

SUSITNA HYDROELECTRIC PROJECT

WATANA AIRSTRIP FEASIBILITY STUDY PHASE I

TASK 39
SEPTEMBER 1983

HARZA-EBASCO
SUSITNA JOINT VENTURE

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WATANA AIRSTRIP
FEASIBILITY STUDY
PHASE I

FOR THE
SUSITNA HYDROELECTRIC PROJECT

SUBMITTED TO
ALASKA POWER AUTHORITY

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SUSITNA JOINT VENTURE

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PHASE I

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WATANA AIRSTRIP FEASIBILITY STUDY

PHASE I

A. INTRODUCTION

During the performance of exploration activities associated with the FY 83 Winter Geotechnical Program, it became apparent that a fixed-wing airstrip at the Watana Camp Site could significantly cut the logistical costs of site programs.

In accordance with Alaska Power Authority guidance and direction, a two-phase Watana Fixed Wing-Airstrip Study Plan was proposed and approved for implementation.

The basic objective of the Phase I Feasibility Study presented in this report was to determine the cost benefits of constructing an airstrip at the Watana Site this summer. The cost benefit analyses were performed by evaluating permitting, site specific soil conditions of the upper materials along the proposed airstrip centerline, airstrip usage and economics.

Based upon APA review and concurrence with the Phase I Feasibility conclusions and recommendations, as stated herein, the scope of Phase II of the study will include planning and preparation activities.

Planning activities will encompass an in depth field study of topography and drainage, equipment mobilization plans and schedules, detailed preparation of cost estimates and the filing of required permit applications.

Preparation activities will encompass the development of a contract package, and will include management, cost and schedule control, quality control and the development of a set of as-built drawings and details. Keeping these goals in mind, the conclusions and recommendations of the Task 39 Study Team now follow.

B. CONCLUSIONS AND RECOMMENDATIONS

As a result of the execution of the Feasibility Study discussed herein, the following conclusions and recommendations have been reached:

CONCLUSIONS

1. The construction of a temporary airstrip at the Watana Camp this summer is both feasible and cost effective.
2. The topography at the Watana site in the vicinity of the proposed airstrip naturally favors a 2,500 foot long runway with expansion potential to 4,000 feet and 6,000 feet lengths requiring additional earthwork activity.
3. The natural existing foundation materials are silty sands with small amounts of gravel overlain by a thin section of peat and organics.
4. Due to the high silt content of the structural foundation materials, these materials are classified as poorly draining. This property of the foundation has been heavily considered in the planning, preparation and maintenance of the airstrip.

5. Two types of airstrips have been proposed; a winter strip and a year round strip. Both strips will require the mobilization of additional equipment to the site.

The winter strip is a 2,500 foot long runway without surfacing. The use of the airstrip will be limited to periods when the foundation materials remain frozen (possibly November to May) and will require the strategic location of snow fences and large quantities of grader maintenance during periods of breakup and freeze. The total order of magnitude cost estimate for this strip is \$240,000 and it will take approximately one month to prepare.

The year round strip places a 7% cement stabilized soil surfacing on top of the proposed winter strip for a total order of magnitude cost of \$530,000 and an additional 20 days of preparation.

6. Results of the economic analyses indicate that the cost of airstrip preparation can be offset in total through savings in fixed-wing support to site activities. Considering an active two season site exploration program and strategically planned fuel hauls;

- a) The winter strip will fully pay for itself after 16 months of use, with a potential savings of \$190,000 each year, thereafter. The winter strip will require a significantly greater amount of maintenance than the surfaced, year round strip.
- b) The year round strip will pay for itself after 21 months of use, with a potential savings of \$280,000 per year, thereafter.

It has therefore been concluded that the year round surfaced strip affords the greatest savings per year of operation after break even, and provides the highest degree of reliability of the cases evaluated.

RECOMMENDATIONS

1. As a result of the above stated conclusions, and taking into consideration budgetary restrictions for the upcoming FY 84, it is Harza-Ebasco's recommendation to proceed with the preparation of a winter strip this summer in July, 1983. Next year with the advent and start up of an active summer exploration program, the stabilized soil surfacing could be installed on the winter strip prior to peak demand on the airstrip.

By advocating this two step preparation scheme, partial benefits will be realized during the first half of FY 84, with full benefits during the second half of the FY 84.

2. Following this approach, after formal Alaska Power Authority review and approval of the Feasibility Results, the Phase II - Planning and Preparation Activities will begin.

The Phase II Activity will be divided into two subtasks. The first subtask will include planning activities such as a detailed field topographic study, the development of a mobilization plan and schedule, a detailed cost estimate preparation and permit application. The second subtask will include preparation activities such as the development of a contract package of preparation details, preparation management, schedule and cost control, quality control and the development of a package of as built details.

The estimated cost of providing the planning subtask activity described above is \$42,000, with a work duration of approximately 3 weeks. During this time, the estimated cost and schedule for the actual airstrip preparation will be developed.

As stated before, preparation activities can not begin until all required permits and authorizations are granted.

C. PERMITTING

A feasibility permitting review was performed on the proposed airstrip in Section 27 (28), T 32N, R5E, SM. Included in this review were requirements for permits, approvals, and land use authorizations. The results of this review are presented in Table A.

In reviewing each of the eleven authorizations presented in the table, attention must be given to Authorization No. 7, Corps of Engineers Section 404 Permit, to discharge dredge or fill materials to wetlands.

The requirements of this permit application are directly dependent upon the results of Authorization No. 6, Wetland Determination by the Corps. To minimize possible delays in preparation, due to the estimated minimum 90 day approval cycle, the Joint Venture has implemented a request for Authorization No. 7. A copy of the U.S. COE Notice of Application, is attached as Appendix E.

D. SITE INVESTIGATIONS

As part of the Phase I Feasibility Study, a site investigation was performed to determine soil properties and foundation requirements, borrow material sources along the proposed airstrip alignment, bearing capacity, drainage, preparation equipment requirements, and schedules of preparation costs.

This section of the report presents the results of the site investigation and laboratory testing program completed in early April 1983 at the Watana Camp Site as they relate to the conceptual planning activities for the proposed airstrip. It is not the detailed plan that is required for preparation of the airstrip. The detailed plan for the airstrip will be developed in Phase II of the program upon review and approval of this report. A temporary airstrip of 2500 feet will be the emphasis of this report with mention of extending the airstrip length to 4,000 and 6,000 feet as deemed necessary.

The airstrip location is as described by R & M Consultants in their October 1980 report, attached as Appendix A. This location has been chosen based on prevailing wind data that has been collected at the Watana Site. The prevailing winds are out of the northeast such that an orientation of north 60° east will provide good wind coverage under most weather conditions.

The airstrip is located on either "Cook Inlet Regional Corp. Property" or native village property [Section 27 (28), T32N, R5E, S.M.] rather than BLM land for the purpose of reducing the permit requirements. The natural topography in the general vicinity of the airstrip is relatively flat, thus providing a site with a potential for the preparation of a cost efficient airstrip.

Presented below is a discussion on the site investigation and laboratory testing programs:

1. SOILS INVESTIGATION

The soils investigation of the airstrip was accomplished in conjunction with the Winter Geotechnical Program. The winter investigation avoided excessive cost and ground disturbance that would have occurred if a spring (break-up) program was implemented. The drill rig used was a Mobile 24 mounted on a self-propelled flex track rig. A four inch drill bit was attached to a 3 3/4" continuous flight auger, thus providing a means of sample recovery and field determination of soil identification.

A total of fifty-five auger holes were drilled along the airstrip alignment to an average depth of five feet, as shown in Figure No. 1. The Boring Logs of these holes are presented in Appendix B. The flight auger procedure of drilling provided a very disturbed sample, affecting identification and classification, and is limited to recovering material no greater than 1' - 1 1/2" in size.

Samples were recovered and placed in plastic bags for laboratory identification, sealed in jars for moisture content, and saved in cloth bags for proctor compaction testing later on.

The soil boring results of the drill program, as shown in Figures 2 and 3, have determined that an organic soil layer of 0-2 feet in depth covers most of the airstrip. An area of deep organics is located just north of centerline at station 36+00; and a very wet and deep organic area is located between station 41+50 and station 47+00. A minor pocket of frozen ground was located just north of station 36+00 at a depth of 3-5 feet.

Underlying the organic material is a silty sand material with small amounts of gravel. This material will be the airstrip structural foundation material.

Figure 2 shows the main strip boring profile along the centerline of the airstrip along with the true scale ground elevation exhibiting the natural slope. For the sake of presenting detailed boring log data, this profile and others, have been exaggerated in scale.

The airstrip has been divided into three main segments. The main strip is 2,500 feet long with the possibility of expansions to the east and west of 1,500 feet and 2,000 feet, respectively. The main strip is differentiated from the east and west extensions by major topographic features. Each of the three airstrip segments requires relatively small amounts of earthwork if treated by itself, but when combined into a single strip, major earthwork will be required at each end of the 2,500 foot strip. Thus, for the present time, considering camploading and budget, emphasis will be placed on the initial strip only.

The centerline grade of the proposed strip shown on Figure 2 has been held as close to 2 % as possible to utilize natural topography, remove unstable materials and to minimize cut and fill quantities. Profile "D-D" shows the depth and limits of peat 75 feet north of the runway between station 34+00 and 37+00. A minimum of two feet of the peat will be removed. A stabilizing fabric will be placed over the completed excavation and natural silty sands backfill will be placed to grade.

Figure 3 shows the soil profile for the east and west extension of the initial main airstrip. The west extension may be used to increase the runway to a total length of 4,000 feet and the east extension in combination with the west extension can increase the runway length to the total length of to 6,000 feet. The west extension will require regrading of the initial temporary airstrip when prepared. The east extension will require substantial earthwork and engineering activities due to topography and foundation conditions. This area has a 500 foot long section of runway that is very wet and consists of peat to depths of five feet. Below the peat is a wet and soft silty sand. Large earthmoving equipment and a borrow source for sand and gravel will be required for extending the airstrip to 6,000 feet through this area.

2. LABORATORY TESTING

Laboratory testing was performed by Harding-Lawson and Associates personnel located at the Watana Site soil laboratory and in the Anchorage laboratory. The types of tests performed were sieve analysis, moisture content, specific gravity, Atterberg limits, minus 200 wash sieves, organic content, hydrometer analysis, proctor compaction and soil stabilization tests. The results of all tests (excluding the soil stabilization program) are summarized in Table 2 and presented in Appendix C.

The results of the sieve analysis tests indicate that the typical natural existing soil, to be used in the preparation of the airstrip, is a silty sand with a small amounts of gravel. Generally there is 50% sand with 30-40% silt and 5-20% gravel. The gravel is subangular and subrounded. Figure 4 shows a group of gradation curves compiled from typical samples. The material is classified as SM under the Unified Soil Classification System.

Moisture contents were performed on samples at various depths and locations. Generally, the soils within four feet of the surface have moisture contents of 15-20% and the lower soils have moisture contents of 8 to 12%. Specific gravity tests were performed with the results ranging between 2.72 and 2.75, the general range for soils with this classification.

Due to the high sand content in most of the samples only three Atterberg limit tests were performed. The samples were located in the area of the west extension. The results of the tests indicate soils with low plasticity. All other samples from the foundation examined were found to be nonplastic. As an extension of the sieve analysis and Atterberg limit data, hydrometer tests were performed. These tests indicate that the clay content of the fines portion of the samples tested is generally less than 5%. As an additional means of determining the amount of fines in the samples, minus 200 sieve tests were performed. This test gave quick results for several soil samples.

Organic content tests were performed to evaluate the heavy organic content of the top layer. Proctor compaction tests were performed at various locations along the airstrip. The results indicated a maximum dry density ranging between 128-133 pcf at an optimum moisture content of 8%.

Through evaluation of the data discussed above, the following considerations are presented:

The ideal material for the airstrip foundation would be a gravelly sand which would allow for a well compacted base along with a free draining material thus providing for low maintenance. The silty sand foundation at the Watana Site is a material with an assumed permeability of 10^{-5} cm/sec and which is classified as a poor drainage material. Therefore, discussions will follow later in the report concerning the preparation of a surface treatment.

Following the completion of the site investigation and laboratory test program, and taking these factors into consideration, Feasibility Study activities were initiated. The details of the study are presented in report Section E, to follow.

E. FEASIBILITY CONSIDERATIONS

Utilizing the data obtained from the site investigation programs, Feasibility Study activities were initiated. These activities included, conceptual planning, construction considerations, soil cement surfacing, runway expansion cost and schedule considerations. The details of each of these activities follows:

1. CONCEPTUAL PLANNING

The natural topography where the proposed airstrip is located is generally flat with minor sloping depressions and hills. To aid in the preparation of the airstrip the proposed runway grade has been selected to follow the natural topography allowing for stripping as required. A major consideration in preparation of the airstrip is the availability of equipment. Presently at the site there is a D-7 bulldozer and a one cubic yard front end loader. Due to the limitations of available site equipment to prepare the airstrip, and the desire to disturb the least amount of land possible, the airstrip has been proposed to be fifty feet wide with ten foot shoulders.

Figure 5 shows a proposed typical airstrip section. The soil stabilized surfacing is an option discussed later in the report.

Drainage ditches will run along both sides of the runway and discharge flow at convenient low points in the natural topography. The ditches are planned to allow for quick drainage of the airstrip surface so that the surface can be used as soon as possible after a rain storm. The airstrip surface is to be crowned at 2% in the transverse direction to create rapid drainage of free surface water.

In the area where the soft material can not be removed without creating a large excavation, filter fabric will be used to stabilize the foundation.

2. PREPARATION CONSIDERATIONS

To prepare the 2,500 foot initial airstrip this summer, extra consideration must be given to the existing topography and equipment availability. A small grader and a small roller must be mobilized to the site to complete the preparation of the strip. Earthwork and grading on the runway will be limited to the capability of the D-7 dozer and a grader to push material and move small quantities of spoil material with the front-end loader. Compaction of material will be accomplished by track walking with the bulldozer, a small wobble wheel roller, and the front end loader. Expected compaction will be about 85%. This will generate an insitu compacted density of approximately 110 pcf.

The method of preparation will be to load and blade the organic material to the sides of the airstrip and push and blade usable materials along the axis of the runway. The total cut volume is approximately 11,500 cubic yards of which 3,350 cubic yards is spoil and 4,620 is to be used for fill. The remaining 1,465 cubic yards of usable fill is cut between stations 12+00 to 34+00 and can be used as fill between stations 35+00 to 37+00 where the deep peat layer exist.

3. SOIL STABILIZATION

As stated earlier in the report, the runway foundation materials are a silty sand with small amounts of gravel. These materials are a poor drainage material which will prevent airstrip use during break-up and wet periods (May through October). Laboratory and field experience gained during the past twenty years in the construction industry has shown conclusively that soils can be hardened adequately by the addition of relatively small quantities of portland cement. The stabilized soil mixture results in a strong, durable surfacing material providing additional longevity to the runway and reducing maintenance costs.

Preparing a soil cement surfacing in the first foot of depth at the proposed Watana airstrip would provide a hard surface and with a 2% crown will provide very good drainage characteristics. Due to frost heaving, settling and loading, the stabilized soil will eventually break-up into a gravel type material that could be regraded as required during normal maintenance of the airstrip and recemented if desired.

One of the key factors that account for successful application of soil-cement as a surfacing layer is careful predetermination of engineering control factors in the laboratory and their application throughout preparation.

To determine the amount of cement required, a trial mix laboratory program was designed by HARZA-EBASCO and executed at Harding-Lawson's Anchorage laboratory. Site soils, representative of the airstrip foundation materials were brought to the laboratory for visual examination and evaluation. The soil was classified by the AASHO system so that the Industry Standard empirical graphs and charts made by Portland Cement Association could be used for the short cut method of determining the percent of cement. The short cut method is based on standard soils and provides trial mix recommendations to help reduce the time needed to perform various tests.

After determining the shortcut soil cement ratio, soil cement cylinders were prepared for wet-dry tests, freeze-thaw tests and compressive strength breaks at 7 days and 28 days.

The details of the trial mix program and test results are presented in Appendix D.

Evaluation of these test results indicates that the 7% soil cement mix selected by the short cut method is adequate to withstand continuous wetting and drying cycles as well as cycles of freezing and thawing. Strength increases with time to approximately 200 psi, providing a stable surfacing layer.

The results of tests performed at a lower 4% cement ratio show that 4% cement is not adequate to stabilize the site soils in question.

As a result of these test findings, a 7% soil cement ratio was used in the Cost Estimates presented later in this report.

4. RUNWAY EXPANSION

The 2500 foot airstrip described above is considered to be a temporary facility. A major expansion may be required before construction of the dam begins. To expand the airstrip to four thousand feet would require regrading the temporary airstrip from

station 0+00 to station 40+00. The soil between station 0+00 and 14+00 will require remedial treatment of a soft foundation area and would require the minor use of major earth moving equipment to excavate and regrade a constant slope airstrip.

If a still longer airstrip is required to support the camp operations and site construction activities, the east extension can be used, thus producing a runway of six thousand feet. This area of expansion would require major earthwork to take care of the very wet and soft area between station 41+50 and station 47+00. Also needed would be a borrow source of sand and gravel so that the airstrip can be adequately built to provide a good landing surface with free drainage.

5. COST AND SCHEDULE

Based upon the conceptual planning details previously discussed, preliminary cost and schedule estimates were developed. Estimates were based upon the preparation of two types of preliminary airstrip, both of which are 2,500 foot by 70 foot. The definition of each of these types of strips are defined below:

A. WINTER STRIP

The winter strip is proposed to be prepared to the standard dimensions without a runway surfacing. Preparation is based upon the availability of a D-7 Dozer, a one-yard frontend loader, a small

motor grader and a small roller. The dozer and loader are already at the site. A small motor grader and roller will have to be mobilized by helicopter to the site prior to the start of preparation.

Preparation activities will emphasize closing up the surface of the runway and drainage features. It is envisioned that with adequately placed snow fences and continued maintenance of the runway, service may be considered reliable from November through May of each year. Air service to the Watana Camp during the remaining months of June through October, is to be supplied through helicopter services when the airstrip can not be used.

A cost proposal for the preparation of this type of strip is estimated to be \$240,000. This estimate presented in detail later in the report is based upon a 7-man construction team on each shift, two shifts per day. Utilizing standard production rates for the required equipment, a duration of fifteen days is calculated for preparation. Equipment mobilization, the cost of materials, and logistical support are also included in this cost proposal.

It must be noted at this time that airstrip preparation activities cannot be started until permitting requirements are fulfilled.

B. YEAR ROUND STRIP

The year round strip is proposed to be prepared to the standard dimensions discussed above with the addition of a one foot thick stabilized soil runway surfacing. Preparation is based upon the completion of the winter strip described above with the addition of the stabilized soil surfacing.

The preparation of the surfacing will require the additional mobilization of a large disc, pump and piping system and cement. The preparation of the surfacing will require an additional twenty days to complete at an additional estimated cost of \$290,000. The total cost of the soil stabilization, year round strip is therefore, estimated to be \$530,000.

The cost-benefit ratios for each of the two types of strips are presented in Section F, Economic Analysis, which follows.

F. ECONOMIC ANALYSES

The economic analyses performed as part of this feasibility study was basically divided into two subtasks. The first, was to formulate the total costs of equipment mobilization and airstrip preparation. The results of this subtask have been presented in Section E of this report. The second subtask involved establishing a rate structure for fixed-wing service of all types, and for rotary wing service as well. The cost savings of fixed-wing service to the proposed airstrip vs. helicopter service for the camp was then calculated considering activities such as fuel hauls, personnel transport, equipment and grocery deliveries, and maintenance. Based on the assumed duration of future exploration programs, fixed-wing costs to the winter strip and to the year round strip were compared to helicopter service costs and the break even durations were established.

1. FIXED-WING VERSUS ROTARY WING SERVICE

In order to accomplish the economic analyses and cost comparisons described above two basic study cases were defined.

CASE 1 Considers the construction of 2,500 foot by 70 foot airstrip at the Watana camp, suitable for light aircraft up to a CASA 212 or a Twin Otter. This case is further divided as follows:

CASE 1A Considers the use of the winter strip from November 1st to April 30th; with heavy maintenance and chancy usage from May 1st to October 31st. Fuel hauls are planned in April and November. The total cost of construction is \$240,000.

CASE 1B Considers the use of the year round strip with normal maintenance and fuel hauls, the total cost of construction is \$530,000.

CASE 2 Considers the use of rotary wing helicopter service to the Watana Site. Winter traffic of personnel and light freight are planned into Miller Lake on skis. Summer traffic is planned to Talkeetna by fixed-wing and then by helicopter to Watana. Fuel lifts are made by helicopter from the Chulitna siding to the site in February and July.

2. USAGE PLAN

Following the definition of the study cases above, the following usage plan was established as a base for the comparative cost analyses.

CASE 1A ASSUMPTIONS (WINTER STRIP)

o Winter Season

- Four fixed-wing trips per week from Anchorage to Watana with personnel and luggage.
- One trip per week from Anchorage to Watana with supplies and freight.
- Two fuel lifts of 100,000 gallons (April & November).

o Break Up and Summer

- Chancy usage with high maintenance factor.
- 40% of flights are able to use the strip. The remainder use helicopter service.
- Two fixed-wing trips per week from Anchorage to Watana with personnel, luggage and supplies (as possible).
- Remainder of flights are fixed-wing to Talkeetna, rotary to Watana as described in detail in Case 2 below.

- o Local Watana helicopter support of field activities will be equal in all cases and is therefore not considered in the cost comparison.

- o Use of 1983 costs-unescalated.

CASE 1B ASSUMPTIONS (YEAR ROUND STRIP)

- o Four fixed-wing trips per week from Anchorage to Watana with personnel and luggage.
- o One trip per week from Anchorage to Watana with supplies and freight.
- o Two fuel lifts of 100,00 gallons each.
- o Local Watana helicopter support of field activities will be equal in all cases and is therefore not considered in the cost comparison.
- o Use 1983 costs-unescalated

CASE 2 ASSUMPTION (ROTARY WING ONLY)

- o Four fixed-wing trips per week from Anchorage to Talkeetna with personnel and luggage, followed by helicopter transport to Watana; from May through December.
- o One trip per week as described above for supplies and freight - all year round.
- o Four fixed-wing trips per week from Anchorage to Watana with personnel and luggage to Miller Lake on skis; from December to May.
- o Two fuel hauls of 100,000 gallons each in February and July by helicopter from the Chulitna siding to Watana.
- o Local Watana helicopter support of field activities will be equal in all cases and is therefore not considered in the cost comparison.
- o Use 1983 costs-unescalated.

3. COST ANALYSIS

Utilizing the above defined study cases and usage plans, the following costs were developed.

CASE 1A (WINTER STRIP)

- o \$ 42,000 cost of preparation of plans
- o \$240,000 construction cost
- o \$ 26,600 per quarter - transport costs (strip open)
- o \$ 40,600 per quarter - transport costs (strip partially closed)
- o \$ 75,000 fuel lift cost
- o \$ 18,000 per quarter - winter maintenance cost (strip open)
- o \$ 30,000 per quarter - summer maintenance cost (strip partially closed)
- o \$48,600 per quarter - work hour cost for travel (strip partially closed)

- o \$32,400 per quarter - work hour cost for travel
(strip open)

CASE 1B (YEAR ROUND STRIP)

- o \$ 63,000 cost of preparation of plans
- o \$530,000 construction cost
- o \$ 26,600 per quarter transport costs
- o \$ 75,000 fuel lift costs
- o \$ 32,400 per quarter - work hour cost for travel

CASE 2 (ROTARY WING ONLY)

- o Zero construction cost
- o \$ 50,600 per quarter transport costs
- o \$171,000 fuel haul costs.
- o \$ 68,400 per quarter - work hour cost for travel

The cost estimates of study cases 1A and 1B are presented on in
Section 4 to follow.

An analysis of these relationships indicates that the potential earned savings from fixed-wing service to the camp will fully equal the \$240,000 construction cost of the winter strip after 16 months of assumed usage. In the same way, the break even point for the \$530,000, year round strip is found to be 21 months.

Once the break even point is reached, the winter strip accrues savings over the helicopter case at an average rate of \$23,000 per month. The year round strip accrues savings over the helicopter case at an average rate of \$30,000 per month taking all these factors into consideration. If the strip is built this summer, the total savings accrued to April 1986 by the construction of the winter strip is approximately \$288,000 while the total savings accrued by the year round strip is approximately \$229,000.

At this time, emphasis must be given to the chancy nature of the winter strip during break up and freeze cycles. Slight changes in weather from the assumed usage pattern could weigh heavily to the helicopter usage case thus increasing the costs significantly. The year round strip provides a much higher level of reliability with an larger overall cost savings as well.

4. COST PROPOSALS

A detailed capitol cost proposal for the winter strip and year round strip follows:

WANTANA AIRFIELD CAPITAL COST PROPOSAL

Site Preparation and Grading - Winter Strip
1983 Dollars

(Assume two shifts at 10 hours per shift for 15 days)

o Labor & Equipment

<u>Quantity</u>	<u>Item</u>		<u>Total Cost</u>
2	570 Grader w/Operator	\$ 2,000/day	
1	Laborer	500	
2	D-7 Dozer w/Operator	2,000	
2	966 Front End Loader w/Operator	2,000	
	52 inch Roller/Vibrator (towed unit)	1,000	
2	Mechanics	1,200	
1	Foreman	700	
1	Surveyor	400	
1	Resident Engineer	600	
	Subtotal	\$10,400/day	
	@ 15 days		\$156,000

o Subsistence

12 men @ \$120/day @ 15 days 21,000

o Material

200 linear feet of 24 inch corrugated
culvert @ \$11.20 per L.F. 2,258

Mirafi filter fabric 4,000

Subtotal 6,258

o Fuel

D-7 Dozer (consumption at 8 gal/hr)
8 gal/hr @ 20 hours/day @ 15 days = 2,400 gal

966 Loader (5 gal/hr)
5 gal/hr @ 20 hours/day @ 15 days = 1,500 gal

570 John Deere Grader (3 gal/hr)
3 gal/hr @ 20 hours/day @ 15 days = 900 gal

o Fuel (Continued)

52" Vibratory Drum/towed Compactor (2 gal/hr)
2 gal/hr @ 20 hours/day @ 15 days = 600 gal

5,400 gal

5,400 gal @ \$3.00/gal

\$ 16,200

o Mobilization/Demobilization

Vertal helicopter, 4 trips @ \$2,820/trip = \$11,280

Fuel (Talkeetna), 468 gal 819

Fuel (Wantana), 780 gal 2,200

Laborers (Chulitna) 3 days @ \$1,400/day 4,200

Train (Anchorage - Chulitna) 1,200

Subtotal mobilization \$19,699

Subtotal mobilization/demobilization

\$ 39,398

TOTAL

\$239,456

Use

\$240,000

WATANA AIRFIELD - SOIL CEMENT STABILIZATION

Assumptions

- o Construction duration 20 days
- o 14,000 bags Type I Portland cement @ 8.80/bag F.O.B. Anchorage
- o Rail shipment of cement to Talkeetna
- o No front-end loaders
- o Add water tank (wheeled)
- o Water source within 1/2 mile
- o CASA 200 aircraft for equipment and cement transport Talkeetna to Watana
- o Ideal weather conditions
- o Equipment fuel by CASA 200

Site Labor & Equipment

<u>Quantity</u>	<u>Item</u>	<u>Daily Cost</u>	<u>Total Cost</u>
2	570 Graders w/Operator	\$ 2,000.00	
1	Large Disc	200.00	
1	D-7 Dozer w/Operator	2,000.00	
1	52 inch Roller/Vibrator	1,000.00	
1	Pump & Piping System	200.00	
1	Tank (Wheeled)	100.00	
1	Laborer	500.00	
1	Foreman	700.00	
1	Surveyor	400.00	
1	Resident Engineer	600.00	
	Subtotal	\$ 8,900/day	
	@ 20 days		\$178,000.00
	CASA 200 Aircraft		
	205 trips @ 1 hr @ \$750		154,000.00

Subsistence

9 men @ \$120/day @ 20 days	21,600.00
-----------------------------	-----------

Material

14,000 bags Type 1 cement F.O.B. Anchorage
@ 8.80/bag

123,200.00

Freight Anc to Talkeetna @ .65CWT

8,700.00

Fuel - Equipment

Say 6,000 gal @ 3.00/gal

18,000.00

Labor for Load/Off Load @ Airstrips/Trains

2 laborers @ 1/2 hr @ 205 loads @ \$25/hr

5,100.00

Mobilization/Demobilization

20,000.00

JOB TOTALS

\$528,600.00

Use

\$530,000.00

TABLES A,
B AND C

TABLE A
Watana Base Camp-Proposed Airstrip
Permits and Land Use Authorizations

<u>Authorization</u>	<u>Agency</u>	<u>Description</u>	<u>Lead Time</u>	<u>Comments</u>
1. Land Use Section 27	Knikatnu, Inc.	APA Agreement	In effect	Will require extension (Expires 1/1/84)
Section 28	CIRI (Knik select)	APA Agreement	In effect	Will require extension (expires 1/1/84)
2. Talkeetna Special Use Permit	Matanuska-Susitna Borough	Special Use Permit	est. 30 days	
3. Material Acquisition	CIRI	Purchase		Dependent upon Native definition of subsurface borrow, or surface use.
4. Notice of Intent to Establish an Airport Landing Area	FAA	Form 7480-1	21-30 days	
5. Operating Certificate	FAA	Form 5280-1	up to 30 days	Airstrip inspection required
6. Wetland Determination	COE	Request to determine if COE permit required	10 days	

TABLE A
Watana Base Camp-Proposed Airstrip
Permits and Land Use Authorizations

<u>Authorization</u>	<u>Agency</u>	<u>Description</u>	<u>Lead Time</u>	<u>Comments</u>
7. Permit to discharge dredged or fill materials to wetlands	COE	Section 404 Permit	est. minimum 90 days	
8. Certificate of Reasonable Assurance	ADEC	Review of COE with respect to maintaining State water quality standards	est. 30 days	
9. Determination of Consistency with Coastal Mgt. Program	ADPDP	Review of COE Permit with respect to maintaining State water quality standards	est. 30 days	
10. Aviation Radio Beacon	FCC	-	none	Watana Base Camp has a signal issued to CIR-H&N 7/29/80
11. Archaeological Clearance	ADNR-DP	-	None	Surveyed 1980 and archaeological clearance recommended. However, should any cultural resources be uncovered during construction or use of the airstrip, the project archaeologist must be contacted so necessary action can be taken.

TABLE B

BORING NO	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	PI.		
				COBBLE	GRAVEL	SAND	SILT/CLAY					W _c (%)	
AS1		0-1											Organic Content 17.2
AS1		1-3											Organic Content 3.9
AS1		1-3					43.4						
AS1		3-4	SM		9.4	53.9	36.7						
AS2		0-1					48.9						Organic Content 76.4
AS2		1-3					50.7						
AS2		3-4.5									1.41		
AS3		2.5-3	SM		6.4	64.3	29.3						
AS3		3-4									25.7		Organic Content 4.5
AS3		5-7											Organic Content 1.7
AS3		8-9.5	SM		3.1	58.6	39.3						
AS4		5-6					18.9						Organic Content 11.5
AS5		3.5-4									84.7		Organic Content 89.5
AS5		5.5-6.5					44.5						
AS5		8-10	SM		6.9	55.4	37.7						
AS7		1.5-3.5	SM		9.4	48.2	42.4						
AS7		10.0	SM		14.6	45.7	39.7				12.7		
AS9		1.5-2.5	SM		8.9	57.3	33.8						
AS10		3.5-4.5	SM		0	57.6	42.4	yes					

Remarks:

LAB TEST SUMMARY

WATANA AIRSTRIP STUDY

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

TABLE B

BORING NO	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	PI.	W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
AS12		.5-1.0	SM		7.4	62.1	30.5						Organic Content 8.8%
AS13		7-10	SM		8.0	54.7	37.3	yes				22.2	
AS13		13-15	SM		25.8	45.0	29.2						
AS13		15-17.5	SM		17.1	49.0	33.9						
AS14		5-7.5											Organic Content 11.2
AS14		8-10	SM		14.6	51.2	34.2						
AS14		12.5-15	SM		12.0	53.5	34.5						
AS16		5-7.5	SM		34.1	38.6	27.3						
AS17		5-7.5	SM		0	52.2	47.8	yes	18.4	16.5		2.3	
AS17		7.5-10	SM		3.9	52.6	43.5		20.8	17.1		3.7	
AS19		5-7	SM		13	52.2	34.8					11.5	
AS21		3-4	SM		9.2	51.3	34.5						
AS23		3-5	SM		7.2	58.8	34.0						
AS24		1.5-2.5	SM		10.2	53.5	36.3					13.3	
AS25		1-2.5	SM		4.6	53.3	42.1						
AS26		1-2.5	SM		4.2	48.7	47.1					26.4	
AS26		2.5-4	SM			46.6	53.4	yes					G _s =2.75
AS26		7.5-9	SM		40.7	30.2	29.1						1 1/2" piece of gravel
AS27		3-5	SM		19.4	52.4	28.2						

Remarks:

LAB TEST SUMMARY

WATANA AIRSTRIP STUDY

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

TABLE B

BORING NO	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
AS28		1.5-2.5	SM		10.8	58.8	30.4						
AS28		9.5-10.0	SM		16.5	52.1	31.5						
AS29		1-2.5	SM		9.8	54.6	35.6						
AS29		6-7.5	SM		20.0	52.1	27.9						
AS30		1-2.5	SM		5.4	54.4	39.7	yes				23.5	
AS30		2.5-5	SM		8.5	52.0	39.5						
AS31		2.5-3										16.8	
AS32		.5-2.0											Organic Content 6.4
AS33		.5-2.5										17.3	
AS33		2.5-5	SM		8.7	56.2	35.1					12.3	
AS34		.5-2.0										86.3	Organic Content 10.1
AS35		0-2.5	SM		19.8	51.0	29.2					10.6	
AS36		0-2.5	SM		21.4	58.7	19.4						
AS37		1-2.5	SM		10.5	64.7	24.8						
AS37		2.5-4.5					37.1						
AS38		1-2.5	SM		13.2	63.2	23.6						
AS38		2.5-4					41.3						
AS40		1-2.5	SM		8.3	55.2	36.5						
AS41		2-4	SM		9.3	48.3	42.4						

Remarks:

LAB TEST SUMMARY

WATANA AIRSTRIP STUDY

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

TABLE B

BORING NO	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.	W _c (%)	
AS42		1-2.5	SM		11.5	51.1	37.4					26.6	
AS42		2.5-5	SM		22.3	57.7	20.0					9.9	G _S =2.67
AS43		1-2										19.8	
AS44		.5-2.0										26.4	
AS44		2-4	SM		15.6	62.8	31.6					14.3	
AS45		1-2.5	SM		3.0	51.7	45.3					21.3	
AS45		3-5	SM		5.8	57.6	36.6					11.0	
AS46		.5-2.0	SM		10.3	60.6	29.1						
AS47		2-3.5										37.6	
AS49		2-3.5	SM		8.3	47.5	45.2						
AS49		5-7.5	SM		0	51.1	48.9	yes					
AS49		5-7.5							20.1	15.4		4.8	G _S =2.72
AS49		5-7.5										13.4	
AS51		1-2.5	SM		10.2	69.3	20.5						
AS51		3-5	SM		6.9	50.1	43.0						
AS52		1-2.5					46.1						
AS54		1-2	SM		5.4	50.4	44.2					13.0	
AS54		8.5-9	SM		6.2	61.4	32.4					5.6	

Remarks:

LAB TEST SUMMARY

WATANA AIRSTRIP STUDY

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

000373

TABLE B

BORING NO	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	LIMITS			W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.		
MC1		2-2.5										22.7	
MC1		3-3.5										20.8	
MC1		0.-1.5											Organic Content 13.7
MC2		2-2.5	SM		8.7	65.9	30.4					20.2	
MC3		2.5-3.0	SM		0.0	62.8	37.2						
MC4		2-2.5	SM		2.1	66.4	31.5						
MC5		2-2.5	SM		7.2	55.5	37.3						
MC6		1-1.5											Organic Content 4.7
MC6		3-5	SM		6.6	54.1	39.3						
MC7		1-2.5					36.0						
MC8		1-2	SM		52.6	47.4							
MC9		1-2					27.9						

Remarks:

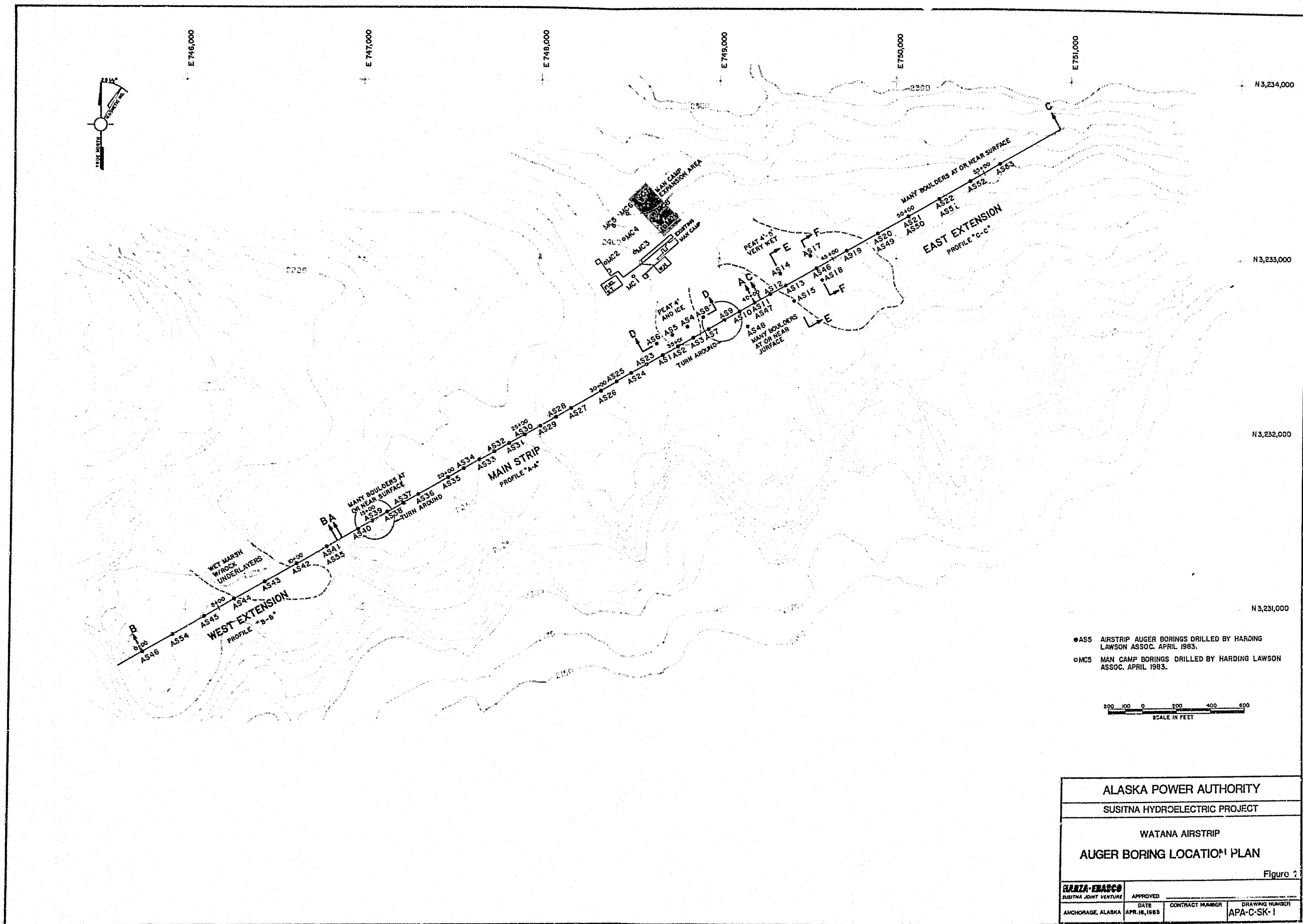
TABLE C
SOIL CEMENT TRIAL MIX
TEST SUMMARY

TEST PARAMETER	NATURAL	+4% CEMENT	+7% CEMENT
1. Soil Gradation			
- Classification	Gray Gravelly Silty Sand (SM)	-	-
- Fines Content	40%	-	-
- Specific Gravity	2.63		
2. Compaction Characteristics			
- Maximum Dry Density	127#/Ft ³	124	126
- Optimum Moisture	10.0%	10.0	9.0
3. Wet-Dry Weight Loss At 12 Cycles	-	87%	21%
4. Freeze-Thaw Weight Loss at 12 Cycles	-	Crumbled At 10 Cycles	14%
5. Unconfined Compressive Strength	-		
- 7 days		130 psi	145 psi
- 28 days		65 psi	180 psi*

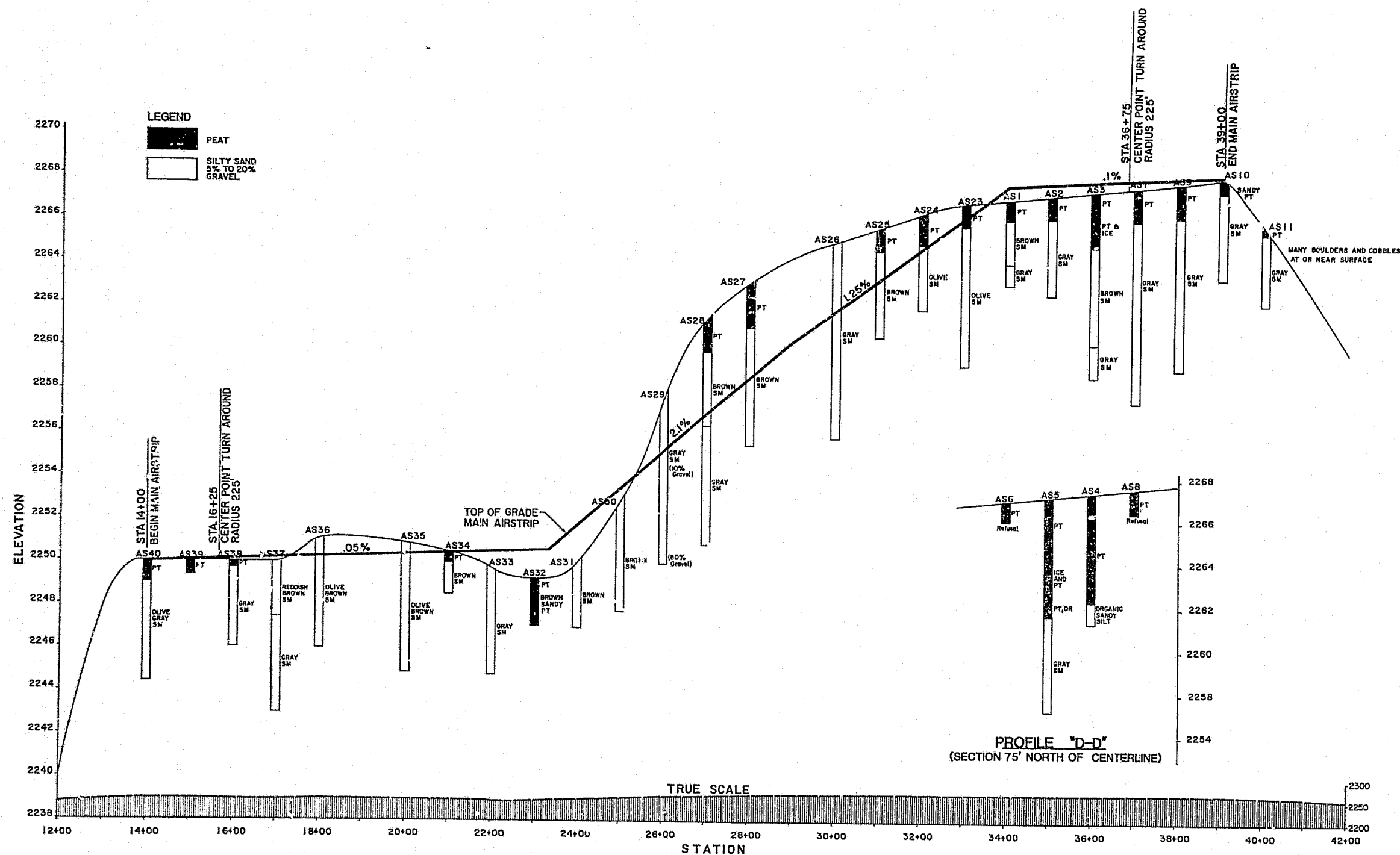
*Curing Induced Tensile Cracking Reducing Strength.

000373

FIGURES 1 - 5



FOLD LENGTH
 12
 11
 8.5
 8
 AUTO
 MANUAL
 FEED



PROFILE "A-A"
AIRSTRIP CENTERLINE
MAIN AIRSTRIP (2,500')

SCALE: 1" = 100' HOR.
1" = 2' VERT.

ALASKA POWER AUTHORITY			
SUSITNA HYDROELECTRIC PROJECT			
WATANA AIRSTRIP			
SOIL BORING			
PROFILES "A-A" & "D-D"			
Figure 2			
HARZA-ERASSO		APPROVED	
SUSITNA JOINT VENTURE		DATE	
ANCHORAGE, ALASKA		APR 16, 1983	
CONTRACT NUMBER		DRAWING NUMBER	
		APA-C-SK-2	

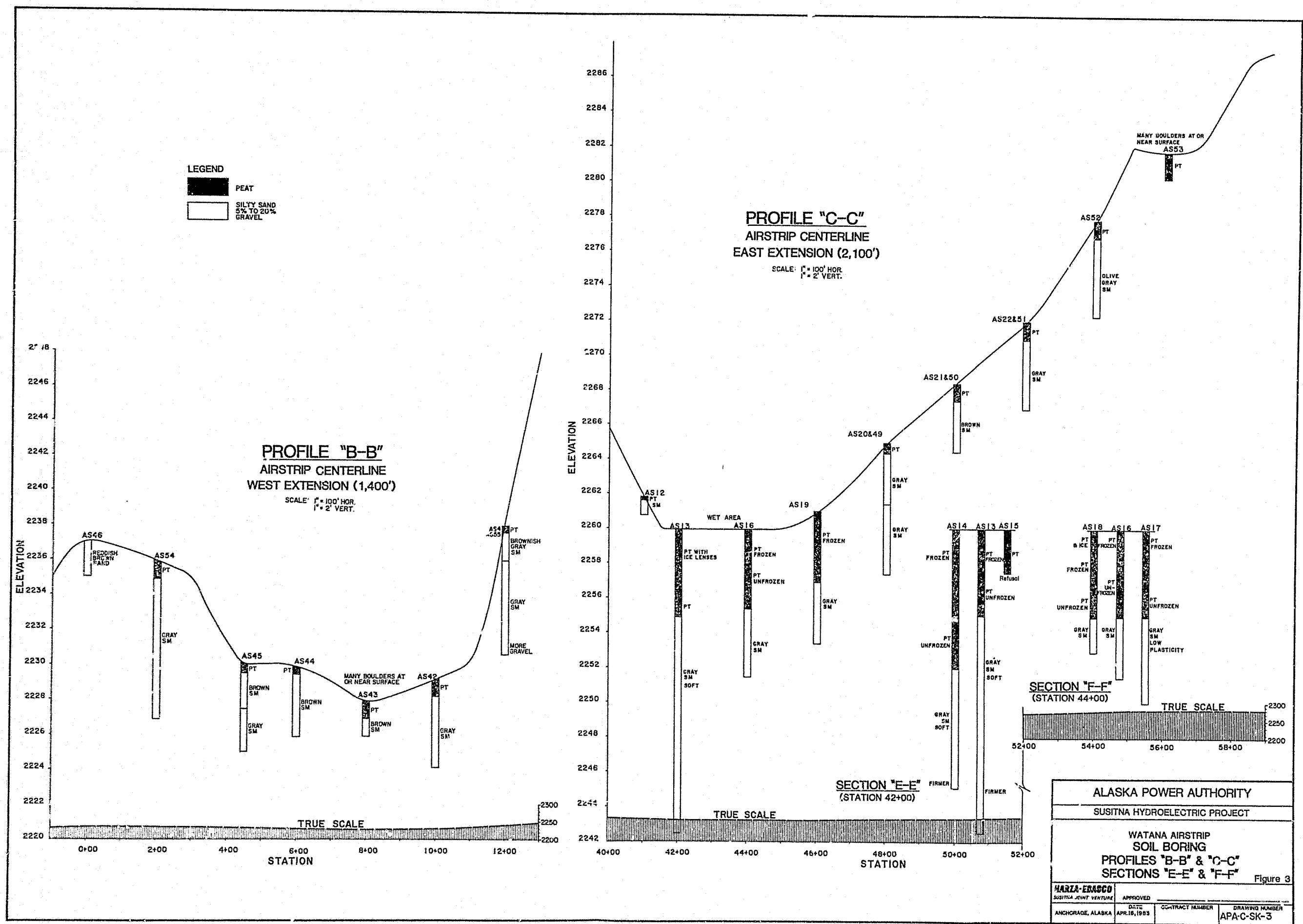
FOLD LENGTH

12
11
8.5
8

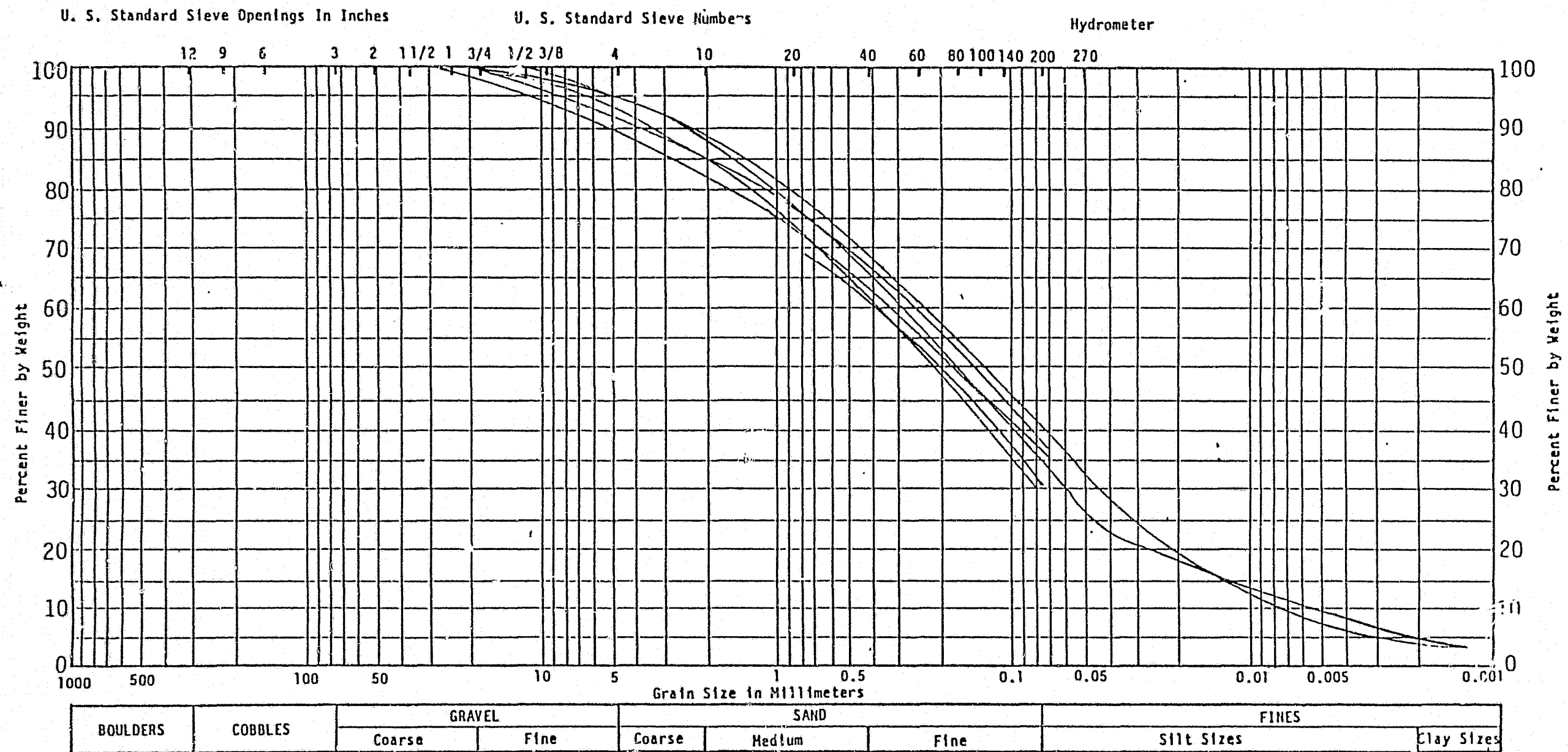
AUTO

MANUAL

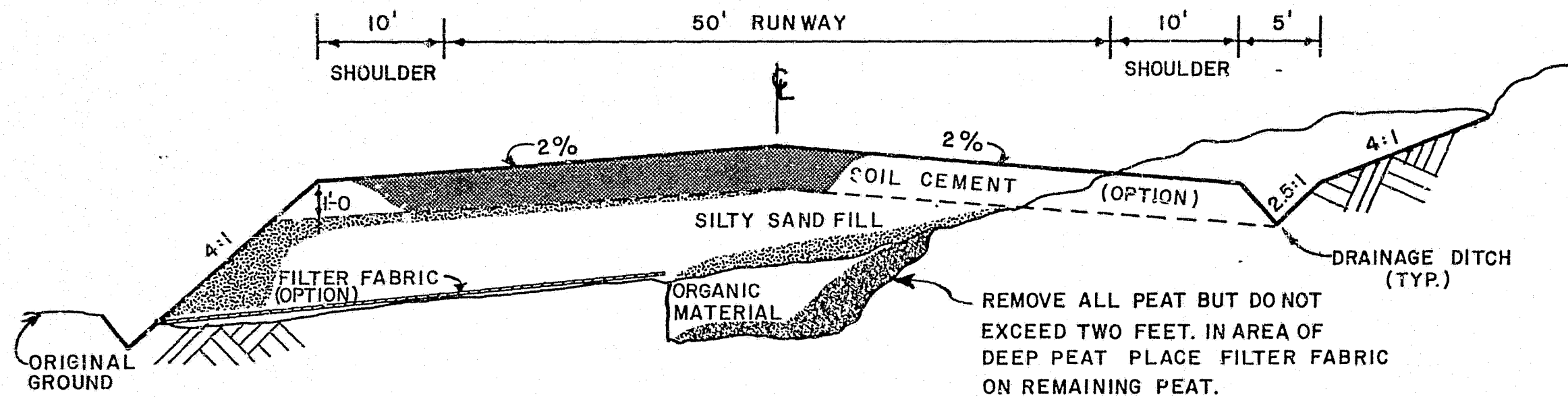
FEED



GRADATION SIZE ANALYSIS



TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
					<u>AIRSTRIIP</u>
					No. _____
					Date <u>APRIL, 1983</u>
VISUAL MANUAL CLASSIFICATION					TYPICAL GRAIN SIZE CURVES
<u>FINE SILTY SAND WITH SOME GRAVEL (SUBANGULAR AND SUBROUNDED)</u>					APA-C- SK-4



TYPICAL RUNWAY SECTION
N T S

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

WATANA AIRSTRIP
TYPICAL RUNWAY SECTION

MAKZA-EDASCO
SUSITNA JOINT VENTURE

APPROVED

ANCHORAGE, ALASKA

DATE
4 / 83

CONTRACT NUMBER

DRAWING NUMBER

APA-C-SK-5

APPENDIX A

R & M WATANA AIRSTRIP REPORT

OCTOBER, 1980

SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

TASK 2

SURVEYS AND SITE FACILITIES

SUBTASK 2.03

RESUPPLY AND EMERGENCY SERVICES

AIRSTRIPE LOCATION STUDY

Prepared For:

ALASKA POWER AUTHORITY

and

ACRES AMERICAN, INCORPORATED

Prepared By:

R&M CONSULTANTS, INC.

OCTOBER 1980

PRELIMINARY

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
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B. Location Parameters	2
C. Approach	5
D. Analysis	5
E. Recommendations	7
F. Quantity Estimates - Watana Airstrip	8
G. Construction Cost Estimates	9

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Exhibits 1 Vicinity Map	10
2 Layout Plan - Alternate A	11
3 Plan View - Alternate A	12
4 Profile - Alternate A	13
5 Typical Cross Section	14
6 Drill Logs AH-D1 and AH-D2	15
7 Drill Logs AH-D3 and AH-D4	16
8 Wind Rose	17

A. INTRODUCTION

This Study was done as an integral part of the larger Susitna Hydroelectric Project studies. The Susitna Hydroelectric Project includes proposals for one or more large hydroelectric dams on the upper Susitna River between the Parks Highway near Talkeetna and the Denali Highway. Site locations for two major dams are being studied. The site identified as "Watana Dam" is the furthest upstream site. Winter access is possible on the North side of the river near the Watana site.

During the winter of 1979/80 a forty man base camp was moved in using a "Roligon" train from the Denali Highway. This camp is located on relatively level terrain North of the Susitna River a short distance upstream from the Watana site. Crews have been working out of this camp since the early spring of 1980 and continuous field operations are expected well into 1982 and beyond. The camp has been labeled "Watana Camp".

Access to Watana Camp at this time is possible by helicopter on a year round basis and by Roligon during winter months. It is difficult to anticipate supply requirements with sufficient accuracy to allow resupply by Roligon on an annual basis. Resupply by helicopter is difficult and much more costly than if fixed wing aircraft could be used. In addition personnel access could be provided much more economically by fixed wing aircraft.

A determination has been made that adequate landing facilities for fixed wing aircraft should be provided near Watana Camp. The purpose of this location study is to determine the best location for a runway capable of handling fixed wing aircraft up to and including the Twin Otter.

4. In order to reduce the permit requirements Watana Camp was located on Cook Inlet Regional Corporation land rather than BLM land. It was felt that, if possible, the runway for the Twin Otter should also be confined to Cook Inlet Regional Corporation land.
5. The orientation of a runway should always be determined, as much as possible, by the prevailing winds. Wind data was available from the camp weather station.
6. Wet land encroachment is always a consideration from an engineering viewpoint. Construction on wet areas is generally more complex and expensive than on well drained soils. It is obviously desirable to choose an alignment with a minimum of water problems.
7. Available soils data has been included as a parameter. Soil logs from barrow pit exploration were available and were considered. The location of available material sources and the suitability of native materials for construction have definite impacts on project costs.
8. While not specified FAA criteria for a General Transport runway is assumed to control. Basic dimensions are shown in Table 1. Maximum runway grades are not to exceed 2%. Exhibit 4 shows the primary cross-sectional requirements.

TABLE I

DIMENSIONAL STANDARDS, BASIC AND GENERAL TRANSPORT AIRPORTS

ITEM	/1 DIM	NON-PRECISION RUNWAY		PRECISION RUNWAY FOR BASIC OR GENERAL TRANSPORT
		BASIC TRANSPORT		
		A/2	B	
Runway Length	A	See Figures 5, 6 and 7		As required by critical airplane
Width-Runway	B	75'	100'	150'
-Taxiway	C	40' /3	40' /3	40' /3
-Runway Safety Area	D	150'	300'	500'
Runway Centerline to				
-Taxiway Center- line	E	200'	200'	400'
-Airplane Parking Area	F	275'	300'	650'
-Parallel Runway	G	As Per Current FAA Criteria		
Taxiway Centerline to				
-Airplane Parking Area	H	75'	100'	250'
-Fixed or Movable Obstacle	I	50'	75'	200'
-Parallel Taxiway	J	150'	150'	300'
Building Restriction Line to				
-Runway Center- line	K	250'	300'	750'
-Taxiway Center- line	L	50'	75'	200'

/1 Letters are keyed to those shown as dimensions on Figure 3.

/2 Basic Transport Column A is to be used only at those low activity sites where an existing utility runway, having no anticipated need for an instrument approach procedure of any kind, is extended for business jets. For all other basic transport airports use Column B.

/3 Make straight taxiway sections 50 feet when airplanes with a wheel tread over 25 feet will use the airport. A width of 60 feet will be required for airplanes with tread over 35 feet. Make curved sections conform to Figure 8.

* Taken from FAA AC 150/5300-6

C. APPROACH

Work began in late August 1980, with a detailed analysis of wind data accumulated by the weather stations at Watana Camp. The prevailing winds are out of the North East such that an orientation of North 60° East will provide good wind coverage under most weather conditions. The wind data is shown on Exhibit 8.

With the prevailing winds documented and the controlling grades and dimensions chose from FAA Advisory Circulars the selection of alternative locations could be made. Contour mapping generated by the Corps of Engineers on a scale of 1"=200' with 5' contour intervals was used. Two potential runway sites were identified on the contour mapping quite close to Watana Camp. Alternate A is South of camp as close as dimensions in Table 1 will allow. Alternate B is on a low ridge North of camp at about the same distance. There were no other locations apparent that were close to Watana Camp.

Each alternative was reviewed to determine how well each controlling parameter was satisfied. Alternative A appears to be the preferred location from this review. A field trip was made to review each alternative. Alternative A was flagged in the field for review by the Archeological team. The Archeological review team cleared the Alternative A location.

D. ANALYSIS

In many respect both alternatives were essentially equal.

Both alternatives were selected to fit FAA criteria in an effort to provide the safest possible facility.

Soils are essentially identical. Both locations lay within an area which has been identified as a potential material source for the dam. Alternate A is located along the edge of the borrow area and would have less impact on use of the borrow area than would alternate B.

There is only minor differences in the amounts of wet land that will be effected by either alternative if extended to dimensions required for the C-130. A portion of alternate A can be developed to handle the Twin Otter without significant encroachment on obvious wet lands or a need for drainage provisions other than careful surface grading.

Alternate A can be developed entirely on Cook Inlet Regional Corporation land. This is true not only for the first stage Twin Otter capability but for the C-130 capability also if length can be held to 5600 feet. Alternate B on the other hand is located largely on BLM land.

Alternate A is positioned so close to Watana Camp that an aircraft parking and fueling areas can be provided adjacent to the existing fuel storage area and the camp warehouse. This will provide for easy servicing and unloading of aircraft.

Grades are such that if alternate B were selected an access road of approximately one-half mile would be necessary to move fuel to planes or personnel and freight from planes. From a logistic stand point alternate A has a major advantage over alternate B.

The principal advantage of alternate B over alternate A is with the clear zone surface on the Westerly approach. This approach is over the North end of the Watana Dam. The approach to alternate B provides a very comfortable clearance of several hundred feet over what may be a very active construction area if the dam is built. Alternate A provides minimum verticle clearance over the

potential construction area. If a runway capable of serving C-130 aircraft is eventually built on alternate A careful consideration must be given to potential conflicts between construction equipment and the clear zone surface for the Westerly approach. An acceptable clear zone can be maintained for alternate A in any case.

When all parameters are considered alternate A is the more attractive alternate for the following reasons:

1. Best access to Watana Camp;
2. Least expensive construction to serve the Otter aircraft;
3. Minimal drainage problems with the first stage of construction;
4. Minimal interference with potential material source for the dam.

E. RECOMMENDATIONS

The preferred location of a runway to provide for Twin Otter service to Watana Camp is fairly clearcut. It is recommended that a 2500 foot runway be constructed using a portion of alternate A as shown on Exhibit 2, 3, and 4. This initial runway should be constructed at the highest elevation consistent with balanced earth work in order to keep construction costs for this temporary facility to a minimum. The finished runway and safety area should be graded to drain to existing natural drainages. In addition, care should be taken so as not to create any areas that will trap snow. Organic soils should be removed from the runway prism as depths to sound material are minimal. Consideration should be given to providing a crushed aggregate surface on the runway itself. There will be occasions when aircraft may choose to use the facility during marginal weather conditions. For this reason the use of retro-reflective runway markers is recommended. These devices are an alternative to low intensity runway lights that do not require power.

F. QUANTITY ESTIMATES - WATANA AIRSTRIP

Item 1. Waste Excavation

$$\frac{(2500 \text{ ft.} \times 100 \text{ ft.} \times 2')}{27} = 18,519 \text{ c.y.}$$

Use 1.2 for contingency - use 22,500 c.y.

Item 2. Unclassified Excavation

$$\frac{(320') (5') (2500') (1.2)}{(2) (27)} = 88,888 \text{ c.y. use } 90,000 \text{ c.y.}$$

Item 3. Fabric for Safty Area - and Parking Area

$$\text{Safety Area } \frac{100' \times 2500'}{9} = 27,778 \text{ s.y.}$$

$$\text{Extended Safty Area } \frac{300 \times 200 \times 2}{9} = 13,333 \text{ s.y.}$$

$$\text{Parking Area} = \underline{13000 \text{ s.y.}} \quad 55,000 \text{ s.y.}$$

Item 4. Crushed Surfacing

$$\left[(13000 \text{ s.y.} + \frac{(2500)(100)(0.5)}{(9)(3)}) \right] (1.05) = 7136 \text{ cy say } 7200 \text{ c.y.}$$

Item 5. Retro-Reflective Markers

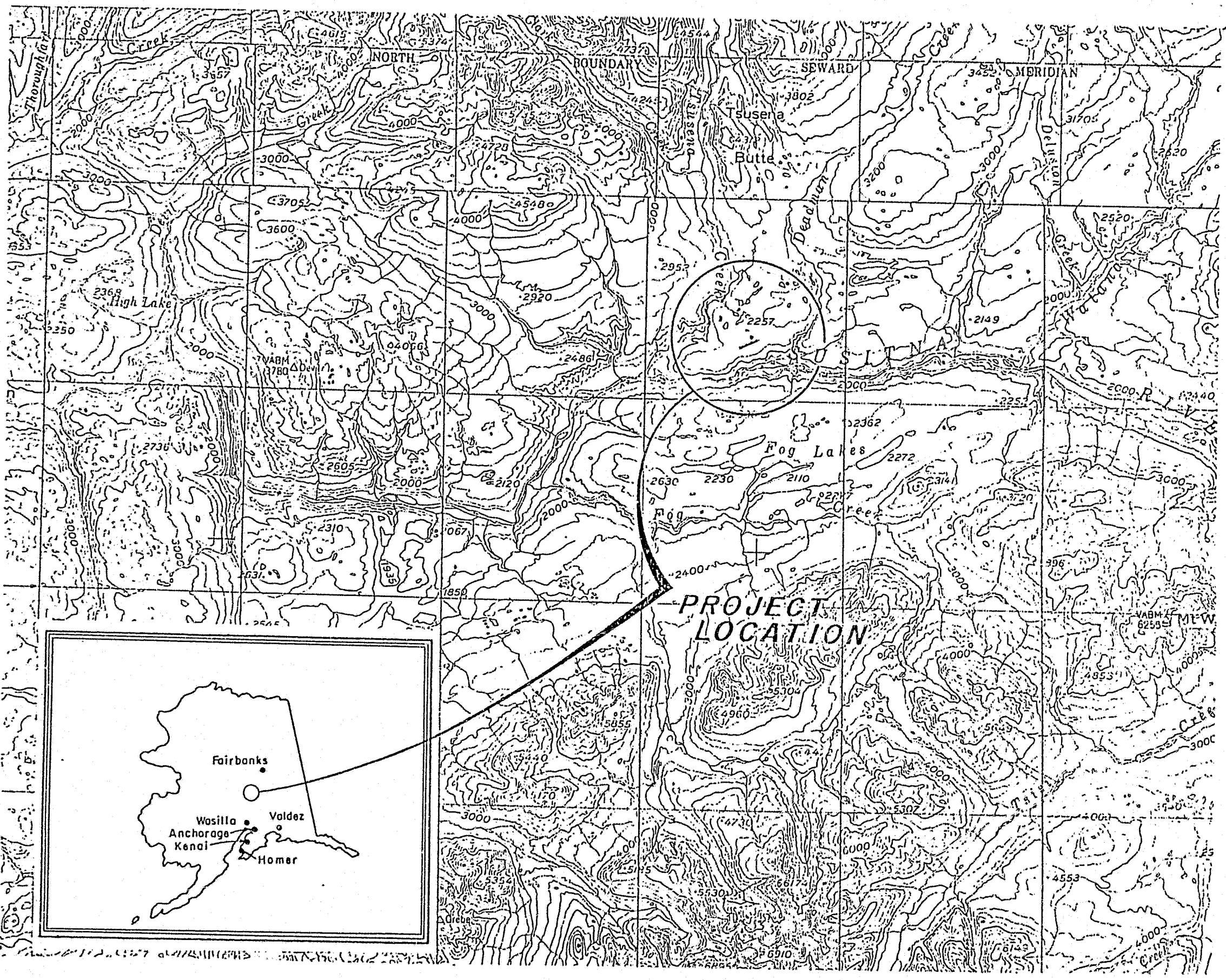
$$\pm \underline{75}$$

G. CONSTRUCTION COST ESTIMATE

1.	22,500 s.y.	@	3.00	67,500
2.	90,000 c.y.	@	5.00	450,000
3.	55,000 s.y.	@	1.00	55,000
4.	7,200 c.y.	@	10.00	72,000
5.	75	@	50.00	3,750
6.	Mobilization	L.S.		<u>200,000</u>
				848,250

Contingency	127,238
-------------	---------

Total	\$975,488
-------	-----------

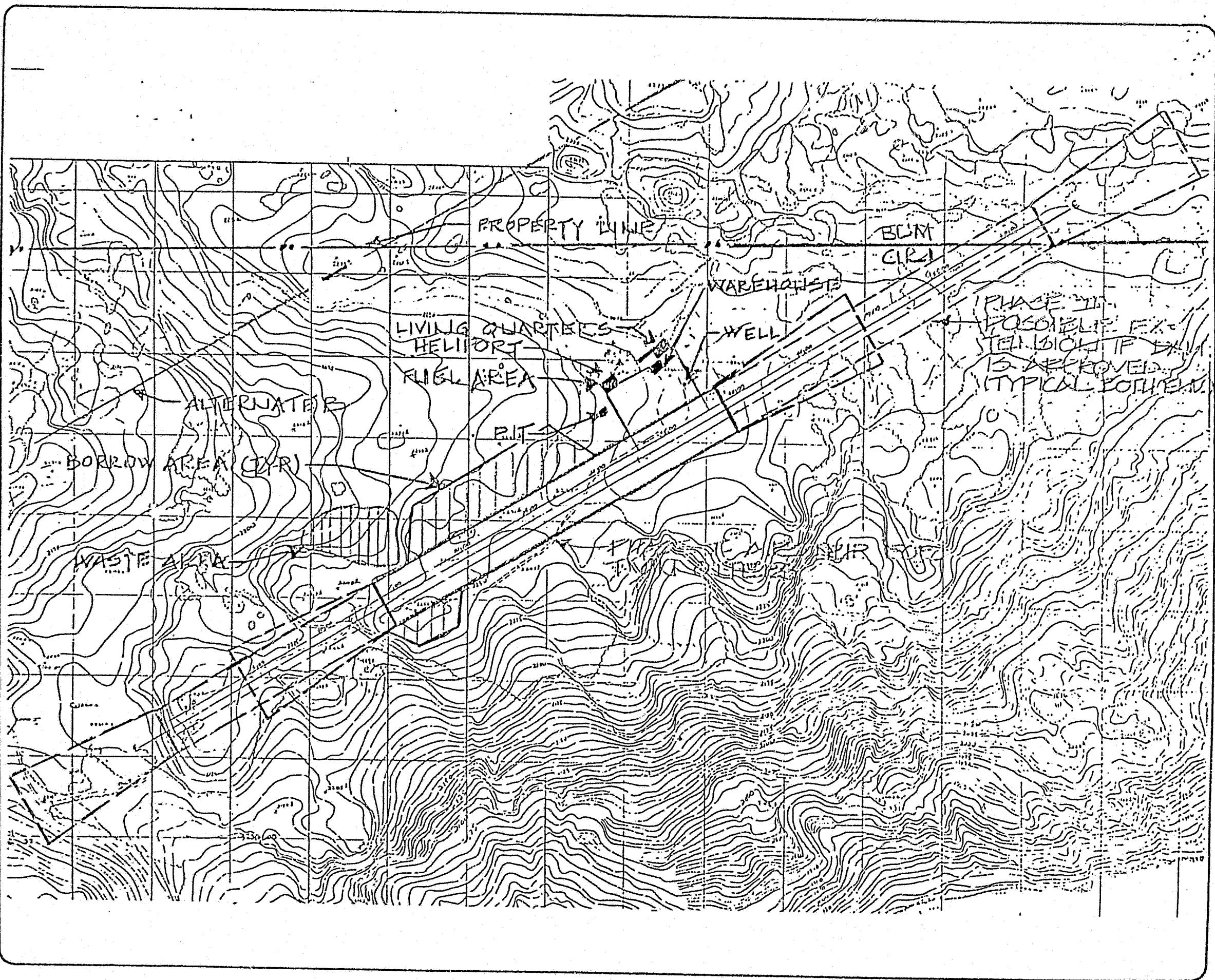


DWN SRS
CKD NK4
DATE 10-3-60
SCALE 1"=1 MI.

