

FINAL REPORT

A STUDY OF THE MORPHOLOGY AND SEDIMENT CONDITIONS OF PONDS
PRIOR TO UPSTREAM HIGHWAY CONSTRUCTION

by

C. R. Holcomb
Summer Undergraduate TraineeVirginia Highway Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia
Department of Highways and the University of Virginia)

Charlottesville, Virginia

January 1973

A STUDY OF THE MORPHOLOGY AND SEDIMENT CONDITIONS OF PONDS PRIOR TO UPSTREAM HIGHWAY CONSTRUCTION

by

C. R. Holcomb
Summer Undergraduate Trainee

INTRODUCTION

Sedimentation in ponds is an important problem for several reasons. The depletion of pond storage capacity is of major concern. Sediments also may degrade the water by burying bottom-dwelling plants and animals and may carry harmful chemicals which promote eutrophication and kill aquatic life.

Road construction may be a major contributor to the siltation of ponds. Disturbances due to highway construction in the Scott Run Watershed in Fairfax County, Virginia produced sediment at the rate of 80,600 tons per square mile per year at the source, and about one half of this amount was measured downstream at a gaging station. (1)* Sediment yields on denuded land during rainstorms were found to be 10 times greater than for cultivated lands, 200 times greater than for grass areas, and 2,000 times greater than for forest lands.

The following factors are likely to affect the quantity of sediment eroded from a highway construction site and deposited in a pond during a specific storm event:

1. Length and degree of the exposed slope;
2. soil grain size;
3. size, depth, shape, and water level of the reservoir;
4. degree of erodibility of the soil; and
5. amount of highway construction. (2)

During the past few years several lawsuits have been filed against the Virginia Department of Highways for damages to water bodies resulting from upstream highway construction. As public awareness of environmental problems increases, the number of suits against the state is also likely to increase.

SCOPE AND PURPOSE

This project involved the development of a scheme for determining whether or not a pond has been affected by upstream highway construction, and if so, to what degree. The project was a "before" phase of a larger study which will investigate the parameters influencing pond siltation.

* Numbers in parentheses refer to entries in the list of references.

Seven ponds located in the three major physiographic regions of Virginia were studied. The soils in each region are different, as are their erosion and sediment potential. Table 1 shows the location of each pond as well as the erosion and sediment potential for the undisturbed soils in their areas.

TABLE 1

Major Physiographic Regions in Virginia

Physiographic Region	Route No.	County	Erosion and Sediment Potential (Tons/Acre/Year) ⁽³⁾
1) Valley and Ridge	779	Botetourt	0.6 to 1.0
	220	Botetourt	
	627	Warren	
2) Piedmont	17	Fauquier	1.2 to 4.3
	15	Orange	
3) Coastal Plain	295	Henrico	0.5
	295	Hanover	

The purpose of this project was twofold:

1. To make a detailed survey of the shape and subaqueous profile of each pond, and
2. to determine the grain size and geochemical properties of the bottom sediments.

Initially, it was expected that this project would establish two procedures:

1. A recommended method of hydrographic surveying, and
2. a recommended method of analyzing bottom sediments of ponds.

POND SELECTION

Several guidelines were used in selecting the ponds to be studied. The following is a list of these guidelines and the reasons for establishing them:

1. The highway construction must occur in the watershed of the pond located downstream.
2. The pond should be close to the road construction. If this guideline is followed there will be a minimum of siltation due to the land between the pond and construction. Also, very little sediment will be deposited along the stream rather than in the pond.

3. The watershed must be relatively free of land disturbances other than the highway construction. This criterion limits the amount of siltation from other sources such as plowed fields or building construction sites.

METHOD OF TESTING

The testing procedure for this project consisted of two distinct steps:

1. A hydrographic survey of each pond. This included determining the outline of the pond and elevations of points in the submerged areas to define the subaqueous profile.
2. Core sampling at selected positions on the bottom of the ponds. The cores taken were briefly described in field and transported to the lab where a detailed analysis was performed.

Hydrographic Survey

When devising a method of hydrographic surveying, simplicity and clarity are of primary concern. A survey party must be able to return within several years of the "before" survey and establish the same points and lines initially laid off.

A well referenced traverse was laid off down one side of the pond from the dam to the mouth of the stream feeding the pond from the construction site (Figure 1). Each point of the traverse was marked by a hub, a 1-foot steel pin, and a guard stake. The hubs and steel pins were driven flush to the ground and were a distance of 50 feet between each other in the traverse. A guard stake was placed by the hub and steel pin during the survey in order to locate the hubs more easily. After the work on the pond was completed, all the guard stakes were removed to avoid leaving obstacles that people or animals could be injured on.

If in the "after" study the survey party has difficulty locating the hubs, a metal detector can be used to locate the steel pins. After finding the steel pins, one can be assured of locating the original traverse points. In the delta area of the pond, where changes in sediment accumulation are more obvious than in the other areas, traverse points and lines were placed closer together. It was decided to place the hubs 25 feet apart in this area in order to get more detailed profiles of the bottom of the pond.

After the traverse on one side of the pond was established, corresponding points were located on the opposite side. A transit was placed over each point of the first traverse and a line approximately perpendicular to the entering stream was shot across the pond. The backsight point and angle turned were recorded to allow duplication of this line in the "after" study. On this line, a stake approximately was placed 10 feet off the water's edge on the side of the opposite pond from the transit. The distance from the water's edge to this take was not important, as the stake was used only as a reference for the line across the pond.

1008

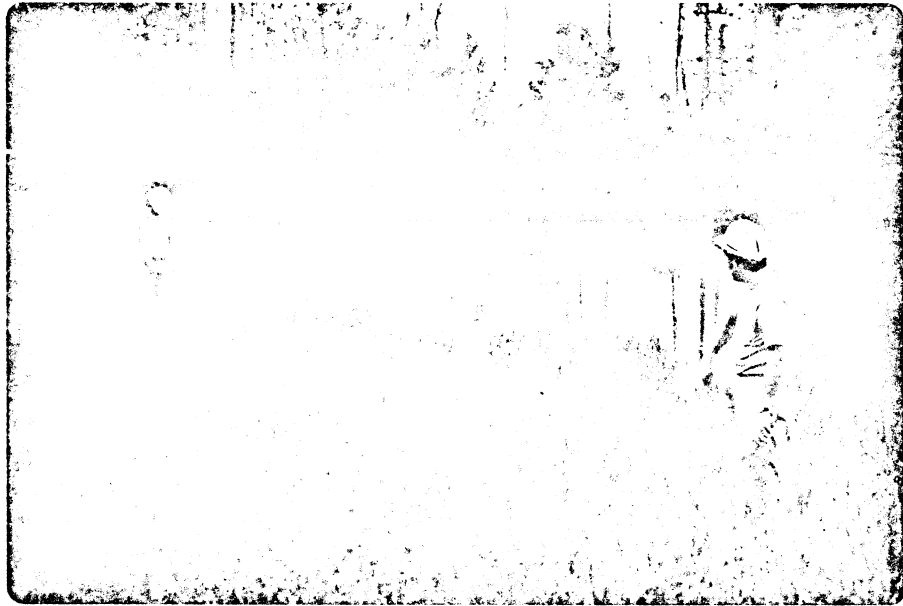


Figure 1

The next step in the hydrographic survey was the determination of the profile of the pond's bottom. First, several permanent markers, such as a big tree or bridge, close to the pond were chosen as benchmarks. One benchmark was arbitrarily assigned an elevation, and those of the others were set from this one. The first benchmark was assigned an elevation of 100.00 feet and the locations of the others were recorded accurately so the "after" survey party could locate them without much difficulty. Therefore, the subaqueous profiles of the pond are only relative to the established benchmarks, and are not true elevations.

A rope with knots at 10-foot intervals was stretched across the pond and secured between two corresponding points of the traverse (Figure 2). Three people in a boat worked across the pond at each line. Elevation readings were taken at the edges of the water as well as at every knot along each line (Figure 3). The elevations were read from a surveying rod placed on the bottom of the pond. However, due to the soft material on the bottom of ponds, it was felt that the rod would not rest on the fine material of interest in this study. To prevent deep penetration of the rod into the soft material, a 3 inch x 6 inch thin metal plate was secured to the bottom of the rod (Figure 4). It was felt that this plate would remain essentially on top of the sediment and would allow measurements of the fine material accumulated on the bottom of the ponds during the study.

To enable accurate plotting of the profiles, the distance from the hubs on the first traverse to the water edge was recorded. Also, the distance from the hub to each knot was recorded. To facilitate measurement of the distance to point being profile, a knot was started at the edge of the water. By doing this and taking elevations at each knot and recording the distance to the water from the hub, then one is assured of the "after" party being able to take readings at the same points as the "before" party, even if the water elevation has changed.

The direction in which readings are taken across the pond with some reference line was recorded to prevent profiles from being compared that are plotted in reverse directions. The reference line was established as a line from the stream to the dam. If readings were started to the right of this line, then it was recorded to avoid profiles starting from the left being compared to the profiles starting from the right.

Efficient performance of the hydrographic survey required six people. One person was required to take readings and record additional data during the survey. Three people were needed in the boat. The middleman in the boat handled the level rod while the other two moved the boat across the water parallel and close to the rope stretched on the line. The fifth and sixth men were stationed at the ends of the rope to make sure it remained taut and secure. They also moved the rope from line to line.

In surveying the ponds it was found that moving the boat across the water was best done by the two men in the boat pulling on the rope. Figure 3 shows the method of profiling and how the boat was steadied.

The above procedure was carried out for every profile desired. In the delta areas, the lines for the profiles were placed 25 feet apart and elevation readings were taken every 5 feet across the pond instead of every 10 feet.

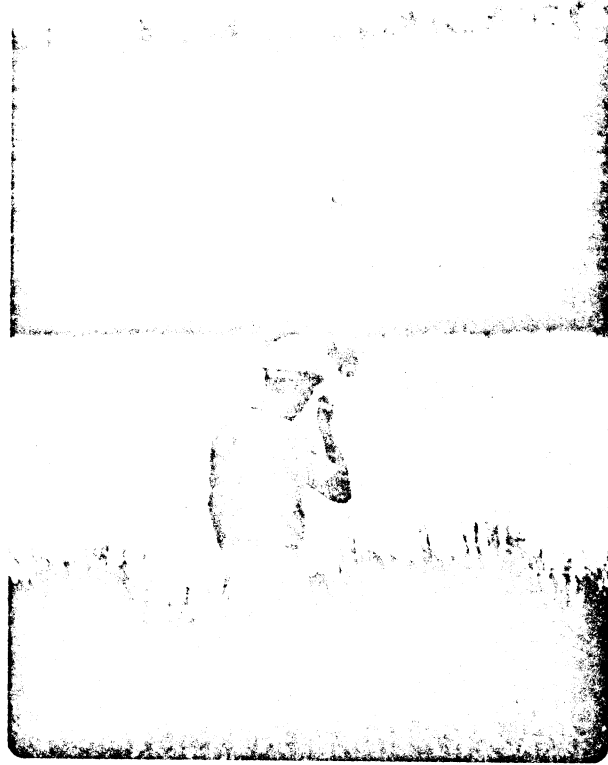


Figure 2

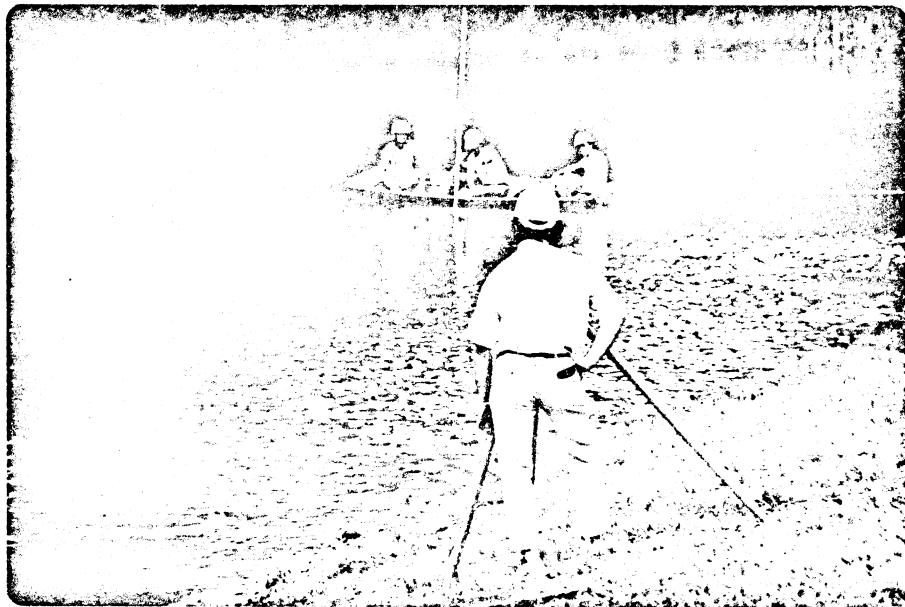


Figure 3



Figure 4

With clear and simple notes from the "before" phase, the "after" phase survey party should have no trouble reproducing the traverses. With the use of a metal detector, the steel pins may be located without a resurvey. By plotting the profile of the "after" survey over that of the "before" survey, one can determine the amount of siltation deposited between the two surveys.

