

SUSITNA HYDROELECTRIC PROJECT

WATANA DEVELOPMENT WINTER 1983 GEOTECHNICAL EXPLORATION PROGRAM

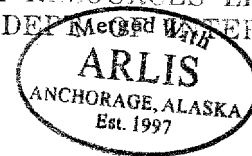
VOLUME 2 APPENDICES

SEPTEMBER 1983

HARZA-EBASCO
SUSITNA JOINT VENTURE

ALASKA POWER AUTHORITY

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SUSITNA HYDROELECTRIC PROJECT
WATANA DEVELOPMENT
WINTER 1983 GEOTECHNICAL EXPLORATION PROGRAM

VOLUME 2

APPENDICES

Prepared for the

ALASKA POWER AUTHORITY

BY

HARZA-EBASCO Susitna Joint Venture

September 1983

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APPENDIX A — GEOPHYSICAL EXPLORATION

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APPENDIX A

GEOPHYSICAL EXPLORATION

The purpose of the winter geophysical program in the river channel at the Watana damsite was to provide overburden and bedrock foundation information in the area between the upstream and downstream cofferdams. The data obtained from this program will be used for rapid determination of subsurface conditions, correlation between borings, and to determine general stratigraphy at greater depths than those penetrated by borings in the river channel and in the relict channel area. Ground penetrating radar (GPR), seismic refraction, and borehole gamma logging methods were employed. The radar and seismic refraction surveys were run by a four-man field crew under the direction of a Harza-Ebasco geophysicist. Two members of the team and the equipment and instruments were provided by Harding Lawson & Associates. The borehole logging was done by a Harza-Ebasco geophysicist.

The ground penetrating radar was used as a rapid reconnaissance tool to delineate shallow overburden depths to bedrock in the river channel, thereby allowing the seismic refraction and drilling programs to be used where they would be most effective. GPR was also used to determine ice thicknesses and river channel profiles to aid in the safe movement of men and equipment over the frozen river surface.

The purposes of the seismic refraction was to provide seismic sections delineating overall depth to bedrock in the river channel.

Borehole gamma logs were run in all open boreholes to assist in hole-to-hole correlations. The ultimate goal of the geophysical program was to provide a better understanding of subsurface conditions above bedrock.

1. GROUND PENETRATING RADAR (GPR) - RIVER CHANNEL

1.1 Data Acquisition

The GPR survey was performed with a Geophysical Survey Systems, Incorporated (GSSI), SIR-7 radar system. The system consists of a power supply, control unit, EPC graphic display recorder, and two transmitting/receiving antennas. All instrumentation was mounted in a Nodwell FN-20 flatbed snow vehicle and the antenna was towed behind. Two antennas were used for this survey: one with a central frequency of 120 MHZ and the other of 300 MHZ.

The GSSI system uses radar technology to obtain a continuous high resolution electromagnetic profile of the subsurface. The depth of penetration is dependent upon the electrical properties of the subsurface materials and the frequency of the radar antenna employed, and may penetrate several tens of feet. The penetration depth was limited to approximately 15 feet for this survey.

Figure A-1 shows the locations of the fourteen radar profiles obtained between January 23, and January 26, 1983. The profiles total 8486 lineal feet of coverage. The profiles that cross the river at the upstream and downstream cofferdams and at the dam centerline were located by utilizing, on the ground, general topography. Profiles at other locations were positioned by taking bearings with a Brunton compass and making use of the survey reference marks available along with the

general topography. Measurements along each line were made with either a tape measure or hip chain.

For this survey, dielectric constants of 30 for saturated material and 81 for water were assumed in order to produce the profiles presented in Figure A-Z.

1.2 Conclusions

The primary objective of the radar survey was to locate local areas in the channel where overburden is very shallow (less than 15 feet below the surface).

Since the bedrock surface was in most instances greater than 15 feet the radar survey was primarily utilized to ascertain ice thickness and river bottom profile information. These data were used in constructing a topographic map of the surface of the river alluvium. The radar data was also used by the ice building and survey crews to check ice conditions in questionable areas of the river channel prior to moving equipment over the ice. The information was thus utilized in planning the routes to be taken by the hammer drill rig during its river channel operation.

2. SEISMIC REFRACTION - RIVER CHANNEL

2.1 Data Acquisition

The seismic refraction survey was conducted with a Geometrics ES-1210 12-channel signal enhancement seismograph and 4 hertz Mark Products vertical geophones. The energy source was Kinestik explosives; Atlas Staticmaster electric blasting caps were used to initiate the explosions.

Ten reversed refraction lines were run totalling 8785 lineal feet of geophone coverage as shown in Figure A-1. Each seismic line contained from one to three spreads of 12 geophones each with an interval of 50 feet between geophones. Shorter geophone spacings were used where necessary.

Generally, two shots were detonated at each end of each spread at distances of 10 to 25 feet and 200 to 600 feet from the end geophones. All geophones were placed either on grounded ice or floating river ice due to the seasonal conditions.

2.2 Data Reduction and Analysis

During the seismic surveying the presence of a high speed ice surficial layer acted to mask seismic arrivals from the slower velocity of the underlying alluvial deposits. It was anticipated that the bedrock velocity would be sufficiently faster than the ice so that it could be detected. This was the case with the first seismic arrival times from the ice preceding and obliterating the slower arrival times from the underlying river sand and gravel deposits, therefore, the seismic velocity of the saturated alluvium was never actually measured. However, the bedrock velocities were sufficiently faster than ice velocities so that with a long offset between the shot and geophone spread, seismic energy from the bedrock surface was detectable. Consequently, refraction profiles were run parallel or oblique to the river channel to take advantage of the long offset method.

Compressional wave (p-wave) arrival times were determined by observing the first break on each of the 12 horizontal wave traces recorded by the seismograph. These arrival times were then plotted against the horizontal distance from the shotpoint to the receiving geophones and grouped by apparent refractors. Standard velocity/intercept time

(Dobrin, 1976), velocity/delay time (Cummings, 1979; Hagedorn, 1959; Scott et al, 1972), and ray tracing (Scott et al, 1972) techniques were applied to these data to provide P-wave velocities and thicknesses for refractors.

2.3 Interpretation

Due to the surface ice layer, velocity data were not obtained for the saturated alluvium beneath the river bottom. In order to make depth calculations, it was assumed that the velocities for this material range between 6000 and 7000 fps velocities for the alluvium provided the best fit. In those exceptions, 6000 to 6250 fps velocities were used, which were still within the expected range.

Seismic velocities of 14,750 to 18,000 fps. were interpreted as indicative of bedrock.

2.4 Conclusions

Seismic profiles for S83-1 and S83-3 through 10 are presented in Figures A-3 through A-12, and show the interpreted bedrock elevations and assumed velocities in feet per second for the alluvium and bedrock. Also shown are the shotpoint positions, time-distance data, and depths to bedrock measured by hammer drilling, and seismic line intersections. Time-distance data for each seismic line are shown in Tables A-1 through A-10. A summary of the velocities in the alluvium (V_1) and bedrock (V_2), and the depth to bedrock are presented in Table A-11. These velocities do not include those of ice or ice-bonded soils.

There is generally good correlation between borehole data and the seismic profile sections where geophone spreads actually cross the

locations of the borings. Typically the variation in the depth to bedrock between these sets of data ranges from 2 to 15 feet.

The upstream end of S83-10 does not agree with data from DH-3, which was drilled during previous exploration. This hole shows bedrock at 78 feet below ice surface while the seismic data indicates depths 20 to 30 feet deeper in this vicinity. It is quite possible that extremely irregular bedrock topography in this location has distorted the seismic data.

In general, the depth to bedrock was shallow (less than 25 feet) along the north shore at the downstream cofferdam, moderately deep (60-80 feet) in the center of the channel at the upstream and downstream cofferdams and at the main dam, and very deep (greater than 150 feet) in localized areas between the main dam centerline and upstream cofferdam. A discussion of each major seismic line follows.

2.4.1 Downstream Cofferdam Foundation

Profiles S83-1 and S83-3 are aligned along the north shore. Profiles S83-4 and S83-10 are oriented parallel to the course of the river channel and are near the center portion of the channel.

Profile S83-1 shows relatively shallow bedrock (2 to 27 feet) with a seismic velocity of 15,300 fps. The apparent dip of the bedrock surface is to the east. An attempt to gather seismic information across the river channel along refraction Line S83-2 was made, but because of the short shore to shore distance, only direct arrivals through the river ice were recorded.

Line S83-3 indicated a single velocity layer with an average seismic velocity of 14,500 fps. This could be interpreted as bedrock at the

surface. Borehole data, however, indicates that rock is over 20 feet deep near this line. Since the velocity is between that of ice and those noted as bedrock on other lines, it was concluded that the alluvium under this line is frozen or partly frozen.

Profiles S83-4 and S83-10 provide subsurface information below the center of the river channel. The depth of bedrock averages 75 feet and the seismic velocity ranges from 15,000 to 17,000 fps. Both profiles indicate that the apparent dip of the bedrock surface is to the south.

2.4.2 Centerline and Upstream Dam Foundation Area

Profile S83-5 intersects the centerline of the proposed Watana Dam, Profiles S83-6 and S83-9 are centered 900 and 1600 feet upstream (east) of the centerline, respectively. All three profiles are oriented parallel to the course of the river and within the river channel.

Profile S83-5 shows an undulating bedrock surface with an average depth of 70 feet. Bedrock velocities (V_2) range between 14,750 and 18,000 fps. Bedrock begins to dip moderately to the east in the eastern portion of the profile. The lateral change in bedrock velocities could be caused by fracturing or shearing of the bedrock.

Profile S83-6 could not be handled by conventional computer modeling techniques, probably because of severe distortion of the field data by near-vertical displacements in the bedrock topography. A delay-time method (Cummings, 1979; Hagedorn, 1959) was applied to the arrival times. The model indicates a vertical displacement of 80 feet in the bedrock surface and bedrock may be as much as 170 feet deep at the base of the scarp.

Profile S83-9 shows a deep bowl-shaped bedrock surface. The maximum depth to rock is 162 feet; the seismic velocity is 15,500 fps.

2.4.3 Upstream Cofferdam Foundation

Profile S83-7 intersects the centerline of the upstream cofferdam. Profile S83-8 is located 550 feet upstream of the centerline and crosses the northeast portion of Profile S83-7.

Both profiles show a slightly undulating to level bedrock surface with an average depth of 65 feet and a velocity of 16,500 fps.

3. BOREHOLE GAMMA LOGGING - RIVER CHANNEL AND RELICT CHANNEL

3.1 Data Acquisition

Natural gamma logs were run in all open boreholes drilled during the winter program using a Mt. Sopris Model II borehole geophysical logging system. With the exception of DH83-4, all boreholes were logged through 2 inch PVC; DH83-4 was steel cased to 60 feet and open below 60 feet. Eight of the boreholes logged were located in the relict channel and 23 were in or near the river channel. The locations of the river channel boreholes are shown in Figure A-1. Individual gamma logs are shown on Figures A-13 through A-47.

3.2 Analysis and Interpretation

The natural-gamma logs were all run at a speed of 10 feet/min. and at a time constant of 5 cps (counts per second) for good definition of gamma anomalies. Chart deflection was set at 5 cps per division horizontally and 10 feet per inch vertically.

Gamma logs of adjacent holes were analyzed by matching log intervals having the same amplitude and similar anomaly signature. Those matches were then checked against the borehole sample logs for geologic identification. Individual gamma/litho units were then checked for their reasonableness according to standard geofluvial processes.

3.3 Conclusions

The gamma ray profile along seismic line DMA indicates that the gamma ray log is quite useful for extrapolation of point lithologic samples both vertically and horizontally. Unit E/F is recognizable in this profile and refinements in the boundaries are suggested from its examination.

The gamma-ray profiles for the river channel demonstrate a similar practicality in the much more complex geologic situation of rapid vertical and horizontal facies changes. The gamma ray anomalies recorded agree reasonably well with the point samples taken from the boreholes. Each of the river gamma/lithologic profiles permit better resolution of the river sections than the samples alone.

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2. Cummings, D., 1979, Determination of depths to an irregular interface in shallow seismic refraction surveys, Geophysics, v. 44, pp. 1987-1998.
3. Hagedoorn, J.G., 1959, The plus-minus method for interpreting seismic refraction lines, Geophysical Prospecting, v. 6, p. 285-294.
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4. TABLES

WATANA DEVELOPMENT SEISMIC REFRACTION SURVEY RIVER CHANNEL

TABLE A-1

TIME-DISTANCE DATA FOR S83-1

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>	
1	1454	0	10	
2	1453	225	10	
3	1454	450	0	

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>		
		<u>SP 1</u>	<u>SP 2</u>	<u>SP 3</u>
1	10	1.0	16.0	32.0
2	25	2.0	15.2	31.0
3	50	4.0	14.0	29.4
4	100	8.0	10.8	27.0
5	150	12.0	6.5	24.0
6	200	15.5	2.5	21.0
7	250	18.5	2.5	18.0
8	300	22.0	6.2	13.0
9	350	25.0	10.5	8.5
10	400	29.5	15.0	4.0
11	425	31.5	17.7	2.0
12	440	32.5	18.5	1.0

TABLE A-2

TIME-DISTANCE DATA FOR S83-2

NOTE:

S83-2 was an attempt to obtain a seismic section perpendicular to the river channel. River surface geometry precluded placing shotpoints at sufficient stepouts to provide first arrivals from bedrock; therefore, only ice arrivals were recorded.

TABLE A-3

TIME-DISTANCE DATA FOR S83-3

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>			
7	1457	720	0			
8	1456	460	10			
9	1456	200	0			
10	1456	0	0			
11	1457	920	0			

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>				
		<u>SP 7</u>	<u>SP 8</u>	<u>SP 9</u>	<u>SP 10</u>	<u>SP 11</u>
1	210	35.5	16.5	1.3	13.0	49.5
2	235	-	-	3.5	15.0	-
3	285	30.0	11.5	5.5	18.0	44.5
4	335	26.8	8.5	10.0	22.0	41.0
5	385	23.5	5.0	12.5	25.0	38.0
6	435	20.0	2.0	16.0	28.5	34.0
7	485	16.0	2.0	19.5	32.0	31.0
8	535	13.0	5.0	23.0	35.0	27.5
9	585	9.5	8.5	26.5	39.0	24.5
10	635	6.3	12.0	30.5	42.0	21.0
11	685	3.0	15.5	34.5	47.0	18.5
12	710	1.3	17.2	35.8	49.0	15.0

TABLE A-4

TIME-DISTANCE DATA FOR S83-4

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>	
12	1456	1110	0	
13	1455	540	30	
14	1453	0	0	

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>		
		<u>SP 12</u>	<u>SP 13</u>	<u>SP 14</u>
1	20	83.0	47.8	3.0
2	50	82.0	44.4	6.0
3	100	81.0	41.2	10.5
4	150	76.0	35.0	15.0
5	200	72.0	30.7	19.0
6	250	67.5	25.8	23.8
7	300	65.0	21.2	28.0
8	350	62.0	17.0	35.0
9	400	55.0	12.5	39.5
10	450	52.0	8.2	43.0
11	500	48.0	4.5	47.2
12	550	45.0	-	52.3
13	550	43.8	1.5	50.0
14	600	41.8	5.0	52.0
15	650	37.0	8.5	55.0
16	700	34.0	12.5	59.0
17	750	31.0	16.0	62.0
18	800	27.5	20.5	70.0
19	850	23.5	25.5	69.0
20	900	19.0	30.5	70.0
21	950	15.0	32.0	73.0
22	1000	10.0	36.3	77.5
23	1050	5.5	-	-
24	1100	1.5	44.7	83.0

TABLE A-5

TIME-DISTANCE DATA FOR S83-5

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>WEST</u>			
		<u>X LOCATION (FT)</u>		<u>Y LOCATION (FT)</u>	
15	1460	1700			
16	1458	1125			
19	1456	525			
20	1455	25		165	

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>			
		<u>SP 15</u>	<u>SP 16</u>	<u>SP 19</u>	<u>SP 20</u>
1	550	92.0	47.5	2.7	49.5
2	600	89.0	45.0	7.0	53.5
3	650	86.3	41.5	11.5	56.5
4	700	83.5	39.0	15.5	60.0
5	750	81.5	36.0	20.5	61.5
6	800	80.0	35.0	25.0	64.5
7	850	77.0	26.0	29.7	70.5
8	900	74.0	22.0	34.0	75.0
9	950	71.0	17.2	39.0	79.0
10	1000	67.0	12.5	42.5	81.0
11	1050	64.0	7.5	44.0	82.5
12	1100	61.0	3.0	46.0	84.0

TABLE A-5 (continued)
TIME-DISTANCE DATA FOR S83-5

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>EAST</u>		<u>Y LOCATION (FT)</u>
		<u>X LOCATION (FT)</u>		
15	1460	1130		0
16	1458	550		0
17	1456	0		0
18	1462	1660		0

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>			
		<u>SP 15</u>	<u>SP 16</u>	<u>SP 17</u>	<u>SP 18</u>
1	575	57.0	3.0	48.0	85.0
2	625	55.5	7.5	52.0	-
3	675	51.5	12.0	54.0	80.0
4	725	41.0	17.0	57.5	-
5	775	35.5	22.0	61.0	75.0
6	825	31.0	26.5	64.0	73.0
7	875	26.0	32.0	67.5	69.0
8	925	21.0	37.5	72.0	65.0
9	975	16.0	42.0	76.0	58.0
10	1025	12.0	46.0	80.0	53.0
11	1075	7.0	50.5	84.5	49.0
12	1125	3.0	55.0	89.0	46.0

TABLE A-6

TIME-DISTANCE DATA FOR S83-6

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>
21	1461	450	0
22	1464	1050	0
23	1459	25	0
23A	1459	0	0
24	1464	1585	0
25	1461	600	0
26	1462	1125	190

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>					
		<u>SP 21</u>	<u>SP 22</u>	<u>SP 23</u>	<u>SP 23A</u>	<u>SP 24</u>	<u>SP 25</u> <u>SP 26</u>
1	25				3.0		51.5 84.5
2	75				6.5		48.0 83.0
3	125				11.0		43.5 79.0
4	175				15.5		39.0 77.0
5	225				20.0		34.0 75.0
6	275				25.0		29.5 73.0
7	325				30.0		25.0 70.0
8	375				34.0		20.0 66.0
9	425				39.0		15.5 63.0
10	475	2.2	46.0	43.0	44.0	93.0	11.5 61.0
11	525	6.5	40.5	47.5	48.0	91.0	7.0 58.5
12	575	11.0	36.5	51.5	52.5	90.5	3.5 57.3
13	625	15.2	33.0	54.5		89.0	
14	675	20.5	29.5	59.0		90.0	
15	725	24.0	25.0	62.0		85.0	
16	775	27.0	21.0	67.5		78.0	
17	825	32.0	17.0	72.0		75.0	
18	875	36.0	12.0	78.5		58.0	
19	925	39.0	9.0	75.5		52.0	
20	975	42.0	5.8	76.5		49.0	
21	1025	46.7	2.3	79.5		46.0	
22	1025	47.0					
23	1075	52.0					
24	1125	60.5					
25	1175	64.5					
26	1225	66.0					
27	1275	70.5					
28	1325	76.0					
29	1375	80.5					
30	1425	85.0					
31	1475	87.5					
32	1525	91.5					
33	1575	95.0					

TABLE A-7

TIME-DISTANCE DATA FOR S83-7

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>
27	1465	825	0
28	1469	1425	8
29	1463	300	0
30	1470	1700	0
31	1464	875	15
32	1463	285	0
33	1463	0	0

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>					
		<u>SP 27</u>	<u>SP 28</u>	<u>SP 29</u>	<u>SP 30</u>	<u>SP 31</u>	<u>SP 32</u> <u>SP 33</u>
1	300		85.0			48.5	3.0 27.0
2	350		80.0			42.5	7.0 31.0
3	400		76.0			39.5	11.5 35.0
4	450		72.5			35.8	16.0 38.5
5	500		69.5			33.0	20.0 43.0
6	550		67.0			29.0	24.5 47.5
7	600		66.0			26.5	28.0 51.0
8	650		65.0			21.4	32.0 57.0
9	700		60.0			17.0	36.0 61.0
10	750		56.0			12.0	41.5 63.5
11	800		55.0			7.8	43.5 67.0
12	850		53.5			3.5	46.0 72.5
13	850	2.8	53.0	47.0	76.0		
14	900	9.0	50.0	52.0	75.0		
15	950	13.5	45.0	55.0	70.0		
16	1000	17.5	40.5	60.5	67.0		
17	1050	22.5	36.5	64.0	66.0		
18	1100	25.5	31.0	67.0	61.5		
19	1150	30.0	27.5	73.0	59.0		
20	1200	42.0	21.5	74.0	51.0		
21	1250	44.0	16.0	75.0	46.0		
22	1300	47.0	11.5	78.0	39.5		
23	1350	50.5	7.0	81.5	36.0		
24	1400	53.5	3.0	84.5	30.0		

ALASKA RESOURCES TUBARRE
U.S. DEPT. OF INTERIOR

TABLE A-8

TIME-DISTANCE DATA FOR S83-8

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>
34	1466	0	0
35	1470	600	0
36	1470	1125	0
37	1470	550	0
38	1470	1150	0

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>				
		<u>SP 34</u>	<u>SP 35</u>	<u>SP 36</u>	<u>SP 37</u>	<u>SP 38</u>
1	25	2.0	51.5	84.0	3.0	52.5
2	75	6.5	51.0	84.0	7.0	48.0
3	125	12.0	-	-	12.5	46.0
4	175	16.0	-	-	17.0	44.5
5	225	22.0	34.0	79.5	22.0	37.5
6	275	27.5	30.0	79.0	26.0	32.0
7	325	32.0	25.0	74.0	30.5	27.0
8	375	36.0	20.0	69.0	36.0	22.5
9	425	38.0	16.0	62.0	41.5	18.0
10	475	41.0	12.5	59.0	47.0	13.0
11	525	46.0	7.0	55.0	50.0	8.0
12	575	49.0	3.0	52.0	51.5	3.0
13	575	50.0				
14	625	54.0				
15	675	57.5				
16	725	59.0				
17	775	63.0				
18	825	66.0				
19	875	68.5				
20	925	72.0				
21	975	75.0				
22	1025	78.0				
23	1075	80.0				
24	1125	84.0				

TABLE A-9

TIME-DISTANCE DATA FOR S83-9

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>
39	1467	1705	0
40	1461	0	0

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>	
		<u>SP 39</u>	<u>SP 40</u>
1	550	98.0	45.0
2	600	95.0	49.0
3	650	-	56.0
4	700	90.5	58.0
5	750	87.5	62.0
6	800	83.0	65.0
7	850	77.0	71.0
8	900	72.0	76.0
9	950	68.0	89.0
10	1000	65.5	89.0
11	1050	61.5	92.0
12	1100	57.0	96.0

TABLE A-10

TIME-DISTANCE DATA FOR S83-10

<u>SHOT POINT</u>	<u>ELEVATION (FT)</u>	<u>X LOCATION (FT)</u>	<u>Y LOCATION (FT)</u>
41	1453	0	20
42	1453	600	
43	1454	1150	

<u>GEOPHONE</u>	<u>X LOCATION (FT)</u>	<u>ARRIVAL TIMES (MSEC)</u>		
		<u>SP 41</u>	<u>SP 42</u>	<u>SP 43</u>
1	25	2.2	49.0	82.5
2	75	6.8	47.0	79.5
3	125	11.0	43.0	78.0
4	175	15.0	38.0	77.5
5	225	20.0	34.0	76.0
6	275	24.0	29.0	74.5
7	325	28.5	24.0	71.0
8	375	33.5	20.0	68.0
9	425	38.0	15.5	65.0
10	475	42.5	11.0	60.0
11	525	46.5	8.0	56.0
12	575	50.0	2.5	52.0
13	575	48.0		
14	625	51.5		
15	675	53.8		
16	725	56.0		
17	775	59.5		
18	825	62.5		
19	875	66.0		
20	925	69.5		
21	975	72.5		
22	1025	76.5		
23	1075	80.0		
24	1125	83.5		

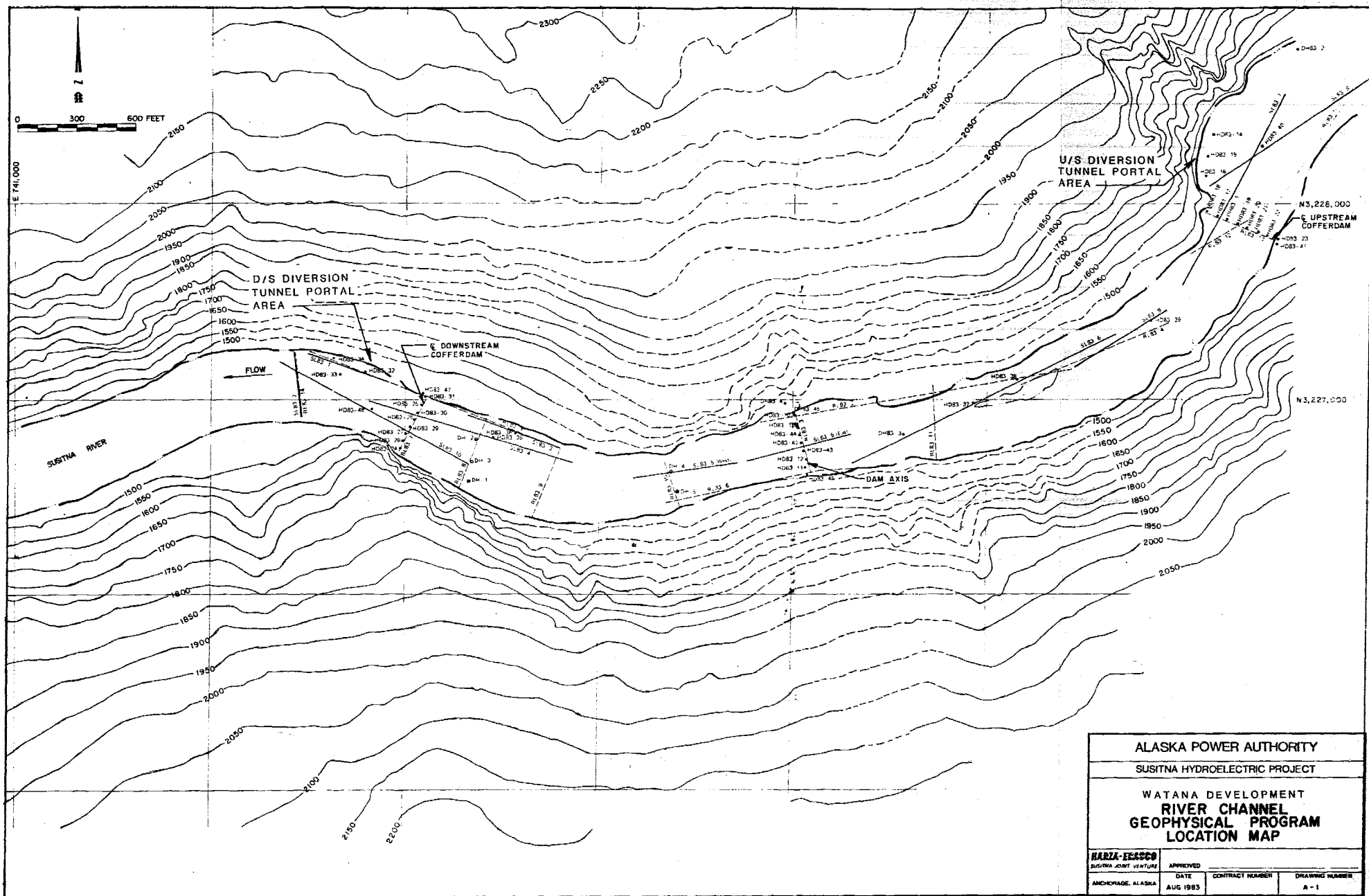
TABLE A-11

SUMMARY OF SEISMIC VELOCITIES AND LAYER DEPTHS

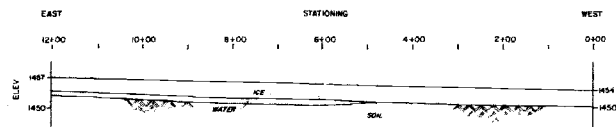
Refraction Profile	Spread	V ₁ (fps)	Depth Below Ice Surface to V ₂ (feet)	V ₂ (fps)
S83-1	1	7000	2 - 27	15350
S83-2	1	not used	-	-
S83-3	1	-	uninterpretable	14500 (frozen soils?)
S83-4	1	6750	54 - 88	15,000
	2	7000	20 - 57	16500
S83-5	1	7000	58 - 83	18000
	2	6250	51 - 100	14750
S83-6	1	-	uninterpretable	-
	2	6750	82 - 168	17500
	3	-	uninterpretable	-
S83-7	1	7000	47 - 76	16500
	2	7000	62 - 87	16500
S83-8	1	6000	21 - 82	16500
	2	6000	41 - 63	16500
S83-9	1	7000	105 - 164	15500
S83-10	1	6750	10 - 69	17000
	2	6750	67 - 110	17000

5. FIGURES

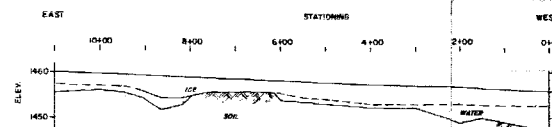
WATANA DEVELOPMENT GEOPHYSICAL EXPLORATIONS



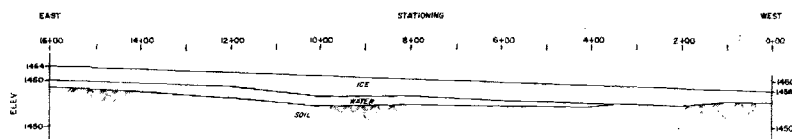
ALASKA POWER AUTHORITY			
SUSITNA HYDROELECTRIC PROJECT			
WATANA DEVELOPMENT			
RIVER CHANNEL			
GEOPHYSICAL PROGRAM			
LOCATION MAP			
HARZA-ERSSCO		APPROVED	
SUSITNA JOINT VENTURE		DATE	
ANCHORAGE, ALASKA		AUG 1983	
CONTRACT NUMBER		DRAWING NUMBER	
		A-1	



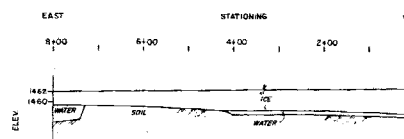
RBS-1



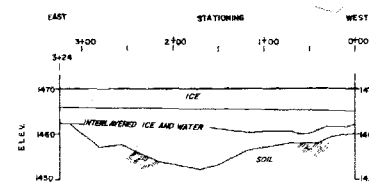
RBS-6



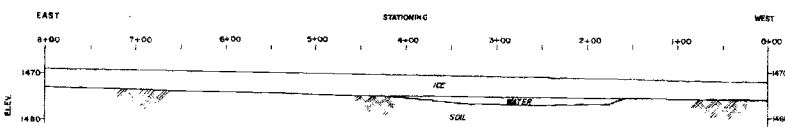
RBS-2



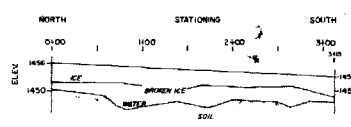
RBS-4



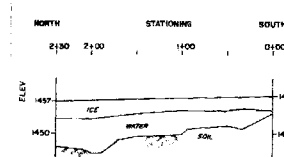
RBS-12



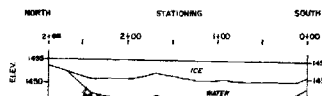
RBS-5



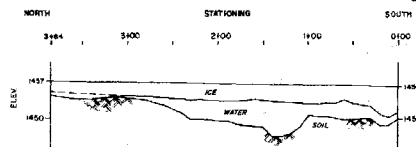
RBS-14



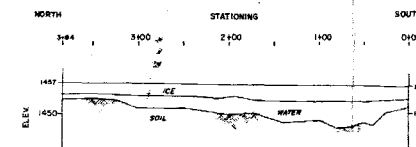
RBS-10



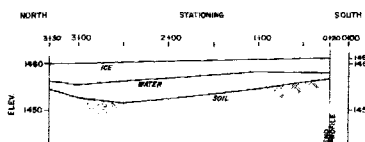
RBS-7



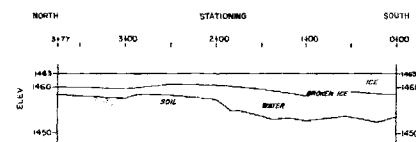
RBS-8



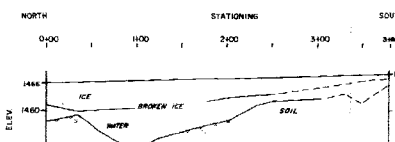
RBS-9



RBS-3



RBS-11



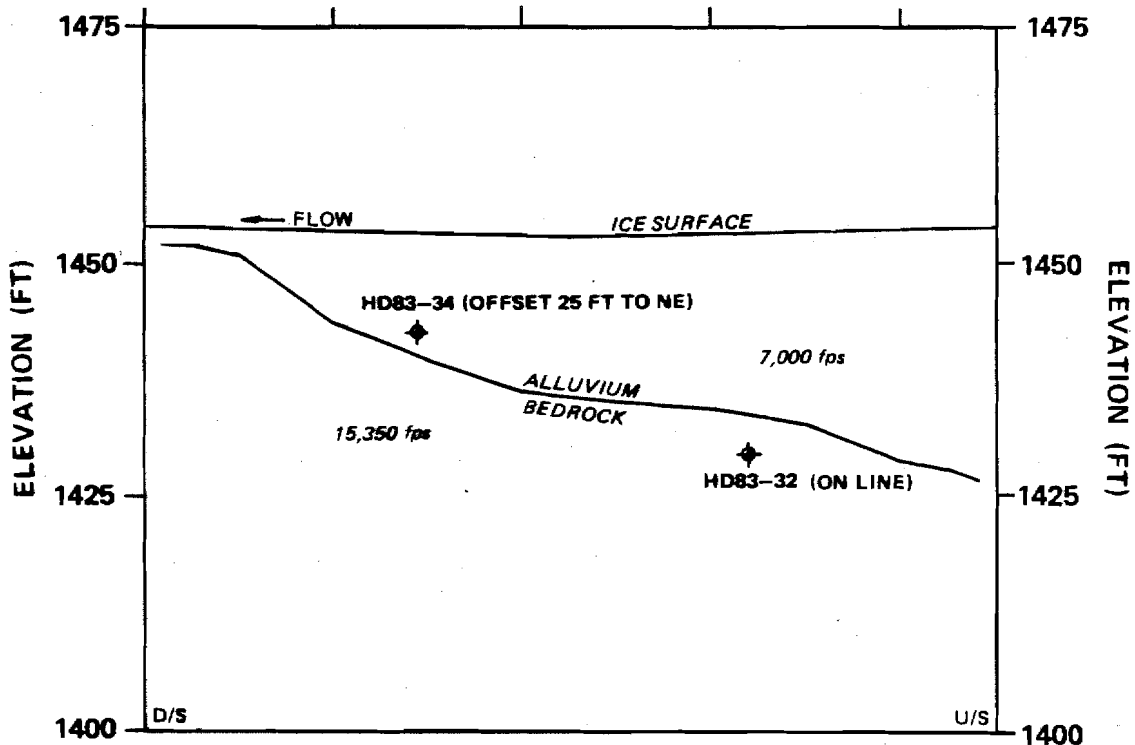
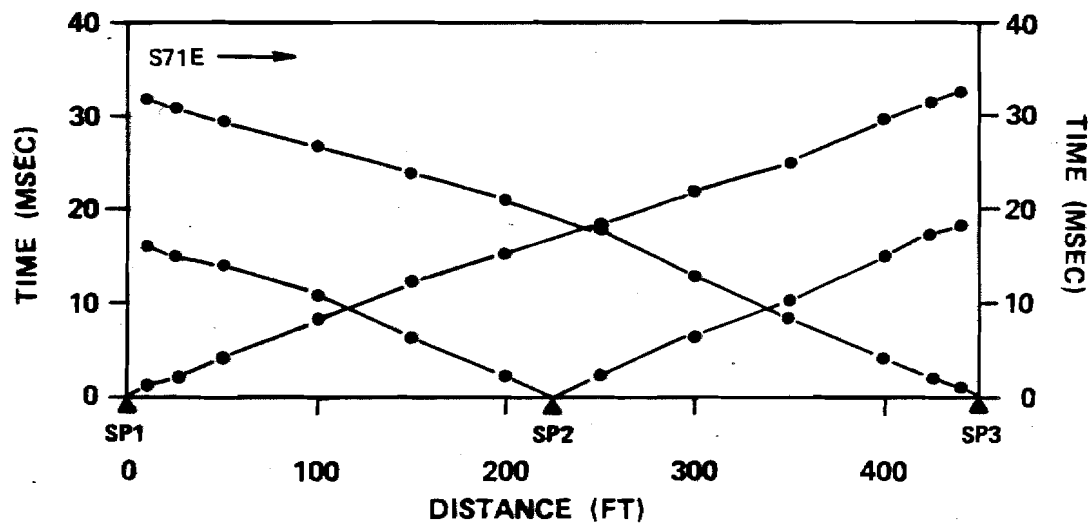
RBS-13

- NOTES:
1. SEE DRAWING NO. A-1 FOR PROFILE LOCATIONS.
 2. VERTICAL SCALE 1"=10', HORIZONTAL SCALE 1"=100' FOR LONGITUDINAL SECTIONS & 1"=50' FOR TRANSVERSE SECTIONS.
 3. PROFILES BASED ON INTERPRETATIONS OF GEOPHYSICAL DATA AND ARE SUBJECT TO FUTURE VERIFICATION.
 4. ALL ELEVATIONS & STATIONING SHOWN IN FEET.

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

WATANA DEVELOPMENT
- RIVER CHANNEL -
GROUND PENETRATING
RADAR PROFILES

BARZA-000000 DATE AUG.83 FIGURE A-2



EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- I DEPTH RANGE INDICATED BY CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION

ALASKA POWER AUTHORITY

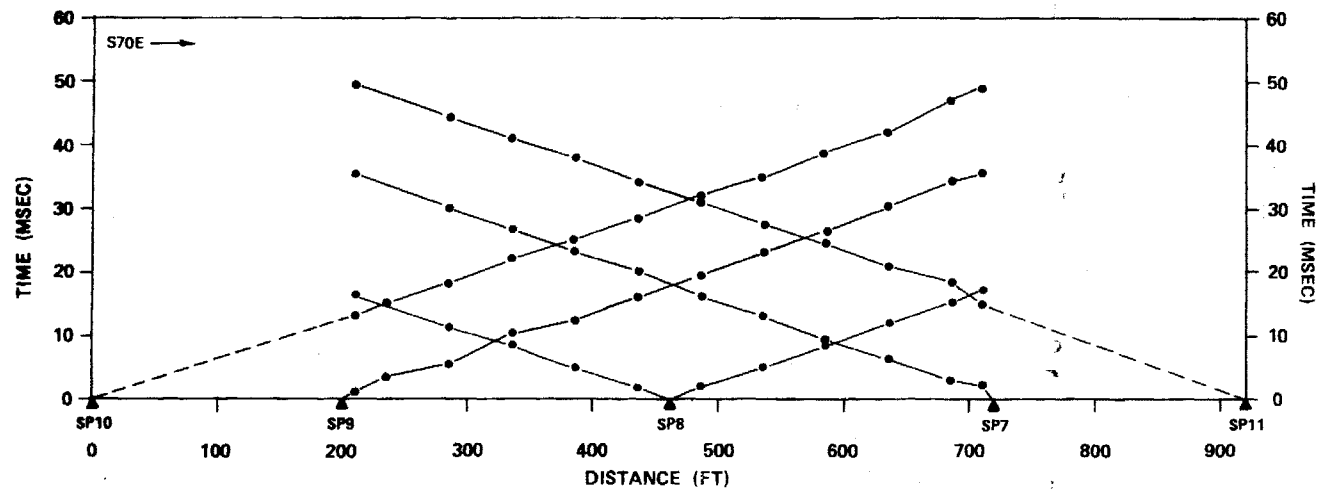
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT
AND SEISMIC SECTION
FOR S83-1

HARZA-EBASCO
SUSITNA JOINT VENTURE

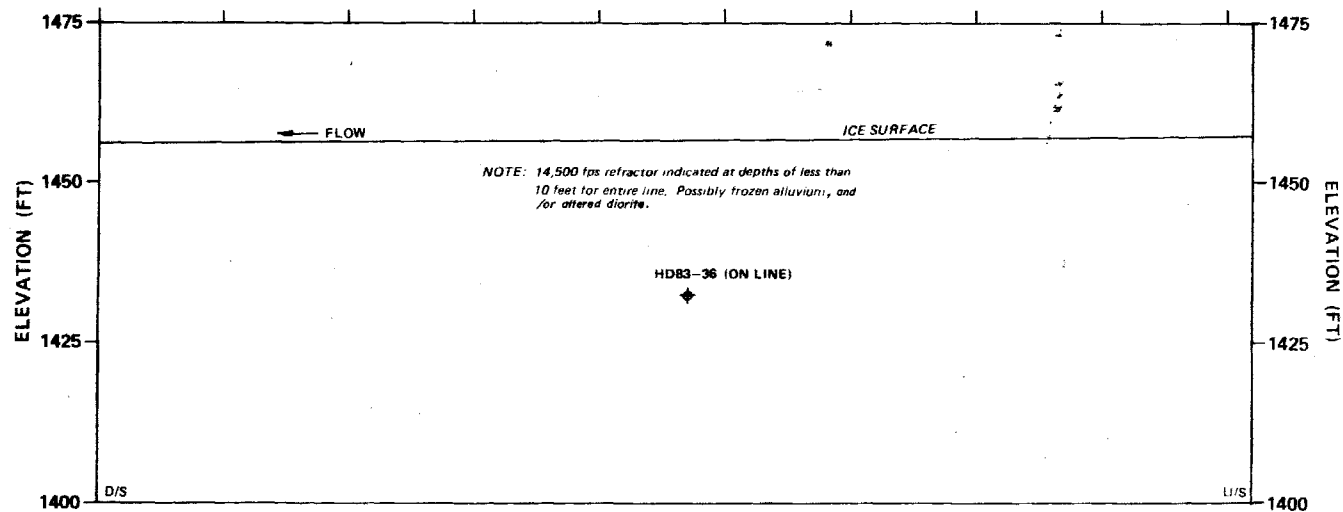
DATE
AUG.83

FIGURE
A-3



EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- ┌ DEPTH RANGE INDICATED BY
│ CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION



ALASKA POWER AUTHORITY

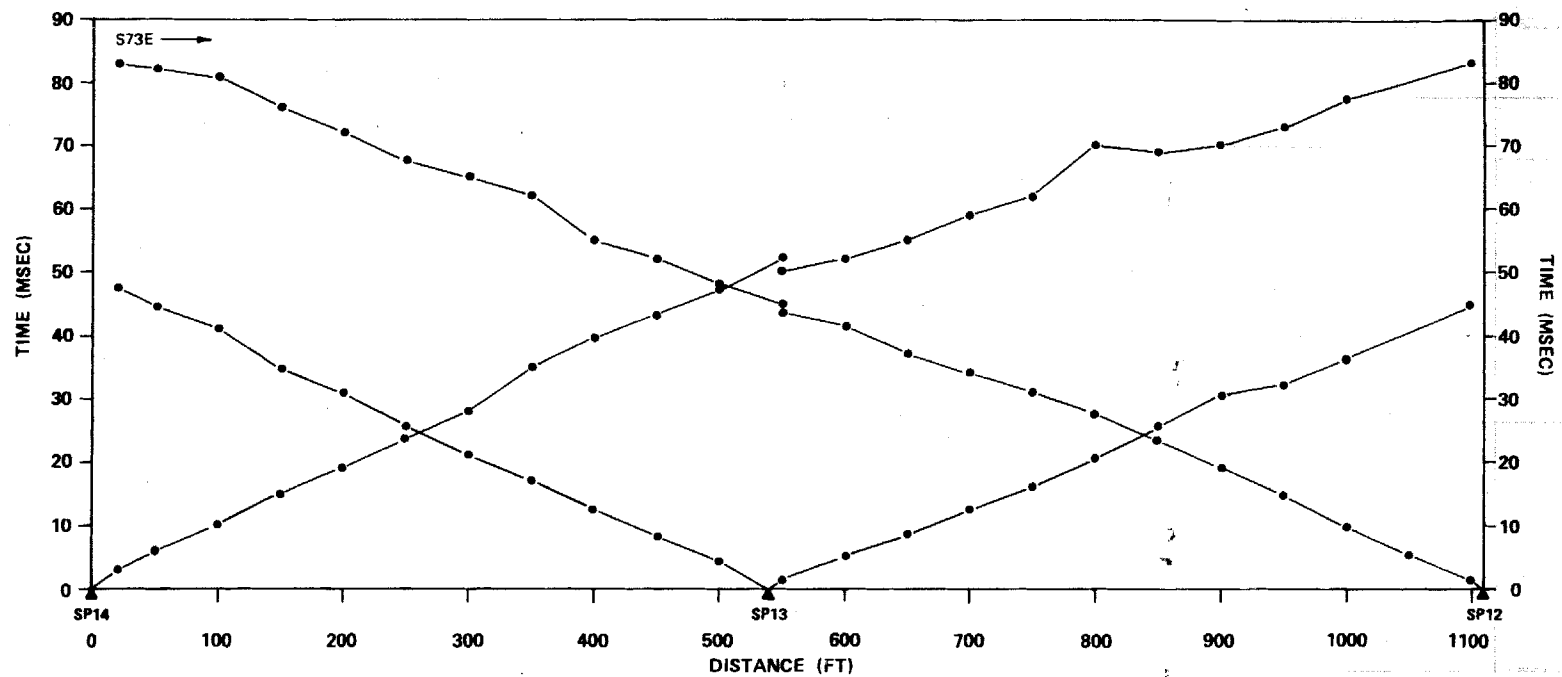
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT
AND SEISMIC SECTION
FOR S83-3

HAZAR-ESASCO

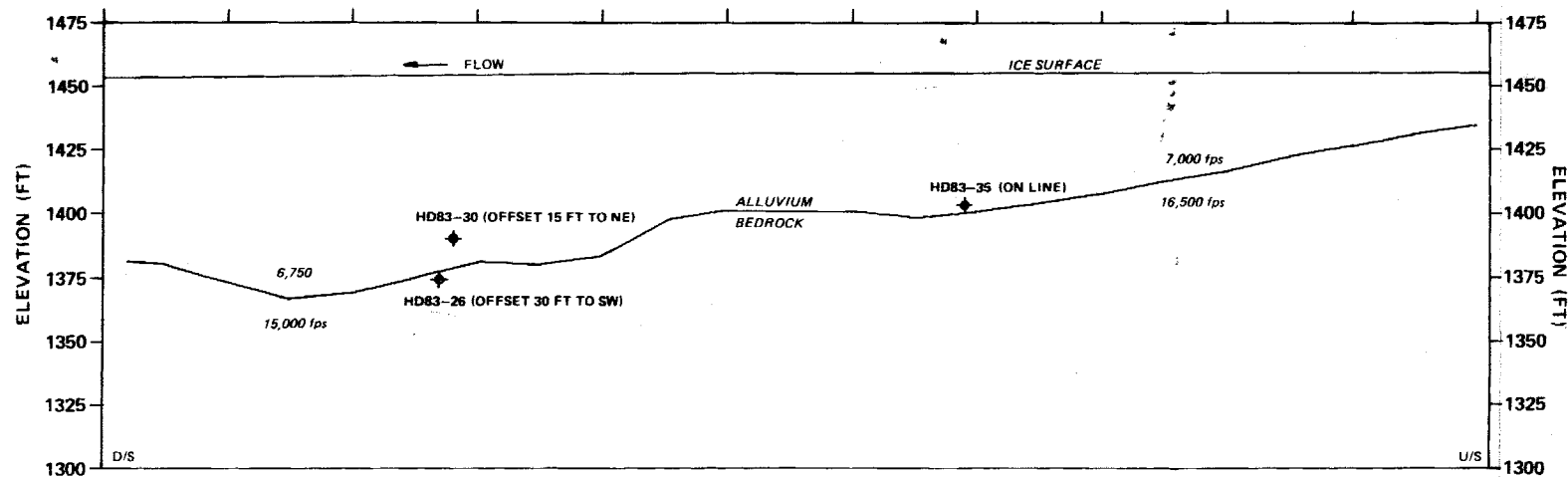
DATE
AUG 83

FIGURE
A-4



EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- ┌ DEPTH RANGE INDICATED BY
│ CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION

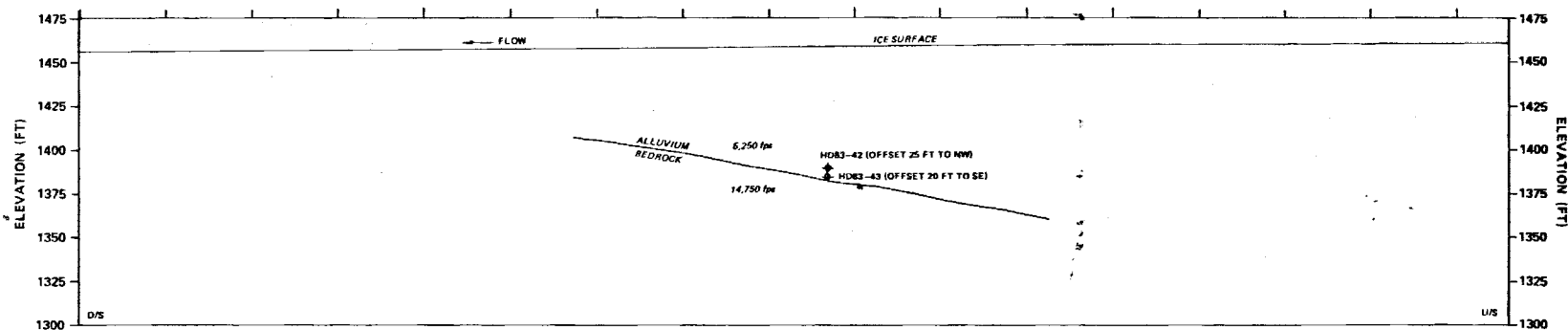
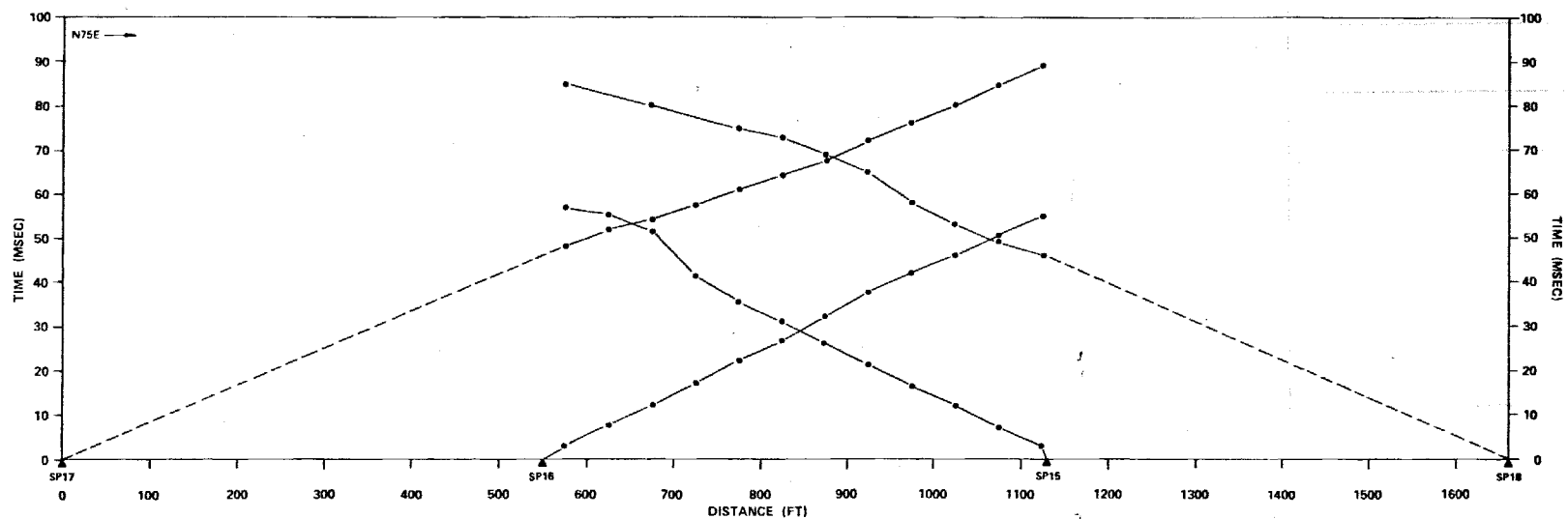


ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
TIME-DISTANCE PLOT
AND SEISMIC SECTION
FOR S83-4

HARZA-EDASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-5



EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- ┌ DEPTH RANGE INDICATED BY
│ CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION

ALASKA POWER AUTHORITY

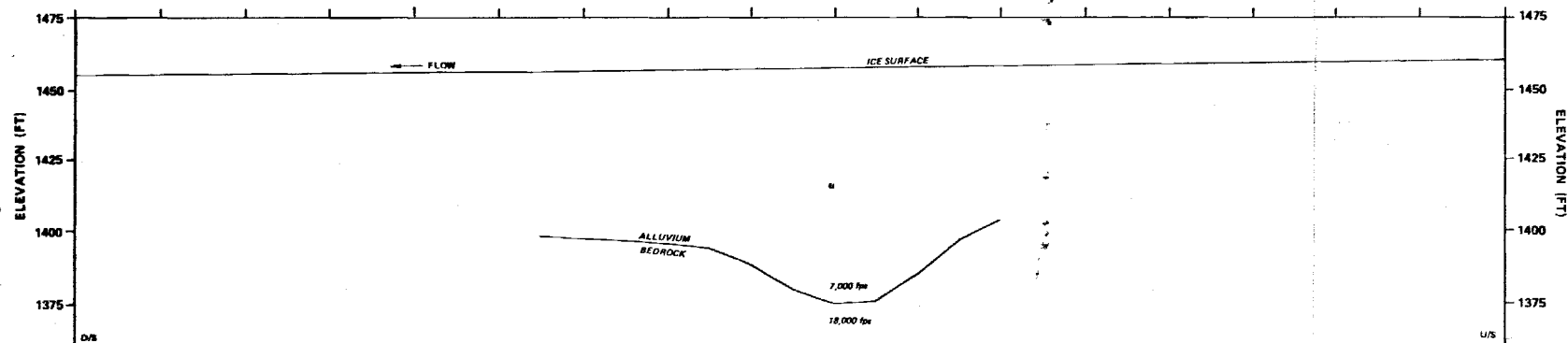
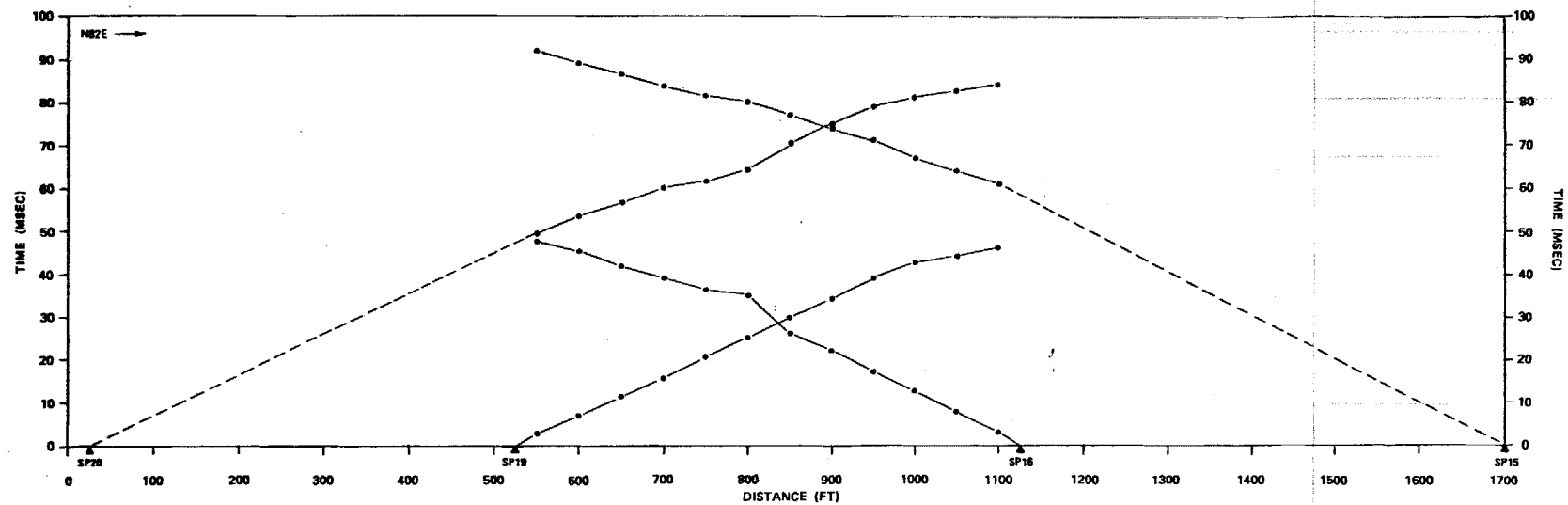
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT
AND SEISMIC SECTION
FOR S83-5

HARZA-ES-5000

DATE
AUG83

FIGURE
A-6



EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- ┌ DEPTH RANGE INDICATED BY
│ CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION

