DUQUESNE LIGHT COMPANY
Nuclear Group
Nuclear Services Unit

SOIL CHEMISTRY (ETS Reference 3.1.3.10)

Objective

Conductivity and pH of soils are studied as part of a program to monitor the impact of cooling tower drift on the terrestrial ecosystem.

Methods

1. pH

Soil samples were collected April, 1984 and analyzed for pH and soluble concentration.

Statistical analyses of pH and soluble salt concentrations indicate that a minimum of ten (10) samples are required from each soil series to detect statistically significant changes at the 0.05 level of probability. Fifteen (15) samples are obtained per sampling point and the arithmetic mean and standard deviation are calculated and compared to prior sampling periods.

Ten (10) permanent sampling locations (See Figure 7-2 representing points of projected low and high salt deposition from cooling tower drift have been established. Using a compass and soil test auger, soil samples are collected in summer and winter at the ten (10) locations.

Three (3) equidistant radii (e.g., 0°, 120°, 240° azimuth) are established about the pin marking each permanent sampling point.

Samples are collected to a depth of six inches at 2, 4, 6, 8, and 10 feet along each radius for a total of fifteen (15) samples per permanent sampling point.

Samples are prepared by transferring each soil sample to a plate, and distributing the sample uniformly over the plate. The sample is dried overnight at 10-15°C above room temperature.

Using the hand grinder, the soil samples are crushed until a major portion will pass a 10-mesh (U.S. No. 10) sieve.

The crushed soil samples are then placed in jars and mixed for five (5) minutes on a mixing wheel. About 20 grams per sample are prepared for chemical analysis. A pH meter and electrodes and thermometer are used to determine the pH.

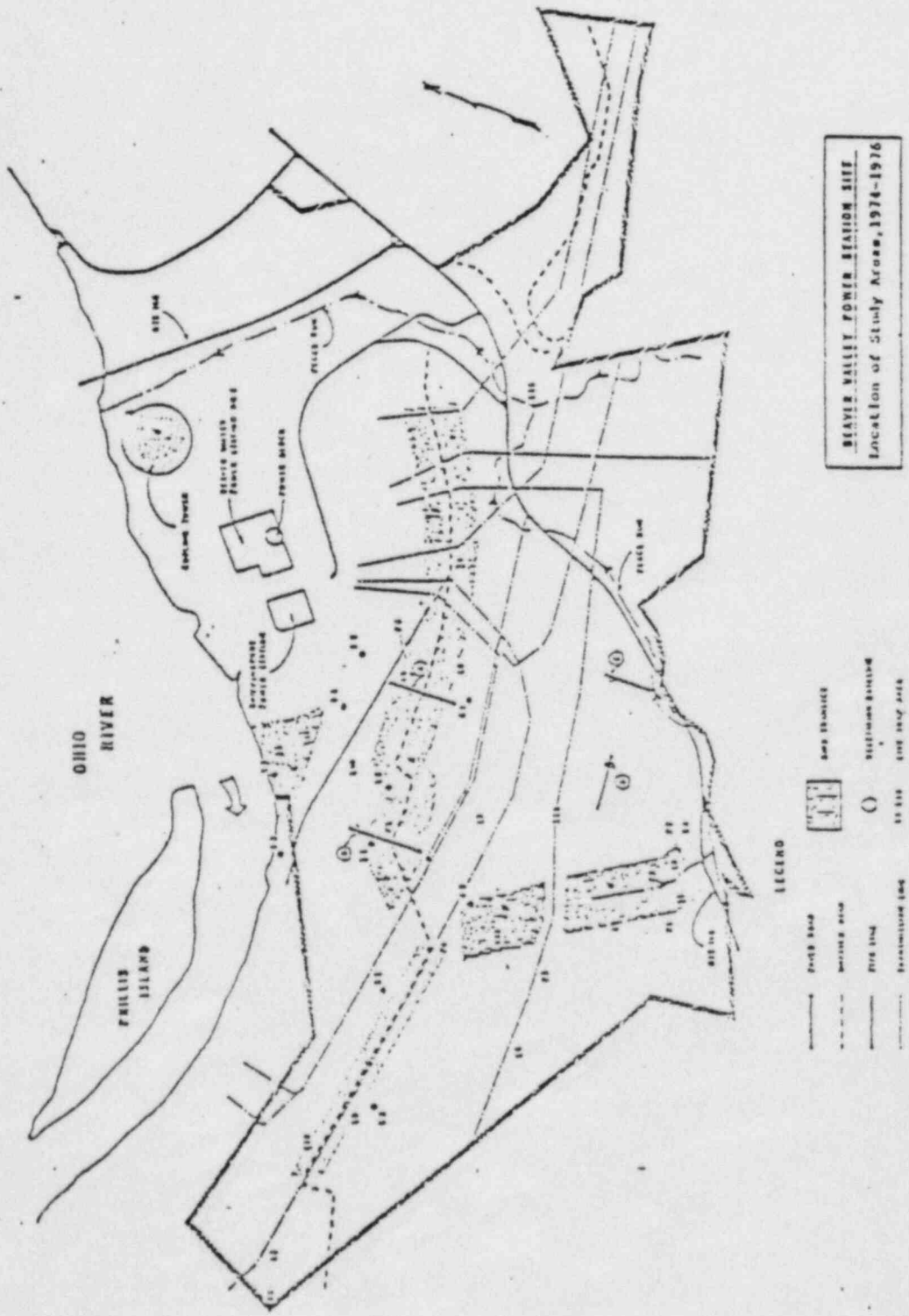
OHIO
RIVER
PHILLIS
ISLAND
LEGEND
BEAVER VALLEY POWER STATION SITE
Location of Study Areas, 1974-1976