The second part of the hydrographic survey consisted of obtaining representative core samples from the bottom of the pond. The samples were taken on the lines established across the pond and each sample location was recorded by the distance from the water's edge.

Sampling Procedure

The procedure for obtaining samples was the same as that for taking profile readings, with the middleman in the boat handling the core sampler instead of the level rod (see Figure 5). The sample was taken with a split-spoon sampler with a trap at the bottom and attached to the end of a small 15-foot drill rod. After the boat was positioned at the proper location, the sampler was lowered close to the top of the sediment, then rammed into the sediment until resistance was met.

If a sample was not obtained, a different trap was placed in the bottom of the sampler. Two types of traps were used in this study. The most effective one is called the basket catch. It consists of flexible strips of steel approximately 1 1/2 inches long pointing upward in the sampler. The strips are placed evenly around a ring with a small gap between them. The loose ends of the strips come close together in the middle of the tube and form a small opening. As the sample is pushed up into the tube, the opening at the end of the strips enlarges to allow the sample to enter. When the sampler is pulled up, the weight of the sample on the strips pushes them together to form a trapdoor that retains the sample.

The other trap used in this study is called a trapdoor catch, and it works on the same principle as the basket catch. The difference in the two types is that instead of the steel strips, the former is equipped with a steel door on a small hinge. Problems were encountered with this catch, probably because the sample did not push the door down from the side of the sampler. With the sample on one side of the tube falling back through the opening and not allowing the weight of the sample on the other side of the tube to push the door shut, most of the samples taken with this type catch were small in quantity, if any material was retained.

When a sample was retained, the tube and sample were brought to shore for field description. The sampler was split open to allow inspection of the sample before it was handled and greatly disturbed (Figure 6). By close inspection one was able to determine different layers and the type material in each layer. The following information was recorded, as was the approximate thickness of each layer.

1. Color
2. Grain Size
 - a. Gravel
 - b. Sand
 - c. Silt and clay
 - d. Combination of a, b, or c

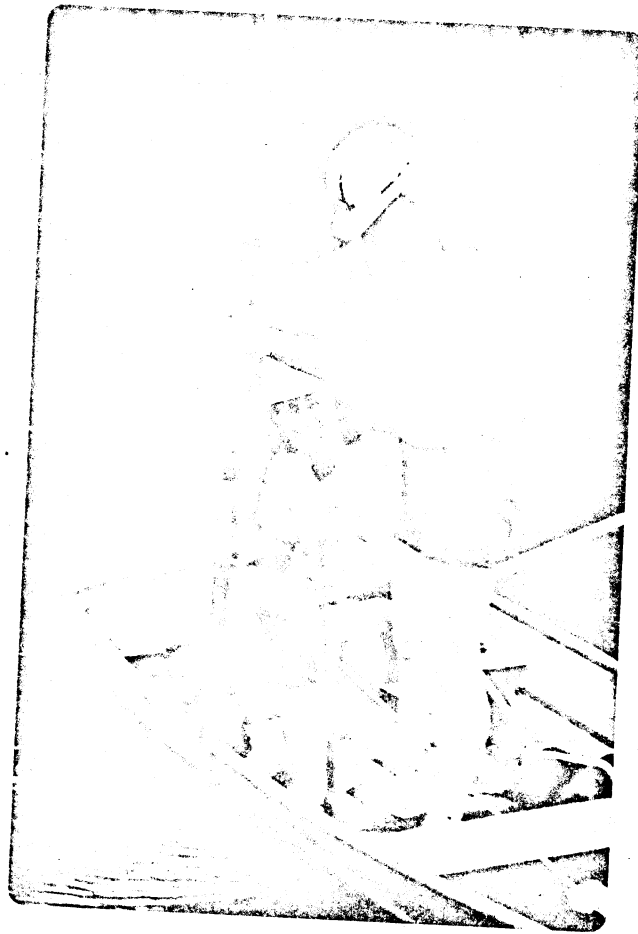


Figure 5



Figure 6

3. Texture
 - a. Gritty
 - b. Smooth
4. Consistency
 - a. Sticky
 - b. Plastic
 - c. Soft
 - d. Stiff
5. Organic Content

After the descriptive data were recorded, each layer was placed in a labelled sample jar. If a layer was thicker than the sample jar height, the sediment was placed in several jars so the location of each part of the layer in the entire sample is known (Figure 7).

The separation of layers in the field when placing the sediment in the sample jars is very important when laboratory analysis of each layer is required later. After the samples are stored and dried out over a period of time, it is hard to distinguish one layer from another, so this extra care should be taken in the field.

STORAGE OF SAMPLES

The samples were stored in the jars at room temperature. Several drops of iodine solution (1 molar concentration) were placed in each jar to preserve the sample, hopefully with no detrimental effect.

After a period of time mold developed on many of the samples that had been treated with the iodine solution. Therefore, this method of storing and preserving samples should be reevaluated. If it does not work, another method of preserving the samples will have to be found.

LABORATORY ANALYSIS

Due to the time limitation on the study, every sample could not be analyzed. Therefore, selected samples were chosen to be tested in the laboratory. The layers of each sample were analyzed separately to determine if there was a large difference between them.

Two tests were run on each layer. First, the grain size analysis was determined by the pipette method ⁽⁴⁾ (see Appendix A). It was planned at first to determine the grain size by the hydrometer method, however, several layers did not have enough material to permit its use. The method requires a minimum of 100 grams of material — fifty for the hydrometer test, and at least another 50 for the specific gravity test.

With only 10 grams of material being used for the pipette test, all weights should be taken from a very sensitive analytical balance. A balance with two decimal places was used for some of the measurements, while a five decimal place balance

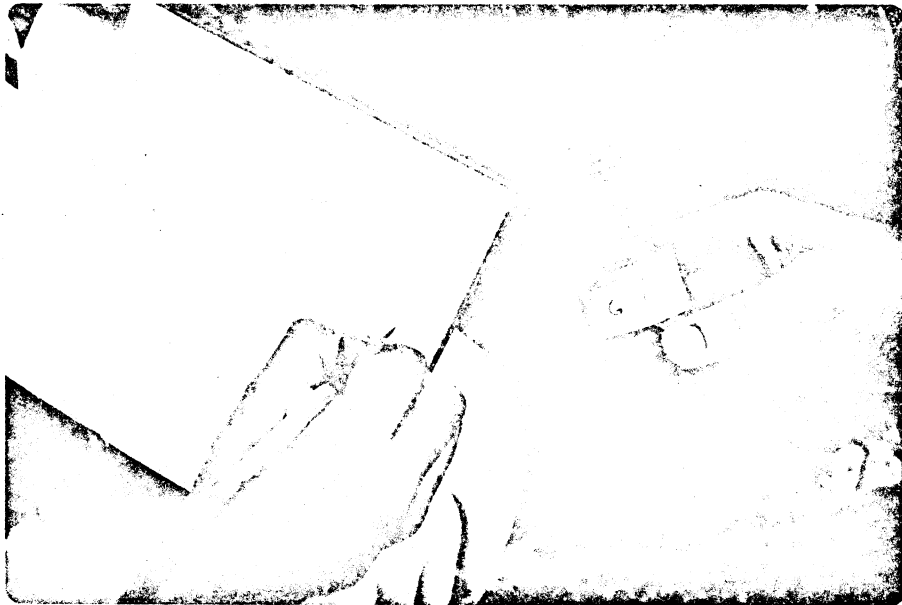


Figure 7

was used for the remaining measurements. The two decimal place balance was not accurate enough for the pipette analysis, therefore the more accurate balance should be used in further work.

The second test run on the laboratory samples was for organic content. There are several ways to determine the organic content of soil. One is to burn the organic matter off at a high temperature, such as 600°C. However, this method is not very accurate for clay particles. The sample is first dried at 110°C to drive off the water. With clay materials, water is also held hygroscopically and will not be released at 110°C. Therefore, when the sample is heated to 600°C, the hygroscopic water plus the organic matter is driven off. In order to avoid erroneous results, the H₂O₂ oxidation and weight loss method (5) was used in this study (see Appendix B). The organic matter is decomposed by treatment with 30 percent H₂O₂. This decomposition process will occur at temperatures lower than 110°C, while the hydroxyl and hygroscopic water are retained in the material.

From grain size analyses and organic content tests run after the second survey one should be able to determine, if the highway construction has a large effect on the silting of the pond. The grain size analysis should show an increase or decrease in grain sizes from the present analysis after the construction is finished. Whether it is an increase or decrease depends mainly on the type material used on the construction job. The distances from the ponds to the construction jobs for all the ponds are fairly close, so if any silting occurs due to the construction most of it will occur in the pond.

The organic content test should give an indication of the origin of the organic material and silt. If the topsoil and top several inches of soil are removed from the construction site, the material in the fills and around other construction will contain very little if any organic matter. Therefore, if the material is eroded from the construction into the pond, the organic content of the sediment should show a decrease from the first survey.

RESULTS

Bottom profiles were plotted for the six ponds surveyed and are available in the Council files in the Soils and Geology laboratory. Sediment and organic tests were completed on one pond near Gordonsville in Orange County on Route 15, and the results are presented in this report. Due to a lack of time, no laboratory tests have been run on the other ponds.

After the ponds were surveyed, the data were reduced in order to plot the profiles on graph paper. The elevations determined were not absolute but relative to the arbitrary benchmark set at each pond. Therefore, if a point on a profile had an elevation of 95.0 feet, this point was 5.0 feet lower than the arbitrary benchmark of 100.0 feet. In plotting the profiles of the bottoms of the ponds, the differences between the benchmark and the points on the bottoms were plotted on the vertical axis while the distance from the edge of the water (usually the left edge) was plotted on the horizontal axis.

Figure 8 shows the pond near Gordonsville. As can be seen, it is only approximately 1 acre in area. Figure 9 shows the location of each profile and the points where bottom samples were taken. The profiles were spread fairly evenly throughout the pond to allow for adequate coverage of the pond bottom with a minimum number of profiles. This was also true for the bottom samples. In selecting locations to be sampled, it was decided to obtain sufficient samples to see how the sediment varied from the mouth of the stream to the dam as well as how it was distributed along the profile. This is the reason for three samples per profile to determine the deposition of sediment to the sides of the main flow into the pond.

Appendix C shows the profiles indicated in Figure 9 as well as the location of the bottom samples. The height of the water from the bottom of the pond varies from approximately 1/2 foot at Station 0+25 to approximately 6 1/2 feet at Station 3+00. Assuming the pond bottom was originally in a bowl shape across and a constant slope from the dam to the mouth of the stream, there was more silting at the shallow end than at the deep end. This was very evident in the field during the survey. At the deep end there was some fine material on the bottom of the pond, while the shallow end near the mouth of the stream was covered quite heavily with silt material. Marshy areas are shown in the first two profiles (Station 0+25 and 0+50). These areas of the original pond were silted in by the sediment from the stream allowing plants to grow. Streams in delta areas usually are relocated due to the sediment they deposit in these areas. As one goes from the shallow end to the deep end, less sediment is encountered. Assuming the original cross section of the pond was bowl shaped and the approximate maximum depth was the maximum depth shown on each profile at that cross section of the pond, the humps in the profile are the approximate amount of sediment deposited at that distance from the mouth of the stream. Looking through the profiles and taking the original edge of the pond of the first two stations as the point where the marsh area ends and solid ground begins, one can see that more sediment has been deposited closer to the mouth of the stream. This is expected due to the velocity of the entering water slowing down. With the decrease in velocity of the water, large size particles that are carried in faster flowing water will fall out of suspension. As the flow of water through the pond decreases more and more from the shallow end to the deep end and the time in suspension of the particles increases, then smaller size particles will settle to the bottom. This accounts for the more bowl shaped cross section for the higher stations, such as Stations 3+00 and 3+50.

The profiles of the pond will be the best measure of the amount of sediment deposited in the pond during construction. Using the present profiles and the profiles along these same lines after construction, one can determine the amount of sediment at each station as well as how it was distributed along this profile. By determining the area between the two profiles for each station one can determine the volume of sediment deposited between two stations by multiplying the distance between the stations times the average of the two stations' area.

