GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station
Atlanta, Georgia

FINAL REPORT

PROJECT A-881

# UTILIZATION OF GRANITE FINES
# PHASE I

By

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Performed for

SAM FINLEY, INC.

## INTRODUCTION

Very fine granite is recovered in a slurry as waste from the sponsor's mixing plant. It is contemplated to use this waste as raw material for possible useful and profitable ends. As a logical first step, chemical and physical characteristics were determined.

## EXPERIMENTAL PROCEDURE

The sampling procedure was as follows: from eight to ten liters of sample slurry were collected twice daily from the classifier outlet for three successive days. This assured that the samples were representative of the normal waste stream. The sampling schedule may be seen in Table 1.

The first three samples were filtered immediately, but since filtration proved to be a problem, the three remaining samples were allowed to settle for several days and decanted before filtering.

After filtration, the solids were weighed wet, dried, and then weighed again (Table 2). The dry cake was then carefully broken up and pulverized by pressing hard on it - to avoid any decrease in particle size which would have occurred on grinding.

The samples were cut in Carpco riffles and two representative portions of each sample were taken for analyses. One portion was used for size analysis, using sedimentation procedures. The other portion was used for the chemical analysis of the waste by means of x-ray fluorescence.

The results of the particle size distribution determinations may be seen in Table 3, which includes specific gravity of the dust. Specific gravity measurements were done by air displacement techniques. The size distribution curves of the six samples may be seen in Figures 1 to 6.

TABLE 1

SAMPLING SCHEDULE

| Sample No. | Date Taken | Time |
|---|---|---|
| 1 | August 11 | 9:15 A.M. |
| 2 | August 11 | 3:00 P.M. |
| 3 | August 12 | 8:00 A.M. |
| 4 | August 12 | 2:45 P.M. |
| 5 | August 13 | 10:00 A.M. |
| 6 | August 13 | 2:05 P.M. |

TABLE 2

SOLIDS CONTENT OF SLURRY AND MOISTURE CONTENT OF FILTRATION CAKE

| Sample No. | Wt. Dry Solids (gms) | Solids Content of Slurry (wt. %) | Moisture in Filtration Cake (% wt.) |
|---|---|---|---|
| 1 | 699.5 | 8.5 | 31.3 |
| 2 | 896.0 | 8.8 | 27.7 |
| 3 | 705.7 | 8.3 | 33.4 |
| 4 | 761.9 | 8.7 | 32.6 |
| 5 | 846.9 | 8.4 | 34.2 |
| 6 | 807.5 | 8.5 | 32.3 |

TABLE 3

SIZE DISTRIBUTION AND SPECIFIC GRAVITY OF GRANITE DUST

| Sample No. | Sp. Gr. | % Wt. Finer than indicated (Microns) 35 | 20 | 15 | 10 | 5 | 2.5 |
|---|---|---|---|---|---|---|---|
| 1 | 2.79 | 97 | 92 | 86 | 70 | 37 | 15 |
| 2 | 2.72 | 96 | 92 | 86 | 50 | 15 | 10 |
| 3 | 2.70 | 96 | 94 | 89 | 75 | 36 | 16 |
| 4 | 2.79 | 97 | 94 | 88 | 69 | 35 | 13 |
| 5 | 2.76 | 96 | 90 | 81 | 66 | 34 | 13 |
| 6 | 2.73 | 97 | 89 | 81 | 67 | 40 | 14 |

Chemical analysis data was obtained using reference standards such as granite G-1 and diabase W-1. Results of the analysis may be seen in Table 4. Qualitative analysis of the mineral content is shown in Table 5. Due to the extremely fine size of the grains, x-ray diffraction analytical techniques were used.