PSM
RSM CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

WATANA AIRSTRIP
VICINITY MAP
EXHIBIT 1

FB
GRID
PROJ NO 052203
DWG NO

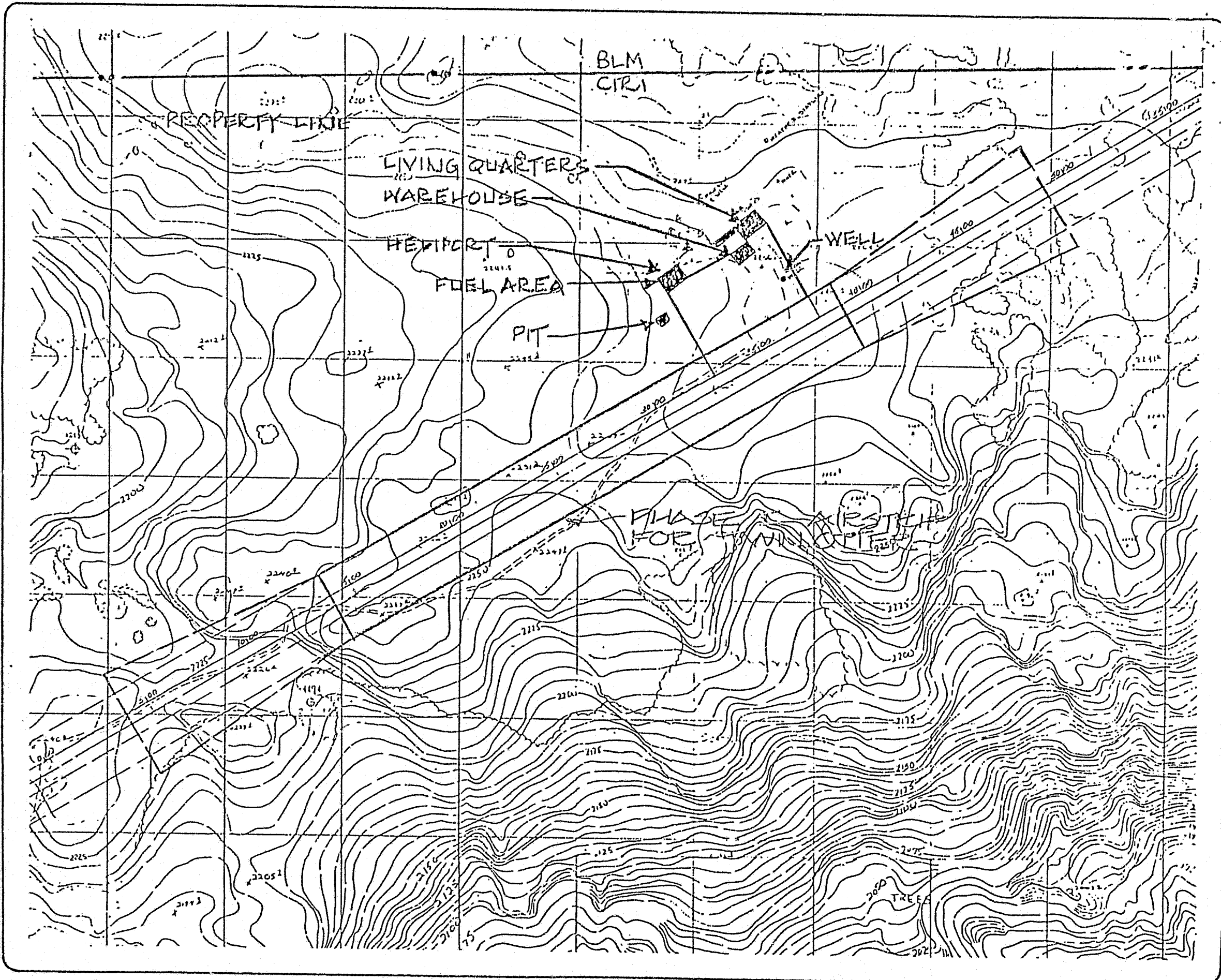


OWN RSH
CKD. NKG
DATE: 10/3/80
SCALE NTS

RSM
RSM CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

WATAKA AIRSTRIP
LAY OUT PLAN
EXHIBIT 2

FB.
GRID.
PROJ. NO. 052202
DWG. NO.



DWN. RSH
CKD. NK6
DATE. 10/15/80
SCALE. NTE

RSM
RSM CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

WATKINS AIRFIELD
PLAN VIEW - PHASE I
EXHIBIT 3

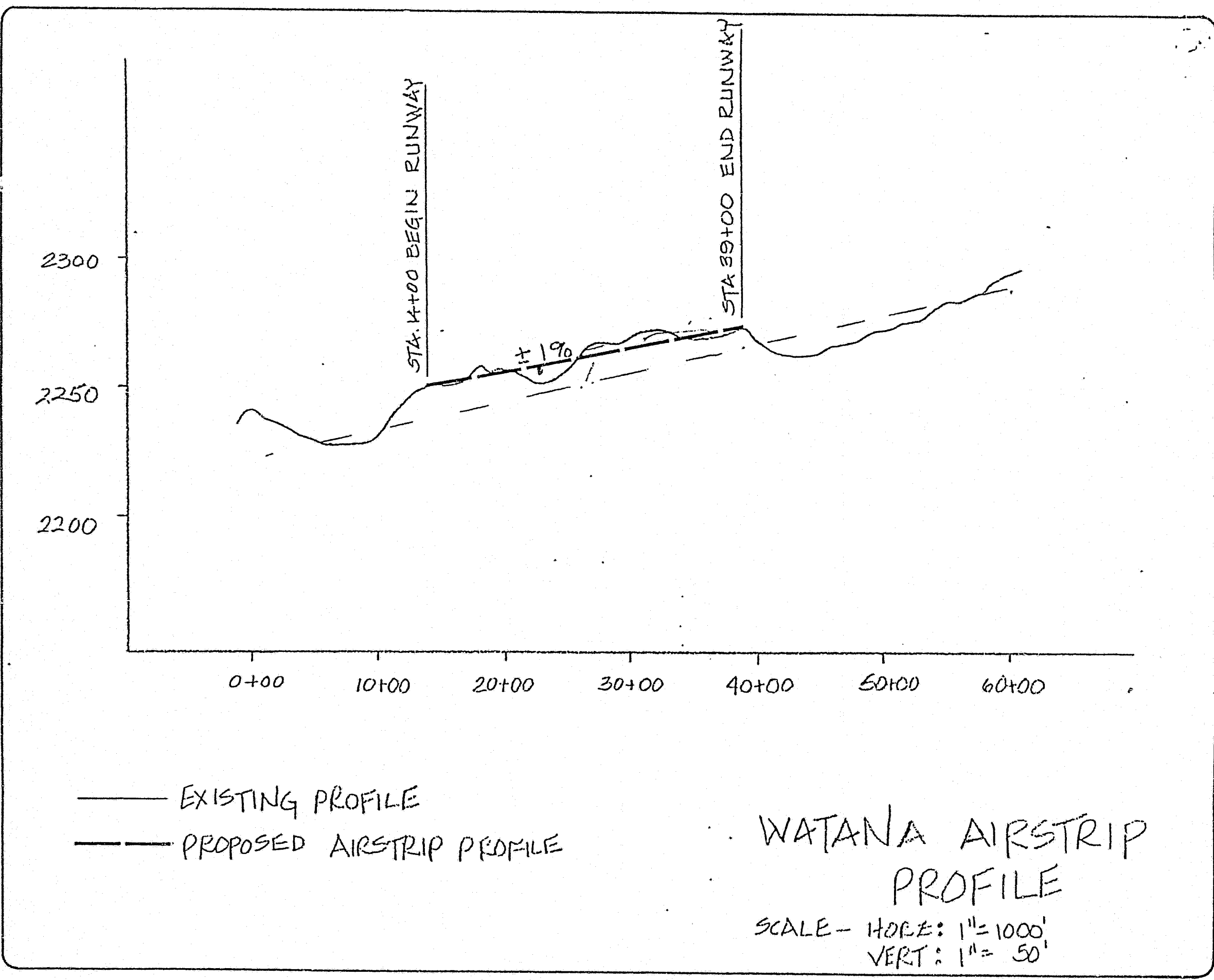
FB.
GRID
PROJ. NO. 052202
DWG. NO.

DWN. RJH
 CKD. NKG
 DATE 10/8/80
 SCALE AS NOTED

PSM
 RSM CONSULTANTS, INC.
 ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

WATANA AIRSTRIP
 PROFILE - PHASE 1
 EXHIBIT 4

FB.
 GRID.
 PROJ. NO. 052203
 DWG. NO.

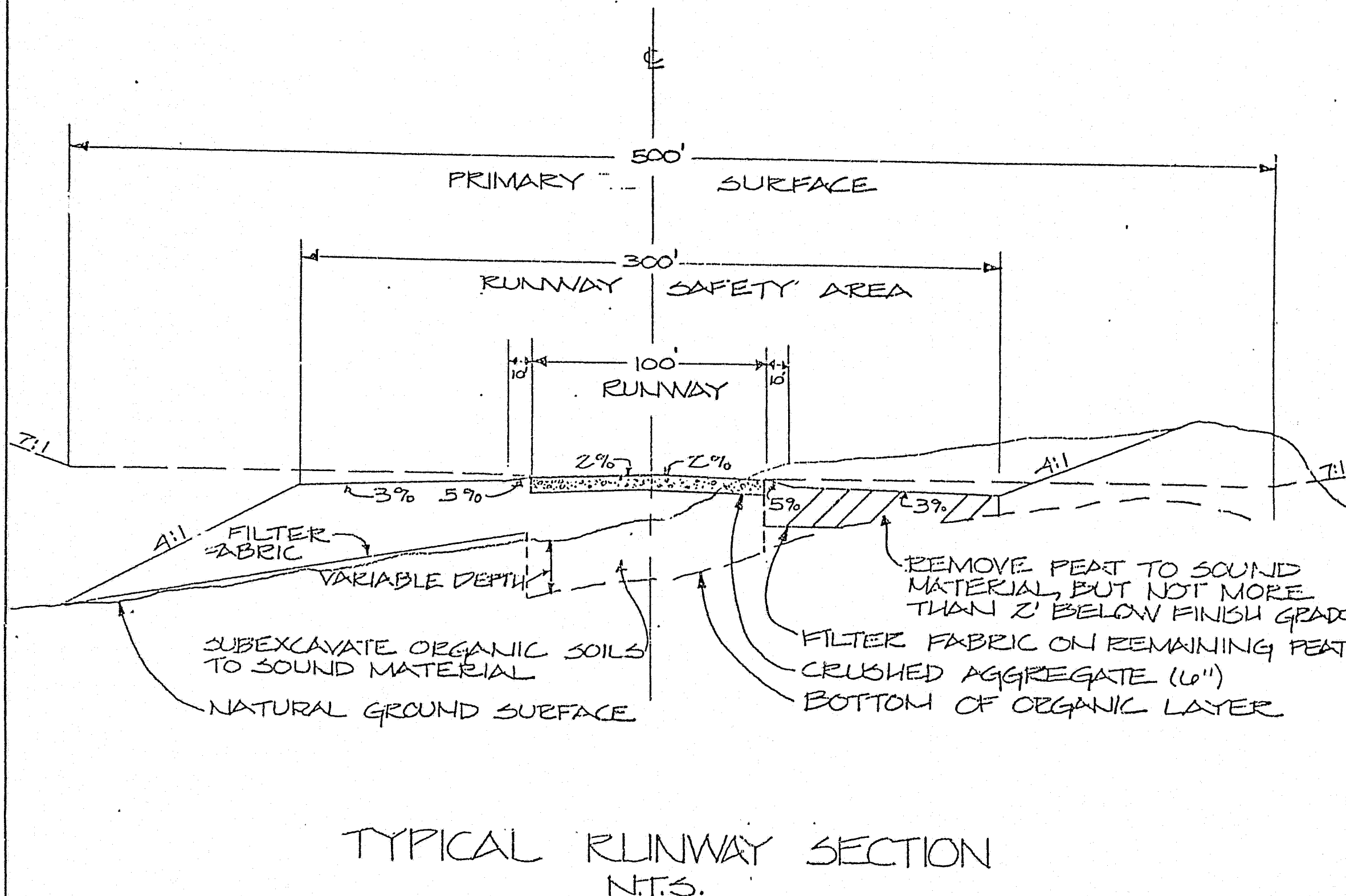


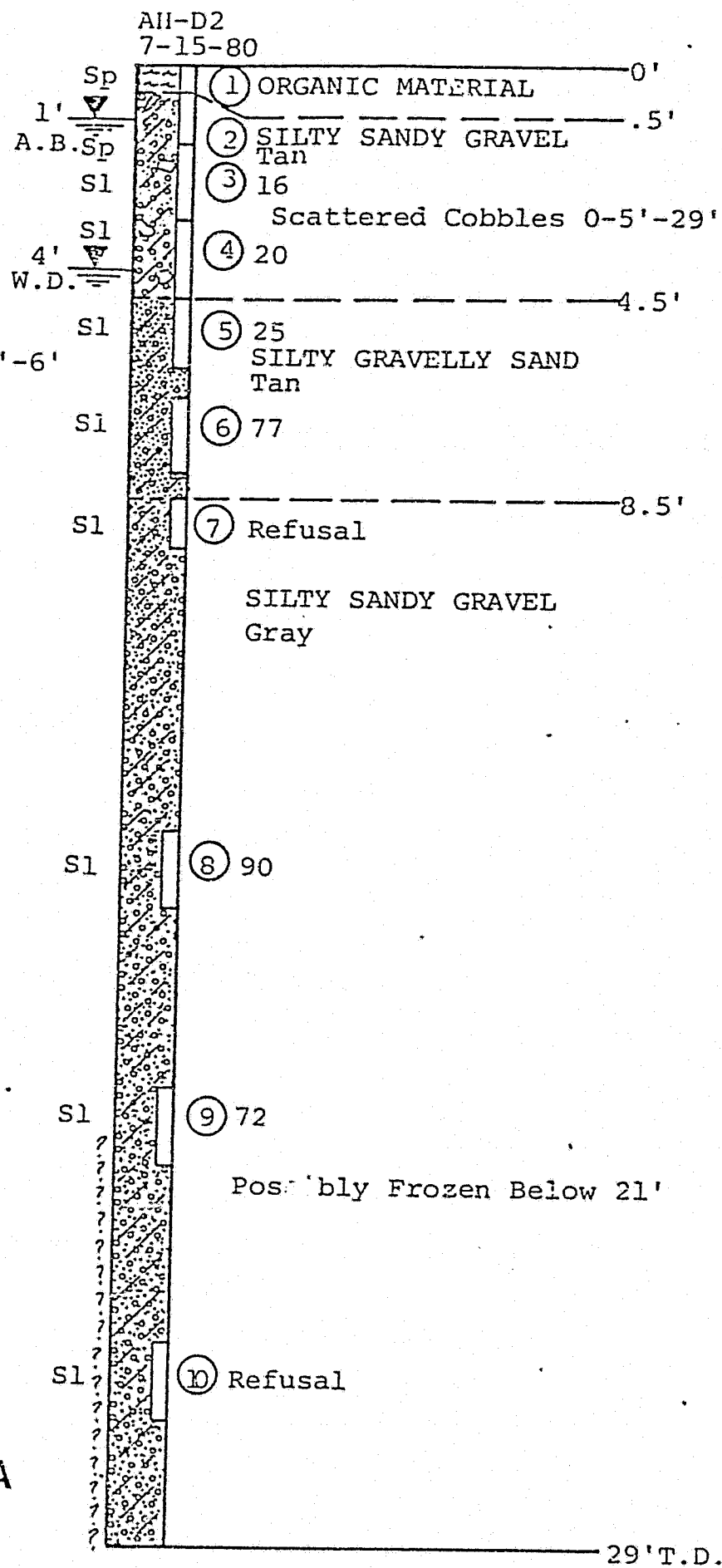
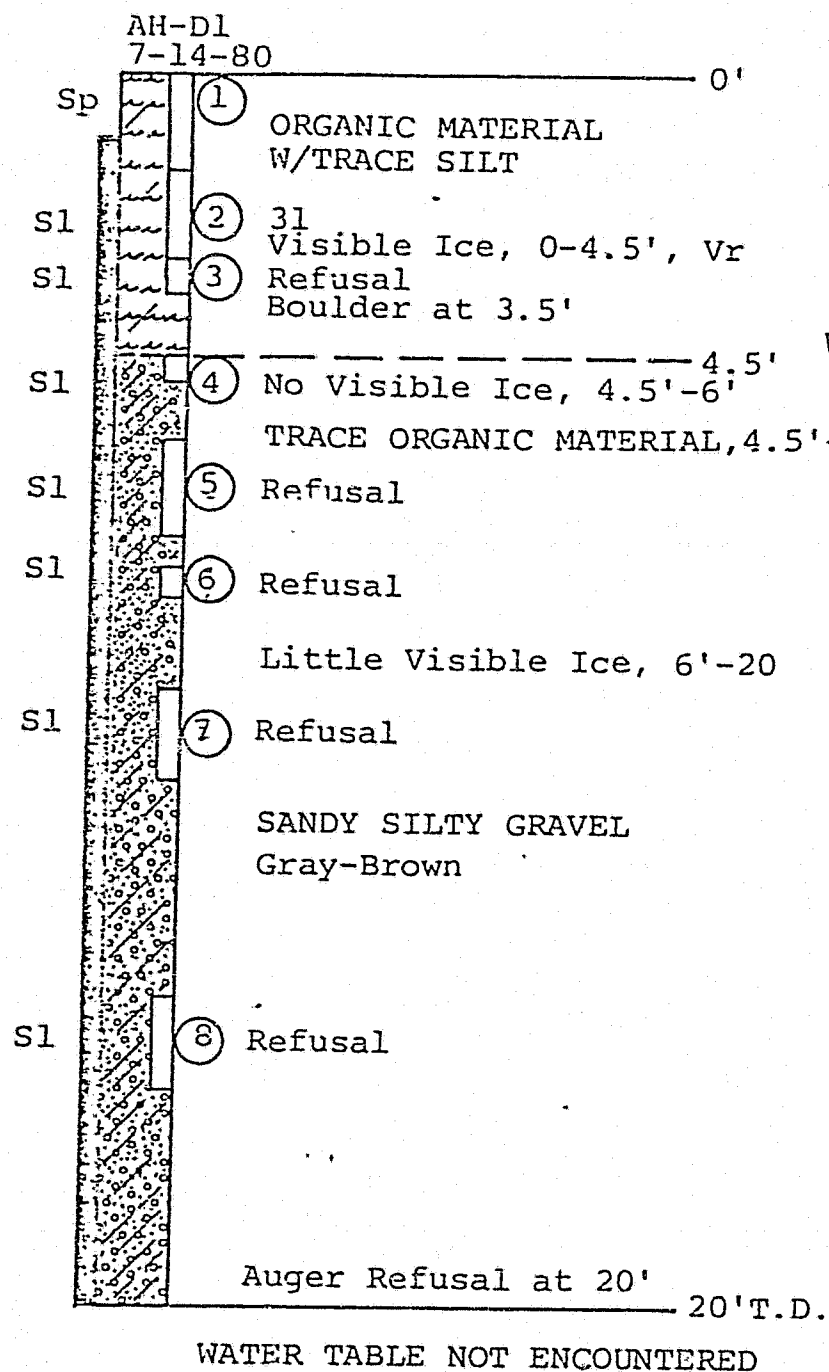
OWN L.A.B.
 CKD. E.J.H.
 DATE 10-8-80
 SCALE N.T.S.

RSM
 RSM CONSULTANTS, INC.
 ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

WATANA AIRFIELD
 TYPICAL SECTION
 EXHIBIT 5

FB.
 GRID.
 PROJ. NO. 002108
 DWG. NO.





PRELIMINARY

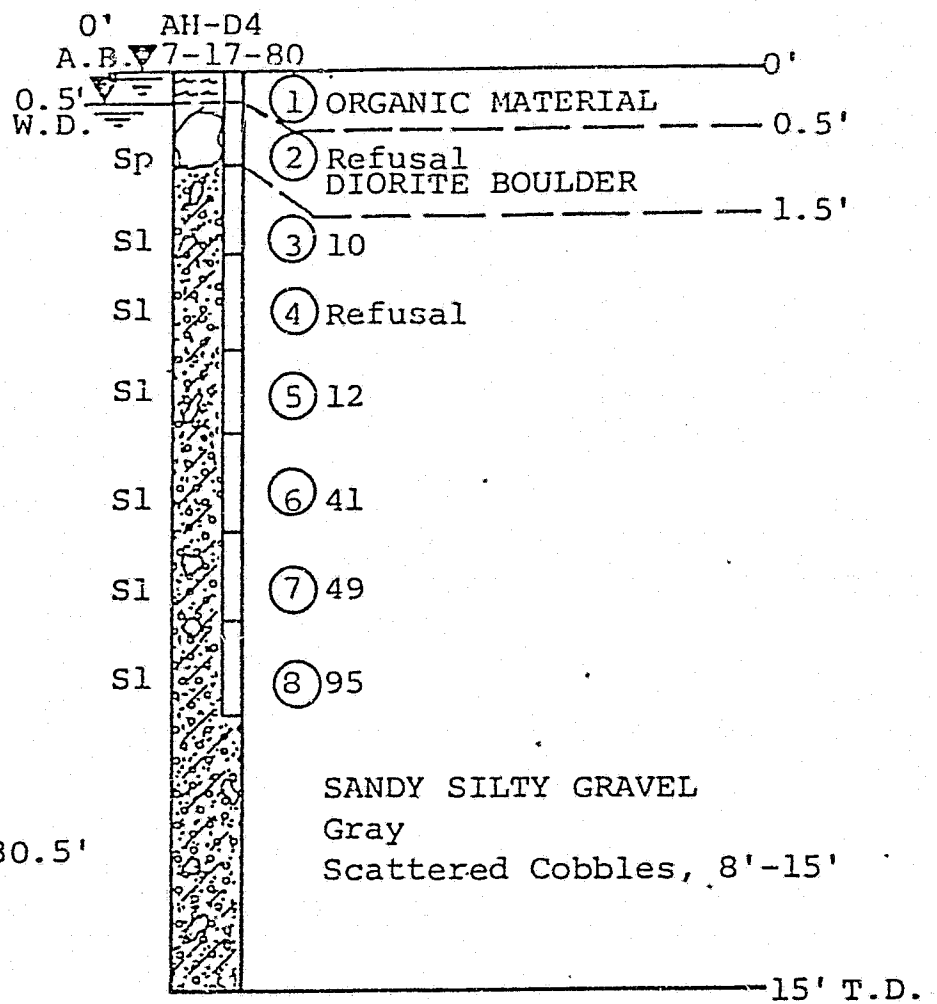
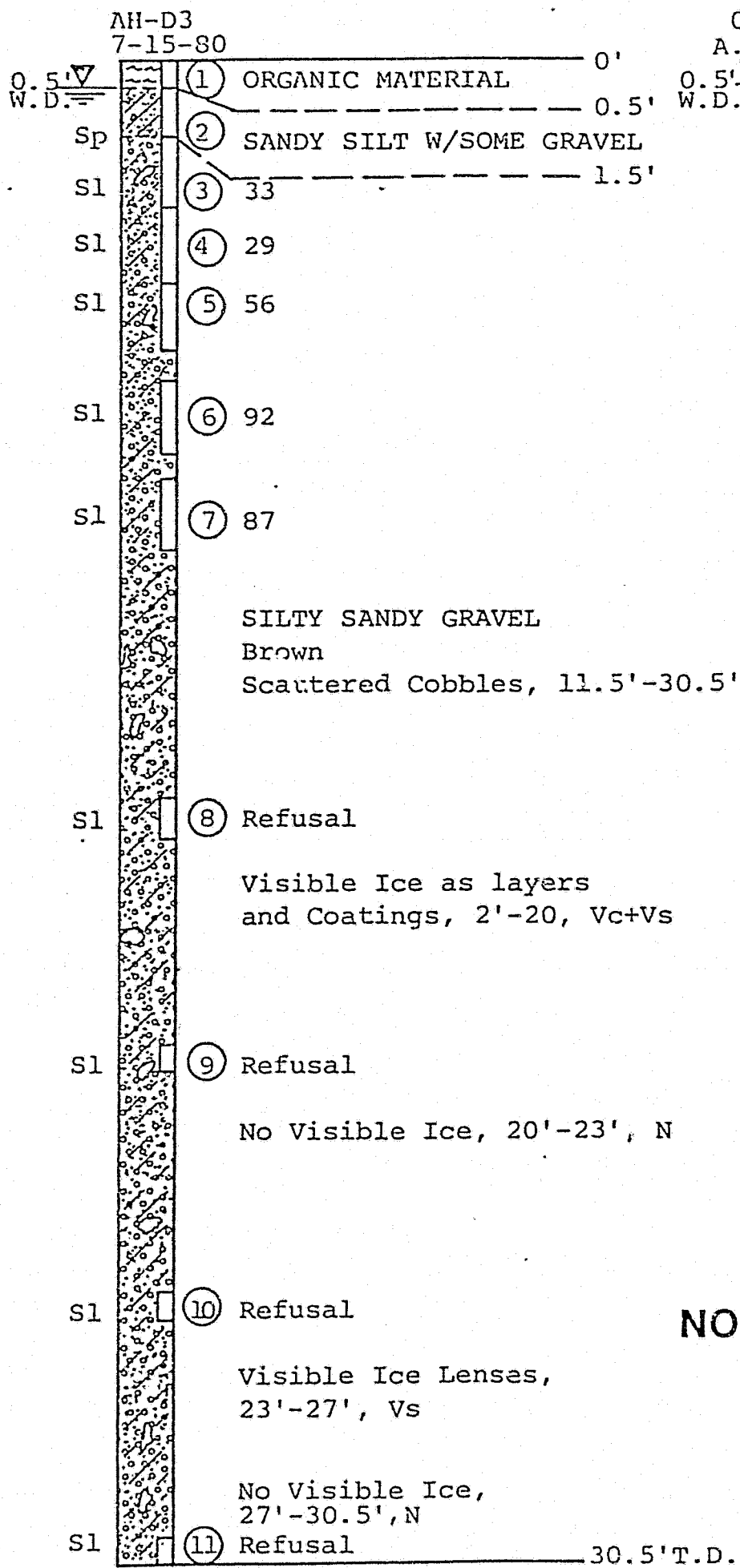
NOT CORRECTED WITH LAB DATA

DWN.
CKD.
DATE. Aug. 80
SCALE. 1' = 4'

R&M
R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

SUSITNA RIVER
HYDROELECTRIC PROJECT
GEOTECHNICAL INVESTIGATIONS
EXHIBIT 60

FR.
GRID.
PROJ. NO. 052504
DWG. NO.



PRELIMINARY

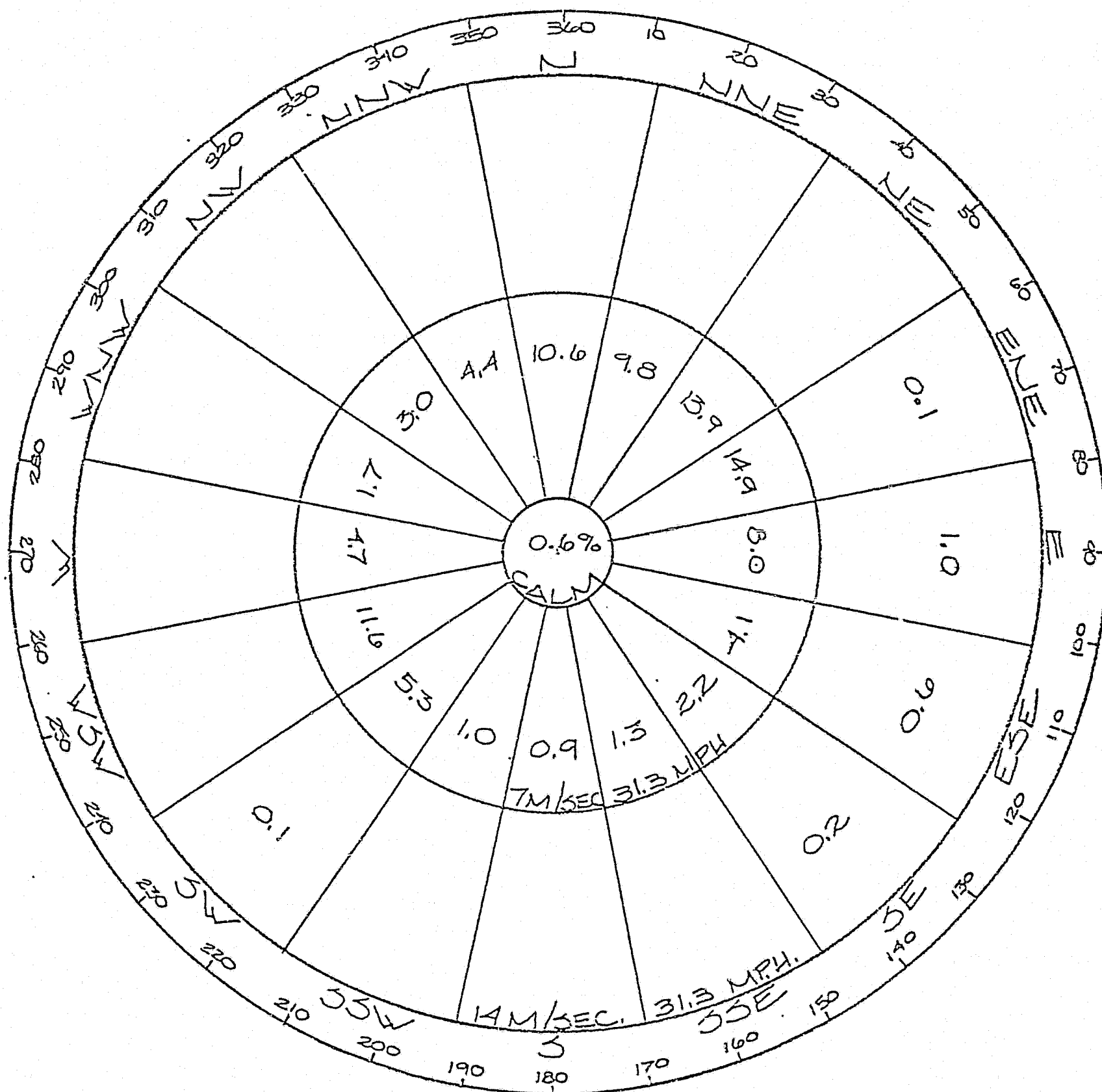
NOT CORRECTED WITH LAB DATA

DWN.
 CKD.
 DATE. Aug. 80
 SCALE 1'=4'

R&M
R&M CONSULTANTS, INC.
 ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

SUSITNA RIVER
 HYDROELECTRIC PROJECT
 GEOTECHNICAL INVESTIGATIONS
 EXHIBIT 7

FB.
 GRID.
 PROJ. NO 052504
 DWG. NO



NOTES

1. OBSERVATIONS ARE 30-MIN. AVERAGES, RECORDED ON THE HOUR.
2. PERIOD OF RECORD = APRIL 8 - MAY 29, 1980.
3. MAX. 15-SEC. GUST RECORDED = 16.5 M/SEC. (36.9 MPH.) - 5/18/80 (FROM EAST).
4. COMPASS BEARINGS GIVEN ARE DEGREES TRUE.

DWN. L.A.E.
CKD. R.J.H.
DATE 10-8-80
SCALE N.T.S.

R&M
R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

WATANA AIRSTRIP
WIND ROSE
EXHIBIT 8

FB.
GRID.
PROJ. NO. 052203
DWG. NO.

APPENDIX B

**HARZA—EBASCO WATANA
SOILS BORING LOGS**

APRIL 6-8, 1983

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 4/6/83

Boring No A S-1 Angle (from Horizontal) 90° Ground Elevation 2266
Feature AIRSTRIP & 31400 Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started 4/6/83 Total Depth 4.0
E _____ Date Completed 4/6/83 Ground-Water Elevation _____
Logged by BEH/DHR

Boring No. _____ Sheet _____ of _____

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

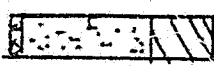
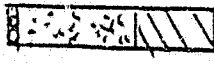
SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No AS-3
Feature AIRSTrip @ 36+00
Coordinates: N
E
Logged by REH / DMR

Angle (from Horizontal) 90°
Bearing
Date Started 4/6/83
Date Completed 4/6/83

Ground Elevation 2267.0
Rock Elevation
Total Depth 9.5
Ground-Water Elevation

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT		
2							SILTY ORGANIC PEAT TRACE OF GRAVEL ICE 20%		
3			1				BROWN GRAVELLY SILTY SAND (MOIST)		
4			2				BROWN SANDY SPT		MOISTURE CONTENT 25.7%
5									
6			3				BROWNISH GRAY SILTY SAND (F-C) (DAMP)		
7									
8									HARD DRILLING
9			4				GRAY SILTY FINE SAND		
10									

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No. AS-5 Angle (from Horizontal) 90 Ground Elevation _____
Feature AIRSTRIPE 75' NORTH Bearing _____ Rock Elevation _____
Coordinates: N OF STA 35+00 Date Started 4/6/83 Total Depth 10.0
E Date Completed 4/6/83 Ground-Water Elevation _____
Logged by REH / DNR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							BROWN PEAT		
2									
3							PERMAFROST ICE & PEAT CLEAR & WHITE ICE		75% ICE
4			1				PEAT & ICE		40% ICE
5							PEAT WITH ICE PT, UR		35% ICE
6			2				GRAY SILTY FINE SAND MOIST		44.5% FINES
7									
8									
9			3				GRAY SILTY (F-C) SAND MOIST		
10									

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 4/6/83

Boring No. AS-6 Angle (from Horizontal) 90° Ground Elevation _____
 Feature AIRSTrip 75' NORTH Bearing _____ Rock Elevation _____
 Coordinates: N OF STA 34+00 Date Started 4/6/83 Total Depth 1.0
 E _____ Date Completed 4/6/83 Ground-Water Elevation _____
 Logged by RFH / DMR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							PEAT REFUSAL ON AUGER @ 1.0		

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No AS 7
Feature AIRSTRIPE 237100
Coordinates: N
E
Logged by REH/DNR

Angle (from Horizontal) 90°
Bearing
Date Started 4/6/83
Date Completed 4/6/83
Ground Elevation
Rock Elevation
Total Depth 10.0
Ground-Water Elevation

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							BROWN PEAT (FROZEN)		
2									
3			1				GRAY SILTY SAND TR OF GRAVEL		
4									
5									TOOK 50# BAB FOR PROCTOR TEST 128 PCF 7% OMC
6									
7									
8									
9									
10			2				SAME		12.7% MC

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 4/6/83

Boring No. AS 8 Angle (from Horizontal) 90 Ground Elevation _____
Feature ARISTIP 75' NORTH Bearing _____ Rock Elevation _____
Coordinates: N OF 2 @ 37:00 Date Started 4/6/83 Total Depth 0.8
E _____ Date Completed 4/6/83 Ground-Water Elevation _____
Logged by REH/DNR

[illegible]

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No. AS-9
Feature AIRSTRIPE #38100
Coordinates: N
 E
Logged by BEH / DMR

Angle (from Horizontal) 90
Bearing
Date Started 4/6/83
Date Completed 4/6/83

Ground Elevation
Rock Elevation
Total Depth 8.5
Ground-Water Elevation

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							BROWN PEAT		
2							BROWN SILTY SAND (F-C) TR OF FINE GRAVEL DAMP		
3									
4							MORE GRAVEL		TOOK 50 th SAMPLE 3.0-8.5 PROCTOR TEST RESULTS 133 PCF 8% OMC
5									
6									
7									
8									
9									
10									

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 4/6/83

Boring No AS 10 Angle (from Horizontal) 90° Ground Elevation _____
 Feature AIRSTRIPE & 39100 Bearing _____ Rock Elevation _____
 Coordinates: N _____ Date Started 4/6/83 Total Depth 4.5
 E _____ Date Completed 4/6/83 Ground-Water Elevation _____
 Logged by REH / DMR

[illegible]

Boring No. _____ Sheet _____ of _____

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 4/6/83

Boring No AS 11 Angle (from Horizontal) 90 Ground Elevation _____
Feature AIRSTrip @ 40+00 Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started 4/6/83 Total Depth 1.0
E _____ Date Completed 4/6/83 Ground-Water Elevation _____
Logged by REA / DMR

[illegible]

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 4/6/83

Boring No. AS 12 Angle (from Horizontal) 90 Ground Elevation _____
 Feature AIRSTRIP @ 4100 Bearing _____ Rock Elevation _____
 Coordinates: N _____ Date Started 4/6/83 Total Depth _____
 E _____ Date Completed 4/6/83 Ground-Water Elevation _____
 Logged by REH/DMR

[illegible]

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 2
Date 4/6/83

Boring No AS 13
Feature AIRSTrip @ 42+00
Coordinates: N
E
Logged by REH/DMR

Angle (from Horizontal) 90°
Bearing
Date Started 4/6/83
Date Completed 4/6/83

Ground Elevation
Rock Elevation
Total Depth 17.5
Ground-Water Elevation 3.5

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT WITH ICE LENSES		
2									
3									
4							PEAT UNFROZEN		
5									
6			1				GRAY SANDY SILT SAT.		
7									
8			2				GRAY SANDY SILT SAT		MOISTURE CONTENT 22%
9									
10									

000373

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 2 of 2
Date 4/6/83

Boring No AS 13
Feature AIRSTrip @ 42+00
Coordinates: N E
Logged by REH/DNR

Angle (from Horizontal) _____
Bearing _____
Ground Elevation _____
Rock Elevation _____
Date Started 4/6/83
Total Depth 17.5
Date Completed 4/6/83
Ground-Water Elevation 9.5

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
11									
12									
13									
14			3				GRAY SILTY SAND TR OF GRAVEL SAT		
15									
16			4				GRAY SILTY SAND TR OF GRAVEL FIRMER		
17									
18									
19									
20									

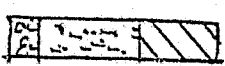
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HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 2
Date 4/7/83

Boring No AS 14 Angle (from Horizontal) 90° Ground Elevation _____
Feature AIRSTRIIP 75' NORTH Bearing _____ Rock Elevation _____
Coordinates: N OF Q 42+00 Date Started 4/7/83 Total Depth 15
E _____ Date Completed 4/7/83 Ground-Water Elevation 7.0
Logged by REH/DNR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							ICE & PEAT		
2									
3									
4							PEAT (FROZEN)		
5									
6							PEAT UNFROZEN		
7									
8									
9							GRAY SILTY SAND TR OF GRAVEL		
10									

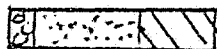
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HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 2 of 2
Date 4/7/83

Boring No. AS 14 Angle (from Horizontal) 90° Ground Elevation _____
Feature AIRSTRIPE 75' NORTH Bearing _____ Rock Elevation _____
Coordinates: N CF 2 42KD Date Started 4/7/83 Total Depth 15 0
E _____ Date Completed 4/7/83 Ground-Water Elevation 70
Logged by REA / DMR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
11							GRAY SILTY SAND TR OF FINE GRAVEL		
12			3						
13									
14			4				GRAY SILTY FINE SAND TR OF FINE GRAVEL FORMER		
15									
16									
17									
18									
19									
20									

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 16 Angle (from Horizontal) 90° Ground Elevation _____
Feature AIRSTRIPE @ 4400 Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started 4/7/83 Total Depth 8.5
E _____ Date Completed 4/7/83 Ground-Water Elevation _____
Logged by REH/DNR

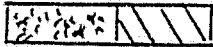
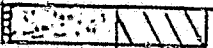
Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT		
2							FROZEN UNFROZEN		
3							PEAT		
4									
5									
6			1				GRAY GRAVELLY SILTY SAND		
7									
8			2				GRAY GRAVELLY SILTY SAND		
9									
10									

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No. AS 17 Angle (from Horizontal) 90° Ground Elevation _____
Feature AIRSTRIIP 75' SOUTH Bearing _____ Rock Elevation _____
Coordinates: N OF E 44°W Date Started 4/7/83 Total Depth 10.0
E _____ Date Completed 4/7/83 Ground-Water Elevation _____
Logged by REH / DNR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT		
2									
3									
4							FROZEN UNFROZEN PEAT		
5									
6			1				GRAY SILTY SANDY		 PI = 2.0 PL = 16 LL = 18 7.7% CLAY
7									
8			2				GRAY SILTY SAND MINOR TRACE OF GRAVEL		 PI = 3.7 LL = 20.75 PL = 17.05
9									
10									

Boring No. _____ Sheet _____ of _____

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No. AS 18 Angle (from Horizontal) 90° Ground Elevation _____
Feature AIRSTrip 75' NORTH Bearing _____ Rock Elevation _____
Coordinates: N CE 2 44+00 Date Started 4/7/83 Total Depth 70
E _____ Date Completed 4/7/83 Ground-Water Elevation 30
Logged by BEH/ DMR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT & ICE		
2							PEAT FROZEN		
3									
4							PEAT UNFROZEN		
5									
6			1				GRAY SILTY SAND NON-PLASTIC		
7									
8									
9									
10									

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No. A5 19
Feature AIRSTR. P. & 4670
Coordinates: N E
Logged by REA/DNR

Angle (from Horizontal) 90
Bearing _____
Date Started 4/7/83
Date Completed 4/7/83

Ground Elevation _____
Rock Elevation _____
Total Depth 7.5
Ground-Water Elevation _____

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1									
2							PEAT (FROZEN)		
3									
4									
5			1				GRAY SILTY SAND TR OF GRAVEL		
6			2				GRAY SILTY SAND TR OF GRAVEL		
7									mc. 115%
8									
9									
10									

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 21
Feature AIRSTrip @ 50+00
Coordinates: N _____
E _____
Logged by DEH / DMR

Angle (from Horizontal) 90
Bearing _____
Date Started 4/17/83
Date Completed 4/17/83

Ground Elevation _____
Rock Elevation _____
Total Depth 4.0 _____
Ground-Water Elevation _____

Logged by DEH / DMR

[illegible]

Boring No. _____ Sheet _____ of _____

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 4/7/83

Boring No. AS 22 Angle (from Horizontal) 90 Ground Elevation _____
Feature AIRSTRIPE 52+00 Bearing _____ Rock Elevation _____
Coordinates: N Date Started 4/7/83 Total Depth 1.0
E Date Completed 4/7/83 Ground-Water Elevation _____
Logged by REH / JNR

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

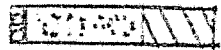
SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 23
Feature AIRSTrip Q 33102
Coordinates: N E
Logged by REH / DNR

Angle (from Horizontal) 90
Bearing _____
Date Started 4/7/83
Date Completed 4/7/83

Ground Elevation _____
Rock Elevation _____
Total Depth 7.5
Ground-Water Elevation _____

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT		
2			1				BROWN SILTY SAND (F-C)		
3									
4			2				BROWN GRAVELLY SILTY SAND		
5									50# SAMPLE FOR PROCTOR TEST
6									129 PCF 8% CMC
7							SAME		
8									

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No. AS 24 Angle (from Horizontal) 90 Ground Elevation _____
Feature AIRSTRIPE & 33100 Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started 4/7/83 Total Depth 1.5
E _____ Date Completed 4/7/83 Ground-Water Elevation _____
Logged by REH/DNR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1 2 3 4 5 6			1				BROWN SILTY SAND (F-C) LITTLE FINE GRAVEL SAME		 MC 13.5 COMBINED SOIL FROM 33100 & 32100 FOR PROCTOR

Boring No. _____ Sheet _____ of _____

Boring No. _____ Sheet _____ of _____

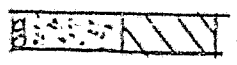
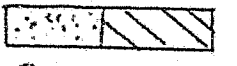
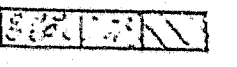
HARZA-EBASCO

SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No. AS 26 Angle (from Horizontal) 90 Ground Elevation _____
Feature AIRSTrip & 30x100 Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started 4/7/83 Total Depth 9.0
E _____ Date Completed 4/7/83 Ground-Water Elevation _____
Logged by REH/ DNR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1									
2			1				GRAY SILTY SAND TRACE OF FINE GRAVEL		 MC 26.4%
3			2				SANDY SILT		 G _s = 2.75 FROM HYDROMETER ANALYSIS 6.8% CLAY
4									
5									
6			3				GRAY SILTY SAND (F-M) TR OF COARSE SAND		
7									
8			4				GRAY SILTY SAND		 NOTE SMALL SAMPLE WITH ONE 1 1/2" ϕ PIECE OF GRAVEL
9									
10									

Boring No. _____ Sheet _____ of _____

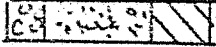
000373

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 27 Angle (from Horizontal) 90 Ground Elevation _____
Feature AIRSTRIP & 28100 Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started 4/7/83 Total Depth 7.5
E _____ Date Completed 4/7/83 Ground-Water Elevation _____
Logged by REH/DNR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							ORGANIC MAT		
2									
3									
4			1				BROWN SILTY FINE SAND LITTLE FINE GRAVEL		
5									
6			2				BROWN SILTY FINE SAND LITTLE FINE GRAVEL (NOTE MORE GRAVEL THAN SAMPLE 1)		
7									
8									
9									
10									

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

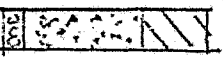
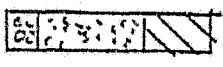
SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 28
Feature AIRSTRIPE & 27WD
Coordinates: N E
Logged by REN/ DNR

Angle (from Horizontal) 90
Bearing _____
Date Started 4/7/83
Date Completed 4/7/83

Ground Elevation _____
Rock Elevation _____
Total Depth 10.5
Ground-Water Elevation _____

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							ORGANIC MAT		
2			1				BROWN GRAVELLY SILTY SAND		
3							BROWN GRAVELLY SILTY SAND		
4			2						
5									BAG SAMPLE FOR PROCTOR TEST 4-10.5
6									
7							SAME		
8									
9									
10			3				GRAY GRAVELLY SILTY SAND		

Boring No. _____ Sheet _____ of _____

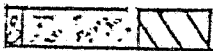
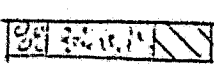
000373

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No. AS 29 Angle (from Horizontal) 90 Ground Elevation _____
Feature AIRSTrip & 26100 Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started 4/7/83 Total Depth 7.5
E _____ Date Completed 4/7/83 Ground-Water Elevation _____
Logged by REH / DMR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1									
2			1				GRAY GRAVELLY SILTY SAND		
3									
4			2				SAME		
5									
6			3				SAME WITH MORE GRAVEL		
7									
8									
9									
10									

Boring No. _____ Sheet _____ of _____

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No. AS 30 Angle (from Horizontal) 90 Ground Elevation _____
 Feature _____ Bearing _____ Rock Elevation _____
 Coordinates: N _____ Date Started 4/7/83 Total Depth 50
 E _____ Date Completed 4/7/83 Ground-Water Elevation _____
 Logged by _____

Logged by

[illegible]

Boring No. _____ Sheet _____ of _____

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 31
Feature AIRSTRIPE 24100
Coordinates: N
 E
Logged by REH/DNR

Angle (from Horizontal) 90°

Ground Elevation _____

Feature AIRSTRIPE @ 24x100

Bearing _____

Rock Elevation _____

Coordinates: N _____

Date Started 4/7/93

Total Depth 30

E _____

Date Completed 4/7/93

Ground-Water Elevation

Logged by REH/DNR

Date Completed 4/7/93

Ground-Water Elevation

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1									
2			1				BROWN GRAVELLY SILTY SAND (FROZEN)		
3			2				SAME BUT MOIST		mc 16.8%
4							REFUSAL ON AUGER @ 3.0		

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO

SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No. AS-32 Angle (from Horizontal) 90 Ground Elevation _____
Feature 4.25' R.P. @ 23'00 Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started 4/7/83 Total Depth 2.0
E _____ Date Completed 4/7/83 Ground-Water Elevation _____
Logged by REH/DMR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT DARK BROWN		1 ST ATTEMPT REFUSAL @ 0.5'
2			1				BROWN ORGANIC SAND		2 ND ATTEMPT REFUSAL @ 1.0
3							REFUSAL ON AUGER 2.0		3 RD ATTEMPT REFUSAL @ 2.0
4									ORGANIC CONTENT 6.4%

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 33
Feature Airstrip @ 22100
Coordinates: N
E
Logged by REH/DNR

Angle (from Horizontal) 90
Bearing
Date Started 4/7/83
Date Completed 4/7/83
Ground Elevation
Rock Elevation
Total Depth 5.0
Ground-Water Elevation

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1			1				OLIVE GRAY SILTY SAND (F-C)		
2							TR OF FINE GRAVEL (FROZEN)		MC 17.3%
3									
4			2				SAME WITH A LITTLE MORE SILT		 MC 12.3%
5									
6									

Boring No. Sheet of

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 7/7/83

Ground Elevation _____

Bearing _____

Rock Elevation _____

Date Started 7/7/83

Total Depth 2.0

Date Completed 4/7/83

Ground-Water Elevation_____

Drawing No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 35

Angle (from Horizontal) 90

Ground Elevation _____

Feature AIRSTRIPE 220100

Bearing _____

Rock Elevation _____

Coordinates: N _____

Date Started 4/7/83

Total Depth 6.0

E _____

Date Completed 4/7/83

Ground-Water Elevation _____

Logged by _____

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1			1				LIGHT BROWN GRAVELLY SILTY SAND (F+M) TR OF COARSE SAND		
2									 MOISTURE CONTENT 10.6%
3									
4									BAG SAMPLE FOR PROCTOR TEST 20-6.0 131 PCF 8% OMC
5									
6									
7									

Boring No. _____ Sheet _____ of _____

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[illegible]

Ground Elevation _____
Rock Elevation _____
Total Depth 5.0 _____
Ground-Water Elevation _____

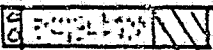
Date Completed 4/7/83

[illegible]

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 37 Angle (from Horizontal) 90 Ground Elevation _____
Feature AIRSTRIPE @ 77100 Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started 4/8/83 Total Depth 7.0
E _____ Date Completed 4/8/83 Ground-Water Elevation _____
Logged by REA/DMR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1									1 ST ATTEMPT REFUSAL @ 1.0
2			1				REDDISH BROWN FINE GRAVELLY SILTY SAND (F-C)		
3									
4			2				GRAY SILTY FINE SAND TR OF COARSE SAND + FINE GRAVEL		37% FINES
5									
6			3				GRAY GRAVELLY SILTY SAND (F-C)		
7									
8									
9									
10									

000373

[illegible]

Sheet 1 of 1
Date 4/8/93

Logged by REH/DNR

Date Completed 2/10/63

[illegible]

Boring No. _____ Sheet _____ of _____

Boring No. _____ Sheet _____ of _____

Boring No. _____ Sheet _____ of _____

Boring No. _____ Sheet _____ of _____

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 4/8/83

Boring No. AS 42 Angle (from Horizontal) 90 Ground Elevation _____
 Feature AIRSTRIPE @ 10'00 Bearing _____ Rock Elevation _____
 Coordinates: N _____ Date Started 4/8/83 Total Depth 50
 E _____ Date Completed 4/8/83 Ground-Water Elevation _____
 Logged by REH / DMR

Boring No. _____ Sheet _____ of _____

SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 7/8/83

Boring No AS 43

Angle (from Horizontal) 90

Ground Elevation _____

Feature Airstrip @ 8+00

Bearing

Rock Elevation _____

Coordinates: N

Date Started 7/8/83

Total Depth 2.0

Date Completed 7/8/83

Ground-Water Elevation_____

Logged by REH, DNR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1			1				PEAT (FROZEN) DARK BROWN		1 ST ATTEMPT REFUSAL @ 0.75'
2							BROWN GRAVELLY SILTY SAND (F.C.)		2 ND ATTEMPT REFUSAL @ .75'
3							REFUSAL ON AUGER @ 2.0		MC = 19.8%
4							AREA HAS MANY BOULDERS BELOW SURFACE		

Boring No. _____ Sheet _____ of _____

Boring No. _____ Sheet _____ of _____

Boring No. _____ Sheet _____ of _____

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 4/3/83

Boring No. A3 46 Angle (from Horizontal) 90 Ground Elevation _____
Feature AIRSTRIPE @ 0+00 Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started 4/8/83 Total Depth 2.25
E _____ Date Completed 4/8/83 Ground-Water Elevation _____
Logged by REH / DMR

[illegible]

Boring No. _____ Sheet _____ of _____

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 4/8/83

Ground Elevation _____

Rock Elevation _____

Total Depth 35

Ground-Water Elevation_____

[illegible]

Sheet 1 of 1
Date 4/8/83

Boring No AS 48
Feature AIRSTRIPE 100' SOUTH
Coordinates: N OF E 3910D
E
Logged by REH / DMR

Angle (from Horizontal) 90 Ground Elevation _____
Bearing _____ Rock Elevation _____
Date Started 4/8/83 Total Depth 3.5
Date Completed 4/8/83 Ground-Water Elevation _____

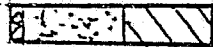
[illegible]

Boring No. _____ Sheet _____ of _____

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 49 Angle (from Horizontal) 90 Ground Elevation _____
Feature AIRSTRIPE 48100 Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started 4/8/83 Total Depth 7.5
E _____ Date Completed 4/8/83 Ground-Water Elevation _____
Logged by REH/DMR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT		
2									
3			1				GRAY SILTY SAND TR OF FINE GRAVEL		 MC 37.6
4									
5									
6			2				GRAY SILTY FINE SAND TR OF COARSE SAND		Gs = 2.72 MC 13.4%
7									 HYDRO. AMB. 9% CLAY
8									PI = 4.75 LL = 20.1 PL = 15.85
9									
10									

Sheet 1 of 1
Date 4/8/83

Boring No AS50
Feature AIRSTrip & 50'OD
Coordinates: N _____
E _____
Logged by REH / DMR

Angle (from Horizontal) 90
Bearing _____
Date Started 4/8/83
Date Completed 4/8/83

Ground Elevation _____
Rock Elevation _____
Total Depth 2.5 _____
Ground-Water Elevation _____

Logged by REH / DMR

[illegible]

Boring No. _____ Sheet _____ of _____

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 4/8/83

Ground Elevation _____
Rock Elevation _____
Total Depth 5.0
Ground-Water Elevation _____

Logged by REH / DMR

Boring No. _____ Sheet _____ of _____

SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 52 Angle (from Horizontal) 90 Ground Elevation _____
Feature AIRSTRIP @ 54100 Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started 4/8/83 Total Depth 5.5
E _____ Date Completed 4/8/83 Ground-Water Elevation _____
Logged by REH/DNR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT		
2			1				OLIVE GRAY SILTY FINE SAND MINOR TR OF COARSE SAND & FINE GRAVEL		46.0% FINES
3							SAME		BAG SAMPLE FOR PROCTOR 2.5-5.0
4									NOTE ON R ^{NO} 23 RD
5									ATTEMPTS REFUSAL @ 1.0
6									MANY BOULDERS AT OR NEAR -
7							REFUSAL ON AUGER @ 5.5		SURFACE

Boring No. _____ Sheet _____ of _____

000373

Sheet 1 of 1
Date 4/8/83

Boring No. AS 53
Feature AIRSTRIPE # 56106
Coordinates: N _____
E _____
Logged by DEH / DNR

Angle (from Horizontal) 90
Bearing _____
Date Started 4/8/83
Date Completed 7/8/83

Ground Elevation _____
Rock Elevation _____
Total Depth 1.5
Ground-Water Elevation _____

[illegible]

Boring No. _____ Sheet _____ of _____

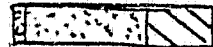
HARZA-EBASCO

SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/9/83

Boring No. A554 Angle (from Horizontal) 90 Ground Elevation _____
Feature AIRSTRIPE # 2100 Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started 4/9/83 Total Depth 9.0
E _____ Date Completed 4/9/83 Ground-Water Elevation _____
Logged by REA/DNR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT		1 ST ATTEMPT REFUSAL @ .5'
2			1				GRAY SILTY SAND (F-C) TR OF GRAVEL		 MC 13%
3									BAG SAMPLE FOR PROCTOR 2.0-8.0
4									HARD DRILLING @ 2, 3.5, 7.0 & 9.0
5									
6									
7									THERE APPEAR TO BE MORE GRAVEL, THAN WHAT WAS COMING UP ON THE AUGER.
8									
9			2				GRAY SILTY SAND TR OF GRAVEL		MC 5.6% 
10									

HARZA-EBASCO

SUSITNA JOINT VENTURE

SOIL BORING LOGSheet 1 of 1
Date 4/8/83Boring No A555Angle (from Horizontal) 90

Ground Elevation _____

Feature AIRSTEIR 212100

Bearing _____

Rock Elevation _____

Coordinates: N _____

Date Started 4/8/83Total Depth 7.0

E _____

Date Completed 4/9/83

Ground-Water Elevation _____

Logged by REH/DNR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT		1ST ATTEMPT REFUSAL @ 1.0
2							LIGHT GRAY GRAVELLY (FINE) SILTY SAND (FC)		BAB SAMPLE FOR PROCTOR
3									131 PCF 9% CMC
4									HARD DRILLING 4.5, 5.0, 6.0 & 7.0'
5							MORE GRAVEL		
6									
7									REFUSAL ON ROGER AT 7.0
8									

Boring No. _____ Sheet _____ of _____

MAN CAMP BORING

LOGS

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No. MC 1 Angle (from Horizontal) 90 Ground Elevation _____
Feature NEW MAN CAMP Bearing _____ Rock Elevation _____
Coordinates: N _____ Date Started 4/8/83 Total Depth 8.5
E _____ Date Completed 4/8/83 Ground-Water Elevation _____
Logged by REA/DNR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1			1				ORGANIC SILT BROWN FROZEN		mc WH 80 HR 50 X 50
2							BROWN SANDY ORGANIC MAT (FROZEN)		1 ST ATTEMPT
3			2				GRAY SILTY SAND (F-C) (FROZEN) MC 22.7		REFUSAL @ 2.5 ON AUGER
			3				SILTY FINE-MED SAND MC 20.8		
4							REFUSAL @ 3.5		
							NOTE MANY BOULDERS AT OR NEAR SURFACE		

Boring No MC 2
Feature NEW MAN CAMP
Coordinates: N _____
E _____
Logged by REH / DMR

Angle (from Horizontal) 90
Bearing _____
Date Started 4/8/83
Date Completed 4/8/83

Ground Elevation _____
Rock Elevation _____
Total Depth 2.5
Ground-Water Elevation _____

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT & ICE		
2							FROZEN SILTY FINE SAND		
3			1				FROZEN SALTY SAND (E-M)		FUEL STORAGE HP 30 20 HP 80'

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 4/8/83

Ground Elevation _____

Rock Elevation _____

Total Depth 3.5

Ground-Water Elevation _____

Ground-Water Elevation _____

Boring No. _____ Sheet _____ of _____

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 7/8/83

Ground Elevation _____

Rock Elevation _____

Total Depth 2.5

Ground-Water Elevation_____

Boring No. _____ Sheet _____ of _____

SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 4/8/83

Ground Elevation _____

Rock Elevation _____

Total Depth 2.75

Ground-Water Elevation_____

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT		
2			1				GRAY SILTY SAND (F-C) (FROZEN)		Ex MR.
3			2				GRAY SILTY SAND (F-C) TR OF GRAVEL (FROZEN)		250 X
4							ADGER REFUSAL @ 2.75		

Boring No. _____ Sheet _____ of _____

SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No MC 7
Feature NEW MAN CAMP
Coordinates: N _____
E _____
Logged by REH/DNR

Angle (from Horizontal) 90
Bearing _____
Date Started 4/8/83
Date Completed 4/8/83

Ground Elevation _____
Rock Elevation _____
Total Depth 1.5
Ground-Water Elevation _____

Logged by REN/DNR

[illegible]

Boring No. _____ Sheet _____ of _____

Sheet 1 of 1
Date 4/8/83

Boring No. _____ Sheet _____ of _____

Boring No. _____ Sheet _____ of _____

Appendix C

Laboratory Test Results -- April 1983

This sheet is provided by Alaska Resources Library and Information Services.
Appendix C lacks a chapter page. It is assumed that it fits in this location.

