	3.54	3.6007	-.414672E-03	35.3
13	.104627E-02	.000039	3.99	4.06628	-.546039E-03	38.5
14	.103955E-02	.000179	4.3	4.37508	-.664107E-03	40
15	.10377E-02	.000329	4.66	4.72927	-.824369E-03	46
16	.103713E-02	.000609	5.28	5.38705	-.118107E-02	56.6

TABLE 3.5.5 SOIL NUMBER 5

NO. OF TITRATION POINTS, PH < 5.5 = 16

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	3.11	.000379	.001093	.000146	.00386	2.68	24.4
2	3.11	.000379	.001093	.000146	.00243	3.01	36.1
3	3.11	.000379	.001093	.000146	.00157	3.31	42.8
4	3.11	.000379	.001093	.000146	.00129	3.53	47.6
5	3.11	.000379	.001093	.000146	.001	3.72	51.8
6	3.11	.000379	.001233	.000146	.001	3.95	60
7	3.11	.000379	.001383	.000146	.001	4.08	72.1
8	3.11	.000379	.001663	.000146	.001	4.36	84.7
9	1.24	.000151	.001037	.000581	.00386	2.6	12.5
10	1.24	.000151	.001037	.000581	.00243	2.92	20.3
11	1.24	.000151	.001037	.000581	.00157	3.31	28.6
12	1.24	.000151	.001037	.000581	.00129	3.55	29.1
13	1.24	.000151	.001037	.000581	.001	3.97	29.1
14	1.24	.000151	.001177	.000581	.001	4.25	33
15	1.24	.000151	.001327	.000581	.001	4.52	44.3
16	1.24	.000151	.001607	.000581	.001	5.14	53.3

OPTIMUM FRACTION THAT IS HA = .43

RMS DEV. IN PH = .307626

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.427877E-02	-.002767	2.68	2.66098	-.225752E-03	24.4
2	.270963E-02	-.001337	3.01	2.95187	-.275358E-03	36.1
3	.174379E-02	-.000477	3.31	3.22869	-.325975E-03	42.8
4	.142619E-02	-.000197	3.53	3.34792	-.346795E-03	47.6
5	.110017E-02	.000093	3.72	3.49095	-.373279E-03	51.8
6	.109299E-02	.000233	3.95	3.53718	-.385447E-03	60
7	.108828E-02	.000383	4.08	3.58464	-.398375E-03	72.1
8	.107813E-02	.000663	4.36	3.67343	-.42334E-03	84.7
9	.510061E-02	-.002823	2.6	2.85415	-.214648E-03	12.5
10	.307913E-02	-.001393	2.92	3.19736	-.214049E-03	20.3
11	.180431E-02	-.000533	3.31	3.58983	-.251523E-03	28.6
12	.14285E-02	-.000253	3.55	3.85906	-.303889E-03	29.1
13	.107304E-02	.000037	3.97	4.2814	-.40142E-03	29.1
14	.105577E-02	.000177	4.25	4.5097	-.466245E-03	33
15	.104781E-02	.000327	4.52	4.74548	-.539339E-03	44.3
16	.104108E-02	.000607	5.14	5.15978	-.673854E-03	53.3

TABLE 3.5.6 SOIL NUMBER 6

NO. OF TITRATION POINTS, PH < 5.5 = 16

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	1.375	.000185	.001074	.000066	.00386	2.63	9
2	1.375	.000185	.001074	.000066	.00243	2.98	10.4
3	1.375	.000185	.001074	.000066	.00157	3.35	19.1
4	1.375	.000185	.001074	.000066	.00129	3.65	24
5	1.375	.000185	.001074	.000066	.001	4.05	29
6	1.375	.000185	.001214	.000066	.001	4.28	37.2
7	1.375	.000185	.001364	.000066	.001	4.5	38.7
8	1.375	.000185	.001644	.000066	.001	4.84	50.4
9	.75	.000101	.00104	.000036	.00386	2.59	5.4
10	.75	.000101	.00104	.000036	.00243	2.9	8
11	.75	.000101	.00104	.000036	.00157	3.33	13.6
12	.75	.000101	.00104	.000036	.00129	3.62	18.2
13	.75	.000101	.00104	.000036	.001	4.13	19.1
14	.75	.000101	.00118	.000036	.001	4.47	22.2
15	.75	.000101	.00133	.000036	.001	4.81	27.9
16	.75	.000101	.00161	.000036	.001	5.35	35.9

OPTIMUM FRACTION THAT IS HA = .24

RMS DEV. IN PH = .179526

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.411293E-02	-.002786	2.63	2.63414	-.220039E-03	9
2	.261753E-02	-.001356	2.98	2.95793	-.277346E-03	10.4
3	.168525E-02	-.000496	3.35	3.35363	-.356646E-03	19.1
4	.13765E-02	-.000216	3.65	3.5693	-.405171E-03	24
5	.105877E-02	.000074	4.05	3.87608	-.482464E-03	29
6	.105082E-02	.000214	4.28	4.02896	-.533173E-03	37.2
7	.104724E-02	.000364	4.5	4.1934	-.593238E-03	38.7
8	.104243E-02	.000644	4.84	4.49571	-.716802E-03	50.4
9	.402823E-02	-.00282	2.59	2.60706	-.214524E-03	5.4
10	.256042E-02	-.00139	2.9	2.92537	-.270782E-03	8
11	.165999E-02	-.00053	3.33	3.34543	-.355746E-03	13.6
12	.135685E-02	-.00025	3.62	3.62404	-.421556E-03	18.2
13	.104297E-02	.00004	4.13	4.16009	-.580448E-03	19.1
14	.103795E-02	.00018	4.47	4.54258	-.73776E-03	22.2
15	.103808E-02	.00033	4.81	4.98124	-.957135E-03	27.9
16	.10389E-02	.00061	5.35	5.75761	-.142984E-02	35.9

TABLE 3.5.7 SOIL NUMBER 7

NO. OF TITRATION POINTS, PH < 5.5 = 16

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	3.224	.00042	.001108	.000397	.00386	2.64	6.1
2	3.224	.00042	.001108	.000397	.00243	2.95	11.9
3	3.224	.00042	.001108	.000397	.00157	3.33	18.6
4	3.224	.00042	.001108	.000397	.00129	3.5	20.7
5	3.224	.00042	.001108	.000397	.001	3.79	22.6
6	3.224	.00042	.001248	.000397	.001	3.92	26
7	3.224	.00042	.001398	.000397	.001	4.05	33.2
8	3.224	.00042	.001678	.000397	.001	4.26	44
9	.806	.000105	.001027	.992E-04	.00386	2.62	2.1
10	.806	.000105	.001027	.992E-04	.00243	2.93	3.5
11	.806	.000105	.001027	.992E-04	.00157	3.33	5.6
12	.806	.000105	.001027	.992E-04	.00129	3.6	6.2
13	.806	.000105	.001027	.992E-04	.001	4.07	6.3
14	.806	.000105	.001167	.992E-04	.001	4.45	7.9
15	.806	.000105	.001317	.992E-04	.001	4.83	10.2
16	.806	.000105	.001597	.992E-04	.001	5.48	16.5

OPTIMUM FRACTION THAT IS HA = .25

RMS DEV. IN PH = .155796

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.464619E-02	-.002752	2.64	2.76728	-.235011E-03	6.1
2	.286436E-02	-.001322	2.95	3.07972	-.281025E-03	11.9
3	.181027E-02	-.000462	3.33	3.38056	-.333942E-03	18.6
4	.147116E-02	-.000182	3.5	3.50999	-.358248E-03	20.7
5	.112701E-02	.000108	3.79	3.66514	-.387634E-03	22.6
6	.111692E-02	.000248	3.92	3.71722	-.401858E-03	26
7	.110505E-02	.000398	4.05	3.77208	-.416896E-03	33.2
8	.108904E-02	.000678	4.26	3.87016	-.446258E-03	44
9	.416561E-02	-.002833	2.62	2.63181	-.216772E-03	2.1
10	.264313E-02	-.001403	2.93	2.96088	-.26631E-03	3.5
11	.168844E-02	-.000543	3.33	3.3839	-.340859E-03	5.6
12	.137125E-02	-.000263	3.6	3.66274	-.404325E-03	6.2
13	.104848E-02	.000027	4.07	4.17509	-.548662E-03	6.3
14	.10399E-02	.000167	4.45	4.52818	-.683345E-03	7.9
15	.103742E-02	.000317	4.83	4.92967	-.862479E-03	10.2
16	.10384E-02	.000597	5.48	5.65812	-.125041E-02	16.5

TABLE 3.5.8 SOIL NUMBER 8

NO. OF TITRATION POINTS, PH < 5.5 = 15

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	7.245	.000274	.001233	.00227	.00386	2.72	6.5
2	7.245	.000274	.001233	.00227	.00243	2.97	10.9
3	7.245	.000274	.001233	.00227	.00157	3.25	20.8
4	7.245	.000274	.001233	.00227	.00129	3.44	28.4
5	7.245	.000274	.001233	.00227	.001	3.72	38.4
6	7.245	.000274	.001373	.00227	.001	3.8	45.1
7	7.245	.000274	.001523	.00227	.001	3.86	49.6
8	7.245	.000274	.001803	.00227	.001	4.08	68.5
9	.736	.278E-04	.001024	.00023	.00386	2.62	2.4
10	.736	.278E-04	.001024	.00023	.00243	2.92	1.8
11	.736	.278E-04	.001024	.00023	.00157	3.3	3.2
12	.736	.278E-04	.001024	.00023	.00129	3.55	3.6
13	.736	.278E-04	.001024	.00023	.001	4.15	4.6
14	.736	.278E-04	.001164	.00023	.001	4.36	6.4
15	.736	.278E-04	.001314	.00023	.001	5.1	9.9

OPTIMUM FRACTION THAT IS HA = .22

RMS DEV. IN PH = .228735

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.554025E-02	-.002627	2.72	2.9496	-.202426E-03	6.5
2	.323817E-02	-.001197	2.97	3.12855	-.215206E-03	10.9
3	.001972	-.000337	3.25	3.29697	-.236158E-03	20.8
4	.159086E-02	-.000057	3.44	3.37166	-.246929E-03	28.4
5	.12111E-02	.000233	3.72	3.46623	-.260889E-03	38.4
6	.119945E-02	.000373	3.8	3.48711	-.265815E-03	45.1
7	.118666E-02	.000523	3.86	3.5088	-.271122E-03	49.6
8	.116635E-02	.000803	4.08	3.54955	-.280866E-03	68.5
9	.44286E-02	-.002836	2.62	2.66904	-.215415E-03	2.4
10	.280735E-02	-.001406	2.92	3.00113	-.239483E-03	1.8
11	.171163E-02	-.000546	3.3	3.37831	-.270903E-03	3.2
12	.001363	-.000266	3.55	3.63852	-.319815E-03	3.6
13	.10405E-02	.000024	4.15	4.23651	-.480385E-03	4.6
14	.103681E-02	.000164	4.36	4.67314	-.626489E-03	6.4
15	.103584E-02	.000314	5.1	5.16747	-.805228E-03	9.9

TABLE 3.5.9 SOIL NUMBER 9

NO. OF TITRATION POINTS, PH < 5.5 = 13

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	3.842	.000108	.001231	.00441	.00386	3.27	5.4
2	3.842	.000108	.001231	.00441	.00243	3.71	4.4
3	3.842	.000108	.001231	.00441	.00157	3.99	3.6
4	3.842	.000108	.001231	.00441	.00129	4.22	4
5	3.842	.000108	.001231	.00441	.001	4.64	4.7
6	3.842	.000108	.001371	.00441	.001	4.99	7.3
7	3.842	.000108	.001521	.00441	.001	5.09	10.7
8	3.842	.000108	.001801	.00441	.001	5.41	20.4
9	.5117	.144E-04	.001031	.000587	.00386	2.84	2
10	.5117	.144E-04	.001031	.000587	.00243	3.27	1.2
11	.5117	.144E-04	.001031	.000587	.00157	3.75	.6
12	.5117	.144E-04	.001031	.000587	.00129	4.02	.9
13	.5117	.144E-04	.001031	.000587	.001	4.81	1.1