FIGURE 7-2

SOIL CHEMISTRY (ETS Reference 3.1.3.10) (continued)

Methods (continued)

2. Specific Conductance (Soluble Salt Concentration)

Specific conductance is determined by using a conductivity bridge, a dip-type conductivity cell, and a thermometer.

When the conductivity value has been determined, the electrical conductivity is converted to approximate salt concentrations using the following formula:

Salt concentration (mg per liter) equals 640 x Electrical conductivity (millimhos per cm)

The arithmetic mean and standard deviation of pH and conductivity values are calculated for each of the ten (10) permanent sampling points.

A one way analysis of variance is used to compare the values of this sampling period with values obtained for previous sampling period.

Results

April 1984:

Soil pH and conductivity results are based on nine (9) sampling points, not ten (10), because sample point 1-1 was apparently obliterated during construction work at the BVPS Unit 2 Emergency Overflow Structure. The mean pH of the soils from the nine (9) sampling points stipulated in this program did vary (See Table VII-2) with the highest mean pH at sampling point 1-2 (6.22) and the lowest at sampling point 4-2 (4.29). Of the 135 soil samples analyzed, the range of pH values was from 4.01 to 6.73. The mean pH of all the samples was 4.69. Sampling points 2-1 and 2-2 exceeded the investigation levels established by the original seventy-five baseline samples by 0.18 and 0.06 pH units, respectively.

Specific Conductance values varied from a low mean value of 0.100 mmhos/cm at sampling point 2-2 to a high mean value of 0.133 mmho/cm at sampling points 1-2 and 3-2 (See Table VII-3). The lowest conductivity value of the 135 samples was at sampling point 2-2. The highest individual conductivity value was 0.228 recorded at sampling point 3-2. Average of the mean specific conductance levels was 0.120 mmhos/cm.

