COMPARISON OF SAMPLING AND TEST METHODS FOR DETERMINING ASPHALT CONTENT AND MOISTURE CORRECTION IN ASPHALT CONCRETE MIXTURES

by

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DISCLAIMER

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100 INTRODUCTION

Concerns have been expressed by the Oregon Asphalt Paving Association regarding the reliability of sampling and test procedures used by OSHD to determine the asphalt content and gradation of asphalt concrete mixtures. In response to these concerns an evaluation of O.S.H.D. sampling procedures, method of moisture determination, and asphalt content were undertaken. The O.S.H.D. Materials Laboratory in cooperation with W. Reid Meritt, Project Manager of the Moro-Grass Valley Contract, and Frank. D. Morrison, Project Manager of the Powers Jct.-Shields Contract, compared two methods of sampling and four methods of determining moisture content of asphalt concrete mixtures.

110 Objective

The purpose of this report is to identify the difference, if any, in AASHTO and OSHD test procedures and results. This report addresses the effect of the size of samples taken in the field and evaluates the methods of determining the moisture content of asphalt concrete mixtures in the determination of asphalt content and gradation.

120 Scope

This report consists of a background of AASHTO procedures, a background of Oregon's procedures, both in the central and field labs, a verification of Oregon's procedures, in both the central and field labs, other agencies' procedures, and a comparison of the test procedures.

200 AASHTO TEST METHODS

AASHTO's procedures for "Sampling Bituminous Paving Mixtures", AASHTO T168, includes plant-mixed bituminous mixtures, at the place of manufacture and from the roadway, and sampling road-mixed bituminous mixtures. This procedure was first written in 1955 and has had only minor revisions, the latest in 1982, when a section on sampling from a conveyor belt was added.

The test procedure for determining moisture in bituminous mixtures, AASHTO T110, was first published in 1942. The test uses a distillation process to remove the moisture from the bituminous sample. This test procedure has been revised twice. First, in 1960, a diagram of the trap used to collect the moisture was added. Then, in 1970, an editorial revision was made changing the format of the text, but not the test itself. Basically the present AASHTO T110, "Moisture or Volatile Distillates in Bituminous Paving Mixtures", is the same as that used in 1942.

AASHTO T164, "Quantitative Extraction of Bitumen from Bituminous Paving Mixtures" was first written in 1955, in which a centrifuge was used. The test has been revised seven times since then, with only three major changes. In 1965, there was the addition of Methods B, C, and D for extracting the bitumen from the mixture sample. A minimum sample size, for different sized aggregates, was adopted in 1974. Then, in 1975, Method E, The Vacuum Extractor, was added as an alternative method of extraction.

The test for "Mechanical Analysis of Extracted Aggregate", AASHTO T30, was first published in 1931. It has had seven revisions, with only two significant changes. One revision, in 1955, gave a more specific description of the precision of equipment used. Then, in 1984, it included a section on "Significance and Use" and "Precision", describing what the results are used for and the allowable differences between two tests on the same material.

300 OSHD TEST METHODS

310 Central Laboratory

Samples received by the lab are warmed in the microwave and split into a 300 gram moisture and a 2000 gram extraction sample. If the mix is received in more than one container, it is mixed together after being warmed and before it is split. A metal plate is used to split the samples.

The 300 gram sample of mix is put in a metal container, weighed and placed in an oven. The oven has a circulating air fan and is capable of maintaining a temperature of 230 plus or minus 9 degrees F. The sample is dried to a constant weight, usually 15 to 24 hours, and weighed again. The percent moisture content of the 300 gram mix sample, which represents the same sample as the 2000 gram extraction sample, equals the weight of the moisture times 100, divided by the weight of the dry material. This oven method, used to determine the moisture content of bituminous mixtures, has been used by Oregon since

1959. This method closely parallels OSHD TM 311,which is used for the oven drying of aggregates.

The 2000 gram sample of mix is put in a stainless steel pan and weighed. Methylene chloride is poured on the sample. The sample is covered and soaked for several hours or overnight. Then a vacuum extractor is used to extract the asphalt as the sample is being washed with methylene chloride. After the sample of asphalt concrete mix is thoroughly washed, the remaining extracted aggregate is put in a pan and dried in an oven, at 230 degrees F., to a constant weight. The moisture content percentage of the 300 gram moisture sample, determined by oven drying, is used to calculate the dry weight of the 2000 gram mix sample before extraction. This mix dry weight is compared to the dry weight of the aggregate after the extraction to determine the extracted asphalt content. This vacuum extraction, OSHD Test Method 309, has been used since 1970. Prior to 1970 a centrifuge method was used.

Since 1969 a retention factor has also been used to determine the total asphalt content of a mix sample. Prior to paving on each project, a mix design is prepared using aggregate and asphalt that is to be used in the paving. During this process, a sample of the aggregate, asphalt, and additives, if required, are mixed in the laboratory and tested to establish the job mix formula that will be used for the paving on each project. A vacuum extraction test is performed on a laboratory prepared sample of mix at the designed asphalt content and the extracted asphalt content is computed. The difference between the computed or extracted asphalt content and the amount of asphalt put in the laboratory prepared sample is the retention factor. This factor, the amount of asphalt that is absorbed by the aggregate or the solvent is unable to extract from the aggregate, generally varies from 0.0 to 0.9 percent, depending on the type of aggregate or asphalt used in the mix. The summation of the extracted asphalt and retention factor equal the total asphalt content in the mix.

OSHD Test Method 207 "Mechanical Analysis of Extracted Aggregate", similar to AASHTO T30, is used to determine the gradation. The OSHD Method uses a dry sieve analysis rather than a wet sieve analysis on extracted sample. The advantage of the OSHD Method is the reduced time required to obtain the results of tests.

320 Field Laboratory

Field sampling procedures for asphalt concrete (AASHTO T168 and OSHD) are referred to in the Highway Construction Manual under Subsection 106.08. The OSHD reference is to the Inspectors Manual, which was printed in about 1968, and subsequent instructions. The Construction Section intends to update and consolidate these procedures by the spring of 1985, utilizing experience gained during the 1984 paving season.(7)

Part III, Page 90 of the Inspectors Manual describes the "cigar box" sampling method used in the 1960s and 1970s. AASHTO 168 describes sampling from the plant and from the roadway. Samples from the roadway for 3/4 inch maximum size mixture are to be taken from a 100 square inch area behind the paver after compaction. OSHD samples the same roadway area, prior to compaction, with a square end device with vertical sides.(7)

During the 1960s and 1970s most roadway samples for job control purposes generally weighed four to five pounds (1800 - 2300 grams). From this sample, a smaller 1000 gram sample was obtained for extraction tests. With the advent of statistical projects about four years ago, vacuum extractors to test larger samples have since been assigned to all such projects. Consequently, since 1983, 16-pound (7200 gram) samples are generally obtained (7). Field tests for determining the moisture content in a mixture are generally performed on a 1000 gram portion of the total sample. The method currently used by the Highway Division for moisture content testing to determine asphalt content on statistical projects utilizes standard drying ovens or microwave ovens, if available, to dry the sample. Presently, OSHD doesn't have a written test method using the microwave oven, however, the test method which has been used requires a correlation to the standard 24 hour or constant weight oven dried test results.

The microwave oven method has been used to obtain test results rapidly for each sublot sample. Projects not having a microwave oven have used the standard drying oven method which requires a drying time of 15 to 24 hours. Microwave ovens for field use have been purchased over the past three years with approximately half of these ovens purchased in 1984. By the start of the 1985 construction season, there will be an OSHD written test procedure for determining the moisture content with a microwave (7). Both the Materials Section and Construction Section will be involved in the writing of this procedure. All field labs will be equipped with a microwave oven.

During the 1970s, field personnel used the rotarex for field extraction testing. This equipment was limited to a sample size of 1000 to 1500 grams. When vacuum extractors were provided to field personnel in the late '70s and early '80s, many Project Managers, but not all, began to use larger extraction samples.

The procedures for running extraction tests are documented in the Materials Section Laboratory Manual, OSHD Test Method 309. This procedure is a slight modification of AASHTO T164. Under Method A, OSHD 309 states that "Normally samples for extraction tests shall be 1000 grams." This was the size limited by the old rotarex equipment. Under Method B, OSHD 309 states that the sample sizes shall "conform to the weight requirement as shown in Table 1." This Table 1 is in agreement with Table 1 from AASHTO T164 which shows a minimum 2000 gram sample for "B" mixes and 1500 grams for "C" mixes. OSHD 309 Method B uses the vacuum extraction apparatus which is the same as that used in AASHTO T164 Method E.

The test performed in the field to determine the gradation of extracted aggregate is the same as that used in the Central Lab. Unlike AASHTO T30 the OSHD method requires a dry sieve analysis rather than washing the extracted aggregate to determine a more precise passing #200 amount of material. However, the second drying of the aggregate, using the T30 procedure, results in nearly twice the time for completion of each individual test.

400 CERTIFICATION OF CENTRAL LAB AND FIELD TESTING PERSONNEL

410 Central Laboratory

The AASHTO Materials Reference Laboratory (AMRL) inspects the OSHD Materials Lab every 12 to 18 months. During these inspections both test procedures and equipment are checked for compliance with AASHTO requirements. Of the 13 inspections since 1966, only minor equipment problems have been found. The most recent inspection, in March of 1984, showed that OSHD Materials Laboratory performs both the T164 (Extractions) and T30 (Gradations) in conformance with AASHTO. All of the equipment for these two tests was also confirmed to be within specifications.

AMRL also sends bituminous concrete reference samples to the lab annually. The results of the tests performed on these samples are compared with those from other state and federal laboratories. Over the past years, the OSHD Materials Lab has received good ratings on these tests.

The Central Lab also does cooperative testing with several Western states to check and compare test results.

420 Field Testing Personnel

Both the Region Construction offices and Materials Section Lab offer training classes each winter to all the lab technicians from the field. The procedures for all the field tests are included in the classes and each person is evaluated for reliability to perform these tests. Upon completion of these training classes and passing a written test the Construction Section certifies field testing personnel in soils, aggregates, concrete, asphalt concrete paving, and portland cement concrete paving.

The Central Lab has also regularly prepared asphalt concrete mixture check samples over the past several years, which are sent to the field labs and tested. The results from field labs are compared with the Central Lab's results. Five hundred of these samples are currently being prepared and will be used for training or sent to the field before the start of the 1985 paving season.

500 SAMPLING AND TESTING PROCEDURES BY OTHER AGENCIES (Based on data obtained in 1984)

Arizona Highway Division obtains its bituminous mix samples off a 1' x 4' steel plate after it has been paved over. A modified AASHTO T110 procedure is used to determine the moisture content of the extraction sample. A vacuum extraction is performed on a 2000 gram sample. This extraction is similar to AASHTO T164, except the solvent is decanted over a #200 sieve before it goes onto the filter paper. The gradation is found by sieving the extracted material after it has been washed and dried.

California Department of Transportation samples its mix from the plant discharge chute or truck box. A 500 gram sample is quartered out and either a microwave oven or standard oven is used to determine the moisture content. A vacuum extractor is used on a 2000 gram sample in accordance with AASHTO T164. The gradation is determined from sieving the dried extracted sample.

Idaho Department of Highways relies mainly on tank stickings to determine the asphalt percentages. They also run dry sieve analysis on aggregate sampled before it is mixed with the asphalt. When they do test the mix for gradation and asphalt content it is sampled from the plant chute. A sample is oven dried to determine the moisture content and compared to a maximum allowable of 1 percent. A vacuum extraction test is performed on an oven driede sample to find the asphalt content, with no moisture correction used.

Washington Department of Transportation samples bituminous mixtures from behind the paver or from the truck box. They determine the moisture content for asphalt content determination by both oven and T110 methods. WSDOT Test Method No. 711 "Quick Method for the Determination of Aggregate Gradation and Asphalt Content of Mixtures" is used in place of AASHTO T164 and T30. In the WSDOT procedure, the bituminous mix sample is washed with trichloroethane over a #200 sieve, dried, and sieved for the gradation. The material passing the #200 sieve and the solvent is then filtered with a vacuum. The difference between the dry weight of the mix sample for extraction and oven dry weight of the material on the filter plus the weight of the material for gradation is used to determine the asphalt content.

Federal Highway Administration obtains their test samples from behind the paver or from the truck box. The AASHTO T110 procedure is used to determine the moisture content. The extraction is performed in accordance with AASHTO T164 Method "E", except the asphalt solvent solution is decanted over a #200 sieve before it goes onto the filter paper. A dry sieve analysis is performed on the dried aggregate from the extracted sample of mix.

600 FIELD SAMPLING AND TESTING PROCEDURES

This study was done on two contract paving projects, Powers Jct.-Shields Ck. and Moro-Grass Valley. Testing personnel from both projects sampled the mix behind the paver and in front of the roller. Two methods of sampling were used on each job. The first method used a large field sample, which was quartered down to test size samples. These samples were designated as "mixed" samples. For the second method, only a small field sample was taken and then tested. These samples were designated as "unmixed".

610 Powers Jct.-Shields Ck.

An ODOT designed large shovel with vertical sides was provided by Bud VanCleave for the sampling of the mixed samples for this study. The sublot ton and position on the mat were determined from random tables. A vertical face was made in the mat down to old pavement and the shovel was pushed longitudinally down the mat. The capacity of the tool when full was approximatly 12 kgs.

The large sample was taken to the field testing lab and placed on a clean 4' by 4' metal road sign which had been sprayed with pam. The sample was remixed using two large putty knives, then quartered and placed in sample boxes, each box containing approximatly 3,000 grams for the extraction and 1,000 grams for a moisture test.

The 1000+ gram moisture sample was placed in a tared pyrex dish, weighed to the nearest 0.01 gram, then placed in a Kenmore microwave oven for 10 minutes at the 30 power setting, then removed and weighed. In most cases one cycle in the oven produced approximately a 0.5 gram weight loss. After 4 or 5 repeated cycles in the microwave oven with a 10 minute heat time and a 10 minute out time, the total weight loss was generally between 0.5 and 2.0 grams. The sample was then put in a standard drying oven at 240 degrees F. for 24 hours and a further weight loss of 2 to 3 grams was reported.

The power setting was increased to 40, 50, then 60, with approximatly the same results. The quantities of liquid asphalt on this project were calculated from the differences between mix dry weight and dry weight of aggregate from the extracted mix. This makes the moisture content critical in determining the asphalt content. Because considerable variation in moisture content was experienced using the microwave oven method and a factor for the microwave results to provide results comparable to oven drying could not be determined, the study using microwave drying was discontinued.

620 Moro-Grass Valley

Five sample boxes of asphalt concrete mixture were obtained by sampling from the roadway. The material from four of the sample boxes was placed on a 36" by 36" steel plate, which was previously covered with pam, and thoroughly mixed. Then it was quartered, designated as "mixed" samples, and used as follows:

1. One quarter to be used for job control testing.
2. One quarter to be sent to the Centrol Lab along with the fifth sample box of mixture taken from the street for testing.
3. One quarter to be stored as a back-up.
4. One quarter to be available to the contractor.

Using the quarter of mixture from 1 above, aggregate gradation, asphalt content, and moisture content were determined. The moisture content was determined by drying a sample in a microwave oven. At least one of these moisture samples were split each day and both the standard 24 hour oven drying and microwave drying tests were performed. The moisture contents by the two methods were then compared.

700 CENTRAL LABORATORY TESTING PROCEDURES

The samples of mix were received by the Aggregate Group. Samples were warmed in a microwave oven, mixed, and split into smaller test samples as they were needed. The "mixed" samples were split into 2,000 gram extraction, 1,000 gram microwave moisture, 500 gram T110 moisture, and 300 gram standard drying oven moisture test samples. The "unmixed" samples were split into 2,000 gram extraction, 1,000 gram microwave moisture, and 300 gram standard drying oven moisture test samples.

710 Extraction, Oven Moisture, and Sieve Analysis Testing

The extractions were performed in accordance with OSHD 309, using a vacuum extractor. The oven moisture sample was placed in a 230 degrees F. oven for 24 hours to determine the moisture content of the mix sample. The extracted samples were oven dried at 230 degrees F., then sieved to determine the gradation.

720 Microwave and T110 Moisture Testing

The Petro/Chem Group was involved with the moisture determination aspect of the study. Two methods were used to determine moisture content, a microwave procedure and the AASHTO T110 procedure.

The microwave method made use of a Sears Kenmore, Model 565 microwave. Initially the power settings had to be tested to determine which setting to use to extract the water from the mix while at the same time not heating excessively, and losing an excessive amount of the lighter volatile oils from the asphalt. A description of the equipment and procedure is as follows.

Microwave Oven Specifications:

Variable power from 140 to 625 watts (10 levels).
60 minute dual speed timer.

Overall dimensions - 24" W by 19 3/4" D by 15 3/4" H
Oven capacity - 14 3/4" W by 16 1/4" D by 9 3/4" H
(1.4 c.f. usable interior dimensions)

Procedure:

1. Weigh out 1,000 grams of mix in a glass pan with a paper towel under the sample.

2. Place in microwave and heat at 70 % power for 10 minutes, then cool 10 minutes outside the oven.

3. Again place in oven and heat for 10 minutes, then cool 10 minutes.

4. Weigh the sample to nearest 0.1 gram.

5. Place in oven and heat 10 minutes, then cool 10 minutes.

6. Reweigh the sample.

7. Continue the cycle until a constant weight is achieved (less than 0.1 gram loss).

The other procedure used for determining moisture content was the AASHTO T110 method. This method involved heating the mix in a retort with xylene, refluxing the solvent plus any water present in the mix, and trapping the water. As the procedure was utilized it became apparent that at the specified heating rate not all the moisture was extracted. This was confirmed by I.R. analysis of the solution. In an effort to overcome this problem a more rigorous heating application was used. This resulted in the second set of values, referred to as modified T110 results. The first set of values were achieved in accordance to the AASHTO T110 procedure.

800 ANALYSIS OF TEST RESULTS

The results from the tests performed in both the Materials Section and field labs are illustrated in graph form. These graphs are located in the Appendix of this report. They are separated into three groups. Appendix A contains the results of 16 samples from the Powers Jct.-Sheilds Ck. project. Appendix B contains the results of 26 samples from the top lift of paving on the Moro-Grass Valley project. Appendix C contains the results of 46 samples from the pre-leveling asphalt concrete mixture used on the Moro-Grass Valley project.

Each Appendix has graphs comparing the different methods of determining moisture contents, the adjusted asphalt contents determined by using the different moisture test methods, and the gradations of the "mixed" and "unmixed" samples.

Each graph shows the average, standard deviation, and coefficient of variation calculated for the test results. The statistics for the different moisture determination methods and the adjusted asphalt contents computed using these different methods are tabulated in the following pages (TABLE 1, 2, and 3).

MOISTURE AND ASPHALT CONTENT STATISTICS FOR
POWERS JCT.-SHIELDS CK.

