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By Authority of RLO-CG-4

December 19, 1950

NATURAL ATMOSPHERIC PARTICULATE BACKGROUND AT THE HANFORD WORKS

Outdoor air is never completely free of suspended solids, the presence of which is dependent mainly on factors such as meteorological conditions and the physical distrubrance of soils by cultivation and vehicular traffic. The presence of this natural atmospheric particulate background often becomes of importance in relation to the techniques and interpretation of air sampling and also in the design of ventilation air cleaning systems where suspended effluent solids may subsequently pass through radioactive atmospheres and in turn become physically radioactive.

The following report contains a discussion of several pertinent factors associated with this subject, mainly, the concentration of atmospheric dust as related to wind velocity, the settling rate of suspended solids, and the relationship of the mass of airborne dust to its particle count. From observation it appeared evident that one of the major factors influencing the level of natural dustiness was the intensity of the wind.

Wind Velocity Measurements

Wind velocity measurements were made with a portable, totalizing, three-cup anemometer located six feet above ground level and about thirty feet from the air sampling station. Readings were taken simultaneously with the start and end of each air sampling test to permit close correlation of these two factors. In the preliminary phases of study, wind velocity data were obtained from hourly readings recorded at the Project Meteorology Station about two miles away. It was felt that this distance might impose undesirable restrictions on the interpretation of the wind velocity data in relation to the findings of the air tests and the portable anemometer, offered by the Meteorology Group, was subsequently used at the 292-U Building.

Air Sampling

To determine the effect of wind on the concentration of dust, air samples were collected outside Building 292-U, 200 West Area. Samples of suspended particulate matter were collected for gravimetric determinations at a four-foot level by means of a high volume filter paper sampler utilizing Whatman No. 41 filter paper. With this instrument and filtering medium, the volumetric flow rate was approximately 15 cfm. The length of sampling periods varied from five minutes up to several hours, the size of the individual samples being dependent on the estimated concentration of suspended particulate matter. This method of air sampling produced data in integrated form; consequently, individual samples did not necessarily portray the degree of fluctuation which occurred in the concentrations during the period of sampling.

Supplementary samples to determine the monthly dust levels were obtained by a portable filter paper sampling head located under a louvered shelter fifteen inches square and eighteen inches high which protected the sampling unit from sand and heavy dust raised during periods of high winds. Whatman No. 41 filter paper was also used in this sampler and the air flow, obtained by means of a water aspirator, was kept low to permit a constant rate of filtration throughout the sampling period. Sample periods with this instrument ranged from one day to approximately one week, the length being determined by the filter loading.

All filter papers used for gravimetric analyses were subjected to a preliminary drying period of twelve days in a convection oven at a temperature of 105° F which had been found sufficient to bring this paper to constant weight. Papers were then weighed to obtain their tare weights. Following the collection of samples, the papers were redried according to the preliminary drying procedure and reweighed. CWS papers No. 5 and 6 were tried, but it was found that the components of these particular filtering media did not produce dependable drying characteristics and difficulty was experienced in obtaining constant weights.

Samples were also collected by Greenberg-Smith impingers to permit a determination of the degree of dustiness, expressed on a particle count basis. Distilled water was used as a collecting medium and particle counts were made according to standard dust counting techniques with the exception of the substitution of a Spencer Bright-Line Haemacytometer cell for counting. Occasional impinger samples were evaporated to dryness to obtain the mass of collected solids.

SUSPENDED SOLIDS

In an effort to determine the influence of wind velocity on atmospheric dustiness, samples were collected over as wide range of wind velocities as possible. A total of 146 air samples was collected and a similar number of wind velocity readings was made during the period from January 1949 through May 1950. The data are shown in Figure I. From the graphical presentation it is apparent that the general level of dustiness remained practically constant up to about seven miles per hour. Samples which were