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Table VII-2
Summary of pH Levels
4/20/84

| Sample Point | Mean pH | Standard Deviation | Standard Error | Range | | Investigation[2] Levels | |
|---|---|---|---|---|---|---|---|
| | | | | High | Low | High | Low |
| 1-2 | 6.22 | 0.30 | 0.071 | 6.73 | 5.97 | 7.4 | 6.0 |
| 2-1 | 4.88 | 0.28 | 0.066 | 5.21 | 4.58 | 4.7 | 3.9 |
| 2-2 | 4.56 | 0.18 | 0.029 | 4.91 | 4.36 | 4.5 | 3.6 |
| 3-1 | 4.33 | 0.22 | 0.033 | 4.82 | 4.01 | 4.8 | 4.0 |
| 3-2 | 4.53 | 0.24 | 0.037 | 4.87 | 4.09 | 4.6 | 3.7 |
| 4-1 | 4.37 | 0.14 | 0.022 | 4.72 | 4.11 | 4.5 | 3.7 |
| 4-2 | 4.29 | 0.12 | 0.019 | 4.49 | 3.98 | 4.7 | 3.8 |
| 5-1 | 4.60 | 0.12 | 0.019 | 4.92 | 4.32 | 4.9 | 4.0 |
| 5-2 | 4.41 | 0.14 | 0.021 | 4.68 | 4.30 | 4.4 | 3.6 |

1. Mean values are the arithmetic averages of the fifteen soil samples obtained per sampling point. Sampling points 2-1 and 2-2 exceeded the investigation levels.

2. The investigation levels are 10% of the mean pH from the first 75 samples (15 samples taken on 5 dates 12/74, 6/75, 2/76, 6/76, and 12/76) obtained at each point.

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TABLE VII-3
Summary of Specific Conductance Values

4/20/84

| Sample Point | Mean of Specific Conductance Levels[1] | Standard Deviation | Standard Error | Range | | Investigation[2] Level |
|---|---|---|---|---|---|---|
| | | | | High | Low | |
| 1-2 | 0.133 | 0.030 | 0.008 | 0.183 | 0.109 | 0.66 |
| 2-1 | 0.107 | 0.028 | 0.006 | 0.148 | 0.073 | 0.48 |
| 2-2 | 0.100 | 0.029 | 0.006 | 0.151 | 0.069 | 0.42 |
| 3-1 | 0.121 | 0.034 | 0.010 | 0.218 | 0.088 | 0.40 |
| 3-2 | 0.133 | 0.026 | 0.008 | 0.228 | 0.106 | 0.40 |
| 4-1 | 0.111 | 0.017 | 0.006 | 0.177 | 0.081 | 0.38 |
| 4-2 | 0.126 | 0.016 | 0.006 | 0.183 | 0.102 | 0.42 |
| 5-1 | 0.121 | 0.014 | 0.005 | 0.165 | 0.107 | 0.38 |
| 5-2 | 0.132 | 0.032 | 0.008 | 0.193 | 0.095 | 0.38 |

1. Mean values are the arithmetic averages of the fifteen soil samples obtained per sampling point. None of the nine sampling points exceeded the investigation levels.

2. The investigation levels are based on a 100% increase in the mean specific conductance values obtained for the first 75 samples per point. (15 samples taken on 5 dates 12/74, 6/75, 2/76, 6/76, and 12/76).

SOIL CHEMISTRY (ETS Reference 3.1.3.10) (continued)

Discussion of Results

April 1984:

A. pH

A one-way analysis of variance was used to compare the pH of April 1984 samples with the pH of June 1983 and December 1978 samples (See Table VII-4). Sampling points 2-1, 2-2, 3-1, 3-2, and 5-2 were significantly different at the 5% level for June 1983. Sampling points 2-2, 3-1, 3-2, and 5-2 were significantly different at the 1% level for December 1978.

The mean pH for all samples from June 1983 was lower than those reported for December 1974, June 1975, February 1976, June 1978, December 1978, and June 1983, but higher than June 1976 and December 1976 values (Figure 7-3). The greatest change in mean pH between successive sampling periods occurred between December 1976 and June 1978. The mean pH of all points for April 1984 decreased by 0.14 units. At the individual sampling locations, only sampling points 1-2 and 3-1 had a lower mean pH value than the average of the seventy-five baseline samples. Sample point 1-2 exhibited the greatest change from baseline samples with a decrease of 0.6 pH units. Since the pH values for sampling points 2-1 and 2-2 exceeded the investigation levels, the points were resampled in June to verify the slight pH level increase. Analysis showed sample point 2-2 to be within the investigation levels while 2-1 still exceeded the investigation levels by 0.09 pH units. Sites 2-1 and 2-2, both located on a steep hillside, could be varying because of the erosion of soil from above onto the site.

