DCNO

3560

HARZA-EBASCO
Susitna Joint Venture
Document Number
3560

WATANA AIRSTRIP
FEASIBILITY STUDY
PHASE I

FOR THE
SUSITNA HYDROELECTRIC PROJECT

SUBMITTED TO
ALASKA POWER AUTHORITY

APRIL 1983

HARZA-EBASCO
SUSITNA JOINT VENTURE

WATANA AIRSTRIP FEASIBILITY STUDY

PHASE I

TABLE OF CONTENTS

		PAGE
I.	REPORT	
	A. INTRODUCTION	1
	B. CONCLUSIONS AND RECOMMENDATIONS	3
	C. PERMITTING	7
	D. SITE INVESTIGATIONS	8
	1. SOILS INVESTIGATION	9
	2. LABORATORY TESTING	12
	E. FEASIBILITY CONSIDERATIONS	15
	1. CONCEPTUAL PLANNING	15
	2. PREPARATION CONSIDERATIONS	16
	3. SOIL STABLIZATION	17
	4. RUNWAY EXPANSION	19
	5. COST AND SCHEDULE	20
	F. ECONOMIC ANALYSES	23
	1. FIXED-WING VERSUS ROTARY WING SERVICE	23
	2. USAGE PLAN	24
	3. COST ANALYSES	28
II.	TABLES	
	TABLE A - PERMITTING REQUIREMENTS	32
	TABLE B - LABORATORY TEST SUMMARY	34
III.	FIGURES	
	FIGURE 1 - AUGER BORING LOCATION PLAN	
	FIGURE 2 - WATANA AIRSTRIP - MAIN STRIP	
	FIGURE 3 - WATANA AIRSTRIP - EAST & WEST EXTENSION	
	FIGURE 4 - FOUNDATION MATERIAL - TYPICAL GRAINSIZE CURVE	
	FIGURE 5 - WATANA AIRSTRIP - TYPICAL RUNWAY SECTION	
	FIGURE 6 - ECONOMIC COMPARISONS	
IV.	APPENDICES	
	APPENDIX A - R & M AIRSTRIP REPORT - OCTOBER 1980	
	APPENDIX B - HARZA-EBASCO - AUGER BORING LOGS - APRIL 1983	
	APPENDIX C - LABORATORY TEST RESULTS - APRIL 1983	

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, culminating with a meeting on March 19, 1983, a two-phase Watana Airport Study Plan was proposed and approved for implementation.

The basic scope 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 soils 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, provide preparation 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 performance 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 maintanence 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 $200,000 and it will take approximately one month to prepare.

The year round strip places a stabilized soil surfacing on top of the proposed winter strip for a total order of magnitude cost of $400,000 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 11 months of use, with a potential savings of $275,000 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 17 months of use, with a potential savings of $360,000 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 the Joint Venture'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 Activitiy 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 preparation cost estimate 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, Corp 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 Corp. To minimize possible delays in preparation, due to the estimated minimum 90 day approval cycle, the Joint Venture will implement a request for Authorization No. 6 as soon as Phase II Activities are approved by the Alaska Power Authority.

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 Cook Inlet native corporations land [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 optium 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 strippi 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 5,350 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 laboratory program is currently in progress at Harding and 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 then classified by the AASHO system so that the Industry Standard empirical graphs and charts made by Portland Cement Association can be used for the short cut method. 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 theoretical soil cement ratio from grain size characteristics, soil cement cylinders are then prepared in four inch models for wet-dry tests, freeze-thaw tests and comprensive strength breaks at 7 days, 28 days, and 60 days.

Due to the time required for the completion of this phase of the testing the results of soil stabilization test program will be presented, as a supplementary report as soon as the results are available.

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.

The order of magnitude cost for the preparation of this type of strip is estimated to be $200,000. This estimate 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 thirty days is calculated for preparation. Equipment mobilization, the cost of materials, and logistical support are also included in this estimate cost.

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 $200,000. The total cost of the soil stabilization, year round strip is therefore, estimated to be $400,000.

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 $200,000.

CASE 1B Considers the use of the year round strip with normal maintenance and fuel hauls are planned in February and July. The total cost of construction is $400,000.

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.

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

- Use of 1983 costs-unescalated.

CASE 1B ASSUMPTIONS (YEAR ROUND STRIP)

- 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 100,00 gallons each.

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

- Use 1983 costs-unescalated

CASE 2 ASSUMPTION (ROTARY WING ONLY)

- Four fixed-wing trips per week from Anchorage to Talkeetna with personnel and luggage, followed by helicopter transport to Watana; from May through December.

- One trip per week as described above for supplies and freight - all year round.

- Four fixed-wing trips per week from Anchorage to Watana with personnel and luggage to Miller Lake on skis; from December to May.

- Two fuel hauls of 100,000 gallons each in February and July by helicopter from the Chulitna siding to Watana.

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

- 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)

- $ 42,000 cost of preparation of plans
- $200,000 construction cost
- $ 26,600 per quarter - transport costs (strip open)
- $ 40,600 per quarter - transport costs (strip partially closed)

  $ 75,000 fuel lift cost

  $ 18,000 per quarter - winter maintenance cost (strip open)
- $ 30,000 per quarter - summer maintenance cost (strip partially closed)
- $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 $400,000 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 accumulated costs of each of the three study cases are presented in Figure 6.

An analysis of these relationships indicates that the potential earned savings from fixed-wing service to the camp will fully equal the $200,000 construction cost of the winter strip after 11 months of assumed usage. In the same way, the break even point for the $400,000, year round strip is found to be 17 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 July 1983, the total savings accrued to April 1986 by the construction of the winter strip is approximately $477,400 while the total savings accrued by the year round strip is also approximately $467,000.

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.

The accumulated cost of ech of these three cases described above are presented in the table which follows.

AIRSTRIP STUDY COSTS

	CASE 1A (Winter Strip)		CASE 1B (Year Round)	CASE 2 (Helicopter)
7/83	$ 42,000	Design Cost	$ 63,000	-0-
	200,000	Cost of Strip	400,000	$ 50,600
	40,600	Strip Operation	26,600	-0-
	30,000	Maintenance (summer)	18,000	-0-
	48,600	Workhour Cost-Travel	32,400	64,800
10/83	$ 361,200	Cumulative Costs	$ 540,000	$ 115,400
	$ 26,600	Strip Operation	$ 26,600	$ 50,600
	75,000	Fuel Haul	75,000	171,000
	18,000	Maintenance (winter)	18,000	-0-
	32,400	Workhour Cost-Travel	32,400	64,800
1/84	$ 513,200	Cumulative Costs	$ 692,000	$ 401,800
	$ 26,600	Strip Operation	$ 26,600	$ 50,600
	18,000	Maintenance (winter)	18,000	-0-
	32,400	Workhour Cost-Travel	32,400	64,800
4/84	$ 590,200	Cumulative Costs	$ 769,000	$ 517,200
	$ 40,600	Strip Operation	$ 26,600	$ 50,600
	75,000	Fuel Haul	75,000	171,000
	30,000	Maintenance (summer)	18,000	-0-
	48,600	Workhour Cost-Travel	32,400	64,800
7/84	$ 784,400	Cumulative Costs	$ 921,000	$ 803,600
	$ 40,600	Strip Operation	$ 26,600	$ 50,600
	30,000	Maintenance (summer)	18,000	-0-
	48,600	Workhour Cost-Travel	32,400	68,800
.0/84	$ 903,600	Cumulative Costs	$ 998,000	$ 923,000
	$ 26,600	Strip Operation	$ 26,600	$ 50,600
	75,000	Fuel Haul	75,000	171,000
	18,000	Maintenance (winter)	18,000	-0-
	32,400	Workhour Cost-Travel	32,400	68,800
1/85	$1,055,600	Cumulative Costs	$1,150,000	$1,213,400
	$ 26,600	Strip Operation	$ 26,600	$ 50,600
	18,000	Miantenance (winter)	18,000	-0-
	32,400	Workhour Cost-Travel	32,400	68,800
4/85	$1,132,600	Cumulative Costs	$1,227,000	$1,332,800
	$ 40,600	Strip Operation	$ 26,600	$ 50,600
	75,000	Fuel Haul	75,000	171,000
	30,000	Maintenance (summer)	18,000	-0-
	48,600	Workhour Cost-Travel	32,400	68,800
7/85	$1,326,800	Cumulative Costs	$1,379,000	$1,623,200

AIRSTRIP STUDY COSTS

	CASE 1A (Winter Strip)		CASE 1B (Year Round)	CASE 2 (Helicopter)
	$ 40,600	Strip Operation	$ 26,600	$ 50,600
	30,000	Maintenance (summer)	18,000	-0-
	48,600	Workhour Cost-Travel	32,400	68,800
10/85	$1,446,000	Cumulative Costs	$ 1,456,000	$1,742,600
	$ 26,600	Strip Operation	$ 26,600	$ 50,600
	75,000	Fuel Haul	75,000	171,000
	18,000	Maintenance (winter)	18,000	-0-
	32,400	Workhour Cost-Travel	$ 32,400	68,800
1/86	$1,598,000	Cumulative Costs	$ 1,608,000	$2,033,000
	$ 26,600	Strip Operation	$ 26,600	$ 50,600
	18,000	Maintenance (winter)	18,000	-0-
	32,400	Workhour Cost-Travel	32,400	68,800
4/86	$1,675,000	Cumulative Costs	$ 1,685,000	$2,152,400

TOTAL COST SUMMARY

Winter Strip- from 7/83 to 4/86	$ 1,675,000	
Year Round Strip- from 7/83 to 4/86	$ 1,685,000	BREAK EVEN
Present Helicopter Usage- from 7/83 to 4/86	$ 2,152,400	

DIFFERENTIAL COST SUMMARY

Using the existing helicopter usage plan as a base:

° The winter strip breaks even in cost in 11 months (6/84), and accumulates savings at the rate of $ 275,000 each year thereafter. By 4/86, the total accumulated savings will amount to $ 477,400.

° The year round strip breaks even in cost in 17 months (12/84), and accumulates savings at the rate of $ 360,000 each year thereafter. By 4/86, the total accumulated savings will amount to $ 467,000.

°The construction of either fixed wing airstrip at the Watana Site this summer will provide significant cost savings ($ 470,000) compares to helicopter use during the planned site investigation programs through April 1986.

TABLES
A AND B

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

Authorization	Agency	Description	Lead Time	Comments
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

Authorization	Agency	Description	Lead Time	Comments
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 archaeolotist 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					
				COBBLE	GRAVEL	SAND	SILT/CLAY		LL	PL	PI	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		9-10	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:

TABLE B

BORING NO	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDROMETER TEST					
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	P.I.	W_c (%)	
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:

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.	P.I.	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	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										37.6	
AS49		2-3.5	SM		[illegible]	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	
AS50		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	

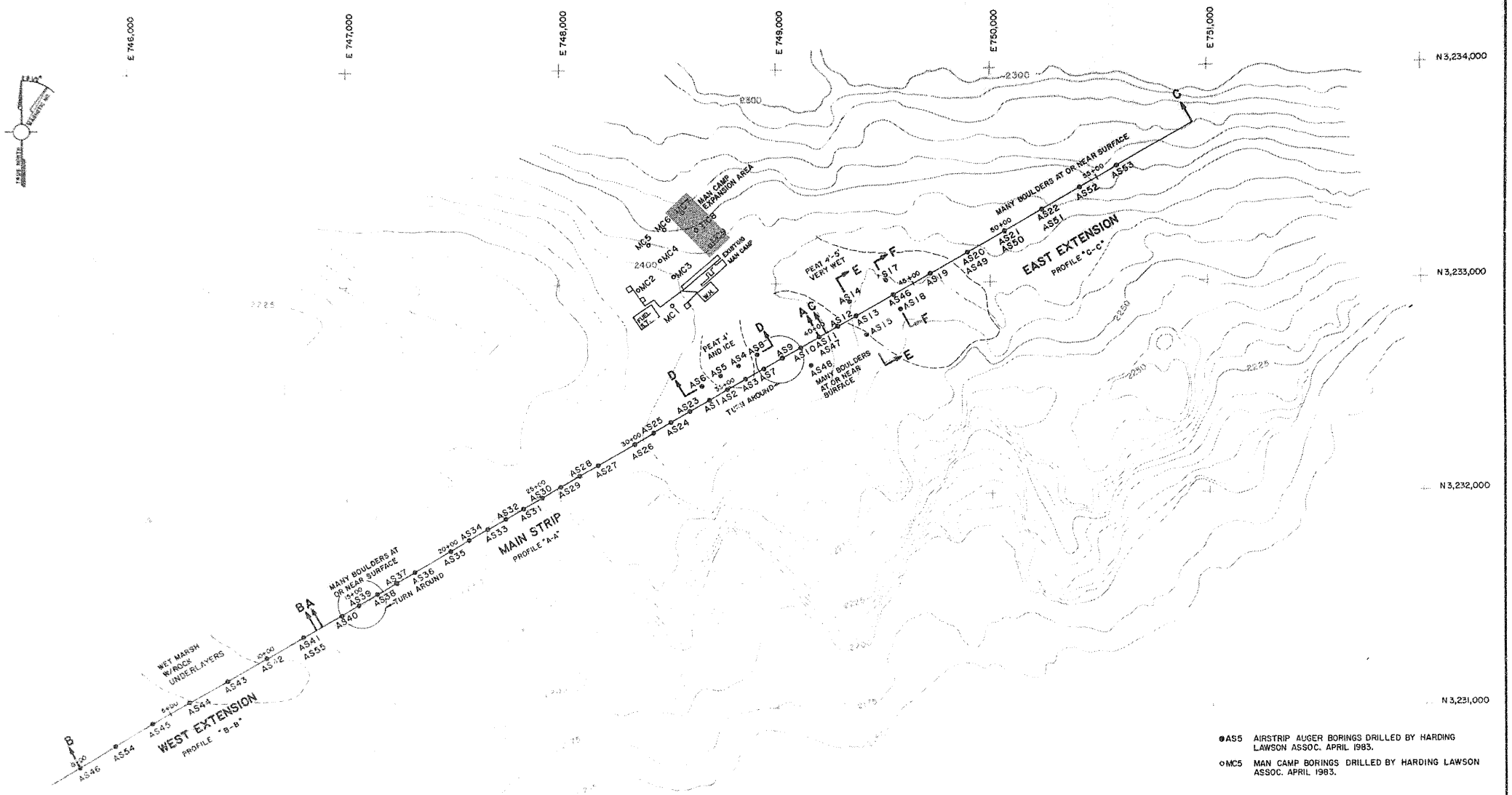
Remarks:

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.	P.I.	W_c (%)	
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:

FIGURES
1 - 6



●AS5 AIRSTRIP AUGER BORINGS DRILLED BY HARDING LAWSON ASSOC. APRIL 1983.

○MC5 MAN CAMP BORINGS DRILLED BY HARDING LAWSON ASSOC. APRIL 1983.

200 100 0 200 400 600
SCALE IN FEET

ALASKA POWER AUTHORITY

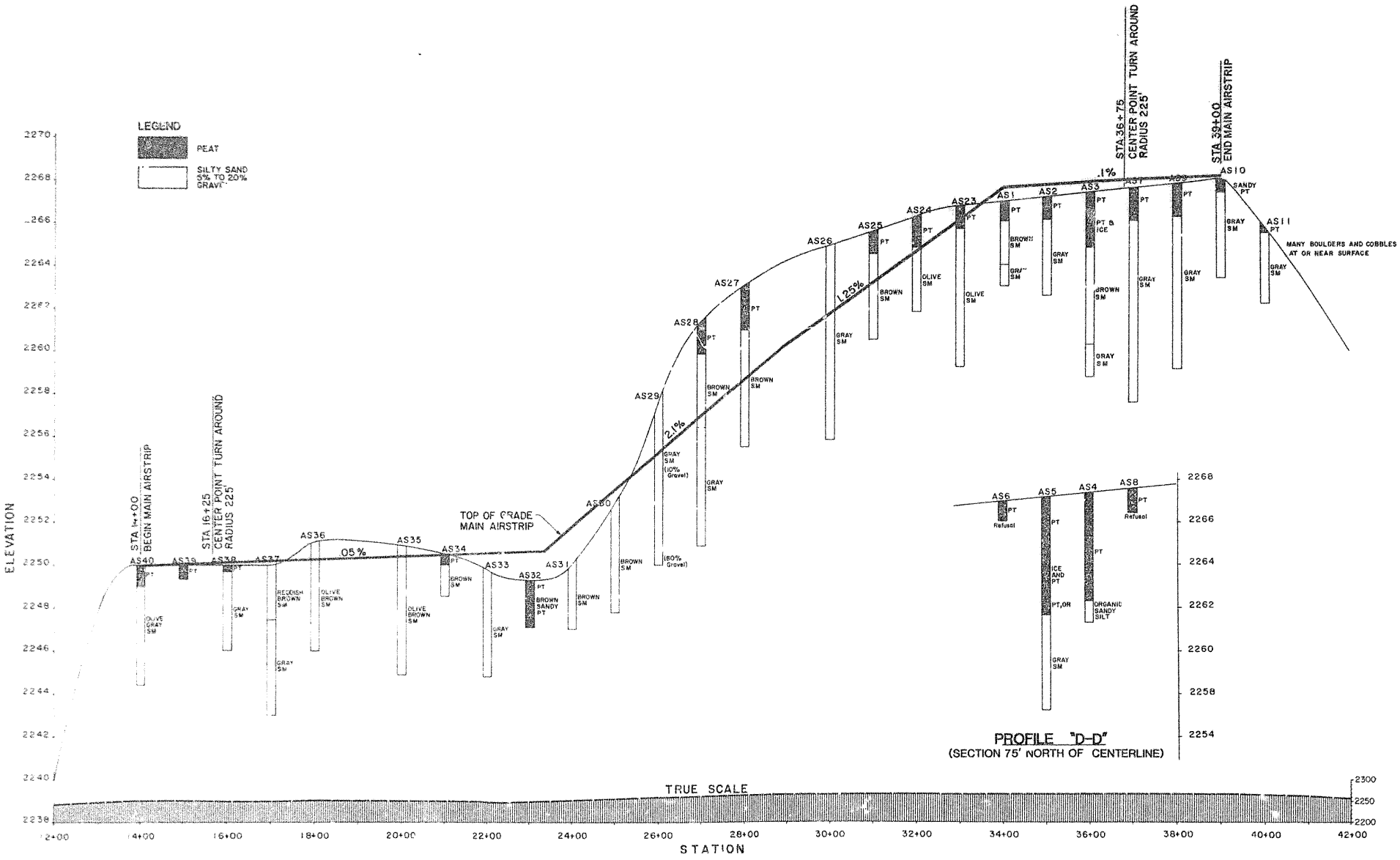
SUSITNA HYDROELECTRIC PROJECT

WATANA AIRSTRIP

AUGER BORING LOCATION PLAN

Figure 1

HARZA-EBASCO SUSITNA JOINT VENTURE	APPROVED		
ANCHORAGE, ALASKA	DATE APR. 18, 1983	CONTRACT NUMBER	DRAWING NUMBER APA-C-SK-1

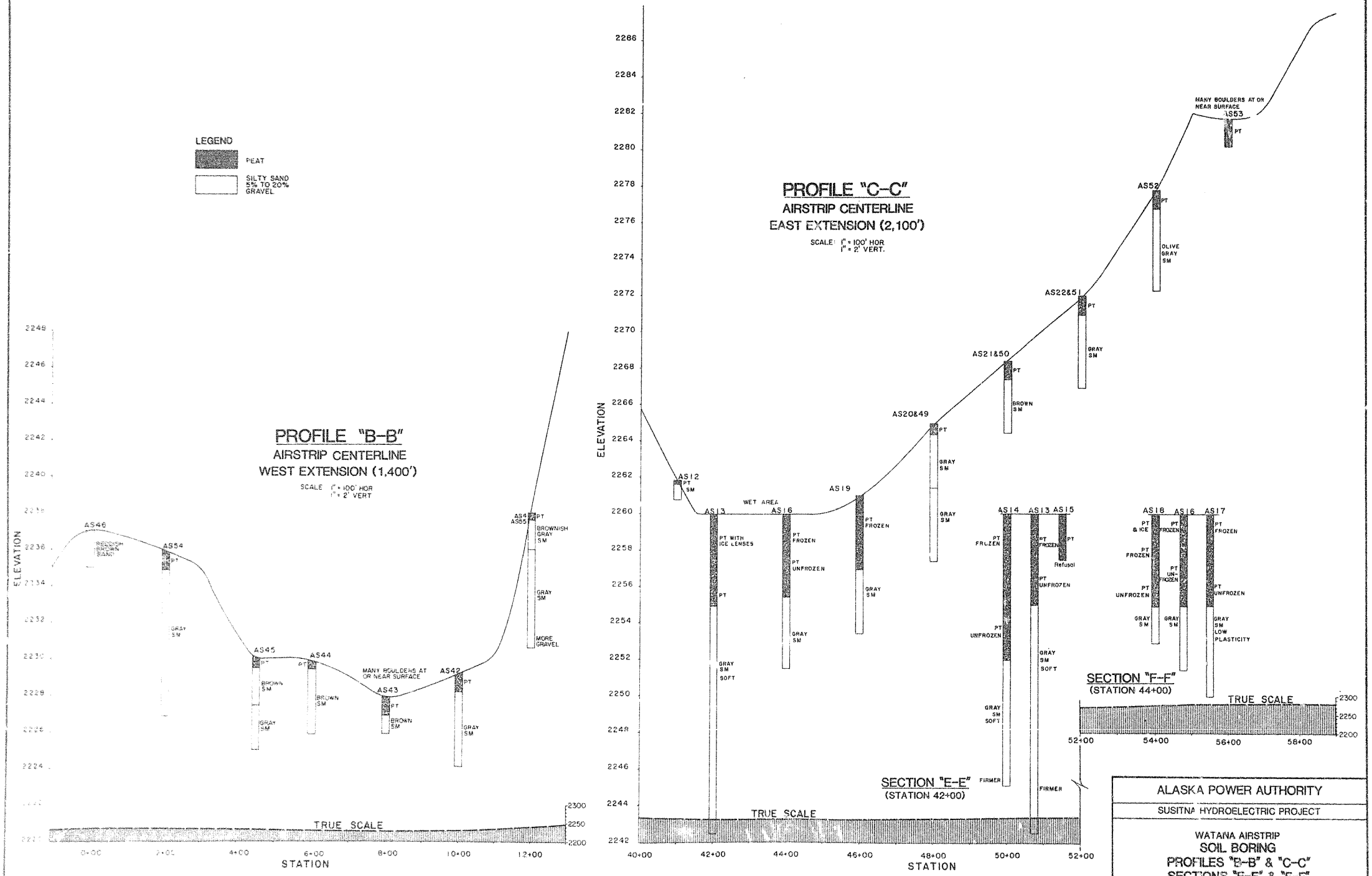


PROFILE "A-A"

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-EBASCO SUSITNA JOINT VENTURE	APPROVED
ANCHORAGE, ALASKA	DATE APR.16,1985
CONTRACT NUMBER	DRAWING NUMBER APA-C-SK-2



ALASKA POWER AUTHORITY

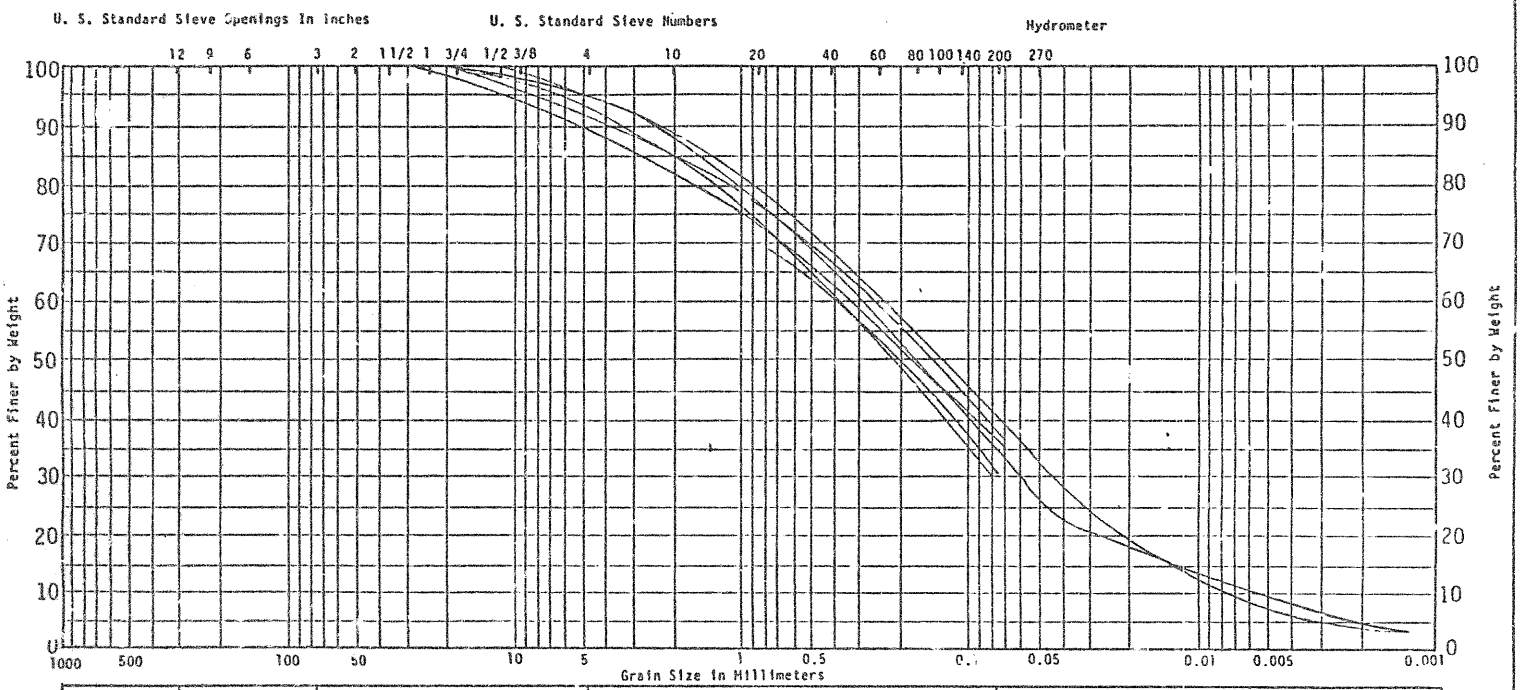
SUSITNA HYDROELECTRIC PROJECT

WATANA AIRSTRIP
SOIL BORING
PROFILES "B-B" & "C-C"
SECTIONS "E-E" & "F-F"

Figure 3

HARZA-EBASCO SUSITNA JOINT VENTURE	APPROVED			
ANCHORAGE, ALASKA	DATE APR.16,1983	CONTRACT NUMBER	DRAWING NUMBER APA-C-SK-3	

GRADATION SIZE ANALYSIS



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

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)

VISUAL MANUAL CLASSIFICATION

FINE SILTY SAND WITH SOME GRAVEL (SUBANGULAR AND SUBROUNDED)

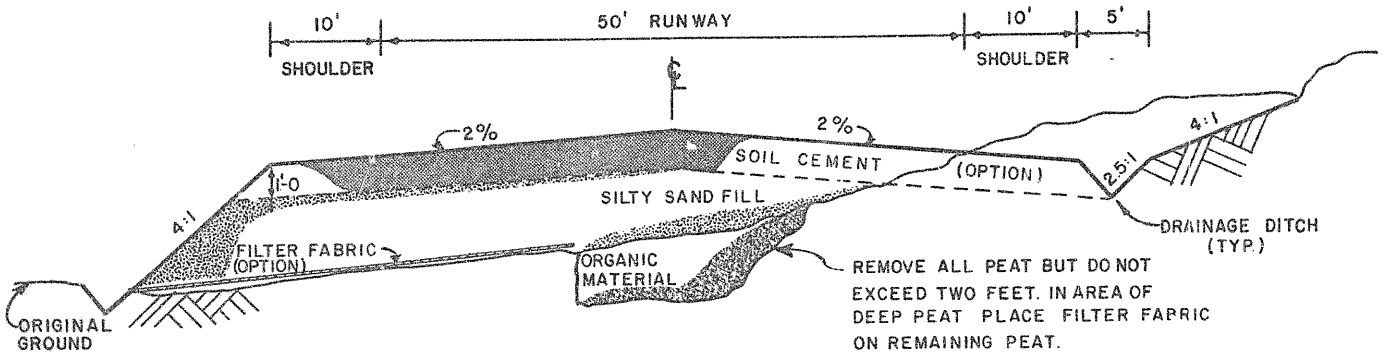
Job WATANA DAM
AIRSTRIP

No.

Date APRIL, 1983

TYPICAL GRAIN SIZE CURVES

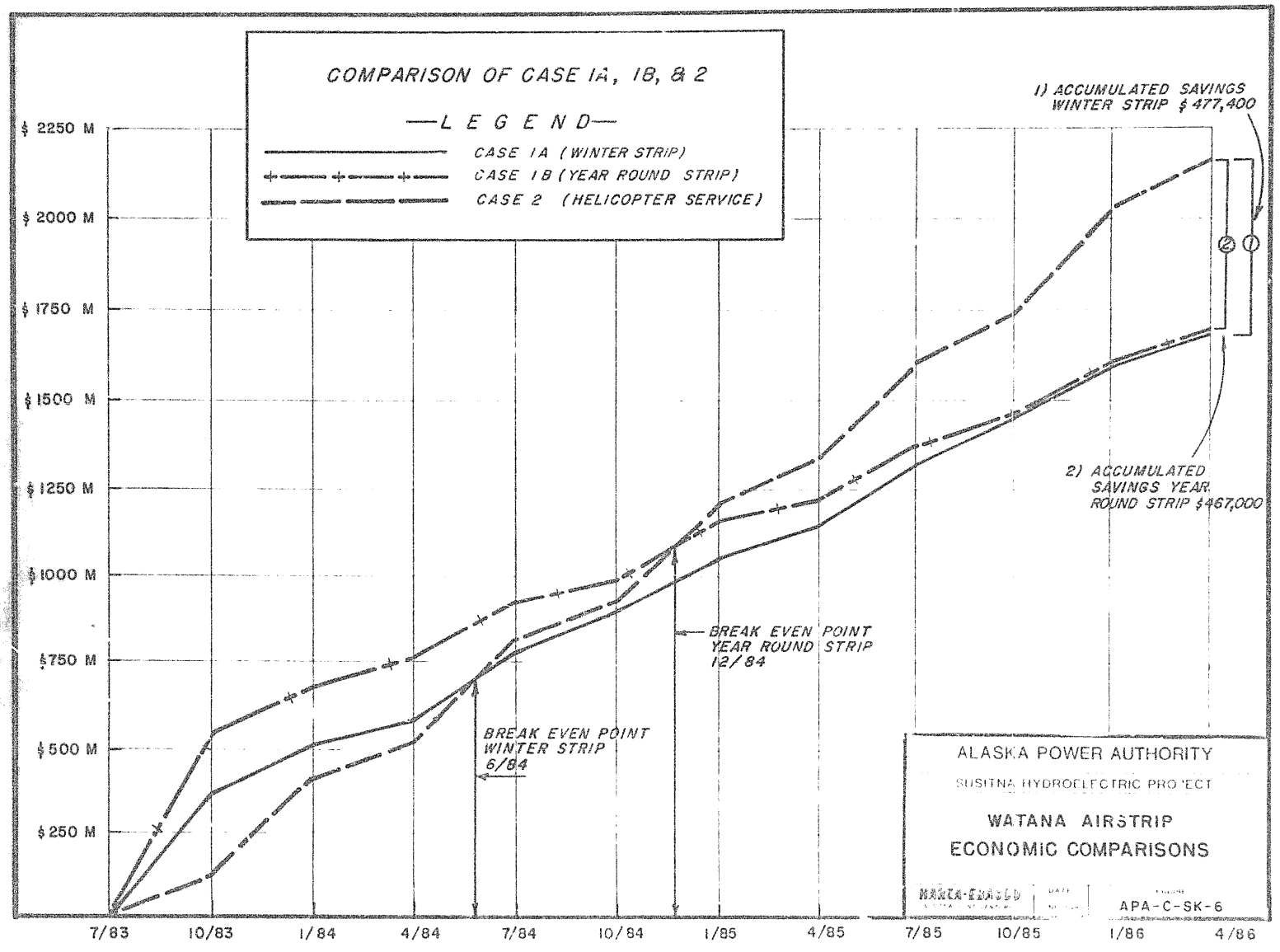
APA-C-SK-4



TYPICAL RUNWAY SECTION

N T S

ALASKA POWER AUTHORITY			
SUSITNA HYDROELECTRIC PROJECT			
WATANA AIRSTRIP TYPICAL RUNWAY SECTION			
WAPA-ECASCO SUSITNA JOINT VENTURE	APPROVED		
ANCHORAGE, ALASKA	DATE 4/83	CONTRACT NUMBER	DRAWING NUMBER APA-C-SK-5


COMPARISON OF CASE IA, IB, & 2
—LEGEND—
CASE IA (WINTER STRIP)
CASE IB (YEAR ROUND STRIP)
CASE 2 (HELICOPTER SERVICE)
1) ACCUMULATED SAVINGS WINTER STRIP $ 477,400
2) ACCUMULATED SAVINGS YEAR ROUND STRIP $467,000
$ 2250 M
$ 2000 M
$ 1750 M
$ 1500 M
$ 1250 M
$ 1000 M
$ 750 M
$ 500 M
$ 250 M
BREAK EVEN POINT YEAR ROUND STRIP 12/84
BREAK EVEN POINT WINTER STRIP 6/84
7/83
10/83
1/84
4/84
7/84
10/84
1/85
4/85
7/85
10/85
1/86
4/86
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA AIRSTRIP
ECONOMIC COMPARISONS
APA-C-SK-6

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 AIRSTRIP LOCATION STUDY

Prepared For:

ALASKA POWER AUTHORITY

and

ACRES AMERICAN, INCORPORATED

Prepared By:

R&M CONSULTANTS, INC.

OCTOBER 1982

PRELIMINARY

TABLE OF CONTENTS

SECTION		PAGE
A.	Introduction	1
B.	Location Parameters	2
C.	Approach	5
D.	Analysis	5
E.	Recommendations	7
F.	Quantity Estimates - Watana Airstrip	8
G.	Construction Cost Estimates	9

TABLES AND EXHIBITS

Table I -	Dimensional Standards, Basic and General Transport Airports		4
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 encrochment 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 definate impacts on project costs.

8. While not specified FAA criteria for a General Transport runway is assumed to control. Basic dèmensions 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		GENERAL TRANSPORT	
		A/2	B		
Runway Length	A	See Figures 5, 6 and 7		As required by critical airplane	As required by critical airplane
Width-Runway	B	75'	100'	100'	150'
-Taxiway	C	40'/3	40'/3	40'/3	40'/3
-Runway Safety Area	D	150'	300'	300'	500'
Runway Centerline to					
-Taxiway Centerline	E	200'	200'	300'	400'
-Airplane Parking Area	F	275'	300'	475'	650'
-Parallel Runway	G	As Per Current FAA Criteria			
Taxiway Centerline to					
-Airplane Parking Area	H	75'	100'	175'	250'
-Fixed or Movable Obstacle	I	50'	75'	100'	200'
-Parallel Taxiway	J	150'	150'	200'	300'
Building Restriction Line to					
-Runway Centerline	K	250'	300'	350'	750'
-Taxiway Centerline	L	50'	75'	100'	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 controling 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 tour 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 barrow 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 deals 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 constuction;
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 consistant 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 occassions 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 devises are on 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 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 c.y. use 90,000 c.y.

Item 3. Fabric for Safty Area - and Parking Area

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

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

Parking Area = 13000 s.y. 55,000 s.y.

Item 4. Crushed Surfacing

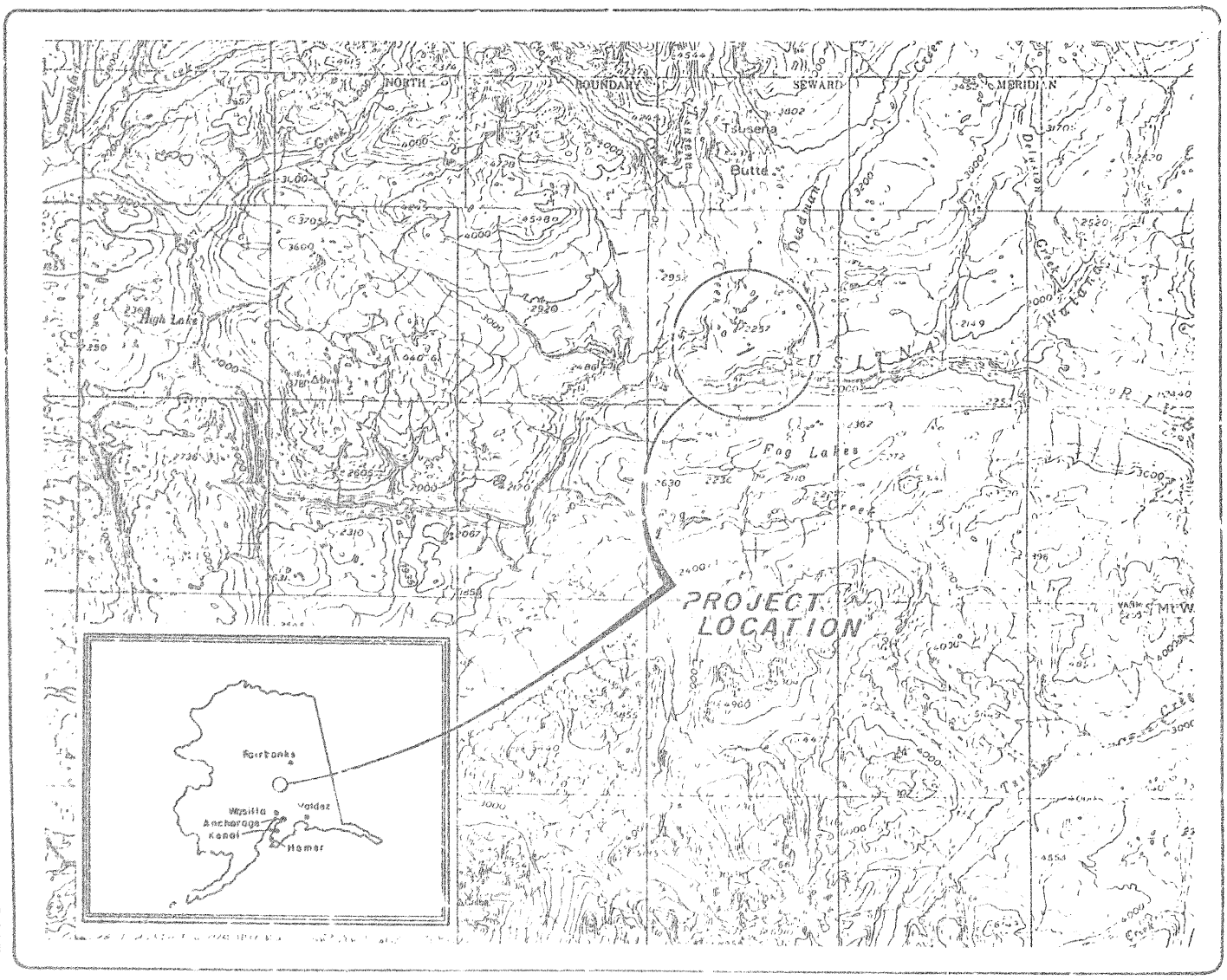
$\left[(13000 \text{ s.y.} + \frac{(2500)(100)(0.5)}{(9)\qquad(3)} \right]$ (1.05) = 7136 cy say 7200 c.y.

Item 5. Retro-Reflective Markers

± 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.	Mo' ilization		L.S.	200,000
				848,250
	Contingency			127,238
	Total			$975,488



DWN SRS
CKD NKG
DATE 10-3-90
SCALE 1" = 1 MI.

RSM CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

WATANA AIRSTRIP
VICINITY MAP
EXHIBIT 1

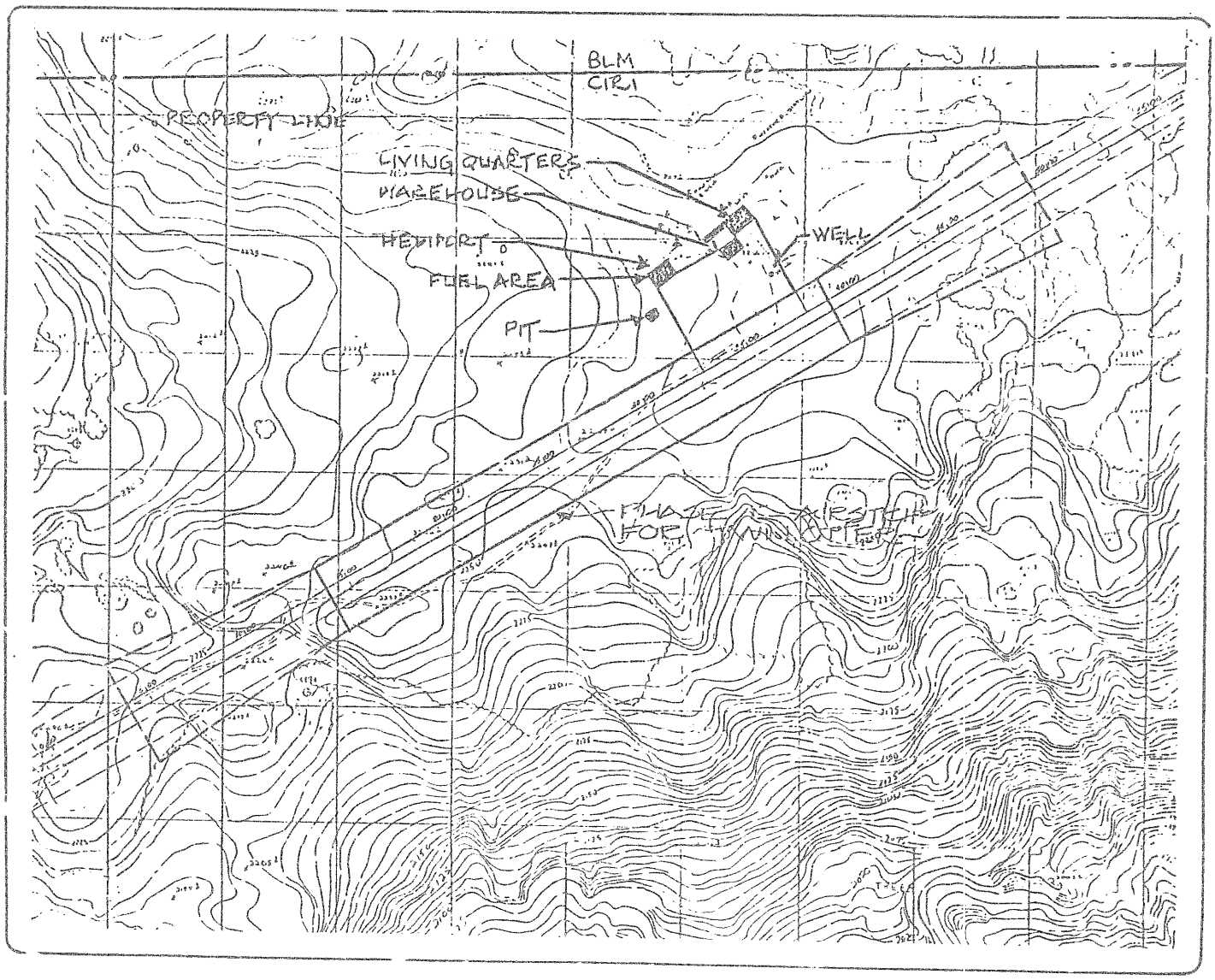
FB
GRID
PROJNO 0220.23
DWG #

DWN RJH
CKD NKS
DATE 10/8/80
SCALE NTS

RSM CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

WATALA AIRSTRIP
LAY OUT PLAN
EXHIBIT 2

EB
GRID
PROJ NO 82202
DWG NO

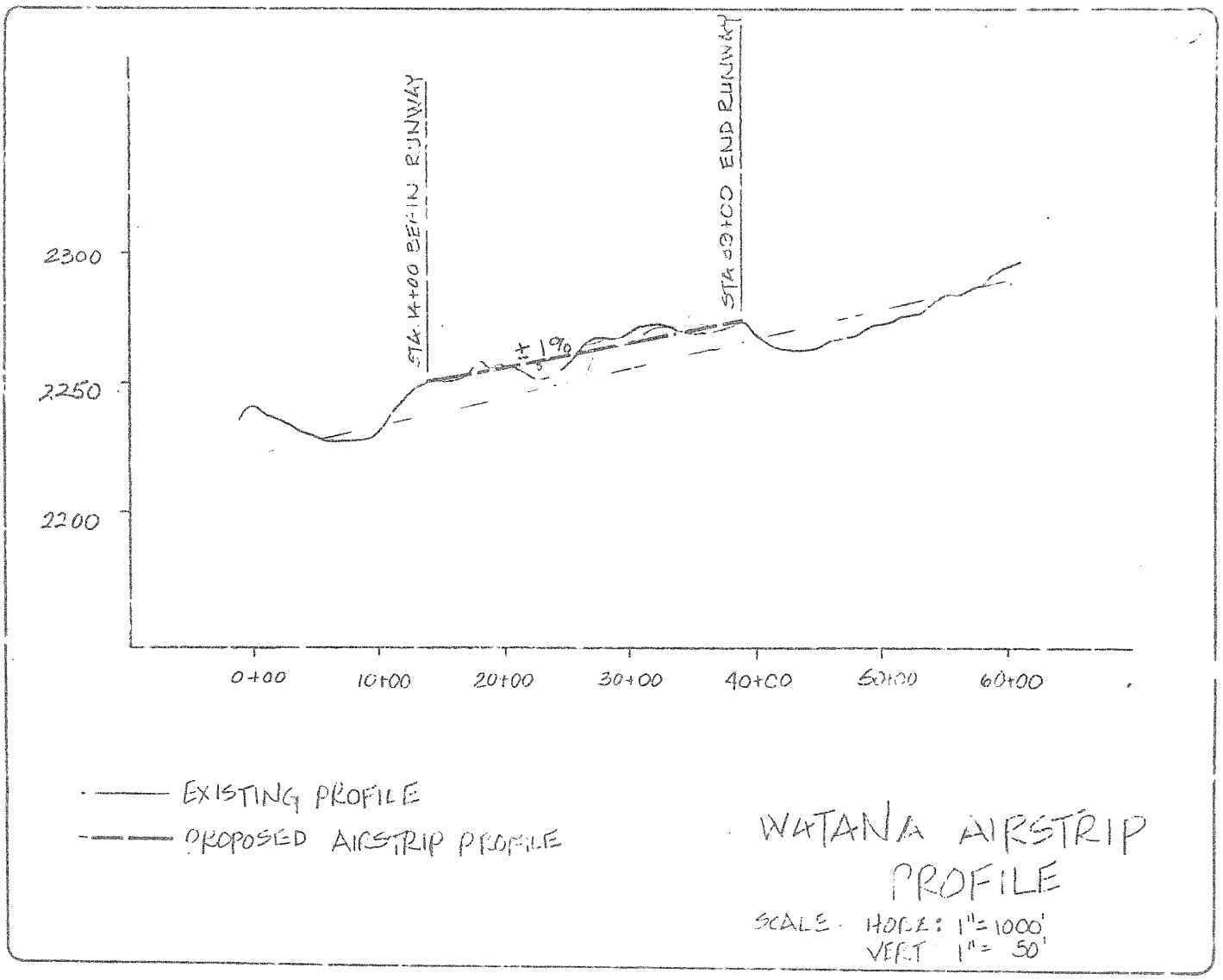


DWN RJH
CKD NKG
DATE 10/5/93
SCALE NTS

RSM CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

WATANA AIRSTRIP
PLAN VIEW - PHASE I
EXHIBIT 3

F.B.
GRID
PROJ.NO. 0521.03
DWG.NO



WATANA AIRSTRIP PROFILE

SCALE: HORZ: 1" = 1000'
VERT 1" = 50'

DWN. RTH
C'D. WKL
DATE: 10/8/80
SCALE AS NOTED

R&M CONSULTANTS, INC.
ENGINEERS GEOLOGISTS PLANNERS SURVEYORS

WATANA AIRSTRIP
PROFILE, PHASE I
EXHIBIT 4

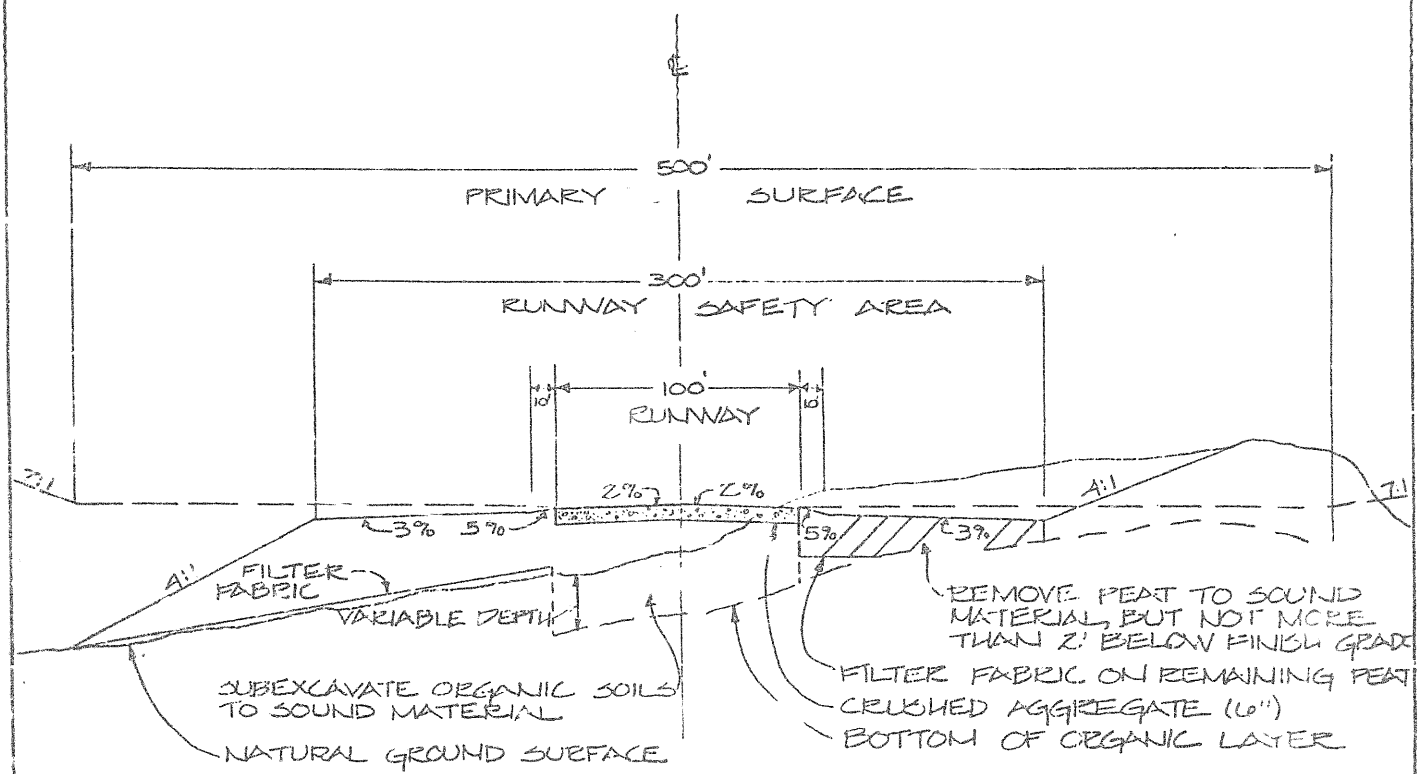
ES
GRID
PROJ. NO. 052205
DWG. NO.