TABLE 1

Method	Oven *	Oven **	Field Oven **	Micro *	Micro **	RT-110 *	MT-110 *
Moisture Content							
Average	0.58	0.54	0.32	0.31	0.22	0.26	0.31
Standard Deviation	0.04	0.06	0.09	0.07	0.06	0.06	0.07
Coefficient of Variation (%)	7.09	11.58	26.81	23.10	28.09	23.62	23.39
Adjusted Asphalt							
Average	5.30	5.31	5.65	5.58	5.64	5.59	5.56
Standard Deviation	0.20	0.12	0.23	0.18	0.15	0.17	0.18
Coefficient of Variation (%)	3.77	2.35	4.01	3.05	2.67	3.09	3.18

* = Mixed Samples
** = Unmixed Samples

MOISTURE AND ASPHALT CONTENT STATISTICS FOR
MORO-GRASS VALLEY (TOP)

TABLE 2

Method	Oven *	Oven **	Field Micro *	Micro *	Micro **	RT-110 *	MT-110 *
Moisture Content							
Average	0.86	0.78	0.37	0.60	0.49	0.55	0.63
Standard Deviation	0.07	0.06	0.10	0.69	0.08	0.08	0.07
Coefficient of Variation (%)	8.52	7.83	26.88	11.63	16.66	15.10	10.77
Adjusted Asphalt							
Average	5.34	5.37	5.52	5.62	5.64	5.65	5.58
Standard Deviation	0.23	0.29	0.38	0.26	0.27	0.23	0.23
Coefficient of Variation (%)	4.23	5.45	6.82	4.59	4.78	4.12	4.15

* = Mixed Samples
** = Unmixed Samples

MOISTURE AND ASPHALT CONTENT STATISTICS FOR
MORO-GRASS VALLEY (PRELEVEL)

TABLE 3

Method	Oven *	Oven **	Field Micro *	Micro *	Micro **	RT-110 *	MT-110 *
Moisture Content							
Average	0.89	0.82	0.29	0.67	0.59	0.52	0.60
Standard Deviation	0.09	0.07	0.09	0.10	0.08	0.06	0.08
Coefficient of Variation (%)	10.34	8.52	31.84	14.81	14.25	10.72	12.54
Adjusted Asphalt							
Average	5.48	5.42	5.49	5.67	5.62	5.80	5.73
Standard Deviation	0.38	0.32	0.38	0.38	0.37	0.39	0.37
Coefficient of Variation (%)	6.91	5.91	6.94	6.74	6.61	6.68	6.54

* = Mixed Samples
** = Unmixed Samples

900 CONCLUSIONS

910 General

1) It is standard practice for contracting agencies to modify AASHTO sampling and testing requirements to accommodate their particular needs and requirements for field testing. AASHTO standards are developed by subcommittees of state and federal materials engineers and often represent practices used by the writers. These are adopted with the understanding that other agencies may need to modify them to accommodate their individual agency's requirements.

2) OSHD specifications currently require sampling of asphalt mixtures from the roadway prior to compaction for pavement thicknesses of one half inch or greater. AASHTO T168 does not address sampling the mixture behind the paver, nor does OSHD have a current written standard procedure. There is a wide variety of both where and how samples are taken by other agencies. Most, however, are taken behind the paver.

3) Sample sizes for extraction testing generally vary from 1000 grams to 2500 grams for various agencies. AASHTO uses this same range. OSHD currently uses the total sample or a 2000 gram sample for lab testing and for most field tests.

4) The only deviation of OSHD 309 from AASHTO T164 is determining the moisture content. OSHD uses a standard drying oven method and has started using microwave ovens on some statistical jobs because they provide the quickest results. AASHTO T164 refers to AASHTO T110 which describes a distillation process for

determining the moisture content. Only a few of the agencies surveyed use the T110 method and generally they use a modified method. Rather a majority of the agencies use a oven drying method and some even use a microwave oven procedure.

5) Since AASHTO T164 allows drying of extracted aggregate on a hot plate at a temperature of 140 Degrees F. or less without a moisture correction for weight of the mix and also allows drying of extracted aggregate in a standard drying oven at 230 Degrees F., it seems that the determination of moisture content of the mix by the same method would be necessary to provide an equal level of moisture in the aggregate and mix. The difference in weight would then be the true asphalt content extracted without the effect of the differences in moisture content.

6) The extracted aggregate from the mix is used to determine the gradation of the asphalt concrete mix. The AASHTO T30 procedure includes washing the aggregate before screening. Most agencies, including OSHD, omit this step and perform a dry sieve analysis.

920 Test Results

7) As shown on the graphs in Appendix A, B, and C, there are no real significant differences in the test results from the two sampling methods used. There were some differences in the moisture contents, but the differences were greater among the different methods for determining the moisture than from the two sampling procedures. The sieve analysis showed little or

no difference in the "mixed" and "unmixed" samples.

8) The test findings show that there is a significant difference in the results from different test methods used in determining the moisture content of bituminous mixtures. Of the four methods of testing, the oven drying method gives the highest moisture content. The field microwave oven drying and the regular AASHTO T110 varied in giving the lowest moisture content. With the lower moisture content of the mix, the asphalt content is at a higher level, because the difference between the dry weight of the mix and the dry weight of the extracted aggregate is greater.

9) The only other conclusion that could be determined from the moisture tests is that the regular AASHTO T110 does not remove all the moisture from the sample. This was concluded from the IR analysis of the solution and by increasing the heat and lengthening the time of the regular AASHTO T110 test procedure. This change in moisture determination was designated as the modified T110.

10) The differences in the moisture content test results by the four methods result in different dry weights for the mix when calculating asphalt content. Since the difference between mix dry weight and extracted aggregate oven dry weight is the asphalt content, the difference in mix dry weight results in differences in asphalt content. These differences were primarily the result of determining moisture content of the mix by a different method than that used for drying the aggregate.

11) The asphalt content, computed by using the oven dried moisture content for the mix, tended to be about 2 tenths of 1 percent lower than that obtained using the other methods.

1000 RECOMMENDATIONS

Since the test results in this report showed a significant difference between moisture contents determined from oven drying and microwave drying, it is recommended that the Central Lab:

1. Undertake additional testing using the microwave oven for determining moisture content of both the asphalt concrete mixture and aggregate extracted from the mix
2. Determine the asphalt content of the mixture based on mix and aggregate dry weights from the drying procedure above and compare to asphalt contents determined by the oven dried method for mix and aggregate.
3. Develope standard procedures for lab and field microwave drying of the mixture and extracted aggregates.

Comparisons between the results for samples obtained by the AASHTO sampling procedures (mixed samples) and the earlier OSHD sampling procedures (unmixed samples) did not show significant differences in moisture, gradation, or asphalt content. However, the AASHTO procedures should be followed in the future to provide larger sample for backup and central lab testing.

REFERENCES

1) AASHTO Materials Reference Laboratory, Inspection Reports of tours 1 thru 13, 1969-1984.

2) AASHTO Materials Reference Laboratory, Reports for Bituminous Reference Samples 1 thru 20, 1974-1984.

3) AASHTO Materials, Tests, - Part II, American Association of State Highway Officials, 1982.

4) Construction Manual, Oregon Department of Transportation.

5) Inspectors Manual, Oregon Department of Transportation.

6) Laboratory Manual of test Procedures, - Vol. I, Oregon Department of Transportation.

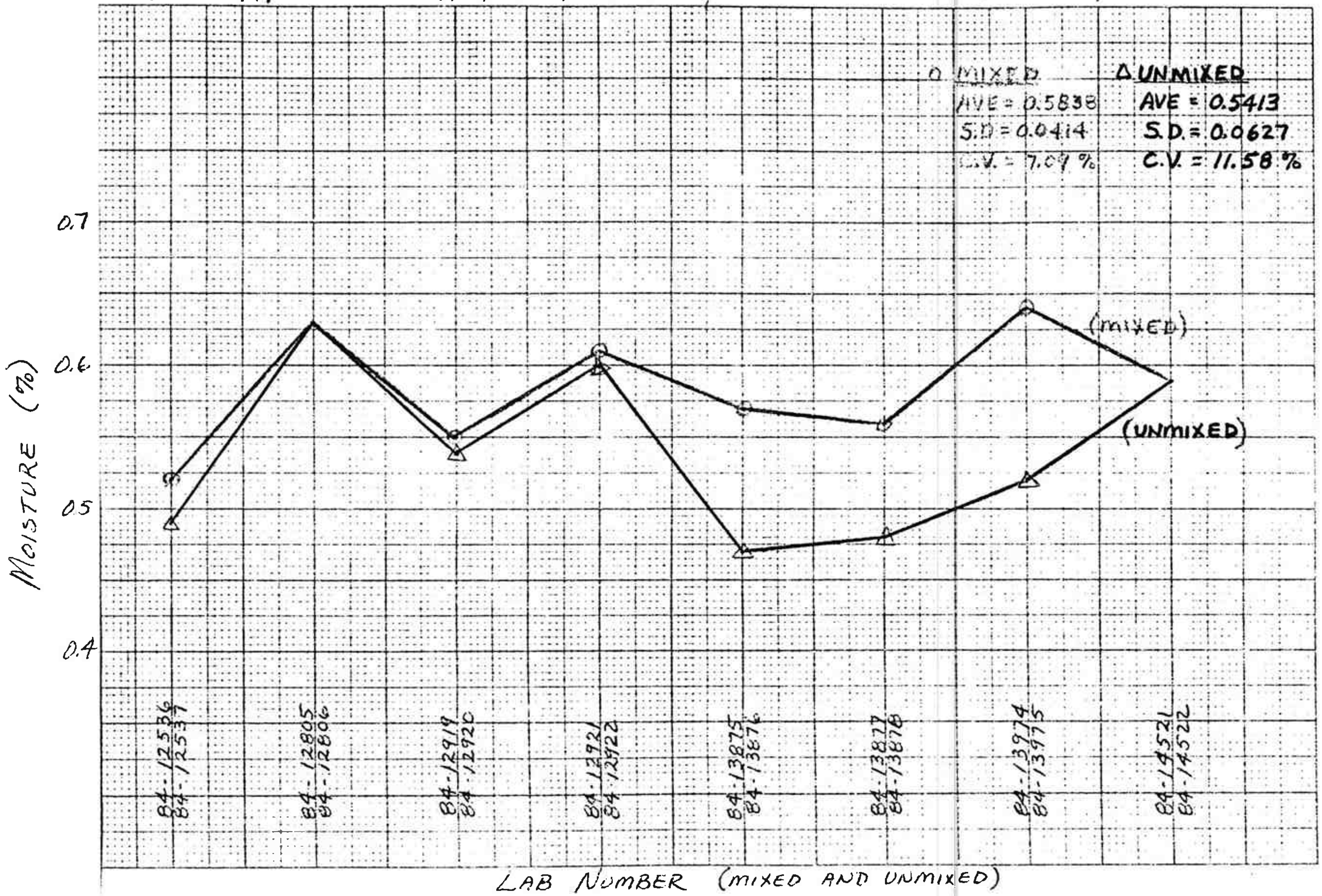
7) Asphalt Concrete Sampling and Testing, Letter from W. E. Shwartz, P.E., Assistant State Highway Engineer for Operations, to Mike Huddleston, Executive Director, APA, Sept. 27, 1984.

APPENDIX A

POWERS JCT - SHIELD CK.

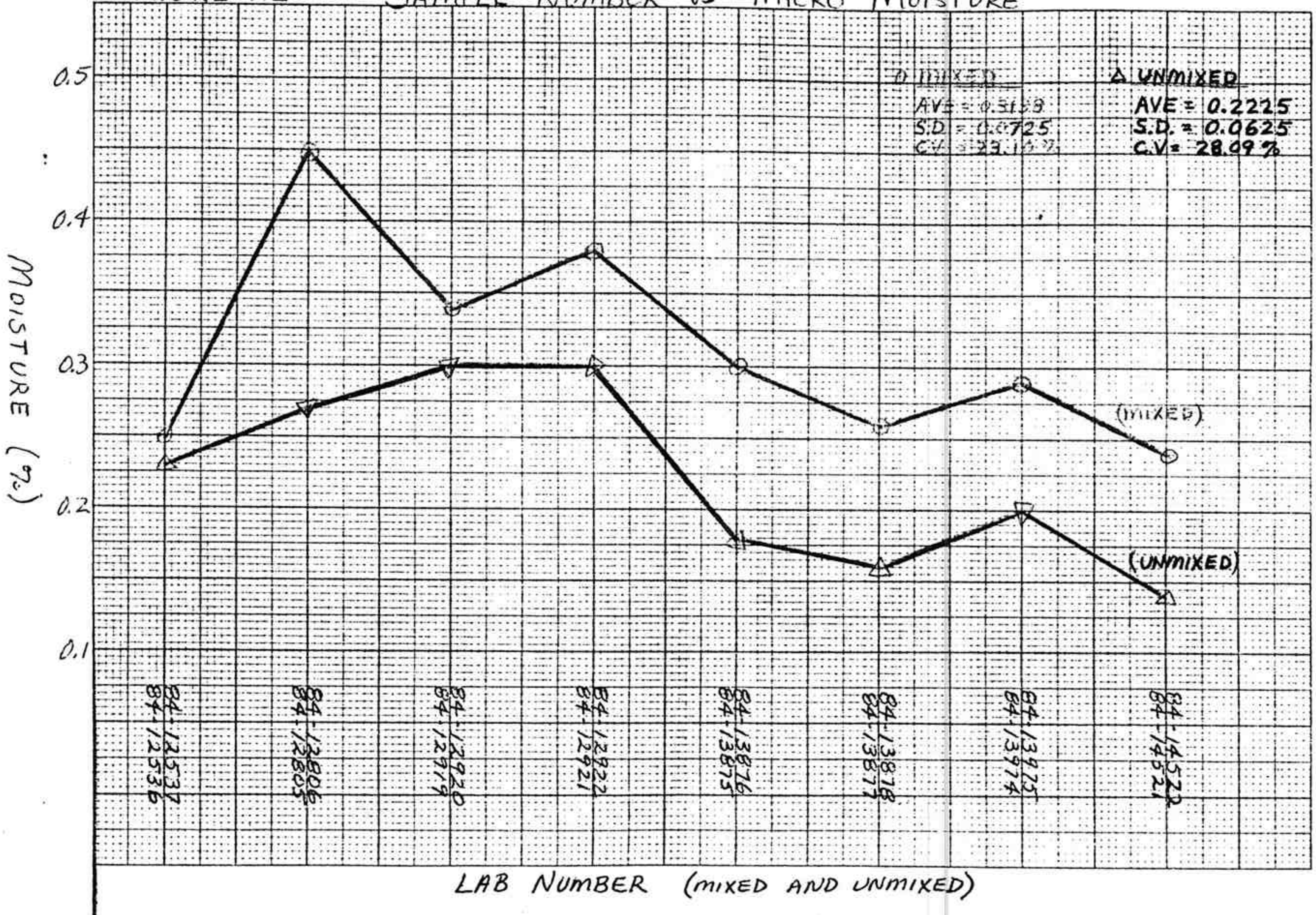
Powers Jct. - Shields Ck

FIGURE A1 — Sample Number vs Oven Moisture



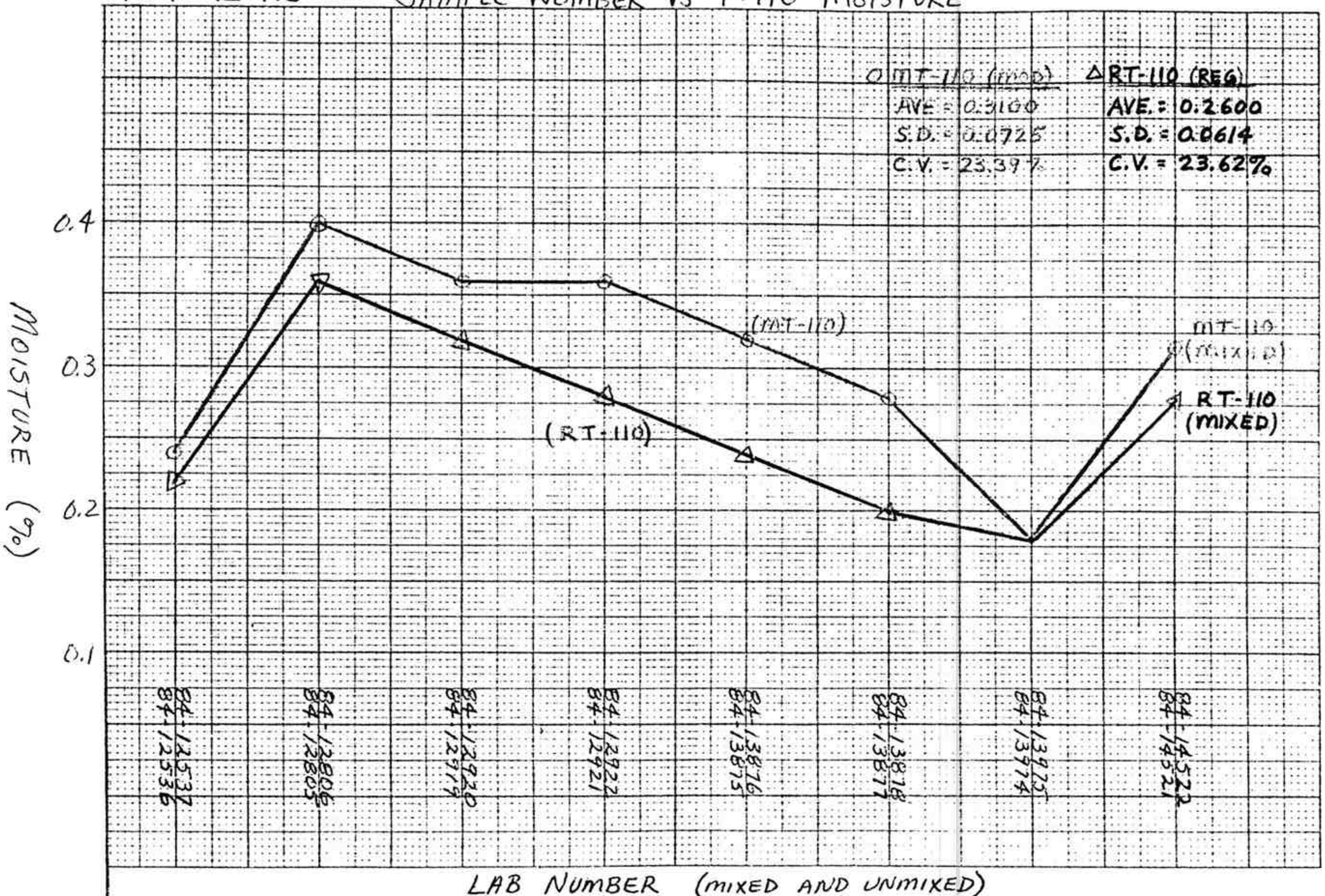
Powers Jct. - Shields Ck.

