A STUDY OF THE PRACTICABILITY OF THE PHOTOMETER METHOD IN MAKING SOIL LOSS MEASUREMENTS

by

WILLIAM TURNER FLESHMAN

B.S. 1939

Virginia Polytechnic Institute

A MAJOR THESIS

Submitted to the Department of Agricultural Engineering

in Partial Fulfillment of Requirements

for a Degree of

MASTER OF SCIENCE

in

AGRICULTURAL ENGINEERING

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June, 1940

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A STUDY OF THE PRACTICABILITY OF THE PHOTOMETER METHOD IN MAKING SOIL LOSS MEASUREMENTS

INTRODUCTION

Since the Soil Conservation Act of 1935 was passed establishing experimental and demonstrational projects over the United States there has been a widespread need for a mechanical method that will measure the soil loss from experimental plots and watersheds. The method now employed is very laborious and requires much time in its performance. Any new method that would reduce the time and labor of these measurements would be welcomed and should be investigated.

Up to the present time no satisfactory method for obtaining continuous records of soil loss, by which rates of soil loss may be determined, has yet been devised. The laborious procedure now employed gives a record of the total soil loss only, after each individual storm. Unsuccessful attempts have been made to correlate these data with the amount and intensity of rainfall and other factors. It is believed that if it were possible to determine relative rates of soil loss at different instances during a runoff period some correlation might be obtained which would lead to a better understanding of the fundamental laws which govern soil movement.

The photometer is a possible device for use in measuring soil losses and if found practical should make a material saving in time and labor in this work. In 1929, Robert N. Clark, assistant engineer in the Syracuse Intercepting Sewer Board, working under the direction of Glenn D. Holmes, conducted some experimental work with a photometer in which he attempted to establish a relation between light absorption and suspended solids in sewerage. In England, E. C. Richardson also did some research on the photometer method in connection with soil in suspension, but his work was never finished.

The photometer is suggested as a possible device that could be setup to make quantity determinations of soil in suspension as it comes from soil erosion experimental plots by means of light absorption of different concentrations of soil runoff. The method semmed to have sufficient possibilities to warrant an investigation of its practicability.

Therefore in the hope that soil loss measurements may be made in this manner a study of the photometer was proposed as a subject for a thesis.

OBJECTIVES

With the above ideas in mind this investigation has been planned toward accomplishing the following objectives:

1. To determine the practicability of the photometer method for measuring soil in solution.
2. To develop a field application of the photometer if it should prove practical.
3. To determine the limiting factors that hinder the use of this method if it should prove impractical.

DESCRIPTION OF PHOTOMETER

The photometer setup used in conducting this investigation consisted of a photoelectric cell, light source, micro-ammeter, rheostat and voltmeter.

Two types of photometer setups were employed in this investigation, that is, (1) with adjustable light source and (2) with stationary light source. The adjustable light source type had the light arranged such that it could be moved toward and away from the cell by means of a worm gear, while the stationary type had all elements stationary.

The light source and photoelectric cell are so arranged in a box such that the light will pass directly through an opening into the space where the sample is to be placed and onto the cell.

The cell is the Weston Photronic No.594 which consists of a light sensitive screen of an electropositive metal. When a beam of light falls upon the cell a direct current is delivered at the cell terminals. This current is indicated by two micro-ammeters, one being a 20-scale meter and the other a 100-scale meter. The 20-scale meter is used to indicate the smaller current outputs of the cell while the 100-scale meter indicates the larger current outputs.

The light source is a 100-watt, single base, bayonatte type projection lamp.

The voltage regulator consists of a rheostat and voltmeter. This regulator was placed in the light circuit in order to keep the intensity of the light constant at all times.

These photometer setups were planned such that light absorption measurements could be made for soil and water solutions of varying concentrations.

PROCEDURE

Establishment of an Effective Photometer Setup: The first necessary step in the procedure for making turbidity measurements by the photometer method was the establishment of an effective photometer setup. An arrangement of the elements of the photometer had to be developed such that a suitable current output of the photoelectric cell was delivered with highly concentrated solutions of soil and water placed in the path of the light.

The first attempt in establishing a photometer for use in this study was in making various setups of the adjustable light source type photometer. This type photometer is shown in Photo. No. 1. The cell and the glass sample jar are in a stationary position while the light source is moveable. An arbitrary position of the light soufce was selected such that the light penetration would be sufficient to give a deflection on the micro-ammeter with distilled water between the light source and cell. This position of the light source was quite evidently the position at which the light source was fartherest from the cell. When a turbid solution was placed between the light source and cell the light dource was moved toward the cell until the micro-ammeter gave the same deflection as it did when the distilled water was measured for light absorption. The

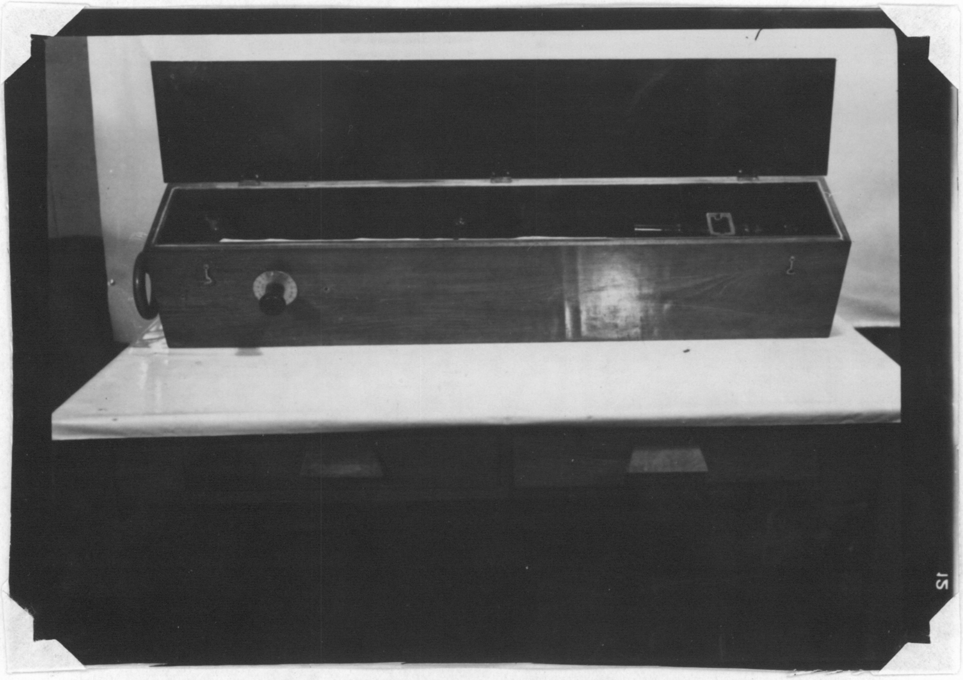


Photo. No.1-View of Photometer Box with Adjustable Light Source.

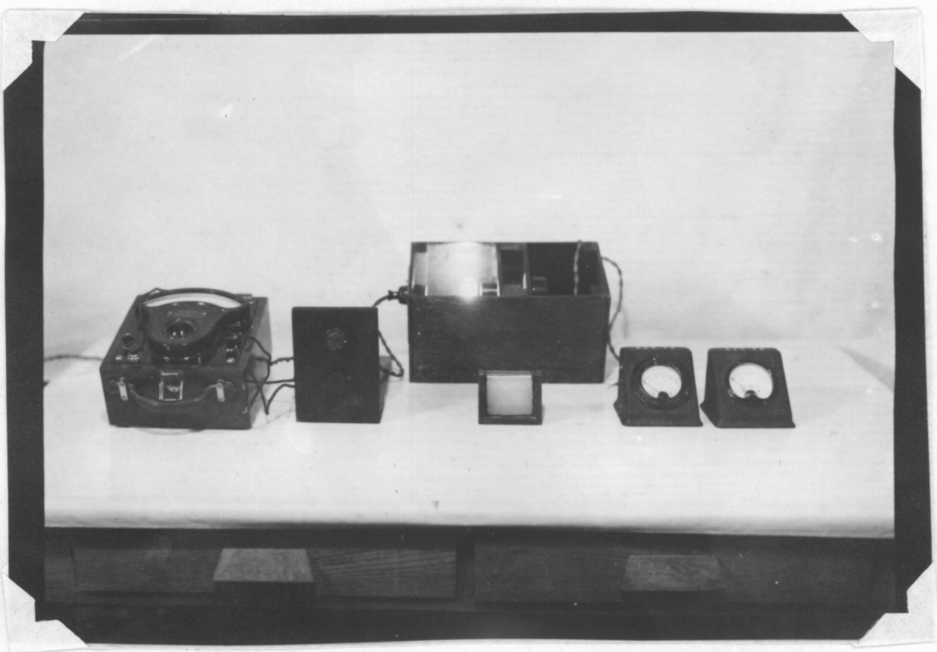


Photo. No.2-View of Photometer with Stationary Light Source.

distance between this position of the light source and the position when using distilled was measured. The positions of the light source with each turbid solution was measured from the distilled water position or the zero percentage position. A graph was then drawn with the percentage soil and water solution, by weight, plotted against the relative linear distance of the light source from the zero percentage position obtained when using distilled water.