DWN. L.A.S.
CKD. R.J.H.
DATE. 10-8-96
SCALE N.T.S.

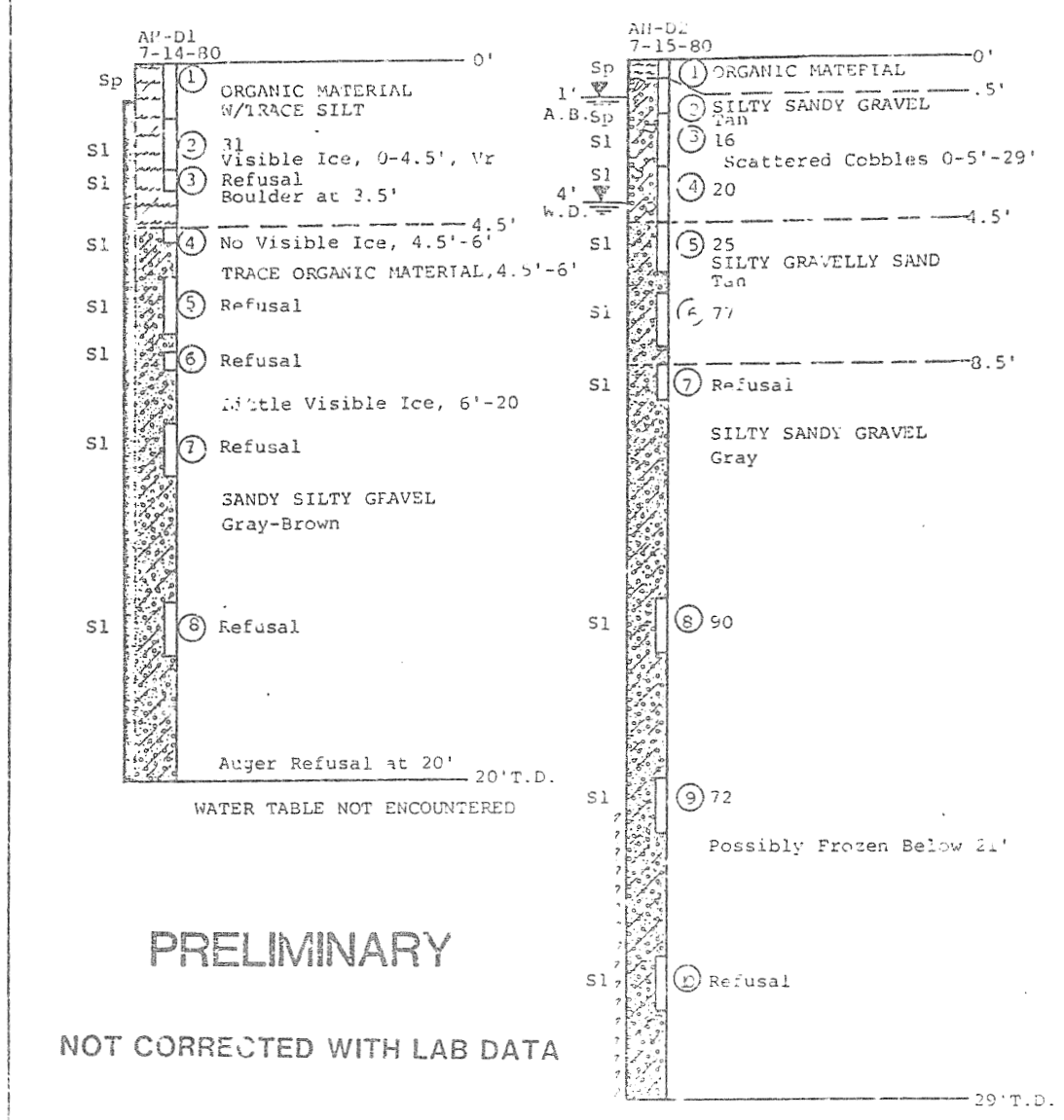
R&M CONSULTANTS, INC.
ENGINEERS ARCHITECTS PLANNERS SURVEYORS

WATANA AIRSTRIP
TYPICAL SECTION
EXHIBIT 13.10

F.B.
GRID
PROJ. NO. 0572.05
DWG. NO.



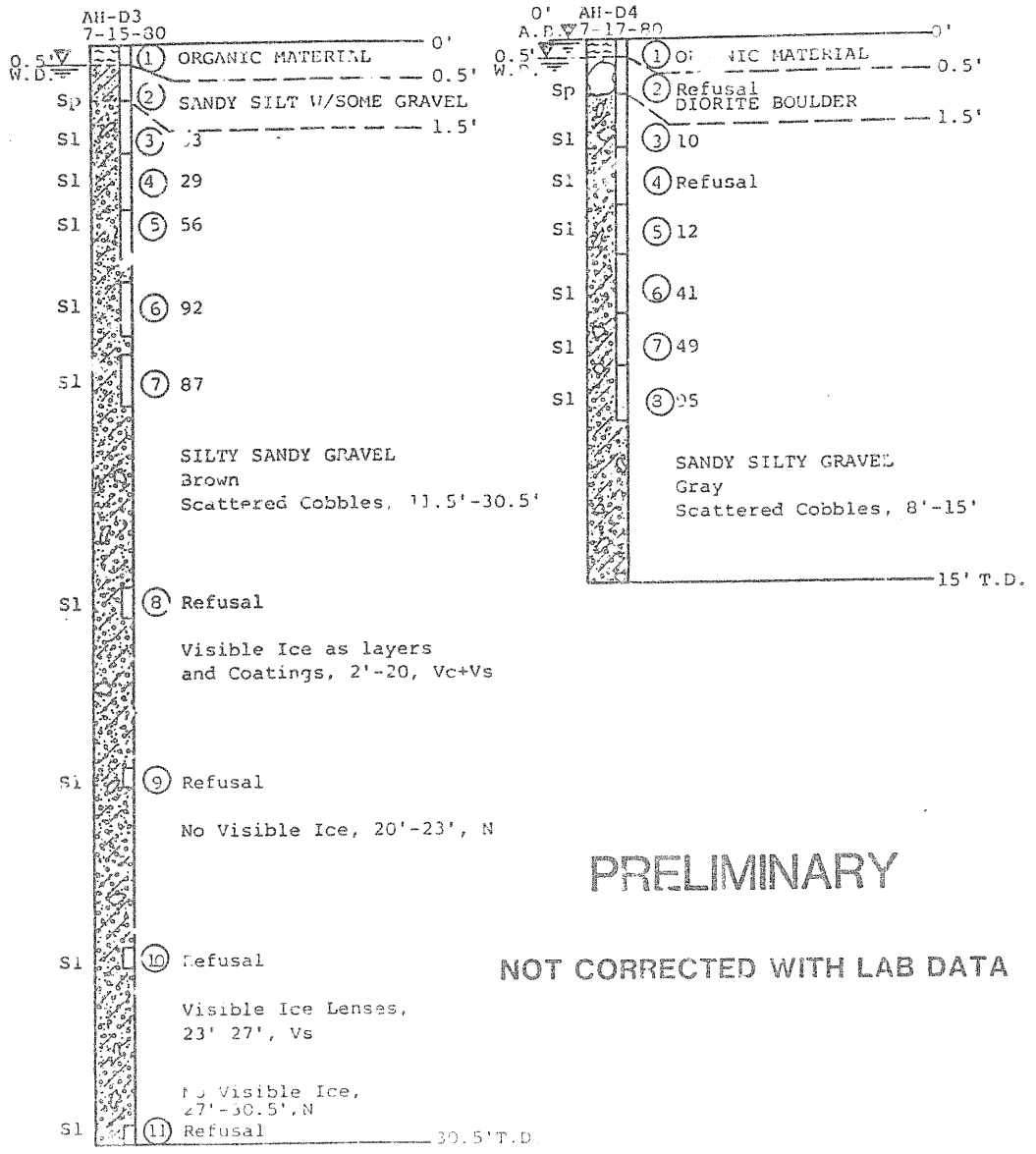
TYPICAL RUNWAY SECTION
N.T.S.



PRELIMINARY

NOT CORRECTED WITH LAB DATA

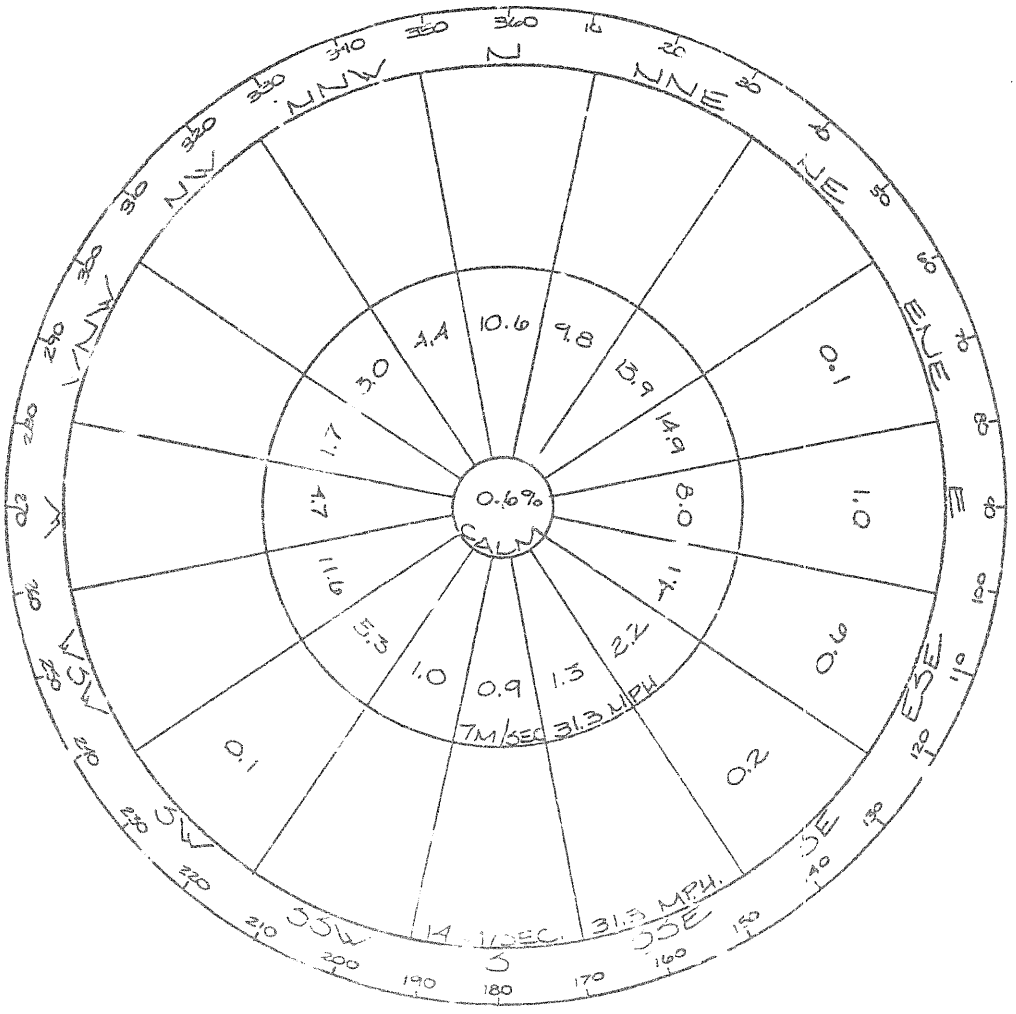
DWN.	R&M CONSULTANTS, INC. ENGINEERS GEOLOGISTS PLANNERS SURVEYORS	SUSITNA RIVER HYDROELECTRIC PROJECT GEOTECHNICAL INVESTIGATIONS EXHIBIT C	FB
CKD.			GRID
DATE Aug. 80			ROJ NO 05230-4
SCALE 1"=4'			DWG NO



PRELIMINARY

NOT CORRECTED WITH LAB DATA

DWN.	R&M CONSULTANTS, INC. ENGINEERS GEOLOGISTS LANDERS SURVEYORS	SUSITNA RIVER HYDROELECTRIC PROJECT GEOTECHNICAL INVESTIGATIONS EXHIBIT 7	B.
CKD.			GRID
DATE Aug. 80			PROJ NO 852504
SCALE 1"=4'			DWG NO



NOTES

1. OBSERVATIONS ARE 10-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 A.E.	R&M CONSULTANTS, INC. ENGINEERS GEOLOGISTS & PLANNERS SURVEYORS	VIATANA AIRSTRIP WIND ROSE EXHIBIT B	F.B.
CKD R.J.H.			GRID
DATE 10-8-80			PROJ.NO 052203
SCALE N.T.S.			DWG.NO

APPENDIX B

HARZA—EBASCO WATANA SOILS BORING LOGS

APRIL 6-8, 1983

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No AS-1
Feature AIRSTRIP ℄ 31+00
Coordinates: N
E
Logged by REH / DHR

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

Ground Elevation 2866
Rock Elevation
Total Depth 4.0
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				PEAT		
2			2				BROWN SILTY GRAVELLY SAND (FROZEN)		
3			3				DARK GRAYISH BROWN GRAVELLY SILTY SAND (SM)		
4									
5									

Boring No. ____ Sheet ____ of ____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No AS-2
Feature AIRSTRIP @ 35+00
Coordinates: N
E
Logged by REH / DNR

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

Ground Elevation 2266.0
Rock Elevation
Total Depth 4.5
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			1				PEAT (FROZEN)		ORGANIC CONTENT 76%
2			2				GRAY GRAVELLY SILTY SAND (F-m) GRAVEL FINE SUBANGULAR		
3									
4			3				SAME		MOISTURE CONTENT 14.1%
5									

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No AS-3 | Angle (from Horizontal) 90° | Ground Elevation 2267.0
Feature AIRSTRIP ℄ 36+00 | Bearing | Rock Elev
Coordinates: N | Date Started 4/6/83 | Total Depth 9.5
E | Date Completed 4/6/83 | Ground-Water Elevation
Logged by REH / DHR

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0	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 SILT		MOISTURE CONTENT 45.7%
5									
6			3				BROWNISH GRAY SILTY SAND (F-C) (DAMP)		
7									
8									HARD DRILLING
9			4				GRAY SILTY FINE SAND		
10									

Boring No. ____ Sheet ____ of ____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No A S 4
Feature AIRSTRIP 75' NORTH
Coordinates: N OF ℄ STA 36+00
E
Logged by

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

Ground Elevation
Rock Elevation
Total Depth 6 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									
4									
5									
6							ORGANIC SILTY SAND BROWN MOIST		ORGANIC CONTENT 11.5 % 19% FINES

Boring No. Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No AS-5
Feature AIRSTRIP 75' NORTH
Coordinates: N OF Q STA 35+00
E
Logged by PEH / DNR

Angle (from Horizontal) 90
Bearing
Date Started 4/4/83
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		
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		11.5% FINES
7									
8									
9			3				GRAY SILTY (F C) SAND MOIST		
10									

Boring No. Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No AS-6
Feature AIRSTRIP 75' NORTH OF ℄ STA 34+00
Coordinates. N
E
Logged by REH / DHR

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

Ground Elevation
Rock Elevation
Total Depth 10
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
							PEAT		
							REFUSAL ON AUGER @ 10		

Boring No Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No AS 1 | Angle (from Horizontal) 90° | Ground Elevation
Feature AIRSTRIP @ 37+00 | Bearing | Rock Elevation
Coordinates: N | Date Started 4/6/83 | Total Depth 10.0
E | Date Completed 4/6/83 | 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							BROWN PEAT (FROZEN)		
2									
3			1				GRAY SILTY SAND TR OF GRAVEL		
4									TOOK 50# BAG FOR PROCTOR TEST 123 PCF 7% OMC.
5									
6							SAME		
7									
8									
9									
10			2						12.7% mc.

Boring No. Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No AS 8
Feature AIRSTRIP 75' NORTH OF ℄ @ 37+00
Coordinates: N
E
Logged by REH / DHR

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

Ground Elevation
Rock Elevation
Total Depth 0.8
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
0							PEAT		
1							REFUSAL ON AUGER		
2									
3									

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 AIRSTRIP @ 38+00
Coordinates: N
E
Logged by REH / BMR

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									TOOK 50# SAMPLE 3.0-8.5
4							MORE GRAVEL		PROCTOR TEST RESULTS 138 PCF 8% OMC
5									
6									
7									
8									
9									
10									

Boring No. ____ Sheet ____ of ____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No AS 10 | Angle (from Horizontal) 90° | Ground Elevation
Feature AIRSTRIP & 33 ROC | 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

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
0							BROWN SANDY GRAVELLY PEAT		
1									
2									
3									
4			1				GRAY SILTY SAND		4.5 CLAY
5									

Boring No. ____ Sheet ____ of ____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No AS 11 | Angle (from Horizontal) 90 | Ground Elevation
Feature ALTERNATE @ 40+00 | Bearing | Rock Elevation
Coordinates: N | Date Started 4/6/83 | Total Depth 10
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							BEAT REFUSAL ON AUGER AFTER 3 ATTEMPTS. MANY BOULDERS AT OR NEAR SURFACE		REDRILLED ON 4/8/83 SEE AS 47
2									
3									

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No AS 12
Feature AIRSTRIP @ 41+00
Coordinates: N
E
Logged by REH/DR'R

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

Ground Elevation
Rock Elevation
Total Depth
Ground-Water Elevation

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Lab's Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT DARK BROWN ORGANIC SILTY SAND REFUSAL ON AUGER @ 1.0'		ORGANIC CONTENT 8.8%
2									
3									

Boring No. _____ Sheet _____ of _____

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									

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 / DMR

Angle (from Horizontal)
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
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									

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 2
Date 4/7/83

Boring No AS 14
Feature AIRSTRIP 75' NORTH
Coordinates: N OF & 42100
E
Logged by REH/DHR

Angle (from Horizontal) 90°
Bearing
Date Started 4/1/83
Date Completed 4/7/83

Ground Elevation
Rock Elevation
Total Depth 15
Ground-Water Elevation 7.0

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									

Boring No. ____ Sheet ____ of ____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 2 of 2
Date 4/7/83

Boring No AS 14
Feature AIRSTRIP 75' NORTH
Coordinates: N CF & 42KD
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 150
Ground-Water Elevation 70

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		
			3				TR OF FINE GRAVEL		
12									
13									
			4				GRAY SILTY FINE SAND		
14							TR OF FINE GRAVEL		
							FARMER		
15									
16									
17									
18									
19									
20									

Boring No. ____ Sheet ____ of ____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 15 | Angle (from Horizontal) 90 | Ground Elevation
Feature AIRSTRIP 75' SOUTH | Bearing | Rock Elevation
Coordinates: N OF Q 42+00 | Date Started 4/7/83 | Total Depth 25
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 (FROZEN)		
3							REFUSAL ON AUGER		

Boring No. ____ Sheet ____ of ____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 16 | Angle (from Horizontal) 90° | Ground Elevation
Feature AIRSTRIP @ 44+00 | 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/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							FROZEN		
							UNFROZEN		
3							PEAT		
4									
5									
6			1				GRAY GRAVELLY SILTY SAND		
7									
8			2				GRAY GRAVELLY SILTY SAND		
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 17 | Angle (from Horizontal) 90° | Ground Elevation
Feature AIRSTRIP 75' SOUTH | Bearing | Rock Elevation
Coordinates: N OF ℄ 7+00 | 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 = 20 PL = 16 LL = 18 77% CLAY
7									
8			2				GRAY SILTY SAND MINOR TRACE OF GRAVEL		PI = 37 LL = 20.75 PL = 17.05
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-18 | Angle (from Horizontal) 90° | Ground Elevation
Feature AIRSTRIP 75' NORTH | Bearing | Rock Elevation
Coordinates: N OF ℄ 44+00 | Date Started 4/7/83 | Total Depth 70
E | Date Completed 4/7/83 | Ground-Water Elevation 30
Logged by REH/DHR

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									

Boring No. Sheet

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No A5 19
Feature AIRSTRIP @ 46+00
Coordinates: N
E
Logged by REH/DMR

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		B.P. = MC. 115%
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 20
Feature AIRSTRIP @ 38+00
Coordinates: N
E
Logged by REA / DMR

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

Ground Elevation
Rock Elevation
Total Depth 1.0
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							PEAT REFUSAL @ 1.0 AFTER THREE ATTEMPTS		REDRILLED ON 4/8/83 SEE AS 49
2									
3									

Boring No. ____ Sheet ____ of ____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 21
Feature AIRSTRIP @ 50+00
Coordinates: N
E
Logged by REH / DHR

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

Ground Elevation
Rock Elevation
Total Depth 4.0
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							PEAT		SECOND ATTEMPT MADE 4/8/83 SEE AS 50
2			1				BROWN SILTY GRAVELLY SAND		
3			2				BROWN SILTY SAND TR TO LITTLE GRAVEL AND COARSE SAND		
4									
5									
6									

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No. AS 2R
Feature ABUTMENT E 52+00
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 10
Ground-Water Elevation

Depth (Elevation)	Hig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							FOUR ATTEMPTS WERE MADE. AUGER WAS UNABLE TO GET PASS BOULDERS		REDRILLED ON 4/8/83 SEE AS 5!
2									
3									

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 @ 33+00
Coordinates: N
E
Logged by REH / DHR

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 129 PCF 8% OMC
6									
7							SAME		
8									

Boring No. ____ Sheet ____ of ____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/03

Boring No AS 24
Feature ACCESS ROAD & 33+00
Coordinates: N
E
Logged by REH/DHR

Angle (from Horizontal) 90
Bearing
Date Started 4/7/03
Date Completed 4/7/03

Ground Elevation
Rock Elevation
Total Depth 4.5
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			1				BROWN SILTY SAND (F-C) LITTLE FINE GRAVEL		MC. 13.5
3									COMBINED SOIL FROM 33+00 & 32+00 FOR PROCTOR
4							SAME		
5									
6									

Boring No. Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 25
Feature AIRSTRIP ℄ 31+00
Coordinates: N
E
Logged by CEH/DMR

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

Ground Elevation
Rock Elevation
Total Depth 50
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			1				BROWN SILTY SAND (F-C) TR - LITTLE FINE GRAVEL		
3							SAME		
4									
5							REFUSAL ON AUGER		
6									
7									

Boring No. Sheet of

SOIL BORING LOG

HARZA-EBASCO
SUSITNA JOINT VENTURE

Sheet 1 of 1
Date 4/7/83

Boring No AS 26
Feature AIRSTRIP & 30100
Coordinates: N
E
Logged by REHI DNR

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

Ground Elevation
Rock Elevation
Total Depth 9.0
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									
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 1/2" ϕ PIECE OF GRAVEL
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 27
Feature AIRSTRIP & ROAD
Coordinates: N
E
Logged by EEH / 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							ORGANIC MAT		
2									
3									
4			1				BROWN SILTY FINE SAND LITTLE FINE GRAVEL		
5									
6			2				BROWN SILTY FINE SAND LITTLE FINE GRAVEL (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 AIRSTRIP & 27400
Coordinates: N
E
Logged by REH/ DHR

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									
4			2				BROWN GRAVELLY SILTY SAND		
5									BAG SAMPLE FOR PROCTOR TEST 4-10.5
6									
7							SAME		
8									
9									
10			3				GRAY GRAVELLY SILTY SAND		

Boring No. Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 29
Feature AIRSTRIP @ 26+00
Coordinates: N
E
Logged by REH / DMR

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			1				GRAY GRAVELLY SILTY SAND		
3			2				SAME		
4									
5									
6			3				SAME WITH MORE GRAVEL		
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 30 | Angle (from Horizontal) 90 | Ground Elevation
Feature | Bearing | Rock Elevation
Coordinates. N | Date Started 4/7/83 | Total Depth 5 C
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									
2			1				BROWN SILTY SAND TR OF FINE GRAVEL		
3									
4			2				BROWN SILTY SAND TR OF FINE GRAVEL		mc 23.5%
5									
6									

Boring No. Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 31
Feature AIRSTRIP @ 24+00
Coordinates. N
E
Logged by REH/DHR

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

Ground Elevation
Rock Elevation
Total Depth 30
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 @ 30		

Boring No. ____ Sheet ____ of ____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS-32
Feature AIRSTRIP @ 23+00
Coordinates: N
E
Logged by LEH / DMR

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

Ground Elevation
Rock Elevation
Total Depth 2.0
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				PEAT DARK BROWN BROWN ORGANIC SAND REFUSAL ON AUGER 2.0		1ST ATTEMPT REFUSAL @ 0.5' 2ND ATTEMPT REFUSAL @ 1.0 3RD ATTEMPT REFUSAL @ 2.0 ORGANIC CONTENT 6.4%
2									
3									
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 ADIT 0 @ 2210
Coordinates: N
E
Logged by DEH/DNR

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

Ground Elevation
Rock Elevation
Total Depth 50
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) TR OF FINE GRAVEL (FROZEN)		MC 17.3%
2									
3									
4			2				SAME WITH A LITTLE MORE SILT		MC 12.3%
5									
6									

Boring No. Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 34 | Angle (from Horizontal) 90° | Ground Elevation
Feature AIRSTRIP & RIHOD | 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			1				PEAT BROWN GRAVELLY SANDY SILT WITH PEAT (FROZEN) REFUSAL ON AUGER @ 2.0		1ST ATTEMPT REFUSAL @ 1.6' 2ND ATTEMPT REFUSAL @ 1.5' 3RD ATTEMPT REFUSAL @ 1.0 MC. 86.3% O.C. 10.1% NOTE MANY BOULDERS AT OR NEAR SURFACE
2									
3									

Boring 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 AIRSTRIP @ 20+00 | 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		MOISTURE CONTENT 10.6%
2									
3									BAG SAMPLE FOR PROCTOR TEST 3.0-6.0
4									131 PCF 8% OMC
5									
6									
7									

Boring No. ____ Sheet ____ of ____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/7/83

Boring No AS 36
Feature AIRSTRIP @ 18+00
Coordinates: N
E
Logged by REH / DHR

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				LIGHT BROWN GRAVELLY SILTY SAND (F-C)		
2									
3			2				SAME		
4									
5							REFUSAL ON AUGER @ 5.0		
6									

Boring No Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 37
Feature AIRSTRIP ℄ 77+00
Coordinates: N
E
Logged by REA/ DNR

Angle (from Horizontal) 90
Bearing
Date Started 4/6/83
Date Completed 4/8/83

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									1ST 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% FIN-
5									
6			3				GRAY GRAVELLY SILTY SAND (FC		
7									
8									
9									
10									

Boring No. Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/21/83

Boring No AS 38
Feature ADIT RIP & 16+00
Coordinates N
E
Logged by REH/DMR

Angle from Horizontal 90
Bearing
Date Started 4/6/83
Date Completed 4/8/83

Ground Elevation
Rock Elevation
Total Depth 13.4'
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 MANY BOULDERS OR LARGE GRAVEL AT SURFACE		1ST, 2ND & 3RD ATTEMPTS REFUSAL AT 0.5' 4TH & 5TH ATTEMPTS REFUSAL @ 0.25'
2			1				OLIVE GRAY GRAVELLY SILTY SAND (F-C)		
3			2				GRAY GRAVELLY (FINE) SILTY SAND (F-C)		41.3% FINES
4									
5									

Boring No Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 39 | Angle (from Horizontal) 90° | Ground Elevation
Feature AIRSTRIP & BORROW | Bearing | Rock Elevation
Coordinates N | Date Started 4/8/83 | Total Depth 0.5
E | Date Completed 4/8/83 | Ground Water Elevation
Logged by DEH/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 AND BOULDERS HOLE CALLED ON ACCOUNT OF MANY BOULDERS AT OR NEAR SURFACE		FIRST ATTEMPT REFUSAL @ 0.25 2ND 3RD 4TH 5TH 6TH & 7TH ATTEMPTS REFUSAL @ 0.5
TD									
3									

Boring No Sheet of

HARZA-EBASCO
SUSQUEHANNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No. AS 40 | Angle (from Horizontal) 90 | Ground Elevation
Feature AIRSTRIP & 14+00 | Bearing | Rock Elevation
Coordinates N | Date Started 4/6/83 | Total Depth 5.0
E | Date Completed 4/8/83 | Ground-Water Elevation
Logged by KEH/DHR

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 MANY BOULDERS ON SURFACE		1ST 2ND 3RD ATTEMPTS REFUSAL @ 0.5
2			1				OLIVE GRAY GRAVELLY SILTY SAND (F-C)		
3									
4			2				OLIVE GRAY GRAVELLY SILTY SAND (F-C) MORE SAND & GRAVEL		
5							REFUSAL ON AUGER 5.0		
6									

Boring No. Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 41 | Angle (from Horizontal) 90 | Ground Elevation
Feature AIRSTRIP @ 12100 | Bearing | Rock Elevation
Coordinates: N | Date Started 4/6/83 | Total Depth 4.0
E | Date Completed 4/8/83 | Ground-Water Elevation
Logged by REH / DHR

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 BROWNISH GRAY GRAVELLY SILTY SAND		
2									HARD DRILLING
3			2D				GRAY GRAVELLY SILTY SAND occ. COBBLES		
4							REFUSAL WITH AUGER @ 4.0 LOSS DRILL BIT DOWN HOLE		
5									
6									

Boring No Sheet of

HARZA-EBASCO
JUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 42 | Angle (from Horizontal) 90 | Ground Elevation
Feature AIRSTRIP & ROAD | Bearing | Rock Elevation
Coordinates: N | Date Started 4/6/83 | Total Depth 50
E | Date Completed 4/9/83 | Ground-Water Elevation
Logged by REH / OHR

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				DARK BROWN GRAVELLY SILTY SAND TR OF ORGANIC		SS
3							GRAY GRAVELLY SILTY SAND (F-C)		Gs = 2.67
4			2						MC 9.9%
5									
6									

Boring No Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 43
Feature AIRSTRIP @ 8+00
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
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				PEAT (FROZEN) DARK BROWN		1ST ATTEMPT REFUSAL @ 0.75'
									2ND ATTEMPT
							BROWN GRAVELLY SILTY SAND (F-C)		REFUSAL @ .75'
2									MC - 19.8%
							REFUSAL ON AUGER @ 2.0		
3							AREA HAS MANY BOULDERS BELOW SURFACE		
4									

Boring No Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 44
Feature AIRSTRIP & CAMP
Coordinates: N
E
Logged by REH / DMR

Angle (from Horizontal) 90
Bearing
Date Started 4/07/83
Date Completed 4/8/83

Ground Elevation
Rock Elevation
Total Depth 4'0"
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
							FLAT		
1			1				BROWN SILTY SAND (F-C) & IMP		MC 26 4% 4/64" RINGS
2									
3			2				BROWN GRAVELLY SILTY SAND (F-C) (IMP)		MC 14.3
4							REFUSAL ON AUGER @ 4'0"		
5									
6									

Boring No Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 45
Feature AIRSTRIP & ATDO
Coordinates N
E
Logged by REH / DNR

Angle (from Horizontal) 90
Bearing
Date Started 4/6/83
Date Completed 4/8/83

Ground Elevation
Rock Elevation
Total Depth 50
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				GRAYISH BROWN SILTY SAND (F-C) TR OF GRAVEL		MC 21%
3									
4			2				GRAY SILTY SAND (F-C) TR OF GRAVEL		MC 11%
5									
6							LOSS DRILL 3' IN HOLE		

Boring No Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No. AS 46
Feature AIRSTRIP & OTOU
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 2.25
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				REDDISH BROWN SILTY SAND (F-C) TR OF FINE GRAVEL DRY		SAMPLE
2							REFUSAL ON AUGER @ 2.25'		
3									

Boring No. Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS-47
Feature AIRSTRIP & ACCESS
Coordinates: N
E
Logged by REH/JMR

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

Ground Elevation
Rock Elevation
Total Depth 25
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									1ST ATTEMPT REFUSAL @ 3.0
2			1				GRAY SILTY SAND (F-C) TR OF FINE GRAVEL		BAG SAMPLE FOR PROCTOR 0.5 - 3.5
3									MC 15.8
4									
5									

Boring No Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 48
Feature AIRSTRIP 100' SOUTH
Coordinates N [illegible] 2742
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 3.5
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 ORGANIC SAND		
2							GRAY SILTY SAND TR OF GRAVEL		1" ø SAMPLE FR PRUCIK 0.5 - 3.5
3							REFUSAL ON AUGER @ 3.5'		
4									
5									

Boring No Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 49
Feature AIRSTRIP & 48TH
Coordinates N
E
Logged by DEH/DMR

Angle (from Horizontal) 90
Bearing
Date Started 4/5/83
Date Completed 4/8/83

Ground Elevation
Rock Elevation
Total Depth 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									
3			1				GRAY SILTY SAND TR OF FINE GRAVEL		MC 37%
4									
5									
6			2				GRAY SILTY FINE SAND TR OF COARSE SAND		G_s - 2.72 MC 13.4% HYDROM. ANA 9% CLAY PI = 4.75 LL = 20.1 PL = 15.35
7									
8									
9									
10									

Boring No. Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/2/83

Boring No AS50
Feature AIRSTRIP & ROAD
Coordinates N
E
Logged by CEH / DMR

Angle (from Horizontal) 90
Bearing
Date Started 1/9/83
Date Complete 1/9/83

Ground Elevation
Rock Elevation
Total Depth 2.5
Ground Wate. 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		1ST ATTEMPT REFUSAL @ 1.0
2			1				BROWN SANDY SILT (FROZEN		
3							REFUSAL ON AUGER 2.5		
4									

Boring No Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 51
Feature AIRSTRIP @ 52+00
Coordinates N
E
Logged by REH / DNR

Angle (from Horizontal) 90
Bearing
Date Started 4/6/83
Date Completed 4/8/83

Ground Elevation
Rock Elevation
Total Depth 50
Ground Water Elevation

Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per .5 ft	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
1							PEAT		HARD DRILLING @ 10
2			1				GRAY GRAVELLY SILTY SAND		
3									
4			2				GRAY SILTY FINE SAND TR OF COARSE SAND & FINE GRAVEL		
5									
1									

Boring No Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 52
Feature AIRSTRIP @ 54+00
Coordinates: N
E
Logged by EEH / DNR

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

Ground Elevation
Rock Elevation
Total Depth 5.5
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				OLIVE GRAY SILTY FINE SAND MINOR TR OF COARSE SAND & FINE GRAVEL		46% FINES
3									BAG SAMPLE FOR PROCTOR 2.5-50
4							SAME		NOTE ON 2ND & 3RD ATTEMPTS
5									REFUSAL @ 1.0 MANY BOULDERS AT OR NEAR SURFACE
6							REFUSAL ON AUGER @ 5.5		
7									

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 53
Feature Abstr. @ 56+00
Coordinates: N
E
Logged by PEH/DHR

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

Ground Elevation
Rock Elevation
Total Depth 1.5
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		1ST ATTEMPT REFUSAL AT SURFACE
2									2ND ATTEMPT REFUSAL @ 1.0
3									3RD ATTEMPT REFUSAL @ 1.5

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/9/83

Boring No AS 54 | Angle (from Horizontal) 90 | Ground Elevation
Feature AIRSTRIP @ 2+00 | 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 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		1ST ATTEMPT REFUSAL @ .5'
2			1				GRAY SILTY SAND (F-C) TR OF GRAVEL		MC 13% BAG SAMPLE FOR PROCTOR 2.0-8.0 HARD DRILLING @ 2, 3.5, 7 & 9.0
3									
4									
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									

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No AS 55
Feature Access @ 12100
Coordinates: N
E
Logged by REN/OMR

Angle (from Horizontal) 90
Bearing
Date Started 4/9/83
Date Completed 4/9/83

Ground Elevation
Rock Elevation
Total Depth 7.0
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							PEAT		1ST ATTEMPT REFUSAL @ 1.0
2							LIGHT GRAY GRAVELLY (FINE) SILTY SAND (FG)		BAG SAMPLE FOR PROCTOR
3									131 PCF 9% OMC
4									HARD DRILLING 4.5, 5.0, 6.0 @ 7.0'
5							MORE GRAVEL		
6									
7									REFUSAL ON AUGER AT 7.0
8									

Boring No. ____ Sheet ____ of ____

MAN CAMP BORING

LOGS

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No MC 1
Feature NEW MAN CAMP
Coordinates. N
E
Logged by REA / DNR

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

Ground Elevation
Rock Elevation
Total Depth 35
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				ORGANIC SILT BROWN FROZEN		MC WH 80 HP 50 50 50
2							BROWN SANDY ORGANIC MAT (FROZEN)		1ST ATTEMPT REFUSAL @ 2.5 ON AUGER
3			2				GRAY SILTY SAND (F-C) (FROZEN) MC 22.7		
			3				SILTY FINE-MED SAND MC 20.8		
4							REFUSAL @ 3.5		
							MOST MANY BOULDERS AT OR NEAR SURFACE		

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No MC E
Feature NEW MAH 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 25
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		FUEL STORAGE
2			1				FROZEN SILTY FINE SAND		HP 90 30 20 HP
3							FROZEN SANDY SAND (F-M)		

Boring No. ____ Sheet ____ of ____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/6/83

Boring No MC 3
Feature NEW MAH CAMP
Coordinates: N
E
Logged by REH / DHP

Angle (from Horizontal) 90
Bearing
Date Started 4/2/83
Date Completed 4/9/83

Ground Elevation
Rock Elevation
Total Depth 3.5
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							DARK BROWN PEAT (FROZEN)		Ex MC x TOWER 50'
2									1ST ATTEMPT REFUSAL ON BOULDER 10
3			1				SAND (F-m) (FROZEN)		
4							REFUSAL ON AUGER @ 3.5		
5									

Boring No. Sheet of

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No MC 1
Feature NEW CAMP CAMP
Coordinates: N
E
Logged by KEH / DNR

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

Ground Elevation
Rock Elevation
Total Depth 25
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		EL MC. x TOWER 150
2			1				GRAY SILTY SAND TR GRAVEL		
3									
4									

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No MC 5
Feature NEW MAH CAMP
Coordinates: N
E
Logged by REH / DHR

Angle (from Horizontal) 90
Bearing
Date Started 4/8/83
Date Completed 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		Ex MC.
2			1				GRAY SILTY SAND (F-C) (FROZEN)		250
			2				GRAY SILTY SAND (F-C) TR OF GRAVEL (FROZEN)		
3							AUGER REFUSAL @ 2.75		
4									

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No MC 6
Feature NEW MAN CAMP
Coordinates: N
E
Logged by REH / DMR

Angle (from Horizonta 90
Bearing
Date Started 4/8/83
Date Completed 4/8/83

Ground Elevation
Rock Elevation
Total Depth 50
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 BROWN		EX MC X TOWER MIDDLE 250 X
2							BROWN SANDY PEAT		
3									HARD DRILLING 2'6" - 3'0
4			2				GRAY SILTY SAND (F-C)		
5							TR OF GRAVEL		FIRST ATTEMPT REFUSAL @ 1.0
6									

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No MC 7 | Angle (from Horizontal) 90 | Ground Elevation
Feature NEW MAIN CAMP | Bearing | Rock Elevation
Coordinates: N | Date Started 4/8/83 | Total Depth 2.5
E | Date Completed 4/8/83 | Ground-Water Elevation
Logged by RSH/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		Ex MC x TOWER 250
2			1				DARK GRAY SILTY SAND (F.C.)		36% FINES
3									
4									

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No MC 8 | Angle (from Horizontal) 90 | Ground Elevation
Feature NEW MAM CAMP | Bearing | Rock Elevation
Coordinates: N | Date Started 4/8/83 | Total Depth 20
E | Date Completed 4/8/83 | Ground-Water Elevation
Logged by REA/DHR

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		Ex MC
2			1				GRAY SILTY SAND		x TOWER 150
3									
4									

Boring No. _____ Sheet _____ of _____

HARZA-EBASCO
SUSITNA JOINT VENTURE

SOIL BORING LOG

Sheet 1 of 1
Date 4/8/83

Boring No MC 9 | Angle (from Horizontal) 90 | Ground Elevation
Feature NEW MAH CAMP | Bearing | Rock Elevation
Coordinates: N | Date Started 4/8/83 | Total Depth 2.0
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			2				PEAT		Ex MC x TOWER 50
2							BROWNISH GRAY GRAVELLY SILTY SAND (F-C)		27.9% FINES 1ST ATTEMPT REFUSAL @ 1.5'
3									

Boring No. ____ Sheet ____ of ____

APPENDIX C

LABORATORY TEST REPORTS

WORK SHEET - PARTICLE SIZE ANALYSIS

Date 4/7/83 | ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER | Job No. 15032.002.08

Project WATANA DAM | Hole AS 1 | Depth 3-4 #3

Dry WT Total Sample & Tare: 1492

Tare Weight: 1K 431.0

Total Sample WT: 1061.0

Moisture Content -10 Material

Can No.

WT-Soil & Can (Wet)

WT-Soil & Can (Dry)

Loss

Weight of Can

WT of Soil (Dry)

% Moisture

TOTAL SAMPLE

Classification: Dark grayish Brown gravelly Silty sand (SM)

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4				0	100
3/4"	19.1	0			3.2	96.8
½"	12.7	34.0			9.4	90.6
#4	4.6	100.0				
#10	2.0					
Pan						
Total						

9.4 % gvl.

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar # | WT Washed Sample & Tare 1114.0 | Tare Weight 431.0 | Washed Sample Weight 683.0

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	168.0				15.8	84.2
20	0.850	253.0				23.8	76.2
30	0.600	299.0				28.2	71.8
40	0.425	341.0				32.1	67.2
100	0.150	564.0				53.2	46.8
200	0.075	672.0				63.3	36.7
270	0.053						
Pan		686.0					
Total							

53.9

36.7 % Fines

HYDROMETER SAMPLE

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

a = | Corrected Weight of Hydrometer Sample _____ grams | Deflocculation Agent

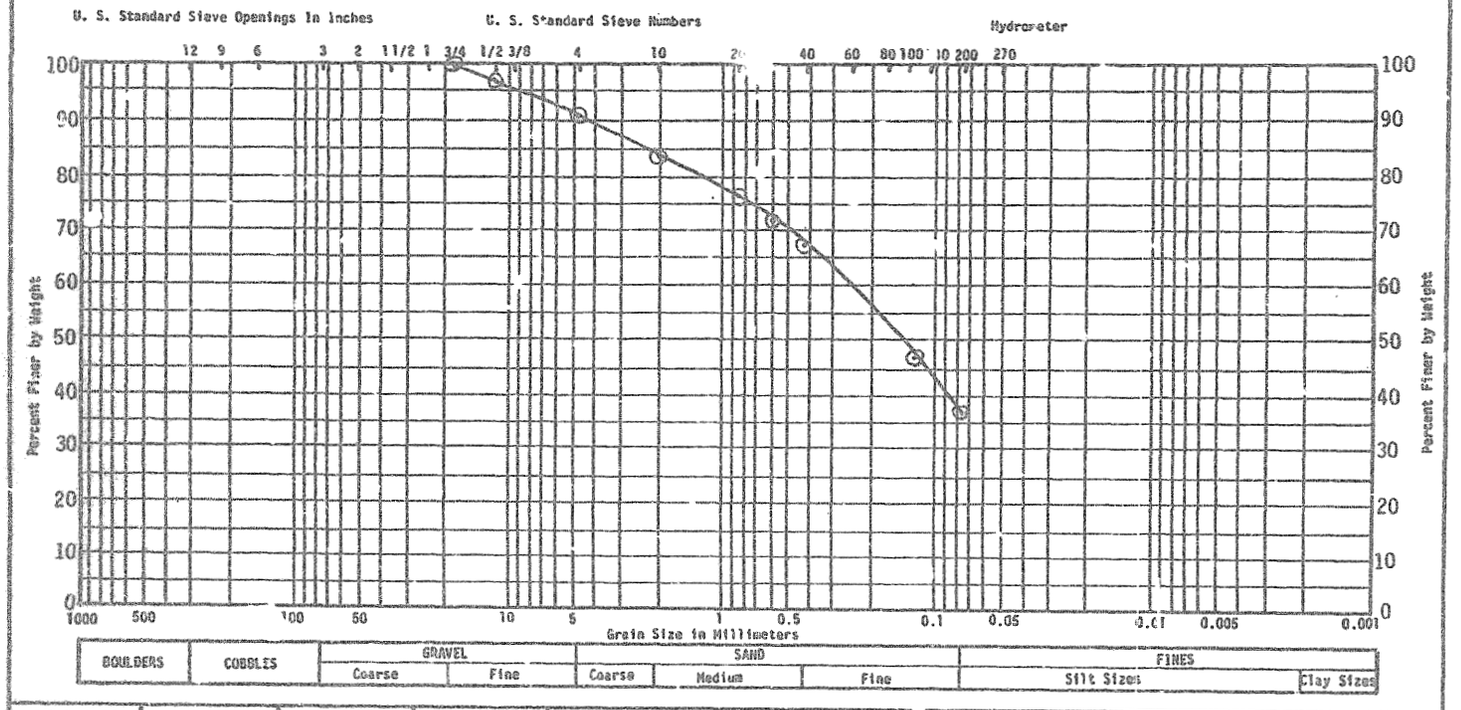
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	Reading R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002							Cc	
									Cu	

Tested by: CAm | Computed by: CAm | Checked by: MA

LT 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)
	AS 1	3	3-4	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-10-83

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
Project WAIANA DAM		Hole AS 3	Depth 25-3' #1

~~Air~~ Dry WT Total Sample & Tare	1213	TOTAL SAMPLE
Tare Weight 66	537	Classification Very Dark Greyish Brown gravelly silty sand (SM)
Total Sample WT	675.0	

Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	0			0	100
½"	12.7	16.0			2.4	97.6
#4	4.5	43.0			6.4	93.6
#10	2.0					
Pan						
Total						

6.4 % gvl.