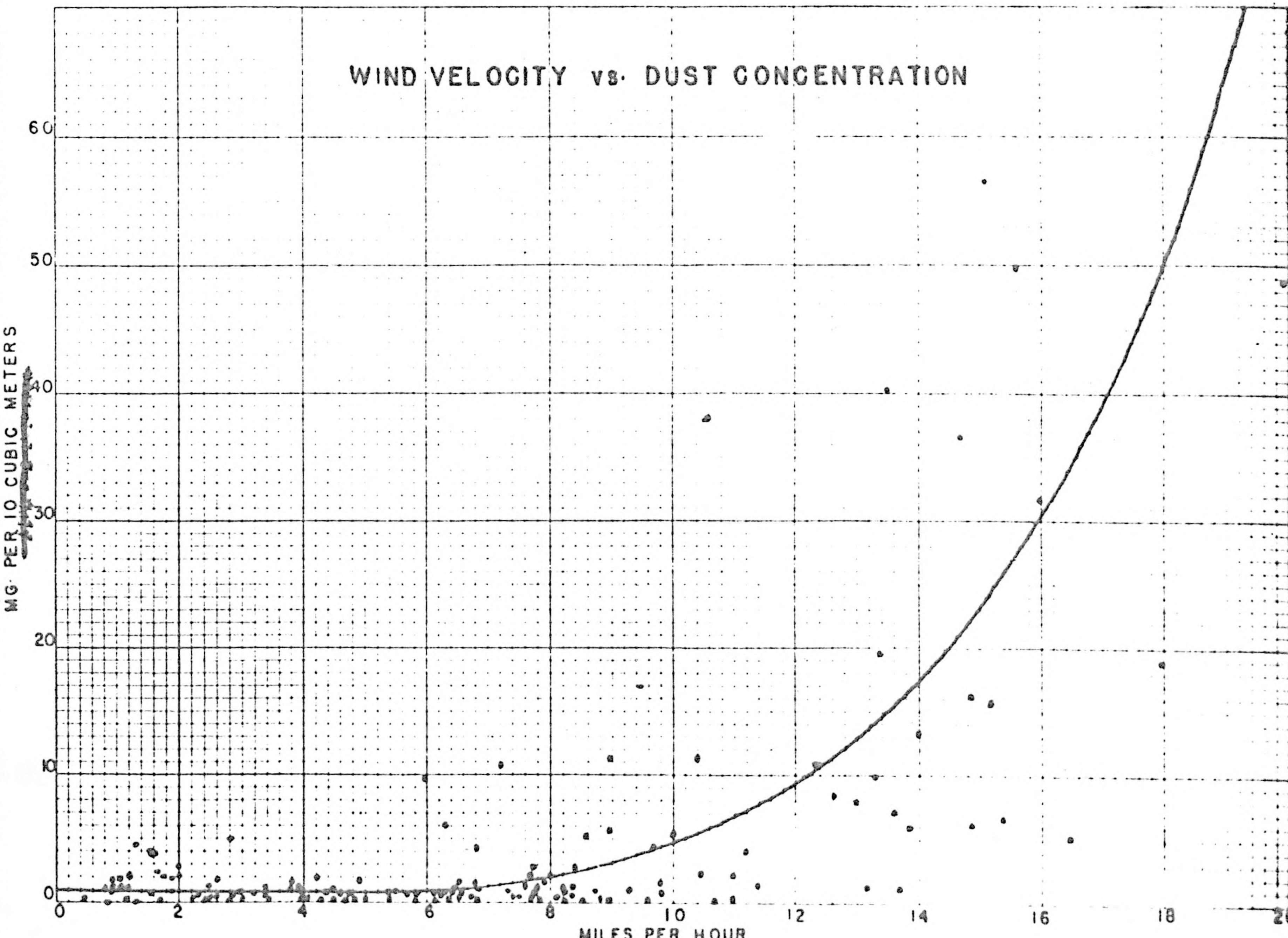
WIND VELOCITY vs. DUST CONCENTRATION
MG. PER 10 CUBIC METERS
0
10
20
30
40
50
60
0
2
4
6
8
10
12
14
16
18
20
MILES PER HOUR

FIGURE I

collected after long periods of essentially still air conditions demonstrated that there was always a suspension of particulates having an average concentration of about 1.0 mg per 10 m^3 (1). This appeared to be the average omnipresent background dust level at minimum wind velocities. The lowest concentrations encountered were slightly less than 0.1 mg per 10 m^3. Occasional samples in the range of low wind velocities showed a distinct deviation in concentration from the average and was believed contributable to sporadic wind gusts and turbulence which raised and transported sufficient particulate matter to influence the samples. The effect of this factor became more pronounced with an increase in wind velocity above six miles per hour.

When the velocity reached a level of about nine or ten miles per hour, a more noticeable increase in atmospheric dust concentrations was prevalent. This level seemed to be just below that where visible dust was being raised from the surface of the ground. Occasional gusts of wind during these periods of elevated velocities were observed to have a more marked effect on the average dust concentrations. Strong gusts frequently raised and transported sand grains approximately 1 mm in diameter to the four-foot sampling level, as observed microscopically in impinger samples. Momentary clouds of relatively large grains of sand produced a marked effect on filter collections even with the protective shelter housing the sampling unit. Above ten miles per hour a progressively wide variation existed in the dust levels as the wind velocity increased. The dustiness at any particular velocity in the higher ranges reflected a more pronounced effect by gusts which appeared to become more frequent with an increase in velocity.

The data did not permit the determination of an exact velocity where dust storms, as identified visibly, occurred. It was observed, however, that the level appeared to be approximately fifteen miles per hour. The maximum velocity encountered for any individual sample during the study was twenty-one miles per hour which produced an accompanying average dust concentration over a period of twenty minutes of 146 mg per 10 m^3.

In an effort to determine the rapidity of the change in atmospheric dustiness, as affected by fluctuations in wind velocity, a series of air samples were collected at short intervals over a period of approximately eight hours when an increase in wind velocity had been predicted. Samples were collected consecutively over the period with a high volume sampler about five feet above ground level. The results shown in Figure II demonstrate that the level of atmospheric dustiness follows with fair rapidity the changes in wind velocity. It was evident that the large particulate matter which was transported by high winds settled rapidly when the velocity diminished. This was evident in three instances during the eight-hour period. At the conclusion of this series of tests, wind velocity dropped from 9.5 miles per hour to 6.4 about thirty minutes later and was accompanied by a decrease in the dust concentration from 16 to 0.72 mg per 10 m^3 which approximated the omnipresent background dust level for this velocity as previously indicated in Figure I.