TABLE 4

X-RAY FLUORESCENCE ANALYSES OF GRANITE DUST
(Weight Percent)

| Sample No. | $Fe_2O_3$ | MnO | $TiO_2$ | $K_2O$ | CaO | $Al_2O_3$* | $SiO_2$* |
|---|---|---|---|---|---|---|---|
| 1 | 5.4 | 0.16 | 0.25 | 2.8 | 0.2 | 14 | 77 |
| 2 | 7.0 | 0.16 | 0.44 | 5.4 | 4.0 | 14 | 69 |
| 3 | 4.5 | 0.10 | 0.30 | 4.4 | 14.0 | 14 | 63 |
| 4 | 6.4 | 0.13 | 0.44 | 6.3 | 6.6 | 14 | 66 |
| 5 | 5.0 | 0.14 | 0.46 | 5.2 | 5.3 | 14 | 70 |
| 6 | 5.9 | 0.15 | 0.45 | 11.4 | 7.8 | 14 | 62 |

*Approximate Percentage

TABLE 5

MINERALOGICAL ANALYSIS OF GRANITE DUST

| Sample No. | Minerals |
|---|---|
| 1 | Biotite mica, chlorite, quartz, feldspars, calcite, anatase, hematite, hornblende. |
| 2 | Biotite (and possibly muscovite) micas, chlorite, quartz, feldspars, calcite, ilmenite, hornblende. |
| 3 | Biotite mica, quartz, feldspars, hornblende, calcite, hematite. |
| 4 | Biotite and muscovite micas, chlorite, quartz, feldspars, hornblende, calcite, hematite. |
| 5 | Biotite mica, possibly muscovite mica, quartz, feldspars, hornblende, calcite. |
| 6 | Biotite mica, quartz, feldspar, anatase, hornblende, hematite, possibly magnetite, calcite. |

## SUMMARY OF RESULTS

### Mineral Composition

The minerals identified in the rock dust include the major and minor components characteristic of granite. The presence of hornblende suggests that the analyzed rock dust differs from other local granites.

### Chemical Composition

The analyzed rock dust has a relatively uniform concentration of iron, manganese, titanium, aluminum, and silicon. The potassium content in samples 1 to 5 is fairly constant; sample 6, however, shows a relatively high $K_2O$ content. Calcium content varies somewhat from low in sample 1 to high in sample 3.

Attempts to correlate these differences with specific gravity measurements and particle size distribution proved unsuccessful. It was noted, however, that samples in which muscovite was not identified showed greater chemical variation than the muscovite-containing samples.

The iron content of the samples is higher than the values listed in published analytical data for granites.

This may be partially attributed to the biotite enrichment of the fine fractions. The biotite content increase in the rock dust may have come about by either the mineral occurring mostly as very fine particles in the original uncrushed rock, or by the action of the air separator which may separate mica particles at a coarser size than the other non-platy minerals.

Another reason to be considered which may partially account for the high iron content is the relative abundance of hornblende and hematite in fine particles in the original rock.

The amount of potassium present in the rock dust is within published experimental values obtained for granite. This is also true of the other elements analyzed, except calcium. Calcium content is higher than literature values. If the hornblende distribution hypothesis advanced above is valid, then the calcium content will be higher than normal, since hornblende contains calcium.

The content of iron, potassium, and calcium present in the dust are of importance if the manufacture of expanded lightweight aggregates for concrete is considered.

It has been stated in the literature that bloating clays usually contain six percent or more of iron oxides and approximately six percent of alkalies and alkali earth (potassium, sodium, and calcium). If the alkali and alkali earths exceed six percent, however, there are tendencies towards stickiness and slagging in the kiln. Since this percentage is exceeded in the granite dust, it is thought that experimentation towards lower bloating temperatures, or the addition of sand to this dust may be a desirable step towards the economic utilization of this waste product.

Specific Gravity in Size Distribution

The specific gravity of the dust is essentially constant as shown in Table 3.

As it may be seen from Table 3 and Figures 1 to 6, the size distribution in all samples remains within the same limits and have from ten to sixteen percent weight finer than 2.5 microns. This size distribution overlaps somewhat the size distribution of some clays. The solids content of the slurry sampled shows little variation in the three-day period of sampling as indicated in Table 2. It is also evident that the moisture retention of the filtration cake is in the range of water content of some kaolin clays filtration cakes (Table 2). Filtration problems, such as very slow filtration rates and filter-plugging, were the result.

Testing of filtration aids, such as flocculants, should prove of interest to remedy these undesirable characteristics.

## CONCLUSIONS

1. The minerals present in the rock dust correspond to the mineral suite normally found in granites.

2. The concentration of analyzed elements in the dust correspond to values found in the literature with the exception of iron and calcium. An explanation is offered: either the biotite or the hornblende (or both) are more abundant in the finer fractions than the other minerals.