ALASKA POWER AUTHORITY

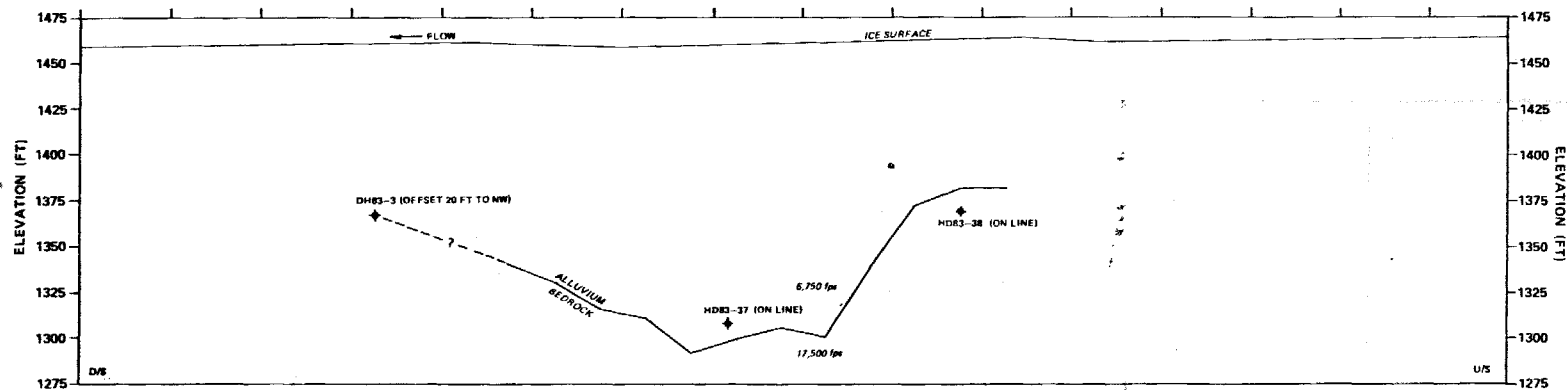
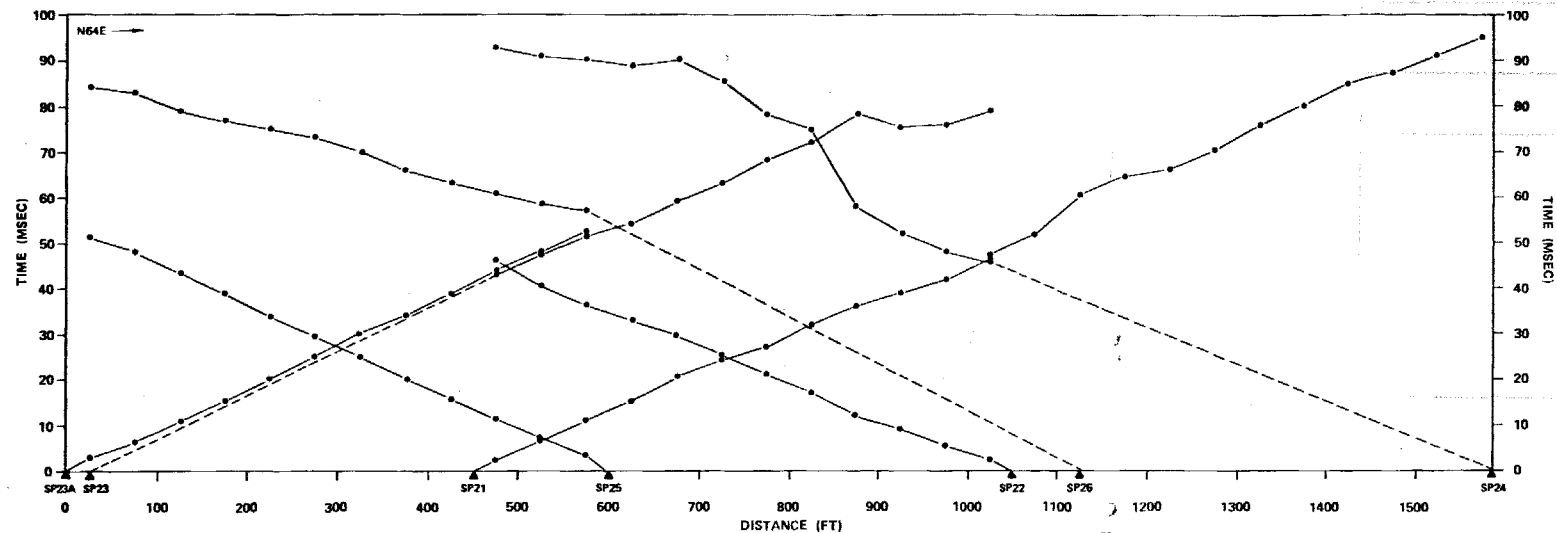
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT
AND SEISMIC SECTION
FOR S83-5 (WEST)

MANA-EBASC
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-7



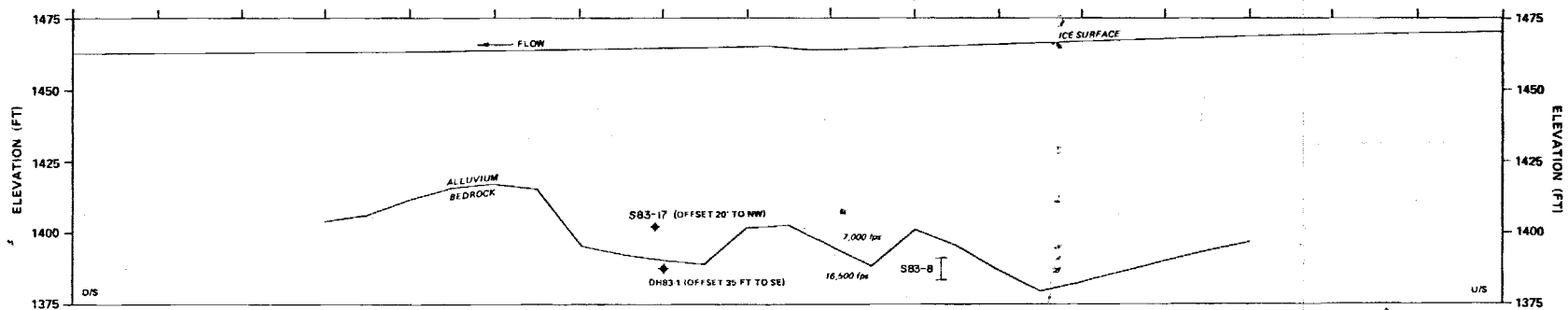
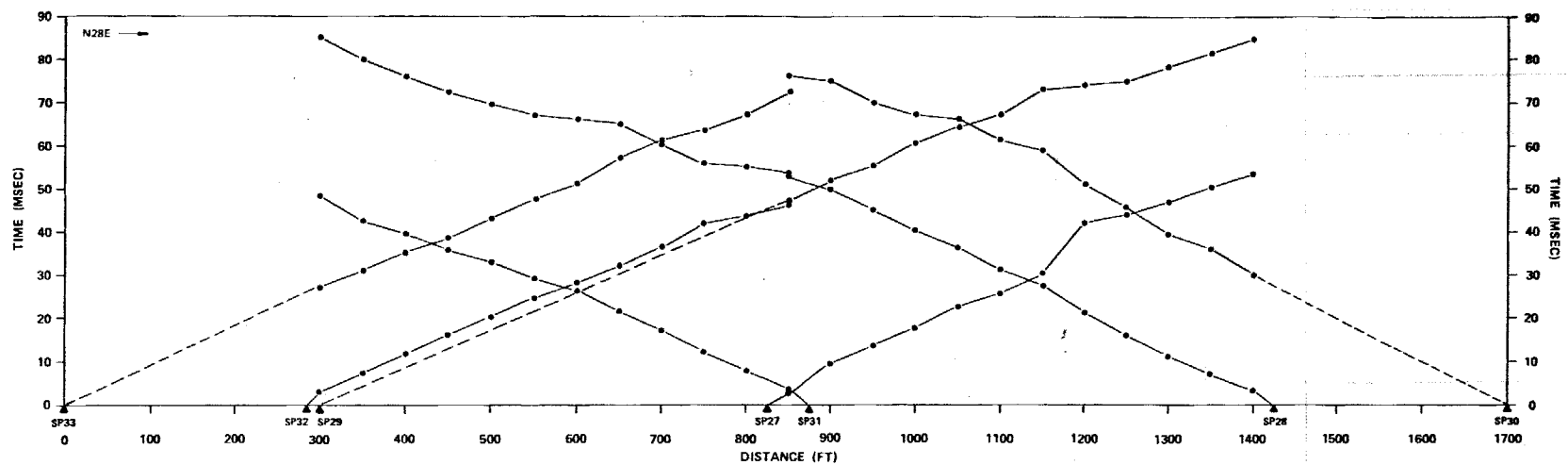
EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- ┌ DEPTH RANGE INDICATED BY
│ CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT
AND SEISMIC SECTION
FOR S83-6

DATE AUG83 FIGURE A-8



EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- ┌ DEPTH RANGE INDICATED BY
CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION

ALASKA POWER AUTHORITY

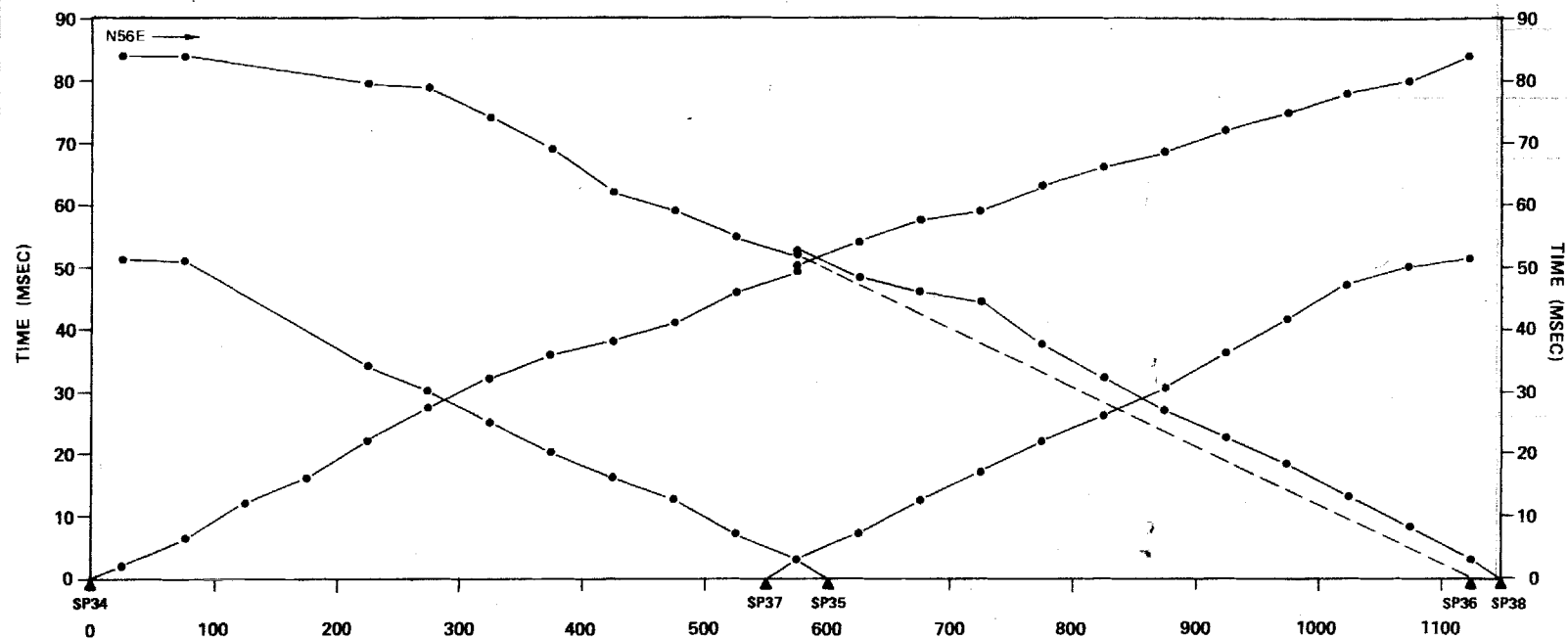
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT
AND SEISMIC SECTION
FOR S83-7

MARZA-ESASSCO
SUSITNA JOINT VENTURE

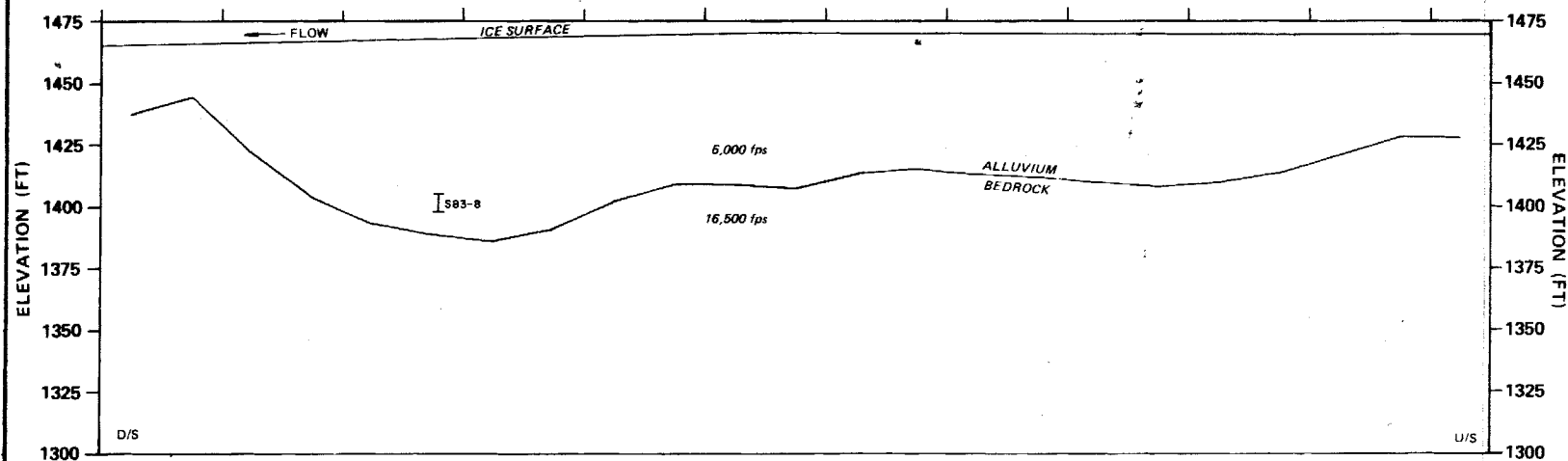
DATE
AUG 83

FIGURE
A-9



EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- | DEPTH RANGE INDICATED BY CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION



ALASKA POWER AUTHORITY

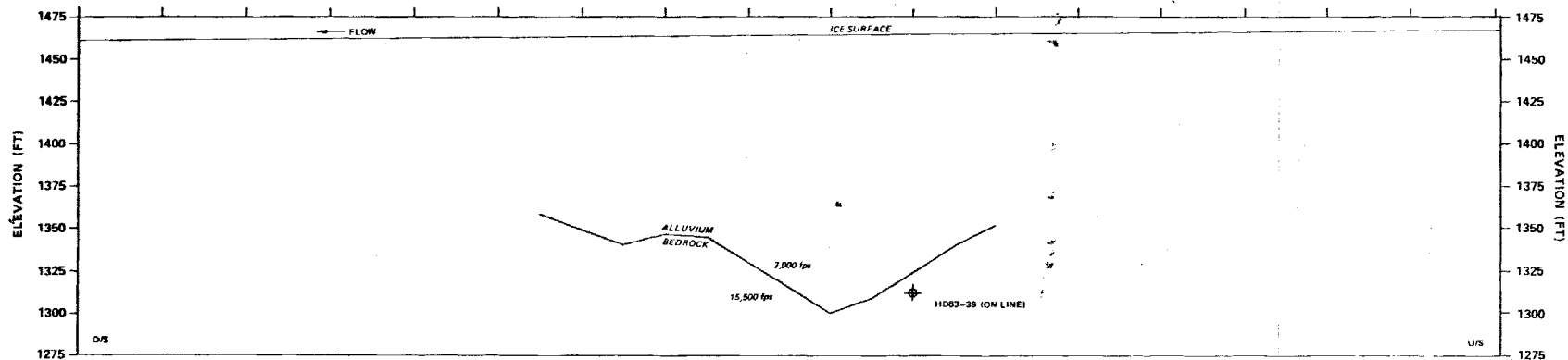
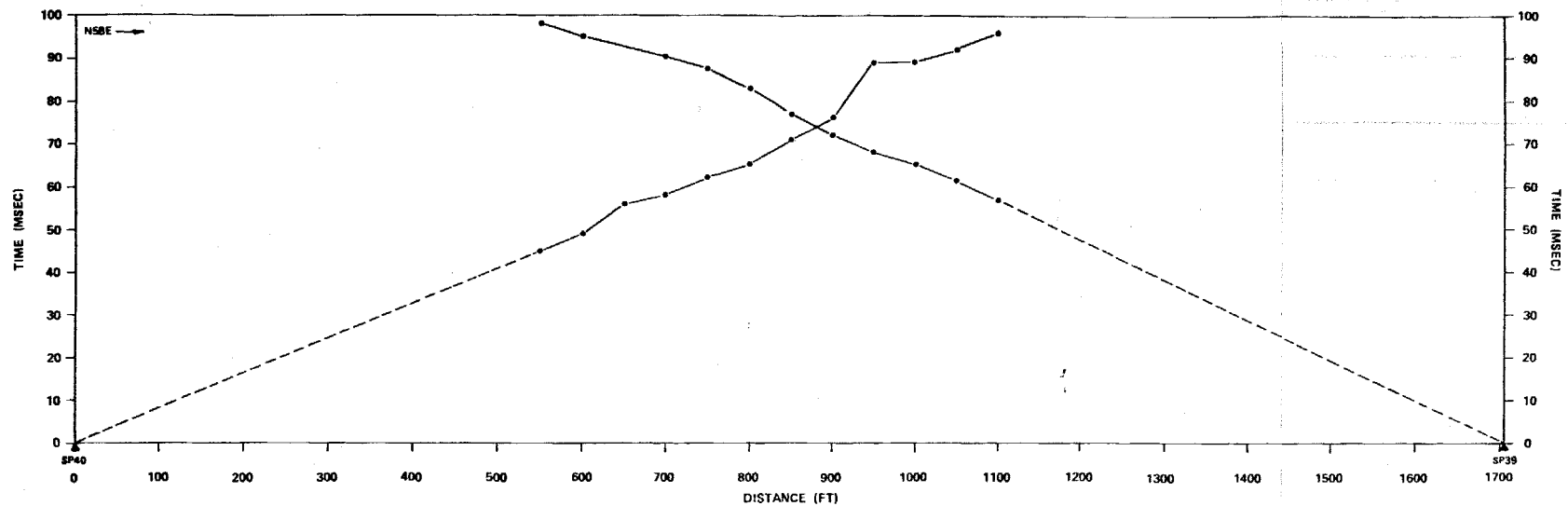
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT
AND SEISMIC SECTION
FOR S83-8

HARZA-ES&S

DATE
AUG.83

FIGURE
A-10



EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- I DEPTH RANGE INDICATED BY CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION

ALASKA POWER AUTHORITY

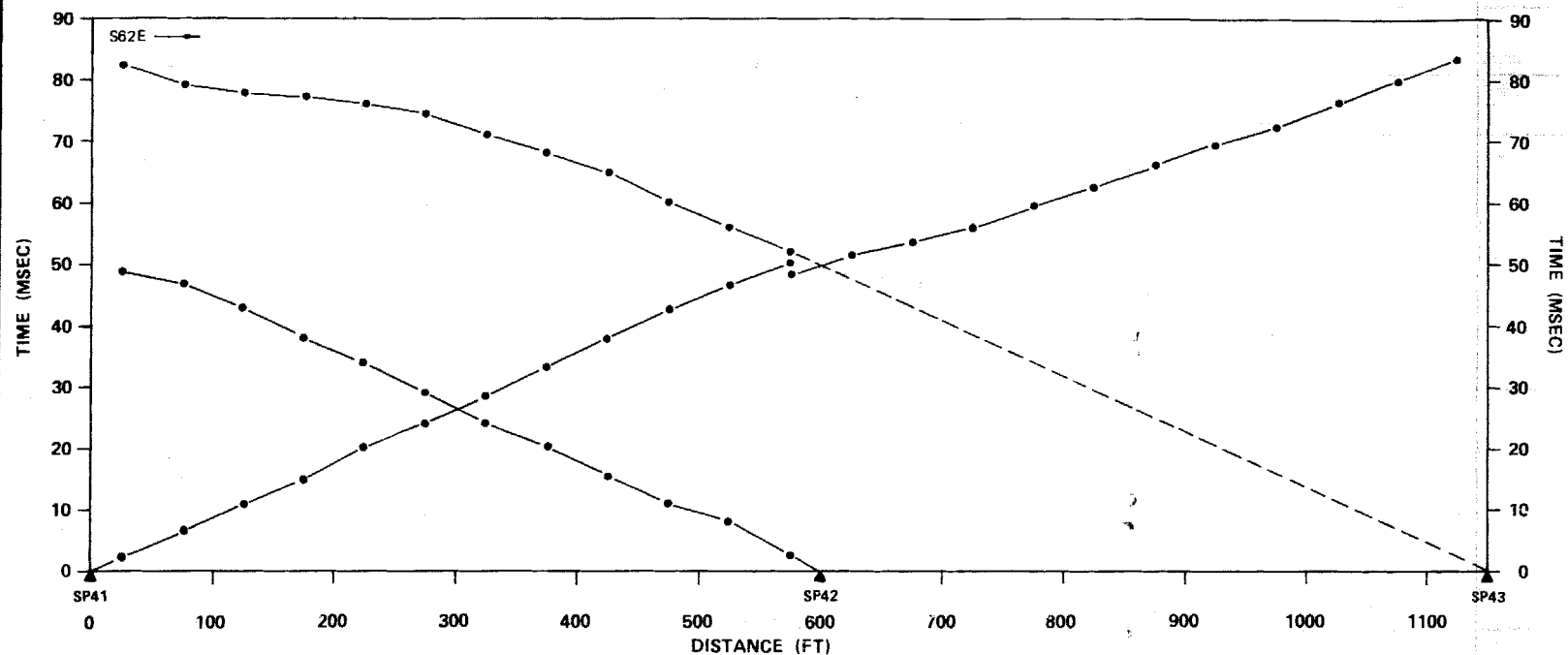
SUSITNA HYDROELECTRIC PROJECT

TIME-DISTANCE PLOT
AND SEISMIC SECTION
FOR S83-9

MAZDA-EBASCO
SUSITNA JOINT VENTURE

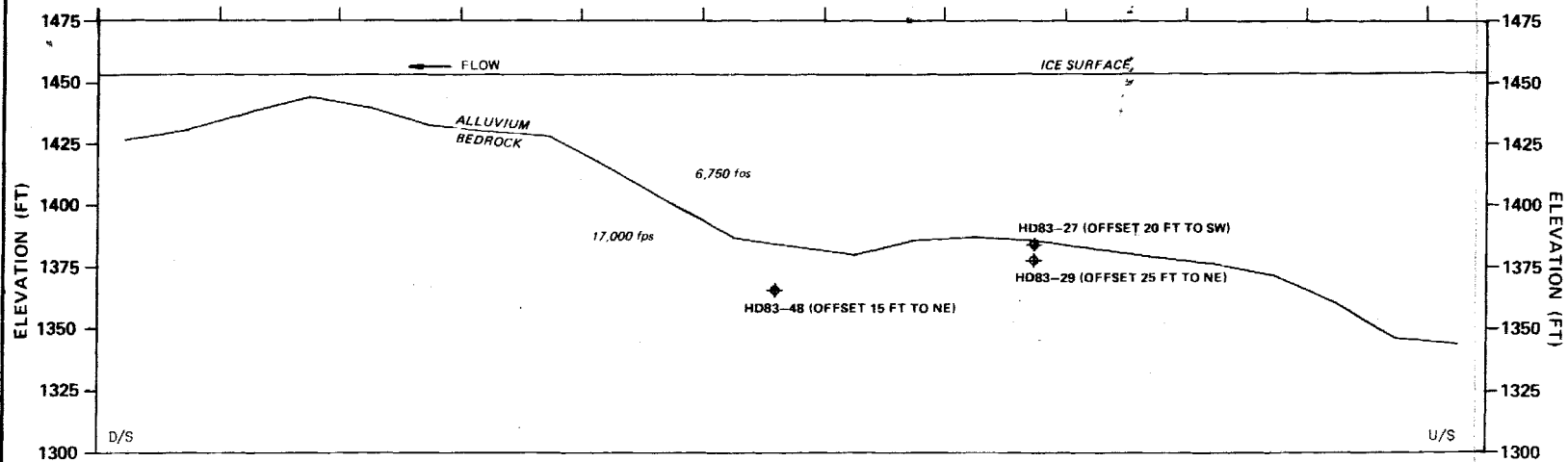
DATE
AUG.83

FIGURE
A-11



EXPLANATION

- ◆ BOREHOLE DEPTH CONTROL
- I DEPTH RANGE INDICATED BY CROSSING SEISMIC LINE
- ▲ SHOTPOINT LOCATION



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

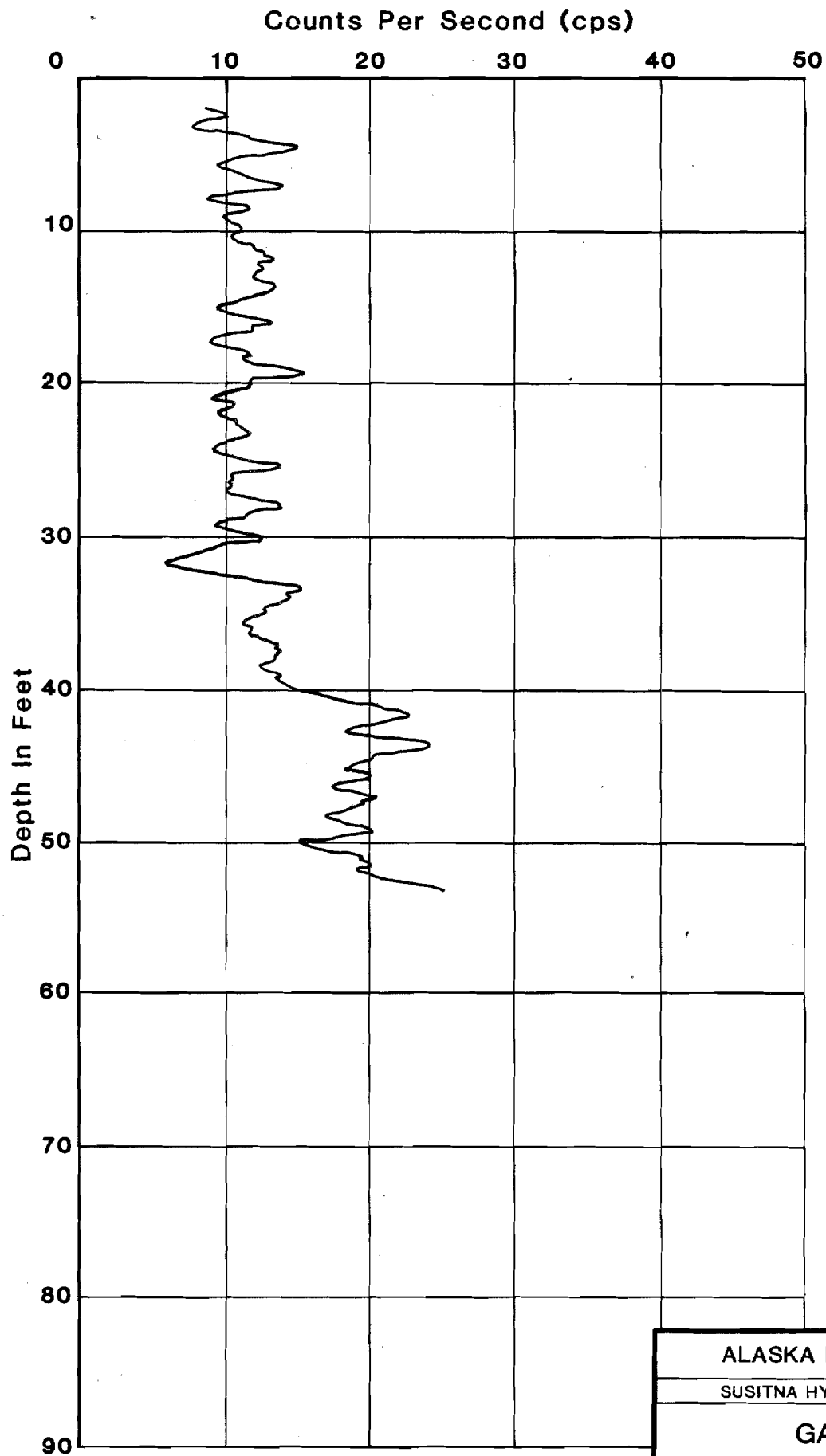
TIME-DISTANCE PLOT
AND SEISMIC SECTION
FOR S63-I0

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-12

GAMMA LOGS — RIVER AND RELICT CHANNELS



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

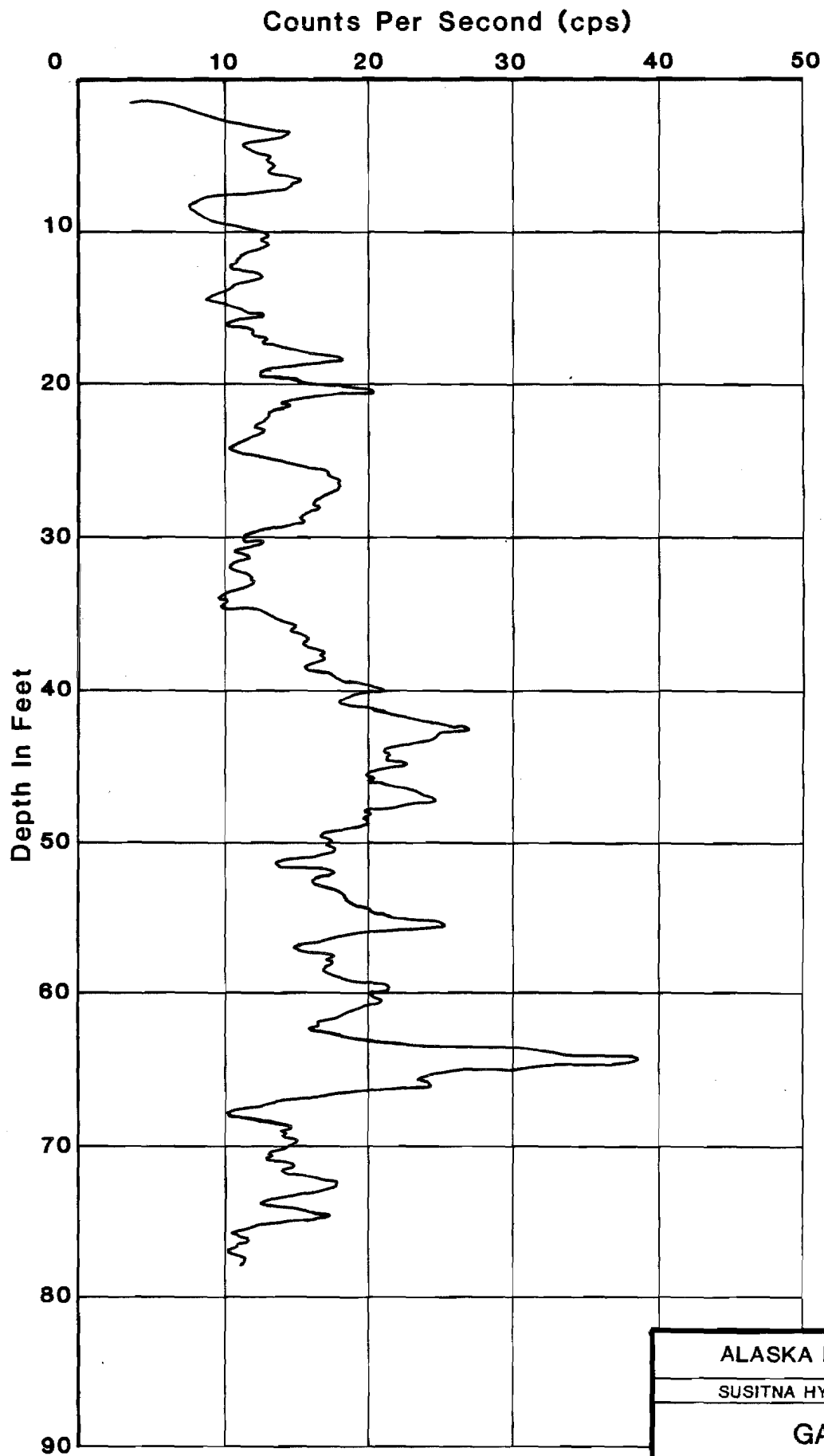
GAMMA LOG

HD83-4

HARZA-ERASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-13



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

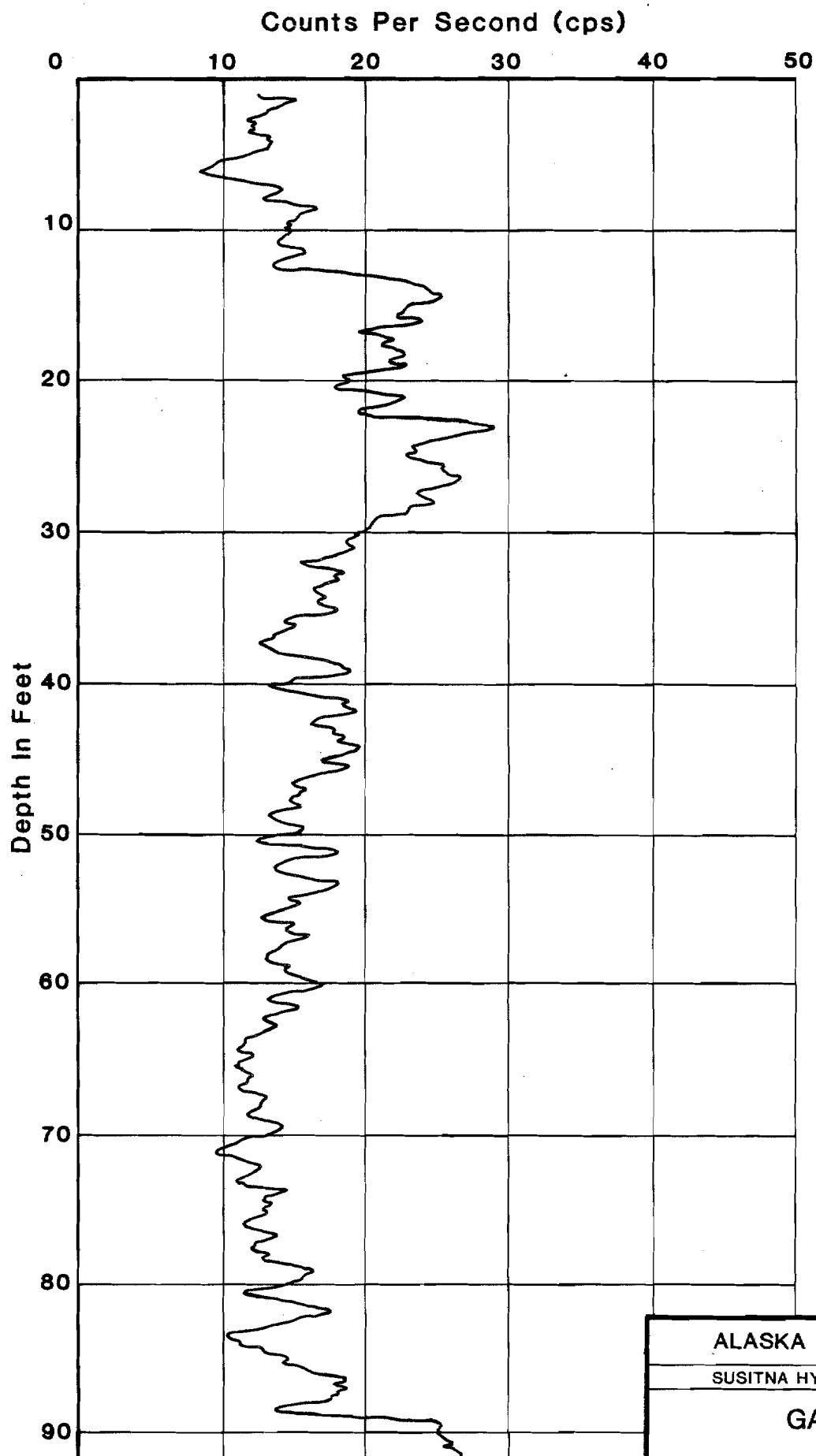
GAMMA LOG

HD83-5

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-14



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

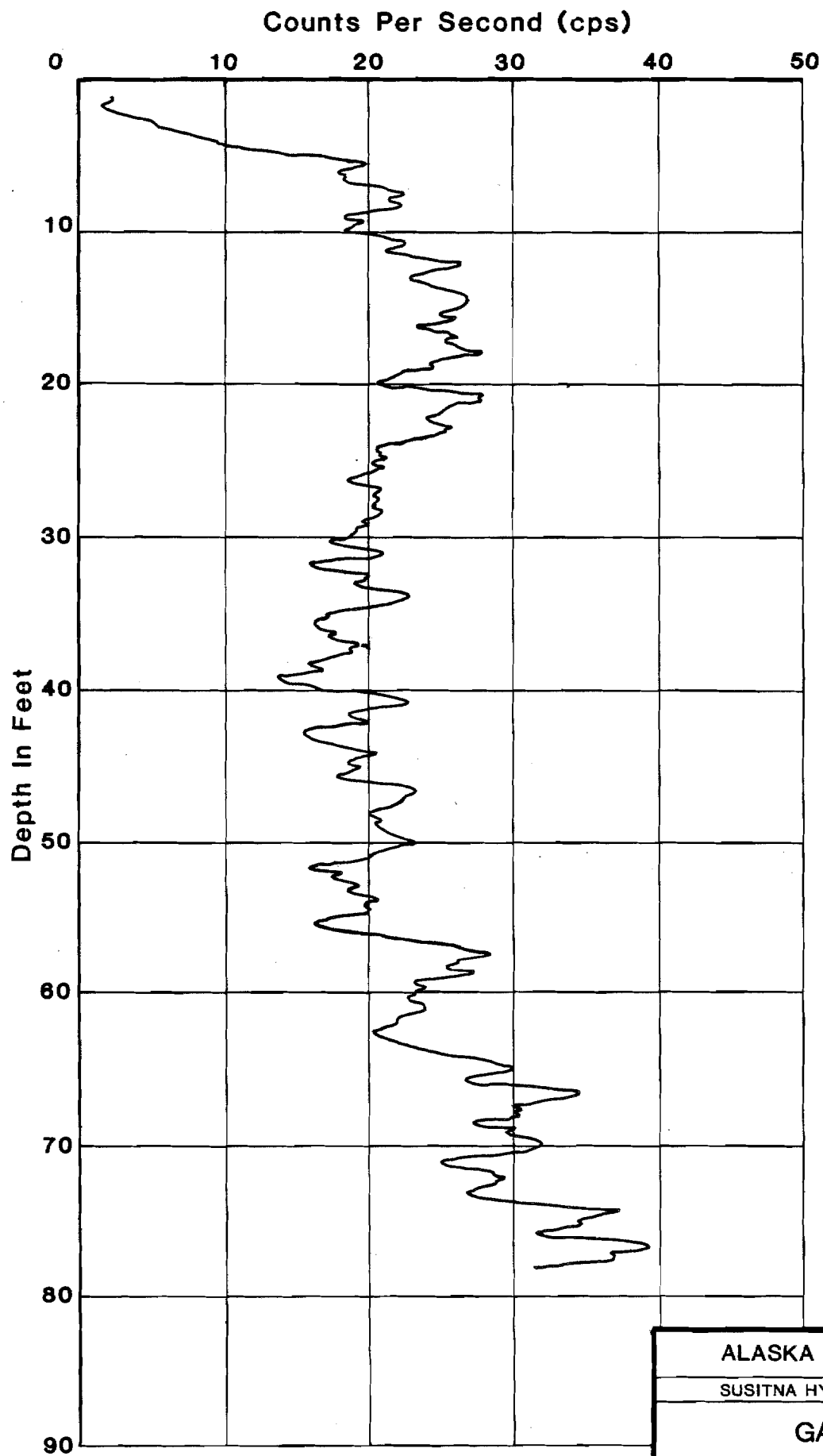
GAMMA LOG

HD83-6

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG83

FIGURE
A-15



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

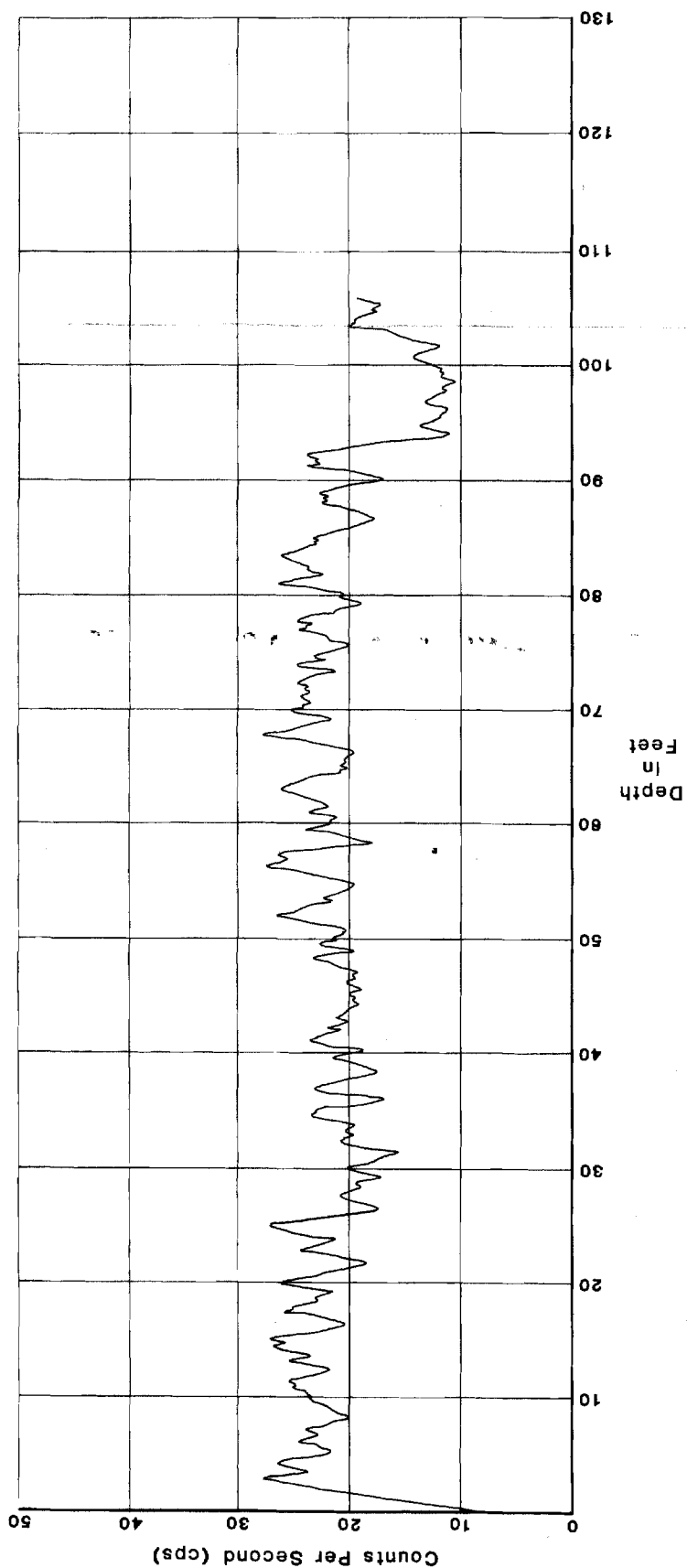
GAMMA LOG

HD83-8

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG 83

FIGURE
A-16



ALASKA POWER AUTHORITY

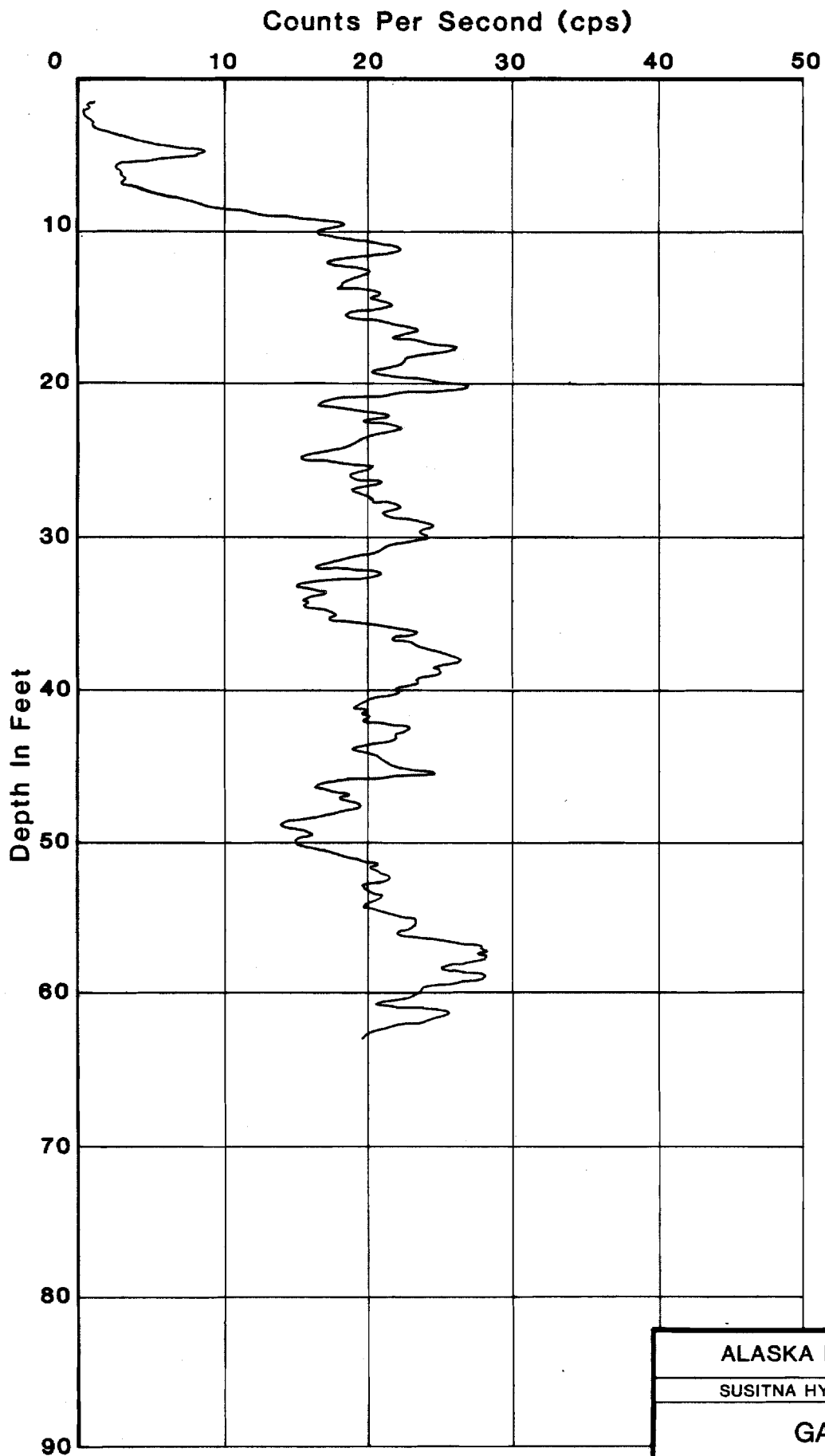
SUSITNA HYDROELECTRIC PROJECT

GAMMA LOG

HD83-9

DATE
AUG83

FIGURE
A-17



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

GAMMA LOG

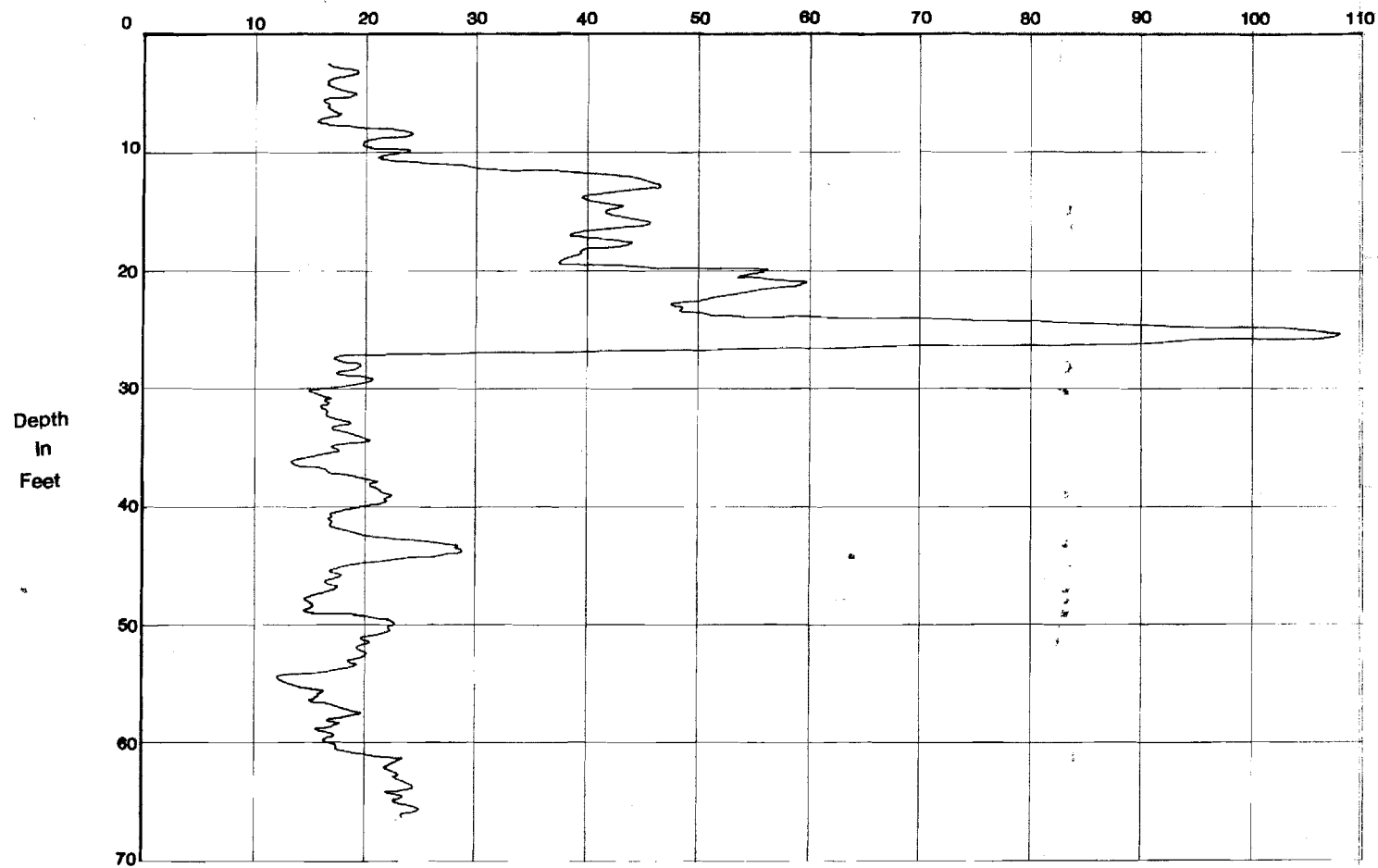
HD83-20

HARZA-ERASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-18

Counts Per Second (cps)



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

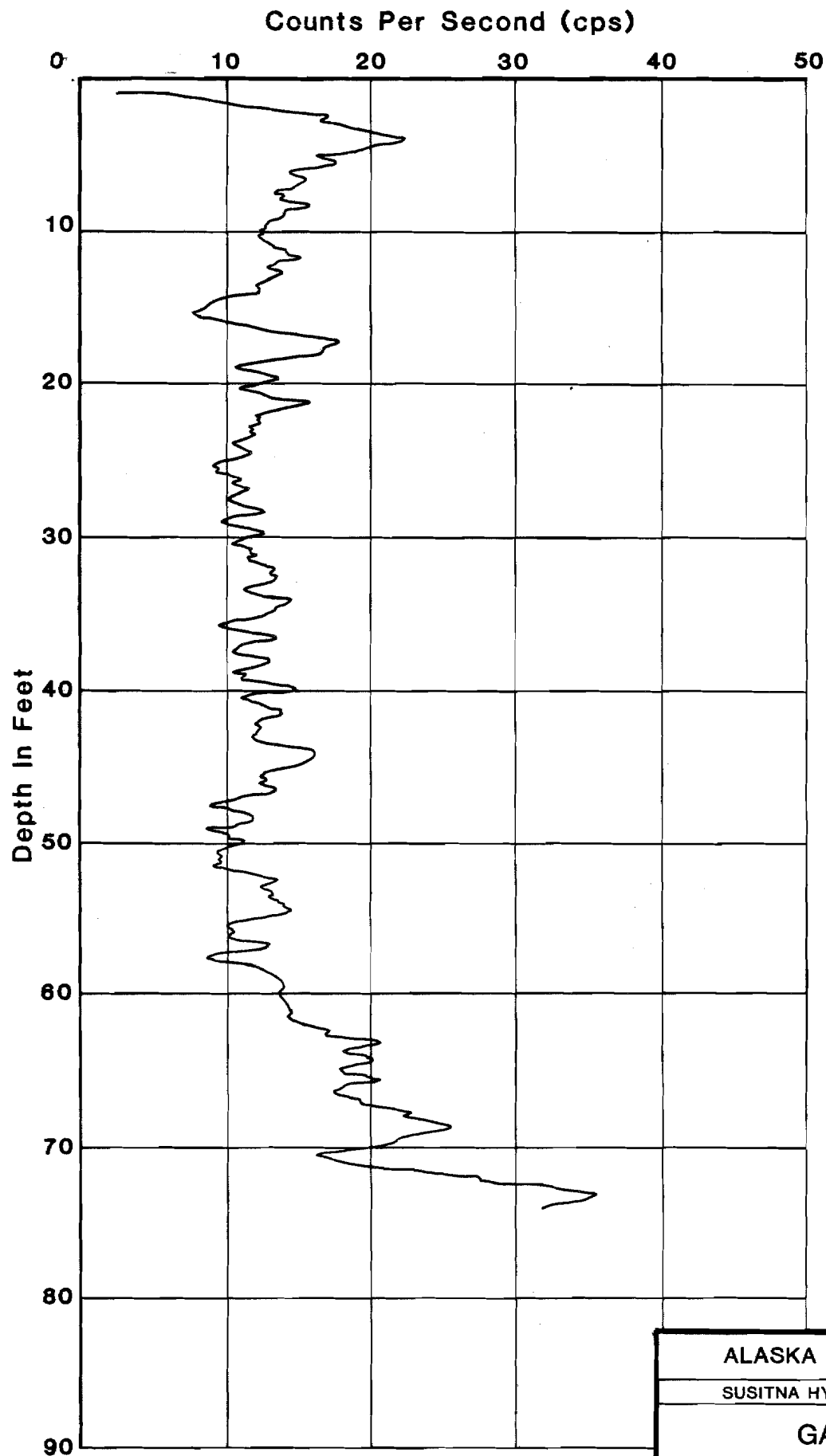
GAMMA LOG

HD83-21

HAZARDOUS
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-19



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

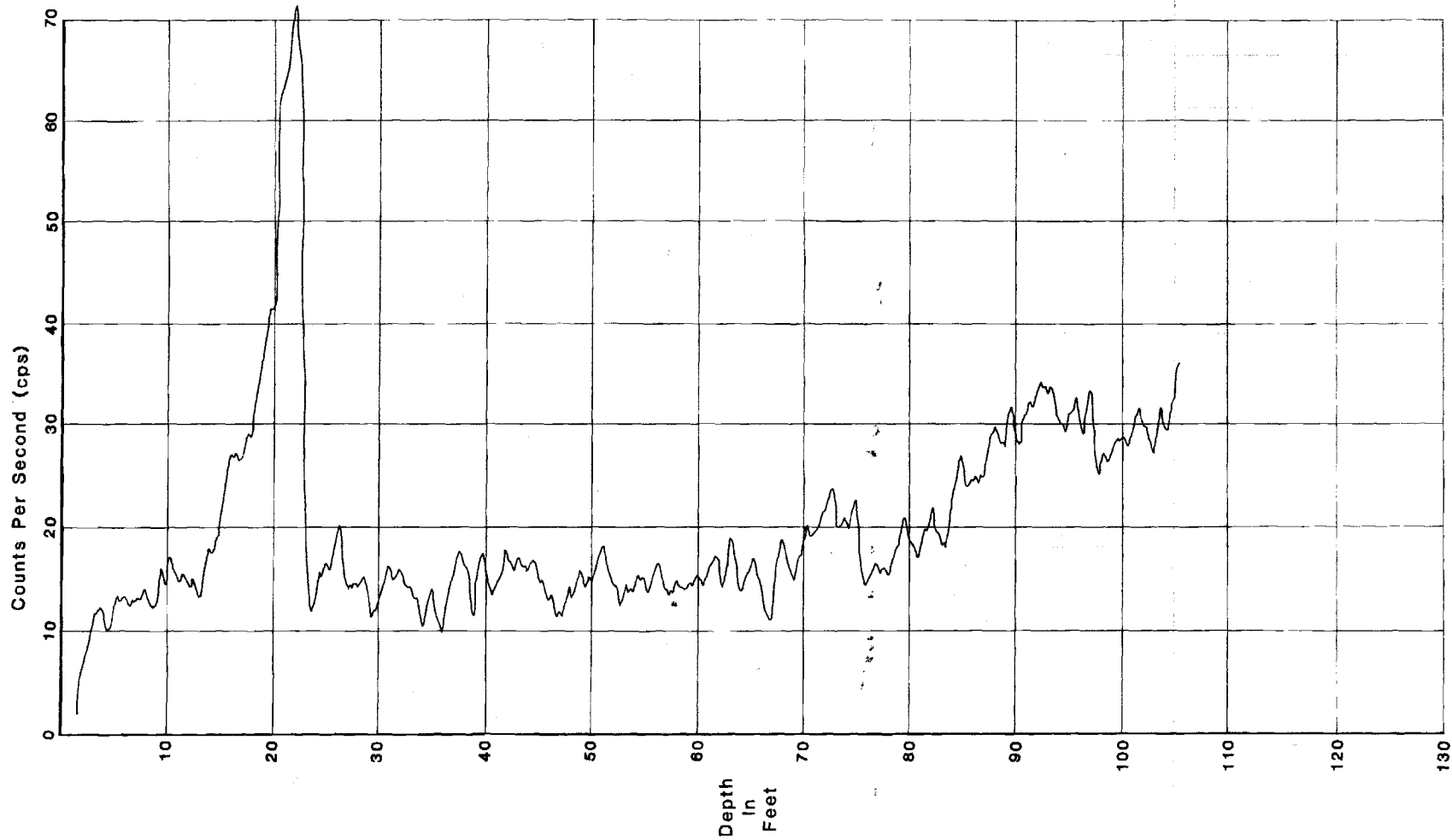
GAMMA LOG

HD83-23

HARZA-ERASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-20



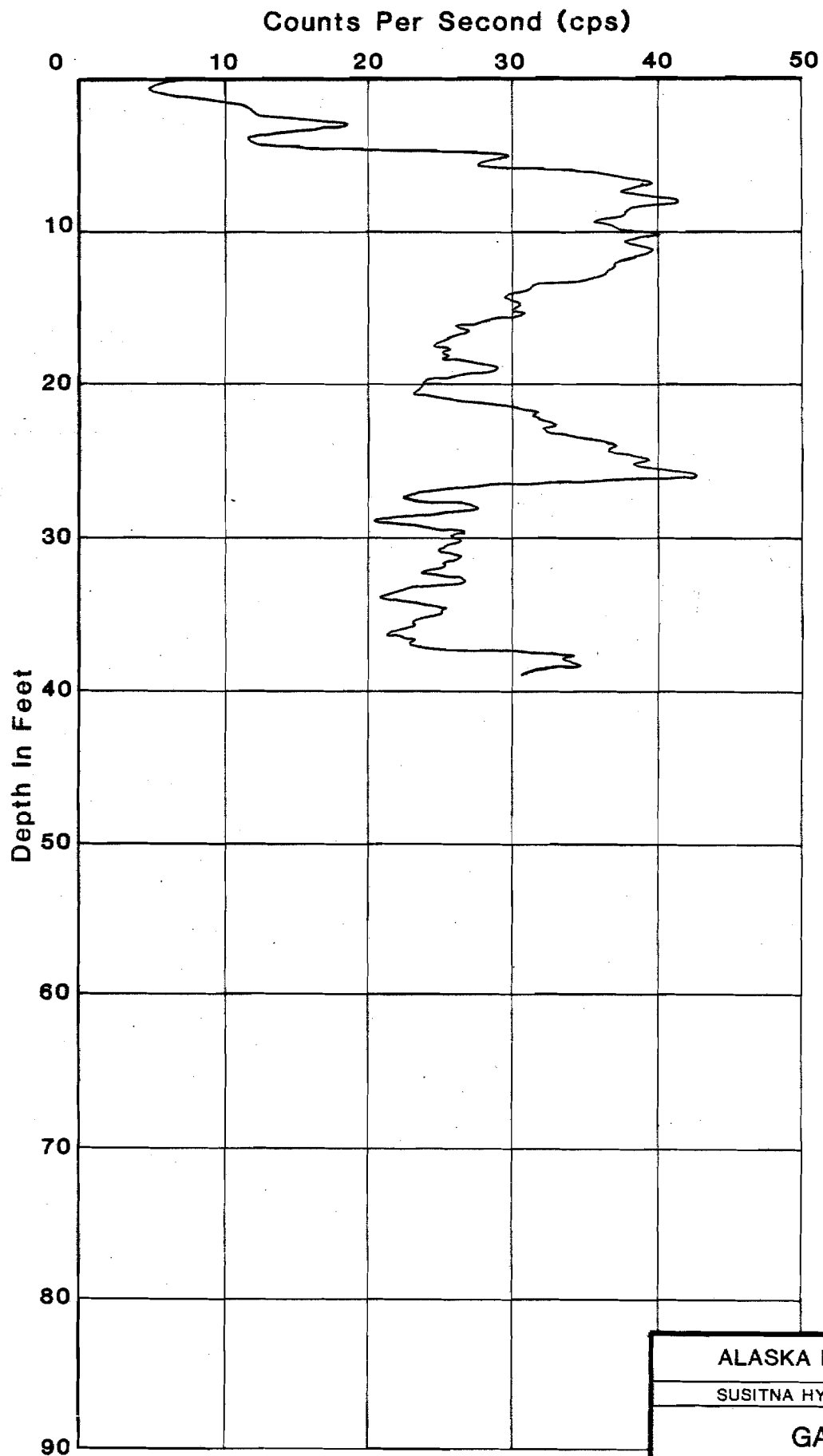
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT

GAMMA LOG
HD83-22

MANZA-ERASCO
SUSITNA UNIT CENTER

DATE
AUG.83

FIGURE
A-21



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

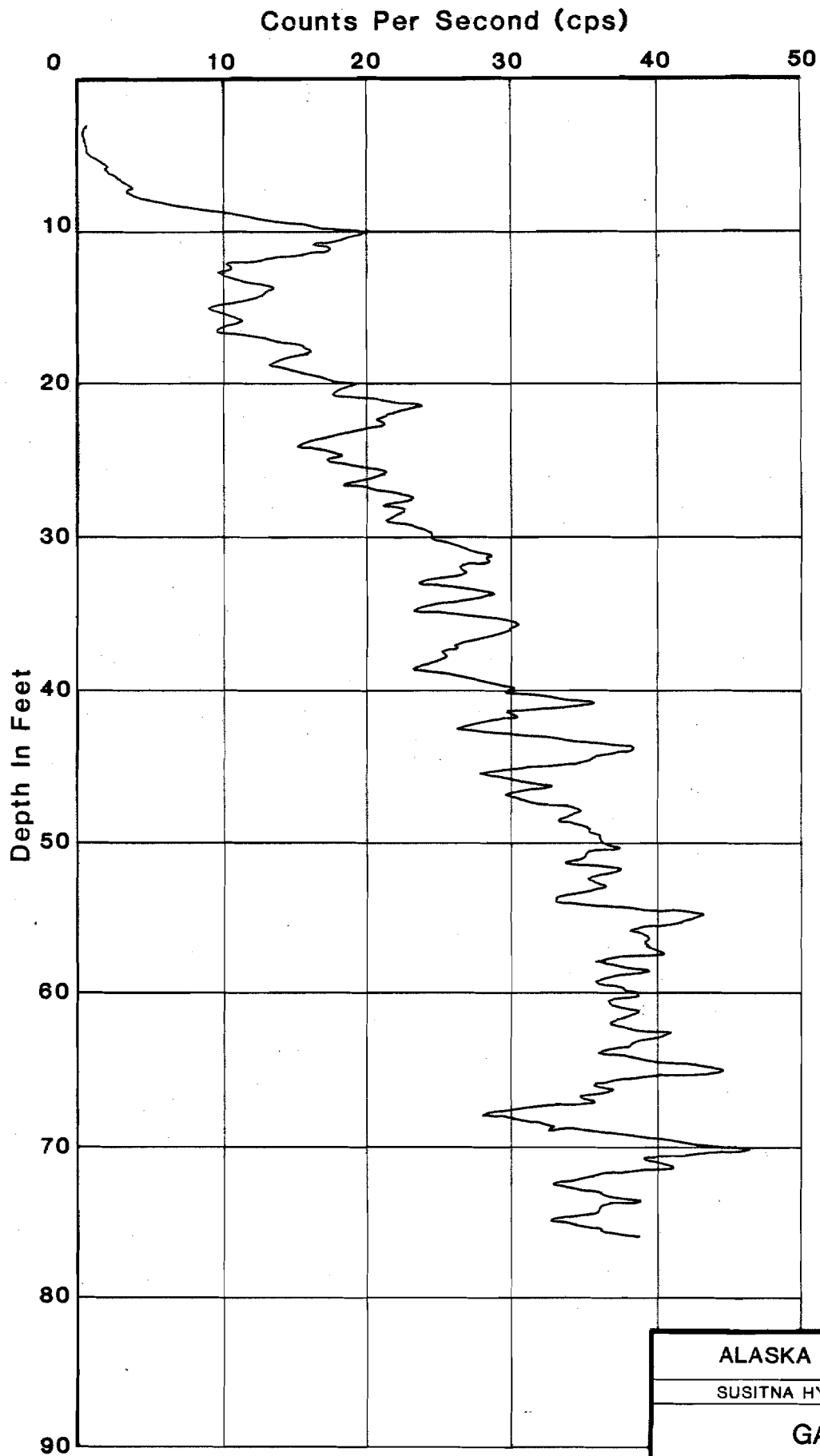
GAMMA LOG

HD83-24

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-22



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

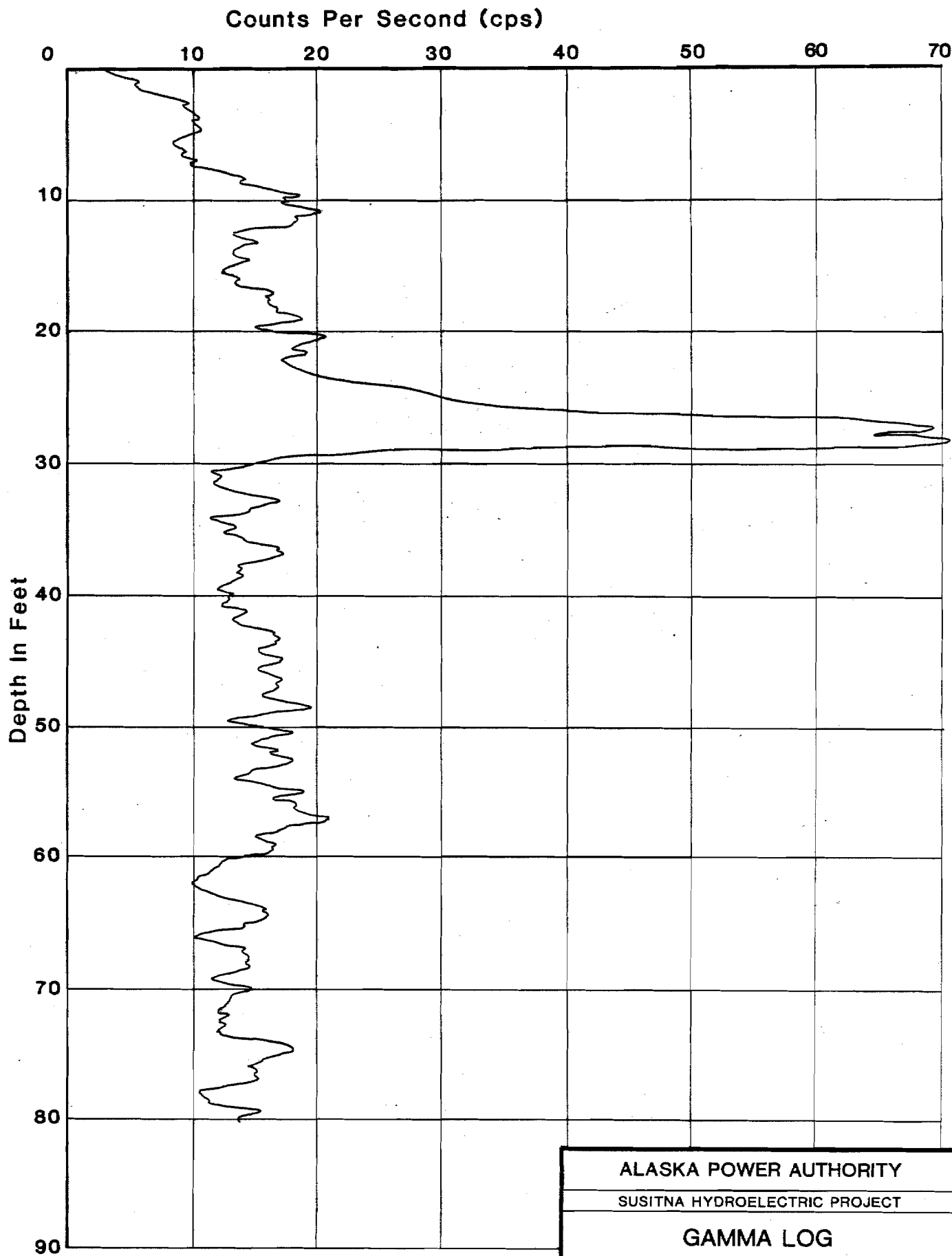
GAMMA LOG

HD83-26

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A - 23



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

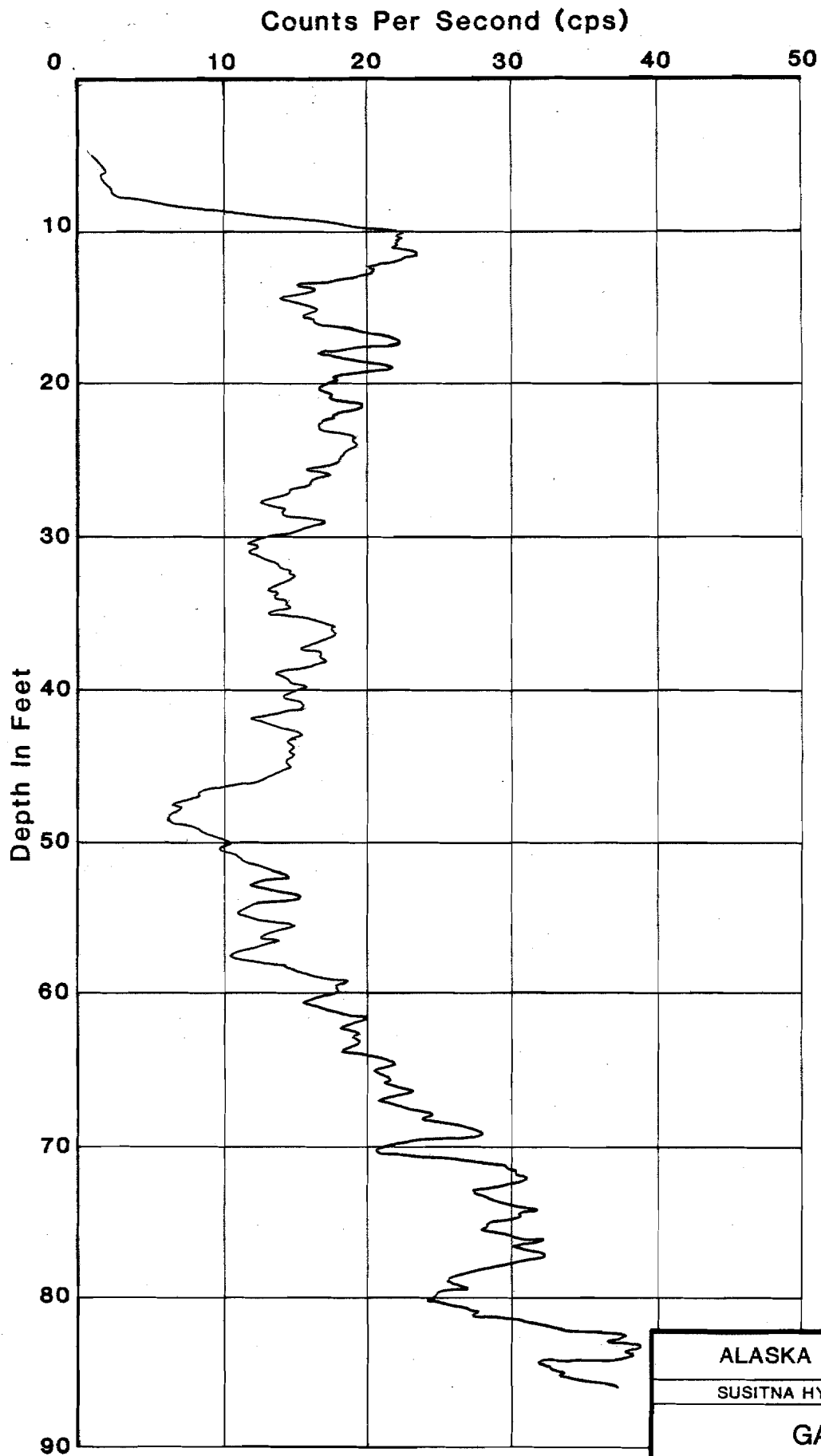
GAMMA LOG

HD83-27

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A - 24



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

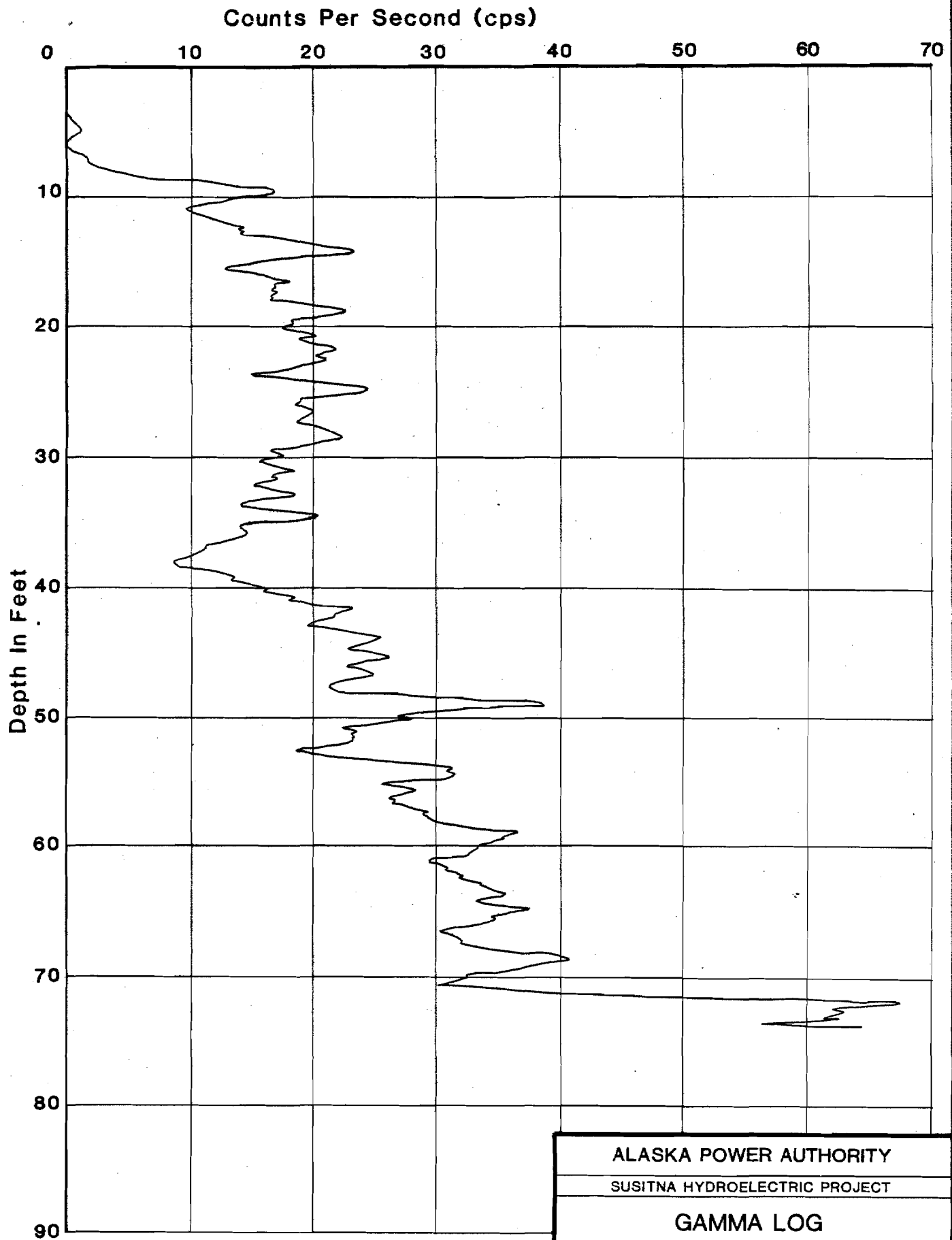
GAMMA LOG

HD83-28

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A - 25



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

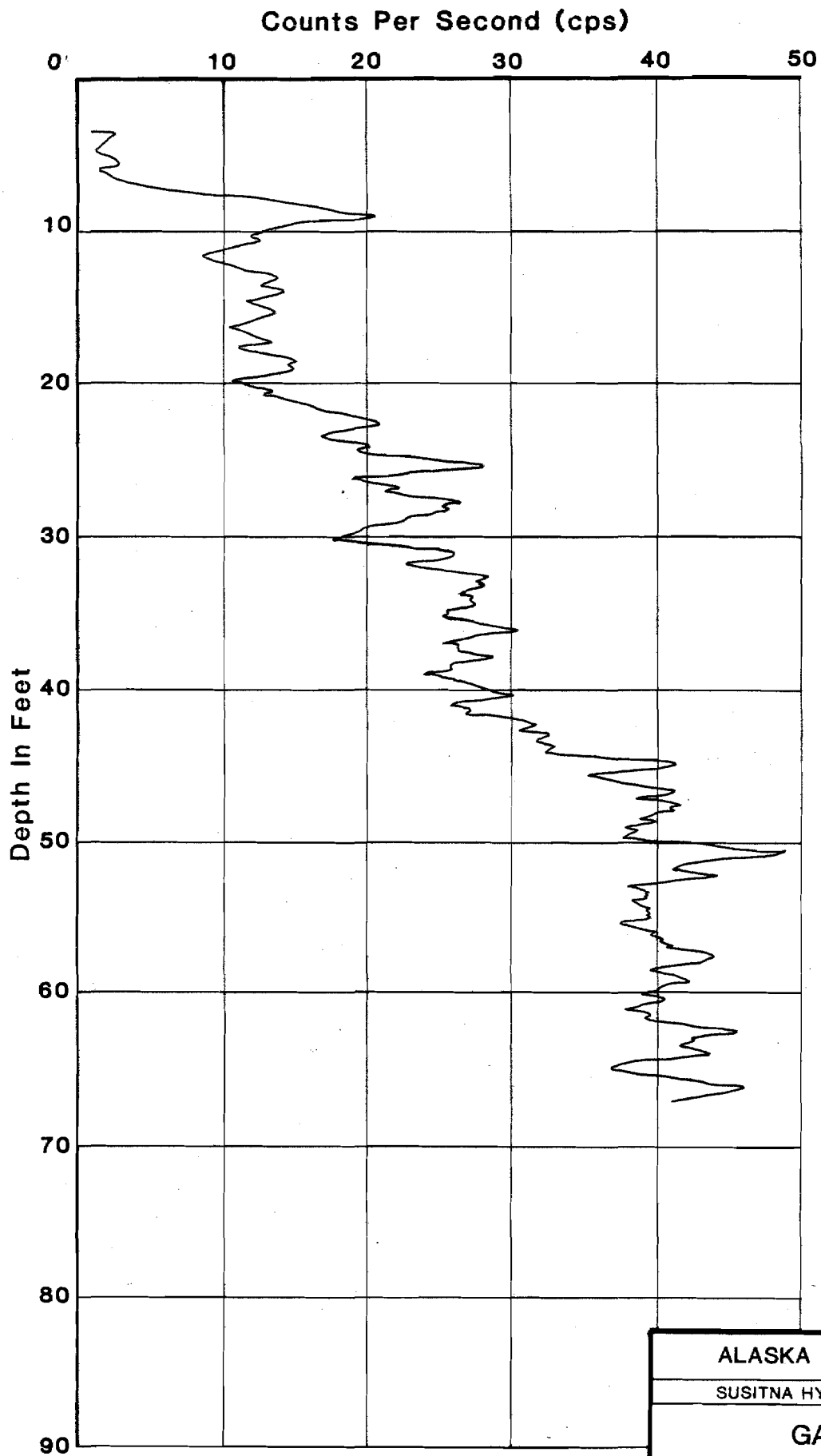
GAMMA LOG

HD83-29

HARZA-ERASCO
SUSITNA JOINT VENTURE

DATE
AUG. 83

FIGURE
A-26



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

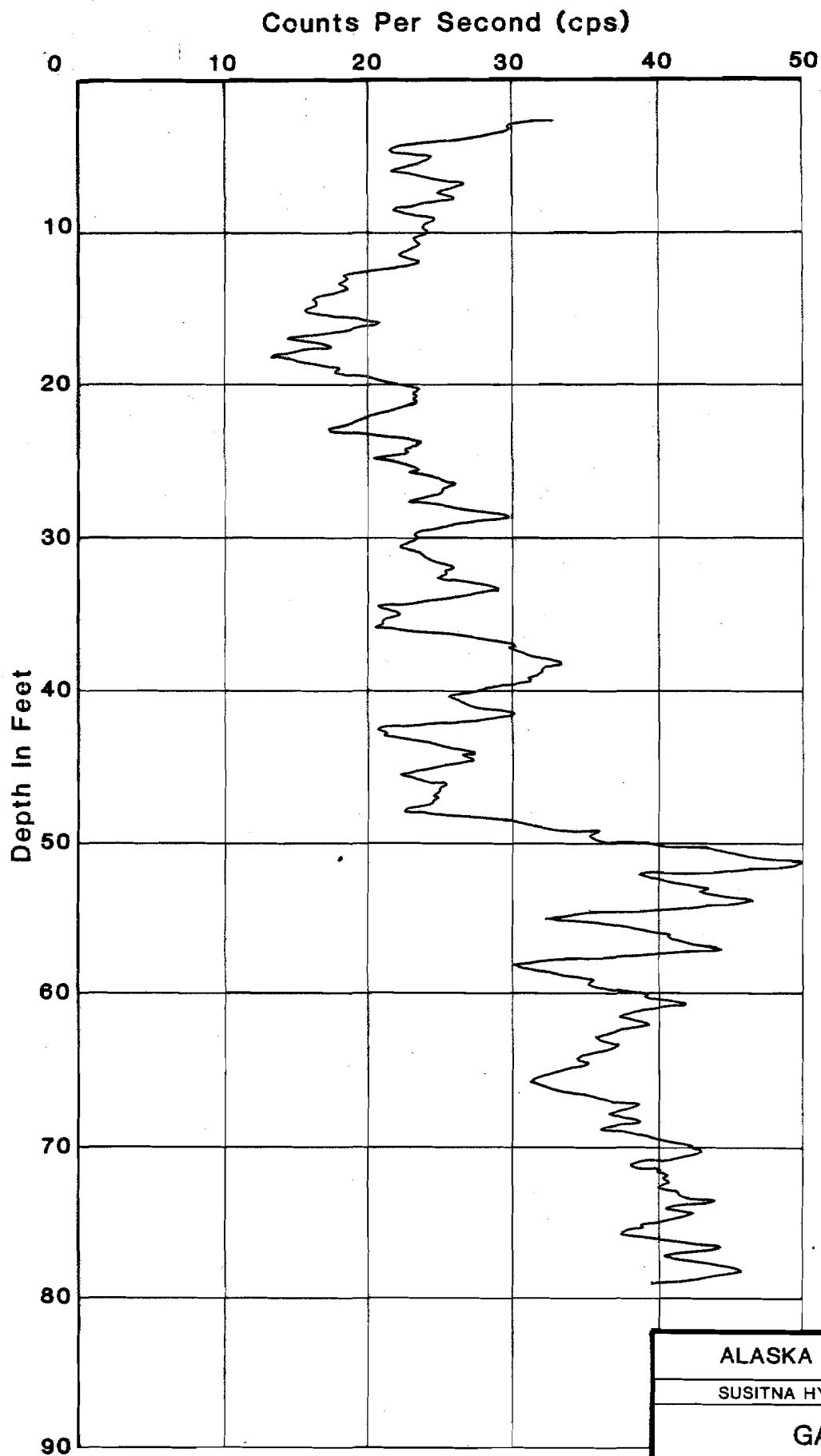
GAMMA LOG

HD83-30

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A -27



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

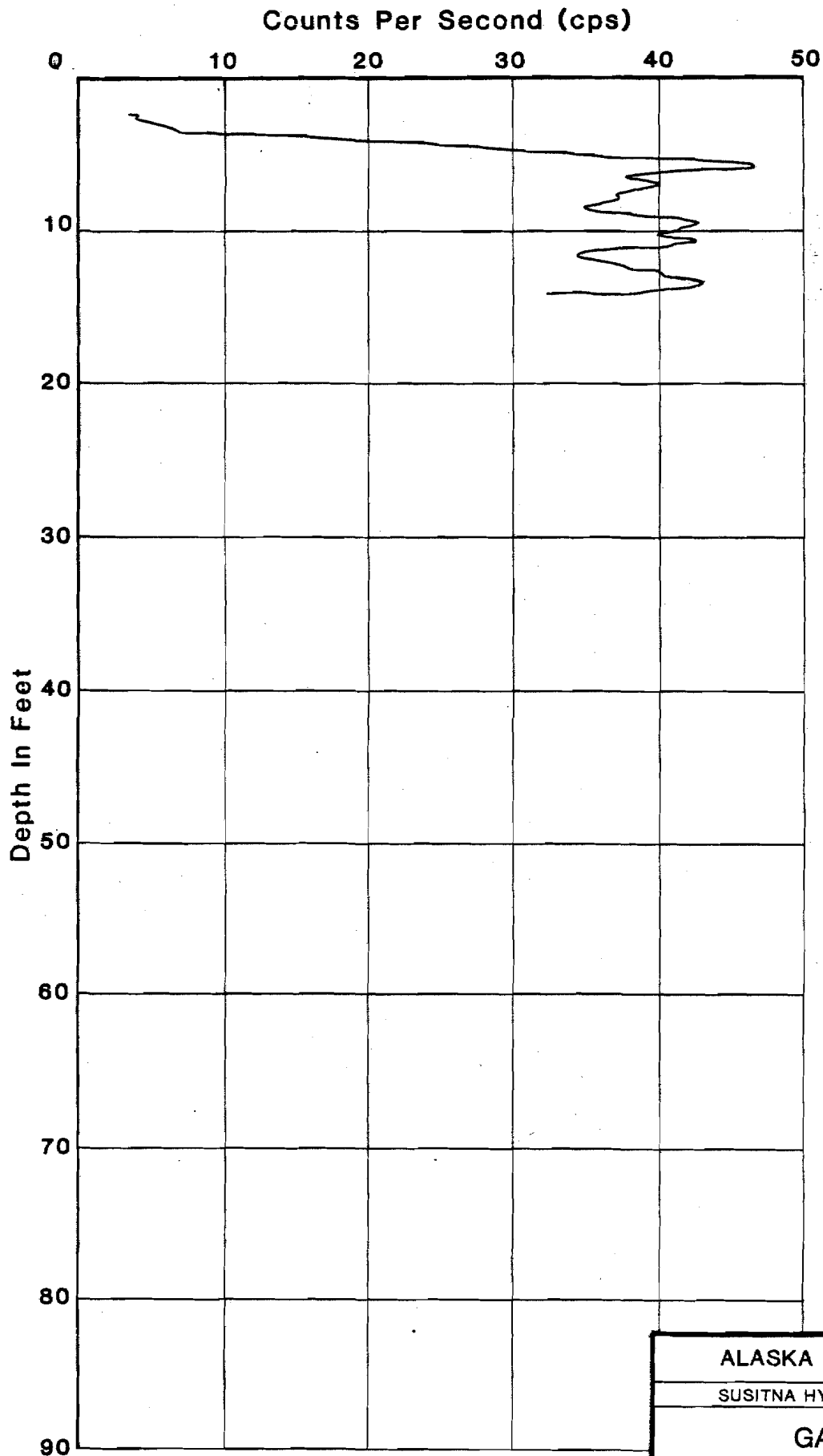
GAMMA LOG

HD83-31

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG83

FIGURE
A-28



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

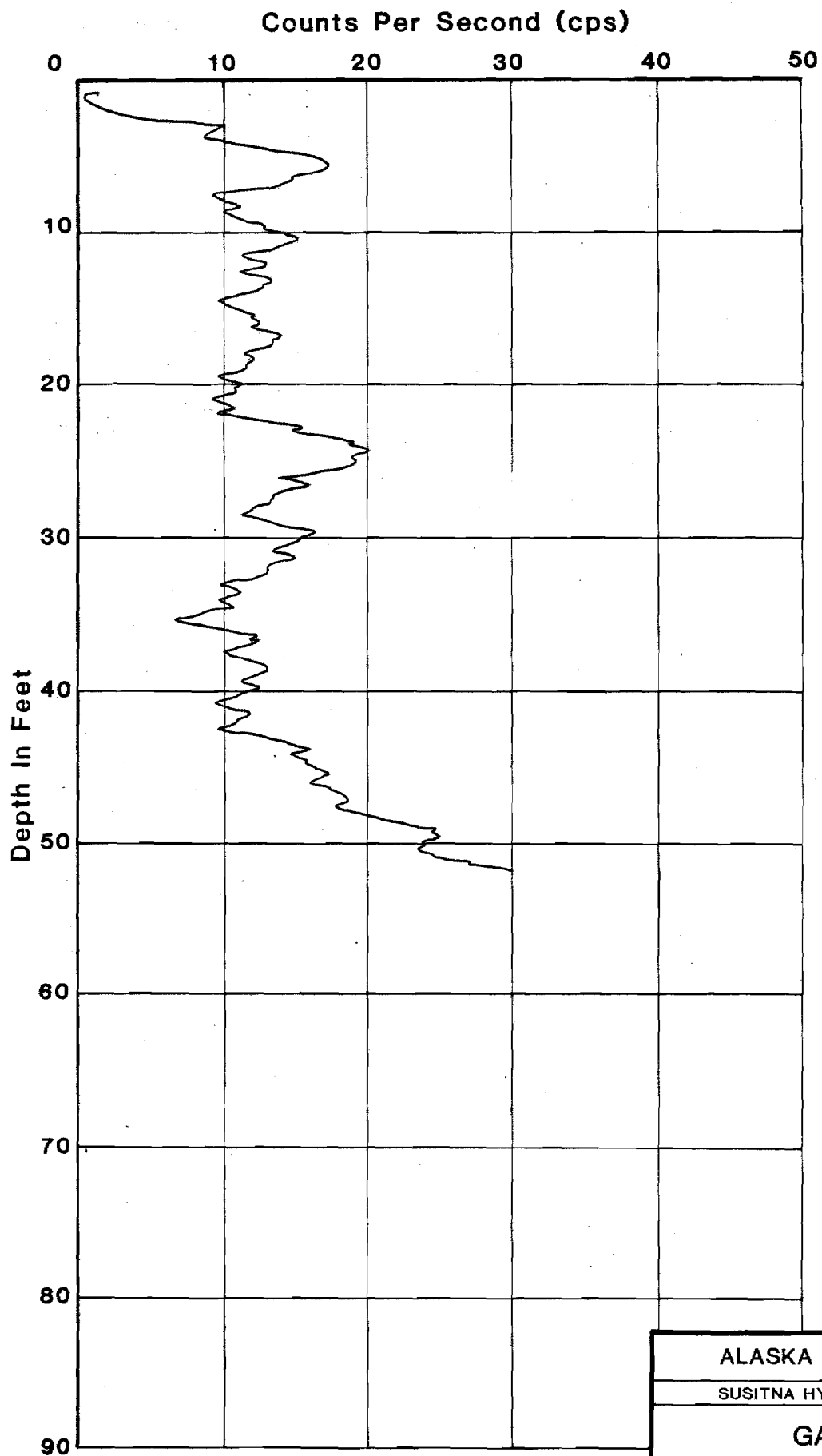
GAMMA LOG

HD83-34

HARZA-ESASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-29



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

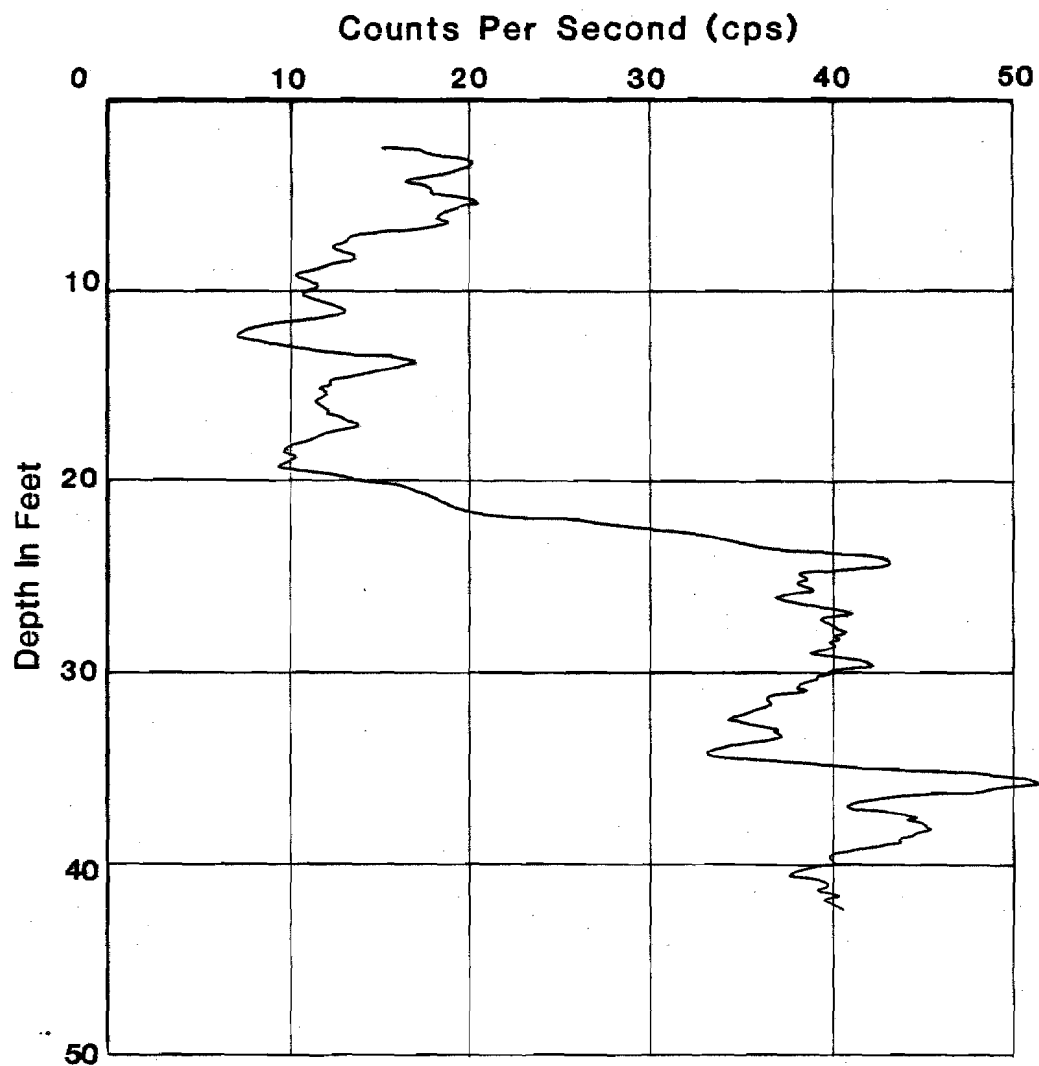
GAMMA LOG

HD83-35

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-30



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

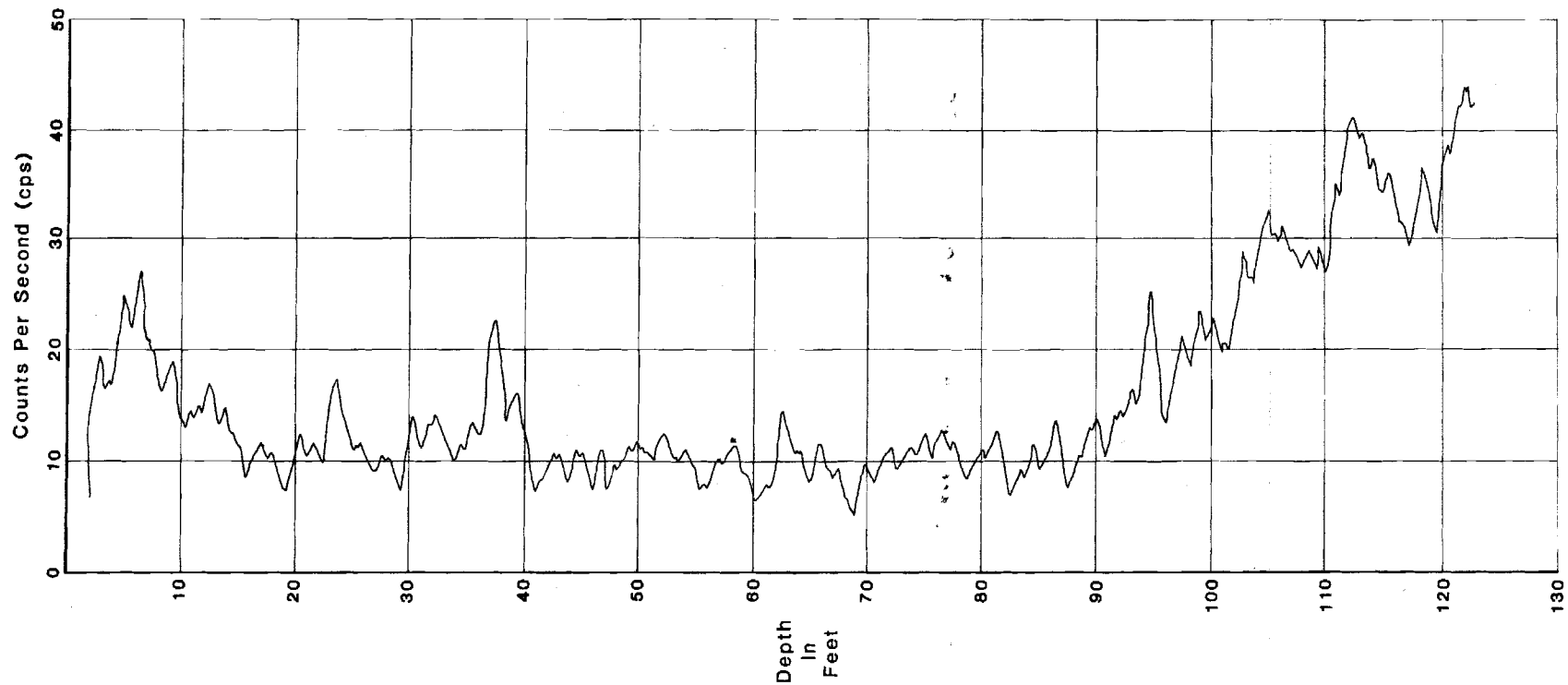
GAMMA LOG

HD83-36

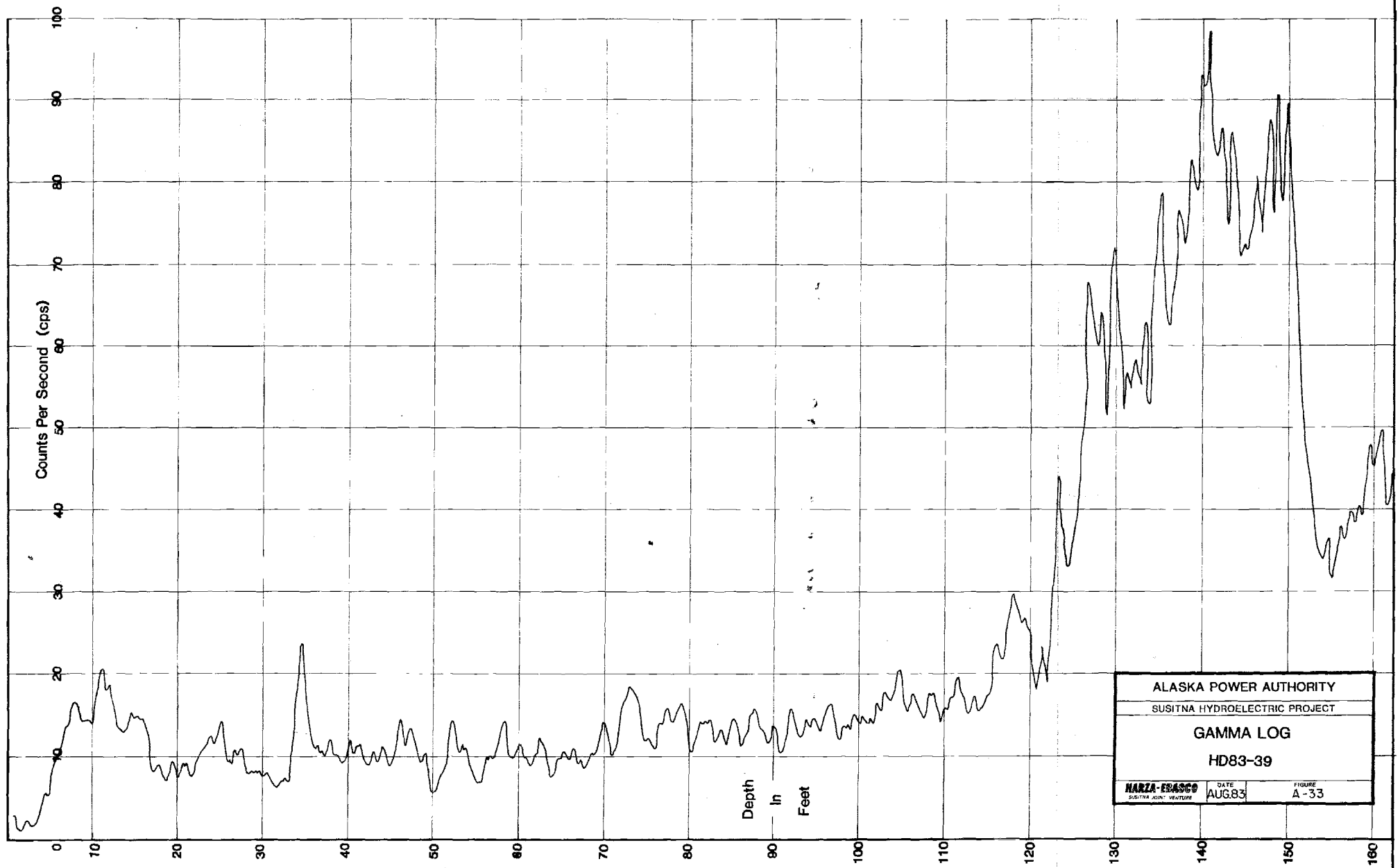
HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG83

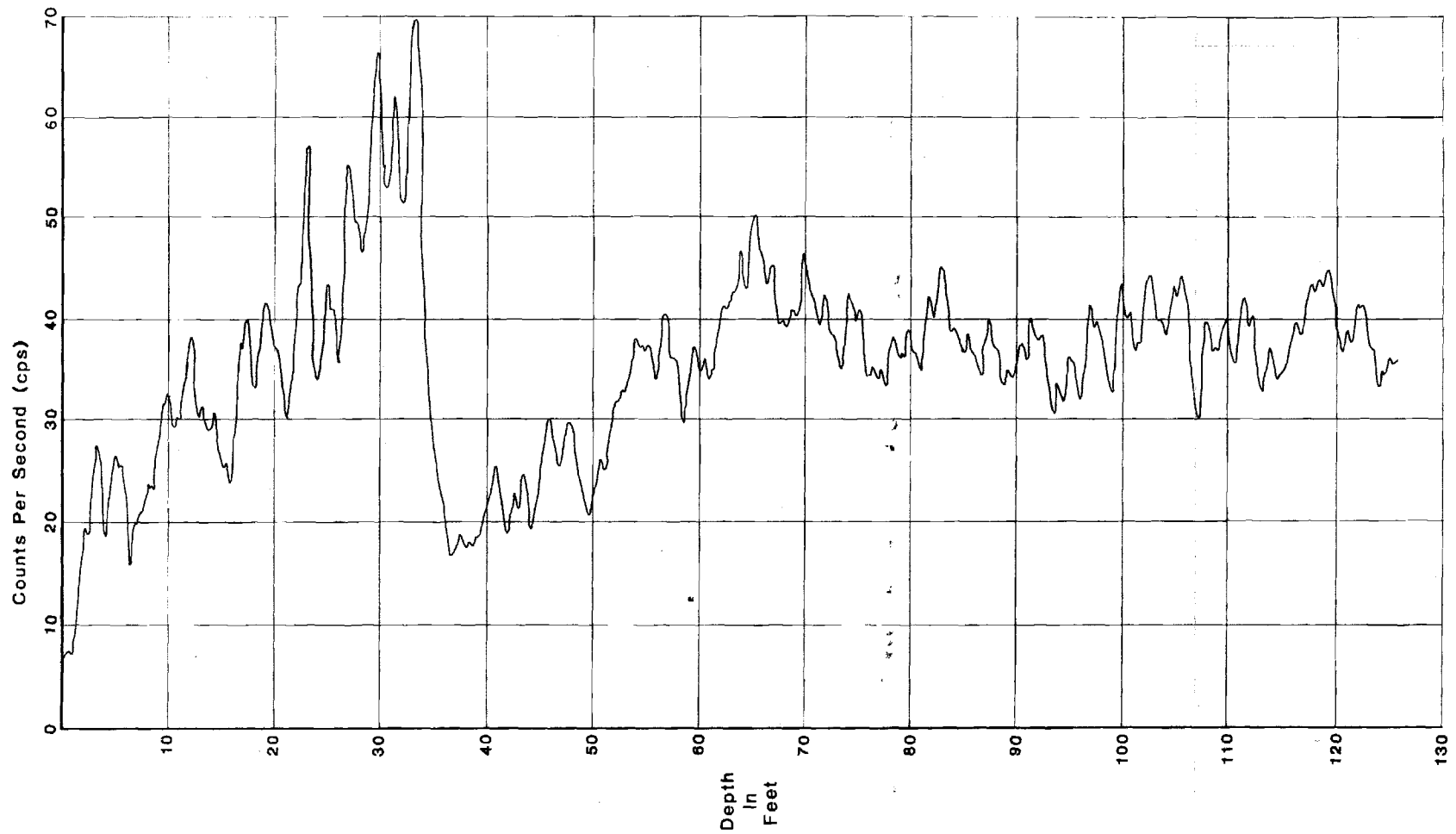
FIGURE
A-31



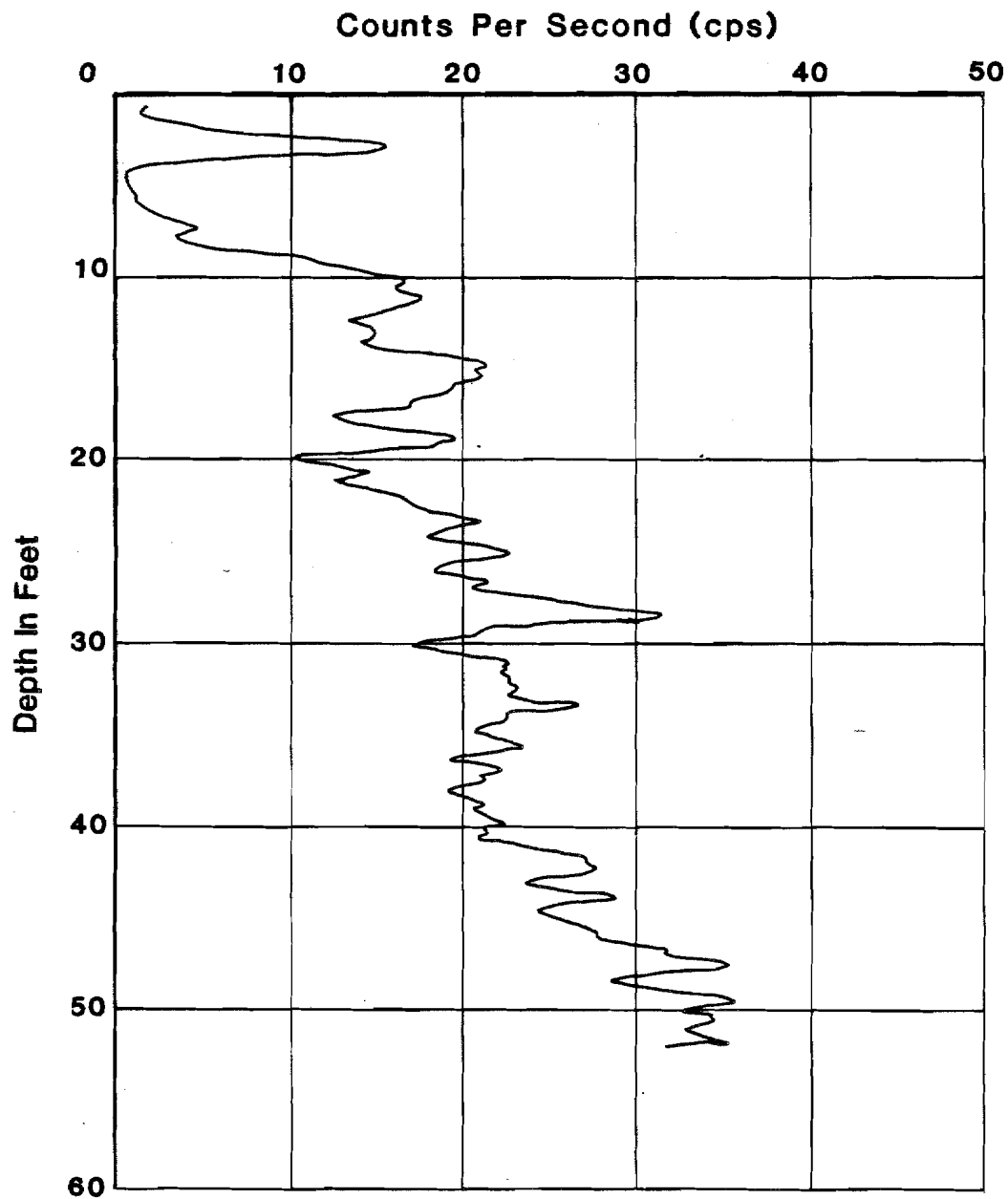
ALASKA POWER AUTHORITY		
SUSITNA HYDROELECTRIC PROJECT		
GAMMA LOG		
HD83-37		
HARZA-ERASSO ALASKA POWER AUTHORITY	DATE AUG.83	FIGURE A-32



ALASKA POWER AUTHORITY		
SUSITNA HYDROELECTRIC PROJECT		
GAMMA LOG		
HD83-39		
HARZA-ERASSCO SUSITNA JOINT VENTURE	DATE AUG 83	FIGURE A-33



ALASKA POWER AUTHORITY		
SUSITNA HYDROELECTRIC PROJECT		
GAMMA LOG		
HD83-42		
HARZA-EBASC9 SUSITNA JOINT VENTURE	DATE AUG.83	FIGURE A-34