B. Conductivity

A comparison of the conductivity values between samples obtained during April 1984 with those obtained during December 1978 indicates significant differences at the 1% level occurred at four (4) locations (See Table VII-4). No significant differences between April 1984 and June 1983 were reported for all ten sample points.

The mean conductivity value for all 135 samples from April 1984 was lower than any value previously recorded (Figure 7-4). Between successive sampling periods, the greatest change occurred between December 1976 and June 1978. The mean conductivity decreased from 0.125 mmhos/cm to 0.120 mmhos/cm - a difference of 0.005 mmhos/cm. At the nine (9) individual sampling locations, all sampling points had lower mean conductance values than the average of the previous baseline seventy-five samples (Figure 7-6). The greatest change at an individual sampling location, between the April 1984 samples and the original 75 samples, occurred at sampling point 1-2 - a difference of 0.19 mmhos/cm. The variance in the conductivity

TABLE VII-4

Comparison of pH and Specific Conductance Values
April 1984 vs June 1983 and December 1978

| Sampling Points | Soil Type | Expected Salt[a] Deposition | pH 4/84 Mean | pH 6/83 Mean | pH 12/78 Mean | pH Significantly[b] Different 6/83 | pH Significantly[b] Different 12/78 | Specific Conductance 4/84 Mean | Specific Conductance 6/83 Mean | Specific Conductance 12/78 Mean | Specific Conductance Significantly[b] Different 6/83 | Specific Conductance Significantly[b] Different 12/78 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-2 | Pope silt loam | High | 6.22 | 6.44 | 6.37 | * | -- | 0.133 | 0.14 | 0.170 | -- | -- |
| 2-1 | Wharton silt loam | Low | 4.88 | 4.58 | 4.74 | ** | -- | 0.107 | 0.12 | 0.139 | -- | ** |
| 2-2 | Wharton silt loam | High | 4.56 | 4.22 | 4.34 | ** | ** | 0.100 | 0.11 | 0.146 | -- | ** |
| 3-1 | Gilpin-Weikert shaly silt loam | High | 4.33 | 4.69 | 4.56 | ** | ** | 0.121 | 0.12 | 0.114 | -- | -- |
| 3-2 | Gilpin-Weikert shaly silt | Low | 4.53 | 4.11 | 4.28 | ** | ** | 0.133 | 0.14 | 0.107 | -- | ** |
| 4-1 | Gilpin channery silt loam | Low | 4.37 | 4.36 | 4.41 | -- | -- | 0.111 | 0.11 | 0.116 | -- | -- |
| 4-2 | Gilpin channery silt loam | High | 4.29 | 4.31 | 4.34 | -- | -- | 0.126 | 0.14 | 0.147 | -- | -- |
| 5-1 | Wellston silt loam | Low | 4.60 | 4.55 | 4.50 | -- | -- | 0.121 | 0.13 | 0.128 | -- | -- |
| 5-2 | Wellston silt | High | 4.41 | 4.26 | 4.23 | ** | ** | 0.132 | 0.14 | 0.172 | -- | ** |

a--Expected low and high deposition levels are relative to each soil type.
b--Signifcantly different: * at the 5% level ** at the 1% level.

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Beaver Valley Power Station Soil Survey Mean and 95 Percent Condidence Limits of Soil pH for all Samples Obtained on each of nine dates.