OPTIMUM FRACTION THAT IS HA = .17

RMS DEV IN PH = .297376

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.628872E-02	-.002629	3.27	3.67215	-.378376E-04	5.4
2	.355919E-02	-.001199	3.71	3.97268	-.274245E-04	4.4
3	.198501E-02	-.000339	3.99	4.28975	-.455812E-04	3.6
4	.153719E-02	-.000059	4.22	4.45853	-.66127E-04	4
5	.113722E-02	.000231	4.64	4.68077	-.996274E-04	4.7
6	.11172E-02	.000371	4.99	4.76756	-.113944E-03	7.3
7	.109674E-02	.000521	5.09	4.85703	-.129679E-03	10.7
8	.107964E-02	.000801	5.41	5.0004	-.155925E-03	20.4
9	.531851E-02	-.002829	2.84	2.88552	-.202587E-03	2
10	.336899E-02	-.001399	3.27	3.34129	-.152542E-03	1.2
11	.19875E-02	-.000539	3.75	3.85436	-.96873E-04	.6
12	.150495E-02	-.000259	4.02	4.18022	-.840113E-04	.9
13	.104117E-02	.000031	4.81	5.48472	-.250974E-03	1.1

TABLE 3.5.10 SOIL NUMBER 10

NO. OF TITRATION POINTS, PH < 5.5 = 15

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	1.944	.000293	.001053	.000842	.00386	2.81	3.6
2	1.944	.000293	.001053	.000842	.00243	3.17	4
3	1.944	.000293	.001053	.000842	.00157	3.61	5.7
4	1.944	.000293	.001053	.000842	.00129	3.87	6.8
5	1.944	.000293	.001053	.000842	.001	4.2	8.4
6	1.944	.000293	.001193	.000842	.001	4.47	10.7
7	1.944	.000293	.001343	.000842	.001	4.71	13.1
8	1.944	.000293	.001623	.000842	.001	5.09	41.4
9	.72	.000109	.00102	.000312	.00386	2.67	2.1
10	.72	.000109	.00102	.000312	.00243	3	1.8
11	.72	.000109	.00102	.000312	.00157	3.45	3.2
12	.72	.000109	.00102	.000312	.00129	3.78	3.8
13	.72	.000109	.00102	.000312	.001	4.38	3.9
14	.72	.000109	.00116	.000312	.001	4.96	5.3
15	.72	.000109	.00131	.000312	.001	5.44	6

OPTIMUM FRACTION THAT IS HA = .24

RMS DEV IN PH = .175494

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.529332E-02	-.002807	2.81	2.95302	-.211567E-03	3.6
2	.31036E-02	-.001377	3.17	3.27543	-.220085E-03	4
3	.184472E-02	-.000517	3.61	3.67105	-.278714E-03	5.7
4	.147718E-02	-.000237	3.87	3.8871	-.321718E-03	6.8
5	.111349E-02	.000053	4.2	4.16457	-.3824E-03	8.4
6	.109222E-02	.000193	4.47	4.2888	-.416539E-03	10.7
7	.107501E-02	.000343	4.71	4.41539	-.453569E-03	13.1
8	.105988E-02	.000623	5.09	4.63236	-.520409E-03	41.4
9	.469786E-02	-.00284	2.67	2.73798	-.219683E-03	2.1
10	.295815E-02	-.00141	3	3.10647	-.230892E-03	1.8
11	.177742E-02	-.00055	3.45	3.53298	-.259717E-03	3.2
12	.141007E-02	-.00027	3.78	3.85408	-.319751E-03	3.8
13	.105353E-02	.00002	4.38	4.54521	-.495014E-03	3.9
14	.104018E-02	.00016	4.96	5.06061	-.663661E-03	5.3
15	.103924E-02	.00031	5.44	5.6141	-.871094E-03	6

TABLE 3.5.11 SOIL NUMBER 11

NO. OF TITRATION POINTS, PH < 5.5 = 14

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	6.896	.6034E-03	.001172	.00168	.00386	2.7	4.3
2	6.896	.6034E-03	.001172	.00168	.00243	2.97	4.8
3	6.896	.6034E-03	.001172	.00168	.00157	3.29	8.6
4	6.896	.6034E-03	.001172	.00168	.00129	3.45	11.3
5	6.896	.6034E-03	.001172	.00168	.001	3.72	14.6
6	6.896	.6034E-03	.001312	.00168	.001	3.82	20.5
7	6.896	.6034E-03	.001462	.00168	.001	3.94	27.6
8	6.896	.6034E-03	.001742	.00168	.001	4.11	40.6
9	.48	.000042	.001012	.000117	.00386	2.59	1.3
10	.48	.000042	.001012	.000117	.00243	2.88	1.1
11	.48	.000042	.001012	.000117	.00157	3.31	.5
12	.48	.000042	.001012	.000117	.00129	3.62	1
13	.48	.000042	.001012	.000117	.001	4.27	.9
14	.48	.000042	.001152	.000117	.001	4.88	5.9

OPTIMUM FRACTION THAT IS HA = .16

RMS DEV IN PH = .240858

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.531249E-02	-.002688	2.7	2.92766	-.224044E-03	4.3
2	.317014E-02	-.001258	2.97	3.1399	-.247709E-03	4.8
3	.198324E-02	-.000398	3.29	3.32937	-.275403E-03	8.6
4	.161513E-02	-.000118	3.45	3.40835	-.286943E-03	11.3
5	.123929E-02	.000172	3.72	3.50404	-.301114E-03	14.6
6	.122839E-02	.000312	3.82	3.52266	-.305524E-03	20.5
7	.121775E-02	.000462	3.94	3.54305	-.310166E-03	27.6
8	.11983E-02	.000742	4.11	3.57847	-.318952E-03	40.6
9	.419359E-02	-.002848	2.59	2.62663	-.213853E-03	1.3
10	.268033E-02	-.001418	2.88	2.95321	-.252386E-03	1.1
11	.168528E-02	-.000558	3.31	3.36156	-.299711E-03	.5
12	.136151E-02	-.000278	3.62	3.65101	-.357976E-03	1
13	.103858E-02	.000012	4.27	4.41524	-.577507E-03	.9
14	.103642E-02	.000152	4.88	5.22877	-.900545E-03	5.9

TABLE 3.5.12 SOIL NUMBER 12

NO. OF TITRATION POINTS, PH < 5.5 = 16

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	6.78	.000515	.00119	.000904	.00386	2.64	10.6
2	6.78	.000515	.00119	.000904	.00243	2.92	23.1
3	6.78	.000515	.00119	.000904	.00157	3.2	40
4	6.78	.000515	.00119	.000904	.00129	3.36	50.9
5	6.78	.000515	.00119	.000904	.001	3.54	58.4
6	6.78	.000515	.00133	.000904	.001	3.59	65.8
7	6.78	.000515	.00148	.000904	.001	3.67	69.1
8	6.78	.000515	.00176	.000904	.001	3.84	78.1
9	.87	.661E-04	.001024	.000116	.00386	2.6	2.6
10	.87	.661E-04	.001024	.000116	.00243	2.89	4.9
11	.87	.661E-04	.001024	.000116	.00157	3.28	6.9
12	.87	.661E-04	.001024	.000116	.00129	3.52	7.9
13	.87	.661E-04	.001024	.000116	.001	3.95	8.1
14	.87	.661E-04	.001164	.000116	.001	4.22	13.9
15	.87	.661E-04	.001314	.000116	.001	4.51	21.3
16	.87	.661E-04	.001594	.000116	.001	5.11	33.5

OPTIMUM FRACTION THAT IS HA = .3

RMS DEV IN PH = .156395

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.489155E-02	-.00267	2.64	2.77239	-.229271E-03	10.6
2	.298311E-02	-.00124	2.92	2.99258	-.258458E-03	23.1
3	.188492E-02	-.00038	3.2	3.18226	-.28607E-03	40
4	.153785E-02	-.0001	3.36	3.26049	-.297594E-03	50.9
5	.118373E-02	.00019	3.54	3.3565	-.311604E-03	58.4
6	.117734E-02	.00033	3.59	3.37331	-.315343E-03	65.8
7	.116825E-02	.00048	3.67	3.39232	-.320062E-03	69.1
8	.115754E-02	.00076	3.84	3.42461	-.327723E-03	78.1
9	.415398E-02	-.002836	2.6	2.6232	-.214367E-03	2.6
10	.262834E-02	-.001406	2.89	2.93745	-.260225E-03	4.9
11	.166537E-02	-.000546	3.28	3.33019	-.328186E-03	6.9
12	.135744E-02	-.000266	3.52	3.57694	-.383286E-03	7.9
13	.104401E-02	.000024	3.95	4.01396	-.500218E-03	8.1
14	.104012E-02	.000164	4.22	4.28496	-.594461E-03	13.9
15	.103834E-02	.000314	4.51	4.59195	-.714637E-03	21.3
16	.103701E-02	.000594	5.11	5.17694	-.984088E-03	33.5

TABLE 3.5.13 SOIL NUMBER 13

NO. OF TITRATION POINTS, PH < 5.5 = 14

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	3.568	.000263	.001132	.00121	.00386	2.87	7.1
2	3.568	.000263	.001132	.00121	.00243	3.13	4.6
3	3.568	.000263	.001132	.00121	.00157	3.48	7.7
4	3.568	.000263	.001132	.00121	.00129	3.68	11.9
5	3.568	.000263	.001132	.00121	.001	3.96	20.1
6	3.568	.000263	.001272	.00121	.001	4.1	26.5
7	3.568	.000263	.001422	.00121	.001	4.23	30.1
8	3.568	.000263	.001702	.00121	.001	4.49	36.5
9	.48	.354E-04	.001018	.000163	.00386	2.61	1.8
10	.48	.354E-04	.001018	.000163	.00243	2.92	.9
11	.48	.354E-04	.001018	.000163	.00157	3.3	1.1
12	.48	.354E-04	.001018	.000163	.00129	3.59	3.1
13	.48	.354E-04	.001018	.000163	.001	4.32	1.5
14	.48	.354E-04	.001158	.000163	.001	4.97	3.4

OPTIMUM FRACTION THAT IS HA = .16

RMS DEV IN PH = .257914

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.529619E-02	-.002728	2.87	2.93228	-.211081E-03	7.1
2	.308174E-02	-.001298	3.13	3.18293	-.227306E-03	4.6
3	.185603E-02	-.000438	3.48	3.44436	-.265318E-03	7.7
4	.149287E-02	-.000158	3.68	3.56543	-.286977E-03	11.9
5	.113542E-02	.000132	3.96	3.71503	-.314821E-03	20.1
6	.112179E-02	.000272	4.1	3.76495	-.327471E-03	26.5
7	.110886E-02	.000422	4.23	3.81888	-.341695E-03	30.1
8	.109178E-02	.000702	4.49	3.91337	-.367705E-03	36.5
9	.430949E-02	-.002842	2.61	2.64742	-.214692E-03	1.8
10	.276042E-02	-.001412	2.92	2.98589	-.244927E-03	.9
11	.001712	-.000552	3.3	3.39111	-.274316E-03	1.1
12	.136816E-02	-.000272	3.59	3.67691	-.324506E-03	3.1
13	.103835E-02	.000018	4.32	4.49897	-.551747E-03	1.5
14	.103565E-02	.000158	4.97	5.39752	-.882647E-03	3.4