This arrangement was discarded when the intensity of the light source was found insufficient to penetrate a 4 per cent solution of soil and water, since a 4 per cent solution, bt weight, was considered the most concentrated water erosion solution that would be obtained as shown by previous records of runoff.

Another arrangement of this photometer was established by inserting a lens between the cell and light source for the purpose of intensifying the light upon the cell. The lens was placed at an arbitrary position and the light source was moved until the focal point of the lens was reached. In this arrangement all elements of the photometer became stationary. This arrangement proved sufficient to make a suitable reading on the micro-ammeter with a 4 per cent solution of soil and water between the light source and cell but trouble was encountered in keeping the soil in suspension. This difficulty was overcome by the addition of an ordinary soda fountain milk shaker to stir up the solution.

This arrangement also had to be discarded due to the fact that a reading could not be obtained on the micro-ammeter when a 4 per cent solution of soil and water was placed between the light and cell while the agitator was in operation. Agitation greatly increased the light absorption in the solution, although, the absorption became constant afeer a few minutes of steady mixing.

Other factors that were found to be detrimental to the precision of this photometer setup were the size and construction of the sample jar and the relative location of the light with respect to the cell. The sample jar was an ordinary 2 in. by 3 in. rectangular museum jar the sidws of which were 1/4 in. thick. The sides of the jar contained many flaws and defects that may have refracted the light from the solutiom. The inside thickness of the jar was found to be much greater than was necessary. In the SEWAGE WORKS JOURNAL, Glenn D. Holmes states;"The light absorbed through a 1/2 in. distance in sewage bears a closer relationship to the suspended solids concentrations of sewage than the light absorbed through a greater distance." The adjustable light source type of photometer was then discarded.

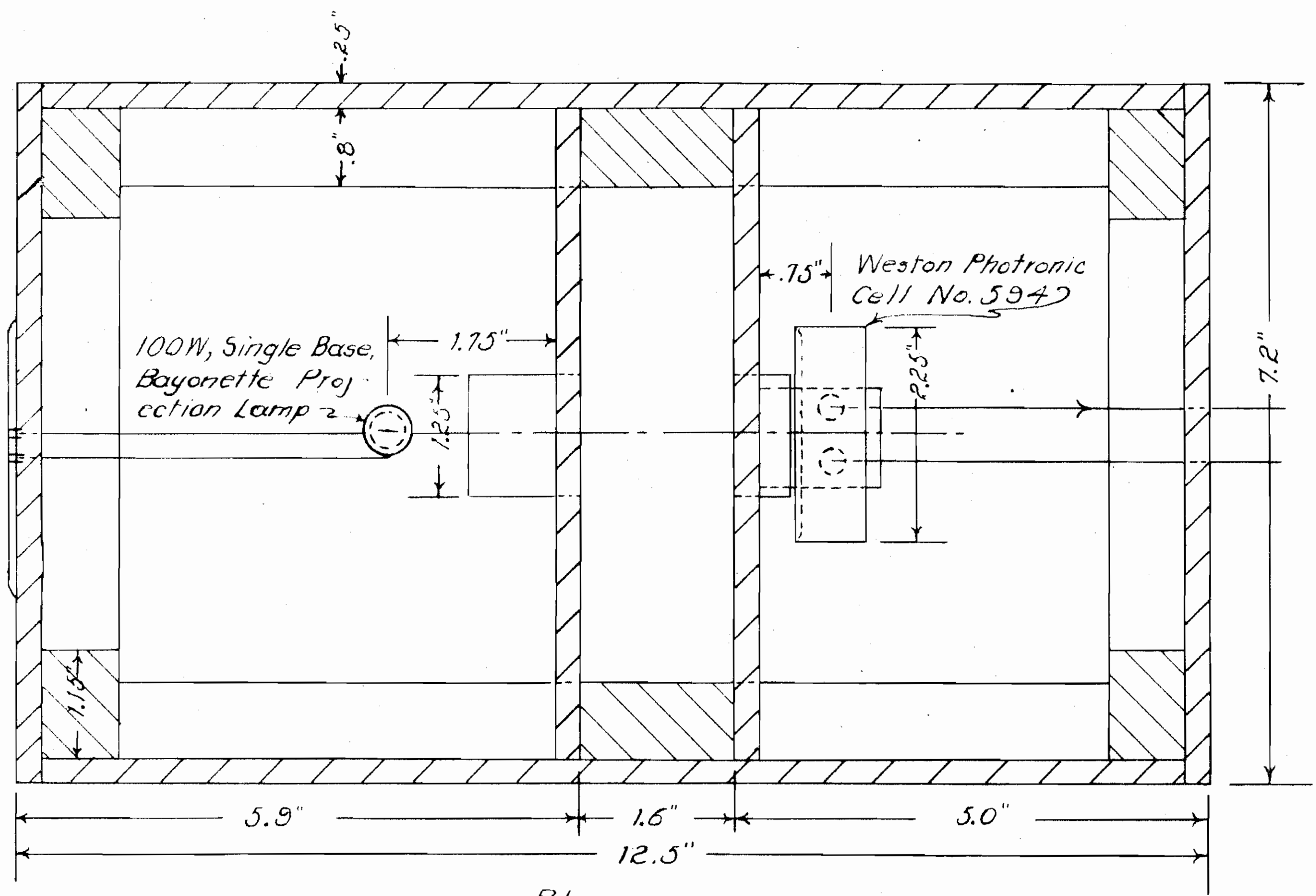
A new arrangement was considered, that is, placing the cell and light source in a stationary position and as closely together as was possible to arrange them. With this in mind, a small box was constructed out of ply board with the cell with the cell and light source arranged in it as shown in Fig. No. 1 and Photo. No.2. The cell and light source measure 1-1/4 in. and 2-1/2 in., respectively, from the sample jar. A new sample jar was constructed with clear, thin glass whose faces are 1/2 in. apart. This sample jar is shown in Fig. No.2.

Calibration of the Photometer: When this photometer setup had proven to be satisfactory to give a suitable reading on the micro-ammeter with a 4 per cent solution of soil and water the next step was to calibrate the photometer. The first step in calibrating the photometer was to prepare known percentage solutions of soil and water. These solutions were prepared on the basis of weights using distilled water and Dunmore silt loam soil. Distilled water, alone, was considered as the zero percentage solution. Samples were prepared for every 1/2 per cent up to 2 per cent solution and every 1 per cent from 2 per cent to a 4 per cent solution. When the meter readings were taken from each soil and water solution a calibration curve was plotted using the soil-water ratio(%) and current discharge in micro-amperes as coordinates.