FIGURE A2 — Sample Number vs Micro Moisture



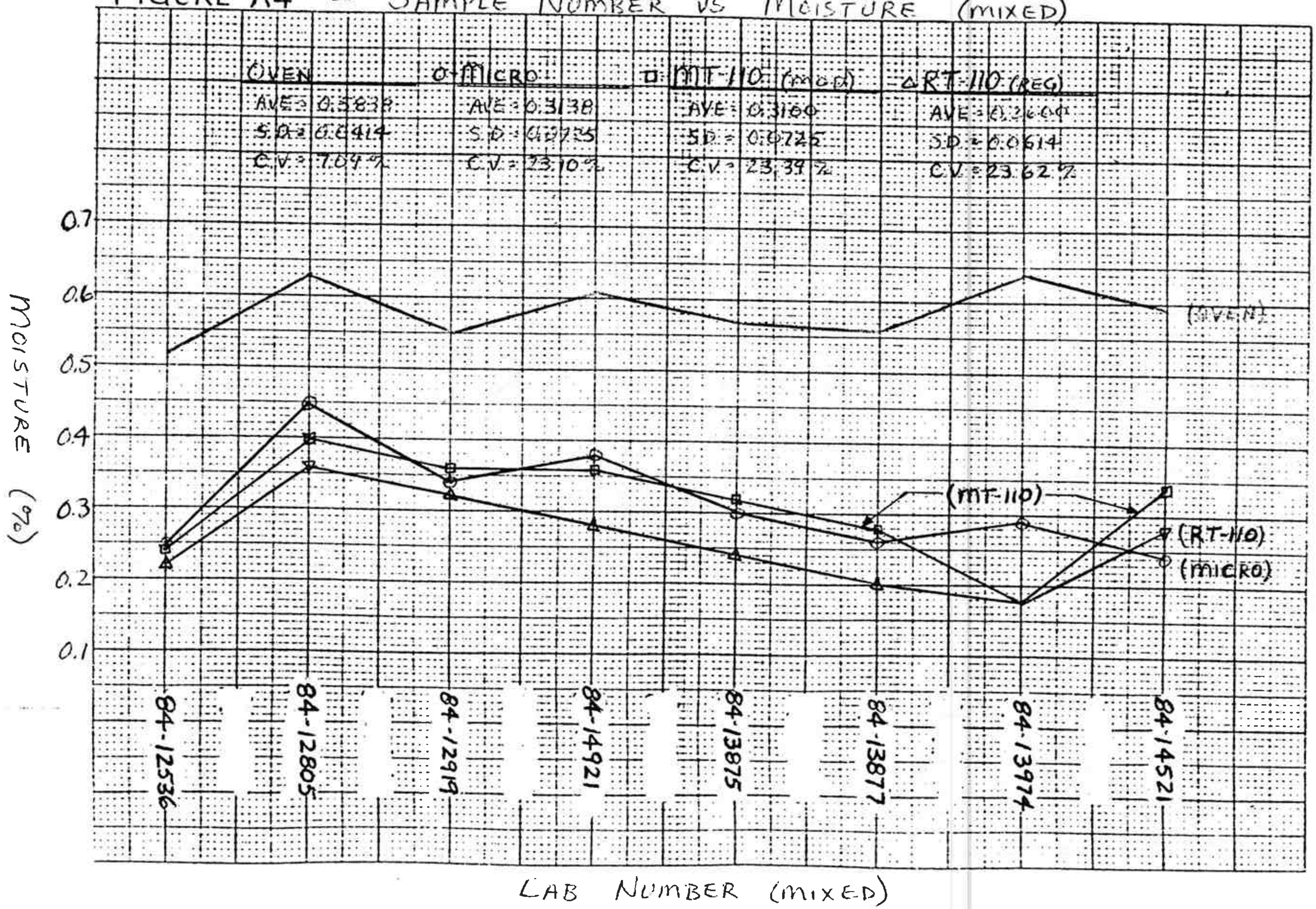
POWERS JCT. - SHIELDS CK.

FIGURE A3 - SAMPLE NUMBER VS T-110 MOISTURE



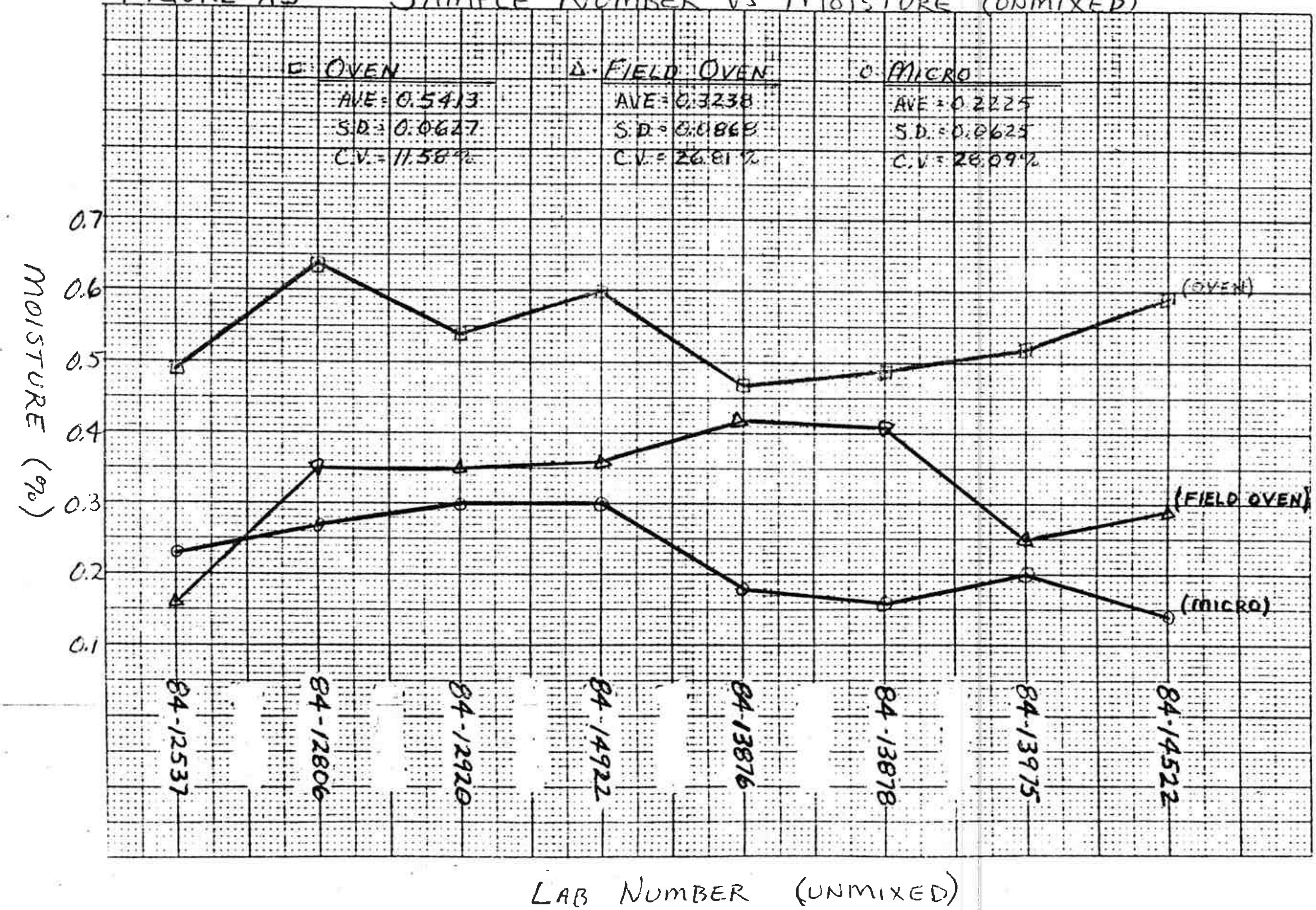
POWERS JCT. - SHIELDS CK.

FIGURE A4 - SAMPLE NUMBER VS MOISTURE (MIXED)



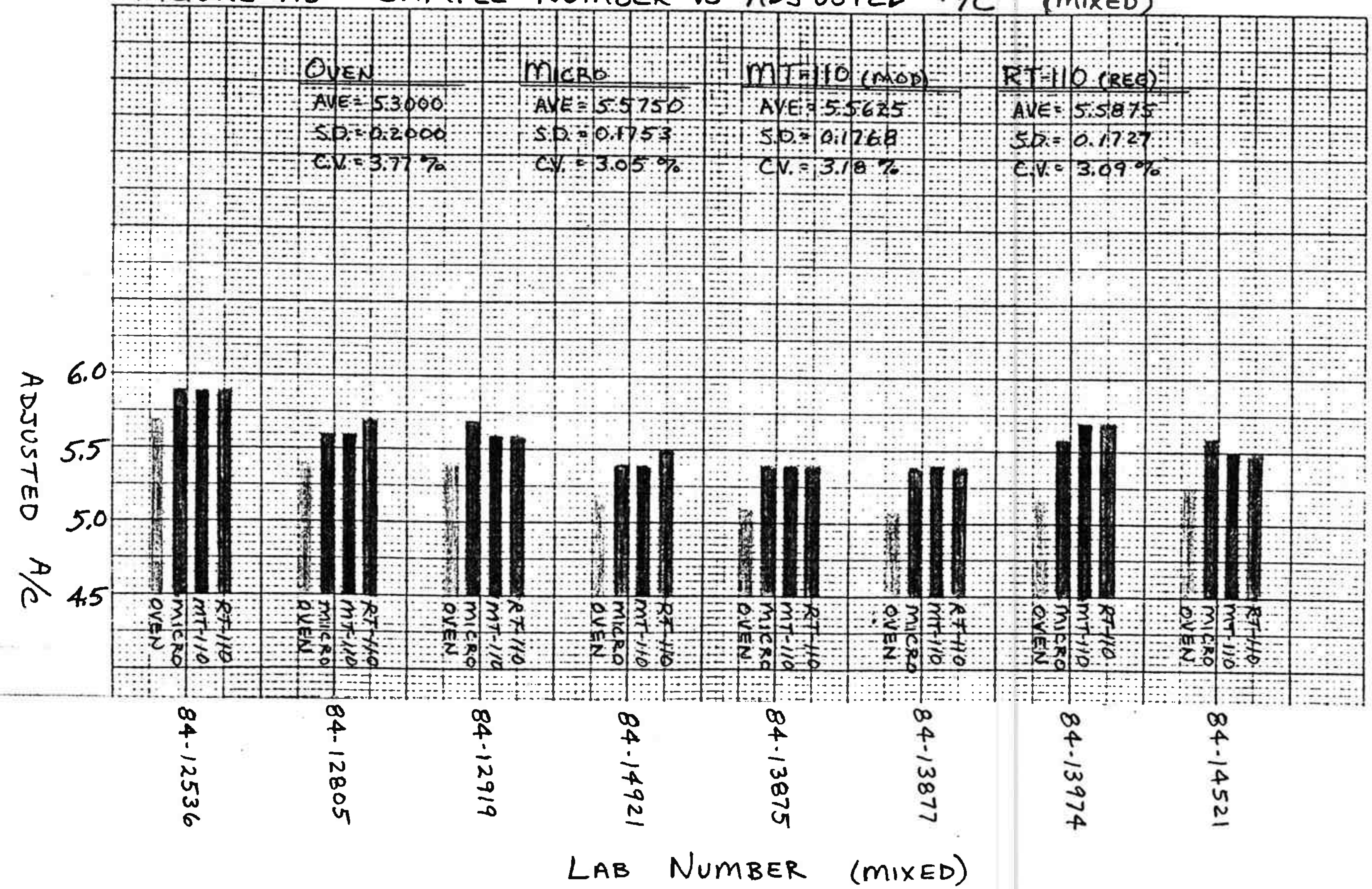
POWERS JCT. - SHIELDS CK.

FIGURE A5 - SAMPLE NUMBER VS MOISTURE (UNMIXED)



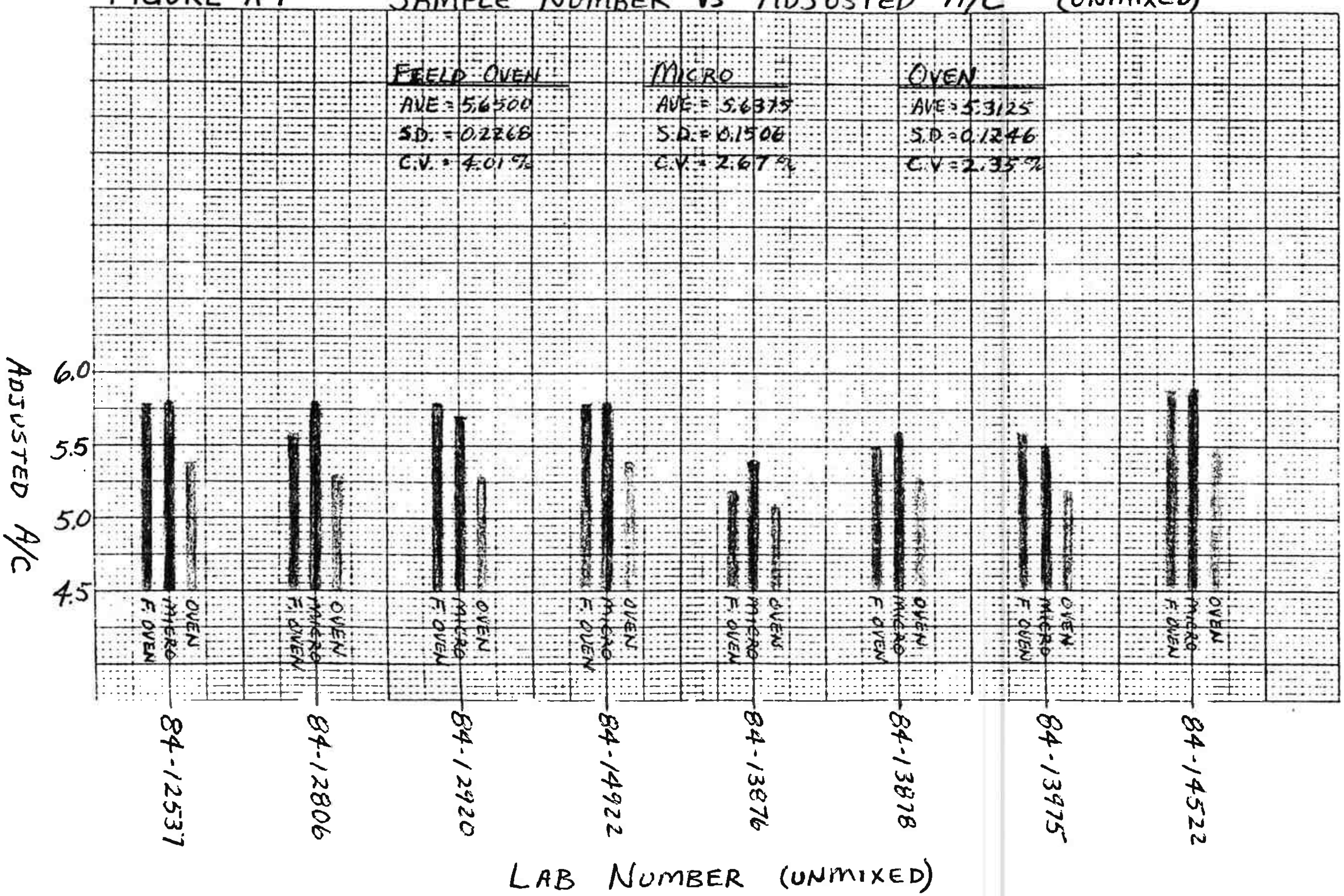
POWERS JCT. - SHIELDS CK.

FIGURE A6 - SAMPLE NUMBER VS ADJUSTED A/C (MIXED)



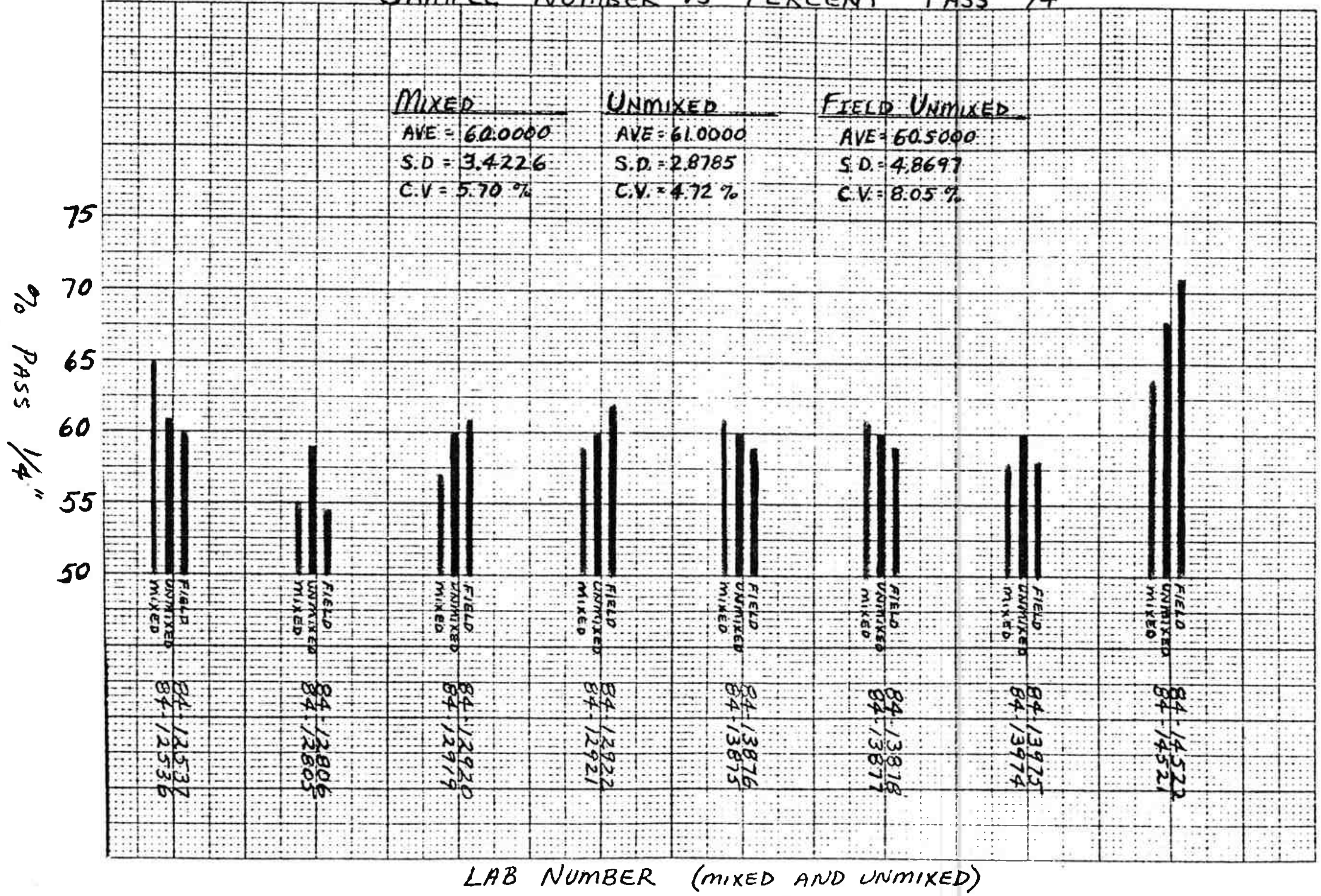
Powers Jct. - Shields Ck.