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar # | WT Washed Sample & Tare 537.0 | Tare Weight 66.0 | Washed Sample Weight 471.0

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	11.0				12.5	86.5
20	0.850	175.5				25.9	74.1
30	0.600	219.5				32.4	67.6
40	0.425	260.0				38.5	61.5
100	0.150	404.0				59.8	40.2
200	0.075	478.0				70.7	29.3
270	0.053						
Pan		490.0					
Total							

64.3 % Sand

29.3 % fines

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

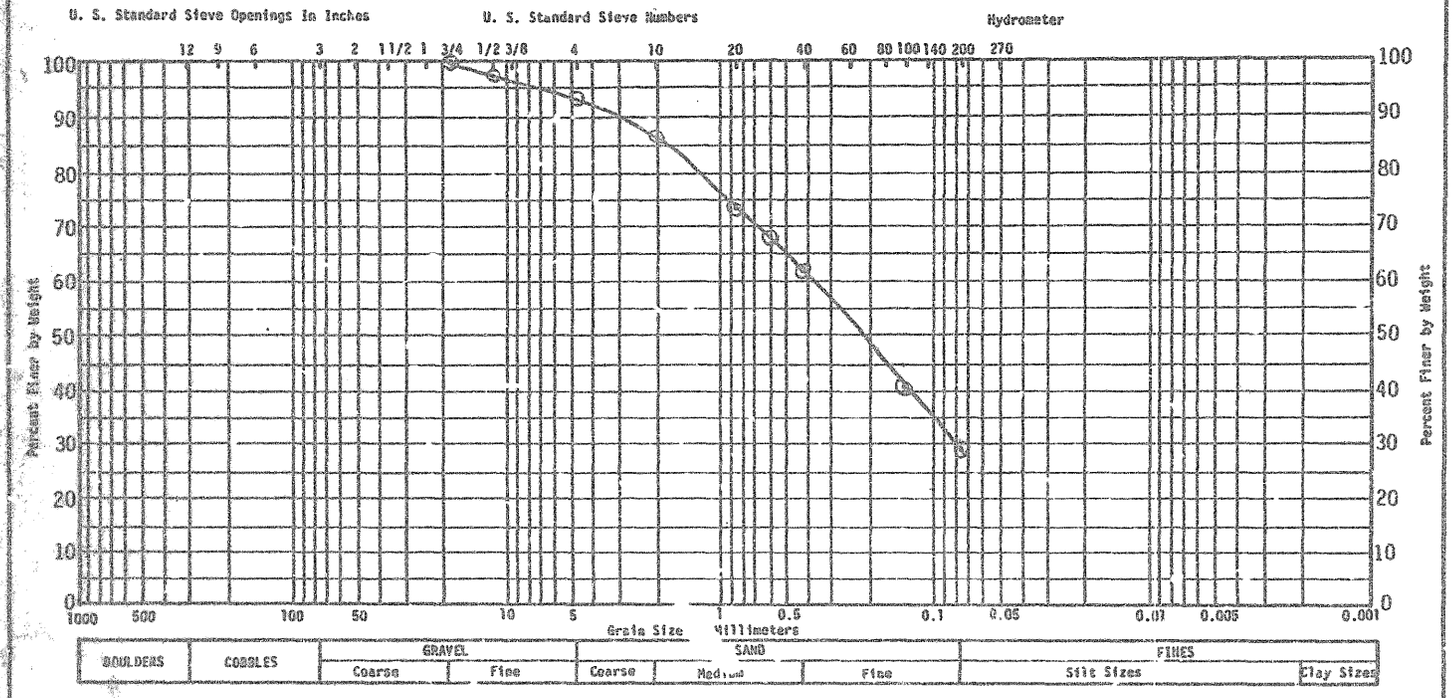
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: CRW | Computed by: [illegible] | Checked by: MA

LF 135-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 3	1	2'-3'	

VISUAL MANUAL CLASSIFICATION Sample was Saturated [illegible] organic matter

Job WATANA DAM

No. 15032.003.08

Date 4-10-83

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
Project WATANA DAM		Hole AC 3	Depth 8-9.5 #4

Air Dry WT Total Sample & Tare	1178.0	TOTAL SAMPLE
Tare Weight GL	427.0	Classification Dark greyish brown silty sand (SM)
Total Sample WT	751.0	

Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1					
½"	12.7	0			0	100
#4	4.6	23.0			3.1	96.9
#10	2.0					
Pan						
Total						

3.1 % gravel

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar #

WT Washed Sample & Tare	755.0
Tare Weight	427.0
Washed Sample Weight	328.0

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	62.0				7.4	61.0
20	0.850	127.0				15.1	53.1
30	0.600	162.0				21.0	47.4
40	0.425	207.0				26.4	43.1
100	0.150	307.0				46.7	31.1
200	0.075	402.0				61.7	16.3
270	0.053						
Pan		468.0					
Total							

53.1 % sand

16.3 % fines

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

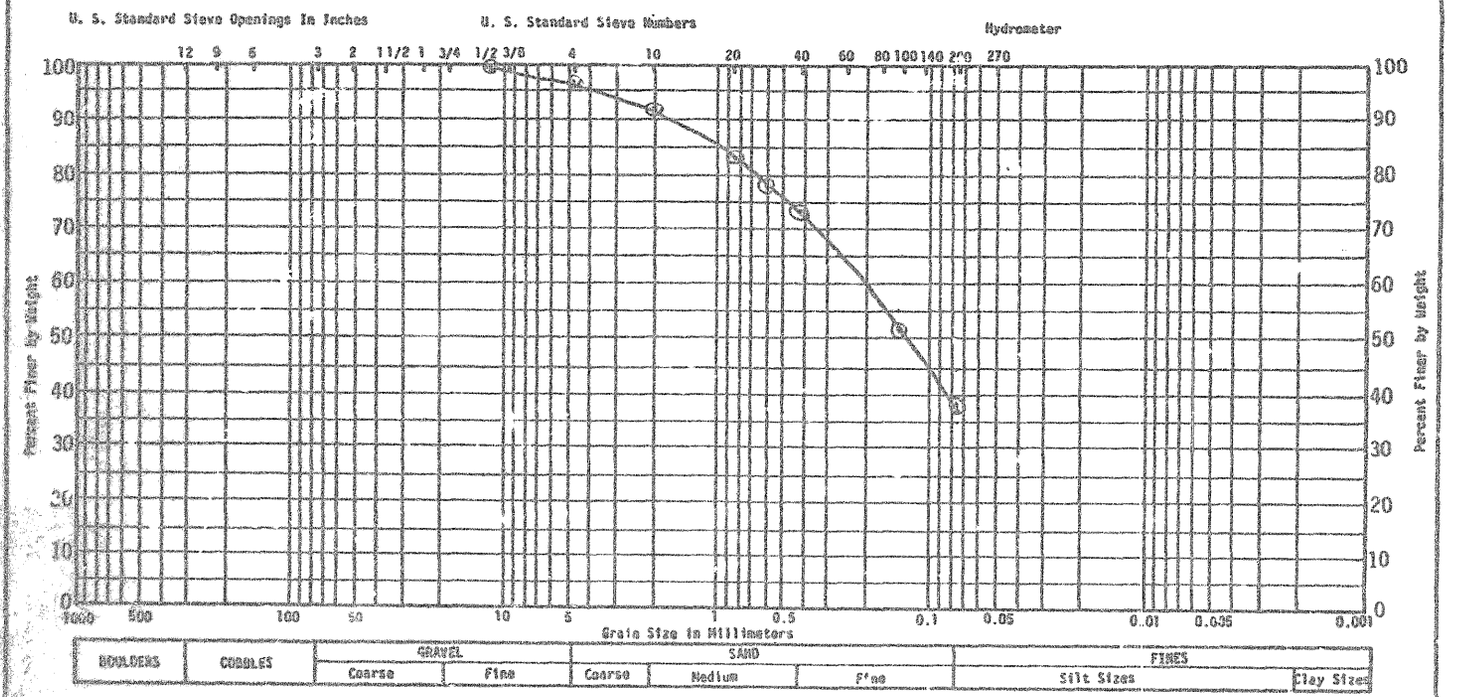
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: CRM | Computed by: RM | Checked by: MA

LF 135-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 3	4	8-9.5	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-10-84

LF MI-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

WORK SHEET - PARTICLE SIZE ANALYSIS

Date: 4/7/83 | ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER | Job No. 15032.003.08

Project: WATANA DAM | Hole: AS 5 | Depth: 8'-10' #3

Air Dry WT Total Sample & Tare	1334	TOTAL SAMPLE						
Tare Weight IP	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.	Cum. % of Total Passing
Moisture Content -10 Material		4"	101.6					
		3"	76.2					
Can No.		2"	50.8					
		1½"	38.1	-				
WT-Soil & Can (Wet)		1"	25.4					
WT-Soil & Can (Dry)		3/4"	19.1	0			0	100
		½"	12.7	340			27	97.3
Loss		#4	4.6	620			69	93.1
Weight of Can		#10	2.0					
WT of Soil (Dry)		Pan						
% Moisture		Total						

6.9 % #10

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.	Cum. % of Total Passing
10	2.000	117.0				12.9	87.1
20	0.850	195.2				21.5	78.5
30	0.600	237.0				26.2	73.8
40	0.425	283.0				31.2	68.8
100	0.150	4[illegible]				57.3	42.7
200	0.075	5[illegible]4.0				62.3	[illegible]
270	0.053						
Pan		567.0					
Total							

SS = 8% sand

37.7 % fines

HYDROMETER SAMPLE

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

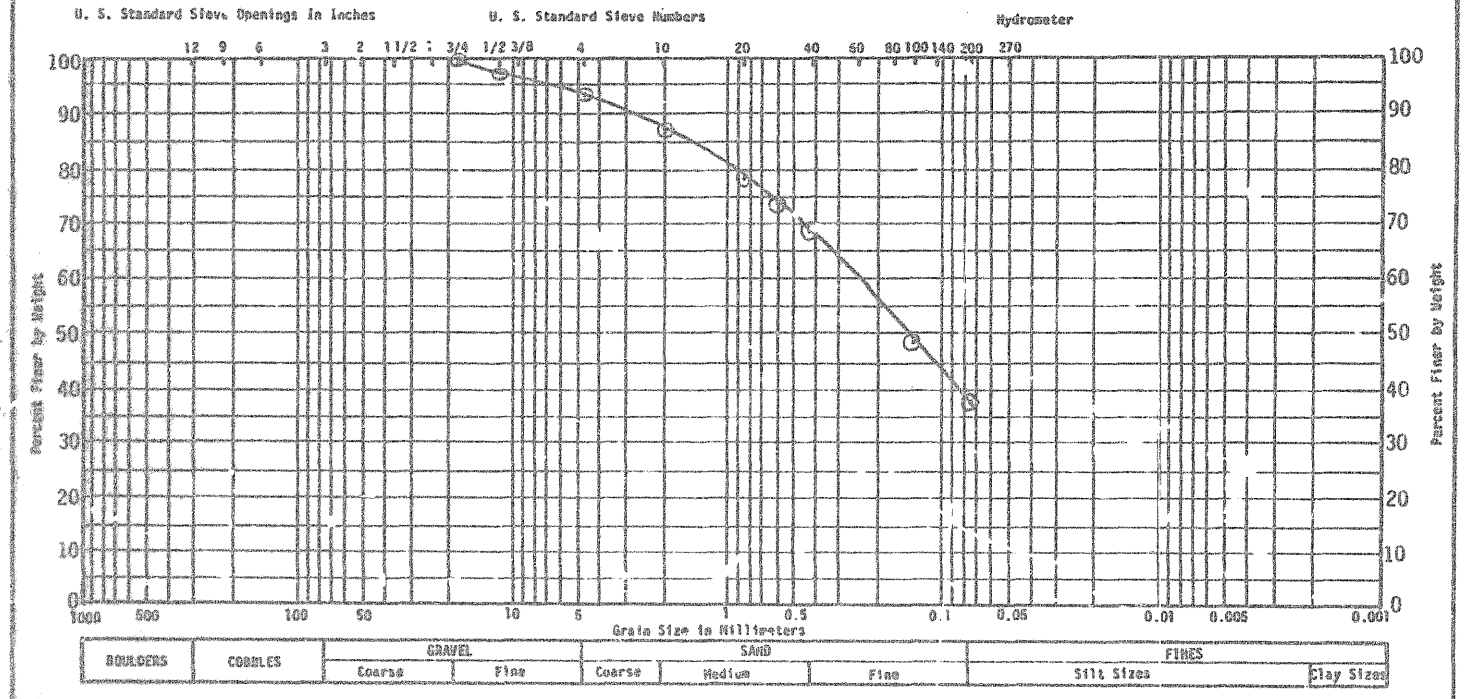
a = | Corrected Weight of Hydrometer Sample _____ grams | Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.079								
	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

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 5	3	8'-10'	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-10-83

LF 141-60A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole AS 7	Depth 1.5-3.5 #1

~~Dir~~ Dry WT Total Sample & Tare	1198.0
Tare Weight	434
Total Sample WT	764.0
Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

TOTAL SAMPLE

Classification: Dark Greyish Brown gravelly silty sand (SM)

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4	0			0	100
3/4"	19.1	21.0			2.7	97.3
½"	12.7	33.0			4.3	95.7
#4	4.6	72.3			9.4	90.6
#10	2.0					
Pan						
Total						

9.4 % Gvl.

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative _____ grams | Jar #

WT Washed Sample & Tare	527
Tare Weight	84.1
Washed Sample Weight	442.9

Sieve	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
	2.000	169.2				14.3	85.7
	0.850	164.0				21.5	78.5
30	0.600	194.0				27.4	74.6
40	0.425	227.1				29.7	70.3
100	0.150	357.2				39.1	57.3
200	0.075	440.5				57.6	42.4
270	0.053						
Pan		443.0					
Total							

45.2 % Sand

42.4 % Fines

HYDROMETER SAMPLE

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

a =	Corrected Weight of Hydrometer Sample _____ grams	Defloculation Agent

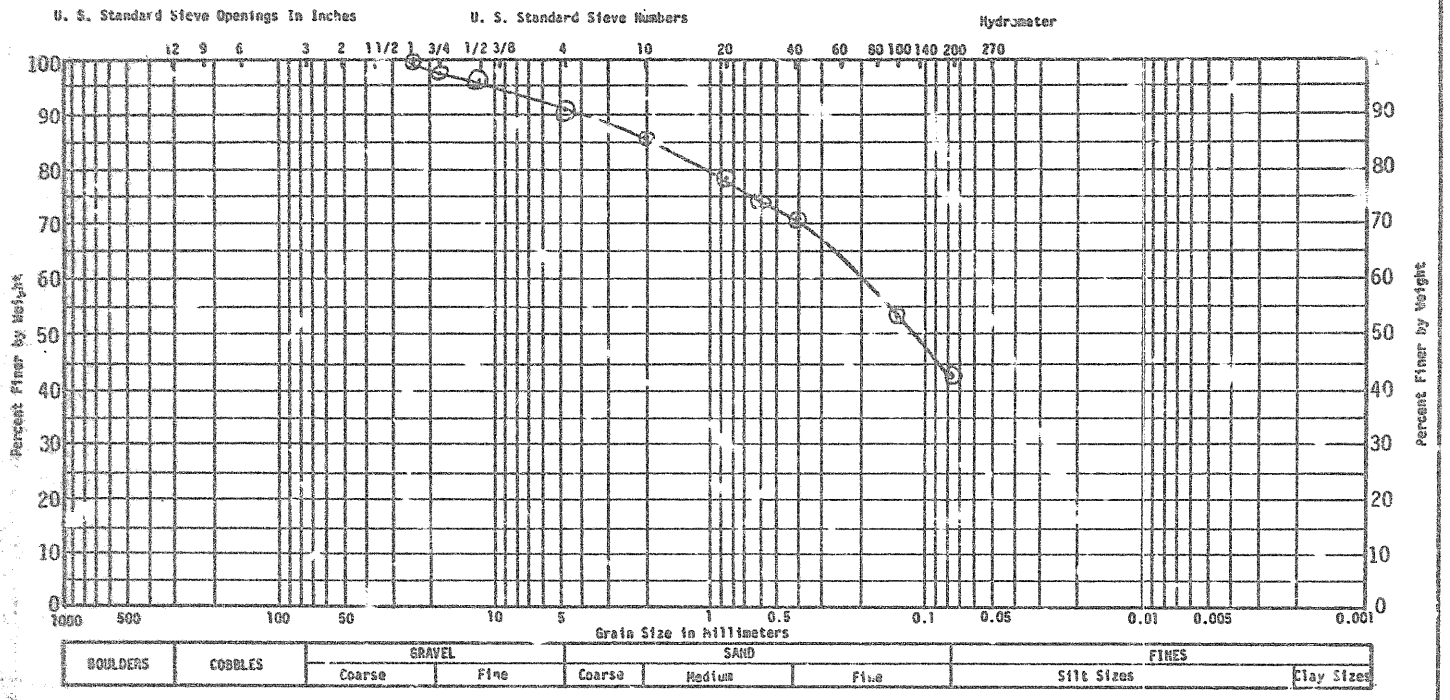
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	Reading R_c	I	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: CAM | Computed by: CAM | Checked by: MA

LF 125-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)
	AS-7	1	1.5-3.5	

VISUAL MANUAL CLASSIFICATION Gravel is Subangular and Cemented

Job WATANA DAM

No. 15032.003.08

Date 4-10-82

LF 741-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole AS 7	Depth 10' #2

~~Dry~~ WT Total Sample & Tare	370.06	TOTAL SAMPLE	THIS SAMPLE DOES NOT MEET ASTM RECOMMENDED MINIMUM WEIGHT.
Tare Weight	89.3	Classification	[illegible] gravelly silty sand (SM)

Total Sample WT	280.10
Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1	0			0	100
1"	25.4	25.[illegible]			8.9	91.1
3/4"	19.1	32.5			11.4	88.6
½"	12.7	37.3			13.1	86.9
#4	4.6	41.3			14.6	85.4
#10	2.0					
Pan						
Total						

14.6 % 85.4

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	359.5
		Tare Weight	189.0
		Washed Sample Weight	170.5

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	55.2				19.4	80.6
20	0.850	67.0				24.3	75.7
30	0.600	73.2				26.6	73.4
40	0.425	80.2				29.1	70.9
100	0.150	134.2				48.7	51.3
200	0.075	161.2				58.3	34.7
270	0.053						
Pan		170.5					
Total							

45.3 / Sand 39.4 % Fines

HYDROMETER SAMPLE

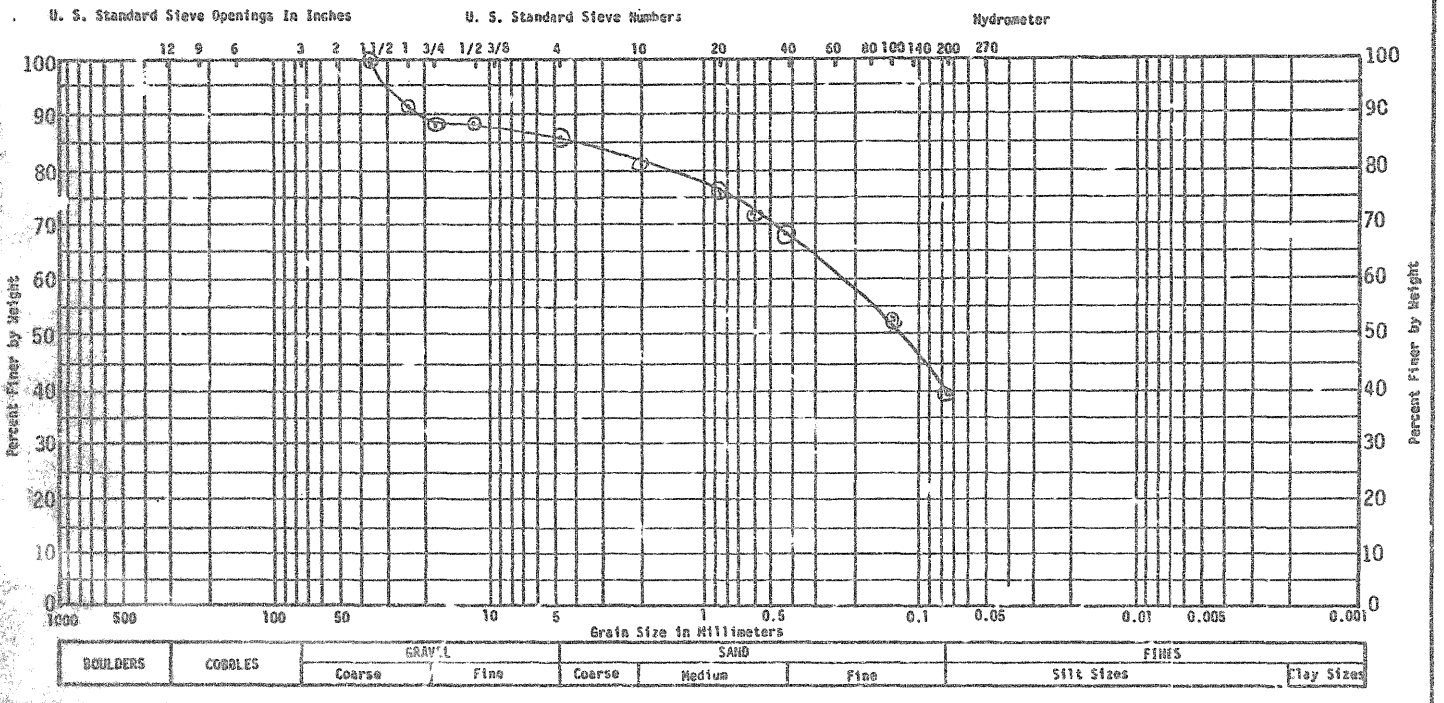
Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading 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								
									Cc	
Tested by: CS		Computed by: [illegible]m			Checked by: MF				Cu	

LF 135-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 7	2	10'	

VISUAL MANUAL CLASSIFICATION

Gravel is Subangular

Job WATANA DAM

No. 15032.001.08

Date 4-10-83

SF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
Project WATANA DAM		Hole AS 9	Depth 1.5-2.5 #1

~~Air~~ Dry WT Total Sample & Tare	1168	TOTAL SAMPLE
Tare Weight	540.	Classification: Olive Brown gravelly silty sand (SM)
Total Sample WT	628.0	
Moisture Content -10 Material		
Can No.		
WT-Soil & Can (Wet)		
WT-Soil & Can (Dry)		
Loss		
Weight of Can		
WT of Soil (Dry)		
% Moisture		

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Re..	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	0			0	
½"	12.7	36.0			4.1	95.2
#4	4.6	56.0			8.9	91.1
#10	2.0					
Pan						
Total						

8.9 % Gravel

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	[illegible]
		Tare Weight	[illegible]
		Washed Sample Weight	[illegible]

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	104.0				17.2	82.8
20	0.850	176.0				27.4	72.6
30	.600	207.0				33.0	67.0
40	.425	240.0				38.2	61.8
100	0.150	353.0				56.2	43.8
200	0.075	416.0				66.2	33.8
270	0.053						
Pan		418.0					
Total							

57.4 % Sand

33.8 % fines

HYDROMETER SAMPLE

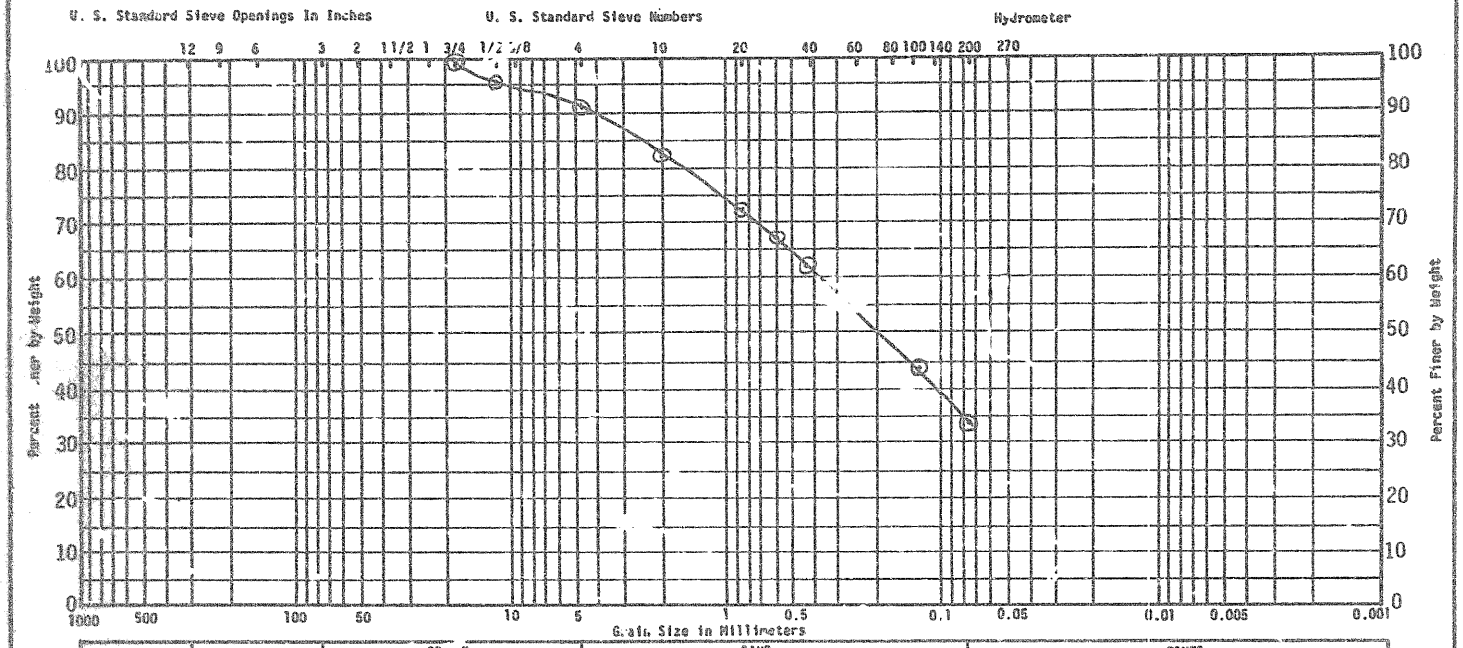
Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
Tested by: [illegible]		Computed by: MA			Checked by: MA				Cu	

F 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)
	AS 9	1	1.5-2.5	

VISUAL MANUAL CLASSIFICATION The Sample is Sandy Gravel [illegible]

Job WATANA DAM

No. 15032.003.08

Date 4-16-83

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐GILSON ☐BRASS SIEVE ☑HYDROMETER	Job No. 15032.003.08
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		

Moisture Content -10 Material	
Can No.	MA. 35
WT-Soil & Can (Wet)	323.9
WT-Soil & Can (Dry)	323.1
Loss	0.8
Weight of Can	89.3
WT of Soil (Dry)	233.80
% Moisture	0.34

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1					
½"	12.7					
#4	4.6					
#10	2.0					
Pan						
Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample 52.5 grams	Jar # 4	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.	Cum. % of Total Passing
10	2.000	0				0.0	100.0
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
270	0.053						
Pan		21					
Total							

57.6 % Sand

42.4 % fines

HYDROMETER SAMPLE

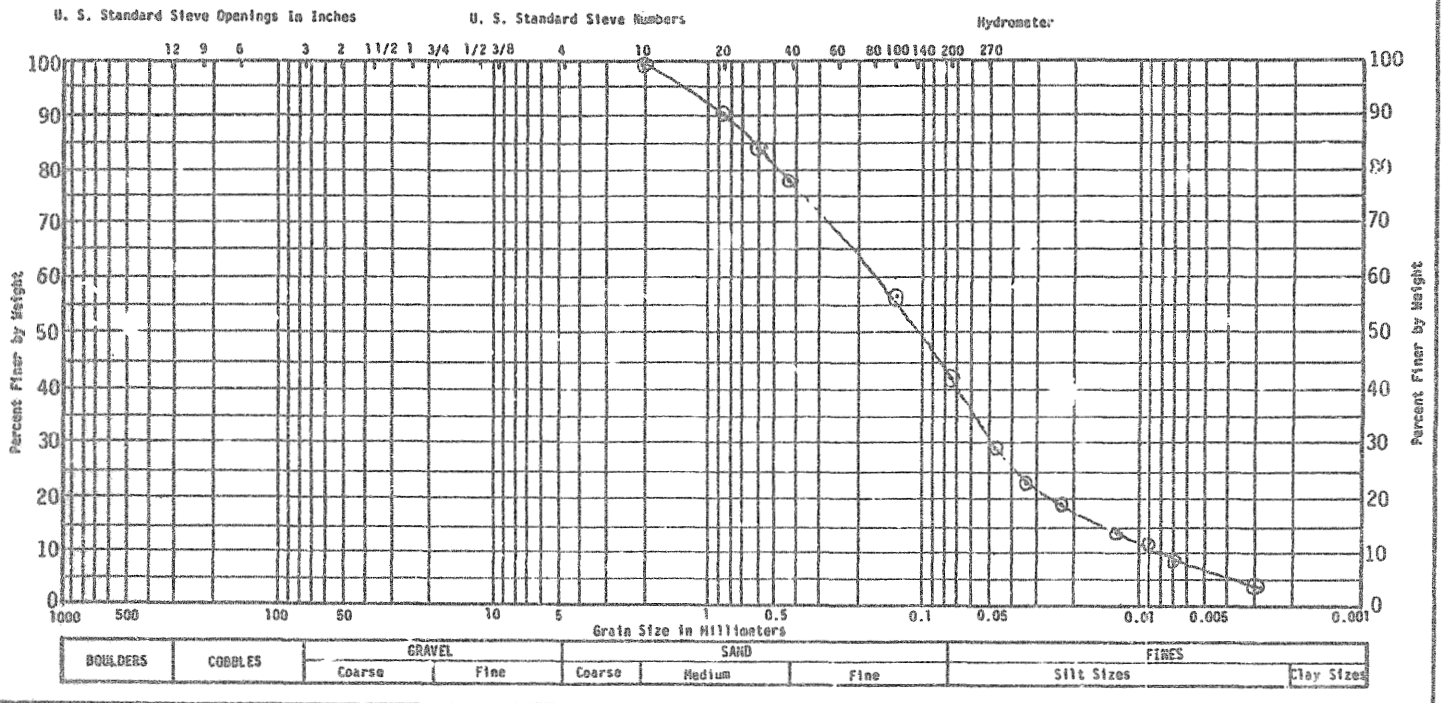
Specific Gravity (G) 2.75 (assumed)	LL — PI —	Hydrometer No. K	Amyl Alcohol Drops: 2
a = 0.98	Corrected Weight of Hydrometer Sample 50.33 grams		Deflocculation Agent Calgon

1325 Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
1327	1	0.078	20.0	0.0133	25.5	21.5	6.9	12.8	0.048	28.4
1327	2	0.055	20.0	"	22.5	18.5	"	13.2	0.034	23.6
1330	5	0.035	20.0	"	19.5	17.0	"	13.5	0.022	19.7
1340	15	0.020	20.0	"	14.3		"	14.0	0.013	14.4
1355	30	0.014	20.0	"	13.0		"	14.2	0.009	11.9
1425	60	0.010	20.0	"	12		"	14.5	0.007	8.4
1725	240	0.005	19.8	"	12		"	14.8	0.003	4.5
1325	1440	0.002	15.0	0.0140	9.5		8.0			
									Cc	
Tested by: DNR/G.B.		Computed by: MA			Checked by: WA				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)
	AS 10	1	3.5-4.5	

VISUAL MANUAL CLASSIFICATION A few small [illegible]

Job WATANA DAM

No. 15032.003.08

Date 4-12-83

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐GILSON ☑BRASS SIEVE ☐HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole AS 12	Depth .5-1.0 #1

~~Air~~ Dry WT Total Sample & Tare	276.93	TOTAL SAMPLE
Tare Weight MP-26	89.13	Classification: Black gravelly silty sand (sm)
Total Sample WT	189.80	

Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	0			4.2	95.8
½"	12.7	8.0			7.4	92.6
#4	4.6	14.0				
#10	2.0					
Pan						
Total						

7.4 % Avl.

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	232.1
		Tare Weight MP-26	94.13
		Washed Sample Weight	137.97

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	29.0				15.3	84.7
20	0.850	55.0				29.0	71.0
30	0.600	64.6				35.8	64.2
40	0.425	80.0				42.1	57.9
100	0.150	114.0				60.1	34.9
200	0.075	132.0				69.5	30.5
270	0.053						
Pan		135.0					
Total							

67.1 % Sand

30.5 % Fines

HYDROMETER SAMPLE

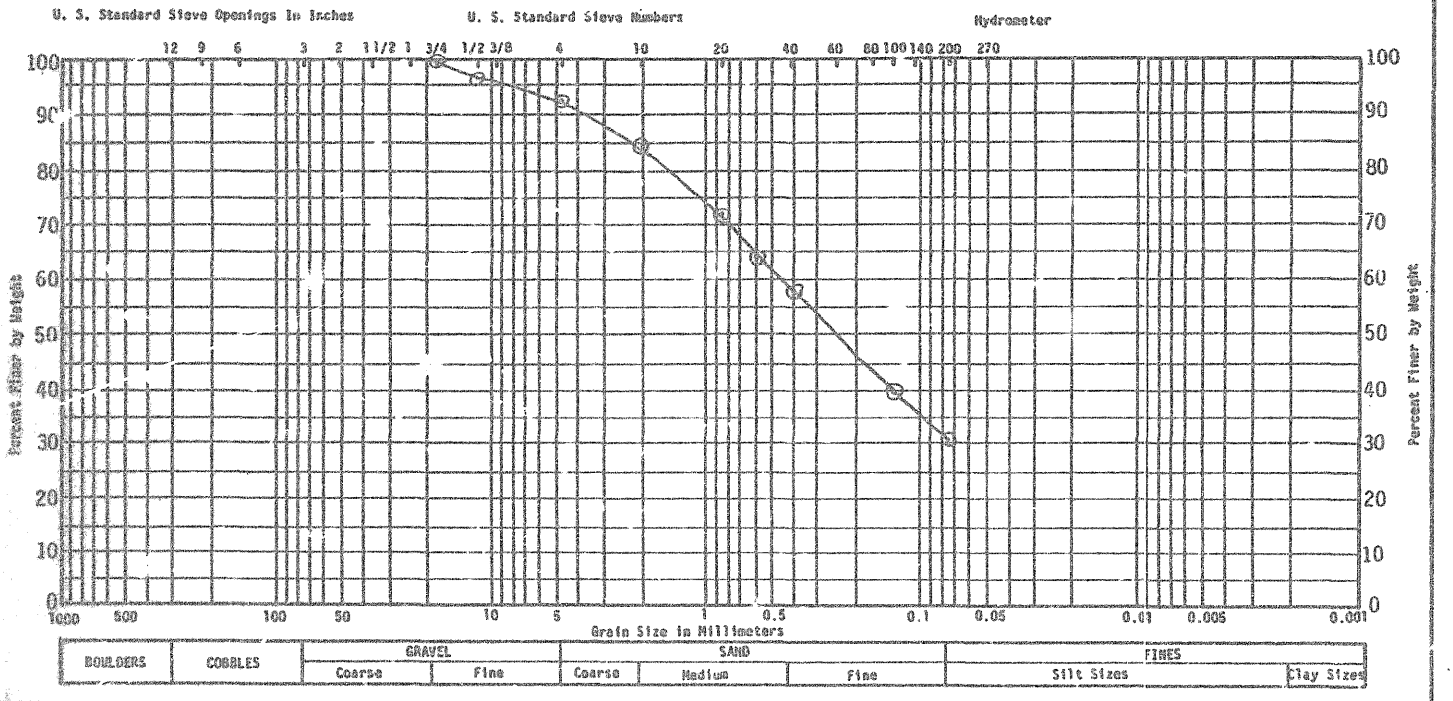
Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading 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: CAM		Computed by: RM			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)
	AS 12	1	.5-1.0	

VISUAL MANUAL CLASSIFICATION Large amount of [illegible]

Job WATANA DAM

No. 5032.003.08

Date 4-10-83

EF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐GILSON ☑BRASS SIEVE ☑HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole 95 13	Depth 7-10 #2

~~Air~~ Dry WT Total Sample & Tare	485	TOTAL SAMPLE
Tare Weight 12	54.6	Classification Very poor very gravelly silty sand (SM)
Total Sample WT	439	

Moisture Content -10 Material	
Can No.	MA-31
WT-Soil & Can (Wet)	527.4
WT-Soil & Can (Dry)	326.4
Loss	1.0
Weight of Can	91.4
WT of Soil (Dry)	235.0
% Moisture	0.4

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1					
½"	12.7	0			0	100.0
#4	4.6	35			8.0	92.0
#10	2.0	45			10.3	89.7
Pan						
Total						

8.0 % Sol.

REPRESENTATIVE MINUS NO. 10 SAMPLE

Representative Sample 76.4 grams | Jar # TB-2

WT Washed Sample & Tare	133
Tare Weight	88
Washed Sample Weight	45

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total 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				57.9	42.2 (37.8)
270	0.053						
Pan		45					
Total							

54% Sand

37.8 % Fines

HYDROMETER SAMPLE

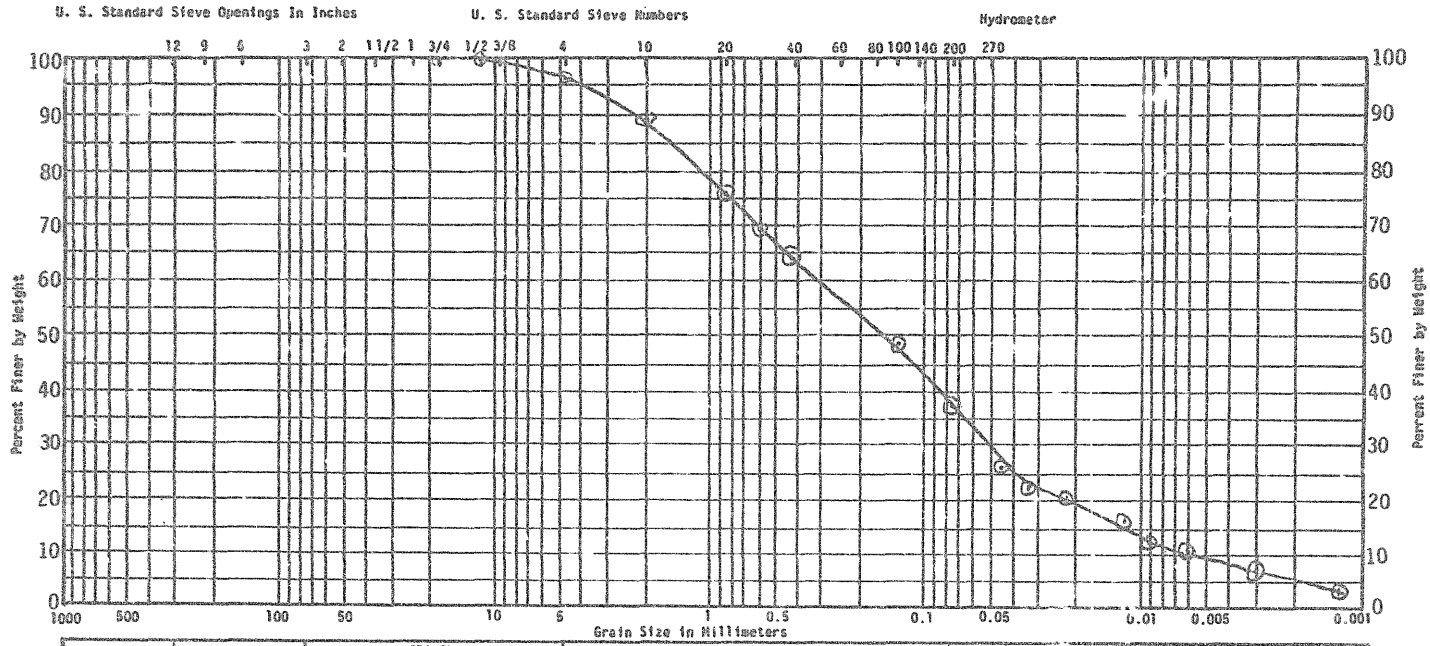
Specific Gravity (G) (assumed) 2.75	LL ____ PI ____	Hydrometer No. 5	Amyl Alcohol Drops: ____
a = 0.98	Corrected Weight of Hydrometer Sample 76.1 grams		Defloculation Agent

1400 Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	Rc	L	Corrected Grain Size, Dia. MM	% of Total Passing
1407	1	0.078	20	0.0133	35.0	30.5	6.0	11.5	0.045	26.1
1408	2	0.055	20	"	31.2	27.0	"	11.9	0.032	23.3
1410	5	0.035	20.0	"	27.1	23.5	"	12.3	0.021	20.3
1415	15	0.020	20.0	"	21.1		"	12.9	0.012	16.3
1430	30	0.014	20.0	"	18.0		"	13.3	0.009	12.9
1500	60	0.010	20.0	"	16.0		"	13.7	0.006	10.5
1600	240	0.005	20.0	"	13.0		"	14.2	0.003	7.1
1800	1440	0.002	15.0	.0140	11.0		5.0	14.5	0.0018	3.5
									Cc	
Tested by: [illegible]			Computed by: MA		Checked by: MK				Cu	

EF 135 - MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 13	2	7-10	

VISUAL MANUAL CLASSIFICATION Small amount of organic matter

Job WATANA DAM

No. 15032.003.08

Date 4-12-83

LF 141-GSA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
Project WATANA DAM		Hole AS 13	Depth 13-15 #3

Dry WT Total Sample & Tare	1025	TOTAL SAMPLE
Tare Weight IN	436	Classification Dark Grey gravelly silty sand (SM)
Total Sample WT	589.0	

Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4	0			0	100
3/4"	19.1	87			14.4	85.6
½"	12.7	121			20.5	79.5
#4	4.6	152			25.7	74.2
#10	2.0					
Pan						
Total						

25.8 % finer

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar #

WT Washed Sample & Tare 525.0
Tare Weight
Washed Sample Weight

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	19.4				3.7	96.3
20	0.850	21.0				5.1	94.9
30	0.600	25.2				8.1	91.9
40	0.425	32.1				14.0	86.0
100	0.150	37.0				22.1	77.9
200	0.075	41.0				29.1	70.9
270	0.053						
Pan		41.8					
Total							

45.0 % finer

29.2 % finer

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

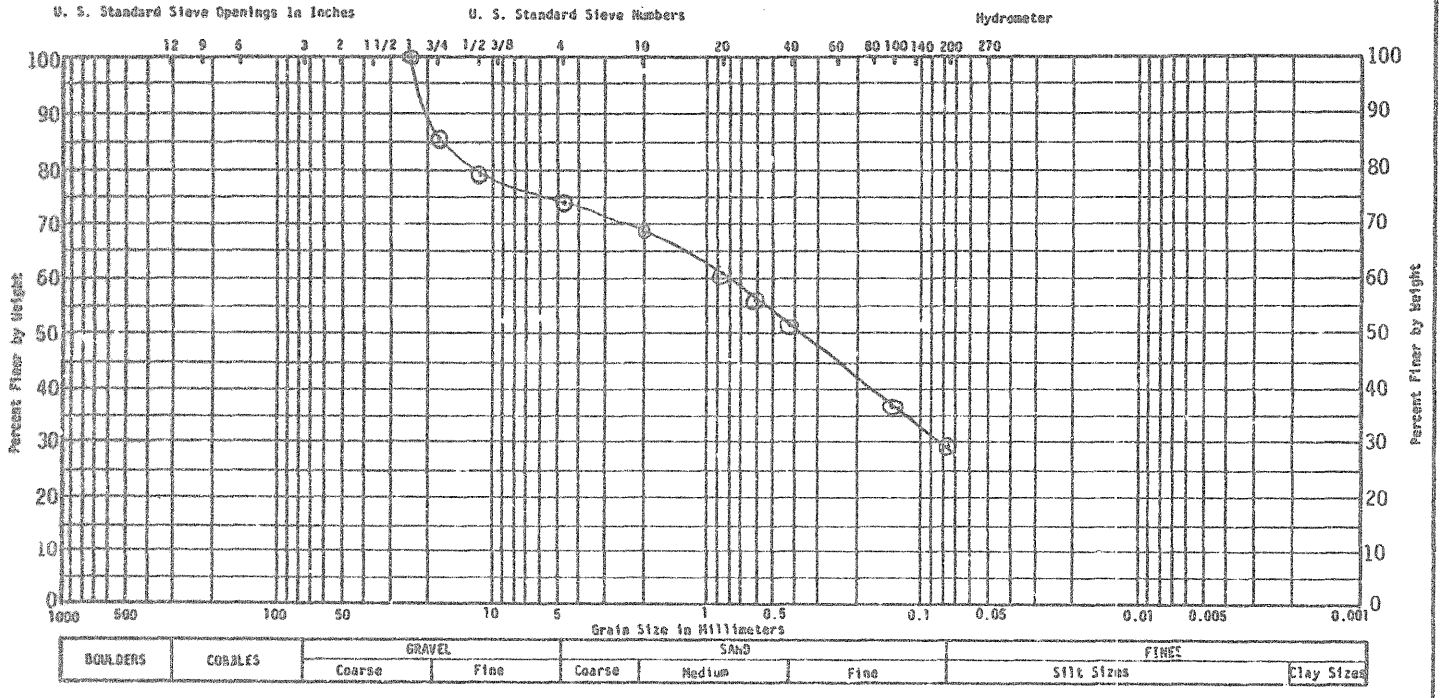
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: RM | Computed by: RM | Checked by: MA

LF 135-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 13	3	13'-15'	

VISUAL MANUAL CLASSIFICATION Sandy silt and clayey silt, trace fine Gravel, micaceous, wet, soft

Job WATANA DAM

No. 15032.003.08

Date 4-10-83

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole AS 13	Depth 15-17.5 #4

~~Air~~ Dry WT Total Sample & Tare	1774
Tare Weight 1B	543
Total Sample WT	1231
Moisture Content -10 Material	
Can No.	
WT-Soil & Can(Wet)	
WT-Soil & Can(Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

TOTAL SAMPLE

Classification: pale brown gravelly silty sand (SM)

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4	0			0	100
3/4"	19.1	55.0			4.5	95.5
½"	12.7	81.0			6.6	93.4
#4	4.6	211.0			17.1	82.9
#10	2.0					
Pan						
Total						

17.1 % Gvl.

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar #

WT Washed Sample & Tare 1200.0
Tare Weight 543.0
Washed Sample Weight 657.0

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	245.0				24.0	76.0
20	0.850	417.0				41.0	59.0
30	0.600	493.0				48.4	51.6
40	0.425	512.0				50.2	49.8
100	0.150	716.0				70.2	29.8
200	0.075	812.0				79.6	20.4
270	0.053						
Pan		817					
Total							

49.0 % Sand
33.9 % Fines

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Deflocculation Agent

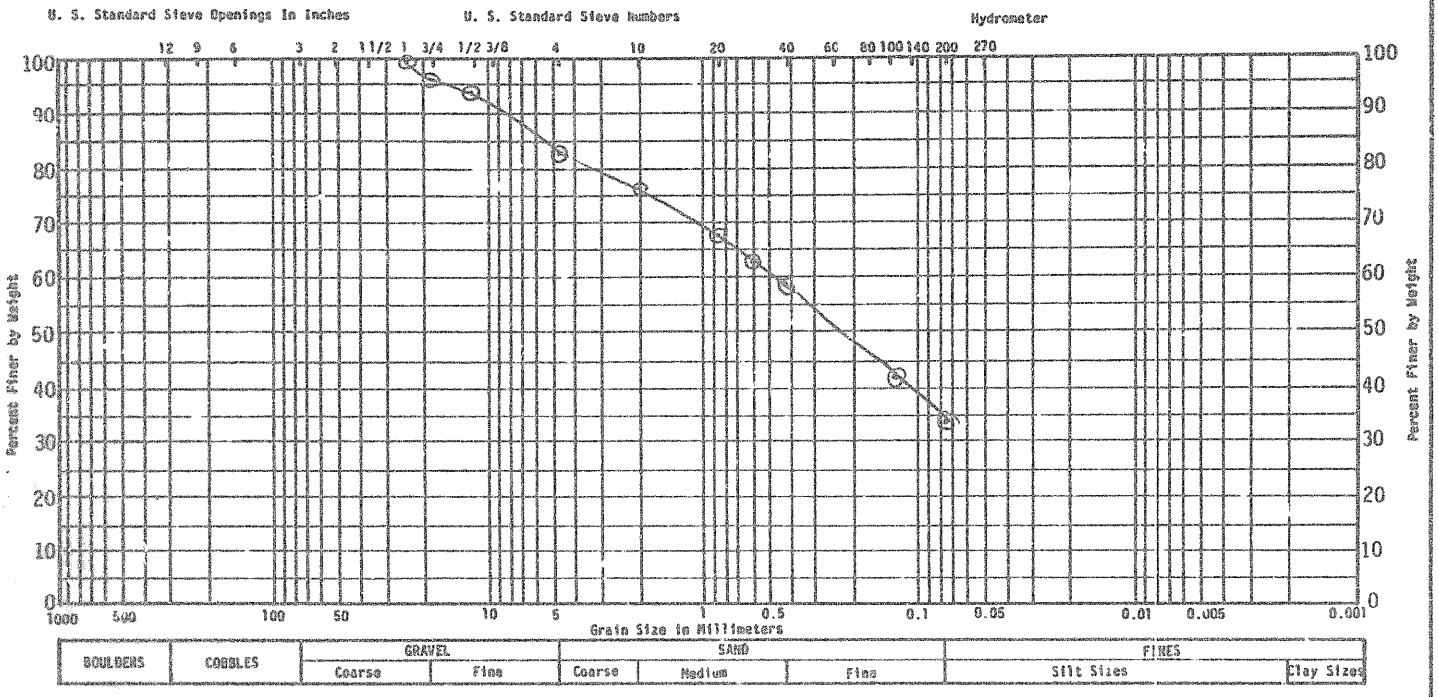
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: CAM | Computed by: CAM | Checked by: MA

LF 135 - MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS13	4	15-17.5	

VISUAL MANUAL CLASSIFICATION [illegible]

Job WATANA DAM

No. 15032.003.08

Date 4-10-83

LF 141-63A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date 4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☒ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
Project WATANA DAM	Hole AS 14	Depth 8-10 #2

Dry WT Total Sample & Tare	20%	TOTAL SAMPLE
Tare Weight DD	537	Classification dark grey gravelly silty sand (SM)
Total Sample WT	1254	
Moisture Content -10 Material		
Can No.		
WT-Soil & Can (Wet)		
WT-Soil & Can (Dry)		
Loss		
Weight of Can		
WT of Soil (Dry)		
% Moisture		

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4				5	100
3/4"	19.1				12	95
½"	12.7	34			32	73
#4	4.6				146	27.4
#10	2.0					
Pan						
Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	1427
		Tare Weight	
		Washed Sample Weight	

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000						
20	0.850						
30	0.600						
40	0.425						
100	0.150						
200	0.075						
270	0.053						
Pan							
Total							

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent:

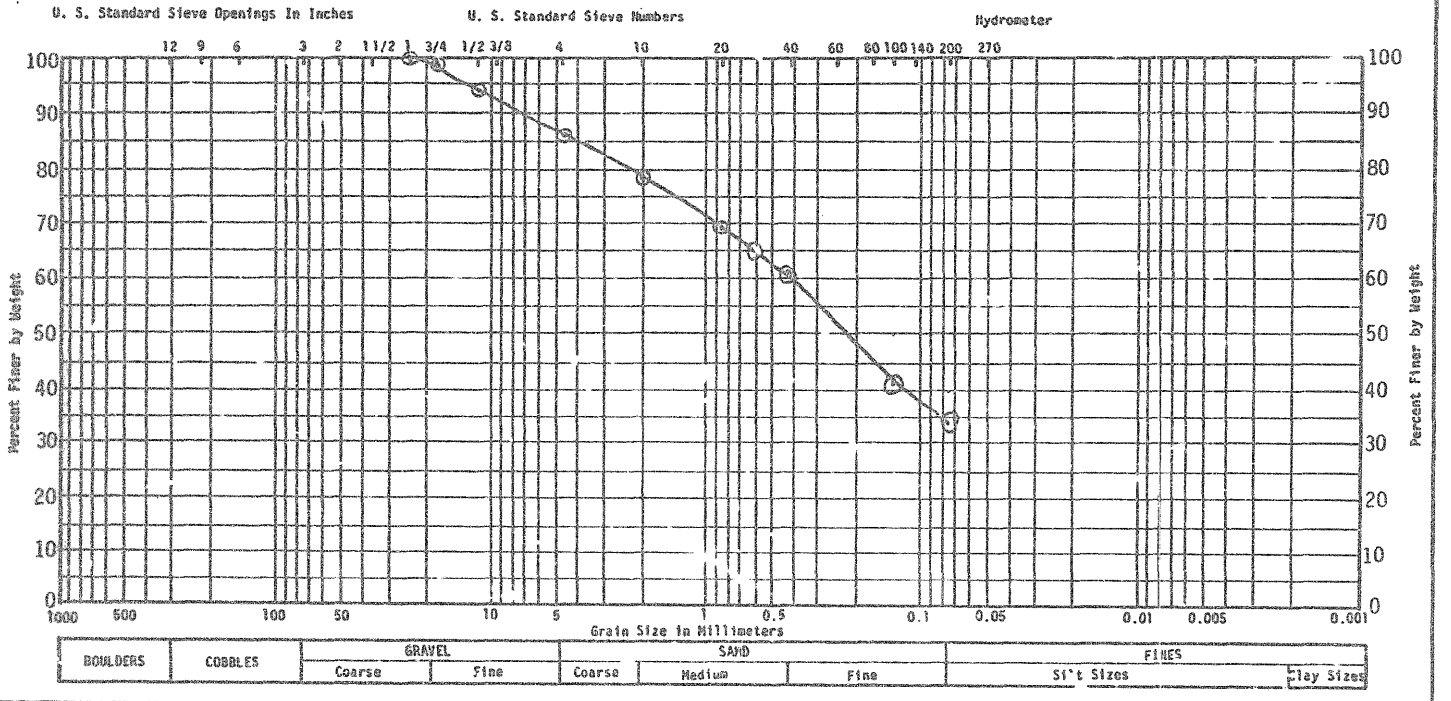
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	Reading Rc	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								

Tested by: _____ Computed by: _____ Checked by: _____ Cc _____ Cs _____

EF 35-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)
	AS-14	2	8-10'	

VISUAL MANUAL CLASSIFICATION: Contains some peat. Gravel sub-angular. Sample saturated

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

LF 141-GSA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date 4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
Project WATANA DAM	Hole AS 14	Depth 18.5-15 #4

Dry WT Total Sample & Tare	1220	TOTAL SAMPLE
Tare Weight SD-7	546	Classification dark grey gravelly silty sand (SM)
Total Sample WT	1264	
Moisture Content -10 Material		
Can No.		
WT-Soil & Can(Wet)		
WT-Soil & Can(Dry)		
Loss		
Weight of Can		
WT of Soil (Dry)		
% Moisture		

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4	0				100
3/4"	19.1	13			1.0	98.9
½"	12.7	51			4.0	95.2
#4	4.6	155			12.1	87.9
-10	2.0					
Pan						
Total						

12.1 % gr.