Another measure of the amount of sediment in the different areas of the pond is the amount of material the sample tube was pushed through prior to resistance from the original bottom of the pond. Most of the samples yielded several inches less than the depth penetrated with the sampler. In the deep end of the pond 3 1/2 to 5 inches of material were retained, while the delta area

1018

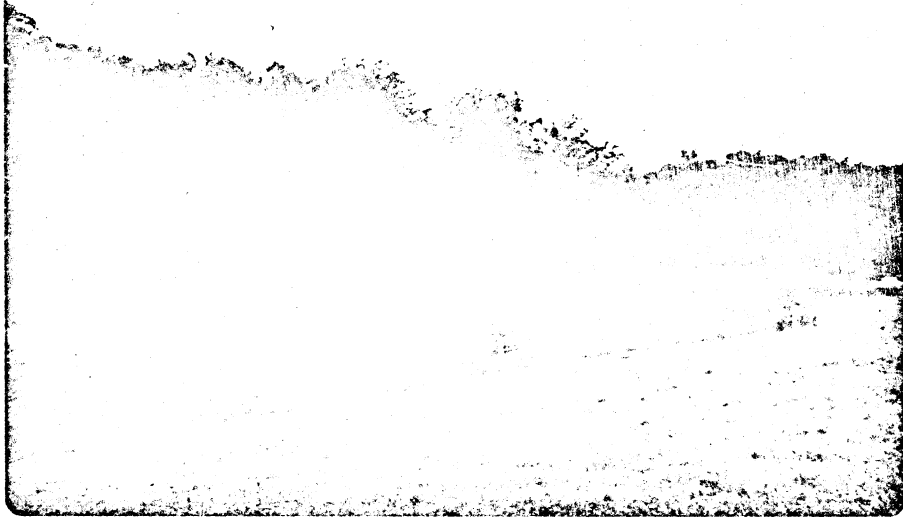


Figure 8

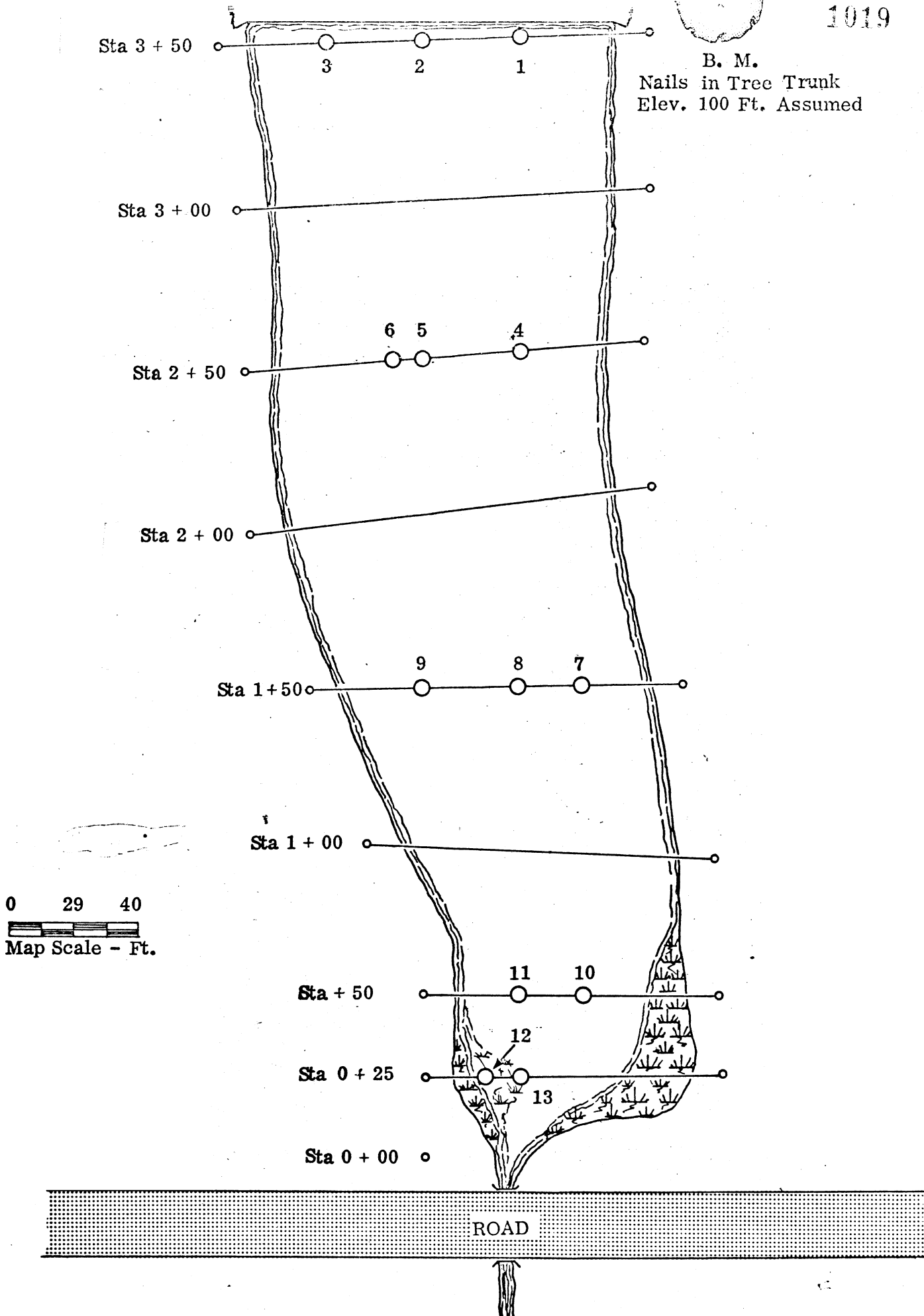


FIGURE 9 — CORE SAMPLE LOCATIONS

yielded approximately 20 inches of sample. Samples from the middle profiles were 8 to 13 inches in length. So one can see that the sediment deposited varies in thickness evenly from the deep end to the shallow end.

Grain size analyses by the pipette method were run on the layers of samples. The layers for some of the samples were tested in order to see the difference in gradation through the depth of the sample. The gradation curves for the layers tested are shown in Appendix D. The entire sample was tested for locations A5, A10, A12, and A13. From the plots for these locations one can see that the sediment falls out with the coarser particles first and the finer particles last. As shown for location A10, one can see that the bottom layer curve (A10B) lies to the right of the top layer gradation curve (A10T). At any percent passing on the vertical scale the bottom layer curve yields a larger size particle than the top layer curve except around 55% passing. This difference is probably due to the method of sampling and the separating point between the layers, both of which cause the layers to become mixed with each other. The mixing of layers is probably the reason that location A12 gradation curves cross each other. This reason is partially true for location A13 curves, but the large difference between the top layer (A13T) and the top half of the middle layer (A13MT) is due to additional sediment load being added to the pond. Since A13 is about in the mouth of the stream, any sediment washed into the pond could be gauged at this location. By comparing this location with the other locations one would suspect a large intense rain that would cause an infiltration of a measurable amount of coarse sediment to cause deposition at the delta area of the pond. However, if the rain was not large enough to cause a large amount of runoff, very little measurable sediment would be carried into the deep end of the pond. This would account for the top layer gradation curve (A13T) being coarser than the top part of the middle layer curve (A13MT). The finer sediment of A13MT is from normal sediment due to no rainfall, while the coarser sediment of A13T is due to some rainfall. As shown by the gradation curves this additional sediment was finer than A13MB but coarser than A13MT.

Pages 5, 6, and 7 in Appendix D show the gradation curves for the top layers of samples on the three different profiles. From samples A10 and A11 on page 5 one can see there is very little difference in grain size across the profile. This conclusion is not very surprising because the samples were close to the mouth of the stream where the flow is fairly even over the narrow width of the pond. As one goes toward the deep end of the pond the gradation curves show a larger difference on the same profile. Also, the gradation curves are coarser for the samples closer to the sides of the pond than for the samples in the middle of each profile. On page 6 the top layer of sample A2(A2T) is finer than the top layer of A3(A3T) because the flow in the middle of the pond is faster than at the sides of the pond. The flow rate in the middle of the pond is very slow but does have sufficient velocity to carry the coarser particles that settled on the sides of the pond further into the pond from the mouth of the stream. This is shown also on the graph on page 7 for samples A4, A5, and A6. Sample A5 was taken from the middle of the pond, while the A4 and A6 were taken towards the sides. Since sample A6 was closer to the middle of the pond than A4, its gradation curve is finer than sample A4's gradation curve but still coarser than sample A5's.

Page 7 shows the gradation curve for sample A5 dropping quite low around grain sizes of 0.015 mm. If someone wanted to know the grain size at 60% finer for this sample, three different sizes would be indicated. This would not be possible if the test had been run properly. The gradation curve cannot have an

1021
increase in percent finer for a decrease in grain size. The curve can be horizontal, indicating several sizes are so much finer than the rest of the sample. With several of the gradation curves indicating the above results, one should evaluate the pipette method and determine if this occurs due to the procedure or to a laboratory error.

Due to a lack of time, only eight organic content determinations were performed. Four different layers of sample A12, one layer of A11, two layers of A13, and one layer of A5 (Figure 9).

As expected, the results show a decrease in organic content as the depth of a sample increases (Figure 10). Organics may decompose with time. Therefore, a relatively high organic content in the most recent layers of sediment would be expected.

Other factors may influence organic content. For example, sample A12 was taken under an overhanging tree. Leaves have fallen from the tree and into the pond, thus resulting in an exceptionally high organic content in the top layer.

RECOMMENDATIONS

Hydrographic Survey

It is recommended that the hydrographic surveying procedure explained in this report be adopted with room for future recommendations and amendments. Experience has improved the method and probably will continue to improve it with further use.

Obtain Core Samples

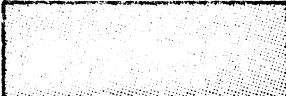
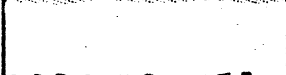
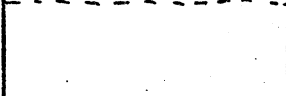

It is recommended that the method of obtaining core samples explained in this report continue to be used. The split-spoon sample tube has proved to be very effective in two respects:





1. Retains the sample (a sample "catch" may be needed).
2. The field worker can examine the core in a relatively undisturbed state.

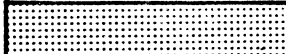
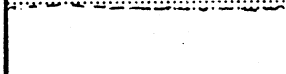
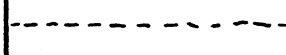
Field Analysis of Samples

It is recommended that a brief description of the core be made in the field. Different personnel use different methods of soil classification. It is imperative for both the "before" and "after" descriptions to be executed under the same classification system.

The general philosophy underlying the decision to divide the core into layers may be reviewed. Studies in other parts of the nation have divided the cores into sections of constant lengths. (6)

Core Layer Length	Sample A 13	Organic Content (%)
6"		3.17
4"		Not tested
8"		Not tested
2"		1.33

A 12		
5"		4.09
5"		3.14
5"		3.12
5"		1.80

A 11		
3.5"		2.30
6"		Not tested
2"		Not tested

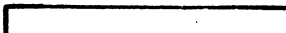
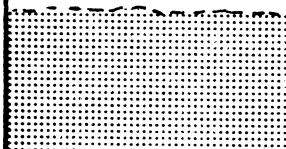
A 5		
2"		Not tested
9"		1.59

Figure 10. Organic Content

Nothing concerning sample storage can be recommended, except that more research is needed.

Elsewhere, samples have been refrigerated at 0°C. (7) Before the lab analysis, perhaps the samples should be air dried. Oven drying may adversely affect the clay particles in a sample.

Grain Size Analysis

The pipette test for grain size analysis was selected for the following reasons. First, most of the layers retained did not have enough material for the hydrometer test (100 gms. or more). The pipette test needs only 10 grams of soil, and a specific gravity test is not needed as with the hydrometer test. The second reason for selecting the pipette test over other tests for small amounts of material (less than 100 gms.) was the information presented in an article comparing the efficiencies of size analysis by the hydrometer and pipette methods. (7)

The following conclusions were drawn from this article.

1. The accuracy of the hydrometer method improves with increasing concentrations of silt and clay. This method is not practical with concentrations of less than 6 g/l and it gives only fair results with concentrations of less than 12 g/l.
2. The pipette method does not give accurate results with concentrations higher than 24 g/l; therefore, the pipette method should not be used without further evaluation of its efficiency at higher concentrations.
3. In moderate ranges of fine-fraction concentrations (6 to 24 g/l), analyses by pipette and hydrometer yield essentially similar results.
4. Within the 6 to 24 g/l range, the pipette method shows a better degree of consistency and closer clustering of results than does the hydrometer method.

The assumption was made that many cases would be encountered when a soil sample would be considerably smaller than 100 gm (the amount needed for hydrometer and specific gravity tests). As it turned out, all of the samples weighed over 50 gm and some close to 100 gm.

Assuming that approximately 100 gm may be obtained from each sample to be tested, it is recommended that a grain size analysis be established using a hydrometer method.

Organic Content Determination

A statistical analysis of the organic content data would aid in the project evaluation. The method appears to be sound and should show any significant changes in organic content.

It is recommended that this experiment be studied in a statistical manner and if the results fall within a reasonable range of variance, that it be adopted.

Summary of Recommendations

In the event that a method of sample storage and a reliable method of grain size analysis for the core samples are developed, it is recommended that this general scheme be adopted as a method of determining the degree that highway construction affects a pond located downstream.