FIGURE A7 - Sample Number vs Adjusted A/C (unmixed)



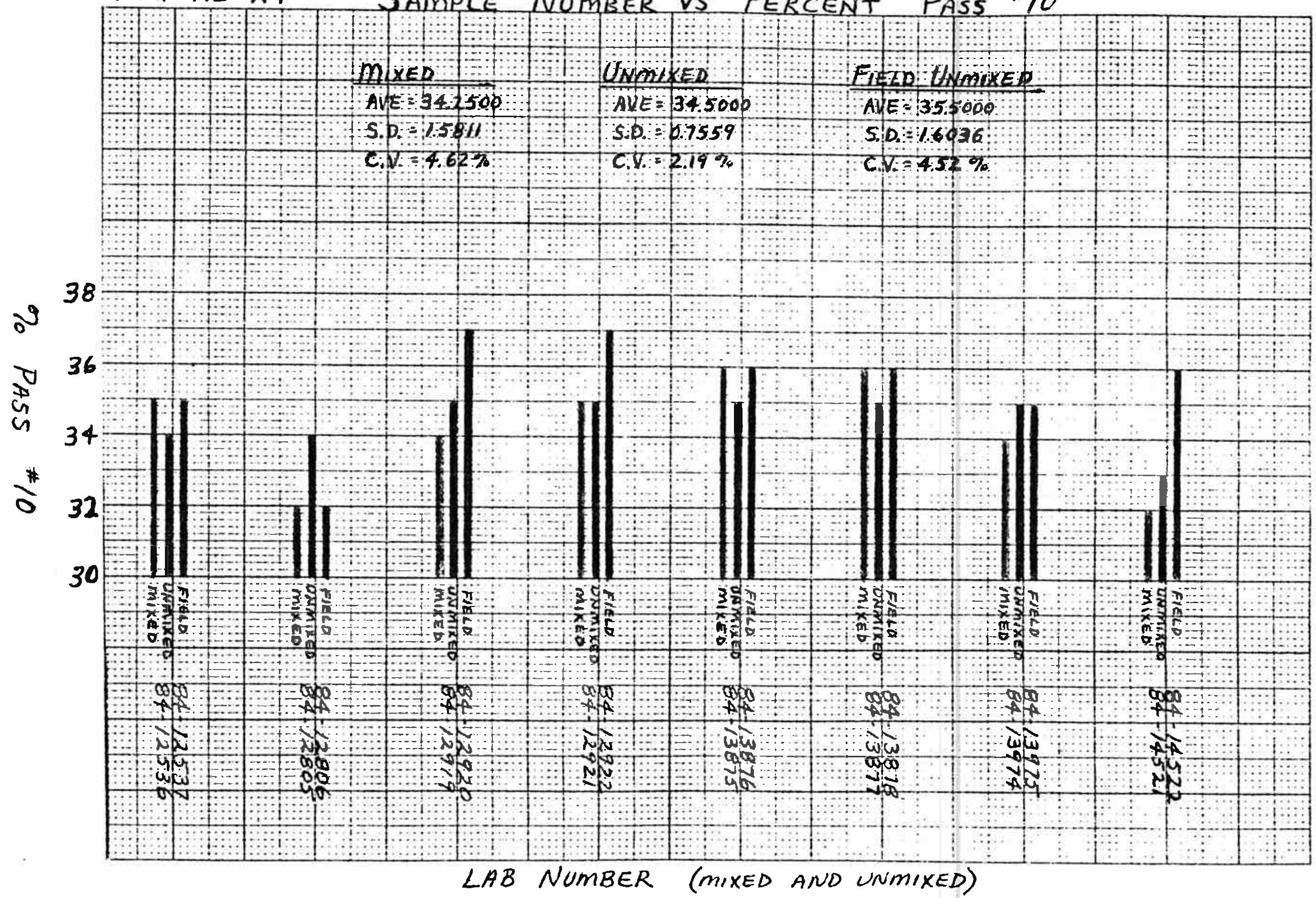
Powers Jct. Shields Ck.

FIGURE A8 – Sample Number vs Percent Pass 1/4"



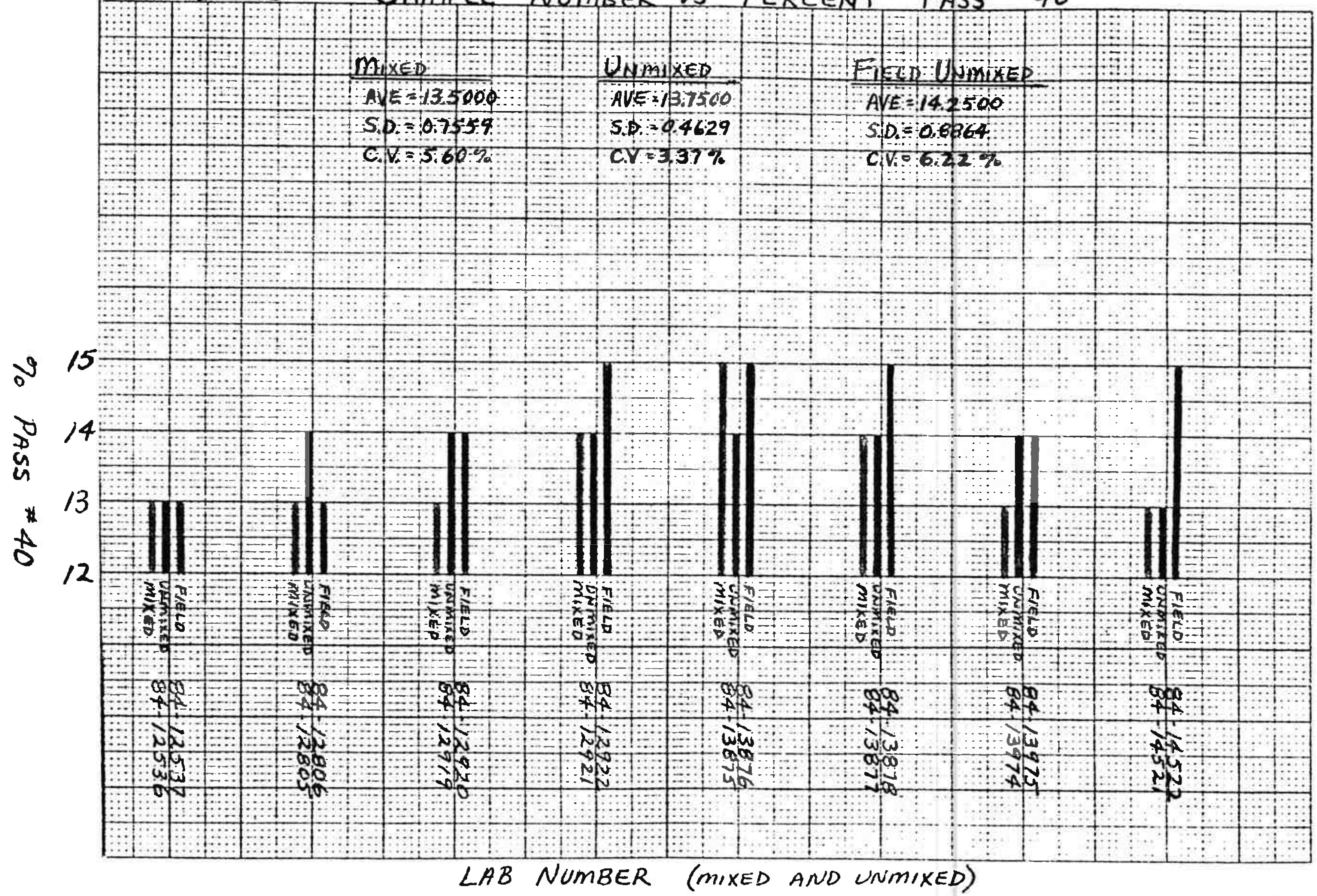
Powers Jct- Shields Ck.

FIGURE A9 - Sample Number vs Percent Pass #10



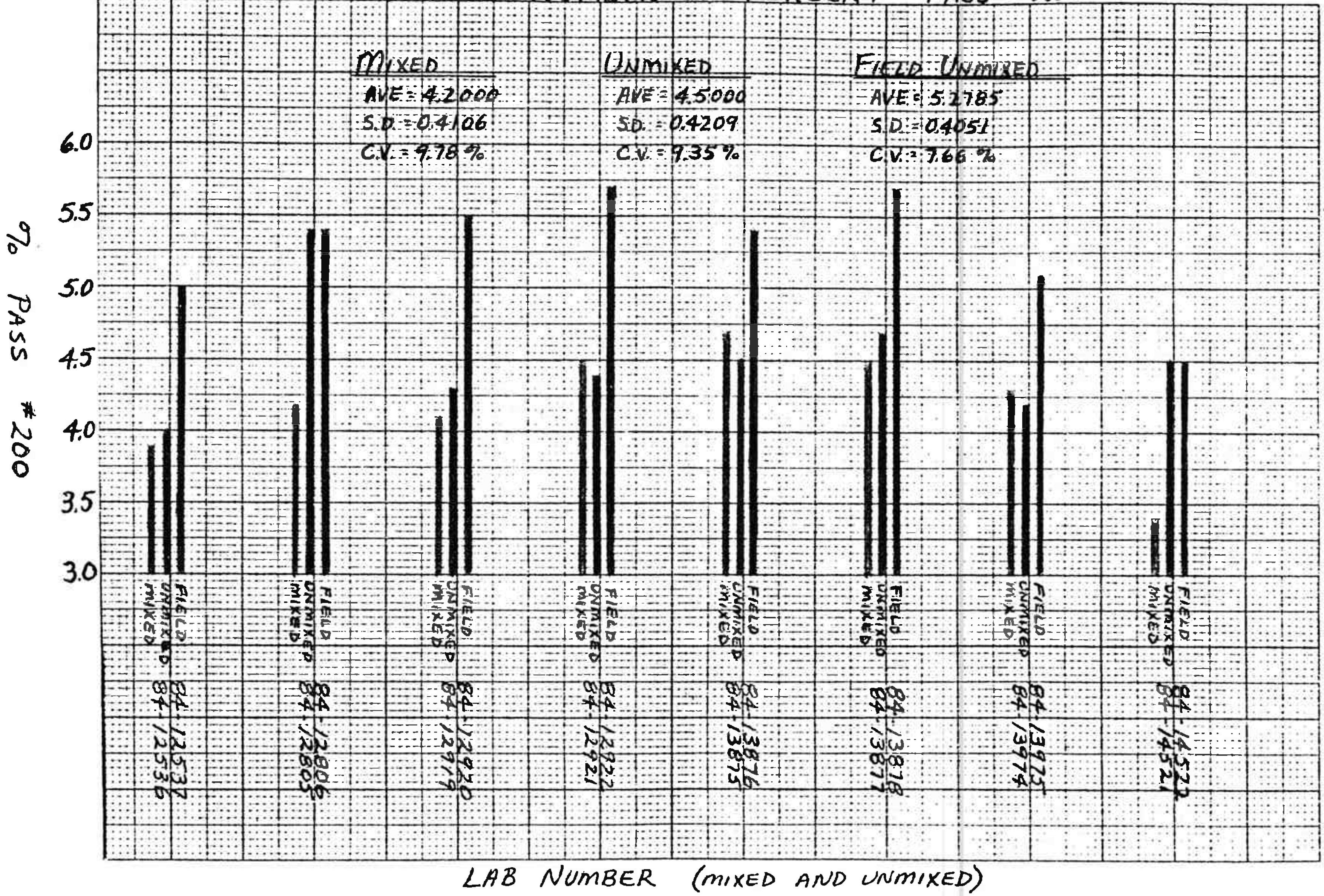
POWERS JCT- SHIELDS CK.

FIGURE A10 - SAMPLE NUMBER VS PERCENT PASS #40



POWERS JCT- SHIELDS CK.

FIGURE A11 - SAMPLE NUMBER VS PERCENT PASS #200

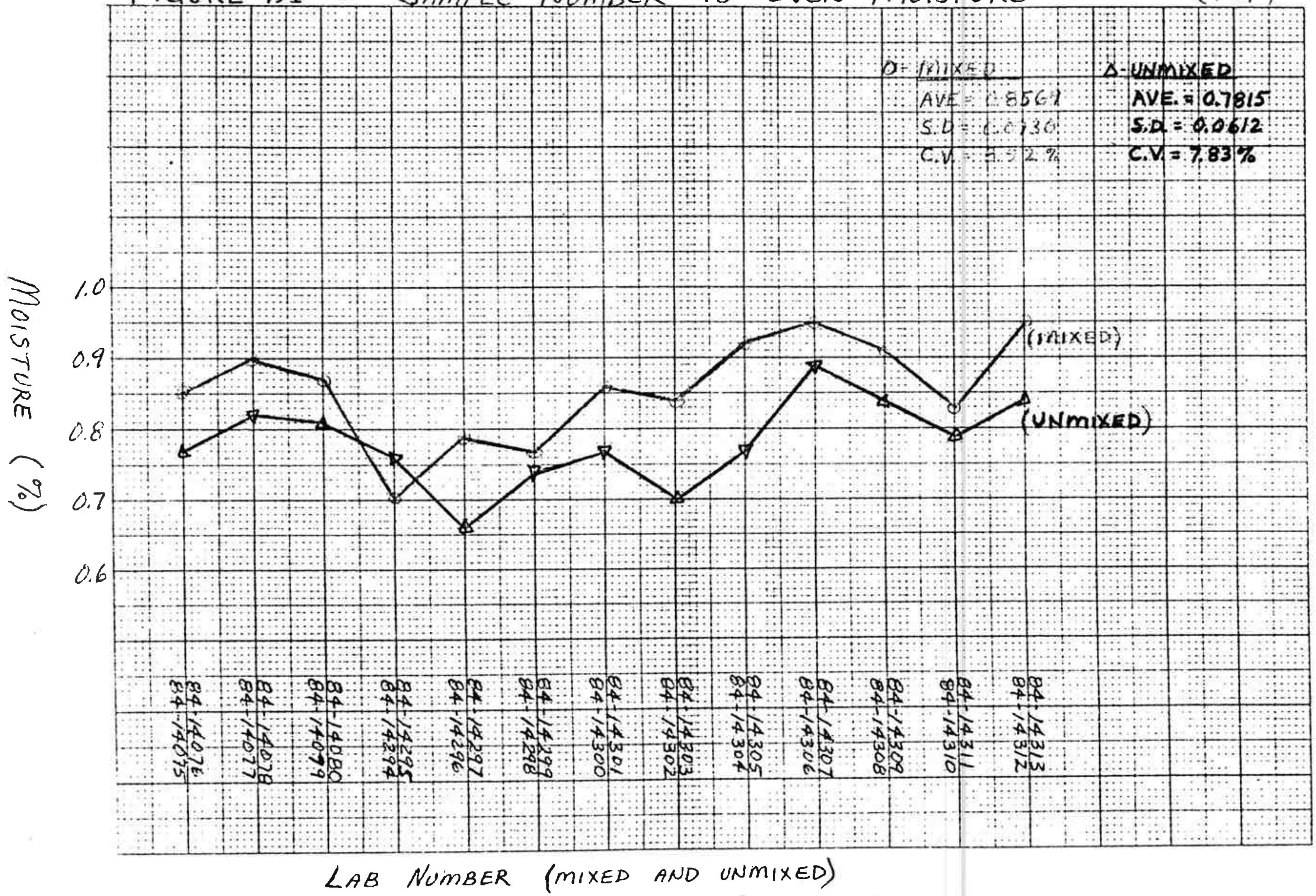


APPENDIX B

MORO - GRASS VALLEY
(TOP)

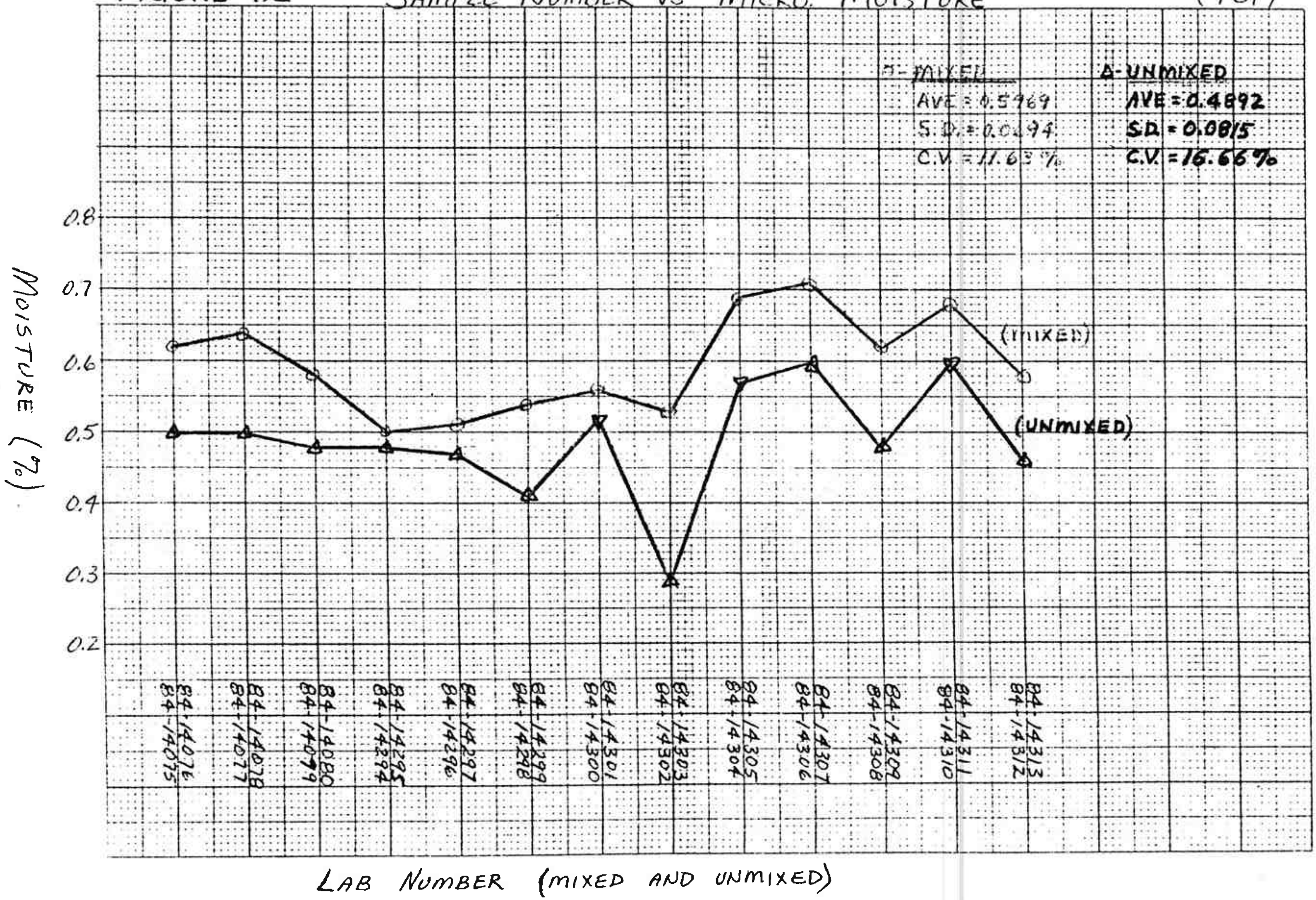
Moro Grass Valley

FIGURE B1 - Sample Number vs Oven Moisture (TOP)