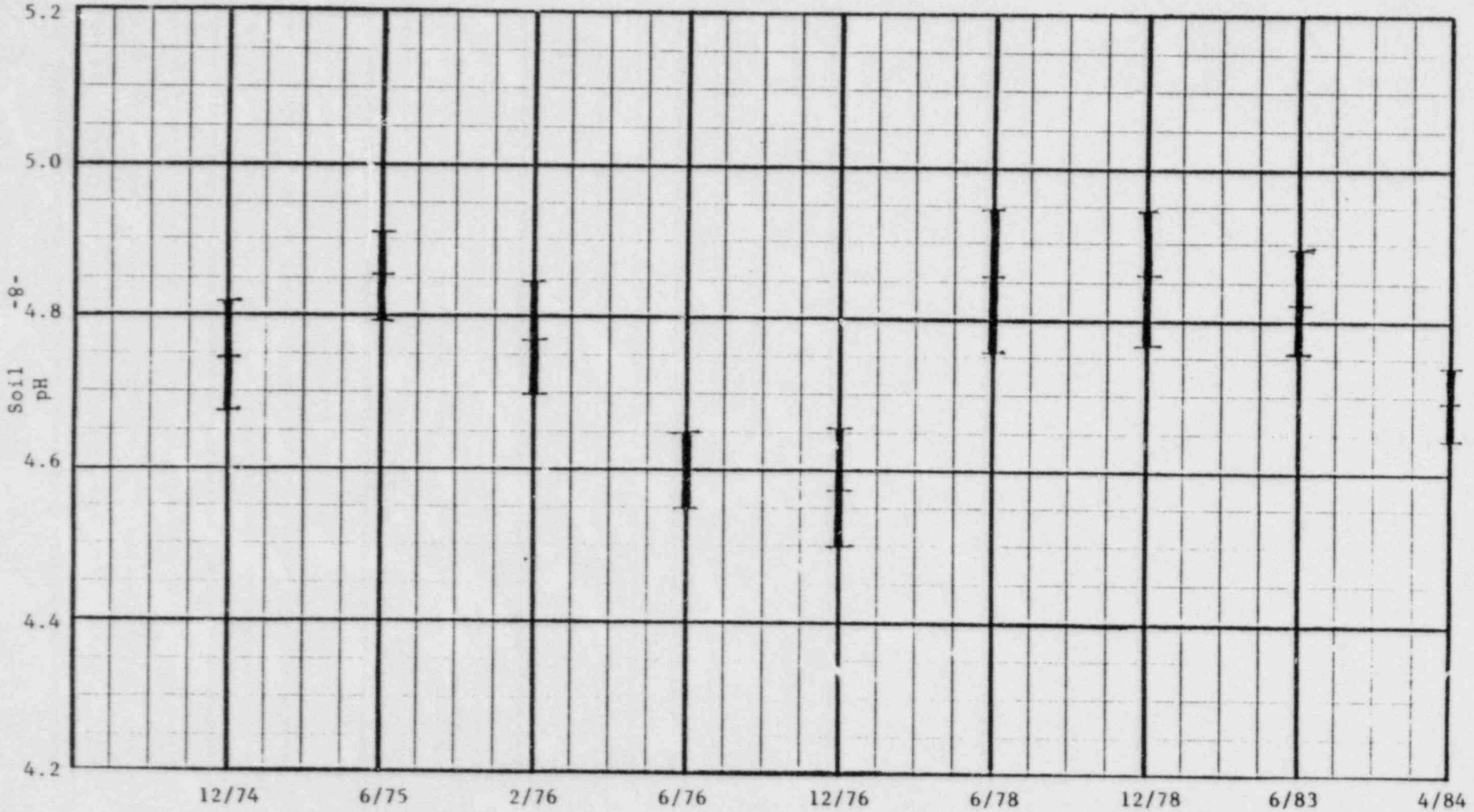


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FIGURE 7-3

Beaver Valley Power Station Soil Survey Mean and 95 Percent Confidence Limits of Soil Conductivity for all Samples Obtained on Each of Nine Dates.