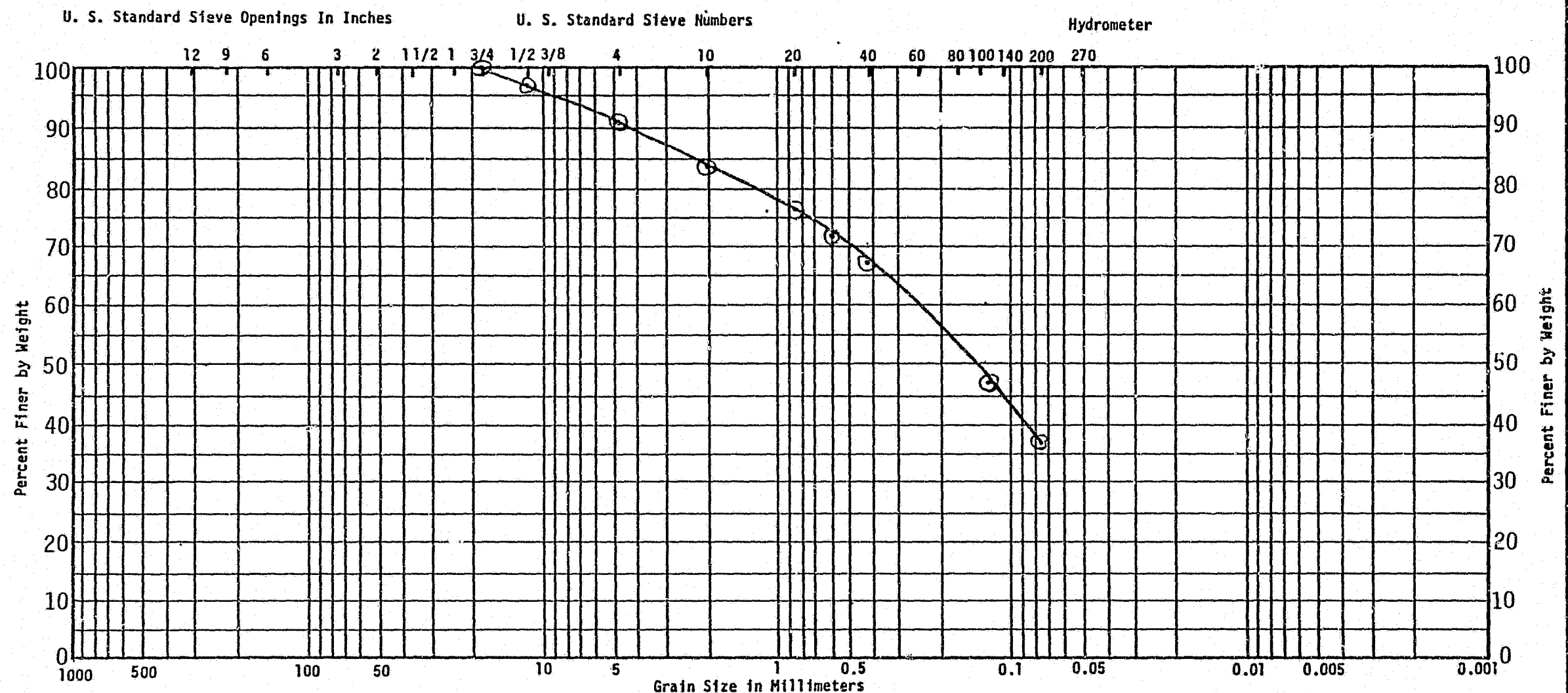
Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08		
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER			
Project WATANA DAM				Hole AS 1		Depth 3-4 #3			
Air Dry WT Total Sample & Tare		1492		TOTAL SAMPLE					
Tare Weight K		431.0		Classification Dark greyish Brown gravelly silty sand (SM)					
Total Sample WT		1061.0		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	
Moisture Content -10 Material		4"		101.6					
		3"		76.2					
		2"		50.8					
Can No.		1 1/2"		38.1					
WT-Soil & Can (Wet)		1"		25.4					
WT-Soil & Can (Dry)		3/4"		19.1		0		100	
Loss		1/2"		12.7		34.0		3.2	
Weight of Can		#4		4.6		100.0		9.4	
WT of Soil (Dry)		#10		2.0				96.8	
% Moisture		Pan						90.6	
		Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample _____ grams				Jar # _____		WT Washed Sample & Tare 1116.0			
						Tare Weight 431.0			
						Washed Sample Weight 687.0			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing		
10	2.000	168.0				15.8	84.2	53.9	
20	0.850	253.0				23.8	76.2		
30	0.600	299.0				28.2	71.8		
40	0.425	348.0				32.8	67.2		
100	0.150	564.0				53.2	46.8	36.7	
200	0.075	672.0				63.3	36.7		
270	0.053								
Pan		686.0							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____		Hydrometer No. _____		Amyl Alcohol Drops: _____			
PI _____									
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Deflocculation Agent _____			
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: CLM		Computed by: CLM		Checked by: M.A.		Cc			
						Cu			

LF 135 - MA



HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS 1</u>	<u>3</u>	<u>3-4</u>		No. <u>15032.003.08</u>
VISUAL MANUAL CLASSIFICATION					Date <u>4-10-83</u>



000373

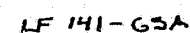
Date <u>4/7/83</u>		WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. <u>15032,003.08</u>			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER			
Project <u>WATANA DAM</u>				Hole <u>AS 3</u>		Depth <u>25-3'</u> # <u>1</u>			
Air Dry WT Total Sample & Tare		<u>1213</u>		TOTAL SAMPLE					
Tare Weight <u>66</u>		<u>537</u>		Classification <u>Very Dark Greyish Brown gravelly silty sand (sm)</u>					
Total Sample WT		<u>676.0</u>		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.		
Moisture Content -10 Material				4"	101.6				
Can No.				3"	76.2				
WT-Soil & Can (Wet)				2"	50.8				
WT-Soil & Can (Dry)				1 1/2"	38.1				
Loss				1"	25.4				
Weight of Can				3/4"	19.1	<u>0</u>			
WT of Soil (Dry)				1/2"	12.7	<u>16.0</u>			
% Moisture				#4	4.6	<u>43.0</u>			
				#10	2.0				
				Pan					
				Total					
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample _____ grams				Jar # _____		WT Washed Sample & Tare <u>1030.0</u>			
						Tare Weight <u>537.0</u>			
						Washed Sample Weight <u>493.0</u>			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing		
10	2.000	<u>41.0</u>				<u>13.5</u>	<u>86.5</u>		
20	0.850	<u>175.0</u>				<u>25.9</u>	<u>74.1</u>		
30	0.600	<u>210.0</u>				<u>32.4</u>	<u>67.6</u>		
40	0.425	<u>260.0</u>				<u>38.5</u>	<u>61.5</u>		
100	0.150	<u>404.0</u>				<u>59.8</u>	<u>40.2</u>		
200	0.075	<u>478.0</u>				<u>70.7</u>	<u>29.3</u>		
270	0.053								
Pan		<u>490.0</u>							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____		Hydrometer No. _____		Amyl Alcohol Drops: _____			
PI _____									
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____			
Time	Elap. Time	Maximum Dia. MM	Temp. O C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Re		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: <u>CRM</u>		Computed by: <u>CRM</u>		Checked by: <u>MA</u>		Cc			
						Cu			

LF 135 - MA



HARDING LAWSON ASSOCIATES
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000373



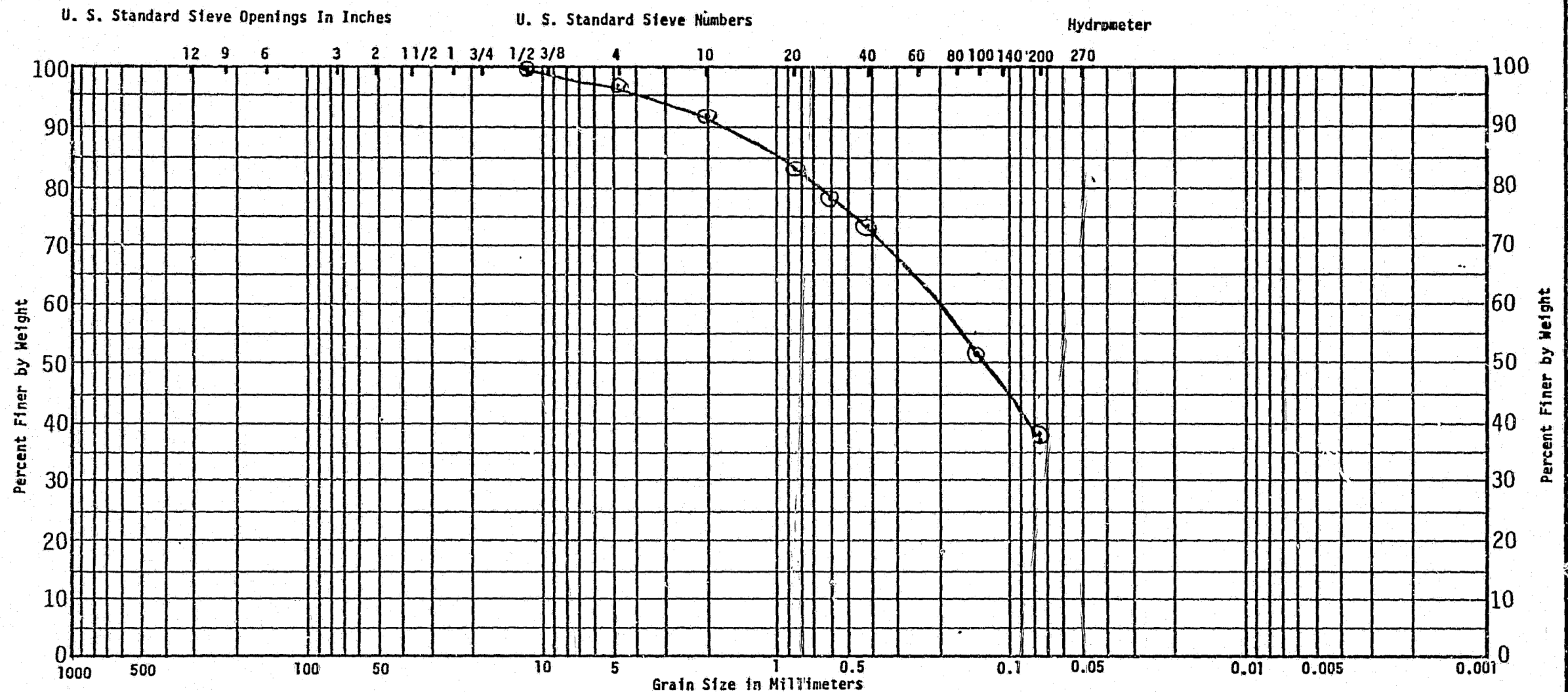
Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER			
Project WATANA DAM				Hole AS 3		Depth 8-9 ⁵ #4			
Air Dry WT Total Sample & Tare		1178.0		TOTAL SAMPLE					
Tare Weight <i>513</i>		427.0		Classification <i>Dark Greyish Brown silty sand (Sm)</i>					
Total Sample WT		751.0		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.		
Moisture Content -10 Material		4"		101.6					
Can No.		3"		76.2					
WT-Soil & Can (Wet)		2"		50.8					
WT-Soil & Can (Dry)		1 1/2"		38.1					
Loss		1"		25.4					
Weight of Can		3/4"		19.1					
WT of Soil (Dry)		1/2"		12.7		0	0		
% Moisture		#4		4.6		23.0	3.1		
		#10		2.0			96.9		
		Pan							
		Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare			
						Tare Weight			
						Washed Sample Weight			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing		
10	2.000	63.0				8.4	91.6		
20	0.850	127.0				16.9	83.1		
30	0.600	162.0				21.6	78.4		
40	0.425	202.0				26.9	73.1		
100	0.150	367.0				48.9	51.1		
200	0.075	463.0				61.7	38.3		
270	0.053								
Pan		468.0							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____		Hydrometer No.		Amyl Alcohol Drops: _____			
PI _____									
a =		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent			
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: CRM								Cc	
Computed by: LRM								Cu	
Checked by: MA									

LF 135-MA



HARDING LAWSON ASSOCIATES
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GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS3	4	8-9 ⁵		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032.003.08
					Date 4-10-89

LF 141-GSA

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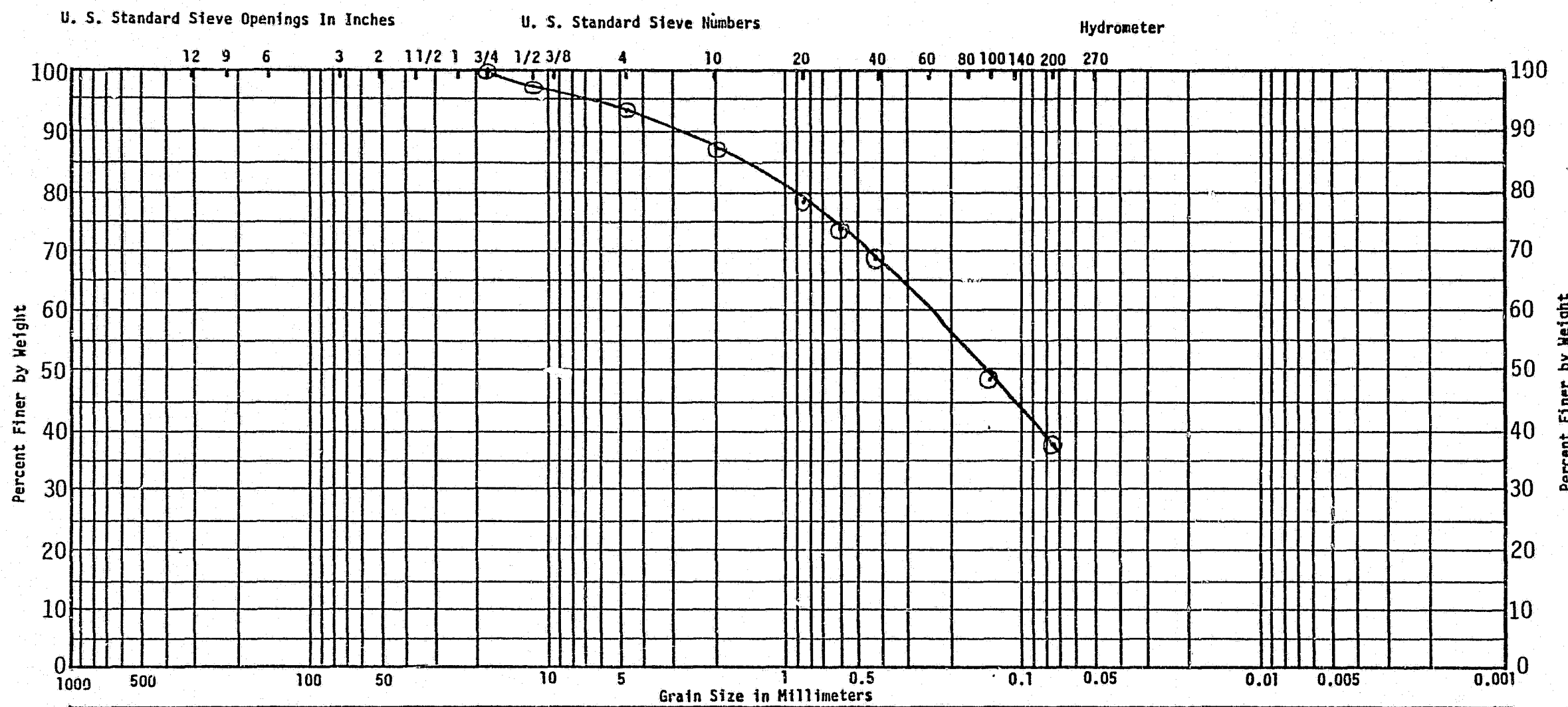
Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER				
Project WATANA DAM				Hole AS 5		Depth 8'-10' #3				
Air Dry WT Total Sample & Tare		1334		TOTAL SAMPLE						
Tare Weight 1P		429		Classification Very Dark Grey gravelly silty sand (Sm)						
Total Sample WT		905.0		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing	
Moisture Content -10 Material		4"		101.6						
		3"		76.2						
		2"		50.8						
Can No.		1 1/2"		38.1						
WT-Soil & Can (Wet)		1"		25.4						
WT-Soil & Can (Dry)		3/4"		19.1		0		0	100	
Loss		1/2"		12.7		24.0		2.7	97.3	
Weight of Can		#4		4.6		62.0		6.9	93.1	
WT of Soil (Dry)		#10		2.0						
% Moisture		Pan								
		Total								
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare		997.0		
						Tare Weight		429.0		
						Washed Sample Weight		568.0		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	117.0				12.9	87.1	55.5		
20	0.850	195.0				21.5	78.5	4.0		
30	0.600	237.0				26.2	73.8			
40	0.425	283.0				31.3	68.7			
100	0.150	46.0				5.4	94.6	37.0		
200	0.075	56.0				6.2	93.8			
270	0.053									
Pan		567.0								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)		LL _____		Hydrometer No.		Amyl Alcohol Drops: _____				
PI _____										
a =		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent				
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc			
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
Tested by: CRM		Computed by: CRM		Checked by: MA				Cc		
								Cu		

LF 135-MA



HARDING LAWSON ASSOCIATES
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GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAR TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS5	3	8'-10'		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003.08
The sample is gravel					Date 4-10-83

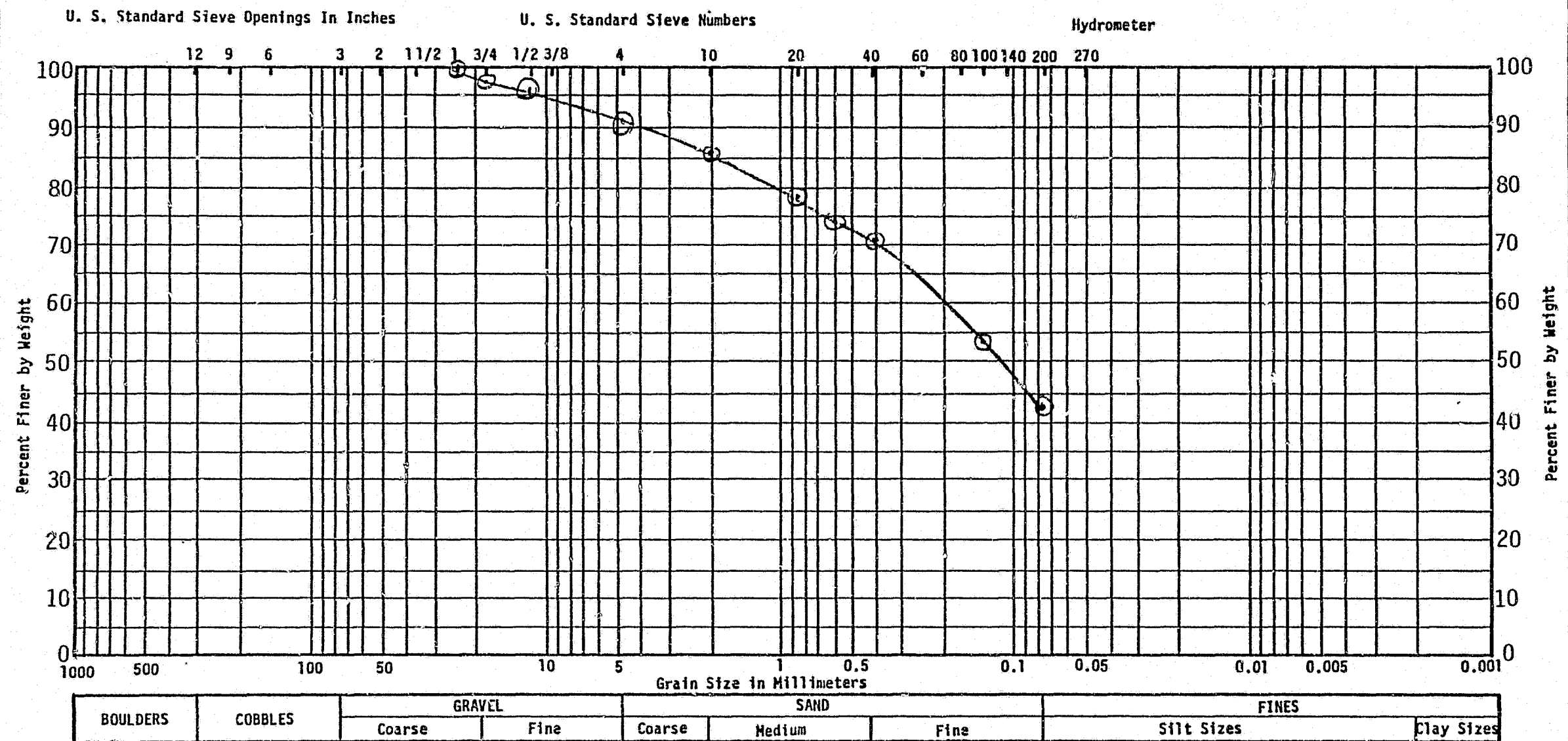
Date <u>4/7/83</u>		WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. <u>15032,003.08</u>				
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER				
Project <u>WATANA DAM</u>				Hole <u>AS 7</u>		Depth <u>1.5-3.5 #1</u>				
Air Dry WT Total Sample & Tare		<u>1198.0</u>		TOTAL SAMPLE						
Tare Weight <u>10</u> <u>434</u>		Classification <u>Dark Greyish Brown gravelly silty Sand (SM)</u>								
Total Sample WT		<u>764.0</u>		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material		4"		101.6						
		3"		76.2						
		2"		50.8						
Can No.		1 1/2"		38.1						
WT-Soil & Can (Wet)		1"		25.4		0			0	100
WT-Soil & Can (Dry)		3/4"		19.1		21.0			2.7	97.3
Loss		1/2"		12.7		33.0			4.3	95.7
Weight of Can		#4		4.6		72.0			9.4	90.6
WT of Soil (Dry)		#10		2.0						
% Moisture		Pan								
		Total								
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample _____ grams				Jar # _____		WT Washed Sample & Tare		877		
						Tare Weight		21.1		
						Washed Sample Weight		443.0		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	109.0				14.3	85.7			
20	0.850	164.0				21.5	78.5			
30	0.600	194.0				25.4	74.6			
40	0.425	227.0				29.7	70.3			
100	0.150	357.0				46.7	53.3			
200	0.075	440.0				57.6	42.4			
270	0.053									
Pan		443.0								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)			LL _____ PI _____		Hydrometer No.		Amyl Alcohol Drops: _____			
a =		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent				
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc			
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
Tested by: <u>RMW</u>									Cu	
Computed by: <u>CLM</u>			Checked by: <u>MA</u>							

LF 135 - MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS-7	1	1.5-3.5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003.08
Gravel is Subangular and Subrounded					Date 4-10-83

LF 141-GSA

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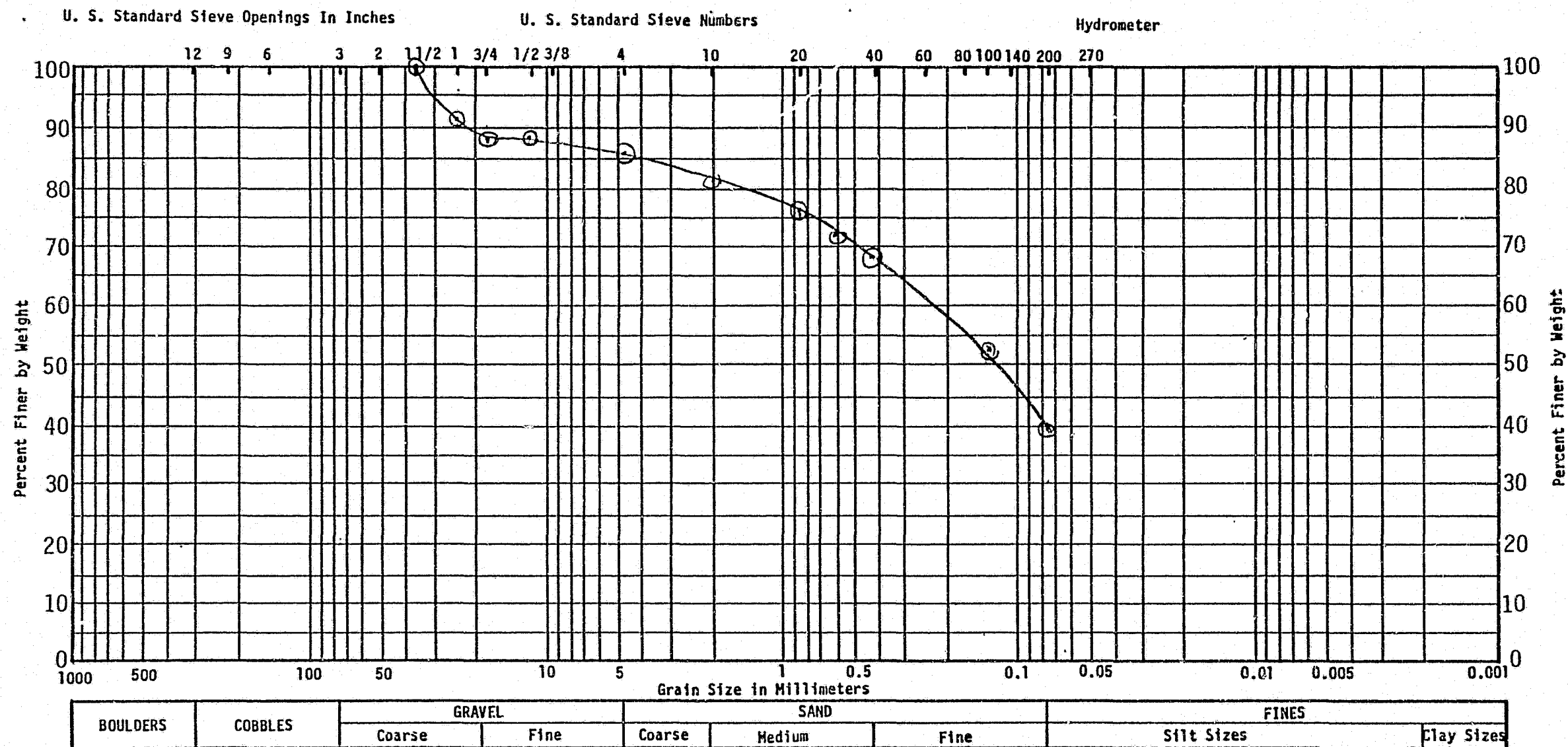
Date <u>4/7/83</u>		WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. <u>15032,003.08</u>	
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER	
Project <u>WATANA DAM</u>				Hole <u>AS 7</u>		Depth <u>10'</u> # <u>2</u>	
Dry WT Total Sample & Tare		<u>370.06</u>		TOTAL SAMPLE			
Tare Weight <u>MA-35</u>		<u>89.3</u>		Classification <u>Dark Greyish brown gravelly silty sand (sm)</u>			
Total Sample WT		<u>280.10</u>		THIS SAMPLE DOES NOT MEET ASTM RECOMMENDED MINIMUM WEIGHT.			
Moisture Content -10 Material		4"		101.6			
		3"		76.2			
		2"		50.8			
Can No.		1 1/2"		38.1		0 100	
WT-Soil & Can (Wet)		1"		25.4		8.9 91.1	
WT-Soil & Can (Dry)		3/4"		19.1		11.4 88.6	
Loss		1/2"		12.7		11.4 88.6	
Weight of Can		#4		4.6		14.6 85.4	
WT of Soil (Dry)		#10		2.0			
% Moisture		Pan					
		Total					
REPRESENTATIVE MINUS NO. 10 SAMPLE							
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare	
						Tare Weight	
						Washed Sample Weight	
Sieve Size		Dia. MM		Cum. WT Ret.		Weight Retained	
						% Retained	
						% of Total Retained	
						Cum. % of Total Ret. Passing	
10		2.000		52.0		18.10 81.9	
20		0.850		69.0		24.3 75.7	
30		0.600		78.0		27.8 72.2	
40		0.425		89.0		31.8 68.2	
100		0.150		134.0		47.8 52.2	
200		0.075		169.0		60.3 39.7	
270		0.053					
Pan				170.5			
Total							
HYDROMETER SAMPLE							
Specific Gravity (G)		LL _____		Hydrometer No.		Amyl Alcohol Drops: _____	
PI _____							
a =		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent	
Time		Elap. Time		Maximum Dia. MM		Temp. ° C.	
						K	
						Reading	
						Initl. Actual Rc	
						L	
						Corrected Gram Size, Dia. MM	
						% of Total Passing	
1		0.078					
2		0.055					
5		0.035					
15		0.020					
30		0.014					
60		0.010					
240		0.005					
1440		0.002					
						Cc	
						Cu	
Tested by: <u>CEW</u>		Computed by: <u>CEW</u>		Checked by: <u>MA</u>			

LF 135 - MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS 7</u>	<u>2</u>	<u>10'</u>		No. <u>15032.003.08</u>
VISUAL MANUAL CLASSIFICATION					Date <u>4-10-83</u>
<u>Gravel is Subangular</u>					

LF 141-G3A

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Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08	
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER		
Project WATANA DAM					Hole AS 9		Depth 1.5-2.5 #1	
Dry WT Total Sample & Tare		1168		TOTAL SAMPLE				
Tare Weight		540		Classification Olive Brown gravelly silty sand (sm)				
Total Sample WT		628.0		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.
Moisture Content -10 Material		4"		101.6				Cum. % of Total Ret.
Can No.		3"		76.2				Passing
WT-Soil & Can (Wet)		2"		50.8				
WT-Soil & Can (Dry)		1 1/2"		38.1				
Loss		1"		25.4				
Weight of Can		3/4"		19.1		0		0
WT of Soil (Dry)		1/2"		12.7		30.0		41.1
% Moisture		#4		4.6		56.0		8.9
		#10		2.0				91.1
		Pan						
		Total						
REPRESENTATIVE MINUS NO. 10 SAMPLE								
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare		95.0
						Tare Weight		540
						Washed Sample Weight		417.0
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing	
10	2.000	107.0				17.2	82.8	57.3
20	0.850	175.0				27.9	72.1	% - sand
30	0.600	207.0				33.0	67.0	
40	0.425	240.0				38.2	61.8	
100	0.150	353.0				56.2	43.8	33.8
200	0.075	416.0				66.2	33.8	% fines
270	0.053							
Pan		418.0						
Total								
HYDROMETER SAMPLE								
Specific Gravity (G)		LL		Hydrometer No.		Amyl Alcohol Drops:		
		PI						
a =		Corrected Weight of Hydrometer Sample				Defloculation Agent		
		grams						
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM
					Initl.	Actual	Rc	% of Total Passing
	1	0.078						
	2	0.055						
	5	0.035						
	15	0.020						
	30	0.014						
	60	0.010						
	240	0.005						
	1440	0.002						
Tested by: RAH		Computed by: MA		Checked by: MA		Cc		
						Cu		

LF 135-MA



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GRADATION SIZE ANALYSIS

U. S. Standard Sieve Openings In Inches

U. S. Standard Sieve Numbers

Hydrometer

BOULDERS		COBBLES		GRAVEL		SAND			FINES	
				Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 9	1	1.5-2.5	
VISUAL MANUAL CLASSIFICATION The sample is sand, gravel is subangular				

Job	WATANA DAM
No.	15032.003.08
Date	4-10-83

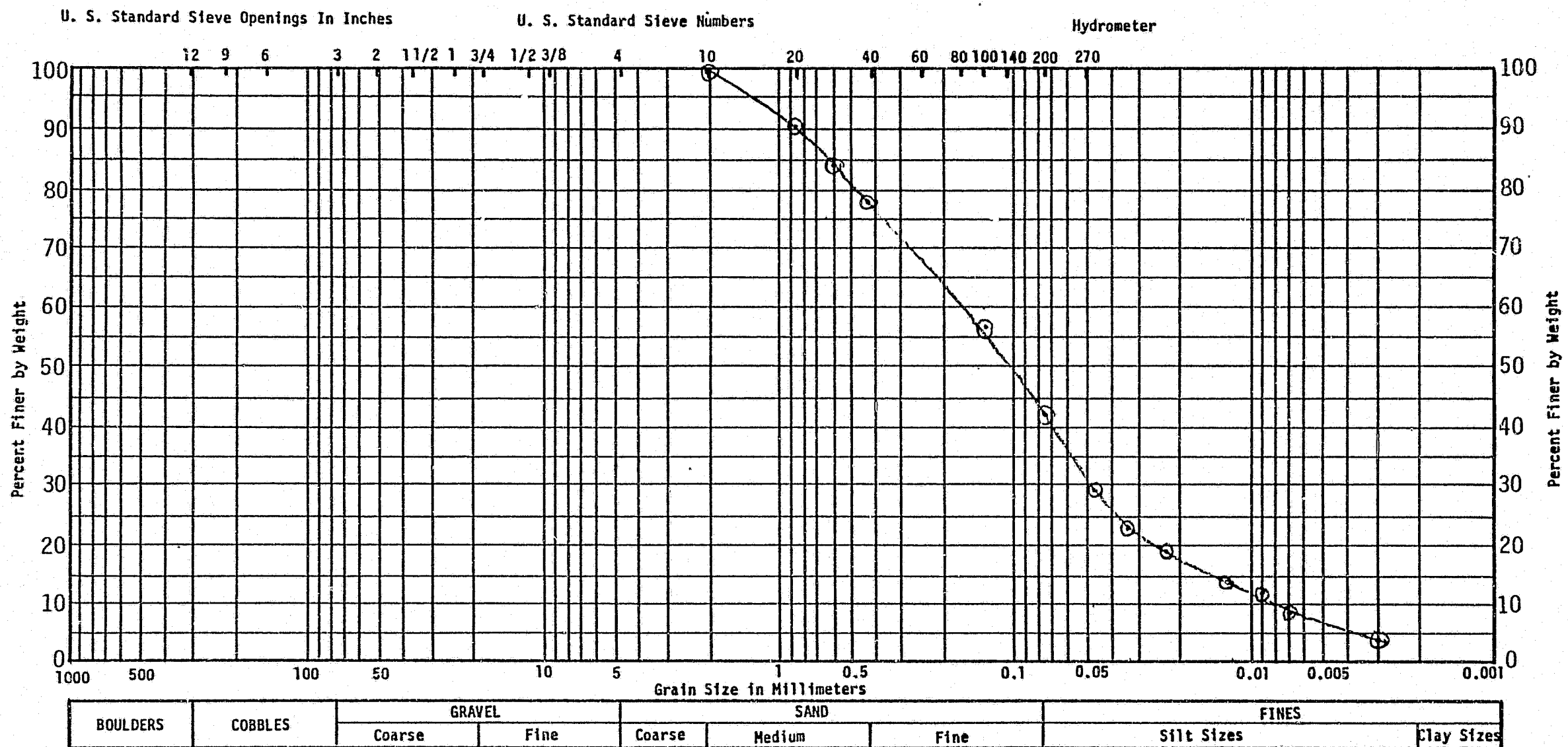
Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08			
		☐ GILSON		☐ BRASS SIEVE		☒ HYDROMETER				
Project WATANA DAM					Hole AS 10		Depth 3.5-4.5 #1			
Air Dry WT Total Sample & Tare		TOTAL SAMPLE								
Tare Weight		Classification Olive silty sand (Sm)								
Total Sample WT		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing		
Moisture Content -10 Material		4"	101.6							
		3"	76.2							
		2"	50.8							
Can No.	MA-33	1 1/2"	38.1							
WT-Soil & Can (Wet)	323.9	1"	25.4							
WT-Soil & Can (Dry)	323.1	3/4"	19.1							
Loss	0.8	1/2"	12.7							
Weight of Can	89.3	#4	4.6							
WT of Soil (Dry)	233.80	#10	2.0							
% Moisture	0.34	Pan								
		Total								
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample		50.5 grams		Jar # J		WT Washed Sample & Tare		120		
						Tare Weight		91		
						Washed Sample Weight		29		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	0				0.0	100.0	57.6 % sand		
20	0.850	5				9.9	90.1			
30	0.600	8				15.9	84.1			
40	0.425	11				21.9	78.1			
100	0.150	22				43.7	56.1			
200	0.075	29				57.6	42.4	42.4 % fines		
270	0.053									
Pan		29								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G) (assumed)		2.75		LL		Hydrometer No.		Amyl Alcohol		
				PI		K		Drops: 2 count		
a = 0.98		Corrected Weight of Hydrometer Sample 50.33 grams				Deflocculation Agent Colloidal				
13:25	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing	
					Initl.	Actual	Rc			
13:26	1	0.078	20.0	0.0133	25.5	21.5	6.9	12.8	0.048	28.4
13:27	2	0.055	20.0	"	22.5	19.0	"	13.2	0.034	23.6
13:30	5	0.035	20.0	"	19.0	17.0	"	13.5	0.022	19.7
13:40	15	0.020	20.0	"	14.3		"	14.0	0.013	14.4
13:55	30	0.014	20.0	"	13.0		"	14.2	0.009	11.9
14:15	60	0.010	20.0	"	11.2		"	14.5	0.007	8.4
17:25	240	0.005	19.8	"	9.2		"	14.8	0.003	4.5
18:35	1440	0.002	15.0	0.0140	9.5		8.0			
									Cc	
Tested by: DNR/G.B.		Computed by: MA		Checked by: MA					Cu	

LF 135-MA



HARDING LAWSON ASSOCIATES
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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS 10</u>	<u>1</u>	<u>3.5-4.5</u>		No. <u>15032,003,08</u>
VISUAL MANUAL CLASSIFICATION <u>A few small silt + fine clay lumps.</u>					Date <u>4-12-83</u>

LF 141-GSA

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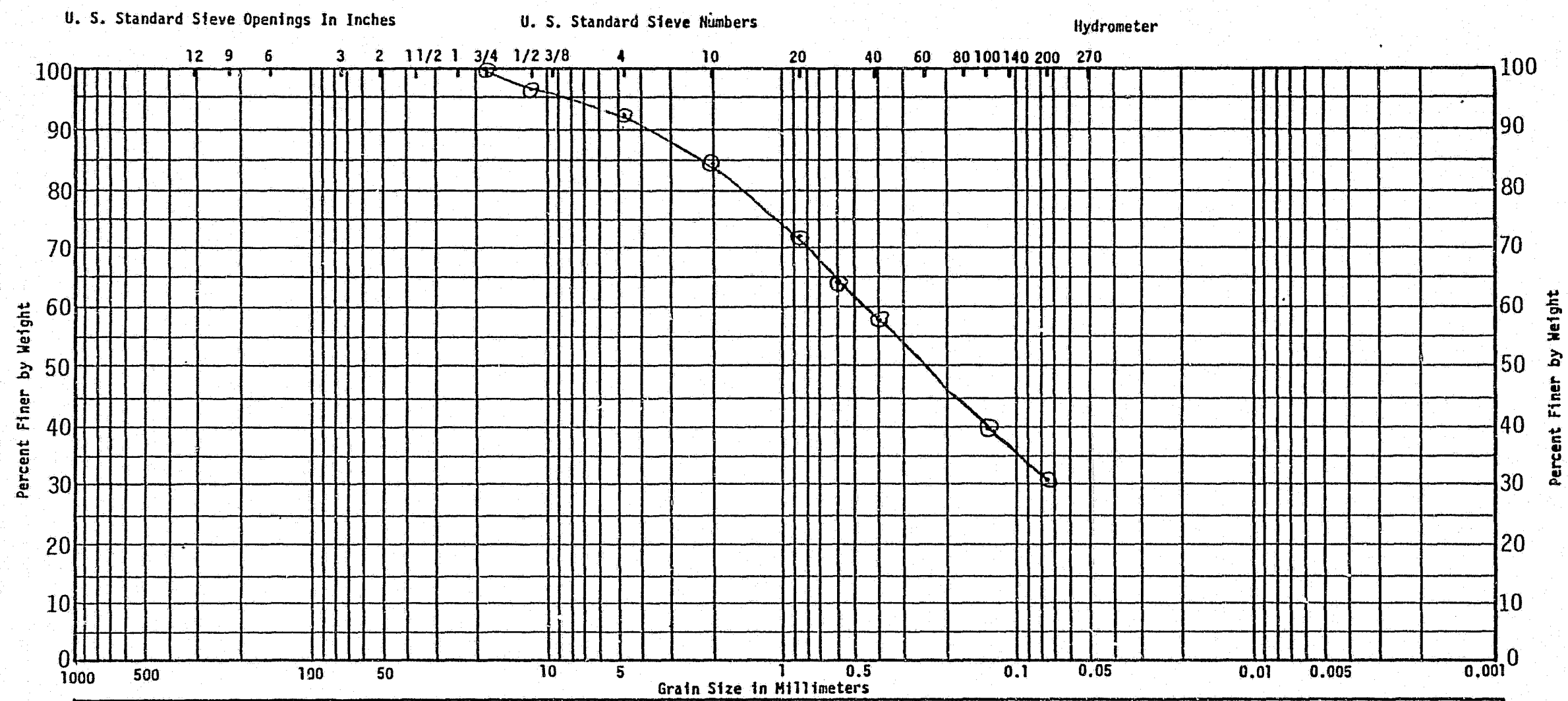
Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08		
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER			
Project WATANA DAM				Hole AS 12		Depth .5-1.0 #1			
Air Dry WT Total Sample & Tare		278.93		TOTAL SAMPLE					
Tare Weight MA-26		89.13		Classification <i>Black gravelly silty sand (sm)</i>					
Total Sample WT		189.80		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	
Moisture Content -10 Material		4"		101.6				Cum. % of Total Ret.	
Can No.		3"		76.2				Passing	
WT-Soil & Can (Wet)		2"		50.8					
WT-Soil & Can (Dry)		1 1/2"		38.1					
Loss		1"		25.4					
Weight of Can		3/4"		19.1	0			1.23	
WT of Soil (Dry)		1/2"		12.7	8.0			4.2	
% Moisture		#4		4.6	17.0			95.8	
		#10		2.0				92.6	
		Pan							
		Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample _____ grams				Jar # _____		WT Washed Sample & Tare		223.4	
						Tare Weight		34.73	
						Washed Sample Weight		134.77	
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret. Passing			
10	2.000	29.0				15.3	84.7		
20	0.850	55.0				29.0	71.0		
30	0.600	62.0				35.8	64.2		
40	0.425	80.0				42.1	57.9		
100	0.150	114.0				60.1	39.9		
200	0.075	132.0				69.5	30.5		
270	0.053								
Pan		135.0							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____		Hydrometer No.		Amyl Alcohol Drops: _____			
PI _____									
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent			
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	
					Initl.	Actual	Rc		
	1	0.078						% of Total Passing	
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
									Cc
									Cu
Tested by: CWM		Computed by: CPM		Checked by: MA					

LF 135-MA



HARDING LAWSON ASSOCIATES
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GRADATION SIZE ANALYSIS



BOULDERS		COBBLES		GRAVEL		SAND			FINES	
				Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 12	1	.5-1.0		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003.08
Large amount of organic in sample					Date 4-10-83

Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS			Job
		☐ GILSON	☒ BRASS SIEVE	☒ HYDROMETER	No. 15032,003.08

Project	WATANA DAM	Hole	AS 13	Depth	7-10 #2
---------	------------	------	-------	-------	---------

Air Dry WT Total Sample & Tare	985	TOTAL SAMPLE						
Tare Weight	17 546	Classification Very Dark Grey gravelly silty sand (SM)						
Total Sample WT	439	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material		4"	101.6					
Can No.	MA-31	3"	76.2					
WT-Soil & Can (Wet)	327.4	2"	50.8					
WT-Soil & Can (Dry)	326.4	1 1/2"	38.1					
Loss	1.0	1"	25.4					
Weight of Can	91.4	3/4"	19.1					
WT of Soil (Dry)	235.0	1/2"	12.7	0			0	100.0
% Moisture	0.4	#4	4.6	35			8.0	92.0
		#10	2.0	45			10.3	89.7
		Pan						
		Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample	76.4 grams	Jar #	JB-2	WT Washed Sample & Tare	132		
				Tare Weight MA-10	57		
				Washed Sample Weight	75		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing
10	2.000	0				—	89.7
20	0.850	12				15.8	84.2 (75.6)
30	0.600	17				22.3	77.7 (69.7)
40	0.425	21				27.6	72.4 (64.9)
100	0.150	35				46.0	54.0 (48.4)
200	0.075	44				57.8	42.2 (32.8)
270	0.053						
Pan		45					
Total							

HYDROMETER SAMPLE

Specific Gravity (G) (assumed)	2.75	LL		Hydrometer No.		Amyl Alcohol				
		PI			G	Drops:	2			
a =	0.98	Corrected Weight of Hydrometer Sample			Defloculation Agent					
		76.1 grams								
1400 Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading		Corrected Gram Size, Dia. MM	% of Total Passing		
					Initl.	Actual				
1401	1	0.078	20.0	0.0133	35.0	29.5	6.9	11.5	0.645	26.1
1402	2	0.055	20.0	"	31.2	27.1	"	11.9	0.632	23.3
1405	5	0.035	20.0	"	27.1	24.5	"	12.3	0.621	20.3
1415	15	0.020	20.0	"	21.1		"	12.9	0.612	16.3
1430	30	0.014	20.0	"	15.0		"	13.3	0.609	12.8
1450	60	0.010	20.0	"	16.0		"	13.7	0.606	10.5
1500	240	0.005	20.0	"	13.0		"	14.2	0.603	7.1
1500	1440	0.002	15.0	0.6146	11.0		8.0	14.5	0.6014	3.5
									Cc	
									Cu	

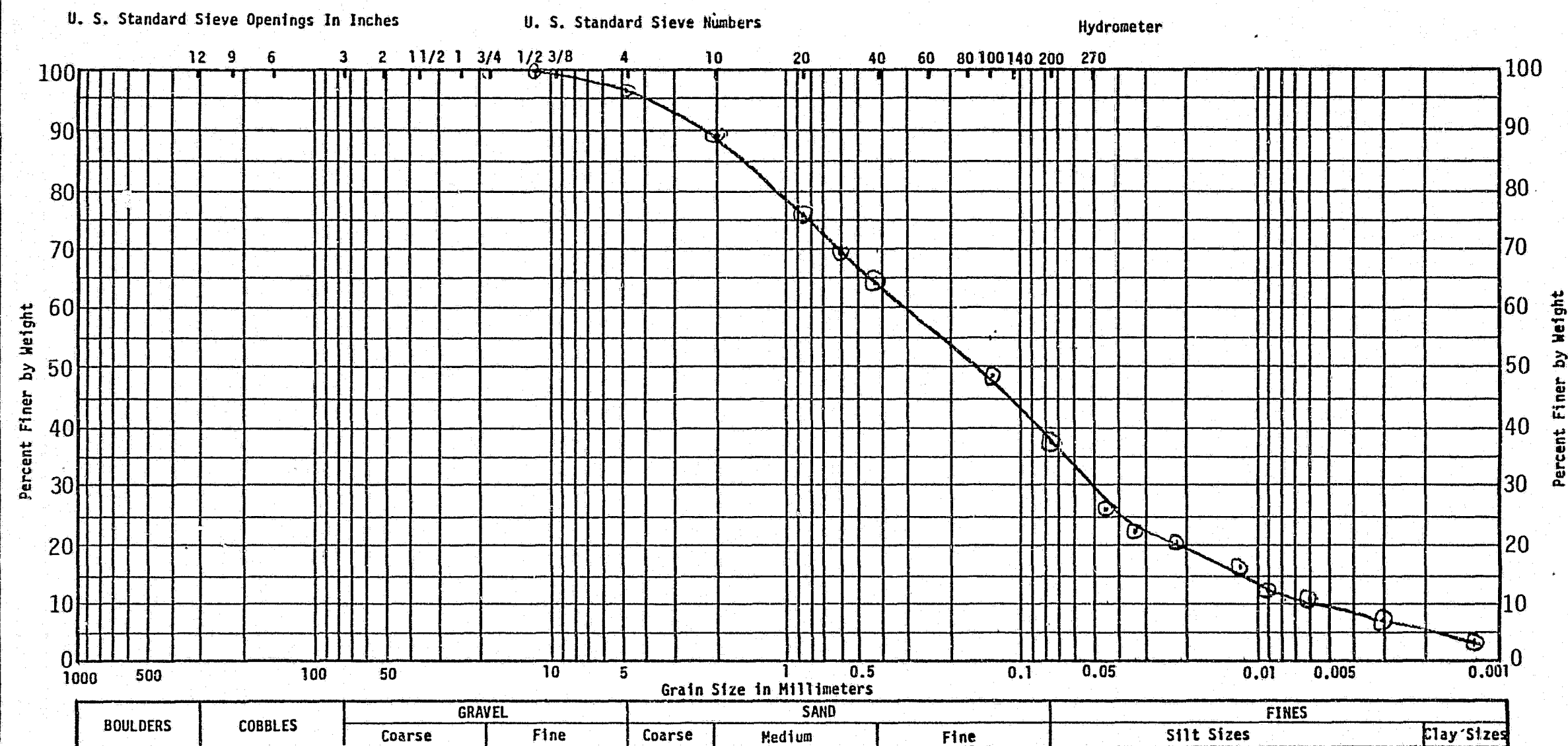
Tested by: J.G.B. Computed by: M.A. Checked by: M.A.

LF 135-MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS13</u>	<u>2</u>	<u>7-10</u>		No. <u>15032,003,08</u>
VISUAL MANUAL CLASSIFICATION <u>Small amount of organic material. Sample is saturated.</u>					Date <u>4-12-83</u>

LF 141-GSA

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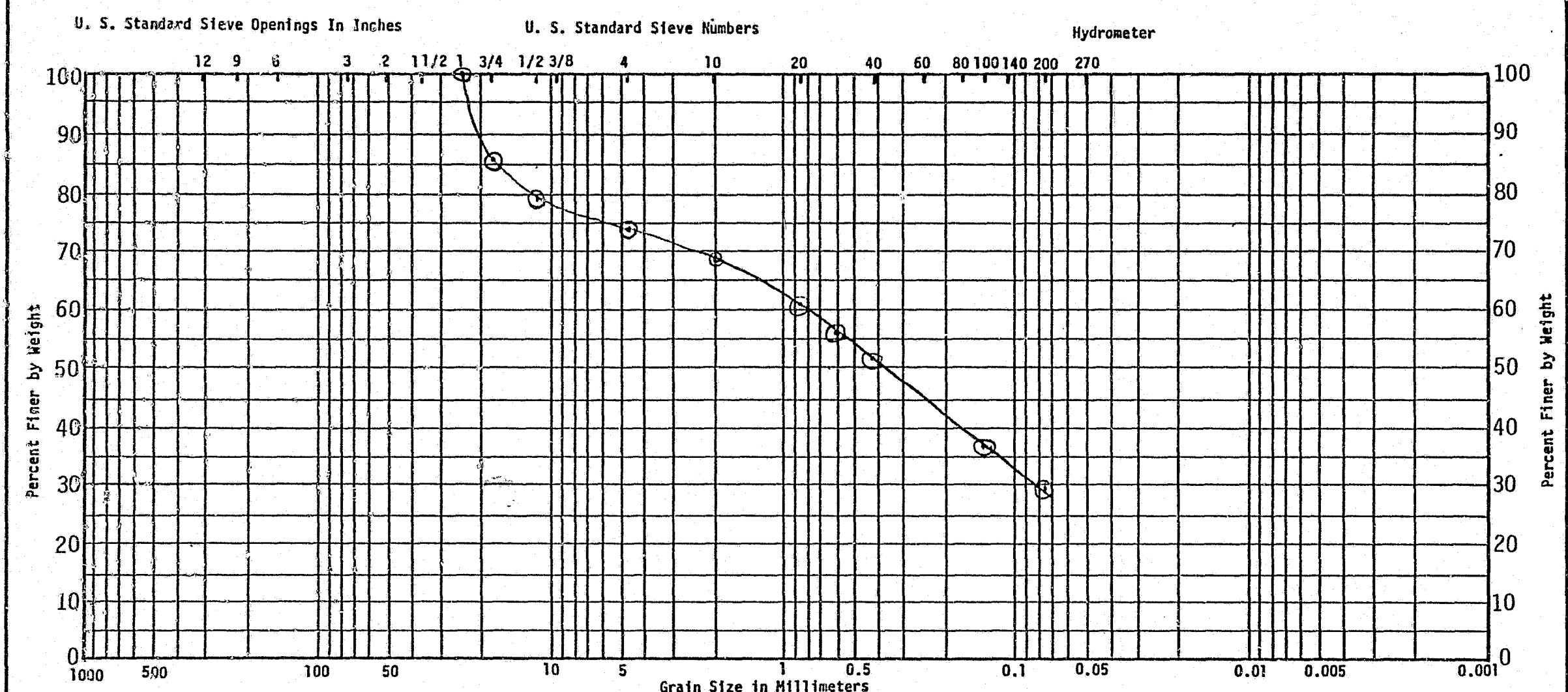
Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08	
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER		
Project WATANA DAM					Hole AS 13		Depth 13-15 #3	
Dry WT Total Sample & Tare		1025		TOTAL SAMPLE				
Tare Weight 11V		436		Classification Dark Grey gravelly silty sand (Sm)				
Total Sample WT		589.0		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.
Moisture Content -10 Material		4"		101.6				
		3"		76.2				
		2"		50.8				
Can No.		1 1/2"		38.1				
WT-Soil & Can (Wet)		1"		25.4		0		100
WT-Soil & Can (Dry)		3/4"		19.1		85		14.4
Loss		1/2"		12.7		121		20.5
Weight of Can		#4		4.6		152		25.8
WT of Soil (Dry)		#10		2.0				74.2
% Moisture		Pan						
		Total						
REPRESENTATIVE MINUS NO. 10 SAMPLE								
WT Representative Sample			grams		Jar #		WT Washed Sample & Tare	
							853.0	
							Tare Weight	
							12.0	
							Washed Sample Weight	
							841.0	
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing	
10	2.000	18.0				21.6	6.4	
20	0.850	23.0				27.4	11.1	
30	0.600	26.0				44.1	55.9	
40	0.425	28.0				48.6	51.4	
100	0.150	37.0				63.2	36.8	
200	0.075	41.0				70.2	29.8	
270	0.053							
Pan		418.0						
Total								
HYDROMETER SAMPLE								
Specific Gravity (G)		LL		Hydrometer No.		Amyl Alcohol		
		PI				Drops:		
a =		Corrected Weight of Hydrometer Sample				Defloculation Agent		
		grams						
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM
					Initl.	Actual	Rc	% of Total Passing
	1	0.078						
	2	0.055						
	5	0.035						
	15	0.020						
	30	0.014						
	60	0.010						
	240	0.005						
	1440	0.002						
								Cc
Tested by: CRM								Cu
Computed by: CRM				Checked by: MAF				

LF 135-MA



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GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 13	3	13'-15'		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003.08
Sample is silty sand, also contains gravel subangular and sub-spherical.					Date 4-10-83

Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS			Job
		☐ GILSON	☒ BRASS SIEVE	☐ HYDROMETER	No. 15032,003.08

Project	WATANA DAM	Hole	AS 13	Depth	15-17 ⁵ #4
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Air Dry WT Total Sample & Tare	1774	TOTAL SAMPLE						
Tare Weight	1 B 543	Classification Dark grey gravelly silty sand (sm)						
Total Sample WT	1231	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material		4"	101.6					
		3"	76.2					
		2"	50.8					
Can No.		1 1/2"	38.1					
WT-Soil & Can (Wet)		1"	25.4	0			5	100
WT-Soil & Can (Dry)		3/4"	19.1	55.0			4.5	95.5
Loss		1/2"	12.7	81.0			6.6	93.4
Weight of Can		#4	4.6	211.0			-17.1	82.9
WT of Soil (Dry)		#10	2.0					
% Moisture		Pan						
		Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE							
WT Representative Sample	grams	Jar #	WT Washed Sample & Tare	1363.0			
			Tare Weight	543.0			
			Washed Sample Weight	817.0			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing
10	2.000	295.0				24.0	76.0
20	0.850	471.0				32.5	61.4
30	0.600	457.0				37.1	66.4
40	0.425	512.0				41.6	58.4
100	0.150	713.0				54.2	41.7
200	0.075	814.0				66.1	33.9
270	0.053						
Pan		817.					
Total							

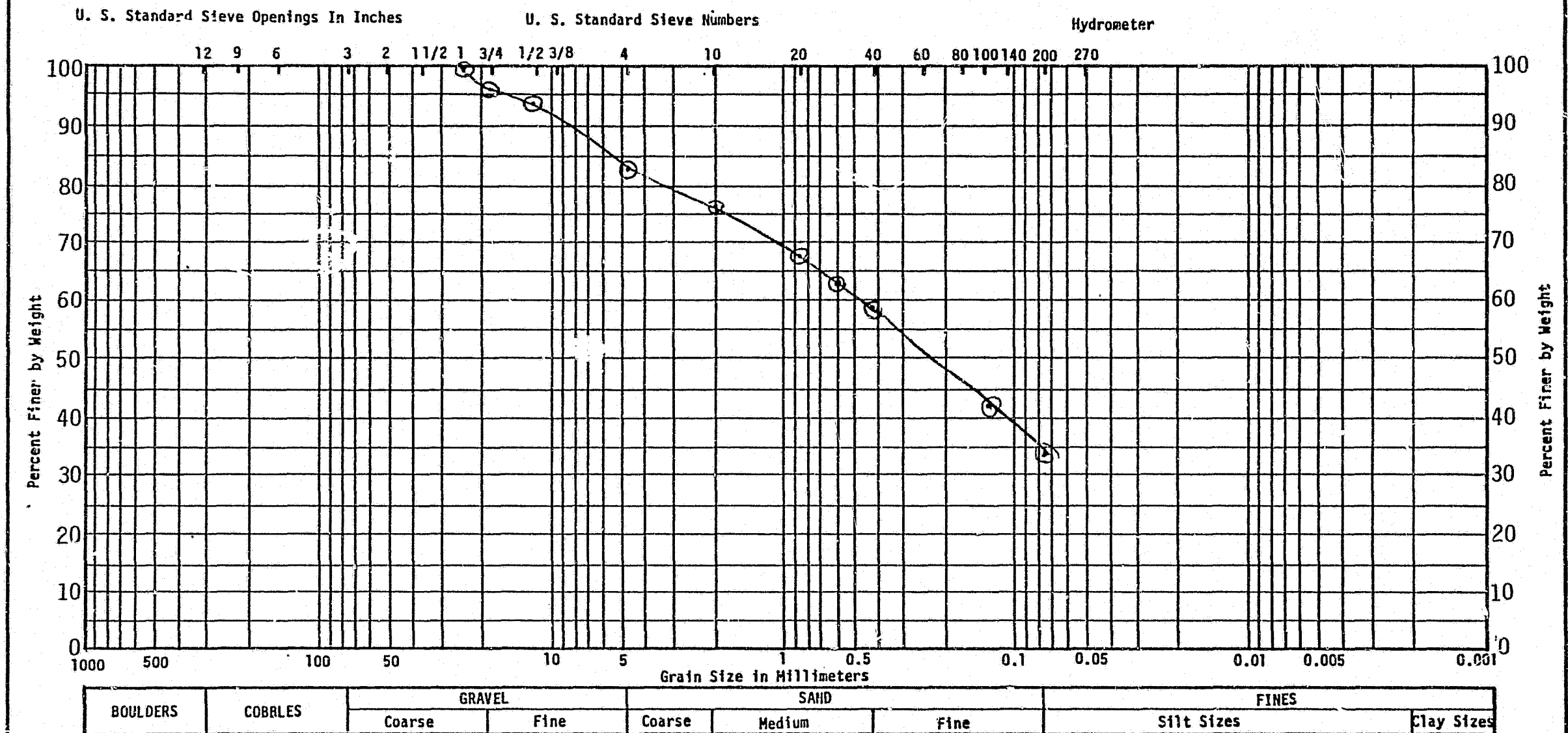
HYDROMETER SAMPLE									
Specific Gravity (G)	LL	PI	Hydrometer No.	Amyl Alcohol Drops:					
a =	Corrected Weight of Hydrometer Sample			grams			Deflocculation Agent		
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: CEM								Computed by: CEM	Checked by: Mft
								Cc	
								Cu	

LF 135 - MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS13	4	15-17 ^s		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032.003.08
Sample is saturated, and color is light brown.					Date 4-10-83

LF 141-GSA

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Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☒ BRASS SIEVE ☐ HYDROMETER			Job No.	15032,003.08
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Project	WATANA DAM	Hole	AS 14	Depth	8-10 #2
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WT Dry WT Total Sample & Tare	1896	TOTAL SAMPLE						
Tare Weight DD	537	Classification <i>dark grey gravelly silty sand (SM)</i>						
Total Sample WT	1359	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material		4"	101.6					
		3"	76.2					
		2"	50.8					
Can No.		1 1/2"	38.1					
WT-Soil & Can (Wet)		1"	25.4	0			0	100
WT-Soil & Can (Dry)		3/4"	19.1	16			1.2	98.8
Loss		1/2"	12.7	84			6.2	93.8
Weight of Can		#4	4.6	198			14.6	85.4
WT of Soil (Dry)		#10	2.0					
% Moisture		Pan						
		Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample	grams	Jar #	WT Washed Sample & Tare	1437			
			Tare Weight	537			
			Washed Sample Weight	899			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing
10	2.000	295				21.7	78.3
20	0.850	415				30.5	68.5
30	0.600	473				34.7	65.2
40	0.425	532				39.1	60.9
100	0.150	806				59.3	40.7
200	0.075	894				65.6	34.2
270	0.053						
Pan		899					
Total							

HYDROMETER SAMPLE

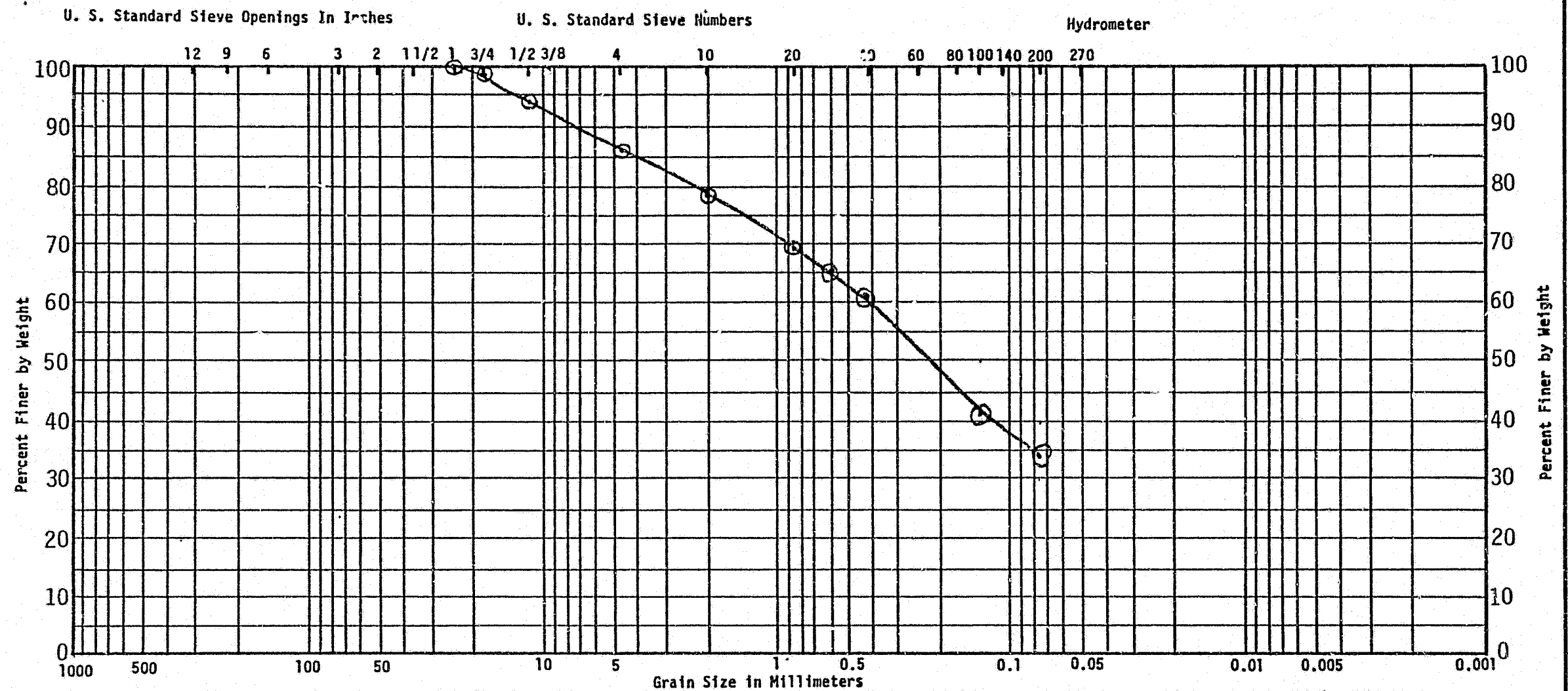
Specific Gravity (G)	LL	PI	Hydrometer No.	Amyl Alcohol Drops:				
a =	Corrected Weight of Hydrometer Sample			Defloculation Agent				
	grams							
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading	L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc	
	1	0.078						
	2	0.055						
	5	0.035						
	15	0.020						
	30	0.014						
	60	0.010						
	240	0.005						
	1440	0.002						
Tested by:	C.R.	Computed by:	CM	Checked by:	MA	Cc		
						Cu		

LF 135-MA



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GRADATION SIZE ANALYSIS



BOULDERS		COBBLES		GRAVEL		SAND			FINES		
				Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes	
LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)						Job <u>WATANA DAM</u>	
	<u>AS-14</u>	<u>2</u>	<u>8-10'</u>							No. <u>15032,003,08</u>	
VISUAL MANUAL CLASSIFICATION				<u>contains some peat. Gravel subangular.</u>						Date <u>4-11-83</u>	
<u>sample saturated</u>											

LF 141-GSA

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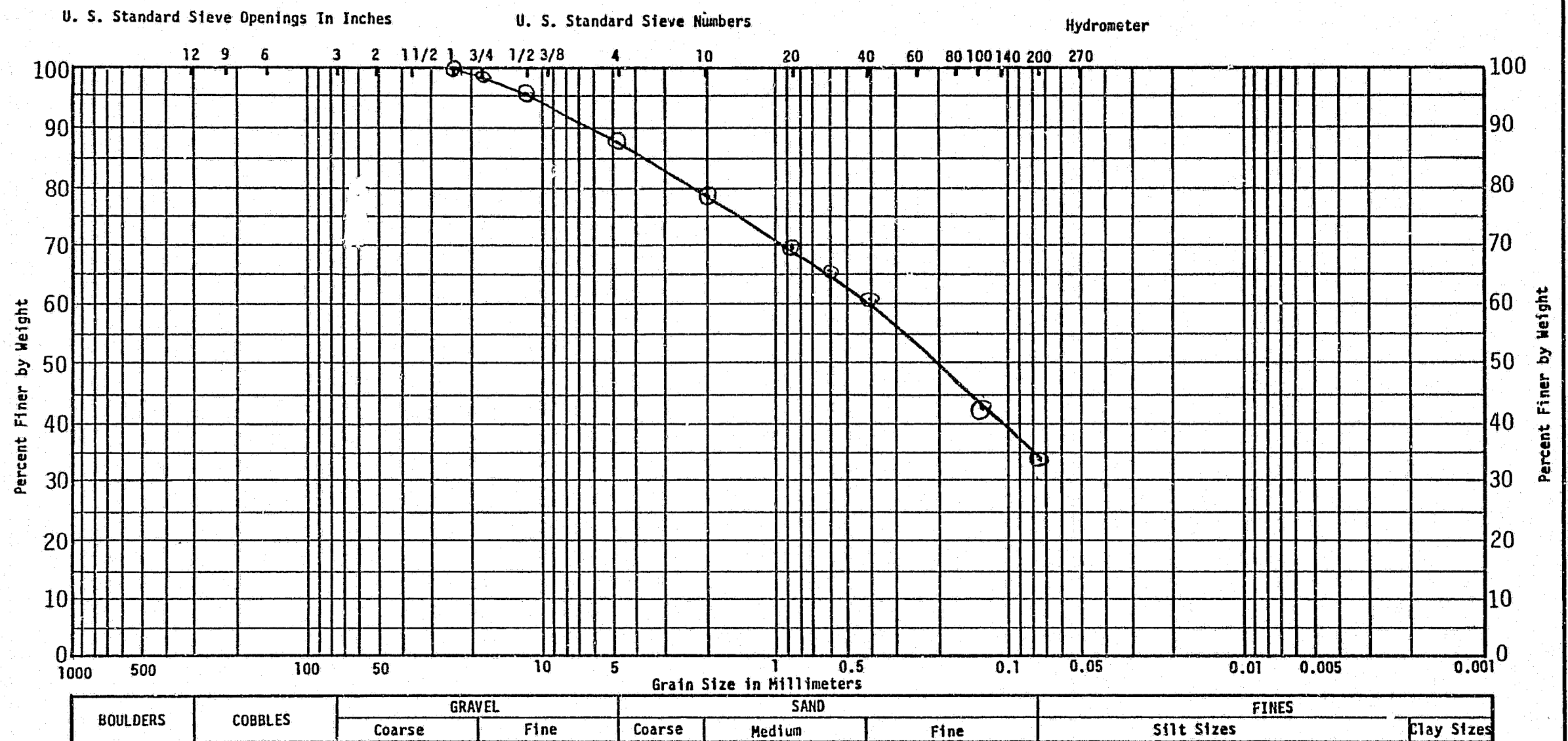
Date <u>4/9/83</u>		WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. <u>15032,003.08</u>	
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER	
Project <u>WATANA DAM</u>				Hole <u>AS 14</u>		Depth <u>12⁵-15 #4</u>	
Dry WT Total Sample & Tare		<u>1830</u>		TOTAL SAMPLE			
Tare Weight <u>SD-7</u>		<u>546</u>		Classification <u>dark grey gravelly silty sand (sm)</u>			
Total Sample WT		<u>1284</u>		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.
Moisture Content -10 Material		4"		101.6			
Can No.		3"		76.2			
WT-Soil & Can (Wet)		2"		50.8			
WT-Soil & Can (Dry)		1 1/2"		38.1			
Loss		1"		25.4	0		0
Weight of Can		3/4"		19.1	19.1		1.4
WT of Soil (Dry)		1/2"		12.7	61		4.8
% Moisture		#4		4.6	155		12.1
		#10		2.0			87.9
		Pan					
		Total					
REPRESENTATIVE MINUS NO. 10 SAMPLE							
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare	
						Tare Weight	
						Washed Sample Weight	
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing
10	2.000	268				20.1	79.1
20	0.850	390				30.4	61.0
30	0.600	447				34.8	65.2
40	0.425	506				39.1	65.6
100	0.150	738				57.5	72.5
200	0.075	842				65.6	84.4
270	0.053						
Pan		847					
Total							
HYDROMETER SAMPLE							
Specific Gravity (G)		LL _____		Hydrometer No.		Amyl Alcohol Drops: _____	
PI _____							
a =		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent	
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading		Corrected Gram Size, Dia. MM
					Initl.	Actual	
	1	0.078					% of Total Passing
	2	0.055					
	5	0.035					
	15	0.020					
	30	0.014					
	60	0.010					
	240	0.005					
	1440	0.002					
Tested by: <u>CZM</u>		Computed by: <u>CZM</u>		Checked by: <u>MA</u>		Cc _____	

LF 135-MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS-14	4	12 ⁵ -15		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003.08
saturated gravel subrounded + subangular, sample					Date 4-10-83

LF 141-GSA

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000037

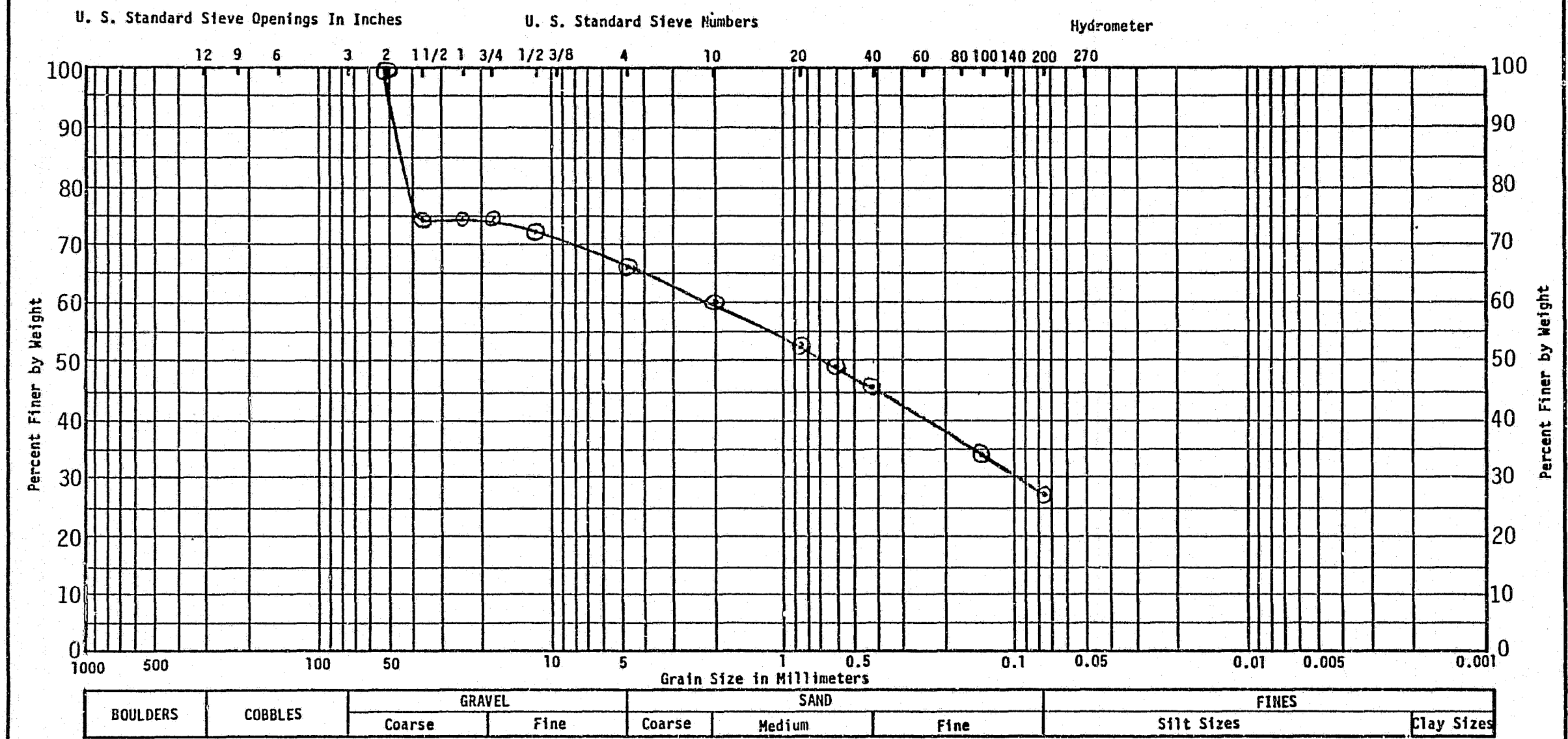
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER				
Project WATANA DAM				Hole AS-16		Depth 5-75 #1				
Dry WT Total Sample & Tare		612.6		TOTAL SAMPLE		SAMPLE DOES NOT MEET ASTM STANDARDS				
Tare Weight MA-21		87.0		Classification dark grey silty gravelly sand (sm)						
Total Sample WT		525.6		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material				4"	101.6					
				3"	76.2					
				2"	50.8	0			0.0	100.0
Can No.				1 1/2"	38.1	133			25.3	74.7
WT-Soil & Can (Wet)				1"	25.4	"			"	"
WT-Soil & Can (Dry)				3/4"	19.1	"			"	"
Loss				1/2"	12.7	147			28.0	72.0
Weight of Can				#4	4.6	179			34.1	65.9
WT of Soil (Dry)				#10	2.0					
% Moisture				Pan						
				Total						
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare		471		
						Tare Weight		87		
						Washed Sample Weight		384		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	210				40.0	60.0	38.6		
20	0.850	249				47.4	52.6	31.5		
30	0.600	267				50.8	49.2	52.1		
40	0.425	285				54.2	45.8			
100	0.150	345				65.6	34.4	27.2		
200	0.075	382				72.7	27.3	1/2		
270	0.053							fines		
Pan		383								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)		LL		Hydrometer No.		Amyl Alcohol				
		PI				Drops:				
a =		Corrected Weight of Hydrometer Sample				Defloculation Agent				
		grams								
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc			
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
Tested by: G.B.		Computed by: M.A.		Checked by: M.A.		Cc				
						Cu				

LF 135-MA



HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS-16	1	5-7 ⁵		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032.003.08
Sample contains peat + organic matter. Gravel subangular + subangular and smooth.					Date 4-11-83

(PI)