3. The average specific gravity of six rock dust samples is 2.75.

4. The particle size distributions show small change among samples in the time investigated.

## RECOMMENDATIONS

1. The filtration of the solids from the slurry has proven difficult, and a study on filter aids, such as flocculants is recommended.

2. The fine particle size of the rock dust may make it suitable for many uses. It is recommended that the following be investigated:

a. expanded lightweight aggregates

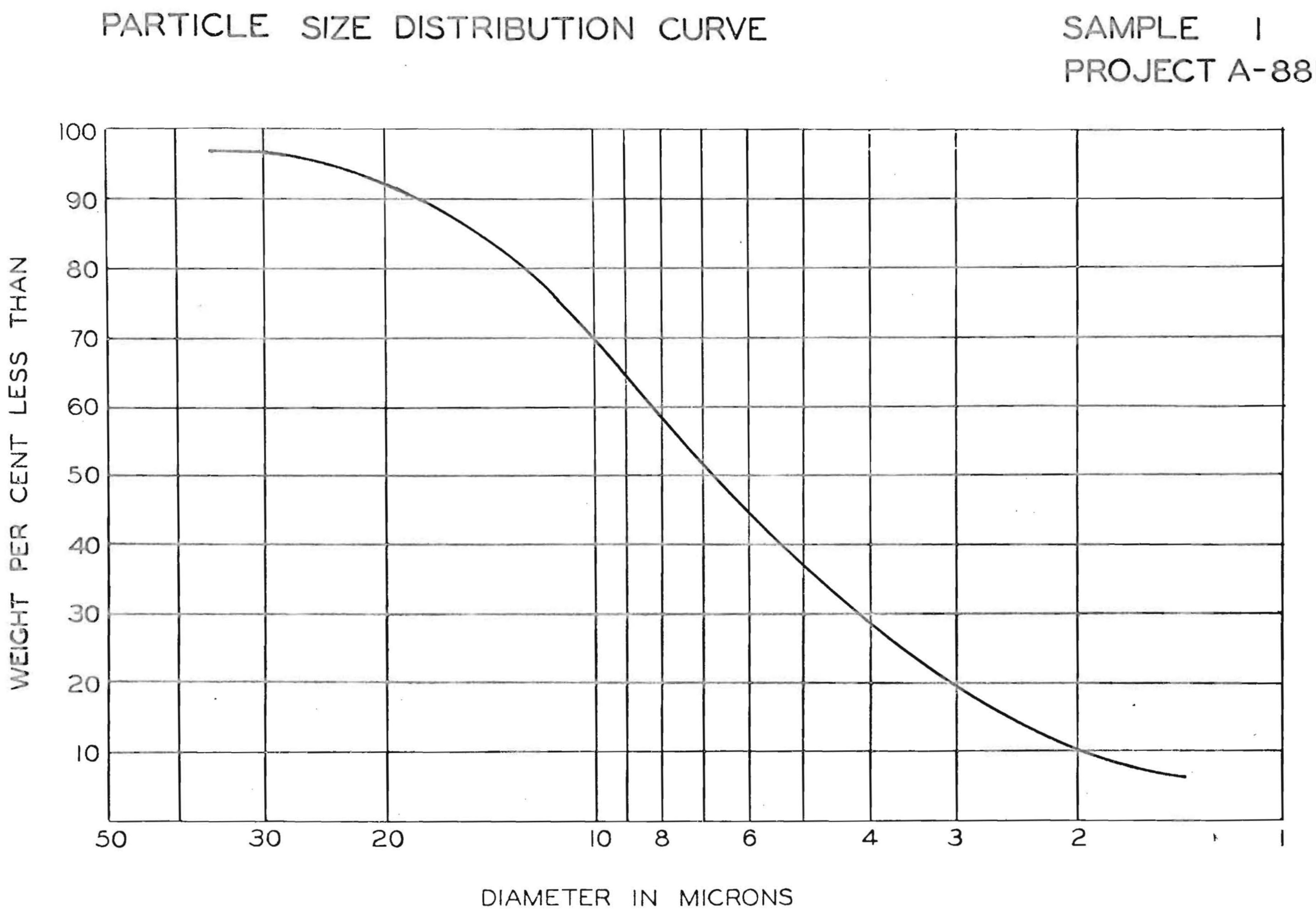
b. inert material for insecticides

c. filler material

d. garden soil conditioners

e. abrasive and polishing material.