TABLE 3.5.14 SOIL NUMBER 14

NO. OF TITRATION POINTS, PH < 5.5 = 15

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	7.826	.000289	.001202	.00361	.00386	2.85	4.2
2	7.826	.000289	.001202	.00361	.00243	3.14	5.3
3	7.826	.000289	.001202	.00361	.00157	3.43	9.1
4	7.826	.000289	.001202	.00361	.00129	3.6	11.8
5	7.826	.000289	.001202	.00361	.001	3.8	15
6	7.826	.000289	.001342	.00361	.001	3.87	21.5
7	7.826	.000289	.001492	.00361	.001	3.97	26.7
8	7.826	.000289	.001772	.00361	.001	4.11	35
9	.78	.288E-04	.00102	.00036	.00386	2.65	1.1
10	.78	.288E-04	.00102	.00036	.00243	2.98	1.6
11	.78	.288E-04	.00102	.00036	.00157	3.37	1.9
12	.78	.288E-04	.00102	.00036	.00129	3.66	2.1
13	.78	.288E-04	.00102	.00036	.001	4.2	2.3
14	.78	.288E-04	.00116	.00036	.001	4.57	6.8
15	.78	.288E-04	.00131	.00036	.001	5	12.8

OPTIMUM FRACTION THAT IS HA = .26

RMS DEV IN PH = .214449

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.589209E-02	-.002658	2.85	3.0797	-.17676E-03	4.2
2	.34447E-02	-.001228	3.14	3.23732	-.185762E-03	5.3
3	.208878E-02	-.000368	3.43	3.3895	-.203469E-03	9.1
4	.168006E-02	-.000088	3.6	3.45804	-.212572E-03	11.8
5	.127577E-02	.000202	3.8	3.54611	-.225203E-03	15
6	.12578E-02	.000342	3.87	3.56481	-.229478E-03	21.5
7	.124217E-02	.000492	3.97	3.58493	-.233689E-03	26.7
8	.121761E-02	.000772	4.11	3.62147	-.241995E-03	35
9	.473086E-02	-.00284	2.65	2.72806	-.21541E-03	1.1
10	.297568E-02	-.00141	2.98	3.07364	-.222002E-03	1.6
11	.176736E-02	-.00055	3.37	3.43977	-.235389E-03	1.9
12	.13845E-02	-.00027	3.66	3.68297	-.272767E-03	2.1
13	.10431E-02	.00002	4.2	4.26987	-.417318E-03	2.3
14	.10384E-02	.00016	4.57	4.69288	-.544333E-03	6.8
15	.103735E-02	.00031	5	5.145	-.686589E-03	12.8

TABLE 3.5.15 SOIL NUMBER 15

NO. OF TITRATION POINTS, PH < 5.5 = 14

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	4.977	.000263	.001244	.00377	.00386	2.95	4.2
2	4.977	.000263	.001244	.00377	.00243	3.29	4.3
3	4.977	.000263	.001244	.00377	.00157	3.66	4.7
4	4.977	.000263	.001244	.00377	.00129	3.89	5.6
5	4.977	.000263	.001244	.00377	.001	4.25	-
6	4.977	.000263	.001384	.00377	.001	4.41	-
7	4.977	.000263	.001534	.00377	.001	4.6	-
8	4.977	.000263	.001814	.00377	.001	4.87	-
9	.63	.333E-04	.001031	.000477	.00386	2.68	1.3
10	.63	.333E-04	.001031	.000477	.00243	3.01	0.9
11	.63	.333E-04	.001031	.000477	.00157	3.45	0.8
12	.63	.333E-04	.001031	.000477	.00129	3.78	0.9
13	.63	.333E-04	.001031	.000477	.001	4.57	1.4
14	.63	.333E-04	.001171	.000477	.001	5.23	4.0

OPTIMUM FRACTION THAT IS HA = .21

RMS DEV IN PH = .313167

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.598662E-02	-.002616	2.95	3.33182	-.125237E-03	4.2
2	.341754E-02	-.001186	3.29	3.54136	-.131401E-03	4.3
3	.002001	-.000326	3.66	3.76606	-.15777E-03	4.7
4	.159511E-02	-.000046	3.89	3.87527	-.174095E-03	5.6
5	.120327E-02	.000244	4.25	4.00924	-.196152E-03	-
6	.118243E-02	.000384	4.41	4.05263	-.204927E-03	-
7	.116254E-02	.000534	4.6	4.09829	-.214644E-03	-
8	.113885E-02	.000814	4.87	4.17666	-.231167E-03	-
9	.504226E-02	-.002829	2.68	2.80889	-.211937E-03	1.3
10	.317361E-02	-.001399	3.01	3.20322	-.191669E-03	0.9
11	.186278E-02	-.000539	3.45	3.61117	-.174688E-03	0.8
12	.143011E-02	-.000259	3.78	3.87151	-.192367E-03	0.9
13	.10418E-02	.000031	4.57	4.75503	-.368488E-03	1.4
14	.103777E-02	.000171	5.23	5.5646	-.567418E-03	4.0

TABLE 3.5.16 SOIL NUMBER 16

NO. OF TITRATION POINTS, PH < 5.5 = 14

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	2.375	.000254	.001133	.000413	.00243	3	3.8
2	2.375	.000254	.001133	.000413	.00157	3.39	6.3
3	2.375	.000254	.001133	.000413	.00129	3.63	8.6
4	2.375	.000254	.001133	.000413	.001	3.96	10.8
5	2.375	.000254	.001273	.000413	.001	4.15	14.2
6	2.375	.000254	.001423	.000413	.001	4.35	17.7
7	2.375	.000254	.001703	.000413	.001	4.65	25.8
8	.57	.609E-04	.001032	.000099	.00386	2.62	2.3
9	.57	.609E-04	.001032	.000099	.00243	2.94	.8
10	.57	.609E-04	.001032	.000099	.00157	3.36	1.5
11	.57	.609E-04	.001032	.000099	.00129	3.67	2.8
12	.57	.609E-04	.001032	.000099	.001	4.25	3.7
13	.57	.609E-04	.001172	.000099	.001	4.76	5
14	.57	.609E-04	.001322	.000099	.001	5.27	6.9

OPTIMUM FRACTION THAT IS HA = .19

RMS DEV IN PH = .252023

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.283235E-02	-.001297	3	3.07485	-.266908E-03	3.8
2	.175756E-02	-.000437	3.39	3.41374	-.326205E-03	6.3
3	.142416E-02	-.000157	3.63	3.57094	-.357914E-03	8.6
4	.109181E-02	.000133	3.96	3.7636	-.398293E-03	10.8
5	.108108E-02	.000273	4.15	3.83986	-.420312E-03	14.2
6	.107104E-02	.000423	4.35	3.91922	-.4448E-03	17.7
7	.106094E-02	.000703	4.65	4.0572	-.488182E-03	25.8
8	.415366E-02	-.002828	2.62	2.62434	-.214629E-03	2.3
9	.002639	-.001398	2.94	2.95167	-.259922E-03	.8
10	.167325E-02	-.000538	3.36	3.37354	-.325156E-03	1.5
11	.135942E-02	-.000258	3.67	3.67332	-.391788E-03	2.8
12	.104107E-02	.000032	4.25	4.35988	-.595018E-03	3.7
13	.103707E-02	.000172	4.76	4.9526	-.838365E-03	5
14	.10384E-02	.000322	5.27	5.66788	-.119599E-02	6.9

TABLE 3.5.17 SOIL NUMBER 17

NO. OF TITRATION POINTS, PH < 5.5 = 14

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	2.772	.000256	.001092	.00157	.00386	2.81	4
2	2.772	.000256	.001092	.00157	.00243	3.13	3.3
3	2.772	.000256	.001092	.00157	.00157	3.54	6.1
4	2.772	.000256	.001092	.00157	.00129	3.8	8.1
5	2.772	.000256	.001092	.00157	.001	4.15	12.2
6	2.772	.000256	.001232	.00157	.001	4.36	15.3
7	2.772	.000256	.001382	.00157	.001	4.57	15.8
8	2.772	.000256	.001662	.00157	.001	4.88	23
9	.63	.582E-04	.001021	.000357	.00386	2.64	1
10	.63	.582E-04	.001021	.000357	.00243	2.98	.8
11	.63	.582E-04	.001021	.000357	.00157	3.4	1.5
12	.63	.582E-04	.001021	.000357	.00129	3.74	3.3
13	.63	.582E-04	.001021	.000357	.001	4.43	4.2
14	.63	.582E-04	.001161	.000357	.001	5.01	4.9

OPTIMUM FRACTION THAT IS HA = .21

RMS DEV IN PH = .235749

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.565606E-02	-.002768	2.81	3.09262	-.1808E-03	4
2	.323655E-02	-.001338	3.13	3.36054	-.183508E-03	3.3
3	.188688E-02	-.000478	3.54	3.67224	-.223159E-03	6.1
4	.150474E-02	-.000198	3.8	3.83702	-.252535E-03	8.1
5	.11324E-02	.000092	4.15	4.04651	-.293089E-03	12.2
6	.111453E-02	.000232	4.36	4.12834	-.312244E-03	15.3
7	.109684E-02	.000382	4.57	4.21416	-.333906E-03	15.8
8	.107818E-02	.000662	4.88	4.36095	-.372052E-03	23
9	.478905E-02	-.002839	2.64	2.74894	-.216564E-03	1
10	.303072E-02	-.001409	2.98	3.12337	-.215896E-03	.8
11	.180192E-02	-.000549	3.4	3.52972	-.218955E-03	1.5
12	.140625E-02	-.000269	3.74	3.81318	-.256899E-03	3.3
13	.104649E-02	.000021	4.43	4.60011	-.439936E-03	4.2
14	.103723E-02	.000161	5.01	5.29681	-.641116E-03	4.9

TABLE 3.5.18 SOIL NUMBER 18

NO. OF TITRATION POINTS, PH < 5.5 = 15

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	2.938	.000644	.00116	.000124	.00386	2.69	.8
2	2.938	.000644	.00116	.000124	.00243	3.03	1.3
3	2.938	.000644	.00116	.000124	.00157	3.39	3.5
4	2.938	.000644	.00116	.000124	.00129	3.61	4.8
5	2.938	.000644	.00116	.000124	.001	3.89	6.7
6	2.938	.000644	.0013	.000124	.001	4.04	8.6
7	2.938	.000644	.00145	.000124	.001	4.19	10.2
8	2.938	.000644	.00173	.000124	.001	4.39	14.1
9	.78	.000171	.001043	.000033	.00386	2.62	.7
10	.78	.000171	.001043	.000033	.00243	2.93	.9
11	.78	.000171	.001043	.000033	.00157	3.36	2.3
12	.78	.000171	.001043	.000033	.00129	3.61	3.2
13	.78	.000171	.001043	.000033	.001	4.11	3.4
14	.78	.000171	.001183	.000033	.001	4.5	5.3
15	.78	.000171	.001333	.000033	.001	4.92	5.6

OPTIMUM FRACTION THAT IS HA = .26

RMS DEV IN PH = .151661

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.446151E-02	-.0027	2.69	2.75908	-.24754E-03	.8
2	.285209E-02	-.00127	3.03	3.11821	-.315731E-03	1.3
3	.183109E-02	-.00041	3.39	3.47736	-.389937E-03	3.5
4	.149607E-02	-.00013	3.61	3.63211	-.423771E-03	4.8
5	.114748E-02	.00016	3.89	3.81451	-.463085E-03	6.7
6	.113113E-02	.0003	4.04	3.87278	-.481773E-03	8.6
7	.111916E-02	.00045	4.19	3.93278	-.500961E-03	10.2
8	.109897E-02	.00073	4.39	4.03979	-.53681E-03	14.1
9	.408373E-02	-.002817	2.62	2.6271	-.219087E-03	.7
10	.261213E-02	-.001387	2.93	2.96315	-.280063E-03	.9
11	.169727E-02	-.000527	3.36	3.42317	-.375967E-03	2.3
12	.13852E-02	-.000247	3.61	3.73063	-.452137E-03	3.2
13	.10529E-02	.000043	4.11	4.3022	-.634543E-03	3.4
14	.104323E-02	.000183	4.5	4.66359	-.796381E-03	5.3
15	.103879E-02	.000333	4.92	5.05592	-.100327E-02	5.6