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

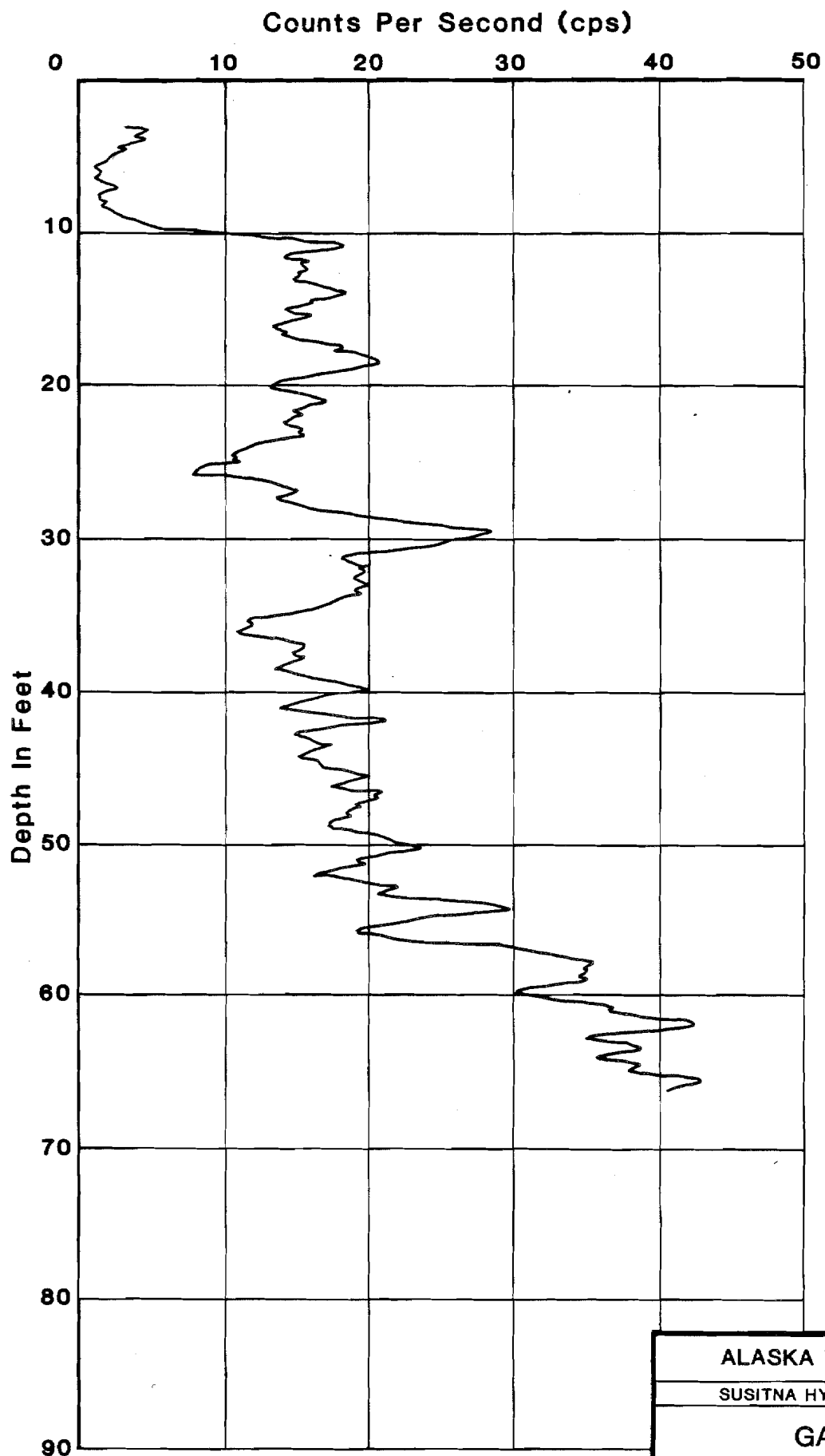
GAMMA LOG

HD83-43

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-35



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

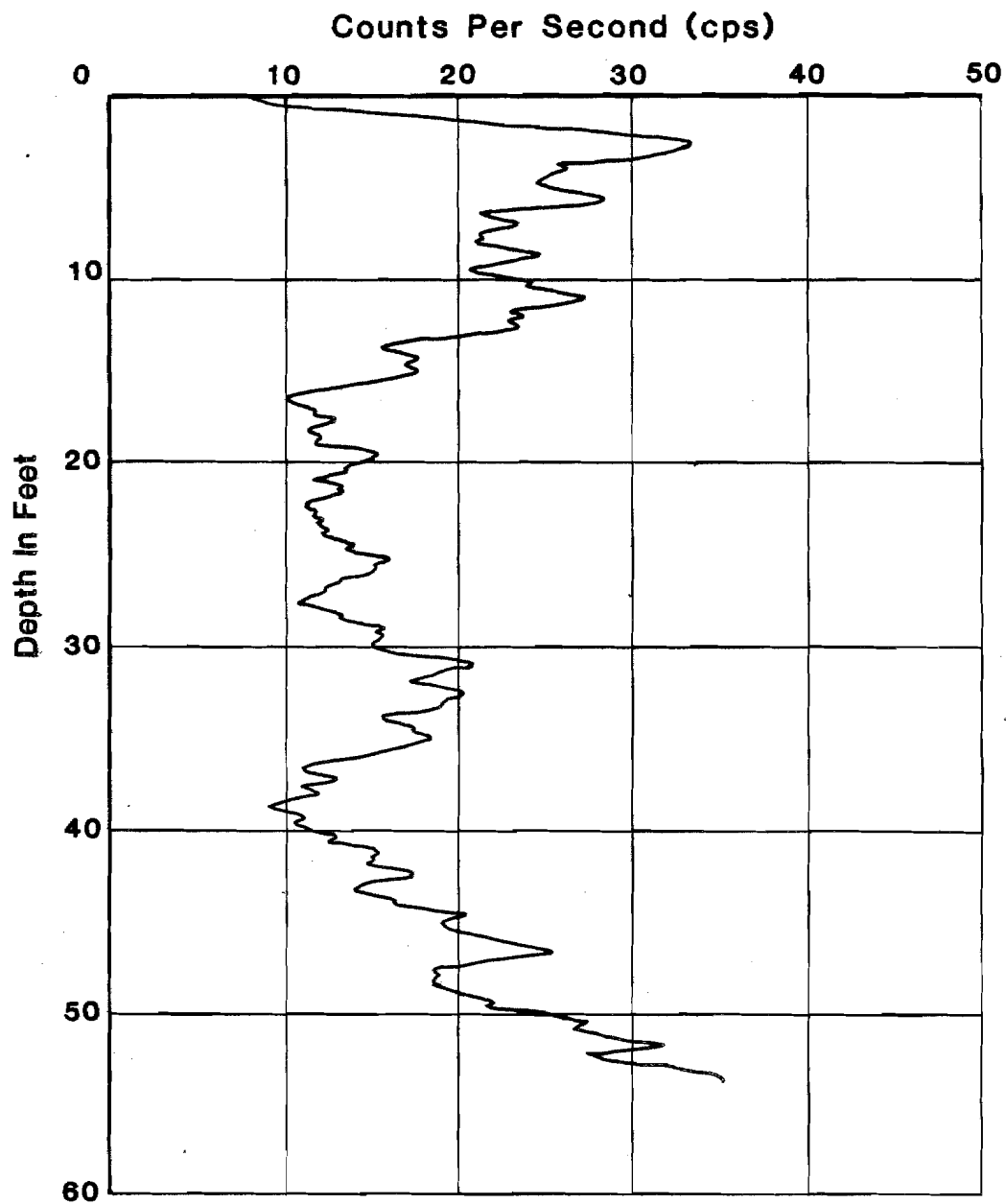
GAMMA LOG

HD83-44

HARZA-ERASCO
SUSITNA JOINT VENTURE

DATE
AUG83

FIGURE
A-36



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

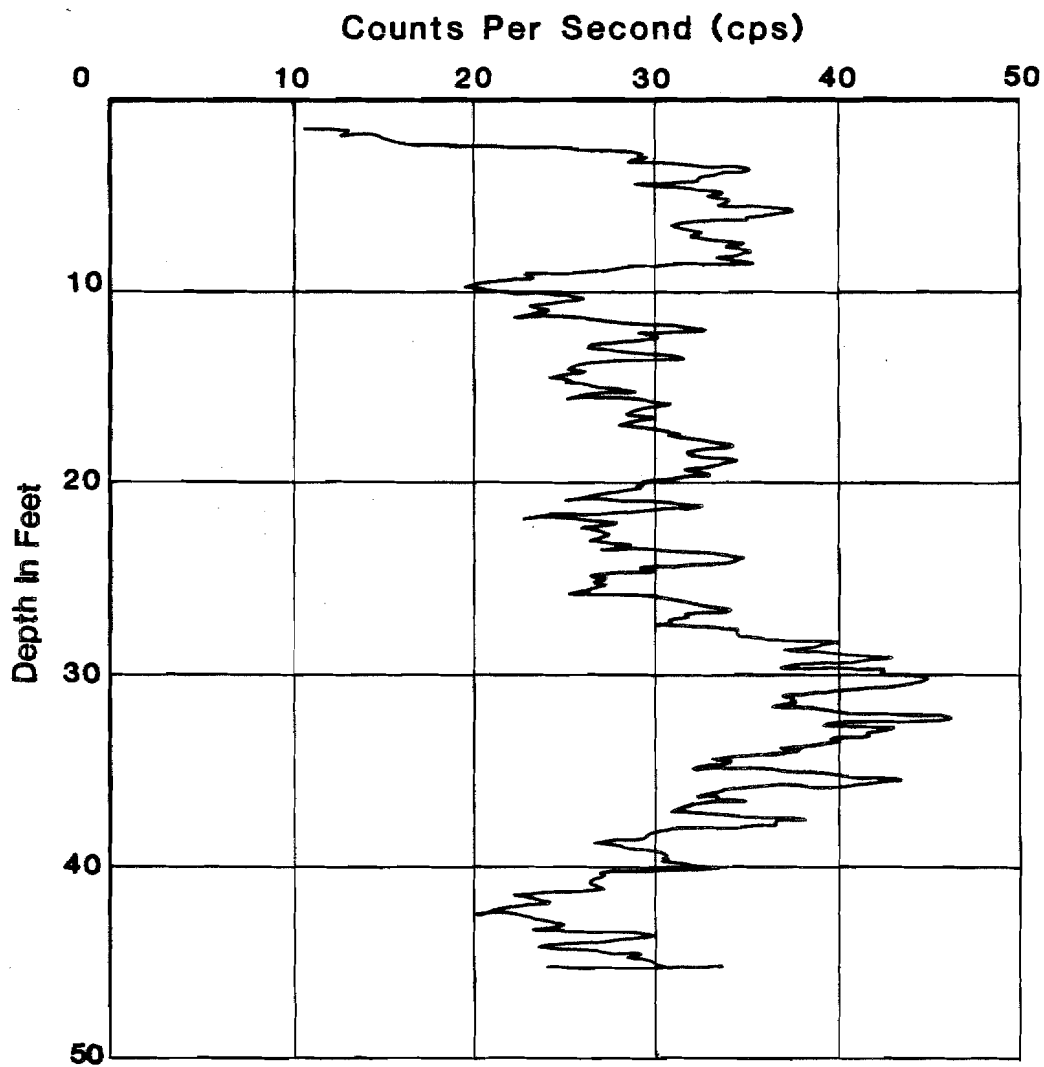
GAMMA LOG

HD83-46

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG. 83

FIGURE
A-37



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

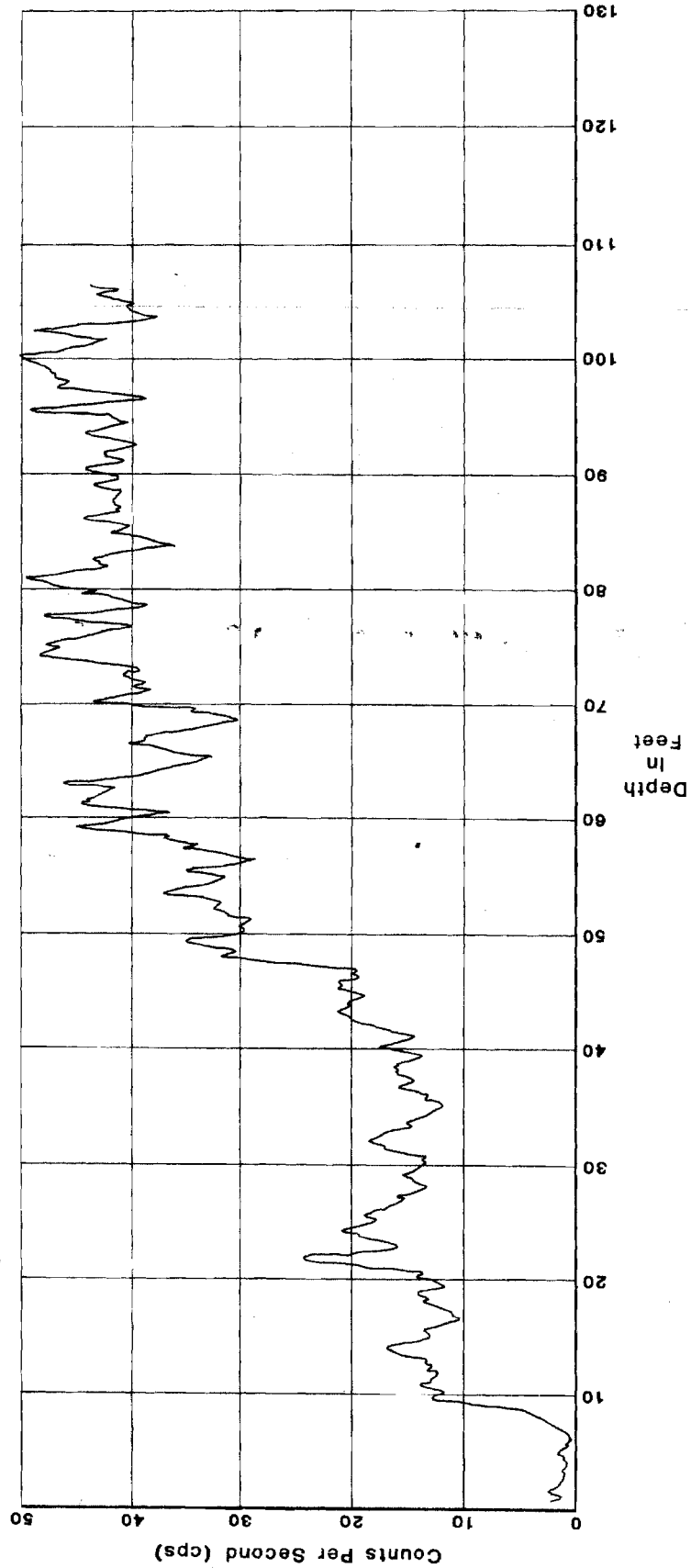
GAMMA LOG

HD83-45

HARZA-ERASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-38



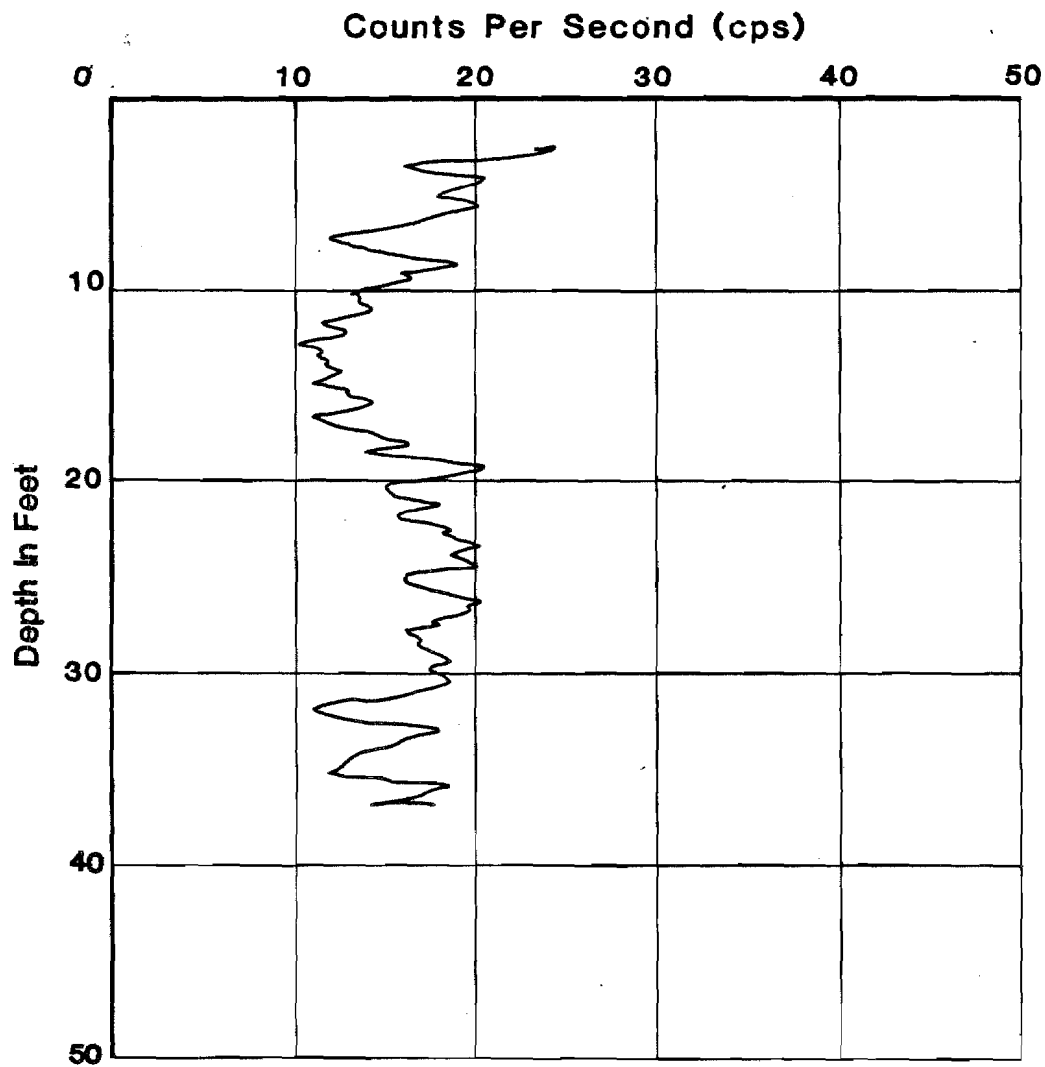
ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

GAMMA LOG

HD83-48

DATE AUG 83
FIGURE A - 39



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

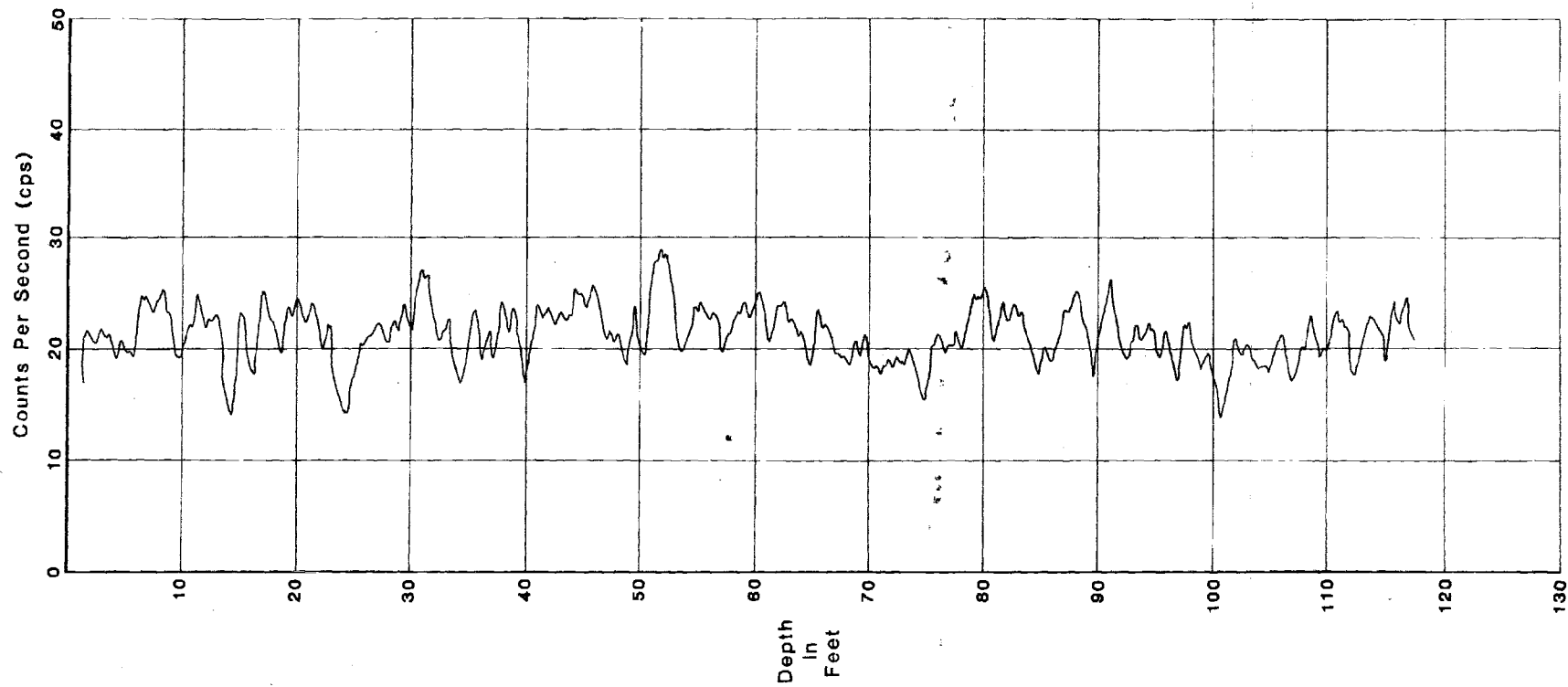
GAMMA LOG

HD83-49

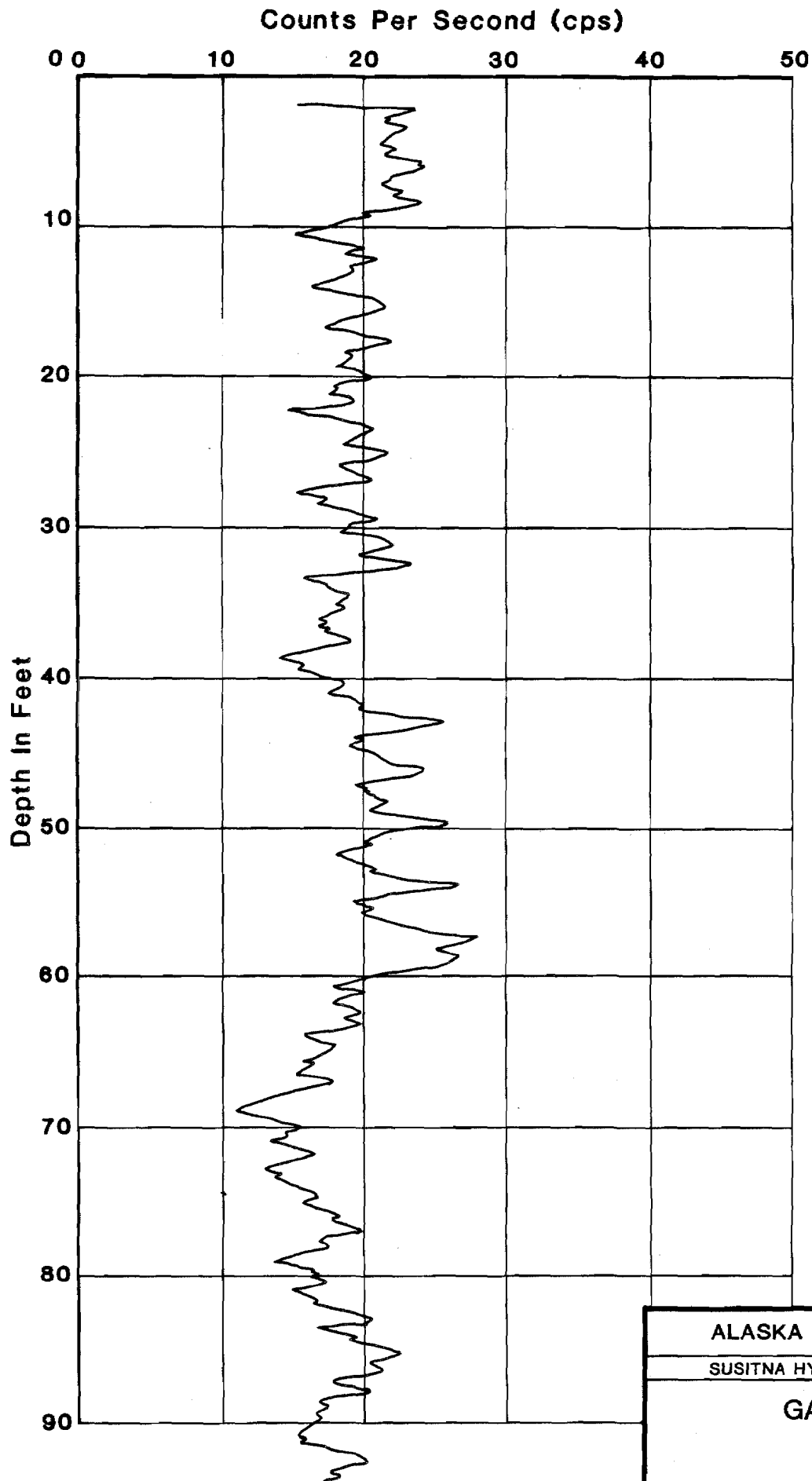
HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-40



ALASKA POWER AUTHORITY	
SUSITNA HYDROELECTRIC PROJECT	
GAMMA LOG	
HD83-50	
NARZA-ERASSCO SUSTAINMENT VENTURE	DATE AUG 83
FIGURE A-41	



ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

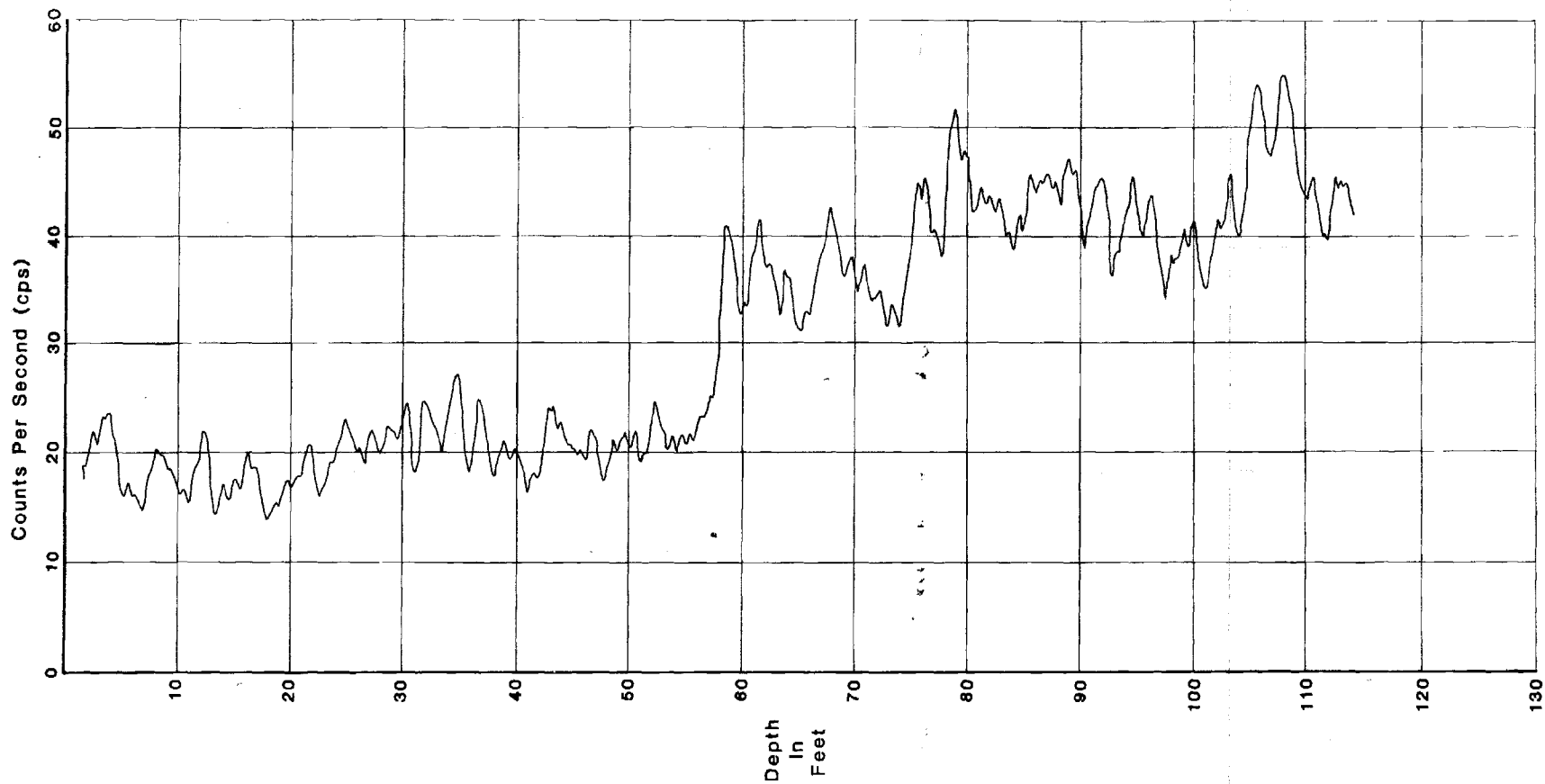
GAMMA LOG

HD83-51

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG.83

FIGURE
A-42



ALASKA POWER AUTHORITY		
SUSITNA HYDROELECTRIC PROJECT		
GAMMA LOG		
DH83-4		
HAZAS-ERASCO SUSITNA JOINT VENTURE	DATE AUG.83	FIGURE A-43

APPENDIX B — DRILLING AND SAMPLING METHODS

1. HAMMER DRILL RIG

1.1 Percussive Hammer

1.2 Rotary Drilling

1.3 Additional Equipment

2. ROTARY DRILL RIG

3. SAMPLING

4. DRILLING PERFORMANCE

APPENDIX B

DRILLING AND SAMPLING METHODS

The January to April 1983 Winter Exploration Program included subsurface drilling along the Susitna River Channel of the Watana Damsite and in the Watana Relict Channel. Early drilling in the relict channel area was discontinued when the river ice became thick enough to support drilling operations and was resumed after the completion of the river drilling program.

A Becker AP-1000 hammer rig drilled 5,239 feet of borehole, using a percussive hammer, occasionally switching to a rotary attachment when drilling conditions became difficult in deeper boreholes. A lightweight rotary coring drill rig was mobilized late in the program for the river areas where ice conditions prohibited the use of the heavier hammer drill rig. The long year 38 rotary drill rig accounted for 398 feet of the total 5,637 feet drilled during the winter program.

1. HAMMER DRILL RIG

1.1 Percussive Hammer

The hammer drill rig used a diesel pile hammer to drive a double-wall pipe while a reverse air circulation system removed the cuttings as the pipe advanced. The inner pipe of the double-wall pipe directs the incoming air through the annulus between the inner and outer pipe to the bottom of the pipe. The returning air with drill cuttings then passes up through the inner pipe into an energy dissipating cyclone that vents the air from the sample. Specially designed tooth bits are

used to penetrate the soil formations and to direct the soil into the inner pipe. The drive pipe is withdrawn by a puller system comprising two 50-ton hydraulic cylinders operating tapered slips that grip the pipe.

The hammer drill rig used for the winter program was an AP 1000 (All Purpose) manufactured by Drill Systems, Calgary, Alberta. The basic elements of this rig include a Link Belt 180 diesel pile drive hammer delivering 8,100 foot-pounds per blow operating at variable speeds to a maximum of 95 blows per minute; a Sullair Rotary Screw Compressor rated at 750 cfm at 250 psi; an 18 gpm Beam mud pump; a hydraulic hoist, a hydraulic pipe puller; a mast; and a cyclone.

The hammer energy is delivered to the drive pipe when the hammer strikes the drive spout which sits atop the drive pipe. The double-wall drive pipe is designed so that only the thicker outer pipe transmits the hammer energy to the bit. The two sizes of double-wall pipe used in this program were 5-1/2 inch O.D. X 3-1/4-inch I.D., and 9-inch O.D. X 6-inch I.D. The 9-inch pipe was used for approximately half of the footage in the relict channel while the 5-1/2-inch was used for the remainder of the relict channel and most of the river channel. A triple-wall drive pipe system using a 7-inch pipe over the 5-1/2-inch double-wall was unsuccessfully attempted at the beginning of the program.

There were two basic bit designs used with the drive pipe, crowd-in or web tooth and crowd-out. The crowd-in bit has the cutting edge diameter slightly larger than the outer pipe diameter which forces all the material within the hole up the inner pipe. The crowd-out bit, with the cutting edge at the inner pipe, samples only the material directly below the inner pipe and pushes the remainder aside as the pipe advances. A 5-5/8-inch web-tooth crowd-in bit was used almost

exclusively for the project. Crowd-out bits were used occasionally when crowd-in bits were unavailable.

1.2 Rotary Drilling

The AP 1000 had the capability of rotary drilling by replacing the drive spout with a rotary drive head. One drive head, the Center Stem Recovery (C.S.R.), using a high-torque, slow-speed gearing, advanced the 5-1/2-inch double-wall drive pipe by rotation. The C.S.R. rotary normally used standard tricone or button tricone bits. The same reverse circulation system used in hammer drilling was used for the C.S.R. rotary.

The rotation of the drill pipe helped to reduce wall skin friction. This allowed more drilling energy to be transferred to the drill bit and helped to increase penetration. Also, the C.S.R. rotary with a tricone bit was used to penetrate boulders. Unfortunately, the recovered sample was usually comprised of rock fragments and did not give a representative grain size distribution. For this reason, the percent by weight of fractured material retained on the 3/4 inch sieve was always recorded during testing to serve as an indicator of the crushing effect. Also, every change between C.S.R. rotary and hammer drilling, or change of drill bits, required the removal of the entire drill string which contributed to borehole instability and redrilling of caved borehole sections.

The 7-inch, triple-wall system using the C.S.R. rotary and an 8-inch tricone bit was attempted in the last hole in the relict channel. Excessive wall skin friction limited penetration and forced the abandonment of the borehole.

The other rotary drivehead, the Diamond Drill Rotary, had a high-speed, low-torque gearing for N-size conventional and wireline core drilling through the drive pipe after bedrock or refusal was encountered.

1.3 Additional Equipment

A down-hole hammer fitting through the drive pipe was also used to drill a pilot hole ahead of the drive pipe when the drive pipe encountered refusal. The down-hole hammer easily penetrated boulders and bedrock, but did not penetrate the softer unconsolidated materials because the resilience necessary to complete the hammer compression cycle was reduced.

Occasionally, a 2-7/8 inch tricone bit was used with the diamond drill rotary to penetrate very dense refusal zones where the hammer drill or the down-hole hammer were ineffective.

To drill angle holes, two 45-degree angle blocks were placed beneath the mast. Four 45-degrees angles holes were drilled by the hammer drill in the river channel.

2. ROTARY DRILL RIG

A light-weight rotary core drill rig was mobilized later in the program for the river areas where ice conditions prohibited the use of the heavier hammer drill rig. A Longyear 38, sectionalized for helicopter transport, performed standard diamond drilling using NX-size wireline with NC-size casing.

3. SAMPLING

The reverse circulation system used on the hammer drill rig provided a composite sample of the materials penetrated. A geologist/soil engineer continuously monitored the drill cuttings dropped from the cyclone. A sample was usually collected every five feet by first clearing the inner pipe. Then the pipe was driven one to two feet before retrieving the sample. Sometimes, when sample recovery was reduced, the sample section was extended beyond two feet. The sample was classified and placed in a canvas bag for transportation to the field laboratory. Samples for moisture determination were placed in plastic bags and sealed.

Disturbed but intact samples were recovered using a split-spoon drive sampler. A 2-1/2-inch diameter sampler was used with 5-1/2-inch pipe, while a 3-inch diameter sampler was used with 9-inch pipe. The first two 5-5/8-inch bits used were reamed for the express purpose of passing the 3-inch sampler.

Standard penetration resistance blow counts per six inches of penetration were recorded during the driving of the split-spoon sampler for estimating the relative densities of the materials sampled. The material directly beneath the drive pipe is considered highly disturbed due to the hammering action of the drive pipe.

Blow counts were also recorded during the drive of the double-wall pipe for estimating material relative densities. However, the energy delivered by the diesel hammer was not always constant because the driller adjusted the fuel injection control pipe penetration rate. Also, the resistance to penetration, due to wall skin friction, increases with depth thereby absorbing an increasing amount of hammer

energy that could be delivered to the drive bit. Therefore, drive pipe blow counts will not be used to estimate finite density values.

Grain size distributions run on those samples recovered by the hammer drill rig are not fully representative of the insitu materials. The hammering action of the drive pipe bit fractures the coarse gravel, cobbles, and boulders producing a gradation skewed toward the fine fraction. The hammer drill system also has a tendency to recover a larger portion of the fine particles, especially when a cobble or boulder is pushed ahead or aside and the finer material moves into the displaced volume. At the other extreme, a small portion of the fine fraction was lost in the air vented from the cyclone and in water overflowing the sample collection bucket. The air used in the reverse circulation system has a tendency to dry the material as it was moving up the pipe to the surface. This action increases the chance of losing fines through the cyclone.

4. DRILLING PERFORMANCE

Early in the program the 5-1/2-inch drive pipe sheared because of faulty welds on the threaded pipe ends. . Drilling of shallow boreholes in the relict channel continued with the 9-inch pipe while the substandard 5-1/2-inch pipe was being rewelded.

Excessive build-up of skin friction along the drive pipe walls limited realistic penetration to approximately 300 feet. Deep holes required additional air capacity and special additives for the air to prevent the cuttings from freezing in the bottom of the drive pipe. Also, the deep hole required several changes between hammer and C.S.R. rotary which generally caused caving of the hole due to the removal of the drill string during changeover. In the two deeper holes drilled, the

borehole wall deteriorated enough to allow the circulating air to pass along the outside of the drive pipe rather than up the inner pipe. The drilling equipment limitations prevented the scheduled drilling and installation of test wells.

Occasionally, when shallow cobble and boulder zones were encountered, the drive pipe was deflected sufficiently to require redrilling of the hole. Deeper cobbles and boulders would bend the pipe, but the soil along the pipe would provide enough support that the pipe sections at the surface would not deflect. As a consequence, in several boreholes, the coring of bedrock was precluded due to the difficulty in passing the core barrel through the bent drive pipe. Other cobble/boulders halted the penetration of the drive pipe which also required redrilling.

The hammer drill rig penetrated very well while drilling shallow holes (less than 200 feet) and in water bearing sands and gravels. Having the drilling and casing combined in one operation provided a rapid, stable borehole. In the river channel, particularly, the hammer drill rig provided useful information in a limited amount of time while penetrating difficult subsurface conditions.

APPENDIX C — BORING LOGS

1. BORING LOG NOMENCLATURE

1.1 Unified Soil Classification System

2. BORING LOGS

2.1 River Channel

2.2 Relict Channel

APPENDIX C

BORING LOGS

1. BORING LOG NOMENCLATURE

Notes:

1. Hammer drill blow counts are for variable energy.
2. Ground surface datum for river borings is for the ice surface.
3. Hammer drill sample cuttings were taken, except where split-spoon samples are noted.
4. Disturbed samples were taken with 2" and 3" split- spoons with a 140 and 300 pound hammer falling 30" and 18" respectively.

Soils:

Grain Size: Unified Soil Classification System

Boulders > 1 foot	Silt 0.0039-0.074mm
Cobbles 3 in - 1 ft.	Clay < 0.0039 mm

Gravel

Coarse	16-64mm
Fine	2-16mm

Sand

Coarse	0.5-2mm
Medium	0.25-0.5mm
Fine	0.074-0.25mm

Density:	<u>N Values</u> (Blows/Foot)
Very Dense	> 50
Dense	30-50
Medium Dense	10-30
Loose	4-10
Very Loose	0-4

Consistency:	<u>N Values</u> (Blows/Foot)
Hard	> 30
Very Stiff	15-30
Stiff	8-15
Medium	4-8
Soft	2-4
Very Soft	0-2

Moisture:	<u>%</u>	<u>Comments</u>
Saturated	100	voids filled with water
Wet	76-99	visible signs of water
Moist	51-75	varying degrees of wetness
Damp/Humid	1-50	
Dry	0	

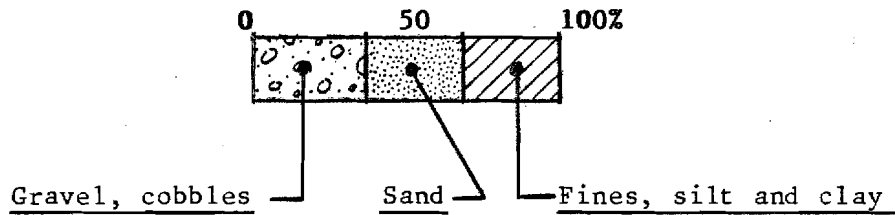
Color:

Munsell Color Chart (wet condition)

Particle Shape:

Angular	Subrounded
Subangular	Rounded

Gradation Graphics:



Rock:

Fracture Spacing:

Feet

Massive	>3.0
Slightly Fractured	1.0-3.0
Moderately Fractured	0.5-1.0
Closely Fractured	0.1-0.5
Intensely Fractured	0.05-0.1
Crushed	5 microns - 0.1

Strength:

Very strong	-	resists breakage from hammer blows, will yield dust and small chips
Strong	-	withstand a few hammer blows but will yield large fragments
Moderately Strong	-	withstands a few firm hammer blows
Weak	-	crumbles with light hammer blows
Friable	-	crumbles by rubbing or breaks easily in hands
Plastic	-	penetrated by fingers

Hardness:

Very Hard	-	cannot be scratched with a knife
Hard	-	scratched with difficulty, often faintly visible little dust.
Moderately Hard	-	readily scratched with knife, considerable dust and visible.
Low Hardness	-	deeply gouged or carved with knife
Friable	-	easily crumbled or pulverized, too soft to cut with knife
Soft	-	plastic material (grooved by fingernail)

Drilling Abbreviations:

<u>Type</u>		<u>Bits</u>
HAM	- Hammer	CI - Crowd In
CSR	- Center Stem Rotary	CO - Crowd Out
COR	- Rock Coring	TC - Tricone
DDH	- Down Hole Hammer	PC - Pentacone
TW	- Triple Wall	HC - Hexacone
LY38	- Longyear 38	BB - Button Bit
		OB - Open Bit

<u>Size</u>	
5 1/2 ϕ	- 5 1/2" Diameter Drive Pipe
7 ϕ	- 7" Diameter Drive Pipe (TW)
9 ϕ	- 9" Diameter Drive Pipe

Abbreviations:

Engineering Properties:

M/C	-	Moisture Content
LL	-	Liquid Limit
PL	-	Plastic Limit
PI	-	Plastic Index
NP	-	Nonplastic
SS	-	Split Spoon
G _s	-	Specific Gravity
K	-	Permeability

Geologic Properties and Nomenclature

AND	-	Andesite
DIO	-	Diorite
Plagio	-	Plagioclase
Bio	-	Biotite
Qtz	-	Quartz
K-Feldspar	-	Potassium Feldspar
K-feld		
Hornbl.	-	Hornblende
Fe	-	Iron
Mag	-	Magnesium
PY	-	Pyrite
Kaolin	-	Kaolinite
Chlor	-	Chlorite
CaCo ³	-	Calcium Carbonate
Fract.	-	Fractured
Frctrd	-	
Weath	-	Weathered
Unweath	-	Unweathered

Alter.	-	Altered
Unstd	-	Unstained
Hrd	-	Hard
Mass	-	Massive
Strg	-	Strong
Xyln	-	Crystalline
Mins	-	Minerals
Pseudo	-	Pseudomorphs
Reheal	-	Rehealed
Jt	-	Joint
Coat	-	Coating
F. Grain	-	Fine Grained
Med. Grain-		Medium Grained

General Abbreviations

m	-	Medium	lt	-	Light
frzn	-	Frozen	drkr	-	Darker
v	-	Very	mod	-	Moderate
dcrs	-	Decreases	modt	-	
prbly	-	Probably	occas	-	Occasional
lmtd	-	Limited	pc	-	Piece
fr	-	Fresh	sl	-	Slight
mech	-	Mechanical	max	-	Maximum
brkg	-	Breaking	min	-	Minimum
inclu	-	Inclusions	consid-		Considerable

1.1 Unified Soil Classification System

The unified System classified all soils as coarse or fine-grained based on the larger amount by weight retained or passing the No. 200 sieve. Coarse grained soils (sand, gravel) are further classified both by the uniformity of the gradation of the soil (GW, GP, SW, SP) as well as the amount and type of fines (silt, clay) filling voids in the coarse soils (GM, GC, SM, SC). Fine grained soils are further classified according to plasticity (CL, ML, CH, MH) as determined by Atterberg Limit tests. Thus, grain size analyses and Atterberg Limit tests are used to classify all non-organic soils into a group symbol which defines the texture and plasticity of the soil. Each group symbol indicates that a soil classified as such should exhibit a broad range of the engineering properties of strength, compressibility and permeability. This range is further defined if a measure of the relative density of the soil and moisture content are provided in conjunction with the group symbol. Given the group symbol, relative density, moisture content, and observations of particle shape, it is possible to predict engineering properties and anticipated behavior within an accuracy suitable for many engineering purposes.

Boring No EXAMPLE Angle (from Horizontal) _____ Ground Elevation _____
 Feature _____ Bearing _____ Rock Elevation _____
 Coordinates: N _____ Date Started _____ Total Depth _____
 E _____ Date Completed _____ 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
							<u>Coarse Gravel</u> : Texture, prefix for >25% coarse or >12% fines; density, moisture, color, particle shape, particle distribution, organics, geologic characteristics		more than 50% visible or retained on #200 sieve
	38 49		1			GM	Silty Sand GRAVEL, medium dense, humid olive grey, light grey silt and clay clumps, fine to coarse, with trace organic matter.		 Organic 4%
							<u>Fine Grained</u> : Texture, prefix for >25% coarse, consistency, moisture, color structure, organics, geologic characteristics		more than 50% not visible or passing #200 sieve
			3SS	12 26 29			Silty CLAY, 10-20% fine to medium sand - less than 5% gravel. Frozen, olive grey, clay layers 6" thick, ice lenses occasional cobble.		 LL31 PI20 PI11 CL M/C 75%

Boring No. <u>EXAMPLE</u>	Angle (from Horizontal) _____	Ground Elevation _____
Feature _____	Bearing _____	Rock Elevation _____
Coordinates: N _____	Date Started _____	Overburden Thickness _____
E _____	Date Completed _____	Ground-Water Elevation _____
Core Sizes _____	Total Depth _____	Logged by _____

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log					
			3 6 9 12	Interval, <u>ROCK TYPE</u> , color, texture (size and shape of crystals, phenocrysts etc.) percentage of, alteration products. fracturing, size of pieces, hardness; hardness, strength, weathering, coating and fillings on joints, thickness of; roughness of joint surfaces, special physical characteristics				
70								
15° 30° 50° 75° 60° 50° 60° 40°	/ / X X / X X			72.5-77.2 Diorite, grey, medium Xyln massive Plagio, hornbl, some pyrite, closely-mod frac., max 1.0, min. ◀ 0.05' mostly 0.3-0.5', hard, strong, unweath, unstained, mech. brkg. common.		98/68		
80								

2.1 RIVER CHANNEL BORING LOGS

Boring No DH83-1 (River Y) Angle (from Horizontal) 90° Ground Elevation 1,464.0
 Feature U/S Cofferdam Bearing - Rock Elevation 1,386.0
 Coordinates: N 3,227,912.0 Date Started 3/3/83 Overburden Thickness 62.5
 E 747,211.2 Date Completed 3/12/83 Ground-Water Elevation -
 Core Sizes HX/NX Total Depth 91.0 Logged by MSC/SEW/DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
0									
5				4.0 Ice					LY 38 - COR, NX
10									
15				15.5 Water					
20				15.5 - 78.0 Alluvium					HW Casing to 18.0 very hard drilling
25				15.5-52 BOULDERS, COBBLES AND COARSE GRAVEL recovered. Max 0.6 mostly 0.2 - 0.4 Heterolithologic subrounded to rounded.		40			
30				Finer grained 40-50% based on recovered pieces. Fines washed away cuttings indicate mostly sand.		66			
35						82			
40						42			Hole caved. Reamed to 40 ft.
45									
50					12				

SUSITNA JOINT VENTURE

WATANA DEVELOPMENT

Boring No DH 83-1 Angle (from Horizontal) 90° Ground Elevation 1464.0
 Feature U/S Cofferdam Bearing - Rock Elevation 1386.0
 Coordinates: N 3227912.0 Date Started 3/03/83 Overburden Thickness 62.5
 E 747211.1 Date Completed 3/12/83 Ground-Water Elevation -
 Core Sizes HX/NX Total Depth 91.0 Logged by MSC /SEW /DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
50									
55				52-63 Recovered COBBLES AND COARSE GRAVEL 0.05-0.2, sand, silt in wash water. Much redrilling because of filling of casing with sand.		25			Running sand reported by driller filling casing, reported encountered @ 52
60						20			
						8			No water return, 60 ft.
						0			Tricone
						0			Tricone
65				Boulder 2.0'		98			Core barrel is getting blocked.
				Boulder with cobbles.		100			
70				63-78 BOULDERS, COBBLES, COARSE GRAVEL recovered fines washed away Max 2.0' min 0.05 Mostly 0.1-0.2 subrounded to rounded.		18			
75				Boulder 1.0'		100			
						67			Core loss in Alluvium
				TOP OF ROCK 78.0					
80	85° 0°	7- ≡		78-89.1 Diorite Med - lt. gray Med. Xyln. Plagio. Hornblends, Bro. Massive Fresh		94			
	60°	7- ≡		Modt fract Max 1.2', Min 0.1' closely fract 78-80 possibly mech		67			
85	60°	7- ≡		Hard, strong fresh unweathered CaCO ₃ filling jts. some re-sl. more fract 86-88					
	60°	7- ≡							
	75°	7- ≡		sl. weath 88-89		28			
	45°	7- ≡							
90	75°	7- ≡		89.1-91.0 Altered Diorite lt gray crushed, field altered to kaolin no matics crshed to closely frct weak rr clay		83			
				T.D. 91.0 ft.					Core loss in Alt. Dio.

Boring No DH83-2 (FF) Angle (from Horizontal) 90° Ground Elevation 1,470.6
 Feature U/S Portals Bearing - Rock Elevation 1,424.6
 Coordinates: N 3,228,775.3 Date Started 3/13/83 Overburden Thickness 41.5 Ft.
 E 747,566.6 Date Completed 3/15/83 Ground-Water Elevation -
 Core Sizes HW/NX Total Depth 64.0 Logged by SEW/MS

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
0			3 6 9 12						
5				4.5 Ice					
10				4.5-46.0 Alluvium Boulders, cobbles, pebbles recovered fines wash away Max boulder 1.0' mostly pebbles and cobbles recovered 0.2-0.4' Subrounded - round.		70			Casing No Recovery
15						50			
20						53			
25						60			
30									
35						46			
40									
45				TOP OF ROCK 46.0 Ft.					
50	70° 0°	3/4		fe 46-64 Diorite med. gray, med. Xyl fe Plagio, hornblende, some bio & qtz fe CaCO ₃ Fresh Massive.	100/86 (in Rock)				

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 2 of 2
Date 4/12/83

Boring No	<u>DH83-2 (FF)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1470.6</u>
Feature	<u>U/S Portals</u>	Bearing	<u>-</u>	Rock Elevation	<u>1424.6</u>
Coordinates: N	<u>3228775.3</u>	Date Started	<u>3/13/83</u>	Overburden Thickness	<u>41.5'</u>
E	<u>747566.6</u>	Date Completed	<u>3/15/83</u>	Ground-Water Elevation	<u>-----</u>
Core Sizes	<u>HW/NX</u>	Total Depth	<u>64.0'</u>	Logged by	<u>MSC/SEW</u>

[illegible]

Boring No DH83-3 Angle (from Horizontal) 90° Ground Elevation 1460.4
Feature Seismic Line Bearing --- Rock Elevation 1367.5
Coordinates: N 3,226,820.9 Date Started 3/15/83 Overburden Thickness 83.3
E 745,565.9 Date Completed 3/25/83 Ground-Water Elevation ---
Core Sizes HW/NX Total Depth 126.5 Logged by SEW/MSJ/MJS

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
0				4.0 Ice					
5				9.8 Water					
10				9.8-92.9 Alluvium					
15				9.8-~70' Cobbles, boulders & coarse gravel recovered. Max pc 0.6' min <0.05" mostly 0.3-0.4', heterolithologic subangular to subrounded, larger pcs fract w/ sl Fe stain		55	1/5		
20				Fines, sand/silt washed away.		60			
25						85			
30									
35						56			
40						53			
45						93			
50						20	2/5		No water return
						50			
						44			

Boring No DH83-3 Angle (from Horizontal) 90° Ground Elevation 1460.4
Feature Seismic Line Bearing --- Rock Elevation 1367.5
Coordinates: N 3226820.9 Date Started 3/15/83 Overburden Thickness 83.3
E 745565.9 Date Completed 3/25/83 Ground-Water Elevation ---
Core Sizes HW/NX Total Depth 126.5 Logged by SEW/MJS

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
50			3 6 9 12			36			
55						48			
60						7			
65						40			
70						25			
75				≈ 70-88 Coarse gravel recovered max 0.2' min 0.05' finer & more uniform recovery than above, Heterolithologic but mainly Andesite, subrounded		44			
80						53			
85						11			
90						10			
92.9				88-92.9 Cobbles, coarse gravel, some boulders, as above 9.8-70		65			
95						80			
100						56			
92.9				Top of Rock 92.9		100/51			
95				92.9-126.5 Diorite, med grey, med Xyl'n, Plagioclase, hornblende some Bio minor qtz, massive					
100									

Boring No DH83-3 Angle (from Horizontal) 90° Ground Elevation 1460.4
 Feature Seismic Line Bearing --- Rock Elevation 1367.5
 Coordinates: N 3226820.9 Date Started 3/15/83 Overburden Thickness 83.3
 E 745565.9 Date Completed 3/25/83 Ground-Water Elevation ---
 Core Sizes HW/NX Total Depth 126.5 Logged by SEW/MJS

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
100	100	100	100	CaCO ₃ Close-mod fract, max 1.4' min 0.1' mostly 0.4-0.7', local close fract intervals, hard, strong, fresh & unweath, unstained jt surfaces, jt surfaces commonly w/CaCO ₃ coating or rehealed w/CaCO ₃ .		100/70	4/5		At 105.3-114.3 Ft K= 2.0E-04
105	105	105	105						
110	110	110	110	CaCO ₃		100/100			
115	115	115	115	CaCO ₃		100/100			
120	120	120	120	CaCO ₃		100/80	5/5		
125	125	125	125						
126.5	126.5	126.5	126.5	T.D. 126.5 Ft.					

Boring No DH83-4 Angle (from Horizontal) 45° Ground Elevation 1475.2
 Feature Q Dam Rt Bank Bearing 350° Rock Elevation 1459.6
 Coordinates: N 3,226,978.0 Date Started 3/28/83 Overburden Thickness 20.0 4
 E 744,958.5 Date Completed 3/30/83 Ground-Water Elevation 11.4 4
 Core Sizes NX Total Depth 116.5 Logged by SEM/MSJ/MJS

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
0				0-2 Snow, Ice					
5				2-22 Talus, frzn, 3' ice in top 10' mixed w/peat, angular blocks to 1+'' fract in clay/silt/sand matrix, consid Fe stains on fract in blocks & surfaces, blocks mostly Diorite w/some Andesite.	66		1/8		
10					83				
15					100				
20					92				
				Top of Rock 22.0					
25	30° 45° 60°	///		22-25.3 Diorite med grey, med Xyl mass, sl weath near jt, close fract 0.7-0.1, hard, strong Fe stain.	98/21		2/8		
30	60°	xx	No Recov	25.3-34.6 Alter Diorite hi weath, red brn, med grain qtz, clay sand hi Fe stain, core loss prbly this material, grade to weath Diorite 30.2-31, low hard-friable weath, weak.	36/0				Core recovery enhance because of frzn cond.
35	60°	xx	No Recov	Core loss prbly same material.	36/16				
40	60°	///		34.6-36.4 Alter Diorite, v weath-decompose, no Fe stain, low hard, weak.	100/21				
45	45° 15° 45° 60° 60°	/// /// /// /// ///		36.4-39.4 Diorite med grey, med Xylh, sl bleached, close fract 0.6-0.1'', hard, mod-strong.	100/0		3/8		
45	45° 60° 60°	/// /// ///		39.4-44.5 Alter Diorite, f grain, lt grey clay & qtz, no mafics, mod-close fract, grades to below	100/0				
50	45° 60° 60°	/// /// ///		Alter Diorite, sl drkr more mafic close fract, Fe stain on jts, clay on others w/Kaolinized feldspare.	100/48				Some mech brkg
				44.5-49.5 Diorite grey, some clay on jts dcrrs w/depth, mod-close fract, sl weath, hard, strong.	100/48				

SUSITNA JOINT VENTURE

WATANA DEVELOPMENT

Boring No DR83-4 Angle (from Horizontal) 45° Ground Elevation 1475.2
 Feature C Dam Rt Bank Bearing 350° Rock Elevation 1459.6
 Coordinates: N 3226978.0 Date Started 3/28/83 Overburden Thickness 20.0
 E 744958.5 Date Completed 3/30/83 Ground-Water Elevation 11.4
 Core Sizes NX Total Depth 116.5 Logged by SEM/MS/MJS

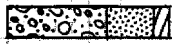
Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
50	80°	X		Fe 50-50.8 Alter Diorite crushed, weak, friable, clayey alter of feldspar.					Hole caving @ 50.0
45°	X			Fe					
30°	X			Fe					
25°	X			CaCO ₃		100/35			
20°	X			Fe					
15°	X			Fe					
10°	X			Fe					
55	85°	X		Fe 50.8-95.7 Diorite med grey, med Xyln, Plagio, hornblende, bio, minor qtz, fresh to v.sl. weath.		100/35	4/8		At 55-64 Ft K= 2.7E-05
45°	X			Fe					
30°	X			Fe					
25°	X			Fe					
20°	X			Fe					
15°	X			Fe					
10°	X			Fe					
60	50°	X		CaCO ₃ 51-62 Close-mod fract, max 1.1' min 0.1' mostly 0.3-0.6', mod hard mod strong, fresh to sl weath, Fe stains on jts common to 55' & occas below CaCO ₃ coat & reheal on some jts, little or no alter of feldspars.		100/72			
45°	X			Fe					
30°	X			Fe					
25°	X			CaCO ₃					
20°	X			CaCO ₃					
15°	X			CaCO ₃					
10°	X			CaCO ₃					
65	30°	X		62-73 Mod-sl fract, max 1.8' min 0.2 mostly 0.5-0.9, hard, strong, fresh, unweath, sl-mod Fe stain on jts as noted, surfaces occas CaCO ₃ healed rough-sl rough.		100/79			
45°	X			Fe					
30°	X			Fe					
25°	X			Fe					
20°	X			Fe					
15°	X			Fe					
10°	X			Fe					
70	45°	X		Fe 73-95.7 Mod fract w/local close fract intervals, max pc 1.5' min 0.3' mostly 0.5-0.6', hard, strong fresh, unweath, Fe stains on jts as noted, CaCO ₃ coat and reheal more common below 82.		100/79	5/8		
50°	X			Fe					
45°	X			Fe					
30°	X			Fe					
25°	X			Fe					
20°	X			Fe					
15°	X			Fe					
10°	X			Fe					
75	60°	X		Fe/CaCO ₃					
60°	X			CaCO ₃					
45°	X			Fe					
30°	X			Fe					
25°	X			Fe					
20°	X			Fe					
15°	X			Fe					
10°	X			Fe					
80	45°	X		Fe					
60°	X			Fe					
45°	X			Fe					
30°	X			Fe					
25°	X			Fe					
20°	X			Fe					
15°	X			Fe					
10°	X			Fe					
85	45°	X		Fe/CaCO ₃		100/67	6/8		At 81-100 Ft. K= 1.0E-05
60°	X			CaCO ₃					
45°	X			Fe					
30°	X			CaCO ₃					
25°	X			Fe					
20°	X			CaCO ₃					
15°	X			CaCO ₃					
10°	X			CaCO ₃					
90	45°	X		CaCO ₃		100/80			
60°	X			CaCO ₃					
45°	X			CaCO ₃					
30°	X			CaCO ₃					
25°	X			CaCO ₃					
20°	X			CaCO ₃					
15°	X			CaCO ₃					
10°	X			CaCO ₃					
95	45°	X		CaCO ₃		100/43	7/8		At 97.5-116.5 K= 3.5E-04
60°	X			95.7-100 Alter Diorite lt grey-white, med-fine grain, soft-low hard, weak to friable, clayey coat on jt surfaces, Plagio alter to Kaolin.					
45°	X								
30°	X								
25°	X								
20°	X								
15°	X								
10°	X								
100	90°	X							

Boring No DH83-4 Angle (from Horizontal) 45° Ground Elevation 1475.2
 Feature 4 Dam Rt. Bank Bearing 350° Rock Elevation 1459.6
 Coordinates: N 3226978.0 Date Started 3/28/83 Overburden Thickness 20.0
 E 744958.5 Date Completed 3/30/83 Ground-Water Elevation 11.4
 Core Sizes NX Total Depth 116.5 Logged by SEM/MS/MJS

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
100	90°	///		CaCO ₃ 100-103 Diorite grey med grain,					Water return, white
45°	///			CaCO ₃ sl alter, close-mod fract, max					
45°	///			CaCO ₃ 1.0' min 0.3' mostly 0.5', mod					
60°	///			CaCO ₃ hard, mod strong.					
105	60°	///		Fe 103-116.5 Alter Diorite mod-sl;					
45°	///			Fe lt grey-grey, mafics bleached,					
60°	///			Fe/ Plagio intact becomes less alter					
45°	///			CaCO ₃ below 110.					
60°	///			Fe Close fract max 0.6' min < 0.05'					
110	45°	///		Fe mostly 0.3', mod hard, mod strong					
45°	///			CaCO ₃ sl weath, Fe stains on jts as					8/8
60°	///			Fe noted, some CaCO ₃ coat and rehel					
45°	///			CaCO ₃ of jts, some clayey matl on jts,					
60°	///			clay smooth-rough.					
115	60°	///							
116.5				T.D.=116.5 Ft.					

Boring No HD83-10 (River H) Angle (from Horizontal) 90° Ground Elevation 1459.4
 Feature E Main Dam Bearing --- Rock Elevation 1363.4
 Coordinates: N 3226920.3 Date Started 2/20/83 Total Depth 119.5
 E 745009.1 Date Completed 2/21/83 Ground-Water Elevation ---

Logged by WMB, RLJ, NBH, JEB/LEM, DAF

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
							3.5 Ice		5 1/2 - HAM, CI
5			1			GM	Silty, sandy GRAVEL WITH COBBLES, saturated, very dark greyish brown, sub-angular to subrounded, fine to coarse, occasional boulders.		
10			2				Sandy GRAVEL WITH COBBLES, 5-12% silt, saturated, very dark greyish brown, rounded to subrounded, fine to coarse, occasional boulders.		
15			3			GP GM			
20			4			GP GM			
25	180		5						
30	21		6			SM	Silty GRAVELLY, SAND, wet, very dark greyish brown, fine to coarse.		Pipe cocked @28 ft., move hole, redrill
35	75		7			GW	Sandy GRAVEL, less than 5% fines, olive grey, angular to subangular, fine to coarse, with COBBLES and occasional boulders. Water @ 39.0		HAM, CO.
40	65		8				Boulder, Andesite.		
45			9			GW GM	5-12% silt, dark olive grey, rounded to subrounded		
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/26/83

Boring No HD83-10 (River H) Angle (from Horizontal) 90° Ground Elevation 1459.4
 Feature ☿ Main Dam Bearing --- Rock Elevation 1363.4
 Coordinates: N 3226920.3 Date Started 2/20/83 Total Depth 119.5
 E 745009.1 Date Completed 2/21/83 Ground-Water Elevation ---

Logged by WMB, RLJ, NBH, JFB / LEM, DAF

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
50	45		10			GP GM	Sandy GRAVEL WITH COBBLES, 5-12% silt, damp, dark olive grey, rounded to sub- rounded.		
55						GW GM	Very dark grey.		
60	35		11			GW	Less than 5% silt.		
65	35		12						
70	35		13						
75	40		14			GW GM	5-12% silt.		
80	32		15			GP GM	Dark grey.		 lots of water at 75.5 ft.
85	50		16			GW GM	BOULDER AND COBBLE ZONE 80.0 to 87.0'		 Hard drilling, 81 ft.
90	75		17				Olive grey.		
95	70		18						Less water
						GP GM	Dark grey.		
	45								
							TOP OF ROCK 96.0'		Hard drilling at 96 ft.
100									Started coring at 99 ft.