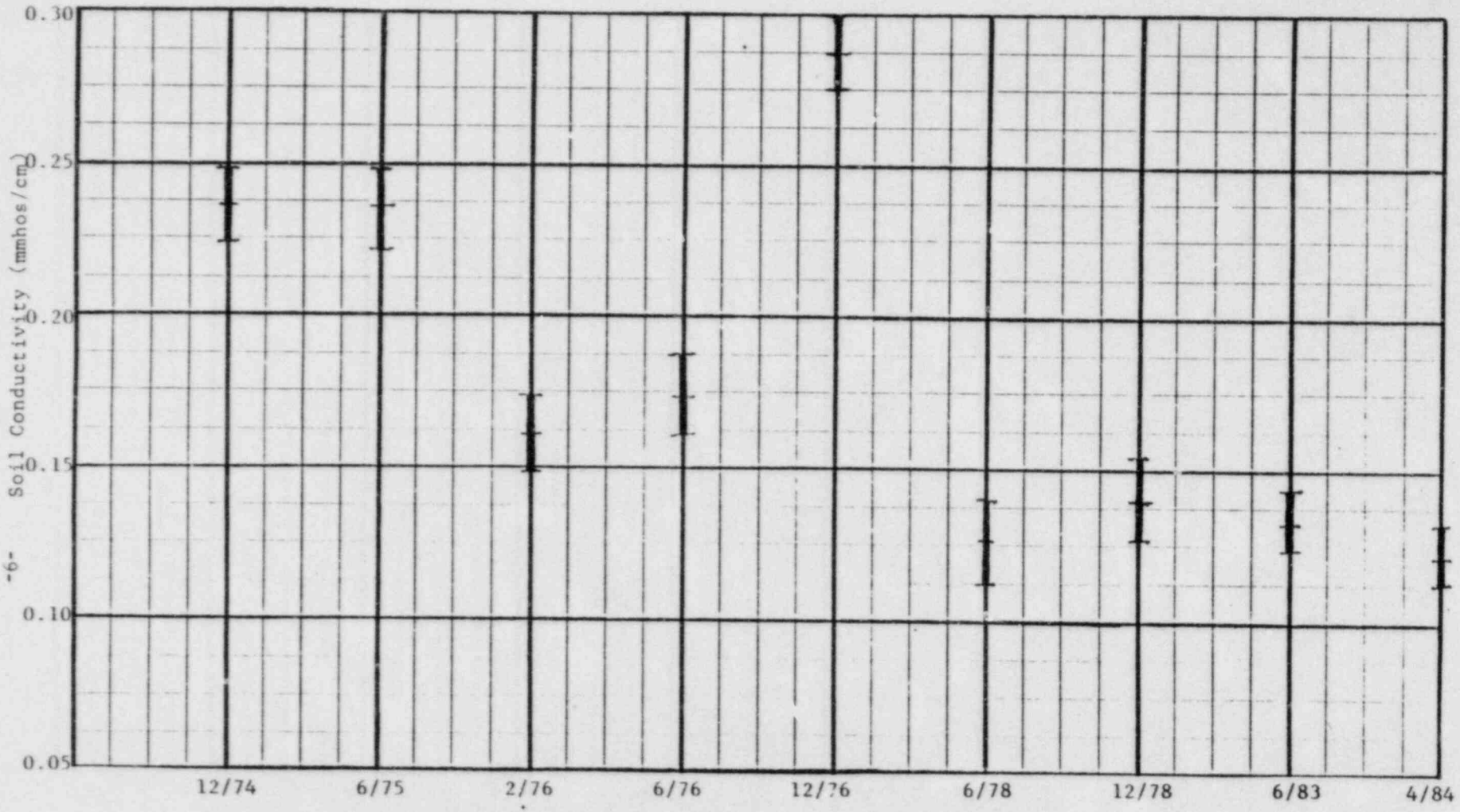


FIGURE 7-4



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Mean and 95 Percent Confidence Limits of Soil pH at each Sampling Location for April 1984. (Data for each sampling location based on 15 samples).