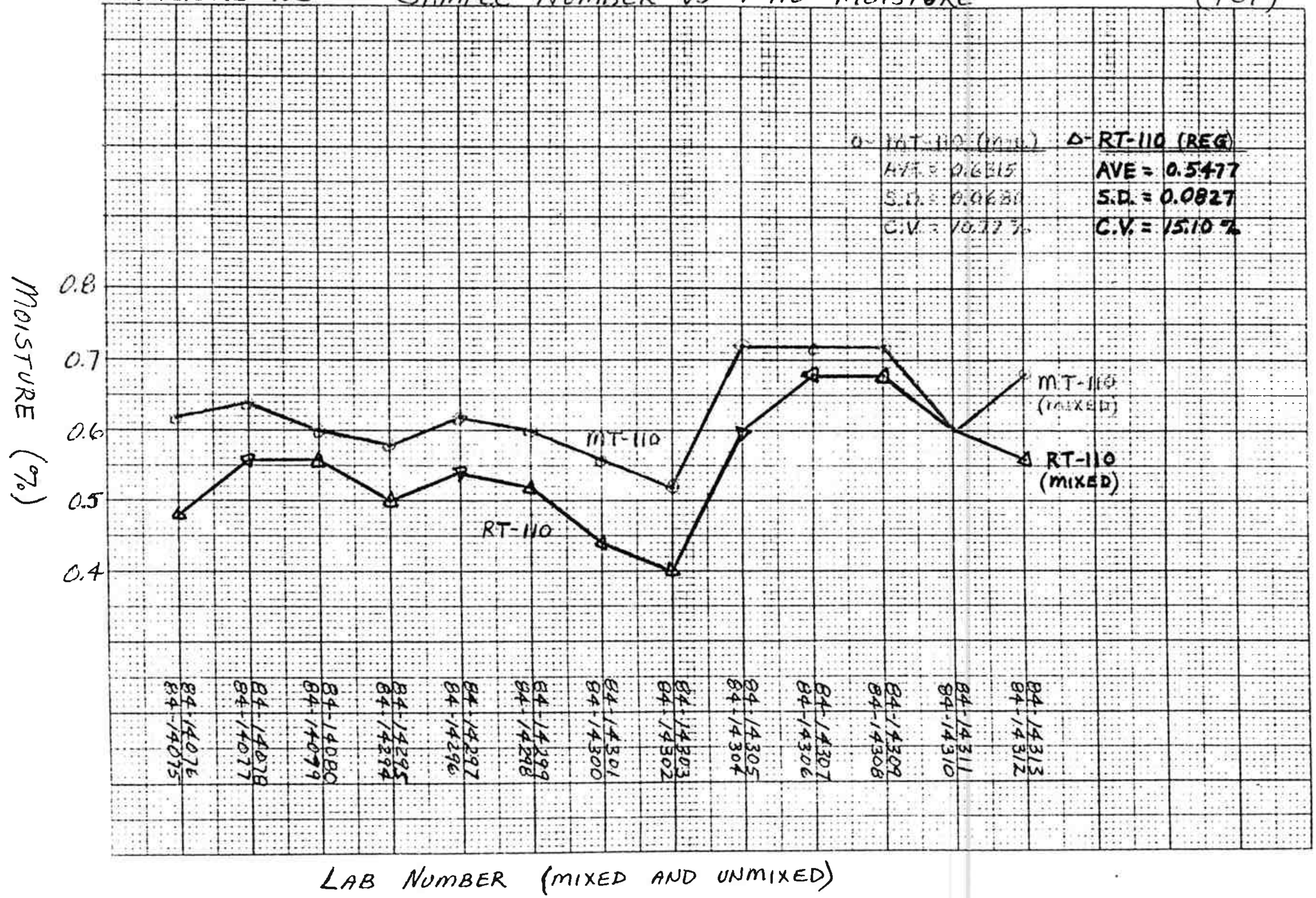
Moro Grass Valley

FIGURE B2 - Sample Number vs Micro Moisture (TOP)



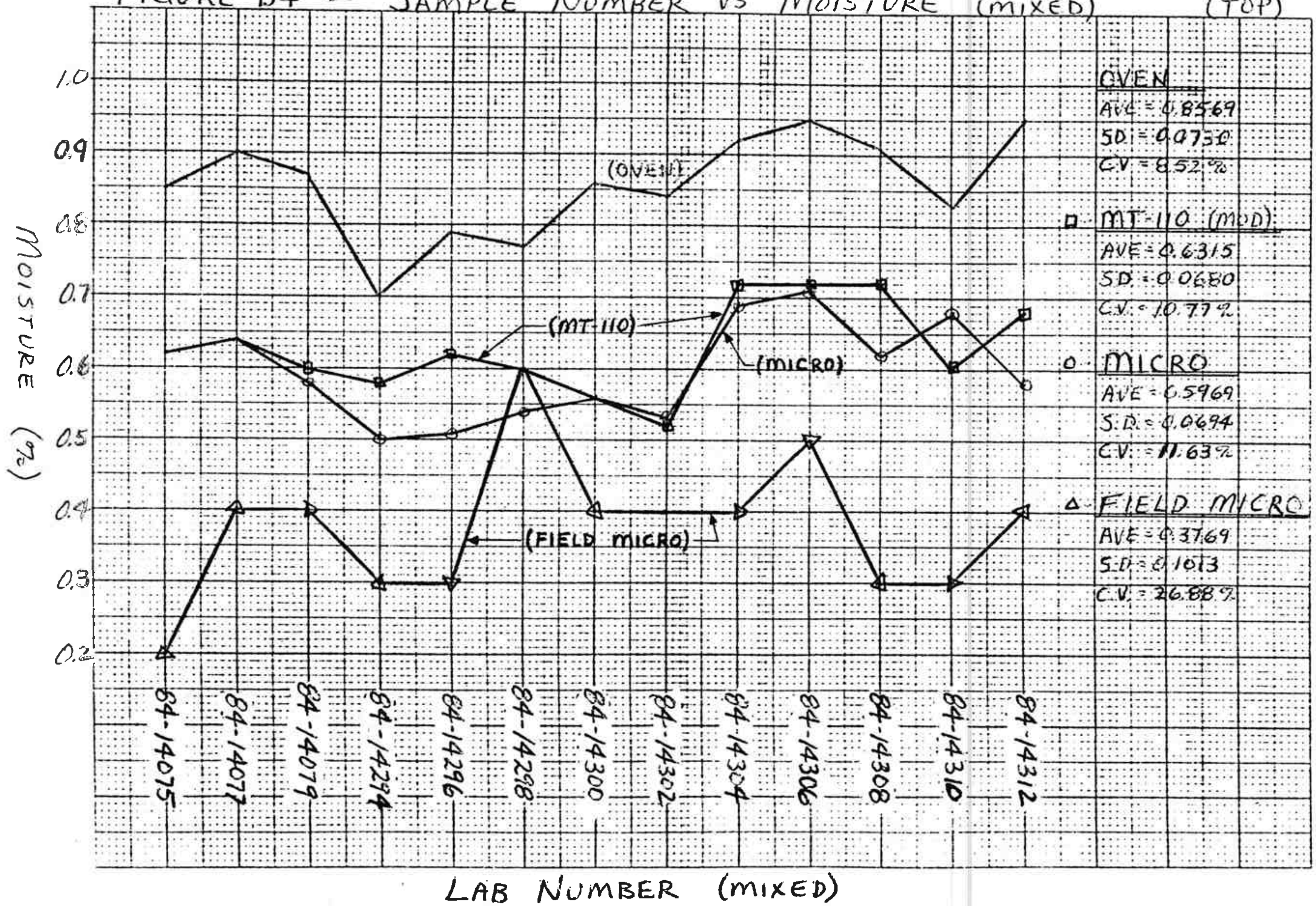
MORO GRASS VALLEY

FIGURE B3 - SAMPLE NUMBER VS T-110 MOISTURE



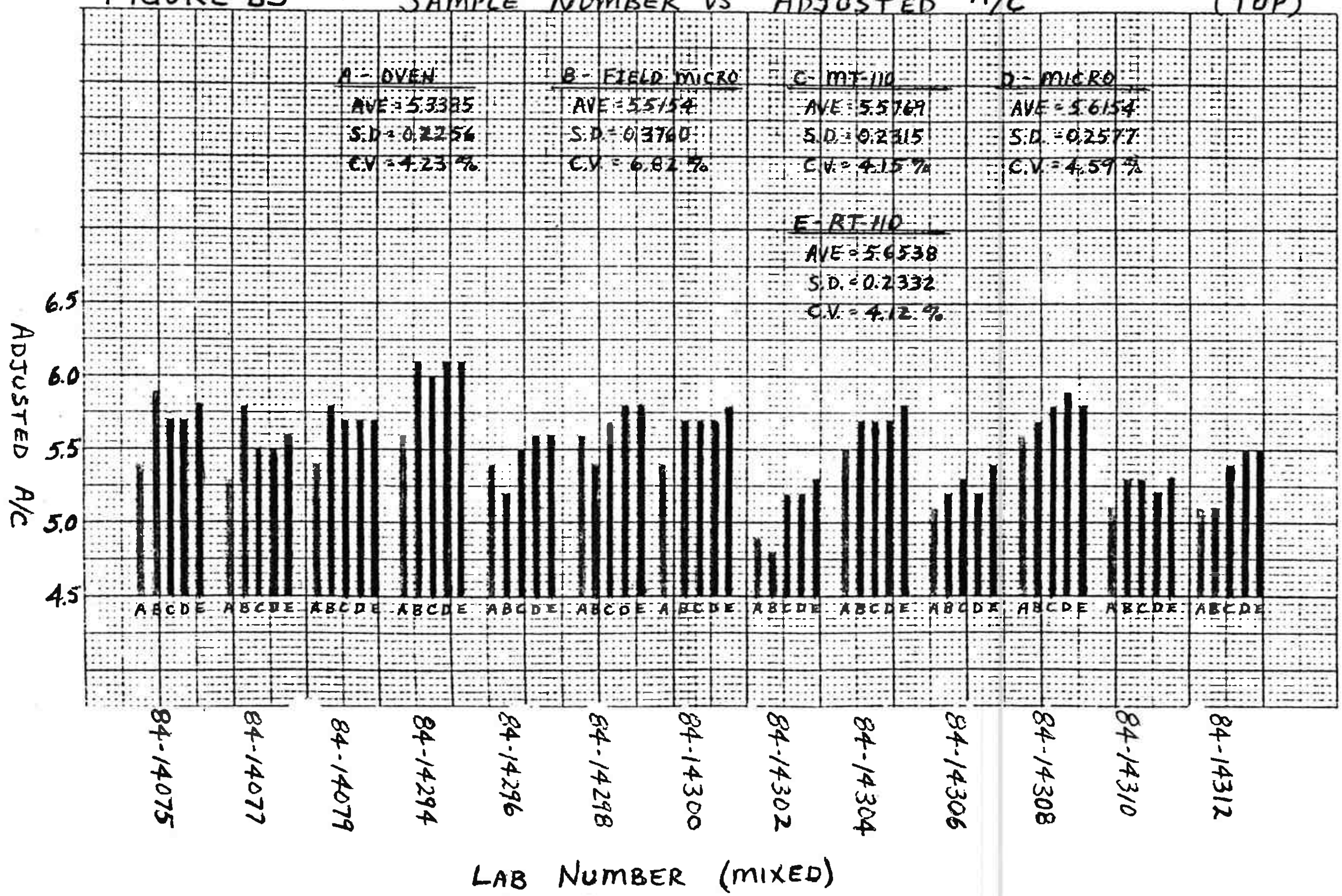
Moro Grass Valley

FIGURE B4 — Sample Number vs Moisture (mixed) (top)



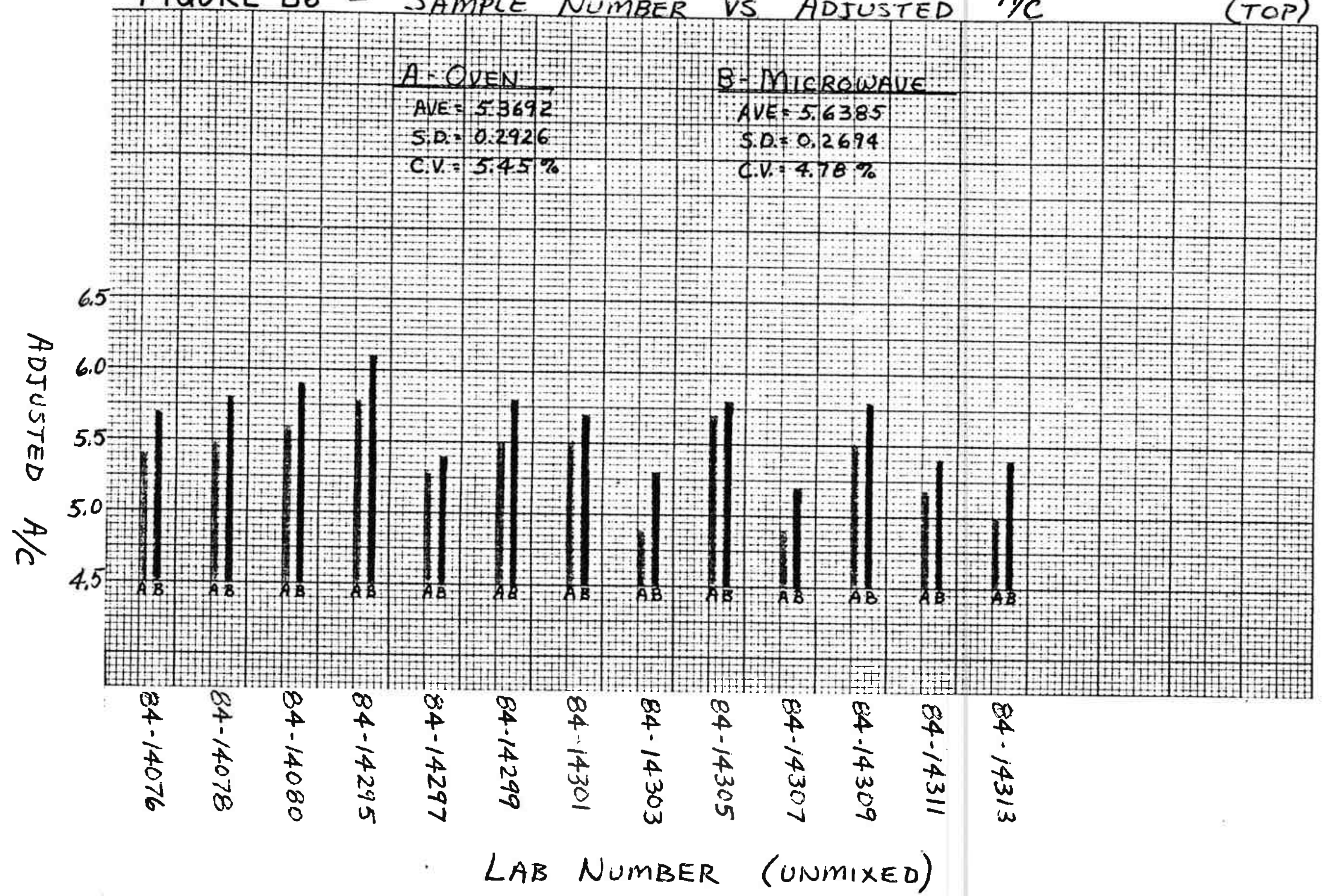
Moro Grass Valley

FIGURE B5 - Sample Number vs Adjusted A/C (Top)



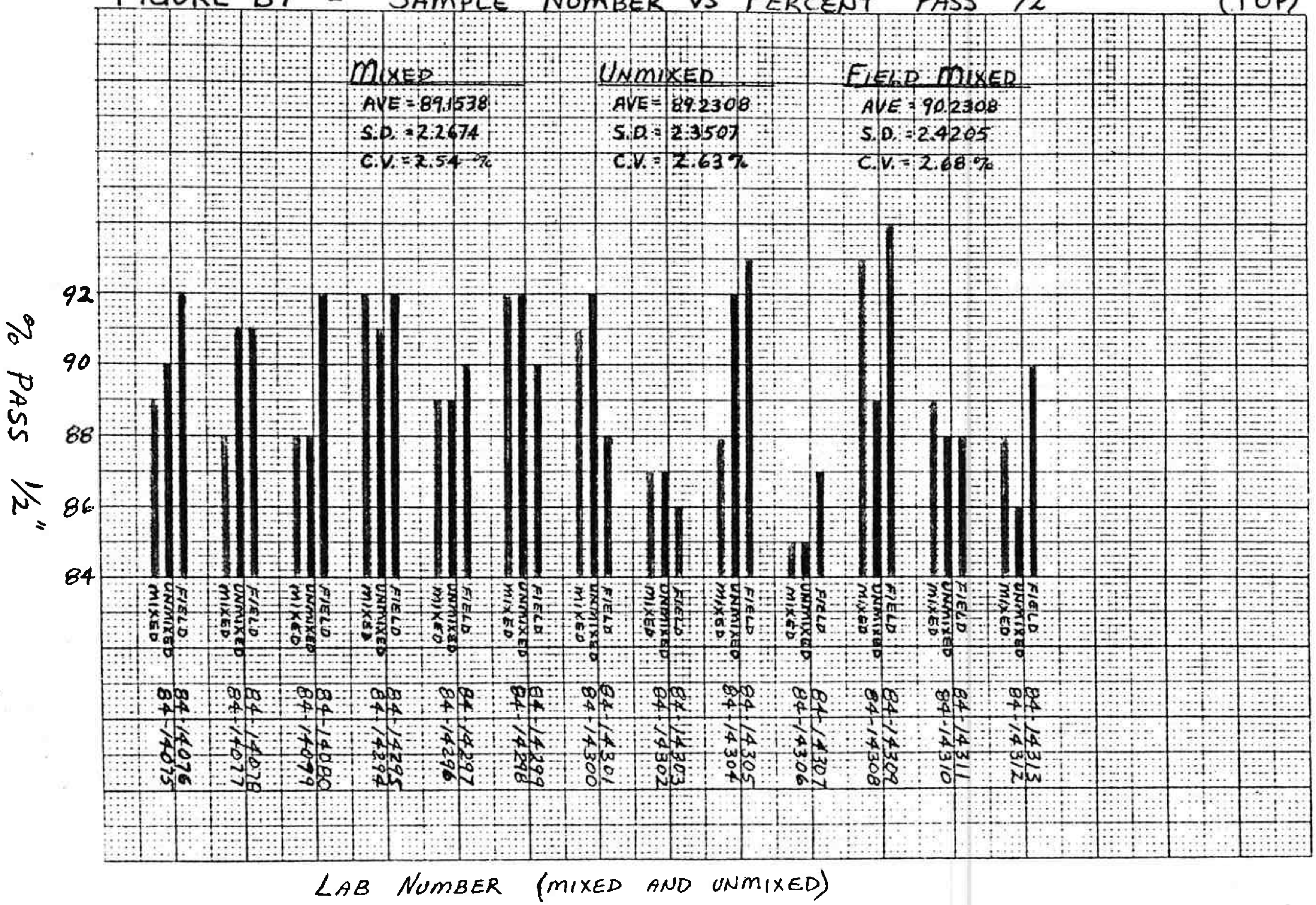
MORO GRASS VALLEY

FIGURE B6 - SAMPLE NUMBER VS ADJUSTED A/C (TOP)