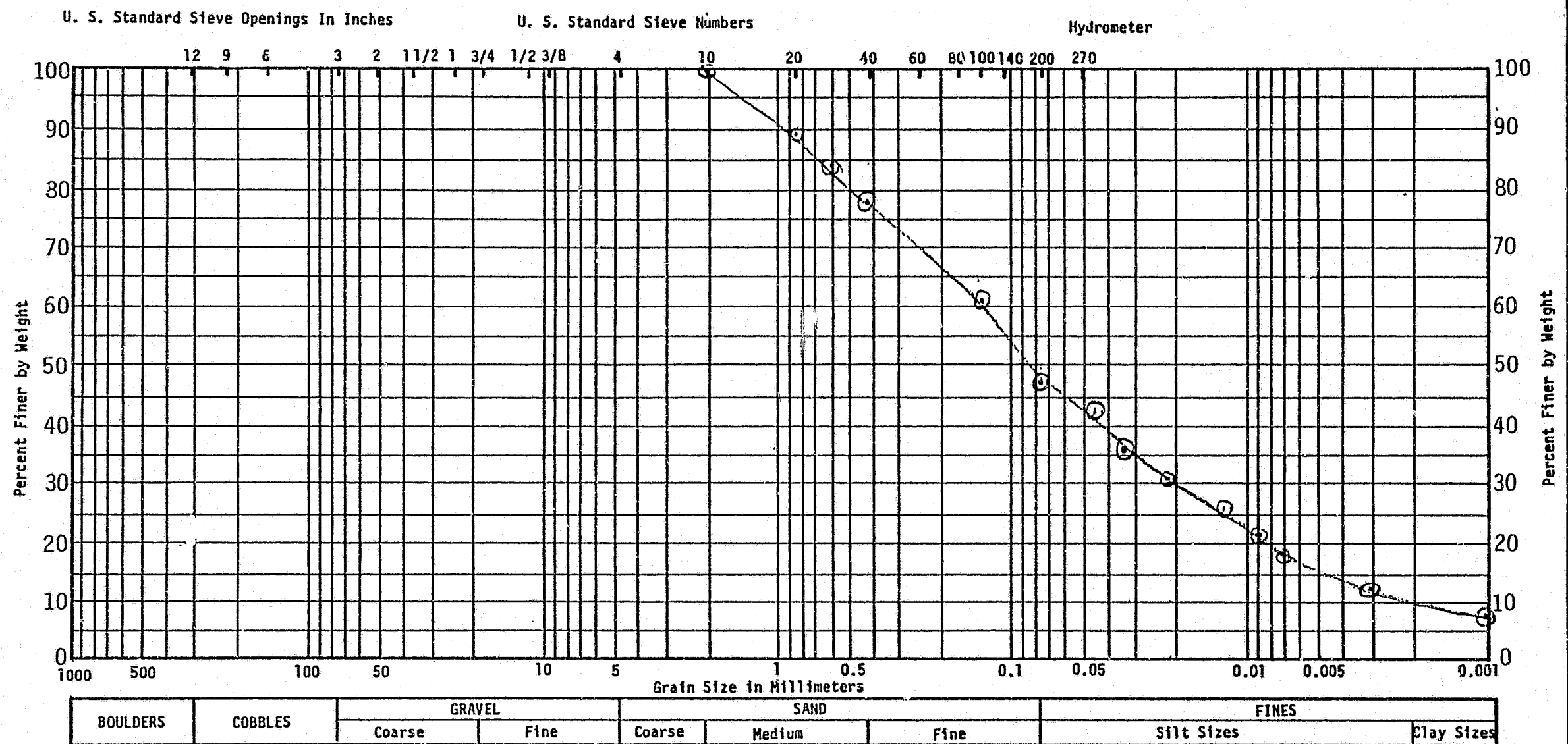
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08				
		☐ GILSON		☐ BRASS SIEVE		☒ HYDROMETER					
Project WATANA DAM				Hole AS-17		Depth 5-7 ⁵ #1					
Dry WT Total Sample & Tare		TOTAL SAMPLE									
Tare Weight MA 16		Classification <i>dark grey silty sand (SM)</i>									
Total Sample WT		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing				
Moisture Content -10 Material		4"	101.6								
		3"	76.2								
		2"	50.8								
Can No. J		1 1/2"	38.1								
WT-Soil & Can (Wet) 37.10		1"	25.4								
WT-Soil & Can (Dry) 36.95		3/4"	19.1								
Loss .15		1/2"	12.7								
Weight of Can 10.78		#4	4.6								
WT of Soil (Dry) 26.17		#10	2.0								
% Moisture .6		Pan									
		Total									
REPRESENTATIVE MINUS NO. 10 SAMPLE											
WT Representative Sample 69.35 grams		Jar # L		WT Washed Sample & Tare 126		Tare Weight 40.33					
				Washed Sample Weight 85.67							
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing				
10	2.000	0				0.0	100.0				
20	0.850	7				10.2	89.8				
30	0.600	11				15.6	84.0				
40	0.425	15				21.8	78.2				
100	0.150	27				39.2	60.8				
200	0.075	36				52.2	47.8				
270	0.053										
Pan		36									
Total											
HYDROMETER SAMPLE											
Specific Gravity (G) 2.75 (assumed)		LL 18 PI 16		Hydrometer No.		Amyl Alcohol Drops: _____					
a = 0.98		Corrected Weight of Hydrometer Sample 68.9 grams			Defloculation Agent						
1030 Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl. Actual		Rc	L	Corrected Gram Size, Dia. MM	% of Total Passing	
31	1	0.078	15.0	0.0140	39.3	39.0	8.0	10.1	0.045	42.7	
32	2	0.055	15.0	"	34.5	33.2	"	10.9	0.033	35.6	
35	5	0.035	15.0	"	30.2	29.2	"	11.5	0.021	30.2	
45	15	0.020	15.0	"	26.1		"	12.0	0.013	25.7	
1100	30	0.014	15.0	"	23.0		"	12.5	0.009	21.3	
1130	60	0.010	15.0	"	21.2		"	12.9	0.007	18.2	
1430	240	0.005	15.0	"	17.0		"	13.8	0.003	12.8	
1030	1440	0.002	15.0	0.0134	11.5		7.1	14.3	0.001	7.7	
									Cc		
Tested by: ANR/G.B.									Computed by: MA	Checked by: MA	Cu

LF 135-MA



HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS-17	1	5-7 ⁵		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032.003.08
Contains organics.					Date 4-12-83

LF 141-GSA

HLA HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

ATTERBERG LIMITS DETERMINATION

PROJECT: Watana Dam

DATE:

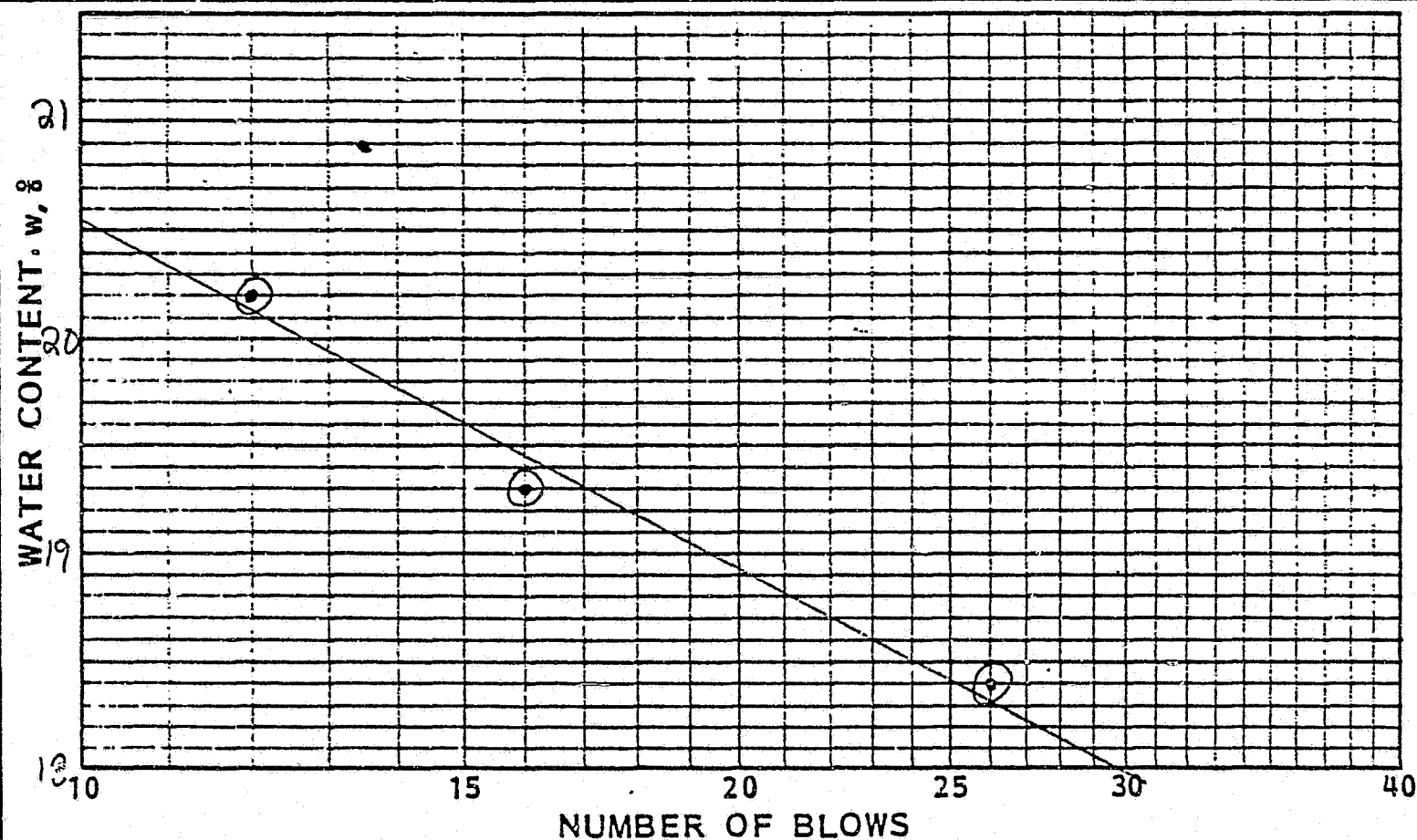
HOLE NO. AS 17

SAMPLE NO. #1 (5-7⁵)

JOB NO. 15032, 003 08

LIQUID LIMIT

RUN NO.	1	2	3	4	5	6
TARE NO.	A-19	A-6	A-34			
WEIGHT IN GRAMS						
TARE PLUS WET SOIL	58.00	47.54	49.76			
TARE PLUS DRY SOIL	50.09	41.68	43.77			
WATER	7.91	5.86	5.99			
TARE	10.84	11.35	11.30			
DRY SOIL	39.25	30.33	32.47			
WATER CONTENT, %	20.2	19.3	18.4			
NUMBER OF BLOWS	12	16	26			



LL	18.4	18
PL	16.15	16
PI	2.25	2

SOIL SYMBOL FROM PLASTICITY CHART ML

PLASTIC LIMIT

RUN NO.	1	2	3	4	5	NATURAL WATER CONTENT
TARE NO.	A-11	A.				
WEIGHT IN GRAMS						
TARE PLUS WET SOIL	11.75	11.83				
TARE PLUS DRY SOIL	10.73	10.79				
WATER	1.02	1.04				
TARE	4.37	4.35				
DRY SOIL	6.36	6.44				
WATER CONTENT, %	16.0	16.1				
PLASTIC LIMIT, % _p						

AVG. 16.15

REMARKS: -40 PORTION OF SAMPLE IS A ML

TESTED BY: MA
COMPUTED BY: G.B.
CHECKED BY: MA



FIELD IDENTIFICATION PROCEDURES FOR FINE-GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking)

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky. Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics)

After removing particles larger than No. 40 sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun, or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity. High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

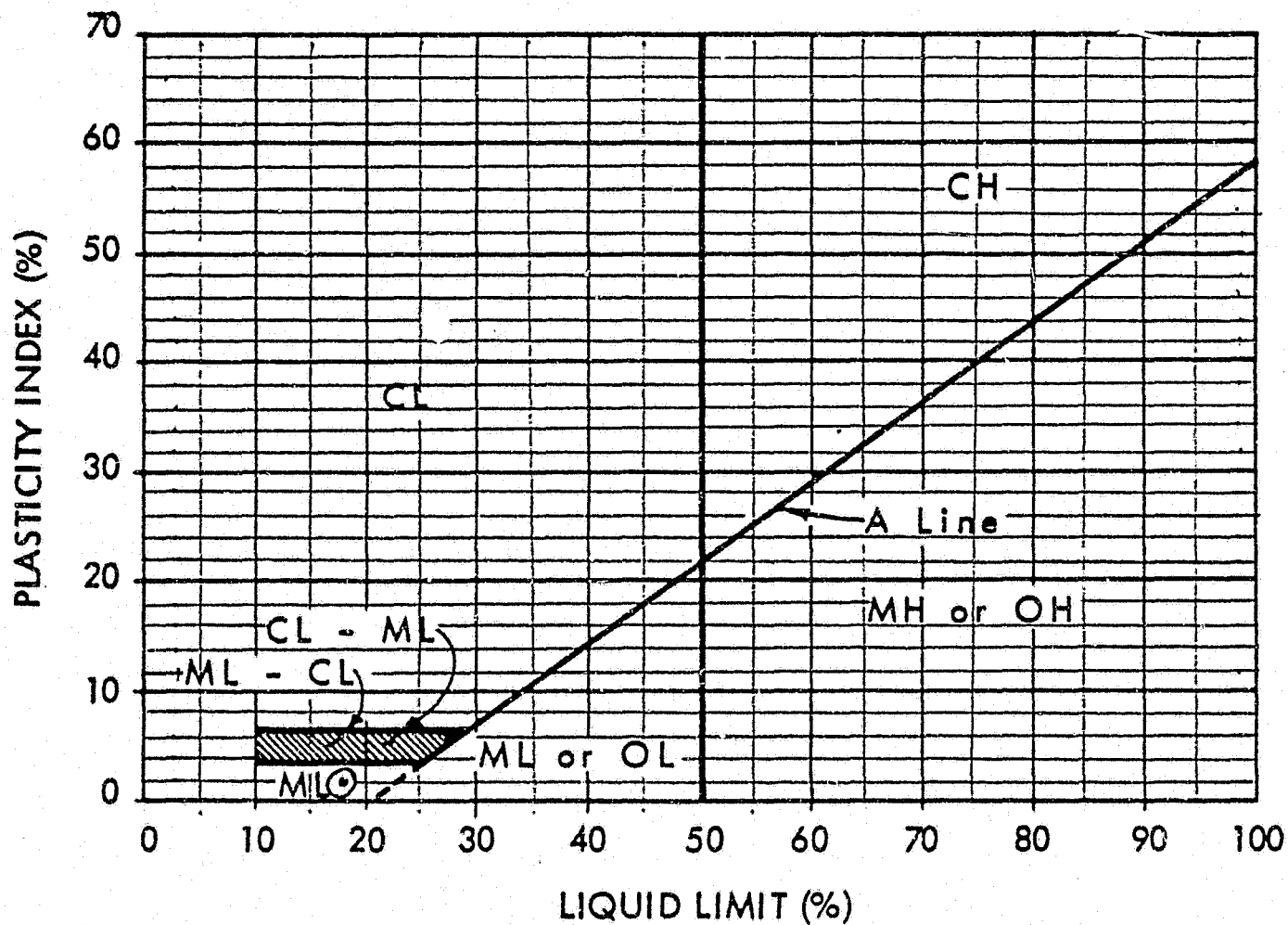
Toughness (Consistency near plastic limit)

After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size is molded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and rerolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.



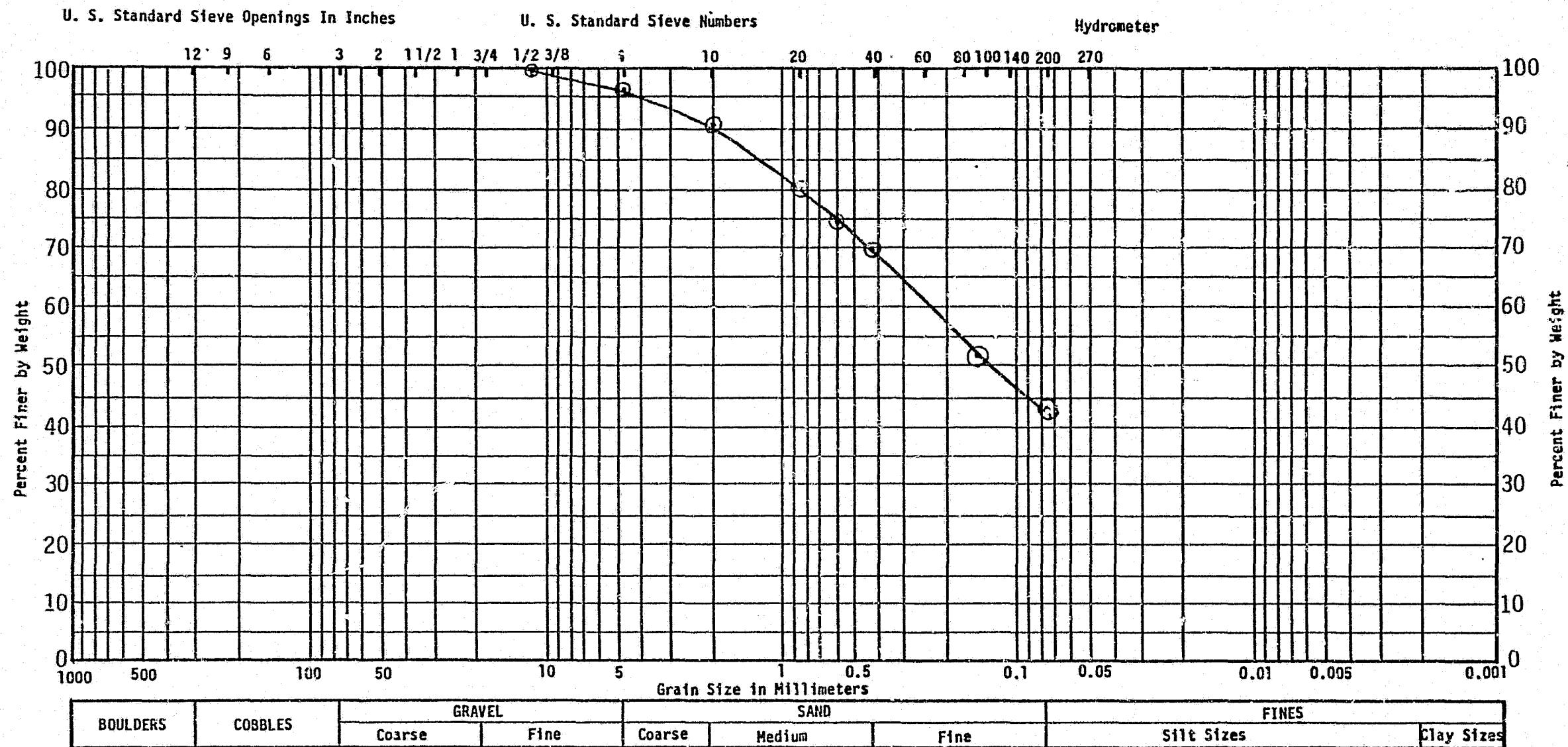
7
0
0
0
3(G_s) (PI)

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08		
		☐ GILSON	☒ BRASS SIEVE	☒ HYDROMETER					
Project WATANA DAM				Hole AS-17		Depth 7 ⁵ 10° #2			
Dry WT Total Sample & Tare		1228	TOTAL SAMPLE						
Tare Weight 1m		428	Classification <i>dark grey silty & clayey sand (SM-SC)</i>						
Total Sample WT		800	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing	
Moisture Content -10 Material			4"	101.6					
			3"	76.2					
			2"	50.8					
Can No.			1 1/2"	38.1					
WT-Soil & Can (Wet)			1"	25.4					
WT-Soil & Can (Dry)			3/4"	19.1					
Loss			1/2"	12.7	0			0 100	
Weight of Can			#4	4.6	31			3.9 96.1	
WT of Soil (Dry)			#10	2.0					
% Moisture			Pan						
			Total						
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample		grams	Jar #		WT Washed Sample & Tare		882		
					Tare Weight		722		
					Washed Sample Weight		459		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret. Passing			
10	2.000	79				7.9		92.1	
20	0.850	160				20.0		80.0	
30	0.600	202				25.3		74.7	
40	0.425	244				30.5		69.5	
100	0.150	391				48.9		51.1	
200	0.075	452				56.5		43.5	
270	0.053								
Pan		455							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL <u>21</u> CL-ML		Hydrometer No.		Amyl Alcohol Drops: _____			
		PI <u>4</u>							
a =		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent			
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	R _c		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: <i>GRM</i>		Computed by: <i>GRM</i>		Checked by: <i>MR</i>		Cc			
						Cu			

LF 135 - MA

HARDING LAWSON ASSOCIATES
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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS-17	2	75-100		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003,08
Gravel subangular + subrounded + some is smooth. Contains organic matter.					Date 4-11-83

LF 141-GSA

HILA HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

000373

ATTERBERG LIMITS DETERMINATION

PROJECT: Watana Dam

DATE:

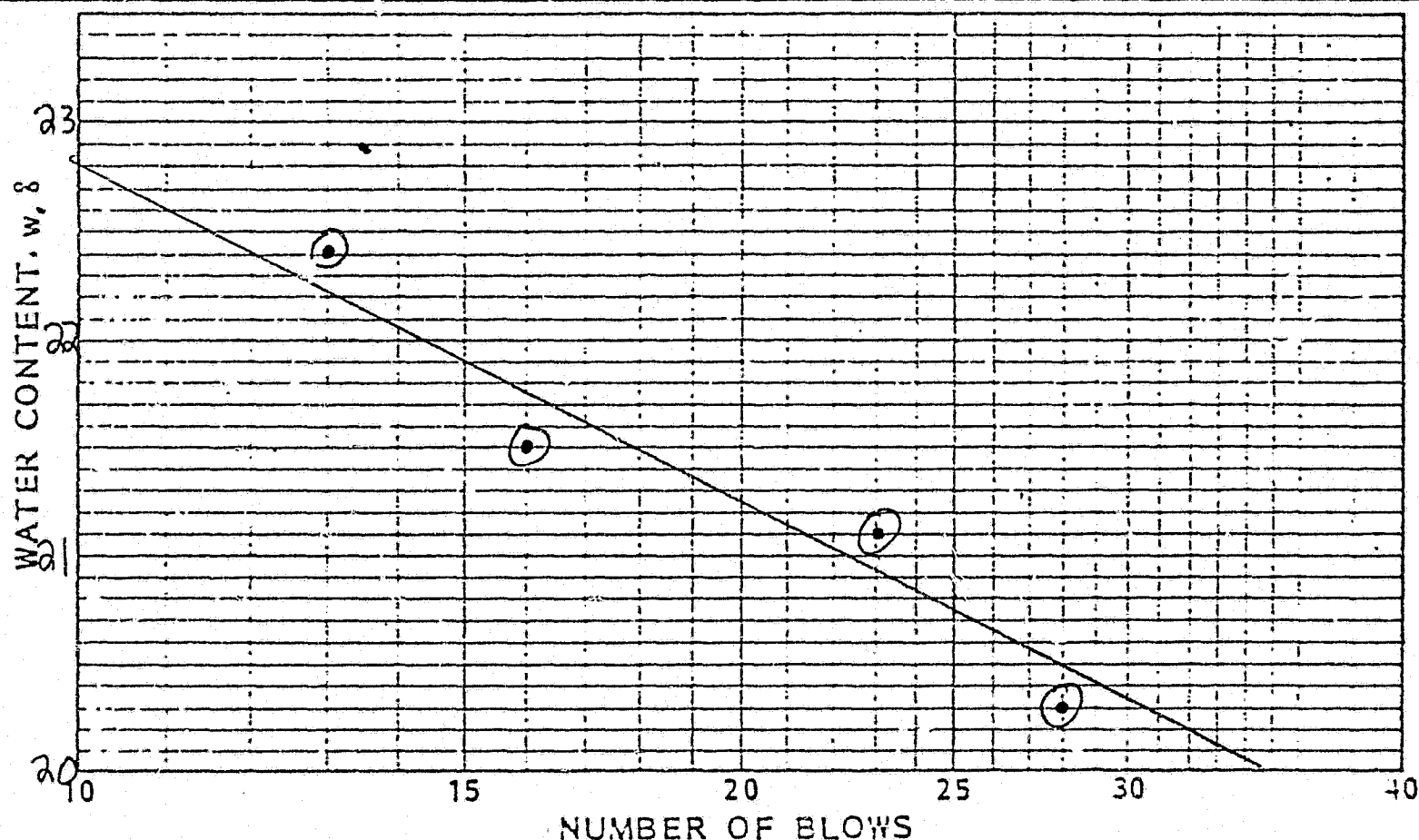
HOLE NO. AS 17

SAMPLE NO. #2 (7.5-10)

JOB NO. 15032, 003.02

LIQUID LIMIT

RUN NO.	1	2	3	4	5	6
TARE NO.	7	G	A-37	A-10		
WEIGHT IN GRAMS						
TARE PLUS WET SOIL	48.19	48.65	43.00	49.37		
TARE PLUS DRY SOIL	41.44	42.02	37.49	42.93		
WATER	6.75	6.63	5.51	6.44		
TARE	11.24	11.23	11.35	11.23		
DRY SOIL	30.20	30.81	26.14	31.70		
WATER CONTENT, %	22.4	21.5	21.1	20.3		
NUMBER OF BLOWS	13	16	23	28		



LL 20.75 21.0
PL 17.05 17.0
PI 3.70 4.0

SOIL SYMBOL FROM PLASTICITY CHART CL - ML

PLASTIC LIMIT

RUN NO.	1	2	3	4	5	NATURAL WATER CONTENT
TARE NO.	A-37	A-30				
WEIGHT IN GRAMS						
TARE PLUS WET SOIL	8.94	10.61				
TARE PLUS DRY SOIL	8.28	9.72				
WATER	.66	.89				
TARE	4.41	4.41				
DRY SOIL	3.81	5.31				
WATER CONTENT, %	17.3	16.8				
PLASTIC LIMIT, %	AVG. 17.05					

REMARKS: -40 PORTION OF SAMPLE IS A CL - ML

TESTED BY: MA
COMPUTED BY: G.B.
CHECKED BY: MA

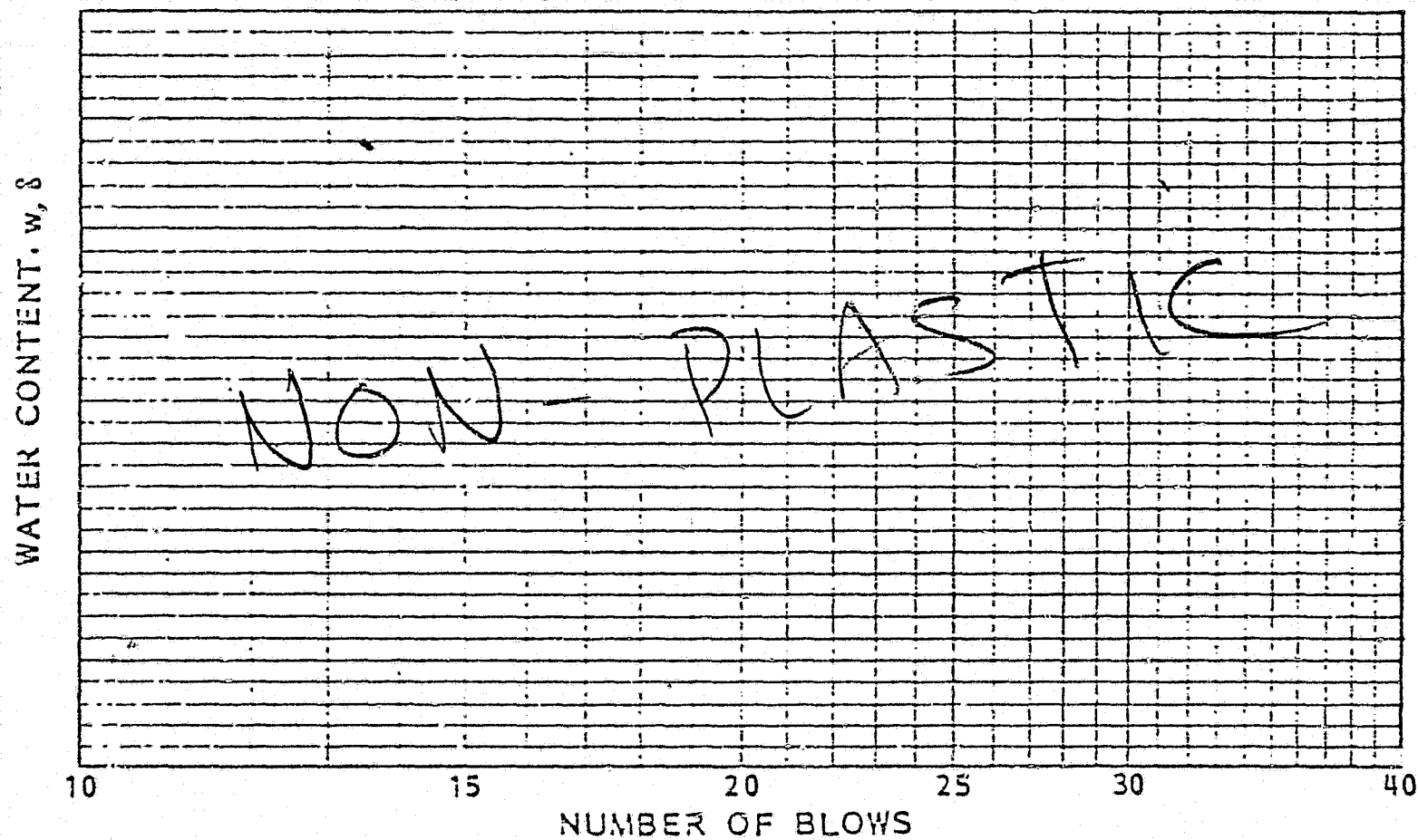
LF 13 - 21



HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

ATTERBERG LIMITS DETERMINATION

PROJECT: <u>Watana Dam</u>				DATE: _____		
HOLE NO. <u>AS 18</u>		SAMPLE NO. # <u>(5-7)</u>		JOB NO. <u>15032, 003 08</u>		
LIQUID LIMIT						
RUN NO.	1	2	3	4	5	6
TARE NO.	<u>I</u>	<u>A-36</u>	<u>A-29</u>			
WEIGHT IN GRAMS	TARE PLUS WET SOIL	<u>45.80</u>	<u>59.13</u>	<u>66.89</u>		
	TARE PLUS DRY SOIL					
	WATER	w_w				
	TARE	<u>11.27</u>	<u>11.36</u>	<u>11.30</u>		
	DRY SOIL	w_s				
WATER CONTENT, %		w				
NUMBER OF BLOWS		<u>21</u>	<u>10</u>	<u>25</u>		



LL
PL
PI

SOIL SYMBOL FROM PLASTICITY CHART

PLASTIC LIMIT						NATURAL WATER CONTENT
RUN NO.	1	2	3	4	5	
TARE NO.	<u>A-13</u>					
WEIGHT IN GRAMS	TARE PLUS WET SOIL					
	TARE PLUS DRY SOIL					
	WATER					
	TARE	<u>4.42</u>				
	DRY SOIL					
WATER CONTENT, %						
PLASTIC LIMIT, p						
REMARKS:						TESTED BY: <u>MA</u> COMPUTED BY: _____ CHECKED BY: _____

LF 151-2



HARDING LAWSON ASSOCIATES
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FIELD IDENTIFICATION PROCEDURES FOR FINE-GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1.04 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking)

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky. Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics)

After removing particles larger than No. 40 sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun, or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

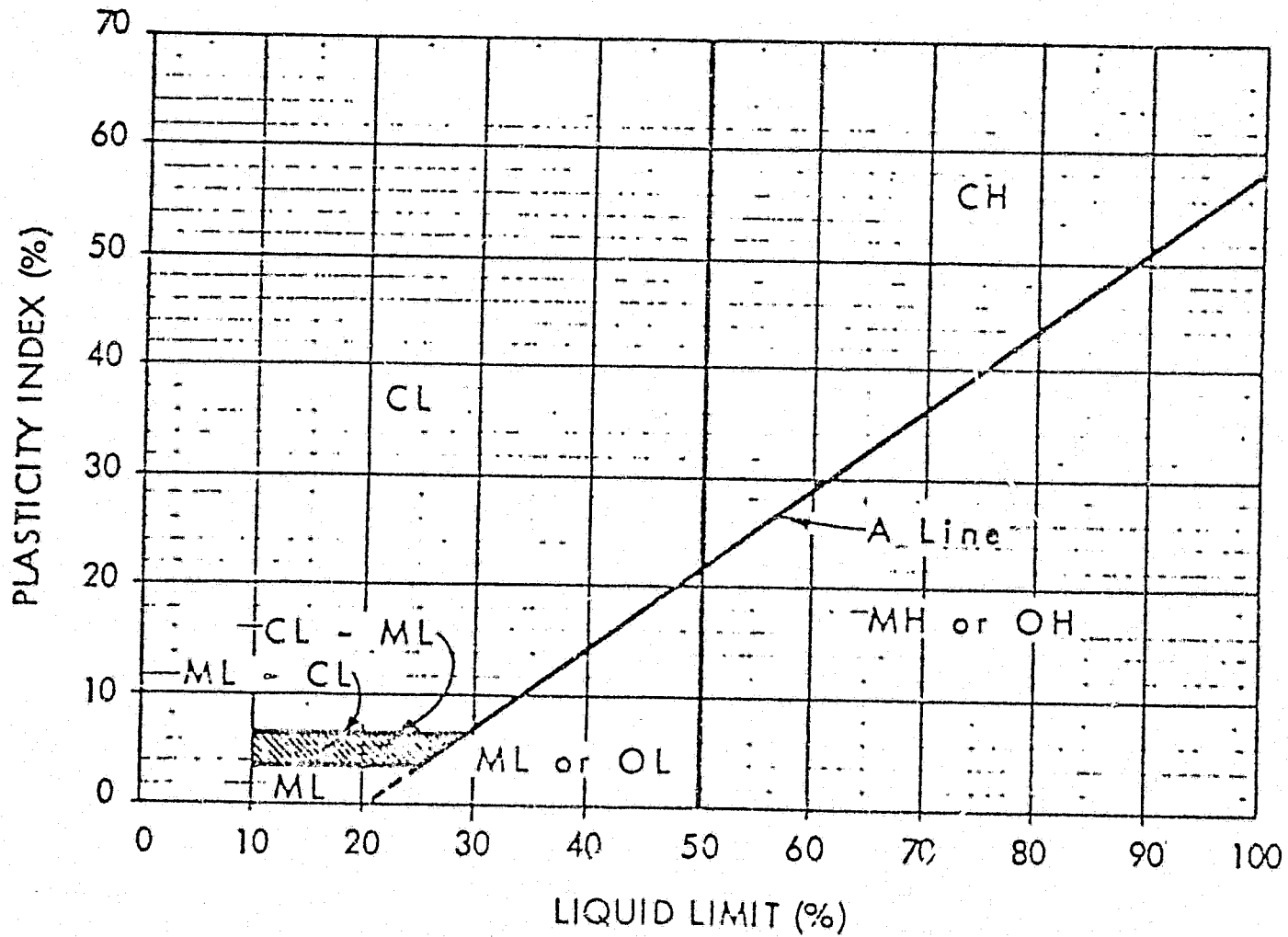
Toughness (Consistency near plastic limit)

After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size is molded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and rerolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity and crumbles when the plastic limit is reached.

After the thread crumbles the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin type clays and organic clays which occur below the A-line.

Highly organic clays have a very peak and spongy feel at the plastic limit.



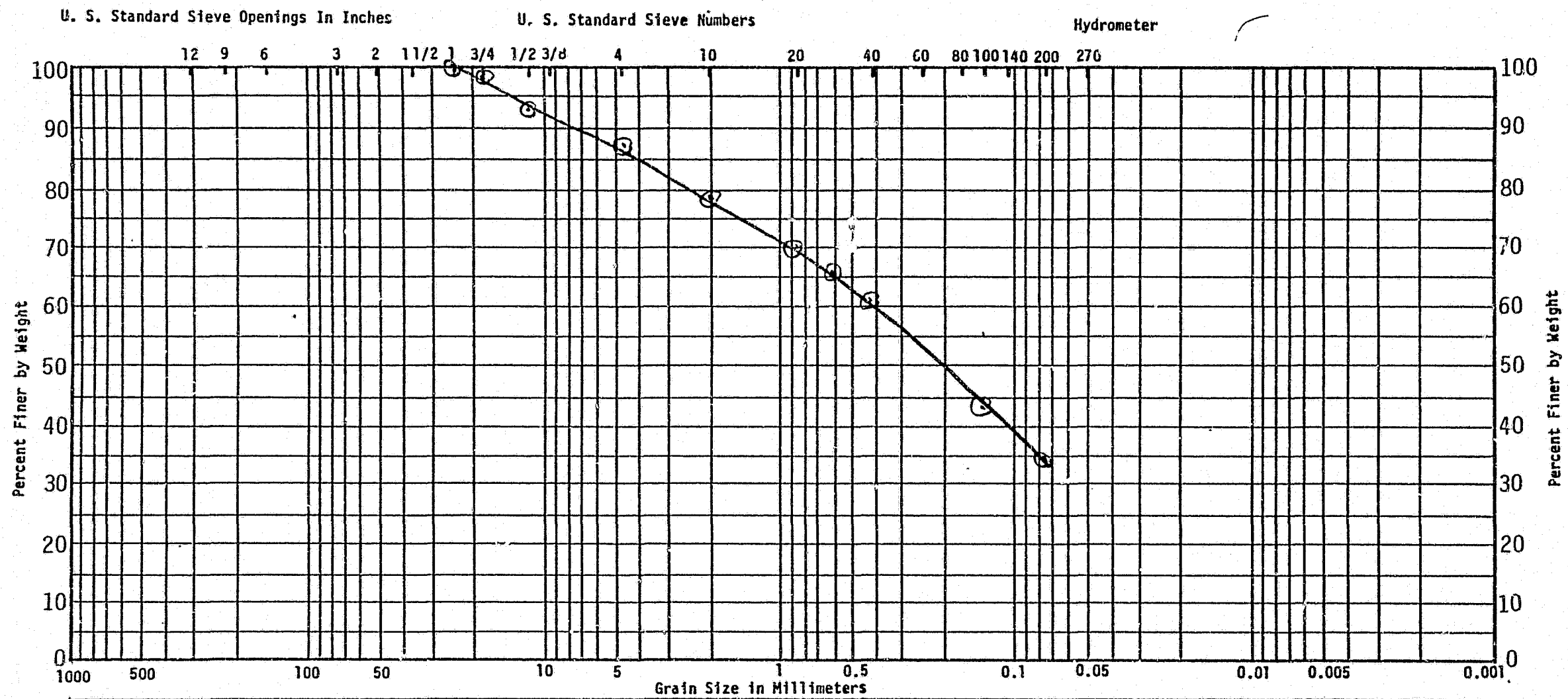
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER				
Project WATANA DAM				Hole AS-19		Depth 5'-7' #2				
Dry WT Total Sample & Tare		1559		TOTAL SAMPLE						
Tare Weight 22		536		Classification <i>dark grey gravelly silty sand (sm)</i>						
Total Sample WT		1023		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing	
Moisture Content -10 Material				4"	101.6					
				3"	76.2					
				2"	50.8					
Can No.				1 1/2"	38.1					
WT-Soil & Can (Wet)				1"	25.4	0			0 100	
WT-Soil & Can (Dry)				3/4"	19.1	15			1.5 98.5	
Loss				1/2"	12.7	71			6.9 93.1	
Weight of Can				#4	4.6	133			13.0 97.0	
WT of Soil (Dry)				#10	2.0					
% Moisture				Pan						
				Total						
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare		1210		
						Tare Weight		536		
						Washed Sample Weight		674		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret. Passing				
10	2.000	214				22.9 77.1				
20	0.850	327				30.0 70.0				
40	0.600	353				34.5 65.5				
100	0.425	401				39.2 60.8				
200	0.150	580				56.7 43.3				
270	0.075	667				65.2 34.8				
Pan		673								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)		LL _____ PI _____		Hydrometer No.		Amyl Alcohol Drops: _____				
a =		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent				
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc			
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
Tested by: CRN		Computed by: CPM		Checked by: M A		Cc		Cu		

LF 135-MA



HARDING LAWSON ASSOCIATES
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GRADATION SIZE ANALYSIS



BOULDERS		COBBLES		GRAVEL		SAND		FINES	
				Coarse	Fine	Coarse	Medium	Fine	Clay Sizes
LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)					Job
	AS-19	2	5'-7'						WATANA DAM
VISUAL MANUAL CLASSIFICATION				Gravel mostly subangular with a few sub-rounded. Contains some organic.					No. 15032,003.08
									Date 4-10-83

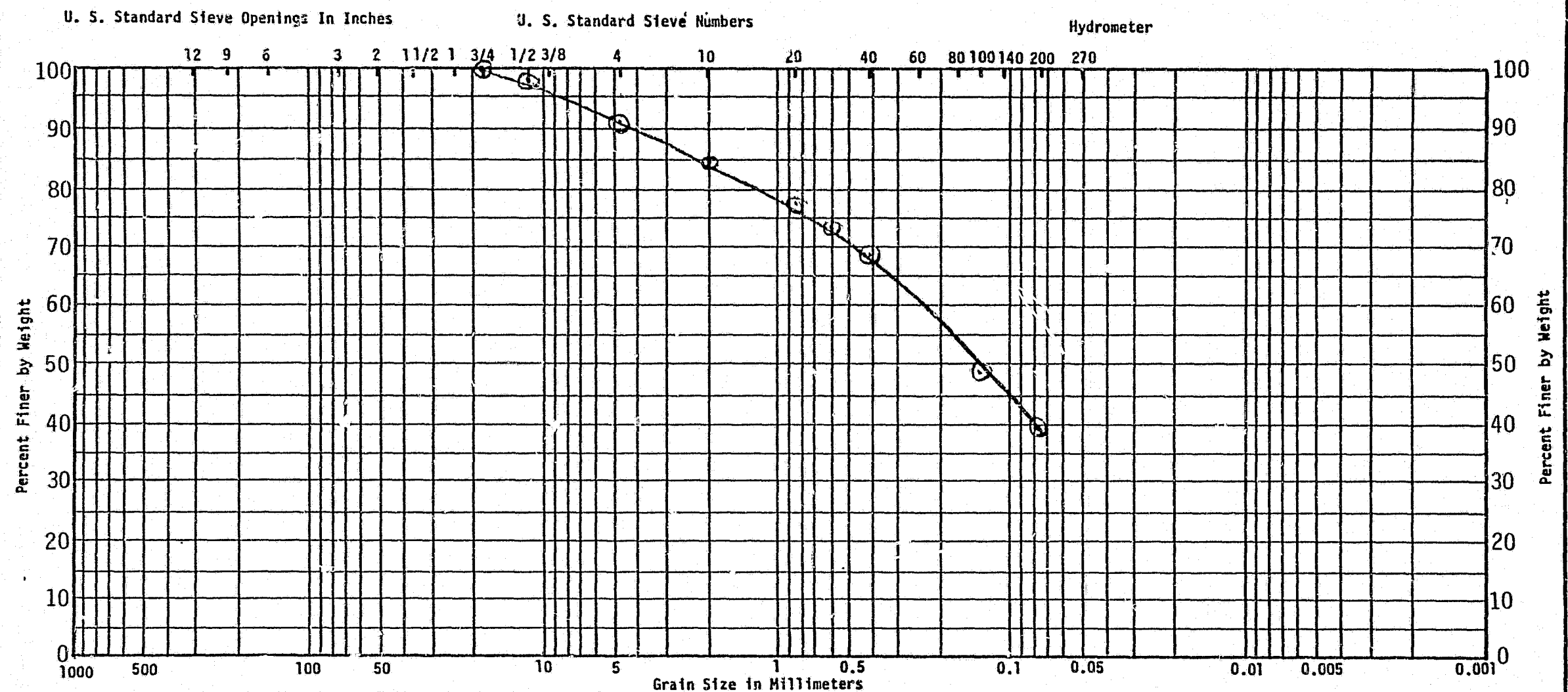
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER				
Project WATANA DAM				Hole AS 21		Depth 3-4 #2				
Dry WT Total Sample & Tare		1879		TOTAL SAMPLE						
Tare Weight SD-3		555		Classification <i>olive brown gravelly silty sand (sm)</i>						
Total Sample WT		1324		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing	
Moisture Content -10 Material		4"		101.6						
		3"		76.2						
		2"		50.8						
Can No.		1 1/2"		38.1						
WT-Soil & Can (Wet)		1"		25.4						
WT-Soil & Can (Dry)		3/4"		19.1		0			0 100	
Loss		1/2"		12.7		16			1.2 98.8	
Weight of Can		#4		4.6		122			9.2 90.8	
WT of Soil (Dry)		#10		2.0						
% Moisture		Pan								
		Total								
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample _____ grams				Jar # _____		WT Washed Sample & Tare		1363		
						Tare Weight		555		
						Washed Sample Weight		808		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	200				15.1	84.9			
20	0.850	301				22.7	77.3			
30	0.600	354				26.7	73.3			
40	0.425	414				31.3	68.7			
100	0.150	682				51.5	48.5			
200	0.075	801				60.5	39.5			
270	0.053									
Pan		806								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)		LL _____ PI _____		Hydrometer No. _____		Amyl Alcohol Drops: _____				
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____				
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl. Actual Rc			L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
Tested by: C.R.M.		Computed by: C.R.M.		Checked by: M.H.		Cc		Cu		

LF 135-MA



HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS-21</u>	<u>2</u>	<u>3'-4'</u>		No. <u>15032,003.08</u>
VISUAL MANUAL CLASSIFICATION <u>Saturated. Contains some organics.</u>					Date <u>4-10-83</u>

LF 141-GSA

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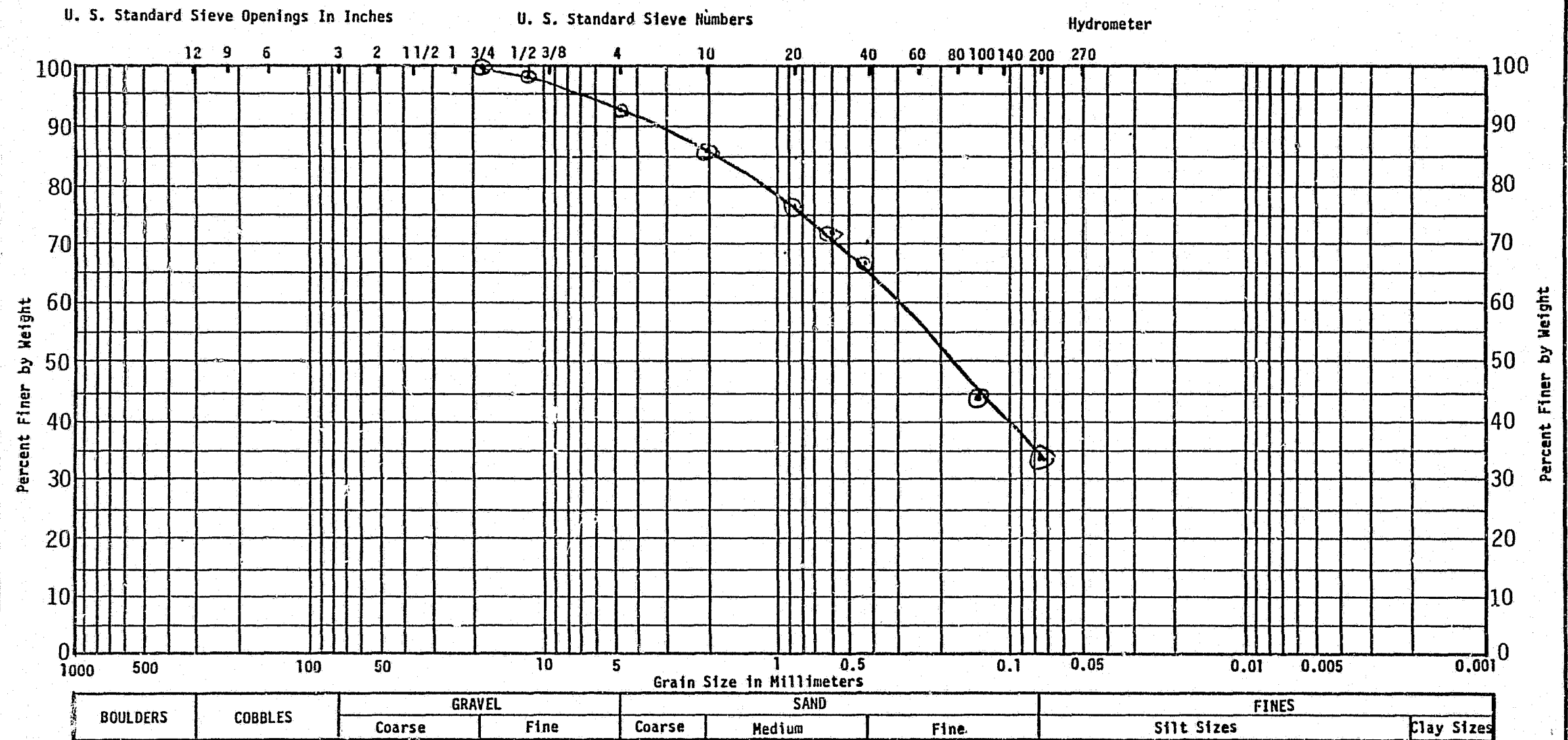
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. 15032,003.08			
		☐ GILSON	☒ BRASS SIEVE	☐ HYDROMETER					
Project WATANA DAM				Hole AS 23		Depth 3'-5' #2			
Air Dry WT Total Sample & Tare		1426.0		TOTAL SAMPLE					
Tare Weight 1Q		536		Classification <i>olive gravelly silty sand (sm)</i>					
Total Sample WT		890.0		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.		
						% Ret.	Cum. % of Total Ret. Passing		
Moisture Content -10 Material		4"		101.6					
		3"		76.2	0		0 100		
		2"		50.8	0		0 100		
Can No.		1 1/2"		38.1	0		0 100		
WT-Soil & Can (Wet)		1"		25.4	0		0 100		
WT-Soil & Can (Dry)		3/4"		19.1	0		0 100		
Loss		1/2"		12.7	16.0		1.8 98.2		
Weight of Can		#4		4.6	64.0		7.2 92.8		
WT of Soil (Dry)		#10		2.0					
% Moisture		Pan							
		Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare			
						Tare Weight			
						Washed Sample Weight			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing		
10	2.000	126.0				14.2	85.8		
20	0.850	210.0				23.5	76.4		
30	0.600	254.0				28.5	71.5		
40	0.425	301.0				33.8	66.2		
100	0.150	490.0				55.1	44.9		
200	0.075	587.0				66.0	34.0		
270	0.053								
Pan		595.0							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL		Hydrometer No.		Amyl Alcohol			
		PI				Drops:			
a =		Corrected Weight of Hydrometer Sample				Defloculation Agent			
		grams							
Time	Elap. Time	Maximum Dia. MM	Temp. O.C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: Cpm		Computed by: ckm		Checked by: MWA		Cc			
						Cu			

LF 135-MA



HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS 23</u>	<u>2</u>	<u>3'-5'</u>		No. <u>15032,003.08</u>
VISUAL MANUAL CLASSIFICATION <u>A few clumps of silt + sand mixed, light brown on outside and dark brown on inside. Fine gravel mostly subangular. Some smooth surfaced gravel.</u>					Date <u>4-10-83</u>

(MC)

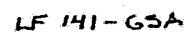
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER				
Project WATANA DAM				Hole AS 24		Depth 1.5-2.5 #1				
Dry WT Total Sample & Tare		961		TOTAL SAMPLE						
Tare Weight IV		559		Classification dark olive gravelly silty sand (sm)						
Total Sample WT		402		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material				4"	101.6					
				3"	76.2					
				2"	50.8					
Can No.				1 1/2"	38.1					
WT-Soil & Can (Wet)				1"	25.4					
WT-Soil & Can (Dry)				3/4"	19.1	0			0	100
Loss				1/2"	12.7	13			4.0	95.3
Weight of Can				#4	4.6	41			10.2	89.7
WT of Soil (Dry)				#10	2.0					
% Moisture				Pan						
				Total						
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample _____ grams				Jar # _____		WT Washed Sample & Tare		317		
						Tare Weight		554		
						Washed Sample Weight		253		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	64				17.2	82.8	53.5		
20	0.850	125				31.1	68.9	% - sand		
30	0.600	123				30.5	61.4			
40	0.425	143				35.6	64.4			
100	0.150	215				53.5	46.5			
200	0.075	256				63.7	36.3	36.2		
270	0.053							% fines		
Pan		258								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)		LL _____		Hydrometer No. _____		Amyl Alcohol Drops: _____				
PI _____										
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____				
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc			
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
Tested by: CRW		Computed by: LCM		Checked by: MA		Cc _____				
						Cu _____				

LF 135-MA



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ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

00037



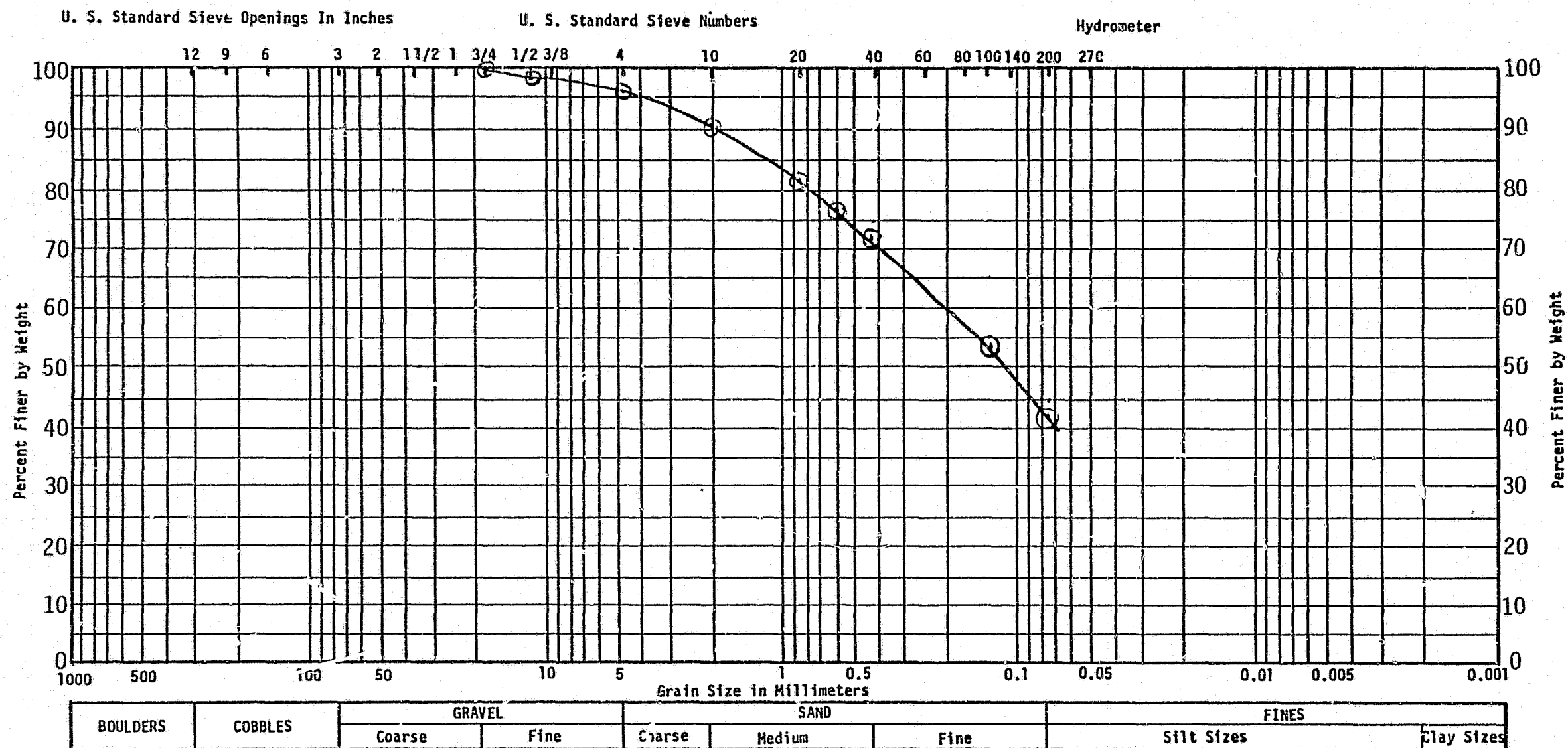
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08		
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER			
Project WATANA DAM					Hole AS 25		Depth 1-2.5 #1		
Dry WT Total Sample & Tare		1259		TOTAL SAMPLE					
Tare Weight SD-12		540		Classification <i>olive brown gravelly silty sand (SM)</i>					
Total Sample WT		719		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	
Moisture Content -10 Material		4"		101.6					
		3"		76.2					
		2"		50.8					
Can No.		1 1/2"		38.1					
WT-Soil & Can (Wet)		1"		25.4					
WT-Soil & Can (Dry)		3/4"		19.1		0		100.0	
Loss		1/2"		12.7		13		98.2	
Weight of Can		#4		4.6		33		95.4	
WT of Soil (Dry)		#10		2.0					
% Moisture		Pan							
		Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample _____ grams				Jar # _____		WT Washed Sample & Tare		962	
						Tare Weight		545	
						Washed Sample Weight		422	
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.		Passing	
10	2.000	70				9.7		90.3	
20	0.850	135				18.8		81.2	
30	0.600	169				23.5		76.5	
40	0.425	204				28.4		71.6	
100	0.150	337				46.9		53.1	
200	0.075	416				57.9		42.1	
270	0.053								
Pan		421							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____		Hydrometer No. _____		Amyl Alcohol Drops: _____			
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____			
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: GIB		Computed by: MA		Checked by: MA		Cc			
						Cu			

LF 135-MA



HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS 25</u>	<u>1</u>	<u>1-2.5</u>		No. <u>15032,003.08</u>
VISUAL MANUAL CLASSIFICATION <u>Contains some organics. also has small clumps of sand + silt or clay which is calc. size.</u>					Date <u>4-11-83</u>

LF 141-05A

HLA HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

1300000

(mC)

Date <u>4/9/83</u>		WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. <u>15032,003.08</u>																																																																																																																														
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER																																																																																																																															
Project <u>WATANA DAM</u>				Hole <u>AS 26</u>		Depth <u>1-2.5 #1</u>																																																																																																																															
Dry WT Total Sample & Tare		<u>763.2</u>		TOTAL SAMPLE																																																																																																																																	
Tare Weight <u>MA-45</u>		<u>88.85</u>		Classification <u>olive silty sand (sm)</u>																																																																																																																																	
Total Sample WT		<u>674.35</u>		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.																																																																																																																														
Moisture Content -10 Material							% Ret.																																																																																																																														
Can No.							Cum. % of Total Ret.																																																																																																																														
WT-Soil & Can (Wet)							Passing																																																																																																																														
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4.2 %
grs.

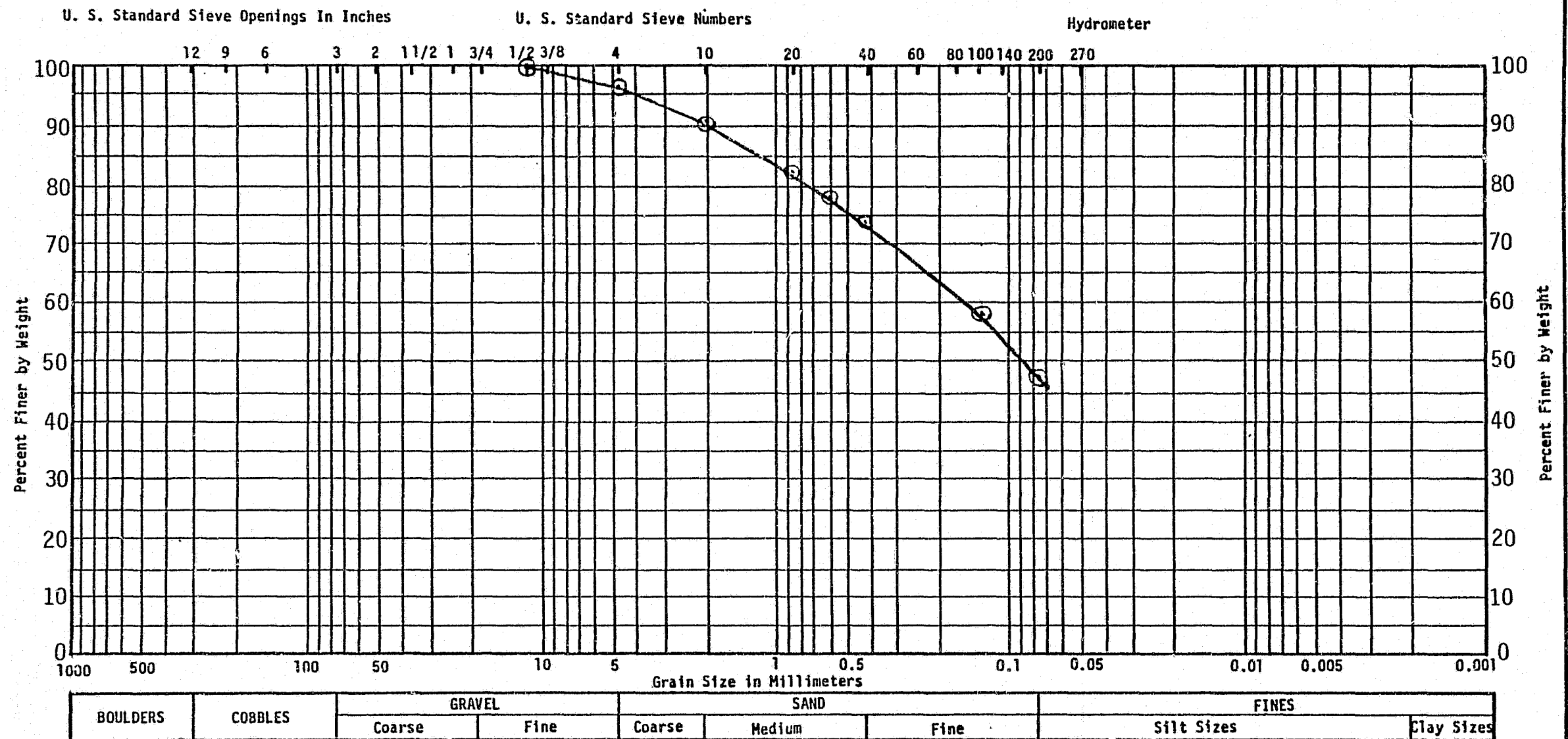
48.7 %
sand

47.1 %
 fines

LF 135 - MA

 **HARDING LAWSON ASSOCIATES**
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 26	1	1-2.5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003.08
Saturated + has large amount of free water.					Date 4-11-83

LF 141-GSA

HLA HARDING LAWSON ASSOCIATES
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65

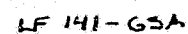
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. 15032,003.08				
		☐ GILSON	☐ BRASS SIEVE	☒ HYDROMETER						
Project WATANA DAM				Hole AS 26		Depth 2.5-4 #2				
Dry WT Total Sample & Tare		TOTAL SAMPLE								
Tare Weight		Classification <i>olive sandy silt (mt)</i>								
Total Sample WT		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing			
Moisture Content -10 Material		4"	101.6							
		3"	76.2							
		2"	50.8							
Can No. K		1 1/2"	38.1							
WT-Soil & Can (Wet) 45.91		1"	25.4							
WT-Soil & Can (Dry) 45.75		3/4"	19.1							
Loss .16		1/2"	12.7							
Weight of Can 10.95		#4	4.6							
WT of Soil (Dry) 34.80		#10	2.0							
% Moisture .5		Pan								
		Total								
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample 71.19 grams		Jar # N		WT Washed Sample & Tare 125.0		Tare Weight 11.7				
				Washed Sample Weight 33.43						
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	0				0.0	100.0			
20	0.850	6				8.5	91.5			
30	0.600	9				12.7	87.3			
40	0.425	12				16.9	83.1			
100	0.150	25				35.3	64.7			
200	0.075	33				46.6	53.4			
270	0.053									
Pan		34								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G) (Tested) 2.75		LL PI		Hydrometer No. C		Amyl Alcohol Drops:				
a = 0.98		Corrected Weight of Hydrometer Sample 70.84 grams			Defloculation Agent					
910 Time	Elap. Time	Maximum Dia. MM	Temp. O C.	K	Reading		L	Corrected Gram Size, Dia. MM	% of Total Passing	
					Initl.	Actual	Rc			
911	1	0.078	15.3	.0139	41.0	39.0	7.8	9.9	0.044	43.2
912	2	0.055	15.3	"	36.1	34.5	"	10.6	0.032	36.9
915	5	0.035	15.3	"	31.0	30.2	"	11.4	0.021	34.0
925	15	0.020	15.5	"	21.2		"	12.9	0.013	28.5
940	30	0.014	15.5	"	23.7					
960	60	0.010	15.3	.0140	20.0		7.7	13.0	0.001	16.1
980	240	0.005	15.0	.0140	15.5		8.0	13.8	0.003	10.4
9910	1440	0.002	20.0	.0133	11.8		6.9	14.3	0.001	6.8
								Cc		
Tested by: JG.B.								Computed by: M.A.	Checked by: M.H.	Cu

LF 135-MA



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00037



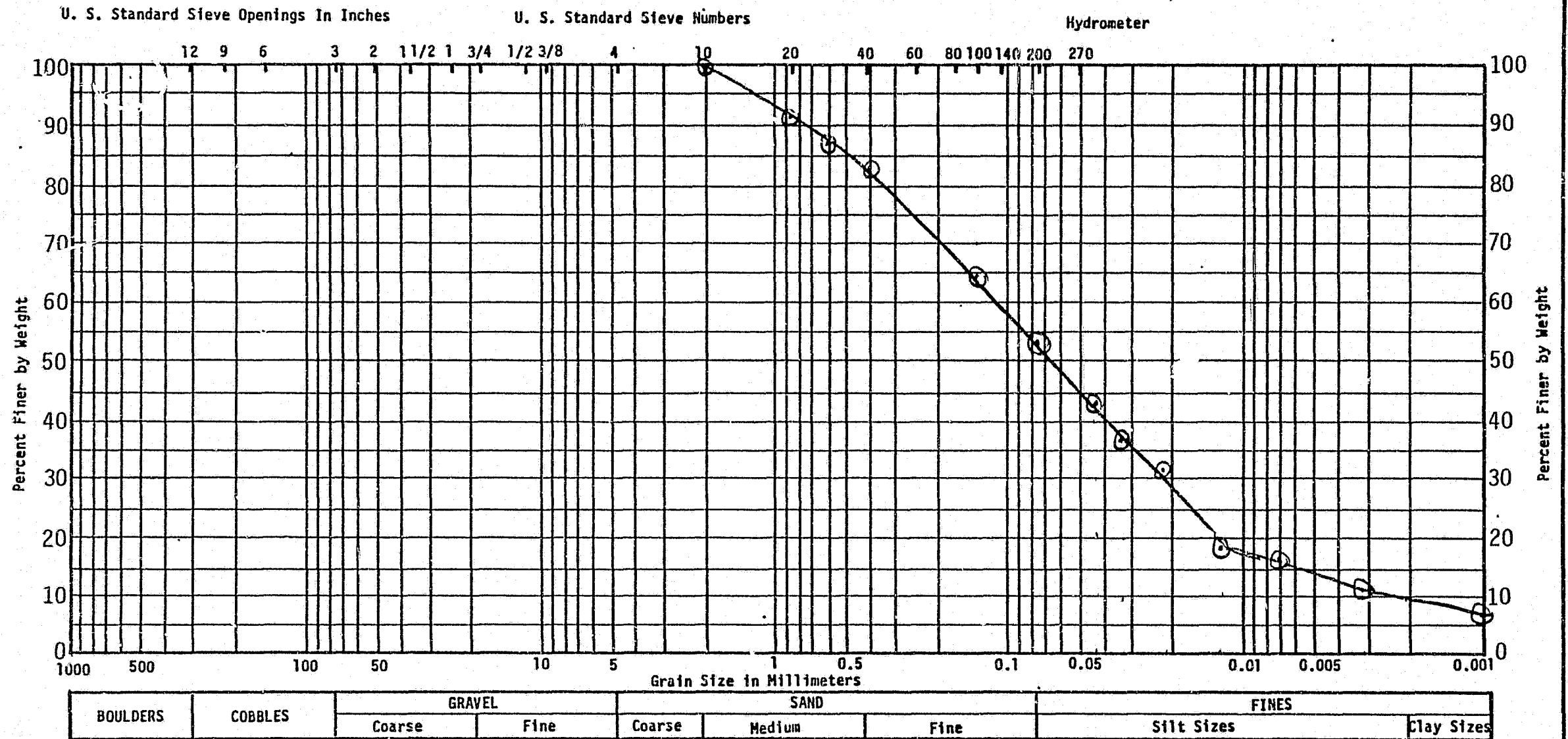
Date <u>4/9/83</u>		WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. <u>15032,003.08</u>				
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER				
Project <u>WATANA DAM</u>				Hole <u>AS 26</u>		Depth <u>7.5-9 #4</u>				
Dry WT Total Sample & Tare <u>1290</u>		TOTAL SAMPLE DOES NOT MEET ASTM STANDARDS								
Tare Weight SD-15 <u>534</u>		Classification <u>olive silty sandy gravel (GM)</u>								
Total Sample WT <u>756</u>		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing			
Moisture Content -10 Material		4"	101.6							
		3"	76.2							
		2"	50.8	0			0 100			
Can No.		1 1/2"	38.1	283			37.4 62.6			
WT-Soil & Can (Wet)		1"	25.4	283			37.4 62.6			
WT-Soil & Can (Dry)		3/4"	19.1	283			37.4 62.6			
Loss		1/2"	12.7	289			38.2 61.8			
Weight of Can		#4	4.6	308			40.7 59.3			
WT of Soil (Dry)		#10	2.0							
% Moisture		Pan								
		Total								
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample _____ grams		Jar # _____		WT Washed Sample & Tare <u>1075</u>						
				Tare Weight <u>534</u>						
				Washed Sample Weight <u>541</u>						
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	331				43.8	56.2			
20	0.850	367				48.5	51.5			
30	0.600	386				51.1	48.9			
40	0.425	406				53.7	46.3			
100	0.150	487				64.1	35.9			
200	0.075	536				70.9	29.1			
270	0.053									
Pan		541								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)		LL _____ PI _____		Hydrometer No. _____		Amyl Alcohol Drops: _____				
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____				
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl. Actual R _c			L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
Tested by: <u>C2m</u>		Computed by: <u>CM</u>		Checked by: <u>MA</u>		Cc		Cu		

LF 135-MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 26	2	2.5-4		WATANA DAM
VISUAL MANUAL CLASSIFICATION <i>gd as some cohesiveness to it.</i>					No. 15032,003.08
					Date 4-12-83