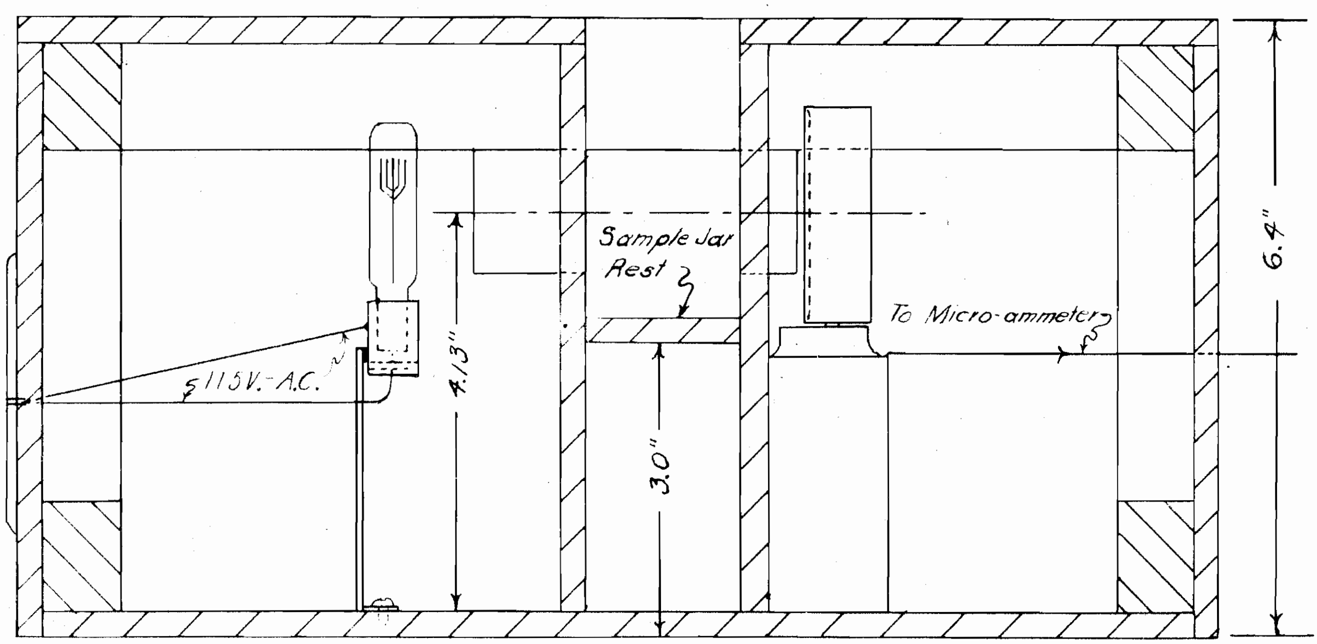
Preliminary Test: A preliminary test was made in order to determine whether there was a close relationship between light absorption and the concentration of the solution. This test was run using soil that

Figure No 1

Arrangement of Photoelectric Cell and Light Source



Plan

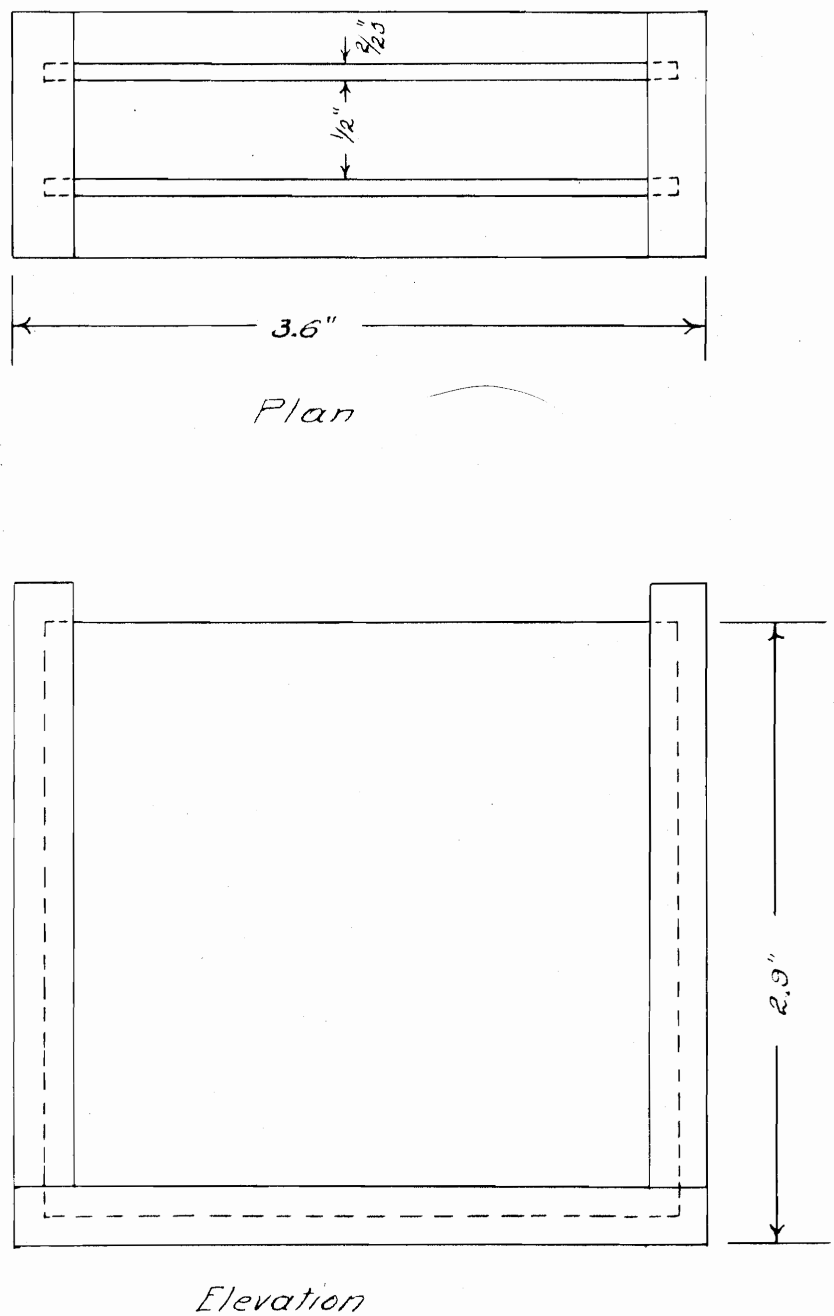


Elevation

Scale 1" = 2"

Figure No. 2

Sample Jar



Full Scale

was taken directly from the surface of a plot of land on Dunmore soil and passing it through a 100-mesh sieve to obtain particles of approximately the same size. The sample solutions to be tested for light absorption were prepared such that each percentage was of the same volume and such that exactly four equal portions of the same sample could be tested separately to be averaged as the true reading of the whole. When these meter readings were obtained a calibration curve was plotted. Two arbitrary samples were measured for light absorption and were compared with the curve. The accuracy of these arbitrary samples were found favorable enough to warrant further sthdy using other soil samples containing particles varying in size.
<u>Calibration with Composite Soil from Previous Runoff</u>: The next tests were made with eroded materials obtained from runoff on plots of Dunmore silt loam soil of 5, 15, and 25 per cent slopes. Three separate soil samples were used from the composite eroded material of each slope and were measured for light absorption. A calibration curve was plotted using the averages of the values obtained for each slope.

A true mean calibration curve was plotted from the mean of the averages of the readings taken with the composite soil samples from the three slopes. When the true mean values were obtained the maximum per cent deviation of the readings in the greatest error from the mean curve was calculated for the meter readings and the soil-water ratio. Six arbitrary samples were measured for light absorption and the micro-ammeter readings were checked for accuracy on the true mean calibration curve and the per cent error calculated.

Meter Variations Due to Voltage Changes: A test was made to determine the effect of voltage variations on the meter readings. This was determined by varying the voltage and taking readings directly from the micro-ammeter. A voltage- meter variation curve was then plotted.

Measurement for Light Absorption of Actual Runoff: After an intense rainstorm had produced runoff and erosion from an experimental plot of land on Dunmore soil, a representative sample of the soil and water was measured for light absorption. The micro-ammeter reading was referred to the mean calibration curve for the soil-water ratio; the sample was dried down and the actual per cent solution was obtained. The results of the two methods were compared and found in error. To determine the factors causing this great error two other tests were planned; one on particles varying in size, the other on soils varying in color.

Effect of Particle Size on Light Absorption: The test on particle sizes was made so as to determine the effect the size of soil particles had upon light absorption . This test was made by passing Dunmore soil through a set of sieves and preparing a 0.50 per cent solution of soil and water from the soil particles remaining on each sieve. These solutions were measured for light absorption and the meter readings were compared.

Effect of Soil Color on Light Absorption: The final test, that is, on soils varying in color was made to determine the effect the color of a soil had upon light absorption. This test was made by passing four soils, each of a different color, through a 100-mesh sieve and preparing a 0.50 per cent solution from each soil. These solutions were measured for light absorption and the meter readings were compared.