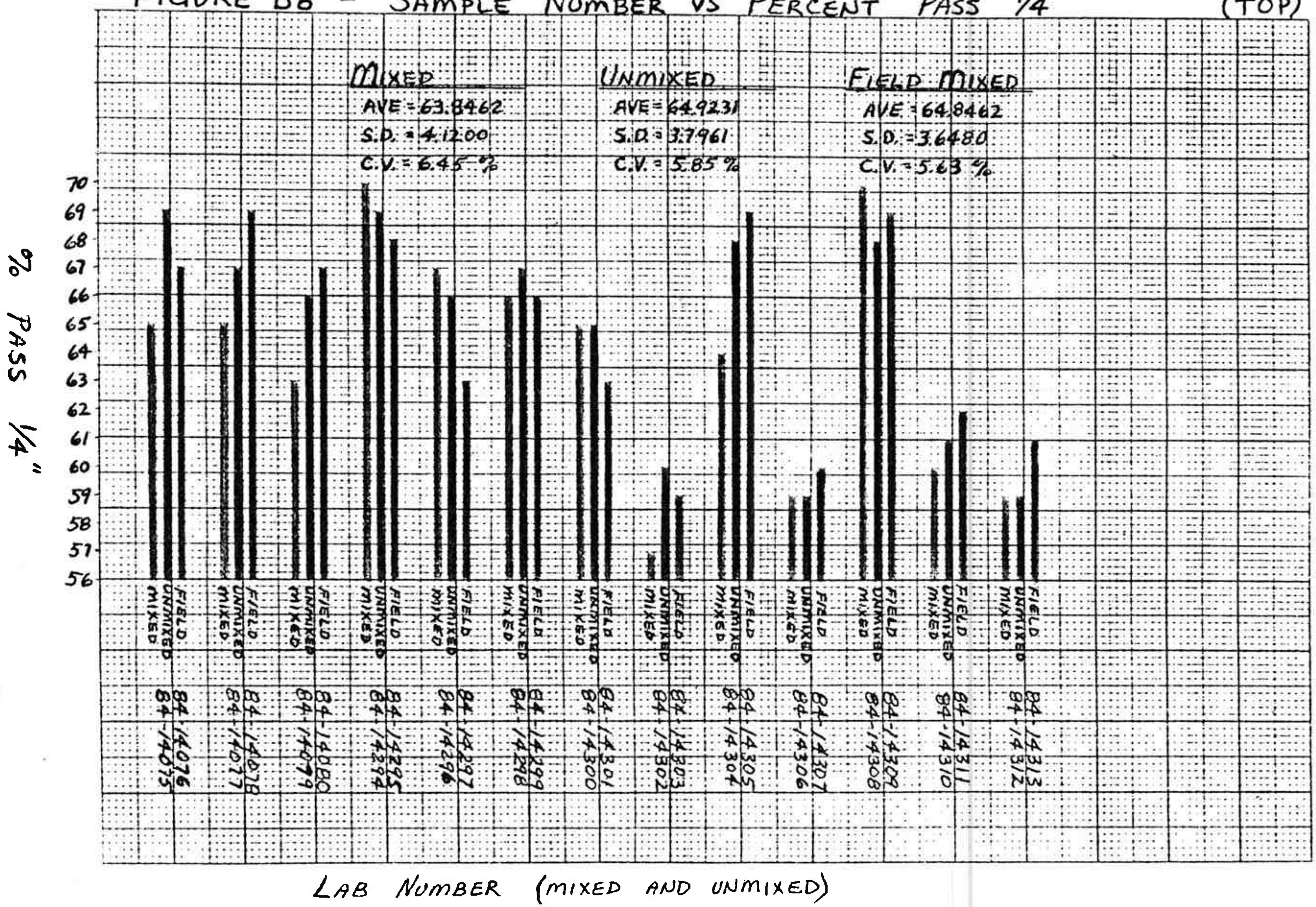
Moro Grass Valley

FIGURE B7 - Sample Number vs Percent Pass 1/2" (TOP)



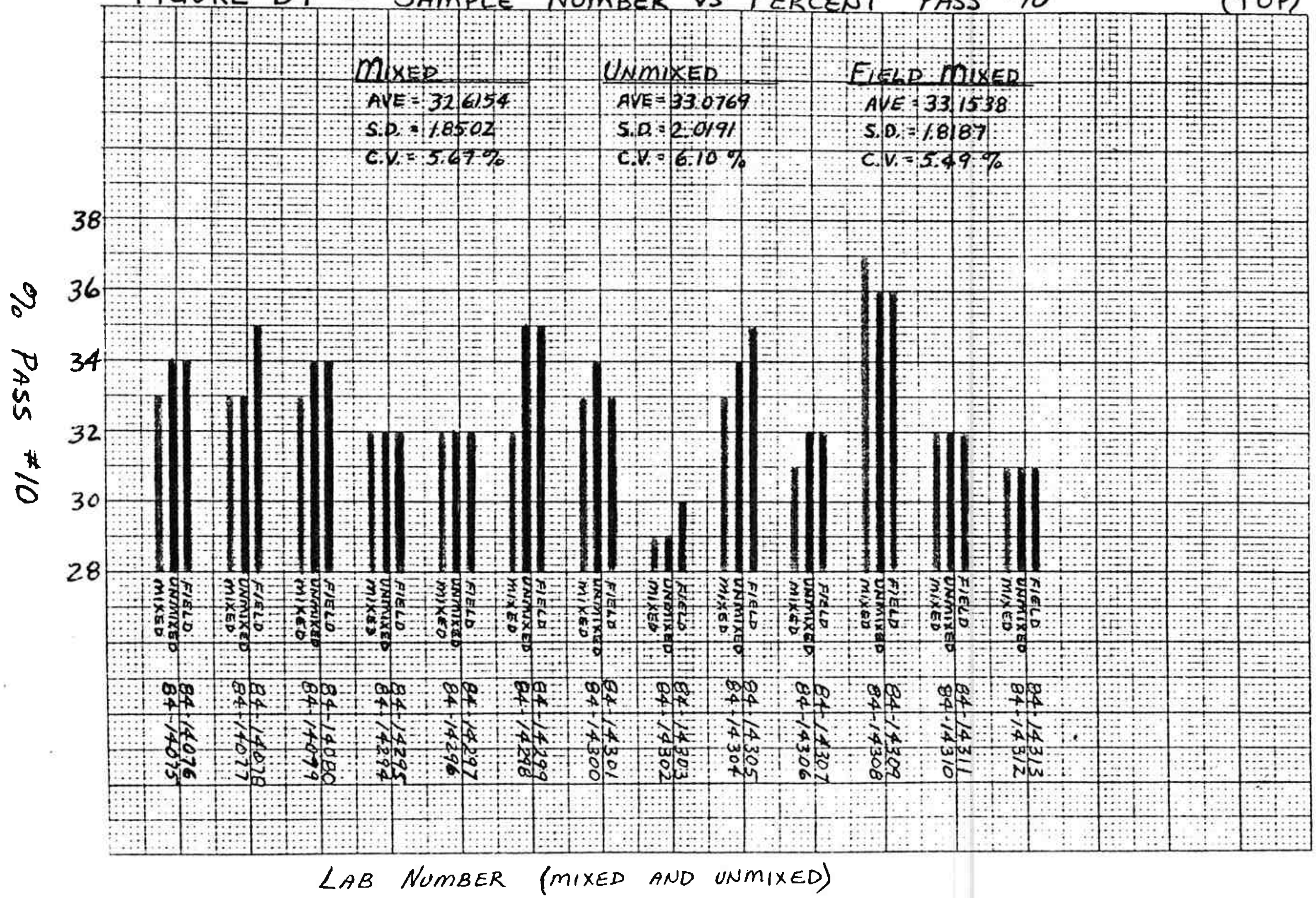
Moro Grass Valley

FIGURE B8 - Sample Number vs Percent Pass 1/4" (TOP)



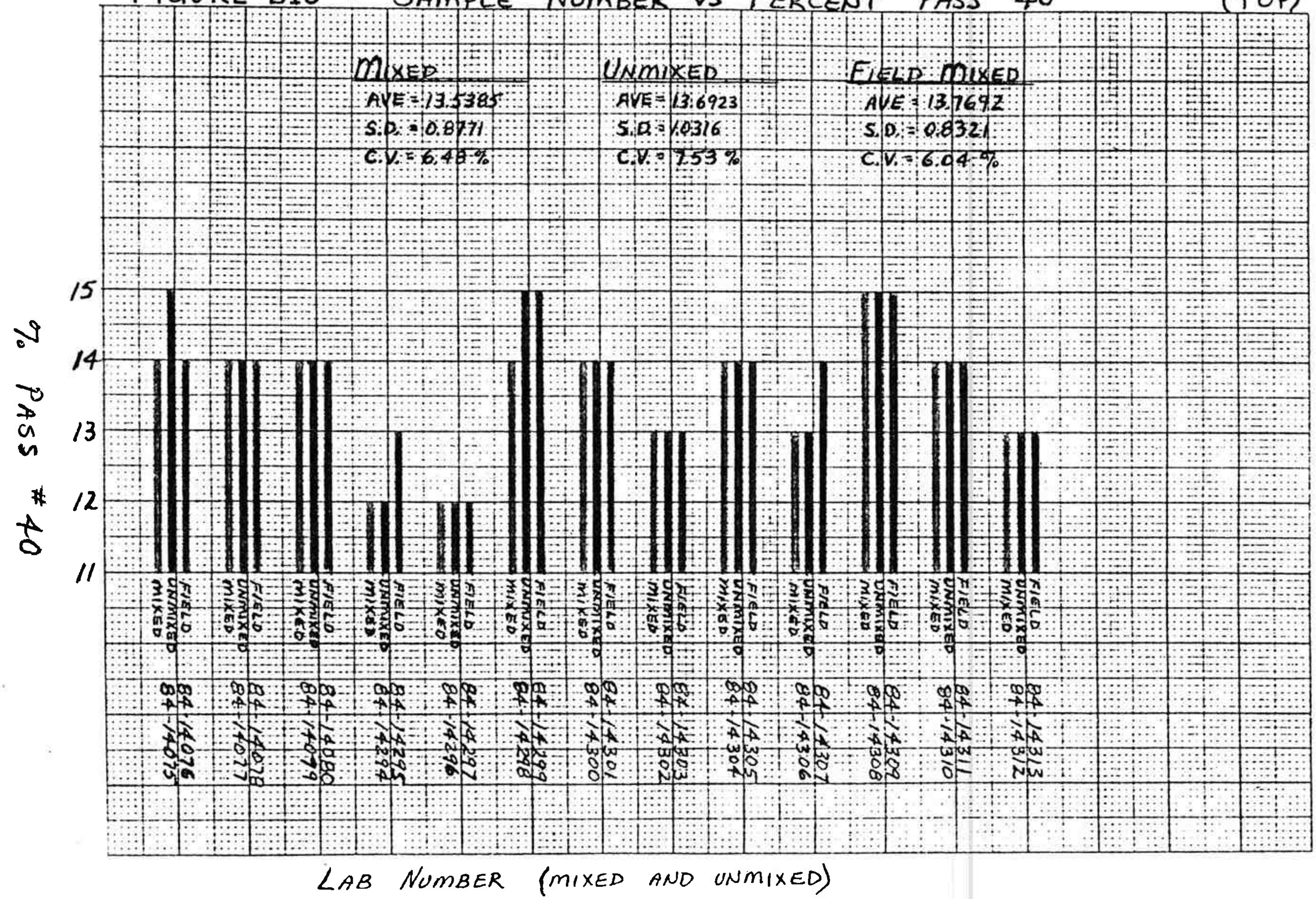
MORO GRASS VALLEY

FIGURE B9 - SAMPLE NUMBER VS PERCENT PASS #10 (TOP)



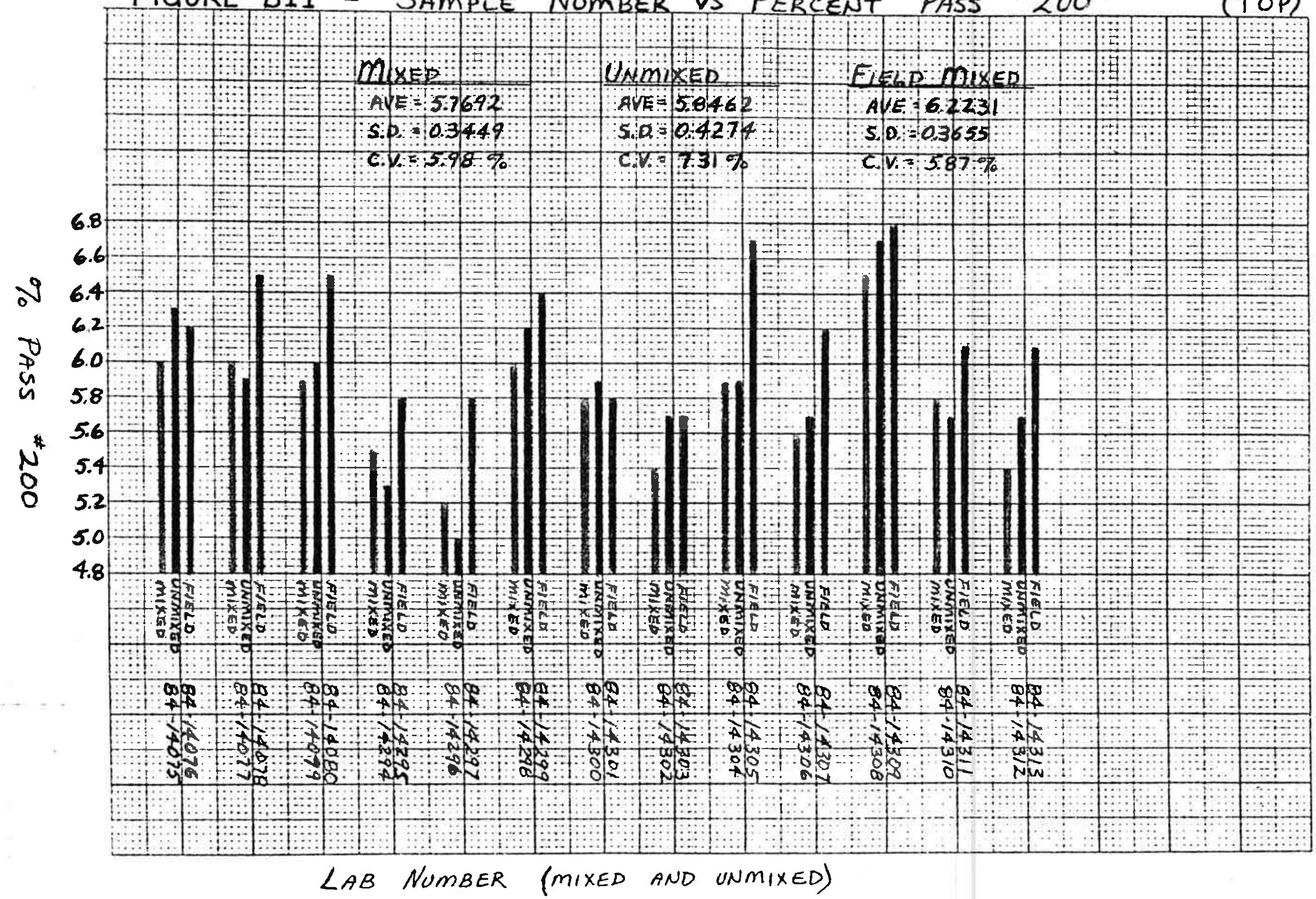
Moro Grass Valley

FIGURE B10 - SAMPLE NUMBER VS PERCENT PASS #40 (TOP)



MORO GRASS VALLEY

FIGURE B11 - SAMPLE NUMBER VS PERCENT PASS #200 (TOP)

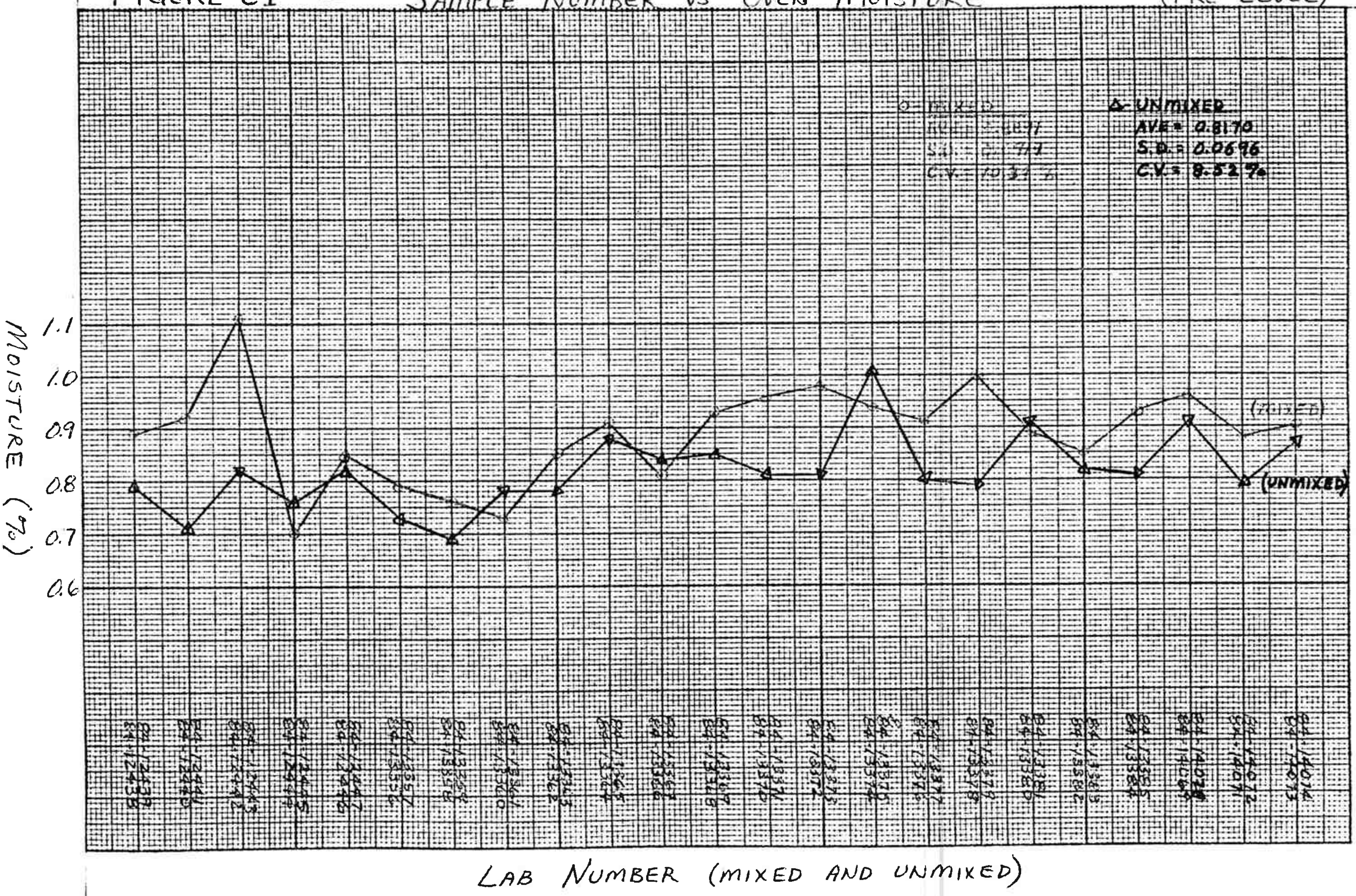


APPENDIX C

MORO - GRASS VALLEY
(PRE-LEVEL)