The ponds should be examined from time to time between the "before" and "after" surveys. Any land disturbances other than the road construction located within the watershed should be noted.

As this general scheme becomes established, the various Highway Department districts should become acquainted with it. When a pond appears to be threatened by upstream highway construction, it should be monitored.

PERSONNEL AND COSTS

The hydrographic surveying procedure requires six men, one with a knowledge of surveying techniques. A pond of average size takes one day to survey and sample.

The laboratory procedure requires approximately 80 man-hours per average pond (1 to 2 acres).

Traveling expenses are difficult to estimate, but some allowance must be made for them.

Considering that the procedure must be executed both before and after construction, the average pond costs approximately \$1,000.00 to analyze.

CONCLUSIONS

This general scheme should be further investigated and hopefully adopted in the future. With a reliable method of grain size analysis and a method of sample storage, this scheme may prove to be valuable in detecting the effect of highway construction on ponds located downstream.

The steps involved in this project should be carried out both before construction has begun and after construction has been completed.

By comparing the "before" and "after" lab tests (grain size analysis and organic content determination) one may be able to determine how much of the siltation results from highway construction as opposed to other sources.

Also, more ponds should be investigated in the different physiographic regions of the state. Perhaps criteria may be developed that will determine the susceptibility of a pond to siltation in the different regions.

Aerial photographs may be useful. If taken both before and after road construction, they may show the effect of siltation on a pond.

ACKNOWLEDGEMENTS

The hydrographic surveys were carried out with the help of M. O. Harris and G. T. Gilbert, highway materials technicians, and E. G. Kerby and W. G. O'Neal, student helpers.

The grain size analyses were conducted by Mr. Harris, the organic content determinations by Mr. O'Neal.

Suggestions and guidance in developing the general study scheme were provided by D. C. Wyant, highway research engineer trainee, Dr. W. C. Sherwood, faculty consultant, and M. C. Anday, senior highway research scientist.

APPENDIX A

GRAIN SIZE ANALYSIS BY PIPETTE METHOD ⁽⁴⁾Apparatus

- (1) #10 Sieve
- (2) 1 Liter graduate cylinder
- (3) 12-50 cc beakers
- (4) Oven
- (5) Analytical balance
- (6) 20-cc pipette
- (7) Mixer

Procedure

- (1) Oven-dry the sample.
- (2) Sieve the sample through a #10 sieve.
- (3) Record percentage passing #10 sieve.
- (4) Obtain 10 grams of a representative portion of the sample passing the #10 sieve.
- (5) Place soil in an open dish and cover with exactly 25 ml of "Calgon" solution. Let it stand overnight.
- (6) Record the weights of 12-50 cc labelled beakers.
- (7) Transfer soil and solution into a mixer. Use distilled water to wash, if necessary.
- (8) Mix for one minute.
- (9) Transfer soil and solution into a 1000 cc graduate cylinder.
- (10) Fill cylinder with distilled water up to 1000 cc mark.
- (11) Cover top of cylinder with hand and mix for one minute.
- (12) Place marks at 5, 10, and 20 cm from bottom of a pipette.
- (13) At designated times lower pipette to proper mark and apply an even section.
- (14) When pipette is filled, transfer to a 50 cc beaker.
- (15) Rinse pipette once with distilled water.
- (16) Remix the solution and start the timer at zero time after each sample is drawn off and transferred to a beaker.
- (17) Dry each beaker and record weight with residue.
- (18) Weight of residue equals weight of beaker with residue minus weight of beaker.

APPENDIX B

ORGANIC CONTENT DETERMINATION ⁽⁵⁾Apparatus

- (1) Tall-form 250-ml Pyrex beakers and cover glasses
- (2) Gas or electric hot plate
- (3) 100 ml centrifuge tubes and centrifuge
- (4) 75 ml platinum or rhotanium dishes

- (5) Analytical balance
- (6) 110°C oven
- (7) Series of ml glass-stopped weighing bottles, numbered in ascending order of weights. (Odd numbered bottle slightly lighter).

Reagents

- (1) 0.1 N HCl
- (2) 30 percent H₂O₂
- (3) 10 percent (NH₄)₂ CO₃ prepared by dissolving 10 gm of reagent grade salt in 100 ml of water.

Procedure

- (1) Weigh a successive 2 gm sample of air dry soil passing #10 screen.
- (2) Place in 2 paired weighing bottles and tightly stopper.
- (3) Record difference of weights of two filled bottles to fourth decimal place
- (4) Set aside even numbered bottle.
- (5) Transfer sample from odd numbered bottle to 250 ml tall form beaker (rinse out soil traces with distilled water).
- (6) Add 10 ml of distilled water to the soil.
- (7) Add 4 ml. 0.1 N HCl.
- (8) Stir and warm on hot plate for 1 hour.
- (9) Add drop of salt-free brom cresol green indicator. (Should remain yellow or green).
- (10) If indicator turns blue, add more 0.1 N HCl.
- (11) Add 10 ml of 30% H₂O₂.
- (12) Cover beaker and digest on hot plate.
- (13) After peroxide is decomposed, and solution has evaporated to volume of about 5 ml, rinse down sides of beaker with 5 ml 30% H₂O₂.
- (14) Continue digestion until peroxide is decomposed (further additions of H₂O₂ may be required).
- (15) Scrub cover glass and rinse into beaker.
- (16) Transfer contents into 100 ml centrifuge tube into which 5 ml of 10% (NH₄)₂ CO₃ solution has previously been placed.
- (17) Cover beaker and set aside.
- (18) Mix suspension in tube with strong jet of water and set aside to flocculate.
- (19) Suspension is centrifuged until supernatant liquid is entirely clear.
- (20) Decant clear liquid into original beaker in which soil was digested, and set aside.
- (21) Two additional washings are given the residue by resuspending with a water jet, adding 5 ml 10% (NH₄)₂ CO₃, flocculating, centrifuging, and decanting into beaker.
- (22) Resuspend with water jet and rinse into original weighing bottle.
- (23) Weighing bottle and contents placed in oven. (8 hrs. at 110°C)
- (24) The pair of weighing bottles is cooled in same desiccator and difference in their weights determined to the nearest 0.1 mgm.
- (25) Net oven dry weight is determined.

To determine the weight of soluble salts removed from the sample:

- (1) Weigh series of platinum or rhotanium dishes to nearest 0.1 mgm.

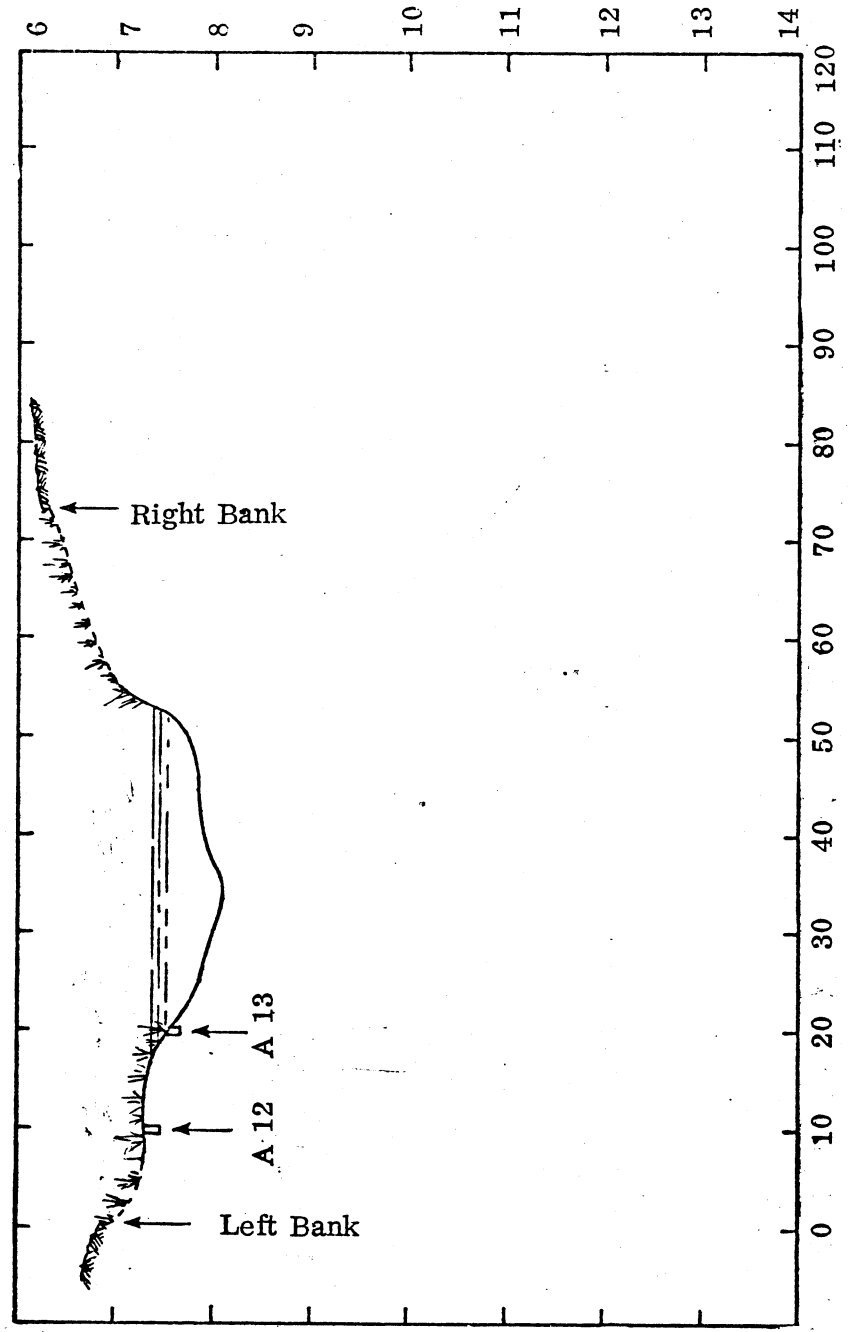
- (2) Transfer supernatant solution from beakers to dishes, evaporate to dryness, ignite at 550°C (medium red) in muffle furnace for a few minutes.
- (3) Cool dishes in desiccator and weigh. (Thus, ignited residue weight is calculated).

Weight of Organic Matter = $\frac{\text{Final weight difference in weigh bottles} - \text{Initial weight difference in weigh bottles}}{\text{Ignited Residue}}$

$$\text{Organic Matter} = \frac{(\text{weight of organic matter}) \times 100}{\text{oven dry sample weight}}$$