TABLE 3.5.19 SOIL NUMBER 19

NO. OF TITRATION POINTS, PH < 5.5 = 15

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	1.562	.000355	.00111	.000107	.00386	2.67	1.5
2	1.562	.000355	.00111	.000107	.00243	3.04	1.8
3	1.562	.000355	.00111	.000107	.00157	3.46	4.9
4	1.562	.000355	.00111	.000107	.00129	3.74	10.1
5	1.562	.000355	.00111	.000107	.001	4.11	13.8
6	1.562	.000355	.00125	.000107	.001	4.33	16
7	1.562	.000355	.001409	.000107	.001	4.58	19.2
8	1.562	.000355	.00168	.000107	.001	5.01	27.1
9	.66	.00015	.001047	.000045	.00386	2.62	1.4
10	.66	.00015	.001047	.000045	.00243	2.94	1.3
11	.66	.00015	.001047	.000045	.00157	3.47	3.4
12	.66	.00015	.001047	.000045	.00129	3.78	5.7
13	.66	.00015	.001047	.000045	.001	4.33	9.7
14	.66	.00015	.001187	.000045	.001	4.8	10
15	.66	.00015	.001337	.000045	.001	5.19	11

OPTIMUM FRACTION THAT IS HA = .22

RMS DEV IN PH = .148818

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.432071E-02	-.00275	2.67	2.70581	-.234239E-03	1.5
2	.275597E-02	-.00132	3.04	3.07972	-.300601E-03	1.8
3	.17646E-02	-.00046	3.46	3.54001	-.397116E-03	4.9
4	.142938E-02	-.00018	3.74	3.78372	-.457201E-03	10.1
5	.108548E-02	.00011	4.11	4.10104	-.544436E-03	13.8
6	.107029E-02	.00025	4.33	4.24018	-.595243E-03	16
7	.105917E-02	.000409	4.58	4.38818	-.653802E-03	19.2
8	.104926E-02	.00068	5.01	4.62038	-.756401E-03	27.1
9	.40977E-02	-.002813	2.62	2.62941	-.218849E-03	1.4
10	.261992E-02	-.001383	2.94	2.96939	-.278113E-03	1.3
11	.169909E-02	-.000523	3.47	3.44385	-.374062E-03	3.4
12	.138439E-02	-.000243	3.78	3.7787	-.457481E-03	5.7
13	.10479E-02	.000047	4.33	4.47327	-.690482E-03	9.7
14	.103989E-02	.000187	4.8	4.9526	-.922079E-03	10
15	.103763E-02	.000337	5.19	5.47078	-.120794E-02	11

TABLE 3.5.20 SOIL NUMBER 20

NO. OF TITRATION POINTS, PH < 5.5 = 16

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	2.208	.000608	.001121	.828E-04	.00386	2.7	.5
2	2.208	.000608	.001121	.828E-04	.00243	3.05	.8
3	2.208	.000608	.001121	.828E-04	.00157	3.46	3.7
4	2.208	.000608	.001121	.828E-04	.00129	3.69	3
5	2.208	.000608	.001121	.828E-04	.001	4.03	6.5
6	2.208	.000608	.001261	.828E-04	.001	4.21	6.5
7	2.208	.000608	.001411	.828E-04	.001	4.42	7.6
8	2.208	.000608	.001691	.828E-04	.001	4.73	11.5
9	.96	.000268	.001052	.000036	.00386	2.64	1.9
10	.96	.000268	.001052	.000036	.00243	2.98	2.2
11	.96	.000268	.001052	.000036	.00157	3.41	3
12	.96	.000268	.001052	.000036	.00129	3.65	3.4
13	.96	.000268	.001052	.000036	.001	4.17	3.6
14	.96	.000268	.001192	.000036	.001	4.52	4.8
15	.96	.000268	.001342	.000036	.001	4.88	6
16	.96	.000268	.001622	.000036	.001	5.5	9.4

OPTIMUM FRACTION THAT IS HA = .32

RMS DEV IN PH = .142728

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.443407E-02	-.002739	2.7	2.76086	-.248968E-03	.5
2	.285084E-02	-.001309	3.05	3.16287	-.327708E-03	.8
3	.183355E-02	-.000449	3.46	3.62281	-.433843E-03	3.7
4	.148888E-02	-.000169	3.69	3.8381	-.489887E-03	3
5	.113366E-02	.000121	4.03	4.09101	-.558636E-03	6.5
6	.111621E-02	.000261	4.21	4.17843	-.590829E-03	6.5
7	.109922E-02	.000411	4.42	4.26894	-.625016E-03	7.6
8	.107824E-02	.000691	4.73	4.4179	-.687233E-03	11.5
9	.416879E-02	-.002808	2.64	2.65622	-.225656E-03	1.9
10	.268056E-02	-.001378	2.98	3.01781	-.292794E-03	2.2
11	.174092E-02	-.000518	3.41	3.52515	-.404718E-03	3
12	.141459E-02	-.000238	3.65	3.85906	-.494772E-03	3.4
13	.106758E-02	.000052	4.17	4.38683	-.672592E-03	3.6
14	.105305E-02	.000192	4.52	4.64933	-.793019E-03	4.8
15	.104474E-02	.000342	4.88	4.92428	-.934802E-03	6
16	.104023E-02	.000622	5.5	5.3916	-.11991E-02	9.4

TABLE 3.5.21 SOIL NUMBER 21

NO. OF TITRATION POINTS, PH < 5.5 = 16

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	5.49	.000968	.00123	.000293	.00386	2.71	2.5
2	5.49	.000968	.00123	.000293	.00243	3	2.7
3	5.49	.000968	.00123	.000293	.00157	3.31	3.6
4	5.49	.000968	.00123	.000293	.00129	3.36	4.5
5	5.49	.000968	.00123	.000293	.001	3.67	5.2
6	5.49	.000968	.00137	.000293	.001	3.75	6.3
7	5.49	.000968	.00152	.000293	.001	3.85	9.2
8	5.49	.000968	.0018	.000293	.001	4.02	10.2
9	.87	.000153	.001037	.464E-04	.00386	2.62	2.2
10	.87	.000153	.001037	.464E-04	.00243	2.94	2
11	.87	.000153	.001037	.464E-04	.00157	3.32	1.9
12	.87	.000153	.001037	.464E-04	.00129	3.54	2.6
13	.87	.000153	.001037	.464E-04	.001	4.01	2.8
14	.87	.000153	.001177	.464E-04	.001	4.28	3.2
15	.87	.000153	.001327	.464E-04	.001	4.64	3.8
16	.87	.000153	.001607	.464E-04	.001	5.28	6.2

OPTIMUM FRACTION THAT IS HA = .3

RMS DEV IN PH = .148385

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.469339E-02	-.00263	2.71	2.8016	-.254893E-03	2.5
2	.296939E-02	-.0012	3	3.09301	-.306175E-03	2.7
3	.191615E-02	-.00034	3.31	3.33454	-.348959E-03	3.6
4	.156945E-02	-.00006	3.36	3.43222	-.365467E-03	4.5
5	.121671E-02	.00023	3.67	3.54626	-.383795E-03	5.2
6	.120277E-02	.00037	3.75	3.56922	-.389988E-03	6.3
7	.119536E-02	.00052	3.85	3.59396	-.396433E-03	9.2
8	.117585E-02	.0008	4.02	3.63742	-.408433E-03	10.2
9	.408605E-02	-.002823	2.62	2.6232	-.218055E-03	2.2
10	.260498E-02	-.001393	2.94	2.95187	-.275735E-03	2
11	.168673E-02	-.000533	3.32	3.38404	-.363321E-03	1.9
12	.137785E-02	-.000253	3.54	3.65561	-.427548E-03	2.6
13	.105212E-02	.000037	4.01	4.12949	-.565269E-03	2.8
14	.104475E-02	.000177	4.28	4.42326	-.679804E-03	3.2
15	.103904E-02	.000327	4.64	4.75503	-.834787E-03	3.8
16	.103812E-02	.000607	5.28	5.34215	-.115373E-02	6.2

TABLE 3.5.22 SOIL NUMBER 22

NO. OF TITRATION POINTS, PH < 5.5 = 13

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	2.415	.000314	.001511	.001038	.00386	2.91	4.1
2	2.415	.000314	.001511	.001038	.00243	3.35	3.5
3	2.415	.000314	.001511	.001038	.00157	3.78	3.9
4	2.415	.000314	.001511	.001038	.00129	4.08	4.9
5	2.415	.000314	.001511	.001038	.001	4.51	6
6	2.415	.000314	.001651	.001038	.001	4.7	7.4
7	2.415	.000314	.001801	.001038	.001	4.84	8.8
8	2.415	.000314	.002081	.001038	.001	5.21	10.7
9	.217	.282E-04	.001046	.933E-04	.00386	2.65	1.5
10	.217	.282E-04	.001046	.933E-04	.00243	2.97	.8
11	.217	.282E-04	.001046	.933E-04	.00157	3.43	.6
12	.217	.282E-04	.001046	.933E-04	.00129	3.78	.5
13	.217	.282E-04	.001046	.933E-04	.001	4.82	.9

OPTIMUM FRACTION THAT IS HA = .07

RMS DEV IN PH = .404482

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.513865E-02	-.002349	2.91	3.06189	-.211447E-03	4.1
2	.291084E-02	-.000919	3.35	3.42553	-.241845E-03	3.5
3	.175106E-02	-.000059	3.78	3.88937	-.332935E-03	3.9
4	.141223E-02	.000221	4.08	4.09026	-.378134E-03	4.9
5	.107882E-02	.000511	4.51	4.31665	-.428819E-03	6
6	.107177E-02	.000651	4.7	4.39422	-.451871E-03	7.4
7	.106621E-02	.000801	4.84	4.47386	-.475618E-03	8.8
8	.105842E-02	.001081	5.21	4.61093	-.519153E-03	10.7
9	.415839E-02	-.002814	2.65	2.62548	-.21396E-03	1.5
10	.268373E-02	-.001384	2.97	2.9666	-.251834E-03	.8
11	.170505E-02	-.000524	3.43	3.42177	-.271255E-03	.6
12	.136481E-02	-.000244	3.78	3.76078	-.312895E-03	.5
13	.103986E-02	.000046	4.82	6.02878	-.106648E-02	.9

TABLE 3.5.23 SOIL NUMBER 23

NO. OF TITRATION POINTS, PH < 5.5 = 15

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	6.006	.000293	.00128	.00295	.00386	2.8	4.9
2	6.006	.000293	.00128	.00295	.00243	3.08	5.1
3	6.006	.000293	.00128	.00295	.00157	3.46	6.8
4	6.006	.000293	.00128	.00295	.00129	3.55	7
5	6.006	.000293	.00128	.00295	.001	3.81	8.6
6	6.006	.000293	.00142	.00295	.001	3.91	9.9
7	6.006	.000293	.00157	.00295	.001	4.03	11.6
8	6.006	.000293	.00185	.00295	.001	4.25	12.8
9	.78	.381E-05	.001036	.000383	.00386	2.65	1.3
10	.78	.381E-05	.001036	.000383	.00243	2.95	.6
11	.78	.381E-05	.001036	.000383	.00157	3.36	1.1
12	.78	.381E-05	.001036	.000383	.00129	3.64	1.3
13	.78	.381E-05	.001036	.000383	.001	4.17	1.5
14	.78	.381E-05	.001176	.000383	.001	4.57	2.3
15	.78	.381E-05	.001326	.000383	.001	5.04	2.8