TABLE NO. I

Calibration Data With Dunmore Soil Which Passed Thru 100 Mesh Sieve

Soil-Water Ratio- %	Voltage	Ammeter Reading-ma.				
		1	2	3	4	Avg.
0.5	115	32	32	33	31	32
1.0		18	14	14	14	14
1.5		9	7	7	7	7
2.0		3.5	3.5	3.5	4	3.5
2.5		2	1.75	2	2	2
3.0		1.5	1.25	1.25	1.25	1.25
4.0		1	1	1	1	1

Figure No 3

Calibration Curve for Soil Which Has Passed thru a 100-mesh Sieve

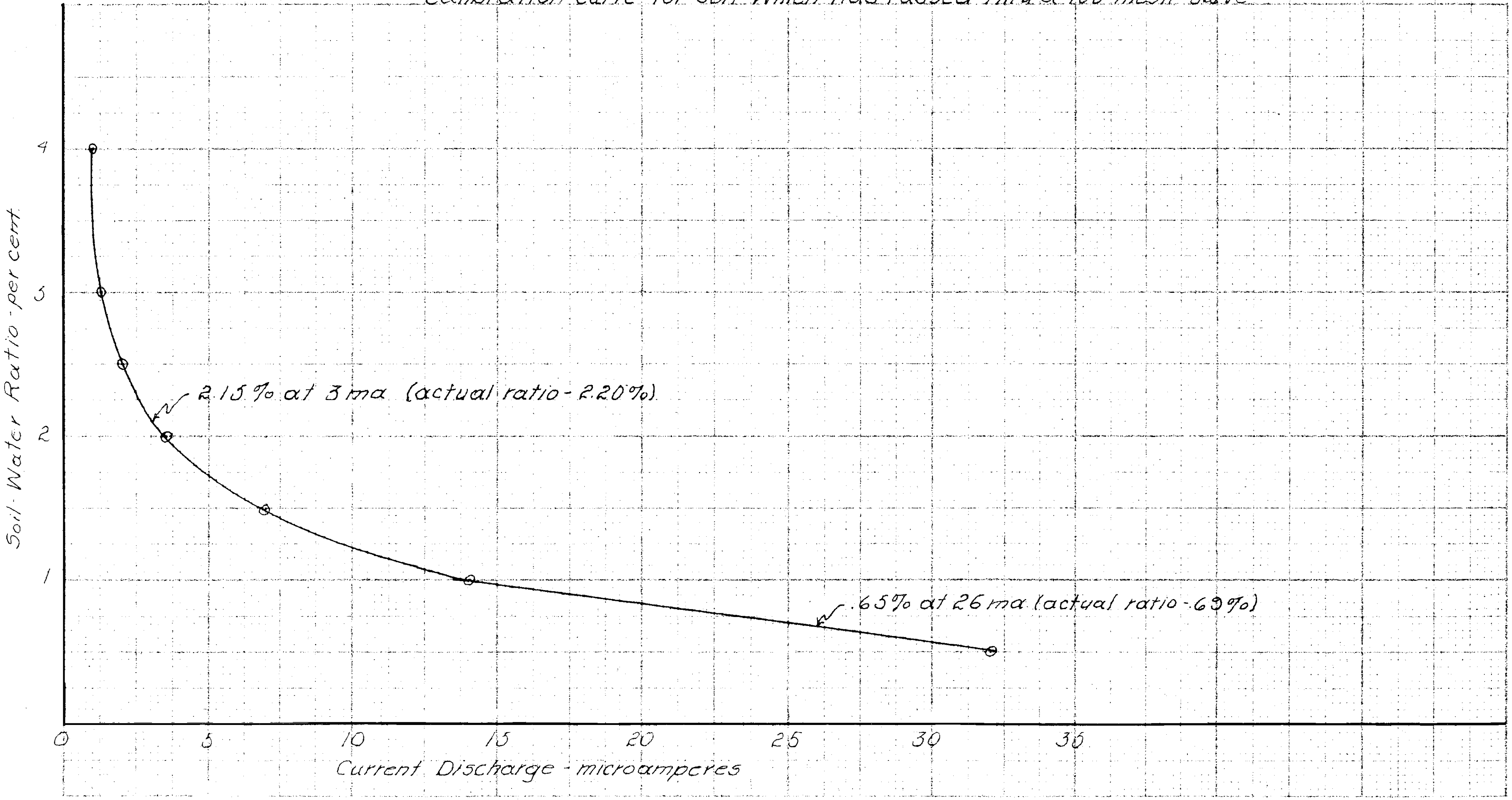


TABLE NO. II

Calibration Data With Composite Dunmore Soil From 15 Per Cent Slope
Sample No. 1

Soil-Water Ratio-%	Voltage	Ammeter Reading-ma.				
		1	2	3	4	Avg.
0.00	115	-	-	-	-	100
0.50	↓	34	34	32.5	33	33.5
1.00	↓	16	15.5	14.5	14	14.5
1.50	↓	7	6.1	4.5	4	5.5
2.00	↓	3.25	2.6	1.6	2	2.25
3.00	↓	.75	.55	.55	.30	.55
4.00	↓	.20	.20	.20	.20	.20
	↓					

TABLE NO. III

Calibration Data With Composite Dunmore Soil From 15 Per Cent Slope
Sample No.2

Soil-Water Ratio-% R	Voltage	Ammeter Reading-ma.				
		1	2	3	4	Avg.
0.00	115	-	-	-	-	102
0.50		38	37.5	37	36	37.3
1.00		15.5	12.5	14.25	11.75	13.3
1.25		12.25	11	9.6	7.7	10.1
1.50		8.25	7.3	6.1	5.0	6.6
1.75		7.0	5.1	4.2	3.5	4.9
2.00		3.5	2.8	2.5	2.0	2.7
3.00		.60	.50	.50	.40	.50
4.00		.20	.15	.15	.15	.15

TABLE IV

Calibration Data With Dunmore Soil(Composite) From 15 Per Cent Slope
Sample No.3

Soil-Water Ratio-%	Voltage	Ammeter Readings-ma.				
		1	2	3	4	Avg.
0.00	115	-	-	-	-	102
0.50		40.5	39	36	36	37.9
1.00		14	13.75	13.3	11.75	13.2
1.25		12	10.8	10	9.75	10.6
1.50		8.25	7	4.8	5.5	6.4
1.75		6.1	5.3	4.85	3.6	4.96
2.00		3.3	2.7	2.4	2.2	2.6
3.00		0.9	0.6	0.5	0.3	0.57
4.00		0.2	0.15	0.15	0.15	0.15