Figure No. 1



PARTICLE SIZE DISTRIBUTION CURVE
SAMPLE I
PROJECT A-881
WEIGHT PER CENT LESS THAN
100
90
80
70
60
50
40
30
20
10
50
30
20
10
8
6
4
3
2
1
DIAMETER IN MICRONS

Figure No. 2

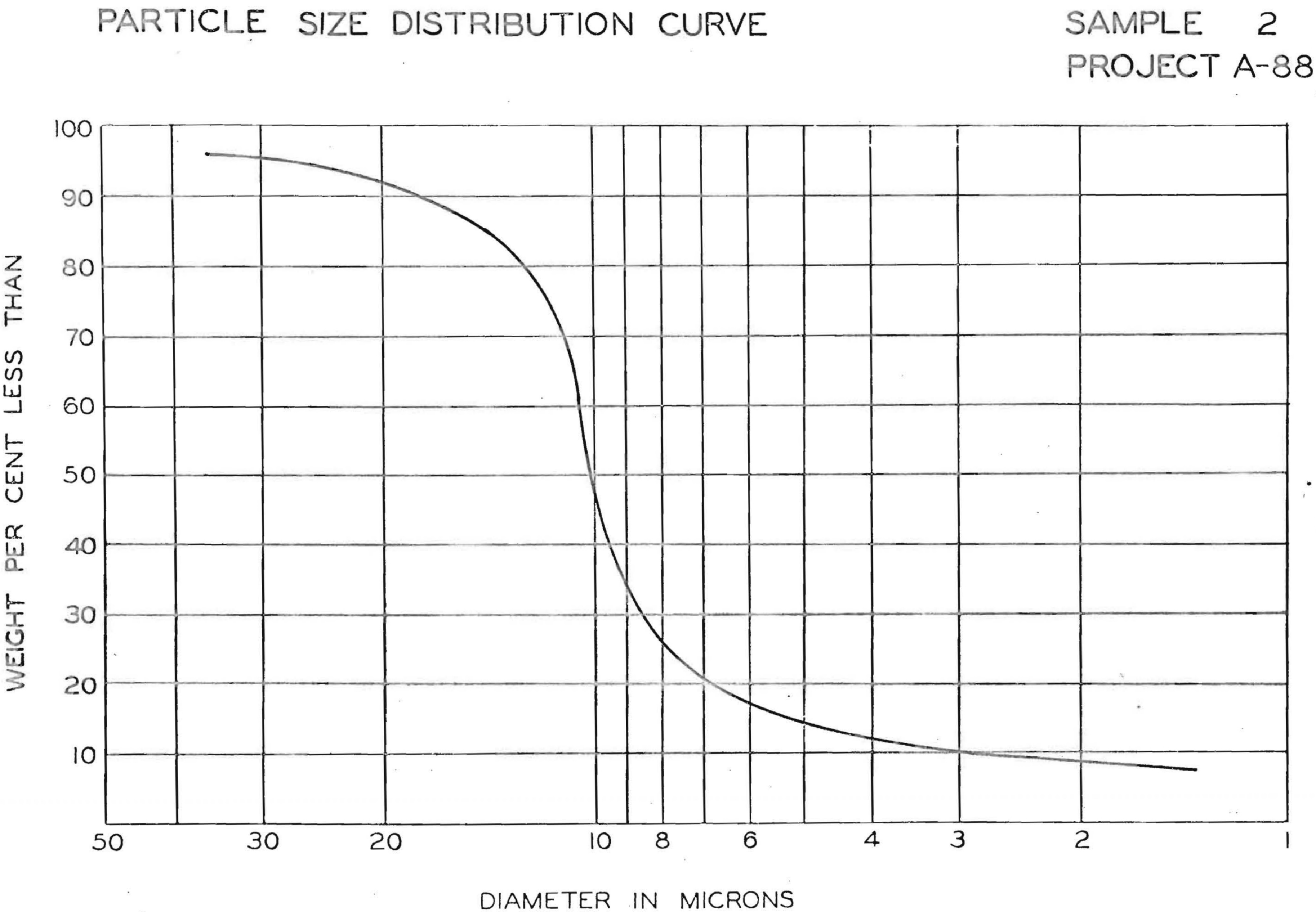
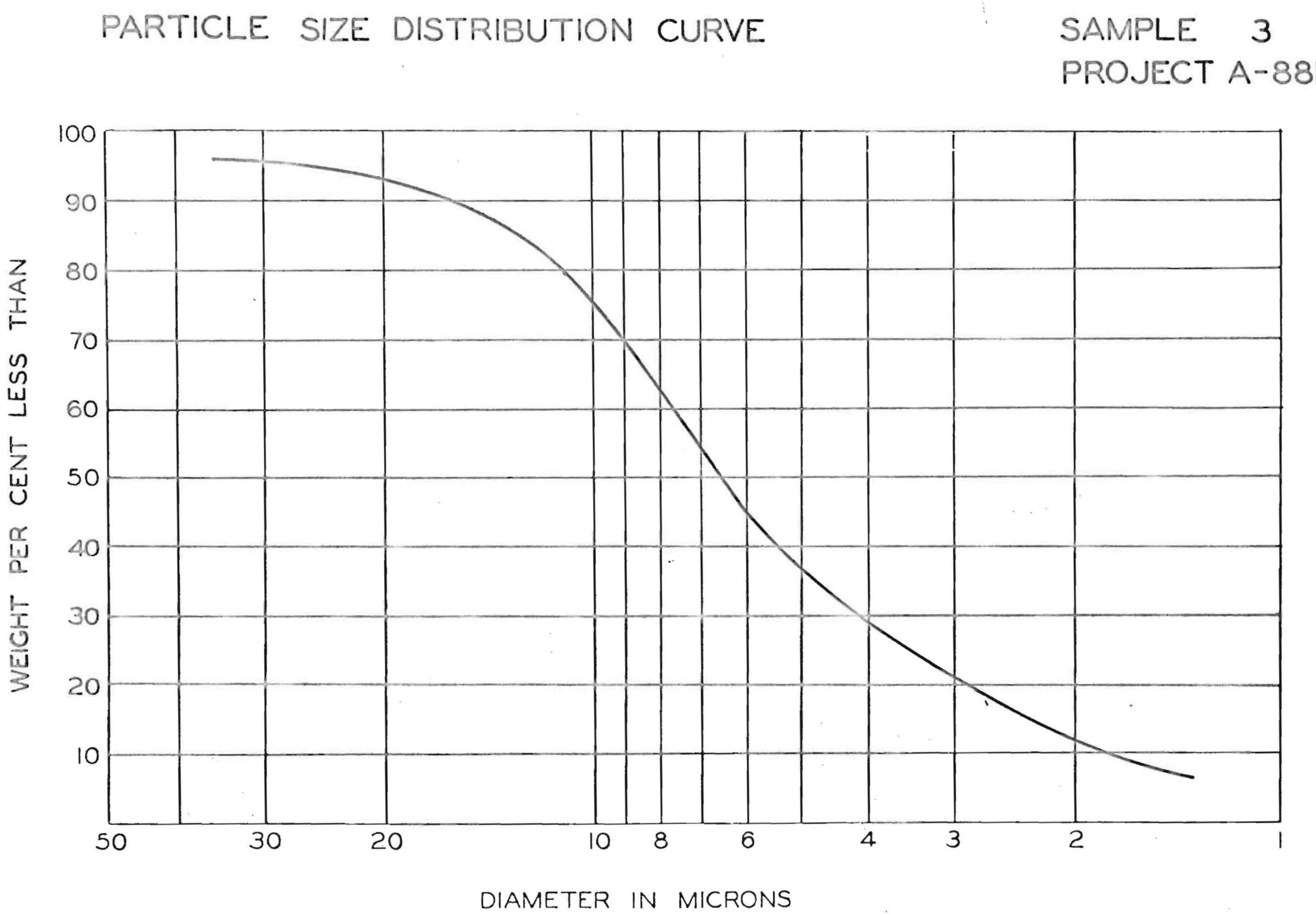
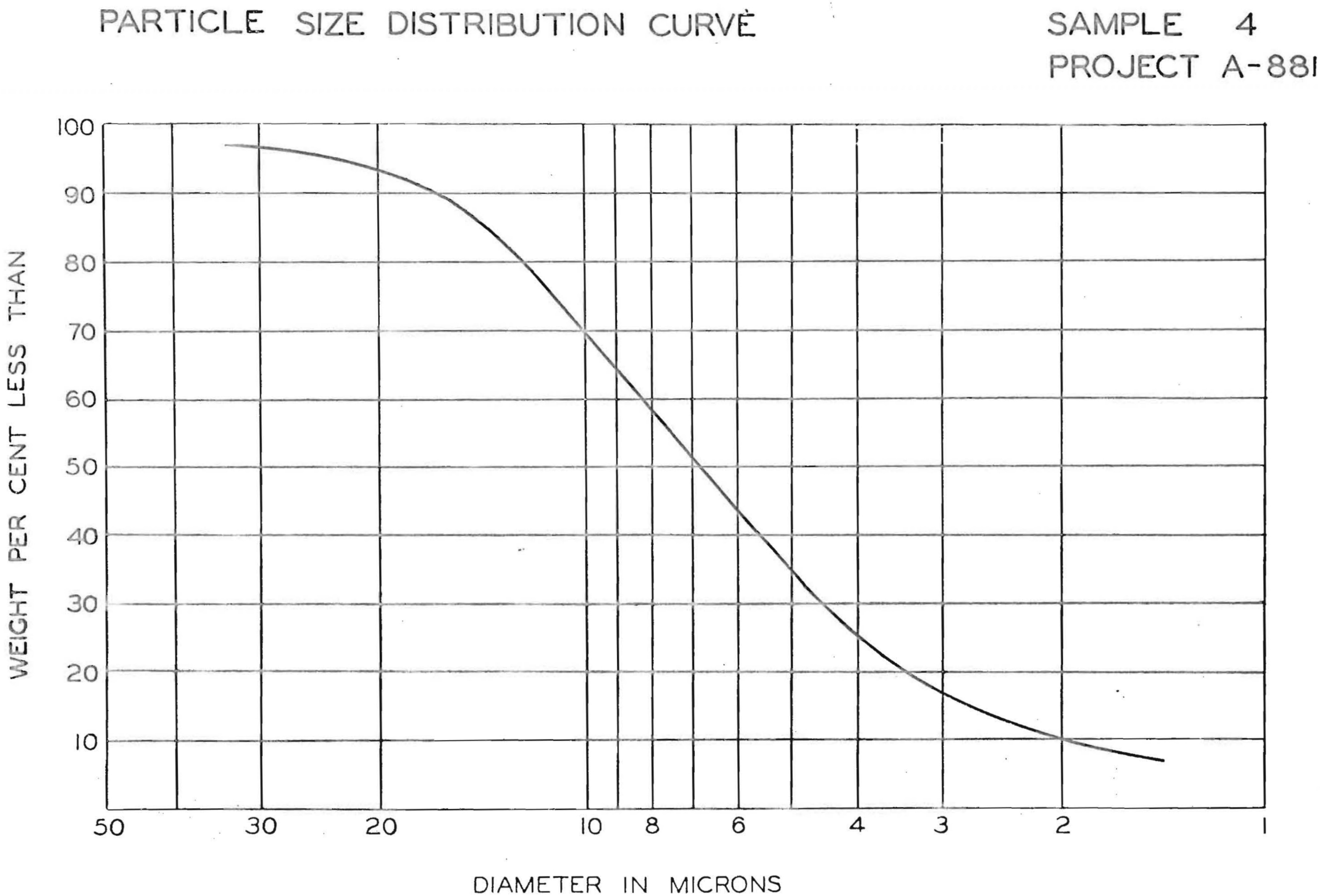