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample ____ grams	Jar #	WT Washed Sample & Tare	[illegible]
		Tare Weight	546
		Washed Sample Weight	[illegible]

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	[illegible]				[illegible]	[illegible]
20	0.850	[illegible]				[illegible]	[illegible]
30	0.600	449				[illegible]	[illegible]
40	0.425	504				[illegible]	[illegible]
100	0.150	732				[illegible]	[illegible]
200	0.075	342				[illegible]	[illegible]
270	0.053						
Pan		347					
Total							

HYDROMETER SAMPLE

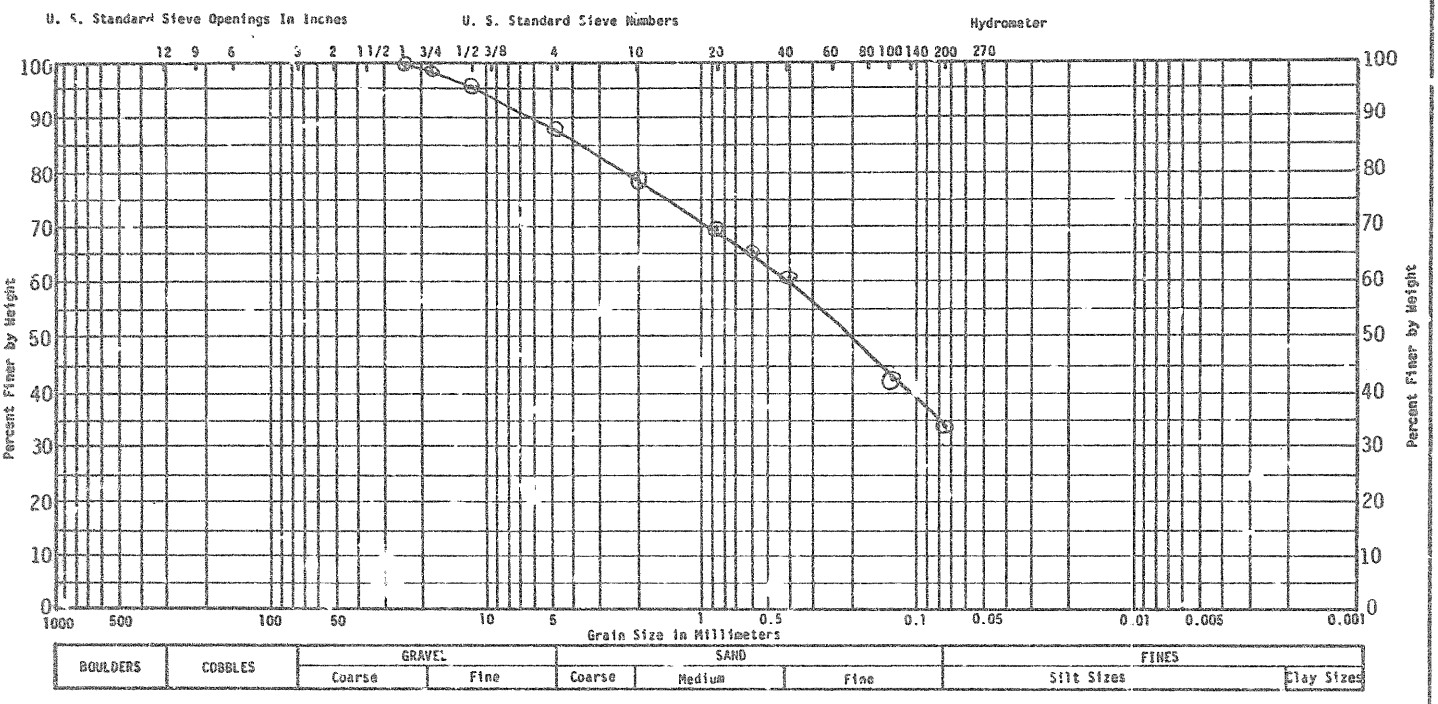
Specific Gravity (G)	LL ____ PI ____	Hydrometer No.	Amyl Alconol Drops: ____
a =	Corrected Weight of Hydrometer Sample ____ grams		Defloculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading 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								
									Cc	
Tested by: [illegible]		Computed by: [illegible]		Cj		by: MA			Cu	

-F 135 - MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS-14	4	12^5-15	

VISUAL MANUAL CLASSIFICATION Gravel & broken rock + sub-angular, sample saturated

Job WATANA DAM

No. 15032.003.08

Date 4-10-83

F 141-63A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS, GEOPHYSICISTS

Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
Project WATANA DAM		Hole AS-16	Depth 5-7' #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 s,Hy gravelly Sand (SM)
Total Sample WT	525.6	
Moisture Content -10 Material		
Can No.		
WT-Soil& Can(Wet)		
WT-Soil& Can(Dry)		
Loss		
Weight of Can		
WT of Soil (Dry)		
% Moisture		

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8	0			0.0	100.0
1½"	38.1	133			25.3	74.7
1"	25.4	"			"	"
3/4"	19.1	"			"	"
½"	12.7	147			28.0	72.0
#4	4.6	179			34.1	65.9
#10	2.0					
Pan						
Total						

34.1 % 5.01

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.	Cum. % of Total Passing
10	2.000	210				40.0	60.0
20	0.850	249				47.4	52.6
30	0.600	267				50.9	49.2
40	0.425	285				54.2	45.8
100	0.150	345				65.7	34.4
200	0.075	382				72.7	27.3
270	0.053						
Pan		383					
Total							

38.0 % 27.3 % Fines

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

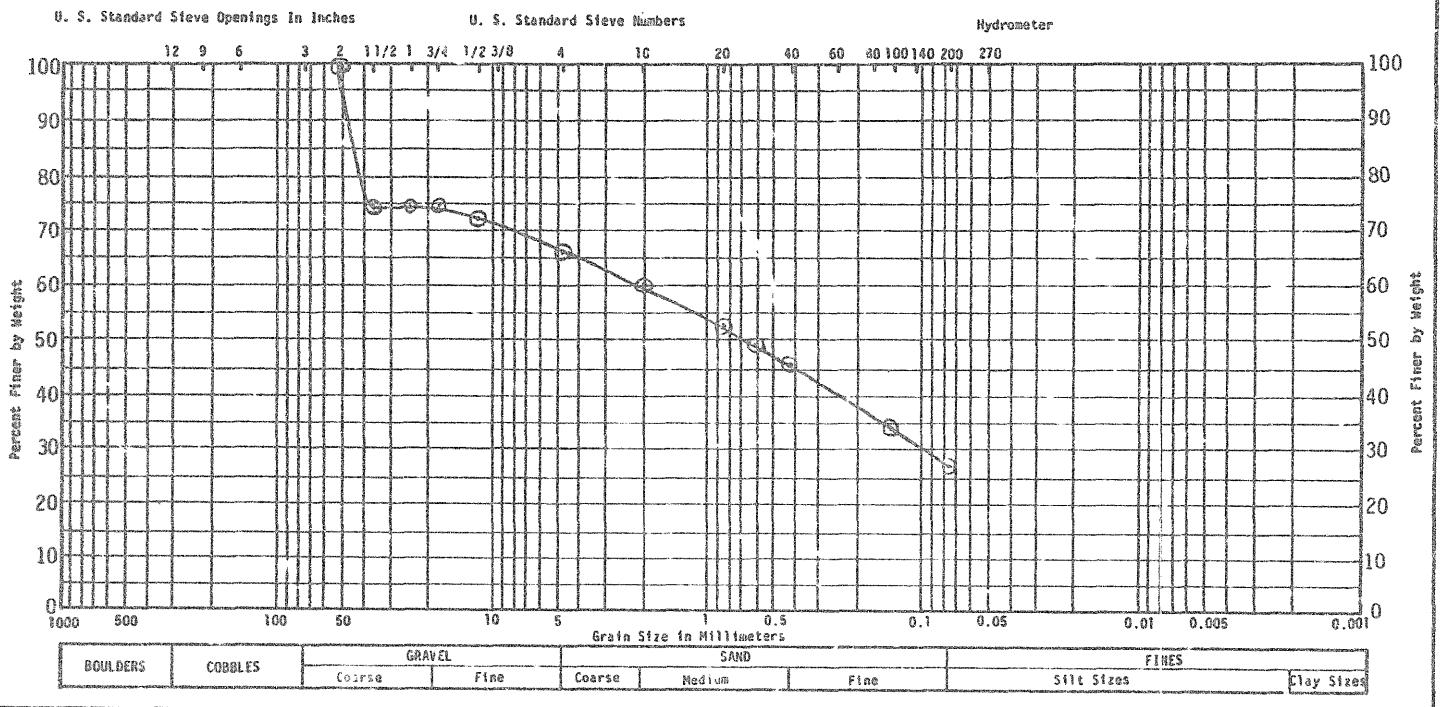
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002							Cc	
									Cu	

Tested by: G.B. Computed by: MA Checked by: [illegible]

LF 135 - MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS-16	1	5-7.5	

VISUAL MANUAL CLASSIFICATION Sample contains peat + organic matter. Gravel subrounded + subangular and cobbles.

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

EF 141-GSA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

(PI)

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☐ BRASS SIEVE ☒ HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole AS-17	Depth 5-75 #1

Dry WT Total Sample & Tare		TOTAL SAMPLE
Tare Weight MA 16		Classification dark gray silty sand (SM)
Total Sample WT		

Moisture Content -10 Material	
Can No.	J
WT-Soil & Can (Wet)	37.10
WT-Soil & Can (Dry)	36.95
Loss	.15
Weight of Can	10.78
WT of Soil (Dry)	26.17
% Moisture	.6

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1					
½"	12.7					
#4	4.6					
#10	2.0					
Pan						
Total						

0% Gravel

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample 69.35 grams	Jar # L	WT Washed Sample & Tare	26
		Tare Weight	4.33
		Washed Sample Weight	21.67

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	8				10.0	100.0
20	0.850	9				10.2	89.8
30	0.600	11				15.0	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							

52.2% Sand

47.8% fines

HYDROMETER SAMPLE

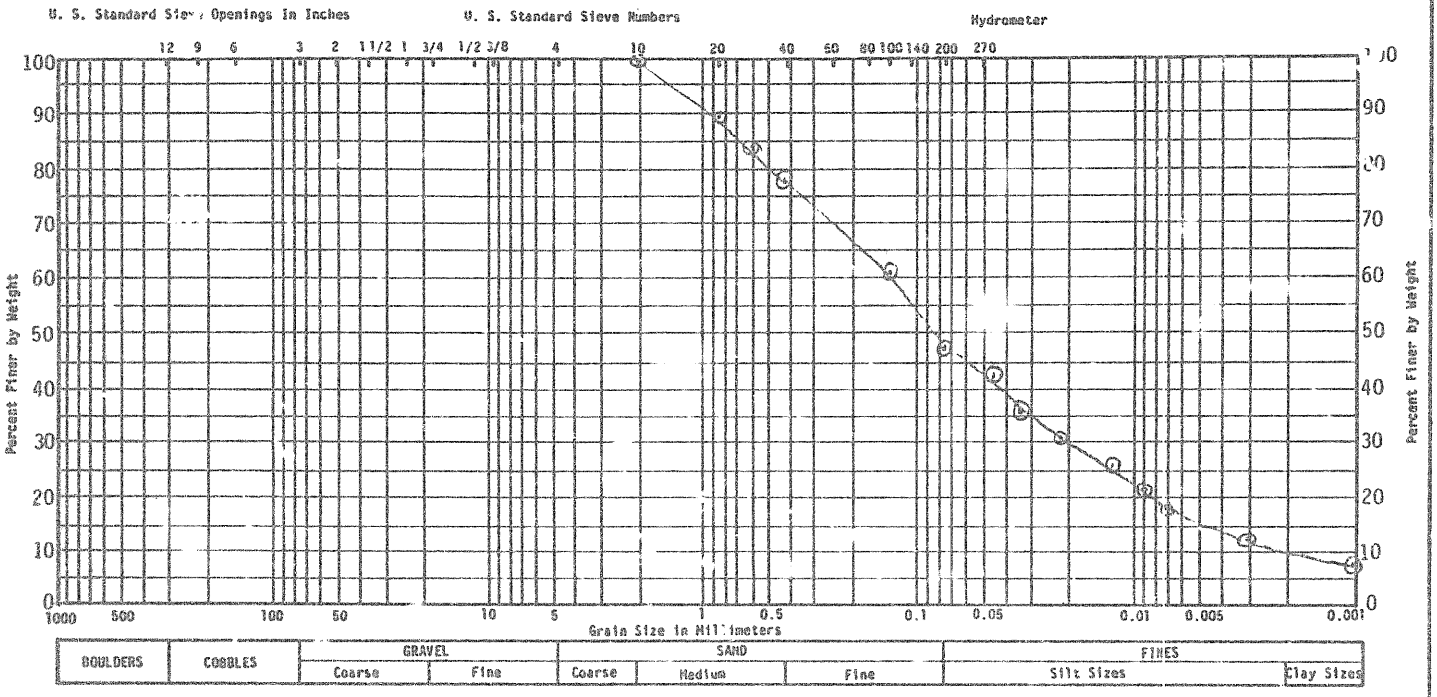
Specific Gravity (G) 2.75 (assumed)	LL 18 NL PI 16	Hydrometer No.	Amyl Alcohol Drops:
a = 0.98	Corrected Weight of Hydrometer Sample 68.9 grams		Defloculation Agent

1030 Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
31	1	0.078	15.6	0.0140	27.5		5.0	10.1	0.045	47.9
32	2	0.055	15.0	"	26.5		"	10.9	0.033	35.6
35	5	0.035	15.2	"	25.5		"	11.5	0.021	30.2
45	15	0.020	15.2	"	24.0		"	12.0	0.013	25.9
100	30	0.014	15.0	"	23.0		"	12.5	0.009	21.3
1130	60	0.010	15.0	"	22.0		"	12.9	0.007	18.2
1430	240	0.005	15.0	"	20.0		"	13.5	0.003	12.8
1530	1440	0.002		0.0130	17.5		7.1	14.3	0.001	7.7
									Cc	
Tested by: MK/G.B.		Computed by: MK		Checked by: MA					Cu	

F-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)
	AS-17	1	5-7.5	

VISUAL MANUAL CLASSIFICATION Contains organics.

Job WATANA DAM

No. 15032.003.08

Date 4-12-83

LF INT-GSA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

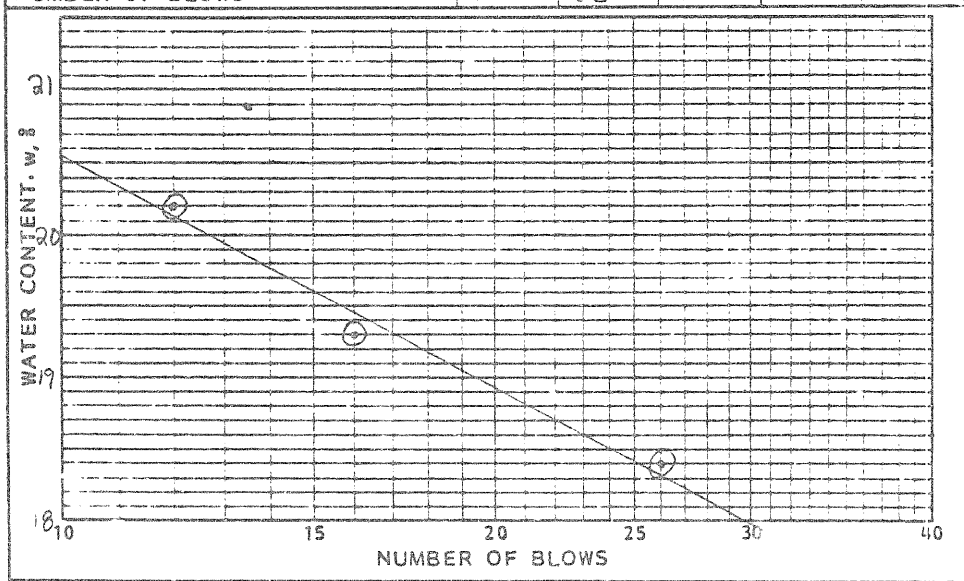
ATTERBERG LIMITS DETERMINATION

PROJECT: Watana Dam | DATE:

HOLE NO. AS 17 | SAMPLE NO. #1 (5-7.5) | 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 W_w	7.91	5.86	5.99			
	TARE	10.84	11.35	11.30			
	DRY SOIL W_s	39.25	30.33	32.47			
WATER CONTENT, %	w	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, w_p		AVG. 16.15					

REMARKS: -40 PORTION OF SAMPLE IS A ML

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

LP 131-PI

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

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.

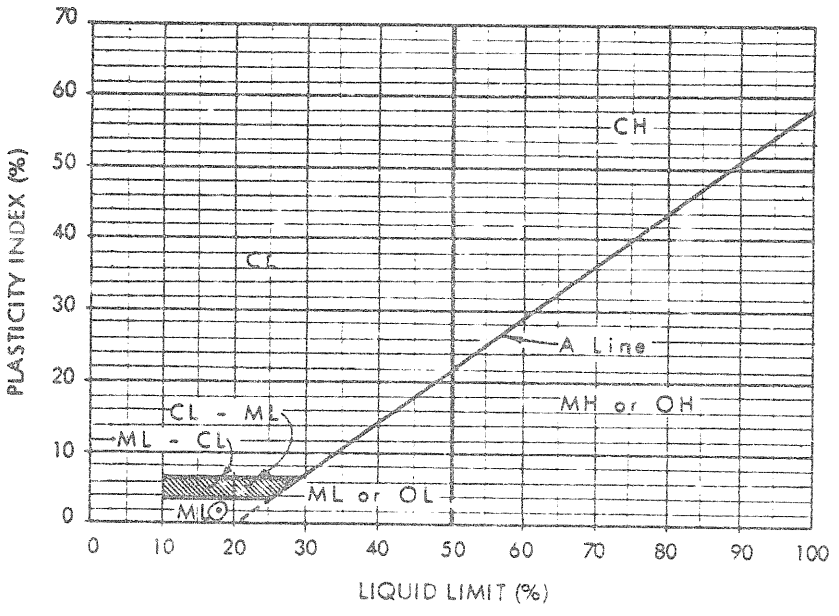
Toughness (Consistency near plastic limit)

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.



(Gs) (PI)

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS STEVE ☑ HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole AS-17	Depth 75.10' #2

Dry WT Total Sample & Tare	1224	TOTAL SAMPLE
Tare Weight	428	Classification dark grey silty clayey SAND (SM-SC)
Total Sample WT	500	

Moisture Content -10 Material

Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1					
½"	12.7	0			0	100
#4	4.6	21			3.1	96.9
#10	2.0					
Pan						
Total						

3.9 % 3/4

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.	Cum. % of Total Passing
10	2.000	74					
20	0.850						
30	0.600						
40	0.425						
100	0.150						
200	0.075	492					
270	0.053						
Pan		475					
Total							

520 g 96.5 3.5 %

HYDROMETER SAMPLE

Specific Gravity (G)	LL 21 PI 4	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Deflocculation Agent

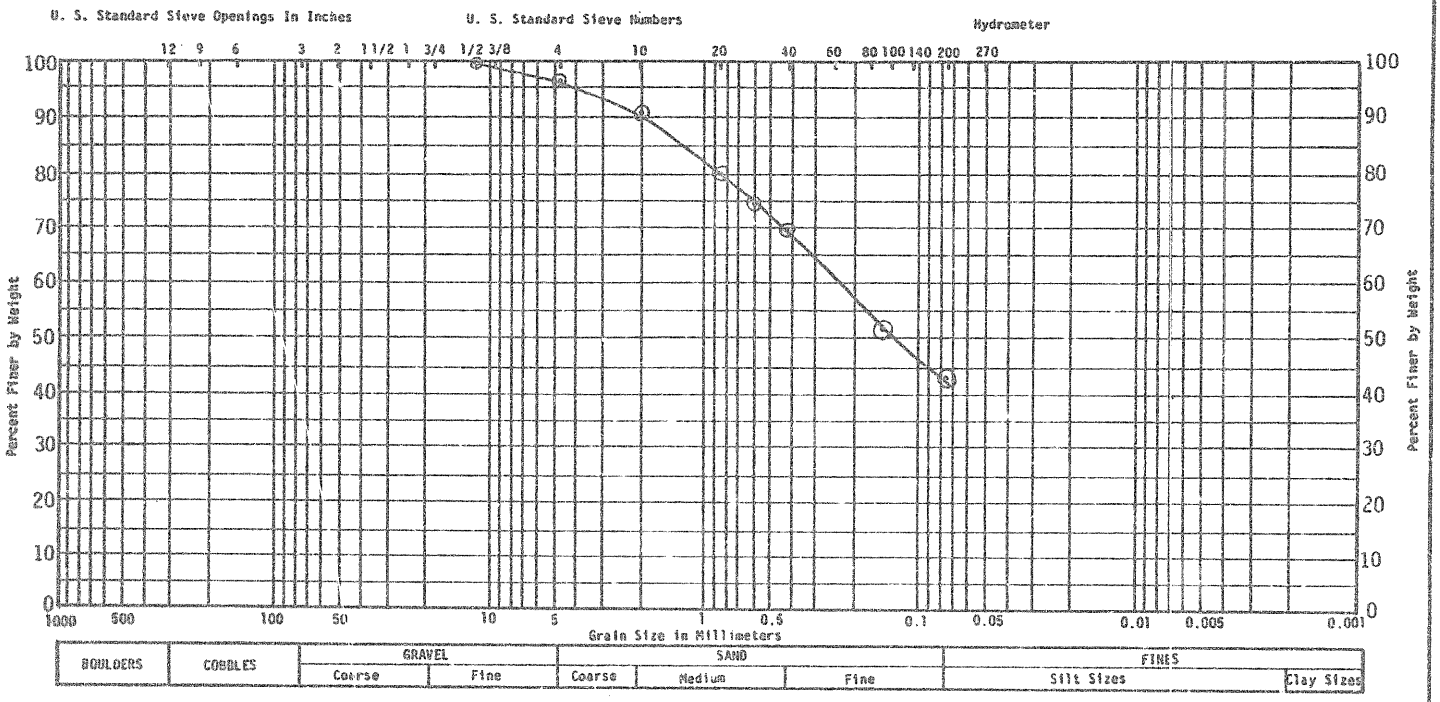
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	Rc	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.076								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	

Tested by: _____ Computed by: [illegible] Checked by: MA Cu

F 135 - MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS-17	2	75-10'	

VISUAL MANUAL CLASSIFICATION Gravel sandy gravel + embedded + some is smooth. Contains organic matter

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

LF 191-63A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

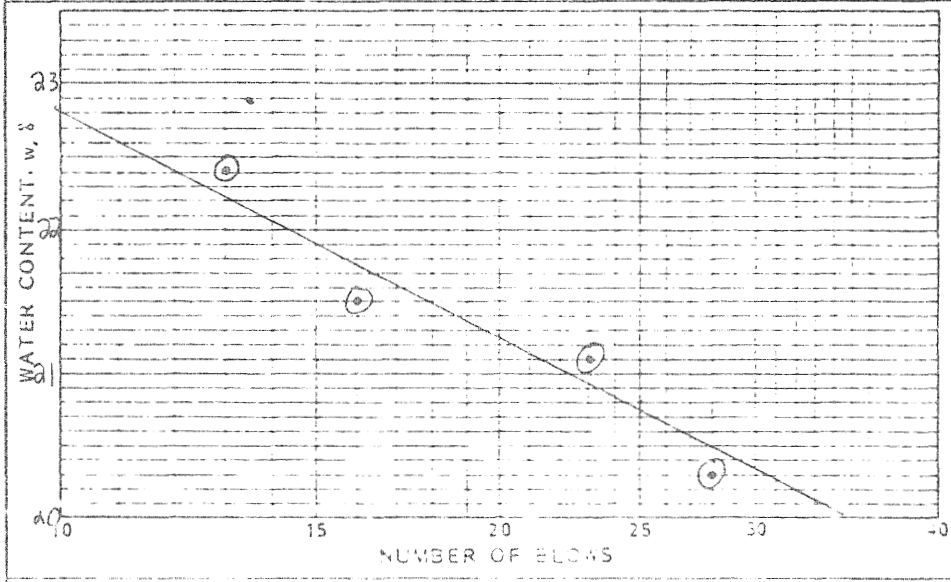
ATTERBERG LIMITS DETERMINATION

PROJECT: Watana Dam | DATE:

HOLE NO. AS 17 | SAMPLE NO. #2 (7.5-10) | JOB NO. 15032, 003.03

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 W_w	6.75	6.63	5.51	6.44		
	TARE	11.24	11.23	11.35	11.23		
	DRY SOIL W_s	30.20	30.81	26.14	31.70		
WATER CONTENT %	w	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, w_p		AVG 17.05					

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

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

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

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 disappears from the surface, the pat stiffens, and finally it crumbles or cracks. The rapidity of appearance of water during shaking and of its disappearance during squeezing aid 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 medium 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 crushing the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

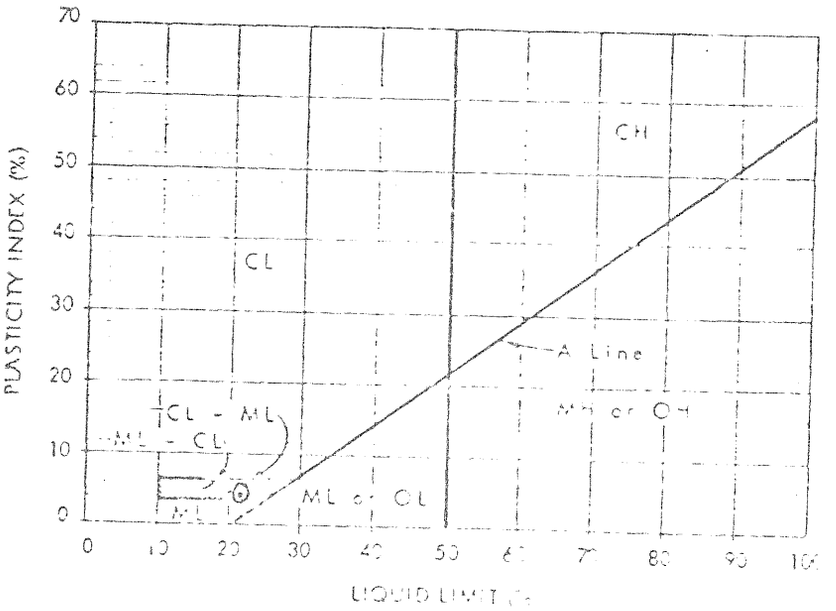
Toughness (Consistency near plastic limit)

After removing particles larger than the No. 40 sieve size, a specimen of soil about one inch cube in size is molded to the consistency of putty. If too dry, water must be added in small increments and thoroughly mixed in. If too wet, the sample should be spread in a thin layer and allowed to lose some moisture by evaporation. From the plastic soil, test specimens are prepared and rolled by hand on a smooth surface or between the palms into threads about 1/8 in. in diameter. The thread is then folded and rerolled repeatedly. During this manipulation the moisture content is reduced by evaporation and the specimen stiffens, finally crumbling when the plastic limit is reached.

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

The tougher the thread near the plastic limit and the stiffer the lump before crumbling, the more highly colloidal is the clay 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 clays 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.



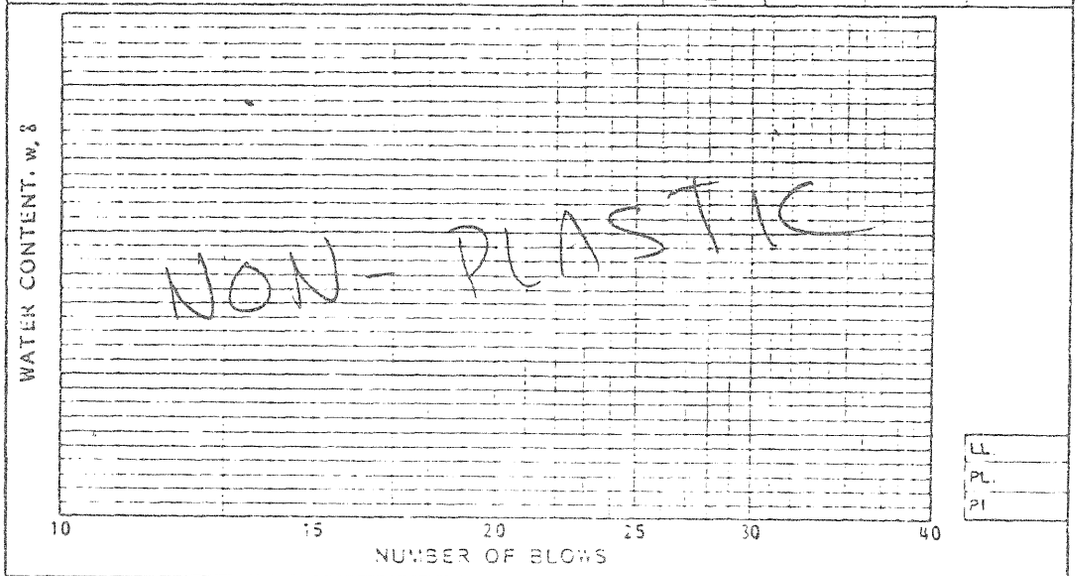
ATTERBERG LIMITS DETERMINATION

PROJECT: Watana Dam | DATE:

HOLE NO. AS 18 | SAMPLE NO.# 1 (5-7) | JOB NO. 15032, 003.08

LIQUID LIMIT

RUN NO.		1	2	3	4	5	6
TARE NO.		I	A-36	A-29			
WEIGHT IN GRAMS	TARE PLUS WET SOIL	45.80	59.13	66.89			
	TARE PLUS DRY SOIL						
	WATER W_w						
	TARE	11.27	11.36	11.30			
	DRY SOIL W_s						
WATER CONTENT, %	w						
NUMBER OF BLOWS		21	10	25			



SOIL SYMBOL FROM PLASTICITY CHART

PLASTIC LIMIT

RUN NO.		1	2	3	4	5	NATURAL WATER CONTENT
TARE NO.		A-13					
WEIGHT IN GRAMS	TARE PLUS WET SOIL						
	TARE PLUS DRY SOIL						
	WATER						
	TARE	4.42					
	DRY SOIL						
WATER CONTENT, %							
PLASTIC LIMIT, w_p							

REMARKS

TESTED BY: MA
COMPUTED BY:
CHECKED BY:

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOTECHNICISTS

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 rock flour show a moderately quick reaction.

Dry Strength (Crushing characteristics)

After removing particles larger than No. 40 sieve size, mould 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 crushing the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit)

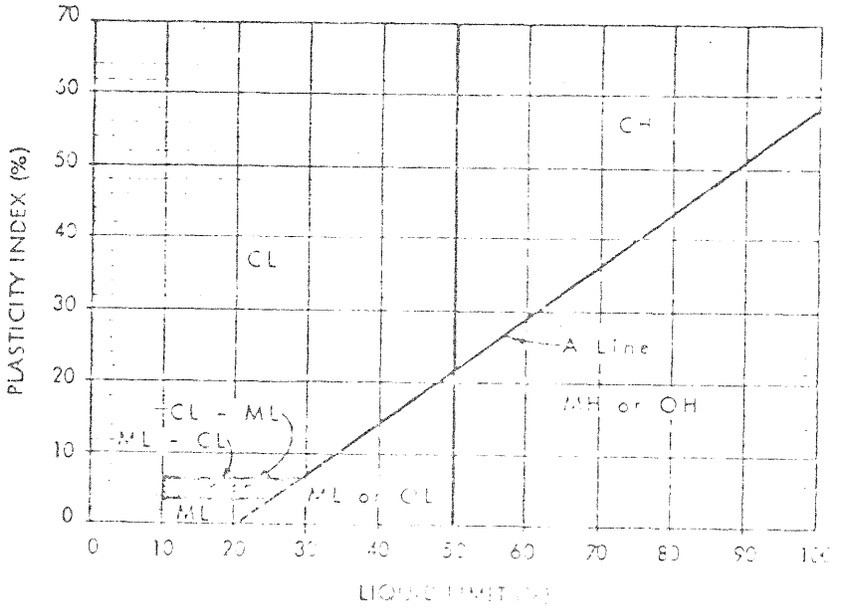
After removing particles larger than the No. 40 sieve size, a specimen of soil about one half inch cube in size is moulded to the consistency of putty. If the soil is too dry this must be added, and if sticky, the specimen should be rolled out in a thin layer and allowed to lose some moisture by evaporation. Then it should be divided into several pieces. Each piece should be rolled under the palm of the hand on a smooth surface into a thread about one eighth inch in diameter. The thread is then folded and the pat rerolled. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally crumbling when the plastic limit is reached.

After the thread crumbles the pieces should be formed together and kneaded with a gentle rolling action of the hand until the lump crumbles.

The toughness of the thread near the plastic limit and that of the lump below the plastic limit are characteristic for the quantity and quality of the colloidal clay fraction contained in the soil. Highly plastic clays have a very tough thread near the plastic limit and a very tough lump when the moisture content is near the plastic limit. On the other hand, inorganic silts, or mixtures of silt and clay, have a weak thread near the plastic limit and the lump crumbles when it is moulded. Organic clays have a weak thread near the plastic limit and the lump has only slight toughness.

Hardness (After drying)

After drying, a specimen of soil will have a very weak and friable feel at the plastic limit.



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

Project WATANA DAM | Hole AS-19 | Depth 5'-7' #2

C.N

Dry WT Total Sample & Tare	1559	TOTAL SAMPLE						
Tare Weight L L	536	Classification dark grey gravelly silty sand (SM)						
Total Sample WT	1023	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
Moisture Content -10 Material		4"	101.6					
		3"	76.2					
Can No.		2"	50.8					
		1½"	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
		⅜"	12.7	71			6.9	93.1
Loss		#4	4.6	133			13.0	870
Weight of Can		#10	2.0					
WT of Soil (Dry)		Pan						
% Moisture		Total						

13.0 % gvl

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.	Cum. % of Total Passing
10	2.000	214				20.9	79.1
20	0.850	307				30.0	70.0
30	0.600	353				34.5	65.5
40	0.425	401				39.2	60.8
100	0.150	580				56.7	43.3
200	0.075	667				65.2	34.8
270	0.053						
Pan		673					
Total							

52.2 % SAND

14.8 % Fines

HYDROMETER SAMPLE

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

a = | Corrected Weight of Hydrometer Sample _____ grams | Defloculation Agent

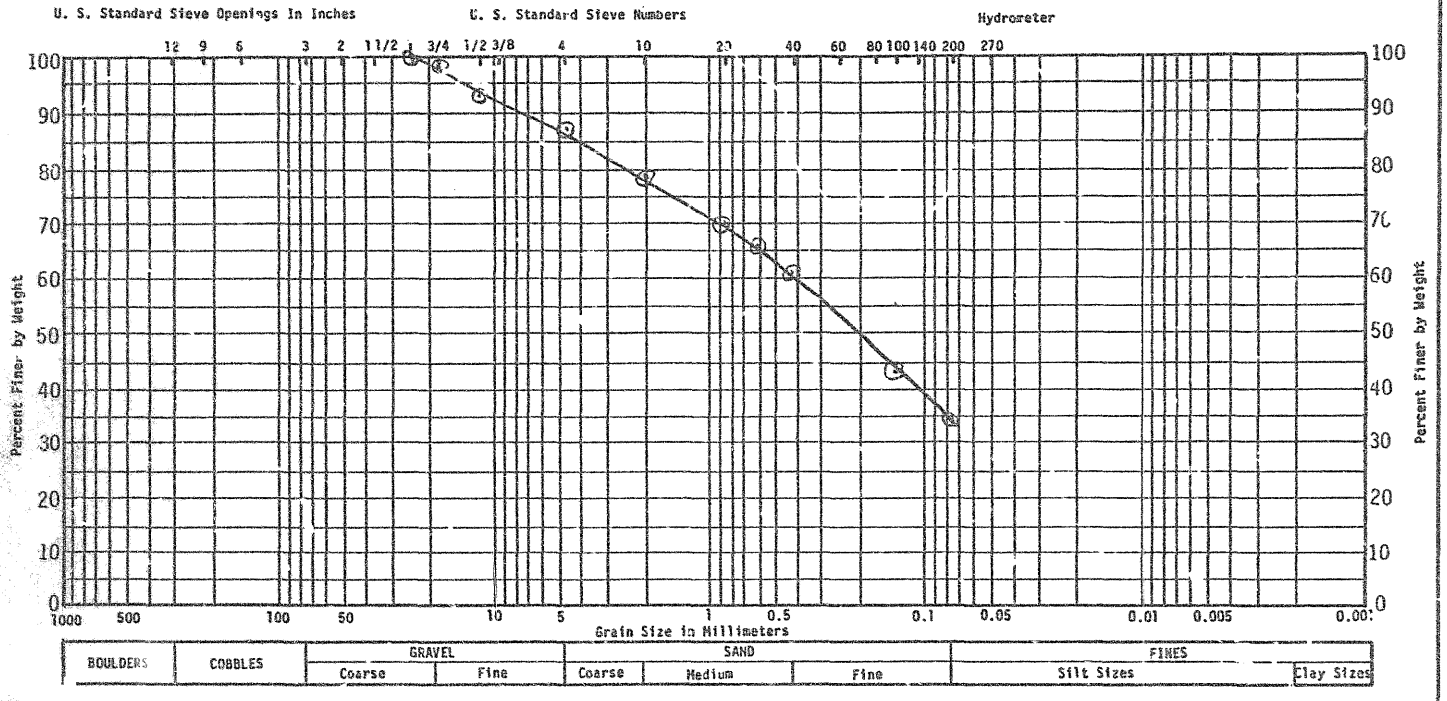
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: CRM | Computed by: CRM | Checked by: MH

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)
	AS-19	2	5'-7'	

VISUAL MANUAL CLASSIFICATION Gravel mostly subangular with a few subrounded. Contains some organics.

Job WATANA DAM

No. 15032.003.08

Date 4-10-83

LF 141-GSA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐GILSON ☑BRASS SIEVE ☐HYDROMETER	Job No. 15032.003.08
Project WATANA DAM		Hole AS 21	Depth 3-4 #2

Dry Wt Total Sample & Tare	1879	TOTAL SAMPLE
Tare Weight SD-3	555	Classification olive brown gravelly SILTY sand (SM)
Total Sample WT	1324	

Moisture Content -10 Material	
Can No.	
WT-Soil & Can(Wet)	
WT-Soil & Can(Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	0			0	100
⅜"	12.7	16			1.2	98.8
#4	4.6	122			9.2	90.8
#10	2.0					
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.	Cum. % of Total Passing
10	2.000	203				15.1	84.9
20	0.850	321				22.7	77.3
30	0.600	354				26.7	73.3
40	0.425	414				31.3	68.7
100	0.150	682				54.5	45.5
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

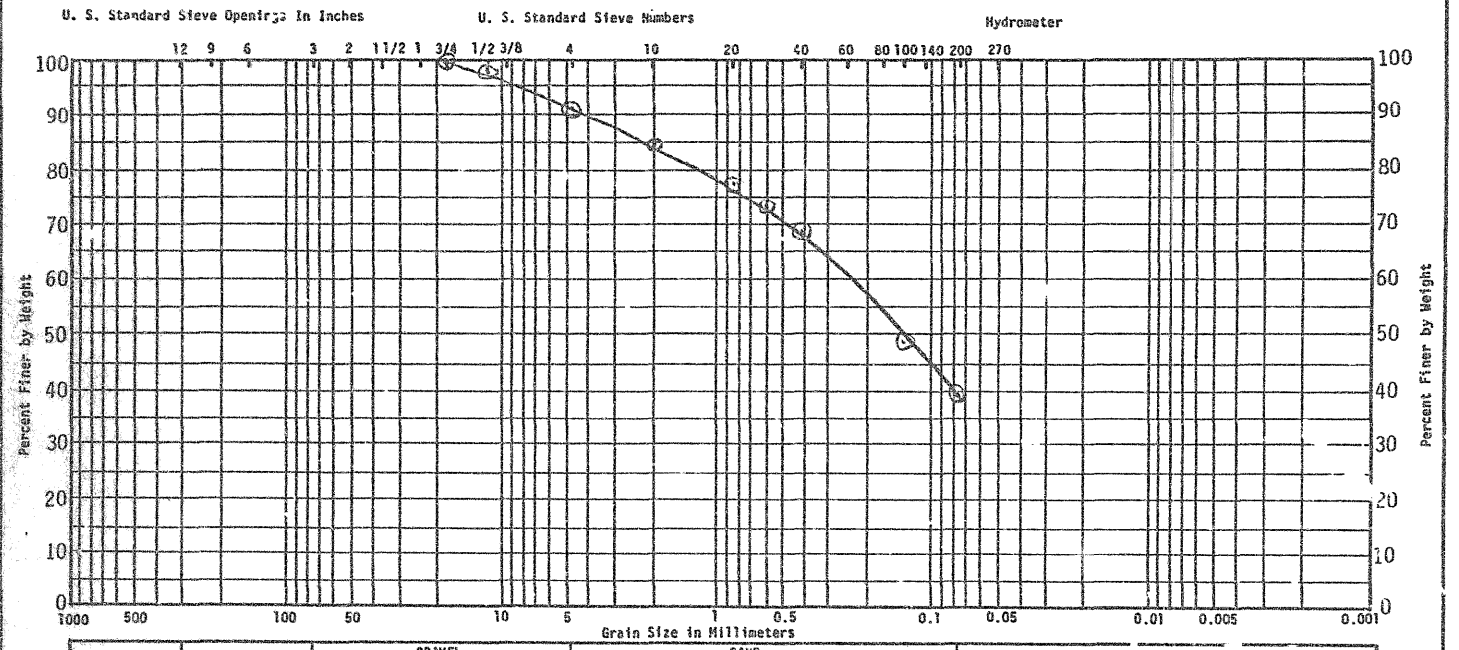
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: CRM Computed by: [illegible] Checked by: [illegible]

LF 135 - MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



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

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS-21	2	3'-4'	

VISUAL MANUAL CLASSIFICATION Saturated. Contains some organics.

Job WATANA DAM

No. 15032.003.08

Date 9-10-85

LF 141-63A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐GILSON ☑BRASS SIEVE ☐HYDROMETER	Job No. 15032,003.08
Project	WATANA DAM	Hole AS 23	Depth 3-5' #2

~~Air~~ Dry WT Total Sample & Tare	1476.0
Tare Weight	10 536
Total Sample WT	890.0
Moisture Content -10 Material	
Can No.	
WT Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

TOTAL SAMPLE

Classification olive gravelly silty sand (SM)

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2	0			0	100
2"	50.8	0			0	100
1½"	38.1	0			0	100
1"	25.4	0			0	100
3/4"	19.1	0			0	100
½"	12.7	16.0			1.8	98.2
#4	4.6	64.3			7.2	92.8
#10	2.0					
Pan						
Total						

7.2 % gvl.

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar #

WT Washed Sample & Tare	591
Tare Weight	53
Washed Sample Weight	538.0

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	126.0				4.2	95.8
20	0.850	210.0				23.4	76.6
30	0.600	254.1				28.5	71.5
40	0.425	301.0				32.4	67.6
100	0.150	490.				55.1	44.9
200	0.075	587				66.0	34.0
270	0.053						
Pan		595.0					
Total							

58.8 % - Sand

34.0 % fine

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

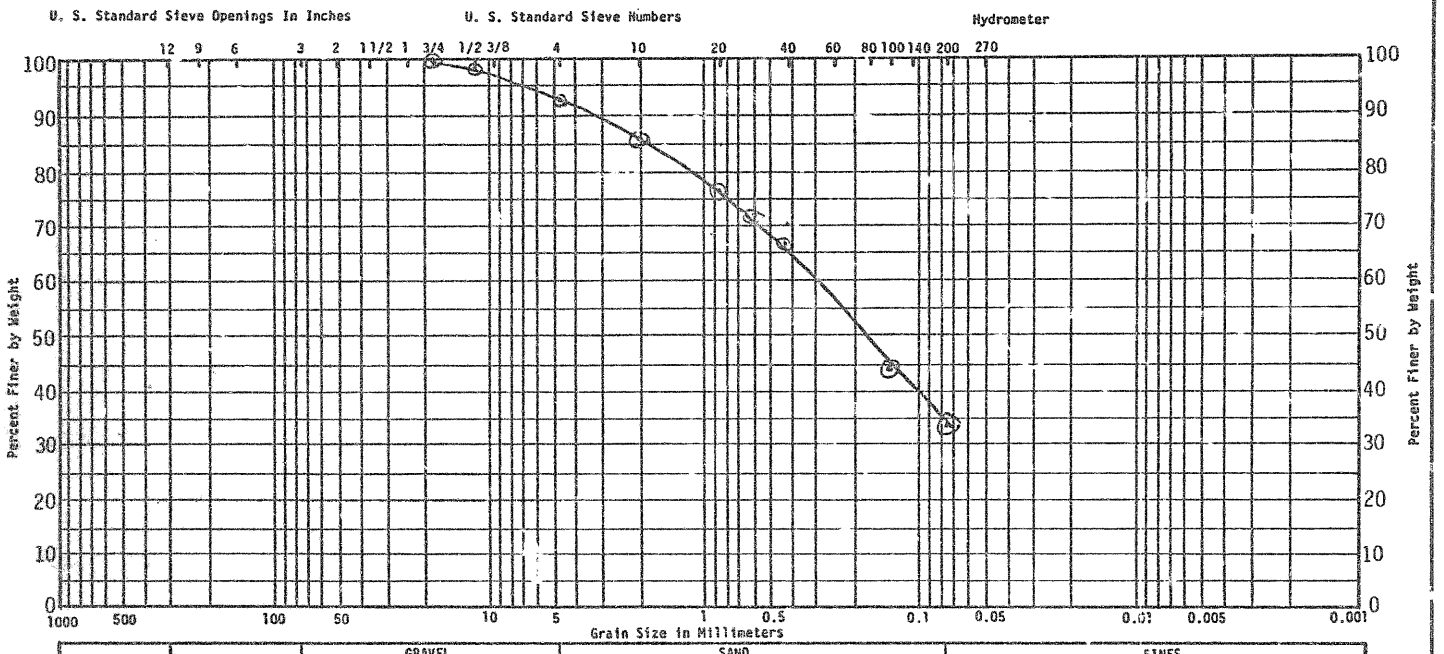
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: CAM | Computed by: CLM | Checked by: MF

LF 135-1A

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)
	AS 23	2	3'-5'	

VISUAL MANUAL CLASSIFICATION: A few clumps of silt + sand mixed, light brown on outside and dark brown on inside. Fine gravel mostly subangular. Some smooth surfaced gravel.

Job WATANA DAM

No. 15032.003.08

Date 4-10-83

LF 141-GSA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

(MC)

WORK SHEET - PARTICLE SIZE ANALYSIS

Date 4/9/83 | ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER | Job No. 15032,003.08

Project WATANA DAM | Hole AS 24 | Depth 1.5-2.5 #1

~~Alip~~ Dry WT Total Sample & Tare: 961

Tare Weight IV: 559

Total Sample WT: 402

Moisture Content -10 Material

Can No.

WT-Soil& Can(Wet)

WT-Soil& Can(Dry)

Loss

Weight of Can

WT of Soil (Dry)

% Moisture

TOTAL SAMPLE

Classification: dark olive gravelly silty sand(SM)

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	0			0	100
½"	12.7	15			4.0	96.0
#4	4.6	41			10.2	89.8
#10	2.0					
Pan						
Total						

10.2 % #4.

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar # | WT Washed Sample & Tare: 317 | Tare Weight: 294 | Washed Sample Weight: 23

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	54				17.5	82.5
20	0.850	104				33.8	66.2
30	0.600	125				40.7	59.3
40	0.425	143				46.5	53.5
100	0.150	214				69.7	30.3
200	0.075	236				76.8	23.2
270	0.053						
Pan		255					
Total							

53.5 % passing #40

36.7 % fines

HYDROMETER SAMPLE

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

a = | Corrected Weight of Hydrometer Sample _____ grams | Deflocculation Agent

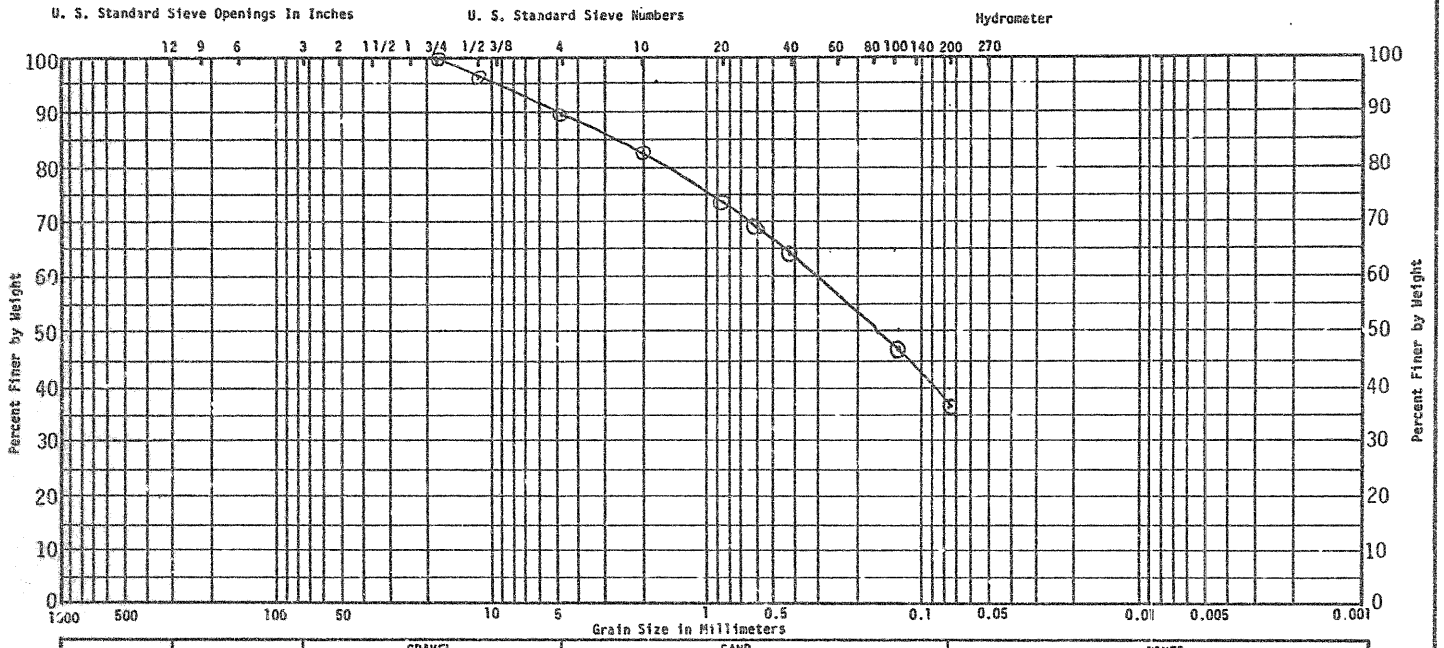
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: CRW | Computed by: CRW | Checked by: VMA

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)
	AS 24	1	1.5-2.5	

VISUAL MANUAL CLASSIFICATION: Fine gravel subangular, Contains organics

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
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 olive brown gravelly silty sand (SM)
Total Sample WT	719	

Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	0			0.0	100.0
½"	12.7	13			1.8	98.2
#4	4.6	33			4.6	95.4
#10	2.0					
Pan						
Total						

4.6 % gvl.