OPTIMUM FRACTION THAT IS HA = .26

RMS DEV IN PH = .197144

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.005735	-.00258	2.8	3.11174	-.177129E-03	4.9
2	.331124E-02	-.00115	3.08	3.29998	-.188234E-03	5.1
3	.199301E-02	-.00029	3.46	3.48709	-.21237E-03	6.8
4	.160046E-02	-.00001	3.55	3.57294	-.225284E-03	7
5	.121623E-02	.00028	3.81	3.67833	-.241618E-03	8.6
6	.119898E-02	.00042	3.91	3.70601	-.248278E-03	9.9
7	.118251E-02	.00057	4.03	3.73614	-.255763E-03	11.6
8	.116146E-02	.00085	4.25	3.78779	-.267397E-03	12.8
9	.476254E-02	-.002824	2.65	2.73333	-.214352E-03	1.3
10	.298652E-02	-.001394	2.95	3.07977	-.217726E-03	.6
11	.177198E-02	-.000534	3.36	3.43339	-.225845E-03	1.1
12	.137681E-02	-.000254	3.64	3.6663	-.258917E-03	1.3
13	.103706E-02	.000036	4.17	4.28286	-.411909E-03	1.5
14	.103529E-02	.000176	4.57	4.71627	-.539762E-03	2.3
15	.103619E-02	.000326	5.04	5.15498	-.671942E-03	2.8

TABLE 3.5.24 SOIL NUMBER 24

NO. OF TITRATION POINTS, PH < 5.5 = 12

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	2.184	.000167	.001097	.00215	.00386	3.12	3.7
2	2.184	.000167	.001097	.00215	.00243	3.56	1.8
3	2.184	.000167	.001097	.00215	.00157	3.93	1.2
4	2.184	.000167	.001097	.00215	.00129	4.14	1.6
5	2.184	.000167	.001097	.00215	.001	4.6	4.1
6	2.184	.000167	.001176	.00215	.001	4.99	5.3
7	2.184	.000167	.001326	.00215	.001	5.31	7.6
8	.78	.597E-04	.001035	.00077	.00386	2.8	2.5
9	.78	.597E-04	.001035	.00077	.00243	3.2	1.5
10	.78	.597E-04	.001035	.00077	.00157	3.76	.8
11	.78	.597E-04	.001035	.00077	.00129	4.07	.6
12	.78	.597E-04	.001035	.00077	.001	4.88	1.9

OPTIMUM FRACTION THAT IS HA = .26

RMS DEV IN PH = .192989

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.607316E-02	-.002763	3.12	3.35924	-.112355E-03	3.7
2	.347227E-02	-.001333	3.56	3.67934	-.903852E-04	1.8
3	.193434E-02	-.000473	3.93	4.05486	-.107001E-03	1.2
4	.149418E-02	-.000193	4.14	4.30862	-.141205E-03	1.6
5	.11084E-02	.000097	4.6	4.67534	-.200559E-03	4.1
6	.109392E-02	.000176	4.99	4.76479	-.217541E-03	5.3
7	.10769E-02	.000326	5.31	4.92997	-.248029E-03	7.6
8	.554846E-02	-.002825	2.8	2.98031	-.190496E-03	2.5
9	.338931E-02	-.001395	3.2	3.40184	-.143089E-03	1.5
10	.194541E-02	-.000535	3.76	3.84578	-.115752E-03	.8
11	.146975E-02	-.000255	4.07	4.14342	-.128187E-03	.6
12	.10522E-02	.000035	4.88	5.09122	-.28141E-03	1.9

TABLE 3.5.25 SOIL NUMBER 25

NO. OF TITRATION POINTS, PH < 5.5 = 15

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	4.862	.00049	.001159	.000842	.00386	2.72	7.7
2	4.862	.00049	.001159	.000842	.00243	3	8.7
3	4.862	.00049	.001159	.000842	.00157	3.32	11.2
4	4.862	.00049	.001159	.000842	.00129	3.47	13.3
5	4.862	.00049	.001159	.000842	.001	3.7	15.5
6	4.862	.00049	.001299	.000842	.001	3.81	18.8
7	4.862	.00049	.001449	.000842	.001	3.98	20.4
8	4.862	.00049	.001729	.000842	.001	4.15	30.9
9	.78	.786E-04	.001026	.000135	.00386	2.6	1.9
10	.78	.786E-04	.001026	.000135	.00243	2.91	2.7
11	.78	.786E-04	.001026	.000135	.00157	3.3	3
12	.78	.786E-04	.001026	.000135	.00129	3.54	3.3
13	.78	.786E-04	.001026	.000135	.001	4.02	4.7
14	.78	.786E-04	.001166	.000135	.001	4.36	5.1
15	.78	.786E-04	.001316	.000135	.001	4.71	7.8

OPTIMUM FRACTION THAT IS HA = .26

RMS DEV IN PH = .202817

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.494408E-02	-.002701	2.72	2.83421	-.232985E-03	7.7
2	.298441E-02	-.001271	3	3.09025	-.26605E-03	8.7
3	.187413E-02	-.000411	3.32	3.32039	-.302015E-03	11.2
4	.152533E-02	-.000131	3.47	3.41513	-.317714E-03	13.3
5	.117115E-02	.000159	3.7	3.52972	-.336225E-03	15.5
6	.116102E-02	.000299	3.81	3.55838	-.342918E-03	18.8
7	.115077E-02	.000449	3.98	3.58934	-.350626E-03	20.4
8	.113307E-02	.000729	4.15	3.64443	-.365371E-03	30.9
9	.422649E-02	-.002834	2.6	2.63884	-.216089E-03	1.9
10	.26767E-02	-.001404	2.91	2.96545	-.259138E-03	2.7
11	.168565E-02	-.000544	3.3	3.37346	-.323277E-03	3
12	.136822E-02	-.000264	3.54	3.64346	-.382838E-03	3.3
13	.104593E-02	.000026	4.02	4.15511	-.523443E-03	4.7
14	.103871E-02	.000166	4.36	4.50202	-.649742E-03	5.1
15	.103696E-02	.000316	4.71	4.89218	-.812604E-03	7.8

TABLE 3.5.26 SOIL NUMBER 26

NO. OF TITRATION POINTS, PH < 5.5 = 16

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	1.917	.000222	.001075	.000199	.00386	2.69	8.4
2	1.917	.000222	.001075	.000199	.00243	2.97	9.2
3	1.917	.000222	.001075	.000199	.00157	3.33	12
4	1.917	.000222	.001075	.000199	.00129	3.55	13
5	1.917	.000222	.001075	.000199	.001	3.86	14
6	1.917	.000222	.001215	.000199	.001	4.04	16.2
7	1.917	.000222	.001365	.000199	.001	4.23	16.8
8	1.917	.000222	.001645	.000199	.001	4.42	20.3
9	.81	.939E-04	.001032	.000084	.00386	2.59	5.4
10	.81	.939E-04	.001032	.000084	.00243	2.9	5.1
11	.81	.939E-04	.001032	.000084	.00157	3.28	6.2
12	.81	.939E-04	.001032	.000084	.00129	3.53	6.9
13	.81	.939E-04	.001032	.000084	.001	4.03	7.9
14	.81	.939E-04	.001172	.000084	.001	4.32	8.3
15	.81	.939E-04	.001322	.000084	.001	4.67	8.6
16	.81	.939E-04	.001602	.000084	.001	5.23	11.1

OPTIMUM FRACTION THAT IS HA = .27

RMS DEV IN PH = .142331

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.433278E-02	-.002785	2.69	2.67806	-.224308E-03	8.4
2	.271728E-02	-.001355	2.97	2.99864	-.274358E-03	9.2
3	.17221E-02	-.000495	3.33	3.35248	-.339295E-03	12
4	.140195E-02	-.000215	3.55	3.52401	-.374423E-03	13
5	.107494E-02	.000075	3.86	3.74473	-.423127E-03	14
6	.106691E-02	.000215	4.04	3.83819	-.450929E-03	16.2
7	.10597E-02	.000365	4.23	3.93793	-.481985E-03	16.8
8	.105234E-02	.000645	4.42	4.11392	-.540739E-03	20.3
9	.411713E-02	-.002828	2.59	2.62092	-.215597E-03	5.4
10	.261151E-02	-.001398	2.9	2.94218	-.266549E-03	5.1
11	.167246E-02	-.000538	3.28	3.35593	-.343471E-03	6.2
12	.136358E-02	-.000258	3.53	3.62054	-.404013E-03	6.9
13	.104462E-02	.000032	4.03	4.10088	-.537466E-03	7.9
14	.104094E-02	.000172	4.32	4.40985	-.651971E-03	8.3
15	.103729E-02	.000322	4.67	4.77202	-.809883E-03	8.6
16	.103774E-02	.000602	5.23	5.45087	-.115792E-02	11.1

TABLE 3.5.27 SOIL NUMBER 27

NO. OF TITRATION POINTS, PH < 5.5 = 16

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	3.596	.00042	.001152	.000429	.00386	2.63	6.3
2	3.596	.00042	.001152	.000429	.00243	2.91	7.7
3	3.596	.00042	.001152	.000429	.00157	3.23	10.2
4	3.596	.00042	.001152	.000429	.00129	3.39	11.6
5	3.596	.00042	.001152	.000429	.001	3.64	13.3
6	3.596	.00042	.001292	.000429	.001	3.73	14.9
7	3.596	.00042	.001442	.000429	.001	3.9	14.8
8	3.596	.00042	.001722	.000429	.001	4.08	29.9
9	.93	.000109	.001039	.000111	.00386	2.57	2.5
10	.93	.000109	.001039	.000111	.00243	2.87	2.5
11	.93	.000109	.001039	.000111	.00157	3.25	3
12	.93	.000109	.001039	.000111	.00129	3.48	3.2
13	.93	.000109	.001039	.000111	.001	3.89	3.7
14	.93	.000109	.001179	.000111	.001	4.18	4.9
15	.93	.000109	.001329	.000111	.001	4.51	6.6
16	.93	.000109	.001609	.000111	.001	5.14	10.7

OPTIMUM FRACTION THAT IS HA = .31

RMS DEV IN PH = .146781

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.463232E-02	-.002708	2.63	2.75959	-.23434E-03	6.3
2	.285205E-02	-.001278	2.91	3.0549	-.278502E-03	7.7
3	.180455E-02	-.000418	3.23	3.32718	-.324909E-03	10.2
4	.147089E-02	-.000138	3.39	3.44133	-.345179E-03	11.6
5	.112929E-02	.000152	3.64	3.57826	-.369576E-03	13.3
6	.111987E-02	.000292	3.73	3.61987	-.380576E-03	14.9
7	.11102E-02	.000442	3.9	3.66377	-.392512E-03	14.8
8	.109616E-02	.000722	4.08	3.74228	-.414254E-03	29.9
9	.417503E-02	-.002821	2.57	2.63531	-.217276E-03	2.5
10	.264476E-02	-.001391	2.87	2.96088	-.266587E-03	2.5
11	.16839E-02	-.000531	3.25	3.37346	-.341279E-03	3
12	.137104E-02	-.000251	3.48	3.62873	-.398835E-03	3.2
13	.104802E-02	.000039	3.89	4.06415	-.516711E-03	3.7
14	.104243E-02	.000179	4.18	4.31989	-.608302E-03	4.9
15	.103978E-02	.000329	4.51	4.60619	-.723949E-03	6.6
16	.103833E-02	.000609	5.14	5.13738	-.974933E-03	10.7

TABLE 3.5.28 SOIL NUMBER 28

NO. OF TITRATION POINTS, PH < 5.5 = 13

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	4.446	.000247	.001385	.00301	.00386	2.89	4.5
2	4.446	.000247	.001385	.00301	.00243	3.19	4
3	4.446	.000247	.001385	.00301	.00157	3.52	4.8
4	4.446	.000247	.001385	.00301	.00129	3.75	5.6
5	4.446	.000247	.001385	.00301	.001	4.08	6.9
6	4.446	.000247	.001525	.00301	.001	4.29	8.6
7	4.446	.000247	.001675	.00301	.001	4.54	11.6
8	4.446	.000247	.001955	.00301	.001	4.73	15.4
9	.27	.000015	.001023	.000183	.00386	2.62	.5
10	.27	.000015	.001023	.000183	.00243	2.93	.5
11	.27	.000015	.001023	.000183	.00157	3.32	.4
12	.27	.000015	.001023	.000183	.00129	3.62	.4
13	.27	.000015	.001023	.000183	.001	4.55	.8