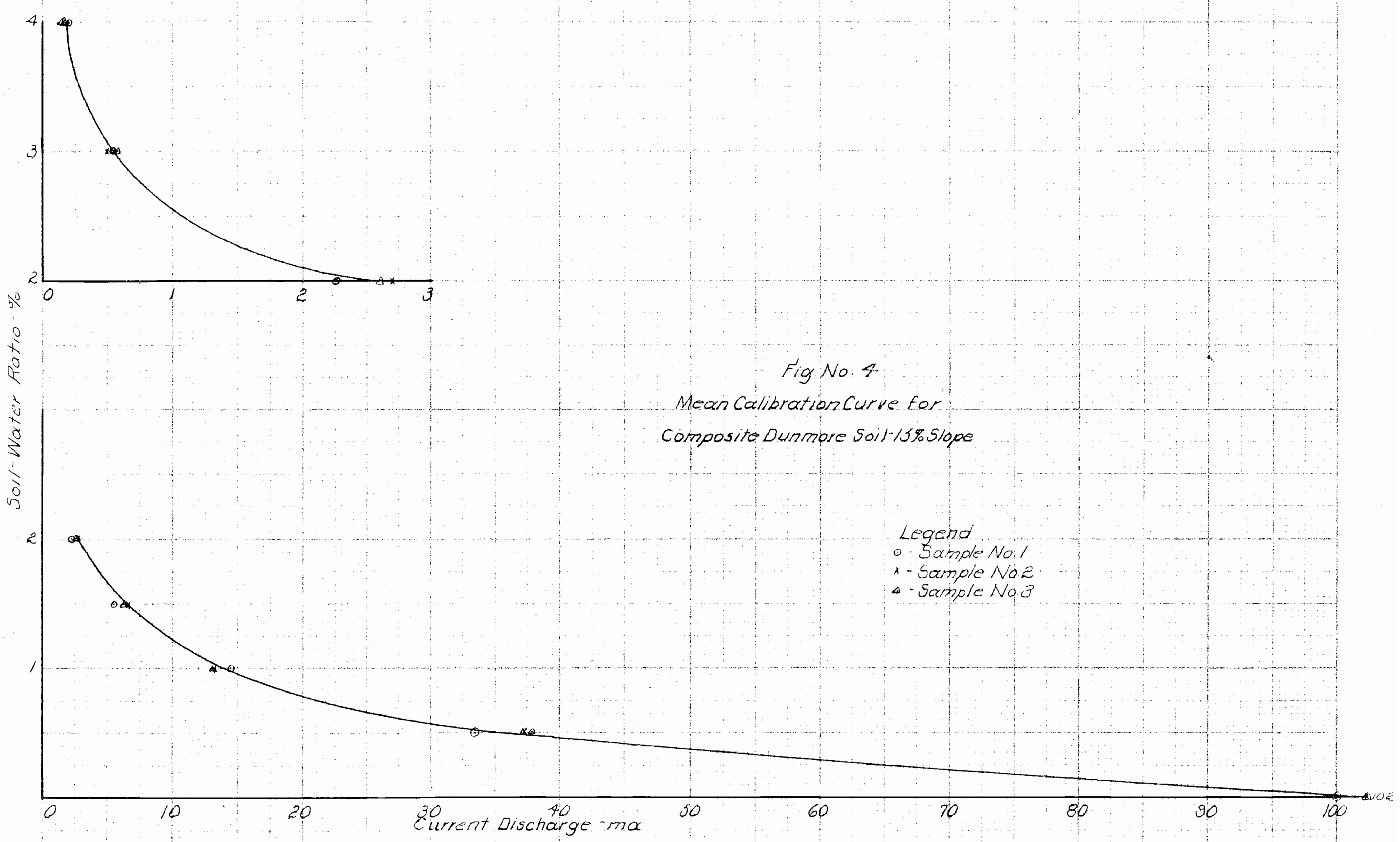


Fig No. 4
Mean Calibration Curve for
Composite Dunmore Soil - 15% Slope

TABLE NO.V

Calibration Data With Composite Dunmore Soil From 5 Per Cent Slope
Sample No. 1

Soil-Water Ratio-%	Voltage	Ammeter Readings-ma.				
		1	2	3	4	Avg.
0.00	115	-	-	-	-	162
0.25		67	65	64	62.5	64.6
0.50		39.5	39	38.5	33.5	37.6
0.75		29	28.5	24.5	24	26.5
1.00		15.5	14.5	13	11.5	13.6
1.50		6.5	6.25	6	5	5.9
2.00		3.25	2.65	2.6	1.6	2.58
3.00		0.70	0.55	0.40	0.30	0.50
4.00		0.20	0.15	0.15	0.15	0.17

TABLE NO. VI

Calibration Data With Composite Dunmore Soil From 5 Per Cent Slope
Sample No. 2

Soil-Water Ratio-%	Voltage	Ammeter Readings-ma.				
		1	2	3	4	Avg.
0.00	115	-	-	-	-	102
0 .25		69	67.5	66	63	66.4
0.50		40.5	38.5	38	35.5	38.1
0.75		29	27.5	27.5	22	26.5
1.00		15	14.5	13	11.5	13.5
1.50		8	7.4	6.75	4.75	6.7
2.00		3	2.5	2.5	1.5	2.4
3.00		0.85	0.65	0.50	0.30	0.57
4.00		0.30	0.25	0.15	0.10	0.20

TABLE NO. VII

Calibration Data With Composite Dunmore Soil From 5 Per Cent Slope
Sample No. 3

Soil-Water Ratio-%	Voltage	Ammeter Readings-ma.				
		1	2	3	4	Avg.
0.00	115	-	-	-	-	102
0.25		65.5	64	63	62	63.6
0.50		44	42	39	31	36.5
0.75		29	28	26	23	26.5
1.00		14.5	13.75	12.75	12.2	13.28
1.50		7.25	6.85	6.6	5.5	6.55
2.00		3.2	2.5	2.4	2.2	2.58
3.00		0.60	0.55	0.55	0.55	0.56
4.00		0.20	0.20	0.20	0.15	0.20

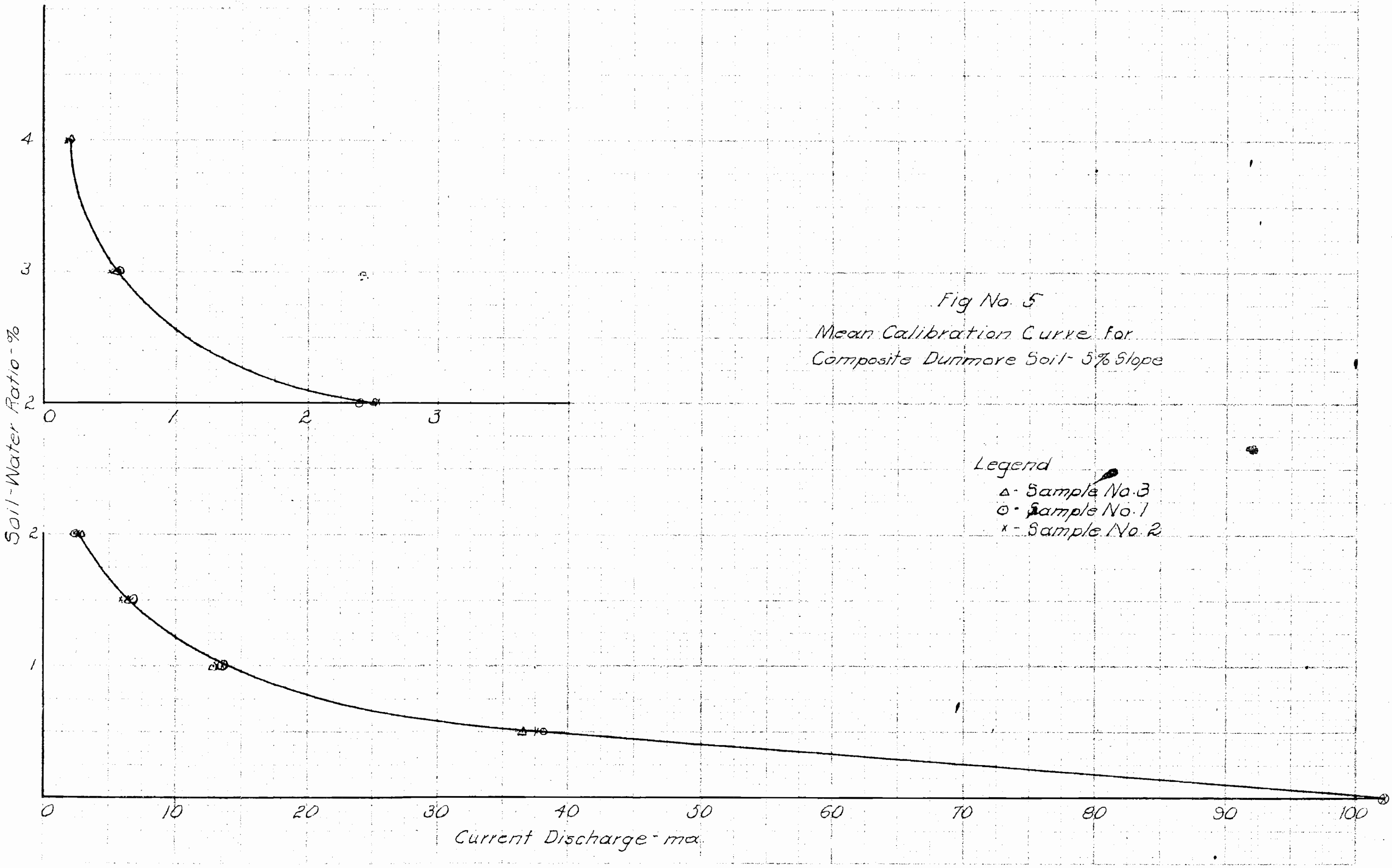


Fig No. 5
Mean Calibration Curve for
Composite Dunmore Soil - 5% Slope
Legend
△ - Sample No. 3
⊙ - Sample No. 1
× - Sample No. 2
Soil-Water Ratio - %
Current Discharge - ma
0
1
2
3
4
10
20
30
40
50
60
70
80
90
100

TABLE NO. VIII

Calibration Data With Composite Dunmore Soil From 25 Per Cent Slope
Sample No. 1

Soil-Water Ratio-%	Voltage	Ammeter Readings-ma.				
		1	2	3	4	Avg.
0.00	115	-	-	-	-	101
0.25		68	66.5	60	66	65.1
0.50		38.5	38	37.5	37	37.75
0.75		31	30.5	28	21.5	27.75
1.00		13.8	13.75	13.25	12.5	13.33
1.50		6.5	5.8	5.65	5.5	5.86
2.00		3.6	3.15	2.6	2.25	2.9
3.00		0.90	0.70	0.60	0.40	0.65
4.00		0.20	0.20	0.20	0.20	0.20

TABLE NO. IX

Calibration Data With Composite Dunmore Soil From 25 Per Cent Slope
Sample No.2

Soil-Water Ratio-%	Voltage	Ammeter Readings-ma.				
		1	2	3	4	Avg.
0.00	115	-	-	-	-	102
0.25	↓	63.5	63	62	59	62
0.50	↓	38.5	36.5	33.5	31	35
0.75	↓	27.5	26	25	24.5	25.7
1.00	↓	14.8	13.7	13.5	12.9	13.7
1.50	↓	7.1	5.75	5.7	5	5.9
2.00	↓	3.4	2.55	2.3	2.25	2.63
3.00	↓	0.65	0.65	0.50	0.35	0.54
4.00	↓	0.20	0.20	0.20	0.15	0.20