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	767
		Tare Weight	345
		Washed Sample Weight	422

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total 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		422					
Total							

53.3 % SM

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

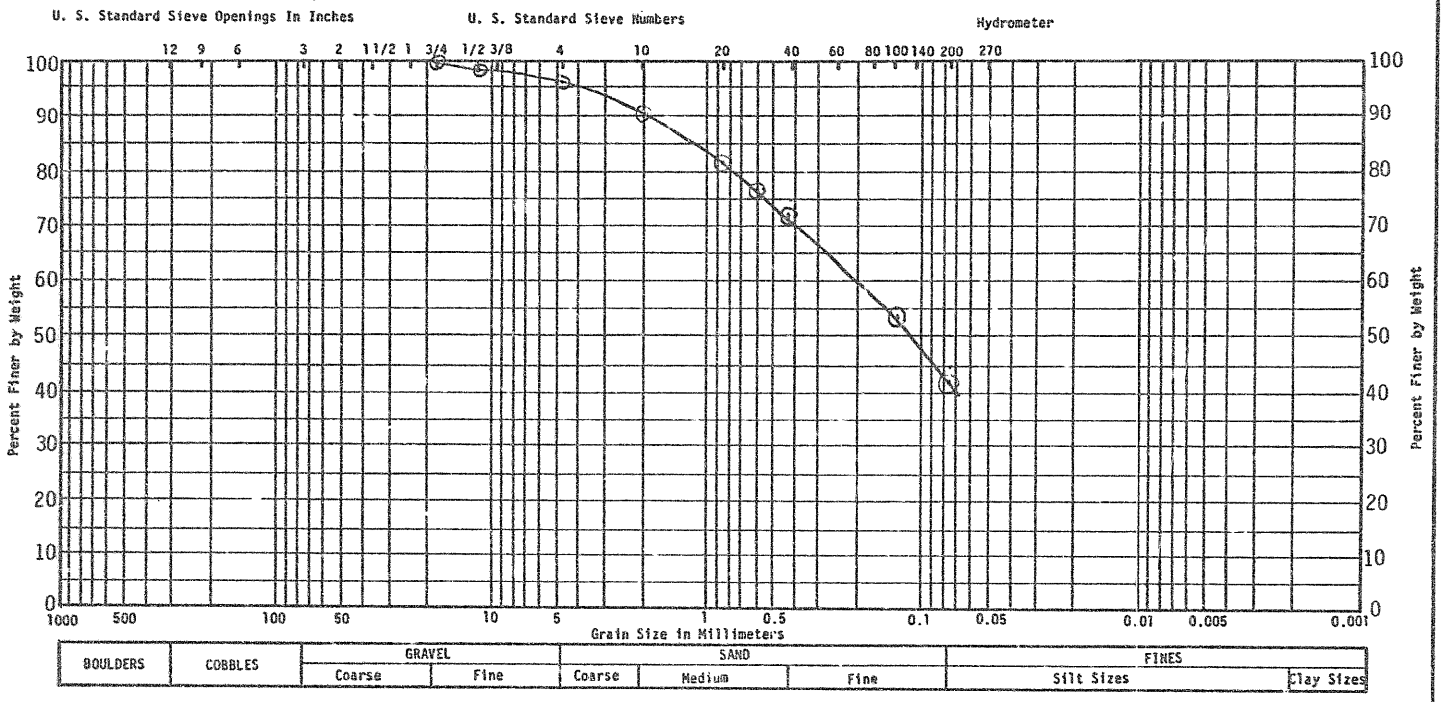
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

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

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)
	AS 25	1	1-2.5	

VISUAL MANUAL CLASSIFICATION Contains some gravel. also has small clumps of sand + silt or clay which is easily disc.

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

LF 141-GSA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

(mc)

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole AS 26	Depth 1-2.5 #1

Dry WT Total Sample & Tare	763.2	TOTAL SAMPLE
Tare Weight MA-45	88.85	Classification olive silty sand (SM)
Total Sample WT	674.35	
Moisture Content -10 Material		
Can No.		
WT-Soil& Can(Wet)		
WT-Soil& Can(Dry)		
Loss		
Weight of Can		
WT of Soil (Dry)		
% Moisture		

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1					
½"	12.7	0			0.0	100.0
#4	4.6	28			4.2	95.8
#10	2.0					
Pan						
Total						

4.2 % gvl.

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar #

WT Washed Sample & Tare	451
Tare Weight	88.65
Washed Sample Weight	362.3

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	67				18.5	90.1
20	0.850	117				32.4	82.6
30	0.600	144				39.4	78.6
40	0.425	171				47.2	74.6
100	0.150	281				77.7	58.3
200	0.075	357				98.9	47.1
270	0.053						
Pan		361					
Total							

47.1 % finer

HYDROMETER SAMPLE

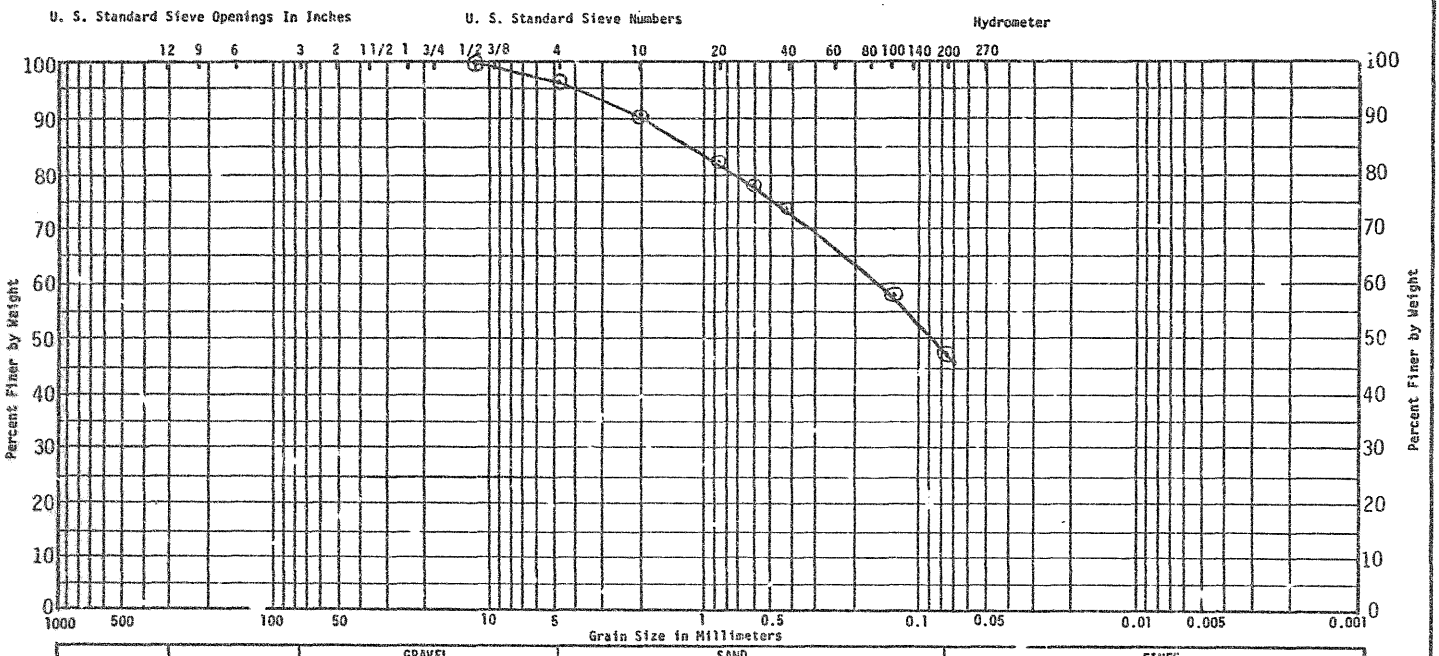
Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading 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								
									Cc	
									Cu	

Tested by: G.B. | Computed by: MA | Checked by: MA

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)
	AS 26	1	1 - 2.5	

VISUAL MANUAL CLASSIFICATION Saturated + have large amount of fine earth.

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

(GS)

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐GILSON ☐BRASS SIEVE ☑HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole AS 26	Depth 2.5-4 #2

Dry WT Total Sample & Tare		TOTAL SAMPLE
Tare Weight		Classification olive sandy s. H (MH)
Total Sample WT		

Moisture Content -10 Material	
Can No.	K
WT-Soil & Can(Wet)	45.91
WT-Soil & Can(Dry)	45.75
Loss	.16
Weight of Can	10.95
WT of Soil (Dry)	34.80
% Moisture	.5

Sieve Size	Dia MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1					
½"	12.7					
#4	4.6					
#10	2.0					
Pan						
Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample 71.19 grams	Jar # N	WT Washed Sample & Tare	125.0
		Tare Weight	[illegible]
		Washed Sample Weight	35.93

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total 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

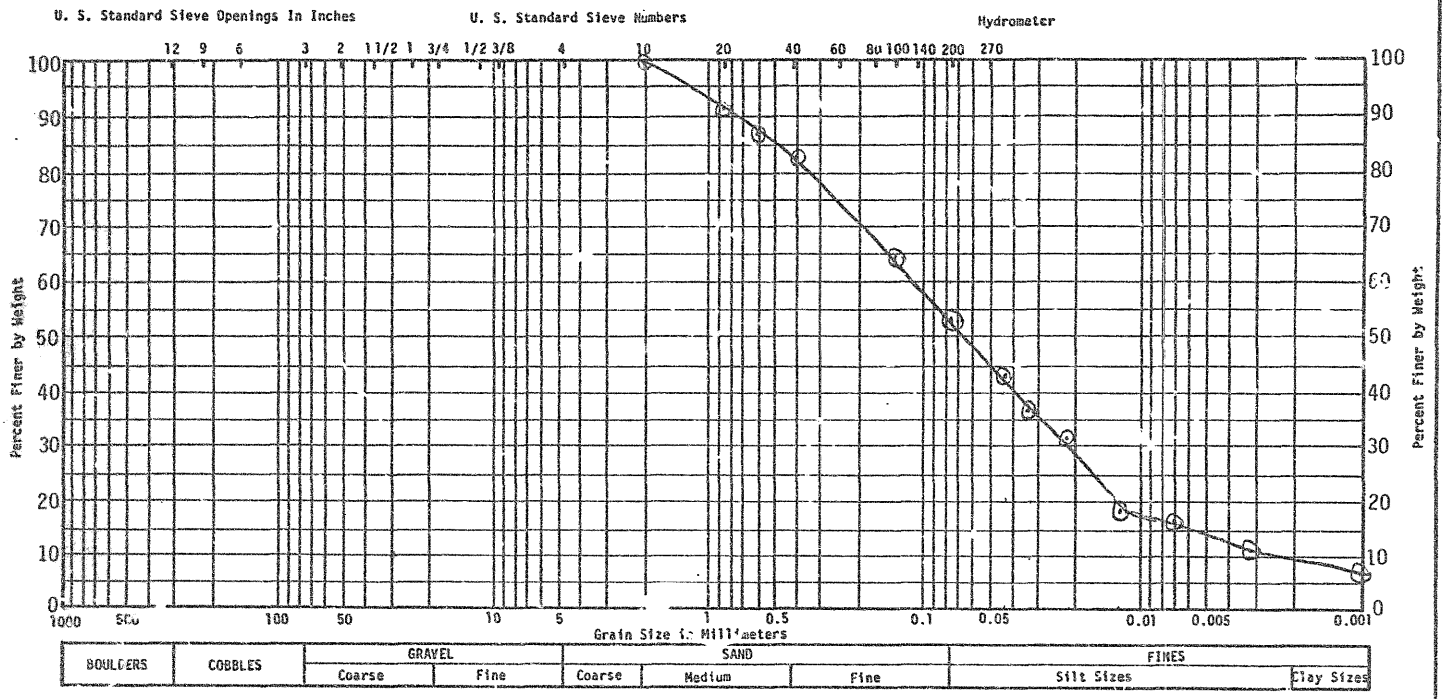
Specific Gravity (G) (Tested) 2.75	LL ____ PI ____	Hydrometer No. C	Amyl Alcohol Drops: ____
a = 0.98	Corrected Weight of Hydrometer Sample 70.84 grams		Defloculation Agent

9:10 Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
9:11	1	0.078	15.3	.0139	41	33.0	7.8	9.9	0.044	43.2
9:13	2	0.055	15.3	"	36	34.5	"	10.6	0.032	38.9
9:15	5	0.035	15.3	"	31.0	30.2	"	11.4	0.021	34.0
9:25	15	0.020	15.5	"	21.2		"	12.9	0.013	18.5
9:40	30	0.014	15.5	"	23.7					
10:10	60	0.010	15.3	.0140	20.0		7.4	12.0	0.001	16.7
1310	240	0.005	15.0	.0140	16.5		8.0	13.9	0.003	10.4
0910	1440	0.002	20.0	.0133	11.9		6.9	16.3	0.001	6.8
									Cc	
Tested by: [illegible] G.B.			Computed by: MA		Checked by: MA				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)
	AS 26	2	2.5-4	

VISUAL MANUAL CLASSIFICATION 96 as some schreinerees to it.

Job WATANA DAM

No. 15032.003.08

Date 4-12-83

LF 141-GSA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole AS 26	Depth 7.5-9 =4

~~Air~~ Dry WT Total Sample & Tare	1240	TOTAL SAMPLE DOES NOT MEET ASTM STANDARDS
Tar Weight SD-15	534	Classification olive silty sandy gravel (GM)
Total Sample WT	756	

Moisture Content -10 Material	
Can No.	
WT-Soil& Can(Wet)	
WT-Soil& Can(Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8	0			0	100
1½"	38.1	283			37.4	62.6
1"	25.4	283			[illegible]	63.6
3/4"	19.1	243			[illegible]	52.6
½"	12.7	259			34.2	65.8
#4	4.6	308			40.7	59.3
#10	2.0					
Pan						
Total						

40.7 % grvl.

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	[illegible]
		Tare Weight	534
		Washed Sample Weight	[illegible]

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	[illegible]				[illegible]	56.7
20	0.850	357				47.5	52.5
30	0.600	340				[illegible]	47.2
40	0.425	403				53.3	[illegible]
100	0.150	482				[illegible]	[illegible]
200	0.075	530				70.1	29.1
270	0.053						
Pan		Soil					
Total							

30.2 % sand

29.1 % fines

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

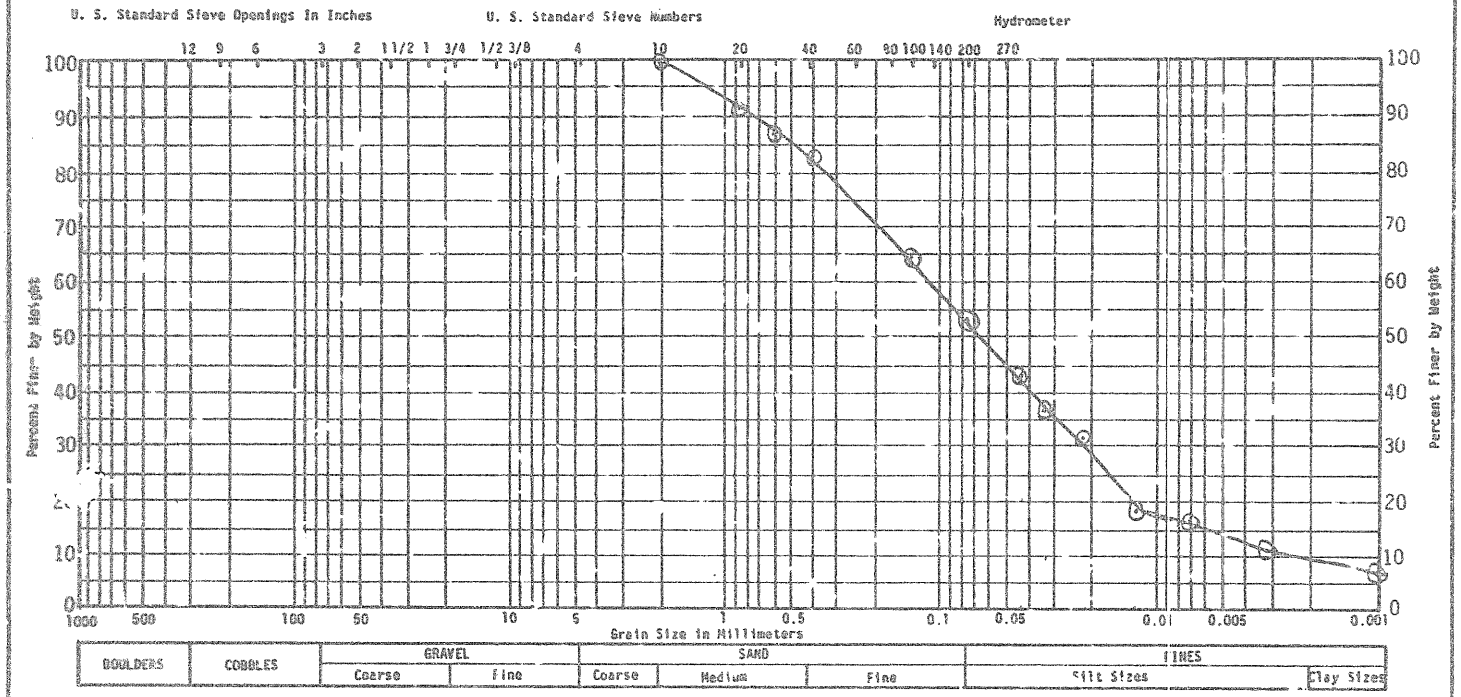
Time	Elap. Time	Maximum Dia. MM	Temp. o C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: [illegible] Computed by: [illegible] Checked by: [illegible]

LF 135-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 26	2	2.5-4	

VISUAL MANUAL CLASSIFICATION Was some cohesiveness to it.

Job WATANA DAM

No. 15032.003.08

Date 4-12-83

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
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 very dark greyish brown gravelly silty sand (SM)							
Total Sample WT	324.6	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing	
Moisture Content -10 Material		4"	101.6						
		3"	76.2						
Can No.		2"	50.8						
WT-Soil& Can(Wet)		1½"	38.1						
WT-Soil& Can(Dry)		1"	25.4						
Loss		3/4"	19.1	0			6.0	100.0	19.4 %
Weight of Can		½"	12.7	49			15.1	84.9	
WT of Soil (Dry)		#4	4.6	63			19.4	80.6	81
% Moisture		#10	2.0						
		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.	Cum. % of Total Passing	
10	2.000	87				26.8	73.2	52.4 % Sand
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	28.2 % fines
270	0.053							
Pan		236						
Total								

HYDROMETER SAMPLE

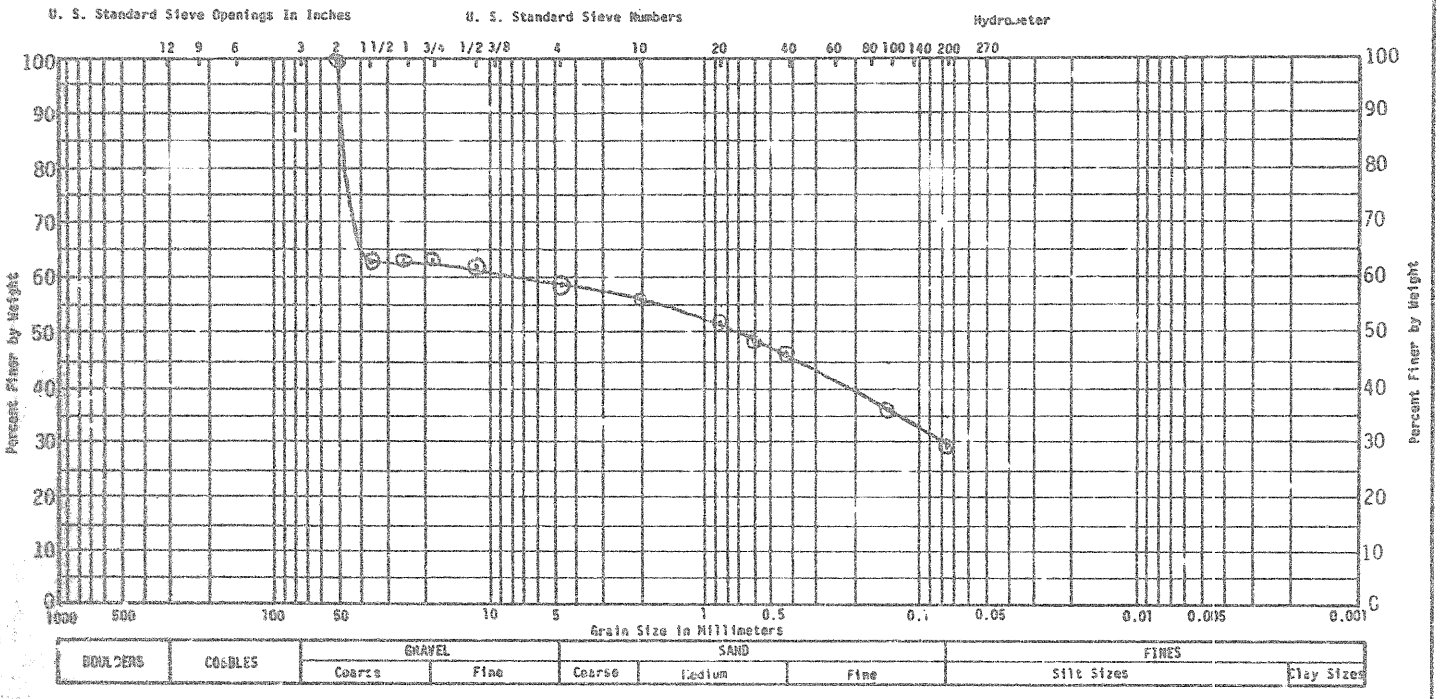
Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading 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: 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)
	AS 26	4	7.5-9	

VISUAL MANUAL CLASSIFICATION A few lens + pock. of silt + sand. Very small amount of organics

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

LF MI-69A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

WORK SHEET - PARTICLE SIZE ANALYSIS

Date 4/9/83 | ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER | Job No. 15032,003.08

Project WATANA DAM | Hole AS 28 | Depth 1.5-2.5 #1

Dry WT Total Sample & Tare: 1223.0

Tare Weight F: 536

Total Sample WT: 687.0

Moisture Content -10 Material

Can No.

WT-Soil & Can (Wet)

WT-Soil & Can (Dry)

Loss

Weight of Can

WT of Soil (Dry)

% Moisture

TOTAL SAMPLE

Classification: olive brown gravelly silty sand (SM)

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2	0				
2"	50.8	0				
1½"	38.1	0				
1"	25.4	0				
3/4"	19.1	140				
½"	12.7	224				
#4	4.6	324				
#10	2.0					
Pan						
Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar #

WT Washed Sample & Tare: 1

Tare Weight:

Washed Sample Weight: 687.0

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	139.0					
20	0.850	171.0					
30	0.600	224.0					
40	0.425	253.0					
100	0.150	310.0					
200	0.075	378.0					
270	0.053						
Pan		486.0					
Total							

HYDROMETER SAMPLE

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

a = | Corrected Weight of Hydrometer Sample _____ grams | Deflocculation Agent

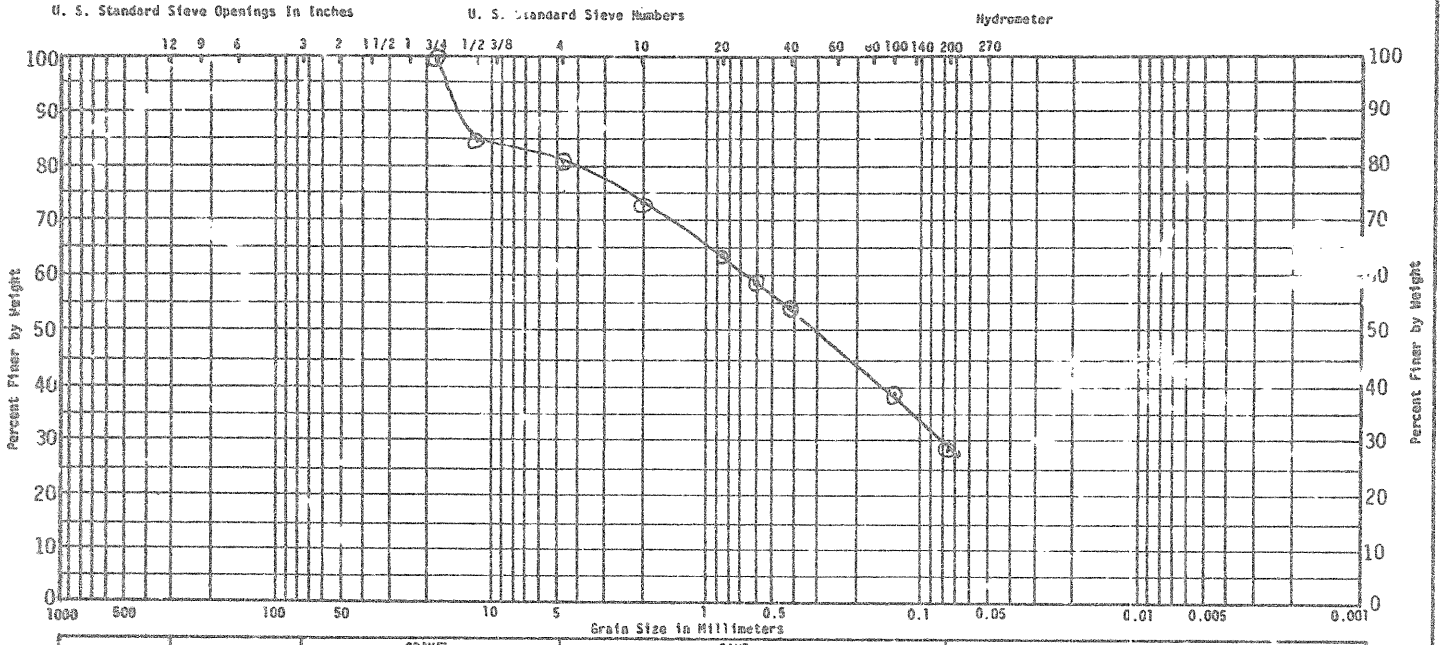
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: CRM | Computed by: [illegible] | Checked by: MP

LF 39-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)
	AS 27	1	3-5	

VISUAL MANUAL CLASSIFICATION Gravel mostly subrounded. Contains organics

Job WATANA DAM

No. 15032.003.08

Date

LF 141-GSA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole AS 28	Depth 9.5 - 10.0 #3

Dry WT Total Sample & Tare		TOTAL SAMPLE
Tare Weight SD-18	545	Classification olive green gravelly silty sand (SM)
Total Sample WT	57[illegible]	
Moisture Content -10 Material		
Can No.		
WT-Soil & Can (Wet)		
WT-Soil & Can (Dry)		
Loss		
Weight of Can		
WT of Soil (Dry)		
% Moisture		

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1					
½"	12.7	34			4[illegible]	4[illegible]
#4	4.6	[illegible]			[illegible]	[illegible]
#10	2.0					
Pan						
Total						

16.5 gvl.

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	[illegible]
		Tare Weight	[illegible]
		Washed Sample Weight	[illegible]

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	[illegible]				2[illegible]	[illegible]
20	0.850	[illegible]				[illegible]	[illegible]
30	0.600	[illegible]				35.9	64.1
40	0.425	[illegible]				40.5	59.5
100	0.150	[illegible]				58.5	41.5
200	0.075	[illegible]				68.6	31.4
270	0.053						
Pan		[illegible]					
Total							

52.1 % Sand
31.5 % Fines

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Deflocculation Agent

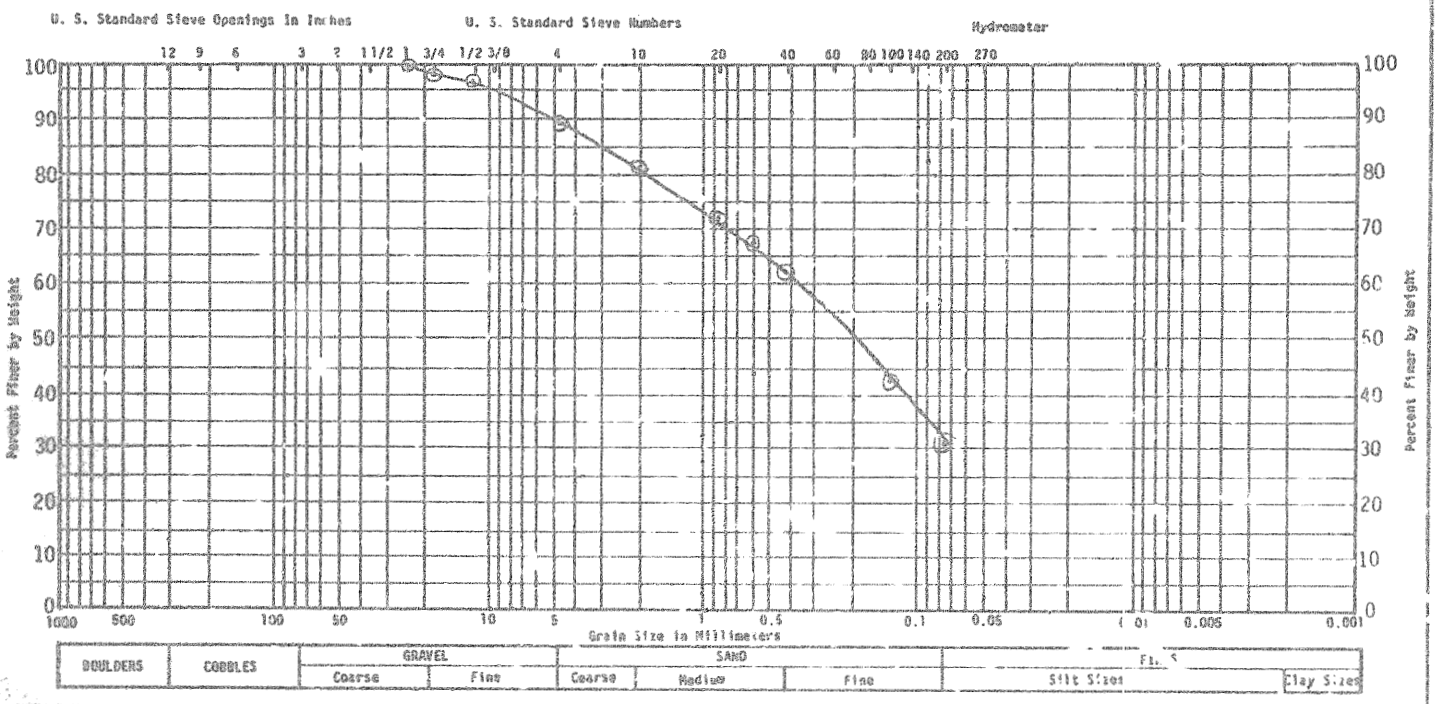
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initi.	Reading Actual	Rc	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.056								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: [illegible] Computed by: [illegible] Checked by: MA

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)
	AS 28	1	1.5-2.5	

VISUAL MANUAL CLASSIFICATION Gravel mostly sandy [illegible]

Job WATANA DAM

No. 15032.003.08

Date 8-10-83

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☒ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
Project	WATANA DAM	Hole AS 29	Depth 1-2.5 #1

Dry WT Total Sample & Tare	1142.0	TOTAL SAMPLE							
Tare Weight	427	Classification							
Total Sample WT	716.0	Sieve Size	Dia. MM	Cum WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing	
Moisture Content -10 Material		4"	101.6						
Can No.		3"	76.2						
WT-Soil & Can(Wet)		2"	50.8						
WT-Soil & Can(Dry)		1½"	38.1						
Loss		1"	25.4						
Weight of Can		¾"	19.1						
WT of Soil (Dry)		½"	12.7						
% Moisture		#4	4.6						
		#10	2.0						
		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.	Cum. % of Total Passing
10	2.000						
20	0.850						
30	0.600						
40	0.425						
100	0.150						
200	0.075						
270	0.053						
Pan							
Total							

HYDROMETER SAMPLE

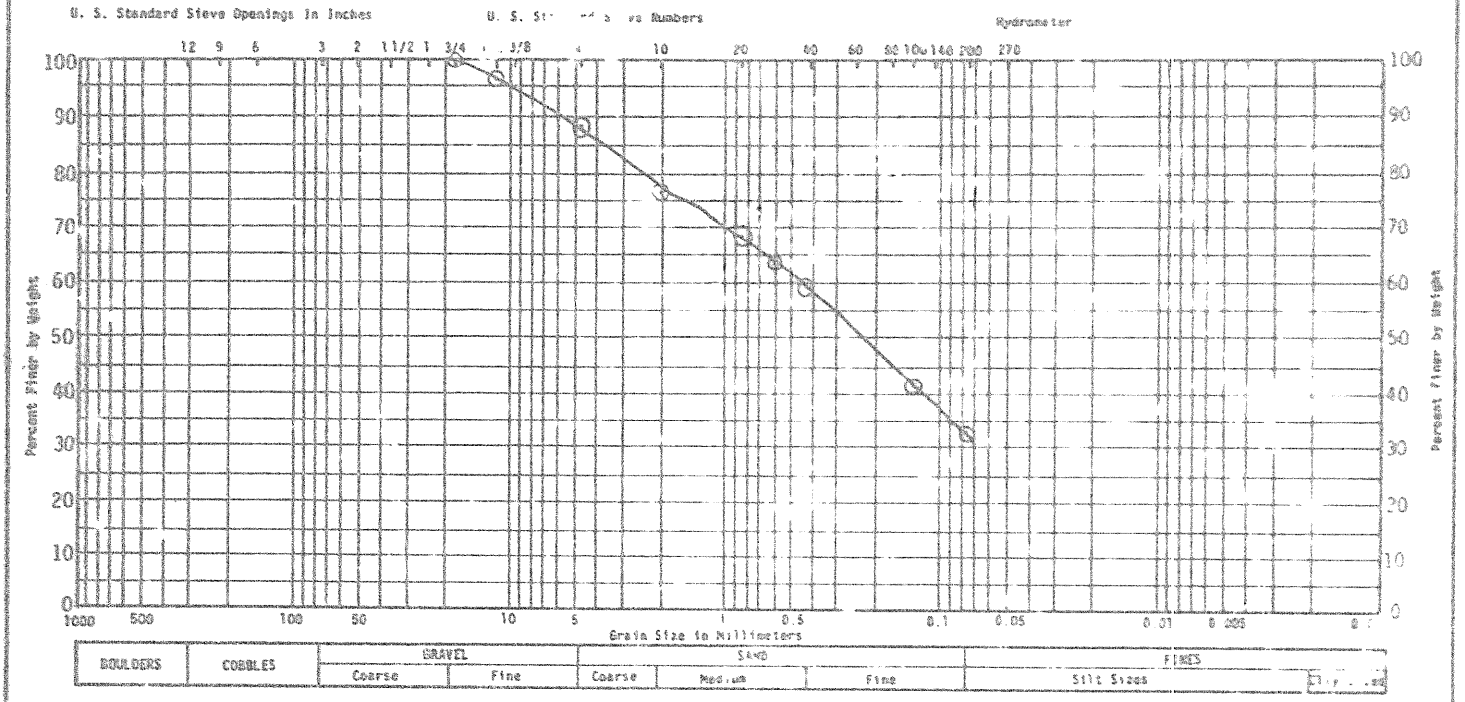
Specific Gravity (G)	LL ____ PI ____	Hydrometer No.	Amyl Alcohol Drops: ____
a =	Corrected Weight of Hydrometer Sample ____ grams	Deflocculation Agent	

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	Reading 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							a_c	
Tested by:		Computed by: MA			Checked by: MF				C_d	

LF 35-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 28	3	7.5-10'	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.002.06
Project MATAMA DAM		Hole A-3 B-9	Depth 6'-7" - 35?

Dry WT Total Sample & Tare	1281.0	TOTAL SAMPLE							
Tare Weight	541	Classification (gravelly silty Sand (SM))							
Total Sample WT	840.0	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % WT Ret.	Cum. % WT Passing	
Moisture Content -10 Material		4"	101.6						
		3"	76.2	3			0	100	
		2"	50.8	5			5	95	
Can No.		1½"	38.1	5			5	95	
WT-Soil& Can(Wet)		1"	25.4	5			5	95	
WT-Soil& Can(Dry)		¾"	19.1	5			5	95	
Loss		½"	12.7	710			85	915	
Weight of Can		#4	4.6	1294					
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. % WT Ret.	Cum. % WT Passing
10	2.000	23					
20	0.850	33					
30	0.500	37					
40	0.425	38					
100	0.150	42.5					
200	0.075	64					
270	0.053						
Pan		64.2					
Total							

HYDROMETER SAMPLE

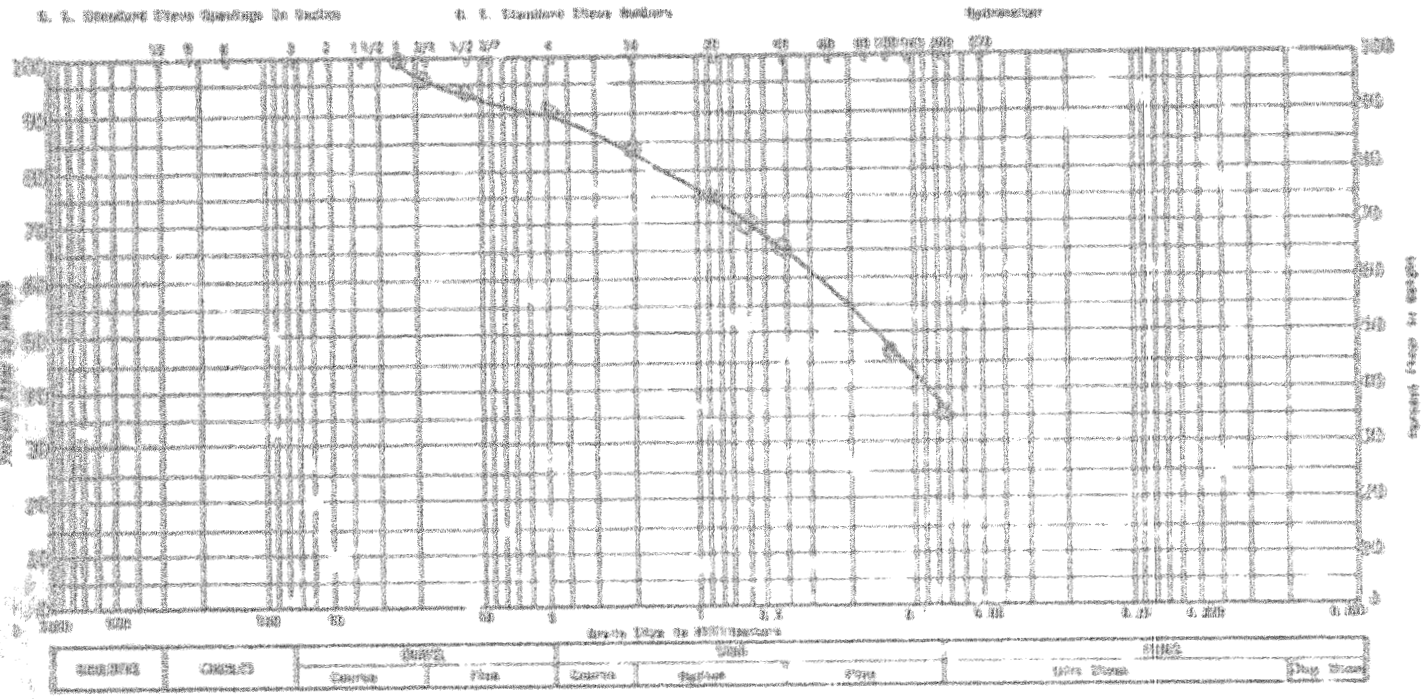
Specific Gravity (G)	LL ____ PI ____	Hydrometer #	Amb. Temp. Degrees ____
a =	Corrected weight of Hydrometer Sample ____ grams		Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initial	Reading Actual	R	Corrected Hydrom Size. MM	% of Total Passing
	1	0.032							
	2	0.025							
	5	0.020							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							

Tested by: CAM | Computed by: [illegible] | Checked by: [illegible]

HARDINGS LAWSON ASSOCIATES
ENGINEERING, DEVELOPMENT & GROUNDWATER

GRADATION SIZE ANALYSIS



GRAVEL		SAND					SILTS	
COBBLES	CHUNKS	Coarse	Fine	Coarse	Medium	Fine	Wet Sieve	Dry Sieve

JOB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH
	A529	1	1-2.5

Job: WALNUT LANE

No.: 1-432-002-02

Date: 4-4-97

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐GILSON ☑BRASS SIEVE ☐HYDROMETER	Job No. 15032,003.08
Project	WATANA DAM	Hole AS-30	Depth 1-2.5 #1

Dry WT Total Sample & Tare	700.1	TOTAL SAMPLE								
Tare Weight MA-32	91.0	Classification dark brown gravelly silty sand (SM)								
Total Sample WT	609.1	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing		
Moisture Content -10 Material		4"	101.6							
		3"	76.2							
		2"	50.8							
Can No.	E	1½"	38.1							
WT-Soil& Can(Wet)	45.02	1"	25.4							
WT-Soil& Can(Dry)	44.89	3/4"	19.1	2			0.0	100.0		
Loss	0.13	½"	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								

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample	73.39 grams	Jar #	WT Washed Sample & Tare	462
			Tare Weight	91
			Washed Sample Weight	371

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing	
10	2.000	73				12.0	88.0	54 %
20	0.850	129				21.2	78.8	½ -
30	0.600	157				25.8	74.2	Sand
40	0.425	186				30.5	69.5	
100	0.150	295				48.4	51.6	
200	0.075	367				60.3	39.7	39 -
270	0.053							½
Pan		371						fine
Total								

HYDROMETER SAMPLE

Specific Gravity (G)	2.75 (assumed)	LL / PI		Hydrometer No. E	Amyl Alcohol Drops: 2 Squirt
a = 0.98	Corrected Weight of Sample 73.10 grams				Deflocculation Agent

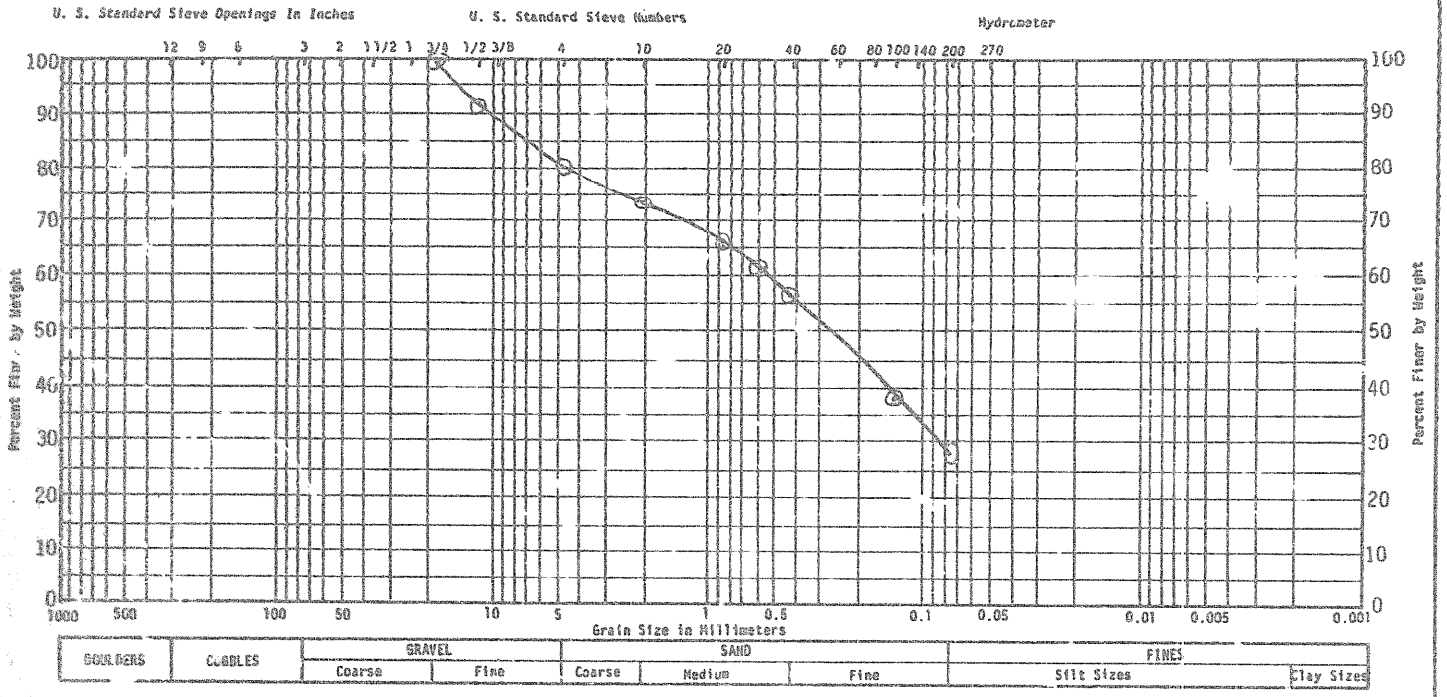
09:30 Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual		R_c	L	Corrected Gram Size, Dia. mm	% of Total Passing
31	1	0.078	15.5	0.0140		37.5	36.5	7.8	10.3	0.045	33.4
32	2	0.055	"	"		32.0	31.0	"	11.2	0.033	27.4
35	5	0.035	"	"		27.0	26.2	"	12.0	0.022	21.9
45	15	0.020	"	"		22.0		"	12.9	0.013	16.8
10:00	30	0.014	"	"		18.5		"	13.3	0.009	12.6
10:30	60	0.010	15.0	"		16.0		8.0	13.9	0.007	9.4
13:30	240	0.005	15.0	"		12.5		"	14.3	0.003	5.3
09:30	1440	0.002	19.0	0.0134		10.0		7.1	14.9	0.0014	3.4
										Cc	
Tested by: E.B./DNR		Computed by: MA		Checked by: MA						Cu	

-F-109-MA

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

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 29	3	6-7.5	

VISUAL MANUAL CLASSIFICATION (Fill)

Job WATANA DAM

No. 15032.003.08

Date 4-10-83

LF 761-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ SIEVE ☑ BRASS SIEVE ☑ HYDROMETER	Job No. 15032.003.08
Project WATANA DAM		Hole AS 3C	Depth 2.5-5' #2

~~Wet~~ Dry WT Total Sample & Tare	1415	TOTAL SAMPLE
Tare Weight SP-17	534	Classification Olive gravelly silty sand (SM)
Total Sample WT	881	

Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4	0			0	100
3/4"	19.1	14			0	98.4
½"	12.7	27			3.1	96.9
#4	4.6	75			8.5	91.5
#10	2.0					
Pan						
Total						

8.5 %. 8 wt.

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	1[illegible]
		Tare Weight	[illegible]
		Washed Sample Weight	[illegible]

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	134				[illegible]	[illegible]
20	0.850	115				[illegible]	[illegible]
30	0.600	334				[illegible]	[illegible]
40	0.425	278				[illegible]	[illegible]
100	0.150	428				[illegible]	[illegible]
200	0.075	533				60.5	39.5
270	0.053						
Pan		540					
Total							

52 %. [illegible]

39.5 %. [illegible]

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Deflocculation Agent

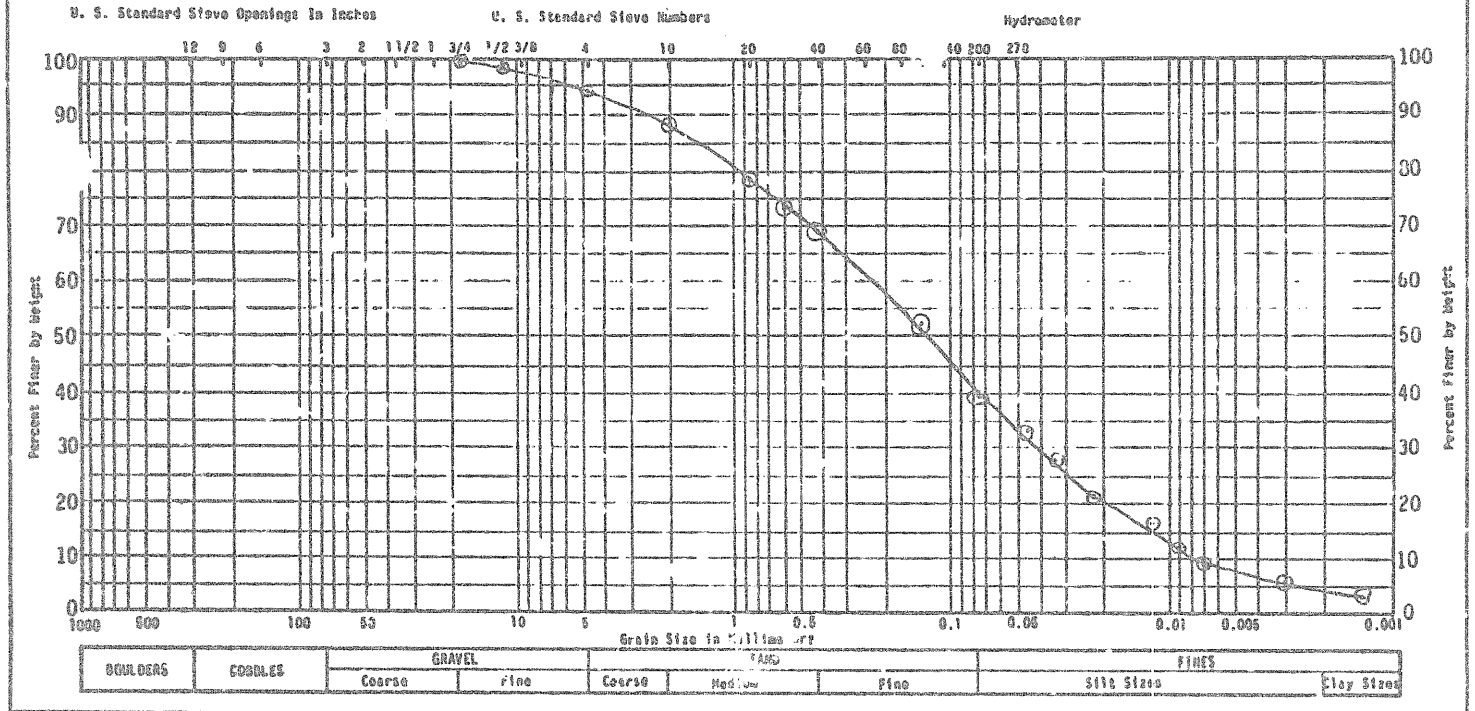
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	Rc	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: Cam | Computed by: [illegible] | Checked by: WA

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)
	AS-30	1	1-2.5	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-11-8

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

(mc)

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
Project WATANA DAM		Hole AS 33	Depth 2-5.5 #2

~~Air~~ Dry WT Total Sample & Tare	1567	TOTAL SAMPLE
Tare Weight A	540	Classification Olive gravelly silty sand (SM)
Total Sample WT	1027	

Moisture Content -10 Material	
Can No.	
WT-Soil & Can(Wet)	
WT-Soil & Can(Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	0			0	100
½"	12.7	31			3.0	97.0
#4	4.6	99			9.7	90.3
#10	2.0					
Pan						
Total						

8.7 % gr.