OPTIMUM FRACTION THAT IS HA = .09

RMS DEV IN PH = .336296

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.577239E-02	-.002475	2.89	3.26418	-.146297E-03	4.5
2	.325874E-02	-.001045	3.19	3.49126	-.155087E-03	4
3	.191015E-02	-.000185	3.52	3.74413	-.189163E-03	4.8
4	.152883E-02	.000095	3.75	3.8648	-.208788E-03	5.6
5	.115669E-02	.000385	4.08	4.00943	-.23434E-03	6.9
6	.113951E-02	.000525	4.29	4.05594	-.244806E-03	8.6
7	.112651E-02	.000675	4.54	4.10362	-.25551E-03	11.6
8	.110709E-02	.000955	4.73	4.18634	-.274391E-03	15.4
9	.439082E-02	-.002837	2.62	2.65985	-.21415E-03	.5
10	.286225E-02	-.001407	2.93	3.02307	-.232708E-03	.5
11	.178926E-02	-.000547	3.32	3.47442	-.216967E-03	.4
12	.139908E-02	-.000267	3.62	3.76776	-.224109E-03	.4
13	.103601E-02	.000023	4.55	5.30787	-.561365E-03	.8

TABLE 3.5.29 SOIL NUMBER 29

NO. OF TITRATION POINTS, PH < 5.5 = 14

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	5.076	.000358	.001234	.00197	.00386	2.83	4.8
2	5.076	.000358	.001234	.00197	.00243	3.12	4.3
3	5.076	.000358	.001234	.00197	.00157	3.49	5.2
4	5.076	.000358	.001234	.00197	.00129	3.68	5.8
5	5.076	.000358	.001234	.00197	.001	3.95	7.2
6	5.076	.000358	.001374	.00197	.001	4.07	9.3
7	5.076	.000358	.001524	.00197	.001	4.23	11.2
8	5.076	.000358	.001804	.00197	.001	4.48	13.9
9	.504	.356E-04	.001023	.000196	.00386	2.61	1.2
10	.504	.356E-04	.001023	.000196	.00243	2.91	.4
11	.504	.356E-04	.001023	.000196	.00157	3.32	.4
12	.504	.356E-04	.001023	.000196	.00129	3.61	.7
13	.504	.356E-04	.001023	.000196	.001	4.34	.7
14	.504	.356E-04	.001163	.000196	.001	5.1	1.7

OPTIMUM FRACTION THAT IS HA = .18

RMS DEV IN PH = .281633

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.548681E-02	-.002626	2.83	3.02682	-.200509E-03	4.8
2	.318263E-02	-.001196	3.12	3.24492	-.217079E-03	4.3
3	.19289E-02	-.000336	3.49	3.46505	-.248895E-03	5.2
4	.155868E-02	-.000056	3.68	3.56086	-.264522E-03	5.8
5	.118671E-02	.000234	3.95	3.67832	-.284143E-03	7.2
6	.117309E-02	.000374	4.07	3.7104	-.291886E-03	9.3
7	.116077E-02	.000524	4.23	3.7443	-.299819E-03	11.2
8	.113772E-02	.000804	4.48	3.80528	-.315828E-03	13.9
9	.439066E-02	-.002837	2.61	2.66384	-.215449E-03	1.2
10	.281325E-02	-.001407	2.91	3.00914	-.2402E-03	.4
11	.172968E-02	-.000547	3.32	3.41389	-.261877E-03	.4
12	.137374E-02	-.000267	3.61	3.6983	-.308587E-03	.7
13	.103925E-02	.000023	4.34	4.52778	-.531478E-03	.7
14	.103662E-02	.000163	5.1	5.38705	-.831244E-03	1.7

TABLE 3.5.30 SOIL NUMBER 30

NO. OF TITRATION POINTS, PH < 5.5 = 15

	[HA]	[M2+]	[M+]	[AL]	[X-]	PHOBS	[DOC]
1	5.76	.000605	.001262	.00142	.00386	2.79	4.5
2	5.76	.000605	.001262	.00142	.00243	3.08	4.5
3	5.76	.000605	.001262	.00142	.00157	3.41	6.2
4	5.76	.000605	.001262	.00142	.00129	3.56	7.1
5	5.76	.000605	.001262	.00142	.001	3.77	9.3
6	5.76	.000605	.001402	.00142	.001	3.88	12.8
7	5.76	.000605	.001552	.00142	.001	3.96	16.8
8	5.76	.000605	.001832	.00142	.001	4.11	23.9
9	.72	.000076	.001033	.000177	.00386	2.61	1.5
10	.72	.000076	.001033	.000177	.00243	2.93	1
11	.72	.000076	.001033	.000177	.00157	3.32	.9
12	.72	.000076	.001033	.000177	.00129	3.58	1.6
13	.72	.000076	.001033	.000177	.001	4.12	1.7
14	.72	.000076	.001173	.000177	.001	4.56	3.1
15	.72	.000076	.001323	.000177	.001	5.06	4.3

OPTIMUM FRACTION THAT IS HA = .24

RMS DEV IN PH = .184123

	IONIC STR	[M+]-[X-]	PHOBS	PHCALC	HUMIC CHARGE	[DOC]
1	.519889E-02	-.002598	2.79	2.95111	-.229051E-03	4.5
2	.31002E-02	-.001168	3.08	3.19106	-.258023E-03	4.5
3	.19406E-02	-.000308	3.41	3.40716	-.291955E-03	6.2
4	.157975E-02	-.000028	3.56	3.49608	-.306018E-03	7.1
5	.121428E-02	.000262	3.77	3.60121	-.321729E-03	9.3
6	.119996E-02	.000402	3.88	3.62581	-.328359E-03	12.8
7	.118945E-02	.000552	3.96	3.65065	-.33412E-03	16.8
8	.116898E-02	.000832	4.11	3.69675	-.346508E-03	23.9
9	.43388E-02	-.002827	2.61	2.66098	-.217358E-03	1.5
10	.275276E-02	-.001397	2.93	2.99729	-.251816E-03	1
11	.170332E-02	-.000537	3.32	3.41374	-.305393E-03	.9
12	.137478E-02	-.000257	3.58	3.70188	-.366866E-03	1.6
13	.104394E-02	.000033	4.12	4.29818	-.532293E-03	1.7
14	.103855E-02	.000173	4.56	4.71627	-.683923E-03	3.1
15	.103731E-02	.000323	5.06	5.20008	-.884263E-03	4.3

Table 3.6 Optimised values of α, the parameter characterizing the release of DOC from organic soils. (cf. equation 3.2).

soil	α	standard error of α	rmsd in $[DOC_{SN}]$	range of $[DOC_{SN}]_{obs}$	r
1	139	8	2.8	3.4 - 38.7	.97
2	178	16	7.1	9.4 - 55.0	.89
3	234	13	2.9	9.4 - 32.3	.95
4	179	7	6.6	16.4 - 75.2	.91
5	143	8	10.1	12.5 - 84.7	.85
6	155	7	4.5	8.0 - 50.4	.94
7	47	4	5.6	2.1 - 44.0	.88
8	43	5	12.4	1.8 - 68.5	.81
9	56	6	2.7	0.6 - 20.4	.87
10	61	11	7.3	1.8 - 41.4	.66
11	23	4	8.1	0.5 - 40.6	.75
12	67	6	13.0	2.6 - 78.1	.84
13	42	5	6.7	0.9 - 36.5	.83
14	21	3	6.9	1.1 - 35.0	.74
15	20	1	0.6	0.8 - 5.6	.95
16	37	4	3.8	0.8 - 25.8	.77
17	37	3	3.0	0.8 - 23.0	.89
18	22	2	2.4	0.7 - 14.1	.77
19	46	4	3.6	1.3 - 27.1	.88
20	33	3	1.9	0.5 - 11.5	.78
21	21	7	2.0	1.9 - 10.2	.60
22	25	1	1.1	0.5 - 10.7	.95
23	23	1	1.3	0.6 - 12.8	.95
24	45	4	1.0	0.6 - 7.6	.88
25	44	4	4.1	1.9 - 30.9	.87
26	108	4	1.8	5.1 - 20.3	.91
27	60	6	4.0	2.5 - 29.9	.83
28	24	2	2.0	0.4 - 15.4	.89
29	25	2	2.0	0.4 - 13.9	.79
30	23	3	4.1	0.9 - 23.9	.62

rmsd = root-mean-square deviation

Table 3.7 Optimised values of β, the parameter characterizing the release of 'colour' from organic soils (cf. equation 3.4).

soil	β	standard error of β	rmsd in A340nm	range of A340nm	r
5	36	5	0.35	0.22 - 2.28	0.83
10	29	6	0.12	0.02 - 0.77	0.81
15	102	28	0.06	0.04 - 0.64	0.50
20	118	9	0.13	0.03 - 1.14	0.91
25	132	18	0.31	0.04 - 1.90	0.81
30	125	20	0.22	0.05 - 1.25	0.78

Table 3.8 Summary of fitting $[DOC_{SN}]$ and Z with equation (3.5). See also Figs. 3.1-3.6.

soil	$10^3\alpha'$ (S.E.)	$10^6\sigma$ (S.E.)	rmsd in $[DOC_{SN}]$	range of $[DOC_{SN}]$	r
5	20.8 (1.5)	3.81 (0.27)	3.6	24.4 - 84.7	0.98
10	2.7 (0.7)	10.05 (0.89)	2.4	3.6 - 41.4	0.98
16	4.1 (0.4)	5.39 (0.33)	1.0	3.8 - 25.8	0.99
20	2.9 (0.7)	4.71 (0.56)	0.9	0.5 - 11.5	0.97
25	2.5 (0.4)	12.90 (1.15)	1.6	4.5 - 23.9	0.98
30	0.28 (0.13)	27.41 (3.41)	1.7	7.7 - 30.9	0.97

rmsd = root-mean-square deviation

Table 3.9 Summary of fitting A340nm and Z with equation (3.6). See also Figs. 3.1-3.6.

soil	β' (S.E.)	rmsd in A340 nm	range of A340nm	r
5	24.8 (1.9)	0.148	0.224 - 2.278	0.97
10	19.1 (2.9)	0.075	0.040 - 0.770	0.95
16	41.6 (2.0)	0.041	0.044 - 0.910	0.99
20	120.6 (2.9)	0.032	0.042 - 1.142	1.00
25	121.3 (6.2)	0.118	0.090 - 1.900	0.98
30	112.9 (3.6)	0.046	0.046 - 1.254	0.99

rmsd = root-mean-square deviation

Figs 3.1 - 3.6

In the following figures the data points are observed values, the lines are calculated using CHAOS in combination with equations (3.5) and (3.6). Only data for the more concentrated soil suspensions were considered (cf. Tables 3.5.5, 3.5.10, 3.5.16, 3.5.20, 3.5.25, 3.5.30).