LF 141-GSA

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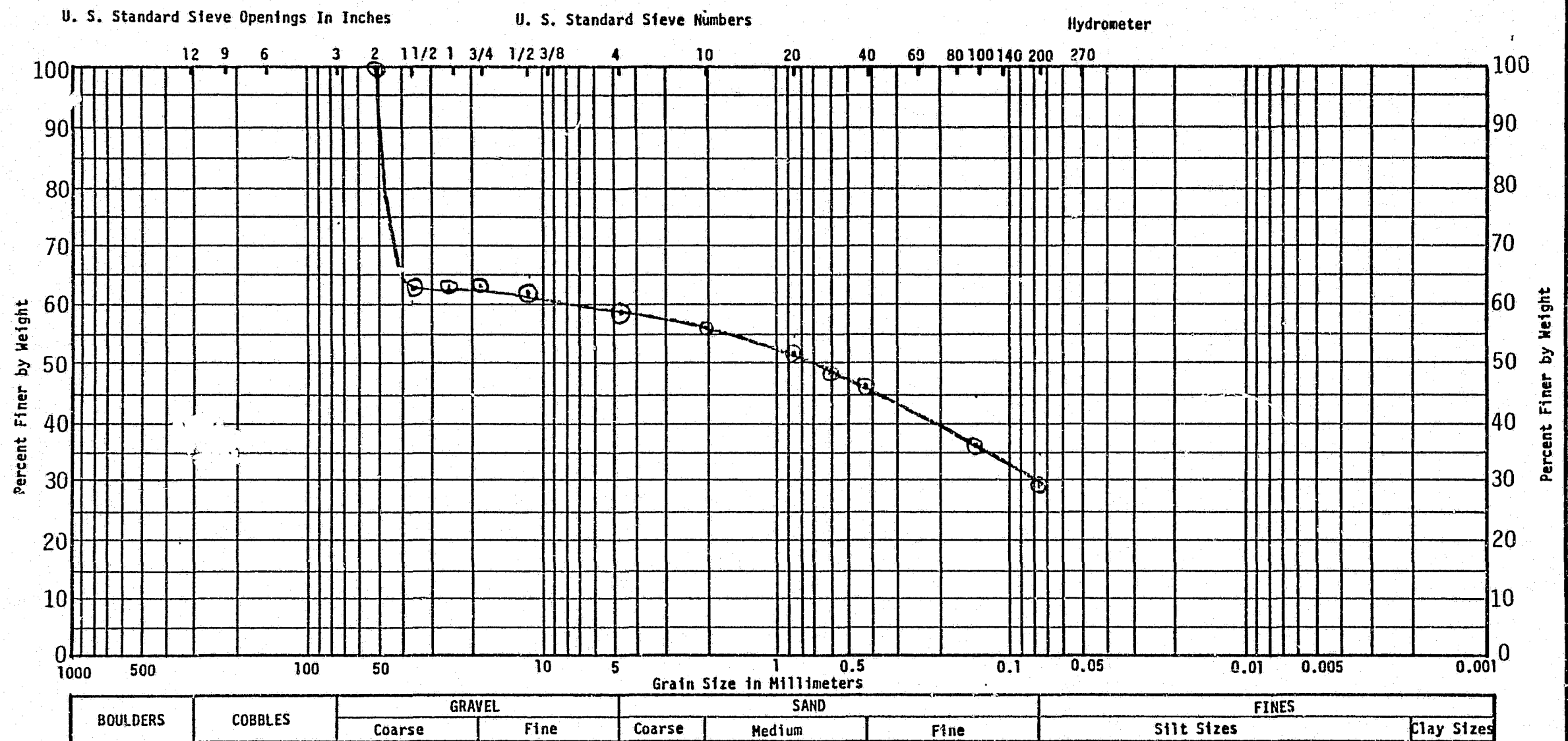
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER			
Project WATANA DAM				Hole AS 27		Depth 3-5 #1			
Dry WT Total Sample & Tare		412.6		TOTAL SAMPLE					
Tare Weight MA-12		88.0		Classification <i>very dark greyish brown gravelly silty sand (Sm)</i>					
Total Sample WT		324.6		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.		
						% Ret.	Cum. % of Total Ret. Passing		
Moisture Content -10 Material		4"		101.6					
		3"		76.2					
		2"		50.8					
Can No.		1 1/2"		38.1					
WT-Soil & Can (Wet)		1"		25.4					
WT-Soil & Can (Dry)		3/4"		19.1		0	6.0 160.0		
Loss		1/2"		12.7		49	15.1 84.9		
Weight of Can		#4		4.6		63	19.4 80.6		
WT of Soil (Dry)		#10		2.0					
% Moisture		Pan							
		Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare 324			
						Tare Weight 88			
						Washed Sample Weight 236			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing		
10	2.000	87				26.8	73.2		
20	0.850	118				36.4	63.6		
30	0.600	133				41.0	59.0		
40	0.425	148				45.6	54.4		
100	0.150	200				61.6	38.4		
200	0.075	233				71.8	28.2		
270	0.053								
Pan		236							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____		Hydrometer No. _____		Amyl Alcohol Drops: _____			
PI _____									
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____			
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: G.B.		Computed by: MA		Checked by: MA		Cc			
						Cu			

LF 135-MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS 26</u>	<u>4</u>	<u>7.5-9</u>		No. <u>15032.003.08</u>
VISUAL MANUAL CLASSIFICATION <u>A few silt + sand clumps. Very small amount of organic</u>					Date <u>4-11-83</u>

LF 141-G3A

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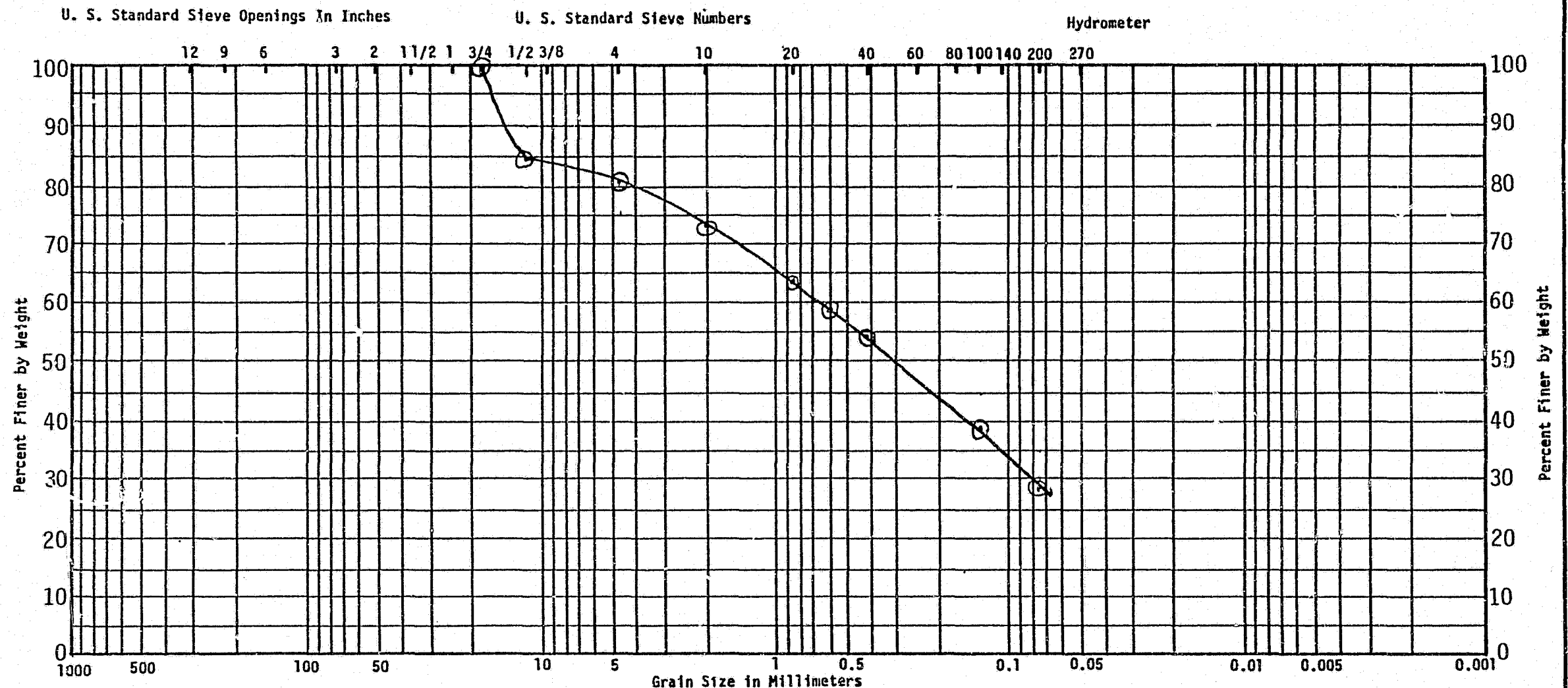
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER				
Project WATANA DAM				Hole AS 28		Depth 1.5-2.5 #1				
Dry WT Total Sample & Tare		1223.0		TOTAL SAMPLE						
Tare Weight F		536		Classification <i>olive brown gravelly silty sand (sm)</i>						
Total Sample WT		687.0		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing	
Moisture Content -10 Material				4"	101.6					
				3"	76.2	0			0 100	
				2"	50.8	0			0 100	
Can No.				1 1/2"	38.1	0			0 100	
WT-Soil & Can (Wet)				1"	25.4	0			0 100	
WT-Soil & Can (Dry)				3/4"	19.1	14.0			2.0 98.0	
Loss				1/2"	12.7	20.0			2.9 97.1	
Weight of Can				#4	4.6	74.0			10.8 89.2	
WT of Soil (Dry)				#10	2.0					
% Moisture				Pan						
				Total						
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample _____ grams				Jar # _____		WT Washed Sample & Tare		1123.0		
						Tare Weight		536.0		
						Washed Sample Weight		487.0		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret. Passing				
10	2.000	129.0				18.8 81.2		58.8		
20	0.850	192.0				27.9 72.1				
30	0.600	224.0				32.6 67.4				
40	0.425	251.0				37.4 62.6				
100	0.150	341.0				57.4 42.6				
200	0.075	478.0				69.6 30.4		30.4 % fines		
270	0.053									
Pan		486.0								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)		LL _____		Hydrometer No. _____		Anyl Alcohol Drops: _____				
PI _____										
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____				
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc			
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
Tested by: CRW		Computed by: CLM		Checked by: MFI		Cc		Cu		

LF 135-MA



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GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 27	1	3-5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003.08
Gravel mostly subangular. Contains organic					Date

LF 141-GSA

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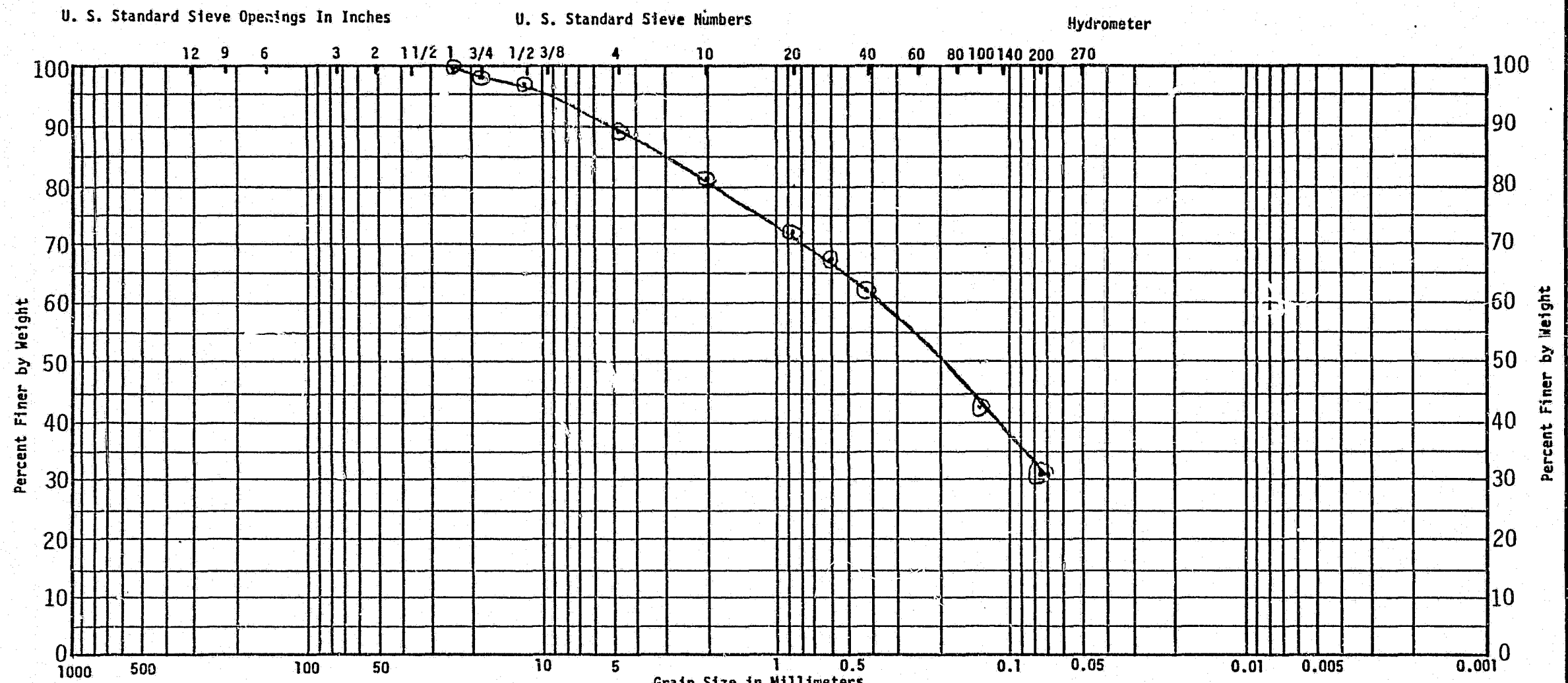
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08		
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER			
Project WATANA DAM				Hole AS 28		Depth 9.5 - 100 #3			
Air Dry WT Total Sample & Tare		1121		TOTAL SAMPLE					
Tare Weight SD-18		545		Classification <i>olive grey gravelly silty sand (sm)</i>					
Total Sample WT		576		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing
Moisture Content -10 Material		4"		101.6					
		3"		76.2					
		2"		50.8					
Can No.		1 1/2"		38.1					
WT-Soil & Can (Wet)		1"		25.4					
WT-Soil & Can (Dry)		3/4"		19.1		0			100
Loss		1/2"		12.7		24			4.2 95.8
Weight of Can		#4		4.6		45			16.5 83.5
WT of Soil (Dry)		#10		2.0					
% Moisture		Pan							
		Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample _____ grams				Jar # _____		WT Washed Sample & Tare		944	
						Tare Weight		545	
						Washed Sample Weight		399	
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret. Passing			
10	2.000	134				23.3		76.7	
20	0.850	182				31.5		68.5	
30	0.600	207				35.9		64.1	
40	0.425	222				40.5		59.5	
100	0.150	237				52.5		47.5	
200	0.075	245				68.6		31.4	
270	0.053								
Pan		245							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____		Hydrometer No.		Amyl Alcohol Drops: _____			
PI _____									
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____			
Time	Elap. Time	Maximum Dia. MM	Temp. O C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: <i>LAH</i>		Computed by: <i>LAH</i>		Checked by: <i>MA</i>				Cc	
								Cu	

LF 135-MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 28	1	1.5 - 2.5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032.003.08
Gravel mostly subangular.					Date 4-10-83

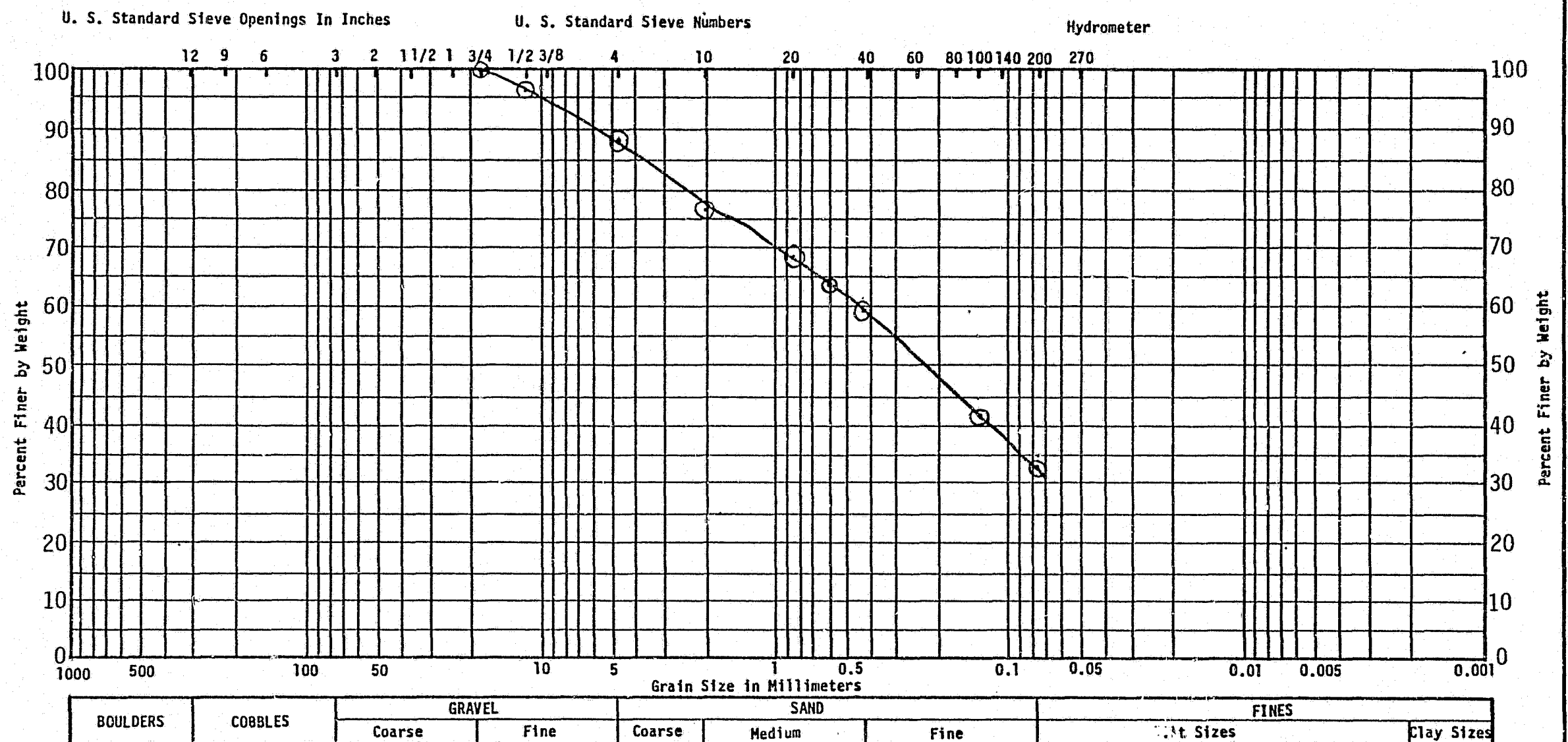
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08		
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER			
Project WATANA DAM				Hole AS 29		Depth 1-2.5 #1			
Air Dry WT Total Sample & Tare		11430		TOTAL SAMPLE					
Tare Weight 1H		427		Classification Olive gravelly silty sand (sm)					
Total Sample WT		7160		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing
Moisture Content -10 Material		4"		101.6					
		3"		76.2		0			0 100
		2"		50.8		0			0 100
Can No.		1 1/2"		38.1		0			0 100
WT-Soil & Can (Wet)		1"		25.4		0			0 100
WT-Soil & Can (Dry)		3/4"		19.1		28.0			3.9 96.1
Loss		1/2"		12.7		41.0			5.7 94.3
Weight of Can		#4		4.6		70.0			9.8 90.2
WT of Soil (Dry)		#10		2.0					
% Moisture		Pan							
		Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample _____ grams				Jar # _____		WT Washed Sample & Tare 895.0		Tare Weight 427.0	
						Washed Sample Weight 468.0			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing		
10	2.000	113.0				15.8	84.2	54.6 % sand	
20	0.850	179.0				25.0	75.0		
30	0.600	213.0				29.7	70.3		
40	0.425	243.0				34.1	65.9		
100	0.150	382.0				53.4	46.6		
200	0.075	461.0				64.4	35.6	35.6 % fines	
270	0.053								
Pan		467.0							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____		Hydrometer No. _____		Amyl Alcohol Drops: _____			
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____			
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: C. M. A.		Computed by: MA		Checked by: MA				Cc	
								Cu	

LF 135-MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 28	3	9.5-100		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032.003.08
					Date 4-11-83

LF 141-GSA

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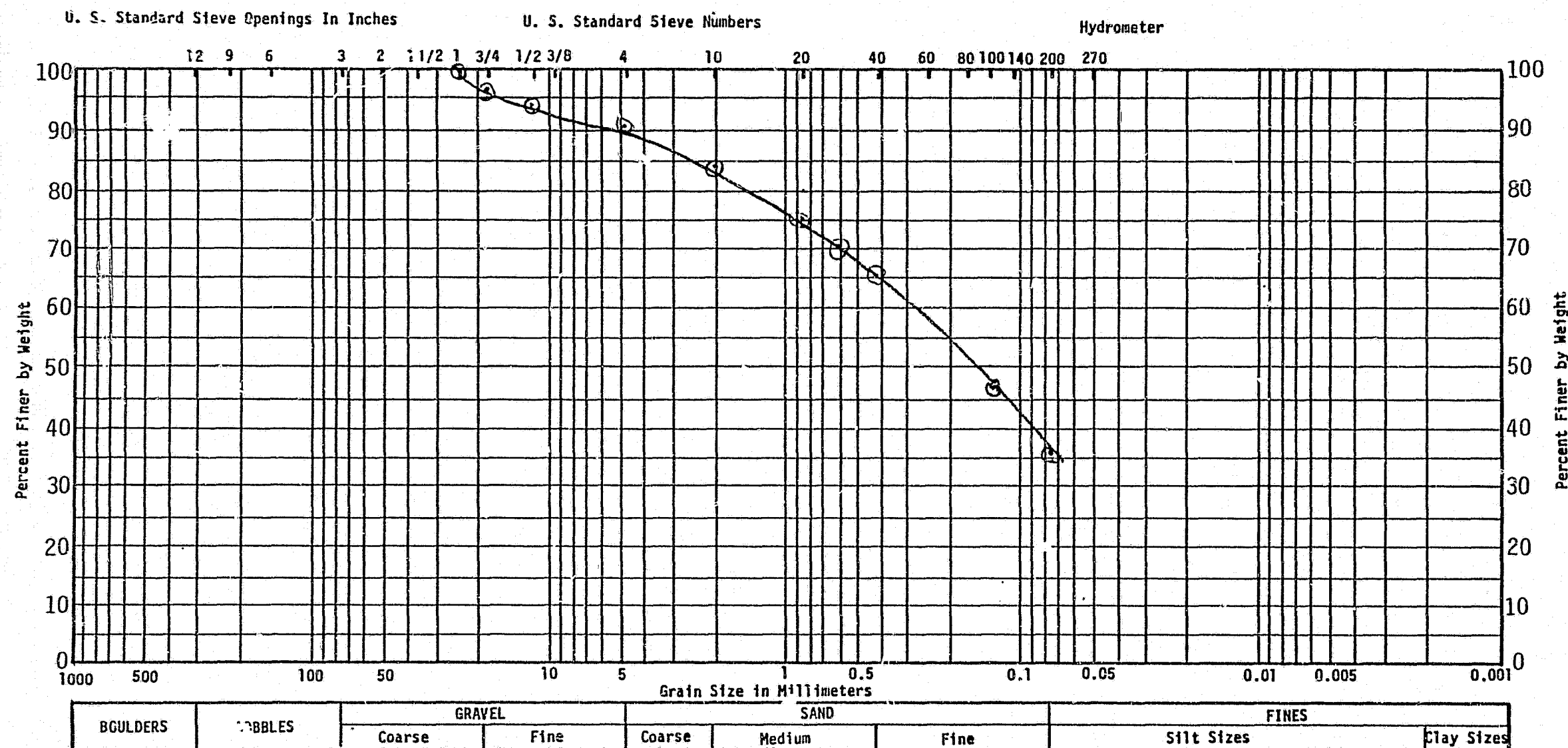
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER				
Project WATANA DAM				Hole AS 29		Depth 6-7.5 #3				
Air Dry WT Total Sample & Tare		1381.0		TOTAL SAMPLE						
Tare Weight 14		541.		Classification <i>Olive gravelly silty sand (sm)</i>						
Total Sample WT		840.0		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing	
Moisture Content -10 Material		4"		101.6						
		3"		76.2		0			0 100	
		2"		50.8		0			0 100	
Can No.		1 1/2"		38.1		0			0 100	
WT-Soil & Can (Wet)		1"		25.4		0			0 100	
WT-Soil & Can (Dry)		3/4"		19.1		0			0 100	
Loss		1/2"		12.7		71.0			8.5 91.5	
Weight of Can		#4		4.6		168.0			20.0 80.0	
WT of Soil (Dry)		#10		2.0						
% Moisture		Pan								
		Total								
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample _____ grams				Jar # _____		WT Washed Sample & Tare		1151.0		
						Tare Weight		541.0		
						Washed Sample Weight		610.0		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret. Passing				
10	2.000	220				26.2 73.8				
20	0.850	289				34.4 65.6				
30	0.600	327				38.9 61.1				
40	0.425	367.0				43.7 56.3				
100	0.150	522.0				62.1 37.9				
200	0.075	606.0				73.1 26.9				
270	0.053									
Pan		610.0								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)		LL _____		Hydrometer No. _____		Amyl Alcohol Drops: _____				
PI _____										
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____				
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc			
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
Tested by: <i>CRM</i>		Computed by: <i>CRM</i>		Checked by: <i>MA</i>				Cc		
								Cu		

LF 135-MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS 29</u>	<u>1</u>	<u>1-2.5</u>		No. <u>15032,003,08</u>
VISUAL MANUAL CLASSIFICATION					Date <u>4-10-83</u>

LF 141-GSA

HILA HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS			Job No.	15032,003.08
		☐ GILSON	☒ BRASS SIEVE	☐ HYDROMETER		

Project WATANA DAM

Hole AS-30

Depth 1-2.5 #1

Air Dry WT Total Sample & Tare	700.1	TOTAL SAMPLE
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Tare Weight MA-32	91.0	Classification	dark brown gravelly silty sand (sm)
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Total Sample WT	609.1	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material		4"	101.6					
		3"	76.2					
		2"	50.8					
Can No.	E	1 1/2"	38.1					
WT-Soil & Can (Wet)	45.02	1"	25.4					
WT-Soil & Can (Dry)	44.89	3/4"	19.1	0			0.0	100.0
Loss	0.13	1/2"	12.7	6			1.0	99.0
Weight of Can	10.94	#4	4.6	33			5.4	94.6
WT of Soil (Dry)	33.95	#10	2.0					
% Moisture	0.4	Pan						
		Total						

5.4
%
silt

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample	73.39 grams	Jar #		WT Washed Sample & Tare	46.2
				Tare Weight	9.1
				Washed Sample Weight	37.1

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing
10	2.000	73				12.0	88.0
20	0.850	129				21.2	78.8
30	0.600	157				25.8	74.2
40	0.425	186				30.5	69.5
100	0.150	295				48.4	51.6
200	0.075	367				60.3	39.7
270	0.053						
Pan		371					
Total							

54.9
%
sand

39.7
%
fine

HYDROMETER SAMPLE

Specific Gravity (G) (assumed)	2.75	LL		Hydrometer No.	E	Amyl Alcohol	
		PI				Drops:	2 Squirf

a = 0.98	Corrected Weight of Hydrometer Sample	73.10 grams	Defloculation Agent	
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09130 Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			L	Corrected Gram Size, Dia. MM	% of Total Passing	
					Initl.	Actual	R _c				
31	1	0.078	15.5	0.0140		31.5	36.5	7.8	10.3	0.045	33.9
32	2	0.055	"	"		32.0	31.0	"	11.2	0.033	27.4
35	5	0.035	"	"		27.0	26.2	"	12.0	0.022	21.7
45	15	0.020	"	"		22.0	"	"	12.7	0.013	16.8
1000	30	0.014	"	"		18.5	"	"	13.3	0.009	12.6
15130	60	0.010	15.0	"		16.0	8.0	"	13.7	0.007	9.4
13:30	240	0.005	15.0	"		12.5	"	"	14.3	0.003	5.3
0930	1440	0.002	19.0	0.0134		10.0	7.1	"	14.7	0.0014	3.4

Tested by:	G. B. / DNR	Computed by:	MA	Checked by:	MT	Cc	
						Cu	

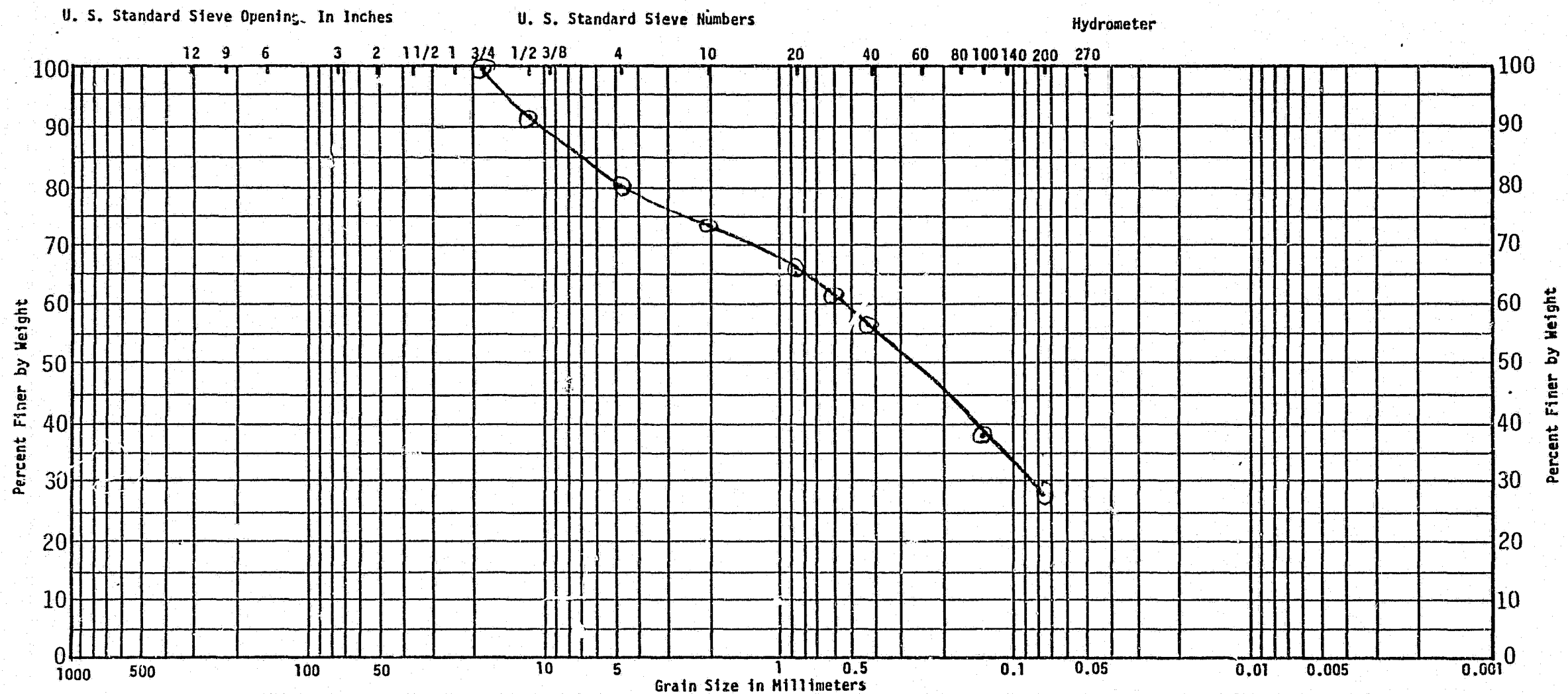
- F 135 - MA

Transferred the HYD. data to sieve sheet, since there was 2 forms.



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GRADATION SIZE ANALYSIS



COBBLES	GRAVEL		SAND			FINES	
	Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 29	3	6-7.5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003,08
Gravel is subangular					Date 4-10-83

LF 141-GSA

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Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS			Job
		☐ GILSON	☒ BRASS SIEVE	☒ HYDROMETER	No. 15032,003.08

Project	WATANA DAM	Hole	AS 30	Depth	2.5-5' #2
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WT Dry WT Total Sample & Tare	1415	TOTAL SAMPLE						
Tare Weight S/D-17	534	Classification Olive gravelly silty sand (Sm)						
Total Sample WT	881	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material		4"	101.6					
		3"	76.2					
		2"	50.8					
Can No.		1 1/2"	38.1					
WT-Soil & Can (Wet)		1"	25.4	0			0	100
WT-Soil & Can (Dry)		3/4"	19.1	14			1.6	98.4
Loss		1/2"	12.7	27			3.1	96.9
Weight of Can		#4	4.6	75			8.5	91.5
WT of Soil (Dry)		#10	2.0					
% Moisture		Pan						
		Total						

8.5 %
fine

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample	grams	Jar #	WT Washed Sample & Tare	1074			
			Tare Weight	534			
			Washed Sample Weight	540			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing
10	2.000	124				14.1	85.9
20	0.850	193				22.1	77.9
30	0.600	234				26.5	73.4
40	0.425	275				31.2	68.8
100	0.150	438				49.7	50.3
200	0.075	533				60.5	39.5
270	0.053						
Pan		540					
Total							

52 %
sand
39.5 %
fine

HYDROMETER SAMPLE

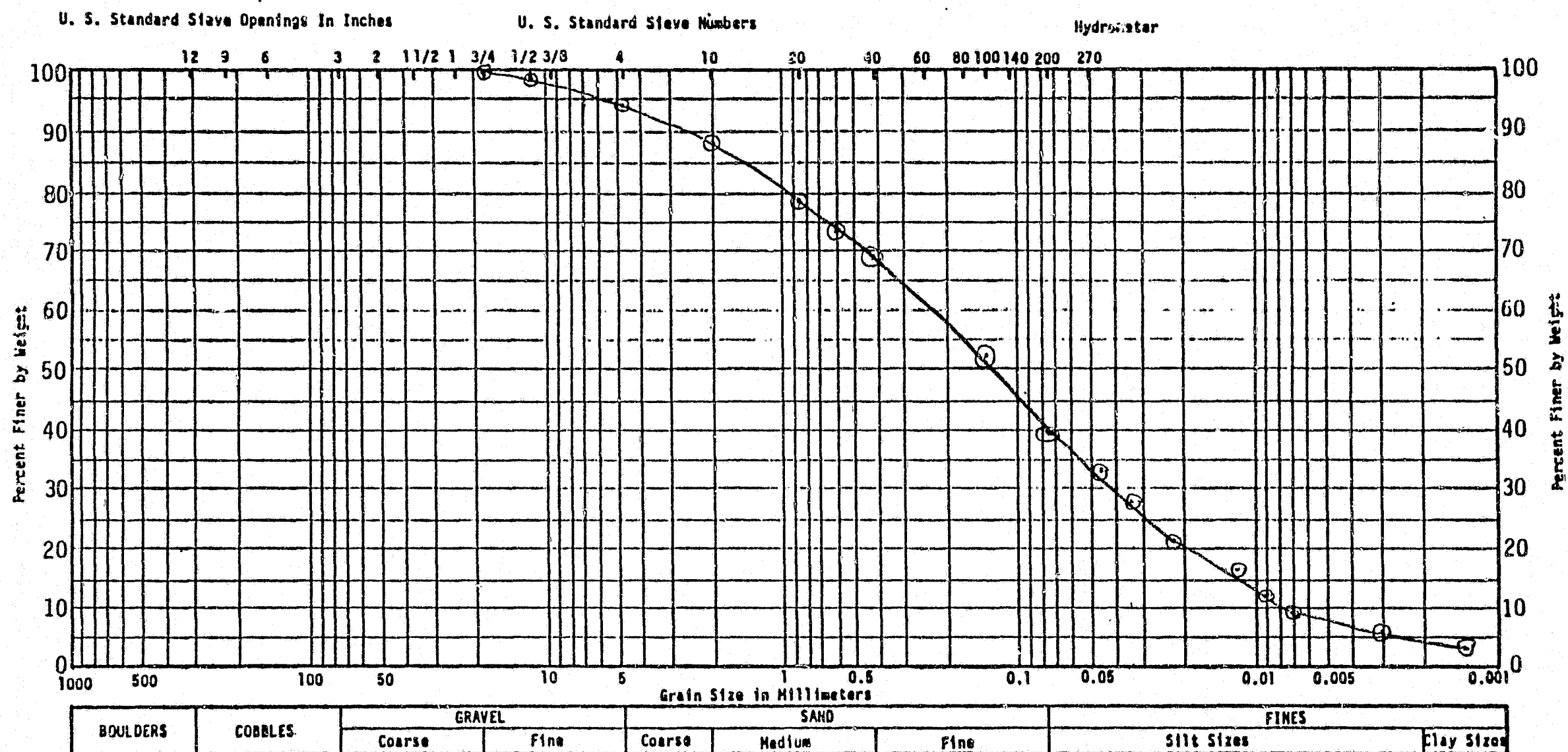
Specific Gravity (G)	LL	PI	Hydrometer No.	Amyl Alcohol Drops:				
a =	Corrected Weight of Hydrometer Sample			Defloculation Agent				
	grams							
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading	L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc	
	1	0.078						
	2	0.055						
	5	0.035						
	15	0.020						
	30	0.014						
	60	0.010						
	240	0.005						
	1440	0.002						
Tested by: Czm		Computed by: W A		Checked by: M A		Cc		
						Cu		

LF 135-MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS-30</u>	<u>1</u>	<u>1-2.5</u>		No. <u>15032.003.08</u>
VISUAL MANUAL CLASSIFICATION					Date <u>4-11-83</u>

mc

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER				
Project WATANA DAM				Hole AS 33		Depth 25.5 #2				
Dry WT Total Sample & Tare		1567		TOTAL SAMPLE						
Tare Weight A		540		Classification Olive gravelly silty sand (sm)						
Total Sample WT		1027		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material		4"		101.6						
		3"		76.2						
		2"		50.8						
Can No.		1 1/2"		38.1						
WT-Soil & Can (Wet)		1"		25.4						
WT-Soil & Can (Dry)		3/4"		19.1		0			0	100
Loss		1/2"		12.7		31			3.0	97.0
Weight of Can		#4		4.6		89			8.7	91.3
WT of Soil (Dry)		#10		2.0						
% Moisture		Pan								
		Total								
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare		1213		
						Tare Weight		540		
						Washed Sample Weight		673		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	164				16.5	83.5			
20	0.850	277				27.0	73.0			
30	0.600	329				32.0	68.0			
40	0.425	382				37.2	62.8			
100	0.150	572				55.7	44.3			
200	0.075	667				64.9	35.1			
270	0.053									
Pan		673								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)		LL		Hydrometer No.		Amyl Alcohol				
		PI				Drops:				
a =		Corrected Weight of Hydrometer Sample				Defloculation Agent				
		grams								
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc			
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
Tested by: CEM		Computed by: CEM		Checked by: MA		Cc				
						Cu				

8.7 %
grl.

56.2 %
sand

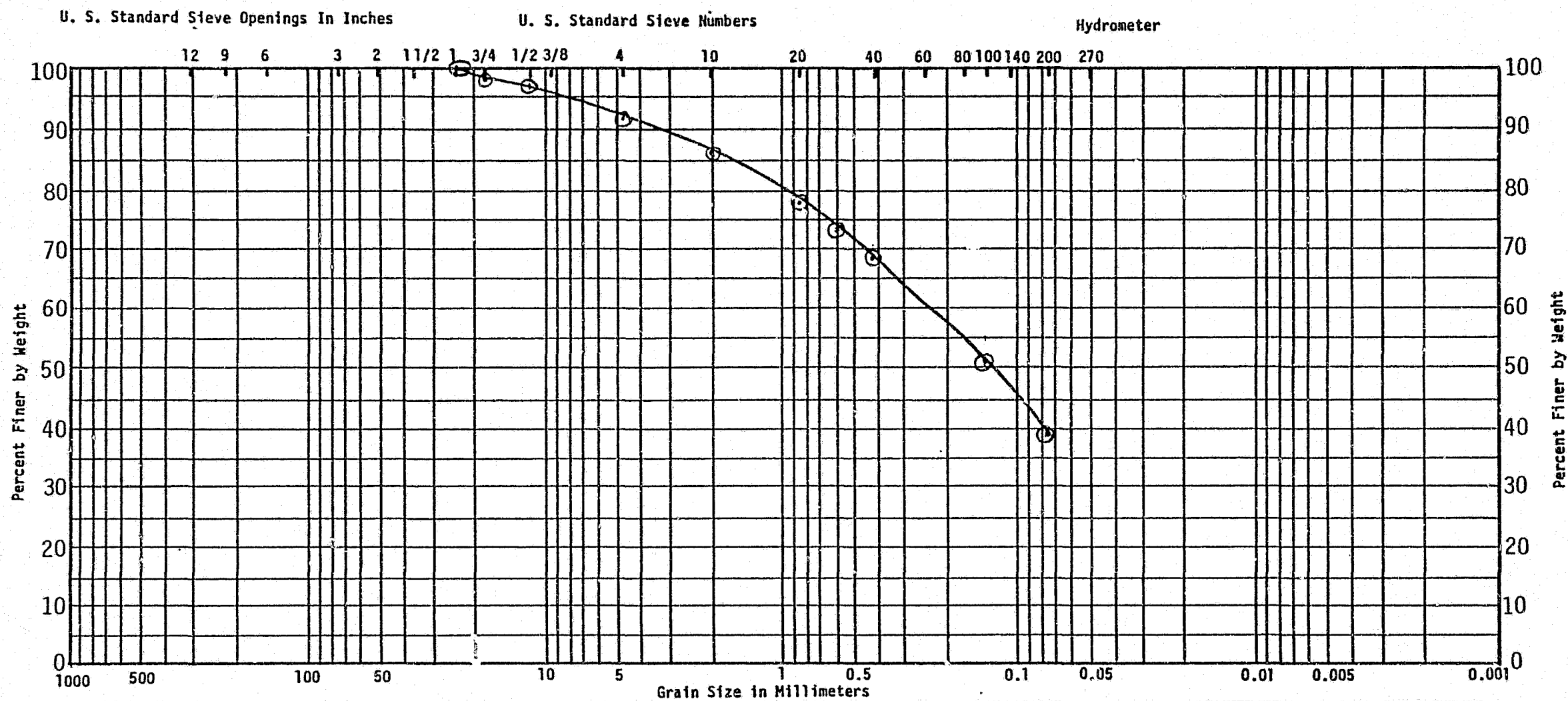
35.1 %
fines

LF 135-MA



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GRADATION SIZE ANALYSIS



mc

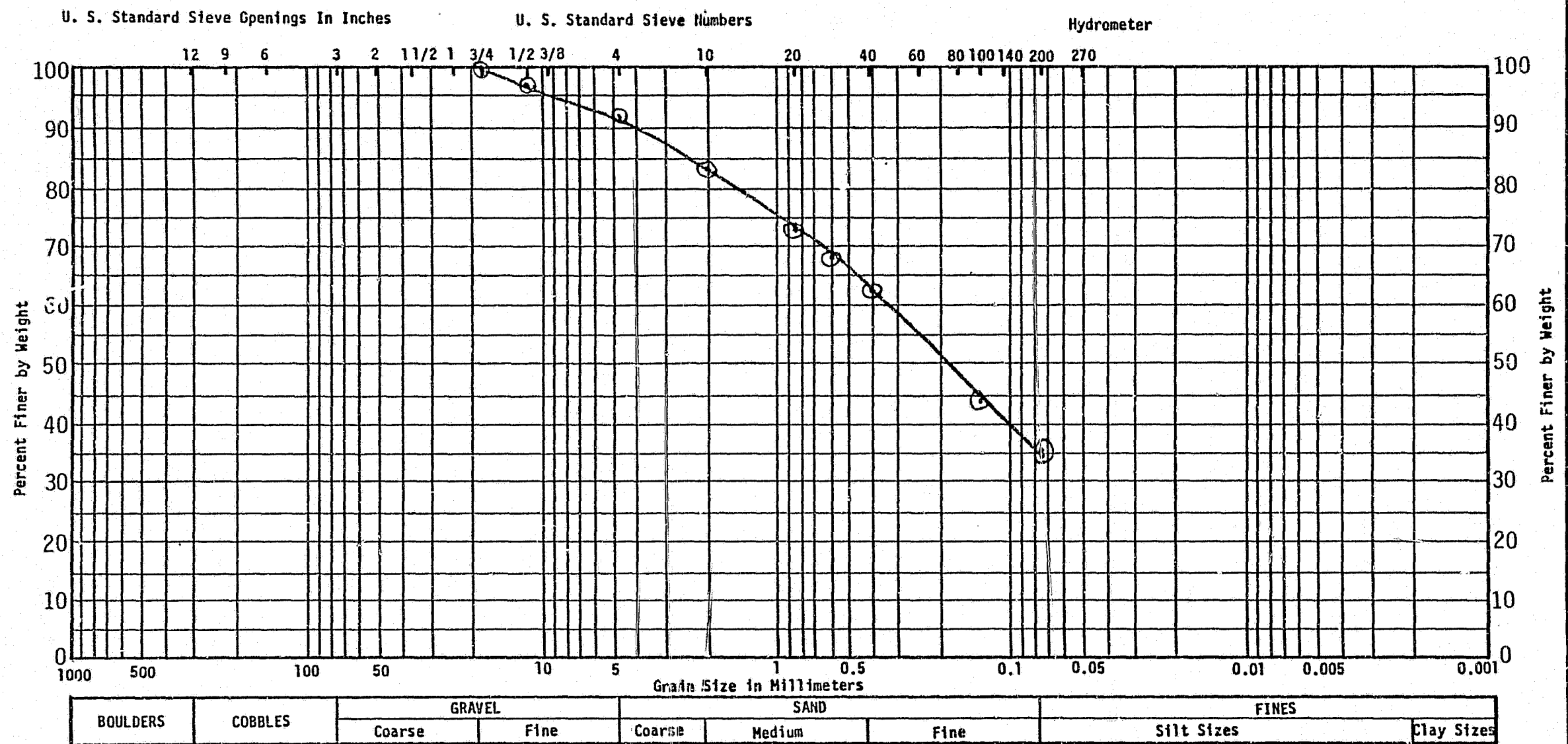
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER				
Project WATANA DAM				Hole AS 35		Depth 0-2.5 #1				
Dry WT Total Sample & Tare		1306		TOTAL SAMPLE SAMPLE IS SMALLER THAN ASTM RECOMMENDED WT.						
Tare Weight SD-10		545		Classification Dark Brown gravelly silty sand (sm)						
Total Sample WT		761		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material				4"	101.6					
				3"	76.2					
				2"	50.8					
Can No.				1 1/2"	38.1	0			0.0	100.0
WT-Soil & Can (Wet)				1"	25.4	84			11.0	89.0
WT-Soil & Can (Dry)				3/4"	19.1	"			"	"
Loss				1/2"	12.7	110			14.5	85.5
Weight of Can				#4	4.6	151			19.8	80.2
WT of Soil (Dry)				#10	2.0					
% Moisture				Pan						
				Total						
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare		1087		
						Tare Weight		545		
						Washed Sample Weight				
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	193				25.4	74.6	51.0		% - sand
20	0.850	255				33.5	66.5			
30	0.600	289				38.0	62.0			
40	0.425	324				42.6	57.4			
100	0.150	460				60.4	39.6			
200	0.075	539				70.8	29.2			
270	0.053									29.2 % fines
Pan		545								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)		LL _____		Hydrometer No.		Amyl Alcohol Drops: _____				
PI _____										
a =		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent				
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc			
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
Tested by: G.B.		Computed by: MA		Checked by: MA				Cc		
								Cu		

LF 135-MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS 33</u>	<u>2</u>	<u>2-5.5</u>		No. <u>15032,003.08</u>
VISUAL MANUAL CLASSIFICATION					Date <u>4-11-83</u>

LF 141-GSA

HLA HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☒ BRASS SIEVE ☐ HYDROMETER			Job No. 15032,003.08
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Project	WATANA DAM	Hole	AS 36	Depth	0-2.5 #1
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Dry WT Total Sample & Tare		1633	TOTAL SAMPLE					
Tare Weight C		540	Classification Dark Brown silty gravelly sand (sm)					
Total Sample WT	1093	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material		4"	101.6					
		3"	76.2					
		2"	50.8					
Can No.		1 1/2"	38.1					
WT-Soil & Can (Wet)		1"	25.4	0			0.0	100.0
WT-Soil & Can (Dry)		3/4"	19.1	56			5.1	94.9
Loss		1/2"	12.7	82			7.5	92.5
Weight of Can		#4	4.6	234			21.4	78.6
WT of Soil (Dry)		#10	2.0					
% Moisture		Pan						
		Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample		grams	Jar #	WT Washed Sample & Tare		1436
				Tare Weight		540
				Washed Sample Weight		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret. Passing
10	2.000	344				31.5 68.5
20	0.850	467				42.7 57.3
30	0.600	522				47.8 52.2
40	0.425	576				52.7 47.3
100	0.150	774				70.8 29.2
200	0.075	875				80.1 19.9
270	0.053					
Pan		884				
Total						

HYDROMETER SAMPLE

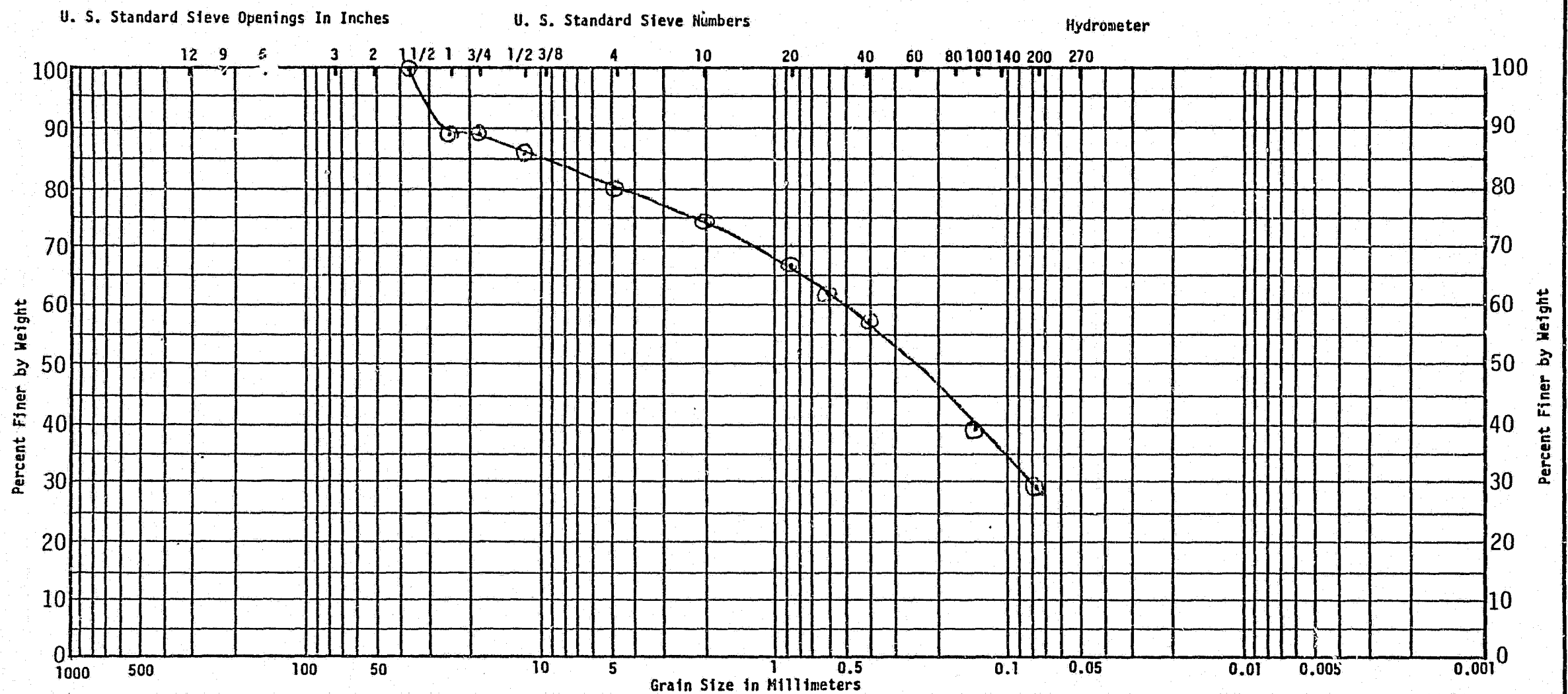
Specific Gravity (G)		LL	Hydrometer No.		Amyl Alcohol Drops:	
		PI				
a =		Corrected Weight of Hydrometer Sample			Defloculation Agent	
		grams				
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading	Corrected Gram Size, Dia. MM
					Initl. Actual Rc	
	1	0.078				
	2	0.055				
	5	0.035				
	15	0.020				
	30	0.014				
	60	0.010				
	240	0.005				
	1440	0.002				
Tested by: G.B.		Computed by: MA		Checked by: MA		Cc
						Cu

LF 135-MA



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GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS 35</u>	<u>1</u>	<u>0-2.5</u>		No. <u>15032,003.08</u>
VISUAL MANUAL CLASSIFICATION <u>Sample not large - ACTUAL 2 to 10</u>					Date <u>4-11-83</u>

LF 141-GSA

HILA HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date <u>4/9/83</u>	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☒ BRASS SIEVE ☐ HYDROMETER	Job No. <u>15032,003.08</u>
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Project <u>WATANA DAM</u>	Hole <u>AS 37</u>	Depth <u>1-2.5 #1</u>
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Dry WT Total Sample & Tare	<u>478.9</u>	TOTAL SAMPLE						
Tare Weight <u>WA-1</u>	<u>88.0</u>	Classification <u>Very Dark Brown gravelly silty sand (sm)</u>						
Total Sample WT	<u>390.9</u>	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material		4"	101.6					
		3"	76.2					
		2"	50.8					
Can No.		1 1/2"	38.1					
WT-Soil & Can (Wet)		1"	25.4					
WT-Soil & Can (Dry)		3/4"	19.1	0			0.0	100.0
Loss		1/2"	12.7	11			2.8	97.2
Weight of Can		#4	4.6	41			10.5	89.5
WT of Soil (Dry)		#10	2.0					
% Moisture		Pan						
		Total						

10.5 %
97.2 %

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar # _____	WT Washed Sample & Tare <u>388</u>	Tare Weight <u>88</u>	Washed Sample Weight <u>300</u>			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing
10	2.000	73				18.7	81.3
20	0.850	118				30.2	69.8
30	0.600	140				35.8	64.2
40	0.425	163				41.7	58.3
100	0.150	244				62.4	37.6
200	0.075	294				75.2	24.8
270	0.053						
Pan		298					
Total							

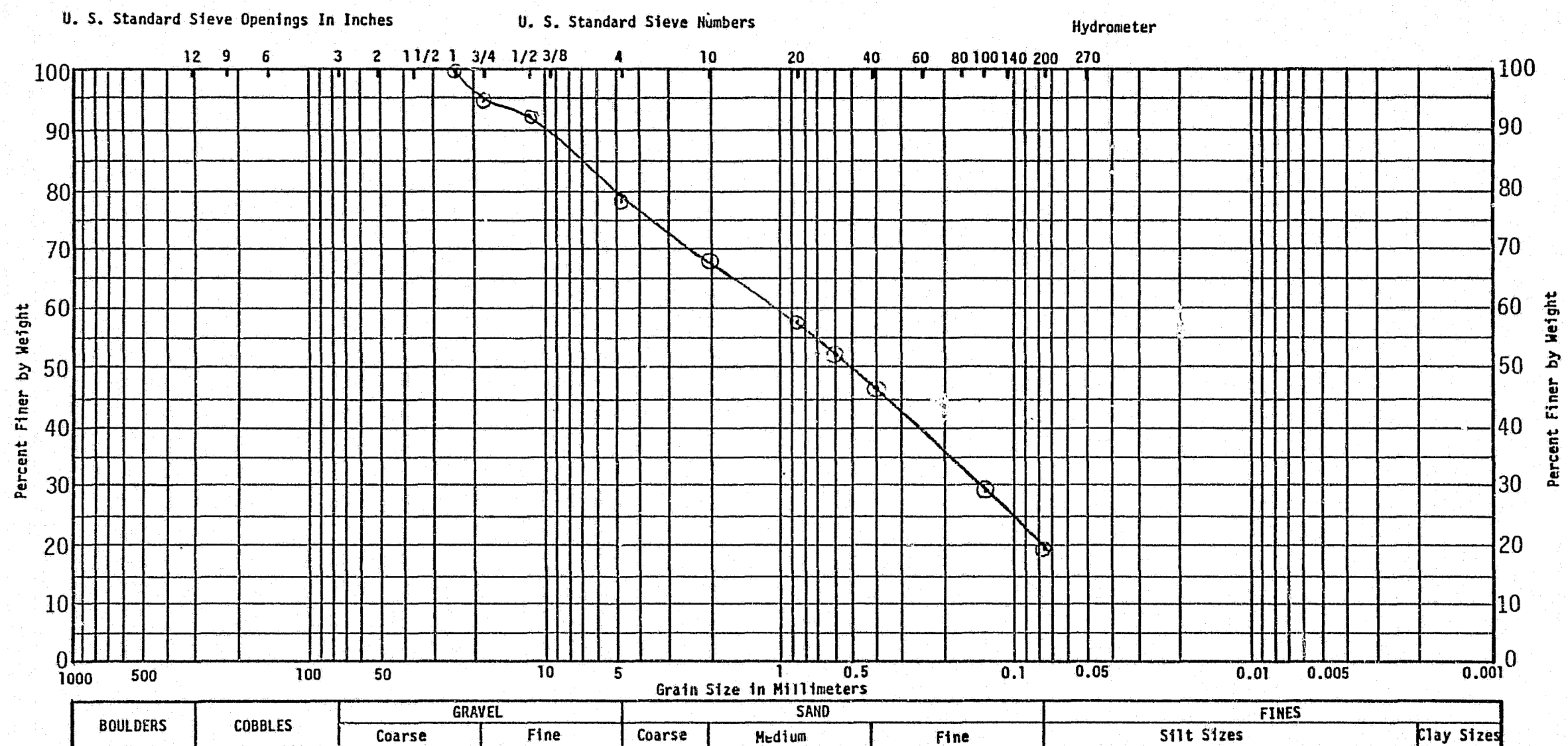
64.7 % - sand
24.8 % fines

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No. _____	Amyl Alcohol Drops: _____					
a = _____	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent _____					
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading	L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl. Actual	Rc		
	1	0.078						
	2	0.055						
	5	0.035						
	15	0.020						
	30	0.014						
	60	0.010						
	240	0.005						
	1440	0.002						
							Cc	
							Cu	

Tested by: C.B. Computed by: MA Checked by: MA

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 36	1	0-2.5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003.08
					Date 4-11-83

LF 141-G3A

HARDING LAWSON ASSOCIATES
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Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS			Job
		☐ GILSON	☒ BRASS SIEVE	☐ HYDROMETER	No. 15032,003.08

Project	WATANA DAM	Hole	AS 38	Depth	1-2.5 #1
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Dry WT Total Sample & Tare	1247	TOTAL SAMPLE			
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Tare Weight	540	Classification	Dark greyish brown sand (sm) gravelly silty		
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Total Sample WT	707	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material		4"	101.6					
		3"	76.2					
		2"	50.8					
Can No.		1 1/2"	38.1					
WT-Soil & Can (Wet)		1"	25.4					
WT-Soil & Can (Dry)		3/4"	19.1	0			0.0	100.0
Loss		1/2"	12.7	40			5.7	94.3
Weight of Can		#4	4.6	93			13.2	86.8
WT of Soil (Dry)		#10	2.0					
% Moisture		Pan						
		Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample	grams	Jar #	WT Washed Sample & Tare	1083
			Tare Weight	540
			Washed Sample Weight	

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing
10	2.000	152				21.5	78.5
20	0.850	234				33.1	66.9
30	0.600	273				38.6	61.4
40	0.425	313				44.3	55.7
100	0.150	461				65.2	34.8
200	0.075	540				76.4	23.6
270	0.053						
Pan		544					
Total							

HYDROMETER SAMPLE

Specific Gravity (G)	LL	Hydrometer No.	Amyl Alcohol
	PI		Drops:

a =	Corrected Weight of Hydrometer Sample	grams	Defloculation Agent
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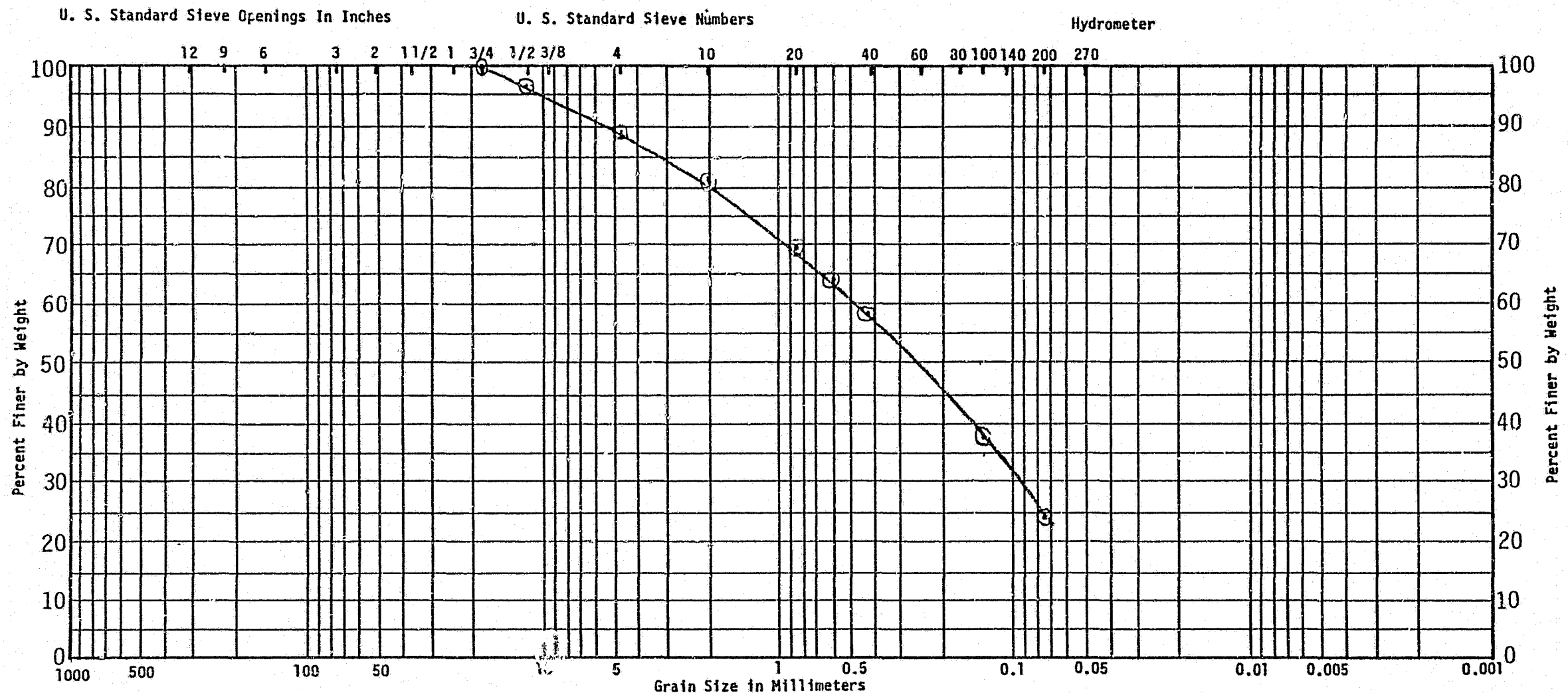
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc			
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								

Tested by: G.B.	Computed by: M.A.	Checked by: M.A.	Cc
			Cu

LF 135-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 37	1	1-2.5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032.003.08
					Date 4-11-83

LF 141-GSA



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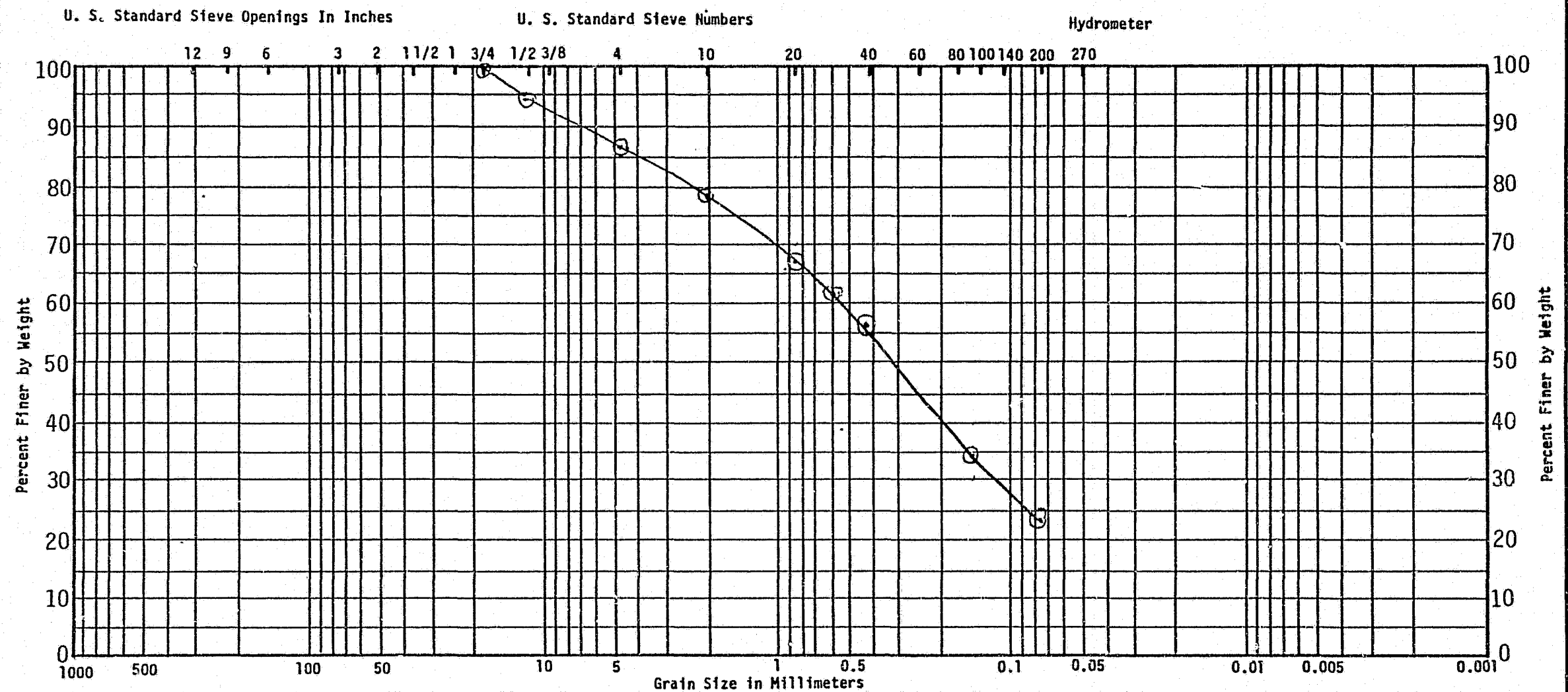
Date 4/9/83		WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. 15032,003.08		
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER		
Project WATANA DAM				Hole AS 40		Depth 1-2.5 #1		
Dry WT Total Sample & Tare		17140		TOTAL SAMPLE				
Tare Weight SD-1		553		Classification Dark Greyish Brown gravelly silty sand (5m)				
Total Sample WT		666.0		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	
Moisture Content -10 Material		4"		101.6				
		3"		76.2				
		2"		50.8				
Can No.		1 1/2"		38.1				
WT-Soil & Can (Wet)		1"		25.4				
WT-Soil & Can (Dry)		3/4"		19.1				
Loss		1/2"		12.7				
Weight of Can		#4		4.6				
WT of Soil (Dry)		#10		2.0				
% Moisture		Pan						
		Total						
REPRESENTATIVE MINUS NO. 10 SAMPLE								
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare		
						Tare Weight		
						Washed Sample Weight		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing	
10	2.000	1714.0				15.9	84.1	
20	0.850	1680.0				25.2	74.8	
30	0.600	200.0				30.0	70.0	
40	0.425	233.0				35.0	65.0	
100	0.150	354.0				53.2	46.8	
200	0.075	423.0				63.5	36.5	
270	0.053							
Pan		427.0						
Total								
HYDROMETER SAMPLE								
Specific Gravity (G)		LL _____ PI _____		Hydrometer No.		Amyl Alcohol Drops: _____		
a =		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent		
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl. Actual Rc			L
	1	0.078						
	2	0.055						
	5	0.035						
	15	0.020						
	30	0.014						
	60	0.010						
	240	0.005						
	1440	0.002						
Tested by: CRM		Computed by: DM		Checked by: MA		Cc		
						Cu		

LF 135-MA



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GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 38	1	1-2.5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032.003.08
					Date 4-11-83