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.	Cum. % of Total Passing
10	2.000	164				24.5	75.5
20	0.850	277				41.5	58.5
30	0.600	329				48.9	51.1
40	0.425	382				56.8	43.2
100	0.150	572				85.0	15.0
200	0.075	607				90.2	9.8
270	0.053						
Pan		673					
Total							

56.2 % Sand

35.1 % fines

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

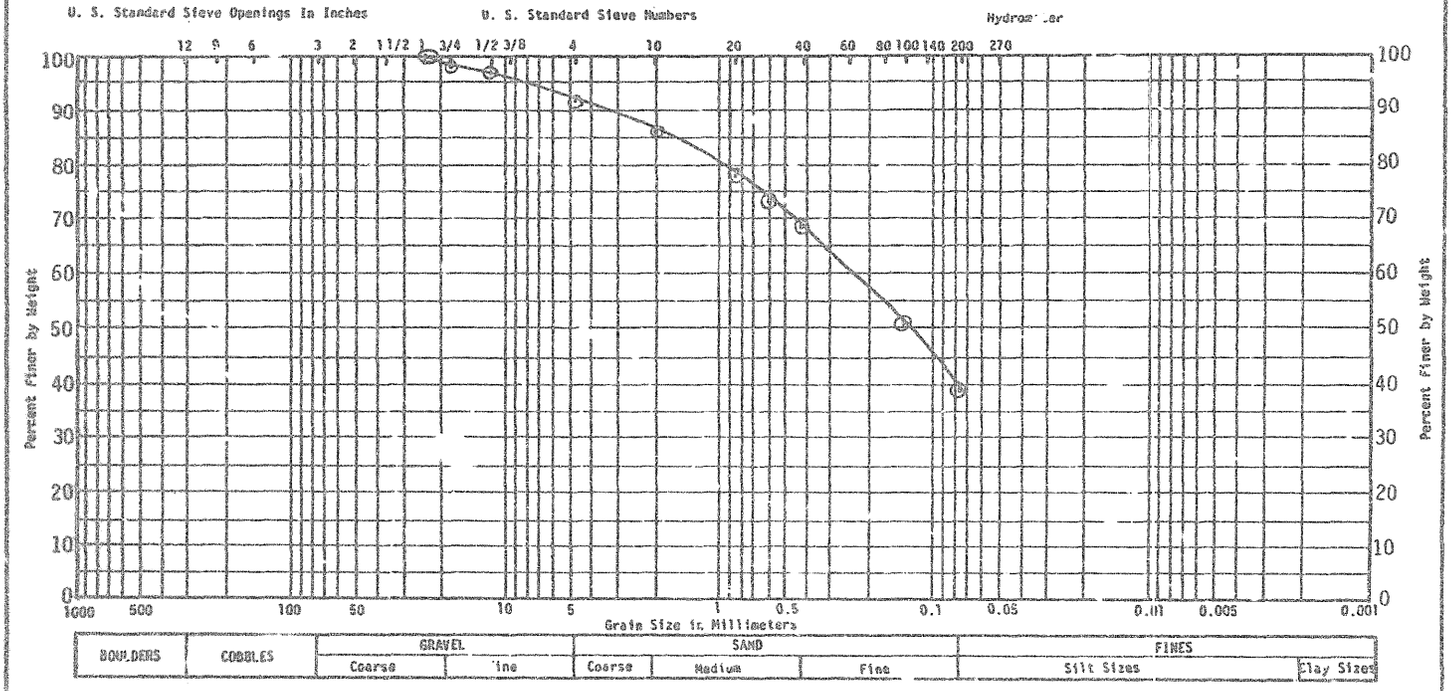
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	

Tested by: CWM | Computed by: CLA | Checked by: MA | 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)
	AS 30	2	2.5-5.0	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

LF 141-GSA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

(mc)

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐GILSON ☑BRASS SIEVE ☐HYDROMETER	Job No. 15032,003.08
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 (10-10)	545	Classification Dark Brown gravelly silty Sand (sm)
Total Sample WT	761	

Moisture Content -10 Material	
Can No.	
WT-Soil & Can(Wet)	
WT-Soil & Can(Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1	0			0.0	100.0
1"	25.4	84			11.0	89.0
3/4"	19.1	"			"	"
½"	12.7	110			14.5	85.5
#4	4.6	151			19.8	80.2
#10	2.0					
Pan						
Total						

19.8 % gravel

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	1067
		Tare Weight	545
		Washed Sample Weight	

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	193				25.4	74.6
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						
Pan		545					
Total							

21.0 % sand

29.2 % fines

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculatior Agent

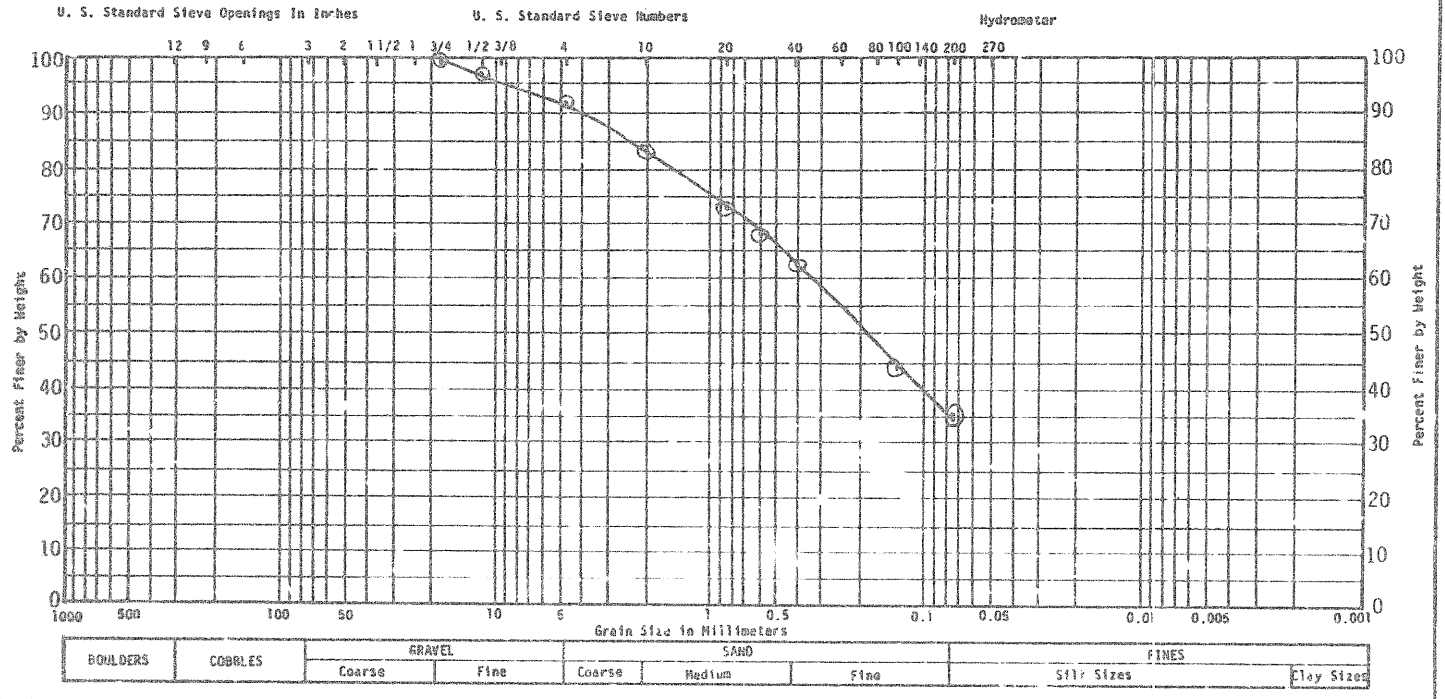
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

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

LF 139-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)
	AS 33	2	2-5.5	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

LF IN1-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole AS 36	Depth 0-2.5 #1

Dry WT Total Sample & Tare	1633	TOTAL SAMPLE
Tare Weight C	540	Classification Dark Brown silty gravelly sandy fine
Total Sample WT	1093	

Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4	0			0.0	100.0
3/4"	19.1	56			5.1	94.9
½"	12.7	82			7.5	92.5
#4	4.6	334			21.4	78.6
#10	2.0					
Pan						
Total						

21.4 % 9/1

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar # | WT Washed Sample & Tare 792 | Tare Weight 540 | Washed Sample Weight

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	244				21.5	68.5
20	0.850	461				42.1	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							

87

19.9 % fines

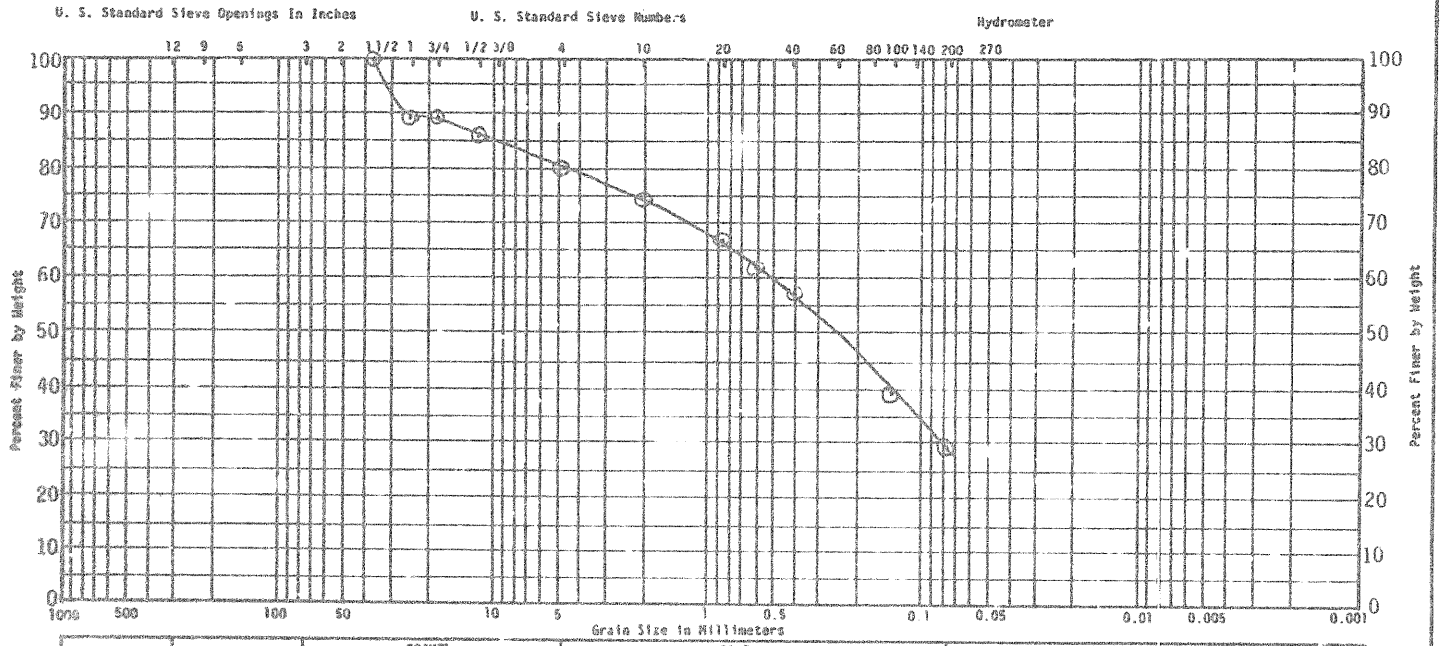
HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alconol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Init	Reading 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 C.B		Computed by M.A			Checked by M.H				Cu	

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)
	AS 35	1	0-25	

VISUAL MANUAL CLASSIFICATION Sample Not Large Min

Job WATANA DAM

No. 15032.0013.08

Date 4-11-83

LF 141-68A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
Project	WATANA DAM	Hole AS 37	Depth -2.5 #1

Dry WT Total Sample & Tare	478.9	TOTAL SAMPLE							
Tare Weight	88.0	Classification							
Total Sample WT	390.9	Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing	
Moisture Content -10 Material		4"	101.6						
		3"	76.2						
Can No.		2"	50.8						
WT-Soil & Can(Wet)		1½"	38.1						
WT-Soil & Can(Dry)		1"	25.4						
Loss		3/4"	19.1	0			0	100.0	
Weight of Can		½"	12.7	11			2.8	97.2	10.5 %
WT of Soil (Dry)		#4	4.6	41			10.5	89.5	
% Moisture		#10	2.0						
		Pan							
		Total							

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar # | WT Washed Sample & Tare | | Tare Weight | | Washed Sample Weight | 32

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing	
10	2.000	73				18.7	81.3	
20	0.850	102				30.2	69.8	
30	0.600	140				35.8	64.2	
40	0.425	162				41.4	58.6	
100	0.150	247				63.4	36.6	
200	0.075	294				75	25	2.5 %
270	0.053							
Pan		298						
Total								

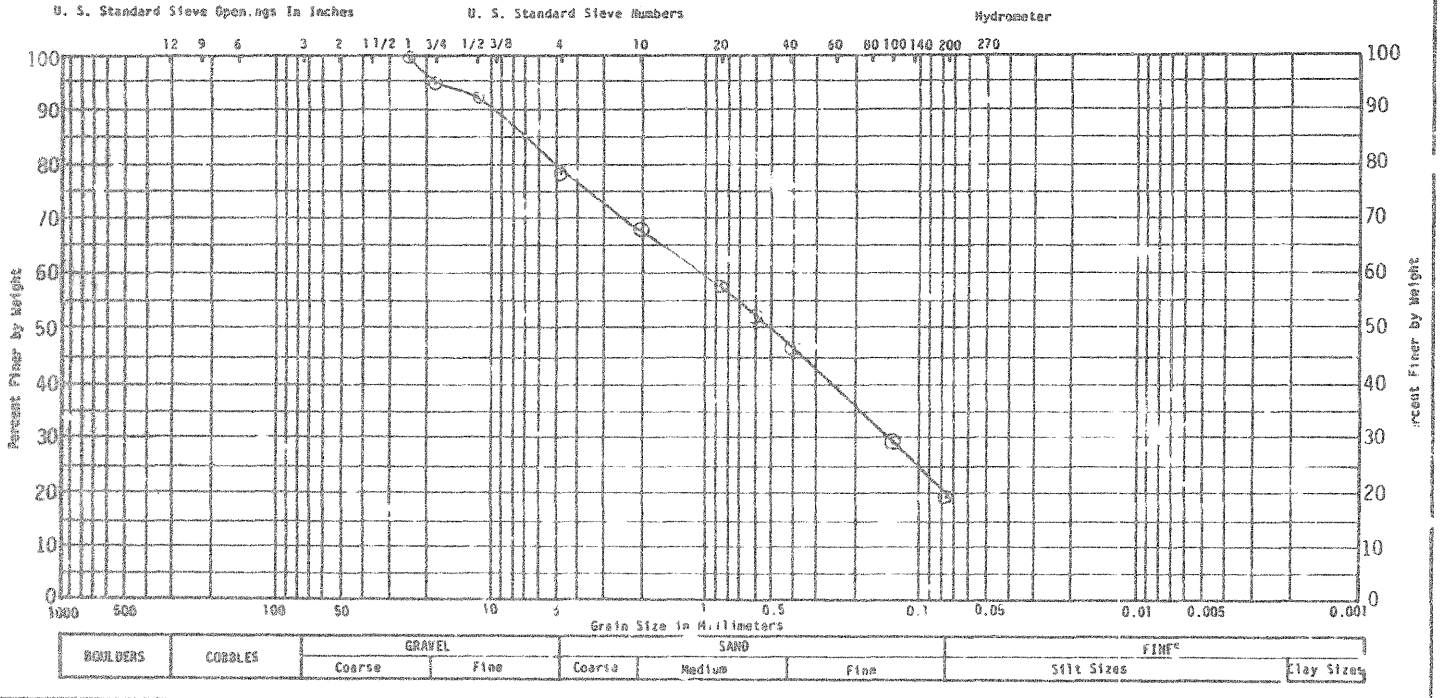
HYDROMETER SAMPLE

Specific Gravity	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								
									Cc	
Tested by:		Computed by:		Checked by:					Cu	

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 3C	1	0-25	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 1503?.003.08

Date 4-11-83

EF 141 - USA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

WORK SHEET - PARTICLE SIZE ANALYSIS

Date: 4/9/83 | ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER | Job No. 15032,003.08

Project: WATANA DAM | Hole: AS 38 | Depth: 1-2.5 #1

Dry WT Total Sample & Tare: 1247

Tare Weight: 540

Total Sample WT: 707

Moisture Content -10 Material

Can No.

WT-Soil & Can (Wet)

WT-Soil & Can (Dry)

Loss

Weight of Can

WT of Soil (Dry)

% Moisture

TOTAL SAMPLE

Classification: Sand (SM) [illegible] gravelly, silty

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	0			0.0	100.0
½"	12.7	40			5.	94.3
#4	4.6	93			13.2	86.8
#10	2.0					
Pan						
Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar # | WT Washed Sample & Tare: 1263 | Tare Weight: 540 | Washed Sample Weight:

Sieve Size	Dia. MM	Cum. WT	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.00	[illegible]				21.5	78.5
20	0.85	[illegible]				33.1	66.9
30	0.600	[illegible]				38.6	61.4
40	0.425	[illegible]				44.3	55.7
100	0.150	[illegible]				65.2	34.8
200	0.075	[illegible]				76.4	23.6
270	0.053						
Pan		544					
Total							

HYDROMETER SAMPLE

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

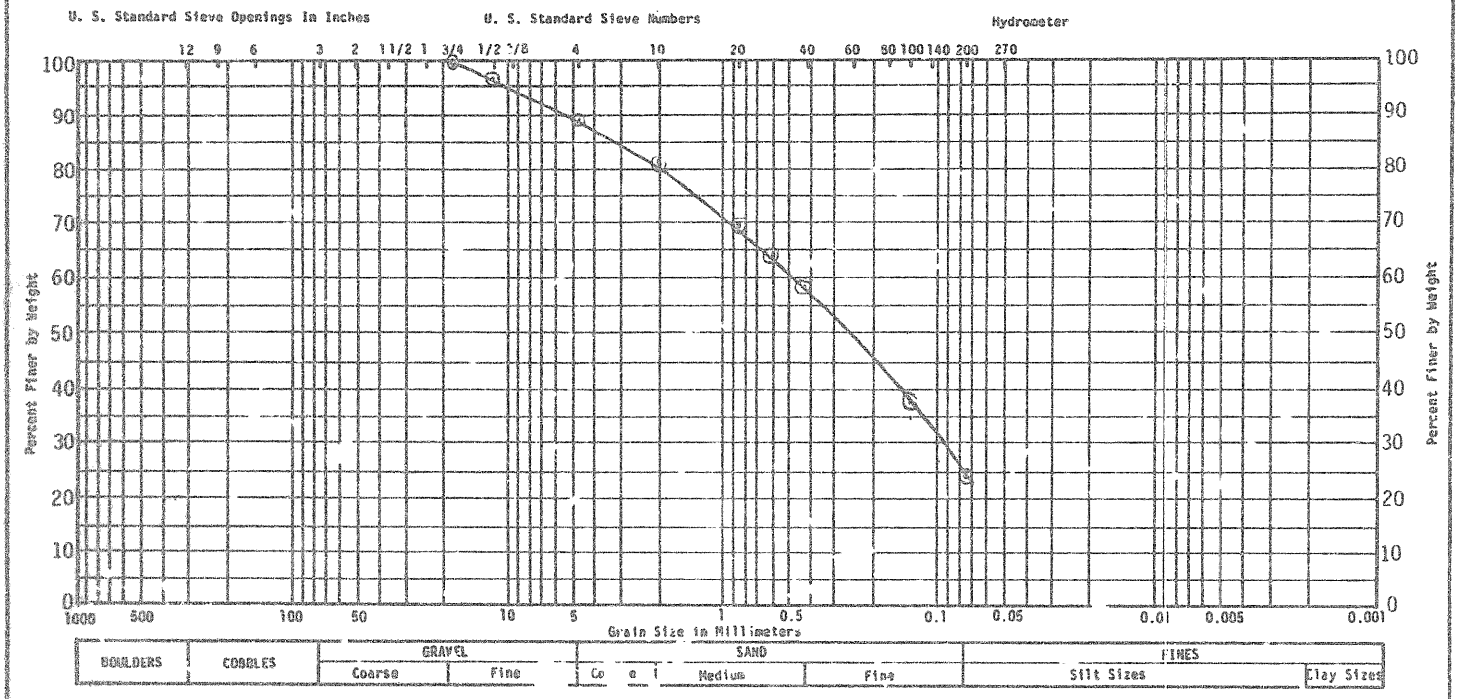
a = | Corrected Weight of Hydrometer Sample _____ grams | Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading 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: [illegible] | Computed by: [illegible] | Checked by: [illegible]

HARDING LAWSON ASSOCIATES
ENGINEERS GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 37	1	-2.5	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

LF 191-63A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole AS 40	Depth 1-2.5 = 1

Air Dry WT Total Sample & Tare	1242	TOTAL SAMPLE
Tare Weight	553	Classification (SM) Poorly Graded Silty Sand

Total Sample WT	689.0
Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1					
½"	12.7	2.0			.5	99.5
#4	4.6	5.5			1.3	98.7
#10	2.0					
Pan						
Total						

8.3

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample ____ grams	Jar #	WT Washed Sample & Tare	
		Tare Weight	
		Washed Sample Weight	423.2

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	7.3.0				17.1	82.9
20	0.840	162.0				38.2	61.8
30	0.600	210.0				49.6	50.4
40	0.425	233.1				55.0	45.0
100	0.150	354.0				83.6	16.4
200	0.075	423.0				99.8	0.2
270	0.053						
Pan		427.0					
Total							

55.2

HYDROMETER SAMPLE

Specific Gravity (G)	LL ____ PI ____	Hydrometer No.	Amyl Alcohol Drops: ____
a =	Corrected Weight of Hydrometer Sample ____ grams		Defloculation Agent

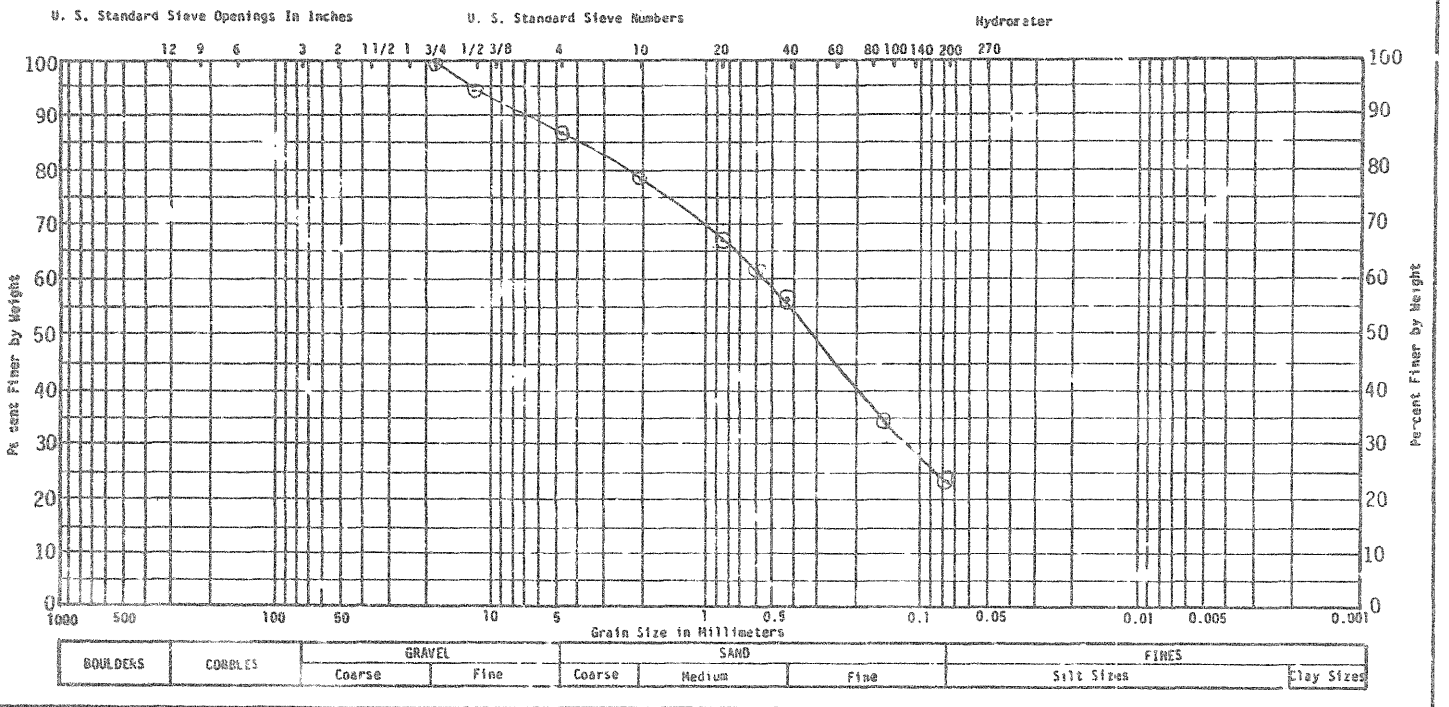
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: CRM | Computed by: [illegible] | Checked by: [illegible]

LF 135-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 38	1	1-2.5	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15932.003.08

Date 4-11-83

LF 181-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	JCD No. 15032,00 ,08
Project	WATANA DAM	Hole AS 41	Depth 2-4 #2

Dry WT Total Sample & Tare	591.3
Tare Weight	88
Total Sample WT	503.3
Moisture Content -10 Material	
Can No.	
WT-Soil & Can(Wet)	
WT-Soil & Can(Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

TOTAL SAMPLE

Classification: Coarse gravelly silty sand (SM)

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
¾"	19.1	2			0.0	100.0
½"	12.7	4			0.8	99.2
#4	4.6	47			9.3	90.7
#10	2.0					
Pan						
Total						

9.3 % SM

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.	Cum. % of Total Passing
10	2.000	86				17.1	82.9
20	0.850	125				24.8	75.2
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
270	0.053						
Pan		293					
Total							

48.1 % sand

42.4 % fines

HYDROMETER SAMPLE

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

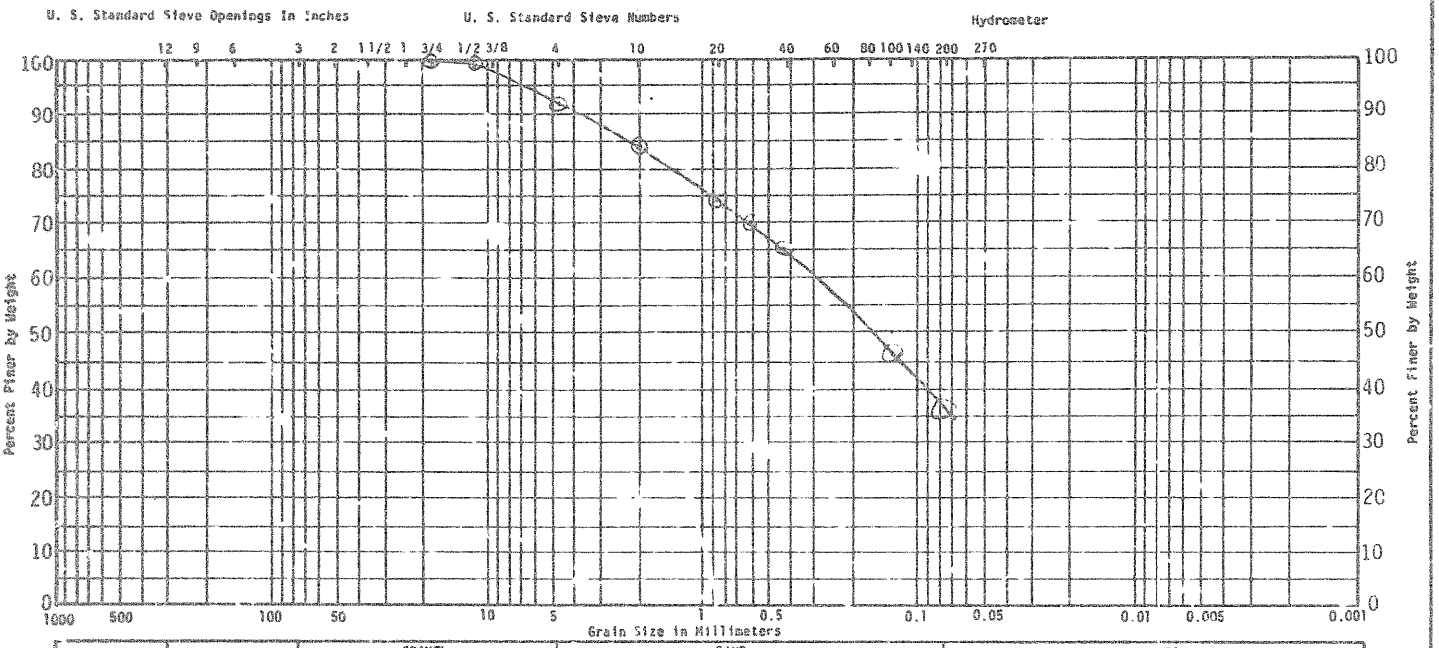
a =	Corrected Weight of Hydrometer Sample _____ grams	Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading 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: G.B. | Computed by: MA | Checked by: 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)
	AS 40	1	1-2.5	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 5032.003.08

Date 9-16-83

LF 141-63A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

(ML)

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
Project WATANA DAM		Hole AS 42.	Depth 1-2.5 #1

Dry WT Total Sample & Tare	723.2	TOTAL SAMPLE
Tare Weight	87.7	Classification Very Dark Brown gravelly silty sand (SM)
Total Sample WT	635.5	

Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	0			0.0	100.0
½"	12.7	21			3.3	96.7
#4	4.6	73			11.5	88.5
#10	2.0					
Pan						
Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	435
		Tare Weight	57.1
		Washed Sample Weight	377.9

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	76				19.8	80.2
20	0.850	163				28.6	71.4
30	0.600	212				32.9	67.3
40	0.425	241				36.8	63.2
100	0.150	341				52.1	47.9
200	0.075	378				62.6	37.4
270	0.053						
Pan		400					
Total							

HYDROMETER SAMPLE

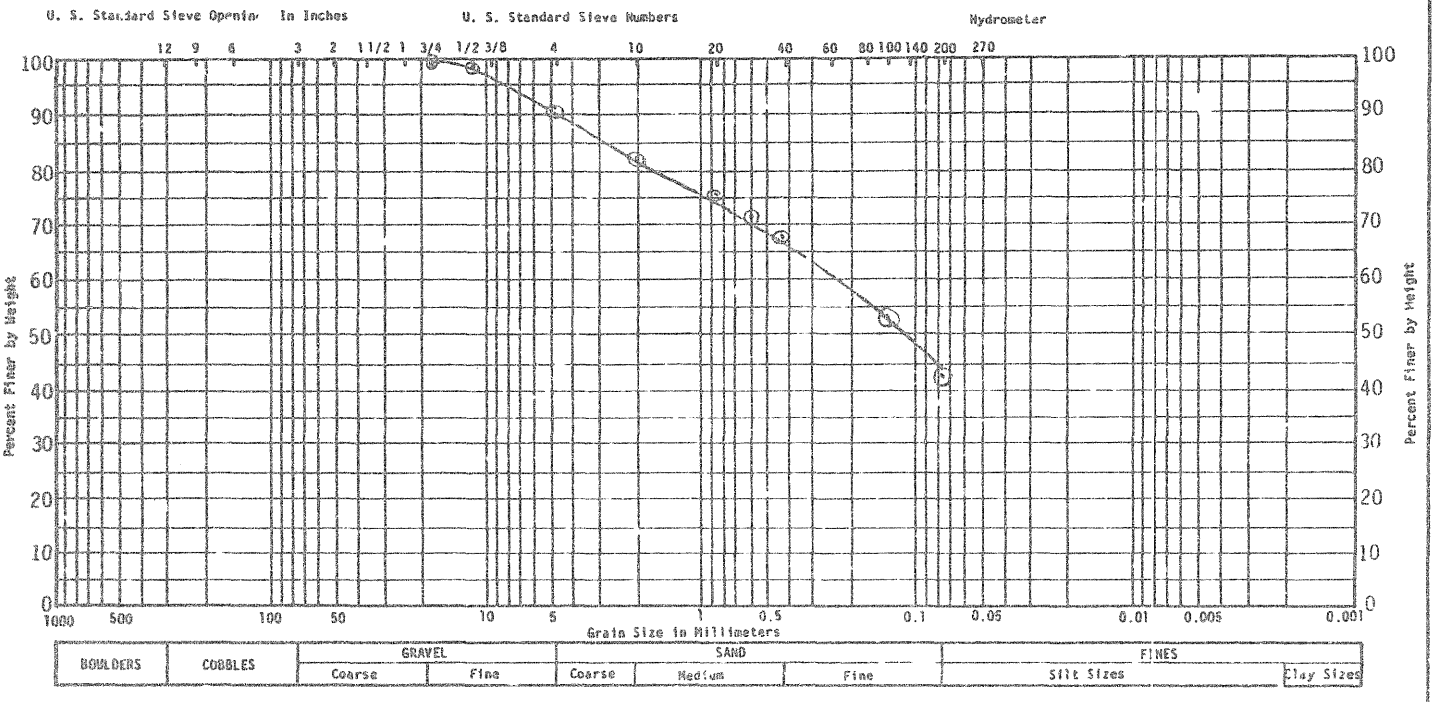
Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading 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								
									Cc	
Tested by: G.B		Computed by: M.A			Checked by: M.A				Cu	

LF 35-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS41	2	2-4	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-11-85

LF 141-G5A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

(Gs) (mc)

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐GILSON ☑BRASS SIEVE ☐HYDROMETER	Job No. 15032,003.08
Project	WATANA DAM	Hole AS 42	Depth 2.5-5.0 #2

Dry WT Total Sample & Tare	1177	TOTAL SAMPLE
Tare Weight	562	Classification silty gravelly sand (SM)
Total Sample WT	615	

Moisture Content -10 Material	
Can No.	
WT-Soil& Can(Wet)	
WT-Soil& Can(Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1	0			0	100
1"	25.4	47			7	93
3/4"	19.1	41			6	87
½"	12.7	83			12	75
#4	4.6	157			23	77
#10	2.0					
Pan						
Total						

22 % gvl

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.	Cum. % of Total Passing
10	2.000	77				3	97
20	0.850	211				8	92
30	0.600	311				12	88
40	0.425	391				15	85
100	0.150	594				23	77
200	0.075	677				26	74
270	0.053						
Pan		771					
Total							

57 % sand

20 % fines

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Deflocculation Agent

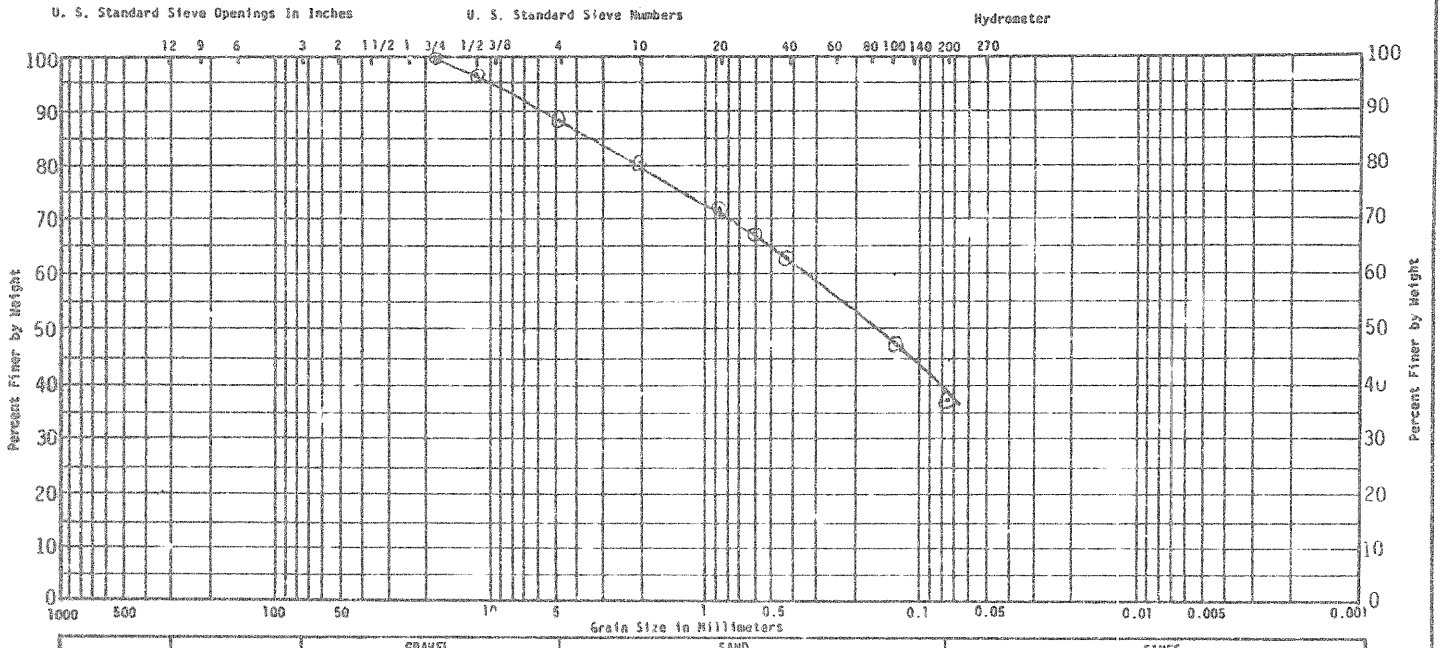
Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl.	Reading Actual	Rc	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								

Tested by: _____ Computed by: KM Checked by: MA a _____ Gs _____

F-35-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)
	A542	1	1-2.5	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

LF 141-63A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

(ML)

WORK SHEET - PARTICLE SIZE ANALYSIS

Date 4/9/83 | ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER | Job No. 15032.003.08

Project WATANA DAM | Hole AS 44 | Depth 2-4 #2

Dry WT Total Sample & Tare 12 - | Tare Weight 431 | Total Sample WT 9135

Moisture Content -10 Material | Can No. | WT-Soil & Can(Wet) | WT-Soil & Can(Dry) | Loss | Weight of Can | WT of Soil (Dry) | % Moistu

TOTAL SAMPLE

Classification: Olive Brown gravelly silty sand (SM)

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	8			5	100
½"	12.7	41			15	94.0
#4	4.6	52			20.5	90.4
#10	2.0					
Pan						
Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar # | WT Washed Sample & Tare 1[illegible] | Tare Weight [illegible] | Washed Sample Weight [illegible]

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	54					
20	0.850	3[illegible]					
30	0.600	3[illegible]					
40	0.425	[illegible]					
100	0.150	5[illegible]					
200	0.075	5[illegible]					
270	0.053						
Pan		[illegible]					
Total							

HYDROMETER SAMPLE

Specific Gravity (G) | LL _____ PI _____ | Hydrometer No. | Amyl Alcor Drops: _____

a = | Corrected Weight of Hydrometer Sample _____ grams | Deflocculation Agent

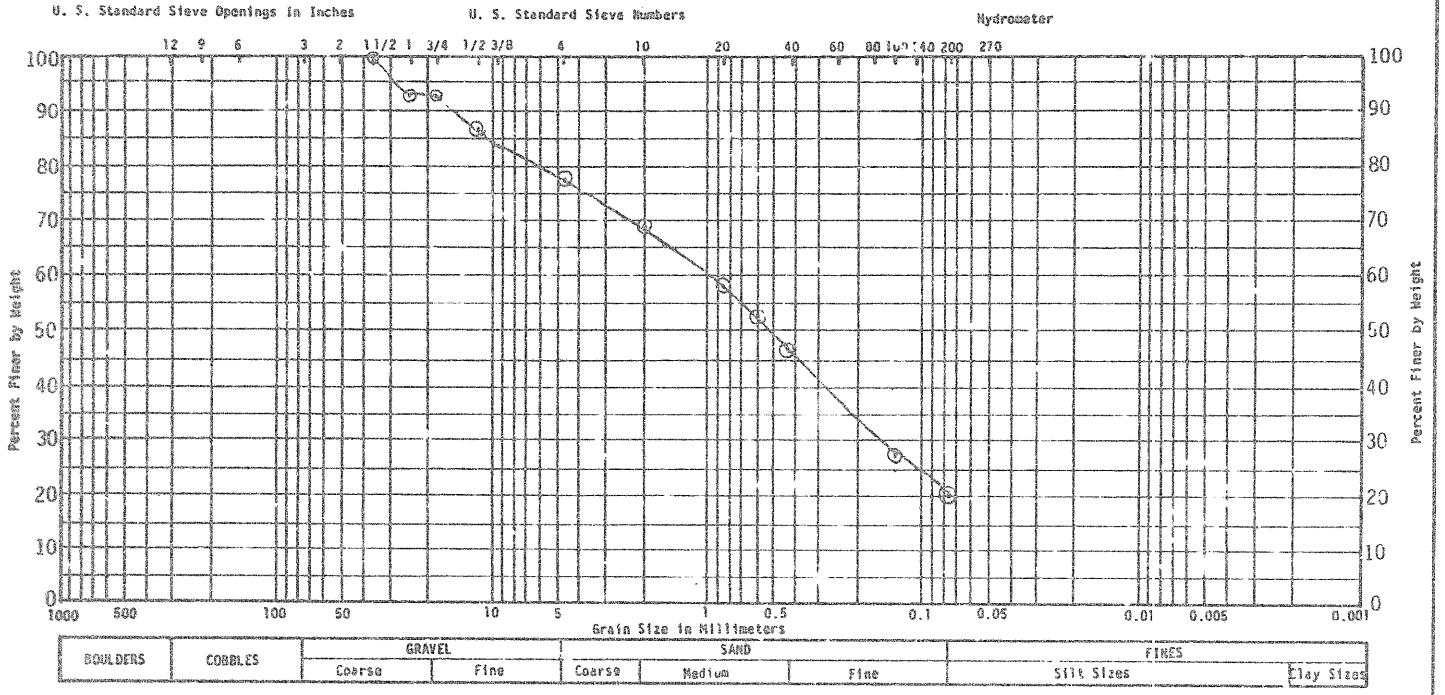
Time	Elap. Time	Maxim Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	Rc	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002							Cc	

Tested by: [illegible] | Computed by: MA | Checked by: [illegible] | Cu

LF-35-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)
	AS 42	2	2.5-5.0	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-[illegible]-83

EF 141-G5A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

MC

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
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: Gravelly coarse to fine silty sand (SM)
Total Sample WT	742.09	

Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1					
½"	12.7	0			0.0	100.0
#4	4.6	22			3.0	97.0
#10	2.0					
Pan						
Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar

WT Washed Sample & Tare	501
Tare Weight	90.71
Washed Sample Weight	410.29

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	57				13.9	86.1
20	0.850	82				20.0	80.0
30	0.600	156				38.0	62.0
40	0.425	193				47.1	52.9
100	0.150	385				93.9	6.1
200	0.075	406				99.0	1.0
270	0.053						
Pan		413					
Total							

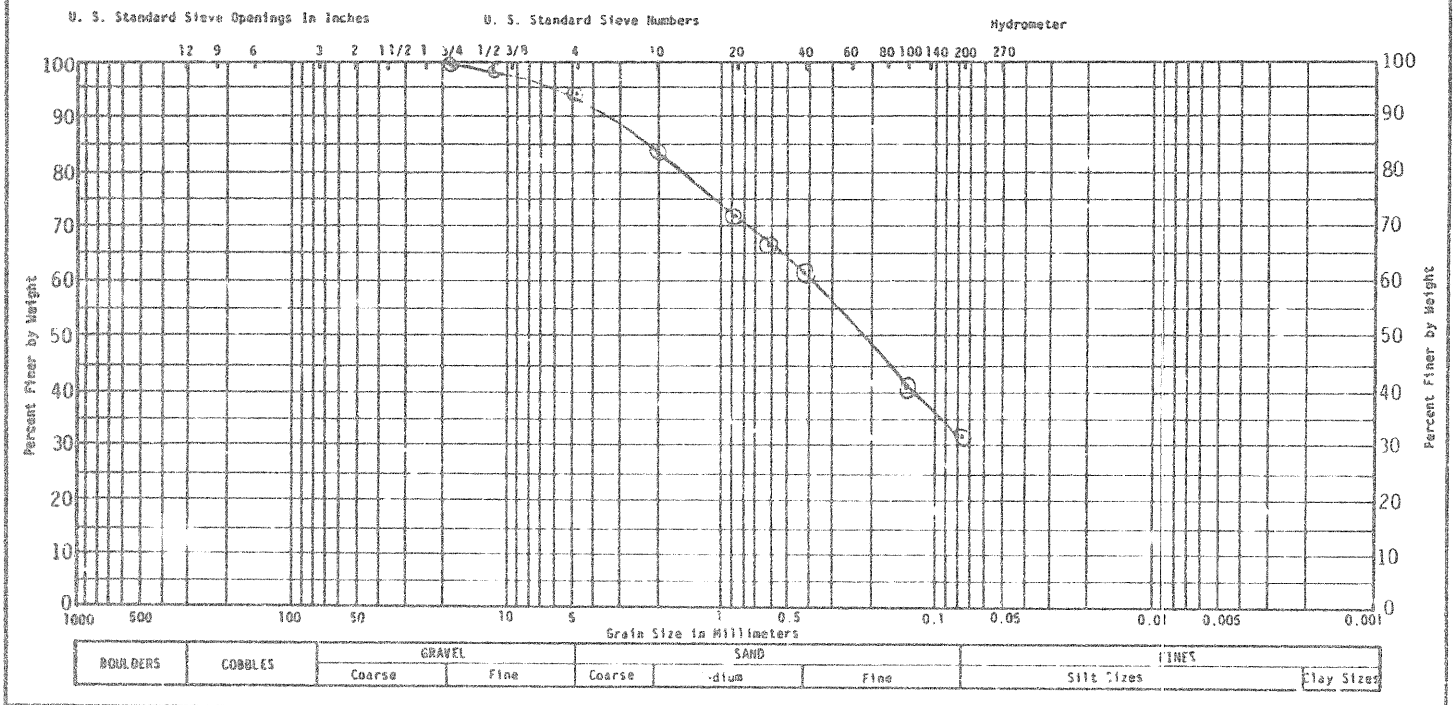
HYDROMETER SAMPLE

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 Initial	Reading Actual	R_c	-	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: G.P.		Computed by: M.L.			Checked by: MM				Cu	

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	-dium	Fine	Silt Sizes	Clay Sizes

LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USCS)
	AS84	2	3-4	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

MC

WORK SHEET - PARTICLE SIZE ANALYSIS

☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER

Date: 4/9/83 | Job No. 15032,003.08

Project: WATANA DAM | Hole: AS 45 | Depth: 3'-5' #2

C EN

Dry WT Total Sample & Tare: 1842.0

Tare Weight: AA 542

Total Sample WT: 1303.0

Moisture Content -10 Material

Can No.

WT-Soil & Can (Wet)

WT-Soil & Can (Dry)

Loss

Weight of Can

WT of Soil (Dry)

% Moisture

TOTAL SAMPLE

Classification: Olive gravelly silty sand (SM)

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1					
½"	12.7	0			0	100
#4	4.6	75.0			5.7	94.3
#10	2.0					
Pan						
Total						

5.8 % gvl.