Fig. 3.1

Observed and Predicted Values for Soil 5

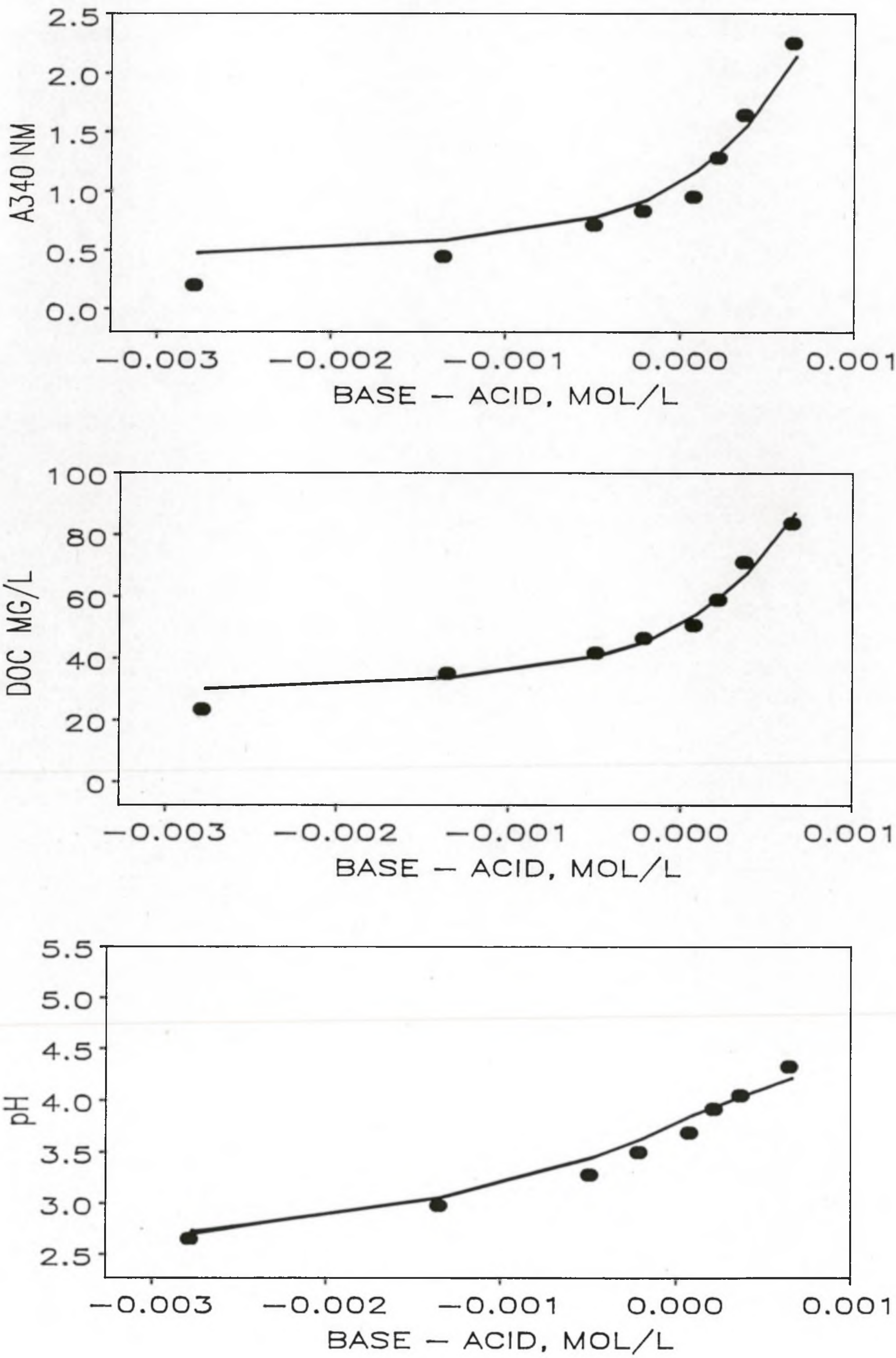
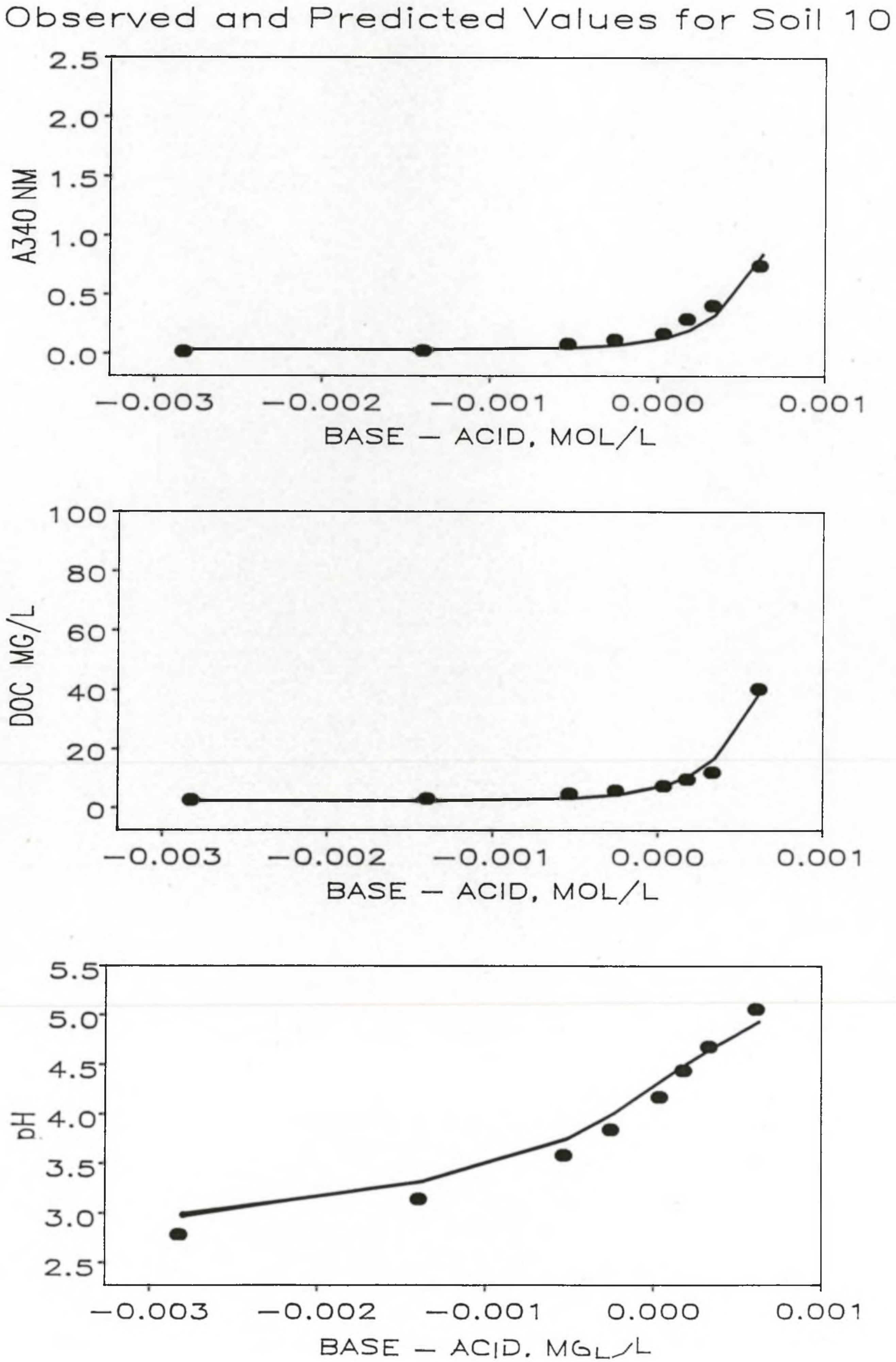


Fig. 3.2



Observed and Predicted Values for Soil 10
A340 NM
2.5
2.0
1.5
1.0
0.5
0.0
−0.003
−0.002
−0.001
0.000
0.001
BASE — ACID, MOL/L
DOC MG/L
100
80
60
40
20
0
−0.003
−0.002
−0.001
0.000
0.001
BASE — ACID, MOL/L
pH
5.5
5.0
4.5
4.0
3.5
3.0
2.5
−0.003
−0.002
−0.001
0.000
0.001
BASE — ACID, MOL/L

Fig. 3.3

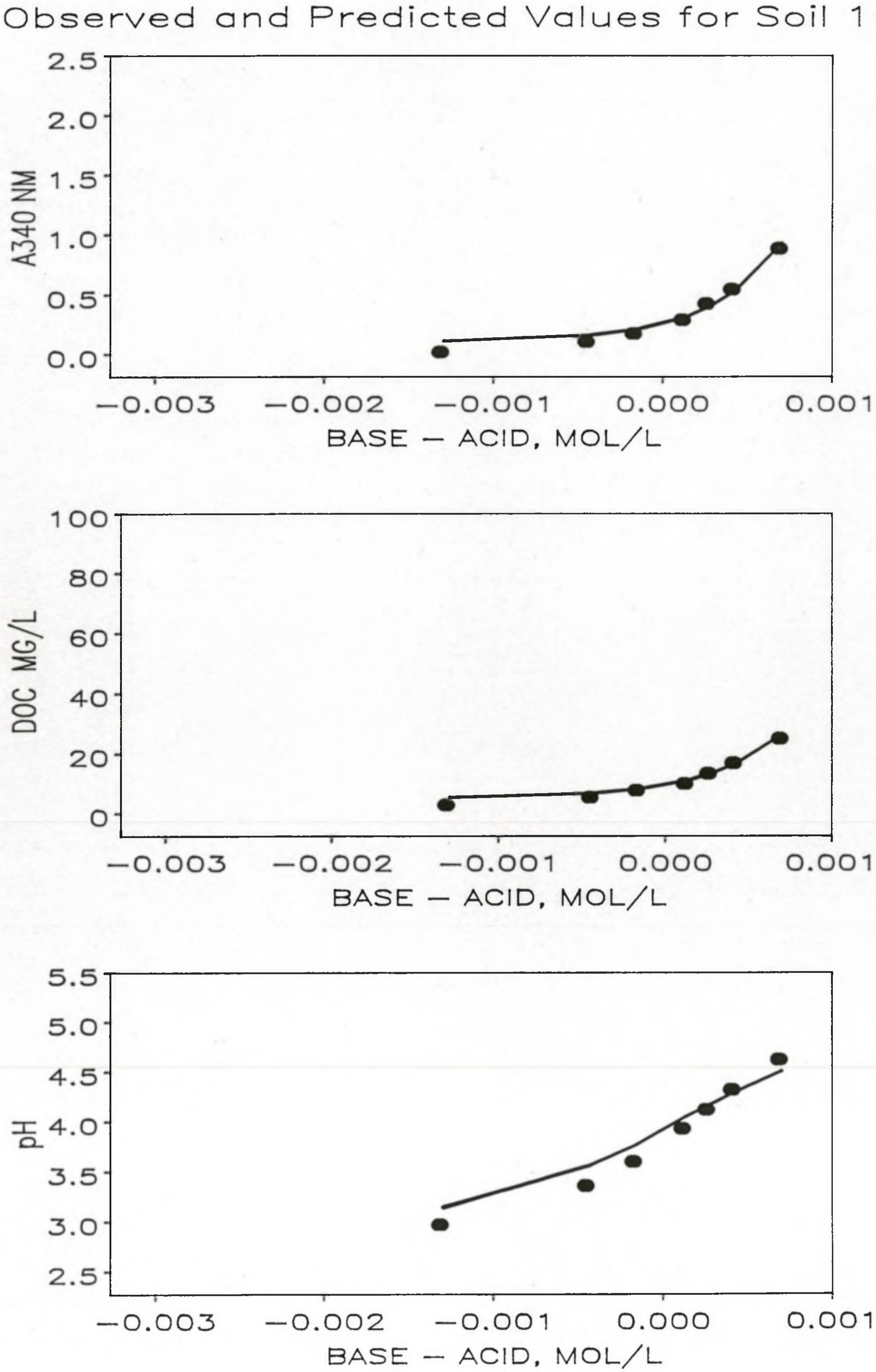

Observed and Predicted Values for Soil 16
A340 NM
2.5
2.0
1.5
1.0
0.5
0.0
−0.003
−0.002
−0.001
0.000
0.001
BASE − ACID, MOL/L
DOC MG/L
100
80
60
40
20
0
−0.003
−0.002
−0.001
0.000
0.001
BASE − ACID, MOL/L
pH
5.5
5.0
4.5
4.0
3.5
3.0
2.5
−0.003
−0.002
−0.001
0.000
0.001
BASE − ACID, MOL/L