Boring No HD83-10 (River H)Angle (from Horizontal) 90°Ground Elevation 1,459.4Feature C Main DamBearing -Rock Elevation 1,363.4Coordinates: N 3226920.3Date Started 2/20/83Overburden Thickness 92.5E 745009.1Date Completed 2/21/83Ground-Water Elevation ---Core Sizes NXTotal Depth 119.5'Logged by NBH, JFB, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
100			3 6 9 12						
90°	/			Diorite Medium olive gray					Mislatch. Mechanical
50°	/			Med. Xyn, massive. Plagio,		75/0			breakage and grind-
60°	/			Hornblende w/ bio, Chlor, qtz.					ing of core.
105	/			fresh.					
70°	/			99'-109.5' closely fractured max		90/30			Many fractures appear
45°	/			piece 0.6' min 0.05' mostly 0.1-0.2					to be mechanical of
70°	/			(99-103.7) and 0.2-0.6 (103.7-					evidence of grinding.
60°	/			109.5) Much fracturing due to mech				1/2	
110	/			breakage. Natural fractures appear					Many fractures appear
60°	/			spaced @ 0.5' - 1.0'. Hard and					to be mechanically
60°	/			strong. Fresh. No stains evident.					caused, related to
45°	/								breakage along high
115	/			109.5'-119.5' closely-modt. fract.		100/54			natural jts. No
60°	/			Max piece 0.8', min 0.1' mostly					grinding.
70°	/			0.2-0.5' some brkg. mechanical.				2/2	2/3 H ₂ O loss @117.5'
60°	/			Hard & strong, fresh, no stains on					
70°	/			jts. Rough jt. surfaces.					
				T. D. = 119.5 ft.					

Boring No HD83-11 (River A) Angle (from Horizontal) 90° Ground Elevation 1459.1
 Feature Q Main Dam Bearing --- Rock Elevation 1385.9
 Coordinates: N 3226653.1 Date Started 2/21/83 Total Depth 89.4
 E 745064.3 Date Completed 2/22/83 Ground-Water Elevation ---

Logged by WMB, RLJ, NBH, JFB/LEM, DAF

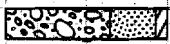
Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
									5 1/2 HAM, CO
5							5.0 Ice		
							8.0 Water		
10	64		1				Sandy GRAVEL WITH COBBLES, 5-12% silt, saturated, dark olive grey, rounded to subrounded, fine to coarse, occasional boulder.		Pipe cocked @ 12.5 Ft. Moved hole 4 times, re-drill
15	65		2				Boulder layer 12.5-25.0 ft. 5 attempts at penetrating this layer.		
20	45		3			GW GM			
25									
	25		4			SP SM	Gravelly SAND, 5-12% clayey silt, saturated, very dark grey, fine to coarse Water @ 28.0'		
30									
35	40		5				Sandy GRAVEL, 5-12% clayey silt, with COBBLES, saturated, dark grey, rounded to subrounded.		
			6						
40									
	85		7				Water @ 41.0'		Hard Drilling, 41.5 Ft.
45									
	70						Less water.		
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/26/83

Boring No HD83-11 (River A) Angle (from Horizontal) 90° Ground Elevation 1459.1
Feature Q Main Dam Bearing --- Rock Elevation 1385.9
Coordinates: N 3226653.1 Date Started 2/21/83 Total Depth 89.4
E 745064.3 Date Completed 2/22/83 Ground-Water Elevation ---
Logged by WMB, RLJ, NBH, JFB/LEM, DAF

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
50			8			GP GM	Dark olive grey.		
55									
60			9				Water @ 58.0'		
65							COBBLE AND BOULDERS		
70							TOP OF ROCK 73.2 FT		
75									Hard Drilling @ 72.0 Ft.
80									
85									
90									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3
Date 3/31/83

Boring No HD83-12 (River B) Angle (from Horizontal) 90° Ground Elevation 1459.0
Feature ± Main Dam Bearing --- Rock Elevation 1382.0
Coordinates: N 3226694.4 Date Started 2/22/83 Total Depth 87.5
E 745072.0 Date Completed 2/22/83 Ground-Water Elevation ---
Logged by WMB/RLJ/LEM, DAF

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
									5½ Ø HAM, CI
5							5.0 Ice		
							7.5 Water		
10			1				Sandy GRAVEL WITH COBBLES, 5-12% clayey silt, saturated, olive grey, rounded to subrounded, fine to coarse, occasional boulder.		
15			2						
20	40		3			GP GM			
25			4			GP GM	Less sand.		
30	25		5						
	25								
35									
			6				More sand.		
40	40								
	60		7						
45			8						
50	5								

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/31/83

Boring No HD83-12 (River B) Angle (from Horizontal) 90° Ground Elevation 1459.0
Feature E Main Dam Bearing --- Rock Elevation 1382.0
Coordinates: N 3226694.4 Date Started 2/22/83 Total Depth 87.5
E 745072.0 Date Completed 2/22/83 Ground-Water Elevation ---
Logged by WMB, RLJ/LEM, DAF

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
50	15		9						
55			10						
60	10								
65									
70	40		11				Sandy GRAVEL WITH COBBLES, 5-12% clayey silt, saturated, dark grey, rounded to subrounded, fine to coarse.		
75	65		12			GP GM	COBBLES AND BOULDERS.		
			13				TOP OF ROCK 77.0 FT		Hard Drilling 72.5 Ft. Hard Drilling 77.0 Ft.
80									
85									
90									

Boring No HD83-12 Angle (from Horizontal) 90° Ground Elevation 1459.0
 Feature L Main Dam Bearing --- Rock Elevation 1382.0
 Coordinates: N 3226694.4 Date Started 2/22/83 Overburden Thickness 69.5
 E 745072.0 Date Completed 2/22/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 87.5 Logged by WMB, RLJ/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
55									
60									
65									
70									
75									
77.5				TOP OF ROCK 77.0 Ft.					
80				775-875 Altered Diorite l+gray - off white. Sl - modt alteration. Some feldspar but mostly Kaolin pseudo morphs alter feldspar, chlorite, talc clayey. Sl - mod. fract of many unbroken incipient, High 4 jts. it filling w/chlorite & talc, sl hard, sl strong, unstained.					Started Coring 77.5 Partial Water Loss 78.5
85				Brkn	100/85		1/1		100% Water Loss
87.5				T.D. = 87.5 Ft.					
90									
95									
100									

Boring No HD83-13 (River G) Angle (from Horizontal) 90° Ground Elevation 1458.5
Feature E Main Dam Bearing --- Rock Elevation 1374.5
Coordinates: N 3226856.3 Date Started 2/22/83 Total Depth 89.0
E 745023.2 Date Completed 2/23/83 Ground-Water Elevation ---
Logged by WMB, RLJ, NBH, JFB, LEM

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
									5 1/2" Ø HAM, CI
5							6.0 Ice		
							9.0 Water		
10	60		1			SP	Gravelly SAND, less than 5% silt, saturated, olive grey, fine to coarse, rounded to subrounded, coarse gravel, occasional cobble.		
15	31		2						
20			3				Sandy GRAVEL, 5-12% clayey silt, saturated, dark olive grey, rounded to subrounded, fine to coarse, occasional cobble and boulder.		
25	44		4			GP GM			
30	46		5			SP SM	More sand, less clay.		
35	59		6						
40	20		7						
45			8						
	39								
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 2
Date 3/27/83

Boring No HD83-13 (River G)
Feature & Main Dam
Coordinates: N 3226856.3
E 745023.2

Angle (from Horizontal) 90°
Bearing ---
Date Started 2/22/83
Date Completed 2/23/83

Ground Elevation 1485.5
Rock Elevation 1374.5
Total Depth 89.0
Ground-Water Elevation ---

Logged by WMB, RLI, NBH, JFB/LEM

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
50	68	9					Sandy GRAVEL, 5-12% silt, moist, dark grey, rounded to subrounded, fine to coarse, occasional cobble and boulder.		
55	24	10				GW GM			
60	45	11					Wet.		
65	42	12							
70	57	13				GP GM	Clayey silt fines.		
75							COBBLES AND BOULDERS to 5.0' diameter.		
80							TOP OF ROCK 83.8 FT		
85							No recovery		Hammer to 89.0, Core Barrell won't fit down drive pipe.
							T.D. = 89.0 Ft.		

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3
Date 3/27/83

Boring No HD83-14 (River DD) Angle (from Horizontal) 90° Ground Elevation 1464.8
 Feature U/S Cofferdam Bearing --- Rock Elevation ---
 Coordinates: N 3228343.0 Date Started 2/23/83 Total Depth 57.5
 E 747142.4 Date Completed 2/27/83 Ground-Water Elevation ---
 Logged by WMB, RLJ, REH, JFB/LEM, DAF

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
									5 ¹ / ₂ - HAM, CO
5							4.0 Ice 5.0 Water		
10							No sample recovered. Probable cobble and boulder layer.		
15			1				GRAVEL AND COBBLES, 15-20% fine to coarse sand, less than 5% silt, damp, dark greyish brown, subrounded to subangular, fine to coarse.		
20	30		2						
25	30		3			GW	Sandy GRAVEL WITH COBBLES, less than 5% silt, damp, dark olive grey, sub-rounded, fine to coarse.		
30	35		4			GW GM	More sand and silt. Olive.		
35	35		5			GW	Less silt.		
35	100						TOP OF ROCK 34.0 FT		Hard Drilling @ 33.0 Ft.
40									
45									
50									

Boring No HD83-14 Angle (from Horizontal) 90° Ground Elevation 1464.8
 Feature U/S Cofferdam Bearing --- Rock Elevation ---
 Coordinates: N 3228343.0 Date Started 2/23/83 Overburden Thickness 29.0
 E 747142.4 Date Completed 2/27/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 57.5 Logged by WMB, RLJ, REH, JFB/LEM, DAI

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
5									
10									
15									
20									
25									
30									
35				TOP OF ROCK 34.0 Ft.					
35	30°	/		35-53.5 Diorite M gray, M Xnl.	100	80			Started Coring 35.0
40	20°	/		Mass Plagio, hornbl. some bio qtz					
45	45°	/		fr unweat, some inclu of andesite					
45	5°	X		47-53.5 Mod to closely fract max					
45	90°	X		1.0 min 0.1 mostly 0.5 closely fr					
45	85°	/		intervals at 38-39 42-42.5 along					
45	20°	/		hi & jts. Hrd, strg. Fr & unweat.					
45	90°	X		chlorite coating on some jts. Jt					
45	90°	/		chlor. surfaces smooth to rough. Some					
45	30°	/		chlor. mechanical breakage.					
45	40°	/							
45	40°	/							
45	30°	/							
45	60°	/		mech					
50									

Boring No HD83-14 Angle (from Horizontal) 90° Ground Elevation 1464.8
 Feature U/S Cofferdam Bearing --- Rock Elevation ---
 Coordinates: N 322834.0 Date Started 2/23/83 Overburden Thickness 29.0
 E 747142.4 Date Completed 2/27/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 57.5 Logged by WMB, RLJ, REH, JFB/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
25°									
20°									
75°									
50°									
55°									
90°									
60°									
70°									
78°									
				53.5-57.5 Altered Diorite Lt gr. med-fine grained. Plagio alter. to Kaolin. Sl-Modt altered. Modt fract. unstained rough it surfaces. T.D. = 57.5 Ft.		100/68	2/2		Mech brkg evident.
60									
65									
70									
75									
80									
85									
90									
95									
100									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 2
Date 3/27/83

Boring No HD83-15 (River CC) Angle (from Horizontal) 90° Ground Elevation 1465.1
 Feature U/S Portal Cofferdam Bearing --- Rock Elevation 1435.6
 Coordinates: N 3228232.7 Date Started 2/24/83 Total Depth 46.0
 E 747112.7 Date Completed 2/27/83 Ground-Water Elevation ---
 Logged by REH, JFB, JEP, RLJ/LEM, DAF

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
							3.0 Ice		5 1/2" - HAM, CI
5							5.0 Water		Boulder at 3 ft. moved hole, re- drill.
10			1				Gravelly SAND WITH COBBLES, less than 5% silt, saturated, grey, medium to coarse.		Pipe cocked at 7 ft. moved hole, redrill.
15	90 250		2			GW	Sandy GRAVEL, less than 5% silt, moist, olive, fine to coarse, with occasional cobble and boulder.		 Water return at 13.2 Ft.
15	500 300		3			GW			 Water return at 16.4 Ft.
20			4				Wet.		
25	25								
30	44		5			GP GM	GRAVEL WITH COBBLES, 20-25% fine to coarse sand, 5-12% silt, dark grey, subrounded, fine to coarse.		
30							TOP OF ROCK 29.5 Ft.		
35									
40									
45									
50									

Boring No HD83-15 Angle (from Horizontal) 90° Ground Elevation 1465.1
 Feature U/S Portal Cofferdam Bearing --- Rock Elevation 1435.1
 Coordinates: N 3228232.7 Date Started 2/24/83 Overburden Thickness 24.5
 E 747112.7 Date Completed 2/27/83 Ground-Water Elevation ---
 Core Sizes --- Total Depth 46.0 Logged by REH, JFB, JEP, RLJ/LEM, DAF

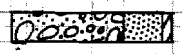
Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
5									
10									
15									
20									
25									
30	70° 60° 45° 30° 25°	///		TOP OF ROCK 29.5 Ft. 29.5-46. Diorite Med gray, Med Xyln. Massive sl porphyritic @ 36.5 sl finer grained in some intervals					Started Coring 29.5
35	70° 70° 50° 45° 50°	/// /// X /		Modt = slightly fractrd w/lmtd closely fract intervals max piece 1.8' min CO.I mostly CaCO ₃ 0.4 Hard & strong, fr & un- weathered. Several rehealed jts w/CaCO ₃ 39.8 & below rock appears sl brecciated and re- healed. Unstained.	96/78		1/2		
40	30° 60° 10°	< X		reheated	100/78				
45	45° 40° 60°	/// /		reheated			2/2		
50				T.D. = 46.0 Ft.					

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 2
Date 3/27/83

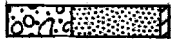
Boring No HD83-16 (River BB) Angle (from Horizontal) 90° Ground Elevation 1465.5
 Feature U/S Cofferdam Portal Bearing --- Rock Elevation 1446.5
 Coordinates: N 3228135.0 Date Started 2/24/83 Total Depth 39.5
 E 747102.7 Date Completed 2/27/83 Ground-Water Elevation ---
 Logged by REH, JFB, JEP, RLJ/LEM, DAF

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
									5.0 - HAM, CO
5							4.0 Ice		
							8.0 Water		Pipe cocked at 9 Ft. moved, redrill
10	140		1				Sandy GRAVEL WITH COBBLES, less than 5% silt, saturated, greyish brown, sub- rounded, fine to coarse.		
			2				Dark grey.		
15							Moist.		
	17 30		3			GW	TOP OF ROCK 19.0 FT.		Pipe cocked at 19 Ft. moved, redrill
20	700								
25									
30									
35									
40									
45									
50									

Boring No HD83-16 Angle (from Horizontal) 90° Ground Elevation 1465.5
 Feature U/S Cofferdam Portal Bearing --- Rock Elevation 1446.5
 Coordinates: N 3228135.0 Date Started 2/24/83 Overburden Thickness 11.0
 E 747102.7 Date Completed 2/27/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 39.5 Logged by REH, JFB, JEP, RLJ/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
5									
10									
15									
20	20°	≡		TOP OF ROCK 19.0 FT. CaCO ₃ 19.5-39.5 Diorite med gray. Chlor. Med Xylm. massive. Plagio. Chlor. hornblend Bio. local areas of pink K-feldspar Fresh.					Started Coring 19.5
25	75° 40°	X		Chlor. CaCO ₃ 19.5-30 sl. modt fract. max pc 1.6' min 0.1 mostly 0.5 Hard Chlor. strg fresh, unweathered CaCO ₃ & chlor on it surfaces.		95/ 80	1/2		
30	75° 20°	/		CaCO ₃ Chlor. 30-39.5 sl. fract max piece 2.0' min 0.4 mostly 0.8-1.5' Hard strong fresh unweathered		98/95			
35	30° 80° 10° 90°	/		Chlor. Chlor. CaCO ₃ & chlor on jt surfaces. Unstained. Chlor.			2/2		
40				T.D. = 39.5 Ft.					
45									
50									

Boring No HD83-17 (River Z) Angle (from Horizontal) 90° Ground Elevation 1464.4
Feature U/S Cofferdam Bearing --- Rock Elevation 1401.4
Coordinates: N 3227931.0 Date Started 2/24/83 Total Depth 77.5
E 747161.2 Date Completed 2/27/83 Ground-Water Elevation ---
Logged by REH, JFB/LEM, DAF

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
									51.0 - HAM, CI
5							Ice 5.0		
10									
15							Water 15.0		
30	30		1			SP	Gravelly SAND, less than 5% silt, saturated, dark olive grey, fine to coarse, rounded to subrounded gravel, with occasional cobble.		
20	50								
	70		2			GP GM	Sandy GRAVEL, 5-12% clayey silt, saturated, dark olive grey, rounded to subrounded, fine to coarse, with occasional cobble.		
25									
	15		3				Increasing fine to coarse sand.		
	18								
30									At 28 Ft., moved hole, redrill Rock in bit, pushing ahead
35			4						
			5			SP SM	Gravelly SAND, 5-12% clayey silt, olive grey.		
40									
	52		6			GW	Well graded GRAVEL, 10-15% coarse sand, less than 5% silt, saturated, olive, rounded to subrounded, fine to coarse.		
	49								
45									
			7			GP	Gravelly SAND, less than 5% silt, saturated, olive grey, fine to coarse, subrounded to subangular, fine to coarse gravel.		
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/27/83

Boring No HD83-17 (River Z)
Feature U/S Cofferdam
Coordinates: N 3227931.0
E 747161.2

Angle (from Horizontal) 90°
Bearing ---
Date Started 2/24/83
Date Completed 2/27/83

Ground Elevation	1464.4
Rock Elevation	1401.4
Total Depth	77.5
Ground-Water Elevation	---

Logged by REH, JFB/LEM, DAF

[illegible]

Boring No HD83-17 (River Z)

Angle (from Horizontal) 90°

Ground Elevation 1464.4

Feature U/S Cofferdam

Bearing ---

Rock Elevation 1401.4

Coordinates: N 3227931.0

Date Started 2/24/83

Overburden Thickness 48.0

E 747161.2

Date Completed 2/27/83

Ground-Water Elevation ---

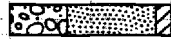
Core Sizes NX

Total Depth 77.5

Logged by REH, JFB/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
50			3 6 9 12						
55									
60									
				Boulders & Pebbles Recovered.					
				TOP OF ROCK 63.0					
65	50' ✓			63-77.5 Diorite Med grey, med	100/65	1/2			Start Coring 60.5
	15' ✓			coarse Xyln. Plagio, Hornbl.					
	0' ✓			Bio. Sl qtz. Massive.					
70	70' ✓			Slightly - Modt fract max					
	5' ✓			piece 1.2' min 0.2' mostly					
	70' ✓			0.6' Fresh to v.sl weath					
	80' ✓			Hard - V. Hard, strong.					
	45' ✓			No staining on jt surfaces.					
	30' ✓			Surfaces tough to sl smooth					
	80' ✓			CaCO ₃ & chlorite coatings on jts	100/74	2/2			Some Mech. Brkg.
75	5' ✓			V. sl. slicker sides on jts.					
77.5	45' ✓			74.5 - 77.5					
				T.D. = 77.5 Ft.					

Boring No HD83-18 (River AA) Angle (from Horizontal) 90° Ground Elevation 1465.7
Feature U/S Cofferdam Bearing --- Rock Elevation 1435.7
Coordinates: N 3227953.7 Date Started 2/24/83 Total Depth 39.0
E 747110.2 Date Completed 2/26/83 Ground-Water Elevation ---
Logged by RLJ, JEP/LEM

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
									90-HAM, CI
5							4.5 ICE		
10	200		1			GP GM	Sandy GRAVEL WITH COBBLES, 5-12% clayey silt, wet, dark olive grey, subangular, fine to coarse.		
15	50		2			GM	Clayey silty sandy GRAVEL WITH COBBLES saturated, dark greyish brown, coarse.		
20	100		3			SM	More sand, subangular, fine to coarse gravel.		
25	250		4			GW GM	Less sand.		Hard Drilling, 20.5 Ft. 
30	150		5			SW SM	Gravelly SAND, 5-12% silt, humid, olive brown, fine to coarse, weathered rock fragments with oxidized coating.		 Started coring @ 24.5 Ft.
35							TOP OF ROCK 30.0 FT		
40									
45									
50									

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 2 of 2Date 3/27/83

Boring No HD83-18 Angle (from Horizontal) 90° Ground Elevation 1465.7
 Feature U/S Cofferdam Bearing --- Rock Elevation 1435.7
 Coordinates: N 3227953.7 Date Started 2/24/83 Overburden Thickness 25.5
 E 747110.2 Date Completed 2/27/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 39.0 Logged by RLJ, JEP/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
5									
10									
15									
20									
25									
29.5				No Recovery - wash water lt. brn. Possibly weathered Diorite		0/0			Started Coring 24.5' Possible Mismatch
30	90°	X		TOP OF ROCK 30.0 FT.					
30	30°	X		29.5-39.0 Diorite med grey, med.					
30	0°	X		Xyl. Massive, Plagio, Hornb. bio.					
30	60°	X		Modt - closely fractured.					
30	70°	X		Max piece 1.0' min 0.1' mostly					
35	45°	X		0.2-0.4' Hard & strong, fresh and					
35	45°	X		unstained except on jt. surfaces					
35	70°	X		to 33' where Fe stain common little					
35	85°	X		CaCO ₃ on jts. Rough - sl rough jt.					
35	10°	X		surfaces. Sl weather on jts.					
40									
45				T. D. = 39 ft.					
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3
Date 3/27/83

Boring No HD83-19 (River X)

Angle (from Horizontal) 90°

Ground Elevation 1463.5

Feature	U/S Cofferdam
---------	---------------

Bearing ---

Rock Elevation ---Coordinates: N 3227888.3

Date Started 2/25/83

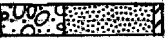
Total Depth 98.0

E 747264.4

Date Completed 2/26/83

Ground-Water Elevation ---

Logged by JEP,RLJ,REH,JFB/LEM,DAF

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
									90- HAM, CI
5							6.0 ICE		
10							10.5 WATER		
15			1			GP	Sandy GRAVEL WITH COBBLES., less than 5% silt, saturated, very dark grey, rounded to subrounded, fine to coarse.		 Hard Drilling @ 14.5 Ft.
20	200		2						Easier Drilling 22.5 Ft.
25	100								
			3			GW	More gravel, dark grey.		 K= 1.5E-03
30			4						
35	130								
			5			SP	Gravelly SAND, less than 5% silt, very dense, saturated, very dark grey, fine to coarse.		
40	95		6						
45									
			7			SP	Poorly graded SAND, less than 10% gravel, less than 5% fines, very dense, saturated, very dark grey, fine to medium.		
50	100								

Boring No HD83-19 (River X) Angle (from Horizontal) 90° Ground Elevation 1463.5
 Feature U/S Cofferdam Bearing --- Rock Elevation 1383.5
 Coordinates: N 3227888.3 Date Started 2/25/83 Total Depth 98.0 ft.
 E 747264.4 Date Completed 2/26/83 Ground-Water Elevation ---

Logged by JEP, RLJ, REH, JFB/LEM, DAF

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
50									
	95		8			SP			
55									
60	300		9			SP SM	Gravelly SAND, 5% silt, very dense, saturated, very dark grey, fine to coarse.		
65	144		10						
			11			GW	Sandy GRAVEL, less than 5% clayey silt, very dense, saturated, dark grey, fine to coarse.		
70			12						
			13			GP	COBBLE AND BOULDERS.		
75									
			14						
80							TOP OF ROCK 80.0'		COR, NX; 72-76 Ft.
			15						HAM, CI Hard Drilling
									Started Coring
85									
90									
95									
100									

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 3 of 3

Date 3/27/83

Boring No	HD83-19 (River X)	Angle (from Horizontal)	90°	Ground Elevation	1463.5
Feature	U/S Cofferdam	Bearing	---	Rock Elevation	1383.5
Coordinates: N	3227888.3	Date Started	2/25/83	Overburden Thickness	69.5
E	747264.4	Date Completed	2/26/83	Ground-Water Elevation	---
Core Sizes	NX	Total Depth	98.0 ft.	Logged by	JEP, RLJ, REH, JFB/LEM, DAF

[illegible]

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 2
Date 3/27/83

Boring No HD83-20 (River W) Angle (from Horizontal) 90° Ground Elevation 1464.9
 Feature U/S Cofferdam Bearing --- Rock Elevation 1388.4
 Coordinates: N 3227868.8 Date Started 2/27/83 Total Depth 76.5 ft.
 E 747316.0 Date Completed 2/28/83 Ground-Water Elevation ---

Logged by JEP, RLJ, REH, JFB/LEM

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
									5 $\frac{1}{2}$ "-HAM, C.O.
5							5.0 Ice		
							9.5 Water		
10	20		1			GW	Well graded GRAVEL WITH COBBLES, less than 5% silt, 20-25% medium to coarse, sand, saturated, dark olive grey, subrounded to rounded, fine to coarse coarse gravel and cobbles decreasing with depth.		
15	60		2						
20									
	30		3			GW	Dark grey.		
25	50								
30	90		4						
35	200		5			GW	Increasing fine to coarse sand 5-12% silt.		
	120								Hard Drilling, 34-37 Ft.
40	35								
45	110		6			SP	Gravelly SAND, less than 5% silt, saturated, very dark grey, fine to coarse, subrounded, coarse gravel.		
			7			GW	More fine gravel.		
50									K= 7.4E-03

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 2
Date 3/27/83

Boring No HD-83-20 (River W) Angle (from Horizontal) 90° Ground Elevation 1464.9
Feature U/S Cofferdam Bearing --- Rock Elevation ---
Coordinates: N 3227868.8 Date Started 2/27/83 Total Depth 76.5
E 747316.0 Date Completed 2/28/83 Ground-Water Elevation ---
Logged by JEP, RLJ, REH, JFB/LEM

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
50									
55	22		8				Fine to coarse SAND lenses.		
60	45		9			GW	Sandy GRAVEL WITH COBBLES and boulders, less than 5% silt, saturated, very dark grey. Rounded to subrounded, fine to coarse.		 Hard Drilling
65	95		10			GW	Subrounded to subangular.		
70	200		11			GM	Sandy, silty GRAVEL WITH COBBLES, wet, grey, rounded to subrounded, fine to coarse.		
75	380		12				GRAVEL, COBBLES & BOULDERS, Wet, grey, subrounded, fine to coarse.		Hard Drilling
									Refusal; core barrell won't go down
							T.D. = 76.5 ft.		
80									
85									
90									
95									
100									

SOIL BORING LOG

Sheet 1 of 3
Date 3/27/83

Boring No HD83-21 (River V) Angle (from Horizontal) 90° Ground Elevation 1467.7
 Feature U/S Cofferdam Bearing --- Rock Elevation 1401.7
 Coordinates: N 3227846.7 Date Started 2/28/83 Total Depth 86.5 Ft.
 E 747373.1 Date Completed 3/01/83 Ground-Water Elevation ---
 Logged by REH, JFB, RLJ, JEP, WMB/LEM, DAF

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
	42		1			SM	Silty fine SAND, 5-10% coarse gravel, damp, olive grey.		 5 1/2' - HAM, CT
5									
			2				More gravel, medium to coarse sand.		
10									
	12 22		3				Sandy GRAVEL, 5-12% silt, moist, olive grey, subangular. Fine to coarse, occasional cobble.		
15									
	58 48					GW GM	More sand, wet.		 K= 5.0E-02
20									
			5			GW	Less sand, less than 5% silt, dark grey.		
25									
			6			GW	More fine sand, 5-12% silt. Saturated.		
30									
	23		7				Gravelly SAND, 5-12% silt, saturated, very dark grey, fine to coarse, subrounded gravel.		Fine washed out.
35									
			8			SP	Less than 5% silt.		 K= 1.2E-02
40									
	95						Boulder @ 41.5 Ft. Dark olive grey.		 Hard Drilling, refusal moved hole, redrill
45									
			9						
	42		10			GP	More gravel, dark grey.		 K= 2.1E-02
50									

SOIL BORING LOG

WATANA DEVELOPMENT

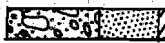
Sheet 2 of 3
Date 3/27/83

Boring No HD83-21 (River V) Angle (from Horizontal) 90° Ground Elevation 1467.7
Feature U/S Cofferdam Bearing --- Rock Elevation 1401.7
Coordinates: N 3227846.7 Date Started 2/28/83 Total Depth 86.5
E 747373.1 Date Completed 3/01/83 Ground-Water Elevation ---

Logged by REH, JFB, RLJ, JEP, WMB/LEM, DAF

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
50									
55			11				Less coarse gravel, very dark grey.		
60			12			SP			 K= 2.6E-02
65			13			GP	Sandy GRAVEL with cobbles and boulders, 5-12% silt, damp, dark grey, subrounded to subangular, fine to coarse. COBBLE/BOULDER TOP OF ROCK 66.9 Ft.		
70									
75									
80									
85									
90									
95									
100									

Boring No HD83-22 (River U) Angle (from Horizontal) 90° Ground Elevation 1467.6
 Feature U/S Cofferdam Bearing --- Rock Elevation 1380.6
 Coordinates: N 3227828.8 Date Started 3/01/83 Total Depth 107.3
 E 747416.2 Date Completed 3/01/83 Ground-Water Elevation ---
 Logged by WMB, REH, NBH, JEP/LEM, DAF

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
							3-0 Ice		5 1/2" - HAM, CI
5	105		1			GP	GRAVEL, 20-25% fine to coarse sand, less than 5% silt, damp, olive grey, rounded to subrounded, fine to coarse with cobbles.		
	64		2			GW			
	48								
10									
	40		3				More sand.		
	42								
								Water @ 13.0 Ft	
15	41								
	34								
	42								
	51								
20									
	10		4			GW	Sandy GRAVEL, 5-10% silt. Saturated, olive brown, rounded to subrounded, fine to coarse, with occasional cobble.		
	12					GM			
25									
	52		5			GW	Less silt, light olive brown.		K = 1.1E-02
30									
			6			GP	Less sand, more clayey silt.		
						GM			
35									
			7			GW			
40									
	46		8						
	38								
45									
			9			SP	Gravelly SAND, less than 5% silt, saturated, dark grey, medium, rounded to subrounded gravel.		
50									

Boring No HD83-22 (River U) Angle (from Horizontal) 90° Ground Elevation 1467.6
Feature U/S Cofferdam Bearing --- Rock Elevation 1380.6
Coordinates: N 3227828.8 Date Started 3/1/83 Total Depth 107.3 Ft.
E 747416.2 Date Completed 3/1/83 Ground-Water Elevation ---
Logged by WMB, REH, NBH, JEP / LEM, DAF

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
50	250		10						Hard Drilling @ 51 Ft.
	13								
55	28		11			GW	Sandy GRAVEL, less than 5% silt, saturated, dark grey, rounded to subrounded, fine to coarse, with occasional cobble.		
	39								
60									K = 1.1E-02
	104		12						Hard Drilling
	115								
65	145		13			GP GM	More clayey silt, grey.		
	95								
70			14			GW	Less clayey silt, very dark grey. Subrounded-subangular.		
75			15						
80	132		16				Less sand.		
							COBBLES AND BOULDERS.		
85			17			GP GM	TOP OF ROCK 87.0 Ft.		
	55								
90									
95									
100									

Boring No. HD83-22 Angle (from Horizontal) 90° Ground Elevation 1467.6
 Feature U/S Cofferdam Bearing --- Rock Elevation 1380.6
 Coordinates: N 3227828.8 Date Started 3/1/83 Overburden Thickness 84.0
 E 747416.2 Date Completed 3/1/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 107.3 ft. Logged by WMB, REH, NBH, JEP/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
55									
60									
65									
70									
75									
80									
85									
				Top of Rock 87.0 Ft.					
90	60° 60° 60°	X X X		Mech 87.5-97.3 Diorite med gray Med. Xyln. massive, fresh.					Started Coring 87.5
	45° 90°	/		Closely - modt. frctrd. max piece 1.0' min 0.1 mostly 0.3-					
95	60°	/		0.6' hard & strong, fresh & un- stained.					Mechanical Brkg and some grinding.
	50°	/		Low mech. brkg.					
100	45°	//		97.3-107.3 Diorite as above w/ Xenoliths of fine gr. gray Amd.					

Boring No HD83-22 Angle (from Horizontal) 90° Ground Elevation 1467.6
Feature U/S Cofferdam Bearing _____ Rock Elevation 1380.6
Coordinates: N 3227828.8 Date Started 3/1/83 Overburden Thickness 84.0
E 747416.2 Date Completed 3/1/83 Ground-Water Elevation _____
Core Sizes N X Total Depth 107.3 Logged by WMB, REH, NBH, JEP/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
105	45° 45° 80° 45° 45° 45°	/		Closely to slightly fractured, Max piece 1.4' min, 0.1' mostly 0.3-1.0'. Hard & strong, fresh and unstained, many brks mechanical.	100/75		2/2		Top 5' of Run w/ mech. brkg. @ Low to core.
				T.D. = 107.3 Ft.					
110									
115									
120									
125									
130									
135									
140									
145									
150									

Boring No HD83-23 (River T) Angle (from Horizontal) 90° Ground Elevation 1468.0
Feature U/S Cofferdam Bearing --- Rock Elevation 1397
Coordinates: N 3227810.9 Date Started 3/1/83 Total Depth 87.0
E 747469.8 Date Completed 3/2/83 Ground-Water Elevation ---
Logged by NBH, JEP, REH, WMB/LEM, DAF

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
							Sandy GRAVEL with cobbles, 5-12% silt, damp, olive grey, subrounded, fine to coarse.		5 1/2" - HAM, CI
5	87		1						
	63		2			GW			
10	56		3			GW	Olive brown, subrounded to subangular, moist.		
	54					GM			
15			4				Wet.		
20	52								
	34		5			GW	Less silt.		
25									
			7			SP	Gravelly SAND, less than 5% silt, saturated, olive, fine to coarse, rounded to subrounded coarse gravel.		
30	50								
			8						
35	63						Silty, Gravelly SAND, wet, olive brown, fine to coarse, subrounded to subangular fine gravel.		
40	30		9			SM			Hard Drilling at 41 Ft.
45									
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/27/83

Boring No HD83-23 (River T)

Angle (from Horizontal) 90°

Ground Elevation 1468.0

Feature	U/S Cofferdam
---------	---------------

Bearing _____

Rock Elevation 1397

Coordinates: N 3227810.9

Date Started 3/1/83

Rock Elevation 1597
Total Depth 87.0

E 747469.8

Date Completed 3/2/83

Ground-Water Elevation _____

Logged by NBH, JEP, REH, WMB/LEM, DAF

[illegible]

Boring No HD83-23 Angle (from Horizontal) 90° Ground Elevation 1468.0
 Feature U/S Cofferdam Bearing --- Rock Elevation 1397
 Coordinates: N 3227810.9 Date Started 3/1/83 Overburden Thickness 71.0
 E 747469.8 Date Completed 3/2/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth --- Logged by NBH, JEP, RSH, WMB/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
55									
60									
65									
70									
				TOP OF ROCK 71.0 Ft.					
75	60° 50° 70° 50° 45° 50° 5°	/		72-87 Diorite Med gray Med Xyln. massive plagioclase, Hornblende, some qtz.		92/50			Started Coring 72.0'
80	30° 5° 90° 10°	xxx xx		72-78 closely-modt fract. Max 0.7, min 0.2 mostly 0.3-0.4 hard & strong, fresh CaCO ₃ on some jts. Unstained.			1/1		
85	15°	/		78-87 modt-sl. fract. w/few closely fract zones 79-80, max 1.1', min 0.1', mostly 0.6 20% CaCO ₃ coatings on jts. Hard and strong, fresh, unstained jt surfaces rough.	100/78				
90				T.D. = 87.0 Ft.					
95									
100									

Boring No HD83-24 (River I)Feature D/S CofferdamCoordinates: N 3226748.3E 742979.2Angle (from Horizontal) 90°Bearing ---Date Started 3/2/83Date Completed 3/2/83Ground Elevation 1453.8Rock Elevation 1409.8Total Depth 57.0Ground-Water Elevation ---Logged by NBH, JEP/LEM, DAF

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
									5 $\frac{1}{2}$ Ø-HAM, CI
							4.0 Ice		
5							5.5 Water		
10	58		1			GW	Sandy GRAVEL WITH COBBLES, less than 5% clayey silt. Saturated, olive grey, subangular, fine to coarse.		
	60		1A			GP	More sand and clayey silt.		
	115					GM			
15	105		2				Cobbles and boulders.		
20									Refusal @ 18 Ft. COR, NX - got 4 Ft., bit broke moved hole, re- drill
25									
30									HAM, CI Refusal @ 27 Ft. Started Coring
35									
40									
							TOP OF ROCK 44.0 Ft.		
45									
50									

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 2 of 3Date 3/27/83

Boring No HD83-24 Angle (from Horizontal) 90° Ground Elevation 1453.8
 Feature D/S Cofferdam Bearing --- Rock Elevation 1409.8
 Coordinates: N 3226748.3 Date Started 3/2/83 Overburden Thickness 38.5
 E 742979.2 Date Completed 3/2/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 57.0 Logged by NBH, JEF/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
5									
10									
15									
20									
25									
30	60° 45° 90°	/		27-40 Diorite med gray, med Xyln. Plagio, Hornb. bio, some Kspar & aplite veins to 2", massive fresh.	100/100	1/2			Started Coring 27.0'
35	30° 10°	/		Modt-sl. fractrd. max 2.0' min o.l, mostly 0.5-2.0', fresh unweathered. Slight Fe stains on jts. Hrd & strg, fresh & unstained except on jts. Some CaCO ₃ fillings on jts.	70/28				
40	10°	/		Core Loss 40-44 Alluvium					
45	70° 45° 80° 20° 45° 50°	X X X X X X		Heterolithologic pebbles & cobbles recvd. 3.0' core loss. Brkn. TOP OF ROCK 44.0 Ft. 44-47 Diorite as above w/some pink k-feldspar. Closely intensely fract. 0.05-0.5' sl-modt weath hard, mdt strg.			2/2		

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3
Date 3/27/83

Boring No HD83-25 Angle (from Horizontal) 90° Ground Elevation 1454.4
Feature D/S Cofferdam Bearing --- Rock Elevation 1379.4
Coordinates: N 3226970.9 Date Started 3/3/83 (D) Total Depth 95.9 Ft.
E 743087.1 Date Completed 3/3/83 (N) Ground-Water Elevation ---

Logged by WMB, REH, NBH, JEP/LEM, DAF

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
									5 1/2" - HAM, CI
5							6.0 Ice		
							8.0 Water		
10							Sandy GRAVEL with cobbles, less than 5% silt, saturated, olive grey, rounded to subrounded, fine to coarse.		
15		1				GW	Water @ 18.0 ft.		Blow by, discharge hose plugged.
20							Less sand.		
25		2					More sand.		
30		3							
35	35						Loose, easily penetrated		Drive bit plugged, 20. Ft. of sample collected for #4 (?)
40	29						Gravelly SAND?		
45	11	4					Formation probably a loose sand, saturated, very dark grey.		
	23	5				SW			
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/27/83

Boring No	HD83-25	Angle (from Horizontal)	90°	Ground Elevation	1454.4
Feature	D/S Cofferdam	Bearing	---	Rock Elevation	1379.4
Coordinates: N	3226970.9	Date Started	3/3/83 (D)	Total Depth	95.9 ft.
E	743087.1	Date Completed	3/3/83 (N)	Ground-Water Elevation	---

Logged by WMB, REH, NBH, JEP/LEM, DAF

[illegible]

Boring No HD83-25 Angle (from Horizontal) 90° Ground Elevation 1454.4
 Feature D/S Cofferdam Bearing --- Rock Elevation 1379.4
 Coordinates: N 3226970.9 Date Started 3/3/83(D) Overburden Thickness 67.0
 E 743087.1 Date Completed 3/3/83 (N) Ground-Water Elevation ---
 Core Sizes NX Total Depth 95.9 ft. Logged by WMB, REH, NBH, JEP/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
55									
60									
65									
70									
75				Top of Rock 75.0 Ft.					
80	45° / 30° / 40° / 70° / 30° / 40° / 70° / 45° //			76-94 Altered Diorite Lt gray, med. grained, variably altered, partially to totally. Mostly Kaolin pseudo-morphs after feldspar, some chlorite talc and quartz. Closely-slightly fract. 76-86 Max 2.5' min 0.05', mostly 0.3-0.8 Sl. hard, Sl strong, occasionally sugary & friable where more altered. Unstained. 86-94 closely fract. to modt. fract. Max 0.8', min <0.05', mostly 0.3-0.6, no staining, some mechanical brkg., Rough jt surfaces. Some talc on jts.		97/65	1/2		Started Coring 76.0 Low frags due to mech brkg.
85	90° { 45° // 60° / 45° / 45° //					95/51			
90	45° / 45° //								
95	45° / 45° //			94-95.9 Diorite med gray, med Xyln. closely-modt fract. Hard, strong. T.D. = 95.9 Ft.			2/2		
100									

SOIL BORING LOG

WATANA DEVELOPMENT

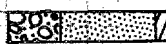
Sheet 1 of 3
Date 3/27/83Boring No HD83-26 (River M)Angle (from Horizontal) 90°Ground Elevation 1453.8Feature D/S CofferdamBearing ---Rock Elevation 1372.8Coordinates: N 3226895.5Date Started 3/4/83 (N)Total Depth 96.0 Ft.E 743049.9Date Completed 3/4/83Ground-Water Elevation ---Logged by JEP, NBH/LEM, DAF

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
									5-10 HAM, CI
5							5.5 Ice		
							8.0 Water		
10	30		1				Sandy GRAVEL, 5-12% silt. Medium dense, saturated, olive grey, rounded to subrounded, fine to coarse. Occasional cobble.		
15			2			GW GM			
20	97		3						
25			4			GP GM	More gravel, coarse gravel, sub- rounded to subangular.		
30	93 49		5			GP GM	Dark grey.		Hard Drilling 31- 32.5 Ft.
35	55 58 50		6						
40			7			SP SM	Gravelly SAND, 5-12% silt. M. dense. Saturated, very dark grey. 40% fine sand, gravel rounded to subrounded.		Easy Drilling @ 40.5-42.5 Ft.
45			8				Fine to coarse sand.		
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/27/83Boring No HD83-26 (River M)Angle (from Horizontal) 90°Ground Elevation 1453.8Feature D/S CofferdamBearing ---Rock Elevation 1372.8Coordinates: N 3226895.5Date Started 3/4/83Total Depth 96.0 ft.E 743049.9Date Completed 3/4/83Ground-Water Elevation ---Logged by JEP, NBH/LEM, DAF

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
55			9			GM	Silty, Sandy GRAVEL, 17% clayey silt, saturated, dark grey, rounded to sub-rounded, fine to coarse, occasional cobble.		
60			10						
65	39		11			SW SM	Gravelly SAND, 5-12% clayey silt. Medium dense, saturated, very dark grey, rounded to subrounded gravel.		
70	53		12				GRAVEL WITH COBBLES, less than 5% silt, medium dense, saturated, dark grey, rounded to subrounded, fine to coarse.		Hard Drilling @ 70.5 Ft.
75	93		13			GC	Sandy, silty GRAVEL WITH COBBLES, dense, saturated, dark grey, rounded to subrounded. 30% clayey silt.		 LL 25 PL 19 PI 6 G _s = 2.76
80							COBBLES AND BOULDERS, rounded, hetero-lithologic		Refusal
85							TOP OF ROCK 81.0 Ft.		Started Coring @ 76.0 Ft. Water return med. grey

Boring No HD83-26 (River M) Angle (from Horizontal) 90° Ground Elevation 1453.8
 Feature D/S Cofferdam Bearing --- Rock Elevation 1372.8
 Coordinates: N 3226895.5 Date Started 3/4/83 Overburden Thickness 73.0
 E 743049.9 Date Completed 3/4/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 96.0 ft. Logged by JEP,NBH/LEM,DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
76				Cobbles & Boulders Recovered.					Start Coring 76.0
80									
				TOP OF ROCK 81.0					
45°				81-84.7 Diorite gray, med Xyln.					
45°				Fresh w/some mineralization along					
30°				jts. Modt fract. 1.3-0.5', hard,					
40°				strong, fresh, unweath, unstained.					
85									
70°				84.7-96.0 Altered Diorite Lt gray					
30°				to white, med. grained. Variably					
70°				altd, partially to totally strong					
40°				and hard to soft and friable, re-					
90				spectively. 84.7-86 Deeply alter.					
85°				86-93 sl altd. 93-96 Altered.					
50°				Closely-modt. fract. Max 0.7, min					
45°				0.1. Mostly 0.3-0.7 unstained					
50°				clayey in highly altered intervals.					
30°									
45°									
96				T.D. = 96.0 Ft.					

Boring No HD83-27 (River K) Angle (from Horizontal) 90° Ground Elevation 1453.7
Feature D/S. Cofferdam Bearing --- Rock Elevation 1383.7
Coordinates: N 3226824.2 Date Started 3/3/83 Total Depth 98.5
E 743007.9 Date Completed 3/4/83 Ground-Water Elevation ---
Logged by JEP, NBH, REH, WMB/LEM, DAF

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
									5 1/2' - HAM, CI
5							5.5 Ice		
							8.0 Water		
10	153		1			GW	Sandy GRAVEL WITH COBBLES, less than 5% silt, saturated, dark grey, rounded to subrounded, fine to coarse, occasional boulder		
15	70		2			GP GM	GRAVEL WITH COBBLES, 20-25% fine to coarse sand, 5-12% silt, wet, olive grey, subangular to angular, fine to coarse		
20	43		3				Subrounded		
25	35		4				Increase water @ 27'		
30	29		5			GP GM	Saturated Dark olive grey Rounded to subrounded		
40			6				GRAVEL WITH COBBLES, 20-25% fine to coarse sand, less than 5% silt, saturated, dark grey, rounded to subrounded fine to coarse		
45			7			GP			
			8			GP	More sand, very dark grey		
50									

Boring No HD83-27 (River K)

Angle (from Horizontal) 90°

Ground Elevation 1453.7

Feature D/S Cofferdam

Bearing ---

Rock Elevation 1383.7

Coordinates: N 3226824.2

Date Started 3/3/83

Overburden Thickness 62.0

E 743007.9

Date Completed 3/4/83

Ground-Water Elevation ---

Core Sizes NX

Total Depth 98.5

Logged by JEP, NBH, REH, WMB/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
55									
60									
65									
70				TOP OF ROCK 70. Ft.					
71	10°	XX		CaCO ₃ 71-82 Andesite, med grey, fine grained, fresh. Mod-close fract					Started coring 71.0
72	30°	XX		71-76', max pc 0.6' min <0.1'					
73	60°	XX		mostly 0.4-0.5'. Close fract 76-					
74	70°	XX		CaCO ₃ 82', most pcs 0.2-0.3', hard &					
75	70°	XX		strong, fresh & unstained along					
76	20°	XX		jts, CaCO ₃ coatings. Rough jt					
77	60°	XX		surfaces increasingly fract &					
78	45°	XX		altered 81-82'.					
79	60°	XX							
80	10°	XX							
81	25°	XX							
82	90°	XX							
83	60°	XX							
84	VBkn	XX		82-94 Altered Diorite, white to					
85	XX	XX		v.lt. grey, kaolin pseudomorphs					
86	XX	XX		after feldspar, talc & some qtz,					
87	XX	XX		variably altered, totally to					
88	XX	XX		partly friable & clayey to hard					
89	XX	XX		& strong, resp. 82-93' totally					
90	60°	XX		alter. 93-94' partial alter.					
91	60°	XX		Intense-close fract, max pc 0.5					
92	45°	XX		min <0.1' mostly 0.2-0.3, rough					
93	60°	XX		jt, surfaces unstained.					
94	60°	XX							
95	70°	XX		94-98.5 Diorite, grey, med Xyln					
96	90°	XX		felspar hornblende, Bio, mod					
97	60°	XX		fract max 1.5' min 0.1' mostly					
98	45°	XX		0.5-0.7', hard, strong, fresh					
99	10°	XX		unstained, some sl alter of					
100	45°	XX		chlor on jts					
				T.D. = 98.5 Ft.					

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3
Date 3/27/83

Boring No HD83-28 (River J) Angle (from Horizontal) 90° Ground Elevation 1453.6
 Feature D/S Cofferdam Bearing --- Rock Elevation 1381.6
 Coordinates: N 3226787.3 Date Started 3/5/83 Total Depth 88.5
 E 742990.2 Date Completed 3/5/83 Ground-Water Elevation ---

Logged by WMB, REH, NBH, JEP/LEM, DAF

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
									5 1/2" - HAM, CI
5							5.0 Ice		
10							10.0 Water		
	95 61		1			GW	GRAVEL WITH COBBLES, 20-25% medium to coarse sand, less than 5% silt, saturated, dark grey subrounded to subangular, fine to coarse		Hard Drilling @ 13 Ft.
15	31 41		2			GW	5-12% silt		
20									
	28 20 21		3			GP GM	Sandy GRAVEL WITH COBBLES AND BOULDERS 5-12% silt, moist, dark grey, rounded to subrounded, fine to coarse		NP G _s = 2.75
25									
			4			GP GM	Olive grey		K = 2.0E-02
30									
	21 34 64		5			GW GM			Hard Drilling @ 34 Ft.
35			6				BOULDERS 34.5-44.5 ft with fine to coarse sand		G _s = 2.78 Started Coring 34.5 Ft.
40									
	28		7						5 1/2" - HAM, CI @ 44.5 Ft.
45									
			8			SP	Gravelly SAND, less than 5% silt, saturated, very dark grey, medium, with trace fine and coarse subangular gravel		
50									

SOIL BORING LOG

Sheet 2 of 3
Date 3/27/83

WATANA DEVELOPMENT

Boring No	<u>HD83-28 (River J)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1453.6</u>
Feature	<u>D/S Cofferdam</u>	Bearing	<u>--</u>	Rock Elevation	<u>1381.6</u>
Coordinates: N	<u>3226787.3</u>	Date Started	<u>3/5/83</u>	Total Depth	<u>88.5</u>
E	<u>742990.2</u>	Date Completed	<u>3/5/83</u>	Ground-Water Elevation	<u>---</u>
Logged by	<u>WMB, REH, NBH, JEP/LEM, DAF</u>				

[illegible]

Boring No HD83-28 (River J) Angle (from Horizontal) 90° Ground Elevation 1453.6
Feature D/S Confferdam Bearing --- Rock Elevation 1381.6
Coordinates: N 3226787.3 Date Started 3/5/83 Overburden Thickness 62.0
E 742990.2 Date Completed 3/5/83 Ground-Water Elevation ---
Core Sizes NX Total Depth 88.5 Logged by WMB, REH, NBH, JEP/LEM
DAF

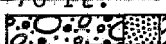
Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
72.5	15°	/		Top of Rock 72.0 Fr.					
30°	/			72.5-77.2 Diorite gray, med Xylm					Start Coring 72.5
50°	/			massive Plagio, hornbl, some pyrite					
60°	X			closely-mod fract, max 1.0' min					
75°	/			<0.05' mostly 0.3-0.5', hard,					
60°	/			strong unweath unstained, mech					
50°	X			brkg common.					
70°	/			77.2-78.5 Altered Diorite, sl					
60°	/			altered, lt gray, closely fract,					
80°	/			hard rehealed jts.					
60°	/			78.5-88.5 Diorite as above w/o					
85°	45°	/		pyrite. Sl fract to massive pcs					
60°	/			1.5-4.0', hard strong, few healed					
	/			jts.					
90				T.D. = 88.5 Ft.					

Boring No HD83-29 (River L) Angle (from Horizontal) 90° Ground Elevation 1453.8
Feature D/S Cofferdam Bearing --- Rock Elevation 1374.8
Coordinates: N 3226858.9 Date Started 3/5/83 Total Depth 104.3
E 743029.5 Date Completed 3/5/83 Ground-Water Elevation ---
Logged by NBH, JEP/LEM, DAF

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
									5 1/2" - HAM, CI
5							5.0 Ice		
							9.0 Water		
10	38		1				Sandy GRAVEL WITH COBBLES, 5-12% silt, saturated, dark greyish brown, sub-rounded, fine to coarse		
	37								
15									
			2			GW GM	Olive grey		
20	60								
			3			GW GM			
25	48								
	44								
	44		4				More sand		
30	30								
			5			GP GM	Sandy GRAVEL, 5-12% silt, saturated, dark grey, subrounded, fine to coarse, occasional cobble		
35									
			6						
40									
45			7				Slightly more sand, less silt		
50									

Boring No HD83-29 (River L) Angle (from Horizontal) 90° Ground Elevation 1453.8
Feature D/S Cofferdam Bearing --- Rock Elevation 1374.8
Coordinates: N 3226858.9 Date Started 3/5/83 Total Depth 104.3
E 743029.5 Date Completed 3/5/83 Ground-Water Elevation ---

Logged by NBH, JEP/LEM, DAF

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
			8				Increase water 53.0-58.0 ft		
55			9			GW	Gravelly SAND, less than 5% silt, saturated, dark olive grey, medium to coarse, trace fine, subangular fine gravel		
60									
65							GRAVEL WITH COBBLES AND BOULDERS, 20-25% coarse sand, less than 5% silt, saturated, dark grey, subrounded, fine to coarse		Hard Drilling 61-71 Ft.
			10						
70							Increase water 68.0-71.0 ft		
									Alternating hard and easy drilling 71-76 Ft.
75			11			GW			
									Refusal at 76 Ft.
							TOP OF ROCK 79.0 FT		
80									
85									

Boring No HD83-29 (River L) Angle (from Horizontal) 90° Ground Elevation 1453.8
Feature D/S Cofferdam Bearing --- Rock Elevation 1374.8
Coordinates: N 3226858.9 Date Started 3/5/83 Overburden Thickness 70.0
E 743029.5 Date Completed 3/5/83 Ground-Water Elevation ---
Core Sizes NX Total Depth 104.3 Logged by NBH, JEP/LEM

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
76				76-86 Mismatch, barrel stuck in rods.					Started coring 76.0
80				Top of Rock 79.0 Ft.					Drill Water, lt. grey color.
85						0/0			
90				86-93 Altered Diorite, lt grey, med grained, mod alter, Fe-Mag mins absent, Plagio partly alter to Kaolinite, close fract max. 1.0' min <0.05' mostly 0.3-0.4', mod hard, mod strong, unstained		100/80			Some mech brkg
95				93-104.3 Diorite, lt-med grey, fine-med grained, fresh, close-mod fract, max 0.7' min 0.1' most 0.3', hard, strong, fresh unweath		100/39			
100				20% jts. of CaCO ₃					

Boring No	HD83-29 (River L)	Angle (from Horizontal)	90°	Ground Elevation	1453.8
Feature	D/S Cofferdam	Bearing	---	Rock Elevation	1374.8
Coordinates: N	3226858.9	Date Started	3/5/83	Overburden Thickness	70.0
E	7430 9.5	Date Completed	3/5/83	Ground-Water Elevation	---
Core Sizes	NX	Total Depth	104.3	Logged by	NBH, JEP/LEM

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
90° 0-5° 40°30° 20°	± xx N x			Diorite (as above)		100/39			
				T.D. = 104.3 Ft.					

SOIL BORING LOG

WATANA DEVELOPMENT

Boring No	HD83-30 (River N)	Angle (from Horizontal)	90°	Ground Elevation	1453.8
Feature	D/S Cofferdam	Bearing	---	Rock Elevation	1388.8
Coordinates: N	3226932.3	Date Started	3/6/83	Total Depth	66.0
E	743068.2	Date Completed	3/6/83	Ground-Water Elevation	---

Logged by WMB, REH, RLJ, SEW/LEM, DAF

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
									5-20 HAM, CI
5							6.0 Ice		
							9.0 Water		
10	38		1			GP	Sandy GRAVEL WITH COBBLES, less than 5% silt, saturated, dark olive grey, subrounded to subangular, fine to coarse, Increase water @ 13.0 ft		
15	30		2			GP			Pipe cocked at 18 Ft. moved, redrill
20	16		3			GW	Less sand, olive grey		
25	11		4			GW			
30	30		5			GW GM	5-12% clayey silt, dark olive grey		
35	35		6			SW SM	Gravelly SAND, 5-12% silt, saturated, very dark grey, fine to coarse, round to subround gravel		
40			7				COBBLE ZONE 40.0-45.0 ft		Difficulty with sample return, formation probably loose.
45	30		8			SP	More gravel, less silt		
50	30								

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/27/83

Boring No	<u>HD83-30 (River N)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1453.8</u>
Feature	<u>D/S Cofferdam</u>	Bearing	<u>---</u>	Rock Elevation	<u>1388.8</u>
Coordinates: N	<u>3226932.3</u>	Date Started	<u>3/6/83</u>	Total Depth	<u>66.0</u>
E	<u>743068.2</u>	Date Completed	<u>3/6/83</u>	Ground-Water Elevation	<u>---</u>
Logged by	<u>WMB, REH, RLJ, SEW/LEM, DAF</u>				

[illegible]

Boring No HD83-30 (River N) Angle (from Horizontal) 90° Ground Elevation 1453.8
 Feature D/S Cofferdam Bearing --- Rock Elevation 1388.8
 Coordinates: N 3226932.3 Date Started 3/6/83 Overburden Thickness 56.0
 E 743068.2 Date Completed 3/6/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 66.0 Logged by WMB, REH, RLJ, SEW/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
				Top of Rock 65.0 Ft.					
66	45	X		66-76 Diorite, lt grey, med grain sl altered, some plagio to kaolin weak foliation, close-mod fract max 1.0' min 0.1' mostly 0.3-0.4 mod hard, strong, some chlor & tale on jt surfaces, occas CaCO ₃ many frags rehealed.	100/79	1/1			Start coring 66.0
	45	X							
	45	X							
	60	X							
70	45	X							Mech brkn
	60	X							
	30	X							
	60	X							Barrel wouldn't go down for 2nd run, call hole.
	60	X							
	30	X							
	60	X							
76	45	X		T.D. - 76.0 Ft.					