(1) - Milligrams per 10 cubic meters of air.

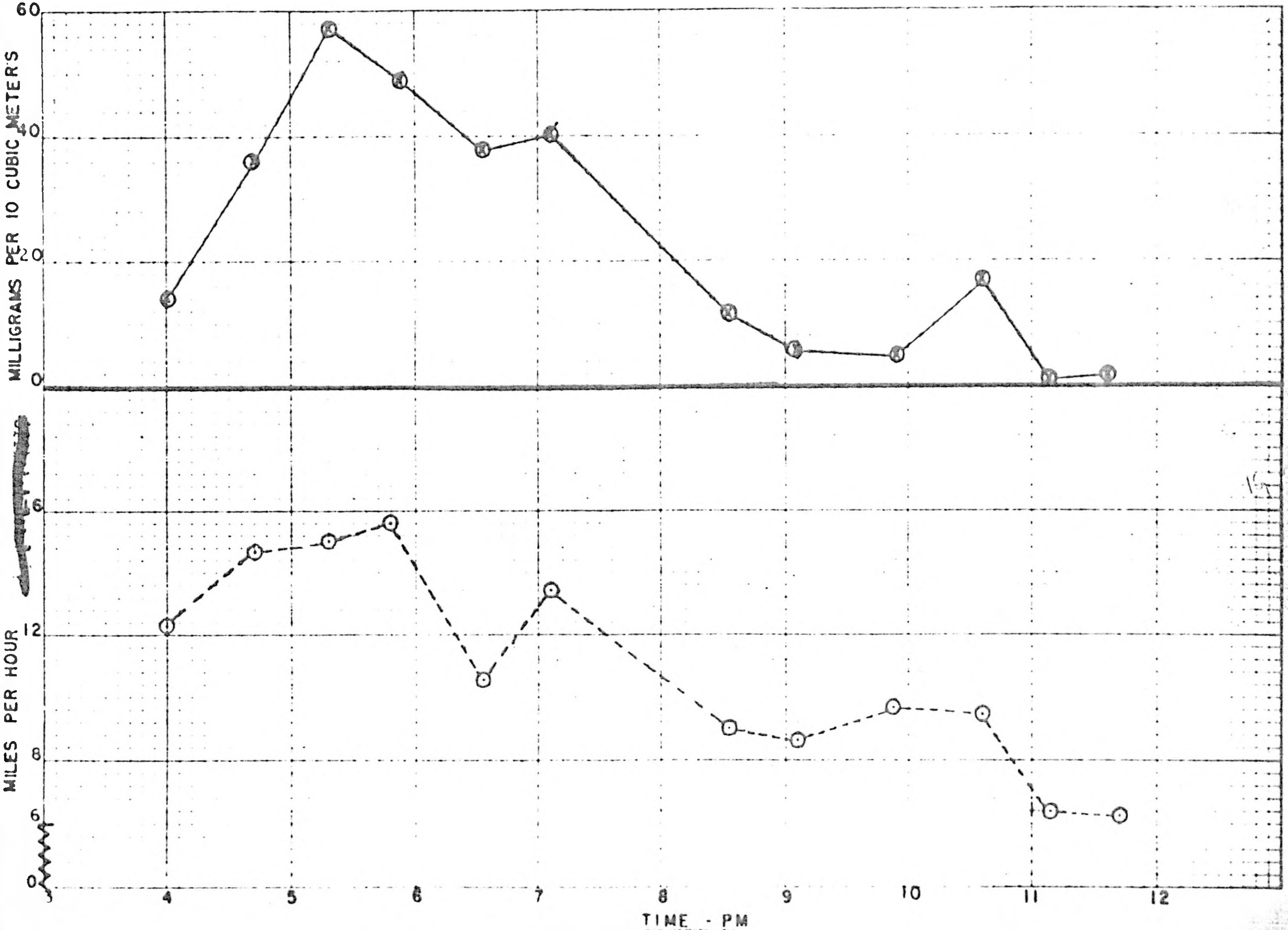

FIGURE 11

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Atmospheric dustiness as portrayed on a particle count basis was evaluated by a series of seventeen dust counts. Samples were collected by a Greenberg-Smith impinger and counted by light microscopy as outlined in standard dust counting techniques. The concentrations were found to vary from a minimum of 0.4 mppcf (1) at an average wind velocity of about 2.2 miles per hour to a maximum of 24 mppcf at a velocity of 15.6 miles per hour. Collected samples showed a large percentage of the total particles having a uniform size of about 0.9 μ or approximately that of the resolving power of the optical system employed. Accordingly, if the settling time for standard counting technique was not adhered to rigidly, wide variations in counting results could be experienced. Although not a part of this investigation, previous air samples of outdoor air obtained by thermal precipitation and analyzed by electron microscopy have demonstrated that the size medium of suspended particulates, on a particle count basis, was approximately 0.02 μ.