Fig. 3.4

Observed and Predicted Values for Soil 20

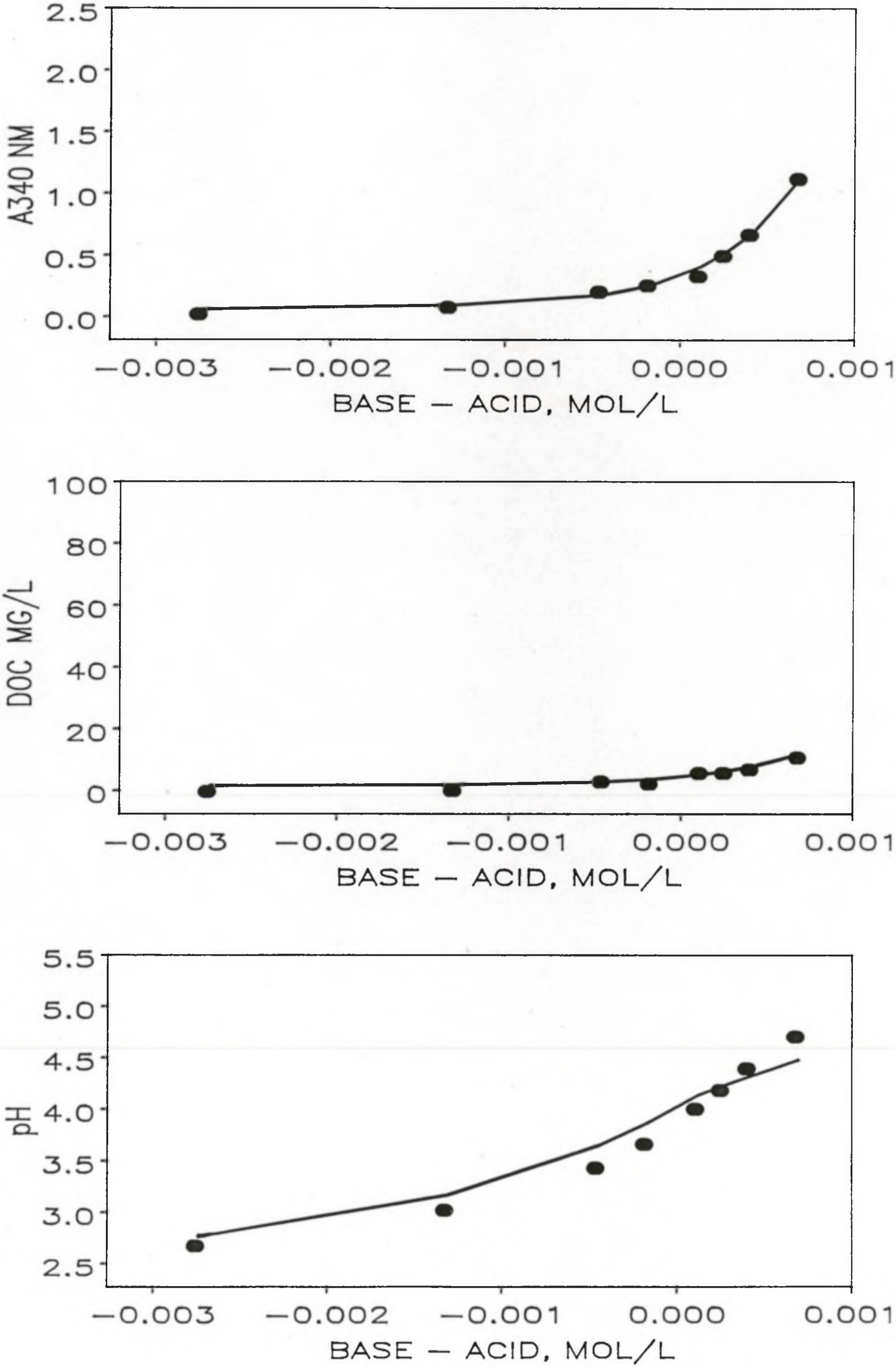


Fig. 3.5

Observed and Predicted Values for Soil 25

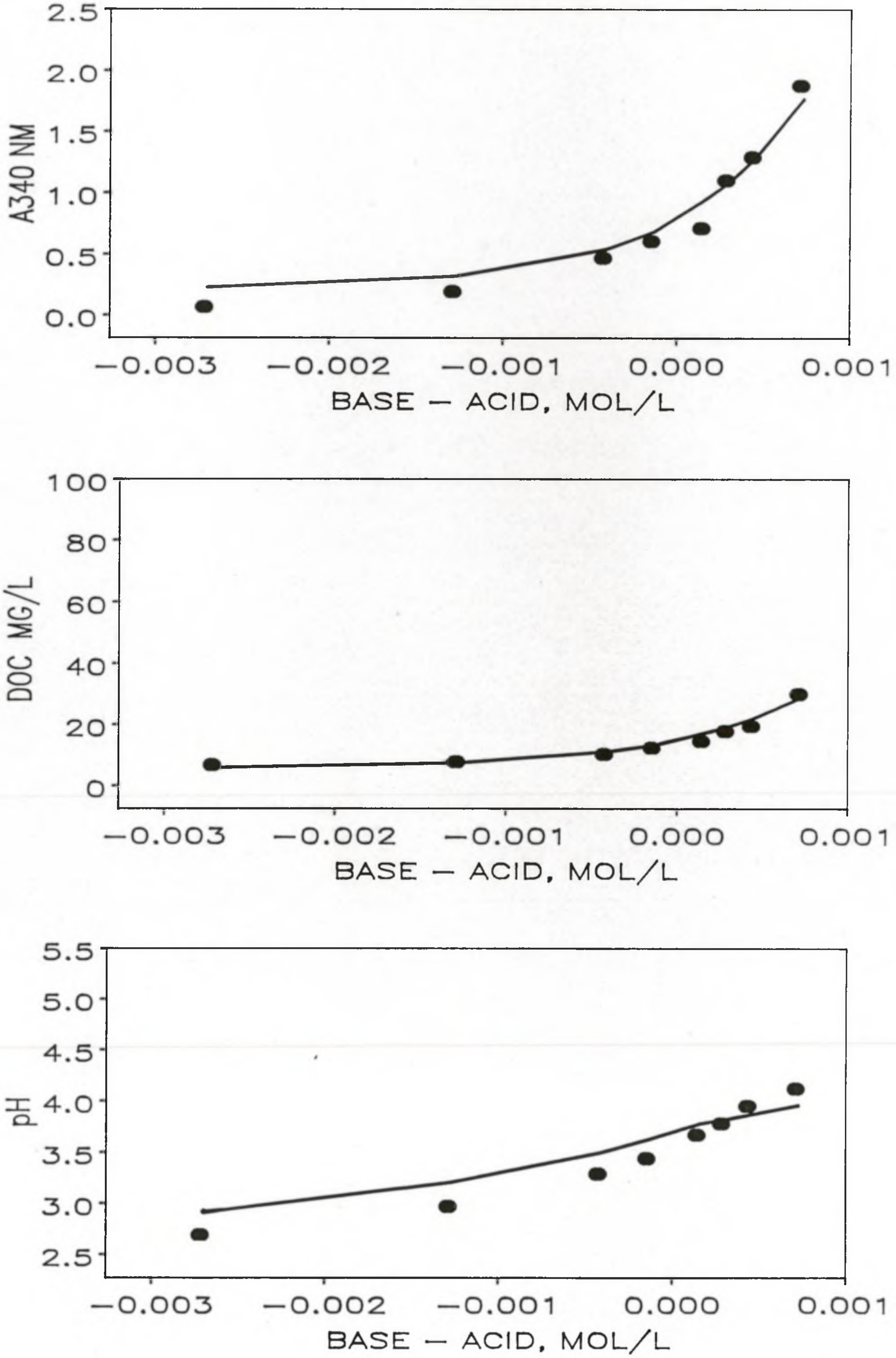
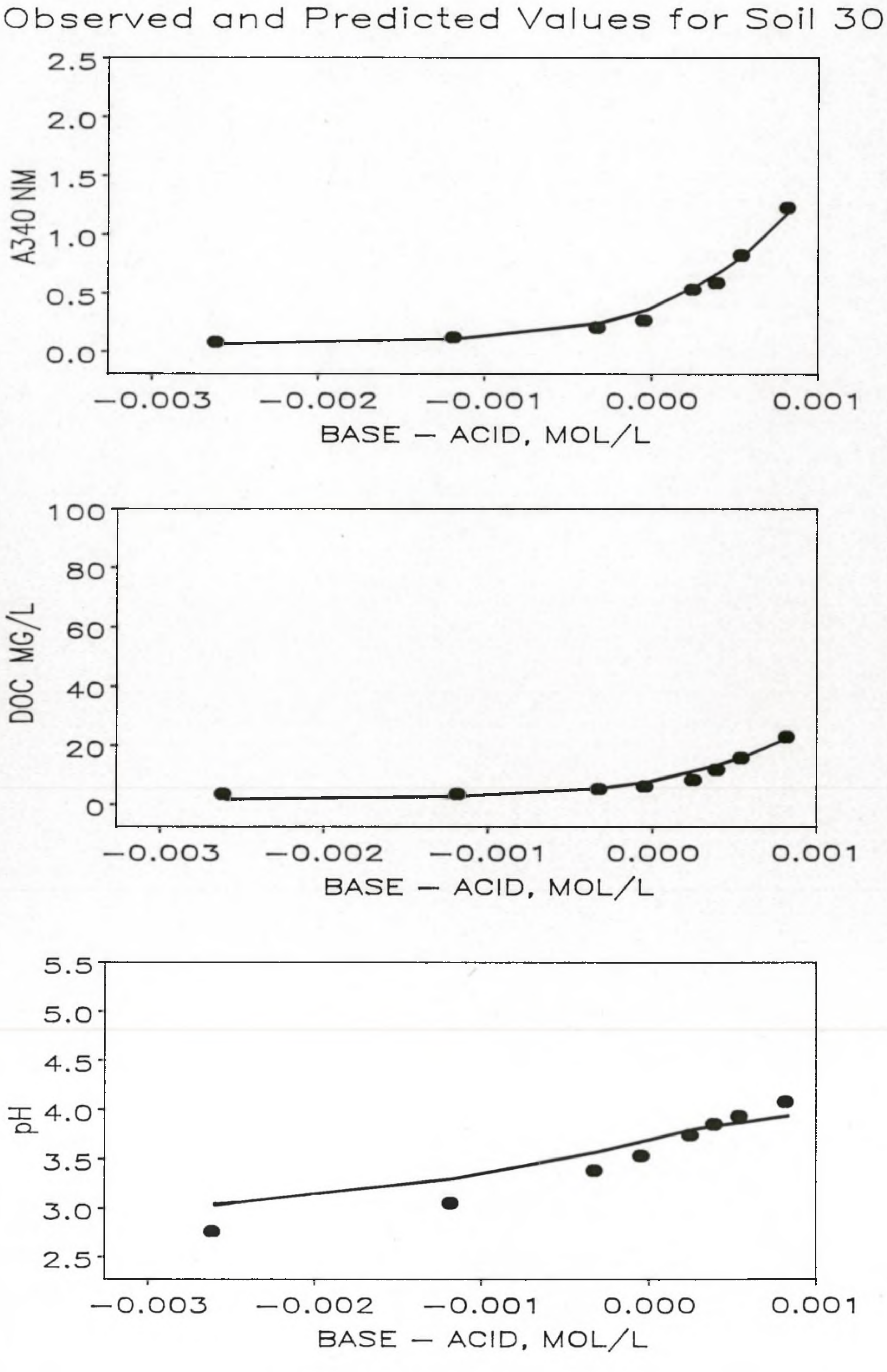


Fig. 3.6


Observed and Predicted Values for Soil 30
A340 NM
2.5
2.0
1.5
1.0
0.5
0.0
−0.003
−0.002
−0.001
0.000
0.001
BASE − ACID, MOL/L
DOC MG/L
100
80
60
40
20
0
−0.003
−0.002
−0.001
0.000
0.001
BASE − ACID, MOL/L
pH
5.5
5.0
4.5
4.0
3.5
3.0
2.5
−0.003
−0.002
−0.001
0.000
0.001
BASE − ACID, MOL/L