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3
Date 3/27/83

Boring No HD83-31 (River P)
Feature D/S Cofferdam
Coordinates: N 3227015.2
E 743107.3

Angle (from Horizontal) 90°
Bearing ---
Date Started 3/6/83
Date Completed 3/6/83

Ground Elevation 1456.2
Rock Elevation 1396.2
Total Depth 82.9
Ground-Water Elevation ---

Logged by NBH, JFB/LEM, DAF

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
							1.0 Ice		
5	101		1			GW	Sandy GRAVEL with cobbles. 5-12% silt, moist, dark grey, subrounded, fine to coarse, organics		5 1/2' - HAM, CI
10	80		2				Sandy GRAVEL with cobbles, less than 5% silt, moist, olive grey, sub-rounded to subangular, fine to coarse.		
15	28		3			GW			
20			4				Saturated.		
25			5						
30			6			GW	Less sand, dark olive grey.		
35			7				Cobble.		
40			8			SP	Gravelly SAND, less than 5% silt, loose, saturated, very dark grey, fine to coarse, rounded to subrounded gravel.		Easy drilling, 33-57.5 Ft.
45							Easy penetration 33-57.5 ft.		
50			9			SW	Less coarse gravel.		

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/27/83

Boring No	HD83-31 (River P)	Angle (from Horizontal)	90°	Ground Elevation	1456.2
Feature	D/S Cofferdam	Bearing	---	Rock Elevation	1396.2
Coordinates: N	3227015.2	Date Started	3/6/83	Total Depth	82.9
E	743107.3	Date Completed	3/6/83	Ground-Water Elevation	---

Logged by NBH, JFB/LEM, DAF

[illegible]

Boring No HD83-31 (River P) Angle (from Horizontal) 90° Ground Elevation 1456.2
 Feature D/S Cofferdam Bearing --- Rock Elevation 1396.2
 Coordinates: N 3227015.2 Date Started 3/6/83 Overburden Thickness 59.0
 E 743107.3 Date Completed 3/6/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 82.9 Logged by NBH, JFB/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
				Top of Rock 60.0 Ft.					
62	45°	Y		62-69.5 <u>Altered Diorite</u> Highly altd, lt. gray, med grained, pseudomorphs of Kaolin after feldspar. Fe-Mg mins. removed, sugary texture, some talc, clay, closely fract. max 1.0'; min 0.05 mostly 0.2'-0.4'. Modt hard, modt strong w/high jts occas coated w/talc		100/60	1/2		Start coring 62.0 Ft.
65	30°	X							
70	45°	X							
75	30°	X							
75	90°	X		69.5-75 <u>Diorite</u> med gray, med Xyln closely-modt fract max 1.2', min 0.05', mostly 0.3-0.7 hard strg, fr	100/80				Lost Water
80	20°	X		75-82.9 <u>Altered Diorite</u> as above except w/less clayey alteration of feldspar.					
80	45°	X		Testn Closely-modt fract. Max 0.9, min .05, mostly 0.2-0.8, local fe stain @ 79.5. Modt hard-hard, strg.			2/2		
82.9	60°	X		T.D. = 82.9 Ft.					

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3
Date 3/27/83

Boring No HD83-32 (River Q) Angle (from Horizontal) 90° Ground Elevation 1454.0
 Feature D/S Diversion Portal Bearing --- Rock Elevation 1425.0
 Coordinates: N 3227138.2 Date Started 3/6/83 Total Depth ---
 E 742798.9 Date Completed 3/7/83 Ground-Water Elevation ---
 Logged by NBH, JFP, WMB, RLJ/LEM, DAF

[illegible]

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 2 of 3

Date 3/27/83

Boring No	HD83-32 (River Q)	Angle (from Horizontal)	90°	Ground Elevation	1454.0
Feature	D/S Diversion Porta	Bearing	---	Rock Elevation	1425.0
Coordinates: N	3227138.2	Date Started	3/6/83	Overburden Thickness	22.5
E	742798.9	Date Completed	3/7/83	Ground-Water Elevation	---
Core Sizes	NY	Total Depth	---	Logged by	NBH, JFP, WMB, RLJ/LEM

[illegible]



WATANA DEVELOPMENT

Date 3/27/83

Logged by NBH, JFP, WMB, RLJ/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12					
50	45°	///		Diorite as above. sl weath,	100/41	2/2		
	45°	///		alter.				
	45°	///		47-57 modt. fract. Max 1.4', min.				
	30°	///		0.1 mostly 0.4-0.6' sl weathered				
55	60°	///		jt surfaces Fe stained. Modt.				
	45°	///		hard-hard strong sl. weathered.				
57	45°	///		T.D. = 57.8 Ft.				

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 2
Date 3/27/83

Boring No HD83-33 (River G7)

Feature Diversion D/S Portal

Coordinates: N 3227126.4

E 742668.9

Angle (from Horizontal) 90°

Bearing _____

Date Started 3/7/83Date Completed 3/7/83

Ground Elevation 1453.2

Rock Elevation 1432.2

Total Depth 43.0

Ground-Water Elevation ---

Logged by R.JL, WMB/LEM, DAF

[illegible]

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 2 of 2

Date 3/27/83

Boring No	<u>HD83-33 (River G7)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1453.2</u>
Feature	<u>Diversion D/S Portal</u>	Bearing	<u>---</u>	Rock Elevation	<u>1432.2</u>
Coordinates: N	<u>3227126.4</u>	Date Started	<u>3/7/83</u>	Overburden Thickness	<u>13.5</u>
E	<u>742668.9</u>	Date Completed	<u>3/7/83</u>	Ground-Water Elevation	<u>---</u>
Core Sizes	<u>NX</u>	Total Depth	<u>43.0</u>	Logged by	<u>RJL, WMB/LEM, DAF</u>

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
				Top of Rock 21.0 Ft.					
23	45°	/		23-43 Diorite. lt-med gray, med					start Coring 23.0
25	60°	\\		Xyln. Plagio hornblende Chlor, sl.					Core loss prob @ Top
	60°	xx		weath. to fresh massive to sl.					
	60°	xx		foliated.					
	45°	\\		23-37 closely-modt fract. Max 1.6,		83/30			Water return, lt.
	90°	xx		min 0.1 mostly 0.4'. Hard, strong,					grey
30	60°	/		jt surfaces. Fe stained sl-modt.					
	90°	xx		some heavier weathering on vert jts					
	60°	\\							
	30°	\\							
35	60°	/					1/2		
	60°	xx							
	60°	xx							
	60°	xx							
40	60°	xx		37-43 closely fract. max 1.1', min.	100/58				
	20°	xx		0.1', mostly 0.2', hard, strong,					
	60°	xx		fresh to sl. weath. w/ Fe stains					
	45°	/		and weathered along jts.			2/2		
43	45°	/							
	30°	/							
				T.D. = 43.0 Ft.					

SUSITNA JOINT VENTURE

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 2
Date 3/27/83

Boring No HD83-34 (River S)
Feature Diversion D/S Portal
Coordinates: N 3227212.5
E 742633.7

Angle (from Horizontal) 90°
Bearing ---
Date Started 3/7/83
Date Completed 3/7/83

Ground Elevation 1454.9
Rock Elevation 1442.8
Total Depth 32.4
Ground-Water Elevation ---

Logged by NBH JFB MSC/LEM DAF

[illegible]

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 2 of 2

Date 3/27/83

Boring No	<u>HD83-34 (River S)</u>	Angle (from Horizontal)	<u>90°</u>	Ground Elevation	<u>1454.9</u>
Feature	<u>Diversion D/S Portal</u>	Bearing	<u>---</u>	Rock Elevation	<u>1442.8</u>
Coordinates: N	<u>3227212.5</u>	Date Started	<u>3/7/83</u>	Overburden Thickness	<u>7.0</u>
E	<u>742633.7</u>	Date Completed	<u>3/7/83</u>	Ground-Water Elevation	<u>---</u>
Core Sizes	<u>NX</u>	Total Depth	<u>32/4</u>	Logged by	<u>NBH, JFB, MSC/LEM, DAF</u>

[illegible]

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3Date 3/27/83

Boring No HD83-35 (River G8) Angle (from Horizontal) 90° Ground Elevation 1458.4
 Feature Seismic Line ES-D Bearing ----- Rock Elevation 1406.9
 Coordinates: N 3226804.8 Date Started 3/7/83 Total Depth 71.5
 E 743456.5 Date Completed 3/8/83 Ground-Water Elevation ---

Logged by NBH, JFB, RLJ, WMB/LEM, DAF

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
							2.5 Ice		5 1/2" - HAM, CI
5			1			GW	Sandy GRAVEL WITH COBBLES, 5-12% silt, moist, dark olive grey, rounded to subrounded, fine to coarse.		
			2			GM			
						GW	Less silt, olive grey.		
10									
	25		3						
15							Water @14.0'		
						GW	Less sand, saturated.		
	29		4				Water @18.5'		Hard Drilling
20							to 19.0'		
	25		5				Water 20.5 to 24.5'		
25									
30	43		6						
						GW	More sand and silt.		
			7			GM	Dark olive grey.		
35	72								
						GW	Slightly less silt very dark greyish brown.		
40			8						
			9						
45									Hard Drilling @ 47 Ft.
									
			10			GP	Less sand, dark olive grey.		
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/27/83

Boring No HD83-35 (River G8)

Angle (from Horizontal) 90°

Ground Elevation 1458.4

Feature Seismic Line E5-D

Bearing _____

Rock Elevation 1406.9

Coordinates: N 3226804.8

Date Started 3/7/83

Total Depth	71.5
-------------	------

E 743456.5

Date Completed 3/8/83

Ground-Water Elevation

Logged by ~~NBH, JFB, RLJ, WMB/LEM, DAF~~

[illegible]

Boring No HD83-35 (River G8) Angle (from Horizontal) 90° Ground Elevation 1458.4
 Feature Seismic Line ES-D Bearing --- Rock Elevation 1406.9
 Coordinates: N 3226804.8 Date Started 3/7/83 Overburden Thickness 49.0
 E 743456.5 Date Completed 3/8/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 71.5 Logged by NBH, JFB, RLJ, WMB/LEM
DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./QCD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
				Top of Rock 51.5 Ft.					
52.545°				52.5-71.5 Diorite lt. gray med. grained slightly weath/altd. Some alteration of Plagio to Kaolin. Intensely-modt fract. Max 0.8, min. 0.05, mostly 0.3-0.5. Modt hard to hard. Mod strong to strong. Locally soft. Jts unstained but chalky and w/CaCO ₃ fillings. Some w/blk Mn(?) coatings. Much brkg along high * jts.		100/33	1/2		Start coring @ 52.5 Core loss prob. @Top.
55									
56									
57									
58									
59									
60									
61									
62									
63									
64									
65									
66									
67									
68									
69									
70									
71.545°									
				T.D. = 71.5 Ft					

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 2
Date 3/27/83

Boring No HD83-36 (River G-9)

Feature Seismic Line ES-C

Coordinates: N 3226826.6

F 743569.8

Angle (from Horizontal) 90°

Bearing _____

Date Started 3/8/83

Date Completed 3/8/83

Ground Elevation 1456.8

Rock Elevation 1432.8

Total Depth 43.6

Ground-Water Elevation ---

Logged by WMB, RLJ, NBH, JFB/LEM, DAF

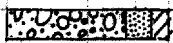
Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							2.5 Ice		5 1/2" - HAM, CI
5	80		1			GW GM	3.0 Water Sandy GRAVEL with cobbles, 5-12% silt, damp, dark olive grey, subrounded to subangular, fine to coarse.		
10	45		2			GP GM	Slightly more clayey silt, olive grey, saturated. Water @ 12.0.		
15	14		3				More sand.		
20	20		4				Less sand.		
25							TOP OF ROCK 24.0 FT		Refusal

Boring No HD83-36 (River G9) Angle (from Horizontal) 90° Ground Elevation 1456.8
 Feature Seismic Line ES-C Bearing --- Rock Elevation 1432.8
 Coordinates: N 3226826.6 Date Started 3/8/83 Overburden Thickness 21.0
 E 743569.8 Date Completed 3/8/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 43.6 Logged by ---

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
24	20°			Top of Rock 24.0 Ft.					
30	30°			24-34 Diorite med gray, Med Xyln. Massive Plagio Hornblende, some bio qtz. Modt-slightly fract. w/local zones of closely fract rock. max 1.5', min 0.1, mostly 0.5-0.8. Hard, strong, fresh, unweath. except for light Fe stain jt surfaces.	96/79				Start Coring 24.0
35	70°								
40	45°			34-43.6 Diorite as above s/sl-modt. altered zone 35-38', modt-slightly fract w/local intervals of closely fact. rock. Max 1.4' min 0.1', mostly 0.3-0.8. Hard, strong w/modt. hard, modt strong alt. zone. Fresh, unweath except for lt. Fe stain on jt surfaces. Jt surfaces rough.	99/76		1/2		Some evidence of grinding.
43.6	10°			T.D. = 43.6 Ft.			2/2		

Boring No HD83-37 (River G2) Angle (from Horizontal) 90° Ground Elevation 1462.5
Feature Seismic Line ES-F Bearing --- Rock Elevation 1309.0
Coordinates: N 3226983.9 Date Started 3/8/83 Total Depth 155.0
E 745913.9 Date Completed 3/9/83 Ground-Water Elevation ---

Logged by NBH, JFB, WMB, RLJ/LEM, DAF

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
							1.0 Ice		
5			1			GW	Sandy GRAVEL WITH COBBLES, less than 5% silt, moist, dark olive grey, rounded to subangular, fine to coarse.		 5 1/2' - HAM, CI Hard drilling at 4 Ft.
			2						
10			3			GP GM	Slightly more silt.		
	50								
15			4				More gravel		
	45								
20									
	61		5			GW	GRAVEL WITH COBBLES, 20-25% medium to coarse sand, less than 5% silt, moist, dark olive grey, subrounded, fine to coarse.		
25			6			GW	Saturated.		
30									
	40		7				Water 31.0-34.0		
35			8						
40									
			9			GW			
45									
			10			GW	Less medium sand.		
50									

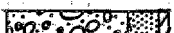
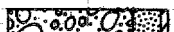
SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 5
Date 3/27/83

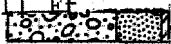
Boring No HD83-37 (River G7) Angle (from Horizontal) 90° Ground Elevation 1462.5
Feature Seismic Line ES-F Bearing --- Rock Elevation 1309.8
Coordinates: N 3226983.9 Date Started 3/8/83 Total Depth 155.0 ft.
E 745913.9 Date Completed 3/9/83 Ground-Water Elevation ---

Logged by NBH, JFB, WMB, RLJ/LEM, DAF

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
55			11						
60			12						
65			13			GW	Olive grey.		
70			14			GP GM	Slightly more clayey silt.		
75			15				Less gravel. Water 70.0 - 74.0 Ft.		
80			16			GP GM	More gravel, olive.		
85			17				Loose formation - easily penetrated.		Easy drilling at 80 - 88 ft.
90			18			GW	Water 87.0 - 88.0 Ft. GRAVEL WITH COBBLES, 15-20% coarse sand. Less than 5% silt, wet, very dark grey, subrounded to subangular, fine to coarse.		
95			19						
100									

Boring No HD83-37 (River G7) Angle (from Horizontal) 90° Ground Elevation 1,462.5
Feature Seismic Line ES-F Bearing --- Rock Elevation 1309.0
Coordinates: N 3226983.9 Date Started 3/8/83 Total Depth 155.0
E 745913.9 Date Completed 3/9/83 Ground-Water Elevation ---

Logged by NBH, JFB, WMB, RLJ/LEM, DAF

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
105			20			GP	More medium sand.		
110			21			GW	COBBLE @ 111.0 Ft. Less medium sand.		Hard Drilling @ 111 Ft. 
115									
120			22						
							Water @ 121.0 Ft.		
125									
130			23						
135			24			GP GC	More silty clay, saturated. Dark grey.		
							Water @ 135.0 Ft.		
140			25			GW GM	Slightly less silty clay and sand.		
							COBBLES AND BOULDERS.		
145									Refusal Started coring at 143.5 ft.
150									

Boring No HD83-37 (G2) Angle (from Horizontal) 90° Ground Elevation 1462.5
 Feature Seismic Line ES-F Bearing --- Rock Elevation 1309.0
 Coordinates: N 3226983.9 Date Started 3/8/83 Overburden Thickness ---
 E 475913.9 Date Completed 3/9/83 Ground-Water Elevation ---
 Core Sizes Nx Total Depth 155.0 Logged by NBH, JFB, WMB, RLJ/LEM,
DAE

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
140									
143.5				Boulders, Cobbles & Gravel Up to 1.1' Ø heterolithologic.					Start Core 143.5 100% H ₂ O Loss 146.5 -155.0
150									

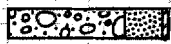
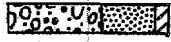
Boring No HD83-37 (G-2) Angle (from Horizontal) 90° Ground Elevation 1462.5
Feature Seismic Line ES-F Bearing --- Rock Elevation 1309.0
Coordinates: N 3226983.9 Date Started 3/8/83 Overburden Thickness ---
E 475913.9 Date Completed 3/9/83 Ground-Water Elevation ---
Core Sizes NX Total Depth 155.0 Logged by NBH, JFB, WMB, RLJ/LEM,
DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
150			3 6 9 12	Alluvium (as above.)					
155	45° 10°	///	■	Assumed Top of Rock 153.5 Diorite fresh, hard, stg, closely fractured. T. D. = 155.0 Ft.					

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 2
Date 3/27/83Boring No HD83-38 (River G1)Feature Seismic Line ES-FCoordinates: N 3227099.9E 746148.4Angle (from Horizontal) 90°Bearing ---Date Started 3/9/83Date Completed 3/9/83Ground Elevation 1,462.7Rock Elevation 1,368.2 (Refusal)Total Depth 94.5Ground-Water Elevation ---Logged by NBH, JFB/LEM

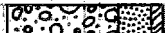
Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
							2.5 Ice		5 1/2' - HAM, CI
5	50		1			GP GM	Sandy GRAVEL with COBBLES, 5-12% silt, moist, dark olive grey, rounded to sub- rounded, fine to coarse.		
10			2				COBBLES 3.0 - 12.0 Ft.		Hard Drilling 3-12 Ft.
15			3			GW	Less silt.		
20			4				More gravel.		
25			5			GW	Less fine sand, wet.		
30			6						
35			7			GP GM	More fine sand, and silt, moist very dark greyish brown.		
40			8						
41	41		9			SM	Silty, gravelly SAND/ Sandy GRAVEL, moist, very dark greyish brown, subrounded coarse gravel, fine to coarse, occasional cobble.		
45			10						
50									

SOIL BORING LOG

WATANA DEVELOPMENT

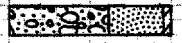
Sheet 2 of 2
Date 3/27/83Boring No HD83-38 (River G1)Angle (from Horizontal) 90°Ground Elevation 1,462.7Feature Seismic Line ES-FBearing ---Rock Elevation 1,368.2 (Refusal)Coordinates: N 3227099.9Date Started 3/9/83Total Depth 94.5E 746148.4Date Completed 3/9/83Ground-Water Elevation ---

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
55	68		11			GM	Slightly less sand, more silt, dark greyish brown.		
60	236		12				Less sand and silt.		Hard Drilling @ 56 Ft.
65			13			GP GM	Saturated.		
			14				Water 67.5 Ft.		
70			15			GP GM	GRAVEL WITH COBBLES, 20-25% Coarse sand, trace fine to medium, 5-12% silt, saturated, olive, rounded to subangular, fine to coarse.		Out of water, 70 Ft.
75	59		16				Less silt, moist.		
80			17			GW	More gravel, dark olive grey, less silt.		
85			18						
90			19			GW GM	More gravel and silt.		Hard Drilling @ 87-89 Ft.
95							TOP OF ROCK 94.5 Ft.		
									Refusal
100									Core barrel won't go below 56. Ft.

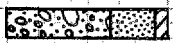
Boring No HD83-39 (River G4) Angle (from Horizontal) 90° Ground Elevation 1462.2
Feature Seismic Line ES-I Bearing --- Rock Elevation 1309.7
Coordinates: N 3227400.0 Date Started 3/10/83 Total Depth 168.0 Ft.
E 746828.3 Date Completed 3/10/83 Ground-Water Elevation ---

Logged by WMB, RLJ, REH, JFB/LEM, NBH

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
									5.0 - HAM, CI
5							5.0 Ice		
	500 200		1			GW GM	Sandy GRAVEL WITH COBBLES, 5-12% silt, damp, dark olive grey, rounded to subangular, fine to coarse		 $G_s = 2.74$ Hard driving at 6 Ft., boulder (?) to 7Ft, moved hole, redrill
10			2	80					
15			3			GP GM	Subrounded to subangular		 $G_s = 2.80$
20	50		4						
25	50		5			GP GM	Saturated.		
30	50								
							Water @ 33.0 Ft.		
35			6	35			Sandy GRAVEL WITH COBBLES, less than 5% silt, saturated, olive grey, subrounded to subangular, fine to coarse.		
40			7			GW			
45									
	70								
50									

Boring No HD83-39 (River G-4) Angle (from Horizontal) 90° Ground Elevation 1462.2
Feature Seismic Line ES-I Bearing --- Rock Elevation 1309.7
Coordinates: N 3227400.0 Date Started 3/10/83 Total Depth 168.0 Ft.
E 746828.3 Date Completed 3/10/83 Ground-Water Elevation ---

Logged by WMB, RLJ, REH, JFB/LEM, NBH

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
50	95		8						
55									
50			9			GW GM	GRAVEL WITH COBBLES, 20-25% medium to coarse sand, 5-12% silt, saturated, dark olive grey, subrounded to subangular, fine to coarse.		
60									
90			10						
65									
220			11			GP GM	More fine sand.		 $G_s = 2.82$
70									
170			12						Hard Drilling 73-75 Ft.
75									
70			13			SM	Silty, gravelly SAND, saturated, olive grey, fine to coarse, sub- angular to subrounded gravel.		
80									
90			14						
85									
200			15			SP SM	More sand, less silt.		 $G_s = 2.76$
90									
225			16						
95									
100									

Boring No HD83-39 Angle (from Horizontal) 90° Ground Elevation 1462.2
Feature Seismic Line ES-I Bearing --- Rock Elevation 1309.7
Coordinates: N 3227400.0 Date Started 3/10/83 Total Depth 168.0 Ft.
E 746828.3 Date Completed 3/10/83 Ground-Water Elevation ---

Logged by WMB, RLJ, REH, JFB/LEM, NBH

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
100									
	93		17			GP GM	Sandy GRAVEL, 5-12% silt, moist, very dark grey, rounded to sub-rounded, fine to coarse, occasional cobble.		
	173								
105			18						
	137								
	125								
110			19			GW GM	Wet.		
	76								
115			20			GP GM	Dark grey.		
	54								
120			21				More gravel and cobbles, damp.		
125			22			GW GM	Less sand, Moist.		
130			23						
135			24			GP GM	Less cobbles. More sand.		
140			25				Saturated.		
145			26			GW GM	More gravel.		
150									

Boring No HD83-39 (G4)
 Feature Seismic Line ES-I
 Coordinates: N 3227400.0
 E 746828.3
 Core Sizes NX

Angle (from Horizontal) 90°
 Bearing ---
 Date Started 3/10/83
 Date Completed 3/10/83
 Total Depth 168.0 ft.

Ground Elevation 1462.2
 Rock Elevation 1309.6
 Overburden Thickness 147.0
 Ground-Water Elevation ---
 Logged by WMB, RLJ, REH, JFB/LEM,
NBH

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
				Top of Rock 152.0 Ft.					
155	10° 80° 30° 80° 20° 80° 15° 20° 50° 60° 40° 40°	10° 80° 30° 80° 20° 80° 15° 20° 50° 60° 40° 40°	3 6 9 12	152.5-157 Diorite lt. gray, med Xyln. sl. weathered/alterned. Closely fract. Max 0.5, min. 0.05 mostly 0.2-0.4', fresh to sl. weathered, hd. strg, unstained. 157-159.2 Altered Diorite lt gray. intensely-closely fract. 0.05-0.2 modt hd, modt strg to weak & friable Much CaCO ₃ , unstained. 159.2-164.2 Diorite as above closely-intensely fract 0.05-0.3 Hard, strg, except where more weath w/CaCO ₃ & clay on jts. 164.2-168 Diorite. Med gray, med. Xyln fresh to sl. weathered Sl.- mod fract unstained some CaCO ₃ .		100/63			Start Coring 152.5 Brkg along vert jts.
160						100/30			
165									
168									
				T.D. = 168.0 Ft.					

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 1
Date 3/28/83Boring No HD83-40 (River G-3)Feature Seismic Line ES-G/HCoordinates: N 3228285.5E 747386.5Angle (from Horizontal) 90°Bearing ---Date Started 3/11/83Date Completed 3/11/83Ground Elevation 1,470.6Rock Elevation ---Total Depth 38.0 Ft.Ground-Water Elevation ---Logged by RLJ, MPB/LEM

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
							2.0 Ice		5 1/2" - HAM, CI Hit boulder at 2 Ft. moved hole, redrill
5	145 110		1				Sandy GRAVEL, 5-12% silt "damp", olive grey, very dense, subrounded to subangular, fine to coarse, occasional cobble.		Pipe cocked at 8 and 38 Ft. moved back three time, redrill.
10	104 100		2			GW GM			
15	92						Water @ 15.0 Ft.		Cobble to boulder surface layer at 2-3 Ft. on gravel bar.
	53		3				Sandy GRAVEL WITH COBBLES, less than 5%, dense, saturated, dark grey, subrounded to subangular, fine to coarse.		
20	170 177		4				Very dense.		
25	80					GW			
	74		5				Dense.		G _s = 2.76
30	140		6			GW GM			
35	131						5 - 12% silt, very dense.		Pipe cocked again @ 38.0 Ft. Bit broken, casing
40							T.D. = 38.0 Ft.		bent.
45									
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 4
Date 3/28/83

Boring No HD83-41 Angle (from Horizontal) 45° Ground Elevation 1,471.9
Feature U/S Cofferdam Bearing 098° Rock Elevation 1,413.2
Coordinates: N 3227786.1 Date Started 3/12/83 Total Depth 104.5 Ft.
E 747464.0 Date Completed 3/12/83 Ground-Water Elevation ---
Logged by RLJ, MPB, REH, JEB/LEM, NBH

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
							2.0 Ice		5 1/2" - HAM, CI
5	177								
	82								
	43		1			SM	Silty, gravelly SAND with COBBLES, moist, olive brown, 30% fine sand, little medium to coarse sand, sub= rounded to subangular coarse gravel.		
10	55								
	80								
	85		2						
15									
	184		3			GP	Sandy GRAVEL WITH COBBLES, 5-12% silt, very dense, damp, dark greyish brown, subrounded to subangular, fine to coarse, occasional boulder.		 $G_s = 2.76$
	195					GM			
20									
	285		4						
	310								
25	335								
	400		5			SP			
						SM	Gravelly SAND, 5-12% silt, very dense, moist, olive grey, fine to coarse, subrounded coarse gravel, occasional cobble and boulder.		$G_s = 2.76$
30	230								
	340		6			GP	Silty fine SAND layer 31.5' - 34.0 Ft.		
	186					GM			
35							More gravel		
	211								
	84		7				Less gravel.		
	71								
40	212								
			8						
	62								
45	61								
			9			SM	More silt.		 $G_s = 2.78$
	7500								
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 4
Date 3/28/83

Boring No HD83-41 Angle (from Horizontal) 45° Ground Elevation 1471.9
Feature U/S Cofferdam Bearing _____ Rock Elevation 1413.2
Coordinates: N 3227786.1 Date Started 3/11/83 Total Depth 104.5 Ft.
E 747464.0 Date Completed 3/12/83 Ground-Water Elevation _____
Logged by RLJ, MPB, REH, JFB/LEM, NBH

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
50									
50	400		10				Sandy GRAVEL WITH COBBLES, 5-12% silt, very dense, damp dark olive grey, fine to coarse, rounded to subrounded, occasional boulder.		
55	900					GP			
	350		11			GM			
60									
			12			GP	Boulder 62 - 63.0 Ft.		
						GM			
65	138								
	234					SW	Gravelly SAND, 5-12% silt, dense, damp, olive, fine to coarse, occasional cobble and boulder.		
	230					SM			
70									
	100								
	239		14			GM	Slightly more gravel and silt, olive brown, rounded to subrounded gravel.		G _s = 2.68
75									
							Water @ 76.0 Ft.		
	145		15				Saturated.		
	88								
80									
			16						
							TOP OF ROCK 83.0 Ft.		
85									
90									
95									
100									

Boring No HD83-41 Angle (from Horizontal) 45° Ground Elevation 1471.9
 Feature U/S Cofferdam Bearing 098° Rock Elevation 1413.2
 Coordinates: N 3227786.1 Date Started 3/11/83 Overburden Thickness 57.3 (vert)
 E 747464.0 Date Completed 3/12/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 104.5 ft. Logged by RLJ,MPB,REH,JFB/LEM,NBH

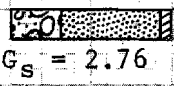
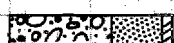
Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
100	20°		3 6 9 12	Fe Modt-closely fract. strong, hard max 0.8 min 0.05 mostly 0.3-0.8 lt to modt Fe stain on jts.					
70°				Fe 102.5-103.8 Highly altered, soft, friable closely fractured.	100/79				
104.5	30°			T.D. = 104.5 ft.					

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 4
Date 3/28/83

Boring No HD83-42 (River D) Angle (from Horizontal) 90° Ground Elevation 1,462.1
 Feature E Main Dam Bearing --- Rock Elevation 1,392.1
 Coordinates: N 3226779.4 Date Started --- Total Depth 127.8
 E 745042.1 Date Completed --- Ground-Water Elevation ---
 Logged by RJL, MPB, REH, JFB/LEM, DAF

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
									5 1/2 - HAM, CI
							4.5 Ice		
10							11.0 Water		
15	25 30 40		1				Gravelly SAND, WITH OCCASIONAL COBBLES, less than 5% silt. Medium dense to dense, saturated olive, medium to coarse.		
20	25 65 90		2			SP	Fine to coarse.		 G _s = 2.76
25	20 70 85		3			GW	Sandy GRAVEL, WITH OCCASIONAL COBBLES, less than 5% fines, dense, saturated, olive brown, subrounded, fine to coarse, medium to coarse sand.		
30	85 90 70 60		4			GP GM	5 - 12% clayey silt, olive.		
35	60 65 60		5			SW	Gravelly SAND, WITH COBBLES, less than 5% fines, dense, saturated, olive grey, rounded to subangular, fine to coarse.		
40	75 40 25		6				Medium dense, grey.		
45	40 40 35 35		7			SM	Silty SAND, with 20% Gravel, medium dense, saturated, grey fine to coarse.		
50	50								

Boring No DH83-42 (River D)
Feature E Main Dam
Coordinates: N 3226779.4
E 745042.1

Angle (from Horizontal) 90°
Bearing ---
Date Started 3/13/83
Date Completed 3/14/83

Ground Elevation 1462.1
Rock Elevation 1392.1
Total Depth 127.8
Ground-Water Elevation ---

Logged by RJL, MPB, REH, JFB/LEM, DAF

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
50	240								
55	151 89		8						
60	89 117 82		9			SP	Gravelly SAND with occasional cobbles, less than 5% silt, 48% gravel, silt is saturated, dark grey, subrounded gravel, fine to coarse.		 $G_s = 2.75$
65	151 125 102 104 105		10			GW GM	Sandy GRAVEL, 6% clayey silt, with occasional cobbles, very dense, saturated, very dark grey, rounded to subrounded, fine to coarse.		
70	620		11			SC	Gravelly, clayey SAND, dense, saturated, very dark grey, gravel rounded to subrounded, fine to coarse. Sandy GRAVEL AND COBBLES.		 LL26 PL18 PI18
							TOP OF ROCK 70.0 Ft.		
75									
80									
85									
90									
95									
100									

Boring No HD83-42 Angle (from Horizontal) 90° Ground Elevation 1462.1
 Feature Main Dam Bearing --- Rock Elevation 1392.1
 Coordinates: N 3226779.4 Date Started 3/13/83 Overburden Thickness 59.0
 E 745042.1 Date Completed 3/14/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 127.8 Logged by RJL,MPB,REH,JFB/LEM,DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
70				Top of Rock 70.0 Ft.					
45°	X			70-71.4 Altered Diorite. modt. lt. gray med Xyln. hard strong, modt-cl fract. 0.6- 0.1"					Started coring 70.0
70°	//			71.4-127.8 Diorite/Qtz Diorite med gray to grn gray, med coarse Xyln. Plagio, hornblde. bio. and variable Qtz. massive color varies w/% of mafics					
75	-				100/60				
60°	/						1/4		
90°	/								
60°	/								
80	-			71.4-84.4 modt. fract. max 1.4' min. 0.1, mostly 0.3-0.8' hard-V.hard, strong, fresh & unweath, unstained. It surfaces modt rough-rough w/lt. coatings of CaCO ₃ .					
85	X			84.4-88.2 closely fract 0.05'-0.3' hard, strong, fresh.	100/62				
90°	X			88.2-99.2 modt. fractured. max 1.6' min 0.1' mostly 0.5-1.0' V. hard strong, fresh & unstained, rough jt surfaces occas coated w/CaCO ₃ .					
90°	X								
90°	X								
90	45°								
95	30°				100/90		2/4		
70°	<								
100	45°								

Boring No HD83-42 Angle (from Horizontal) 90° Ground Elevation 1462.1
Feature E Dam Axis Bearing --- Rock Elevation 1392.1
Coordinates: N 3226779.4 Date Started 3/13/83 Overburden Thickness 59.0
E 745042.1 Date Completed 3/14/83 Ground-Water Elevation ---
Core Sizes NX Total Depth 127.8 Logged by R.JL, MPB, REH, JFB/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
100			3 6 9 12						
30°				99.2-101.4 closely fract Max 0.6'					
30°				min 0.05', hrd, strg. Sl altd					Partial Water
				100.9-101.4					Loss 103.0
105									
30°				101.4-107.7 Modt fract. max 1.2'		100/77			
30°				min < 0.1 mostly 0.5'-0.7'. Some			3/4		
60°				mech. brkg. Hard, strong, fresh,					Complete water loss
60°				some CaCO ₃ on jt surfaces.					109.0
110									
60°				107.7-115.1 Closely fractured, Max		90/60			
80°				0.3' min 0.05 w/evidence of mech					
70°				brkg and grinding, esp 113-115.					
60°				Hard & strong, fresh and unweathered					
115				unstained, rough -modt rough jt		100/80			
80°				surfaces.					
20°				115.1-127.8 Modt fract. Max 1.5'					
				min 0.1', mostly 0.3-0.8', hard &					
120				strong, fresh & unweath, unstained.					
60°				Jts healed w/CaCO ₃ , rough jt surfcs					
40°									
30°									
20°									
125						100/93	4/4		
0°									
40°									
				T.D. 127.8 Ft.					
130									
135									
140									
145									
150									

Boring No HD83-43 (River C) Angle (from Horizontal) 90° Ground Elevation 1,461.1
Feature E Main Dam Bearing --- Rock Elevation 1,385.7
Coordinates: N 3226736.8 Date Started 3/14/83 Total Depth ---
E 745055.6 Date Completed 3/14/83 Ground-Water Elevation ---

Logged by RLJ, MPB, REH, JFB/LEM, NBH

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
									5 1/2" - HAM, GI
							4.5 Ice		
10							10.0 Water		
	34		1			SP	Gravelly SAND/Sandy GRAVEL, less than 5% silt, saturated, dark olive grey, fine to coarse, subrounded to sub-angular gravel, occasional cobble.		
	49								
15	75								
	30					GP	Slightly more gravel.		
	60								
	102								
20									
	40		3						
	50								
	50								
25	31								
	25		4			GW			No water return
30	25								
	110		5				Sandy GRAVEL, 5-12% clayey silt, saturated, olive, subrounded to sub-angular. Fine to coarse.		 STANDARD PROCTOR MAX = 143.5 M/C 6%
	125								
35	125								
	78								
	41		6			SP	Gravelly SAND, less than 5% silt, saturated, olive, fine to coarse.		 G _s = 2.83
40	50								
	41		7			GW	GRAVEL, 20% medium to coarse sand, 5-12% silt.		
	35					GM	Subrounded to subangular, fine to coarse, occasional cobble.		No water return 42.48 feet
45									
	34								
	30		8						
50	43								

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 4
Date 3/28/83

Boring No HD83-43 (River C) Angle (from Horizontal) 90° Ground Elevation 1461.1
Feature E Main Dam Bearing --- Rock Elevation 1385.7
Coordinates: N 3226736.8 Date Started 3/14/83 Total Depth ---
E 745055.6 Date Completed 3/14/83 Ground-Water Elevation ---

Logged by RLJ, MPB, REH, JFB/LEM, NBH

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
50									
	42								
	34		9						
55						SC SM	Silty, clayey, gravelly SAND, saturated, dark olive grey, fine to coarse.		LL ZZ PL 18 PI 4 CL-ML
	53								
	31		10						
	68								
60									
						GM	Clayey, silty, sandy GRAVEL. Saturated, very dark grey, subrounded. Fine to coarse, occasional cobble.		
			11						
65									
	126		12			SW	COBBLES AND BOULDERS @ 63.0 Ft.		Hard Drilling and water @ 63ft.
70									Start coring at 67.0 Ft.
75							Top of Rock 75.4 Ft.		
80									
85									
90									
95									
100									

Boring No. HD83-43 Angle (from Horizontal) 90° Ground Elevation 1461.1
 Feature C Main Dam Bearing --- Rock Elevation 1385.7
 Coordinates: N 3226736.8 Date Started 3/14/83 Overburden Thickness 65.4
 E 745055.6 Date Completed 3/14/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 107.7 Logged by RJL, MPB, REH, JFB/LEM, NBH

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12					
67				Rounded heterolithic Cobbles, Boulders & gravel. Recovered 70% greater than 4" Ø	81 Recov.			Start Coring 67
70								100% water loss @73
75				TOP OF ROCK 75.4				
75				75.4-89.4 Diorite/Monzanite Med. grn. gray, med-coarse Xyl. Plagio, Hornblde, pink K-feld, v. minor Qtz. Massive, fresh.	100/82	1/3		No water return
80				75.4-85 Closely - modt fract. max 1.4' min 0.1 mostly 0.3-0.5 V. Hard, strg., fresh, unweath., rough fract. surfaces some CaCO ₃ jt. coatings.				
85				85-89.4 Closely-intensely fract. Brkn. Max 0.25 min 0.05' mostly 0.1-0.2. Hrd, strg, fresh to slightly weathered, some CaCO ₃ in jt surfcs.				Some mech. brkg.
90				89.4-94.4 Altered Diorite med grnd. lt. gray, some alter of Plagio to Kaolinite.	90/8	2/3		
95				Intensely-closely fract max 0.25 min 0.05 mostly 0.1-0.2, hard, modt strong, fresh-sl weather CaCO ₃ on fract. surfaces.				
100				94.4-104.4 Diorite/Monzanite (as above) moderately-closely fractd 94-100 Modt.	100/78			

Boring No HD83-43 Angle (from Horizontal) 90° Ground Elevation 1461.1
 Feature C Main Dam Bearing --- Rock Elevation 1385.7
 Coordinates: N 3226736.8 Date Started 3/14/83 Overburden Thickness 65.4
 E 745055.6 Date Completed 3/14/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 107.7 Logged by R.J.L., MPB, REH, JFB/LEM,
NBH

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./QCD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
100			3 6 9 12						
78°	//	/		Fract. 100-104.4 Max 1.4', min		100/78	3/3		
80°				CaCO ₃ 0.1' mostly 0.4-0.6' Hard-V. Hrd.					
60°				strong fresh - V.sl. weath. Rough					
30°				jt surfaces w/some CaCO ₃ , minor					
105				Fe stain.					
				104.4-107.7 No recovery					
				T.D. = 107.7 Ft.					RODS Sheared, hole abandoned

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 4
Date 3/28/83

Boring No HD83-44 (River E) Angle (from Horizontal) 90° Ground Elevation 1,459.9
Feature E Main Dam Bearing --- Rock Elevation 1,392.4
Coordinates: N 3226818.9 Date Started 3/15/83 Total Depth 118.0
E 745032.9 Date Completed 3/16/83 Ground-Water Elevation ---
Logged by RLI, MPB, REH, JEP/LEM, NBH

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
									5 1/2, HAM, CI
5							5.0 Ice		
10							Water		
14.4	144		1			SW	Gravelly SAND, less than 5% silt, saturated, dark olive grey, fine to coarse, subrounded to subangular gravel.		
15			2						
18						SP	Gravelly SAND, less than 5% silt, saturated, olive brown, fine to coarse.		
20	204670		3						
25	24					SP	Gravelly SAND, less than 5% silt. Saturated, dark olive grey, fine to coarse, subrounded to subangular gravel, occasional cobble.		
30	7374		4						
35	5968124		6						STANDARD PROCTOR Y _{Max} = 135PCF
40	1148884		7			SP	Less gravel.		G _s = 2.81
45	5454								
50	79		8			SW SC/SM	Gravelly SAND, 5-12% clay-silt, saturated, dark olive grey, medium to coarse.		LL25 PL20 PI5 CL-ML

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 4
Date 3/28/83

Boring No HD83-44 (River E) Angle (from Horizontal) 90° Ground Elevation 1459.9
Feature E Main Dam Bearing --- Rock Elevation 1392.4
Coordinates: N 3226818.9 Date Started 3/15/83 Total Depth 118.0
E 745032.9 Date Completed 3/16/83 Ground-Water Elevation ---

Logged by RLJ, MPB, REH, JEP/LEM, NBH

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
50									
	54		9			GW	Sandy GRAVEL, 5-12% clayey silt,		
	68					GM	saturated, very dark grey, subrounded,		
55	67						to subangular, fine to coarse, medium		
							to coarse sand, occasional		
							cobble.		
	76		10						
60	139								
	251					GW	COBBLES AND BOULDERS.		
	312		11			GM			
65	54								
							TOP OF ROCK 67.5 Ft.		Refusal at 67.5
70									Ft.
75									
80									
85									
90									
95									
100									

Boring No HD83-44 (River E) Angle (from Horizontal) 90° Ground Elevation 1459.9
Feature C Main Dam Bearing --- Rock Elevation 1392.4
Coordinates: N 3226818.9 Date Started 3/15/83 Overburden Thickness 57.5
E 745032.9 Date Completed 3/16/83 Ground-Water Elevation ---
Core Sizes NX Total Depth 118.0 Logged by RLJ, MPB, REH, JEP/LEM, NBH

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
			3 6 9 12						
30°									
45°									
70									
30°									
45°									
45°									
75									
0°									
45°									
45°									
80									
10°									
45°									
45°									
85									
45°									
30°									
45°									
90									
60°									
45°									
45°									
95									
30°									
30°									
45°									
60°									
100									

TOP OF ROCK 67.5 Ft.
67.5 - 77.5 Diorite red grey. med
Xyln. Fresh.

Modt-closely fract max 1.0' min
0.05' mostly 0.2-0.5' Hard, strong,
fresh unstained.

Sl altered zone @ 73.

77.5-90? Diorite/Monzanite grey med-
coarse xyln. w/pink K-feld sl alter
zone @ 82.5

Closely-modt fract. max 1.2, min
0.05 mostly 0.3-0.6' some mech
brkg. Hard, strong, fresh, unweath,
unstained. Some jts w/CaCO₃ coat-
ings.

No
Recov

90-118 Diorite olive gray-gray.
Med-coarse grained 15-20% mafics,
Plagioclase Fresh.

90-103 closely to locally intensely
fract. max 0.5' min 0.05' mostly
0.2-0.3 Hrd, strg, fr, unstained
some CaCO₃ on jt surfaces. Many
Many mechanical low & breaks.

Start Coring 67.5 Ft.

No Recovery - No
Tube in Core Barrel

Boring No HD83-44 (River E) Angle (from Horizontal) 90° Ground Elevation 1459.0
 Feature C Main Dam Bearing --- Rock Elevation 1392.4
 Coordinates: N 3226818.9 Date Started 3/15/83 Overburden Thickness 57.5
 E 745032.9 Date Completed 3/16/83 Ground-Water Elevation ---
 Core Sizes --- Total Depth 118.0 Logged by RLJ, MPB, REH, JEP/LEM, NBH

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
100			3 6 9 12						
100	50%	/		Diorite as above.		80/24			Many mech. fract.
	60%	/		dike 0.5' @ 104.					
	70%	/							
	80%	/							
105	50%	/		103-118 closely-mott fract. max		100/95	3/4		Mech Brkg & grinding.
	60%	/		piece 0.7 min 0.05, mostly 0.1-					
	70%	/		0.4 in interval. 103-108 and					
	80%	/		0.2-0.6 108-118					
110	50%	/							
	60%	/		Hard, strong, fresh, unweathered,		95/95			Grinding evident
	70%	/		unstained w/light CaCO ₃ coating					100% water loss @ 111.75
	80%	/		on some jts.					
115	30%	/				100/95	4/4		Mechanical brkg.
	45%	/							
	60%	/							
118	60%	/							
				T.D. = 118.0 Ft.					

HARZA-EBASCO

SUSITNA JOINT VENTURE

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3Date 3/28/83

Boring No HD83-45 Angle (from Horizontal) 45° Ground Elevation 1463.5
Feature E Dam - Right Abutment Bearing 328 Rock Elevation 1423.9
Coordinates: N 3226933.2 Date Started 3/16/83 Total Depth 80.0 Ft.
E 745003.6 Date Completed 3/17/83 Ground-Water Elevation ---

Logged by NBH, MPB, JEP, REH/LEM, DAF

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
50	50		11						
55	50								
							TOP OF ROCK 56.0 Ft.		
60									
65									
70									
75									
80									
85									
90									
95									

Boring No. C HD83-45 Angle (from Horizontal) 45° Ground Elevation 1463.5
 Feature L Dam- Right Abutment Bearing 328 Rock Elevation 1423.9
 Coordinates: N 3226933.2 Date Started 3/16/83 Overburden Thickness 38.9 (vert)
 E 745003.6 Date Completed 3/17/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 80.0 ft. Logged by NBH, JEP, MPB, REH/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./QCD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 8 9 12						
				TOP OF ROCK 56.0 Ft.					
56	45°	X		56-60 Diorite/Granodiorite gray med-coarse Xyn. Plagio Hornblende. qtz some bio & K-feld. Modt-closely fract. max 1.6 min 0.1, mostly 0.4-0.6'. Hard, strong, fresh, unweath, except for modt Fe stain on jt surfaces. Core loss at top of run CaCO ₃ coatings on jts.		65/52			Started Coring 56
60									
65				Core		0/0			Mismatch No. Recov
				Loss		20/0	1/2		Mismatch core ground.
70	30°	X		70-72.1 Diorite as above modt. fract. Fe stained on jts w/CaCO ₃					
75	60°	X		72-75 Altered Diorite r. lt gray-white plagio alter to Kaolin Closely fract soft & friable to modt hard and strong.		100/42			Water return, lt. grey
	5°	X		75-80 Diorite grn. gray as above. Closely fract. 0.1-0.8', fresh & unweath. Lt to modt. Fe stains on jts w/CaCO ₃ Hard, strong, sl. altered 79-80.		100/50	2/2		
80	70°	X		T.D. = 80.0 Ft.					

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3
Date 3/28/83

Boring No HD83-46 Angle (from Horizontal) 45° Ground Elevation 1,461.5
Feature Dam Bearing 155 Rock Elevation 1,406.0
Coordinates: N 3226614.7 Date Started 3/17/83 Total Depth 98.2 FT.
E 795075.3 Date Completed 3/18/83 Ground-Water Elevation ---

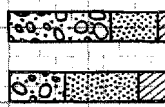
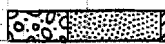
Logged by NBH, MPB, JEP, REH/LEM, DAF

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
							2.0 Snow & Ice		5.0 - HAM, CI
5			1			GW GM	Boulder Sandy GRAVEL, 5-12% silt, damp (frozen), very dark greyish brown, subangular, fine to coarse, occasional cobble and boulders.		
10	24		2				Wet.		
			3				Cobble or boulder.		
15	12		4			OH	Organic clay/silt (Peat)		 LL56 PL52 PI4
			5			SM	20-25% gravel, 15-20% fine sand, very dark brown, occasional cobbles.		OH Organic
20			6				Clayey silt, more fine sand.		 N P
			7			GP GM	Sandy GRAVEL, 5-12% silt, humid, dark olive grey, rounded to subangular, fine to coarse, occasional cobble.		3% organic
25									Hard Drilling at 19.5 - 22.0 Ft.
30	50						Water @ 30.5 Ft.		 Hard Drilling at 29.5 Ft.
35	30		8						
	20		9			GP GM			
40	60		10			SP	Less silt and fine sand. Medium to coarse sand and fine gravel.		
45			11				More coarse gravel.		
50							Cobbles and boulders.		

Boring No. HD83-46 Angle (from Horizontal) 45° Ground Elevation 1461.5
 Feature L Dam Bearing 155° Rock Elevation 1406.0
 Coordinates: N 3226614.7 Date Started 3/17/83 Overburden Thickness 37.8 (vert)
 E 795075.3 Date Completed 3/18/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 98.2 Ft. Logged by NBH, MPB, JEP, REH/LEM, DA

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
55.5	70°			Top of Rock 55.5 Fr.					
40°	30°			55.5-76 Diorite gray-grn gray med Xyln. Plagio hornbl. bio.		100/30			Start Coring 55.5
60°	30°			Massive fresh except for jt surf					
60°	30°			55.5-57.0 closely fract Mostly					
60°	30°			Fe 0.1 Fe stain along joints.					
60°	30°			57-65 modt fract max 0.8' min.					
60°	30°			Fe 0.5 mostly 0.5-0.6 Hard.					
60°	30°			Fe Strong, fresh & unstained except					
60°	30°			for Fe stain on jt surfcs. jts.					
65°	30°			Fe Brkn 65-67 Closely fract 0.4'-0.8' w/		100/56	1/3		
65°	30°			Fe Fe stain, chlorite rough surfcs.					50% H ₂ O Loss ± 67'
65°	30°			Fe 67-76 modt-sl fract, max 1.4,					
70°	45°			min 0.1, mostly 0.7-1.4'		97/73			100% H ₂ O Loss
70°	45°			CaCO ₃ Modt - sl Fe stain w/CaCO ₃ on jt					
70°	45°			surfaces, hard, strong, fresh.					
75°	45°			76-78.5 Altered Diorite wht, med					
75°	45°			grained sl-deeply altered.		100/64			H ₂ O Return
75°	45°			Closely intensely fract max 0.5					
75°	45°			min 0.05, var soft & fria. to					
80°	45°			hard strg. modt Fe stain & CaCO ₃ .			2/3		
80°	45°			78.5-82.2 Diorite as above					
80°	45°			closely fract max 0.5 min 0.1					
80°	45°			mostly 0.2-0.3 hard strg unweath					
85°	45°			82.2-84.8 Altered Diorite modt a					
85°	45°			closely fract many incipient jts		100/55			
85°	45°			modt hard-modt strg to weak and					
85°	45°			friable CaCO ₃ in jt surfaces.					
85°	45°			84.8-98.2 Diorite as above.					
90°	45°			Modt fract to sl fract. max 2.0'					
90°	45°			min 0.1 mostly 0.5-1.1 hard, strg					
90°	45°			fresh unweath V sl Fe stain and					
90°	45°			CaCO ₃ on jt surfaces.					
95°	60°			Fe		100/90	3/3		
98.2	45°			CaCO ₃					
				T.D. = 98.2 Ft.					

Boring No HD83-47 Angle (from Horizontal) 45° Ground Elevation 1,459.6
 Feature D/S Cofferdam Bearing 010° Rock Elevation ---
 Coordinates: N 3227033.0 Date Started 3/18/83 Total Depth 65.0
 E 743094.6 Date Completed 3/19/83 Ground-Water Elevation ---
 Logged by JEP, REH, NBH, MPB/LEM

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
							2.0 Ice		5 1/2' HAM, CI
5			1			GP GM	Sandy GRAVEL WITH COBBLES, 5-12% silt, dry (frozen) dark olive grey, rounded to subrounded, fine to coarse.		
10			2			SM	Silty, gravelly SAND with COBBLES, frozen, very dark greyish brown, 30% fine sand, trace medium to coarse.		N.P. Hard drilling at 2, 5.5-6.0 ft.
15	21 12		3				Subrounded to subangular gravel. COBBLE/BOULDER.		V. Easy drilling 12-14 ft. No recover, cobble in bit.
20			4			GW GM	Sandy GRAVEL, 5-12% silt, dark olive grey, saturated, Water @ 22.0 Ft. subrounded to subangular.		
25			5			SP	Gravelly SAND, less than 5% silt, saturated, dark olive grey, fine to coarse, subrounded to subangular gravel. Occasional cobble.		
30	45 74 27		6				Less fine sand.		
35			7			GW	More gravel, olive grey.		
40	200		8			SP SM	More fine to medium sand.		Hard drilling, 40 ft.
45			9				Less fine sand.		
50	10								

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 2
Date 4/11/83

Boring No HD83-47 Angle (from Horizontal) 45° Ground Elevation 1459.6
Feature D/S Cofferdam Bearing 010° Rock Elevation ---
Coordinates: N 3227033.0 Date Started 3/18/83 Total Depth 65.0 Ft.
E 743094.6 Date Completed 3/19/83 Ground-Water Elevation ---

Logged by JEP, REH, NBH, MPB / LEM

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
55									No recovery from 50-60 ft. Pipe blocked.
60	56								
148						GW	Sandy GRAVEL, 5-12% clayey silt, moist, light yellowish brown, fine to coarse,		
178						GM	COBBLES.		
65	110						REFUSAL @ 65.0 Ft.		
							T.D. = 65.0 ft.		Core barrel won't go down through rods.
70									
75									
80									
85									
90									
95									
100									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 4
Date 4/11/83

Boring No HD83-48 (River GG) Angle (from Horizontal) 90° Ground Elevation 1,455.6
Feature --- Bearing --- Rock Elevation ---
Coordinates: N 3226951.3 Date Started 3/19/83 Total Depth 108.0
E 742833.4 Date Completed 3/19/83 Ground-Water Elevation ---

Logged by NBH, MPB, REH, JEP/LEM, DAF

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
55	47 27 12		8						Poor return
60			9			SP	Poorly graded SAND, 15-20% fine to coarse gravel, less than 5% silt, saturated, very dark grey, fine to medium.		Hard Drilling at 55.5 Ft.
65	53 41 42 42		10				Sandy GRAVEL, 5-12% silt. Saturated, very dark grey, subrounded, fine to coarse.		
70	48 85		11			SW SM	Gravelly SAND, 5-12% clayey silt, saturated, very dark grey, medium coarse, subrounded to subangular gravel.		
75	87 200 160		12				Sandy GRAVEL, 5-12% clayey silt, wet, very dark grey, subrounded to subangular, fine to coarse, occasional cobble.		
80	46 46 35		13				More coarse gravel and cobbles.		
85	38 40 46 51 46		14			GC	Clayey, sandy GRAVEL, wet, dark grey, subrounded to subangular, fine to coarse, occasional cobble.		LL27 PL18 PI9 CL
90			15			GP GC	Less clay.		
95							TOP OF ROCK 88.0 Ft.		Refusal
100									

GEOLOGIC LOG

WATANA DEVELOPMENT

Sheet 3 of 4

Date 4/11/83

Boring No HD83-48

Angle (from Horizontal) 90°

Ground Elevation 1455.6

Feature _____

Bearing _____

Rock Elevation ---Coordinates: N 3226951.3

Date Started 3/19/83

Overburden Thickness 80.0

E 742833.4

Date Completed 3/19/83

Ground-Water Elevation ---Core Sizes NX

Total Depth 108.0

Logged by NBH, MPB, REH, JEP/LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log					
			3 6 9 12					
88	10'			TOP OF ROCK 88.0 Ft.				
90	20'			88-103 Diorite Slightly altered. lt gray med grained. Alternating layers of fresh & sl altered Diorite.				Started Coring 88.0
95	30'			Closely fract 88-94 max 0.3 min 0.05 Hrd strg CaCO ₃ healed fractcs 94-98 closely - modt fract max 1.5' min 0.1 mostly 0.4 many healed fractcs. hard strong 98-103	95/46	1/2		
100	40'			Closely fract max 0.6 min 0.1 Hard strong.				

Boring No HD83-48 Angle (from Horizontal) 90° Ground Elevation 1455.6
 Feature --- Bearing --- Rock Elevation ---
 Coordinates: N 3226951.3 Date Started 3/19/83 Overburden Thickness 80.0
 E 742833.4 Date Completed 3/19/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 108.0 Logged by NBH,MPB,REH,JEP/LEM,DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R.-Graphic	C.R./RQD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log						
100			3 6 9 12						
105	30° 45° 0° 60° Brkn			103-106 Altered Diorite modt-sl.altd lt gray, med grained, intensely fract. max 0.2 CaCO ₃ on jts. Modr hard, Modr strong.	98/33		2/2		Water loss 105- 105.5 Ft.
108	45° 5°			106-108 Diorite Modr fract. Hard, strong. T.D. = 108.0 Ft.					

2.2 RELICT CHANNEL BORING LOGS

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 5
Date 1/28/83

Boring No Water Well
Feature Watana Base Camp
Coordinates: N ---
E ---

Angle (from Horizontal) 90°
Bearing ---
Date Started 1/28/83
Date Completed 1/31/83

Ground Elevation 2267.0 (Approx.)
Rock Elevation 2060.5 (Approx.)
Total Depth 214.5
Ground-Water Elevation ---

Logged by JEP, WMB/LEM

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
									70- HAM, CI, TW
5			1			SM	Silty SAND, 20-25% Fine to coarse gravel, moist, light olive gray. Fine to coarse. Occasional cobble.		
10			2			SM	Grayish brown, Angular to subangular gravel.		
15	65 56 59 63		3			SM	Less gravel.		 NP
20			4			SM	Less gravel.		
25			5				Dark grayish brown.		
							Water @ 40 Ft.		
30			6			SM	Silty, gravelly SAND, moist dark gray, fine to coarse striated gravel, clay/silt clumps, occasional cobble.		
35			7			SM SC	More clay, very dark gray. Subangular gravel.		 LL19 PL14 PT5 ML-CL
40			8			SM SC	Dark olive gray.		 LL18 PL14 PT4 ML-CL G _s =2.72
45			9			SM	Dark gray.		
							Cobbles/Boulder		
50			10			SM			

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 5
Date 1/29/83

Boring No Water Well
Feature Watana Base Camp
Coordinates: N ---
E ---
Logged by JEP, WMB/LEM

Angle (from Horizontal) 90°
Bearing ---
Date Started 1/29/83
Date Completed 1/31/83

Ground Elevation 2267.0 (Approx)
Rock Elevation 2060.5 (Approx.)
Total Depth 214.5
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
55	1000		11			SM	Silty SAND, 15-20% gravel, humid, light olive gray. Fine to coarse, to angular gravel. Occasional cobble/boulder.		Hard Drilling. moved hole 5 1/2" HAM, CI re-drill, hard drilling
60	170		12			SM	More sand. More cobbles/boulders. light brown gray.		90-HAM, CI
65	40		13			SM	Brownish gray.		
70	160								
75	60		14			SM	Silty SAND, 10-15% gravel. Gray. Fine to coarse Laminations.		
80	36		15			ML/CL	Clayey SILT, 10-15% Fine to coarse sand, moist, very dark gray, laminations.		
85	75		16			ML	More fine to medium sand, gray varved silt/clay clumps.		
90	100		17			SM	More fine to coarse sand, fine gravel, olive gray.		
95	135		18			SM	Clayey, silty SAND, less than 5% gravel, very dark grayish brown, fine to coarse, occasional cobble.		
100	135		19				Gravelly silty SAND, very dark grayish brown, fine to coarse.		