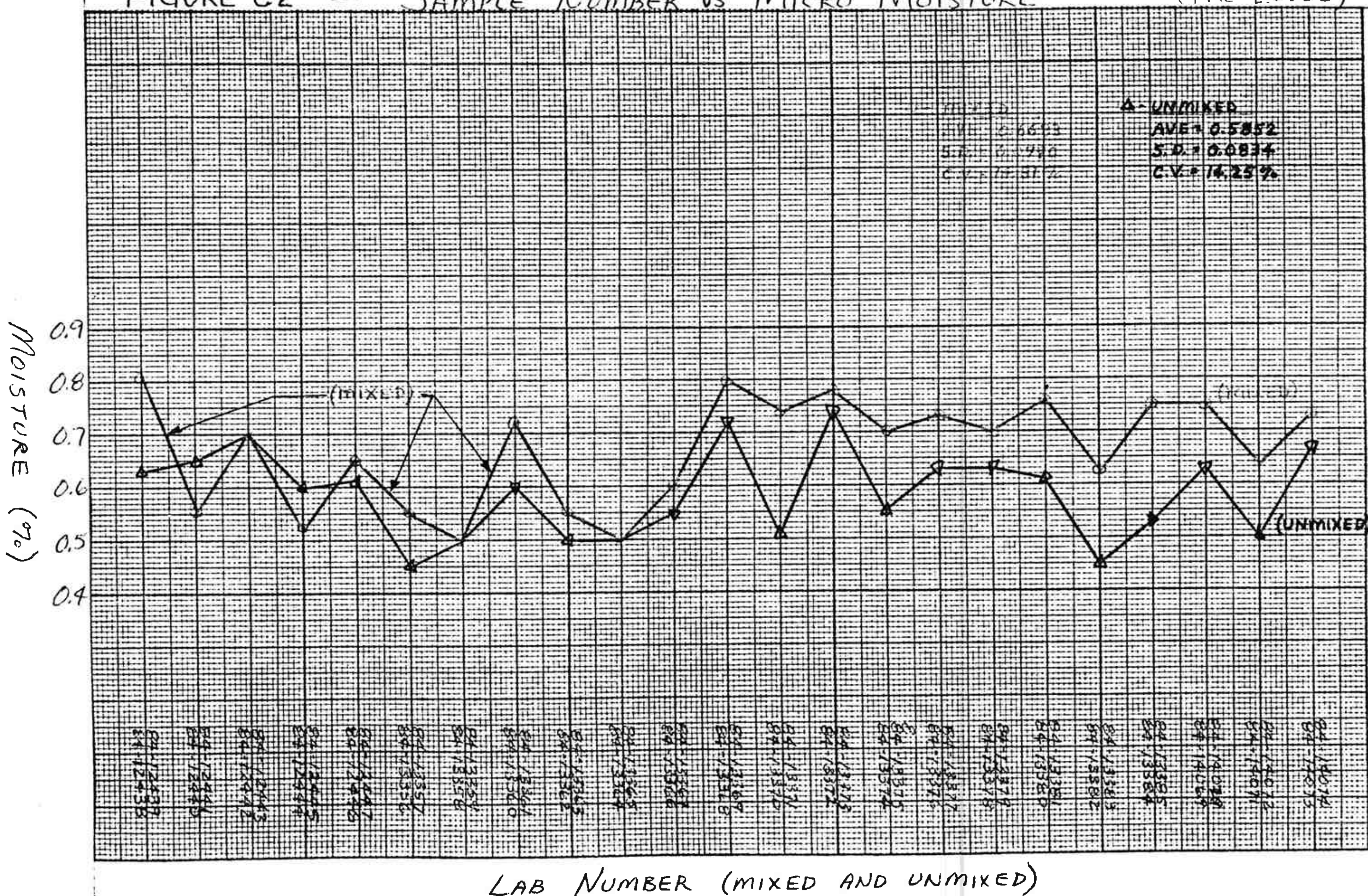
Moro Grass Valley

FIGURE C1 — Sample Number vs Oven Moisture (PRE-LEVEL)



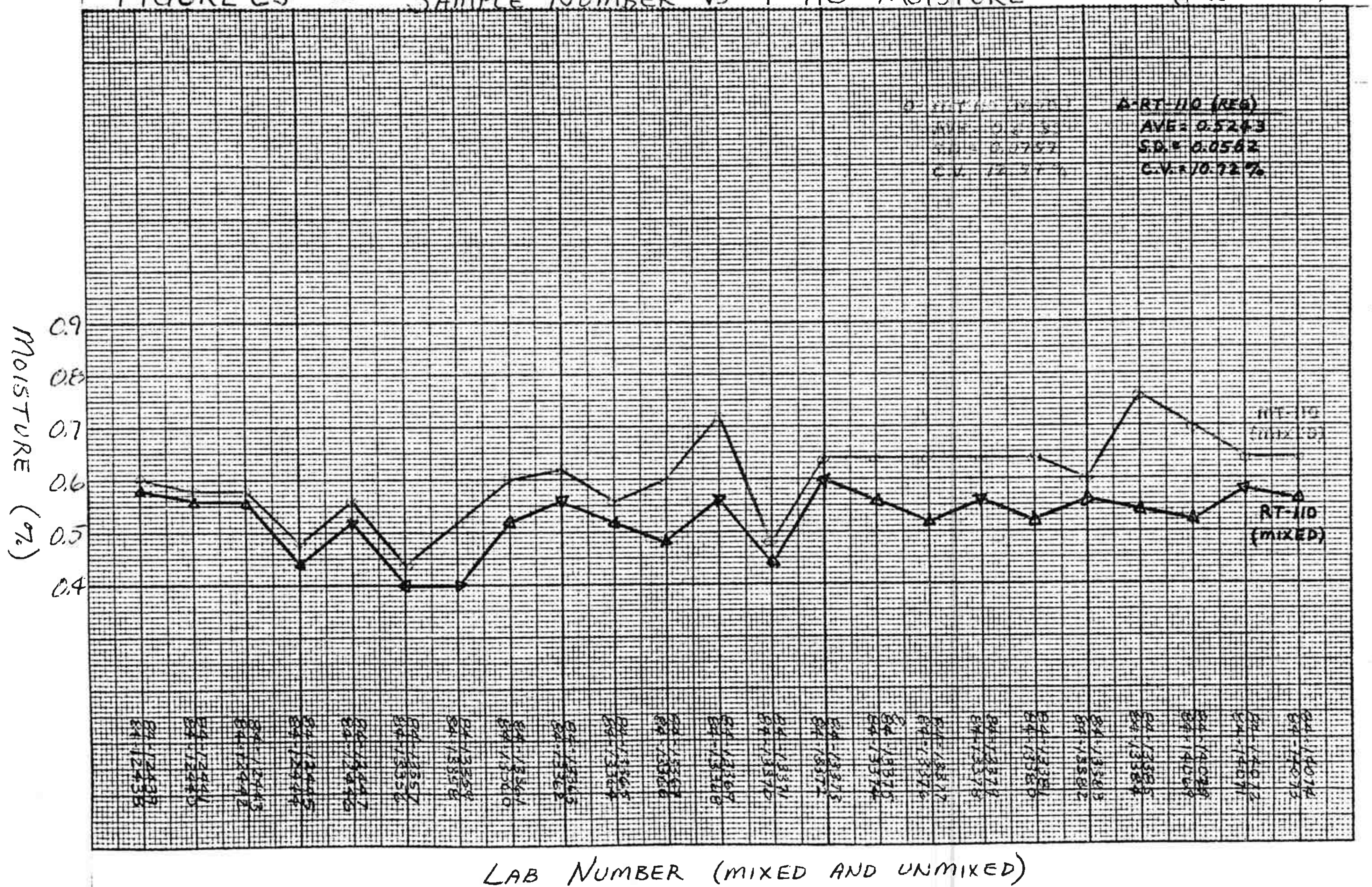
MORO GRASS VALLEY

FIGURE C2 — SAMPLE NUMBER VS MICRO MOISTURE (PRE·LEVEL)



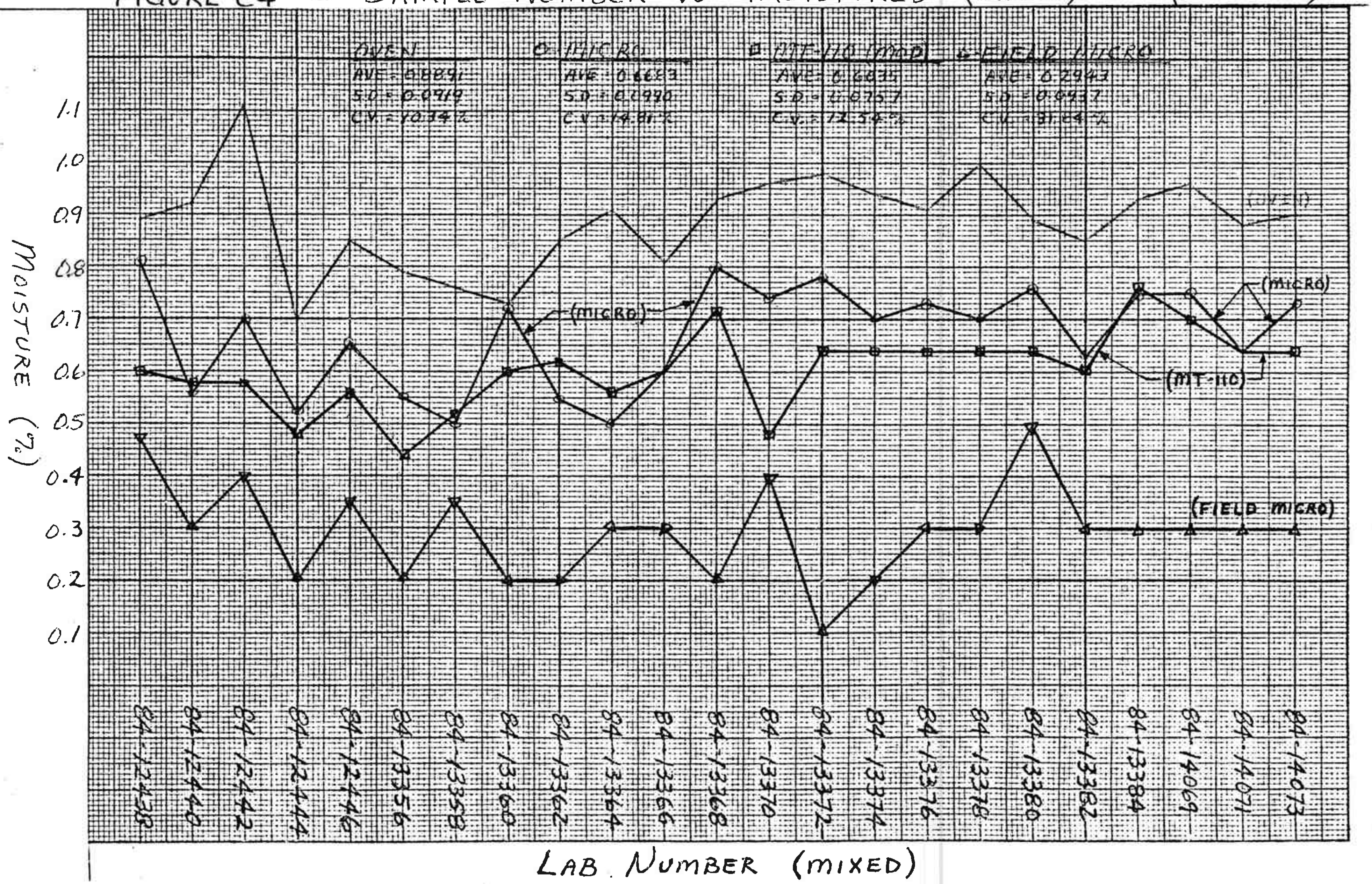
MORO GRASS VALLEY

FIGURE C3 — SAMPLE NUMBER VS T-110 MOISTURE (PRE-LEVEL)



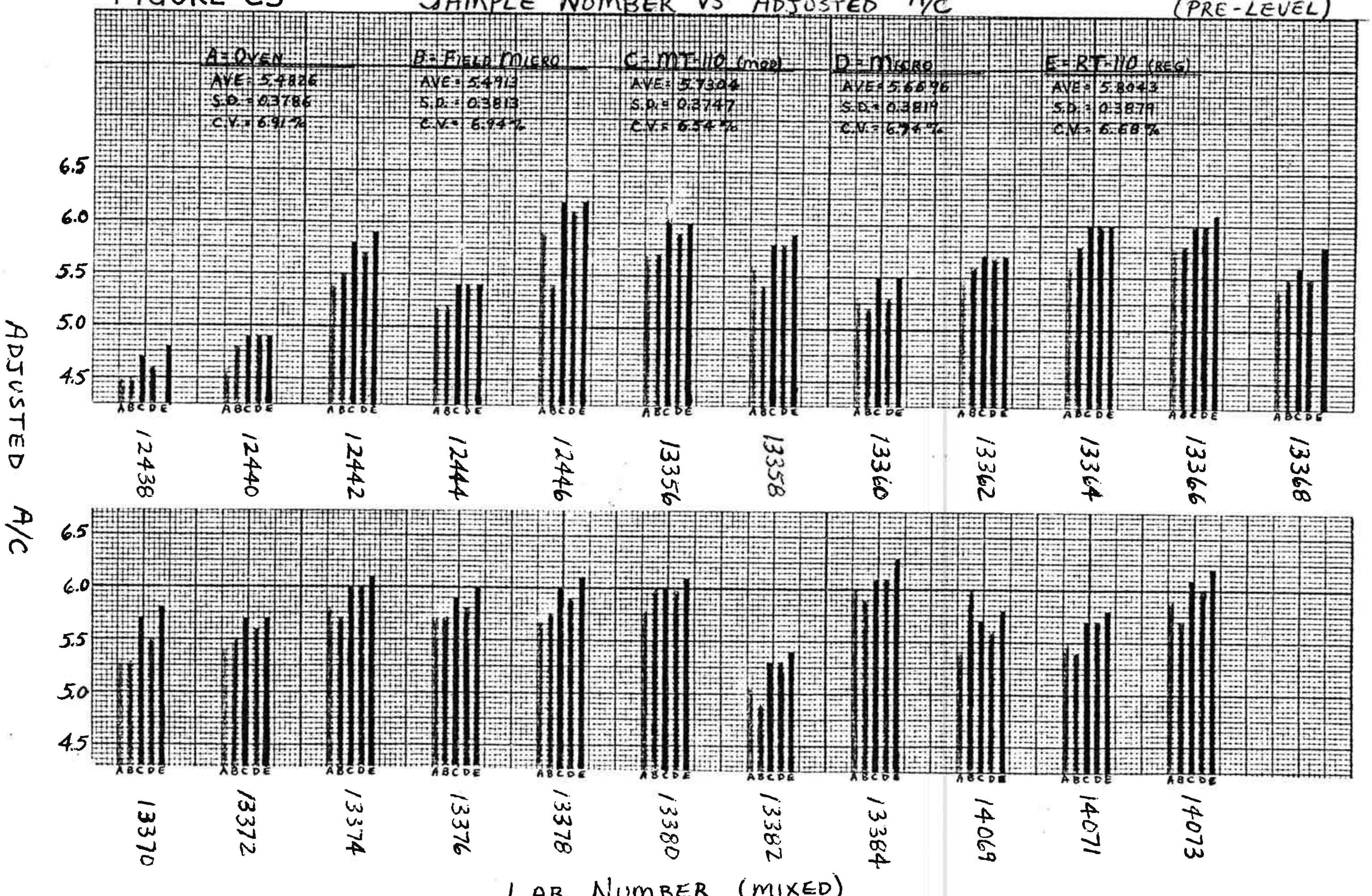
Moro Grass Valley

Figure C4 - Sample Number vs Moistures (mixed) (pre-level)



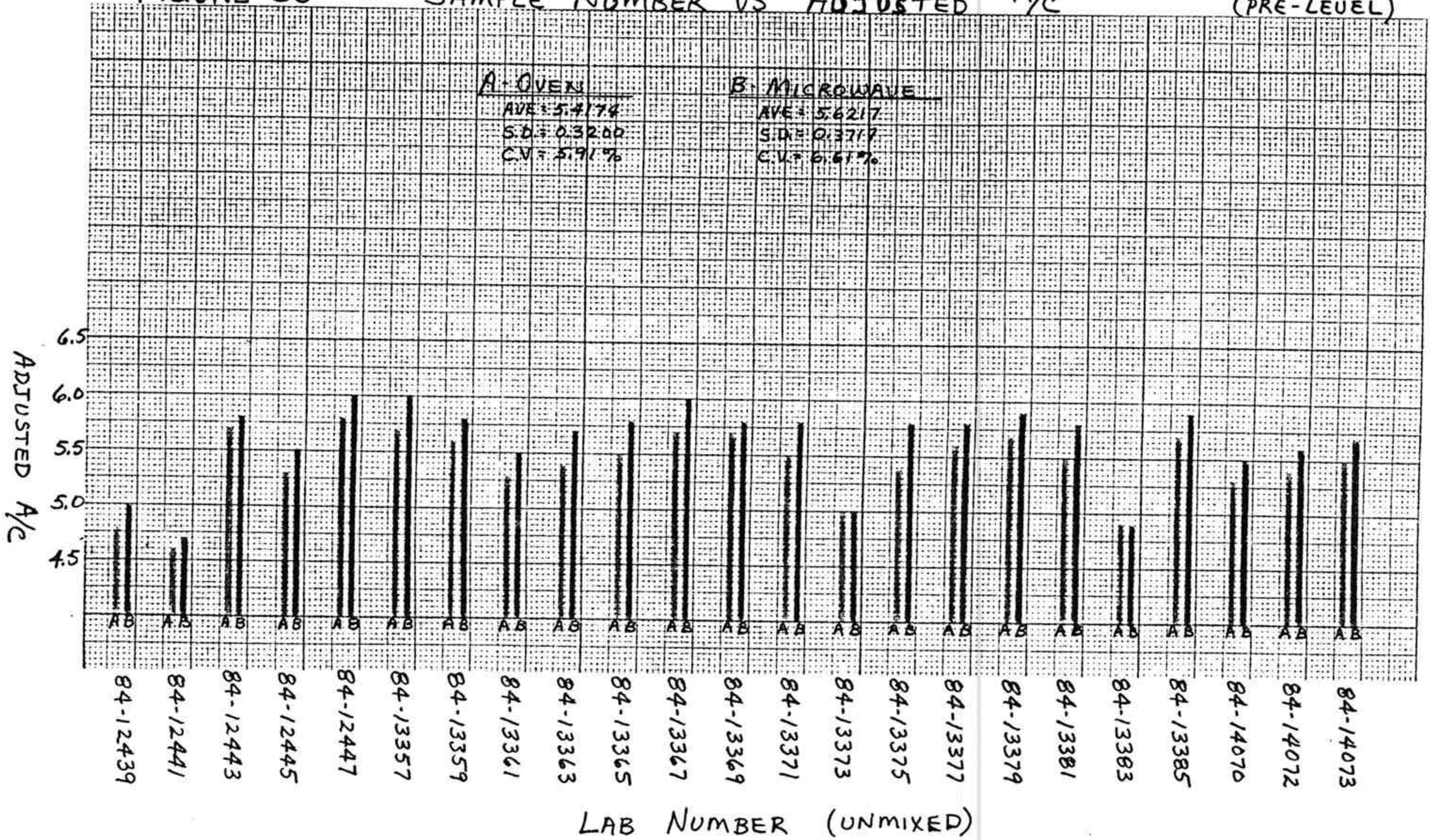
Moro Grass Valley

FIGURE C5 – Sample Number vs Adjusted A/C (Pre-Level)