PARTICLE SIZE DISTRIBUTION CURVE
SAMPLE 2
PROJECT A-881
WEIGHT PER CENT LESS THAN
100
90
80
70
60
50
40
30
20
10
50
30
20
10
8
6
4
3
2
1
DIAMETER IN MICRONS

Figure No. 3



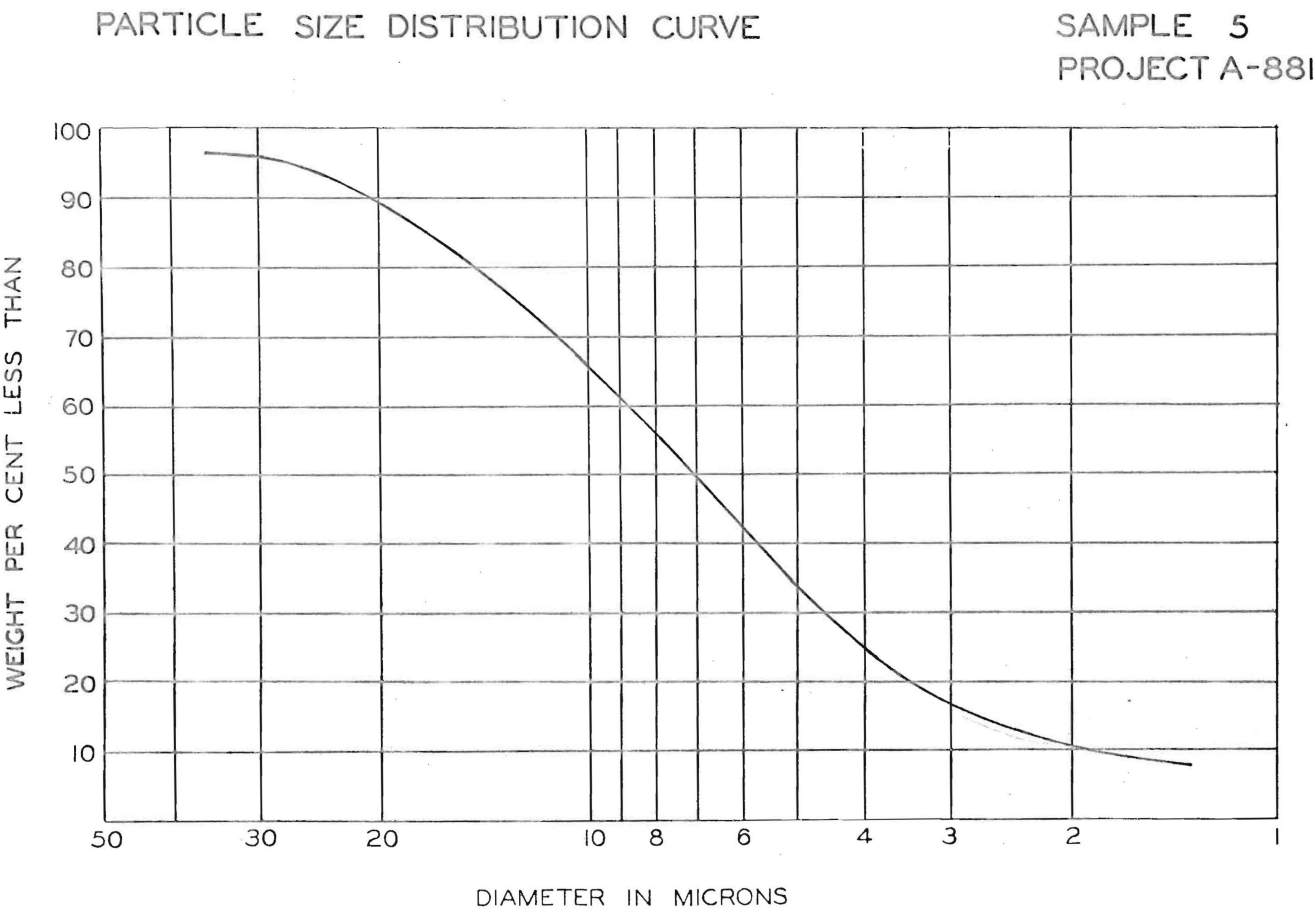
PARTICLE SIZE DISTRIBUTION CURVE
SAMPLE 3
PROJECT A-881
WEIGHT PER CENT LESS THAN
100
90
80
70
60
50
40
30
20
10
50
30
20
10
8
6
4
3
2
1
DIAMETER IN MICRONS