TABLE NO. X

Calibration Data With Composite Dunmore Soil From 25 Per Cent Slope
Sample No. 3

Soil-Water Ratio-%	Voltage	Ammeter Readings-ma.				
		1	2	3	4	Avg.
0.00	115	-	-	-	-	102
0.25	↓	61.5	61.5	61	61.5	61.4
0.50	↓	44	42	40	35	40
0.75	↓	27	24	23.5	22	24.1
1.00	↓	14.25	15.5	13.5	9.8	13.3
1.50	↓	7.1	7.1	5.85	5.75	6.45
2.00	↓	3.5	3.1	2.6	2.2	2.85
3.00	↓	0.65	0.55	0.55	0.50	0.56
4.00	↓	0.30	0.25	0.15	0.15	0.21

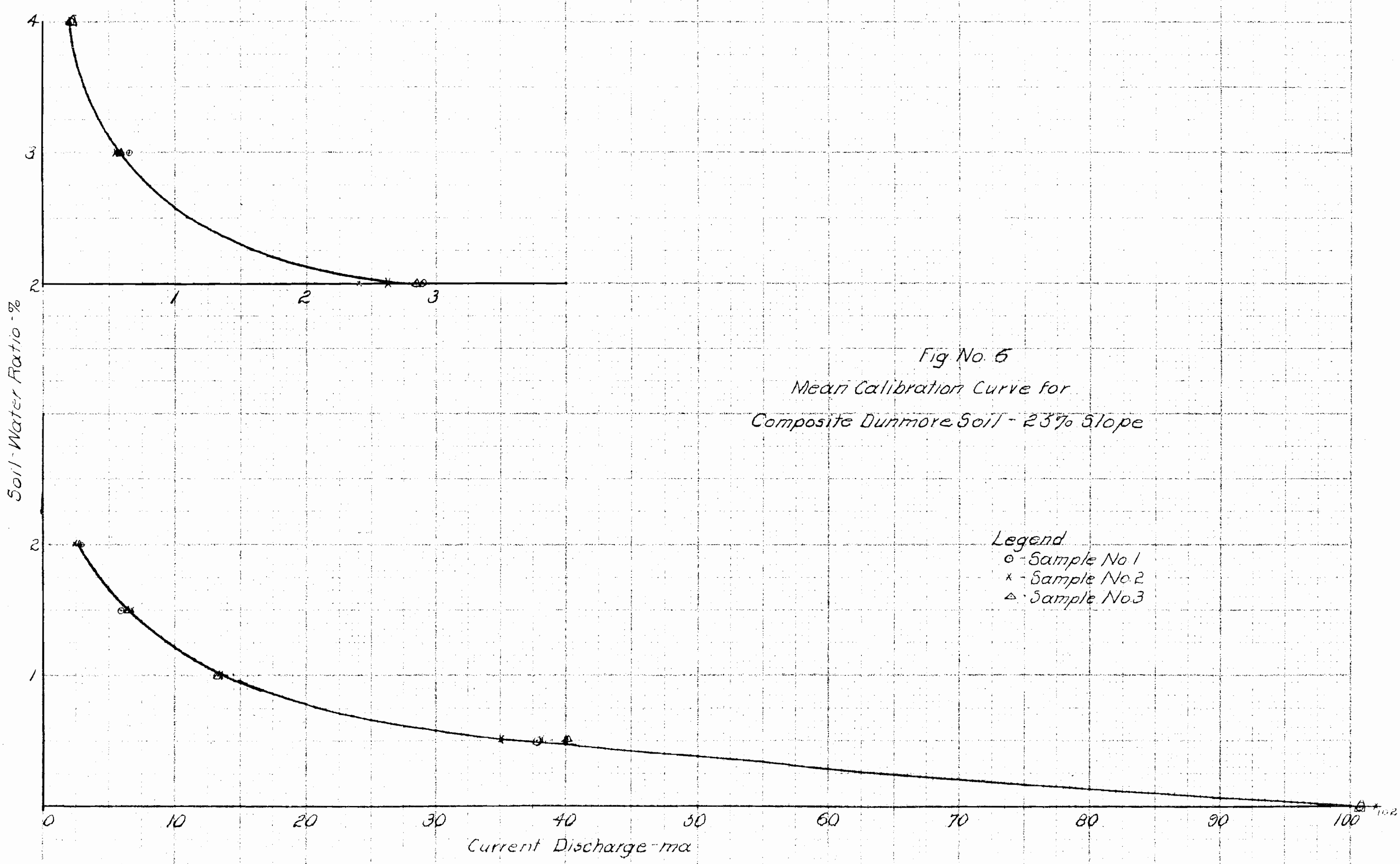


Fig No. 6

Mean Calibration Curve for

Composite Dunmore Soil - 23% Slope

TABLE NO.XI

Average Microammeter Readings For The Slopes

Soil-Water Ratio %	Slopes											
	15%				5%				25%			
	Sample Numbers			Average	Sample Numbers			Average	Sample Numbers			Averag
	1	2	3		1	2	3		1	2	3	
0.00	100	102	102	101.3	102	102	102	102	101	102	102	101.3
0.25	-	-	-	-	64.6	66.4	63.6	64.9	65.1	62	61.4	62.8
0.50	33.5	37.3	37.9	36.2	37.6	38.1	36.5	37.4	37.75	35	40	37.6
0.75	-	-	-	-	26.5	26.5	26.5	26.5	27.75	25.7	24.1	25.9
1.00	14.5	13.3	13.2	13.66	13.6	13.5	13.3	13.5	13.33	13.7	13.3	13.4
1.50	5.5	6.6	6.4	6.16	5.9	6.7	6.55	6.38	5.86	5.9	6.45	6.07
2.00	2.25	2.7	2.6	2.52	2.58	2.4	2.58	2.52	2.9	2.63	2.85	2.79
3.00	0.55	0.50	0.57	0.54	0.50	0.57	0.56	0.54	0.65	0.54	0.56	0.58
4.00	0.20	0.15	0.15	0.17	0.17	0.20	0.20	0.19	0.20	0.20	0.21	0.20

TABLE XII

Per Cent Deviation of Meter Readings-Soil Water Ratio from Mean

Soil-Water Ratio %	Ammeter Readings 5% ma.	15% ma.	25% ma.	Mean ma.	Maximum Deviation from Mean Meter Read. ma.	Maximum % Deviation from Mean Meter Read. %	Maximum Error Soil-Water Ratio-%	Maximum Error Soil-Water Ratio-% %
0.00	101.3	102	101.3	101.5	0.50	0.49	-	-
0.50	37.4	36.2	37.6	37.0	0.80	2.16	0.005	1.0
1.00	13.5	13.7	13.4	13.5	0.13	0.96	0.01	1.0
1.50	6.38	6.16	6.07	6.20	0.18	2.90	0.015	1.0
2.00	2.52	2.52	2.79	2.61	0.18	6.90	0.02	1.0
3.00	0.54	0.54	0.58	0.55	0.03	5.45	0.03	1.0
4.00	0.19	0.17	0.21	0.19	0.02	10.52	0.11	2.75