APPENDIX C — PROFILES

Depth from B. M. in Feet

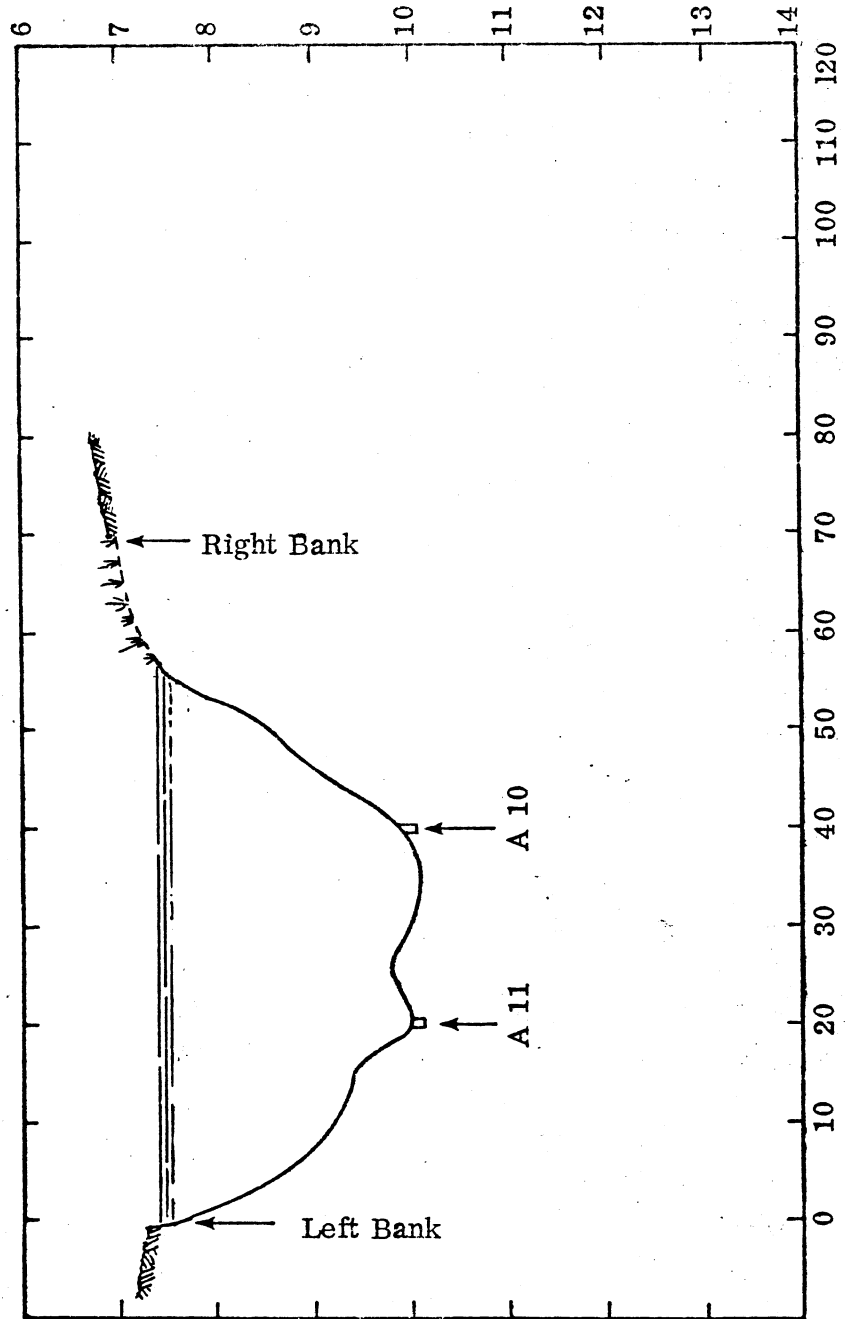


Distance in Feet

Sta 0 + 25

1031

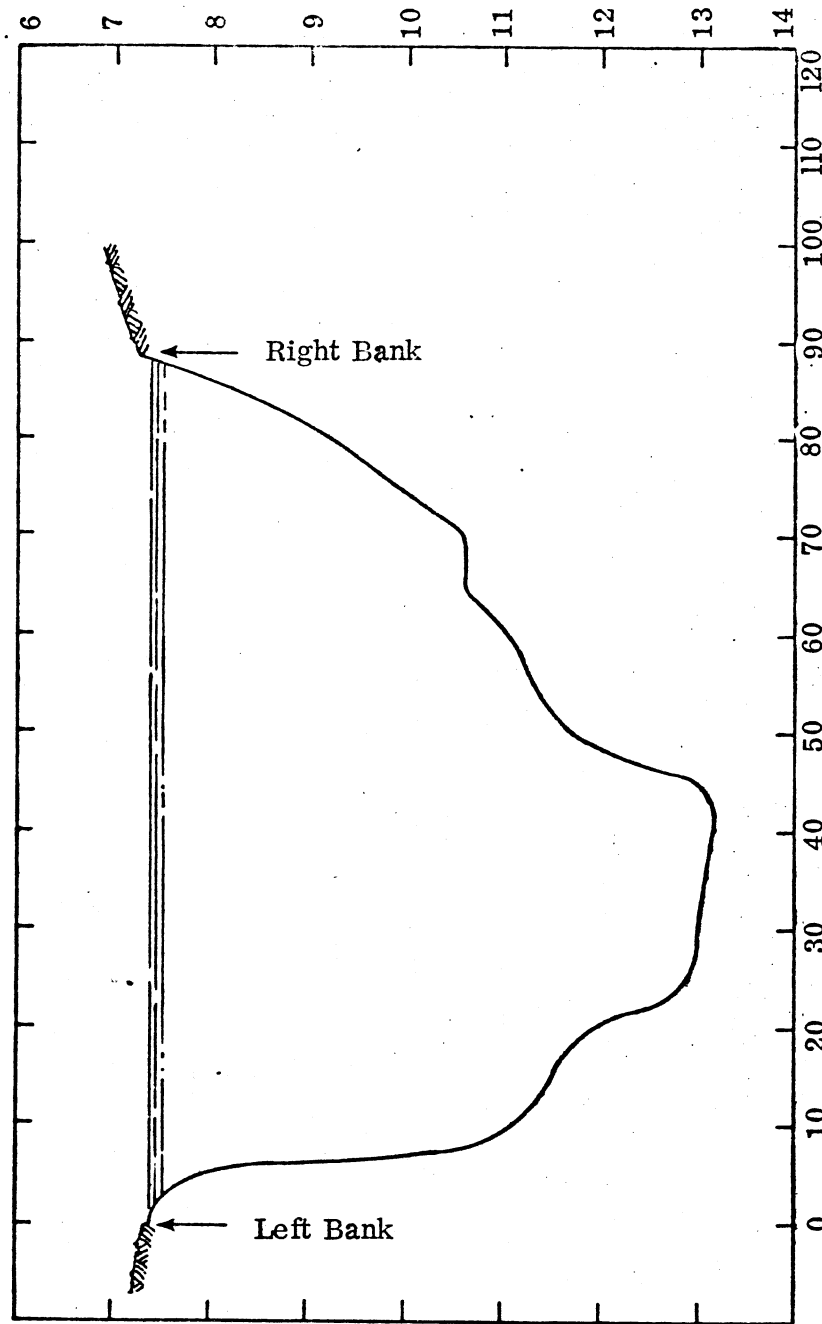
Depth from B. M. in Feet



Distance in Feet

Sta 0 + 50

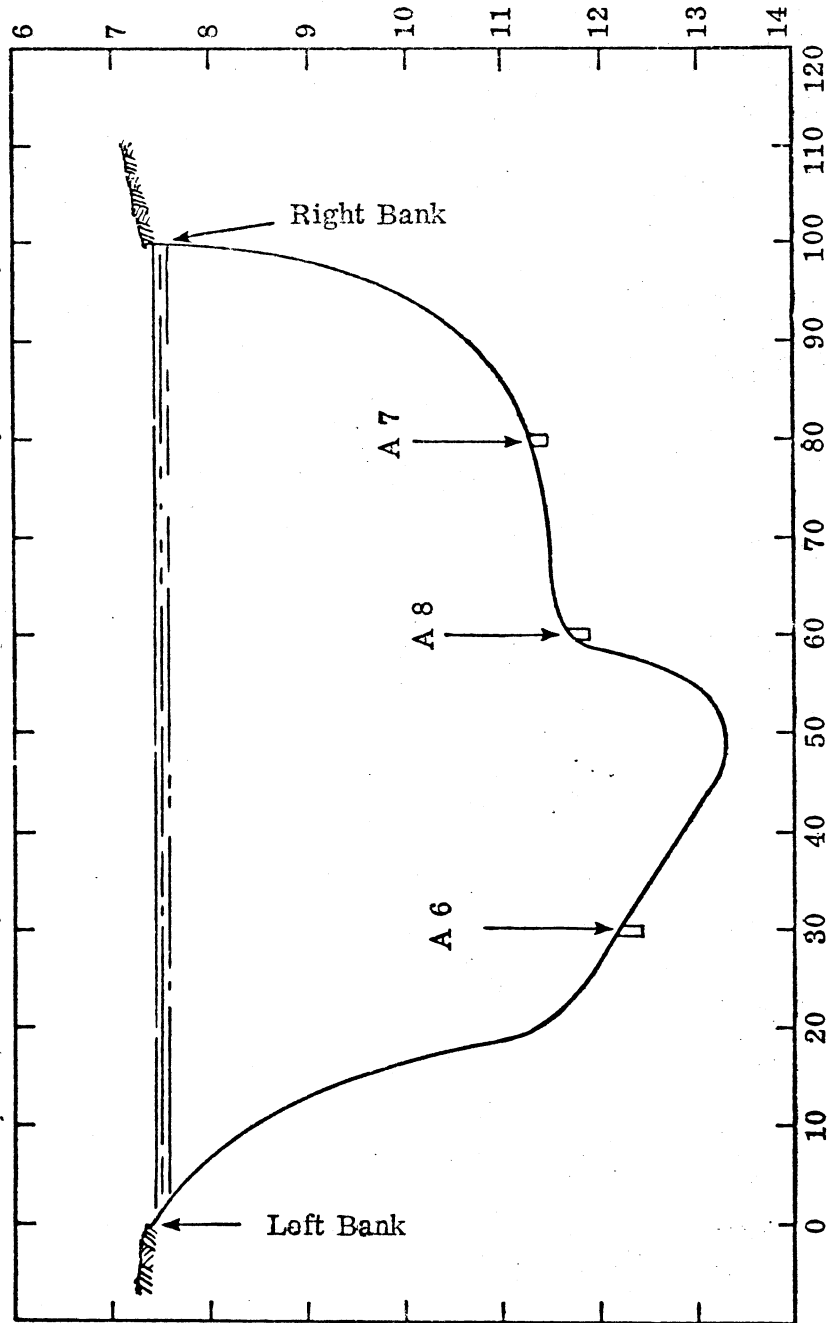
Depth from B. M. in Feet



Distance in Feet

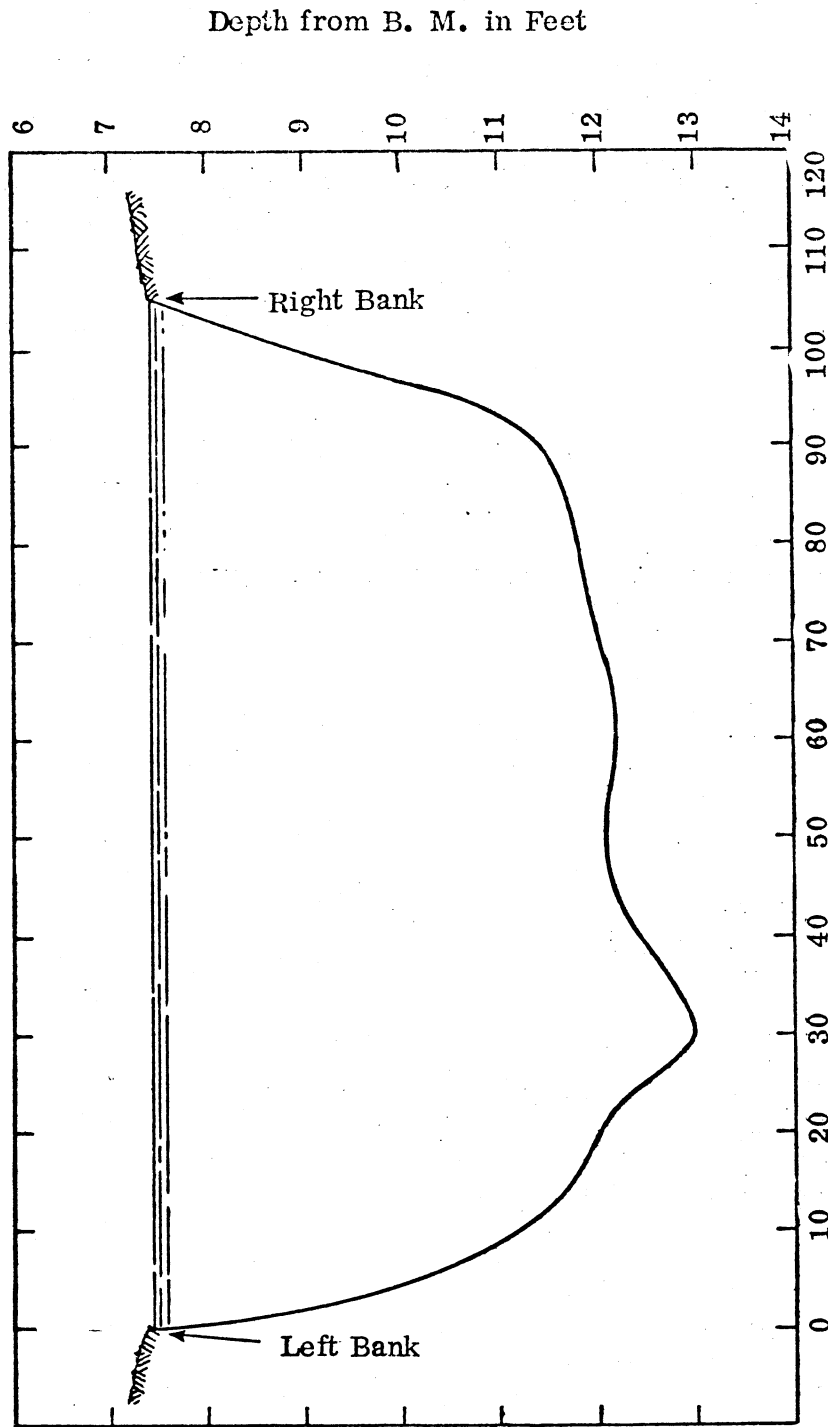
Sta 1 + 00

Depth from B. M. in Feet

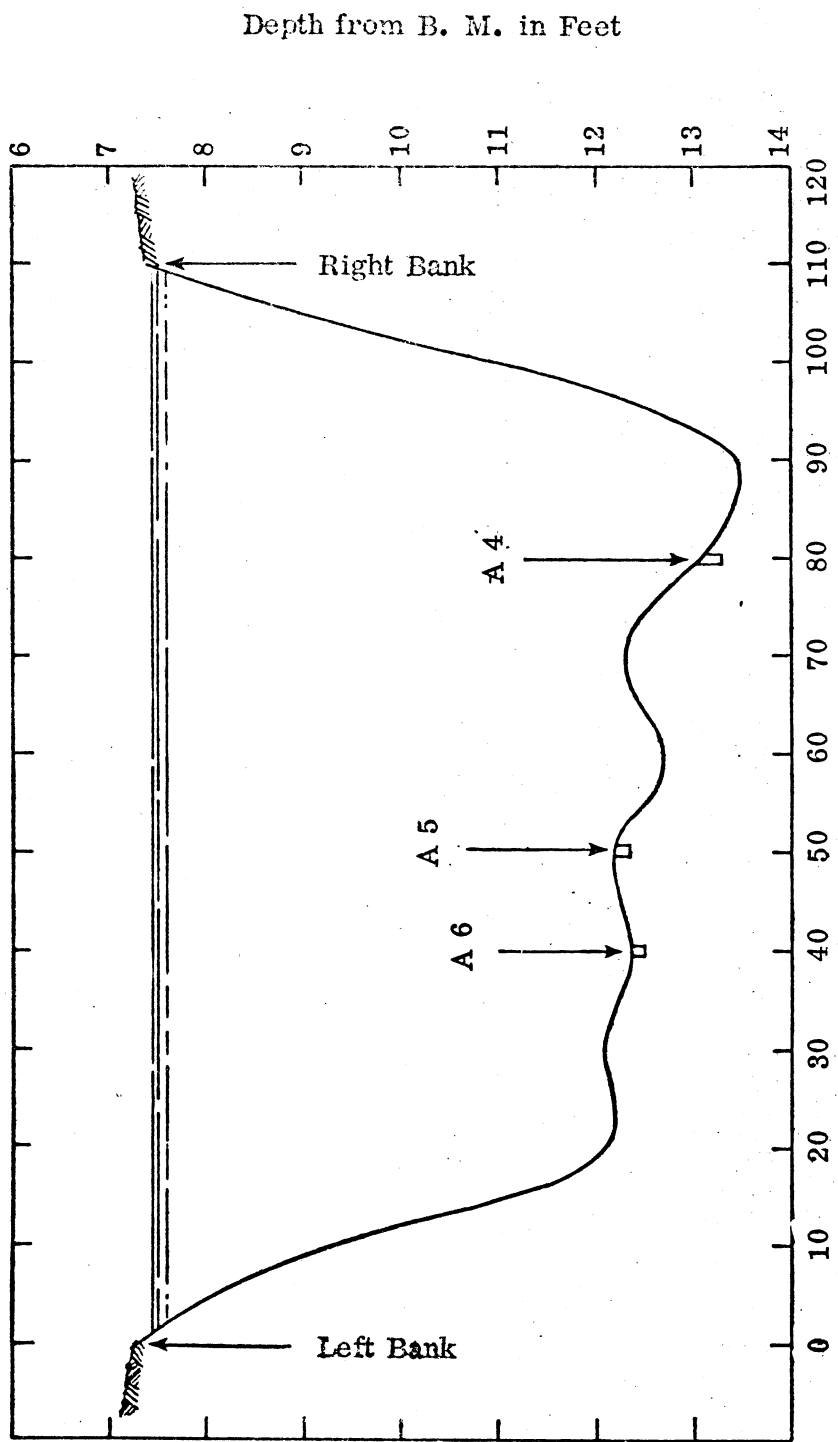


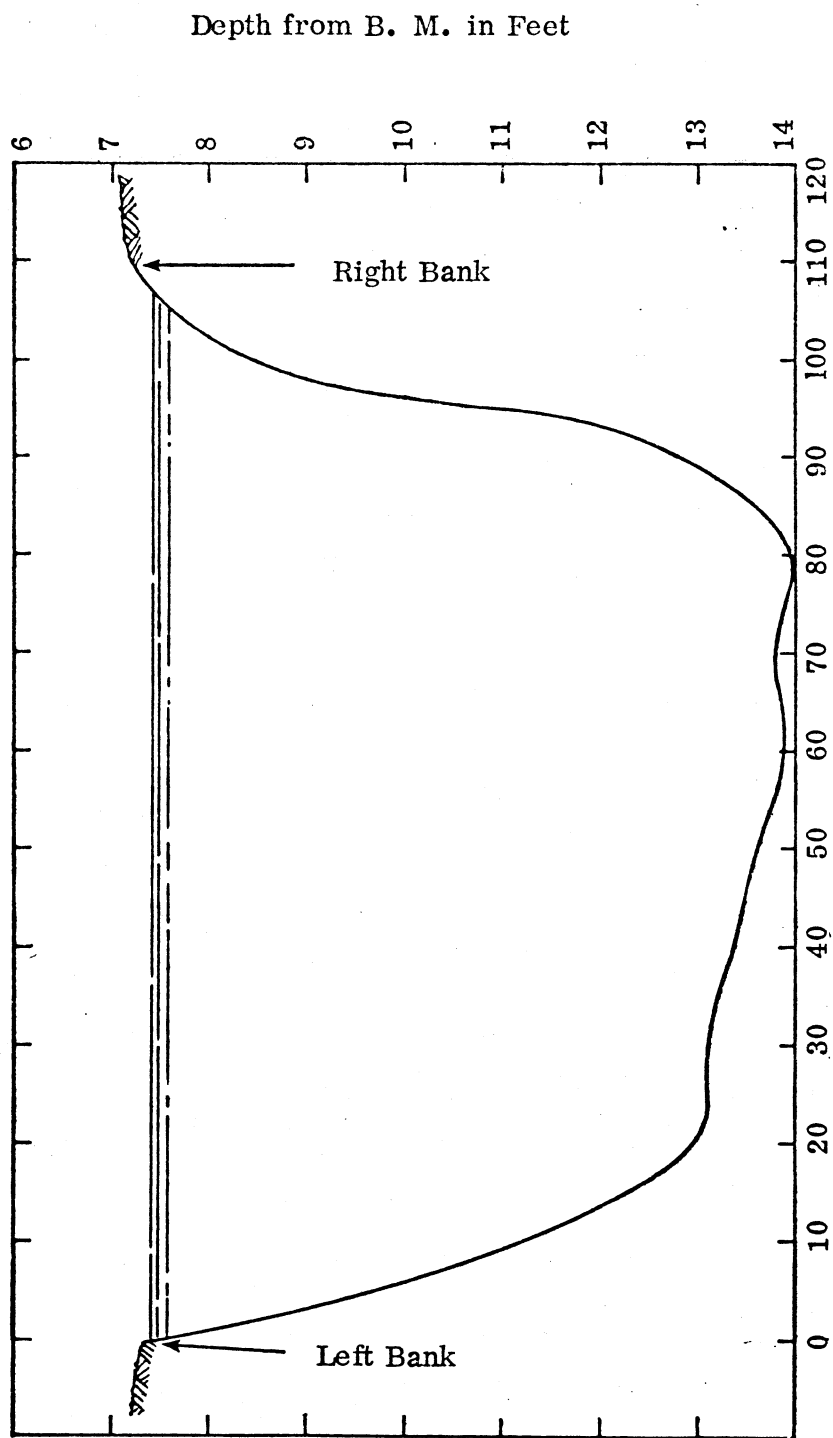
Distance in Feet

Sta 1 + 50



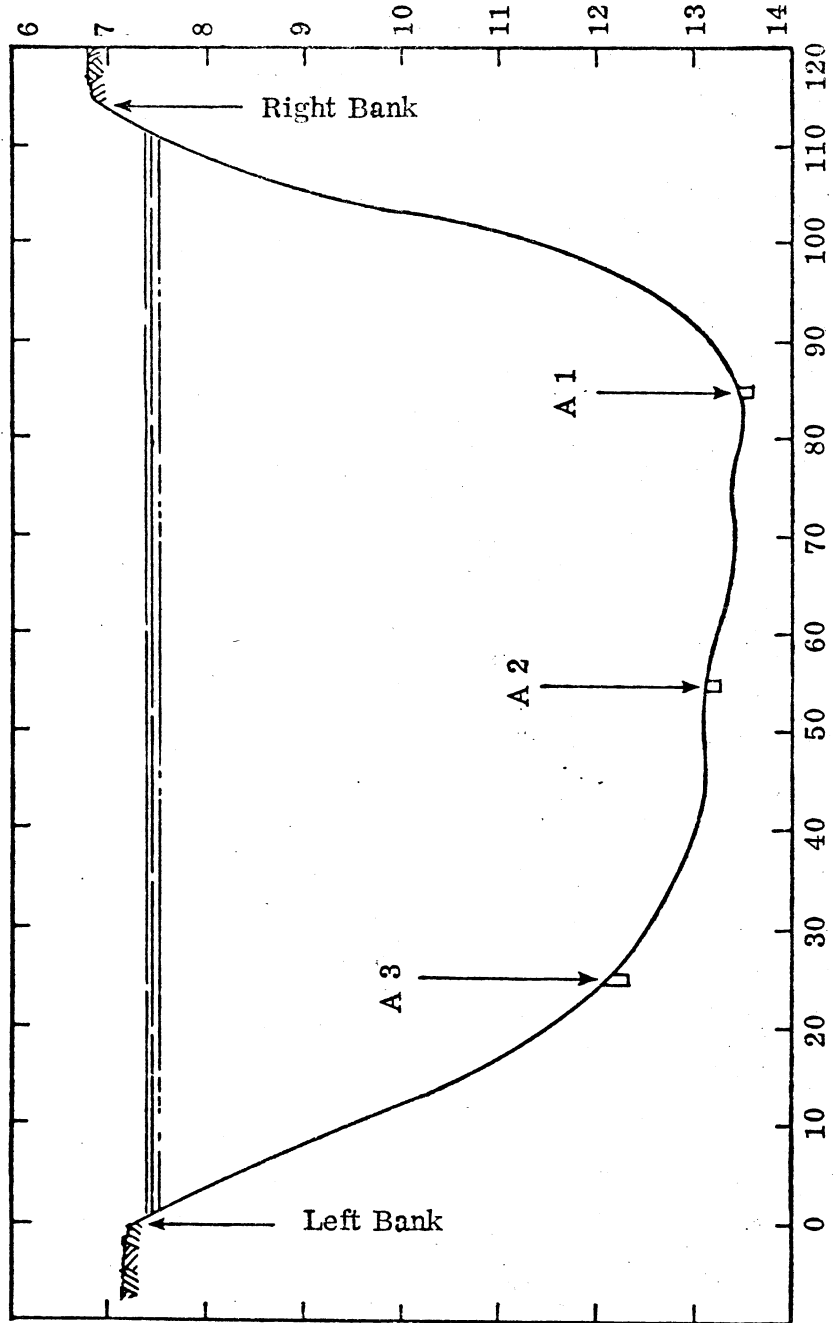