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 3 of 5
Date 1/29/83

Boring No Water Well
Feature Watana Base Camp
Coordinates: N ---
E ---

Angle (from Horizontal) 90°
Bearing ---
Date Started 1/28/83
Date Completed 1/31/83

Ground Elevation 2267.0 (Approx.)
Rock Elevation 2060.5 (Approx.)
Total Depth 214.5
Ground-Water Elevation ---

Logged by JEP, WMB/LEM

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
105	540		20			GM	(cont) Subangular coarse gravel, Laminated & varied silt clumps. Less silt, more gravel. Light brownish gray, occ. cobble/bldr.		On boulder
110	350		21			SM	Less gravel, more silt and sand, dark gray.		
115	220		22			SM	Less gravel.		
120	290		23			SM	More cobbles and boulders. Silty SAND, 5-10% Fine gravel, dark grayish brown, fine to coarse, occasional cobbles/boulders.		
125	420		24			SM	More gravel, less sand and silt, humid.		
130			25			GM	More cobbles and boulders. More gravel Boulder.		
135	1479		26			SM	Less gravel, damp.		
140			27			GP GM	More gravel, cobbles & boulders. Water @ 138.5 to 143.0 Ft.		
145			28			CL	CLAY, saturated, dark gray. Some laminations?		LL43 PL23 FI20 CL
150									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 4 of 5
Date 1/30/83

Boring No Water Well Angle (from Horizontal) 90° Ground Elevation 2267.0 (Approx.)
Feature Water Base Camp Bearing --- Rock Elevation 2060.5 (Approx.)
Coordinates: N --- Date Started 1/28/83 Total Depth 214.5
E --- Date Completed 1/31/83 Ground-Water Elevation ---
Logged by JEP, WMB/LEM

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
							Moist.		
155	162								
	73		29			CL	More fine to medium sand, dark olive gray,		
			30			ML	Brownish gray, more silt.		
160			31			SM	Silty SAND, 15-20% Fine gravel, dark grayish brown, fine to coarse, sub-angular to subrounded gravel.		
	200		32				Grayish brown.		
165						GM	Silty, sandy GRAVEL, damp.		
			33				Gray, subangular to subrounded, fine to coarse.		
170									Very hard Drilling go to water injection
175			34						
			35				Sandy GRAVEL WITH COBBLES		
			36				Subrounded to subangular		
			37				(Most fines washed away in water return)		
180							Rounded to subrounded gravel		
			38				Oxidation coating on gravel.		
							Subrounded gravel.		
185			39						
			40						
190			41						
	377								
	37								
	24		42						
195									
			43						
200									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 7
Date 3/25/83

Boring No HD83-1 Angle (from Horizontal) 90° Ground Elevation 2,246.2
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3231536.1 Date Started 2/4/83 Total Depth 328.0
 E 746996.6 Date Completed 2/18/83 Ground-Water Elevation ---
 Logged by WMB, EJK, REH, JEP, NBH/LEM

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
37 24 27 16 15 35 19 19 18 57 54 56 62 80 69 78 101 125 150 137 115 158 218 197 180 159 182 226			1 2 3 4 5 6 7 8 9	24 19 17		SM SM SM SM SM SC	Silty, gravelly SAND, moist, olive brown, fine to coarse, subangular to subrounded gravel. Damp, dense. Clayey, silty SAND, 15-20% fine gravel. Damp, dark gray, sub-rounded, fine to coarse, occasional cobbles. More coarse gravel. Very dense. More silty clay, less gravel. COBBLE/BOULDER TO 38.5 FT. Striations on gravel. More sand, cobbles. Striations.	Thermal Probe to 230 Ft.	5 1/2' - HAM, CI MC 9% LL18 PL13 PI5 ML-CL

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 7

Date 3/25/83

Boring No HD83-1 Angle (from Horizontal) 90° Ground Elevation 2,246.2
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3231536.1 Date Started 2/4/83 Total Depth 328.0
 E 746996.6 Date Completed 2/8/83 Ground-Water Elevation ---

Logged by WMB, EJK, REH, JEP, NBH/LEM

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
50									
	102 119		10			SM	Less sand and gravel, moist.		 NP
55			11			SM SC	Clayey SAND, 15-20% gravel. Gray, fine to medium. Subrounded to subangular gravel, striations on gravel.		
60	118 158		12			SM SC	Moist, more gravel.		
65	248		13			SC	Damp.		
70	301		9SS 14	35 40 56		SC	Very dense.		LL24 PL14 PI10 CL LL42 PL18 PI24 CL M/C 12% 
75	313		15 16			SM	Silty SAND, 20-25% gravel Humid, dark gray. Fine to coarse.		
80	358		17			SM	Subangular gravel, striated, occasional cobble. Dry, more gravel.		
85	262 211 242		18			SM	Less gravel.		 NP
90	388		10SS 19	38 62/24		SM	Very dense.		M/C 11% 
95	487		20			SM	Less silt, more gravel, noticeable mica.		
100									

Boring No HD83-1 Angle (from Horizontal) 90° Ground Elevation 2,246.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3231536.1 Date Started 2/4/83 Total Depth 328.0
E 746996.6 Date Completed 2/18/83 Ground-Water Elevation ---

Logged by WMB, EJK, REH, JEP, NBH/LEM

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
100	269		21			SM	Silty gravelly SAND, Damp.		
105							COBBLE/BOULDER		
110	256 336		22			SM	Less gravel, striations. More gravel.		 NP
115	370 482		23			SM	Dry		 Defective pipe abandoned hole @ 117.0
120			24			SM	Less gravel		5 1/2" - CSR, BB Redrill twice  LL17 PL15 PI2 ML M/C 4%
125			25			SM			 LL17 PL15 PI2 ML M/C 3%
130			26			SM SC	Clayey, silty SAND, 5-10% fine gravel, moist, dark grey		 LL19 PL14 PI5 ML-CL M/C 5%
135			27			SM SC	fine to coarse, occasional cobble.		 LL20 PL14 PI6 ML-CL M/C 6%
140			28			SM	Slightly less clay.		 LL18 PL16 PI2 ML M/C 3%
145			29			SM	More gravel.		 NP M/C 5%
150									

Boring No HD83-1 Angle (from Horizontal) 90° Ground Elevation 2,246.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3231536.1 Date Started 2/4/83 Total Depth 328.0
E 746996.6 Date Completed 2/18/83 Ground-Water Elevation ---

Logged by WMB, RJK, REH, JEP, NBH/LEM

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
150									
155			30						
160							COBBLE/BOULDER 158.0 - 164.0 FT.		
165			31			SM	More gravel, subangular to subrounded Laminated silt clumps.		NP M/C 3%
170			32				Less gravel.		WATER LEVEL @ 165.0 Ft. 2/16/83 M/C 3%
175							COBBLE/BOULDER		
180			33				Dry.		M/C 1%
185			34			SM	Silty SAND, 10-15% fine gravel. Dry, olive gray, fine to coarse.		M/C 1%
190			35			SM	More gravel, moist, subrounded		NP M/C 2%
195			36			SM	Silty, gravelly SAND. More gravel, subrounded. WET 191-194.0 FT.		M/C 3%
200			37			SM	Less gravel, more fine to coarse sand Laminated silt clumps?		NP

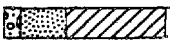
Boring No HD83-1 Angle (from Horizontal) 90° Ground Elevation 2,246.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3231536.1 Date Started 2/4/83 Total Depth 328.0
E 746996.6 Date Completed 2/18/83 Ground-Water Elevation ---

Logged by WMB, EJK, REH, JEP, NBH/LEM

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
200			38			SM	Silty SAND, 15-20% fine gravel, saturated, very dark gray, fine to coarse, subrounded to rounded gravel.		 LL18 PL16 PI2 ML M/C 13%
205									
210			39			SW SM	Well graded SAND, 20-25% fine to coarse gravel. 5-12% clayey silt. Saturated, olive gray. Fine to coarse.		 No recovery, material coming up return pipe when adding sec- tion. Plugged. Tried: CSR,OB; HAM,CI
215									
220									
225								P	
230			40			SM	Silty SAND, 10-15% coarse gravel, saturated, olive gray, fine to medium.		 PNEUMATIC PIEZOMETER @ 225.0 Ft. NP At 225 Ft., very easy drilling, just by weight of rods
235									
240									
245			41			SM SC	Clayey, silty SAND 20-25% fine to coarse gravel, wet, olive gray, fine to medium, trace coarse rounded to subrounded gravel striations and polished.		 LL20 PL16 PI4 ML-CL 2% ORGANICS
250									

Boring No HD83-1 Angle (from Horizontal) 90° Ground Elevation 2,246.2
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3231536.1 Date Started 2/4/83 Total Depth 328.0
 E 746996.6 Date Completed 2/18/83 Ground-Water Elevation ---

Logged by WMB, EJK, REH, JEP, NBH/LEM

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
250									
255									
260			42			CL	CLAY, 10-15% fine gravel, 20-25% fine to coarse sand. Damp, olive gray, trace organic.		 LL26 PL18 PI8 CL M/C 13%
265	45		43			SC	Clayey SAND, 20-25% gravel, damp, dark gray, fine to coarse, Angular to subangular gravel.		 LL31 PL17 PI14 CL M/C 9% 1% Org.
265	48		44			SC	Varved silt clumps, trace organics. Less gravel, more clay.		 M/C 18%
270	22		45			CL	CLAY, less than 5% gravel. 5-10% fine to medium sand, Moist, olive gray. Medium stiff.		 M/C 23%
275			46			CL ML	Less than 5% sand, dark grav. Laminated silt clumps.		 LL25 PL20 PI5 CL-ML M/C 21%
280			47			CL	Varved silt clumps?		 LL31 PL22 PI9 CL M/C 24%
285									
290			48			CL	Laminated silt clumps.		 LL29 PL22 PI7 CL M/C 22%
295			49			GM	BOULDER. Silty, sandy, GRAVEL Dry, olive gray.		 Hard Drilling
300			50			GM	Subrounded to fine to coarse, oxidation on surface of gravel.		

Boring No HD83-1 Angle (from Horizontal) 90° Ground Elevation 2,246.2
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3231536.1 Date Started 2/4/83 Total Depth 328.0
 E 746996.6 Date Completed 2/8/83 Ground-Water Elevation ---

Logged by WMB, EJK, REH, JEP, NBH/LEM

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
300									
305			51			GW	Sandy GRAVEL, 5-12% silt. Olive gray, fine to coarse with COBBLES, sub-rounded gravel.		CSR, TC w/ foam injection
			52			GM			
			53			GP	Less sand, fine to medium, olive brown.		
						GM			
310			54			GP	More sand, subrounded to subangular gravel.		NP
						GM			
3			55			GP	Less silt, rounded to subrounded gravel.		
315			56			GW	More sand.		
			57			SW			
320									
			58			GP	Less sand, subrounded fine gravel.		
325									No recovery of cuttings
330							T.D. = 328Ft.		
335									
340									
345									
350									

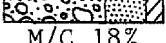
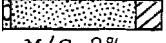
SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 2
Date 3/25/83

Boring No HD83-2 (F) Angle (from Horizontal) 90° Ground Elevation 2,147.1
 Feature Relict Channel Bearing --- Rock Elevation 2069.6
 Coordinates: N 3229506.2 Date Started 2/7/83 Total Depth 87.0
 E 746104.4 Date Completed 2/7/83 Ground-Water Elevation ---

Logged by WMB, RAW/LEM

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
							ORGANIC MATERIAL		90 - HAM, CI
5			1			SM	Silty, gravelly SAND, wet. Olive brown, fine to coarse, subangular to subrounded gravel.		 Pipe cocked at 10.5 Ft., moved hole, redrill
10			2	18 14 10		SM	Medium dense, grayish brown.		 M/C 13%
							Water @ 11.0 Ft.		LL20 PL17 PI3
15	46		3			GM	Silty sandy GRAVEL, medium dense wet, grayish brown, subrounded, fine to		 ML
			4			GP	coarse, occasional cobbles,		 M/C 18%
			5	100		GM	COBBLE.		
20	45		6			GM	Dark grayish brown.		 M/C 13%
			7	87			Silty SAND, less than 5% gravel, moist, olive brown, fine to coarse weathered rock grains, sub- angular gravel.		M/C 17%
25	45		8			SM			 NP
	46		9	50			Very weathered,		M/C 11%
30	48								M/C 12%
	43								
	45								
	72		10			SM	Few dark gray silt clumps.		 M/C 8%
35	98		11			SW	Slightly less silt, light olive brown		 M/C 6%
			12	100		SM			M/C 6%
40	53		13			SC	Some dark gray clay clumps, olive brown, damp.		 LL 34 PL23 PI11 CL
			14			SM	Less clay, light olive gray.		M/C 19%
45	76		15			SM	Olive brown.		
50	202		16			SW SM	Olive gray.		M/C 5%

SOIL BORING LOG

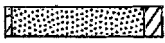
WATANA DEVELOPMENT

Sheet 2 of 2

Date 3/25/83

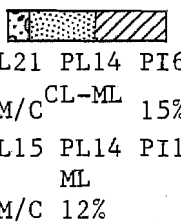
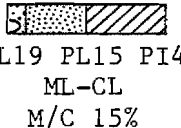
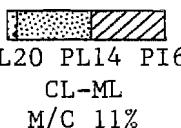
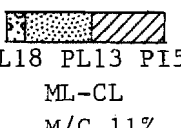
Boring No HD83-2 (F) Angle (from Horizontal) 90° Ground Elevation 2,147.1
 Feature Relict Channel Bearing --- Rock Elevation 2069.6
 Coordinates: N 3229506.2 Date Started 2/7/83 Total Depth 87.0
 E 746104.4 Date Completed 2/7/83 Ground-Water Elevation ---

Logged by WMB, RAW/LEM

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
50	150								
55	130		17			SM	Occasional gray clay/silt laminations Olive brown.		 NP
	153		18			SW SM	Olive gray.		 NP
	183		19	100					M/C 6%
60			20			SW SM	More large gravel, occasional cobble. Yellowish brown.		 NP
65									
	382		21			SM	Less gravel, olive yellow.		 NP
70	113		22			SW SM	More coarse gravel, olive gray. Becoming coarser and drier.		 NP M/C 6%
75								P	PNEUMATIC PIEZOMETER @ 75.5 Ft.
			23				TOP OF ROCK 77.5		HAM, DDH
80							No recovery		
85									
90							T.D. = 87.0 Ft.		
95									
100									

Boring No HD83-3 (L) Angle (from Horizontal) 90° Ground Elevation 2,220.0
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3231246.7 Date Started 2/7/83 Total Depth 82.5'
E 745855.1 Date Completed 2/8/83 Ground-Water Elevation ---

Logged by REH, WMB, RAW, EJK, DAF/LEM

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
5									90 - HAM, CI
10			1				Silty SAND, 20-25% gravel. Moist, olive brown.		
15	18		2			SM	Silty SAND, 10-15% gravel. Very dark gray, fine to coarse. Rounded to subrounded gravel. Occasional cobble, frozen.		
20	37		3SS	15 28 35 50	20				
25			4			ML	Slightly more clayey silt, sub-rounded to subangular gravel.		
30			5SS	50 5"	5"		Ice lenses.		
35	87		6			SM	Slightly less clayey silt, dark gray, rounded to subrounded gravel, polished and striated.		
40			7						M/C 14%
45			8SS	29 46 54 84	24	SM	Boulders/cobbles to 58.5 Ft.		
50			9						M/C 6%
									HAM, DDH at 49.75 Ft.

SOIL BORING LOG

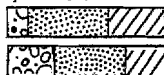
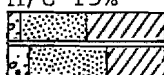
WATANA DEVELOPMENT

Sheet 2 of 2
Date 3/25/83

Boring No HD 83-3 (L) Angle (from Horizontal) 90° Ground Elevation 2,220.0
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3231246.7 Date Started 2/7/83 Total Depth 82.5'
E 745855.1 Date Completed 2/8/83 Ground-Water Elevation ---
Logged by REH, WMB, RAW, EJK, DAF/LEM

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
50									
55									
60			LOSS	52 50 3"					HAM, CI @ 58.5 Ft. M/C 12%
65	245		11				Moist.		M/C 4%
70	202		12				COBBLES/BOULDERS.		M/C 6%
75	252		13			GM	Silty, sandy GRAVEL, WITH COBBLES. Moist, dark gray, subrounded to subangular, fine to coarse.		 NP M/C 5% Refusal at 77 Ft. HAM, DDH at 77 Ft.
80									
85							T.D. = 82.5'		
90									
95									
100									

Boring No. HD 83-4 (0) Angle (from Horizontal) 90 Ground Elevation 2,246.7
Feature Relict Channel Bearing --- Rock Elevation N/A
Coordinates: N 3233160.2 Date Started 2/9/83 Total Depth 94.0
E 747719.7 Date Completed 2/9/83 Ground-Water Elevation ---
Logged by JEP, RAW LEM

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
5							Peat (?)		90 HAM, CI Easy Drilling to 20.0 Ft.
10			1SS 2	9 8 11 11	12"	SW SM	silty SAND, 10-15% gravel. Frozen, grayish brown fine to coarse. Subrounded to subangular gravel brownish gray. Contains 6" of peat in upper portion of spoon. Occasional cobble.		M/C 12%  NP.
15			3SS 4	0 3 17 37		SM SM	Olive brown, medium dense, 10-20% fine to coarse gravel subrounded, wet, dark grayish brown		M/C 15%  N.P.
20							More gravel, moist		Hard Drilling at 21.0 Ft.
25			5			SM	Boulder @ 27ft.		
30									
35	51		6			ML	Sandy SILT, less than 5% gravel, dark gray, varied silt clumps	Thermal Probe to 60.0 Ft.	LL 21 PL 18 PI 3 ML M/C 17%
40	22		7			SW SM	Gravelly SAND, 5-12% silt dark gray fine to coarse, saturated, angular to subangular gravel, occasional cobble. striations		 N.P.
45							Loose Sand.		
50			8SS	2 4 13 20			More sand.		

SOIL BORING LOG

WATANA DEVELOPMENT

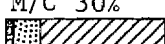
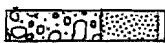
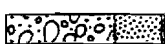
Sheet 2 of 2
Date 3/26/83

Boring No HD 83-4 (0) Angle (from Horizontal) 90 Ground Elevation 2,246.7
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3233160.2 Date Started 2/9/83 Total Depth 94.0
E 747719.7 Date Completed 2/9/83 Ground-Water Elevation ---
Logged by JEP, RAW/LEM

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
50									
55							No water @ 51 ^{ft} More gravel/cobbles		Hard Drilling at 53-55 Ft.
60	78		9			SM			 LL17 PL16 PI1 ML
65			10			SM	Silty Sand, 15-20% fine to coarse gravel dark gray, fine to coarse, subangular to subrounded gravel		LL17 PL14 PI3 ML-CL
70									
75	49		11				Varied clumps		M/C 15%
80			12			CL	Clay, 10-15% fine to coarse sand. Varied silt/clay clumps dark gray		 LL 28 PL 19 PI 9 CL M/C 15%
85			13			SC	Clayey, gravelly sand, damp brownish gray, fine to coarse subangular to subrounded gravel		
90	280		14			SM	Less clay, grayish brown.		 LL 19 PL 14 PI 5 ML-CL Hard Drilling at 91.5 Ft. REFUSAL
95							T.D. = 94.0 ft.		
100									

Boring No HD 83-5 (Q) Angle (from Horizontal) 90 Ground Elevation 2,283.7
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3234350.6 Date Started 2/10/83 Total Depth 138.0'
E 748873.3 Date Completed 2/10/83 Ground-Water Elevation ---

Logged by EJK, DAF, RAW, JEP/LEM

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
5									90 - HAM, CI
10	51		1			SM	Silty SAND, less than 5% gravel, frozen, olive brown, fine.		 G _s = 2.69
15			2			ML CL	Sandy clayey SILT, less than 5% gravel, dark gray, frozen laminations, ice lenses.		 LL22 PL16 PI5 CL-ML M/C 47%
20	22								
25	23		3			CL	Silty CLAY, 10-20% fine to medium sand, less than 5% gravel. Frozen, olive gray, clay layers 6" thick, Ice lenses Occasional cobble.		 LL31 PL20 PI11 CL M/C 75%
30	35		4 SS	11 28 17 5 13		CL ML	Gravel/Cobble layer Dark gray		LL46 PL28 PI18 CL/ML M/C 41% M/C 45%
35									
40			6			MH	Slightly laminated		G = 2.75 LL53 PL31 PI22 MH M/C 30%
45	51		7			CL			 LL31 PL21 PI10 CL
50	55		8			GW	Sandy GRAVEL, less than 5% silt, moist olive gray, rounded to subrounded, fine to coarse, occasional cobble Wet.		  M/C 6%

SOIL BORING LOG

SUMMARY LOG

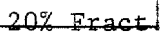
WATANA DEVELOPMENT

Sheet 2 of 3

Date 3/26/83

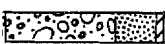
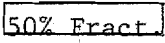
Boring No HD 83-5 (Q) Angle (from Horizontal) 90 Ground Elevation 2,283.7
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3234350.6 Date Started 2/10/83 Total Depth 138.0
 E 748873.3 Date Completed 2/10/83 Ground-Water Elevation ---

Logged by EJK, DAF, RAW, JEP/LEM

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
50	48		10			SP	Medium to coarse sand layer with gravel		 M/C 8%
55							Water @ 54.0ft to 86.0 ft		
60									
65							Flowing fine to medium sand		Easy Drilling, 61-66 Ft. lots of water
70								P	Pneumatic Piezometer @ 70 Ft.
75									At 74 Ft. water flow reduced
80			11				More gravel and cobbles, coarse sand.		 20% Fract
85	55		12						50% Fractured Out of water @ 86 Ft.
90			13			SM	Gravelly, silty SAND, damp, dark olive fine to coarse, subangular to subrounded gravel, occasional cobble		 LL18 PL16 PI2 ML M/C 9%
95	74		14			SM	More silt, dark olive gray Water 94-95.0ft to 108.5ft Cobble/boulder 96.5 to 98.5 ft		 Hard Drilling, 86.5-98.5 Ft.
100									

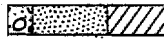
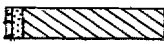
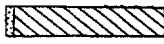
Boring No. HD 83-5(Q) Angle (from Horizontal) 90° Ground Elevation 2,283.7
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3234350.6 Date Started 2/10/83 Total Depth 138.0
 E 748873.3 Date Completed 2/10/83 Ground-Water Elevation ---

Logged by EJK, DAF, RAW, JEP/LEM

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
100			15			GM	Silty sandy GRAVEL, saturated, olive gray, subangular to subrounded, fine to coarse, with cobbles. Oxidized coating of gravel cobble/boulder 104.0 to 109.0ft		
105							End Water 108.5 ft		Hard Drilling 104-109 Ft.
110	64		16			GW	GRAVEL WITH COBBLES, 20-25% medium to coarse sand, less than 5% silt, moist olive gray, rounded to subrounded, fine to coarse.		
115							Less cobbles (?)		Hard Drilling, 111.5 Ft. more water return
120									Drilling easier @ 115.0
125	50		17			SM	Silty SAND less than 5% gravel, wet, olive gray, fine.		
							Less moisture @ 126ft		N.P.
130	145		18				GRAVEL WITH COBBLES, 20-25% silt and sand wet, olive green. Oxidized gravel @ 132ft.		
135	108		19				Yellowish brown sand and rock fragments		50% Fract. Hard Drilling, 131.5
			20						Easy Drilling, 133-134 Ft.
140							T.D. = 138.0 Ft.		
145									
150									

Boring No HD 83-6 (J) Angle (from Horizontal) 90° Ground Elevation 2,211.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3230265.7 Date Started 2/11/83 Total Depth 126.5
E 744788.6 Date Completed 2/12/83 Ground-Water Elevation ---

Logged by DAF, RAW, JEP, MPB/LEM

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
5							Frozen to 11.0 ft. no samples taken		5½Ø-HAM, CI Drive pipe blocked
10									
15	26	1				SM	Silty SAND 15-20% gravel, damp, dark grayish brown, fine to coarse, subrounded gravel, striated and polished		 M/C 11% G _s = 2.69
20		2				SM	More gravel, less sand and silt, sub-angular to subrounded gravel, damp, olive gray		Pipe cocked, move hole, redrill 
25	56	3				SM	Clayey, silty SAND, 15-20% gravel, damp olive gray, fine to coarse, rounded to subrounded gravel, striated and polished Silt clumps contain coarse sand and fine gravel		 LL17 PL14 PI3 ML
30									
35		4				CL	Varved SILT/CLAY, moist, dark gray		 LL29 PL20 PI9 CL G _s = 2.74
40									
45		5				CL ML	Dark gray clay/light gray silt, less than 10% fine sand		 LL44 PL27 PI17 CL/ML
50		6				CL	Less sand, olive gray		 LL32 PL23 PI9 CL

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3

Date 3/26/83

Boring No HD 83-6 (J) Angle (from Horizontal) 90° Ground Elevation 2,211.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3230265.7 Date Started 2/11/83 Total Depth 126.5
E 744788.6 Date Completed 2/12/83 Ground-Water Elevation ---

Logged by DAF, RAW, JEP, MPB/LEM

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
50	200			7			Gravelly, sandy-SILT, dry, olive gray Fine to coarse, subrounded to subangular gravel		 Hard Drilling
55				8		SM	More sand and gravel, brownish gray		
				9		GP GM	Sandy GRAVEL, 5-12% silt, damp, grayish brown, subrounded fine to coarse More sand, saturated WATER @ 60.0ft to 86.0 ft		
60									
65									
70	105			10		SW SM	Olive brown		
75									
80	74 20			11			More gravel subangular to subrounded, slight oxidation		
85	186 96			12		GP	Sandy GRAVEL, less than 5% silt, olive gray, saturated subrounded to subangular		
90				13			Silty sand, less than 10% gravel light olive brown, fine to medium oxidation coating.		
				14		SM	Laminated silt clumps		
95	264 90			15		SC SM	More clayey silt		 LL25 PL21 PI4 CL-ML
100									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 3 of 3
Date 3/26/83

Boring No HD 83-6 (J) Angle (from Horizontal) 90 Ground Elevation 2,211.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3230265.7 Date Started 2/11/83 Total Depth 136/5'
E 744788.6 Date Completed 2/12/83 Ground-Water Elevation ---
Logged by DAF, RAW, JEP, MPB/LEM

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
100							More gravel		
105	39 66		16			SC SM	Silty, clayey SAND, less than 5% gravel, olive yellow, fine to medium, silty/ clay/sand layers.		 LL28 PL22 PI6 CL-ML
110	76		17 SS 18	71 29		SM	Slightly more GRAVELLY, dark yellowish brown		 M/C 27%
115			19				Gravel altered/weathered to white/ yellowish brown		
120									Hard Drilling
125	321 660		20			SM	Less clay, gravel, yellow, bucy. REFUSAL @ 126.5 Ft.		 LL22 PL20 PI2 ML
130							T.D. = 126.5 Ft.		
135									
140									
145									
150									

Boring No HD 83-7 (D Acres)

Angle (from Horizontal) 90

Ground Elevation 2095.5

Feature Relict Channel

Bearing ---

Rock Elevation ---

Coordinates: N 3232100.1

Date Started 2/12/83

Total Depth 82.0'

E 743745.9

Date Completed 2/12/83

Ground-Water Elevation ---

Logged by JEP, DAF, RAW/LEM

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
5									5 1/2" - HAM, CI
10			1			SP	Poorly graded SAND, 15-20% fine gravel less than 5% silt dark olive, fine to coarse, subrounded gravel. "Loose" 9.0 to 13.0 ft.		Easy Drilling, 9-13 Ft.
15	14		2			ML	WATER @ 13.0 ft Clayey SILT, 10-15% fine sand moist, olive gray. More fine to medium sand, gravel		
20	28		3			ML	Less sand, more silt Laminated silt/clay clumps more clay, moist olive gray		
25									
30									
35			4				Laminated silt/clay, moist		M/C 31%
40									
45			5			ML CL	Laminated silt/clay, 20-25% fine sand Olive.		M/C 23%
50									

THERMAL PROBE to 82.0 Ft.

Boring No HD 83-7 (D Acres)

Angle (from Horizontal) 90°

Ground Elevation 2095.5

Feature Relict Channel

Bearing ---

Rock Elevation ---

Coordinates: N 3232100.1

Date Started 2/12/83

Total Depth 82.0'

E 743745.9

Date Completed 2/12/83

Ground-Water Elevation ---

Logged by JEP, DAF, RAW/LEM

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
50									
55			6				More varved	LACUSTRINE	M/C 24%
60									Hard Drilling @ 59 Ft.
65			7			SM	Silty SAND, no gravel, damp pale olive fine.		NP M/C 3%
70			8			GM	Sandy clayey, silty GRAVEL "Dry", olive gray, fine to coarse subrounded with cobbles		LL18 PL14 PI4 ML-CL M/C 2%
75									
80			9			SP	Less clayey silt, more fine to coarse sand, Dark olive, gray rounded to subrounded gravel	ALLUVIUM	Pipe cocked, hole abandoned.
85							T.D. = 82.0'		
90									
95									
100									

Boring No HD 83-8 (E) Angle (from Horizontal) 90 Ground Elevation 2,217.2
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3228853.6 Date Started 2/13/83 Total Depth 78.0'
E 745428.5 Date Completed 2/13/83 Ground-Water Elevation ---
Logged by JEP, MPB/LEM

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
5									5 1/2" - HAM, CI
10	20		1				Silty SAND 10-25% gravel damp, dark grayish brown, fine to coarse, Angular to subangular gravel occasional cobbles.		
	23 29		2			SM			
15	27 97		3				Humid		
20	32 45		4			SM	More gravel		 N.P.
25	93 92		5						
30	38 79		6			SM	Less gravel, grayish brown. Subrounded to subangular gravel		
35									
40	42 209		8				Gravel/cobble		Hard Drilling @ 36.5-37.0 Ft. 42.0-42.5 Ft. 45.0-47.0 Ft.
45									
50			9			SM	Gravel/cobble More silt, Olive gray		 LL15 PL14 PI1 ML

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 2

Date 3/26/83

Boring No HD 83-8 (E) Angle (from Horizontal) 90 Ground Elevation 2,217.2
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3228853.6 Date Started 2/13/83 Total Depth 78.0
 E 745428.5 Date Completed 2/13/83 Ground-Water Elevation ---
 Logged by JEP, MPB/LEM

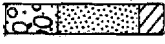
Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
50									
53	38		10			SP SM	Poorly graded SAND, 20-25% gravel. 5-12% silt, moist, dark gray. Fine to coarse, rounded to subrounded gravel.	ALLUVIUM	
55									
59	33 37		11			SM	Silty, gravelly SAND, moist very dark grayish brown, fine to coarse. Subrounded to subangular gravel. WATER @ 59.0 ft. to 61.0 ft.		
60									
64	19 39		12			SM	Silty SAND, less than 10% fine gravel, wet, dark olive gray, fine to coarse subangular to subrounded gravel.		
65									LL20 PL18 PI2 ML
67	675 770		13				Boulder/cobbles 66.0 to 72.0 ft.		Hard Drilling @ 66-72 Ft.
70									
74			14			SM	Silty SAND, less than 10% gravel "Dry" olive, fine to medium subangular - subrounded gravel. Few weath. silt clumps (oxidized)	OUTWASH	
75									
78			15				Weathered/altered rock fragments		
			16				REFUSAL @ 78.0 ft.		
80							T. D. = 78.0 Ft.		
85									
90									
95									
100									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3
Date 3/26/83

Boring No. HD83-9 (M) Angle (from Horizontal) 90° Ground Elevation 2,237.6
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N 3231621.8 Date Started 2/13/83 Total Depth 110.0'
 E 746381.5 Date Completed 2/13/83 Ground-Water Elevation ---
 Logged by JEP, REH/LEM

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
5			1				Silty, gravelly SAND, grayish brown, fine to coarse subangular to subrounded gravel.	THERMAL PROBE to 110.0 Ft.	5½Ø - HAM, CI
10			2			SM			
15			3						
20	60		4			SM			
25	125		5						
30	110		6			SM			
35	215		7						
40	400		8			SM	Silty SAND, 15-20% gravel. "Dry", olive, fine to coarse, rounded to subrounded gravel, few silt clumps.		Hard Drilling @ 39 Ft.  NP
45			9			SM			20-25% gravel, dark olive gray.  LL16 PL14 PI2 ML
50									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/26/83

Boring No HD83-9 (M) Angle (from Horizontal) 90° Ground Elevation 2,237.6
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3231621.8 Date Started 2/13/83 Total Depth 110.0'
E 746381.5 Date Completed 2/13/83 Ground-Water Elevation ---
Logged by JEP, REH/LEM

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
50									
55	102		10			SM	More gravel, Silty, gravelly SAND, "Dry" dark olive gray, fine to coarse, subangular gravel, occasional cobble.		LL16 PL14 PI2 ML
60	140		11						
65	115		12			SM	Less silt		
70	160		13						
75	150		14			SM	Slightly more silt, dark gray.		NP
80	300		15						
85	400		16			SM	Subangular to subrounded gravel.		
90	130		17						
95	250		18				More gravel.		
100	500		19			SM	Less gravel, more silt.		LL18 PL15 PI3 ML

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 3 of 3
Date 3/26/83

Boring No HD83-9 (M) Angle (from Horizontal) 90° Ground Elevation 2,237.6
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3231621.8 Date Started 2/13/83 Total Depth 110.0'
E 746381.5 Date Completed 2/13/83 Ground-Water Elevation ---
Logged by JEP, REH/LEM

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
100	150		20				Slightly more gravel.		
105			21			SC	Less gravel, more clay.		 LL23 PL15 PI8 CL
110							Boulder (?)		
115							T.D. = 110.0 Ft.		

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 1

Date 3/31/83

Boring No HD83-49 (K) Angle (from Horizontal) 90° Ground Elevation 2,207.2
 Feature Relict Channel Bearing --- Rock Elevation N/A
 Coordinates: N 3230708.3 Date Started 3/20/83 Total Depth 38.0
 E 745271.5 Date Completed 3/20/83 Ground-Water Elevation ---

Logged by - JEP, REH/LEM

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
5			1			GM	Silty, Sandy GRAVEL, Medium dense, humid, olive gray, light gray silt and clay clumps, fine to coarse, with trace organic matter.		5 1/2" - HAM, CI
8	28								
10	28		2SS	54	18"	GM	Frozen (CL-ML)		LL23 PL19 PI4 (CL-ML)
13			3	17			Dark grayish brown, subrounded to subangular.		
15			4			GP GM	More gravel, 5-12% silt, dark olive gray.		
18	41								
20	6		5SS	28	15"				
22	13			39					
25	28		6	41		CL	CLAY, 20% fine sand, hard, humid, dark olive gray.		LL34 PL20 PI14
28							Proportions of clay and silt vary slightly.		
30	27		7						
32	27								
34	30		8SS	9	18'	ML	Occasional lens of fine sandy silt, wet.		LL22 PL19 PI3 M/C 31
36	40			42			SILT - moist to wet.		
38	33		9	115					
40	89		10			CL	Less than 15% sand.		LL32 PL22 PI10
42									
44									
46									
48									
50							T.D. = 38.0 Ft.		

THERMAL PROBE to 38.0 Ft.

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 3
Date 3/31/83

Boring No HD 83-50 (P) Angle (from Horizontal) 90 Ground Elevation 2,290.8
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3233761.2 Date Started 3/20/83 Total Depth 119.5
E 748255.0 Date Completed 3/21/83 Ground-Water Elevation ---
Logged by JEP, REH, WMB, JFB/LEM

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
5	59 37		1			SM	Silty SAND, less than 15% gravel medium dense (frozen), humid dark grayish brown, fine to coarse with occasional yellowish brown silt clumps.		 NP $G_s = 2.70$
	28 40		2						5 1/2" - HAM, CI
10	37 48		3						
15	35 39		4			SM	Silty clumps with fine gravel varved silt clumps 40% fine to coarse subangular to subrounded gravel - dark olive gray. Occasional thin clay seams		 M/C 16%
20			5 SS	16 32 34	18"				
25	25		6			SC	Clayey SAND, less than 15% gravel medium dense, moist, dark olive gray, fine to coarse		 LL24 PL16 PI8
30	60 69		7			SM SC	Gravelly, silty, clayey SAND, Dense, moist, dark olive gray, fine to coarse, silty clay clumps with fine gravel		 LL20 PL15 PI5
35			8			SM SC	Very dark gray		 Hard Drilling @ 33.5 Ft.
40	120 240		9			SM SC	Dark gray Cobbles and boulders to 52.0 ft.		 LL20 PL16 PI4 $G_s = 2.70$ Very hard Drilling
45			10						
50			11			SC	Slightly more clay. Very dark gray		 At 48-52 Ft HAM, DDH

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 3
Date 3/31/83

Boring No HD 83-50 (P) Angle (from Horizontal) 90 Ground Elevation 2290.8
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3233761.2 Date Started 3/20/83 Total Depth 119.5
E 748255.0 Date Completed 3/21/83 Ground-Water Elevation ---
Logged by JEP, REH, WMB, JFB/LEM

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
50									
55	380	12					Gravelly, silty, clayey SAND, dense to very dense, humid, very dark gray, fine to coarse subrounded to subangular gravel silt/clay clumps with fine gravel with occasional cobbles.		At 52 Ft., HAM, CI
	116	13				SM SC	Moist		LL18 PL14 PI4
60									
	111	14							
65	93								
	148	15							
70	185								
		16				SM SC	Slightly more gravel.		LL18 PL14 PI4 G _s = 2.72
75									
	117 172	17				SM SC	Dark olive gray		LL20 PL15 PI5
80		18	SS 48 100		5" 3"				
	196	19							
85									
	200 200	20				SC	Slightly more clay		LL25 PL15 PI10 G _s 2.70
90		21	SS 100		4"				
	200	22					More silt		
95	171								
	200 200	23				SM			LL20 PL17 PI3
100									

Boring No HD 83-50 (P) Angle (from Horizontal) 90 Ground Elevation 2290.8
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N 3233761.2 Date Started 3/20/83 Total Depth 119.5
E 748255.0 Date Completed 3/21/83 Ground-Water Elevation ---
Logged by JEP, REH, WMB, JFB/LEM

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
100	198		24				Gravelly, silty SAND, WITH COBBLES very dense, moist, dark olive gray, fine to coarse, subrounded to subangular gravel		
105	200		25			SM	Slightly more clay		 LL20 PL19 PI1 M/C 8%
110	156		27			GC	Clayey, sandy gravel, very dense, humid olive gray, fine to coarse, rounded to subrounded		 LL23 PL16 PI7
115	300		28			SC SM	Silty, clayey sand, 20-25% gravel, humid dark olive gray, fine to coarse, sub- angular to subrounded gravel, silt-clay clumps with fine gravel		 M/C 7%
120							BOULDER @ 119.5 T.D. = 119.5 Ft.		Refusal
125									

Boring No HD83-51 (N) Angle (from Horizontal) 90° Ground Elevation 2,236.7
Feature Relict Channel Bearing --- Rock Elevation N/A
Coordinates: N 3232725.0 Date Started 3/21/83 Total Depth 98.5 Ft.
E 747293.4 Date Completed 3/22/83 Ground-Water Elevation ---

Logged by JEP/RLJ, WMB/JFB, LEM

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
5	20 18 18 28 26		1				Gravelly SAND, 5-12% silt, medium dense, frozen to 8.0, olive brown, subrounded to subangular gravel, fine to coarse. Trace of organic material to 8.0'.		5' - HAM, CI Poor recovery, 0-9 Ft.
10	33 32		2				Occasional cobble.		3% ORGANIC
15	45		3SS	45 50 40		SP SM	Laminations 5' to 8' Humid.		
20	70		5SS	70 30/3"	6"	SM	Silty SAND, 20-25% gravel. Very dense, humid, olive brown, fine to coarse. Few small varved silt/clay clumps.		M/C-9%
25	300 500		6 7 8	100		SM	Subangular to subrounded gravel. More gravel, olive moist.		M/C 11%
30	44 63 67 71		9SS	45 57/4"	10"	SM	Occasional cobble. More silt, less than 10% gravel. Olive brown.		NP
35	75		11				Clayey/silty SAND, Dense, humid, dark olive gray, fine to medium. Trace rounded to subrounded fine gravel.		M/C 9%
40	70 200 300 200 300		12SS	60	12"	SM SC	Moist. Note: Slight variations in clay/silt proportions change classification.		NP
45	284		13	60	12"	SM SC	Wet.		M/C 15%
50			14SS	62 80		SM SC	15-20% gravel, olive gray clay/silt clumps with fine gravel. Occasional cobble.		LL18 PL14 PI4
			15			SC	Humid.		MODIFIED PROCTOR Y MAX = 136 Bsf MC 8PT
			16						LL21 PL13 PI9
			17SS	100/4"	4"				M/C 5%

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 2
Date 3/31/83

Boring No HD83-51 (N) Angle (from Horizontal) 90° Ground Elevation 2236.7
Feature Relict Channel Bearing --- Rock Elevation N/A
Coordinates: N 3232725.0 Date Started 3/21/83 Total Depth 98.5 FT.
E 747293.4 Date Completed 3/22/83 Ground-Water Elevation ---

Logged by JEP/RLJ, WMB/JFB, LEM

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
50			18			SM SC	Clayey/silty SAND, 10-15% gravel, humid, olive gray; fine to coarse, occasional cobble.		LL18 PL14 PI4 (ML-CL)
55			19SS	100	6"		Very dense, wet.		M/C 15%
	117 116		20						
60			21SS	100	6"				LL19 PL16 PI3 ML M/C 7%
	62								Hard Drilling @ 59.5 Ft.
65			23	22		SM	Silty SAND, less than 10% gravel.		HAM-DDH
			24SS	79	11"		Very dense, wet, olive gray. 60% fine sand.		
	43		25			SM			NP M/C 10%
70									
	36		26			SM			NP
75									
	45								
	196		27			SC	Clayey SAND, 15-20% gravel, very dense, moist to wet, dark olive gray, fine to coarse, occasional cobble.		LL25 PL16 PI9 CL
80			28SS	100/2"	2"		Clay/silt clumps with fine gravel.		M/C 14%
	200		29						
	105								
85			30SS	67/100	8.5"				M/C 17%
	117		31						
			32SS	100	5.5"				M/C 20%
90									
	76		33			SM SC	Slightly more silt.		LL21 PL16 PI5 CL-ML
95			34SS	45/48					M/C 16%
	189		35			CL	CLAY, with 20-25% fine to coarse sand Less than 5% gravel Hard, moist, very dark gray. T.D. = 98.5 Ft.		LL33 PL18 PI15
100									

Boring No HD 83-52 (D) Angle (from Horizontal) 90 Ground Elevation 2251.4
Feature Relict Channel Bearing --- Rock Elevation 1931.4
Coordinates: N 3231835.6 Date Started 3/22/83 Total Depth 333
E 747266.9 Date Completed 3/26/83 Ground-Water Elevation ---

Logged by WMB, JFB, JEP, RLJ, MPB/LEM, DAF

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
5			1			SP SM	Gravelly SAND, 5-12% silt, damp, dark grayish brown, fine to coarse, subangular to subrounded gravel limonite stain around gravel, occasional cobble.		5-10-HAM, CI
10			2 SS	29 24 29	13"	SM	(Silty SAND, 5-10% gravel, olive) very dense.		M/C 5%
			3			SM	Silty, gravelly SAND, dark grayish brown, Humid, fine to coarse		N.P.
15			4 SS	50/9 55/6	9"	SM	(Silty SAND, 20-25% gravel, olive) very dense		M/C 6%
			5			SM			NP
20			6 SS	70 47	12"	SM	(Silty SAND, 20-25% gravel, olive)		M/C 7%
			7			GP GM	Humid Sandy GRAVEL, 5-12% silt. WATER @ 22' Olive gray. (Wet)		M/C 8% =
25			8 SS	100/5	4"				
			9			SM SC	Clayey/silty, gravelly SAND WITH COBBLES, Humid		
30			10 SS	100/4	4"		BOULDERS @ 25' - 27'		
35			12 SS	70 100/5	11"	SM SM	Gravelly, silty SAND WITH COBBLES, very dark gray, fine to coarse		M/C 8%
			13				Humid		
40			14			SM			LL16 PL14 PI2
45			15 SS	60 100	12"		Very dense		M/C 8%
			16				Damp		
50			17 SS	100	4"		Gravel and cobbles		M/C 4%

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 8

Date 4/1/83

Boring No HD 83-52 (D) Angle (from Horizontal) 90 Ground Elevation 2251.4
 Feature Relict Channel Bearing --- Rock Elevation 1931.4
 Coordinates: N 3231835.6 Date Started 3/22/83 Total Depth 333
 E 7471266.9 Date Completed 3/26/83 Ground-Water Elevation ---

Logged by WMB, JFB, JEP, RLJ, MPB/LEM, DAF

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
50	120								
150			18			SM	Gravelly, silty SAND WITH COBBLES, humid dark olive gray, fine to coarse, sub-angular to subrounded gravel.		
180									
200									
55	95		19SS	100	5"				
60	60		20						
60			21SS	25 75 85					
			22			SM SC	Wet More clay, very dark gray		M/C 9%
65			23SS	65 70 100	12"		Moist, very dense.		
	180		24			SM	Boulder 66' to 68'		
	300		25SS	100	2"		Fine argillite gravel striated.		
70	100		26						
	110								
	245								
75			27SS	100	1 1/2"				
	90		28				Humid		V. Hard Drilling, 79.5-80 Ft. HAM-DDH HAM, CI
80	100								
	130								
	250		29						
85			30			SC	Clayey SAND, 20-25% gravel, moist, very dark gray, fine to coarse		
			31				Gravelly, silty SAND with cobbles, moist very dark gray, fine to coarse sub-rounded to subangular gravel.		
90			32SS	100	5" 1"				
			33				Boulder @ 91		
95			34						
			35SS	88 100	4"				
100									

Boring No HD83-52 (D) Angle (from Horizontal) 90° Ground Elevation 2251.4
Feature Relict Channel Bearing --- Rock Elevation 1931.4
Coordinates: N 3231835.6 Date Started 3/22/83 Total Depth 333
E 7471266.9 Date Completed 3/26/83 Ground-Water Elevation ---

Logged by WMB, JFB, JEP, RLJ, MPB/LEM, DAF

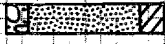
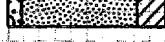
Depth (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
100	200								
105	200		36			SM	Silty, gravelly SAND with cobbles, dark gray, fine to coarse, sub-rounded to subangular striated gravel.		NP
110	153		37						
115	200		38SS	100/3"	0				
	200		39						
	200								
120			40			SM SC	Clayey, silty, gravelly SAND. Very dark gray, fine to coarse.		
			41			SM	Boulder @ 118-123'		
125	200		42				Clayey SAND WITH COBBLES AND BOULDERS, 5-10% gravel. Hard, wet, very dark gray, fine to coarse.		Moved hole, re-drill. Bit broken @ 120.5 Ft. HAM, CI
	200		43SS	40/100/4.5"	10.5"	SC			
130	200		44			SM	Less clay, moist.		LL31 PL17 PI14 CL M/C 9% NP
135	200		45						
	200		46				Wet.		LL34 PL17 PI17 CL M/C 8%
140	200		47			SC	More clay and fine to coarse gravel		LL26 PL14 PI12
	200						Moist.		
145							BOULDER @145'		
150									HAM, DDH CSR, BB

SOIL BORING LOG

WATANA DEVELOPMENT

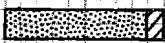
Sheet 4 of 8
Date 4/1/83

Boring No HD83-52 (D) Angle (from Horizontal) 90° Ground Elevation 2251.4
Feature Relict Channel Bearing --- Rock Elevation 1931.4
Coordinates: N 3231835.6 Date Started 3/22/83 Total Depth 333
E 7471266.9 Date Completed 3/26/83 Ground-Water Elevation ---
Logged by WMB, JFB, JEP, RLJ, MPB/LEM, DAF

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
150			48			SM	Less clay, Dark olive grey.		 NP
155			51			SM	Very dark grey		 NP
160			52						
165			53			SM	Dark Olive grey		 NP
170			54						
175			55			SM	Cobble Layer 171-173'		Hard Drilling, 177-178.5 Ft.
180			56			SW SM	Less silt		 NP G _s = 2.81
185			57			SM			 NP LL17 PL14 PI3 G _s = 2.77
190			58			CL ML	Sandy, silty CLAY, 15-20% gravel Moist, olive grey, fine to coarse sand.		 NP HAM, CI  NP LL23 PL17 PI6 G _s = 2.82 CL-ML
195			59						
200				100/0.05'	0				

Boring No HD83-52 (D) Angle (from Horizontal) 90° Ground Elevation 2251.4
Feature Relict Channel Bearing --- Rock Elevation 1931.4
Coordinates: N 3231835.6 Date Started 3/22/83 Total Depth 333
E 7471266.9 Date Completed 3/26/83 Ground-Water Elevation ---

Logged by WMB, JEB, JEP, RLJ, MPB/LEM, DAF

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
200									
			60			CL	CLAY 20-25% fine sand, wet, dark olive gray.		 LL29 PL19 PI10 CL
205	76								
	200		61			SM SC	More medium to coarse sand, olive gray. WATER @ 206.5'		Hard Drilling  LL22 PL18 PI4 CL - ML
	400								
210			62SS	100/5.5"			(silty SAND, olive), wet.		M/C 13%
							SAND, 5-12% silt, 15-20% gravel. Saturated, olive gray, fine to coarse.		
215			63			SW SM			 NP
			64			SP SM	No gravel, moist, dark olive gray.		
220	39		65SS	64/100/4"	8"	SM	Silty, fine sand. Olive gray, very dense.		
	55		66						
225			67			SM	10-15% fine gravel.		 NP
	69		68SS	66/100/4"	10"	SM	Very dense.		 M/C 21%
230	55								
	126		69			SM	Medium to fine sand, olive moist.		
235	52		70						
	57		71	100/3.5"			Very dense.		M/C 6%
240	78			4"					
	98		72			SM	Silty, gravelly SAND, very dense. Moist, olive, fine to coarse. Sub-rounded gravel, occasional laminated silt clumps. Oxidized surface on gravel.		
245	114		73						
	200								
	200								
250			74SS	100/1.5"			More gravel.		

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 6 of 8
Date 4/1/83

Boring No HD83-52 (D) Angle (from Horizontal) 90° Ground Elevation 2251.4
Feature Relict Channel Bearing --- Rock Elevation 1931.4
Coordinates: N 3231835.6 Date Started 3/22/83 Total Depth 333
E 7471266.9 Date Completed 3/26/83 Ground-Water Elevation ---
Logged by WMB, JFB, JEP, RLJ, MPB/LEM, DAF

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
250	350		75						
	650		Cont.			SM	Less gravel, humid.		
	225								
	60								
255	60								
	80								
	100		76						
	75								
			77SS	100/1"	0				
260						SM	COBBLE @ 258.5. Laminated silt clumps. Damp.		 NP
	300		78						
	120								
	160		79						
265									
	225								
	175								
	300								
			80SS	100/2"					
270	285		81			SM	COBBLE @ 268.0 Humid.		 NP
	135								
	150								
	150								
	180								
275	150								Hard Drilling 275 Ft.
	600		82						
	150								
	225								
	600		83SS	100/6"	3"				Hard Drilling, 278.5 Ft.
280	130		84			SM	COBBLE @ 278.5		 G = 2.74 V. Hard Drilling 282-283 Ft.
	350								
	180								
	1000								
							GRAVEL & COBBLE LAYER		
285	130		85						
	100								
	120								
	170		86			SP SM	Less silt, gravel striated.		 NP
	380								
290	300		87						
	225								
	300								
	400								
	220								
295	525								
	350		88			SP SM	Gravelly SAND, 5-12% silt, humid. Olive gray, fine to coarse. Gravel subrounded to subangular, smooth, slightly striated.		
	50								
			89SS	100/2"	2"				
300	110		90						

Boring No HD83-52 (D) Angle (from Horizontal) 90° Ground Elevation 2251.4
 Feature Relict Channel Bearing --- Rock Elevation 1931.4
 Coordinates: N 3231835.6 Date Started 3/22/83 Overburden Thickness 320.0
 E 7471266.9 Date Completed 3/26/83 Ground-Water Elevation ---
 Core Sizes NX Total Depth 333 Logged by WMB, JFB, JEP, RLI, MPB/
LEM, DAF

Depth (Elevation)	Graphic Log			Classification and Physical Description	C.R. Graphic	C.R./QD %	Box Number	Instrumentation	Remarks
	Lithology	Structure	Fracture Log 3 6 9 12						
320				TOP OF ROCK 320. Ft.					
70°				Diorite Medium grey, med. Xyln.					
65°				massive, Composed predom.					
60°				mantly of plagio. and horn-					
0°				blde. w/ some biotite & chlor					
325				Fresh modt. slightly fractrd.					
60°				max piece 1.5', min. piece					
				0.2'. Mostly 0.4-0.8'. Hard					
50°				and strong. Fresh to v. sl.					
330	Fe			weath. Jt. surfcs w/sl Fe					
5°				stain ocassionally. Coatings					
30°				also chlorite and CaCo ₃ .					
333				Rough jt surfaces					
55°				T.D. 333.0 Ft.					
0°									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 1 of 5
Date 4/1/83

Boring No HD83-53(A) Angle (from Horizontal) 90° Ground Elevation 2248.0
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N --- Date Started 3/28/83 Total Depth 212.0
 E --- Date Completed 4/8/83 Ground-Water Elevation ---

Logged by WMB, JFB, RLJ, MPB, JEP/LEM

Depth O (Elevation)	Rig Blow Count	Sample Interval	Sample No. and Type	Blow Count per 0.5 ft.	Length Recovered	Graphic Log	Soil Description	Instrumentation	Remarks
5									70 - CSR, PC, TW
10						SM	Silty SAND, 10-15% fine gravel. Damp, olive, fine to coarse, subrounded to subangular gravel.		 Lots of blow by
15									
20									
25			1			SM	Silty SAND, 15-20% fine gravel, damp, olive, fine to coarse, subrounded to subangular gravel, silt/sand clumps, occasional cobble.		LL16 PL16 PI10 ML At 25.5 Ft., hole blocked, use tricone
30	23		2SS	43 21	3"				90 - HAM, CI
35	90 160 120 75			31		SC SM	Gravelly, silty, clayey SAND, very dense, moist, olive gray, fine to coarse, subangular gravel, laminations, silt/clay clumps with gravel. Gravel polished and striated.		 LL22 PL16 PI6 CL-ML G _s =2.72
40	110 175 170		4	20 40 50	18"	SC GC	Less silt, dark olive gray. Less sand, more fine to coarse gravel.		 LL75 PL15 PI10CL  LL36 PL17 PI19 CL M/C 13%
45	210								
50	210 230 220		6			SC SM	Less gravel, more sand.		 LL20 PL14 PI6 CL-ML G _s =2.71

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 2 of 5

Date 4/1/83

Boring No HD83-53(A) Angle (from Horizontal) 90° Ground Elevation 2248.0
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N --- Date Started 3/28/83 Total Depth 212.0
 E --- Date Completed 4/8/83 Ground-Water Elevation ---

Logged by WMB, JFB, RLJ, MPB, JEP/LEM

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
50	220								
	275								
	275								
55	320						COBBLE/BOULDER 55.0 to 57.0 Ft.		
	520								
			7						
60	400					GC	More gravel and cobbles.		LL24 PL15 PI9 CL
			8						
65									
			9						
70									
			10			SC	Clayey, gravelly SAND, "Dry", very dense, very dark gray. Fine to coarse, subangular to subrounded gravel.		LL21 PL13 PI8 CL
75							Clay clumps with coarse sand and fine gravel.		
			11				Occasional cobble.		
80									
			12			SC	Less gravel.		LL19 PL11 PI8 CL
85									
			13						
90									
			14			SC	More gravel.		LL22 PL14 PI8 CL
95									
			15						
100									

Boring No HD83-53(A) Angle (from Horizontal) 90° Ground Elevation 2248.0
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N --- Date Started 3/28/83 Total Depth 212.0
E --- Date Completed 4/8/83 Ground-Water Elevation ---
Logged by WMB, JFB, RLJ, MPB, JEP/LEM

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
100			16			GC	Less sand, more clay.		 LL22 PL14 PI8 CL
105			17						
110			18			GC	Less sand.		 LL25 PL16 PI9 CL
115			19						
120			20			SM SC	Less gravel, more sand.		 LL20 PL15 PI5 CL-ML
125			21						
130	315 410		22			SM SC	More gravel, less sand COBBLE/BOULDER 132.0-135.0 FT		Difficulty in lifting cuttings  LL19 PL14 PI5 ML-CL
135	500 600								Started w/water injection
140			23				Large cobbles.		
145	90 305 380 20 95		24			GW	Sandy GRAVEL WITH COBBLES, less than 5% silt, dark gray. Fine to coarse, subrounded to subangular.		Refusal @ 149.5 Ft.  LL20 PL15 PI5 ML-CL G _s = 2.69
150									

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 4 of 5

Date 4/14/83

Boring No HD83-53 (A) Angle (from Horizontal) 90° Ground Elevation 2248.0
 Feature Relict Channel Bearing --- Rock Elevation ---
 Coordinates: N --- Date Started 3/28/83 Total Depth 212.0
 E --- Date Completed 4/8/83 Ground-Water Elevation ---

Logged by WMB, IFB, RLJ, MPB, JEP/LEM

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
150							BOULDER @ 149.0 FT.		HAM, DDH, -
155									CSR, HC, TW Poor sample re- covery, blocked?
160			25						HAM, DDH
165									Pipe clogged, pulled pipe
170							WATER @ 169.0 FT. to 197.0 FT.		CSR, HC, TW foam injection, material coring up outside of casing.
175									Inner tube plugged.
180									
185									
190									
195			26				Sandy SILT with thin layers of fine gravel, wet to 197.0 FT. Olive gray.		
200									

HARZA-EBASCO

SUSITNA JOINT VENTURE

SOIL BORING LOG

WATANA DEVELOPMENT

Sheet 5 of 5
Date 4/18/83

Boring No HD83-53 (A) Angle (from Horizontal) 90° Ground Elevation 2248.0
Feature Relict Channel Bearing --- Rock Elevation ---
Coordinates: N --- Date Started 3/28/83 Total Depth 212.0
E --- Date Completed 4/8/83 Ground-Water Elevation ---

Logged by WMB, JFB, RLJ, MPR, JEP/LEM

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
200									
205			27				Gravel and cobbles.		
210									Excessive skin friction on ro- tating drill pipe stopped penetra- tion.
							T.D. = 212.0 ft.		
215									
220									
225									
230									
235									
240									
245									
250									

APPENDIX D — LABORATORY TESTING

1. PROCEDURES

- 1.1 Sample and Control Processing
- 1.2 Particle Size Analysis
- 1.3 Atterberg Limits
- 1.4 Moisture Contents
- 1.5 Organic Content
- 1.6 Specific Gravity
- 1.7 Compaction Tests
- 1.8 Visual Classification

2. LAB TEST SUMMARIES

- 2.1 River Channel
- 2.2 Relict Channel

3. GRADATION CURVES

- 3.1 River Channel
 - 3.1.1 Main Dam
 - 3.1.2 Upstream Cofferdam
 - 3.1.3 Downstream Cofferdam
 - 3.1.4 Portals
- 3.2 Relict Channel

APPENDIX D

LABORATORY TESTING

As part of the Winter 1983 Field Drilling Program, Harza-Ebasco established and operated a field soils laboratory at the Watana site. Routine index property and classification tests were performed on soil samples taken during the Drilling Exploration Program.