The relationship between particle count and mass of suspended solids was also investigated. In some instances impinger samples were taken to dryness and weighed and in other tests the Greenberg-Smith impinger and the high volume sampler were operated simultaneously which permitted direct results on a particle count and weight basis, respectively. No significant difference was noted in the results obtained by the two methods. The relationship between the count and weight of suspended dust is presented in Figure III. The counts reported therein were obtained through standard counting techniques. At the highest wind velocities encountered during this series of tests, the number of particles per milligram of dust was found to be about 10^8. An inverse relationship was found to exist between the ratio of count to weight and at a six mile per hour wind velocity, a predominance of small particles, created by the settling out of the larger particles, showed that a milligram of dust contained about 1.5×10^9 particles. At minimum wind velocities difficulty was experienced as noted previously by the majority of the particles being at the limit of resolution of the microscope system employed.

Samples obtained by long period sampling were conducted consecutively when possible to permit a representative demonstration of the average monthly dust levels. This investigation was conducted for six months, from February through July, consecutively. The average monthly dust levels and the accompanying wind velocities are presented in Figures IV and V, respectively, where it can be seen that the six-month average level of suspended particulate matter was approximately 1 mg per 10 m^3.

SEDIMENTATION OF SOLIDS

The rate of settling of atmospheric solids was determined at four locations on the Hanford Project; two were located on roofs of buildings in the 200 West and 300 Areas, one was in an office in the 300 Area, and the fourth in a louvered attic space of a Richland residence.

Outdoor samples were collected in six-inch diameter battery jars having a height of twelve inches. The jars were placed on four-foot tripods on the two roofs mentioned above. In this manner the collection jar in the 200 West Area on Building 292-U was 25 feet above ground level, and that in the 300 Area in Building 3745-A was about 18 feet above ground level. The

(1)- mppcf = million particles per cubic foot of air.

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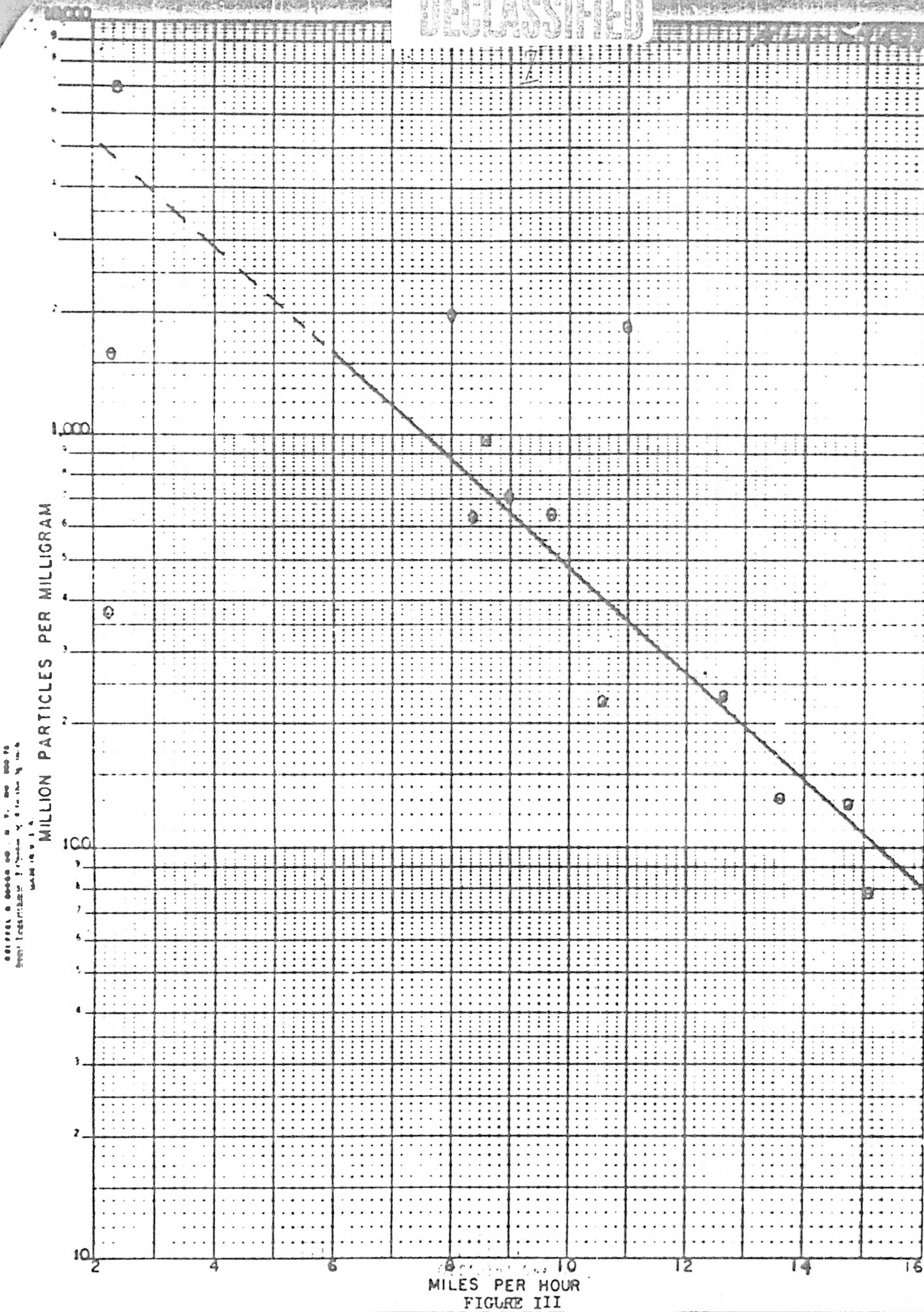
MILLION PARTICLES PER MILLIGRAM
10,000
1,000
100
10
2
4
6
8
10
12
14
16
MILES PER HOUR