Figure No. 4



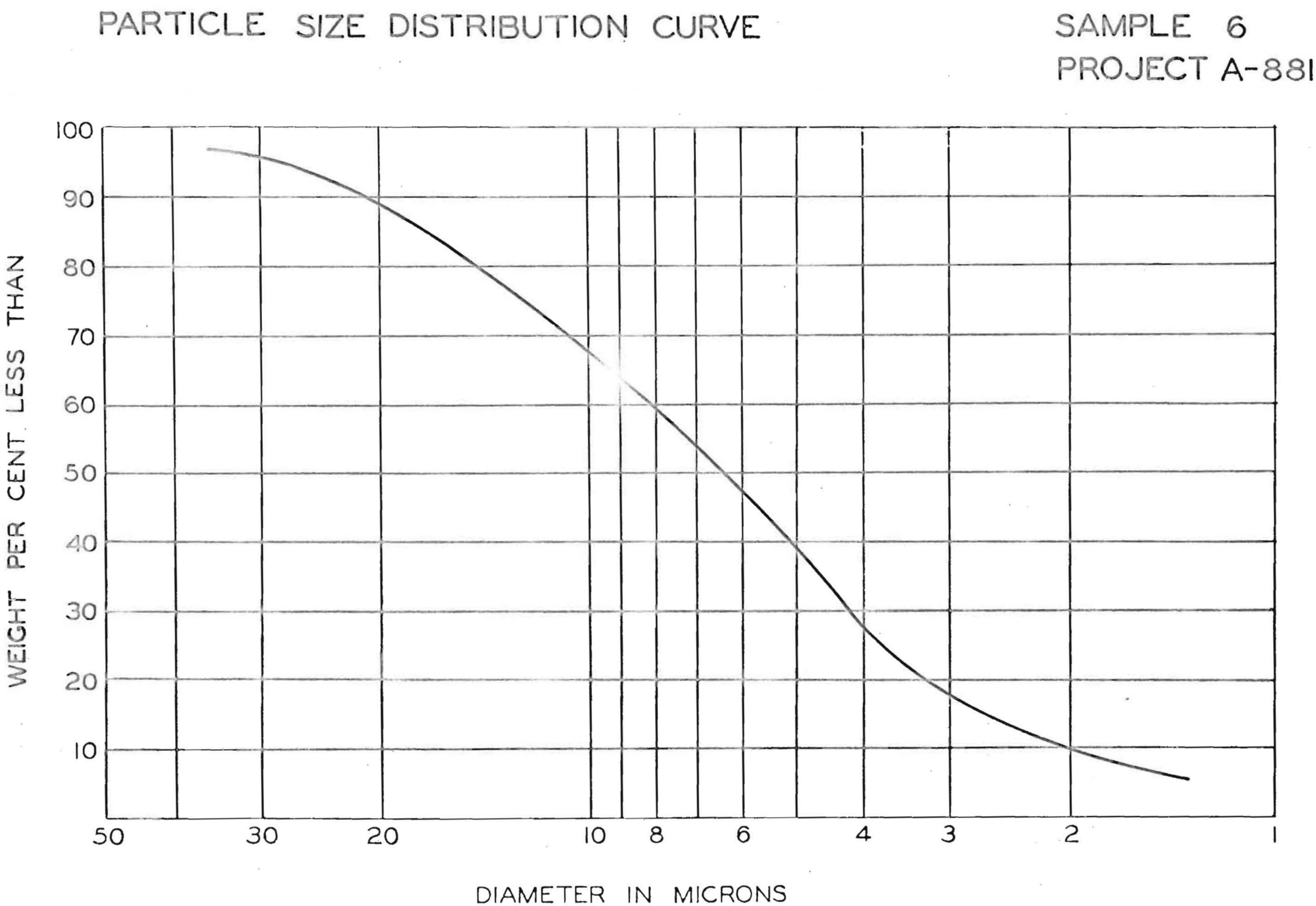
PARTICLE SIZE DISTRIBUTION CURVE
SAMPLE 4
PROJECT A-881
100
90
80
70
60
50
40
30
20
10
WEIGHT PER CENT LESS THAN
50
30
20
10
8
6
4
3
2
1
DIAMETER IN MICRONS

Figure No. 5



PARTICLE SIZE DISTRIBUTION CURVE
SAMPLE 5
PROJECT A-881
WEIGHT PER CENT LESS THAN
100
90
80
70
60
50
40
30
20
10
50
30
20
10
8
6
4
3
2
1
DIAMETER IN MICRONS

Figure No. 6



PARTICLE SIZE DISTRIBUTION CURVE
SAMPLE 6
PROJECT A-881
WEIGHT PER CENT LESS THAN
100
90
80
70
60
50
40
30
20
10
50
30
20
10
8
6
4
3
2
1
DIAMETER IN MICRONS