LF 141-GSA

HLA HARDING LAWSON ASSOCIATES
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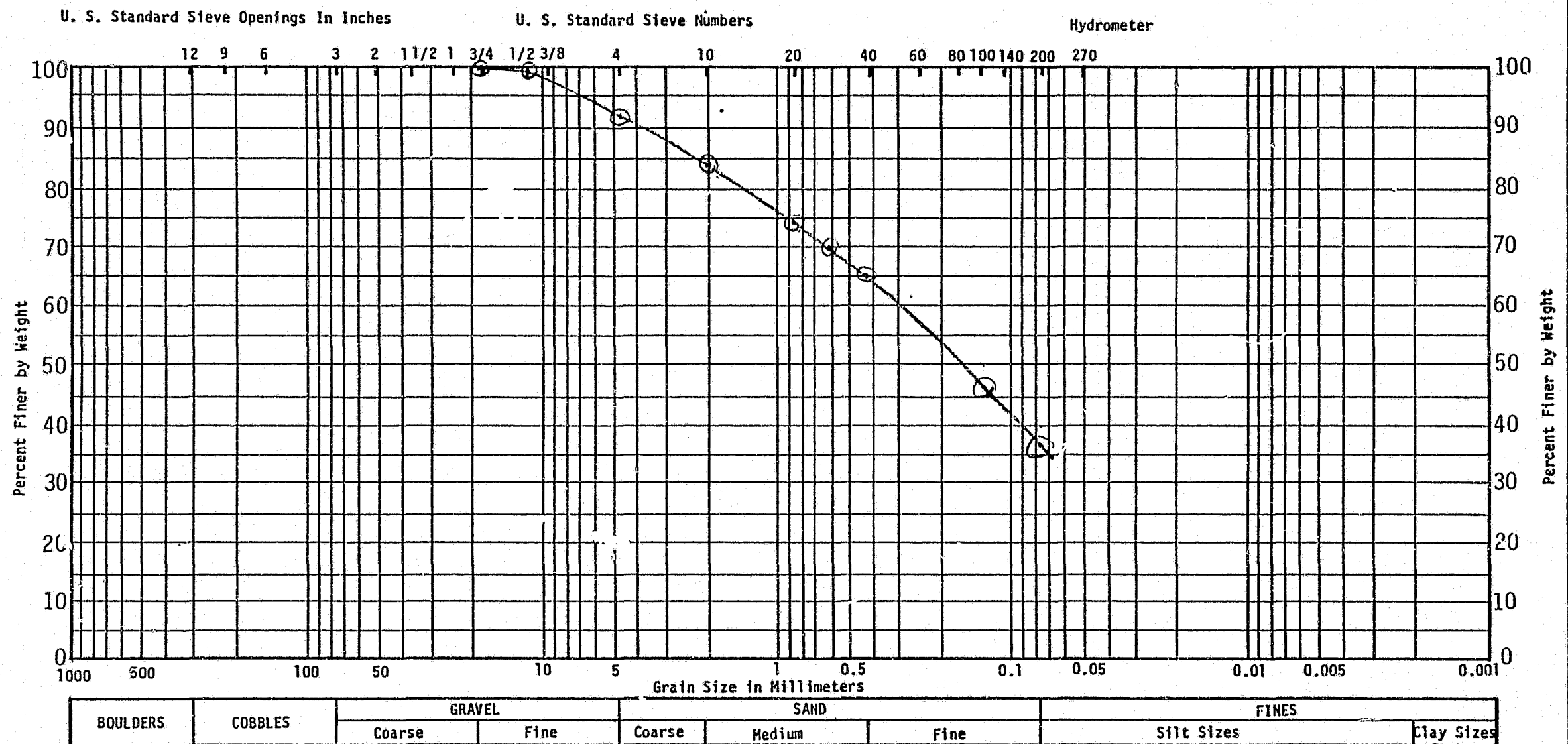
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08		
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER			
Project WATANA DAM				Hole AS 41		Depth 2-4 #2			
Dry WT Total Sample & Tare		591.3		TOTAL SAMPLE					
Tare Weight MA 47		88		Classification Olive gravelly silty sand (sm)					
Total Sample WT		503.3		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing
Moisture Content -10 Material		4"		101.6					
		3"		76.2					
		2"		50.8					
Can No.		1 1/2"		38.1					
WT-Soil & Can (Wet)		1"		25.4					
WT-Soil & Can (Dry)		3/4"		19.1		0		0.0 100.0	
Loss		1/2"		12.7		4		0.8 99.2	
Weight of Can		#4		4.6		47		9.3 90.7	
WT of Soil (Dry)		#10		2.0					
% Moisture		Pan							
		Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare		382	
						Tare Weight		88	
						Washed Sample Weight		294	
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing		
10	2.000	86				17.1	82.9	48.3	
20	0.850	125				24.8	75.2	% Sand	
30	0.600	144				28.6	71.4		
40	0.425	162				32.2	67.8		
100	0.150	238				47.3	52.7		
200	0.075	290				57.6	42.4	42.4	
270	0.053							% fines	
Pan		293							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____		Hydrometer No.		Amyl Alcohol Drops: _____			
a =		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent			
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: G.B.		Computed by: MA		Checked by: MA		Cc			
						Cu			

LF 135-MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 40	1	1-2.5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003.08
					Date 4-10-83

ML

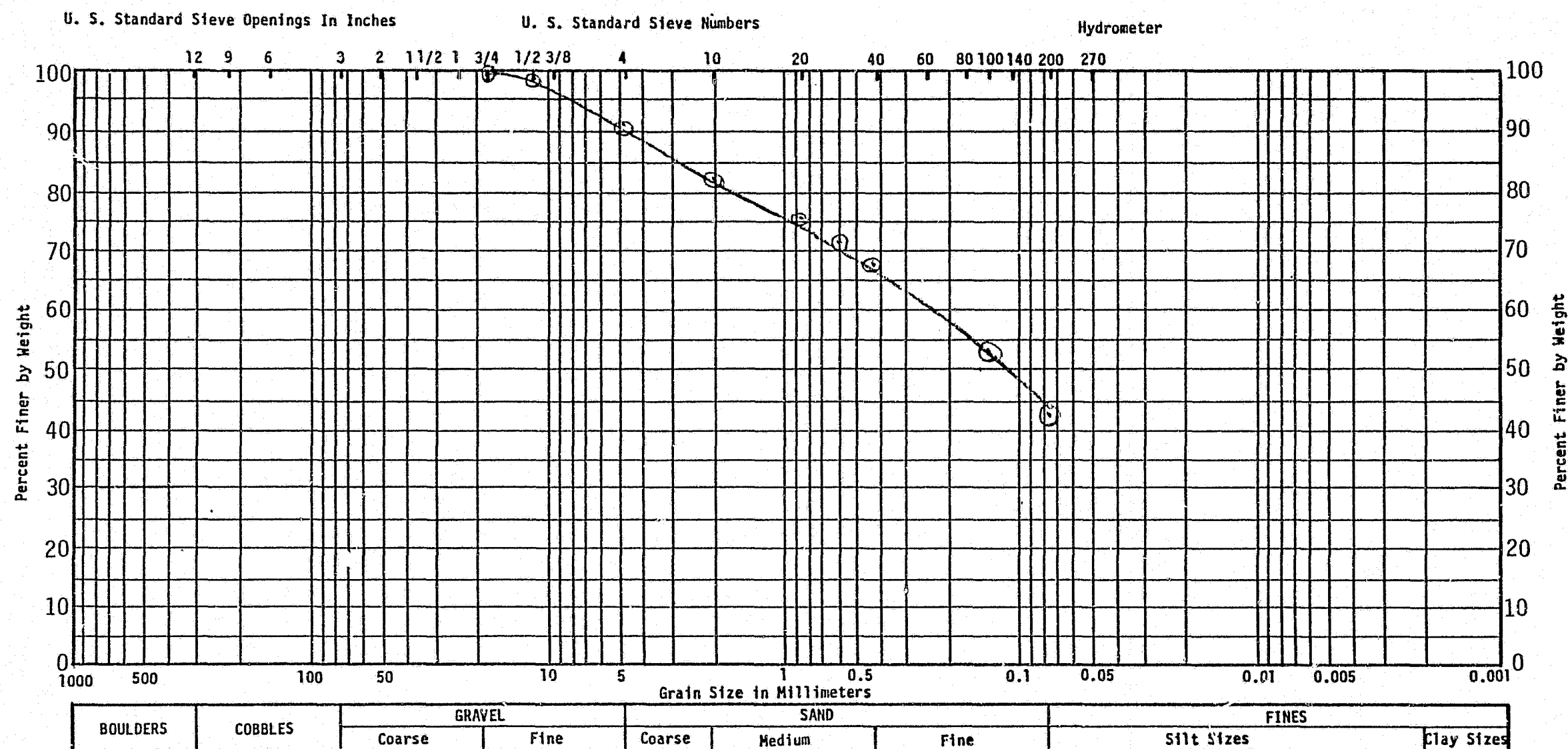
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08		
		☐ GILSON	☒ BRASS SIEVE	☐ HYDROMETER					
Project WATANA DAM				Hole AS 42.		Depth 1-2.5 #1			
Dry WT Total Sample & Tare		723.2	TOTAL SAMPLE						
Tare Weight MA-13		87.7	Classification Very Dark Brown gravelly silty sand(sm)						
Total Sample WT		635.5	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing	
Moisture Content -10 Material			4"	101.6					
			3"	76.2					
			2"	50.8					
Can No.			1 1/2"	38.1					
WT-Soil & Can(Wet)			1"	25.4					
WT-Soil & Can(Dry)			3/4"	19.1	0		0.0	100.0	
Loss			1/2"	12.7	31		3.3	96.7	
Weight of Can			#4	4.6	73		11.5	88.5	
WT of Soil (Dry)			#10	2.0					
% Moisture			Pan						
			Total						
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample		grams	Jar #		WT Washed Sample & Tare		489		
					Tare Weight		87.1		
					Washed Sample Weight		401.3		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret. Passing			
10	2.000	126				19.8	80.2		
20	0.850	182				28.6	71.4		
30	0.600	208				32.7	67.3		
40	0.425	234				36.8	63.2		
100	0.150	331				52.1	47.9		
200	0.075	378				62.6	37.4		
270	0.053								
Pan		400							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____		Hydrometer No.		Amyl Alcohol Drops: _____			
		PI _____							
a =		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent			
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: G.B.		Computed by: MA		Checked by: MA		Cc			
						Cu			

LF 135 - MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 41	2	2-4		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032.003.08
					Date 4-11-83

GS ML

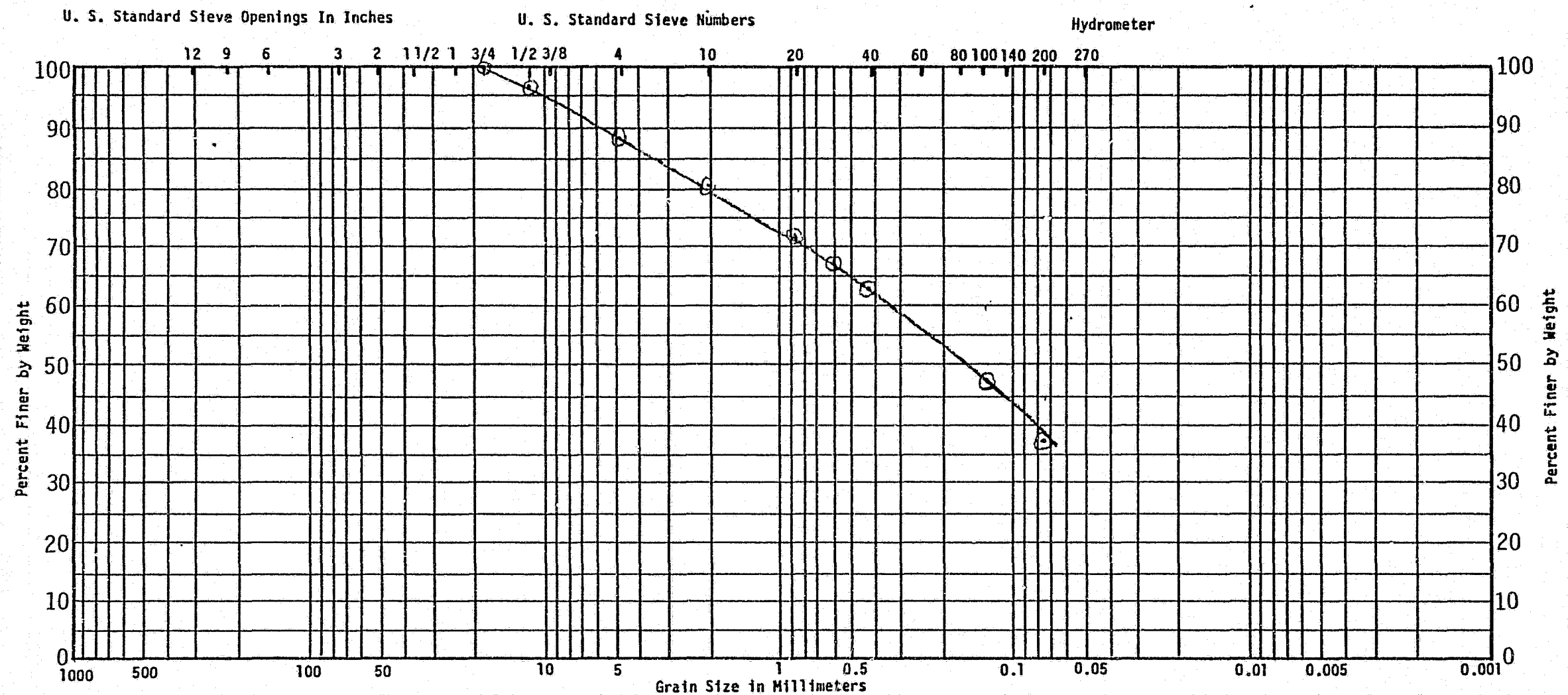
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08						
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER							
Project WATANA DAM				Hole AS 42		Depth 2.5-5.0#2							
WT Dry WT Total Sample & Tare		1177		TOTAL SAMPLE									
Tare Weight IX		562		Classification silty gravelly sand (sm)									
Total Sample WT		615		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing			
Moisture Content -10 Material		4"		101.6									
		3"		76.2									
		2"		50.8									
Can No.		1 1/2"		38.1		0			0	100			
WT-Soil & Can (Wet)		1"		25.4		47			7.6	92.4			
WT-Soil & Can (Dry)		3/4"		19.1		47			7.6	92.4			
Loss		1/2"		12.7		85			13.6	86.2			
Weight of Can		#4		4.6		137			22.3	77.7			
WT of Soil (Dry)		#10		2.0									
% Moisture		Pan											
		Total											
REPRESENTATIVE MINUS NO. 10 SAMPLE													
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare		1057					
						Tare Weight		532					
						Washed Sample Weight		495					
Sieve Size		Dia. MM		Cum. WT Ret.		Weight Retained		% Retained		% of Total Retained	Cum. % of Total Ret.	Passing	
10		2.000		190							30.4	69.1	
20		0.850		257							41.8	88.2	
30		0.600		291							47.3	92.7	
40		0.425		327							53.2	96.8	
100		0.150		443							72.4	97.6	
200		0.075		492							80.2	99.2	
270		0.053											
Pan				494									
Total													
HYDROMETER SAMPLE													
Specific Gravity (G)		LL		PI		Hydrometer No.		Amyl Alcohol Drops:					
a =		Corrected Weight of Hydrometer Sample				grams		Defloculation Agent					
Time		Elap. Time		Maximum Dia. MM		Temp. ° C.		K		Reading		Corrected Gram Size, Dia. MM	% of Total Passing
										Initl. Actual Rc			
1		0.078											
2		0.055											
5		0.035											
15		0.020											
30		0.014											
60		0.010											
240		0.005											
1440		0.002											
												Cc	
Tested by:		CRM		Computed by:		CRM		Checked by:		MA		Cu	

LF 135-MA



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GRADATION SIZE ANALYSIS

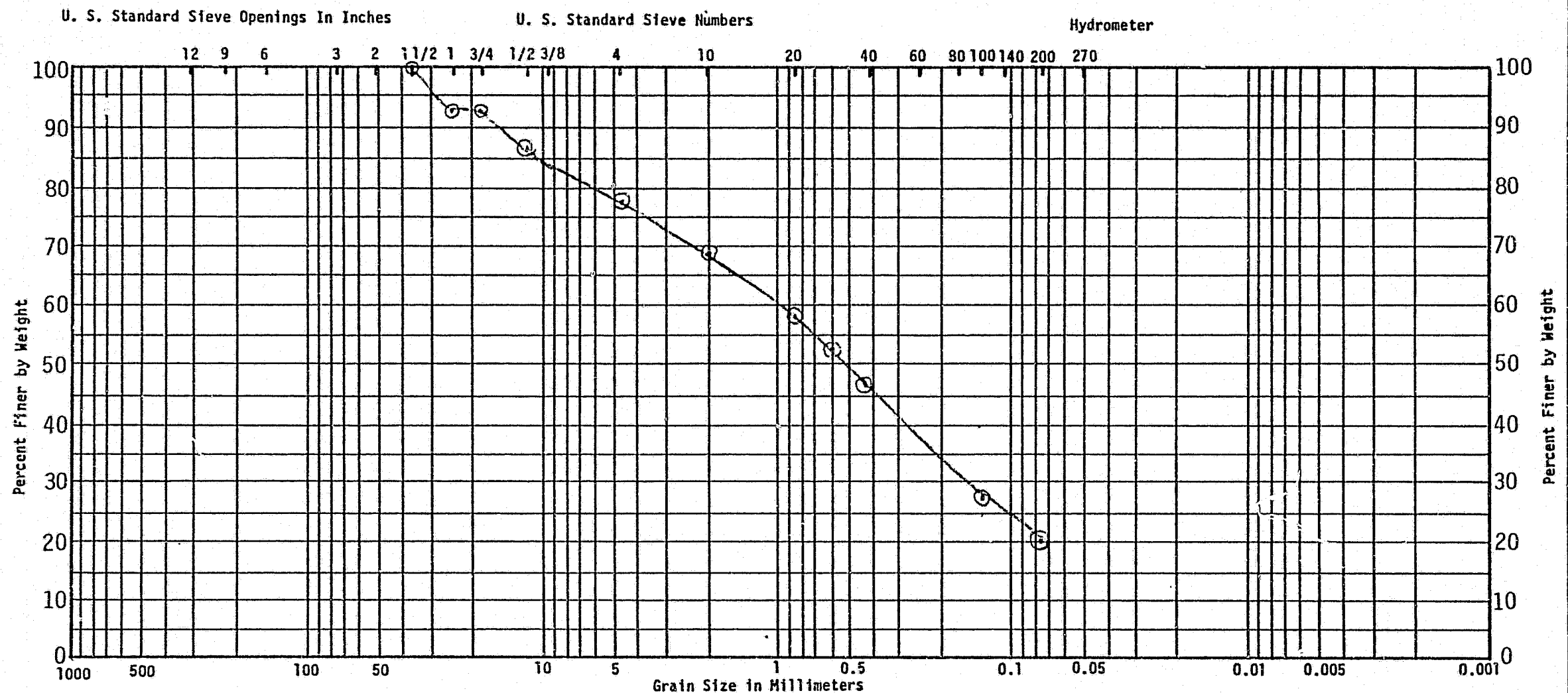


BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS 42</u>	<u>1</u>	<u>1-2.5</u>		No. <u>15032.003.08</u>
VISUAL MANUAL CLASSIFICATION					Date <u>4-11-83</u>

Date <u>4/9/83</u>		WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☒ BRASS SIEVE ☐ HYDROMETER					Job No. <u>15032,003.08</u>			
Project <u>WATANA DAM</u>						Hole <u>AS 44</u>		Depth <u>2-4 #2</u>		
WT Dry WT Total Sample & Tare		<u>1350</u>		TOTAL SAMPLE						
Tare Weight <u>10</u>		<u>431</u>		Classification <u>Oliver Brown gravelly silty sand (SM)</u>						
Total Sample WT		<u>915</u>		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing	
Moisture Content -10 Material		4"		101.6						
		3"		76.2						
		2"		50.8						
Can No.		1 1/2"		38.1						
WT-Soil & Can (Wet)		1"		25.4						
WT-Soil & Can (Dry)		3/4"		19.1	0			0	100	
Loss		1/2"		12.7	9			1.0	99.0	
Weight of Can		#4		4.6	52			5.6	94.4	
WT of Soil (Dry)		#10		2.0						
% Moisture		Pan								
		Total								
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample _____ grams				Jar # _____		WT Washed Sample & Tare		<u>1076</u>		
						Tare Weight		<u>431</u>		
						Washed Sample Weight		<u>645</u>		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret. Passing				
10	2.000	154				16.5		83.5		
20	0.850	263				29.1		70.9		
30	0.600	311				33.3		66.7		
40	0.425	351				38.6		61.4		
100	0.150	559				59.8		40.2		
200	0.075	640				68.4		31.6		
270	0.053									
Pan		645								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)			LL _____ PI _____		Hydrometer No. _____		Amyl Alcohol Drops: _____			
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____				
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl. Actual Rc			L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
Tested by: <u>Clem</u>									Computed by: <u>MA</u>	Checked by: <u>MA</u>
									Cu	

GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS 42</u>	<u>2</u>	<u>2.5-5.0</u>		No. <u>15032,003,08</u>
VISUAL MANUAL CLASSIFICATION					Date <u>4-11-83</u>

LF 141-GSA

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MC

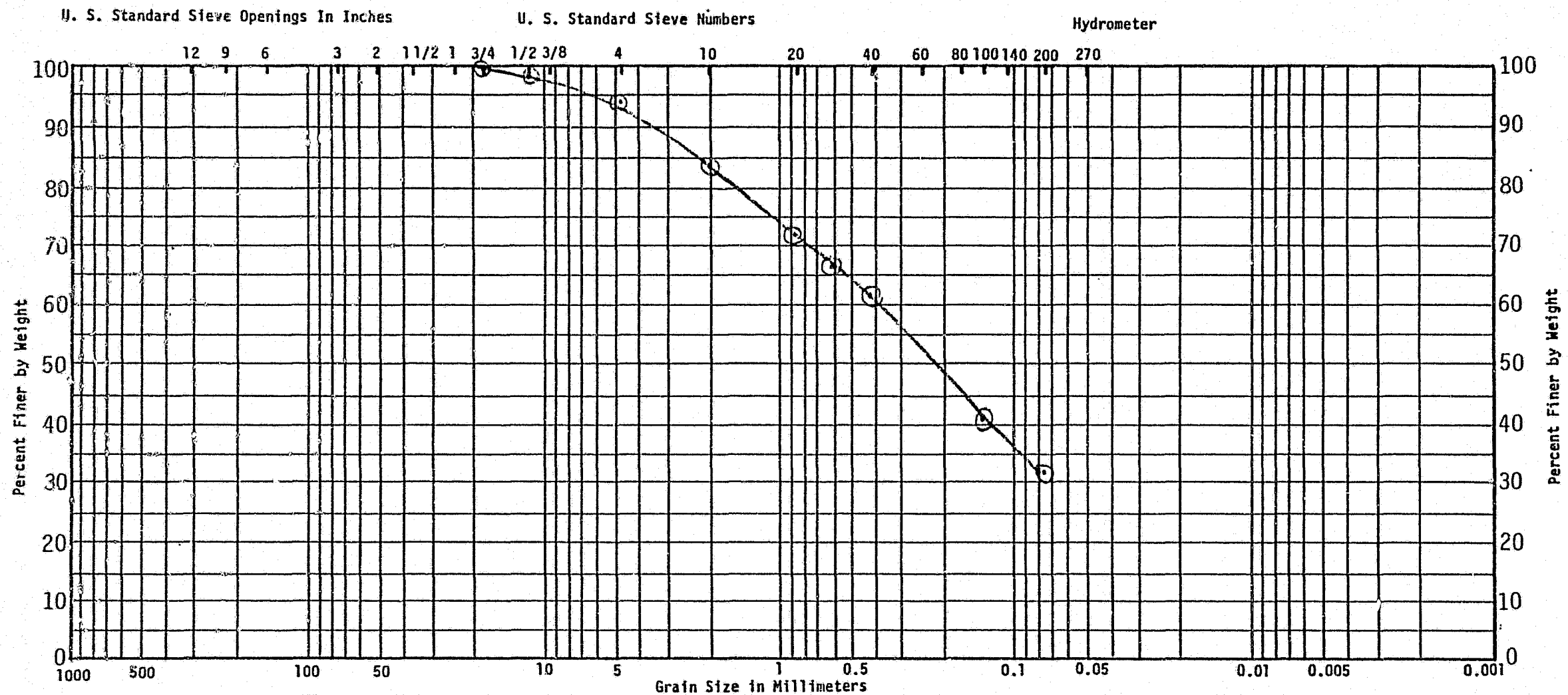
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08		
		☐ GILSON	☒ BRASS SIEVE	☐ HYDROMETER					
Project WATANA DAM				Hole AS 45		Depth 1-2.5 #1			
Dry WT Total Sample & Tare		832.8	TOTAL SAMPLE						
Tare Weight		90.71	Classification Greyish Brown silty sand (sm)						
Total Sample WT		742.09	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing	
Moisture Content -10 Material			4"	101.6					
			3"	76.2					
			2"	50.8					
Can No.			1 1/2"	38.1					
WT-Soil & Can (Wet)			1"	25.4					
WT-Soil & Can (Dry)			3/4"	19.1					
Loss			1/2"	12.7	0			0.0 100.0	
Weight of Can			#4	4.6	22			3.0 97.0	
WT of Soil (Dry)			#10	2.0					
% Moisture			Pan						
			Total						
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample _____ grams			Jar # _____		WT Washed Sample & Tare		501		
					Tare Weight		90.71		
					Washed Sample Weight		410.3		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret. Passing			
10	2.000	57				7.7	92.3		
20	0.850	122				16.4	83.6		
30	0.600	156				21.0	79.0		
40	0.425	192				25.9	74.1		
100	0.150	328				44.2	55.8		
200	0.075	406				54.7	45.3		
270	0.053								
Pan		410							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____ PI _____		Hydrometer No. _____		Amyl Alcohol Drops: _____			
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____			
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: G.B.		Computed by: MA		Checked by: MN		Cc			
						Cu			

LF 135-MA



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GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	ASA4	2	2-4		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003,08
					Date 4-11-83

LF 141-GSA

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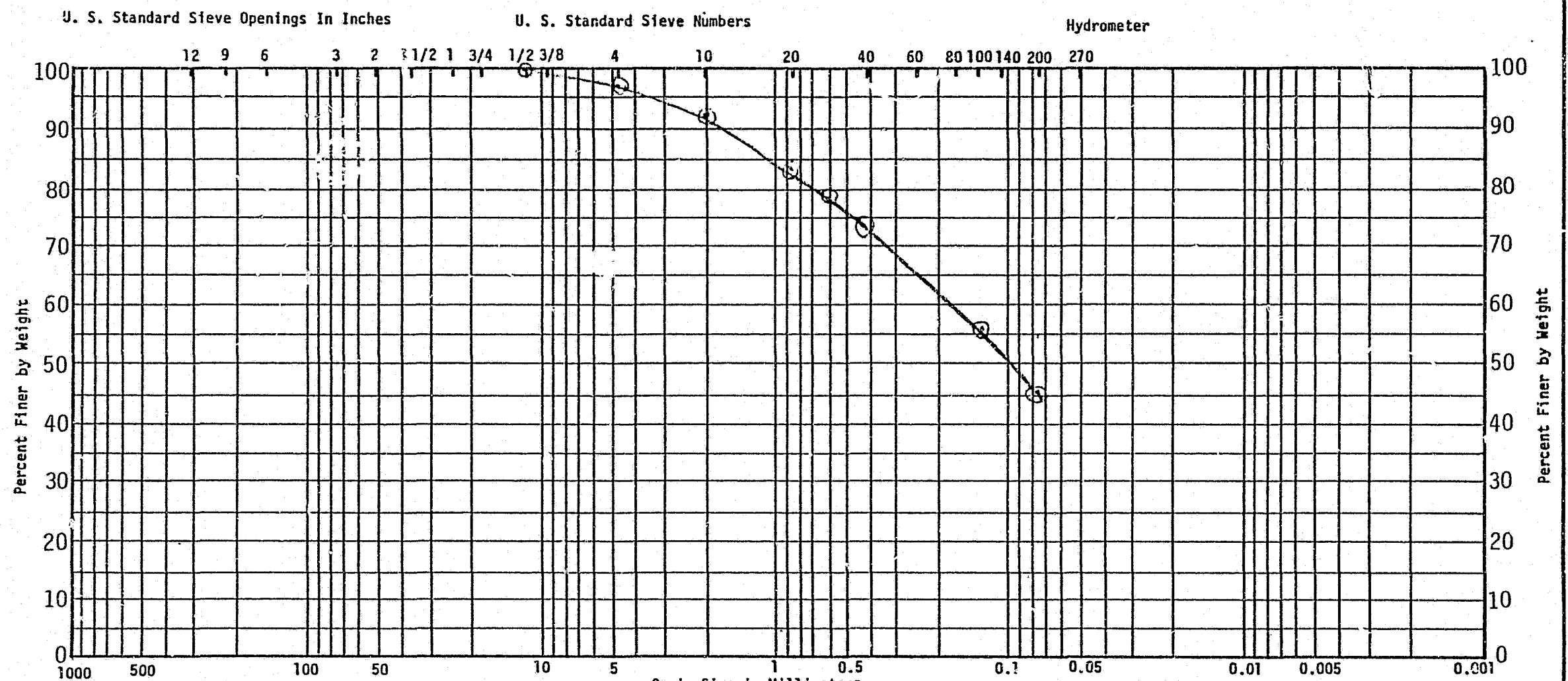
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. 15032,003.08				
		☐ GILSON	☒ BRASS SIEVE	☐ HYDROMETER						
Project WATANA DAM				Hole AS 45		Depth 3'-5' #2				
Dry WT Total Sample & Tare		18450	TOTAL SAMPLE							
Tare Weight AA		542	Classification Olive gravelly silty sand (sm)							
Total Sample WT		13030	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing	
Moisture Content -10 Material			4"	101.6						
			3"	76.2						
			2"	50.8						
Can No.			1 1/2"	38.1						
WT-Soil & Can (Wet)			1"	25.4						
WT-Soil & Can (Dry)			3/4"	19.1						
Loss			1/2"	12.7	0			0	100	
Weight of Can			#4	4.6	75.0			51.8	94.2	
WT of Soil (Dry)			#10	2.0						
% Moisture			Pan							
			Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample		grams	Jar #		WT Washed Sample & Tare		1372.0			
					Tare Weight		542.0			
					Washed Sample Weight		830.0			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	177.0				13.0	86.4			
20	0.850	318.0				24.3	75.7			
30	0.600	385.0				29.5	70.5			
40	0.425	455.0				34.9	65.1			
100	0.150	720.0				55.5	44.5			
200	0.075	826.0				63.4	36.6			
270	0.053									
Pan		830.0								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)		LL _____ PI _____		Hydrometer No.		Amyl Alcohol Drops: _____				
a =		Corrected Weight of Hydrometer Sample _____ grams				Deflocculation Agent				
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl. Actual Rc			L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
Tested by: CRW		Computed by: CLM		Checked by: MA		Cc		Cu		

LF 135-MA



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ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

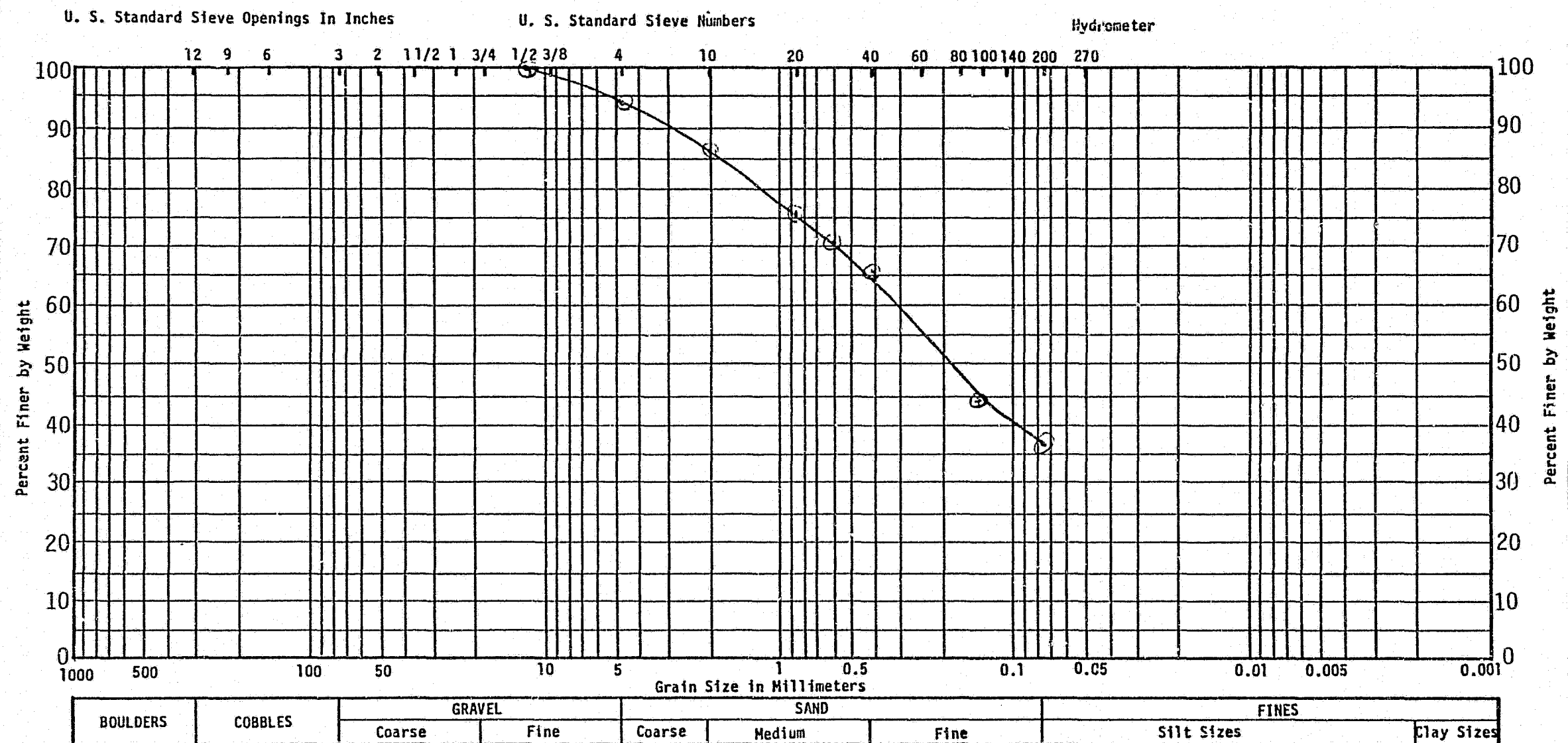
LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 45	1	1-2.5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003,08
					Date 4-11-83

LF 141-GSA

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10.3 % gvl.	60.6 % Semi	29.1 % Fines
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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 45	2	3-5'		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032.003.08
					Date 4-10-83

LF 141-GSA

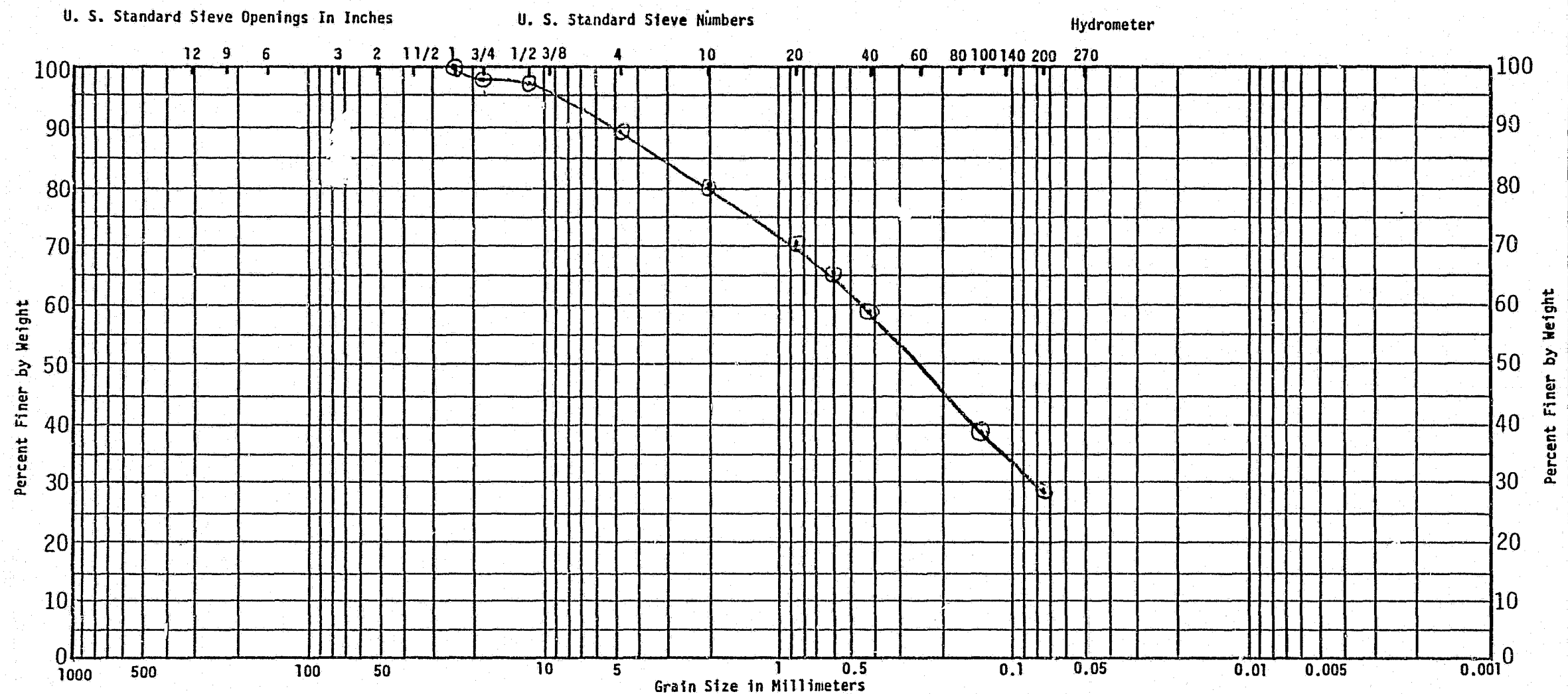
HILA HARDING LAWSON ASSOCIATES
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MC

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08			
		☐ GILSON	☒ BRASS SIEVE	☐ HYDROMETER						
Project WATANA DAM				Hole AS 49		Depth 2-3.5 #1				
Dry WT Total Sample & Tare		1722	TOTAL SAMPLE							
Tare Weight (W)		559	Classification Olive gravelly silty sand (Sm)							
Total Sample WT		1163	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing		
Moisture Content -10 Material			4"	101.6						
			3"	76.2						
			2"	50.8						
Can No.			1 1/2"	38.1						
WT-Soil & Can (Wet)			1"	25.4	0		0	100		
WT-Soil & Can (Dry)			3/4"	19.1	19		1.6	98.4		
Loss			1/2"	12.7	33		2.8	97.2		
Weight of Can			#4	4.6	95		7.3	92.7		
WT of Soil (Dry)			#10	2.0						
% Moisture			Pan							
			Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample _____ grams			Jar # _____		WT Washed Sample & Tare		1196			
					Tare Weight		559			
					Washed Sample Weight		637			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	150				12.4	87.1	47.5 % sands		
20	0.850	242				20.8	79.2			
30	0.600	289				24.8	75.2			
40	0.425	338				29.1	70.9			
100	0.150	539				46.3	53.7			
200	0.075	636				54.8	45.2	45.2 % fines		
270	0.053									
Pan		637								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)		LL _____ PI _____		Hydrometer No. _____		Amyl Alcohol Drops: _____				
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____				
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl. Actual Rc			L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
Tested by: / 241		Computed by: C/M		Checked by: M/M		Cc		Cu		

LF 135-MA

GRADATION SIZE ANALYSIS



BOULDERS		COBBLES		GRAVEL		SAND			FINES	
				Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 46	1	1.5-2.0		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032.003.08
					Date 4-10-83

LF 141-GSA

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7
3
0
0
0
3

PI 159

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032.003.08			
		☐ GILSON		☐ BRASS SIEVE		☒ HYDROMETER				
Project WATANA DAM				Hole AS 49		Depth 5-7.5 #2				
Air Dry WT Total Sample & Tare		TOTAL SAMPLE								
Tare Weight 1R		Classification Olive silty sand (sm)								
Total Sample WT		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing			
Moisture Content -10 Material		4"	101.6							
		3"	76.2							
		2"	50.8							
Can No. F		1 1/2"	38.1							
WT-Soil & Can (Wet) 42.25		1"	25.4							
WT-Soil & Can (Dry) 42.14		3/4"	19.1							
Loss .11		1/2"	12.7							
Weight of Can 11.47		#4	4.6							
WT of Soil (Dry) 30.67		#10	2.0							
% Moisture .4		Pan								
		Total								
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample 72.63 grams		Jar # K		WT Washed Sample & Tare 126						
				Tare Weight 89.32						
				Washed Sample Weight 36.68						
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	0				0.0	100			
20	0.850	6				8.3	91.7			
30	0.600	10				13.8	86.2			
40	0.425	13				18.0	82.0			
100	0.150	28				38.7	61.3			
200	0.075	37				51.1	48.9			
270	0.053									
Pan		37								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G) (Tested) 2.72		LL 20 PI 5		Hydrometer No. J		Amyl Alcohol Drops: _____				
a = 0.99		Corrected Weight of Hydrometer Sample 72.34 grams			Defloculation Agent					
10/10 Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading		Corrected Gram Size, Dia. MM	% of Total Passing		
					Initl.	Actual	Rc			
"	1	0.078	15.3	0.0142	39.3	39.0	7.9	10.1	0.045	41.2
12	2	0.055	15.3	"	35.0	34.0	"	10.7	0.033	35.7
15	5	0.035	15.0	"	31.3	30.0	8.0	11.4	0.021	30.1
25	15	0.020	15.0	"	27.0		"	11.9	0.013	26.0
1040	30	0.014	15.0	"	24.5		"	12.3	0.009	22.6
1110	60	0.010	15.0	"	22.1		"	12.7	0.007	19.3
1410	240	0.005	15.0	"	18.3		"	13.3	0.003	14.1
1510	1440	0.002		0.0136			7.2	14.0	0.0013	9.0
Tested by: DJH / G.B. Computed by: MA Checked by: MA								Cc		
								Cu		

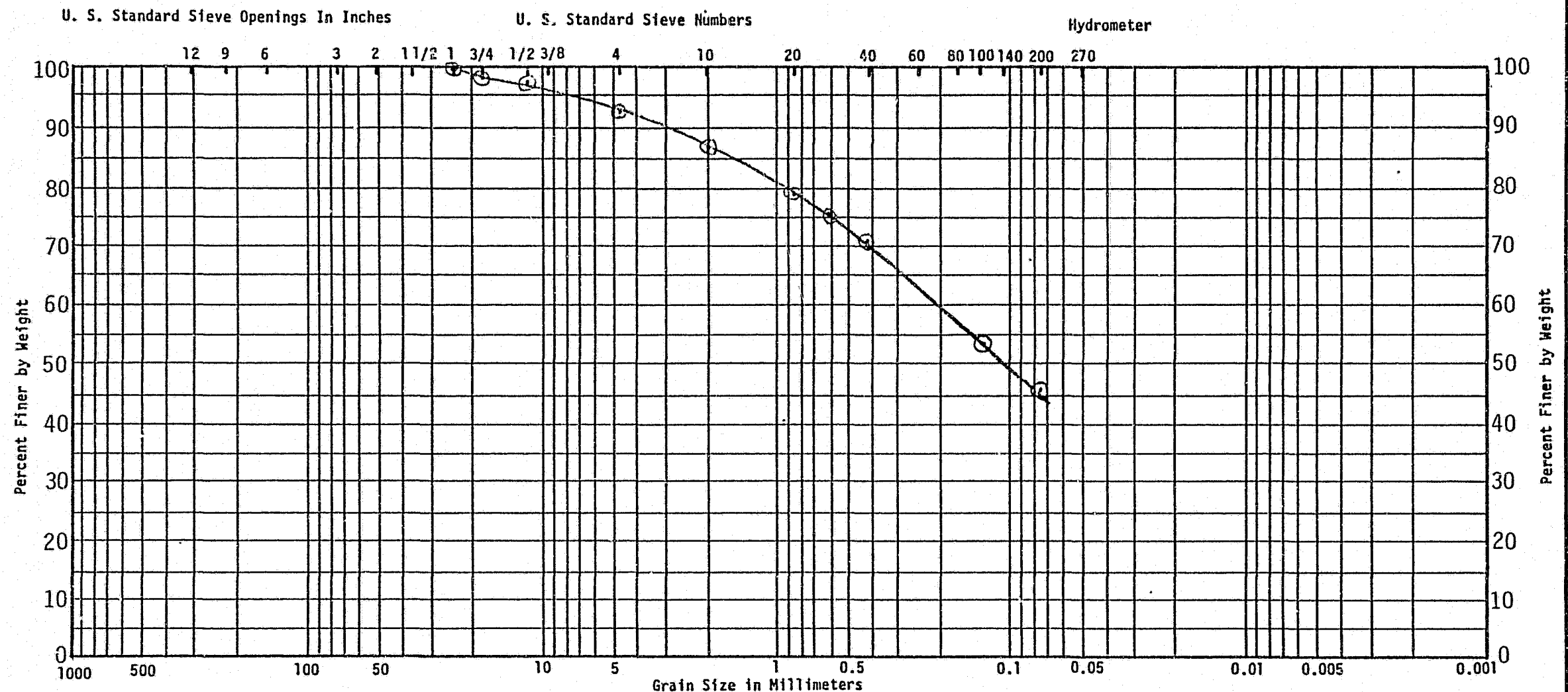
51.1
%
sand
48.9
%
fines

LF 135-MA



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GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

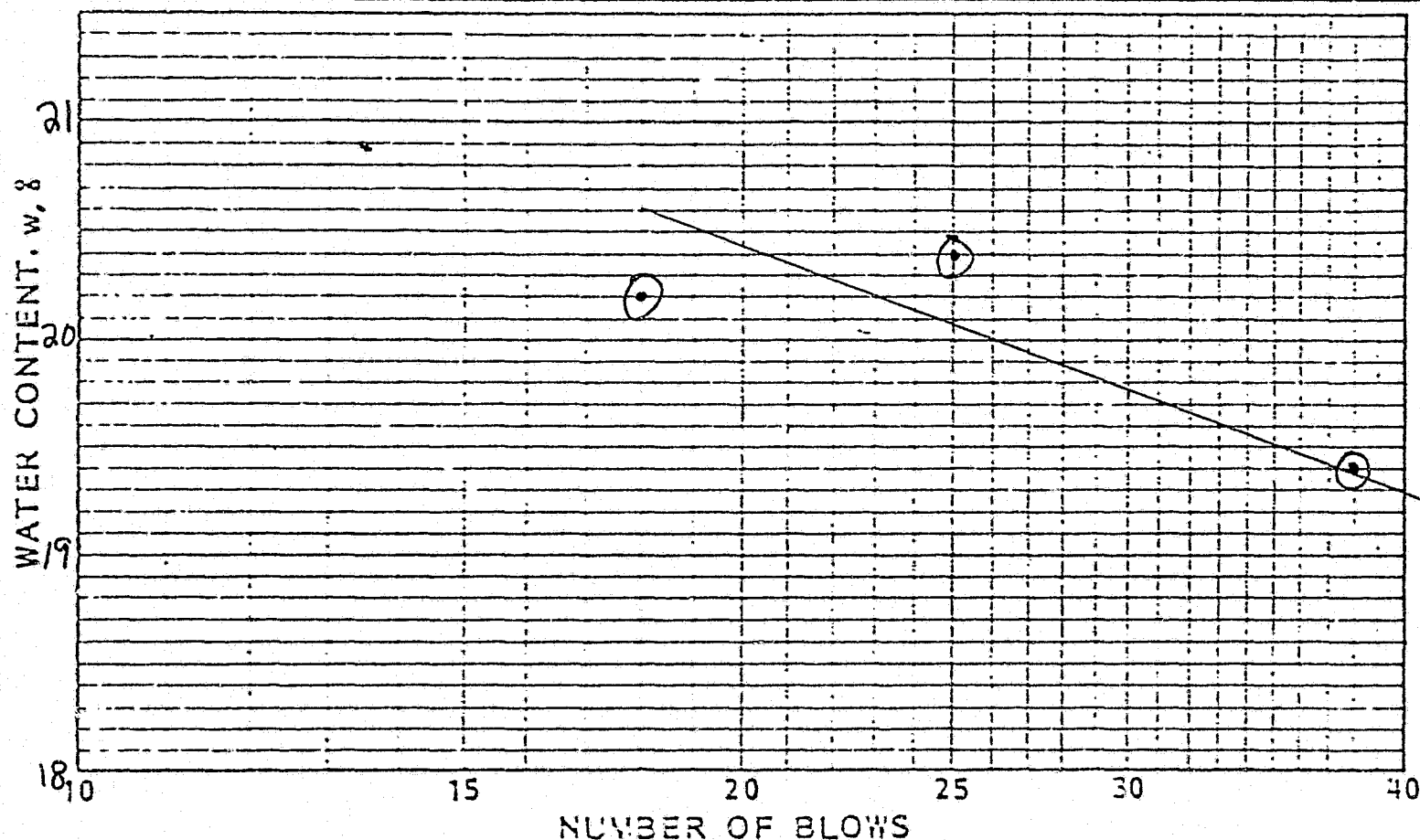
LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 49	1	2.-3.5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032.003.08
					Date

LF 141-GSA

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ATTERBERG LIMITS DETERMINATION

PROJECT: Watana Dam		DATE: 4/11/83					
HOLE NO. AS 49		SAMPLE NO. #2 (5-7.5)			JOB NO. 15032, 003.08		
LIQUID LIMIT							
RUN NO.		1	2	3	4	5	6
TARE NO.		A-8	S	A-12			
WEIGHT IN GRAMS	TARE PLUS WET SOIL	46.28	53.07	63.81			
	TARE PLUS DRY SOIL	40.38	46.28	54.89			
	WATER	5.90	6.79	8.92			
	TARE	11.20	11.25	11.10			
	DRY SOIL	29.18	35.03	43.79			
WATER CONTENT, %		20.2	19.4	20.4			
NUMBER OF BLOWS		18	38	25			



LL	20.1	20.0
PL	15.35	15.0
PI	4.75	5.0

SOIL SYMBOL FROM PLASTICITY CHART CL-ML

PLASTIC LIMIT						NATURAL WATER CONTENT
RUN NO.	1	2	3	4	5	
TARE NO.	A-17	A-28				
WEIGHT IN GRAMS	TARE PLUS WET SOIL	8.87	11.65			
	TARE PLUS DRY SOIL	8.27	10.68			
	WATER	.60	.97			
	TARE	4.36	4.40			
	DRY SOIL	3.91	6.28			
WATER CONTENT, %		15.3	15.4			
PLASTIC LIMIT, %		AVG = 15.35				

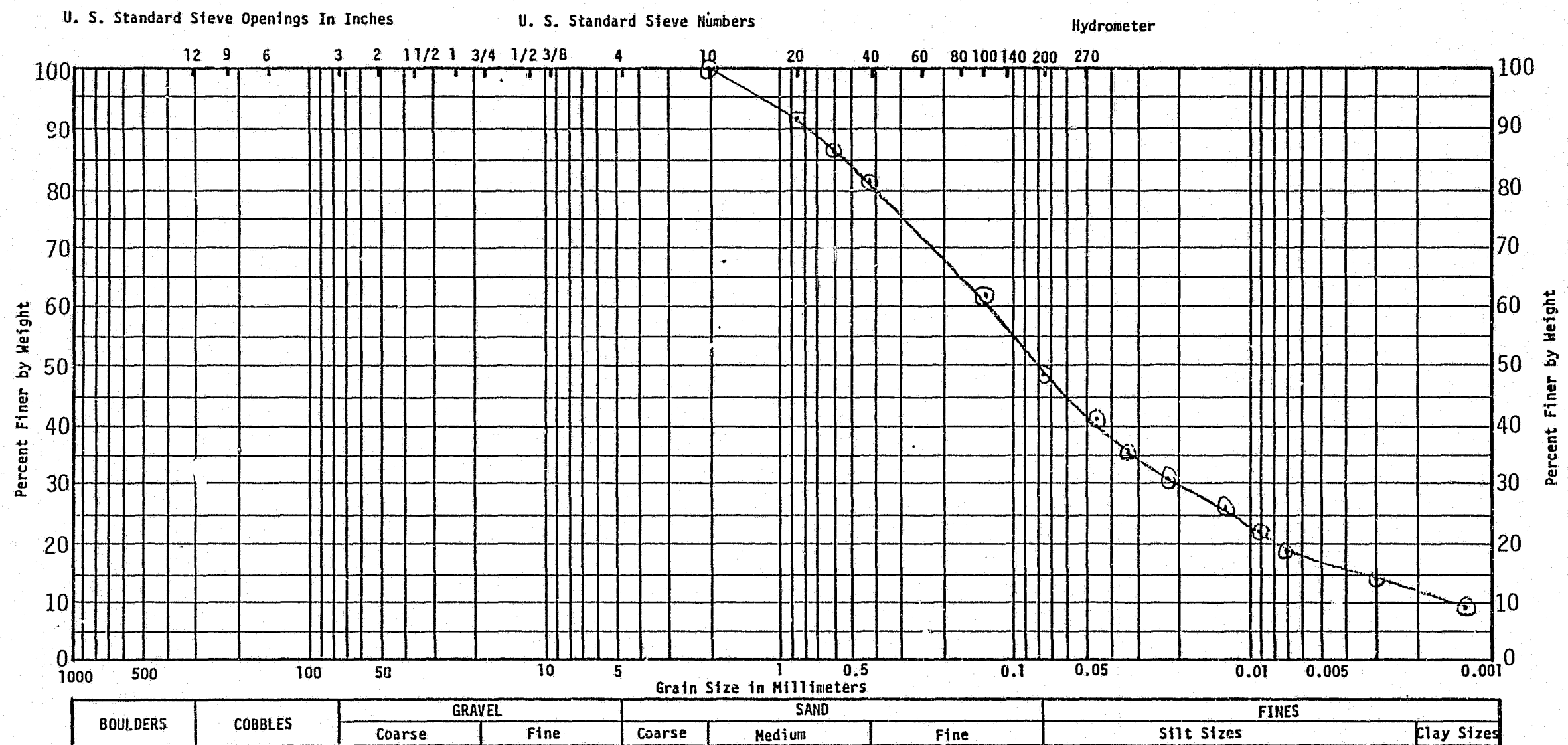
REMARKS: -40 PORTION OF SAMPLE IS A CL-ML
IS NEAR THE LINE WHICH SEPARATES CL-ML FROM ML-CL

TESTED BY: MA
COMPUTED BY: G.B.
CHECKED BY: MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 49	2	5-7.5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032.003.08
					Date 4-12-83

LF 141-GSA

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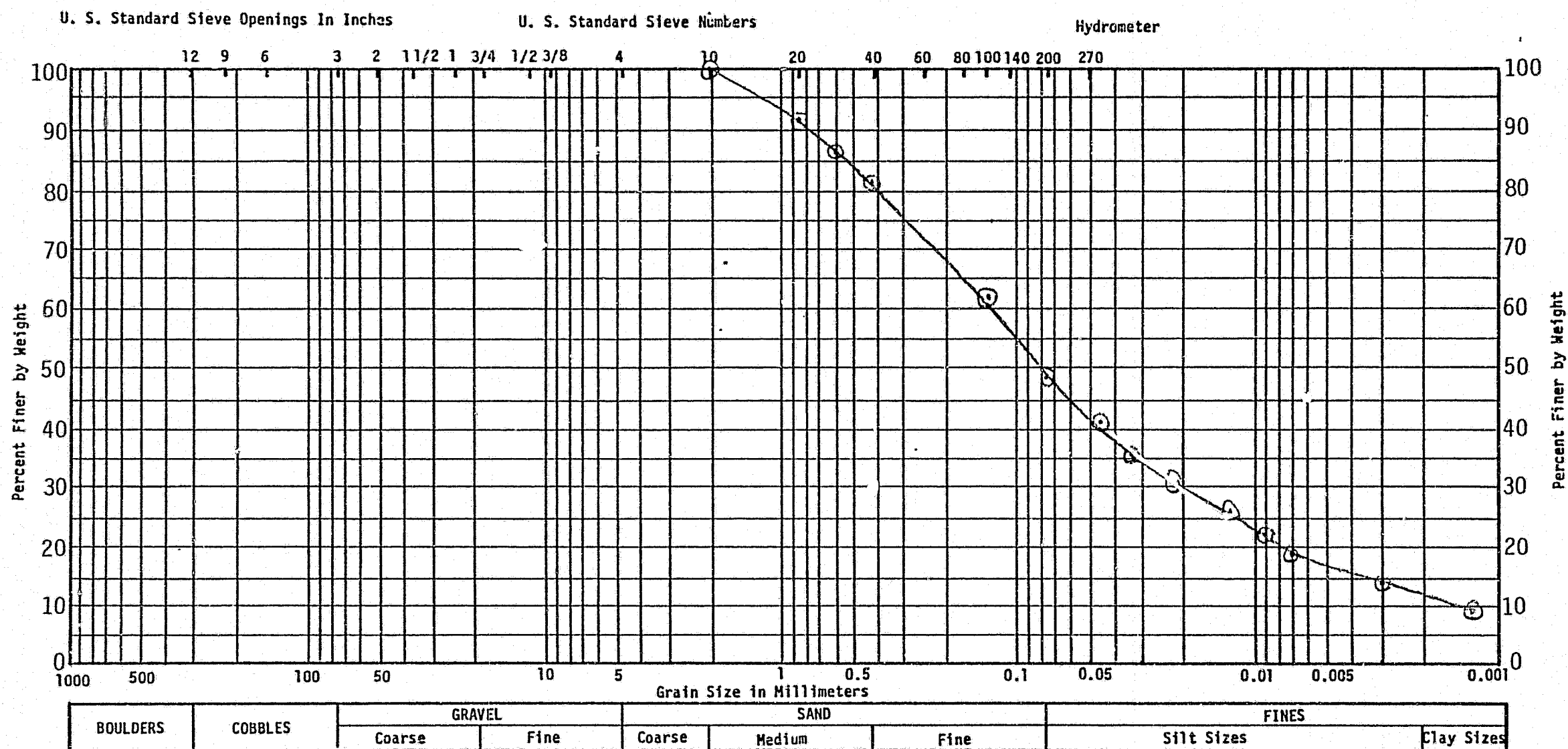
Date <u>4/9/83</u>		WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. <u>15032,003.08</u>		
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER		
Project <u>WATANA DAM</u>				Hole <u>AS 51</u>		Depth <u>1-2.5 #1</u>		
Dry WT Total Sample & Tare		<u>1320</u>		TOTAL SAMPLE				
Tare Weight <u>CC</u>		<u>536</u>		Classification <u>Olive gravelly silty sand (Sm)</u>				
Total Sample WT		<u>7840</u>		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	
Moisture Content -10 Material		4"		101.6				
Can No.		3"		76.2				
WT-Soil & Can (Wet)		2"		50.8				
WT-Soil & Can (Dry)		1 1/2"		38.1				
Loss		1"		25.4				
Weight of Can		3/4"		19.1		0	100	
% Moisture		1/2"		12.7		28	3.6	
		#4		4.6		80	10.2	
		#10		2.0			89.8	
		Pan						
		Total						
REPRESENTATIVE MINUS NO. 10 SAMPLE								
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare		
						Tare Weight		
						Washed Sample Weight		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing	
10	2.000	155				19.8	80.2	
20	0.850	266				33.9	66.1	
30	0.600	321				40.9	59.1	
40	0.425	379				48.3	51.7	
100	0.150	557				71.0	29.0	
200	0.075	623				79.5	20.5	
270	0.053							
Pan		629						
Total								
HYDROMETER SAMPLE								
Specific Gravity (G)		LL _____ PI _____		Hydrometer No. _____		Amyl Alcohol Drops: _____		
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____		
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl. Actual Rc			L
	1	0.078						
	2	0.055						
	5	0.035						
	15	0.020						
	30	0.014						
	60	0.010						
	240	0.005						
	1440	0.002						
Tested by: <u>CRL</u>		Computed by: <u>CRL</u>		Checked by: <u>MT</u>		Cc		
						Cu		

10.2 %
grl.

69.3 %
Sand
20.5 %
Fines



GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 49	2	5-7.5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003,08
					Date 4-12-83

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS			Job
		☐ GILSON	☒ BRASS SIEVE	☐ HYDROMETER	No. 15032,003.08

Project	WATANA DAM	Hole	AS 51	Depth	3-5 #2
---------	------------	------	-------	-------	--------

Dry WT Total Sample & Tare		1543	TOTAL SAMPLE					
Tare Weight		16 424	Classification Olive gravelly silty sand (sm)					
Total Sample WT		1159	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing
Moisture Content -10 Material			4"	101.6				
			3"	76.2				
			2"	50.8				
			1 1/2"	38.1				
Can No.			1"	25.4	0			0 100
WT-Soil & Can (Wet)			3/4"	19.1	17.0			1.5 98.5
WT-Soil & Can (Dry)			1/2"	12.7	22.0			1.9 98.1
Loss			#4	4.6	81.6			6.9 93.1
Weight of Can			#10	2.0				
WT of Soil (Dry)			Pan					
% Moisture			Total					

6.9 %
93.1

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample		grams	Jar #	WT Washed Sample & Tare		1047.0
				Tare Weight		212.0
				Washed Sample Weight		673.0
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret. Passing
10	2.000	140				12.0 88.0
20	0.850	231				19.8 80.2
30	0.600	279				23.4 76.6
40	0.425	334				28.6 71.4
100	0.150	555				47.5 52.5
200	0.075	666				57.0 43.0
270	0.053					
Pan		673				
Total						

50.1 %
Sand
43.0 %
Fines

HYDROMETER SAMPLE

Specific Gravity (G)		LL	PI	Hydrometer No.		Amyl Alcohol Drops:	
a =		Corrected Weight of Hydrometer Sample				Defloculation Agent	
		grams					
Time	Elap. Time	Maximum Dia. MM	Temp. O C.	K	Reading		Corrected Gram Size, Dia. MM
					Initl.	Actual	
	1	0.078					% of Total Passing
	2	0.055					
	5	0.035					
	15	0.020					
	30	0.014					
	60	0.010					
	240	0.005					
	1440	0.002					
Tested by: CLM							Cu
Computed by: CLM							
Checked by: MA							

LF 135-MA



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GRADATION SIZE ANALYSIS

U. S. Standard Sieve Openings In Inches

U. S. Standard Sieve Numbers

Hydrometer

BOULDERS		COBBLES		GRAVEL		SAND			FINES	
				Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes
LAB TEST NO. BORING NO. SAMPLE NO. DEPTH CLASSIFICATION (USC) AS 49 2 5-7.5 VISUAL MANUAL CLASSIFICATION Job WATANA DAM No. 15032,003.08 Date 1-12-83										

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. 15032, 003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER			
Project WATANA DAM				Hole AS 54		Depth 1-2 #1			
Dry WT Total Sample & Tare		1368		TOTAL SAMPLE					
Tare Weight SD-11		536		Classification Dark Greyish Brown gravelly silty sand (SM)					
Total Sample WT		832		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.		
Moisture Content -10 Material		4"		101.6					
		3"		76.2					
		2"		50.8					
Can No.		1 1/2"		38.1					
WT-Soil & Can (Wet)		1"		25.4					
WT-Soil & Can (Dry)		3/4"		19.1		0	0		
Loss		1/2"		12.7		4	1.1		
Weight of Can		#4		4.6		45	5.4		
WT of Soil (Dry)		#10		2.0					
% Moisture		Pan							
		Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare			
						1004			
						Tare Weight			
						532			
						Washed Sample Weight			
						473			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total			
						Ret.	Passing		
10	2.000	45				11.4	88.6		
20	0.850	167				20.1	79.9		
30	0.600	222				24.3	75.7		
40	0.425	236				28.4	71.6		
100	0.150	377				45.3	54.7		
200	0.075	464				55.8	44.2		
270	0.053								
Pan		473							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL		Hydrometer No.		Amyl Alcohol			
		PI				Drops:			
a =		Corrected Weight of Hydrometer Sample				Defloculation Agent			
		grams							
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: CRM		Computed by: CRM		Checked by: MA		Cc			
						Cu			

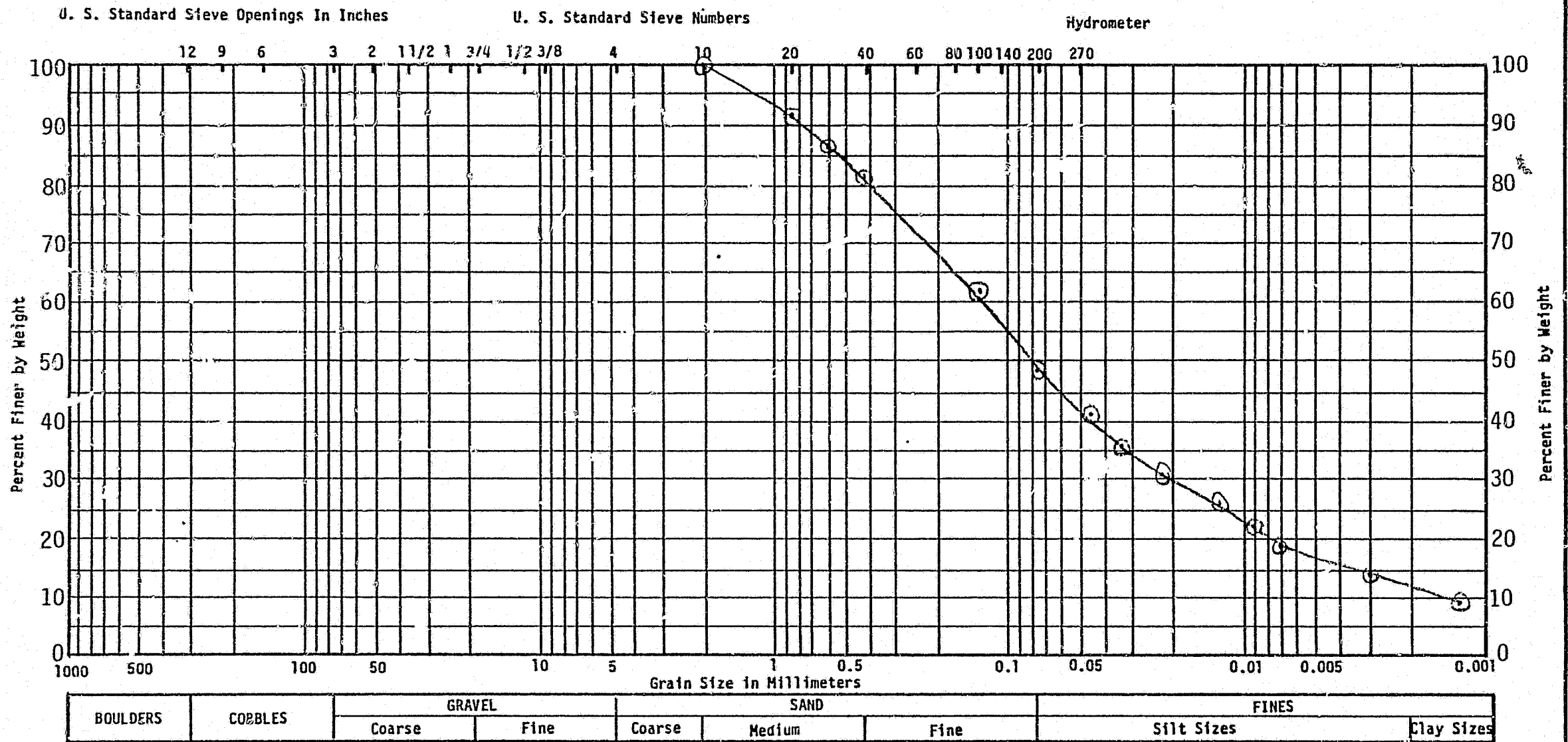
5.4 %
gsl.

50.4 % - Sand

44.2 % fines



GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS 49</u>	<u>2</u>	<u>5-7.5</u>		
VISUAL MANUAL CLASSIFICATION					No. <u>15032,003.08</u>
					Date <u>1-12-83</u>

ML

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER				
Project WATANA DAM				Hole AS 54		Depth 8.5-9 #2				
Dry WT Total Sample & Tare		1797	TOTAL SAMPLE							
Tare Weight		542.0	Classification Olive gravelly silty sand (sm)							
Total Sample WT		1255	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing	
Moisture Content -10 Material			4"	101.6						
			3"	76.2						
			2"	50.8						
Can No.			1 1/2"	38.1						
WT-Soil & Can (Wet)			1"	25.4						
WT-Soil & Can (Dry)			3/4"	19.1	0			0	100	
Loss			1/2"	12.7	9			.7	99.3	
Weight of Can			#4	4.6	78			6.2	93.8	
WT of Soil (Dry)			#10	2.0						
% Moisture			Pan							
			Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample		grams	Jar #		WT Washed Sample & Tare		1396			
					Tare Weight		542			
					Washed Sample Weight		854			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	172				13.7	86.3			
20	0.850	210				23.1	76.9			
30	0.600	352				28.2	71.8			
40	0.425	423				32.7	67.3			
100	0.150	751				59.6	40.4			
200	0.075	849				67.6	32.4			
270	0.053									
Pan		853								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)		LL		Hydrometer No.		Amyl Alcohol Drops:				
		PI								
a =		Corrected Weight of Hydrometer Sample				Defloculation Agent				
		grams								
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc			
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
Tested by:		Computed by:		Checked by:		Cc				
						Cu				

LF 135-MA



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FIELD IDENTIFICATION PROCEDURES FOR FINE-GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1 mm. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking)

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one half cubic inch. Add enough water if necessary to make the soil soft but not sticky. Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a shiny consistency and becomes glossy. When the pat is squeezed between the fingers, the water and gloss disappear from the surface, the pat splits, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction, whereas a plastic clay has no reaction. Inorganic silts such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics)

After removing particles larger than No. 40 sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun, or air-drying, and then test its strength by breaking and crumbling between the fingers. Dry strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity. High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

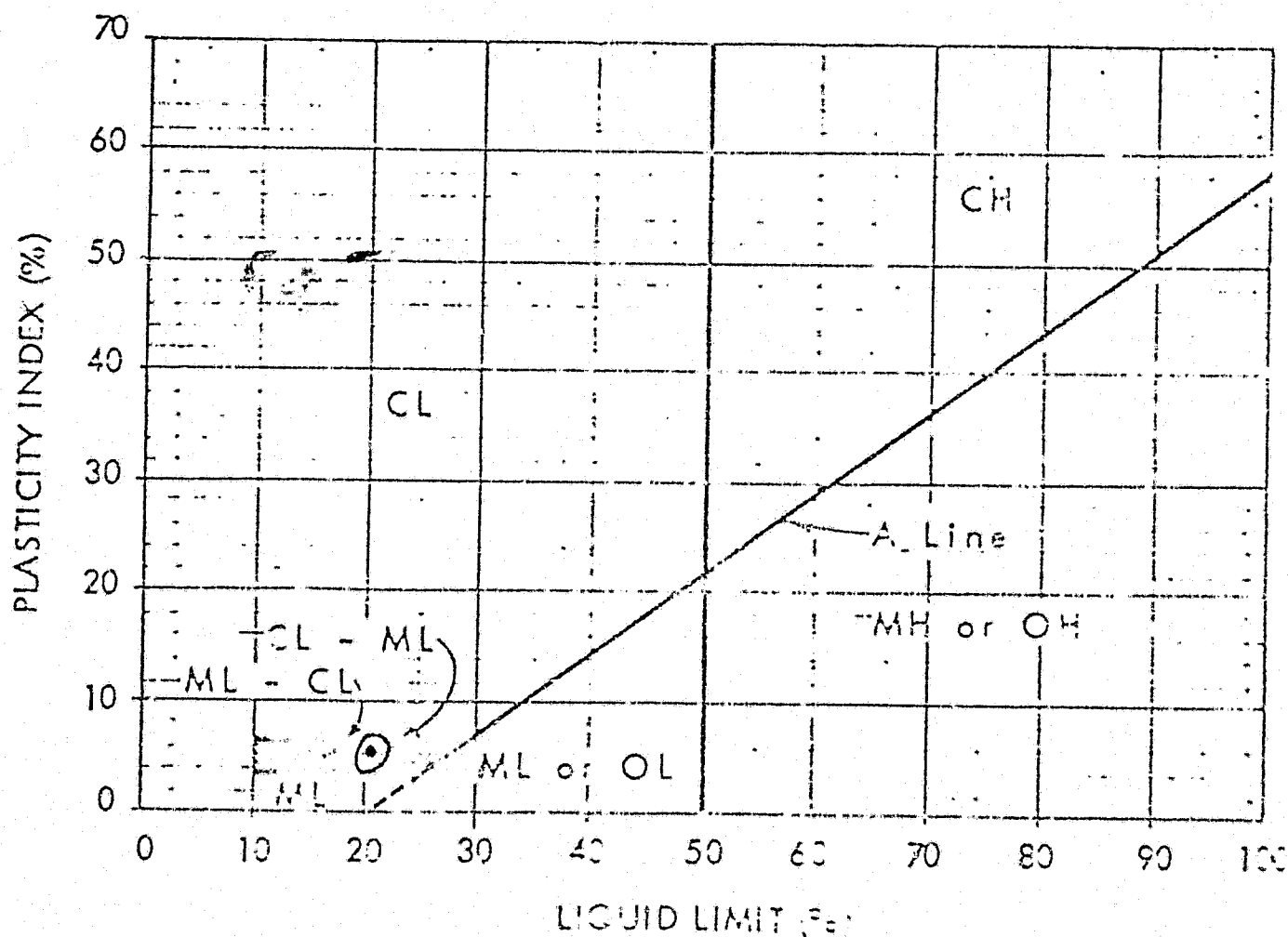
Table 1. Consistency near plastic limit

After removing particles larger than the No. 40 sieve size, a specimen of soil about one half cubic inch in size is molded to the consistency of putty. If the soil is dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand to a thickness of about one eighth inch in diameter. The thickness is then folded and tested repeatedly. Due to the nature of the moisture content, a specimen is usually tested at the plastic limit and the specimen is then tested at the liquid limit and sometimes at the shrinkage limit.