FIGURE III

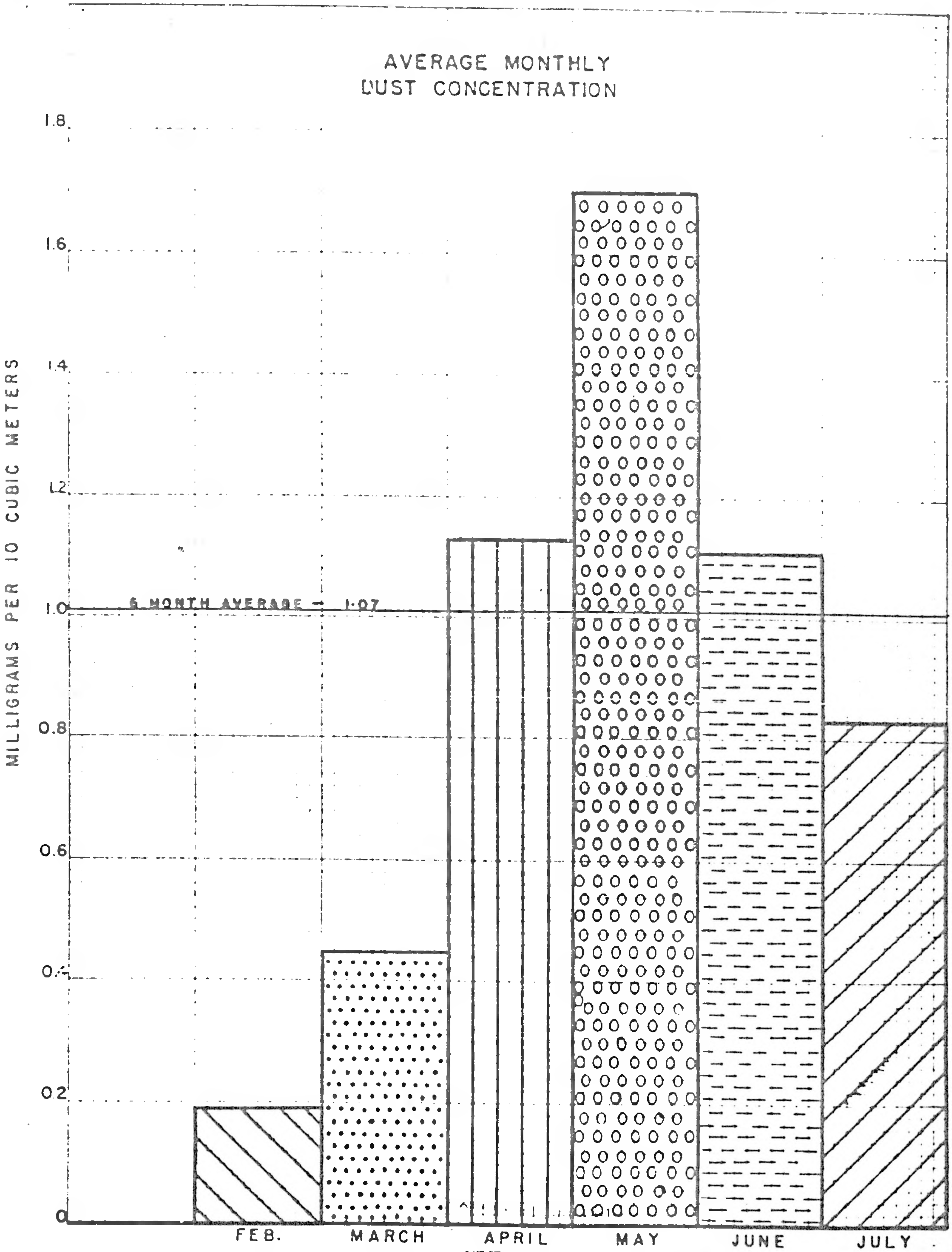
AVERAGE MONTHLY
DUST CONCENTRATION
MILLIGRAMS PER 10 CUBIC METERS
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
6 MONTH AVERAGE → 1.07
FEB.
MARCH
APRIL
MAY
JUNE
JULY