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.	Cum. % of Total Passing
10	2.000	1240					
20	0.850	3163					
30	0.600	3830					
40	0.425	4550					
100	0.150	7290					
200	0.075	8230					
270	0.053						
Pan		8360					
Total							

57.6 % sand

36.6 % fines

HYDROMETER SAMPLE

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

a = | Corrected Weight of Hydrometer Sample _____ grams | Deflocculation Agent

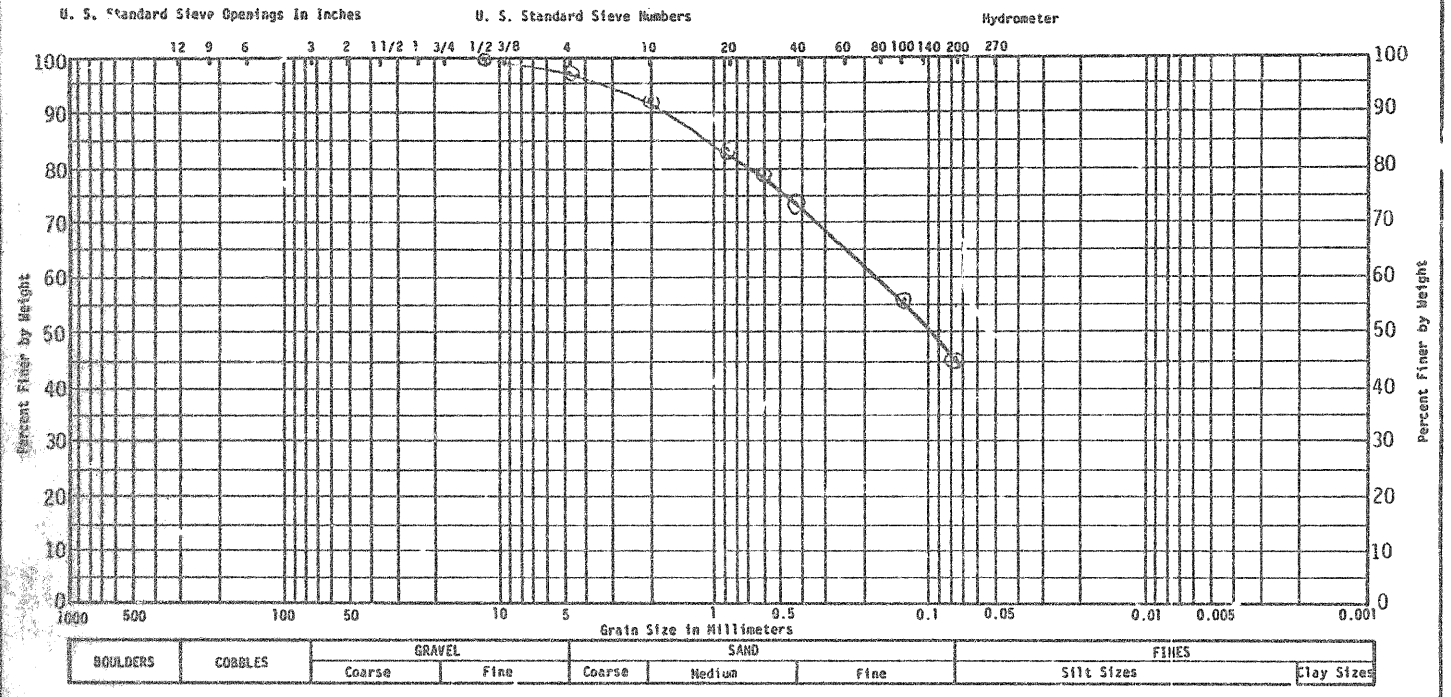
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: CK/M | Computed by: RM | Checked by: MA

LF 139 - MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 45	1	1-2.5	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 9-11-83

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole AS 46	Depth .5-2.0 #1

OVEN

Dry WT Total Sample & Tare	1335	TOTAL SAMPLE
Tare Weight	538	Classification Dark brown gravelly silty sand (SM)

		Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
Total Sample WT	797.0	4"	101.6					
Moisture Content -10 Material		3"	76.2	0			0	100
Can No.		2"	50.8	0			0	100
WT-Soil& Can(Wet)		1½"	38.1	0			0	100
WT-Soil& Can(Dry)		1"	25.4	0			0	100
Loss		3/4"	19.1	16.5			3.3	96.7
Weight of Can		½"	12.7	21.0			2.6	97.4
WT of Soil (Dry)		#4	4.6	[illegible]			[illegible]	[illegible]
% Moisture		#10	2.0					
		Pan						
		Total						

10.3 % gvl

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	1114.0
		Tare Weight	538.0
		Washed Sample Weight	576.0

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum % of Total Ret.	Cum % of Total Passing
10	2.000	152.0				17.7	[illegible]
20	0.850	238.0				29.9	70.1
30	0.600	294				35.0	[illegible]
40	0.425	334				40.3	59.7
100	0.150	460.0				53.3	33.3
200	0.075	560.0				70.9	29.1
270	0.053						
Pan		577.0					
Total							

60.7 % [illegible]
25.[illegible]
29.1 % fines

HYDROMETER SAMPLE

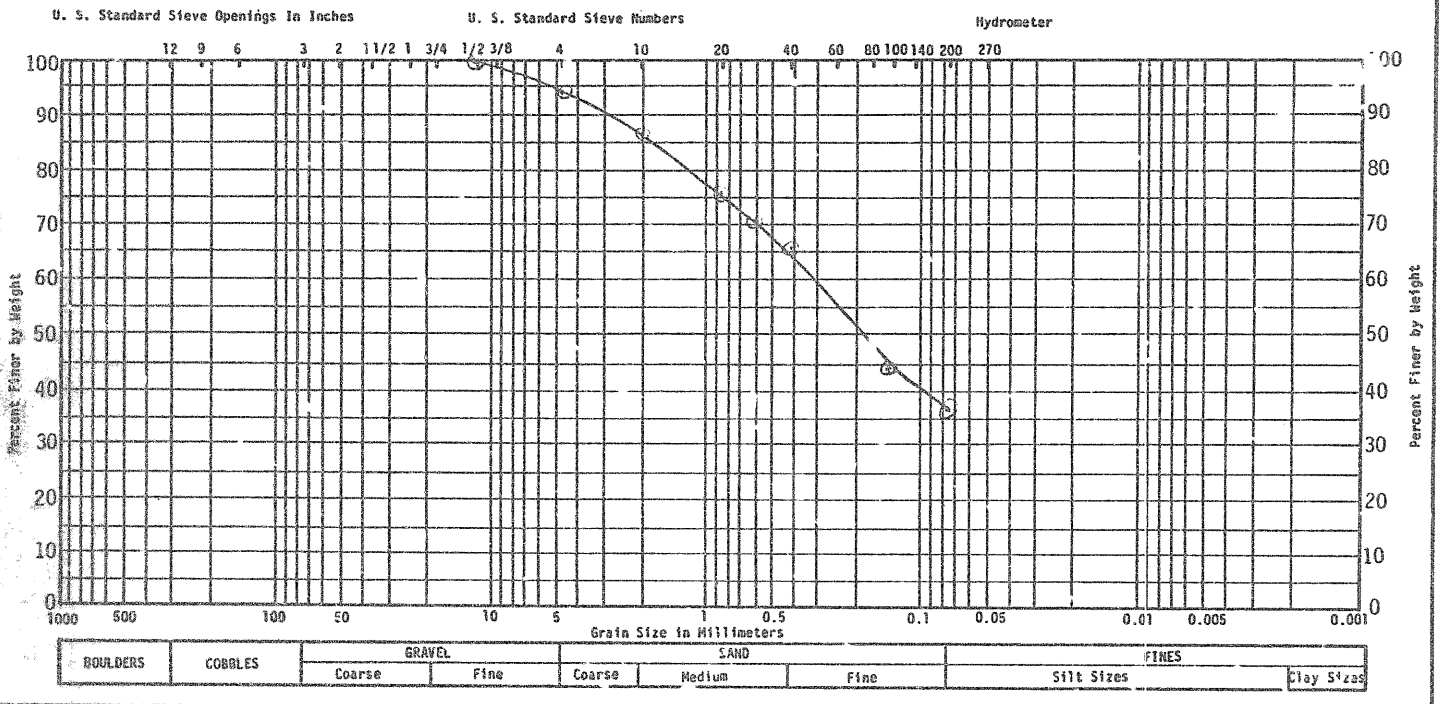
Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl.	Reading 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								
									Cc	
Tested by: RAM		Computed by: RAM		Checked by: MH					Cu	

LF 135 - MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 45	D	3-5'	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-10-83

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

(mc)

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
Project WATANA DAM		Hole AS 49	Depth 2-3.5 #1

~~Air~~ 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.	Cum. % of Total Passing	
Moisture Content -10 Material		4"	101.6						
		3"	76.2						
Can No.		2"	50.8						
WT-Soil & Can (Wet)		1½"	38.1						
WT-Soil & Can (Dry)		1"	25.4	0			0	100	
Loss		3/4"	19.1	19			1.6	98.4	7.3 % Silt
Weight of Can		½"	12.7	33			2.8	97.2	
WT of Soil (Dry)		#4	4.6	75			7.3	92.7	
% Moisture		#10	2.0						
		Pan							
		Total							

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar # | WT Washed Sample & Tare 1163 | Tare Weight 559 | Washed Sample Weight 604

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing	
10	2.000	150				12.9	87.1	
20	0.850	242				20.8	79.2	47.5 % Sand
30	0.600	289				24.8	75.2	
40	0.425	332				28.6	71.4	
100	0.150	539				46.3	53.7	
200	0.075	626				53.8	46.2	
270	0.053							45.2 % fines
Pan		627						
Total								

HYDROMETER SAMPLE

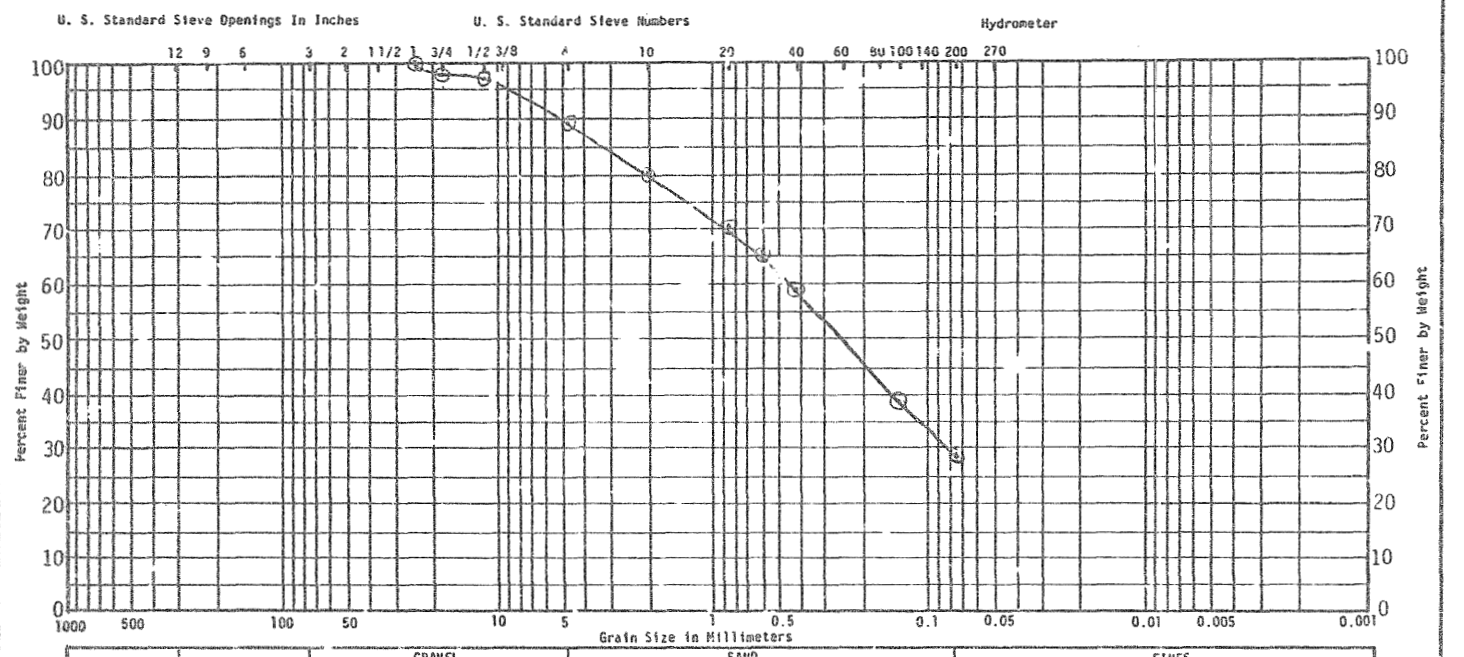
Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alconol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	Reading 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								
									Cc	
Tested by:		Computed by:		Checked by:					Cu	

LF-35-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 46	1	.5-2.0	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-10-83

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

PI

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☐ BRASS SIEVE ☑ HYDROMETER	Job No. 15032,003.08
Project	WATANA DAM	Hole AS 49	Depth 5-7.5 #2

Dry WT Total Sample & Tare		TOTAL SAMPLE
Tare Weight	IR	Classification Olive silty sand (SM)
Total Sample WT		

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1					
½"	12.7					
#4	4.6					
#10	2.0					
Pan						
Total						

Moisture Content -10 Material	
Can No.	F
WT-Soil & Can (Wet)	42.25
WT-Soil & Can (Dry)	42.14
Loss	.11
Weight of Can	11.47
WT of Soil (Dry)	30.67
% Moisture	.4

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample 72.63 grams | Jar # K

WT Washed Sample & Tare 126
Tare Weight [illegible]
Washed Sample Weight 36.68

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total 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) 2.72 (Tested) | LL 20 61 mL | PI 5 | Hydrometer No. 5 | Amyl Alcohol Drops: ____

a = 0.99 | Corrected Weight of Hydrometer Sample 72.34 grams | Deflocculation Agent

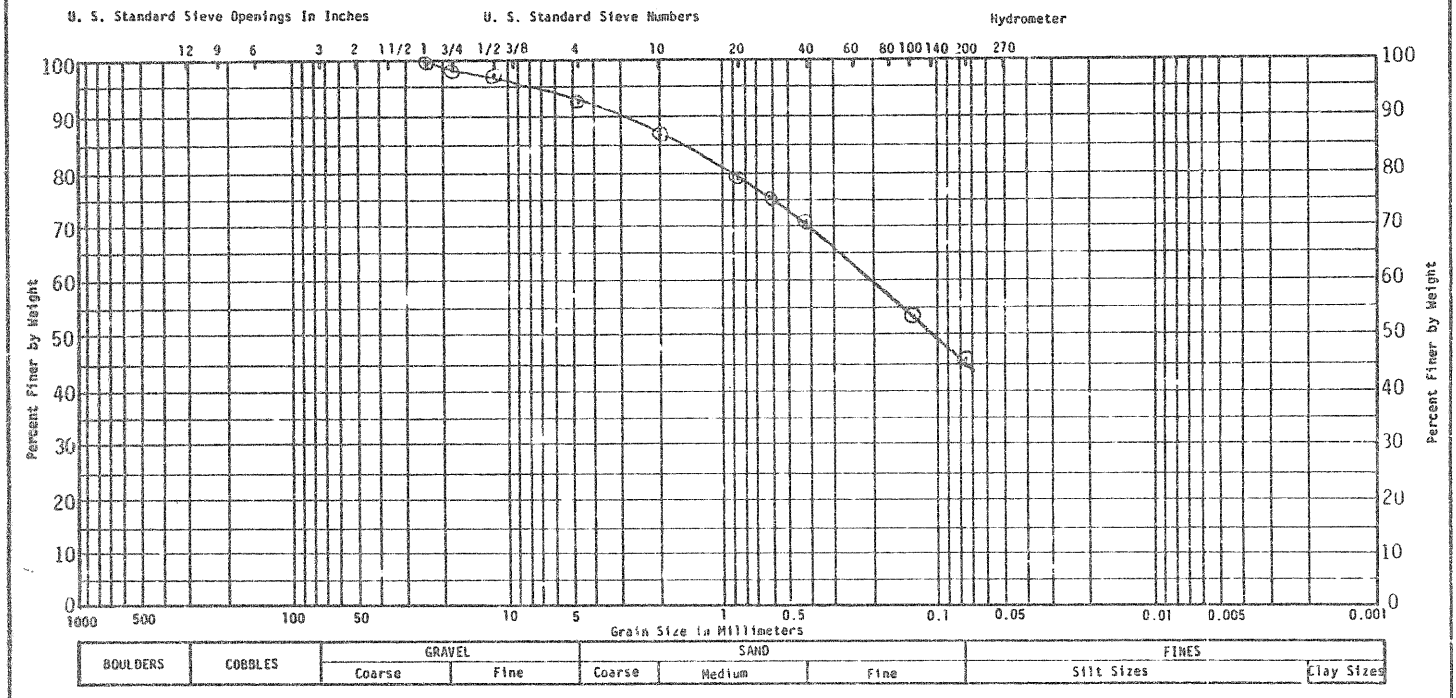
1010 Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	Rc	L	Corrected Gram Size, Dia. MM	% of Total Passing
1'	1	0.078	15.3	0.0142	39	40	7.9	10.1	0.045	41.2
2	2	0.055	15.3	"	35	36	"	10.7	0.033	35.7
5	5	0.035	15.0	"	31	33	8.0	11.4	0.021	30.1
15	15	0.020	15.0	"	27		"	11.9	0.013	26.0
30	30	0.014	15.0	"	24.5		"	12.3	0.009	22.6
1h	60	0.010	15.0	"	22.1		"	12.7	0.007	19.3
4h	240	0.005	15.0	"	33		"	13.3	0.003	14.1
16h	1440	0.002		0.0136			7.2	14.0	0.0013	9.0
									Cc	
									Cu	

Tested by: [illegible]/G.B. Computed by: M.A Checked by: M.A

LF 125 - 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)
	AS 49	1	2 -3.5	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

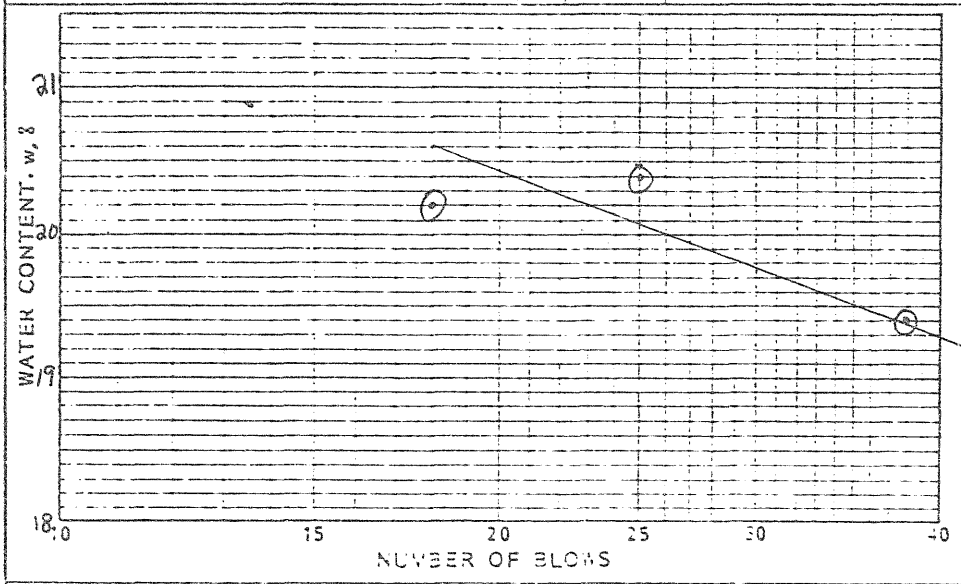
ATTERBERG LIMITS DETERMINATION

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 W_w	5.90	6.79	8.92			
	TARE	11.20	11.25	11.10			
	DRY SOIL W_s	29.18	35.03	43.79			
WATER CONTENT, %	w	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

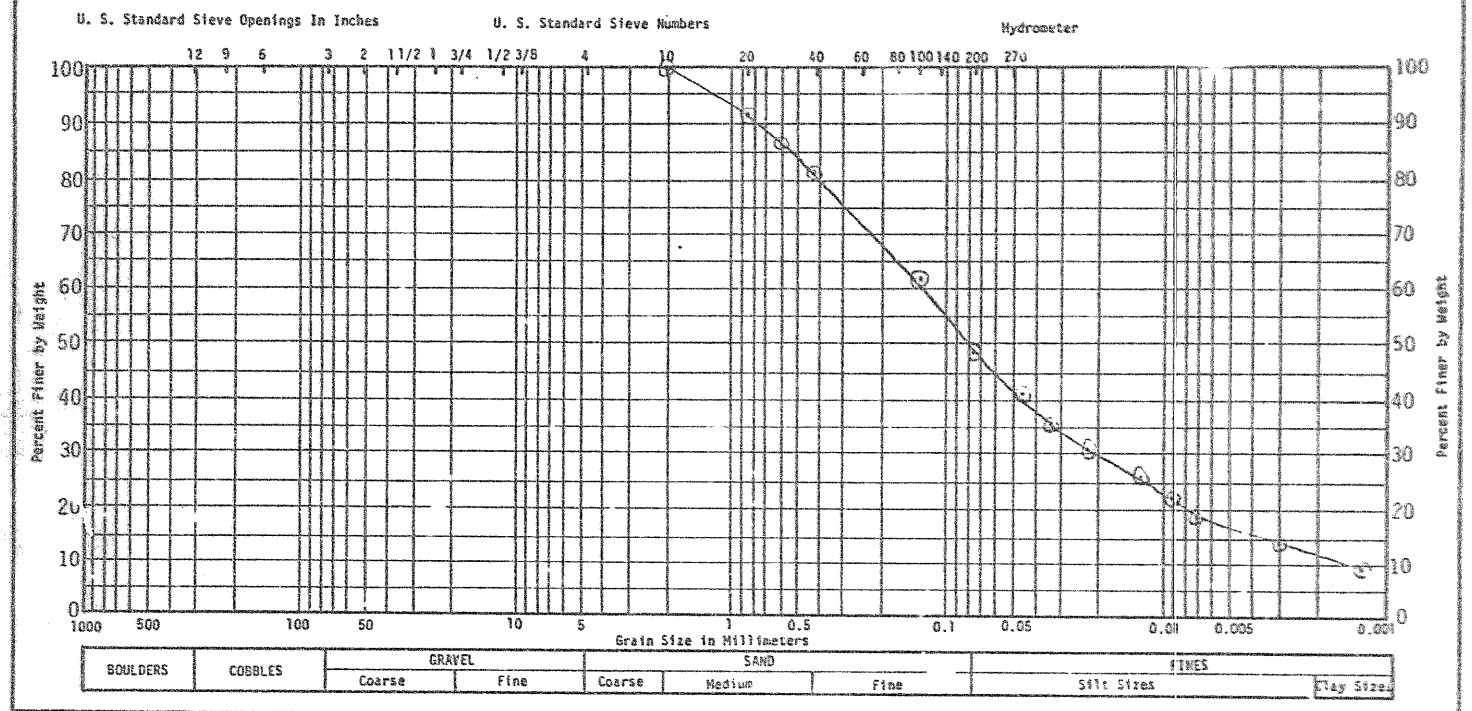
RUN NO.		1	2	3	4	5	NATURAL WATER CONTENT
TARE NO.		A-17	A-28				
WEIGHT IN GRAMS	TARE PLUS WET SOIL	8.87	11.65				
	TARE PLUS DRY SOIL	8.27	10.68				
	WATER	.60	.97				
	TARE	4.36	4.40				
	DRY SOIL	3.91	6.28				
WATER CONTENT, %		15.3	15.4				
PLASTIC LIMIT, w_p		AVG = 15.35					

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: S.B.
CHECKED BY: MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



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 8-12-83

LF 141-654

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

WORK SHEET - PARTICLE SIZE ANALYSIS

Date 4/9/83 ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER

Job No. 15032.003.08

Project WATANA DAM

Hole AS 51

Depth 1-2.5 #1

OVEN

~~Wet~~ Dry WT Total Sample & Tare: 1320

Tare Weight CC: 536

Total Sample WT: 784.0

Moisture Content -10 Material

Can No.

WT-Soil& Can(Wet)

WT-Soil& Can(Dry)

Loss

Weight of Can

WT of Soil (Dry)

% Moisture

TOTAL SAMPLE

Classification: Olive gravelly silty sand (SM)

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4				0	100
3/4"	19.1	0			3.6	96.4
½"	12.7	28			10.2	89.8
#4	4.6	80				
#10	2.0					
Pan						
Total						

10.2 % gravel

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams

Jar #

WT Washed Sample & Tare: 1.080.5

Tare Weight: [illegible]

Washed Sample Weight: 650.5

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	155				17.8	50.2
20	0.850	260				33.4	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							

49.2 % sand

20.5 % fines

HYDROMETER SAMPLE

Specific Gravity (G)

LL _____

PI _____

Hydrometer No.

Amyl Alcohol Drops: _____

a =

Corrected Weight of Hydrometer Sample _____ grams

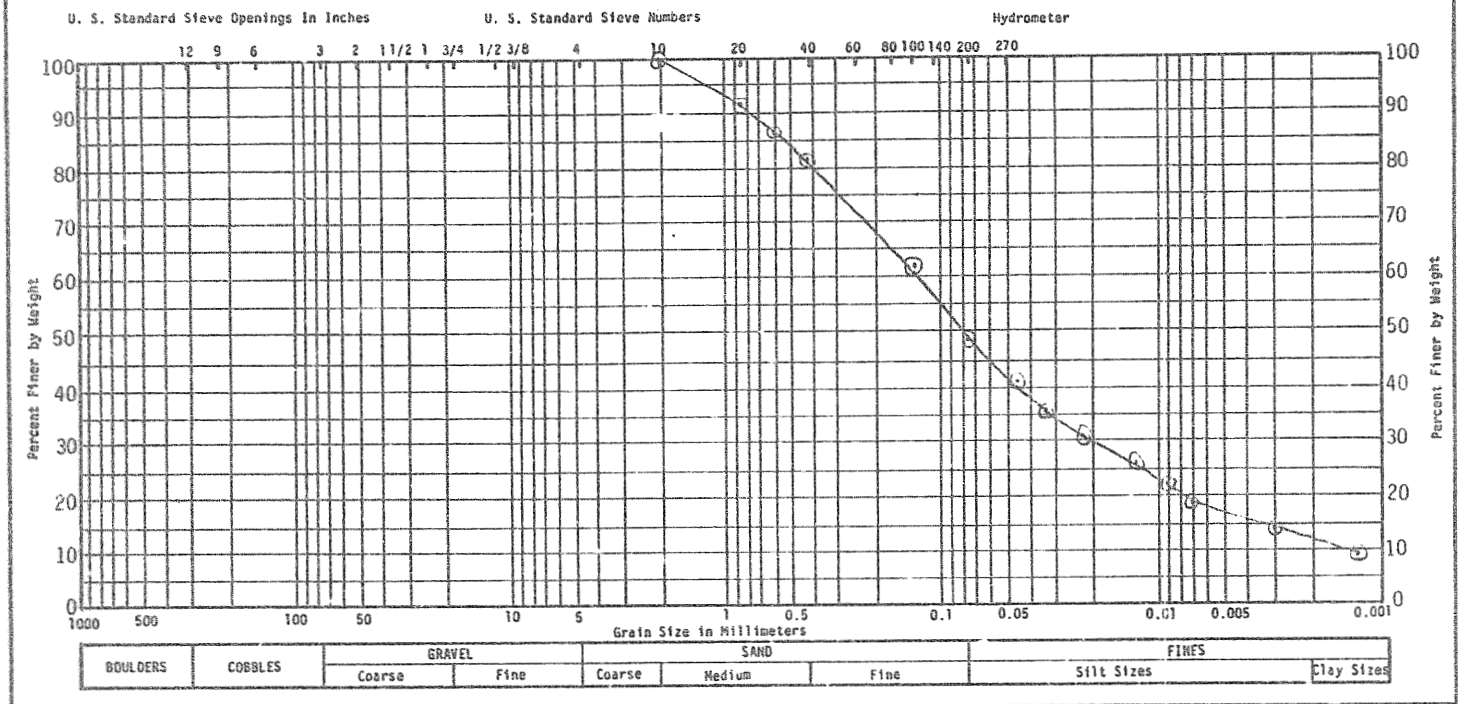
Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading 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								
									Cc	
Tested by: CNM			Computed by: [illegible]		Checked by: MM				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)
	AS 47	2	5-7.5	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 1-12-83

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
Project WATANA DAM		Hole AS 51	Deptn 3-5 #2

Dry WT Total Sample & Tare	1532	TOTAL SAMPLE
Tare Weight	1076	Classification Olive gravelly silty sand (SM)
Total Sample WT	1151	

Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4	0			0	100
3/4"	19.1	17.0			1.5	98.5
½"	12.7	22.5			1.9	98.1
#4	4.6	81.5			6.4	93.1
#10	2.0					
Pan						
Total						

6.9 % +4

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	[illegible]
		Tare Weight	[illegible]
		Washed Sample Weight	= 850

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	140				17.0	83.0
20	0.850	231				19.8	80.2
30	0.600	279				23.1	76.1
40	0.425	324				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							

50.2 % +10
43.0 % -200

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

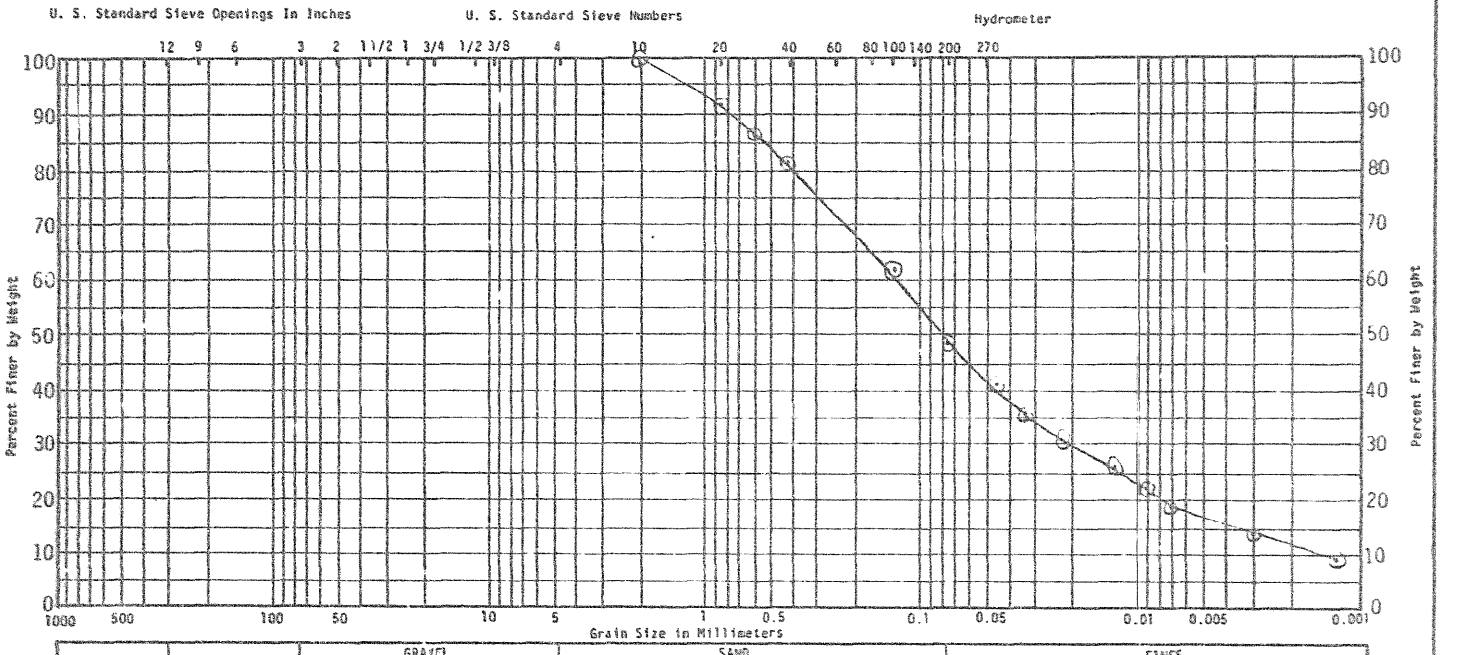
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: CAM | Computed by: RPM | Checked by: MH

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)
	AS 49	2	5-7.5	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-12-83

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

WORK SHEET - PARTICLE SIZE ANALYSIS

Date 4/9/83 | ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER | Job No. 15032,003.08

Project WATANA DAM | Hole AS 54 | Depth 1-2 #1

Dry WT Total Sample & Tare: 1368

Tare Weight: 536

Total Sample WT: 832

Moisture Content -10 Material

Can No.

WT-Soil& Can(Wet)

WT-Soil& Can(Dry)

Loss

Weight of Can

WT of Soil (Dry)

% Moisture

TOTAL SAMPLE

Classification: [illegible] gravelly silty sand (SM)

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	3			[illegible]	[illegible]
½"	12.7	-1			[illegible]	[illegible]
#4	4.6	45			[illegible]	[illegible]
#10	2.0					
Pan						
Total						

5.4 % soil

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar # | WT Washed Sample & Tare: [illegible] | Tare Weight: [illegible] | Washed Sample Weight: [illegible]

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	[illegible]				[illegible]	[illegible]
20	0.850	[illegible]				[illegible]	[illegible]
30	0.600	[illegible]				[illegible]	[illegible]
40	0.425	[illegible]				[illegible]	[illegible]
100	0.150	[illegible]				[illegible]	[illegible]
200	0.075	[illegible]				[illegible]	[illegible]
270	0.053						
Pan		[illegible]					
Total							

50.4 % sand

44 % [illegible]

HYDROMETER SAMPLE

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

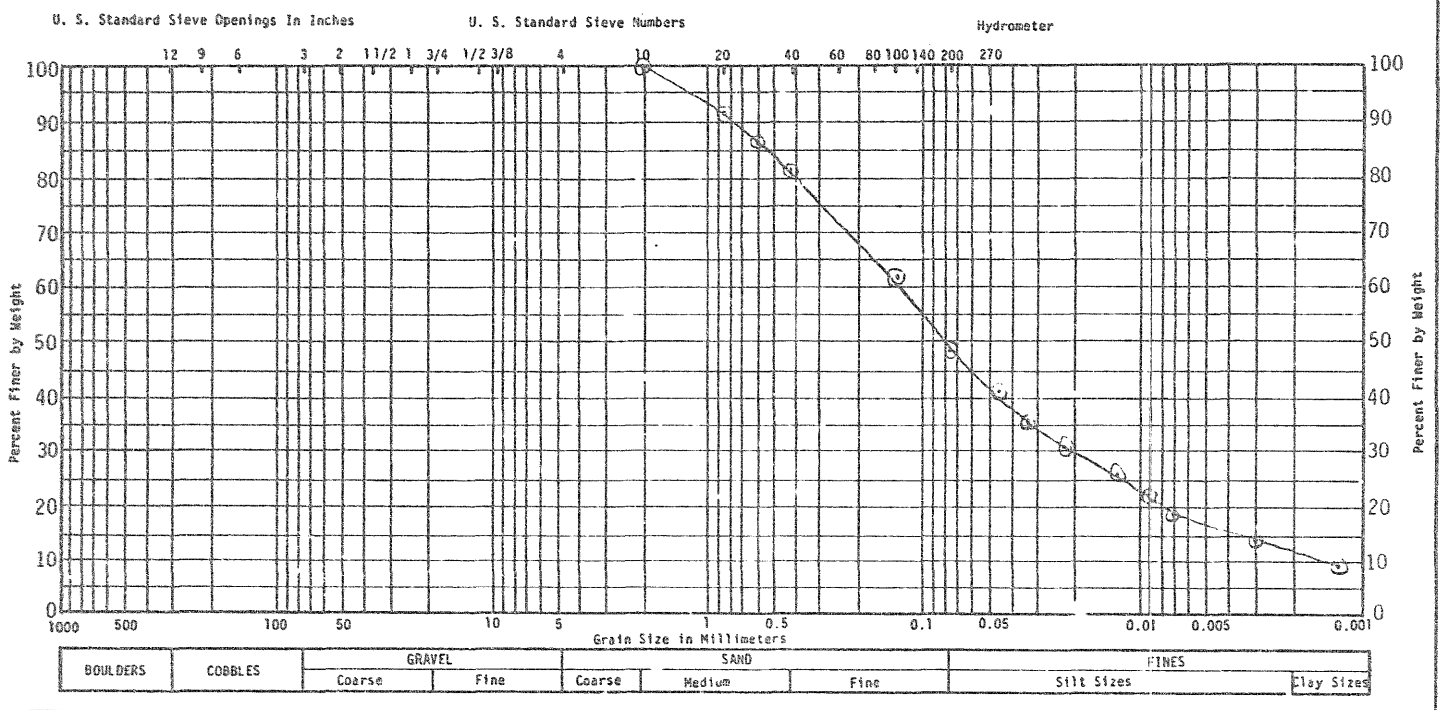
a = | Corrected Weight of Hydrometer Sample _____ grams | Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initi.	Reading 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								
									Cc	

Tested by: [illegible] | Computed by: [illegible] | Checked by: [illegible] | Cu

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



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 4-12-83

LF INT-GSA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

(mc)

WORK SHEET - PARTICLE SIZE ANALYSIS

Date: 4/9/83 | ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER | Job No. 15032,003.08

Project: WATANA DAM | Hole: AS 54 | Depth: 8.5-9 #2

Dry WT Total Sample & Tare	1797	TOTAL SAMPLE						
Tare Weight (Can)	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.	Cum. % of Total Passing
Moisture Content -10 Material		4"	101.6					
		3"	76.2					
Can No.		2"	50.8					
		1½"	38.1					
WT-Soil & Can (Wet)		1"	25.4					
WT-Soil & Can (Dry)		3/4"	19.1	0			0	100
		½"	12.7	9			7	99.3
Loss		#4	4.6	78			6.2	93.8
Weight of Can		#10	2.0					
WT of Soil (Dry)		Pan						
% Moisture		Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar # | WT Washed Sample & Tare: 1342 | Tare Weight: 542 | Washed Sample Weight: 800

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	177				13.7	86.3
20	0.850	319				25.1	74.9
30	0.600	392				32.1	67.9
40	0.425	457				38.7	61.3
100	0.150	751				67.1	32.9
200	0.075	849				75.9	24.1
270	0.053						
Pan		853					
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.	Reading 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								
									Cc	
Tested by:		Computed by:			Checked by:				Cu	

F 135-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

FIELD IDENTIFICATION PROCEDURES FOR
FINE GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus
No. 40 sieve size particles, approximately
For field classification purposes, screen
tained simply remove
material interfere with the tests.

Dilatancy (Reaction to shaking)

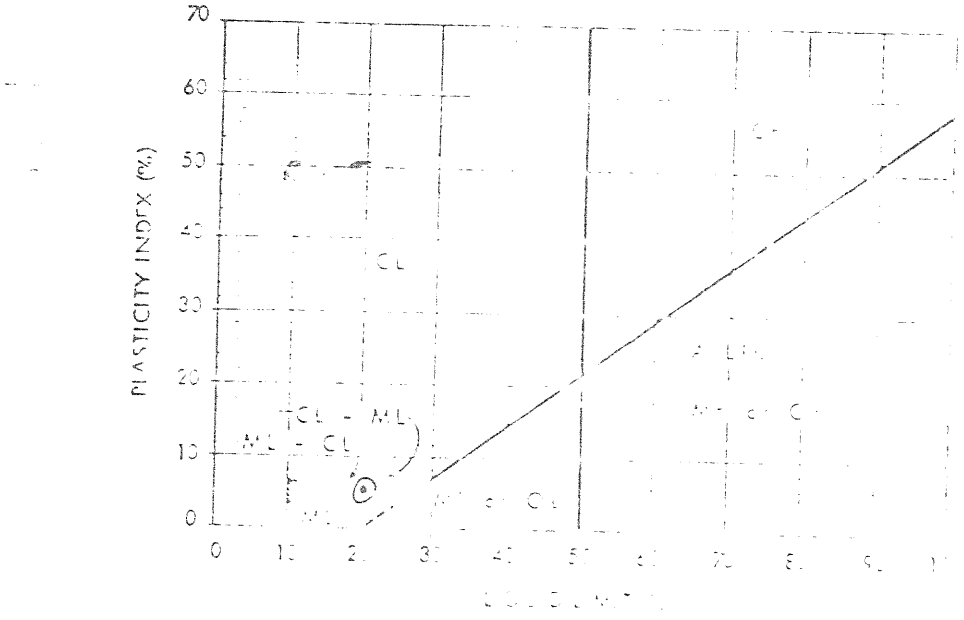
After removing particles larger than No.
size, prepare a pat of moist soil with
of water necessary to make it soft but
Place the pat in the open palm of one
shake horizontally, striking vigorously
the other hand. Observe
consistency of the pat when
face of the pat becomes
water appears quickly on the
to squeeze the sample
gers, the water disappears
sample stiffens, and finally it cracks or
rapidity of appearance of water during
and of its disappearance during
in identifying the
soil.

Very fine clean sands give the most
distinct reaction, whereas a plastic clay
reaction. Inorganic silts, such as a typical
rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics)

After removing particles larger than
sieve size, mold a pat of soil to the consistency
putty, adding water if necessary. From the moist
pat, mold an ball about in diameter. Allow
pat to dry completely by oven, sun, or air
drying, and then test its strength by breaking
and crumbling between the fingers. This
is a measure of the character and quantity
the colloidal fraction contained in the soil.
dry specimen breaks into individual grains
powder pressure can be broken into powder
fingers usually after a few seconds.

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
pat when moistened and allowed to dry a second time;
the latter will crack readily and set
with a weak finger pressure.



Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BPASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
Project WATANA DAM		Hole AS51	Depth 1-25 ft

Dry WT Total Sample & Tare	1320	TOTAL SAMPLE
Tare Weight	530	Classification Olive gravelly silty sand (SM)
Total Sample WT	7840	

Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1				0	100
½"	12.7	28			3.6	96.4
#4	4.6	50			10.2	89.8
#10	2.0					
Pan						
Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	
		Tare Weight	
		Washed Sample Weight	6310

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Fines	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	155					
20	0.850	365					
30	0.600	522					
40	0.425	658					
100	0.150	957					
200	0.075	1133					
270	0.053						
Pan		629					
Total							

HYDROMETER SAMPLE

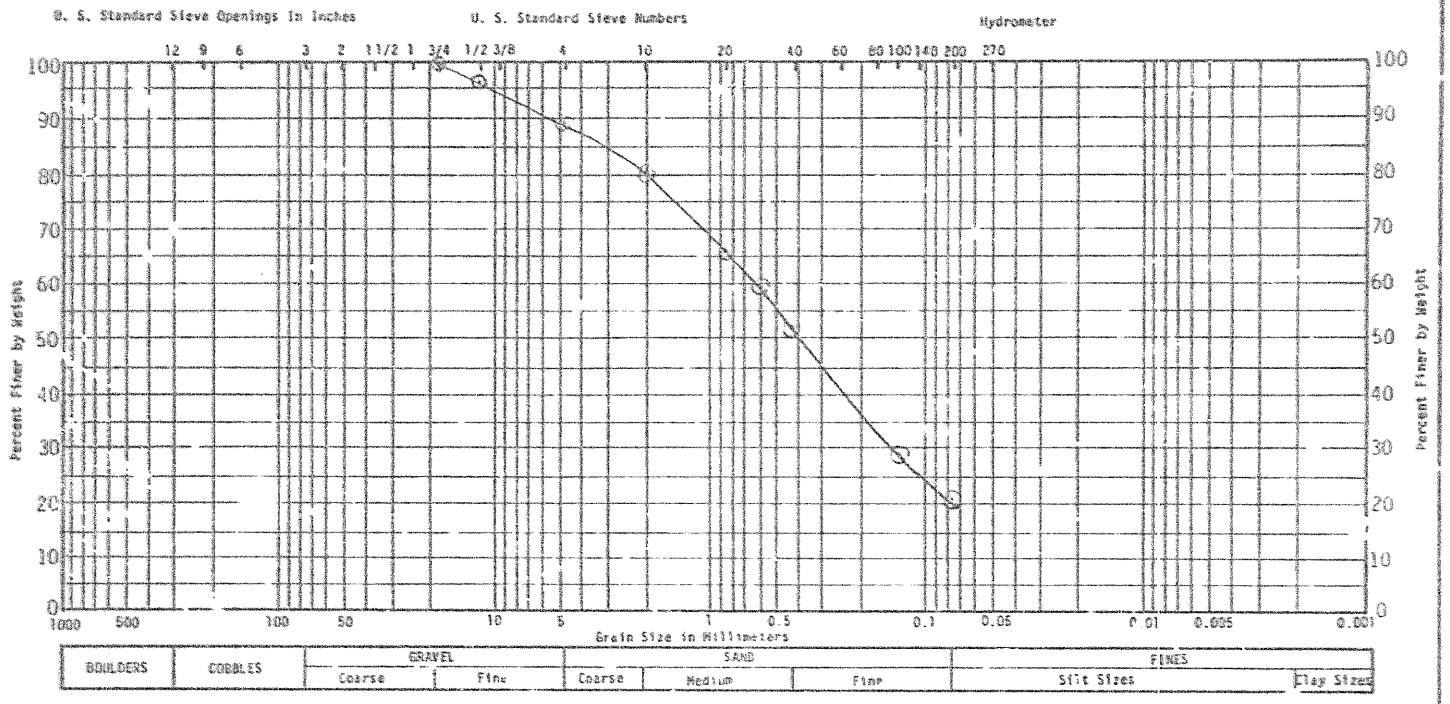
Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops. _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Diam 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:		Computed by:		Checked by:					Cu	

EF 135-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	_ING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	AS 51	1	1.2.5	

V' AL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-10-83

EF 741-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date 4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
Project WATANA DAM	Hole AS 51	Depth 3-5 #2

~~Wet~~ Dry WT Total Sample & Tare	1502	TOTAL SAMPLE
Tare Weight	476	Classification Silty gravelly sand (sm)
Total Sample WT	1126	
Moisture Content -10 Material		
Can No.		
WT-Soil & Can(Wet)		
WT-Soil & Can(Dry)		
Loss		
Weight of Can		
WT of Soil (Dry)		
% Moisture		

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4	0			0	100
3/4"	19.1	72.3			6.4	93.6
½"	12.7	225			19.9	80.1
#4	4.6	381.5			33.9	66.1
#10	2.0					
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.	Cum. % of Total Passing
10	2.000	142				91.7	8.3
20	0.850	231				85.2	14.8
30	0.600	274				82.6	17.4
40	0.425	334				78.8	21.2
100	0.150	555				64.7	35.3
200	0.075	666				57.9	42.1
270	0.053						
Pan		673					
Total							

HYDROMETER SAMPLE

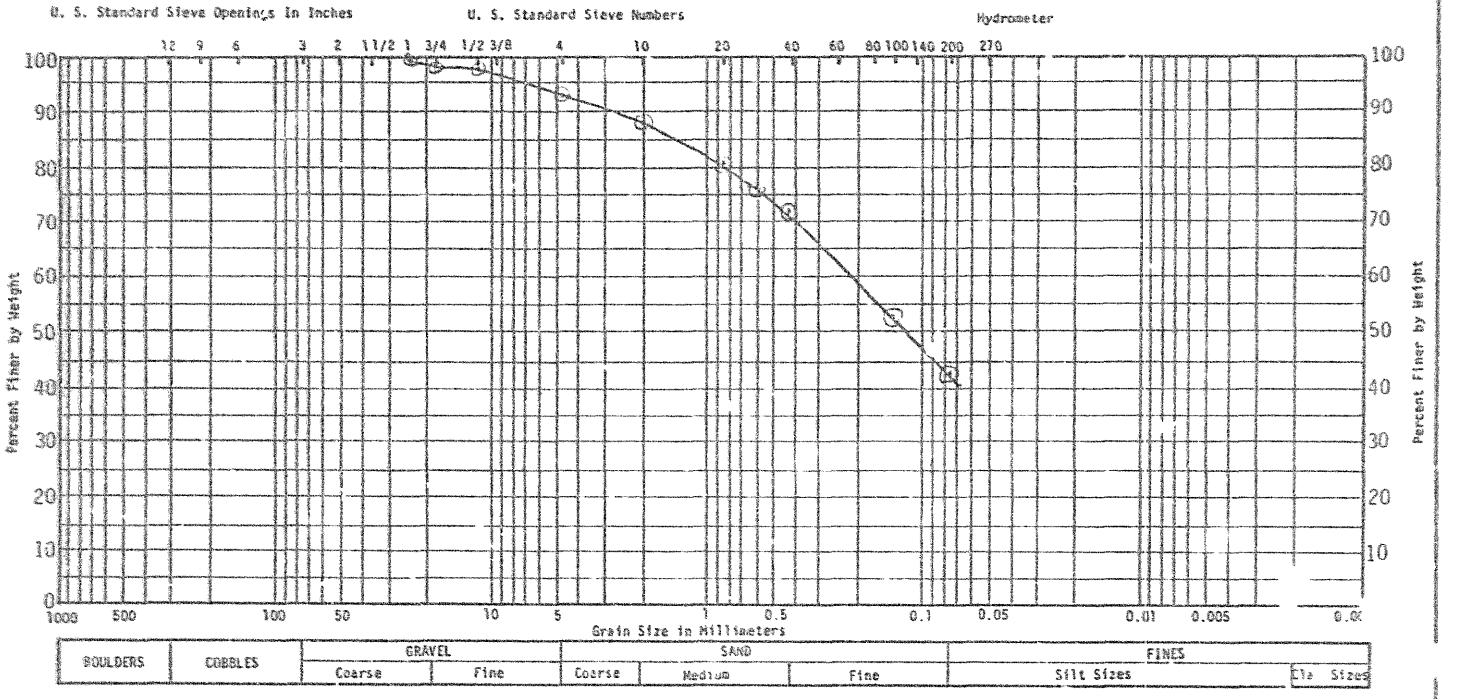
Specific Gravity (G	LL _____ PL _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl.	Reading Actual	Reading Rc	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.038							
	2	0.055							
	5	0.035							
	15	0.020							
	30	0.014							
	60	0.010							
	240	0.005							
	1440	0.002							

Tested by: [illegible] Computed by: [illegible] Checked by: [illegible]

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)
	AS 51	2	3-5	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-10-53

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole AS 54	Depth 1-3 #1

Dry WT Total Sample & Tare	1368	TOTAL SAMPLE
Tare Weight	536	Classification Dk. f. Grained Poorly gravelly silty SAND (SM)

Total Sample WT	832
Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	0			0	100
½"	12.7	1			[illegible]	[illegible]
#4	4.6	49			[illegible]	94.6
#10	2.0					
Pan						
Total						

5.4 % gol

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	[illegible]
		Tare Weight	[illegible]
		Washed Sample Weight	[illegible]

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	85				[illegible]	[illegible]
20	0.850	167				[illegible]	[illegible]
30	0.600	252				[illegible]	[illegible]
40	0.425	23[illegible]				[illegible]	[illegible]
100	0.150	2[illegible]				[illegible]	[illegible]
200	0.075	4[illegible]				[illegible]	[illegible]
270	0.053						
Pan		45[illegible]					
Total							

50.2 % 50.[illegible]

44.[illegible] %

HYDROMETER SAMPLE

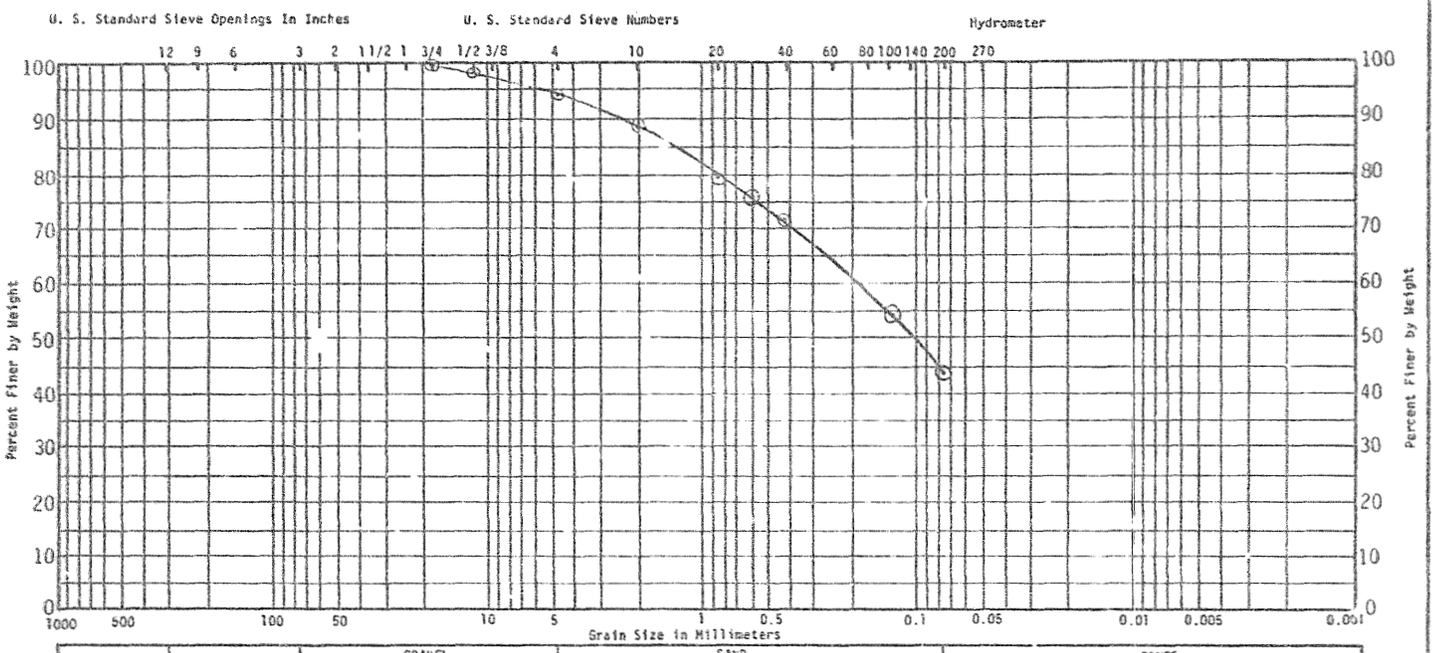
Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Defloculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl.	Reading 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	0.0[illegible]								
	240	0.005								
	1440	0.002								
									Cc	
Tested by: [illegible]		Computed by: [illegible]		Checked by: [illegible]					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)
	HS 5-4	1	1-2	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003 08

Date 4-[illegible] [illegible]

LF 741-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

(MC)

WORK SHEET - PARTICLE SIZE ANALYSIS

Date: 4/9/83 | ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER | Job No. 15032,003.08

Project: WATANA DAM | Hole: AS 54 | Depth: 8.5-9 #2

Dry WT Total Sample & Tare	1797	TOTAL SAMPLE						
Tare Weight (Can)	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.	Cum. % of Total Passing
Moisture Content -10 Material		4"	101.6					
		3"	76.2					
Can No.		2"	50.8					
		1½"	38.1					
WT-Soil & Can (Wet)		1"	25.4					
WT-Soil & Can (Dry)		3/4"	19.1	5			0	100
		½"	12.7	9			1	99
Loss		#4	4.6	78			6.2	93.8
Weight of Can		#10	2.0					
WT of Soil (Dry)		Pan						
% Moisture		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.	Cum. % of Total Passing
10	2.000	172					
20	0.850	[illegible]					
30	0.600	[illegible]					
40	0.425	[illegible]					
100	0.150	[illegible]					
200	0.075	[illegible]					
270	0.053						
Pan		353					
Total							