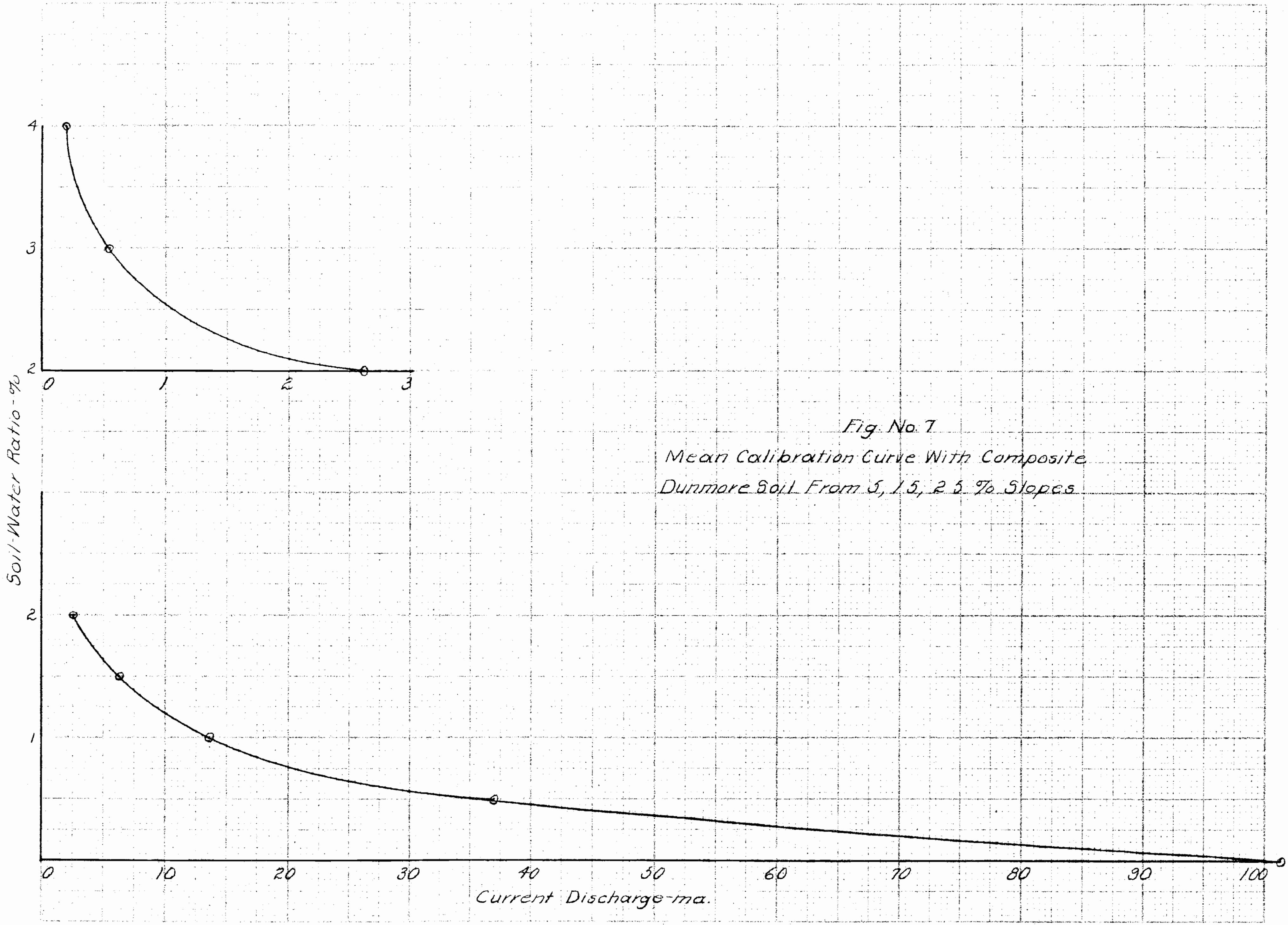


Fig. No. 7
Mean Calibration Curve With Composite
Dunmore Soil From 5, 15, 25 % Slopes

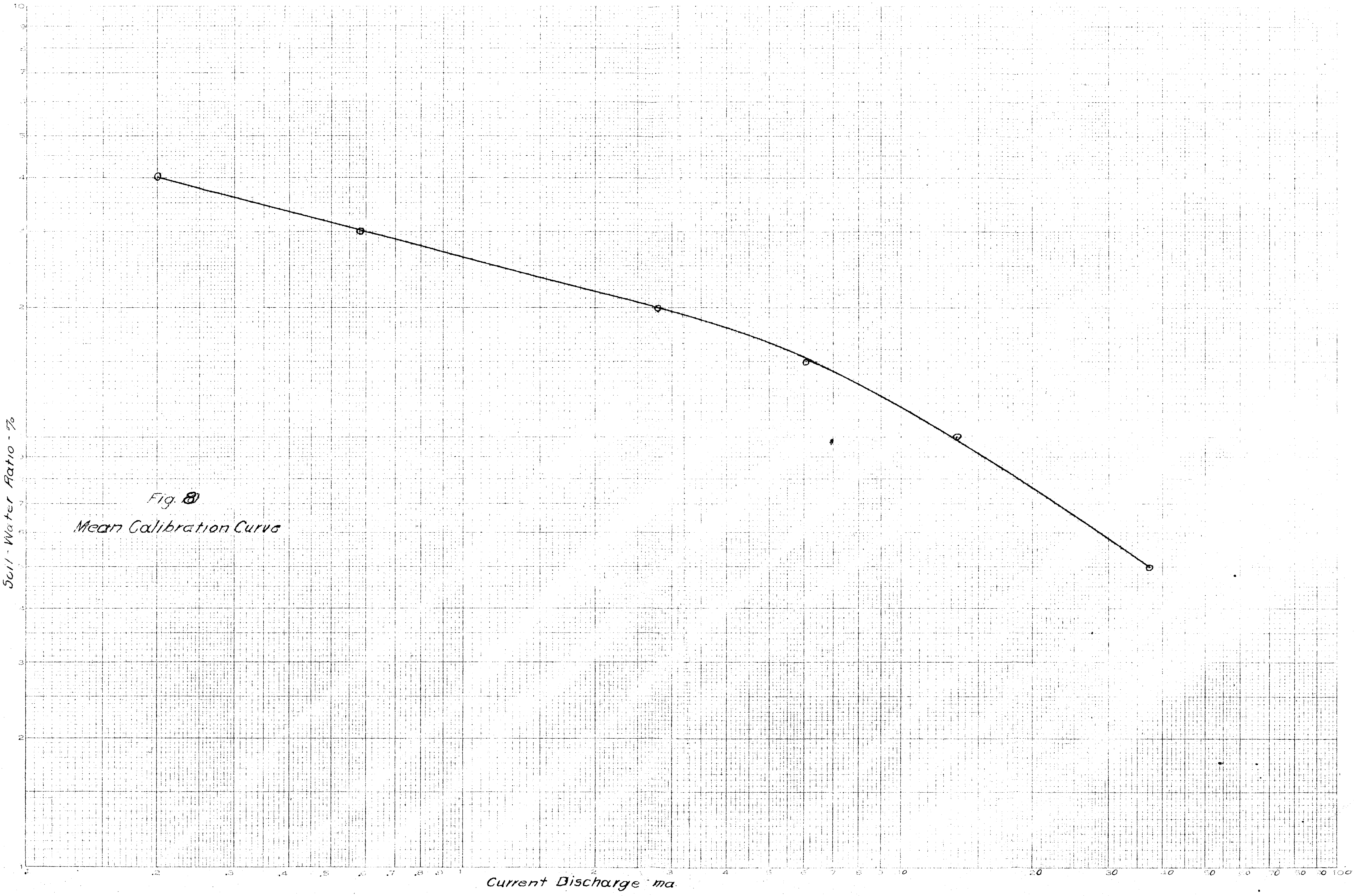


Fig. 8
Mean Calibration Curve

TABLE NO. XIII

Arbitrary Samples of Known % Compared on Mean Curve

Actual Soil-Water Ratio %	Micro-ammeter Reading ma.	Soil-water Ratio From Curve %	Deviation from Curve %	% Error
0.25	62.8	0.25	0	0
0.75	25.9	0.63	0.12	16
0.81	17.0	0.86	0.05	6.2
1.25	10.1	1.19	0.06	4.8
1.75	4.9	1.65	0.10	5.7
3.10	0.4	3.20	0.10	3.2

TABLE NO. XIV

Mechanical Analysis of Dunmore Soil from 5, 15, 25% Slopes

Slopes %	% Sand	% Silt	% Clay
5	6.0	42.4	51.6
15	11.0	43.4	45.6
25	13.0	45.0	42.0