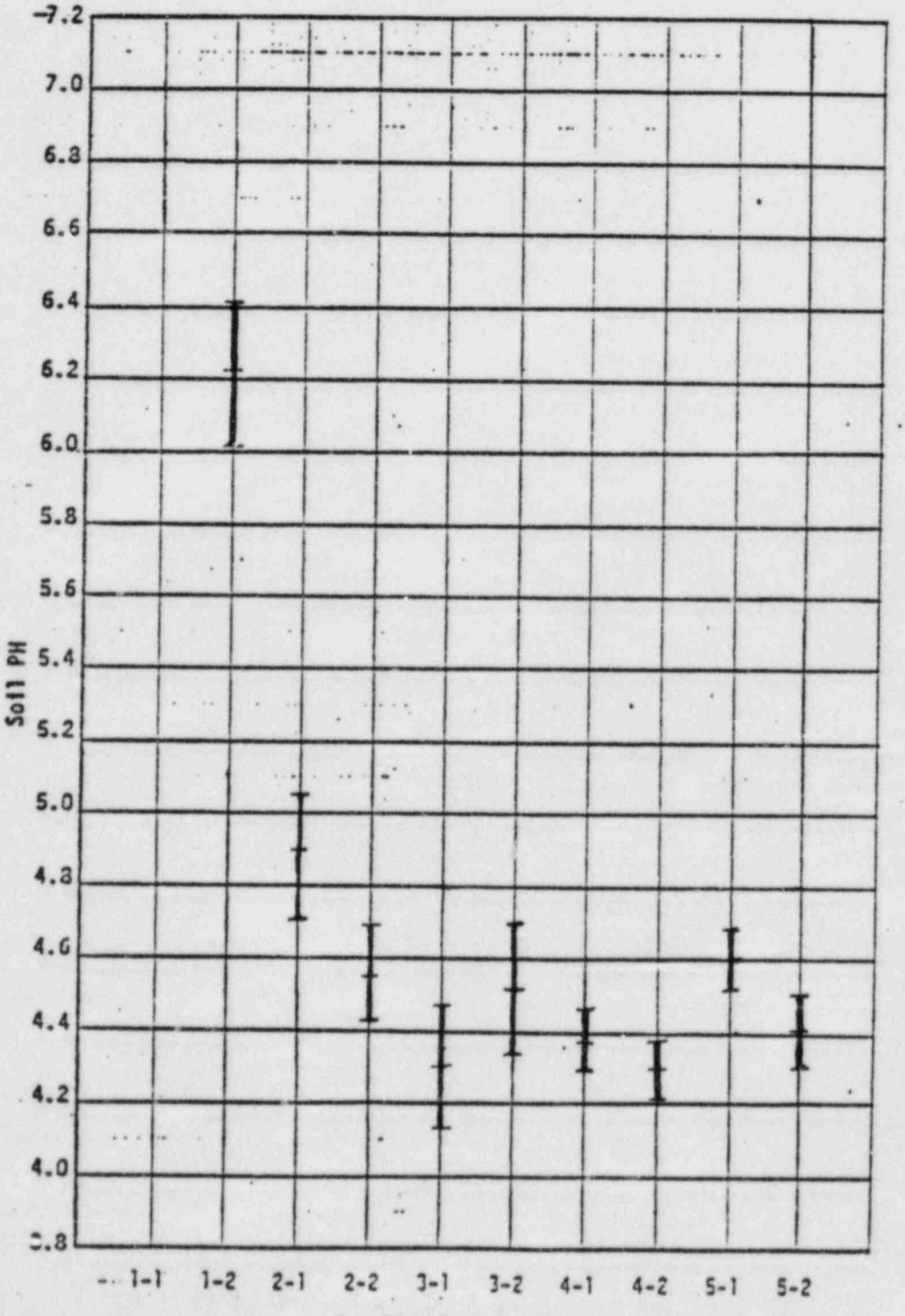


FIGURE 7-5

Mean and 95 Percent Confidence Limits of Soil Conductivity at each Sampling Location for April 1984. (Data for each sampling location based on 15 samples).