HYDROMETER SAMPLE

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

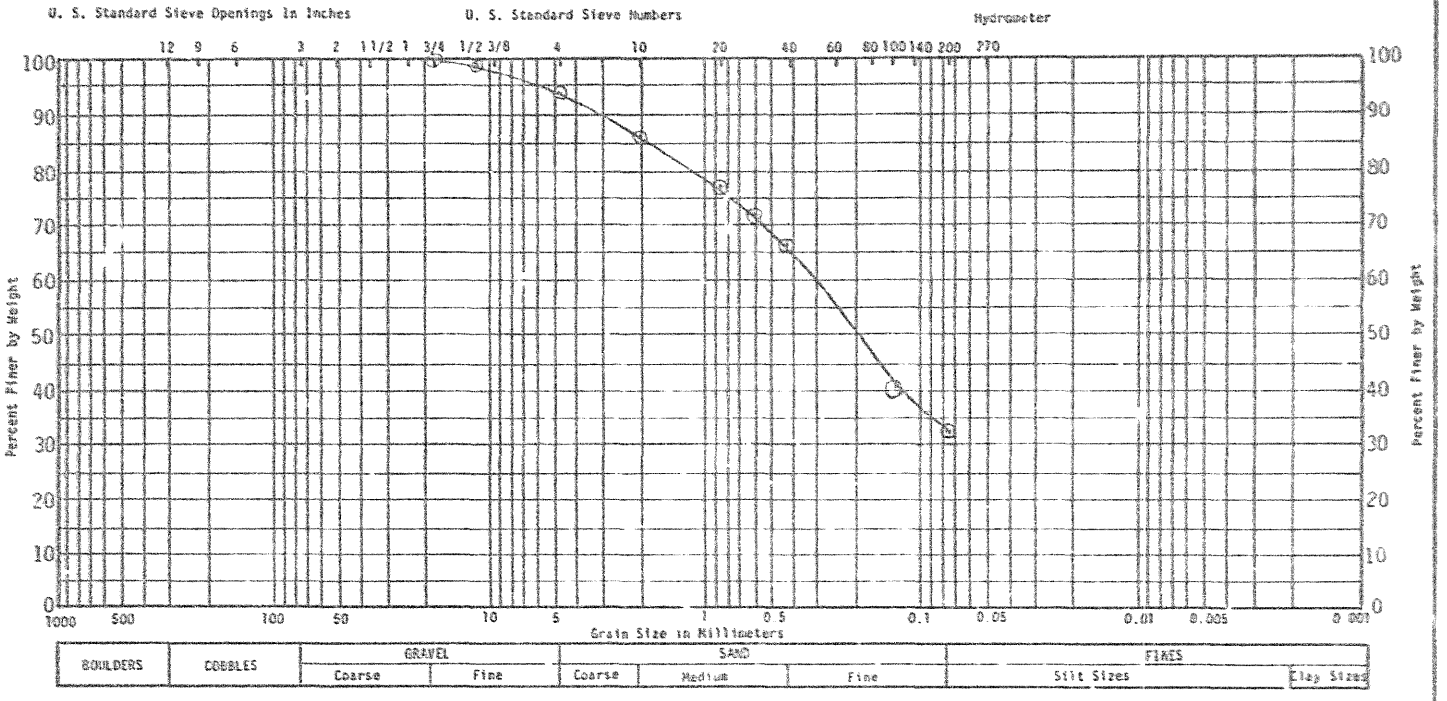
a = | Corrected Weight of Hydrometer Sample _____ grams | Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initial	Reading 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								
									Cc	
Tested by: [illegible]		Computed by: [illegible]		Checked by: M.A.					Cu	

F-35-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USCS)
	HS 5-1	2	8.5-9.0	

USBR MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

LF 147-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

MISCELLANEOUS TEST RECORDS

% Passing #200 Sieve

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

Boring	AS1 #2	AS2 #3	AS1 #4	AS2 #2	AS5 #2			
Depth	1-3'	3-4.5	5-6	1-3'	5.5-6.5			
Soil	Very Dark Brown Silty Sand	Dark Brown Brown small c... c... ... mixed ... and Sand	Mottled Cohesive	... Brown				
Cup No.	MA-10	MA-37	MA-11	MA-46	MA-8			
Dry Wt. Before Wash & Tare	316.28	379.19	205.91	481.10	818.9			
Dry Wt After Wash & Tare	247.2	258.2	183.6	282.0	495.0			
Dry Wt Passing No. 200	69.08	121.7	22.31	199.1	323.7			
Cup Wt	88.0	90.06	83.09	88.9	91.4			
Dry Wt Before Wash	159.2	258.93	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								

% Passing #200 Sieve

Job Watana Dam No. 15032,003.08 By: Date:

Boring	AS 37	AS 38	AS52	MC-7	MC-9	AS44
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 wet- water Dark brown	ORGANIC
Cup No.	MA-4	EE	SD-13	BB	1U	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	989.0	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

Organic Content Loss By Ignition

Project: Watana Dam Job No.: 15032,003.08 By: CRM-CB / MH Date: 4/8/

Boring	AS1 = 1	AS1 = 2	AS2 = 1	AS3 = 2	AS3 = 3
Depth	0-1	1-2	0-1	3-4'	5-7'
Soil	very Dark Brown Peat all of Sample Used	very Dark Brown Silty Sand all of Sample Used	very Dark Brown Peat all of Sample Used	very Dark Brown all of Sample	Dark Grey-ish
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	15.53	15.37	15.24	16.19
Dry Wt Before Burn	20.97	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'	0.5-1.0		
Soil	Black	very Dark Brown	Black Organic		
Pan No.	C-16	C-19	C-20		
Dry Wt Before Burn & Tare	48.24	22.59	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	3.14		
Dry Wt Before Burn	30.51	5.60	32.88		
% Organic Matter	11.5%	89.5%	9.8%		

Notes & Additional Tests

LP 134-01

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

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		Very Dark grayish Brown		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 1340L1

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS GEOPHYSICISTS

JOB Watana Dam — 15032,003.08 MOISTURE CONTENT - DRY DENSITY — No. 15032, 003.08 BY JM/MA DATE 7/10 82

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 Grayish Brown Small Silt Clumps containing Silt + Sand a lot Gravel	Very Dark Grayish-Brown Sample is Saturated appears to be all organic	Very Dark Brown	Dark Grayish 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	311.92	100.37	405.9	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	86.30	87.46	71.20	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								

LF 133 - MCOD

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

JOB Watana Dam — J32,003.08 MOISTURE CONTENT - DRY DENSITY No. 15032, 00.08 BY GB / MF DATE 4-11-83

BORING	AS 19	AS 24	AS 26	P-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 3-5.5
SOIL				Dark 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	319.09	941.0	843.5				
CUP + D. SOIL	353.41	318.95	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	90.76	91.33	88.95	90.98		91.15	90.80	54.2
D. SOIL	262.69	227.52	674.35	609.12		731.65	936.4	1037
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	#1 1-2	#1 .5-2.0	#2 2.4	#1 1-2.5
S	Several Dark Brown					Dark		
LENGTH								
TUBE + W. SOIL								
TUBE								
W. SOIL								
FACTOR								
W. DENSITY								
CUP #		SD-10						
CUP + W. SOIL	608.9							
CUP + D. SOIL	369.2	1306	723.2	1177	617.1	837?	1366	933.8
MOIST. LOS.	237.7	81	168.9	61	104.7	198.3	134	157.8
CUP		545.0						
D. SOIL	277.87	761	635.5	615	529.64	750.87	935	742.07
MOIST. CONT.	86.3	10.6	26.6	9.4	19.8	26.4	14.3	21.3
DRY DENSITY								

LF 133 - M000

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

JOB Watara Dam — 15032,003.08 No. 15032, 003 08 — MOISTURE CONTENT - DRY DENSITY — BY CM/MA — DATE 4-11-83

BORING	AS 45	AS 47	AS 49	AS 49	AS 54	AS 54	mc 1	mc 1
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 [illegible] brown	Olive Grey	Dark Brown	Olive
LENGTH								
TUBE + W. SOIL								
TUBE								
W. SOIL								
FACTOR								
W. DENSITY								
CUP #	X	[illegible]	IIIA-7	1L	SL-11	CRM	IIIA-6	CM-1
CUP + W. SOIL	355.1	271.47	36.1	725.2	1[illegible]	1[illegible]	22.57	23.1
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	25.73
CUP	80.47	80.05	91.36	424.	536	542	[illegible]	79.[illegible]
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	mc 2							
DEPTH	#2 2-3.5							
SOIL	[illegible] Grey							
LENGTH								
TUBE + W. SOIL								
TUBE								
W. SOIL								
FACTOR								
W. DENSITY								
CUP #	IIIA-2							
CUP + W. SOIL	2[illegible]							
CUP + D. SOIL	209.40							
MOIST. LOSS	23.78							
CUP	91.47							
D. SOIL	117.93							
MOIST. CONT.	20.2							
DRY DENSITY	-							

LF 133 - M600

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

WORK SHEET - SPECIFIC GRAVITY TESTS

Project: Watana Dam	15032,003.08 Job No.	Hole No.	Date 6-11-83

SPECIFIC GRAVITY OF SOLIDS (G_s)

Sample No.			ASBC #4 3.5-4	ASBC #4 5-5.5	ASBC #4 5-7.5			
Flask No.			F	S	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}		664.10	665.28	670.00		
	W_s + W_{bw}			764.12	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	.99745	.9993		
$(W_s K) \div (W_s + W_{bw} - W_{bws})$		G_s		2.75	2.67	2.72		

APPARENT (G_a) AND BULK (G_m) SPECIFIC GRAVITY

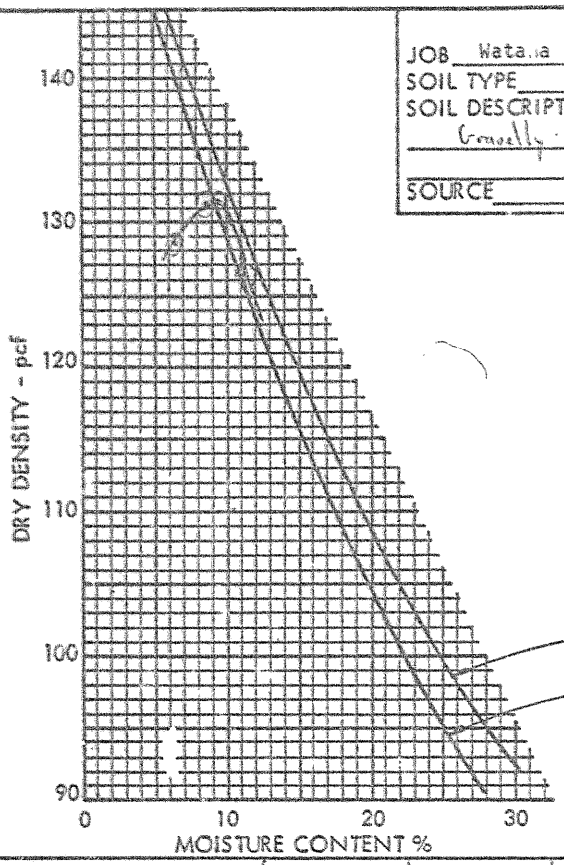
						Temp.	Corr. Factor
Sample No.						°C	K
Temperature of Water and Soil, T, °C						14	1.0010
Wt. in grams	Pan + Saturated Surface - Dry Soil					15	1.0009
	Tare Weight					16	1.0007
	Saturated Surface - Dry Soil	B				17	1.0006
	(Wire Basket + Soil) in Water					18	1.0004
	Wire Basket in Water					19	1.0002
	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: mf

LF 137 - 50

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

LABORATORY COMPACTION TEST



JOB Watana Dam NO. 15032,003.08
SOIL TYPE SM DATE [illegible] BY [illegible]
SOIL DESCRIPTION Dark Grayish Brown Gravelly Sandy Silt (SM)
SOURCE STA 12T00

☑ 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)

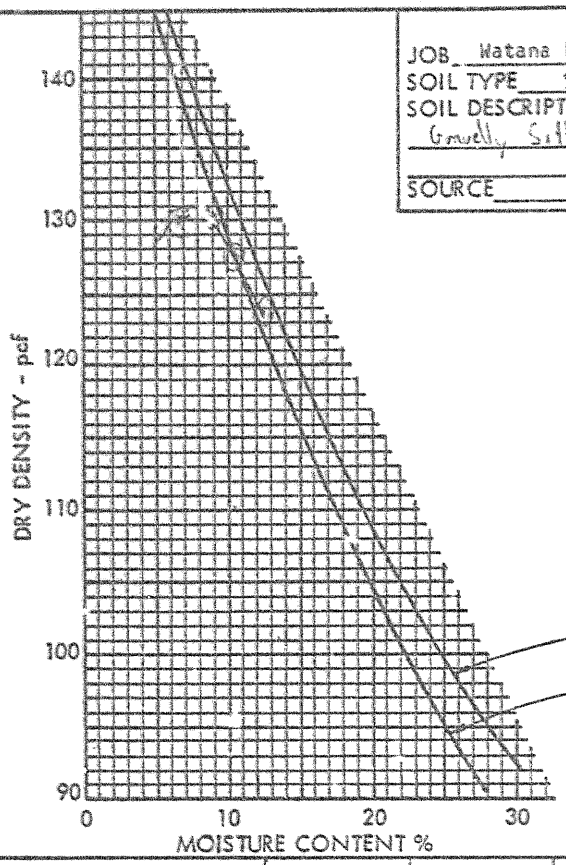
(*For weight of wet soil in grams and volume = 1/30 cu. ft)

	1	2	3	4	5	6
MOLD + WET SOIL	6318	6406	6421	6373		
MOLD	4251	4251	4251	4251		
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	[illegible]	131.4	126.3		

LF 132-C

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

LABORATORY COMPACTION TEST



JOB Watana Dam NO. 15032,003.08
SOIL TYPE SM DATE - - BY [illegible]
SOIL DESCRIPTION Olive Gravel y [illegible]
Gravelly Silty Sand (SM)
SOURCE STA 25T00

☐ ASTM D1557-78(A)

☐ AS)98

☐ Other (Specify)

MAXIMUM DRY DENSITY 131 PCF

OPTIMUM MOISTURE CONTENT 5 %

⊙ Laboratory Compaction Point

△ Field Check Point

100% Saturation (G_s = 2.68)

90% Saturation (G_s = 2.68)

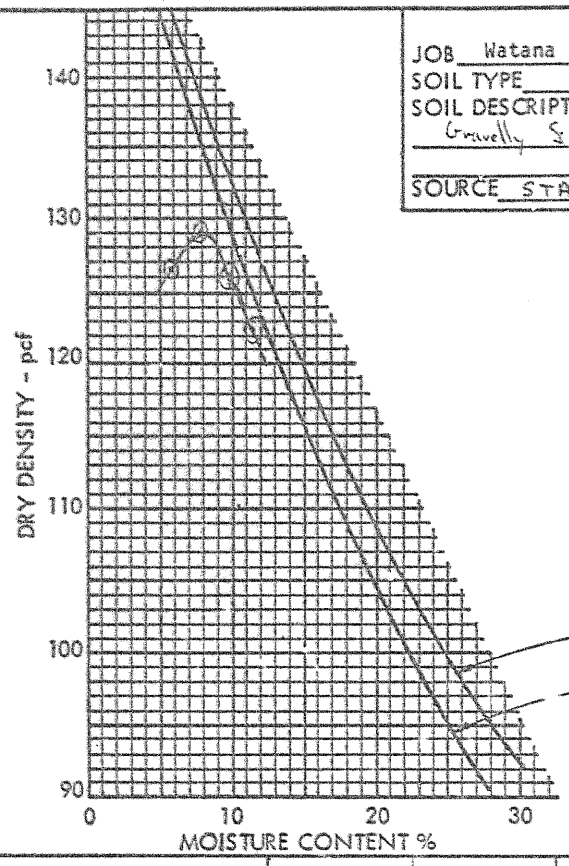
(*For weight of wet soil in grams and volume = 1/30 cu. ft)

	1	2	3	4	5	6
MOLD + WET SOIL	6347	6401	6324	6255		
MOLD	[illegible]	[illegible]	[illegible]	[illegible]		
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-32		
PAN + WET SOIL	1280.4	1311.1	1143.3	1003.6		
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	[illegible]	[illegible]	[illegible]		
DRY SOIL	[illegible]17.1	1118.7	953.2	814.7		
MOISTURE CONTENT	6.8	9.2	[illegible]	12.4		
DRY DENSITY	130.9	130.3	127.7	123.9		

LF 132-C

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

LABORATORY COMPACTION TEST



JOB Watana Dam NO. 15032,003.08
SOIL TYPE SM DATE BY CRM / MFT
SOIL DESCRIPTION Olive brown to grey brown 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)

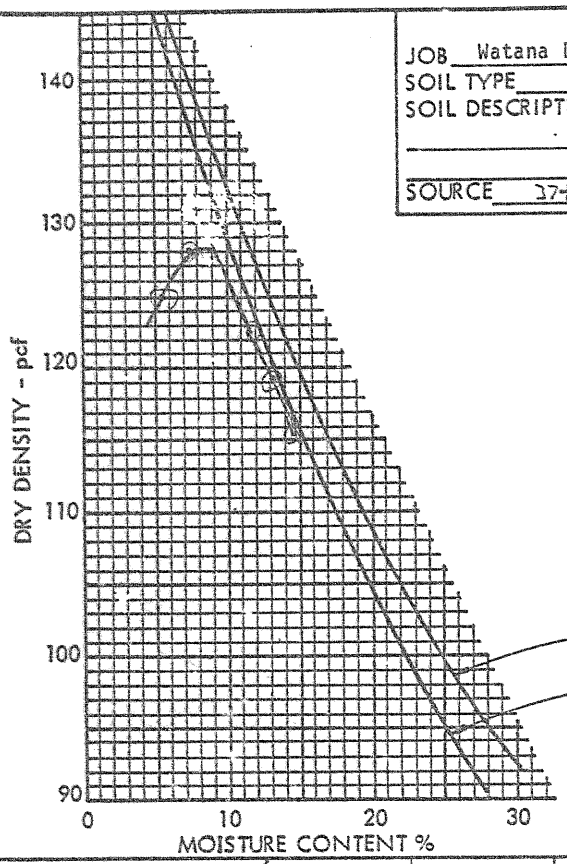
(*For weight of wet soil in grams and volume = 1/30 cu. ft)

	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	1325.2	1362.5	1274.1	1304.7		
PAN + DRY SOIL	1257.5	1269.6	1185.2	1200.0		
MOISTURE LOSS	67.7	92.9	89.0	104.7		
PAN TARE	84.25	88.35	27.41	88.8		
DRY SOIL	1168.3	1180.5	1098.0	1111.2		
MOISTURE CONTENT	5.8	7.9	8.1	9.5		
DRY DENSITY	126.6	129.0	126.1	122.3		

LF 132-C

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

LABORATORY COMPACTION TEST



JOB Watana Dam NO. 15032,003.08
SOIL TYPE SM DATE 4-10-83 BY DNR / 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)

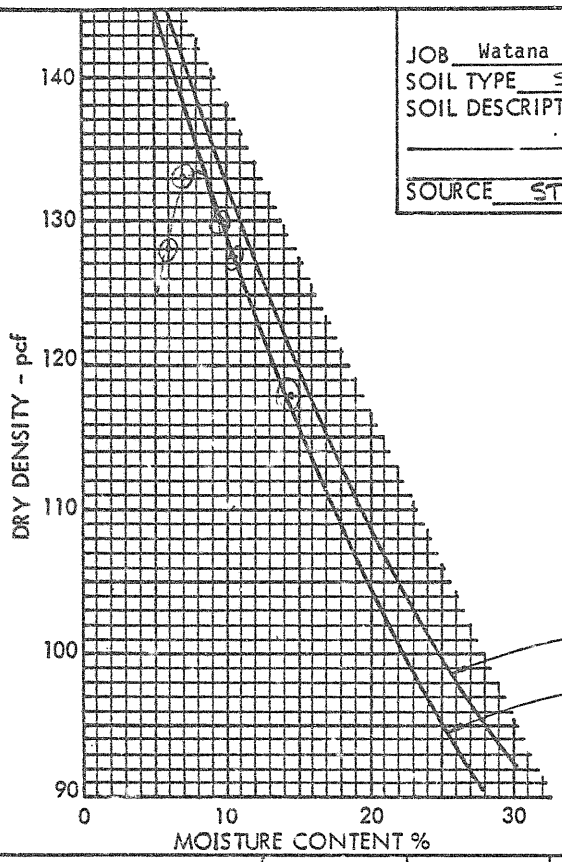
(*For weight of wet soil in grams and volume = 1/30 cu. ft)

	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	540.7	376.9	667.2	
PAN + DRY SOIL	442.8	497.9	569.7	357.4	636.2	
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	14.9	7.3	5.5	
DRY DENSITY	122.7	119.1	115.5	128.1	125.1	

LF 132-C

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

LABORATORY COMPACTION TEST



JOB Watana Dam NO. 15032,003.08
SOIL TYPE SM DATE 4-10-83 BY CWR / 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	6406	6395	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	733.5	
MOISTURE CONTENT	9.8	10.7	14.3	7.1	6.0	
DRY DENSITY	130.0	127.5	117.8	133.1	128.0	

LF 132-C

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

MAN CAMP
LABORATORY TEST
RECORDS

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐GILSON ☑BRASS SIEVE ☐HYDROMETER	Job No. 15032.003.08
Project WATANA DAM		Hole mc 5	Depth 2-2.5 #2

Dry WT Total Sample & Tare	874	TOTAL SAMPLE
Tare Weight SB-14	539	Classification Very Dark Greyish Brown silty gravelly sand (sm)
Total Sample WT	335	

Moisture Content -10 Material	
Can No.	
WT-Soil& Can(Wet)	
WT-Soil& Can(Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	0			0.0	100.0
½"	12.7	8			2.4	97.6
#4	4.6	24			7.2	92.8
#10	2.0					
Pan						
Total						

7.2 % gm.

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams	Jar #	WT Washed Sample & Tare	753
		Tare Weight	539
		Washed Sample Weight	214

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total 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							

55.1 % Sand

37.3 % fines

HYDROMETER SAMPLE

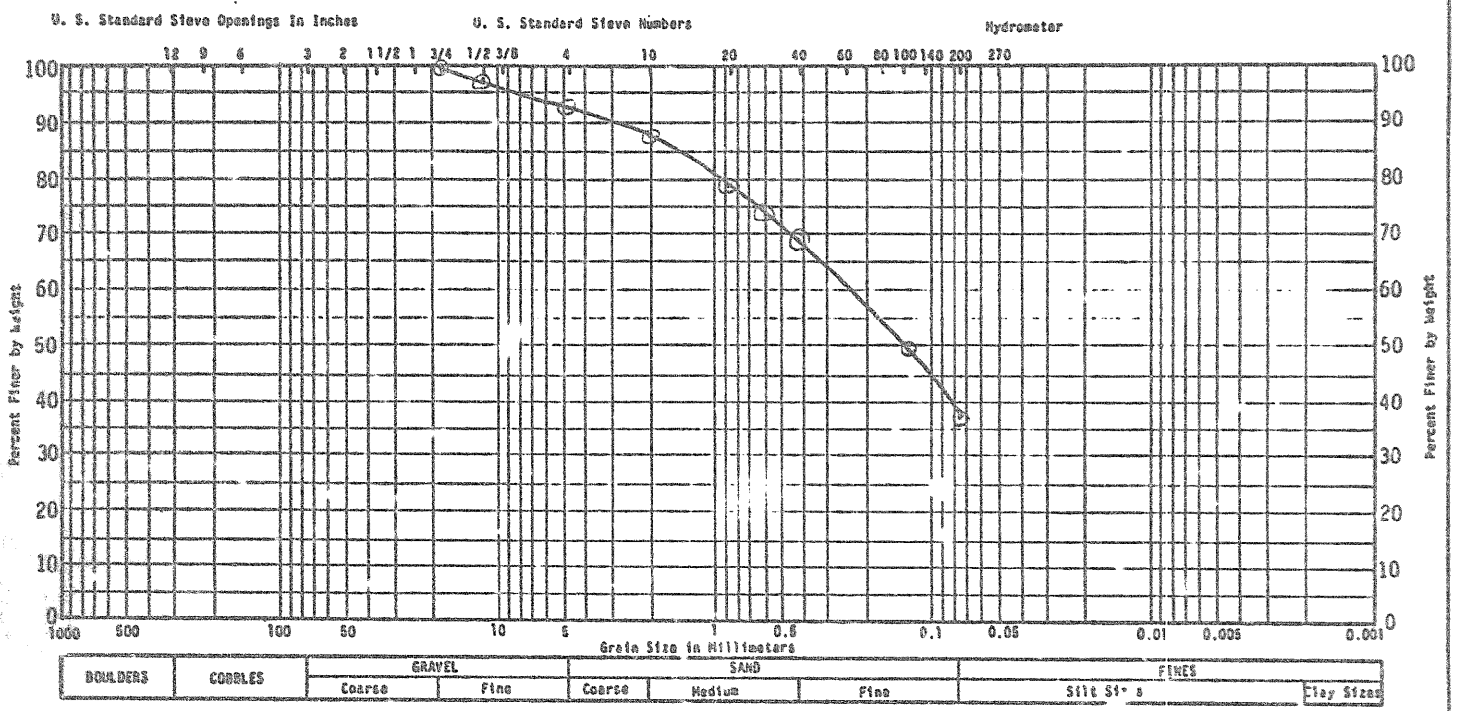
Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Oefloculation Agent

Time	Elap Time	Maximum Dia. MM	Temp. ° C.	K	Reading Initl.	Reading Actual	Reading 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: G.B. Computed by: MA Checked by: MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	MC 5	2	2-2.5	

VISUAL MANUAL CLASSIFICATION Sample [illegible]

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

LF 191-69A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date		WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☐ BRASS SIEVE ☐ HYDROMETER	Job No. 15032,003.08
Project WATANA DAM		Hole mc 6	Depth 3-5 ≈2

Dry WT Total Sample & Tare	1131	TOTAL SAMPLE
Tare Weight	424	Classification gravelly S. & sand (SM)
Total Sample WT	707	
Moisture Content -10 Material		
Can No.		
WT-Soil & Can(Wet)		
WT-Soil & Can(Dry)		
Loss		
Weight of Can		
WT of Soil (Dry)		
% Moisture		

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	0			0.0	100.0
½"	12.7	2			0.3	99.7
#4	4.6	47			6.6	93.4
#10	2.0					
Pan						
Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar #

WT Washed Sample & Tare	556
Tare Weight	424
Washed Sample Weight	132

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	91				12.9	87.1
20	0.850	153				21.6	78.4
30	0.600	185				26.2	73.8
40	0.425	216				30.8	69.2
100	0.150	343				48.5	51.5
200	0.075	427				60.4	39.6
270	0.053						
Pan		43					
Total							

HYDROMETER SAMPLE

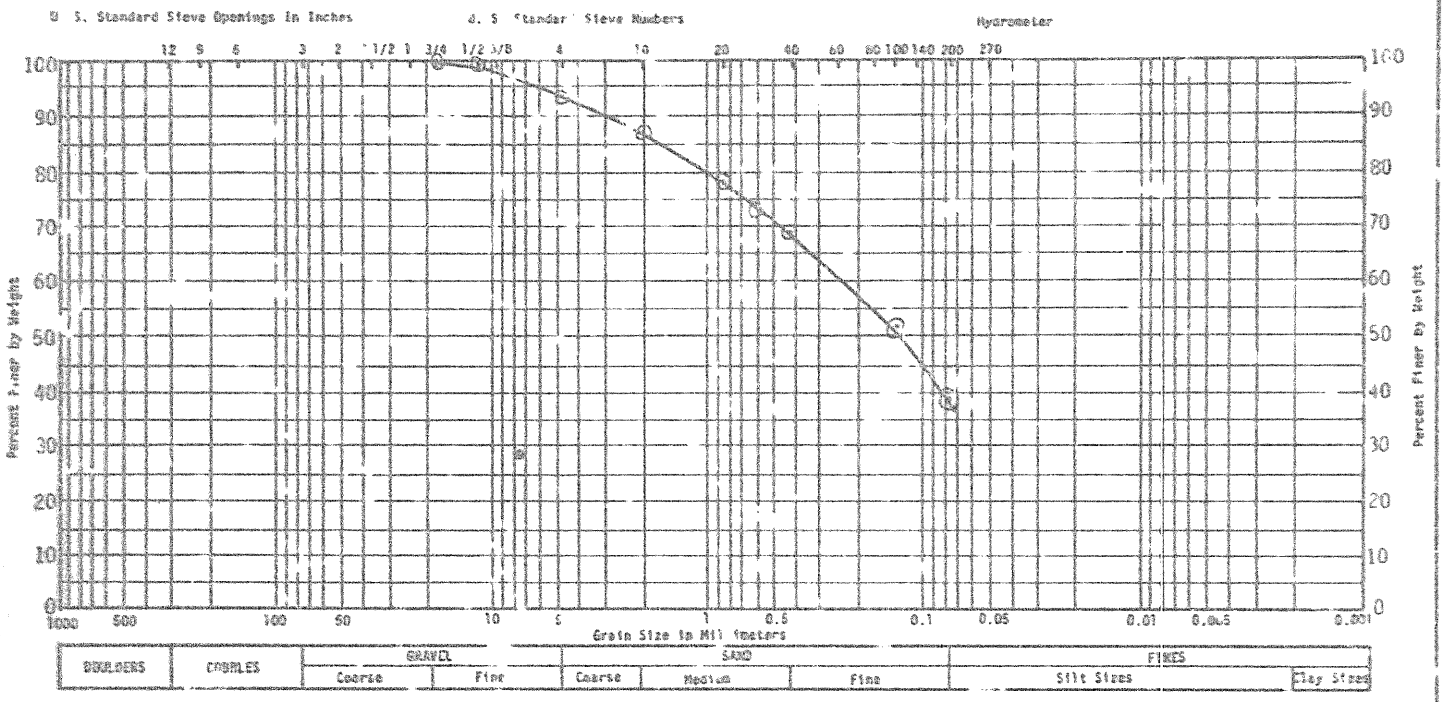
Specific Gravity (G)	LL _____ PI _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	R_c	L	Corrected Gram Size, Dia. ""	% 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								
									C_c	
Tested by: C.B.		Computed by: MA			Checked by: MA				C_u	

LF 135-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	MC6	2	3-5	

TYPICAL CLASSIFICATION

Job MATANA DAM

No. 15032.003.08

Date 4-11-83

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

LF MI-GSA

WORK SHEET - PARTICLE SIZE ANALYSIS

Date 4/9/83 ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER

Job No. 15032.003.08

Project WATANA DAM

Hole AH-4

Depth 2-25 #1

Dry WT Total Sample & Tare: 1016

Tare Weight: 537

Total Sample WT: 479

Moisture Content -10 Material

Can No.

WT-Soil& Can(Wet)

WT-Soil& Can(Dry)

Loss

Weight of Car

WT of Soil (Dry)

% Moisture

TOTAL SAMPLE

Classification: [illegible] silty sand (SM)

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1					
½"	12.7	0				100
#4	4.6	10			2	98
#10	2.0					
Pan						
Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams

Jar #

WT Washed Sample & Tare: 522

Tare Weight: 537

Washed Sample weight: -15

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	32					
20	0.850	90					
30	0.600	115					
40	0.425	[illegible]					
100	0.150	265					
200	0.075	325					
270	0.053						
Pan		331					
Total							

HYDROMETER SAMPLE

Specific Gravity (G)

LL _____

PI _____

Hydrometer No.

Amyl Alcohol Drops: _____

a =

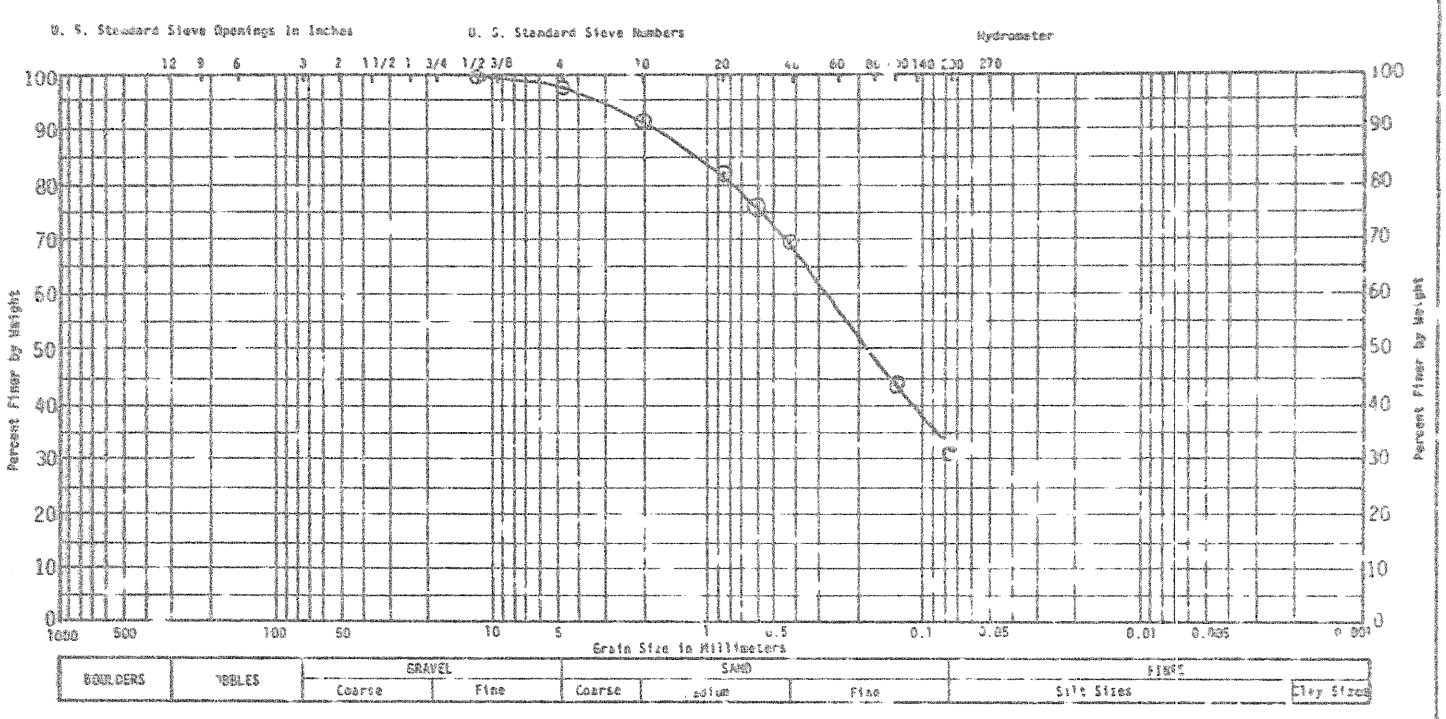
Corrected Weight of Hydrometer Sample _____ grams

Deflocculation Agent

Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading 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: C.S.M			Computed by: [illegible]		Checked by: [illegible]				Cu	

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USCS)
	MC 4	1	2-2.5	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 5032.003.05

Date 8-11-83

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date	4/7/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 15032.003.08
Project WATANA DAM		Hole mc 3	Depth 2.5-3.0 #1

Dry WT Total Sample & Tare	939
Tare Weight SID-2	552
Total Sample WT	387
Moisture Content -10 Material	
Can No.	
WT-Soil & Can (Wet)	
WT-Soil & Can (Dry)	
Loss	
Weight of Can	
WT of Soil (Dry)	
% Moisture	

TOTAL SAMPLE

Classification Very Dark Grayish Brown silty sand (SM)

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.3					
1½"	38.1					
1"	25.4					
3/4"	19.1					
½"	12.7					
#4	4.6		0		0	100
#10	2.0					
Pan						
Total						

0 % Gravel

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample _____ grams | Jar #

WT Washed Sample & Tare	807
Tare Weight	552
Washed Sample Weight	255

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total 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		∝-1					
Total							

62.8 % - sand

37.2 % Fines

HYDROMETER SAMPLE

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

a =	Corrected Weight of Hydrometer Sample _____ grams	Defloculation Agent

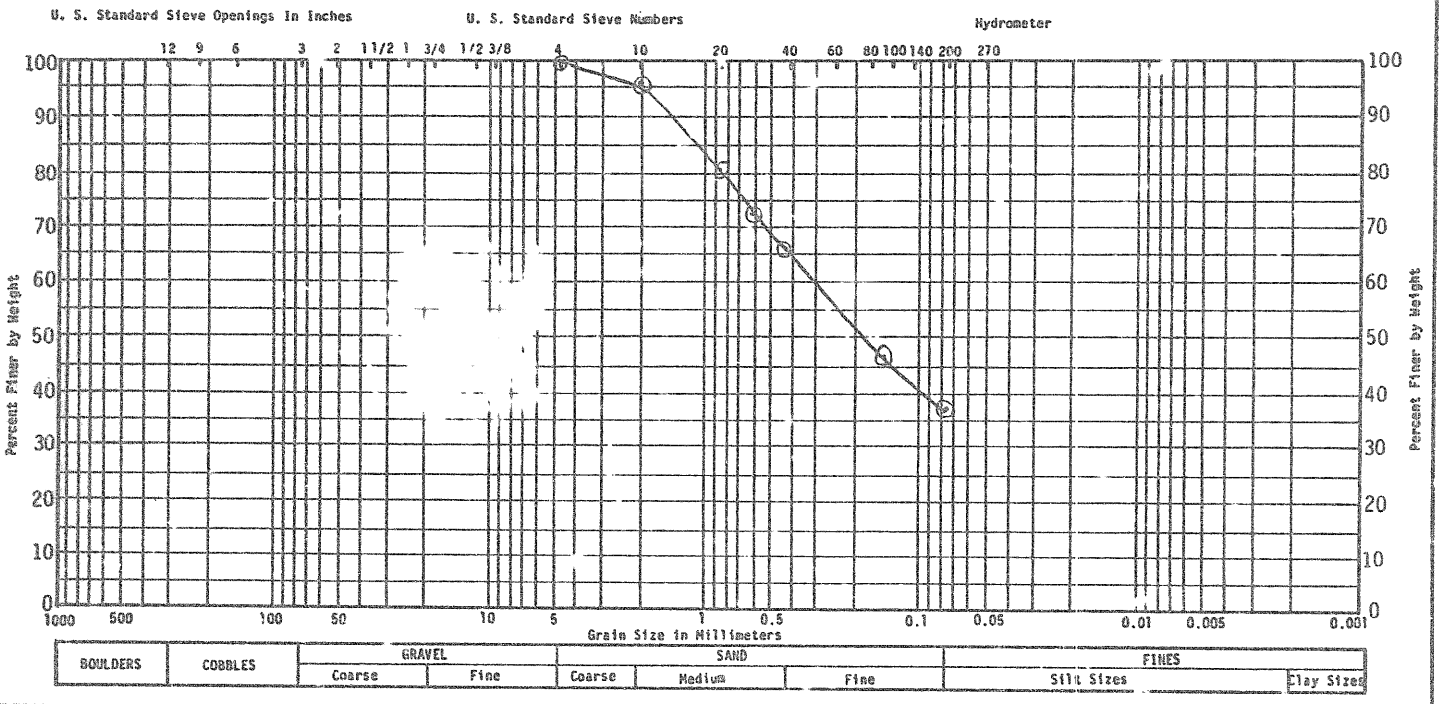
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	Rc	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: G. B. | Computed by: MA | Checked by: MA

LF 139-MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	MC 3	1	2.5-3.0	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.003.08

Date 4-11-83

LF INT-GSA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

(mc)

Date	4/9/83	WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☑ BRASS SIEVE ☐ HYDROMETER	Job No. 1503?,003.08
Project WATANA DAM		Hole mc 2	Depth 2-2.5 ±2

Dry WT Total Sample & Tare	1007	TOTAL SAMPLE
Tare Weight	546.0	Classification Dark Grey Silty sand (SM)
Total Sample WT	461	
Moisture Content -10 Material		
Can No.		
WT-Soil & Can (Wet)		
WT-Soil & Can (Dry)		
Loss		
Weight of Can		
WT of Soil (Dry)		
% Moisture		

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1	0			0.0	100.0
½"	12.7	8			1.7	98.3
#4	4.6	17			3.7	96.3
#10	2.0					
Pan						
Total						

3.7 % Gvl.

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.	Cum. % of Total Passing
10	2.000	54				7.6	92.6
20	0.850	89				19.3	80.7
30	0.600	134				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
270	0.053						
Pan		326					
Total							

<5% Gravel

30.4 % Sand

HYDROMETER SAMPLE

Specific Gravity (G)	LL _____ Pl _____	Hydrometer No.	Amyl Alcohol Drops: _____
a =	Corrected Weight of Hydrometer Sample _____ grams		Deflocculation Agent

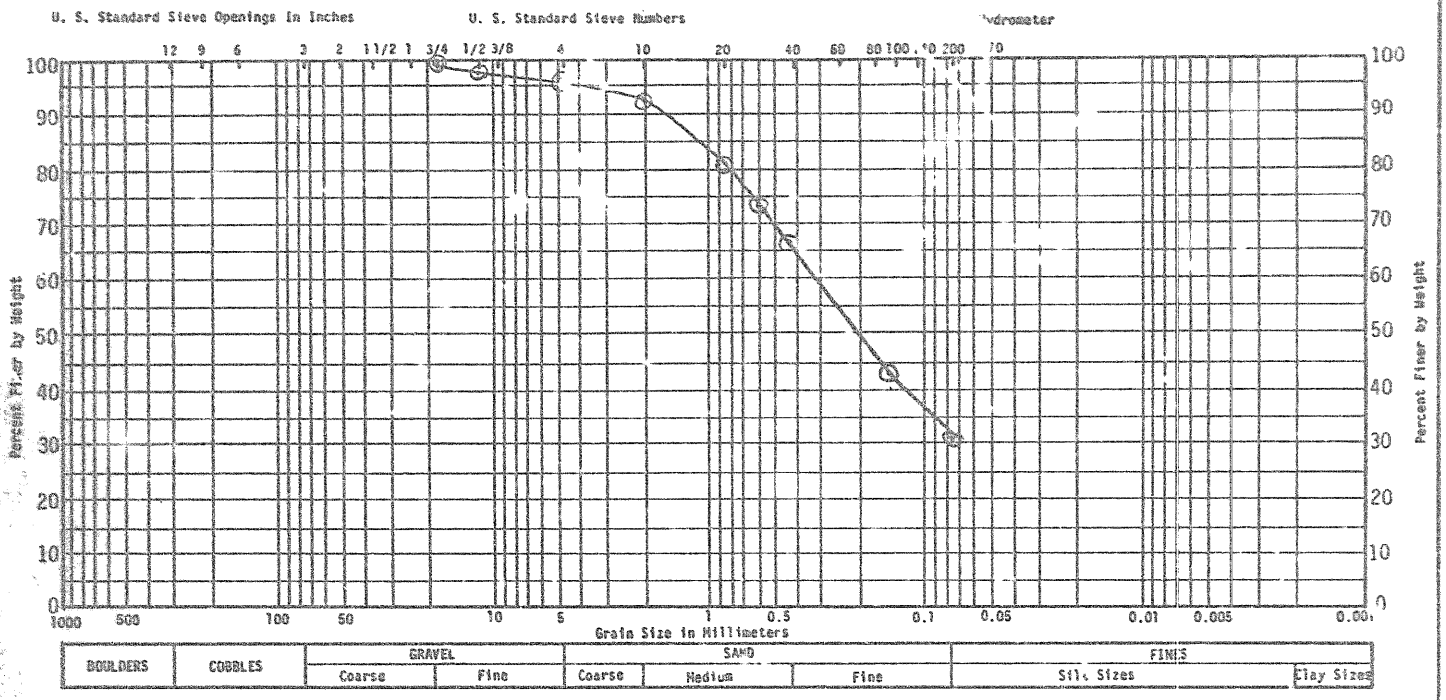
Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initl.	Reading Actual	Rc	L	Corrected Gram Size, Dia. MM	% of Total Passing
	1	0.078								
	2	0.055								
	5	0.035								
	15	0.020								
	30	0.014								
	60	0.010								
	240	0.005								
	1440	0.002								
									Cc	
									Cu	

Tested by: G.R. | Computed by: MA | Checked by: MA

F 35 - 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)
	MC 2	2	2-2.5	

VISUAL MANUAL CLASSIFICATION

Job WATANA DAM

No. 15032.001.08

Date 4-11-83

LF 141-65A

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

Date 4/9/83 | WORK SHEET - PARTICLE SIZE ANALYSIS ☐ GILSON ☐ BRASS SIEVE ☑ HYDROMETER | Job No. 15032.003.08

Project WATANA DAM | Hole RIC 8 | Depth 1-2 #1

Air Dry WT Total Sample & Tare	
Tare Weight 12	
Total Sample WT	
Moisture Content -10 Material	
Can No.	A-5
WT-Soil & Can (Wet)	50.85
WT-Soil & Can (Dry)	50.72
Loss	.13
Weight of Can	11.29
WT of Soil (Dry)	39.43
% Moisture	.3

TOTAL SAMPLE

Classification Olive s.Hy sand (sm)

Sieve Size	Dia. MM	Cum. WT Ret.	Dry WT Ret.	% Ret.	Cum. % of Total Ret.	Cum. % of Total Passing
4"	101.6					
3"	76.2					
2"	50.8					
1½"	38.1					
1"	25.4					
3/4"	19.1					
⅜"	12.7					
#4	4.6					
#10	2.0					
Pan						
Total						

REPRESENTATIVE MINUS NO. 10 SAMPLE

WT Representative Sample 62.00 grams | Jar # M

WT Washed Sample & Tare 123.0
Tare Weight 89.7
Washed Sample Weight 33.3

Sieve Size	Dia. MM	Cum. WT Ret.	Weight Retained	% Retained	% of Total Retained	Cum. % of Total Ret.	Cum. % of Total Passing
10	2.000	0				0.0	100.0
20	0.850	6				9.6	90.4
30	0.600	9				14.4	85.6
40	0.425	12				19.1	80.9
100	0.150	24				38.3	61.7
200	0.075	33				52.6	47.4
270	0.053						
Pan		34					
Total							

HYDROMETER SAMPLE

Specific Gravity (G) 2.75 (assumed) | LL — | PI — | Hydrometer No. H | Amyl Alcohol Drops: 2

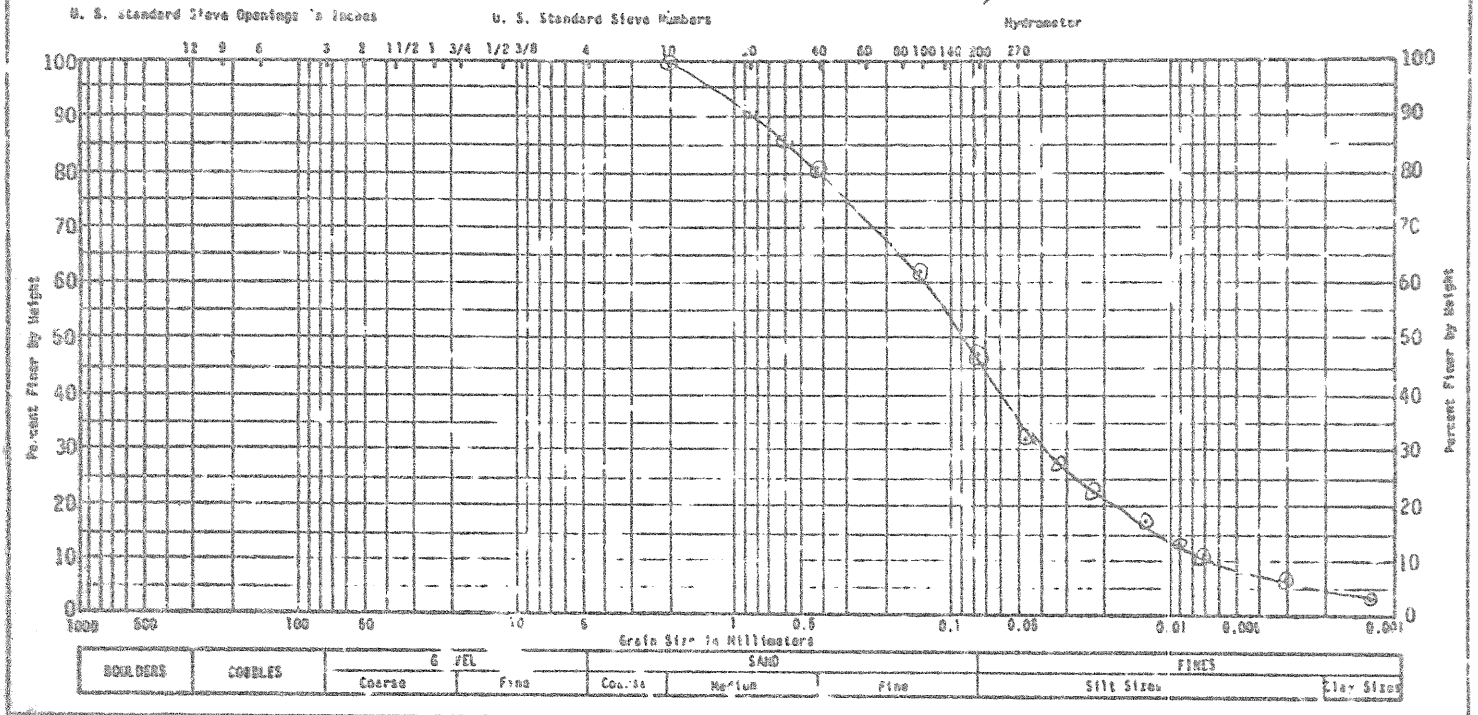
a = 0.98 | Corrected Weight of Hydrometer Sample 62.7 grams | Deflocculation Agent

2852 Time	Elap. Time	Maximum Dia. MM	Temp. °C.	K	Reading Initial	Reading Actual	R_c	L	Corrected Gram Size, Dia. MM	% of Total Passing
2854	1	0.078	15.8	0.0139	28.5	29.0	7.8	11.7	0.018	21.2
2857	2	0.055	15.8	"	25.3	25.3	"	12.2	0.034	19.3
2905	5	0.035	15.9	"	22.9	22.9	"	12.6	0.022	23.0
2920	15	0.020	15.9	"	19.1		"	13.2	0.013	17.9
2950	30	0.014	15.5	"	16.5		"	13.6	0.009	13.6
3050	60	0.010	15.5	"	14.9		"	13.8	0.007	10.9
1250	240	0.005	15.0	0.0140	12.0		7.9	14.3	0.003	6.4
0750	1440	0.002	15.0	0.0133	7.1		6.9	14.8	0.0012	3.0
									Cc	
									Cu	

Tested by: MR/GB | Computed by: MA | Checked by: MA

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS

GRADATION SIZE ANALYSIS



LAB TEST NO.	BORING NO.	SAMPLE NO.	DEPTH	CLASSIFICATION (USC)
	mc 8	1	1-2	

VISUAL MANUAL CLASSIFICATION

Job WAIANA DAM

No. 15032.003.08

Date 4-12-83

HARDING LAWSON ASSOCIATES
ENGINEERS, GEOLOGISTS & GEOPHYSICISTS