After the specimen is rolled, the edges should be smoothed together and a slight spreading action exerted on the specimen.

The thickness of the strand, the plastic limit, and the liquid limit are then determined. The moisture content is determined by drying the soil. Weigh the soil at the plastic limit and liquid limit, and the weight of the soil below the plastic limit is the weight of the soil at the liquid limit. The weight of the soil at the liquid limit is the weight of the soil at the plastic limit plus the weight of the water added to reach the liquid limit.

Highly plastic clays have a very weak and stringy feel at the plastic limit.



Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS			Job No.	15032,003.08
		☐ GILSON	☒ BRASS SIEVE	☐ HYDROMETER		

Project	WATANA DAM	Hole	AS 51	Depth	1-2.5 #1
---------	------------	------	-------	-------	----------

Dry WT Total Sample & Tare		1320	TOTAL SAMPLE						
Tare Weight (C)		536	Classification Olive gravelly silty sand (Sm)						
Total Sample WT		7840	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material			4"	101.6					
			3"	76.2					
			2"	50.8					
Can No.			1 1/2"	38.1					
WT-Soil & Can (Wet)			1"	25.4					
WT-Soil & Can (Dry)			3/4"	19.1	0			0	100
Loss			1/2"	12.7	28			3.6	96.4
Weight of Can			#4	4.6	80			10.2	89.8
WT of Soil (Dry)			#10	2.0					
% Moisture			Pan						
			Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample		grams	Jar #	WT Washed Sample & Tare		1166.0
				Tare Weight		536.0
				Washed Sample Weight		630.0
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret. Passing
10	2.000	155				19.8 80.2
20	0.850	266				33.9 66.1
30	0.600	321				40.9 59.1
40	0.425	379				48.3 51.7
100	0.150	557				71.0 29.0
200	0.075	623				79.5 20.5
270	0.053					
Pan		629				
Total						

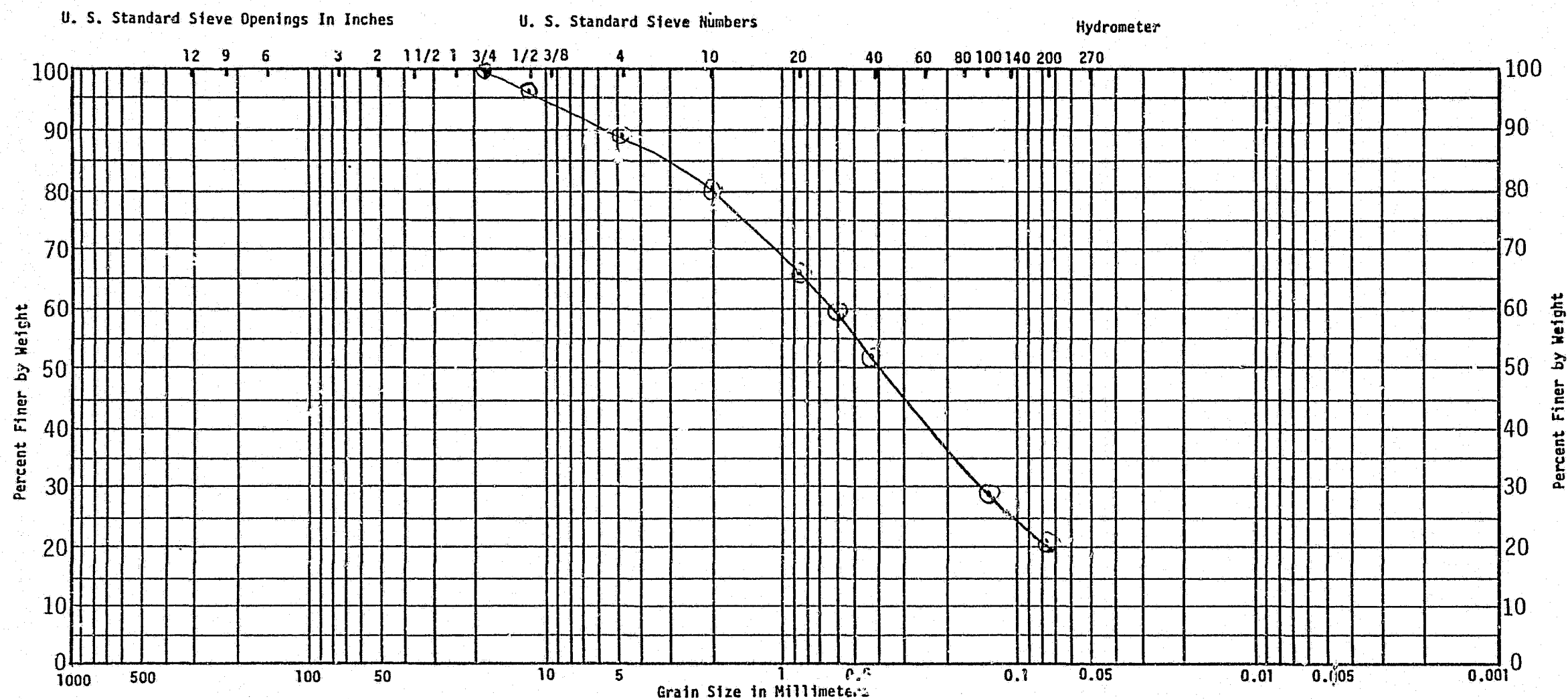
HYDROMETER SAMPLE

Specific Gravity (G)		LL	Hydrometer No.		Amyl Alcohol Drops:	
		PI				
a =		Corrected Weight of Hydrometer Sample			Defloculation Agent	
		grams				
Time	Elap. Time	Maximum Dia. MM	Temp. O C.	K	Reading	Corrected Gram Size, Dia. MM
					Initl. Actual Rc	% of Total Passing
	1	0.078				
	2	0.055				
	5	0.035				
	15	0.020				
	30	0.014				
	60	0.010				
	240	0.005				
	1440	0.002				
Tested by: CRLM		Computed by: CRLM		Checked by: MFL		Cc
						Cu

LF 135 - MA

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GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 51	1	1.2.5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003,08
					Date 4-10-83

LF 141-GSA

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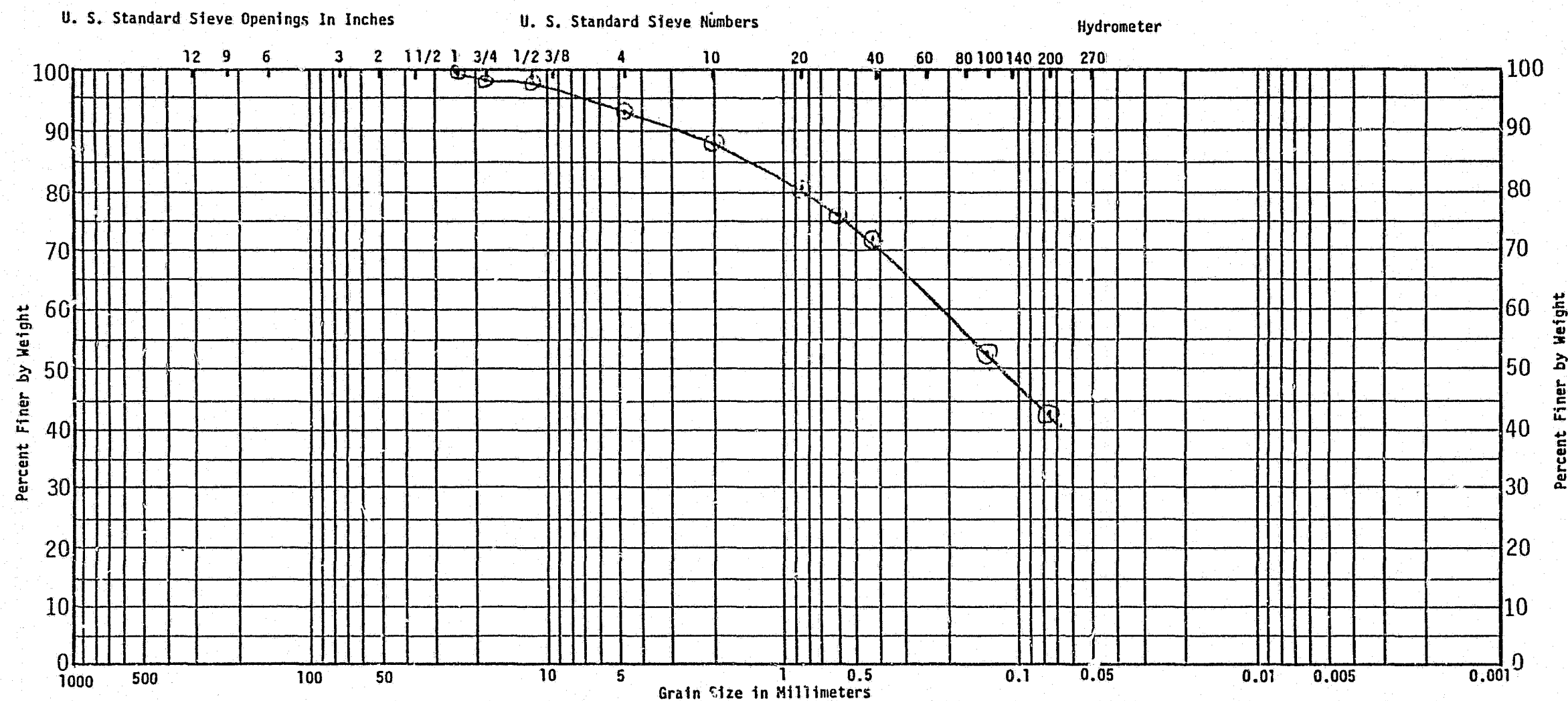
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER			
Project WATANA DAM				Hole AS 51		Depth 3-5 #2			
Dry WT Total Sample & Tare		1593		TOTAL SAMPLE					
Tare Weight 16		424		Classification Olive gravelly silty sand(sm)					
Total Sample WT		1151		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.		
						% Ret.	Cum. % of Total Ret.		
							Passing		
Moisture Content -10 Material		4"		101.6					
		3"		76.2					
		2"		50.8					
Can No.		1 1/2"		38.1					
WT-Soil & Can(Wet)		1"		25.4		0	0		
WT-Soil & Can(Dry)		3/4"		19.1		17.0	1.5		
Loss		1/2"		12.7		22.0	1.9		
Weight of Can		#4		4.6		81.0	6.9		
WT of Soil (Dry)		#10		2.0			93.1		
% Moisture		Pan							
		Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare			
						Tare Weight			
						Washed Sample Weight			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing		
10	2.000	140				12.0	88.0		
20	0.850	231				19.8	80.2		
30	0.600	279				23.4	76.1		
40	0.425	334				28.6	71.4		
100	0.150	555				47.5	52.5		
200	0.075	666				57.0	43.0		
270	0.053								
Pan		673							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____		Hydrometer No.		Amyl Alcohol Drops: _____			
		PI _____							
a =		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent			
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: CAM		Computed by: CPM		Checked by: MA		Cc			
						Cu			

LF 135 - MA



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GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 51	2	3-5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003.08
					Date 4-10-83

LF 141-GSA

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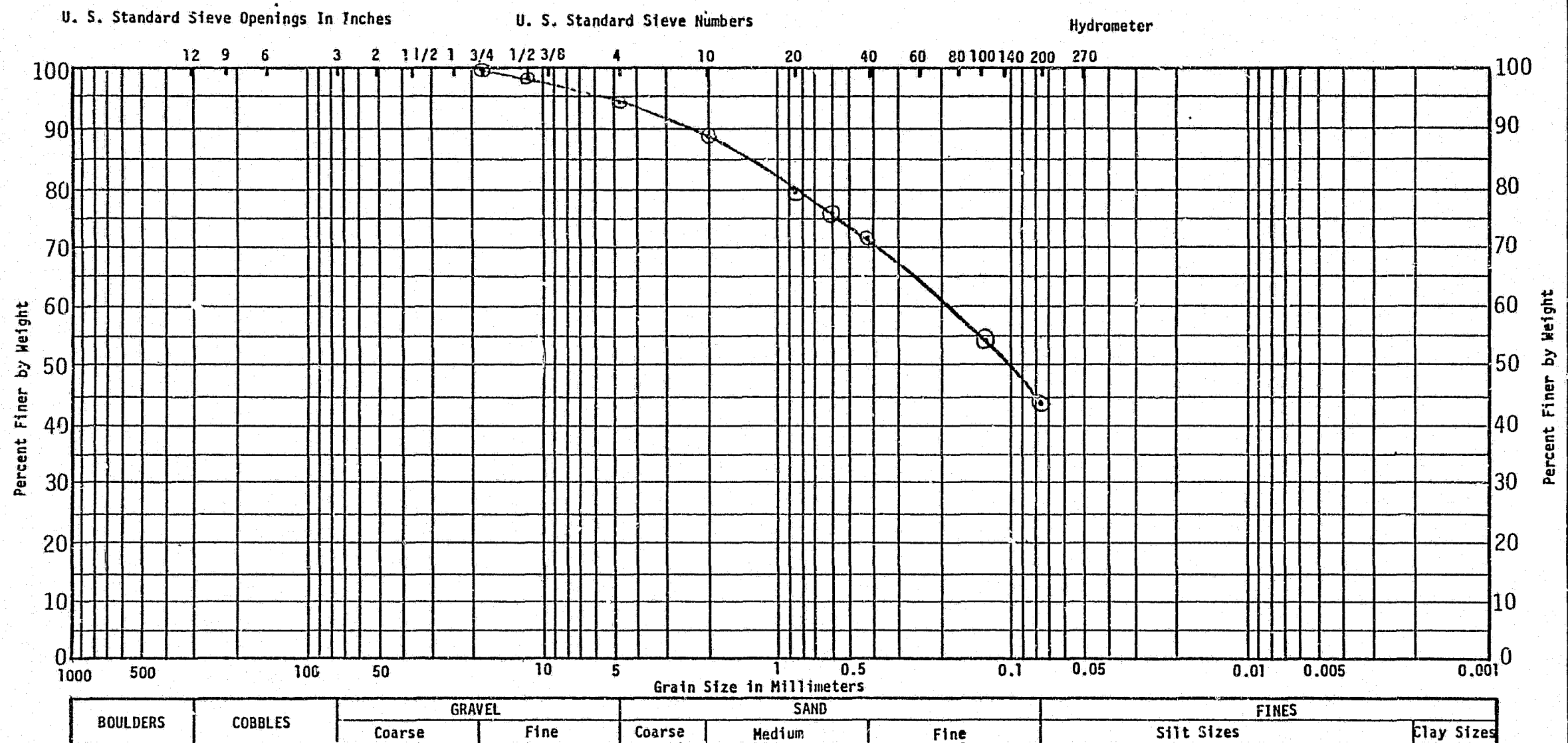
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08	
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER		
Project WATANA DAM				Hole AS 54		Depth 1-2 #1		
Air Dry WT Total Sample & Tare		1368		TOTAL SAMPLE				
Tare Weight SD-11		536		Classification Dark Greyish Brown gravelly silty sand (SM)				
Total Sample WT		832		Sieve Size	Dia. Mm	Cum. WT Ret.	Dry WT Ret.	% Ret.
Moisture Content -10 Material		4"		101.6				
		3"		76.2				
		2"		50.8				
Can No.		1 1/2"		38.1				
WT-Soil & Can (Wet)		1"		25.4				
WT-Soil & Can (Dry)		3/4"		19.1	0			100
Loss		3/8"		12.7	4			98.9
Weight of Can		#4		4.6	45			94.6
WT of Soil (Dry)		#10		2.0				
% Moisture		Pan						
		Total						
REPRESENTATIVE MINUS NO. 10 SAMPLE								
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare		1004
						Tare Weight		532
						Washed Sample Weight		473
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing	
10	2.000	95				11.4	88.6	50.4 % Sand
20	0.850	167				20.1	79.9	
30	0.600	222				24.3	75.7	
40	0.425	230				28.4	71.6	
100	0.150	377				45.3	54.7	
200	0.075	464				55.8	44.2	
270	0.053							44.2 % fines
Pan		473						
Total								
HYDROMETER SAMPLE								
Specific Gravity (G)		LL _____ PI _____		Hydrometer No.		Amyl Alcohol Drops: _____		
a =		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent		
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl. Actual Rc			L
	1	0.078						
	2	0.055						
	5	0.035						
	15	0.020						
	30	0.014						
	60	0.010						
	240	0.005						
	1440	0.002						
Tested by: CPM		Computed by: CPM		Checked by: MA		Cc _____ Cu _____		

LF 135-MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>AS 54</u>	<u>1</u>	<u>1-2</u>		No. <u>15032,003.08</u>
VISUAL MANUAL CLASSIFICATION					Date <u>4-11-83</u>

LF 141-G5A

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ML

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08		
		☐ GILSON	☒ BRASS SIEVE	☐ HYDROMETER					
Project WATANA DAM			Hole AS 54		Depth 8.5-9 #2				
Dry WT Total Sample & Tare		1797	TOTAL SAMPLE						
Tare Weight (g)		5420	Classification Olive gravelly silty sand (sm)						
Total Sample WT	1255	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret. Passing		
Moisture Content -10 Material		4"	101.6						
		3"	76.2						
		2"	50.8						
Can No.		1 1/2"	38.1						
WT-Soil & Can (Wet)		1"	25.4						
WT-Soil & Can (Dry)		3/4"	19.1	0			100		
Loss		1/2"	12.7	9			99.3		
Weight of Can		#4	4.6	78			6.2		
WT of Soil (Dry)		#10	2.0				93.8		
% Moisture		Pan							
		Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample		grams	Jar #	WT Washed Sample & Tare		1396			
				Tare Weight		542			
				Washed Sample Weight		854			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing		
10	2.000	172				13.7	86.3		
20	0.850	270				23.1	76.9		
30	0.600	352				29.0	71.0		
40	0.425	423				32.7	67.3		
100	0.150	751				54.2	45.8		
200	0.075	849				61.6	38.4		
270	0.053								
Pan		853							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL	Hydrometer No.		Amyl Alcohol Drops:				
		PI							
a =		Corrected Weight of Hydrometer Sample			Defloculation Agent				
		grams							
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading		L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: CWM		Computed by: CWM		Checked by: MA		Cc			
						Cu			

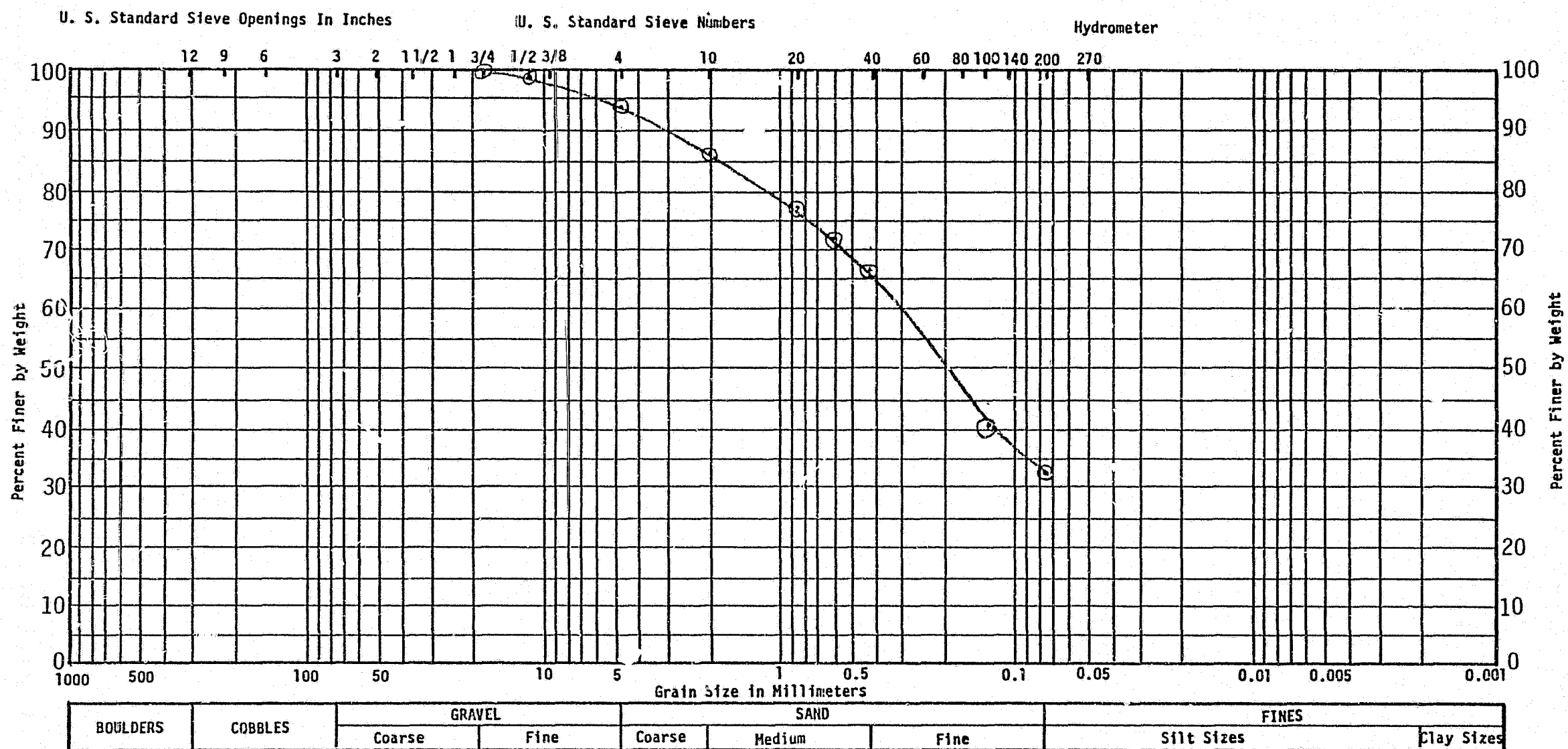
6.2 % fines
61.4 % sand
32.4 % fines

LC 135-MA



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GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	AS 54	2	8.5-9.0		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003.08
					Date 4-11-83

LF 141-GSA

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73000

MISCELLANEOUS
TEST RECORDS

1
1
3
5

1
1
1
1
1

% Passing #200 Sieve							
Job	Watana Dam		No. 15032,003.08		By: GB/MA	Date: 4-11-83	
Boring	AS1 #2	AS2 #3	AS1 #1	AS2 #2	AS5 #2		
Depth	1-3'	3-4.5'	5-6'	1-3'	5.5-6.5'		
Soil	Very Dark Brown Silty Sand all sample used	Dark Greyish Brown small silt clumps containing pebbles + sand	Black cohesive	Dark Greyish Brown			
Cup No.	MA-10	MA-37	MA-11	MA-46	MA-8		
Dry Wt. Before Wash & Tare	316.28	379.99	205.91	481.10	818.9		
Dry Wt After Wash & Tare	247.2	238.2	183.6	282.0	495.0		
Dry Wt Passing No. 200	69.08	141.71	22.31	199.1	323.9		
Cup Wt	88.0	90.06	87.99	88.7	91.4		
Dry Wt Before Wash	159.2	289.93	117.92	392.4	727.5		
% Passing No. 200	43.4	48.9	18.9	50.7	44.5		

Boring							
Depth							
Soil							
Cup No.							
Dry Wt. Before Wash & Tare							
Dry Wt After Wash & Tare							
Dry Wt Passing No. 200							
Cup Wt							
Dry Wt Before Wash							
% Passing No. 200							

Boring							
Depth							
Soil							
Cup No.							
Dry Wt. Before Wash & Tare							
Dry Wt After Wash & Tare							
Dry Wt Passing No. 200							
Cup Wt							
Dry Wt Before Wash							
% Passing No. 200							

LF-136-P



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% Passing #200 Sieve							
Job	Watana Dam.		No. 15032,003.08		By:	Date:	
Boring	AS 37	AS 38	AS 52	MC-7	MC-9	AS 44	
Depth	#2 2.5-4.5	#2 2.5-4	#1 1-2.5	#1 1-2.5	#1 1-2	#1 0.5-2	
Soil	dark brown	silt clumps olive	dark greyish brown	sample saturated dark brown	sample is sat. unwatered dark brown	ORGANIC	
Cup No.	MA-4	EE	SD-13	BB	IU	MA-48	
Dry Wt. Before Wash & Tare	488.5	1311.0	1047.0	1044.0	962.0	837.1	
Dry Wt After Wash & Tare	341.1	939.0	812.0	864.0	845.0	526.5	
Dry Wt Passing No. 200	147.4	322	235	180	117	310.6	
Cup Wt	90.81	531	537	544.0	542.0	86.4	
Dry Wt Before Wash	397.69	780	510	500	420	750.7	
% Passing No. 200	37.1	41.3	46.1	36.0	27.9	41.4	

Boring							
Depth							
Soil							
Cup No.							
Dry Wt. Before Wash & Tare							
Dry Wt After Wash & Tare							
Dry Wt Passing No. 200							
Cup Wt							
Dry Wt Before Wash							
% Passing No. 200							

Boring							
Depth							
Soil							
Cup No.							
Dry Wt. Before Wash & Tare							
Dry Wt After Wash & Tare							
Dry Wt Passing No. 200							
Cup Wt							
Dry Wt Before Wash							
% Passing No. 200							

LF-136-P



HARDING LAWSON ASSOCIATES
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Organic Content Loss By Ignition

Project: Watana Dam

Job No.: 15032,003.08

By: CKM-CB / MHA

Date: 4/8/83

Boring	AS1 #1	AS1 #2	AS2 #1	AS3 #2	AS3 #3
Depth	0-1	1-3	0-1	3-4'	5-7'
Soil	very Dark Brown Pete all of sample used	very Dark Brown silty Sand all of sample used	Very Dark Brown Pete all of sample used	Very Dark Greyish Brown all of sample used	Dark Greyish Brown
Pan No.	C-7	C-22	C-6	C-5	C-8
Dry Wt Before Burn & Tare	38.36	62.06	27.13	61.85	62.86
Dry Wt After Burn & Tare	34.76	60.78	20.44	59.88	62.20
Wt Loss	3.60	1.28	6.69	1.97	.66
Pan Wt	17.49	18.53	18.37	18.24	16.19
Dry Wt Before Burn	20.87	43.53	8.76	43.61	46.67
% Organic Matter	17.2%	2.9%	76.4%	4.5%	1.4%
Boring	AS4 #1	AS5 #1	AS12 #1		
Depth	5-6'	3.5-4'	5-10'		
Soil	Black	very Dark Brown	Black with large amount Organic		
Pan No.	C-11	C-19	C-20		
Dry Wt Before Burn & Tare	48.24	22.10	52.02		
Dry Wt After Burn & Tare	44.72	17.09	49.04		
Wt Loss	3.52	5.01	2.98		
Pan Wt	17.73	16.50	18.14		
Dry Wt Before Burn	30.51	5.60	33.88		
% Organic Matter	11.5%	89.5%	8.8%		
Notes & Additional Tests	See Arpa Dry Strength				

LF 134-011



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Organic Content Loss By Ignition

Project: Watana Dam Job No.: 15032,003.08 By: GB /MA
Date: 4-11-83

Boring	AS 14 #1	AS 32	AS 34	MC1	MC6
Depth	5-7.5	#1 .5-2.0	#1 .5-2.0	#1 0-1.5	#1 1-1.5
Soil		Sample is saturated Very Dark greyish Brown		Dark Brown	Very Dark Brown
Pan No.	C-22	C-5	C-7	C-19	C-20
Dry Wt Before Burn & Tare	48.75	49.25	45.19	43.57	61.19
Dry Wt After Burn & Tare	45.37	47.27	42.38	39.86	59.18
Wt Loss	3.38	1.98	2.81	3.71	2.01
Pan Wt	18.54	18.23	17.48	16.49	18.14
Dry Wt Before Burn	30.21	31.02	27.71	27.08	43.05
% Organic Matter	11.2	6.4	10.1	13.7	4.7
Boring					
Depth					
Soil					
Pan No.					
Dry Wt Before Burn & Tare					
Dry Wt After Burn & Tare					
Wt Loss					
Pan Wt					
Dry Wt Before Burn					
% Organic Matter					
Notes & Additional Tests					

LF 134-011



HARDING LAWSON ASSOCIATES
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JOB <u>Watana Dam</u>		15032,003.08 <u>MOISTURE CONTENT - DRY DENSITY</u>					
		No. <u>15032</u> , BY <u>CRM/MA</u> DATE <u>4/10/83</u>					
		003.08					
BORING	AS2#3	AS3#2	AS5#1	AS7#2	AS13#2		
DEPTH	3'-4.5'	3'-4'	3'-5-4'	10'	7'-10'		
SOIL	Dark Greyish Brown Small Silt Clumps containing H ₂ O + Sand all of Sample	Very Dark Greyish Brown Sample is Estimated appears to Be all organic	Very Dark Brown	Dark Greyish Brown	Very Dark Grey		
LENGTH							
TUBE + W. SOIL							
TUBE							
W. SOIL							
FACTOR							
W. DENSITY							
CUP #	MA-1	MA-48	MA-20	MA-35	MA-4		
CUP + W. SOIL	307.26	314.42	190.37	405.4	267.02		
CUP + D. SOIL	280.21	272.26	98.40	370.06	234.95		
MOIST. LOSS	27.05	47.66	91.97	35.74	32.07		
CUP	88.84	86.60	87.46	89.20	90.76		
D. SOIL	191.37	185.66	10.94	280.86	144.19		
MOIST. CONT.	14.1	25.7	840.7	12.7	22.2		
DRY DENSITY							

BORING							
DEPTH							
SOIL							
LENGTH							
TUBE + W. SOIL							
TUBE							
W. SOIL							
FACTOR							
W. DENSITY							
CUP #							
CUP + W. SOIL							
CUP + D. SOIL							
MOIST. LOSS							
CUP							
D. SOIL							
MOIST. CONT.							
DRY DENSITY							



JOB <u>Watana Dam</u>		15032,003.08 <u>MOISTURE CONTENT - DRY DENSITY</u>						
		No. 15032, BY <u>GB / MA</u> DATE <u>4-11-83</u>						
		003.08						
BORING	AS 19	AS 24	AS 26	AS 30	AS 31	AS 31	AS 33	AS 33
DEPTH	#2 5-7	#1 1.5-2.5	#1 1-2.5	#1 1-2.5	#1 1-2.5	#2 2.5-3	#1 .5-2.5	#2 2-5.5
SOIL				Dark Brown		Dark greyish Brown	Sample is saturated Dark greyish Brown	Olive
LENGTH								
TUBE + W. SOIL								
TUBE								
W. SOIL								
FACTOR								
W. DENSITY								
CUP #	MA-22	MA-18	MA-45	MA-32		MA-15	MA-38	A
CUP + W. SOIL	383.75	349.09	941.0	843.5		1189.2	1642.0	
CUP + D. SOIL	353.41	318.85	763.2	700.1		822.8	1027.2	1567.0
MOIST. LOSS	30.34	30.24	177.8	143.4		122.6	162.0	126
CUP	90.72	91.33	88.85	90.98		91.15	90.80	540.
D. SOIL	262.69	227.52	674.35	609.12		731.65	936.4	1027
MOIST. CONT.	11.5	13.3	26.4	23.5		16.8	17.3	12.3
DRY DENSITY								

BORING	AS 34	AS 35	AS 42	AS 42	AS 43	AS 44	AS 44	AS 45
DEPTH	#1 .5-2.0	#1 0-2.5	#1 1-2.5	#2 2.5-5	#1 1-2	#1 .5-2.0	#2 2-4	#1 1-2.5
SOIL	Saturated Dark Brown	Dark Brown	Sample is saturated Very Dark Brown	Dark Greyish Brown	Sample is Very Dark greyish brown	Sample is saturated Dark Brown	Olive Brown	Greyish Brown
LENGTH				SA		-200		
TUBE + W. SOIL								
TUBE								
W. SOIL								
FACTOR								
W. DENSITY								
CUP #	MA-19	SD-10	MA-12	1 X	MA-20	MA-48	1 D	MA-4
CUP + W. SOIL	608.9	1387	892.0	1232	721.7	1310.0	1500	873.50
CUP + D. SOIL	369.2	1306	723.2	1177	617.1	837.7	1366	832.8
MOIST. LOSS	239.7	81	168.8	61	104.7	198.3	134	157.8
CUP	211.32	545.0	228.8	562	87.16	200.3	431.0	203.71
D. SOIL	277.87	761	635.5	615	529.64	750.87	935	742.09
MOIST. CONT.	86.3	10.6	26.6	9.9	19.8	26.4	14.3	21.3
DRY DENSITY								

LF 133-MC00



HARDING LAWSON ASSOCIATES
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JOB Watana Dam		15032,003.08 MOISTURE CONTENT - DRY DENSITY						
		No. 15032, BY CLM/MA DATE 4-11-83						
		003.08						
BORING	AS 45	AS 47	AS 49	AS 49	AS 54	AS 54	mcl	mcl
DEPTH	#2 3-5	#1 2-5	#1 2-3.5	#2 5-7.5	#1 1-2	#2 8.5-9	#2 2-2.5	#3 3-3.5
SOIL	Olive	olive grey	Olive	Olive	Dark Greyish Brown	Olive Grey	Dark Brown	Olive
LENGTH								
TUBE + W. SOIL								
TUBE								
W. SOIL								
FACTOR								
W. DENSITY								
CUP #	X	B	MA-7	IL	SD-11	CRM	MA-6	CRM-1
CUP + W. SOIL	354.43	294.87	360.48	725.0	1476.0	1913.0	227.57	230.10
CUP + D. SOIL	327.82	265.50	286.6	690.0	1368.0	1797.0	201.85	204.17
MOIST. LOSS	27.11	29.37	73.88	35	108	116	25.72	25.93
CUP	80.47	80.05	90.36	429.	536	542	84.32	79.74
D. SOIL	247.35	185.45	196.24	261	832	1255	113.53	124.43
MOIST. CONT.	11.0	15.8	37.6	13.4	13.0	5.6	22.7	20.8
DRY DENSITY								

BORING	mcl 2							
DEPTH	#2 2-2.5							
SOIL	Dark Grey							
LENGTH								
TUBE + W. SOIL								
TUBE								
W. SOIL								
FACTOR								
W. DENSITY								
CUP #	MA-26							
CUP + W. SOIL	237.14							
CUP + D. SOIL	209.40							
MOIST. LOSS	23.78							
CUP	91.47							
D. SOIL	117.93							
MOIST. CONT.	20.2							
DRY DENSITY								

LF 133 - MCOB



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WORK SHEET - SPECIFIC GRAVITY TESTS

Project: Watana Dam 15032,003.08 Job No. Hole No. Date 4-11-83

SPECIFIC GRAVITY OF SOLIDS (G_s)

Sample No.		ASAC #2 2.5-4	AS42 #2 2.5-5.0	AS49 #2 5-7.5		
Flask No.		F	C	E		
Temperature of Water and Soil, T, °C		22°	22.5	23°		
Pan No.						
Wt. in grams	Pan + Dry Soil					
	Pan					
	Dry Soil	W _s	100.02	100.00	100.00	
	Flask + Water at T, °C	W _{bw}	664.40	665.28	670.00	
	W _s + W _{bw}		764.42	765.28	770.00	
	Flask + Water + Immersed Soil	W _{bws}	728.1	727.8	733.3	
	Displaced Water, W _s + W _{bw} - W _{bws}		36.32	37.48	36.70	
Correction Factor	K		.9996	.99945	.9993	
(W _s K) ÷ (W _s + W _{bw} - W _{bws})	G _s		2.75	2.67	2.72	

APPARENT (G_a) AND BULK (G_m) SPECIFIC GRAVITY

APPARENT (G_a) AND BULK (G_m) SPECIFIC GRAVITY				Temp.	Corr. Factor
Sample No.				°C	K
Temperature of Water and Soil, T, °C				14	1.0010
Wt. in grams	Pan + Saturated Surface - Dry Soil			15	1.0009
	Tare Weight			16	1.0007
	Saturated Surface - Dry Soil	B		17	1.0006
	(Wire Basket + Soil) in Water			18	1.0004
	Wire Basket in Water			19	1.0002
	Saturated Soil in Water	C		20	1.0000
	Tare Weight + Dry Soil			21	0.9998
	Tare Weight			22	0.9996
	Dry Soil	A		23	0.9993
Correction Factor		K		24	0.9991
(AK) ÷ (A-C) (Apparent)		G_a		25	0.9988
(AK) ÷ (B-C) (Bulk)		G_m		26	0.9986
Remarks:				27	0.9983
				28	0.9980
				29	0.9977
				30	0.9974
				31	0.9971

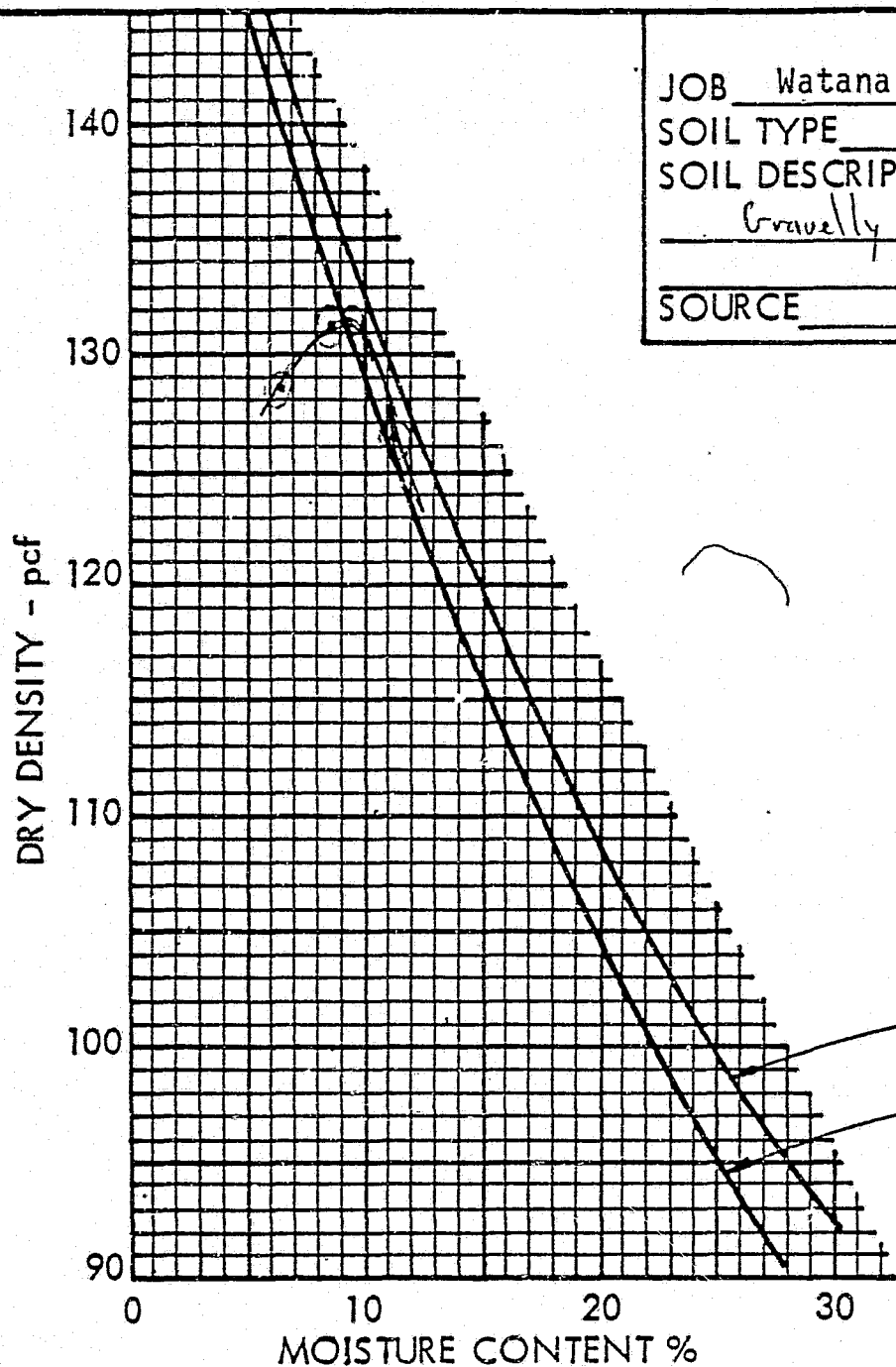
Tested by: DNR

Computed by: G.B.

Checked by: MA



LABORATORY COMPACTION TEST



JOB Watana Dam NO. 15032,003.08
 SOIL TYPE SM DATE 4/1/83 BY Rich M
 SOIL DESCRIPTION Dark Greenish Brown Gravelly Silty Sand (SM)
 SOURCE STA 12+00

☒ ASTM D1557-78(A)

☐ ASTM 698

☐ Other (Specify) _____

MAXIMUM DRY DENSITY 131 PCF

OPTIMUM MOISTURE CONTENT 9 %

⊙ Laboratory Compaction Point

△ Field Check Point

100% Saturation ($G_s = 2.68$)

90% Saturation ($G_s = 2.68$)

(*For weight of wet soil in grams and volume = 1/30 cu. ft)

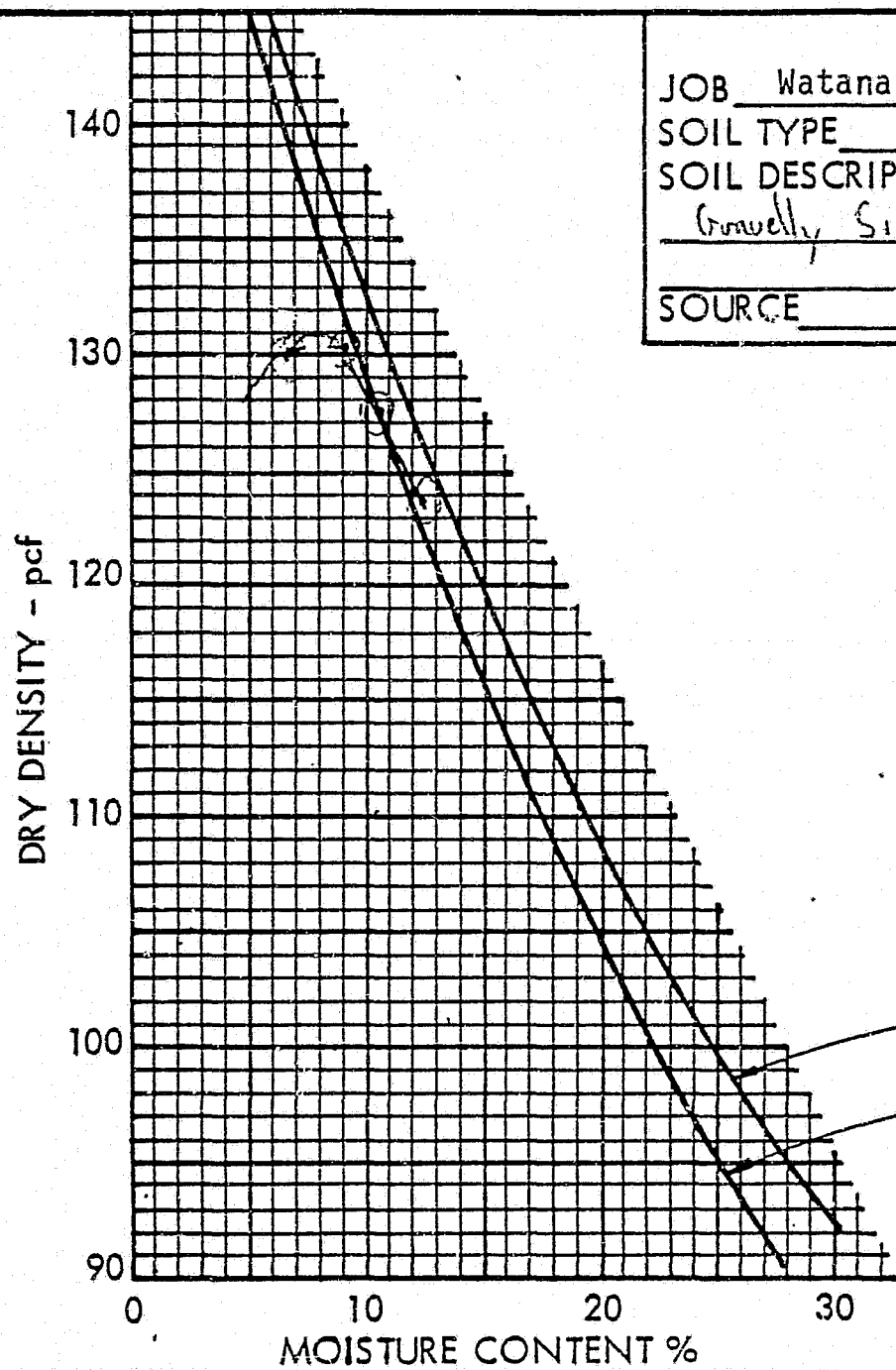
	1	2	3	4	5	6
MOLD + WET SOIL	6318	6406	6421	6373		
MOLD	4251	4151	4151	4151		
WET SOIL	2067	2155	2170	2122		
FACTOR *	.0662	.0662	.0662	.0662	.0662	.0662
WET DENSITY	136.8	142.7	143.7	140.5		
PAN NO.	MA-27	MA-19	MA-7	MA-43		
PAN + WET SOIL	1261.7	1214.5	1349.1	1053.1		
PAN + DRY SOIL	1189.7	1125.0	1241.3	956.5		
MOISTURE LOSS	72.0	89.5	107.8	96.6		
PAN TARE	87.3	91.3	90.3	91.1		
DRY SOIL	1102.4	1033.7	1151.0	865.4		
MOISTURE CONTENT	6.5	8.7	9.4	11.2		
DRY DENSITY	128.5	121.3	124.4	126.3		

LF 132-C



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LABORATORY COMPACTION TEST



JOB Watana Dam NO. 15032,003.08
 SOIL TYPE SM DATE 2/1/83 BY CRM / MVA
 SOIL DESCRIPTION Olive Gravelly Silty Sand (SM)
 SOURCE STA 20700

☒ ASTM D1557-78(A)

☐ ASTM 698

☐ Other (Specify) _____

MAXIMUM DRY DENSITY 131 PCF

OPTIMUM MOISTURE CONTENT 8 %

○ Laboratory Compaction Point

△ Field Check Point

100% Saturation ($G_s = 2.68$)

90% Saturation ($G_s = 2.68$)

(*For weight of wet soil in grams and volume = 1/30 cu. ft)

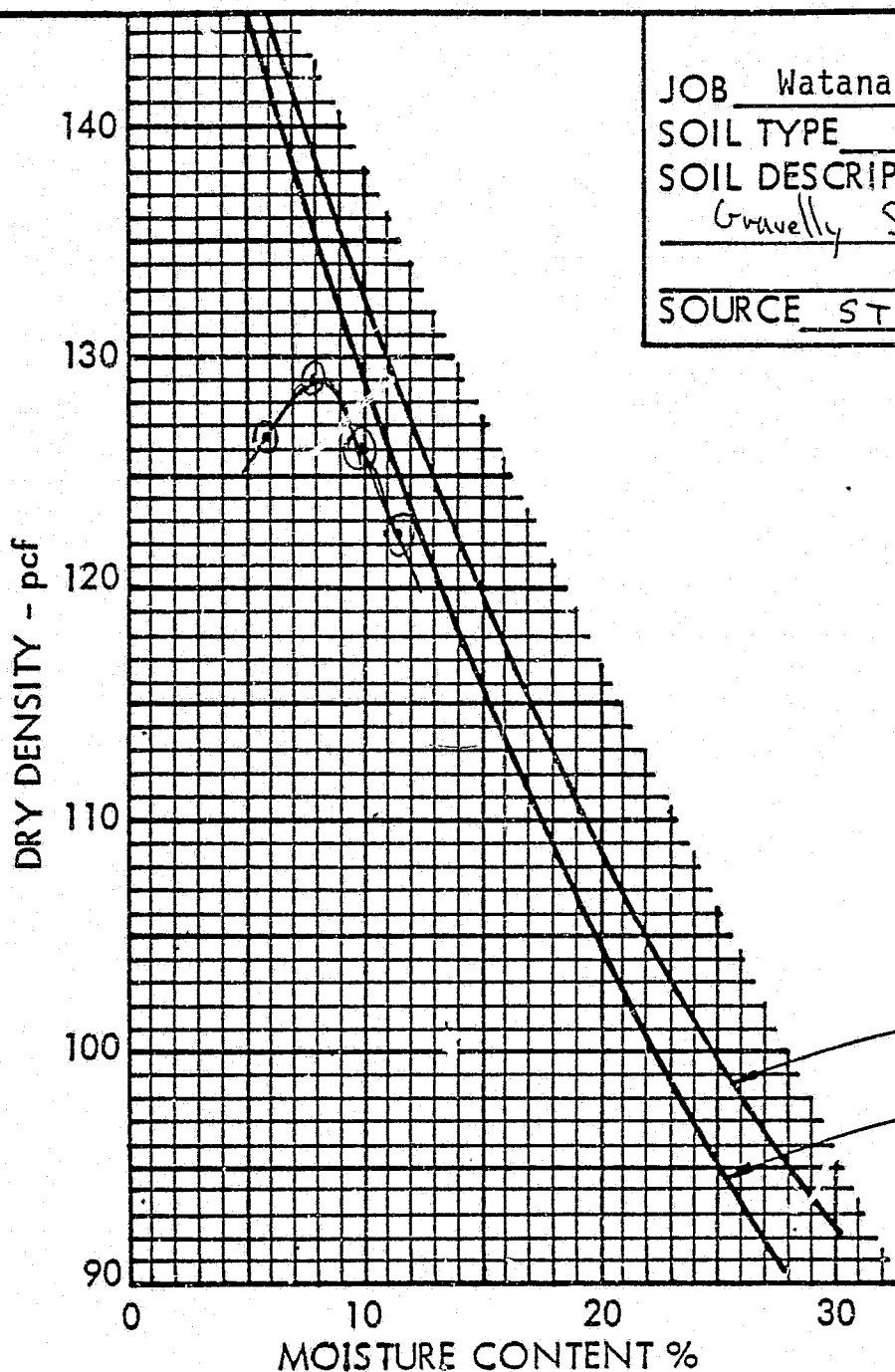
	1	2	3	4	5	6
MOLD + WET SOIL	6347	6401	6384	6355		
MOLD	4251	4251	4251	4251		
WET SOIL	2096	2150	2133	2104		
FACTOR *	.0662	.0662	.0662	.0662	.0662	.0662
WET DENSITY	139.8	142.3	141.2	139.3		
PAN NO.	MA-14	MA-23	MA-6	MA-22		
PAN + WET SOIL	1280.4	1311.1	1143.0	1006.6		
PAN + DRY SOIL	1204.7	1208.5	1041.6	905.5		
MOISTURE LOSS	75.7	102.6	101.4	101.1		
PAN TARE	87.6	89.9	81.4	70.8		
DRY SOIL	1117.1	1118.7	953.2	814.7		
MOISTURE CONTENT	6.8	9.2	10.6	12.4		
DRY DENSITY	130.0	130.3	127.7	123.9		

LF 132-C



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LABORATORY COMPACTION TEST



JOB Watana Dam NO. 15032,003.08
 SOIL TYPE SM DATE BY CLM / MTS
 SOIL DESCRIPTION Olive brown silty sand is subangular
Gravelly Silty Sand (SM)
 SOURCE STA 33+00 + 32+00

☒ ASTM D1557-78(A)

☐ ASTM 698

☐ Other (Specify)

MAXIMUM DRY DENSITY 129 PCF

OPTIMUM MOISTURE CONTENT 8 %

○ Laboratory Compaction Point

△ Field Check Point

100% Saturation ($G_s = 2.68$)

90% Saturation ($G_s = 2.68$)

(*For weight of wet soil in grams and volume = 1/30 cu. ft)

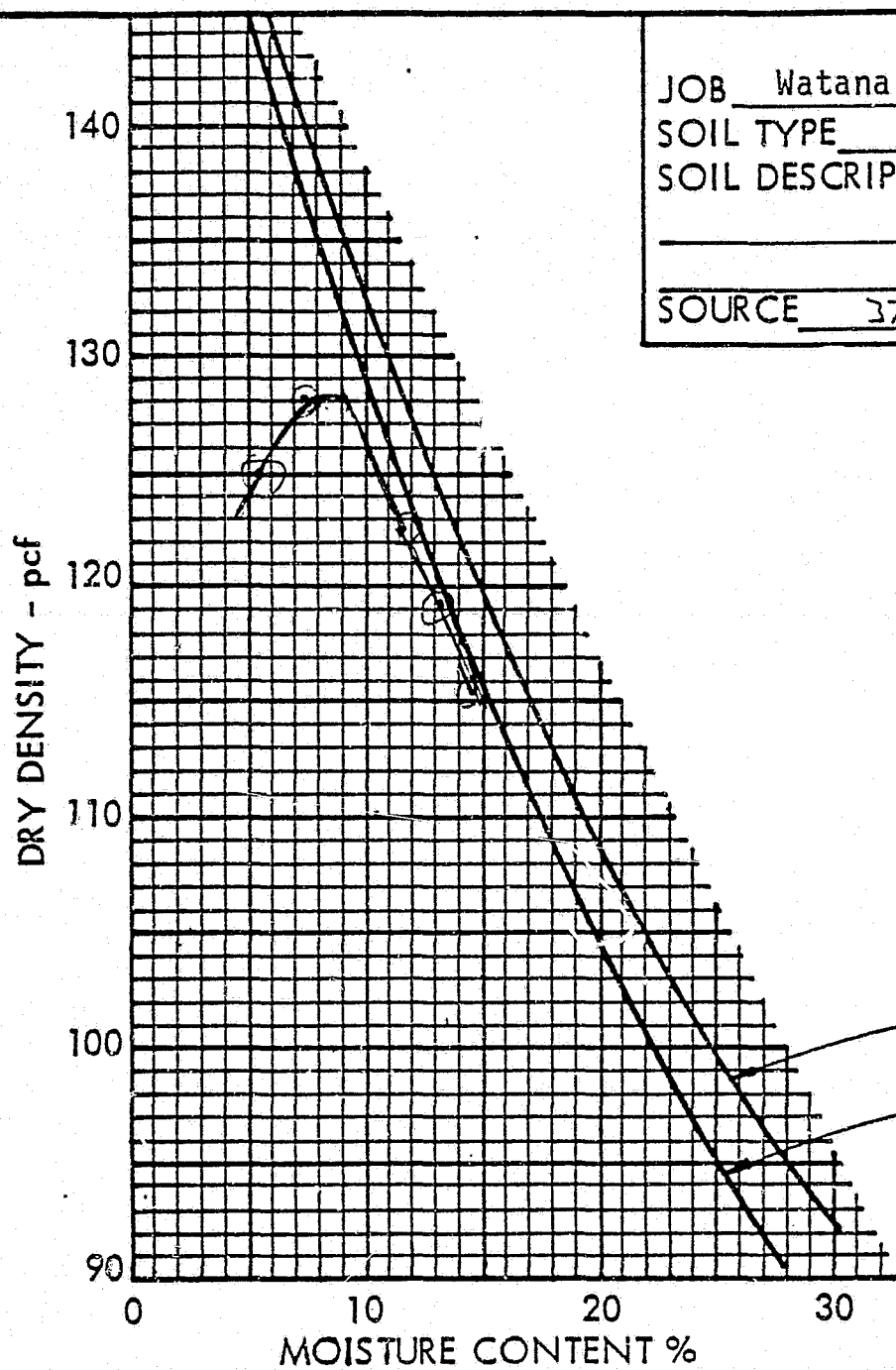
	1	2	3	4	5	6
MOLD + WET SOIL	6274	6353	6345	6312		
MOLD	4251	4251	4251	4251		
WET SOIL	2023	2102	2094	2061		
FACTOR *	.0662	.0662	.0662	.0662	.0662	.0662
WET DENSITY	133.9	139.2	138.6	136.4		
PAN NO.	MA-41	MA-5	MA-3	MA-24		
PAN + WET SOIL	1325.3	1362.5	1074.8	1104.7		
PAN + DRY SOIL	1257.5	1269.6	985.8	1000.0		
MOISTURE LOSS	67.7	92.9	89.0	104.7		
PAN TARE	89.25	88.85	27.81	89.8		
DRY SOIL	1168.3	1180.8	898.0	911.2		
MOISTURE CONTENT	5.8	7.9	9.9	11.5		
DRY DENSITY	126.6	129.0	126.1	122.3		

LF 132-C



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LABORATORY COMPACTION TEST



JOB Watana Dam NO. 15032,003.08
 SOIL TYPE SM DATE 4-10-83 BY DWR/MA
 SOIL DESCRIPTION DK BRN SILTY SAND SM
 SOURCE 37+00

☒ ASTM D1557-78(A)

☐ ASTM 698

☐ Other (Specify) _____

MAXIMUM DRY DENSITY 128 PCF

OPTIMUM MOISTURE CONTENT 8 %

○ Laboratory Compaction Point

△ Field Check Point

100% Saturation ($G_s = 2.68$)

90% Saturation ($G_s = 2.68$)

(*For weight of wet soil in grams and volume = 1/30 cu. ft)

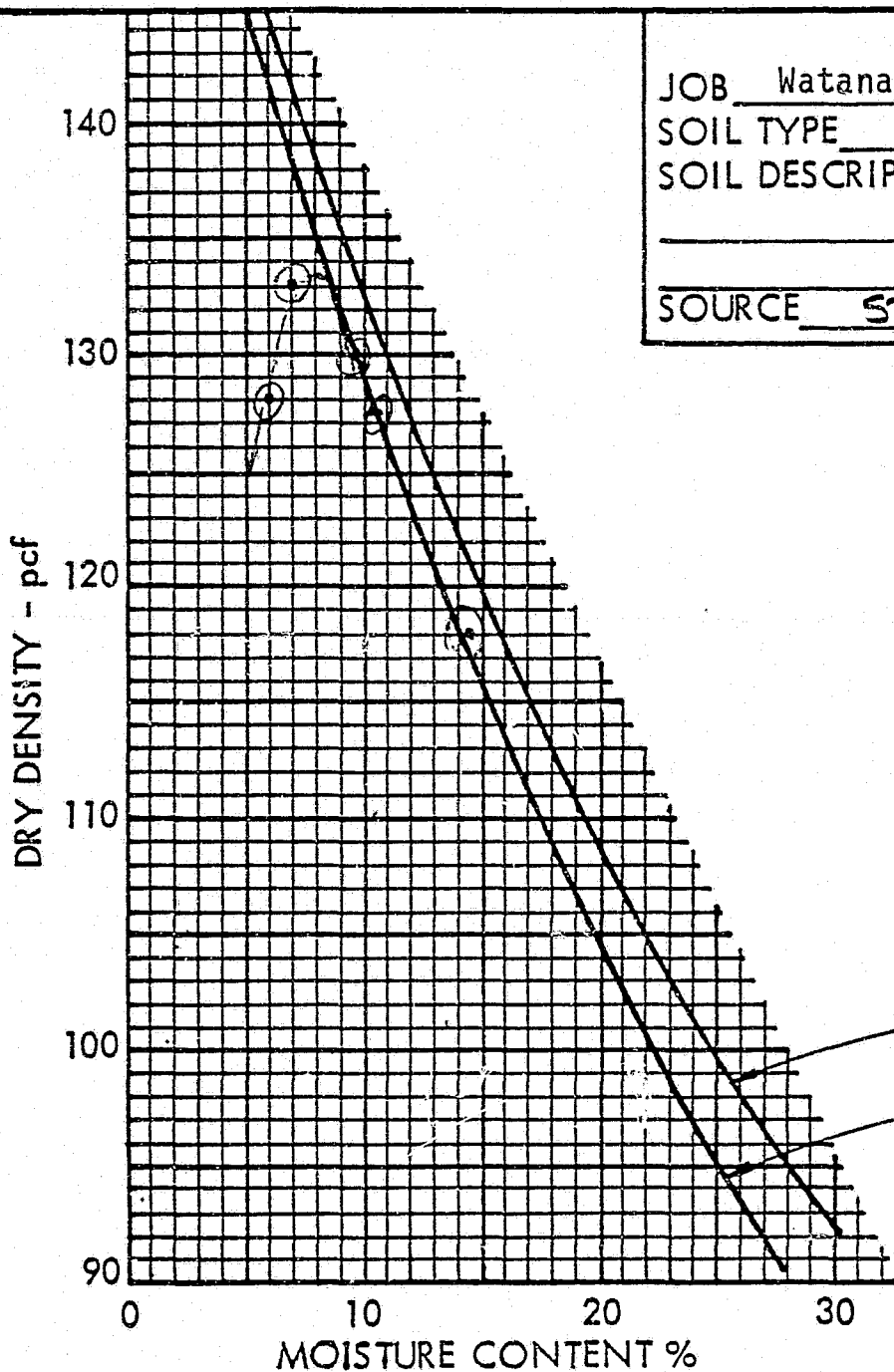
	1	2	3	4	5	6
MOLD + WET SOIL	6321	6291	6256	6329	6245	
MOLD	4253	4253	4253	4253	4253	
WET SOIL	2068	2038	2003	2076	1992	
FACTOR *	.0662	.0662	.0662	.0662	.0662	.0662
WET DENSITY	136.9	134.9	132.6	137.4	131.9	
PAN NO.	MA-6	MA-28	MA-15	MA-22	X	
PAN + WET SOIL	483.9	552.0	640.7	376.9	667.2	
PAN + DRY SOIL	442.8	497.9	569.7	357.4	636.8	
MOISTURE LOSS	41.1	54.1	71.0	19.5	30.4	
PAN TARE	88.3	91.5	91.2	90.8	80.5	
DRY SOIL	354.5	406.4	478.5	266.6	556.3	
MOISTURE CONTENT	11.6	13.3	14.8	7.3	5.5	
DRY DENSITY	122.7	119.1	115.5	128.1	125.0	

LF 132-C



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LABORATORY COMPACTION TEST



JOB Watana Dam NO. 15032,003.08
 SOIL TYPE SM DATE 4-10-83 BY DNR/MA
 SOIL DESCRIPTION BRN GRAVELLY SILTY SAND (SM)
 SOURCE STATION 38+00

- ☒ ASTM D1557-78 A 4" mold
☐ ASTM 698
☐ Other (Specify) _____

MAXIMUM DRY DENSITY 133 PCF

OPTIMUM MOISTURE CONTENT 8 %

○ Laboratory Compaction Point

△ Field Check Point

100% Saturation ($G_s = 2.68$)

90% Saturation ($G_s = 2.68$)

(*For weight of wet soil in grams and volume = 1/30 cu. ft)

	1	2	3	4	5	6
MOLD + WET SOIL	6408	6345	6287	6405	6302	
MOLD	4253	4253	4253	4253	4253	
WET SOIL	2155	2132	2034	2152	2049	
FACTOR *	.0662	.0662	.0662	.0662	.0662	.0662
WET DENSITY	142.7	141.1	134.7	142.5	135.6	
PAN NO.	MA-7	MA-18	MA-20	X	MA-33	
PAN + WET SOIL	506.2	668.4	667.6	498.3	867.0	
PAN + DRY SOIL	469.1	612.6	594.9	470.6	823.1	
MOISTURE LOSS	37.1	55.8	72.7	27.7	43.9	
PAN TARE	90.3	91.4	87.5	80.5	89.3	
DRY SOIL	378.8	521.2	507.4	390.1	733.8	
MOISTURE CONTENT	9.8	10.7	14.3	7.1	6.0	
DRY DENSITY	130.2	127.5	117.8	133.1	128.0	

LF 132-C

132

128.3

130.2

134



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MAN CAMP
LABORATORY TEST
RECORDS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER			
Project WATANA DAM				Hole mC 5		Depth 2-2.5 #2			
Dry WT Total Sample & Tare		874		TOTAL SAMPLE					
Tare Weight S10-14		539		Classification Very Dark Greyish Brown silty gravelly sand (sm)					
Total Sample WT		335		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.		
Moisture Content -10 Material		4"		101.6					
		3"		76.2					
		2"		50.8					
Can No.		1 1/2"		38.1					
WT-Soil & Can (Wet)		1"		25.4					
WT-Soil & Can (Dry)		3/4"		19.1		0	0.0		
Loss		1/2"		12.7		8	2.4		
Weight of Can		#4		4.6		24	7.2		
WT of Soil (Dry)		#10		2.0			92.8		
% Moisture		Pan							
		Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare			
						Tare Weight			
						Washed Sample Weight			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing		
10	2.000	42				12.5	87.5		
20	0.850	70				20.9	79.1		
30	0.600	86				25.7	74.3		
40	0.425	103				30.7	69.3		
100	0.150	169				50.4	49.6		
200	0.075	210				62.7	37.3		
270	0.053								
Pan		214							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL		Hydrometer No.		Amyl Alcohol Drops:			
		PI							
a =		Corrected Weight of Hydrometer Sample				Defloculation Agent			
		grams							
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1740	0.002							
Tested by: G.B.		Computed by: MA		Checked by: MA		Cc			
						Cu			

LF 135-MA



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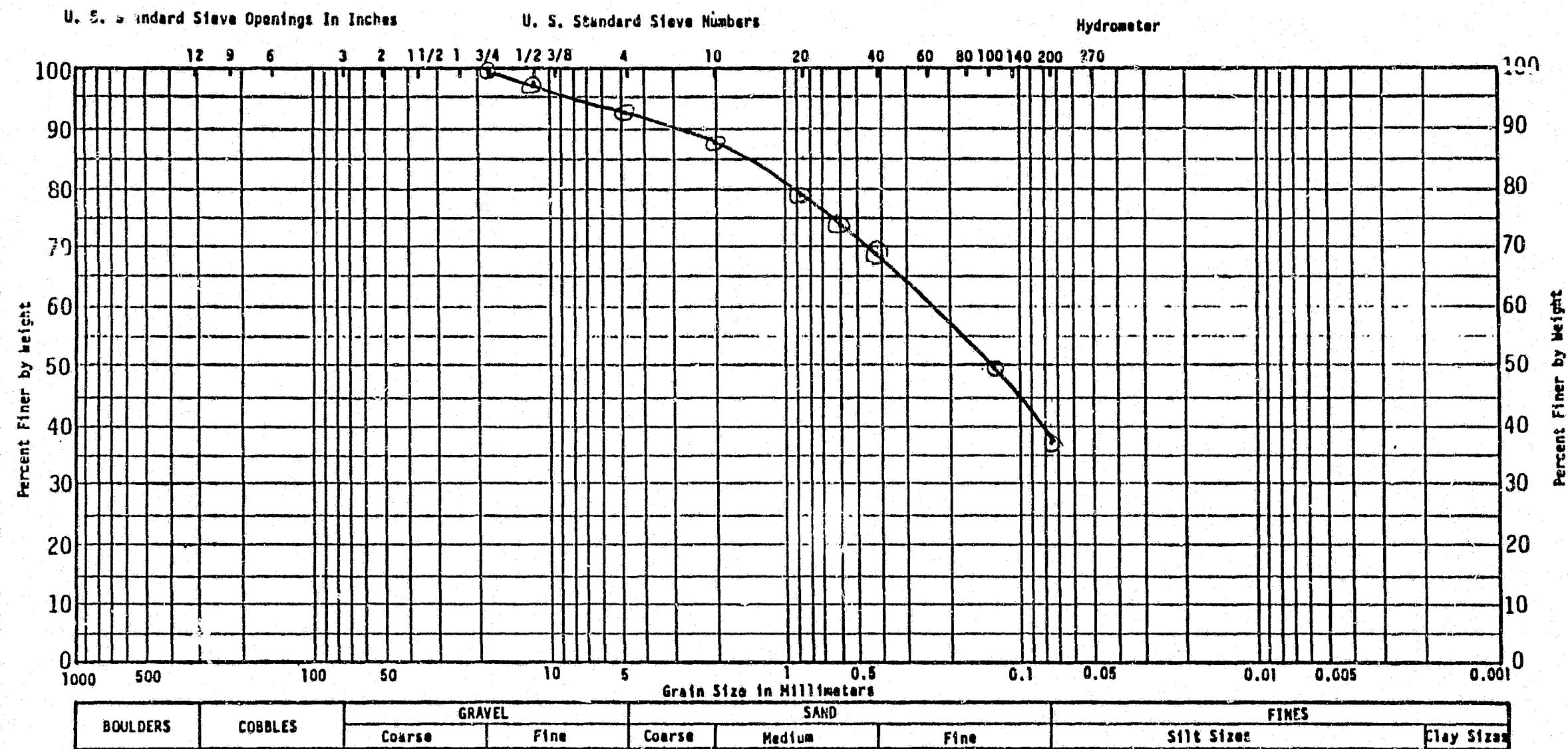
Date		WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08		
		☐ GILSON		☐ BRASS SIEVE		☐ HYDROMETER			
Project WATANA DAM				Hole mC 6		Depth 3-5 #2			
WT Dry WT Total Sample & Tare		1131		TOTAL SAMPLE					
Tare Weight 15		424		Classification Olive gravelly s, Hy sand (sm)					
Total Sample WT		707		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	
Moisture Content -10 Material		4"		101.6					
		3"		76.2					
		2"		50.8					
Can No.		1 1/2"		38.1					
WT-Soil & Can (Wet)		1"		25.4					
WT-Soil & Can (Dry)		3/4"		19.1		0		0.0 100.0	
Loss		1/2"		12.7		3		0.3 99.7	
Weight of Can		#4		4.6		47		6.6 93.4	
WT of Soil (Dry)		#10		2.0					
% Moisture		Pan							
		Total							
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample _____ grams				Jar #		WT Washed Sample & Tare 856			
						Tare Weight 424			
						Washed Sample Weight 432			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing		
10	2.000	91				12.9	87.1		
20	0.850	153				21.6	78.4	54.7	
30	0.600	185				26.2	73.8	% sand	
40	0.425	218				30.8	69.2		
100	0.150	343				48.5	51.5	39.3	
200	0.075	429				60.7	39.3	% fines	
270	0.053								
Pan		434							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____		Hydrometer No.		Amyl Alcohol Drops: _____			
PI _____									
a =		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent			
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: G.B.		Computed by: M.A.		Checked by: M.A.		Cc			
						Cu			