FIGURE IV

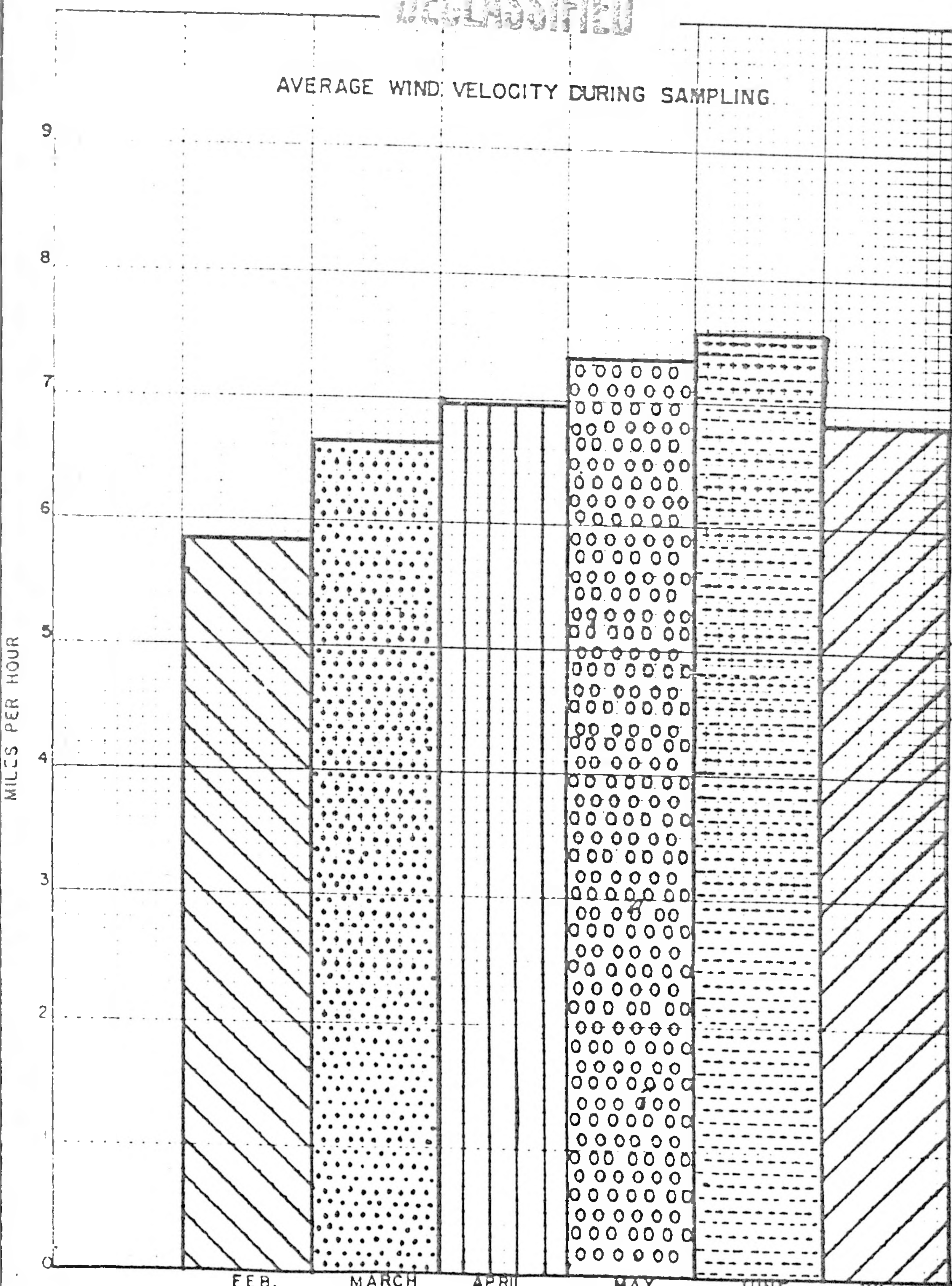
AVERAGE WIND VELOCITY DURING SAMPLING
MILES PER HOUR
9
8
7
6
5
4
3
2
0
FEB.
MARCH
APRIL
MAY
JUNE
JULY

FIGURE V

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sample obtained in Room 14 of 3703 Building, 300 Area, was collected about five feet above floor level in a 4 3/4 inch crystallizing dish placed on a file. The fourth sample, also collected in a crystallizing dish, was collected in the attic space of a residence in Richland.

Considering the possibility of collected dust being blown from the jars, a glycerol-water solution was placed in the bottom to a depth of about 1/8 inch. This liquid was found to be satisfactory for holding all materials which settled from the atmosphere and did not freeze at the low temperatures encountered occasionally during the tests. The sampling jars and dishes were left undistrubed for a period of a month after which the collections were washed out and replaced with fresh solutions.

The glycerol solutions and the contained samples were washed by distilled water from the collection devices and filtered through previously weighed Whatman low-ash paper. The papers were then dried and reweighed. The organic content of the settled solids was determined by placing the papers in a muffle furnace and burning off the combustible fraction.

Sampling was conducted from August 1949 through January 1950, making a total of twenty-four samples. The quantities of settled solids, expressed as tons of material per square mile of area per month, are presented in Table I. The length of an equivalent month was thirty days.

MONTH	SEDIMENTATION RATE (tons/mile^2/month)			
	Bldg. 292-U	Bldg. 3745-A	Bldg. 3703, Room 14	Richland residence
August	32.2	226	1.6	5.8
September	15.3	207	0.6	4.6
October	118	207	2.6	2.5
November	3.3	452	1.4	2.9
December	42.4	1100	8.6	36.1
January	3.6	222	2.5	12.4

TABLE I

The sampling station which consistently demonstrated the dustiest conditions was on the roof of Building 3745-A in 300 Area. This building was adjacent to an unsurfaced driveway which had considerable vehicular traffic. The average rate of settled solids at this location was approximately 400 tons per square mile per month. The second highest dust-fall was at the other outdoor station on the roof of Building 292-U, 200 West Area, where there was comparatively less traffic. The average rate of deposition was 36 tons per square mile per month. The maximum at this location occurred in October, at which time the dust-fall was 118 tons per square mile per month. The sampling station located in the attic space in Richland was sheltered by

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the roof and the dust was carried mainly through the louvers at each end of the attic space. The average rate of deposition in this instance was 11 tons per square mile per month. The lowest values obtained were from the office sampling station in Building 3703, 300 Area, where the average settling rate for the six-month period was 6 tons per square mile per month.