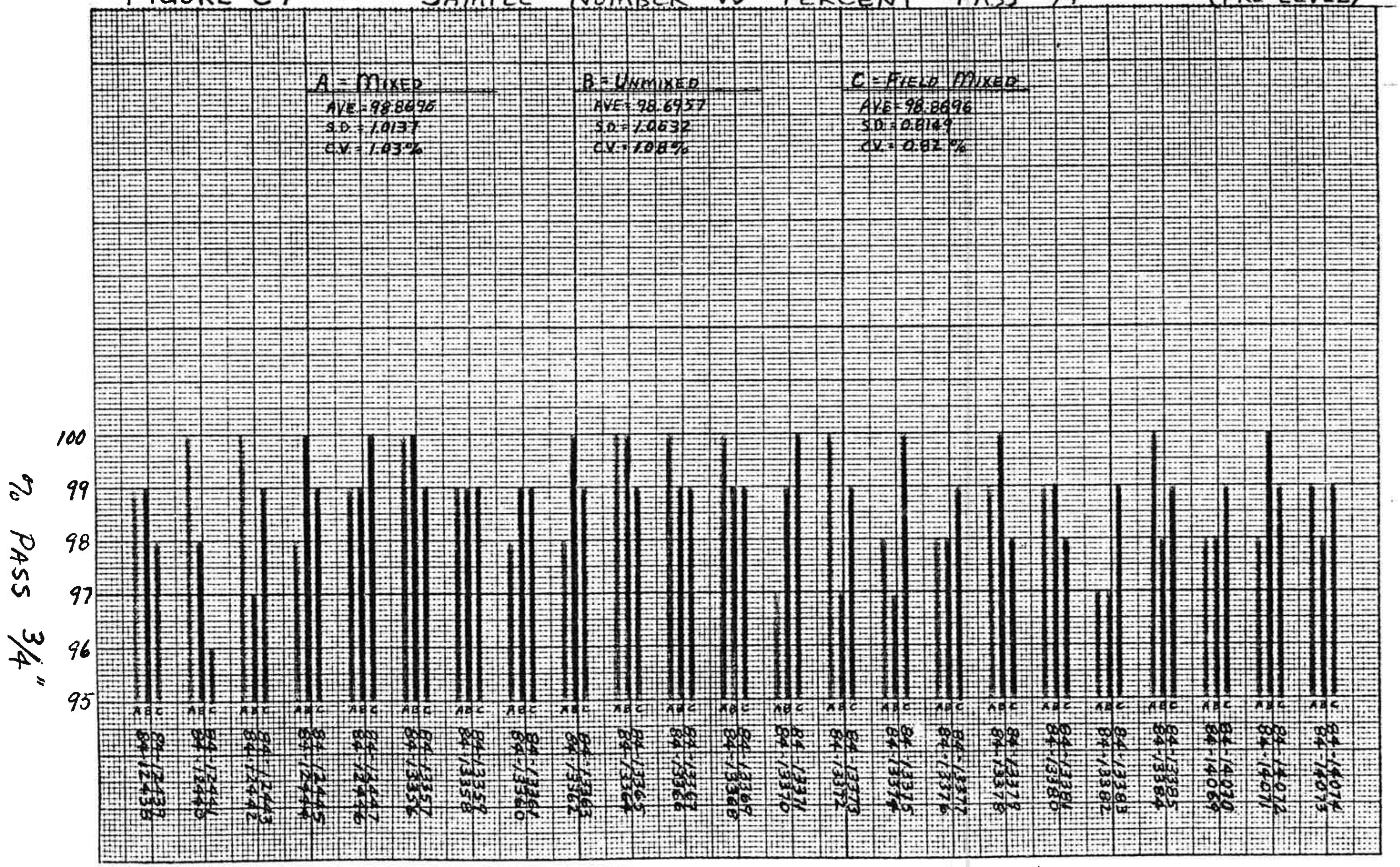
Moro Grass Valley

FIGURE C6 - Sample Number vs Adjusted A/C (PRE-LEVEL)



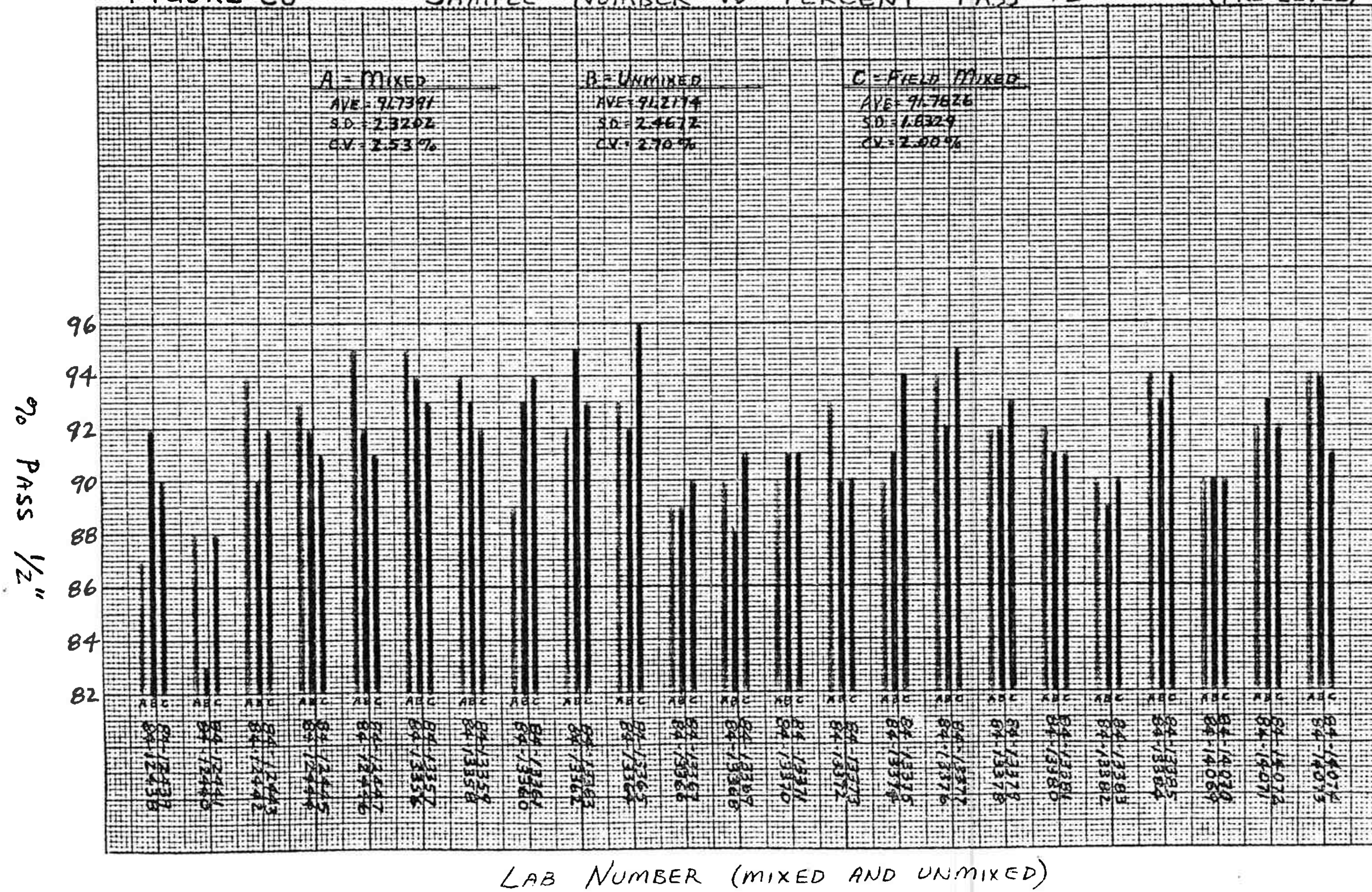
Moro Grass Valley

FIGURE C7 — SAMPLE NUMBER VS PERCENT PASS 3/4" (PRE-LEVEL)



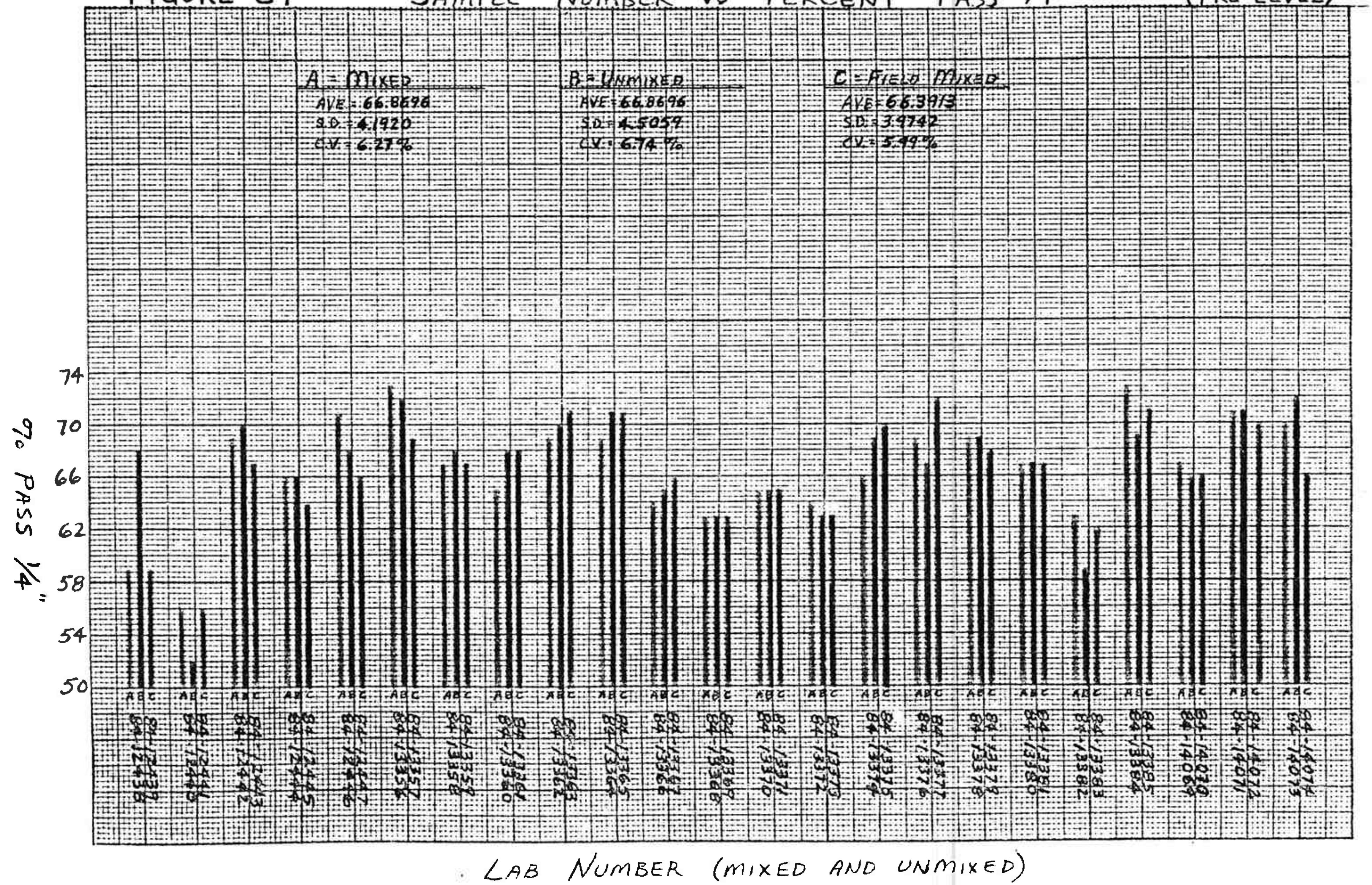
Moro Grass Valley

FIGURE C8 — SAMPLE NUMBER VS PERCENT PASS 1/2" (PRE-LEVEL)



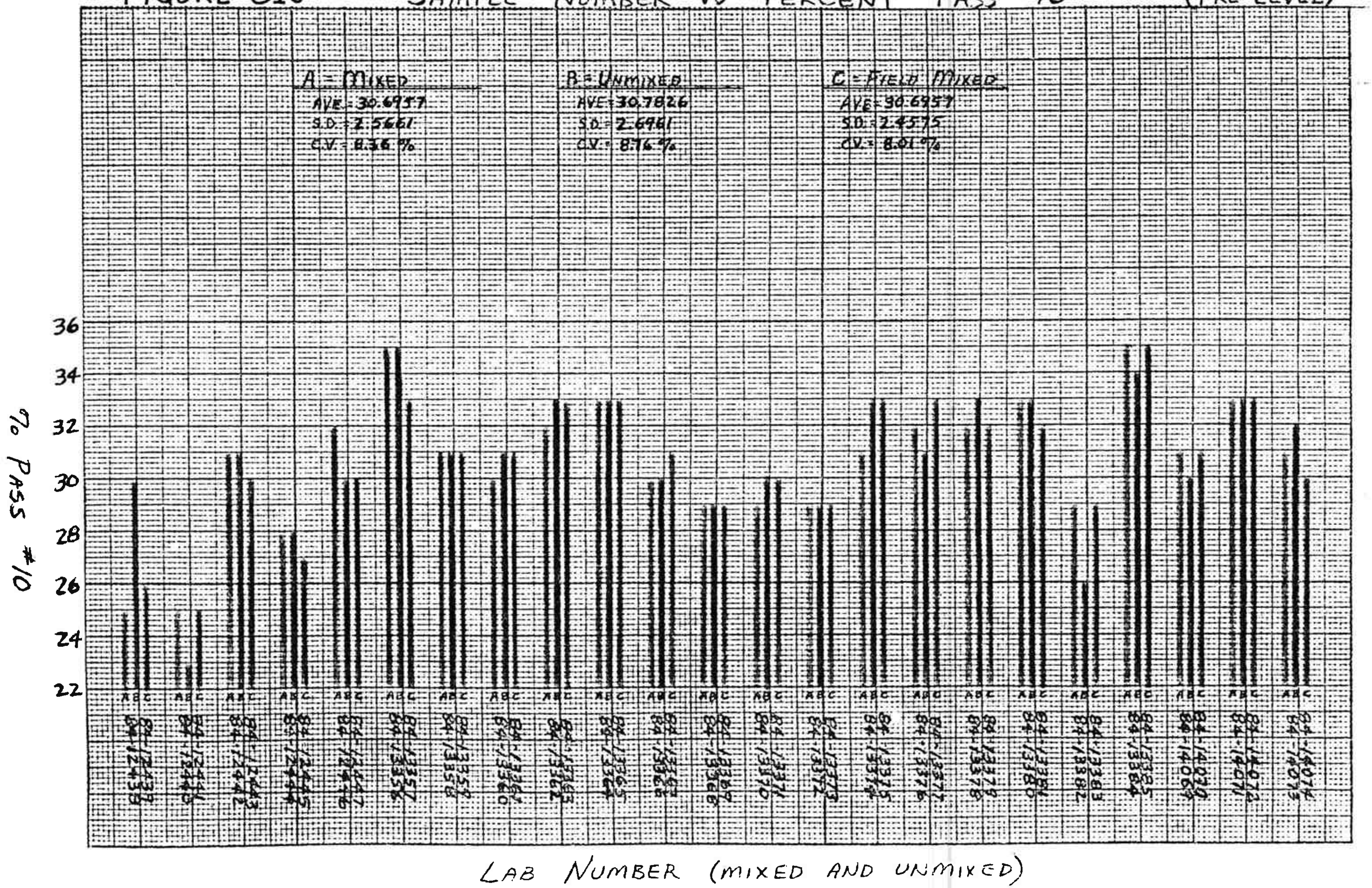
Moro Grass Valley

FIGURE C9 – SAMPLE NUMBER VS PERCENT PASS 1/4" (PRE-LEVEL)



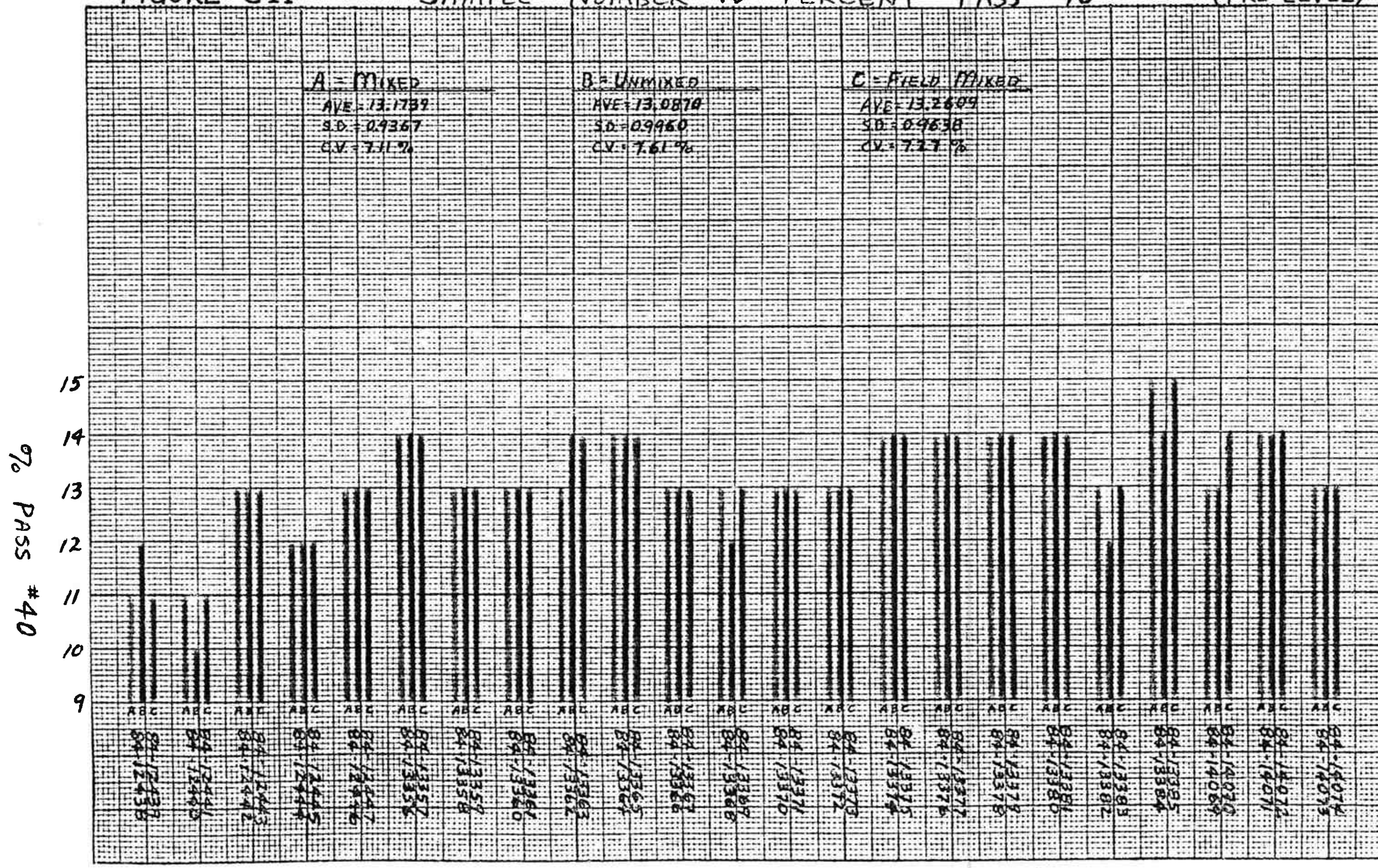
MORO GRASS VALLEY

FIGURE C10 — SAMPLE NUMBER VS PERCENT PASS #10 (PRE-LEVEL)



Moro Grass Valley

FIGURE C11 — Sample Number vs Percent Pass #40 (PRE-LEVEL)



Moro Grass Valley

FIGURE C12 – SAMPLE NUMBER VS PERCENT PASS #200 (PRE-LEVEL)