LF 135-MA



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GRADATION SIZE ANALYSIS



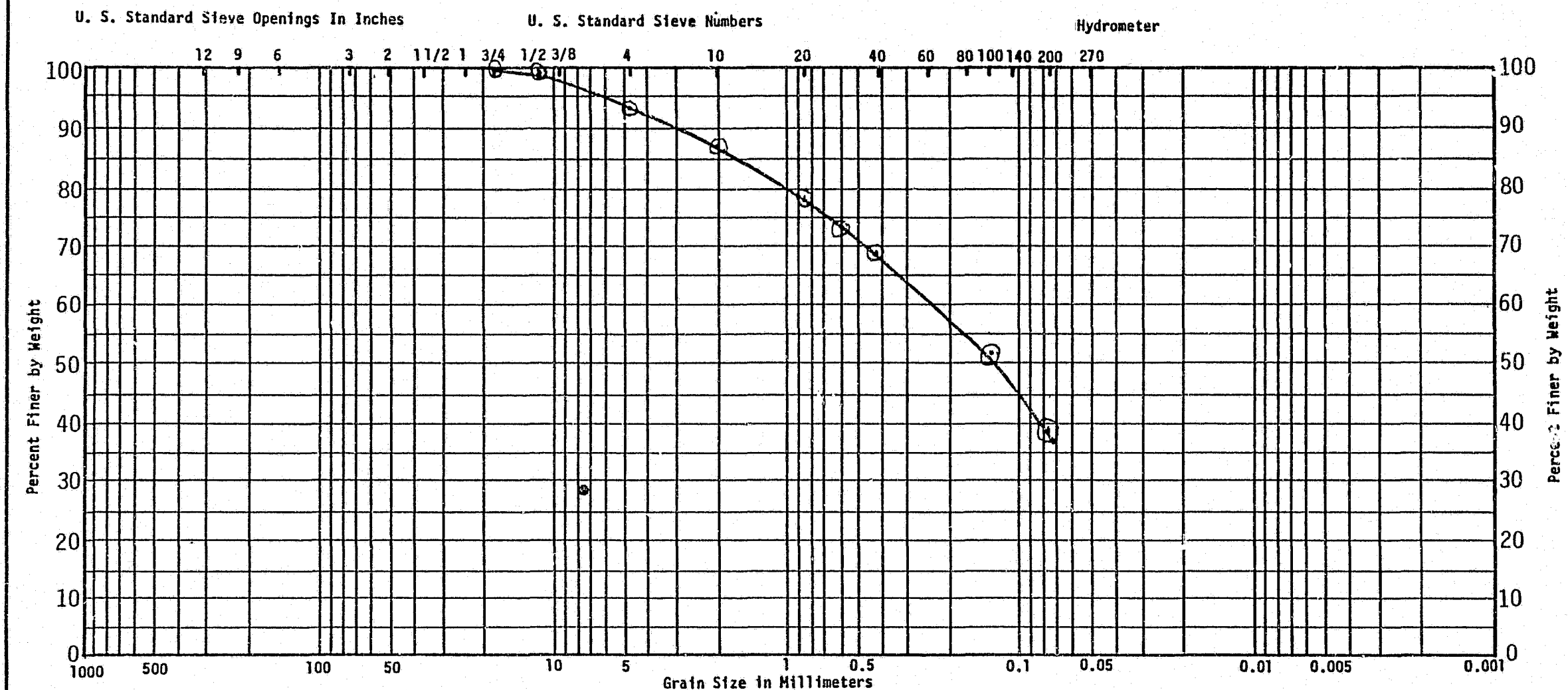
LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>MC 5</u>	<u>2</u>	<u>2-2.5</u>		No. <u>15032.003.08</u>
VISUAL MANUAL CLASSIFICATION <u>Sand, silty</u>					Date <u>4-11-83</u>

LF 141-G2A

HLA HARDING LAWSON ASSOCIATES
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000372

GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>mc6</u>	<u>2</u>	<u>3-5</u>		No. <u>15032.003.08</u>
VISUAL MANUAL CLASSIFICATION <u>Sample - unsorted</u>					Date <u>4-11-83</u>

LF 141-G5A

HLA HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date <u>4/9/83</u>		WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. <u>15032.003.08</u>			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER			
Project <u>WATANA DAM</u>				Hole <u>ML 4</u>		Depth <u>2-2.5 #1</u>			
Dry WT Total Sample & Tare		<u>1016</u>		TOTAL SAMPLE					
Tare Weight <u>D</u>		<u>537</u>		Classification <u>Very Dark Grayish Brown silty sand (sm)</u>					
Total Sample WT		<u>479</u>		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.		
Moisture Content -10 Material							% Ret.		
Can No.							Cum. % of Total Ret.		
WT-Soil & Can (Wet)							Passing		
WT-Soil & Can (Dry)									
Loss									
Weight of Can									
WT of Soil (Dry)									
% Moisture									
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample _____ grams				Jar # _____		WT Washed Sample & Tare <u>868</u>			
						Tare Weight <u>537</u>			
						Washed Sample Weight <u>331</u>			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing		
10	2.000	38				7.9	92.1		
20	0.850	86				18.0	82.0		
30	0.600	115				24.0	76.0		
40	0.425	144				30.1	69.9		
100	0.150	265				55.3	44.7		
200	0.075	328				68.5	31.5		
270	0.053								
Pan		331							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____		Hydrometer No. _____		Amyl Alcohol Drops: _____			
PI _____									
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____			
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: <u>CPM</u>		Computed by: <u>CPM</u>		Checked by: <u>MA</u>		Cc			
						Cu			

LF 135-MA



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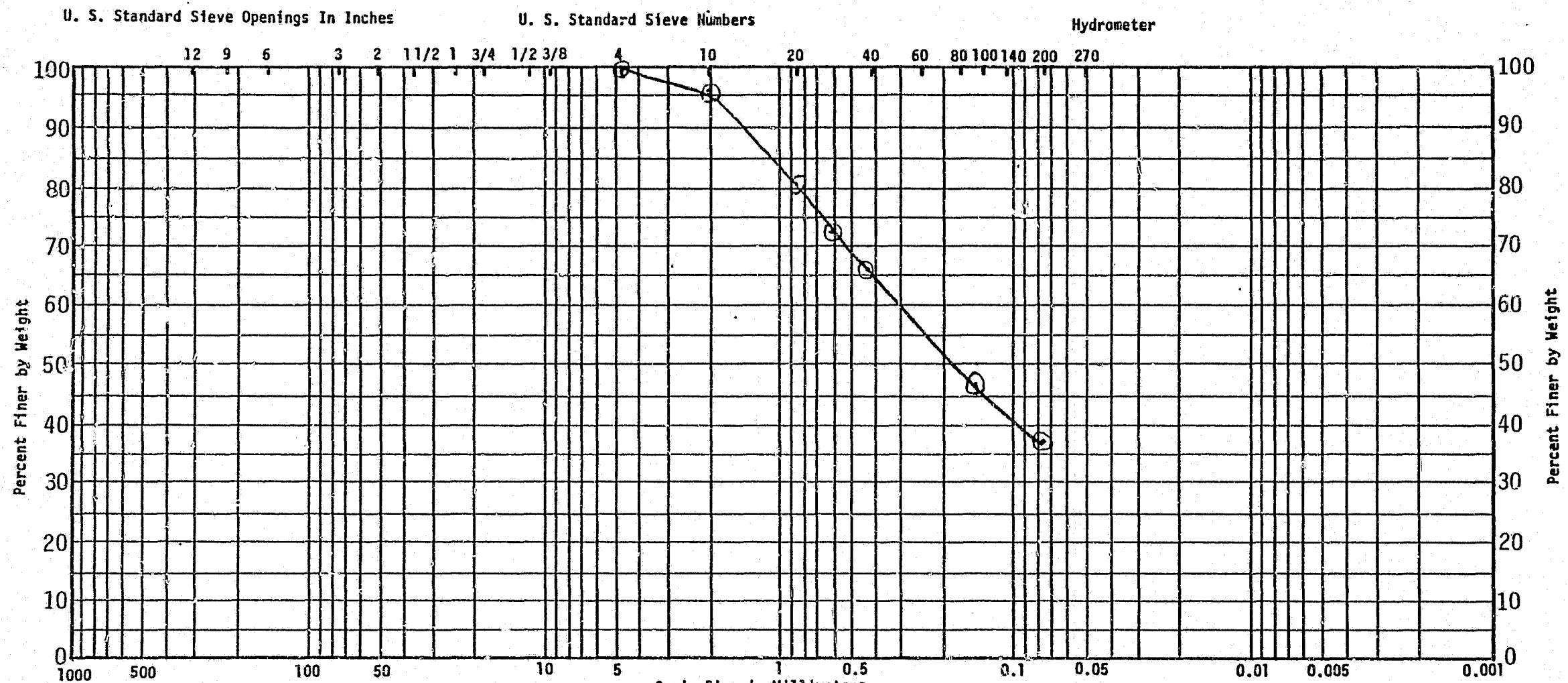
Date <u>4/9/83</u>		WORK SHEET - PARTICLE SIZE ANALYSIS				Job No. <u>15032,003.08</u>			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER			
Project <u>WATANA DAM</u>				Hole <u>mc 3</u>		Depth <u>2.5-3.0 #1</u>			
Dry WT Total Sample & Tare		<u>939</u>		TOTAL SAMPLE					
Tare Weight <u>SD-2</u>		<u>552</u>		Classification <u>Very Dark Greyish Brown silty sand (s m)</u>					
Total Sample WT		<u>387</u>		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.		
Moisture Content -10 Material				4"	101.6				
				3"	76.2				
				2"	50.8				
Can No.				1 1/2"	38.1				
WT-Soil & Can (Wet)				1"	25.4				
WT-Soil & Can (Dry)				3/4"	19.1				
Loss				1/2"	12.7				
Weight of Can				#4	4.6				
WT of Soil (Dry)				#10	2.0				
% Moisture				Pan					
				Total					
REPRESENTATIVE MINUS NO. 10 SAMPLE									
WT Representative Sample _____ grams				Jar # _____		WT Washed Sample & Tare <u>807</u>			
						Tare Weight <u>552</u>			
						Washed Sample Weight <u>255</u>			
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing		
10	2.000	17				4.4	95.6		
20	0.850	76				19.6	80.4		
30	0.600	107				27.6	72.4		
40	0.425	133				34.4	65.6		
100	0.150	206				53.2	46.8		
200	0.075	243				62.8	37.2		
270	0.053								
Pan		254							
Total									
HYDROMETER SAMPLE									
Specific Gravity (G)		LL _____ PI _____		Hydrometer No. _____		Amyl Alcohol Drops: _____			
a = _____		Corrected Weight of Hydrometer Sample _____ grams				Defloculation Agent _____			
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading			Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc		
	1	0.078							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							
Tested by: <u>G. B.</u>		Computed by: <u>MA</u>		Checked by: <u>MA</u>		Cc			
						Cu			

LF 135-MA



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GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	MC 3	1	2.5-3.0		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032.003.08
					Date 4-11-83

LF 141-GSA

HLA HARDING LAWSON ASSOCIATES
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MC

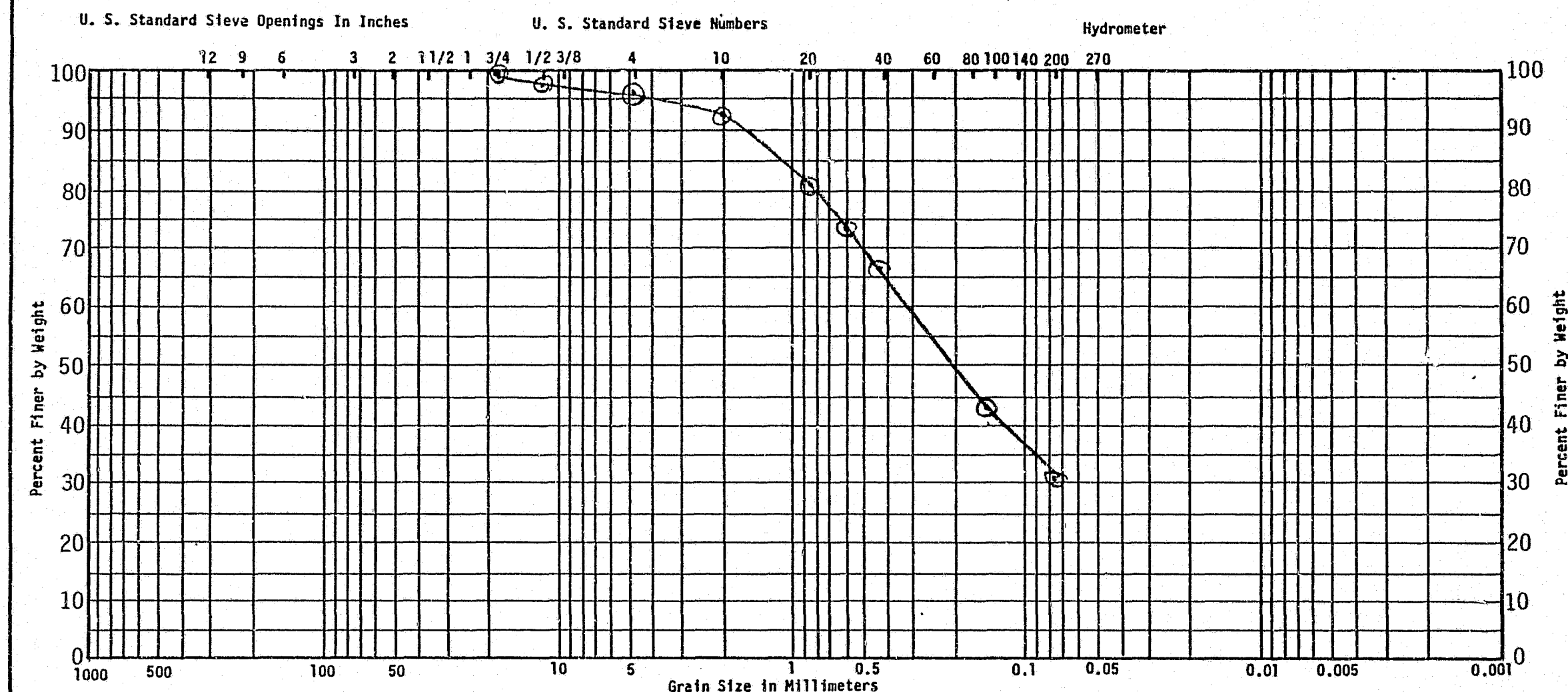
Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032,003.08			
		☐ GILSON		☒ BRASS SIEVE		☐ HYDROMETER				
Project WATANA DAM				Hole MC 2		Depth 2-2.5 #2				
Dry WT Total Sample & Tare		1007		TOTAL SAMPLE						
Tare Weight 1C		546.0		Classification Dark Grey Silty sand (SM)						
Total Sample WT		461		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material		4"		101.6						
		3"		76.2						
		2"		50.8						
Can No.		1 1/2"		38.1						
WT-Soil & Can (Wet)		1"		25.4						
WT-Soil & Can (Dry)		3/4"		19.1		0			0.0	100.0
Loss		1/2"		12.7		8			1.7	98.3
Weight of Can		#4		4.6		17			3.7	96.3
WT of Soil (Dry)		#10		2.0						
% Moisture		Pan								
		Total								
REPRESENTATIVE MINUS NO. 10 SAMPLE										
WT Representative Sample		grams		Jar #		WT Washed Sample & Tare		870		
						Tare Weight		546		
						Washed Sample Weight		324		
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing			
10	2.000	34				7.4	92.6	65.9 % sand		
20	0.850	89				19.3	80.7			
30	0.600	124				26.9	73.1			
40	0.425	158				34.3	65.7			
100	0.150	261				56.6	43.4			
200	0.075	321				69.6	30.4	30.4 % sand		
270	0.053									
Pan		326								
Total										
HYDROMETER SAMPLE										
Specific Gravity (G)		LL		Hydrometer No.		Amyl Alcohol Drops:				
		PI								
a =		Corrected Weight of Hydrometer Sample				Defloculation Agent				
		grams								
Time	Elap. Time	Maximum Dia. MM	Temp. O C.	K	Reading			L	Corrected Gram Size, Dia. MM	% of Total Passing
					Initl.	Actual	Rc			
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
Tested by: G.B.		Computed by: MA		Checked by: MA				Cc		
								Cu		

LF 135-MA



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GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job
	mc 2	2	2-2.5		WATANA DAM
VISUAL MANUAL CLASSIFICATION					No. 15032,003.08
					Date 4-11-83

LF 141-GSA

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Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS					Job No. 15032.003.08	
		☐ GILSON		☐ BRASS SIEVE		☒ HYDROMETER		
Project WATANA DAM				Hole mC 8		Depth 1-2 #)		
Air Dry WT Total Sample & Tare		TOTAL SAMPLE						
Tare Weight 12		Classification Olive silty sand (sm)						
Total Sample WT		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT. Ret.	% Ret.	Cum. % of Total Ret.	Passing
Moisture Content -10 Material		4"	101.6					
		3"	76.2					
		2"	50.8					
Can No.	A-5	1 1/2"	38.1					
WT-Soil & Can (Wet)	50.85	1"	25.4					
WT-Soil & Can (Dry)	50.72	3/4"	19.1					
Loss	.13	1/2"	12.7					
Weight of Can	11.29	#4	4.6					
WT of Soil (Dry)	39.43	#10	2.0					
% Moisture	.3	Pan						
		Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample 62.90 grams		Jar # M	WT Washed Sample & Tare 122.0		Tare Weight 71.2		Washed Sample Weight 33.8	
Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Passing	
10	2.000	0				0.0	100.0	52.6
20	0.850	6				9.6	90.4	1.1
30	0.600	9				14.4	85.6	5.2
40	0.425	12				19.1	80.9	
100	0.150	24				38.3	61.7	
200	0.075	33				52.6	47.4	47.4
270	0.053							1.1
Pan		34						fin
Total								

HYDROMETER SAMPLE

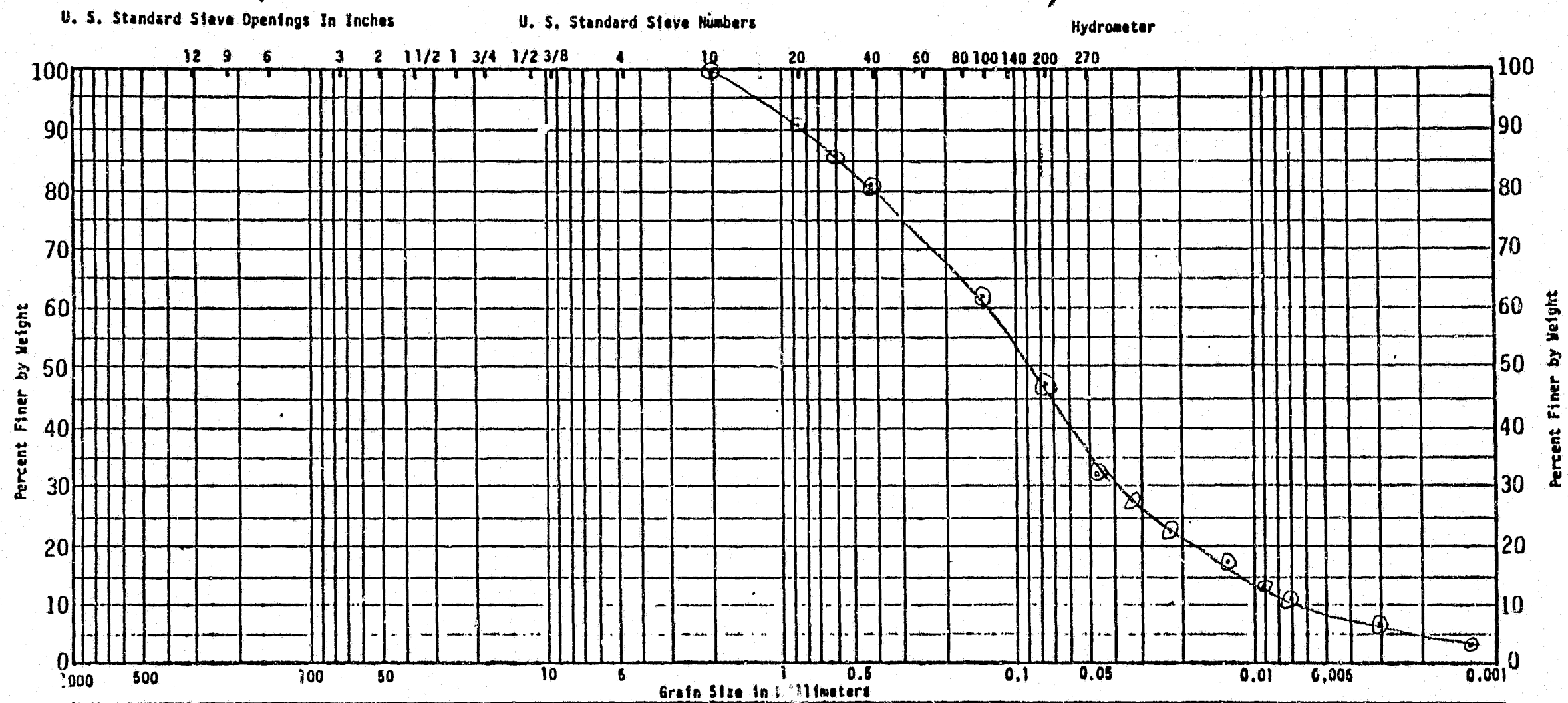
Specific Gravity (G) (assumed) 2.75		LL	Hydrometer No. H		Amyl Alcohol Drops: 2	
a = 0.98		Corrected Weight of Hydrometer Sample 62.71 grams			Defloculation Agent	
Obsd Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading	% of Total Passing
					Initl. Actual R _c	
0850	1	0.078	15.8	0.0139	32.5 23.0	31.6
0902	2	0.055	15.8	"	28.3 25.3	27.3
0915	5	0.035	15.8	"	24.5 22.5	23.0
0925	15	0.020	15.8	"	19.1	17.7
0940	30	0.014	15.5	"	16.5	13.6
0950	60	0.010	15.5	"	14.8	10.9
1250	240	0.005	15.0	0.0140	12.0	6.4
0150	1440	0.002	20	0.0133	9.1	3.4
					Cc	
Tested by: DLR/G.B.					Computed by: M/A	Checked by: M/A
					Cu	

LF 35-MA



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GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)	Job <u>WATANA DAM</u>
	<u>mc 8</u>	<u>1</u>	<u>1-2</u>		No. <u>15032.003.08</u>
VISUAL MANUAL CLASSIFICATION					Date <u>4-12-83</u>

LF 141-G3A

HARDING LAWSON ASSOCIATES
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000373

APPENDIX D

SOIL CEMENT STABILIZATION - TRIAL MIX

1599

Harding Lawson Associates



August 9, 1983

15032,006.08

Harza-Ebasco, J.V.
8740 Hartzell Road
Anchorage, Alaska 99507

Attention: Mr. Myron Temchin

Gentlemen:

Watana Airstrip
Susitna Hydroelectric Project

This report presents the results of our laboratory testing program on the soil-cement which may be used in the construction of the Watana Airstrip at the Watana Dam Site, Alaska. The work was performed under Harza-Ebasco's Contract No. P5700.10.121 with Harding Lawson Associates (HLA), dated December 1, 1983. It was authorized by Mr. Robert Howard of Harza-Ebasco on April 22, 1983. During the course of our work, we have consulted with Mr. Myron Temchin.

The purpose of the laboratory testing program was to determine the abrasion characteristics and strength of the soil-cement which might be used as a surface course for the airstrip.

Approximately 200 pounds of soil was obtained by combining samples from the borings of the subsurface investigation for the proposed airstrip.

The procedures we used to test the soil-cement are presented in the Portland Cement Associations's (PCA) Soil-Cement Laboratory Handbook, 1959. Our scope of work was to perform laboratory tests on the soil-cement mixture following the procedures presented in the handbook with some modifications requested by our client. Specifically, we performed the following laboratory tests:

1. One Particle Size Analysis
2. Three Standard Proctor Compaction Tests

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Geologists &
Geophysicists

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Anchorage, AK 99502
Telecopy 907/349-2713

Telephone
907/563-8102
Telex 340523

Alaska
California
Colorado

Hawaii
Illinois
Nevada

Texas
Washington
Saudi Arabia

August 9, 1983
15032,006.08
Harza-Ebasco, J.V.
Mr. Myron Temchin
Page 2

Harding Lawson Associates

3. One Specific Gravity Test
4. Test on Concrete Cylinders of Soil-cement
 - a. Freezing-and-thawing tests on eight cylinders
 - b. Wetting-and-drying tests on eight cylinders
 - c. Seven-day compressive strength tests on six cylinders and twenty-eight day compressive strength tests on five cylinders

LABORATORY TESTING PROCEDURES

A description of the laboratory testing procedures followed in our program are presented below:

1. Particle Size Analysis

One Particle Size Analysis was performed on the soil following the ASTM D-422 procedure. The test results are presented on Plate 1.

2. Compaction Test

One Standard Proctor Compaction test was performed on the soil using ASTM D-698 test methods. Standard Proctor tests were performed on four and seven percent soil-cement mixtures using the ASTM D-558 test method. The compaction test results are presented on Plates 2, 3 and 4.

3. Specific Gravity

One Specific Gravity test was performed on the soil using ASTM C-127-77 test method. The test results yielded a specific gravity of 2.63.

4. Concrete Cylinder Test

Using the grain size distribution test results and charts presented in the PCA handbook, the recommended cement content for this soil is seven percent. Our client requested that we prepare concrete cylinders at cement contents of four and seven percent, a density corresponding to 85 percent of standard Proctor optimum, and a water content on the wet side of the compaction curve at 85 percent of optimum. (The PCA procedures call for the soil-cement cylinders to be prepared at the

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Harza-Ebasco, J.V.
Mr. Myron Temchin
Page 3

Harding Lawson Associates

standard Proctor optimum density and water content.) A total of 27 four-inch concrete cylinders were prepared; 14 at four and 13 at seven percent cement content, respectively. Type I Portland cement was used in our testing program.

The prepared cylinders were placed in a humidity room to cure. After seven days, some of the molds were removed from the cylinders. It was noted the cylinders had tension cracks around their centers. We believe these cracks formed because of the high water content used in the soil-cement mixture.

4a. Freeze-and-Thaw Test

Freeze-and-Thaw tests were performed following ASTM D-560-57 test procedures on cylinders 1 through 8 which were prepared at cement contents of four and seven percent. The cylinders were allowed to cure in a humidity room for seven days, after which, they were subjected to 12 freeze-thaw cycles using the following procedure: (1) the cylinders were placed in a freezer at -7°F for 24 hours, (2) the cylinders were removed from the freezer and placed in the humidity room for 23 hours, (3) the cylinders were brushed with two firm strokes on all areas with a stiff wire brush and the weight loss was recorded, and finally (4) the cylinders were placed in the freezer for another cycle. The test results are presented on Plates 5 and 6.

4b. Wetting-and-Drying Test

Wetting-and-drying tests were performed following ASTM D-559-57 test procedures on cylinders 9 through 16 which were prepared at cement contents of four and seven percent. The cylinders were allowed to cure in a humidity room for seven days after which they were subjected to 12 wet-dry cycles using the following procedures: (1) the cylinders soaked in water at room temperature for five hours, then placed in an oven at 160°F for 42 hours, (2) the cylinders were removed from the oven and brushed with two firm strokes on all areas with a stiff wire brush and the weight loss recorded and, finally (3) the cylinders were soaked in water for another five hours and the test repeated for a total of 12 wet-dry cycles. The test results are presented on Plates 7 and 8.

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Mr. Myron Temchin
Page 4

Harding Lawson Associates

4c. Compressive Strength

Compressive strength tests were performed on cylinders 17 through 27 at 7 and 28 days after preparation using ASTM C-38 testing procedures. The test results are presented on Plate 9. All cylinders failed by crumbling. It is interesting to note that the four percent cement content samples had a decrease in strength between 7 and 28 days while the seven percent cement content samples showed a slight increase in strength.

Very truly yours,

HARDING LAWSON ASSOCIATES

G. Scott Crowther

G. Scott Crowther
Project Engineer

DEB

Donald E. Bruggers

Donald E. Bruggers, P.E.
Associate Engineer

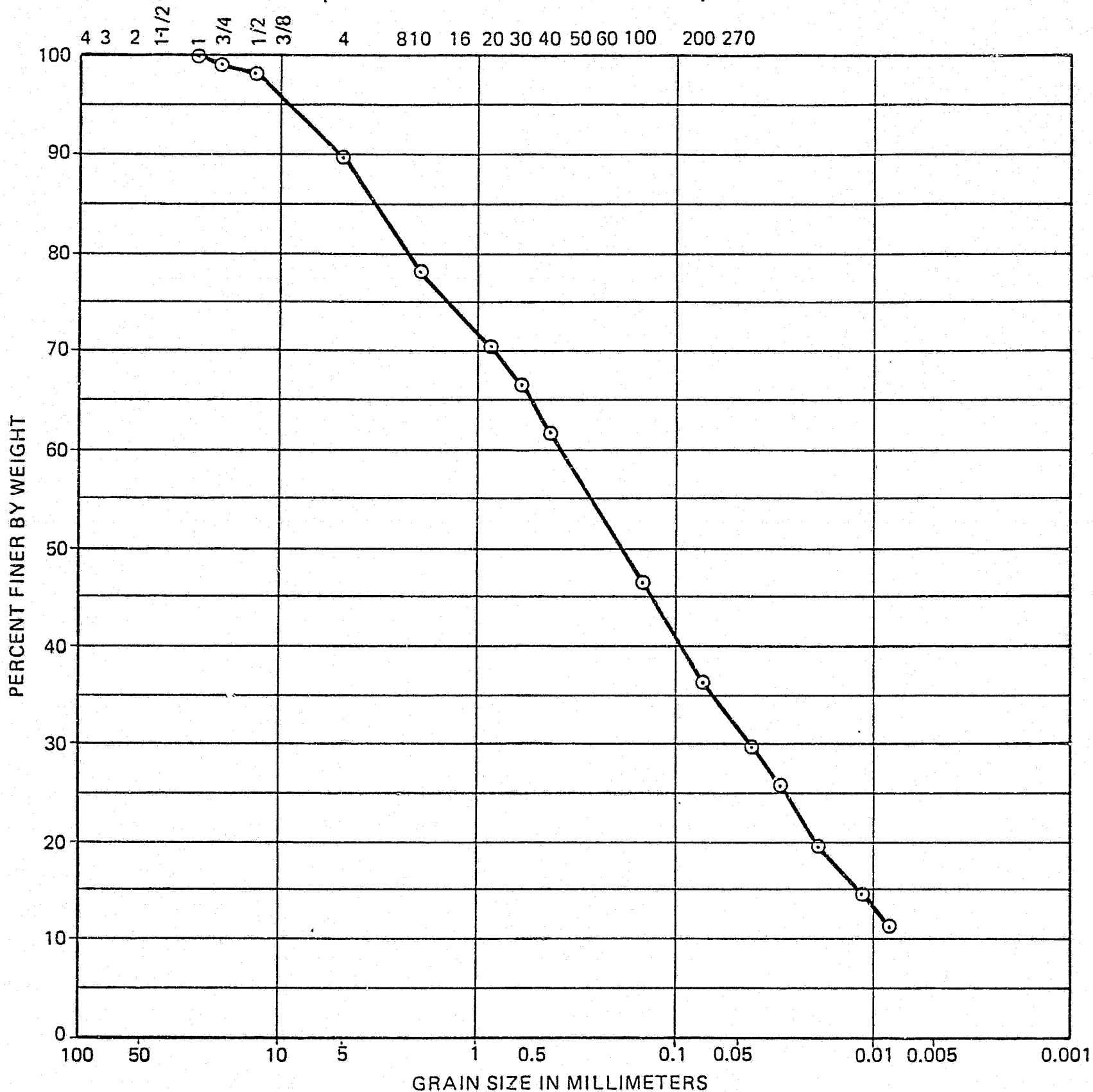
GSC/DEB/plm/0106R

Attachments: Plate 1 - Particle Size Analysis
Plates 2 through 4 - Compaction Test Data
Plate 5 - Weight Loss During Wetting and Drying Test
Plate 6 - Cumulative Percentage of Weight Loss Wetting and Drying Test
Plate 7 - Weight Loss During Freezing and Thawing Test
Plate 8 - Cumulative Percentage of Weight Loss Freezing and Thawing Test
Plate 9 - Compressive Strength Test

U. S. Standard Sieve Opening Size

U.S. Standard Sieve Numbers

Hydrometer



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
○	Combined Sample	GRAY GRAVELLY SILTY SAND (SM) $G_s = 2.63$



Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Particle Size Analysis

Watana Airstrip

Susitna Hydroelectric Project

PLATE

1

DRAWN

JOB NUMBER

15032,006.08

APPROVED

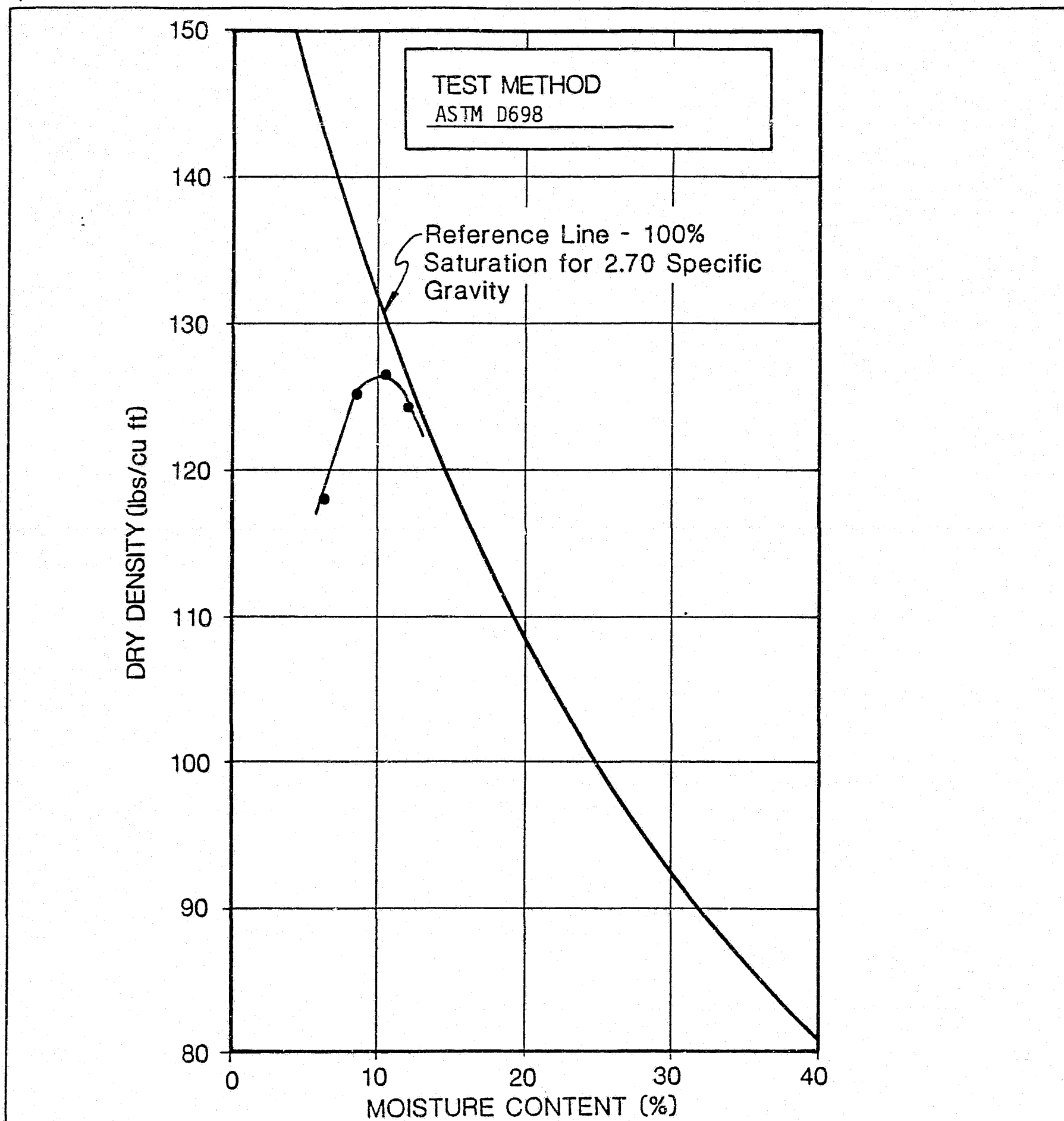
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DATE

7/83

REVISED

DATE



Symbol	Sample Source	Classification	Optimum Moisture (%)	Maximum Dry Density (pcf)
•	Combined Sample No Cement	GRAY GRAVELLY SILTY SAND (SM)	10.0	127.0



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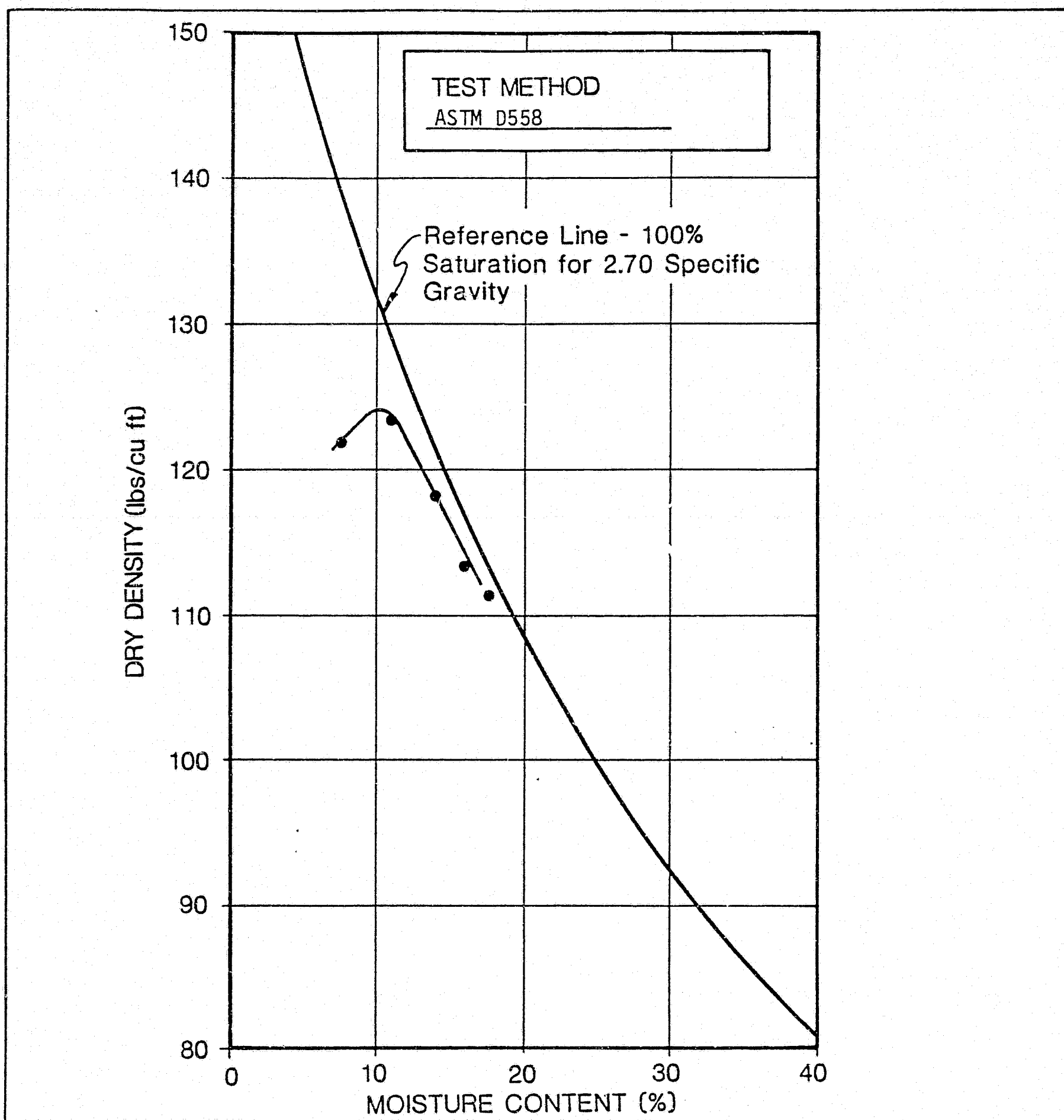
Compaction Test Data
Watana Airstrip
Susitna Hydroelectric Project

PLATE

2

DRAWN	JOB NUMBER 15032,006.08	APPROVED DAB	DATE 7/83	REVISED	DATE
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000373



Symbol	Sample Source	Classification	Optimum Moisture (%)	Maximum Dry Density (pcf)
•	Combined Sample 4% Cement	GRAY GRAVELLY SILTY SAND (SM)	10.0	124



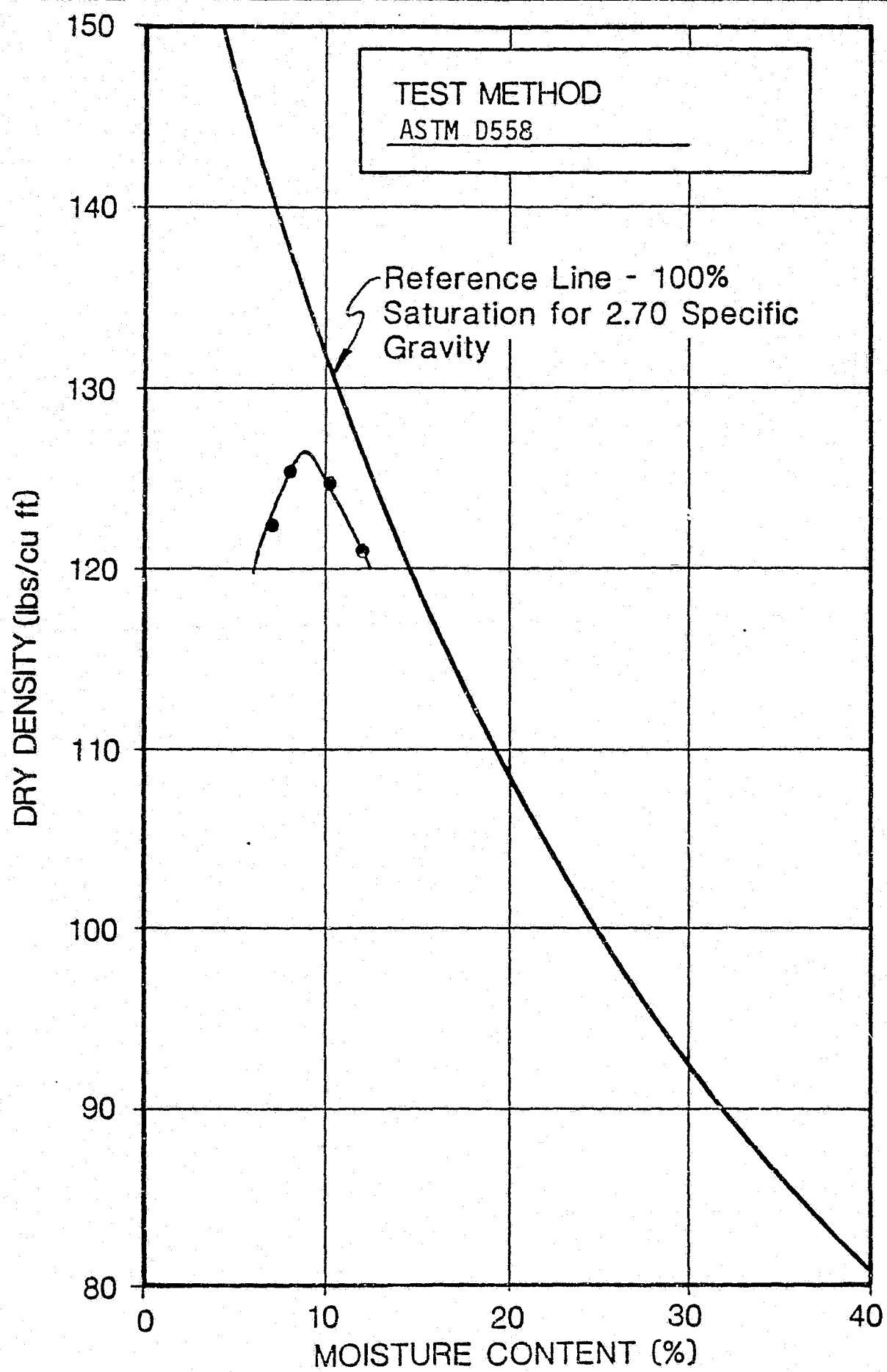
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Compaction Test Data
Watana Airstrip
Susitna Hydroelectric Project

PLATE

3

DRAWN	JOB NUMBER 15032,006.08	APPROVED <i>DAR</i>	DATE 7/83	REVISED	DATE
-------	----------------------------	------------------------	--------------	---------	------



Symbol	Sample Source	Classification	Optimum Moisture (%)	Maximum Dry Density (pcf)
•	Combined Sample 7% Cement	GRAY GRAVELLY SILTY SAND (SM)	9.0	126



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Compaction Test Data
Watana Airstrip
Susitna Hydroelectric Project

PLATE

4

DRAWN

JOB NUMBER
15032,006.08

APPROVED

DAB

DATE
7/83

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DATE

Cylinder Number	Weight Loss for Each Test Cycle (grams)							
	Four Percent Cement				Seven Percent Cement			
	1	2	3	4	5	6	7	8
Beginning Weight (grams)	2838	2825	---	---	2869	2845	2866	2849
Cycle Number								
1	282	316	*	*	55	60	34	67
2	448	444			115	96	109	90
3	403	438			101	105	91	104
4	332	244			75	49	45	47
5	228	299			81	63	44	48
6	136	123			40	39	35	36
7	139	186			53	43	40	36
8	109	100			40	28	32	27
9	90	85			35	30	35	25
10	93	82			35	25	30	20
11	86	80			30	35	23	21
12	78	75			30	27	20	18

* Cylinder Fractured or Crumbled



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Engineers, Geologists
& Geophysicists

**Weight Loss During
Wetting and Drying Test**
Watana Airstrip
Susitna Hydroelectric Project

PLATE
5

DRAWN

JOB NUMBER

15032,006.08

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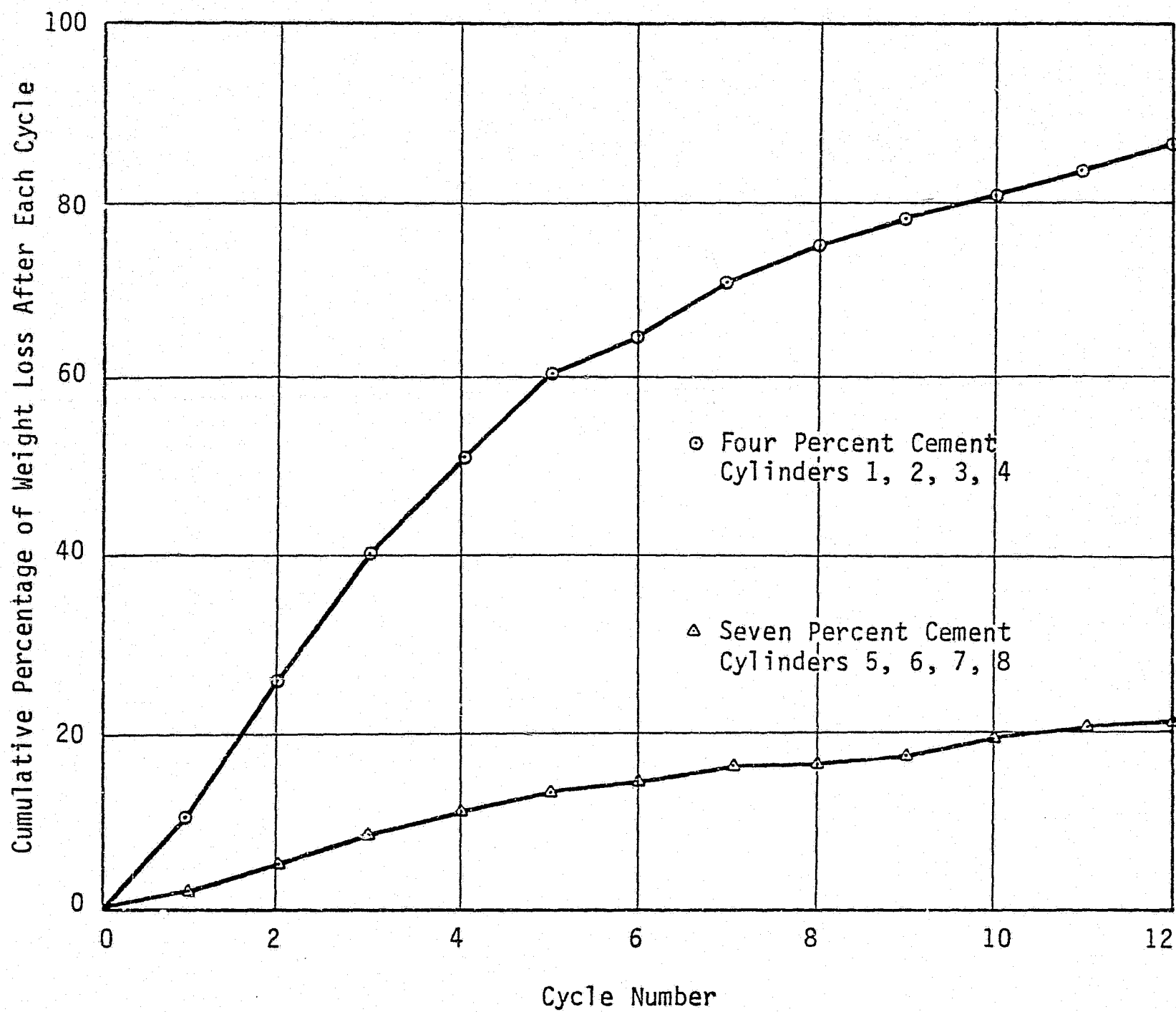
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**Cumulative Percentage of Weight
Loss Wetting and Drying Test**
Watana Airstrip
Susitna Hydroelectric Project

PLATE

6

DRAWN

JOB NUMBER

15032,006.08

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Cylinder Number	Weight Loss for Each Test Cycle (grams)							
	Four Percent Cement				Seven Percent Cement			
	9	10	11	12	13	14	15	16
Beginning Weight (grams)	3376	3346	3362	---	3336	3329	3350	3373
Cycle Number								
1	59	34	25	*	9	17	11	14
2	36	42	38		9	13	10	10
3	76	*	110		19	37	16	26
4	205		101		58	39	32	23
5	161		128		44	45	35	38
6	104		234		41	60	43	40
7	231		171		68	45	43	36
8	223		165		69	52	46	55
9	169		127		50	55	83	49
10	243		238		46	54	59	60
11	*		*		42	52	47	56
12					54	55	55	45

* Cylinder Fractured or Crumbled



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& Geophysicists

Weight Loss During Freezing and Thawing Test

Watana Airstrip
Susitna Hydroelectric Project

PLATE

7

DRAWN

JOB NUMBER

15032,006.08

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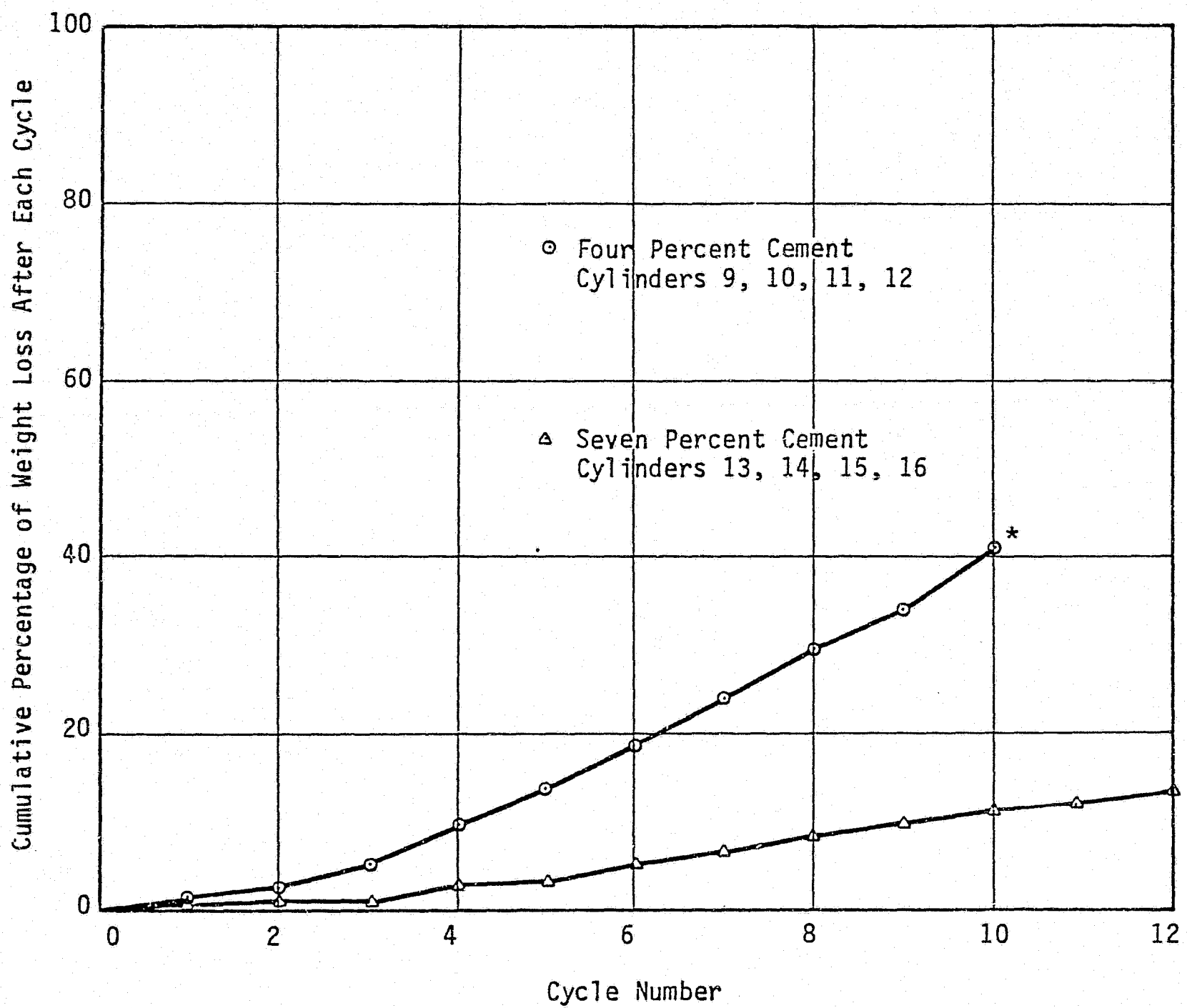
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& Geophysicists

Cumulative Percentage of Weight Loss Freezing and Thawing Test

Watana Airstrip
Susitna Hydroelectric Project

PLATE

8

DRAWN

JOB NUMBER

15032,006.08

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[Signature]

DATE

7/83

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DATE

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Cylinder Number	Percent Soil-Cement	Compressive Strength (psi)	
		7 day	28 day
17	4	130	---
18	4	130	---
19	4	130	---
20	7	140	---
21	7	150	---
22	7	140	---
23	4	---	60
24	4	---	70
25	4	---	70
26	7	---	170
27	7	---	190



Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Compressive Strength Test
Watana Airstrip
Susitna Hydroelectric Project

PLATE

9

DRAWN

JOB NUMBER

15032,006,08

APPROVED

[Signature]

DATE

7/83

REVISED

DATE

APPENDIX E

U.S. ARMY CORPS OF ENGINEERS APPLICATION FOR PERMIT



1983

US Army Corps
of Engineers

Alaska District
Regulatory Functions Branch
Pouch 898
Anchorage, Alaska 99506

Public Notice of Application for Permit

PUBLIC NOTICE DATE: August 17, 1983

EXPIRATION DATE: September 19, 1983

REFERENCE NUMBER: 071-OYD-4-830374

WATERWAY NUMBER: Susitna River 9

Interested parties are hereby notified that an application has been received for a Department of the Army permit for certain work in waters of the United States, as described below and shown on the attached plan.

APPLICANT: Alaska Power Authority, 334 West 5th Avenue, 2nd Floor, Anchorage, Alaska 99501

LOCATION: Wetlands adjacent to Susitna River, Alaska, T. 32 N., R. 5 E., S.M., sec. 27 and 28.

WORK: The applicant proposes to construct an airstrip by grading onsite material. Approximately 2' of peat [5,350 cubic yards (cy)] would be removed and stockpiled along the edge of the runway to be used during rehabilitation of the area after the project use. Approximately 4,620 cy of fill materials would be placed by grading within the project area. No additional fill material would be brought to the site. A filter fabric would be used as required to stabilize the foundation and facilitate drainage. The airstrip would be approximately 2,500' long, and 50' wide, with 2-foot-wide shoulders and a centerline grade close to 2% to utilize natural topography.

PURPOSE: To support field activities conducted to collect data during the Watana Dam Detailed Design Phase of the Susitna Hydroelectric Project.

ADDITIONAL INFORMATION: No refueling facilities or structures would be erected. All support activities would be conducted from Watana Base Camp located north of the proposed strip. Natural drainage is towards Tsusena Creek located over a mile to the west.

AUTHORITY: This permit will be issued or denied under the following authorities:

(X) Discharge dredged or fill material into waters of the United States.-
Section 404, Clean Water Act (33 U.S.C. 1344).

WATER QUALITY CERTIFICATION: A permit for the described work will not be issued until a certification or waiver of certification as required under Section 401 of the Clean Water Act (Public Law 95-217), has been received from the Alaska Department of Environmental Conservation.

COASTAL ZONE MANAGEMENT ACT CERTIFICATION: Section 307(c)(3) of the Coastal Zone Management Act of 1972, as amended by 16 U.S.C. 1456(c)(3), requires the applicant to certify that the described activity affecting land or water uses in the Coastal Zone complies with the Alaska Coastal Management Program. A permit will not be issued until the Division of Policy Development and Planning has concurred with the applicant's certification.

PUBLIC HEARING: Any person may request, in writing, within the comment period specified in this notice, that a public hearing be held to consider this application. Requests for public hearings shall state, with particularity, the reasons for holding a public hearing.

CULTURAL RESOURCES: The latest version of the National Register of Historic Places has been consulted and no properties listed on or known to be eligible for inclusion on the Register are located in the permit area.

ENDANGERED SPECIES: Preliminarily, this described activity will not affect endangered species, or their critical habitat designated as endangered or threatened, under the Endangered Species Act of 1973 (87 Stat. 844). Formal consultation under Section 7 of the Act is not required for the described activity.

FLOOD PLAIN MANAGEMENT: Evaluation of the described activity will include conformance with appropriate State or local flood plain standards; consideration of alternative sites and methods of accomplishment; and weighing of the positive, concentrated and dispersed, and short and long-term impacts on the flood plain.

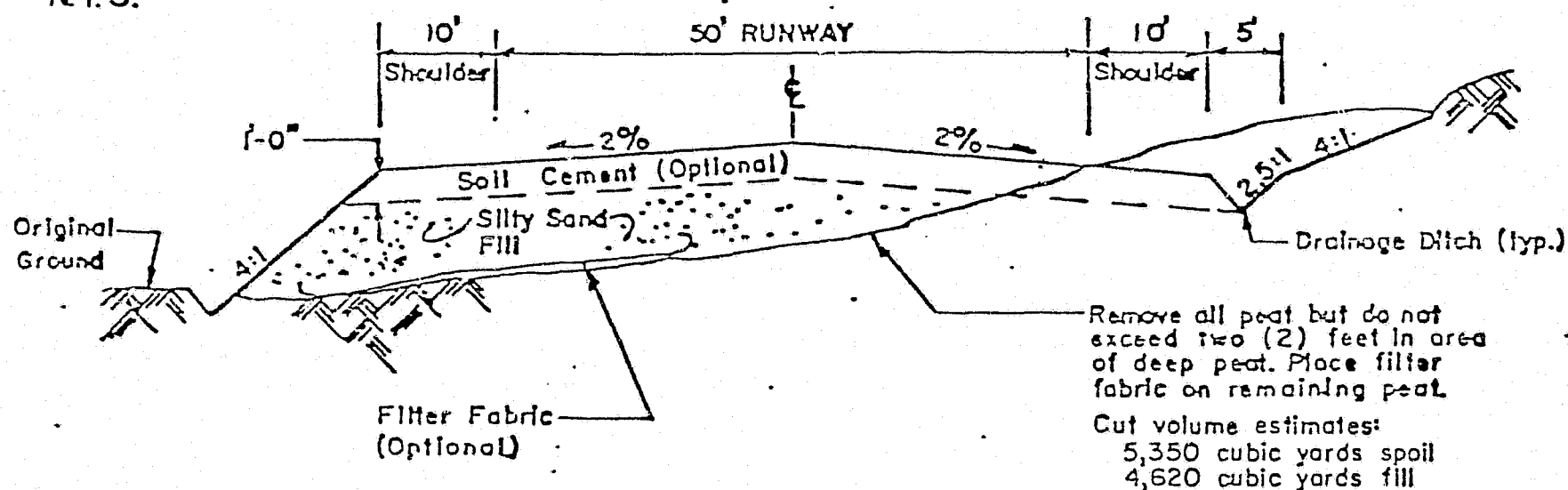
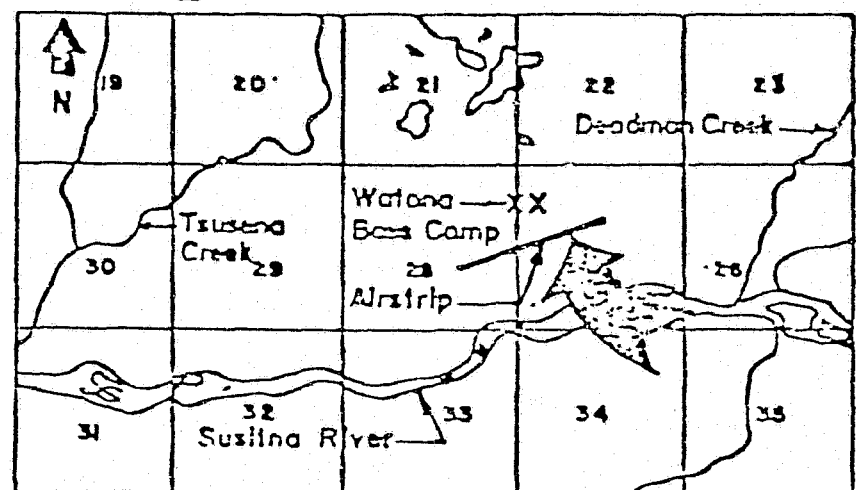
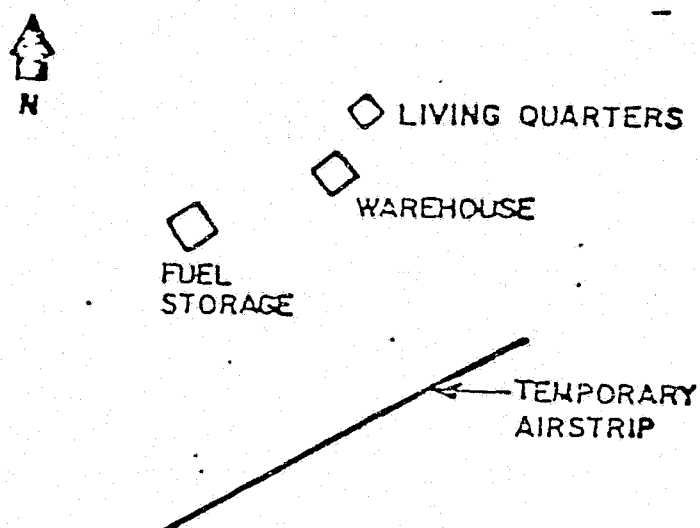
EVALUATION: The decision whether to issue a permit will be based on an evaluation of the probable impact including cumulative impacts of the proposed activity on the public interest. That decision will reflect the national concern for both protection and utilization of important resources. The benefit which reasonably may be expected to accrue from the proposals must be balanced against its reasonably foreseeable detriments. All factors which may be relevant to the proposal will be considered including the cumulative effects thereof; among these are conservation, economics, aesthetics, general environmental concerns, wetlands, cultural values, fish and wildlife values, flood hazards, flood plain values, land use, navigation, shoreline erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, and, in general, the needs and welfare of the people.

Comments on the described work, with the reference number, should reach this office no later than the expiration date of this Public Notice to become part of the record and be considered in the decision. If further information is desired concerning this notice, contact Georgina Akers at (907) 552-4942 or 279-4123.

A plan, Notice of Authorization for Certification of Consistency with the Alaska Coastal Management Program, and Notice of Authorization for State Water Quality Certification are attached to this Public Notice.

District Engineer
U.S. Army, Corps of Engineers

Attachments



NOTES:

1. Temporary airstrip will be 2500 feet long with a centerline grade as close to 2% as possible.
2. A minimum of two feet of peat will be removed and stockpiled along the edge of the runway for use during restoration upon airstrip closure.
3. Materials during construction will balance out and no additional borrow material is required. Filter fabric will be used as required.
4. Natural drainage is toward Tsusena Creek located over a mile to the west.
5. Watana Base Camp is located just north of the proposed site.
6. Construction is proposed for August 1983.

LAND OWNERSHIP:

1. Section 27, T32N, R5E, S.M. is owned by Knikatu, Inc., Box 2130, Wasilla, Alaska 99645.
2. Section 28, T32N, R5E, S.M. is held in interim conveyance for Knikatu, Inc., by Cook Inlet Region, Inc., 2525 C Street, Anchorage, Alaska 99503.

PROPOSED WATANA AIRSTRIP
SUSITNA HYDROELECTRIC PROJECT
Submitted by

SUSITNA
RIVER 9

STATE OF ALASKA

OFFICE OF THE GOVERNOR

DIVISION OF POLICY DEVELOPMENT AND PLANNING

BILL SHEFFIELD, GOVERNOR

Phone 465-3512

Pouch AD - Juneau 99811

STATE OF ALASKA

DIVISION OF POLICY DEVELOPMENT AND PLANNING

Notice of Application for
Certification of Consistency with the
Alaska Coastal Management Program

Notice is hereby given that a request is being filed with the Division of Policy Development and Planning for concurrence, as provided in Section 307 (c)(3) of the Coastal Zone Management Act of 1972, as amended [P.L. 94-370; 90 Stat. 1013; 16 U.S.C. 1456 (c)(3)], that the project described in the Corps of Engineers Public Notice No. 071-0YD-4-830374 will comply with the Alaska Coastal Management Program and that the project will be conducted in a manner consistent with that program.

Any person desiring to present views on considerations pertaining to the project's compliance or consistency with the Alaska Coastal Management Program may do so by providing his views in writing to the State Clearinghouse, Division of Policy Development and Planning, Office of the Governor, Pouch AD, Juneau, Alaska 99811, within 20 days of publication of this notice.

Attachment 2

STATE OF ALASKA

DEPT. OF ENVIRONMENTAL CONSERVATION

465-2601

BILL SHEFFIELD, GOVERNOR

FOUCH 0 - JUNE 1977

NOTICE OF APPLICATION FOR STATE WATER QUALITY CERTIFICATION

Any applicant for a Federal license or permit to conduct any activity which may result in any discharge into the navigable waters must first apply for and obtain certification from the Alaska Department of Environmental Conservation that any such discharge will comply with the Clean Water Act of 1977 (PL 95-217), the Alaska Water Quality Standards and other applicable State laws. By Agreement between the U.S. Army Corps of Engineers and the Alaska Department of Environmental Conservation application for a Department of the Army Permit may also serve as application for State Water Quality Certification when such certification is necessary.

Notice is hereby given that the application for a Department of the Army Permit described in the Corps of Engineers Public Notice No. 071-0YD-4-830374 also serves as application for State Water Quality Certification from the Alaska Department of Environmental Conservation, as provided in Section 401 of the Clean Water Act of 1977 (PL 95-217).

The Department will review the proposed activity to insure that any discharge to waters of the United States resulting from the referenced project will comply with the Clean Water Act of 1977 (PL 95-217) the Alaska Water Quality Standards and other applicable State laws.

Any person desiring to comment on the water quality impacts of the proposed project may do so by writing to:

Alaska Department of Environmental Conservation
Southcentral Regional Office
437 "E" Street, Second Floor
Anchorage, Alaska 99501
Telephone: 274-2533

within 30 days of publication of this notice.