Organic determinations were made on eight individual monthly samples which represented a range in sedimentation rate from 2.5 to 1100 tons per square mile per month. It can be seen in Figure VI that the organic content of the settled atmospheric dust varied inversely as the rate of dust-fall. The organic content ranged from 73.3 percent at 2.5 tons per square mile per month to 3.8 percent at 1100. It has been reported (1) that an analysis of surface soil from the 200 East Area showed an organic content of only 2 percent. It is felt that the inverse relationship indicated in Figure VI was attributed to the pick-up of grains of sand and other salient inorganic particulates from the ground surface during periods of elevated wind velocities which created a reduction of the organic content of suspended solids at such times.

Soil samples for moisture content were secured from the top 1/4 inch of soil, excluding gravel and stone, in a ten-foot square plot of level, unprotected ground. The samples were weighed immediately, then dried to constant weight and reweighed. During periods of minimal precipitation samples were taken weekly. Following precipitation or the melting of snow, samples were collected with sufficient frequency to determine the rapid change in surface moisture content. In most instances soil sampling was conducted coincidental with air sampling and wind velocity measurements. The findings of moisture content are shown graphically in Figure VII.

An attempt was made to correlate the moisture content of the soil surface with the dust and wind conditions prevailing at any particular time. It was found that the data compiled was insufficient to permit a satisfactory determination of any correlation which might have existed in these relationships. It is felt that this was due largely to a dissimilarity of the soil moisture content in areas proximate to the Hanford Works, in which cases the local soil moisture conditions were not necessarily representative of other areas which contributed to the atmospheric dustiness at the sampling location.

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HEALTH INSTRUMENT DIVISIONS

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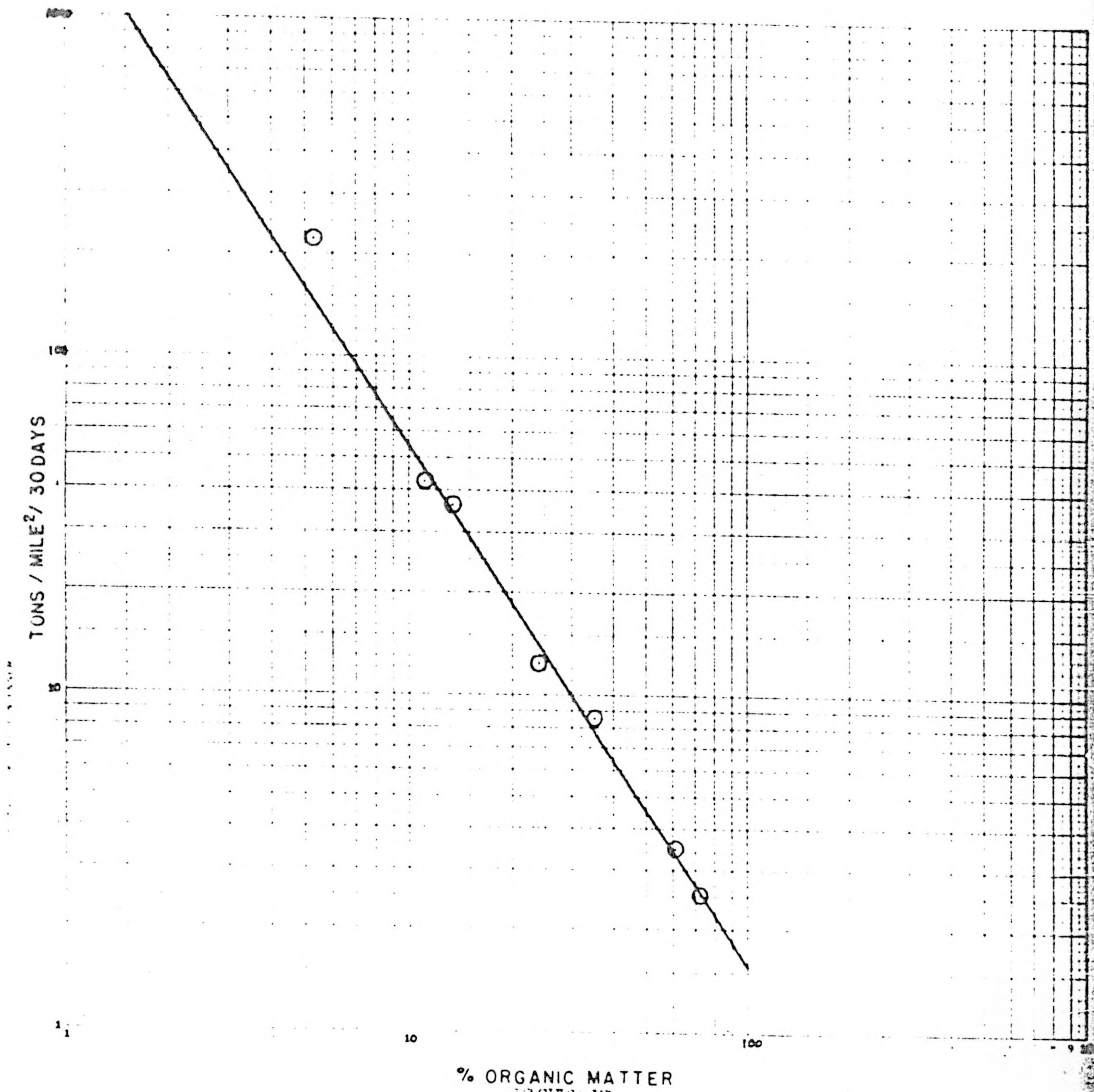