Sta 2 + 00





Sta 3 + 00

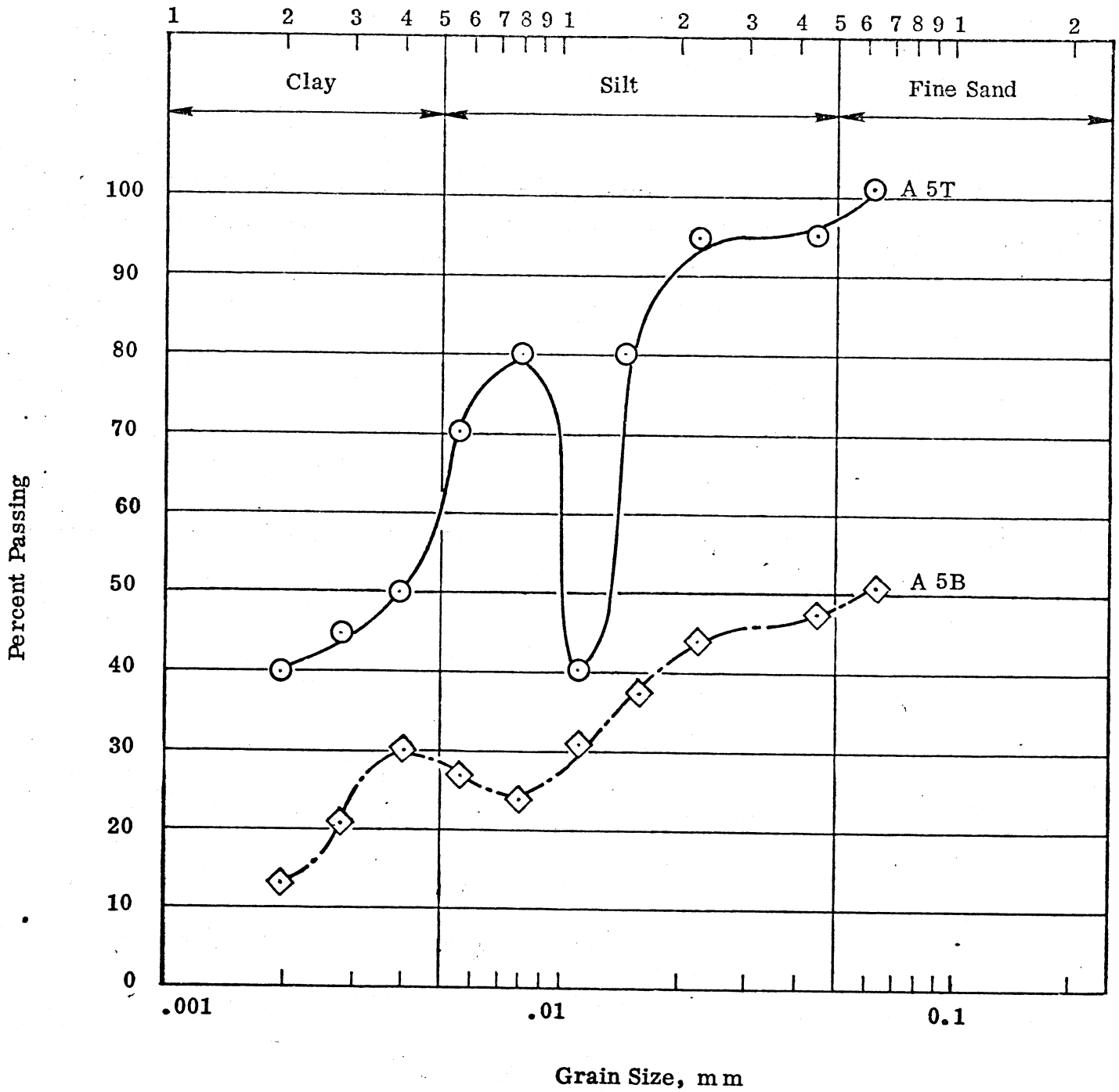
Depth from B. M. in Feet

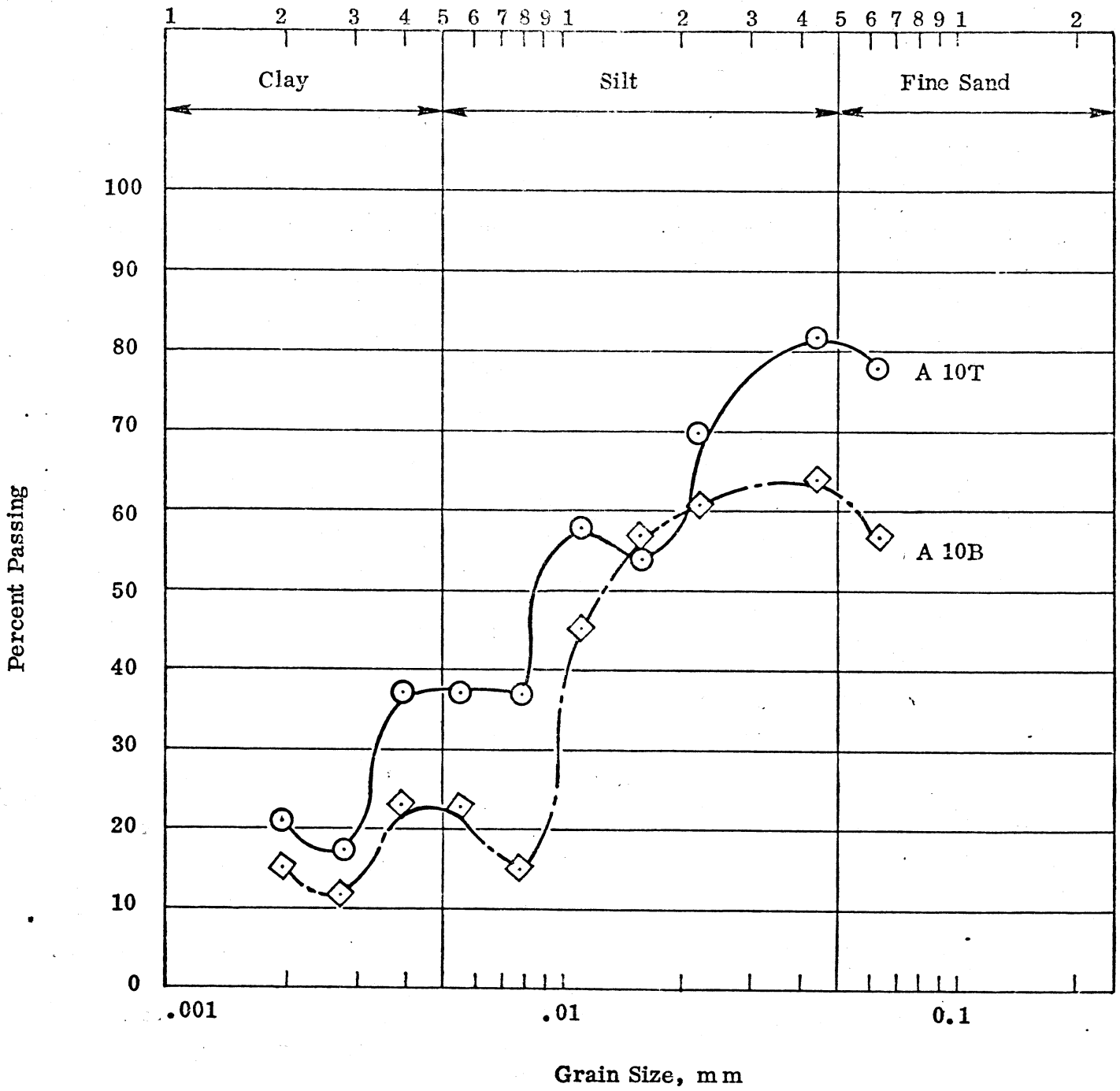


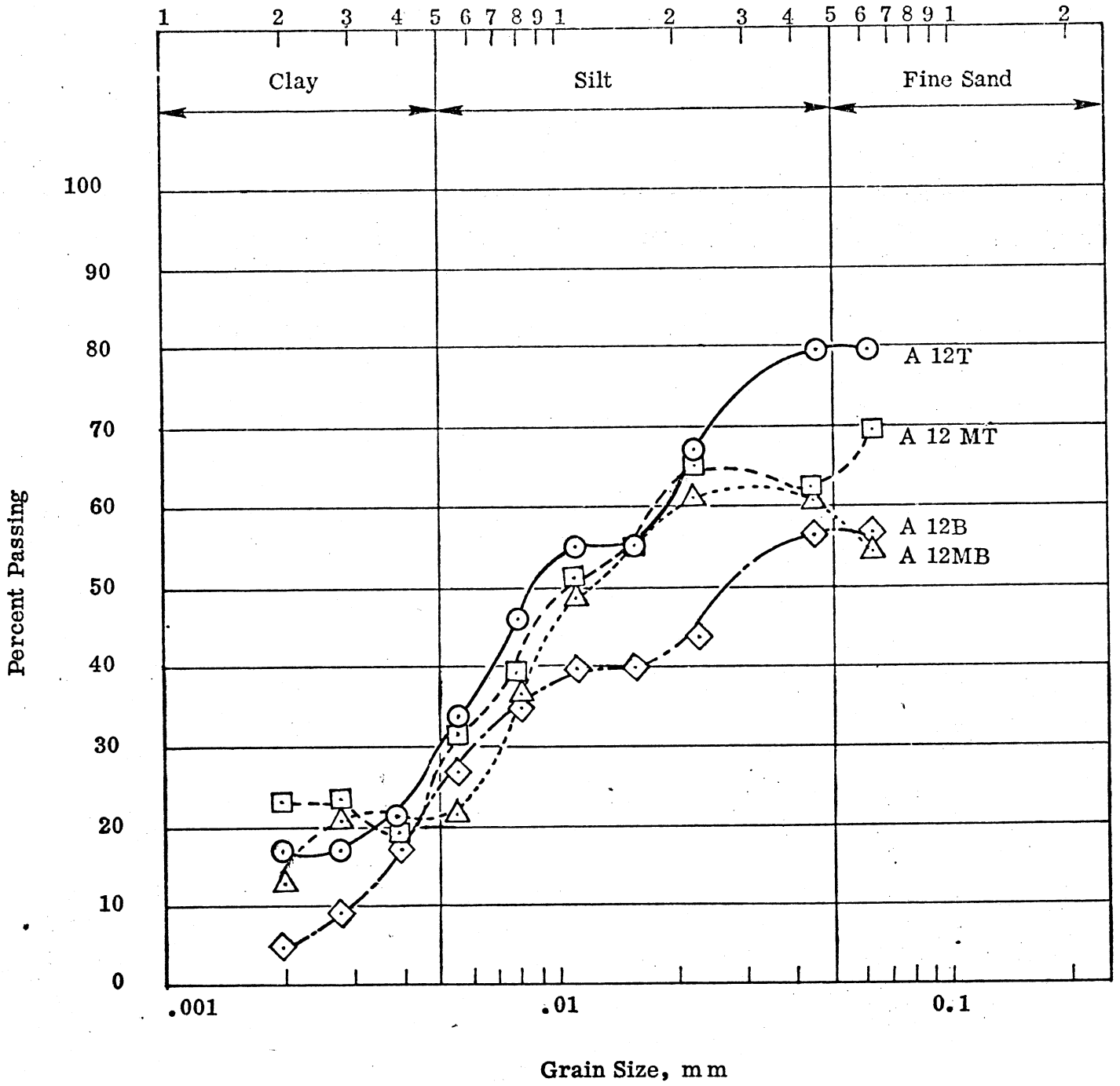
Distance in Feet

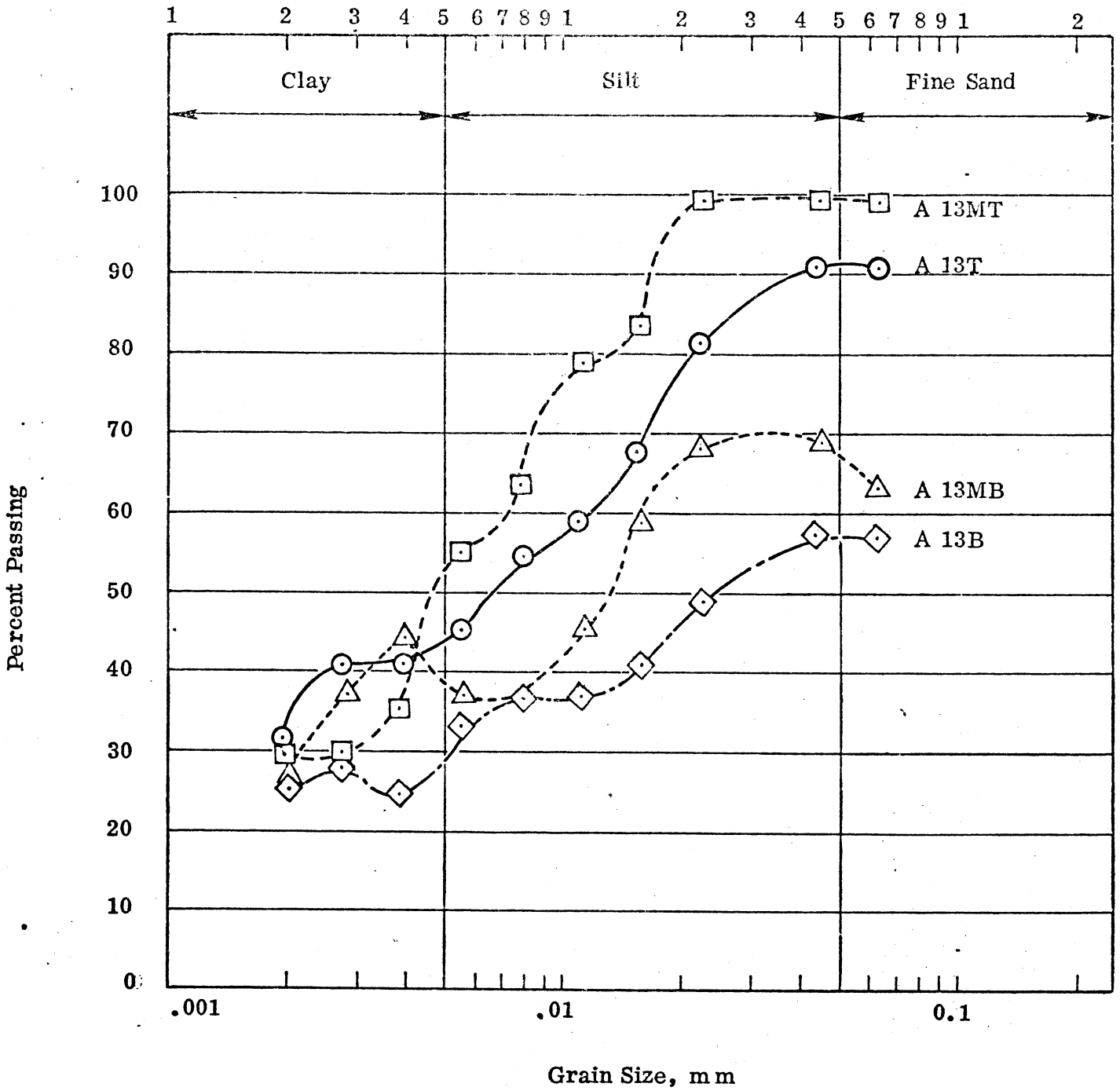
Sta 3 + 50

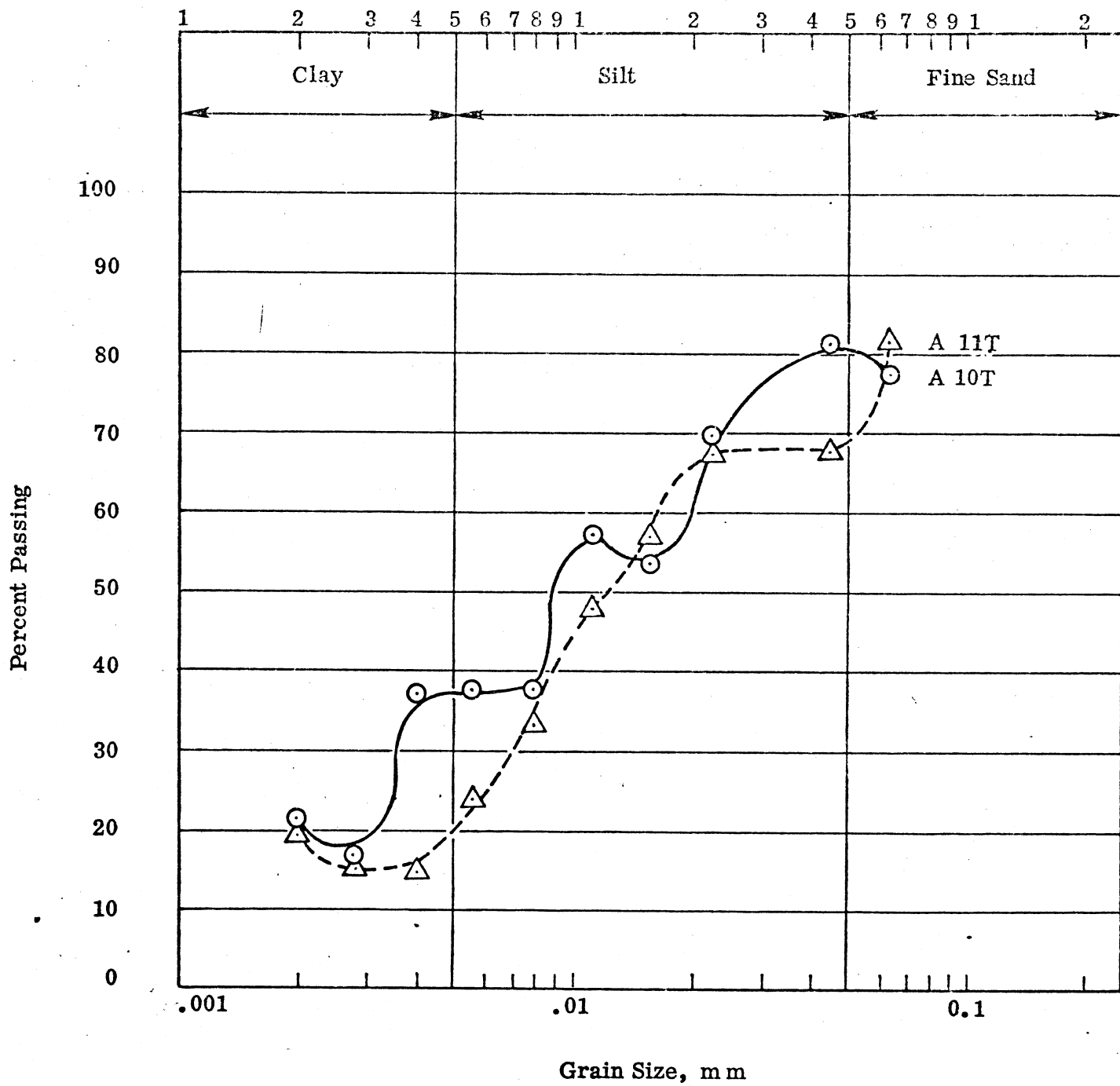
APPENDIX D — GRADATION CURVES

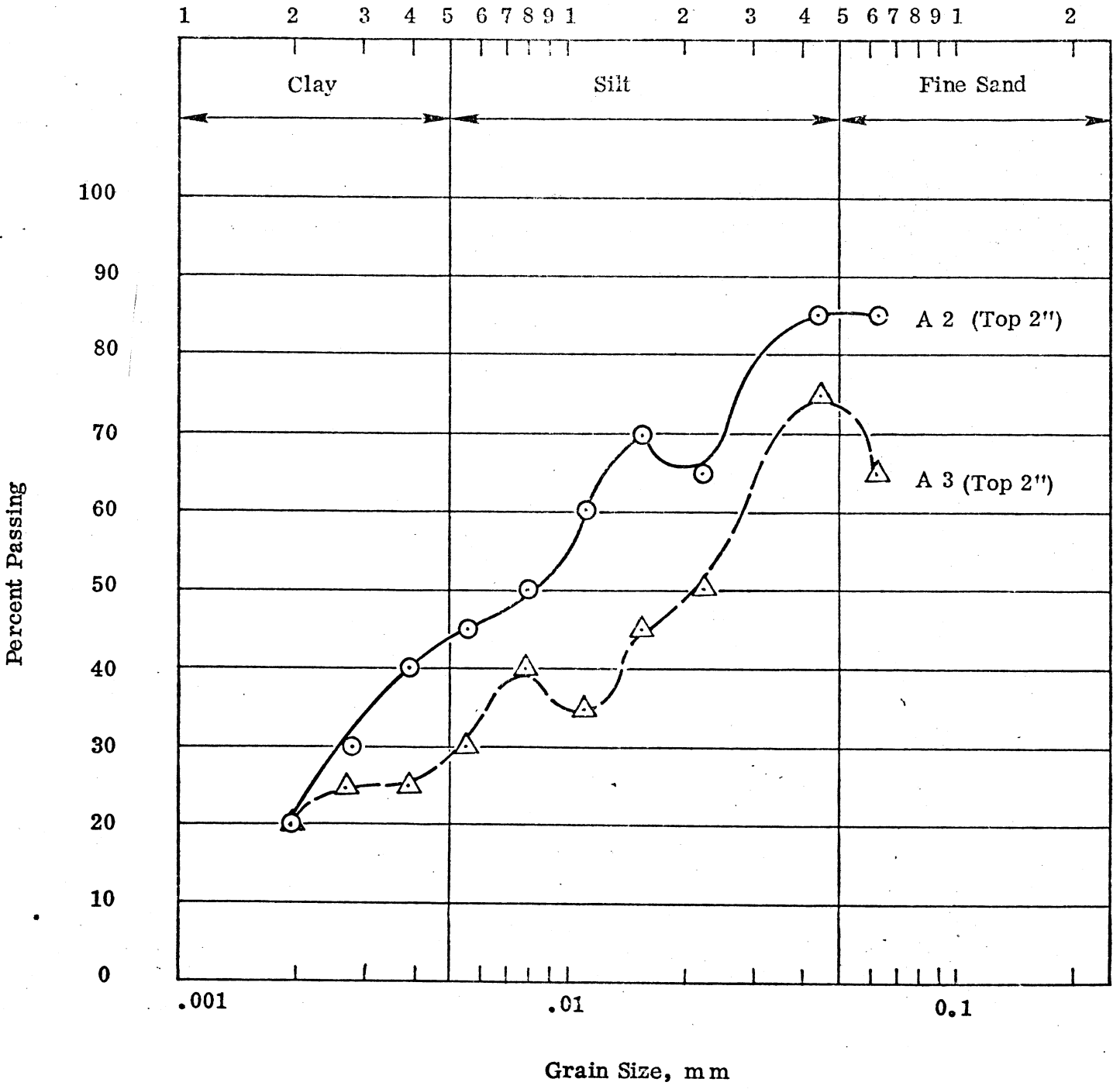


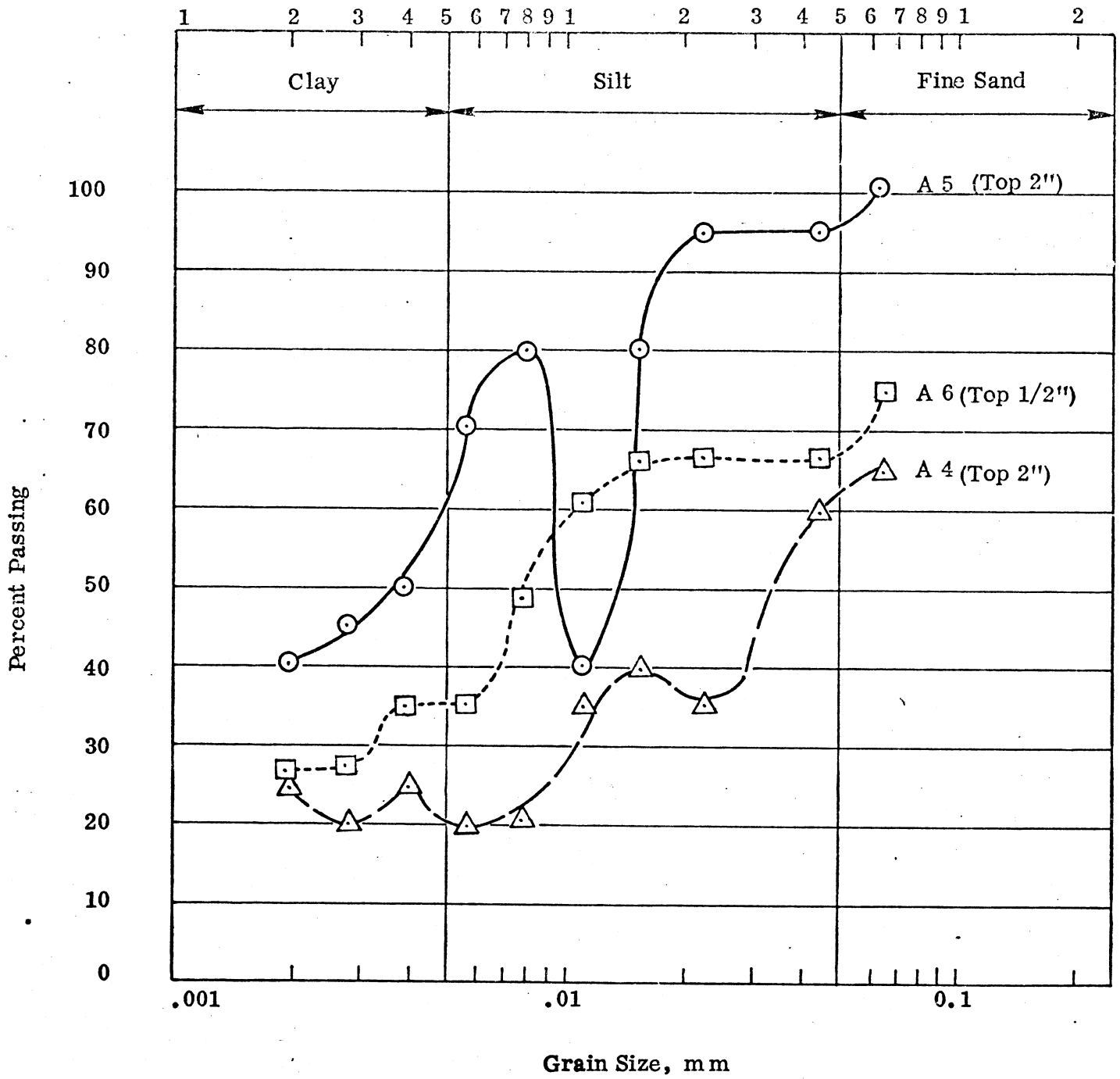












REFERENCES

1. Vici, R. B., G. E. Ferguson, and H. P. Guy, "Sediment Movement in an Area of Suburban Highway Construction, Scott Run Basin, Fairfax County, Virginia, 1961-64," U. S. Geological Survey Research, Washington, D. C., 1967.
2. Guy, H. P., and G. E. Ferguson, "Sediment in Small Reservoirs Due to Urbanization," Journal of the Hydraulics Division, ASCE, Vol. 88, No. Hy2, March 1962.
3. Report of Task Force on Erosion and Sedimentation Control, Prepared by the Governor's Council on the Environment by the Erosion and Sedimentation Control Task Force, Richmond, Virginia, August 1971.
4. Krumbein, W. C., and F. J. Pettijohn, Manual of Sedimentary Petrography, Appleton - Century - Crofts, Inc., New York, 1968.
5. Jackson, M. L., Soil Chemical Analysis, 3rd printing, Prentice-Hall, Inc. 1958.
6. Kohnke, Helmut, Manuel Paulet and L. J. Lund, "Pedologic Features of Reservoir Sedimentation," Purdue University Water Resources Research Center, Lafayette, Indiana, April 1971.
7. Sternberg, R. W., and J. S. Creager, "Comparative Efficiencies of Size Analysis by Hydrometer and Pipette Methods," Journal of Sedimentary Petrology, Vol. 31, No. 1, March 1961.