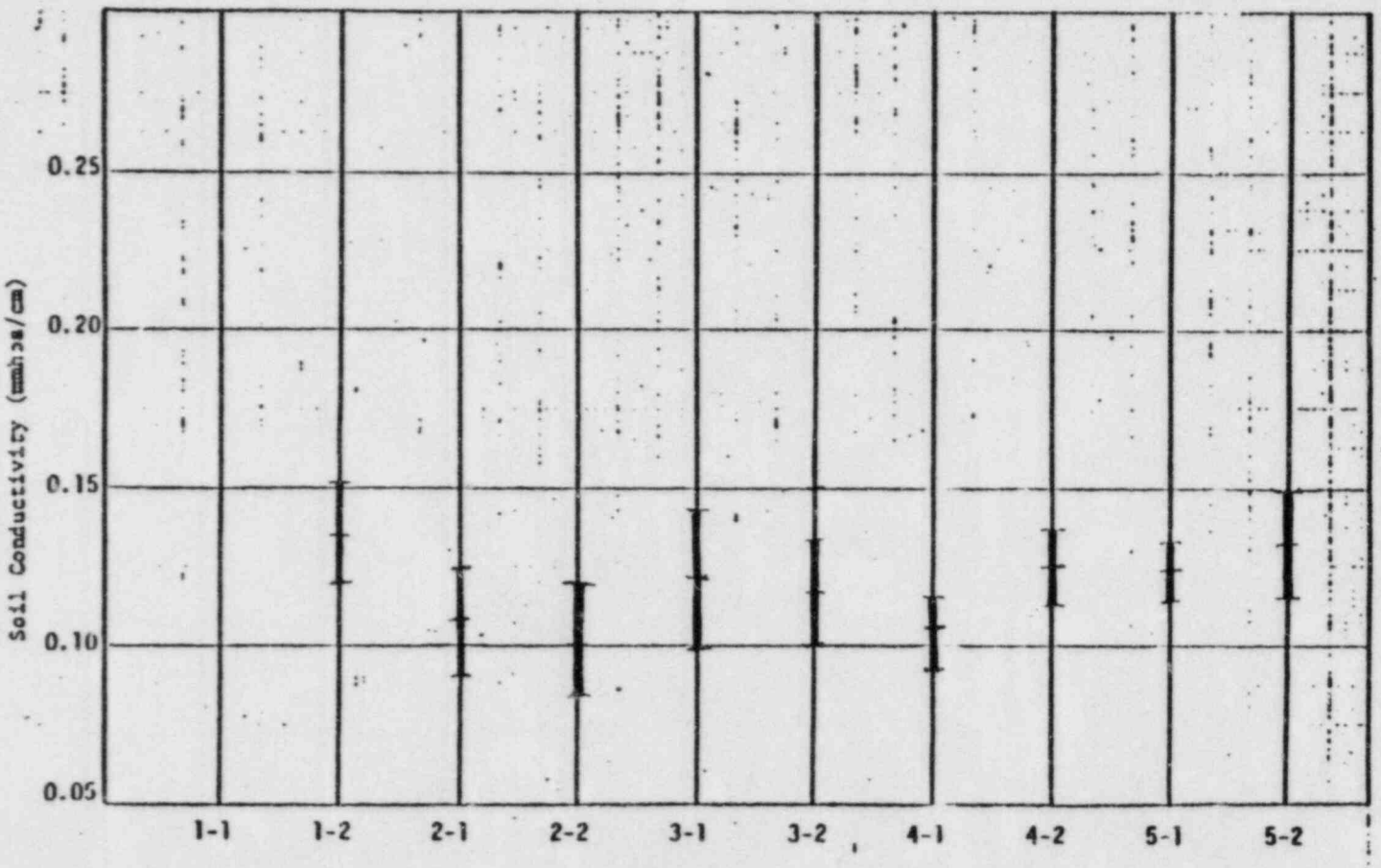


FIGURE 7-6

SOIL CHEMISTRY (ETS Reference 3.1.3.10) (continued)

DISCUSSION OF RESULTS (continued)

data was similar to the variance in the pH data. The usual dispersion was observed for the mean of all samples and the individual sampling location means as compared to the five (5) previous sampling periods. None of the mean conductivity values exceeded the investigation levels established by the original samples.

SUMMARY OF APRIL 1984 RESULTS

As summarized in Table VII-4, the pH and specific conductance levels varied slightly. The fluctuations noted between years and seasons are a result of natural phenomena (i.e., flooding, soil moisture) to which terrestial biota are adapted. The 1984 soluble salts concentrations are considerably below the point where vegetation would be adversely affected. Cooling tower drift did not affect either pH or conductivity in a measurable way.