TABLE NO. XV

Variation of Meter Readings Due to Changes in Voltage

Voltage	Micro-amps	Micro-amps
110	78	77.5
112	79	79.5
114	81	81.5
115	82	82

Fig. No. 9

Voltage-Microamp Variation Curve

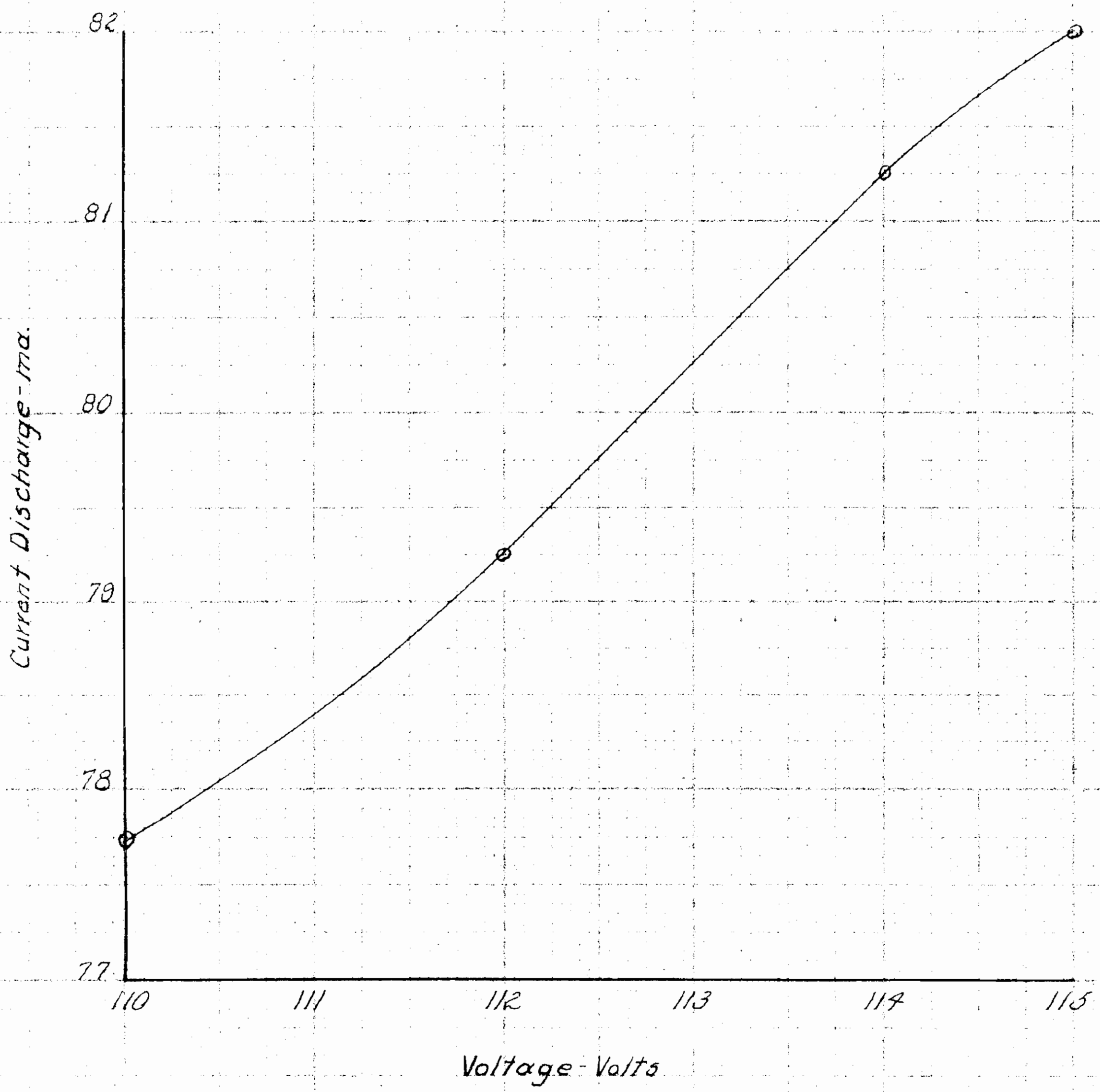


TABLE NO. XVI

Data on the Effect of Particle Size on Light Absorption

Particle Size (Mesh)	Soil-Water Ratio %	Meter Readings				
		1	2	3	4	Avg.
> 10	0.50	49	48	46	42.5	46.4
> 20 & < 10		40	35	33.5	32.5	37.0
> 40 & < 20		39	33.5	33	31.5	34.3
> 60 & < 40		36.5	34.5	32.5	28.5	33
> 80 & < 60		34.5	33	32.5	32	33
>100 & < 80		36	35	34	34	34.8
< 100		36.5	35	35	35	35.4

TABLE NO. XVII

Data on Light Absorption Variations Due to Color of Soil

Soil Class	% Soln.	Ammeter Readings				
		1	2	3	4	Avg.
Orange	0.50	58.5	57.0	55.5	55.0	56.5
Cecil	↓	51.0	50.0	50.0	42.0	48.3
Iredell	↓	49.0	48.5	48.0	47.0	48.1
Dunmore	↓	40.0	39.0	37.0	36.0	38.0

DISCUSSION OF RESULTS

In comparing the two arbitrary samples with the values taken from the calibration curve, as shown in Fig. No.3, evidence shows that a definite relationship between the concentration of the solution and light absorption exists. The actual percentage solutions were 2.20 and 0.69 while from the curve the percentages were read as 2.15 and 0.68, respectively. The accuracy of these readings are within that desired.

When the data obtained with the composite samples of Dunmore soil from 5, 15, and 25 per cent slopes, as given in Tables II-X, was averaged to a final value, as given in Tables XI and XII, a true mean calibration curve was drawn as shown in Fig. 7 and 8. Fig. 7 is the mean calibration curve on ordinary graph paper while Fig. 8 is the curve on logarithmic graph paper. The more concentrated soil and water solutions gave readings that plotted a straight line on logarithmic paper and enabled more accurate results for the higher percentage solutions.

Table XII also presents the maximum deviation and maximum per cent deviation of the meter readings and the per cent solution from the mean values. In comparing columns 7 and 9 the following statements may be drawn: (1) with distilled water the maximum error of the photometer readings was 0.49 per cent and this error gave no error in the value of the soil-water ratio(%); (2) with 0.50 per cent solution a maximum error of 2.16 per cent existed in the meter readings and only gave a maximum error of one per cent in the value of the soil-water ratio(%); etc. These comparisons show definitely that with an appreciable error in the meter readings a much smaller error exists in the soil-water ratio.

Table XIII presents data from arbitrary samples that were measured for light absorption. Here the meter readings have been referred to the mean curve for obtaining the soil-water ratio as a means to check the accuracy of this method of making turbidity measurements. The largest error came with the 0.75 per cent solution, this error was 16 per cent from the actual value. This may be attributed to the error in using a correction factor on the 100-scale micro-ammeter. (This factor was selected due to the internal resistance of the two meters. This factor ~~was~~ had to be used due to the difference in this resistance of the two meters and was not correctly used within certain limits.) The 0.75 per cent reading was the least reading taken with the larger meter and the correction factor may have been used at its maximum error. The other arbitrary samples varied in error from 0 to 6.2 per cent which is condidered within the accuracy desired.

Table XIV presents the mechanical analysis of the Dunmore silt loam soil from the three slopes. The amounts of sand,silt and clay varied only slightly in the samples.

Table XV shows clearly that the least variation in the voltage or light source input gave an appreciable error in the meter readings.

When the actual soil runoff sample was measured for light absorption and found to be in great error from the mean curve the data in Tables XVI and XVII were obtained in order to determine what factors hindered the accuracy of this method. Table XVI shows the effect of particle size on light absorption, while Table XVII shows the effect of soil color on light absorption. From Table XVI it is evident that the smaller the soil particles the greater was the light absorption, but as the particle size became very small the light absorption became nearly constant. From Table XVII it is evident that the darker the soil and water solution the greater was the light absorption. The Dunmore soil was dark brown, Cecil was yellowish-brown, Iredell was gray, while the Orange was deep red in color. The dark brown soil offered the greatest light absorption while the deep red soil offered the smallest amount of light absorption.

CONCLUSIONS

The following conclusions may be drawn from this investigation:

(1) The photometer is an accurate and dependable device for measuring light absorption by turbid soil and water solutions when the soil particles are of nearly constant size. The tests made with the soil that had passed through a 100-mesh sieve proved this fact, also, the tests made with the composite soil gave very accurate results.

(2) The composite runoff soil samples from the three slopes must have contained particles of approximately the same size. This is shown by the accuracy of the results obtained with this soil.

(3) The average error of this method when using the composite soil was less than 6 per cent. This error was obtained by taking the average of the values given with the arbitrary samples that were measured for light absorption.

(4) The voltage must be kept constant for accurate results. It is shown that the least variation in the voltage gave an appreciable error in the meter readings.

(5) Particle size has an appreciable effect on light

absorption. The smaller the soil particle the greater was the light absorption.

(6) The color of the soil has an appreciable effect on light absorption. The darker the soil in color the greater was the light absorption.

This investigation is only a preliminary study in order to present most of the factors entering into this new and previously uninvestigated problem. It is believed that the results already obtained demonstrate the possibilities of the light absorption method for determining suspended soil in water and it is hoped that sufficient interest has been aroused to induce others to carry on further investigations of this promising method.

Future studies should be directed toward eliminating errors produced by the varying size and color of soil particles. If a color filter is employed the color factor may be eliminated. No definite suggestions can be made in relation to future studies on particle sizes. From this investigation it is probable that if studies were made with soils of a definite mechanical analysis the error in this factor may be recognized more definitely.

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