FIGURE VI

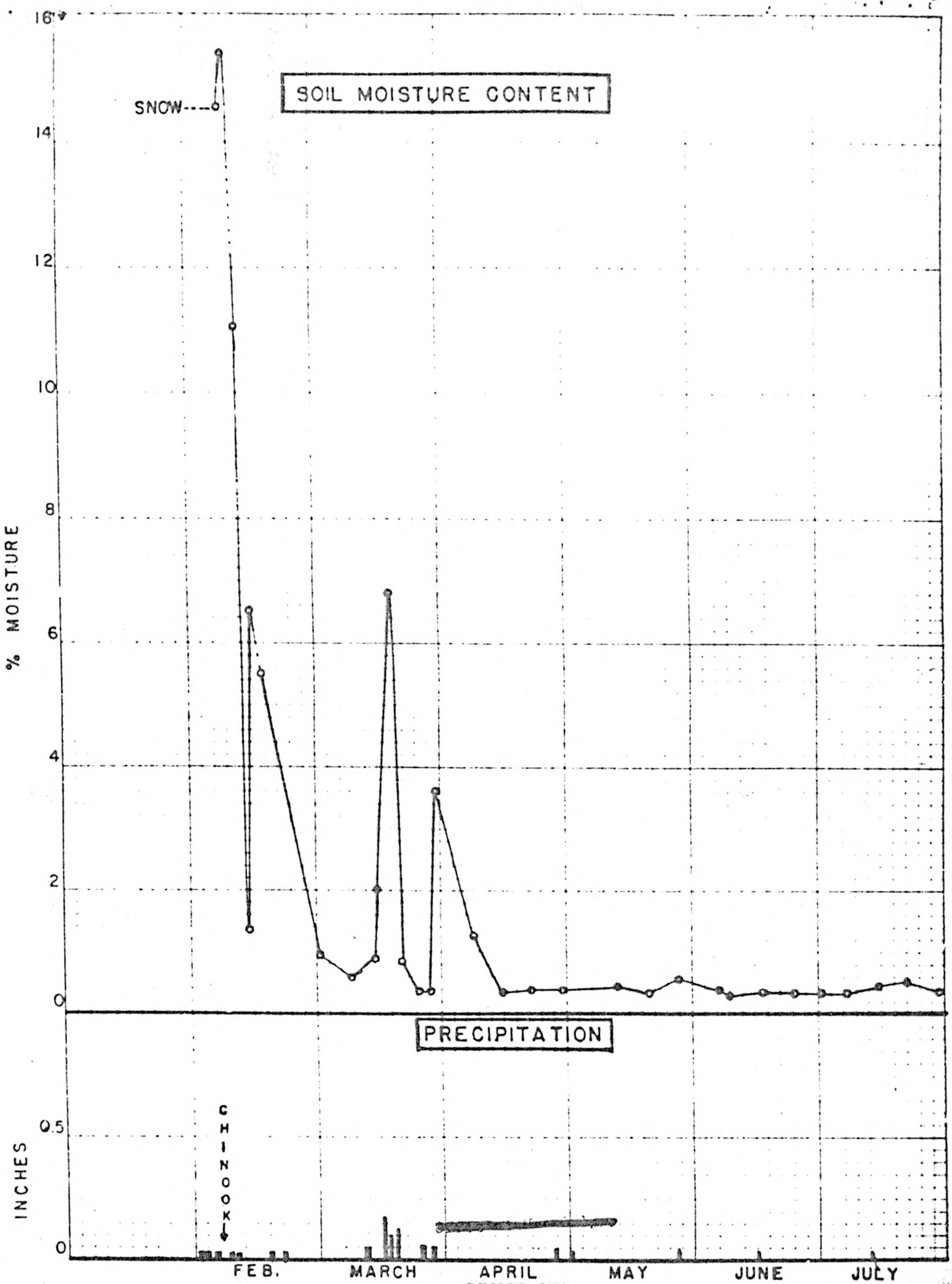
SOIL MOISTURE CONTENT
SNOW
% MOISTURE
16
14
12
10
8
6
4
2
0
PRECIPITATION
INCHES
0.5
0
CHINOOK
FEB.
MARCH
APRIL
MAY
JUNE
JULY

FIGURE VII

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