Soil index tests were performed to classify soils and determine their grain size distributions, plasticity indices, in-situ moisture contents, organic contents, specific gravity, and compaction characteristics. Also, visual descriptions of soils were made.

The procedures employed in the laboratory testing program were generally in accordance with those suggested by the American Society of Testing and Materials (ASTM). When deviations from ASTM recommended procedures were made, they were noted on the test forms. The specific test procedures and variations from ASTM methods are discussed in the following sections:

1. PROCEDURES

1.1 Sample and Control Processing

Samples collected during each shift of drilling were inventoried and recorded on the sample test schedule and inventory forms. The selected soil samples were then prepared for testing. Preparation of samples required splitting with a mechanical splitter to obtain representative portions for testing. Visual classifications were performed and the

results were recorded on the appropriate sheets thus starting the documentation cycle.

The untested portions of those samples used, and the samples not tested, were transferred to the storage cage for future use, as necessary. An accurate record of the stored samples with precise locations was kept to facilitate relocating samples for either further testing or visual examinations. Upon completion of each test, the tested portion of samples were passed through a 3/4-inch sieve to separate selected materials finer than 3/4-inch sieve. This material was used for back-filling of drill holes.

1.2 Particle Size Analyses

Gradation analysis (sieve and hydrometer tests) was performed on selected soil samples, based on ASTM D422-63 test procedures. All bulk samples collected from the Hammer Drill Cyclone used for sieve analysis met the minimum ASTM weight requirements. However, the majority of soil samples obtained with split-spoon sampler were usually smaller than this minimum weight. Whenever a smaller than ASTM recommended weight sample was used for testing, it was noted on the test data sheet.

Because the hammer drill uses a diesel pile-driver hammer to penetrate the soil, thus breaking boulders, cobbles and gravel into smaller pieces as the hole is advanced, the soil samples obtained have a high percentage of mechanically fractured materials. This percentage of fractured soils retained on the 3/4" sieve were recorded on the test data sheet so that the effect of this fractured material on the grain size distribution could be accounted for.

1.3 Atterberg Limits (Liquid and Plastic Limits)

The classification of samples containing fine grained soils was determined by performing Atterberg Limit Tests. The liquid and plastic limits were determined in accordance with ASTM D423-66 and D424-59 test procedures, respectively.

The soil samples tested for plasticity indices were prepared utilizing two different methods, dry or wet method. ASTM recommends "dry preparation of soil samples for grain-size analysis and determination of soil constants" (ASTM D421-58). In this method of sample preparation, the soil sample was air-dried and then sieved through a No. 40 screen to obtain the minus #40 sample fraction for Atterberg Limit Indices Testings.

In the wet method of preparation, the soil sample was first soaked in water for 12 hours and then washed through a No. 40 sieve. Both methods of sample preparation have been used at the Watana Site. The wet method was normally used for soil samples with large clay and silt clumps which could not be easily processed using the dry method.

1.4 Moisture Content

Moisture content tests were performed in accordance with the ASTM D2216-71 test procedure to evaluate the water content of the soils encountered.

Moisture contents were determined for most soil samples obtained with split-spoon samplers, and on those bulk samples which were secured in plastic bags. No moisture content tests were performed on bulk samples kept in cloth bags.

1.5 Organic Content

The organic contents of selected samples were determined by the "standard method of testing for organic content of soils" (State of Alaska, 1980), also known as the organic ignition test. The samples tested were oven-dried for 24 hours at a temperature of 105°C and the dry weight recorded. The samples were then weighed to the nearest 0.01 gram and placed in a tared crucible. The crucible containing the sample was then placed in a muffle furnace at a temperature of 950°C $\pm$ 50°C until all organic matter was combusted, usually about two hours. The samples, were then cooled to room temperature, weighed, and the percent of weight loss calculated and presented as the amount of organic materials.

1.6 Specific Gravity

Selected samples were tested to determine the specific gravity, G_s , of their soil constituents. Specific gravity tests were periodically performed to establish a representative range. The ASTM D854-58 test method was used for conducting specific gravity determinations.

1.7 Compaction Tests

A limited quantity of standard and modified proctor tests were performed to establish typical compaction characteristics of selected samples from the relict channel/borrow area. ASTM D698 and D1557-78 test procedures were used for the standard and modified proctor tests, respectively.

1.8 Visual Classification

Visual procedures, based on ASTM D2488-69 test method, were performed on the majority of soil samples to assist with the soil classifications. Visual descriptions of soils such as color, dry strength, toughness, dilatancy and roundness were recorded on each test data sheet.

A summary of the results of laboratory testing performed during the river channel and relict channel testing program are presented in the lab test summary sheets which follow. Interpretation of the laboratory gradation data is presented in a set of curves at the back of this appendix.

2. LAB TEST SUMMARIES

2.1 RIVER CHANNEL

BORING NO.

HD83-10

SAMPLE 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 (%)	
1	BULK	4-5	GM	N/A	46.2	39.7	14.1	-	-	-	-	-	
2	BULK	8-10	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	14-15	GP-GM	N/A	61.9	30.0	8.1	-	-	-	-	-	
4	BULK	20-22	GP-GM	N/A	59.2	33.2	7.6	-	-	-	-	-	
5	BULK	23-27	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	30-31	SM	N/A	35.1	48.9	16.0	-	-	-	-	-	
7	BULK	34-36	GW	N/A	58.2	38.3	3.5	-	-	-	-	-	
8	BULK	40-42	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	46-48	GW-GM	N/A	72.7	21.2	6.1	-	-	-	-	-	
10	BULK	50-52	GP-GM	N/A	56.7	37.0	6.3	-	-	-	-	-	
11	BULK	55-57	GW-GM	N/A	57.0	37.2	5.8	-	-	-	-	-	
12	BULK	60-65	GW	N/A	60.6	35.8	3.6	-	-	-	-	-	
13	BULK	65-70	-	N/A	-	-	-	-	-	-	-	-	
14	BULK	70-75	GW-GM	N/A	61.6	31.0	7.4	-	-	-	-	-	
15	BULK	75-80	GP-GM	N/A	56.1	33.3	10.6	-	-	-	-	-	
16	BULK	80-85	GW-GM	N/A	45.8	45.3	8.8	-	-	-	-	-	
17	BULK	85-90	-	N/A	-	-	-	-	-	-	-	-	
18	BULK	90-95	GP-GM	N/A	70.7	20.1	9.2	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-10

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-11

SAMPLE 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 (%)	
1	BULK	10-15	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	15-18	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	20-25	GW-GM	N/A	60.1	31.1	8.8	-	-	-	-	-	
4	BULK	25-30	SP-SM	N/A	30.1	62.1	7.8	-	-	-	-	-	
5	BULK	32-35	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	35-40	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	40-43	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	51-55	GP-GM	N/A	64.7	28.8	6.5	-	-	-	-	-	
9	BULK	55-60	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-11

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-12

SAMPLE 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 (%)	
1	BULK	10-15	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	15-20	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	20-25	GP-GM	N/A	54.5	37.0	8.5	-	-	-	-	-	
4	BULK	25-30	GP-GM	N/A	70.4	22.9	6.7	-	-	-	-	-	
5	BULK	30-35	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	35-40	GW-GM	N/A	51.0	41.9	7.1	-	-	-	-	-	
7	BULK	40-45	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	45-50	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	50-55	-	N/A	-	-	-	-	-	-	-	-	
10	BULK	55-60	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	65-70	-	N/A	-	-	-	-	-	-	-	-	
12	BULK	70-73	GP-GM	N/A	56.9	33.8	9.3	-	-	-	-	-	
13	BULK	75-76	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-12

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-13

SAMPLE 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 (%)	
1	BULK	10-15	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	15-20	SP	N/A	44.7	52.0	3.3	-	-	-	-	-	
3	BULK	20-25	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	25-30	GP-GM	N/A	54.1	35.8	10.1	-	-	-	-	-	
5	BULK	30-35	SP-SM	N/A	46.0	48.6	5.4	-	-	-	-	-	
6	BULK	35-40	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	40-42	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	45-57	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	50-52	-	N/A	-	-	-	-	-	-	-	-	
10	BULK	55-57	GW-GM	N/A	52.6	38.9	8.5	-	-	-	-	-	
11	BULK	60-62	-	N/A	-	-	-	-	-	-	-	-	
12	BULK	65-67	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	70-72	GP-GM	N/A	63.2	27.5	9.3	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-13

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-14

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-14

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-15

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-15

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-16

Remarks:

Boring No.

HD83-16

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-17

Remarks:

Boring No.

Susitna Hydroelectric Project

SUSITNA JOINT VENTURE

HD83-18

Remarks:

Boring No.

HD83-18

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-19

SAMPLE 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 (%)	
1	BULK	14-15	GP	0.0	56.8	42.4	0.8	-	-	-	-	-	
2	BULK	19-20	-	0.0	-	-	-	-	-	-	-	-	
3	BULK	27-28	GW	0.0	68.3	28.5	3.2	-	-	-	-	-	
4	BULK	31-32	-	0.0	-	-	-	-	-	-	-	-	
5	BULK	37-38	SP	0.0	39.0	59.0	2.0	-	-	-	-	-	
6	BULK	41-42	-	0.0	-	-	-	-	-	-	-	-	
7	BULK	46-47	SP	0.0	9.3	88.3	2.4	-	-	-	-	-	
8	BULK	51-52	SP	0.0	5.5	92.3	2.2	-	-	-	-	-	
9	BULK	60-61	SP-SM	0.0	35.3	59.5	5.2	-	-	-	-	-	
10	BULK	65-66	-	0.0	-	-	-	-	-	-	-	-	
11	BULK	67-68	GW	0.0	54.8	41.2	4.0	-	-	-	-	-	
12	BULK	71-72	GP	0.0	74.9	24.5	0.6	-	-	-	-	-	
13	BULK	-	-	-	-	-	-	-	-	-	-	-	
14	BULK	77-78	-	0.0	-	-	-	-	-	-	-	-	
15	BULK	80-81	-	0.0	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-19

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-20

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	PI.	W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	10-15	GW	N/A	78.5	20.9	0.6	-	-	-	-	-	
2	BULK	15-20	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	20-27	GW	N/A	77.2	20.2	2.6	-	-	-	-	-	
4	BULK	30-33	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	33-38	GW	N/A	55.9	35.9	8.2	-	-	-	-	-	
6	BULK	42-45	SP	33.5	62.8	3.9	-	-	-	-	-	-	
7	BULK	46-48	GW	N/A	49.2	47.9	2.9	-	-	-	-	-	
8	BULK	54-55	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	57-60	GW	N/A	73.3	25.1	1.6	-	-	-	-	-	
10	BULK	61-65	GW	N/A	64.6	31.3	4.3	-	-	-	-	-	
11	BULK	66-68	GM	N/A	36.0	30.5	33.5	-	-	-	-	-	
12	BULK	70-75	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-20

Gusitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-21

SAMPLE 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 (%)	
1	BULK	1-2	SM	N/A	7.5	74.6	17.9	-	-	-	-	-	
2	BULK	6-7	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	10-12	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	15-18	GW-GM	N/A	61.1	33.2	5.7	-	-	-	-	-	
5	BULK	20-25	GW	N/A	74.7	23.9	1.4	-	-	-	-	-	
6	BULK	26-28	GW	N/A	60.6	29.6	9.8	-	-	-	-	-	
7	BULK	30-33	SP	N/A	31.5	66.3	2.2	-	-	-	-	-	
8	BULK	36-38	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	40-45	SP	N/A	32.4	63.4	4.2	-	-	-	-	-	
10	BULK	45-50	GP	N/A	51.8	43.8	4.4	-	-	-	-	-	
11	BULK	50-55	-	N/A	-	-	-	-	-	-	-	-	
12	BULK	55-60	SP	N/A	19.7	76.7	3.6	-	-	-	-	-	
13	BULK	60-65	GP	N/A	59.5	32.5	9.0	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-21

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-22

SAMPLE 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 (%)	
1	BULK	3-5	GP	N/A	74.5	23.6	1.9	-	-	-	-	-	
2	BULK	5-8	GW	N/A	72.7	23.8	3.5	-	-	-	-	-	
3	BULK	10-17	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	21-23	GW-GM	N/A	58.5	36.3	5.2	-	-	-	-	-	
5	BULK	25-28	GW	N/A	57.8	39.2	3.0	-	-	-	-	-	
6	BULK	30-34	GP-GM	N/A	67.9	26.1	6.0	-	-	-	-	-	
7	BULK	35-38	GW	N/A	61.2	34.2	4.6	-	-	-	-	-	
8	BULK	40-42	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	45-48	SP	N/A	27.7	69.0	3.3	-	-	-	-	-	
10	BULK	50-53	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	54-58	GW	N/A	66.1	31.0	2.9	-	-	-	-	-	
12	BULK	61-64	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	65-67	GP-GM	N/A	68.4	25.9	5.7	-	-	-	-	-	
14	BULK	70-72	GW	N/A	59.1	37.1	3.8	-	-	-	-	-	
15	BULK	74-78	-	N/A	-	-	-	-	-	-	-	-	
16	BULK	80-83	-	N/A	-	-	-	-	-	-	-	-	
17	BULK	85-87	GP-GM	N/A	69.1	23.0	7.9	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-22

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-23

SAMPLE 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 (%)	
1	BULK	2-4	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	5-8	GW-GM	N/A	66.7	28.1	5.2	-	-	-	-	-	
3	BULK	10-13	GW-GM	N/A	57.7	34.7	7.6	-	-	-	-	-	
4	BULK	15-18	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	21-24	GW	N/A	61.5	34.5	4.0	-	-	-	-	-	
6	BULK	25-28	GM	N/A	47.4	38.4	14.2	-	-	-	-	-	
7	BULK	32-34	SP	N/A	40.1	55.4	4.5	-	-	-	-	-	
8	BULK	39-41	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	45-48	SM	N/A	43.3	44.1	12.6	-	-	-	-	-	
10	BULK	51-53	GW-GM	N/A	60.1	33.7	6.2	-	-	-	-	-	
11	BULK	55-58	-	N/A	-	-	-	-	-	-	-	-	
12	BULK	61-65	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	67-69	SM	N/A	34.8	50.6	14.6	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-23

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-24

[illegible]

Remarks:

LAB TEST SUMMARY

Working No. HD83-24

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-25

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS	
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)		
				COBBLE	GRAVEL	SAND	SILT/CLAY	L.L.	P.L.	PI.				
1	BULK	13-15	GW	N/A	56.8	39.6	3.6	-	-	-	-	-		
2	BULK	21-25	GW	N/A	68.5	27.3	4.2	-	-	-	-	-		
3	BULK	25-28	GP	N/A	50.0	45.3	4.7	-	-	-	-	-		
4	BULK	41-45	GW	N/A	57.9	39.1	3.0	-	-	-	-	-		
5	BULK	45-48	SW	N/A	34.0	62.8	3.2	-	-	-	-	-		
6	BULK	50-58	SW	N/A	32.0	65.0	3.0	-	-	-	-	-		
7	BULK	61-63	-	N/A	-	-	-	-	-	-	-	-		
8	BULK	71-74	GW-GM	N/A	67.9	26.7	5.4	-	-	-	-	-		

Remarks:

LAB TEST SUMMARY

Boring No. HD83-25

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-26

SAMPLE 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 (%)	
1	BULK	10-13	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	15-18	GW-GM	N/A	61.2	31.8	7.0	-	-	-	-	-	
3	BULK	20-23	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	25-28	GP-GM	N/A	68.9	25.7	5.4	-	-	-	-	-	
5	BULK	30-33	GP-GM	N/A	65.0	26.4	8.6	-	-	-	-	-	
6	BULK	35-38	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	40-43	SP-SM	N/A	27.0	65.8	7.2	-	-	-	-	-	
8	BULK	45-48	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	52-54	GM	N/A	48.7	34.0	17.3	-	-	-	-	-	
10	BULK	55-58	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	61-63	SW-SM	N/A	34.7	58.0	7.1	-	-	-	-	-	
12	BULK	65-68	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	70-73	GC-GM	N/A	39.7	29.9	30.4	X	25	19	6	-	G _S =2.76

Remarks:

LAB TEST SUMMARY

Boring No. HD83-26

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-27

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	10-13	GW	N/A	77.3	19.6	3.1	-	-	-	-	-	
2	BULK	15-18	GP-GM	N/A	69.0	24.7	6.3	-	-	-	-	-	
3	BULK	20-23	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	28-30	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	31-35	GP-GM	N/A	70.6	24.3	5.1	-	-	-	-	-	
6	BULK	35-38	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	40-45	GP	N/A	72.9	22.7	4.4	-	-	-	-	-	
8	BULK	45-48	GP	N/A	58.1	38.0	3.9	-	-	-	-	-	
9	BULK	50-52	GP	N/A	73.2	22.9	3.9	-	-	-	-	-	
10	BULK	55-58	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	60-64	GW-GM	N/A	71.6	23.1	5.3	-	-	-	-	-	
12	BULK	65-68	GP-GM	N/A	66.5	24.4	9.1	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-27

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-28

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	10-13	GW	N/A	73.3	23.6	3.1	-	-	-	-	-	
2	BULK	14-18	GP-GM	N/A	68.7	23.9	7.4	-	-	-	-	-	
3	BULK	20-24	GP-GM	N/A	62.0	28.8	9.2	X	Non-Plastic			-	G _S =2.75
4	BULK	25-28	GP-GM	N/A	64.6	29.0	6.4	-	-	-	-	-	
5	BULK	30-34	GW-GM	N/A	64.7	29.4	5.9	-	-	-	-	-	
6	BULK	34-35	SP-SM	N/A	12.6	81.6	5.8	X	-	-	-	-	G _S =2.78
7	BULK	41-45	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	46-48	SP	N/A	25.1	71.5	3.4	-	-	-	-	-	
9	BULK	52-55	-	N/A	-	-	-	-	-	-	-	-	
10	BULK	65-68	GP-GM	N/A	65.3	25.7	9.0	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-28

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-29

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	P.I.	W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	10-15	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	15-20	GW-GM	N/A	56.8	37.6	5.6	-	-	-	-	-	
3	BULK	20-25	GW-GM	N/A	55.8	34.6	9.6	-	-	-	-	-	
4	BULK	25-30	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	30-33	GP-GM	N/A	49.1	41.0	9.9	-	-	-	-	-	
6	BULK	35-40	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	43-48	GP	N/A	50.3	45.5	4.2	-	-	-	-	-	
8	BULK	50-54	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	55-58	SW	N/A	43.0	53.7	3.3	-	-	-	-	-	
10	BULK	65-68	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	73-75	GW	N/A	73.9	22.4	3.7	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-29

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-30

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	10-15	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	15-20	GP	N/A	56.4	39.2	4.4	-	-	-	-	-	
3	BULK	20-25	GW	N/A	67.2	29.2	3.3	-	-	-	-	-	
4	BULK	27-30	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	30-35	GW-GM	N/A	61.3	32.1	6.6	-	-	-	-	-	
6	BULK	35-38	SW-SM	N/A	24.3	68.4	7.3	-	-	-	-	-	
7	BULK	40-45	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	45-48	SP	N/A	43.8	52.9	3.3	-	-	-	-	-	
9	BULK	55-58	-	N/A	-	-	-	-	-	-	-	-	
10	BULK	60-65	GW	N/A	63.6	33.4	3.0	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-30

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-31

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	1-2	GW-GM	N/A	59.7	33.4	6.9	-	-	-	-	-	
2	BULK	5-8	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	10-13	GW	N/A	67.9	28.9	3.2	-	-	-	-	-	
4	BULK	16-18	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	21-24	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	25-28	GW	N/A	75.4	21.5	3.1	-	-	-	-	-	
7	BULK	30-32	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	40-43	SP	N/A	30.7	67.3	2.0	-	-	-	-	-	
9	BULK	45-48	SW	N/A	29.3	65.8	4.9	-	-	-	-	-	
10	BULK	55-56	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	56-58	GW-GM	N/A	59.4	33.6	7.0	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-31

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-32

[illegible]

Remarks:

LAB TEST SUMMARY

Ordering No.

HD83-32

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-33

[illegible]

Remarks:

LAB TEST SUMMARY

Ordering No. HD83-33
Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-34

[illegible]

Remarks:

LAB TEST SUMMARY

Filing No. HD83-34

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-35

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD-83-36

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-36

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-37

SAMPLE 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						
1	BULK	1-5	GW	N/A	70.4	25.9	3.7	-	-	-	-	-	
2	BULK	5-8	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	10-13	GP-GM	N/A	63.9	30.6	5.5	-	-	-	-	-	
4	BULK	15-18	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	20-25	GW	N/A	73.7	23.5	2.8	-	-	-	-	-	
6	BULK	25-26	GW	N/A	75.3	22.9	1.8	-	-	-	-	-	
7	BULK	30-35	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	35-40	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	40-45	GW	N/A	74.2	22.2	3.6	-	-	-	-	-	
10	BULK	45-50	GW	N/A	81.8	14.4	3.8	-	-	-	-	-	
11	BULK	50-55	-	N/A	-	-	-	-	-	-	-	-	
12	BULK	55-60	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	60-65	GW	N/A	81.7	15.4	2.9	-	-	-	-	-	
14	BULK	65-70	GP-GM	N/A	72.2	20.6	7.2	-	-	-	-	-	
15	BULK	70-75	-	N/A	-	-	-	-	-	-	-	-	
16	BULK	75-80	GP-GM	N/A	75.6	19.2	5.2	-	-	-	-	-	
17	BULK	85-88	-	N/A	-	-	-	-	-	-	-	-	
18	BULK	88-94	GW	N/A	77.6	20.1	2.3	-	-	-	-	-	
19	BULK	96-100	-	N/A	-	-	-	-	-	-	-	-	
20	BULK	100-109	GP	N/A	55.2	41.6	3.2	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-37

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-37

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-37

Jusitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-38

SAMPLE 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 (%)	
1	BULK	3-6	GP-GM	N/A	57.6	33.5	8.9	-	-	-	-	-	
2	BULK	7-10	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	13-15	GW	N/A	57.6	37.7	4.7	-	-	-	-	-	
4	BULK	17-20	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	23-25	GW	N/A	75.0	22.4	2.6	-	-	-	-	-	
6	BULK	25-27	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	30-33	GP-GM	N/A	57.8	32.8	9.4	-	-	-	-	-	
8	BULK	35-38	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	40-43	SM	N/A	42.3	43.3	14.2	-	-	-	-	-	
10	BULK	45-48	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	50-53	GM	N/A	41.3	40.1	18.6	-	-	-	-	-	
12	BULK	55-58	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	60-63	GP-GM	N/A	59.9	30.8	9.3	-	-	-	-	-	
14	BULK	65-68	-	N/A	-	-	-	-	-	-	-	-	
15	BULK	70-73	GP-GM	N/A	70.0	23.0	7.0	-	-	-	-	-	
16	BULK	75-78	-	N/A	-	-	-	-	-	-	-	-	
17	BULK	80-83	GW	N/A	77.1	18.0	4.9	-	-	-	-	-	
18	BULK	85-88	-	N/A	-	-	-	-	-	-	-	-	
19	BULK	90-93	GW-GM	N/A	54.5	39.1	6.4	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-38

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-39

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	P.I.	W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	5-8	GW-GM	N/A	58.2	35.1	6.7	-	-	-	-	-	G _S =2.74
2	BULK	10-15	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	15-20	GP-GM	N/A	60.7	32.5	6.8	-	-	-	-	-	G _S =2.80
4	BULK	20-25	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	25-34	GP-GM	N/A	50.7	42.1	7.2	-	-	-	-	-	
6	BULK	35-40	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	40-48	GW	N/A	59.5	36.6	3.9	-	-	-	-	-	
8	BULK	50-55	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	55-60	GW-GM	N/A	72.4	21.2	6.4	-	-	-	-	-	
10	BULK	60-65	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	65-70	GP-GM	N/A	65.8	26.5	7.7	-	-	-	-	-	G _S =2.82
12	BULK	70-74	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	75-78	SM	N/A	40.2	43.3	16.5	-	-	-	-	-	
14	BULK	80-85	-	N/A	-	-	-	-	-	-	-	-	
15	BULK	85-88	SP-SM	N/A	40.7	53.1	6.2	-	-	-	-	-	G _S =2.76
16	BULK	90-95	-	N/A	-	-	-	-	-	-	-	-	
17	BULK	100-104	GP-GM	N/A	54.3	37.0	8.7	-	-	-	-	-	G _S =2.76
18	BULK	105-108	-	N/A	-	-	-	-	-	-	-	-	
19	BULK	108-113	GW-GM	N/A	61.4	33.4	5.2	-	-	-	-	-	
20	BULK	115-118	GP-GM	N/A	52.4	37.8	10.1	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-39

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-39

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-39

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-40

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-40

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-41

SAMPLE 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 (%)	
1	BULK	5-10	SM	N/A	34.2	48.8	17.0	-	-	-	-	-	
2	BULK	10-15	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	15-20	GP-GM	N/A	55.1	35.9	9.0	-	-	-	-	-	G _S =2.76
4	BULK	20-25	-	N/A	-	-	-	-	-	-	-	-	
5	BULK	25-30	SP-SM	N/A	32.6	57.5	9.9	-	-	-	-	-	
6	BULK	30-35	GP-GM	N/A	47.0	43.7	9.3	-	-	-	-	-	G _S =2.76
7	BULK	35-40	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	40-45	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	45-50	SM	N/A	32.5	51.3	16.2	-	-	-	-	-	G _S =2.78
10	BULK	50-55	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	55-60	GP-GM	N/A	54.7	39.4	5.9	-	-	-	-	-	
12	BULK	60-65	GP-GM	N/A	47.6	45.6	6.8	-	-	-	-	-	
13	BULK	65-70	SW-SM	N/A	40.1	48.1	11.8	-	-	-	-	-	
14	BULK	70-75	GM	N/A	45.7	38.8	15.5	-	-	-	-	-	G _S =2.68
15	BULK	75-80	-	N/A	-	-	-	-	-	-	-	-	
16	BULK	80-83	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-41

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-42

SAMPLE 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 (%)	
1	BULK	12-17	N/A	-	-	-	-	-	-	-	-	-	
2	BULK	20-23	SP	N/A	32.1	63.2	4.7	-	-	-	-	-	G _S =2.76
3	BULK	25-28	GW	N/A	64.2	32.0	3.8	-	-	-	-	-	
4	BULK	30-33	GP-GM	N/A	64.0	29.1	6.9	-	-	-	-	-	
5	BULK	35-38	SW	N/A	46.7	48.9	4.4	-	-	-	-	-	
6	BULK	40-43	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	45-48	SM	N/A	19.1	66.9	13.2	-	-	-	-	-	
8	BULK	50-55	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	55-60	SP	N/A	47.6	44.1	3.3	-	-	-	-	-	G _S =2.75
10	BULK	60-65	GW-GM	N/A	61.6	32.6	5.8	-	-	-	-	-	
11	BULK	65-68	SC	N/A	31.5	32.9	35.6	-	26	18	8	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-42

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-43

SAMPLE 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 (%)	
1	BULK	10-15	SP	N/A	46.3	50.2	3.5	-	-	-	-	-	
2	BULK	15-20	GP	N/A	50.1	46.8	3.1	-	-	-	-	-	
3	BULK	20-25	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	25-30	GW	N/A	50.6	46.9	2.5	-	-	-	-	-	
5	BULK	30-35	GW-GM	N/A	56.9	35.4	7.7	-	-	-	-	-	
6	BULK	35-40	SP	N/A	37.6	58.6	3.8	-	-	-	-	-	Proctor D698 max=143.5pcf
7	BULK	40-45	GW-GM	N/A	70.6	24.4	5.0	-	-	-	-	-	wopt=6.0% G _s =2.83
8	BULK	45-50	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	50-55	SM-SC	N/A	39.7	41.4	18.9	-	22	18	14	-	
10	BULK	55-58	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	60-63	GM	N/A	56.5	25.5	18.0	-	-	-	-	-	
12	BULK	65-67	SW	N/A	41.1	56.8	2.1	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-43

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-44

SAMPLE 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 (%)	
1	BULK	10-15	SW	N/A	44.6	52.7	2.7	-	-	-	-	-	
2	BULK	15-18	SP	N/A	34.7	60.8	4.5	-	-	-	-	-	
3	BULK	18-25	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	25-30	SP	N/A	47.4	50.7	1.9	-	-	-	-	-	
5	BULK	30-35	GW	N/A	64.4	31.7	3.9	-	-	-	-	-	
6	BULK	35-40	-	N/A	-	-	-	-	-	-	-	-	Proctor 698 max=135pct.
7	BULK	40-45	SP	N/A	33.5	63.6	2.9	-	-	-	-	-	wopt.=10.0 G _s =2.81
8	BULK	45-50	SW-SC	N/A	39.9	51.4	8.7	-	25	20	5	-	
9	BULK	50-55	GW-GM	N/A	51.0	43.4	5.6	-	-	-	-	-	
10	BULK	55-60	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	60-65	GW-GM	N/A	53.4	39.5	7.1	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-44

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-45

SAMPLE 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 (%)	
1	BULK	0-4	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	4-7	GW-GM	N/A	60.2	32.0	7.8	X	-	-	-	-	
3	BULK	10-13		N/A	-	-	-	-	-	-	-	-	
4	BULK	14-17	GW-GM	N/A	62.9	31.2	5.9	-	-	-	-	-	
5	BULK	20-23	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	24-27	GM	N/A	47.8	40.1	12.4	X	Non-Plastic			-	
7	BULK	30-33	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	35-38	SW-SM	N/A	39.2	51.5	9.3	X	-	-	-	-	
9	BULK	40-43	-	N/A	-	-	-	-	-	-	-	-	
10	BULK	45-47	GP-GM	N/A	45.2	46.4	8.4	-	-	-	-	-	
11	BULK	50-53	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD93-45

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-46

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	P.I.	W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	2-5	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	5-10	GW-GM	N/A	54.3	33.1	10.6	-	-	-	-	-	
3	BULK	10-13	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	13-16	OH	N/A	24.7	18.0	57.3	-	56	52	4	-	Organic content=13.9%
5	BULK	17-20	SM	N/A	5.9	47.5	46.6	-	Non-Plastic			-	Organic content=2.8%
6	BULK	20-25	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	25-29	GP-GM	N/A	48.2	42.4	9.4	-	-	-	-	-	
8	BULK	30-34	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	34-39	GP-GM	N/A	46.8	43.7	9.5	-	-	-	-	-	
10	BULK	40-45	SP	N/A	32.3	63.5	4.2	-	-	-	-	-	
11	BULK	45-48	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-46

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-47

SAMPLE 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 (%)	
1	BULK	2-4	GP-GM	N/A	63.3	30.5	6.2	-	-	-	-	-	
2	BULK	4-8	SM	N/A	35.5	45.8	18.7	-	Non-Plastic			-	
3	BULK	10-14	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	20-23	GW-GM	N/A	56.7	36.0	7.3	-	-	-	-	-	
5	BULK	24-28	SP	N/A	37.7	59.0	3.3	-	-	-	-	-	
6	BULK	30-33	-	N/A	-	-	-	-	-	-	-	-	
7	BULK	34-38	GW	N/A	50.6	44.8	4.6	-	-	-	-	-	
8	BULK	40-41	SP-SM	N/A	14.1	77.7	8.2	-	-	-	-	-	
9	BULK	41-45	-	N/A	-	-	-	-	-	-	-	-	
10	BULK	45-48	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	60-64	GW-GM	N/A	47.1	43.0	9.9	-	18	15	3	-	
12	BULK	64-65	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-47

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-48

SAMPLE 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 (%)	
1	BULK	10-15	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	15-19	SP	N/A	14.9	80.7	4.4	-	-	-	-	-	
3	BULK	19-25	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	25-30	SP-SM	N/A	42.5	48.9	8.6	-	Non-Plastic			-	
5	BULK	30-35	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	35-40	GW	N/A	67.2	31.2	1.6	-	-	-	-	-	
7	BULK	42-47	GW	N/A	53.2	43.9	2.7	-	-	-	-	-	
8	BULK	50-55	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	55-58	SP	N/A	20.7	76.1	3.2	-	Non-Plastic			-	
10	BULK	60-65	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	65-69	GW-GM	N/A	32.9	60.9	6.2	-	-	-	-	-	
12	BULK	70-75	GP-GM	N/A	51.2	38.0	10.8	-	-	-	-	-	
13	BULK	75-78	-	N/A	-	-	-	-	-	-	-	-	
14	BULK	80-85	GC	N/A	49.7	33.7	16.6	X	27	18	9	-	
15	BULK	85-88	GP-GM	N/A	57.2	33.8	9.0	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-48

Jusitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-1

SAMPLE 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 (%)	
1	BULK	2-9	SM	N/A	33.4	48.3	18.3	-	-	-	-	-	
2	SPT	9-10	-	-	-	-	-	-	-	-	-	8.9	
3	BULK	19-20	SM	N/A	20.2	49.1	30.7	X	-	-	-	-	
4	BULK	26-28	SM	N/A	29.8	40.0	30.2	-	-	-	-	-	
5	SPT	28-29	-	-	-	-	-	-	-	-	-	-	
6	BULK	32-34	SM-SC	N/A	21.1	39.5	39.4	X	18	13	5	-	
7	BULK	37-38	-	-	-	-	-	-	-	-	-	-	
8	SPT	38-39	-	-	-	-	-	-	-	-	-	-	
9	BULK	44-45	-	-	-	-	-	-	-	-	-	-	
10	BULK	50-52	SM	N/A	11.3	42.7	46.0	X	Non-Plastic-			-	
11	BULK	55-56	SM	N/A	17.8	41.4	40.8	-	-	-	-	-	
12	BULK	60-62	SM	N/A	27.0	32.9	40.1	-	-	-	-	-	
13	BULK	65-66	SC	N/A	25.8	37.8	36.4	-	24	14	10	-	
13B	SPT	69-71	SC	-	-	-	-	-	42	18	24	12.4	
14	BULK	71-72	SM	N/A	19.7	35.1	45.2	X	-	-	-	-	
15	BULK	75-76	SM	N/A	22.6	41.1	36.3	-	-	-	-	-	
16	BULK	77	-	-	-	-	-	-	-	-	-	-	
17	BULK	80-81	SM	N/A	30.2	39.7	30.1	-	-	-	-	-	
18	BULK	85-88	SM	N/A	21.3	42.3	36.4	-	Non-Plastic-			-	
18B	SPT	89-90	-	-	-	-	-	-	-	-	-	11.3	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-1

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-1

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	P.I.	W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
19	BULK	90-92	SM	N/A	20.5	44.7	34.8	-	-	-	-	-	
20	BULK	95-96	SM	N/A	37.4	43.0	19.6	-	-	-	-	-	
21	BULK	100-101	SM	N/A	30.4	40.5	29.4	-	-	-	-	-	
22	BULK	107-108	SM	N/A	19.8	47.3	32.9	X	Non-Plastic			-	
23	BULK	114-116	SM	N/A	27.3	43.4	29.3	-	-	-	-	-	
24	BULK	121-123	SM	N/A	29.9	41.2	28.9	-	17	15	2	4.4	
25	BULK	126-128	SM	N/A	21.6	48.9	29.5	-	17	15	2	2.6	
26	BULK	131-133	SM-SC	N/A	9.2	54.3	36.5	-	19	14	5	5.3	
27	BULK	136-138	SM+SC	N/A	12.0	50.9	37.1	-	20	14	8	5.8	
28	BULK	141-143	SM	N/A	17.8	56.7	26.1	X	18	16	2	2.7	
29	BULK	146-148	SM	N/A	21.5	51.4	27.1	-	Non-Plastic			4.7	
30	BULK	151-153	-	-	-	-	-	-	-	-	-	-	
31	BULK	161-163	SM	N/A	35.3	41.6	23.1	-	Non-Plastic			2.9	
32	BULK	166-168	-	-	-	-	-	-	-	-	-	3.1	
33	BULK	174-176	-	-	-	-	-	-	-	-	-	1.3	
34	BULK	178-180	SM	N/A	13.6	74.4	12.0	-	-	-	-	0.6	
35	BULK	183-185	SM	N/A	38.1	49.8	12.1	-	Non-Plastic			2.2	
36	BULK	188-190	SM	N/A	43.4	44.0	12.6	-	-	-	-	2.7	
37	BULK	194-196	SM	N/A	10.8	64.0	25.2	X.	Non-Plastic			-	
38	BULK	200-202	SM	N/A	20.1	52.1	27.8	-	18	16	2	12.6	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-1

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-1

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	P.I.	W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
39	BULK	208-210	SW-SM	N/A	21.3	69.2	9.5	-	-	-	-	-	
40	BULK	225-233	SM	N/A	15.4	63.7	20.9	-	Non-Plastic			-	
41	BULK	243-245	SM-SC	N/A	22.0	38.9	39.1	X	20	16	4	-	
42	BULK	255-257	CL	N/A	11.7	21.8	61.0	-	26	18	8	13.2	Organic Content 2.1%
43	BULK	260-261	SC	N/A	22.4	37.8	39.8	-	31	17	14	8.5	Organic Content 1.4%
44	BULK	263-264	SM	N/A	18.5	32.4	49.1	-	-	-	-	18.0	
45	BULK	270-271	CL	N/A	0.7	6.1	93.2	-	-	-	-	22.7	
46	BULK	276-278	CL-ML	N/A	-0-	1.6	98.4	X	25	20	5	21.4	
47	BULK	282-284	CL	N/A	-0-	5.3	94.7	-	31	22	9	24.0	
48	BULK	290-291	CL	N/A	-0-	2.5	97.5	-	29	22	7	22.0	
49	BULK	295-296	GM	N/A	35.2	34.6	30.2	-	-	-	-	-	
50	BULK	299-300	GM	N/A	34.2	28.2	37.6	X	-	-	-	-	
51	BULK	304-305	-	-	-	-	-	-	-	-	-	-	
52	BULK	305-306	GW-GM	N/A	66.6	26.7	6.7	-	-	-	-	-	
53	BULK	308-309	GP-GM	N/A	72.5	19.7	7.8	-	-	-	-	-	
54	BULK	309-310	GP-GM	N/A	51.1	37.4	11.5	X	Non-Plastic			-	
55	BULK	312-313	GP	N/A	64.8	33.0	2.2	-	-	-	-	-	
56	BULK	314-315	GW	N/A	58.0	39.9	2.1	-	-	-	-	-	
57	BULK	316-317	SW	N/A	37.8	59.1	3.1	-	-	-	-	-	
58	BULK	321-322	GP	N/A	61.0	34.5	4.5	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-1

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-2

SAMPLE 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 (%)	
1	BULK	3-8	SM	12.2	27.1	47.5	13.2	-	-	-	-	-	
2	SPT	8-10	SM	0.0	26.0	55.1	18.9	-	-	-	-	12.5	
3	BULK	13-14	GM	9.7	44.4	31.3	13.1	-	20	17	3	8.1	
4	BULK	14-17	GP-GM	8.8	57.8	24.4	9.0	-	-	-	-	17.7	
5	SPT	-	-	-	-	-	-	-	-	-	-	-	
6	BULK	18-20	GM	0.0	51.0	36.9	12.1	-	-	-	-	12.7	
7	SPT	20-21	-	-	-	-	-	-	-	-	-	16.6	
8	BULK	24-25	SM	0.0	2.8	74.5	22.7	-	Non-Plastic			10.8	
9	SPT	28-29	-	-	-	-	-	-	-	-	-	12.1	
10	BULK	33-34	SM	0.0	4.8	79.2	16.0	-	-	-	-	8.2	
11	BULK	36-37	SW-SM	0.0	12.7	76.5	10.8	-	-	-	-	6.1	
12	SPT	38-39	-	-	-	-	-	-	-	-	-	5.9	
13	BULK	40-41	SC	0.0	2.1	64.9	33.0	-	34	23	11	19.2	
14	BULK	44-45	SM	0.0	0.9	85.7	13.4	-	-	-	-	-	
15	BULK	46-47	SM	0.0	15.1	70.1	14.8	-	-	-	-	6.4	
16	BULK	49-50	SW-SM	0.0	16.1	72.9	11.0	-	-	-	-	5.2	
17	BULK	52-53	SM	0.0	5.5	82.0	12.5	-	Non-Plastic			-	
18	BULK	55-56	SW-SM	0.0	3.5	84.9	11.6	-	Non-Plastic			6.1	
19	SPT	58-59	-	-	-	-	-	-	-	-	-	-	
20	BULK	61-62	SW-SM	0.0	29.1	59.8	11.1	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-2

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-2

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-2

Jusitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-3

SAMPLE 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 (%)	
1	BULK	7-9	-	-	-	-	-	-	-	-	-	-	
2	BULK	14-15	SM-SC	0.0	13.0	41.7	45.3	X	21	14	6	15.4	
3	SPT	18-19	ML	-	-	-	-	-	15	14	1	11.8	
4	BULK	22-23	ML-CL	0.0	12.0	37.0	51.0	-	19	15	4	14.6	
5	SPT	28-29	-	-	-	-	-	-	-	-	-	12.0	
6	BULK	30-31	SM-SC	0.0	7.6	44.0	48.4	-	20	14	6	10.5	
7	BULK	36-37	-	-	-	-	-	-	-	-	-	14.3	
8	SPT	38-40	SM+SC	0.0	12.9	45.8	41.3	X	18	13	5	10.6	
9	BULK	46-47	-	-	-	-	-	-	-	-	-	6.2	
10	SPT	58-59	-	-	-	-	-	-	-	-	-	12.3	
11	BULK	63-64	-	-	-	-	-	-	-	-	-	4.4	
12	BULK	68-69	-	-	-	-	-	-	-	-	-	5.5	
13	BULK	73-74	GM	0.0	44.2	30.2	25.6	-	Non-Plastic			4.6	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-3

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-4

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	SPT	7-8	SM	0.0	14.4	51.6	34.0	-	-	-	-	12.2	
2	BULK	7-9	SM	0.0	30.3	44.8	24.9	-	Non-Plastic			-	
3	SPT	17-19	SM	0.0	8.2	43.7	48.1	-	-	-	-	15.0	
4	BULK	17-19	SM	0.0	17.5	46.2	36.3	-	Non-Plastic			-	
5	BULK	23-24	SM	0.0	18.6	44.8	36.6	-	-	-	-	-	
6	BULK	31-32	ML	0.0	1.8	27.0	71.2	X	21	18	3	16.7	
7	BULK	35-36	SW-SM	8.3	39.2	41.0	11.5	-	Non-Plastic			-	
8	SPT	47-49	-	-	-	-	-	-	-	-	-	-	
9	BULK	58-59	SM	0.0	24.3	46.5	29.2	-	17	16	1	-	
10	BULK	60-61	SM	0.0	16.1	37.7	46.2	X	17	14	3	-	
11	BULK	73-74	-	-	-	-	-	-	-	-	-	14.7	
12	BULK	77-78	CL	0.0	0.4	11.0	88.6	-	28	19	9	15.4	
13	BULK	85-86	SC	0.0	25.8	28.3	45.9	X	24	17	7	8.3	
14	BULK	87-88	SM-SL	0.0	20.5	43.4	36.1	-	19	14	5	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-4

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-5

SAMPLE 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 (%)	
1	BULK	8-9	SM	0.0	0.0	68.5	31.5	-	-	-	-	-	G _s =2.69
2	BULK	14-15	CL-ML	0.0	1.4	32.6	66.0	X	22	16	5	46.5	
3	BULK	21-22	CL	0.0	0.5	12.1	87.4	X	31	20	11	74.5	
4	SPT	28-30	CL-ML	-	-	-	-	-	46	28	18	40.7	
5	BULK	28-30	-	-	-	-	-	-	-	-	-	44.6	
6	BULK	38-39	MH	-	-	-	-	-	53	31	22	30.4	G _s =2.75
7	BULK	41-42	CL	0.0	3.3	18.6	78.1	X	31	21	10	-	
8	BULK	44-45	GW	0.0	59.4	36.3	4.3	-	-	-	-	-	
9	BULK	47-48	GW	0.0	67.9	29.4	2.7	-	-	-	-	6.4	
10	BULK	50-51	SP	0.0	35.4	61.1	3.5	-	-	-	-	8.4	
11	BULK	77-78	-	-	-	-	-	-	-	-	-	-	
12	BULK	83-84	-	-	-	-	-	-	-	-	-	-	
13	BULK	86-87	SM	0.0	28.2	34.6	37.2	X	18	16	2	9.0	
14	BULK	93-94	SM	0.0	21.0	29.9	49.1	X	-	-	-	7.0	
15	BULK	100-101	GM	5.2	40.6	34.1	15.8	X	-	-	-	-	
16	BULK	110-111	GW	0.0	71.3	24.1	4.6	-	-	-	-	-	
17	BULK	123-124	SM	0.0	0.0	58.1	41.9	X	Non-Plastic			-	
18	BULK	129-130	-	-	-	-	-	-	-	-	-	-	
19	BULK	135-136	-	-	-	-	-	-	-	-	-	-	
20	BULK	137-138	-	-	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-5

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-6

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST	L.L.	P.L.	P.I.	W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
1	BULK	11-15	SM	N/A	16.1	46.8	37.1	-	-	-	-	10.5	G _S =2.69
2	BULK	18-20	SM	N/A	35.9	36.8	28.3	-	-	-	-	-	
3	BULK	24-26	SM	N/A	15.4	43.6	41.0	X	17	14	3	-	
4	BULK	32-38	CL	N/A	10.2	31.0	58.8	X	29	20	9	-	G _S =2.74
5	BULK	41-43	CL/ML	N/A	2.5	8.0	89.5	X	44	27	17	-	
6	BULK	46-48	CL	N/A	0.2	4.3	95.7	-	32	23	9	-	
7	BULK	50-51	ML	N/A	17.1	23.1	59.8	X	-	-	-	-	
8	BULK	52-54	SM	N/A	30.6	42.0	27.4	X	-	-	-	-	
9	BULK	56-57	GP-GM	N/A	48.1	40.5	11.4	-	-	-	-	-	
10	BULK	69-70	SW-SM	N/A	36.7	52.2	11.1	-	-	-	-	-	
11	BULK	77-79	-	N/A	-	-	-	-	-	-	-	-	
12	BULK	83-85	GP	N/A	68.0	27.5	4.5	-	-	-	-	-	
13	BULK	86-88	-	N/A	-	-	-	-	-	-	-	-	
14	BULK	91-93	SM	N/A	5.8	58.6	35.6	-	-	-	-	-	
15	BULK	94-96	SM-SL	N/A	4.6	60.4	35.0	-	25	21	4	-	
16	BULK	104-106	SM-SL	N/A	0.6	57.0	42.4	-	28	22	6	-	
17	SPT	108-109	-	N/A	-	-	-	-	-	-	-	26.9	
18	BULK	108-109	SM	N/A	10.7	56.0	33.3	X	-	-	-	-	
19	BULK	115-117	-	N/A	-	-	-	-	-	-	-	-	
20	BULK	124-126	SM	N/A	2.4	58.0	39.2	X	22	20	2	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-6

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

$\frac{d}{dt} \left(\frac{\partial L}{\partial \dot{x}} \right) = \frac{\partial L}{\partial x}$

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-6

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-7

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-7

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-8

SAMPLE 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 (%)	
1	BULK	6-8	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	11-13	SM	N/A	9.5	61.4	29.1	-	-	-	-	-	
3	BULK	16-18	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	21-23	SM	N/A	28.4	51.3	20.3	X	Non-Plastic			-	
5	BULK	26-28	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	31-33	SM	N/A	12.1	68.2	19.7	-	-	-	-	-	
7	BULK	36-38	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	41-43	-	N/A	-	-	-	-	-	-	-	-	
9	BULK	46-48	SM	N/A	19.0	46.6	34.4	-	15	14	1	-	
10	BULK	51-53	SP-SM	N/A	22.6	71.3	6.1	-	-	-	-	-	
11	BULK	56-58	SM	N/A	29.8	53.7	16.5	-	-	-	-	-	
12	BULK	61-63	SM	N/A	9.3	58.4	32.3	X	20	18	2	-	
13	BULK	66-68	-	N/A	-	-	-	-	-	-	-	-	
14	BULK	72-73	SM	N/A	6.0	68.2	25.8	-	-	-	-	-	
15	BULK	75-76	-	N/A	-	-	-	-	-	-	-	-	
16	BULK	76	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-8

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-9

SAMPLE 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 (%)	
1	BULK	5-7	SM	N/A	-	-	-	-	-	-	-	-	
2	BULK	10-12	SM	N/A	33.4	50.7	15.9	X	-	-	-	-	
3	BULK	15-17	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	20-22	SM	N/A	38.1	46.6	15.3	-	-	-	-	-	
5	BULK	25-27	-	N/A	-	-	-	-	-	-	-	-	
6	BULK	30-32	SM	N/A	40.2	42.6	17.2	-	-	-	-	-	
7	BULK	35-37	-	N/A	-	-	-	-	-	-	-	-	
8	BULK	40-42	SM	N/A	16.4	47.1	36.5	X	Non-Plastic			-	
9	BULK	46-48	SM	N/A	24.1	44.3	31.6	X	-	-	-	-	
10	BULK	50-52	SM	N/A	30.4	40.7	28.9	-	16	14	2	-	
11	BULK	56-58	-	N/A	-	-	-	-	-	-	-	-	
12	BULK	60-62	SM	N/A	32.6	48.4	19.0	-	-	-	-	-	
13	BULK	66-68	-	N/A	-	-	-	-	-	-	-	-	
14	BULK	70-72	SM	N/A	27.5	46.9	25.6	-	Non-Plastic			-	
15	BULK	76-78	-	N/A	-	-	-	-	-	-	-	-	
16	BULK	80-82	SM	N/A	30.5	43.5	26.0	-	-	-	-	-	
17	BULK	86-88	-	N/A	-	-	-	-	-	-	-	-	
18	BULK	90-92	-	N/A	-	-	-	-	-	-	-	-	
19	BULK	95-97	SM	N/A	17.2	47.8	35.0	-	18	15	3	-	
20	BULK	100-102	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-9

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-9

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-9

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-49

[illegible]

Remarks:

LAB TEST SUMMARY

Boring No. HD83-49

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-50

SAMPLE 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 (%)	
1	BULK	1-4	SM	N/A	12.4	47.7	39.9	X	Non-Plastic			-	G _S =2.70
2	BULK	4-8	-	N/A	-	-	-	-	-	-	-	-	
3	BULK	10-13	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	15-18	SM-SC	N/A	40.5	42.8	16.5	-	-	-	-	-	
5	SPT	18-20	-	N/A	-	-	-	-	-	-	-	16.5	
6	BULK	21-26	SC	N/A	11.4	41.7	46.9	-	24	16	18	-	
7	BULK	25-28	SM-SC	N/A	27.4	44.5	28.1	-	20	15	5	-	
8	BULK	30-34	SM-SC	N/A	29.1	46.1	24.8	-	-	-	-	-	
9	BULK	35-38	SM-SC	N/A	38.8	42.3	18.9	X	20	16	14	-	G _S =2.70
10	BULK	40-46	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	46-48	SM-SC	N/A	31.6	48.5	19.9	-	-	-	-	-	
12	BULK	52-54	-	N/A	-	-	-	-	-	-	-	-	
13	BULK	55-58	SM-SC	N/A	27.4	43.2	25.1	-	18	14	4	-	
14	BULK	60-65	-	N/A	-	-	-	-	-	-	-	-	
15	BULK	65-68	-	N/A	-	-	-	-	-	-	-	-	
16	BULK	70-75	SM-SC	N/A	36.5	43.6	19.8	X	18	14	4	-	G _S =2.72
17	BULK	75-78	SM-SC	N/A	36.1	45.4	18.5	-	20	15	5	-	
18	SPT	78-79	-	N/A	-	-	-	-	-	-	-	-	
19	BULK	80-85	-	N/A	-	-	-	-	-	-	-	-	
20	BULK	85-88	SC	N/A	36.4	43.0	20.6	X	25	15	10	-	G _S =2.70

Remarks:

LAB TEST SUMMARY

Boring No. HD83-50

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-50

Remarks:

Boring No. HD83-50

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD83-51

SAMPLE 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 (%)	
1	BULK	2-5	-	N/A	-	-	-	-	-	-	-	-	
2	BULK	5-8	-	N/A	-	-	-	-	-	-	-	-	Organic Content 2.9%
3	SPT	8-10	-	N/A	-	-	-	-	-	-	-	-	
4	BULK	10-14	Sp-SM	N/A	33.5	56.4	10.1	-	-	-	-	-	
5	SPT	15-16	-	N/A	-	-	-	-	-	-	-	8.7	
6	BULK	16-18	SM	N/A	21.2	54.9	23.9	-	-	-	-	-	
7	BULK	18-19	-	N/A	-	-	-	-	-	-	-	11.4	
8	BULK	20-24	SM	N/A	36.9	49.2	13.9	-	Non-Plastic			-	
9	SPT	24-25	-	N/A	-	-	-	-	-	-	-	9.1	
10	BULK	25-28	SM	N/A	9.1	45.1	45.8	-	Non-Plastic			-	
11	BULK	30-34	-	N/A	-	-	-	-	-	-	-	-	
12	SPT	34-35	SM-SC	N/A	0.0	69.4	30.6	X	-	-	-	13.3	
13	BULK	35-38	-	N/A	-	-	-	-	-	-	-	-	
14	SPT	38-39	-	N/A	-	-	-	-	-	-	-	14.5	
15	BULK	40-43	SM-SC	N/A	19.6	38.5	41.9	-	18	14	4	-	Proctor D 1557 max.= 136
16	BULK	45-48	SC	N/A	20.4	39.5	40.1	-	21	13	9	-	W _{opt.} = 7.3 G _s = 2.72
17	SPT	48-49	-	N/A	-	-	-	-	-	-	-	5.2	
18	BULK	50-53	SM-SC	N/A	14.2	54.9	30.9	-	18	14	4	-	
19	SPT	55-56	-	N/A	-	-	-	-	-	-	-	14.5	
20	BULK	56-58	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-51

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD-83-51

SAMPLE 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 (%)	
21	SPT	58-59	ML	N/A	-	-	-	-	19	16	3	7.4	
22	BULK	60	-	N/A	-	-	-	-	-	-	-	-	
23	BULK	64-65	SM	N/A	7.9	66.7	25.4	-	-	-	-	-	
24	SPT	65-66	-	N/A	-	-	-	-	-	-	-	9.7	
25	BULK	66-70	SM	N/A	0.7	79.9	19.4	-	Non-Plastic			-	
26	BULK	70-75	SM	N/A	5.5	62.9	30.3	-	Non-Plastic			-	
27	BULK	76-78	SC	N/A	18.3	33.8	47.9	-	25	16	9	-	
28	SPT	78-79	-	N/A	-	-	-	-	-	-	-	14.2	
29	BULK	80-83	-	N/A	-	-	-	-	-	-	-	-	
30	SPT	84-85	-	N/A	-	-	-	-	-	-	-	17.0	
31	BULK	85-88	-	N/A	-	-	-	-	-	-	-	-	
32	SPT	88-89	-	N/A	-	-	-	-	-	-	-	19.8	
33	BULK	90-94	SM-SC	N/A	9.5	61.3	29.2	-	21	16	5	-	
34	SPT	94-95	-	N/A	-	-	-	-	-	-	-	15.8	
35	BULK	96-98	CL	N/A	3.6	24.3	72.1	-	33	18	15	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-51

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD-83-52

SAMPLE 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 (%)	
1	BULK	3-8	SP-SM	N/A	39.5	50.6	9.9	-	-	-	-	-	
2	SPT	8-10	SM	N/A	9.1	67.7	23.2	-	-	-	-	5.1	
3	BULK	10-14	SM	N/A	39.5	46.7	13.8	X	Non-Plastic			-	
4	SPT	14-15	SM	N/A	22.3	58.6	19.1	-	-	-	-	6.1	
5	BULK	16-18	SM	N/A	31.3	55.1	13.2	X	Non-Plastic			-	
6	SPT	18-19	SM	N/A	20.5	53.1	26.2	-	-	-	-	7.2	
7	BULK	20-23	GP-GM	N/A	47.2	41.3	11.5	-	-	-	-	-	
8	SPT	24-25	-	N/A	-	-	-	-	-	-	-	5.2	
9	BULK	25-28	SM-SC	N/A	32.4	48.1	19.5	-	-	-	-	-	
10	SPT	28-29	-	N/A	-	-	-	-	-	-	-	-	
11	BULK	32-34	SM	N/A	25.3	47.9	26.8	-	-	-	-	-	
12	SPT	34-35	SM	N/A	1.9	57.4	40.7	-	-	-	-	7.5	
13	BULK	35-38	-	N/A	-	-	-	-	-	-	-	-	
14	BULK	40-43	SM	N/A	27.4	47.5	25.1	-	16	14	2	-	
15	SPT	44-45	SM	N/A	5.5	57.8	36.7	-	-	-	-	8.2	
16	BULK	45-48	-	N/A	-	-	-	-	-	-	-	-	
17	SPT	48-49	-	N/A	-	-	-	-	-	-	-	3.6	
18	BULK	50-53	SM	N/A	28.2	44.6	27.2	-	16	14	2	-	
19	SPT	54-55	-	N/A	-	-	-	-	-	-	-	14.1	
20	BULK	55-58	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-52

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD-83-52

SAMPLE 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 (%)	
21	SPT	52-60	-	N/A	-	-	-	-	-	-	-	8.6	
22	BULK	60-63	SM-SC	N/A	27.6	42.9	29.5	-	18	14	4	-	
23	SPT	64-66	ML-CL	N/A	-	-	-	-	20	15	5	9.4	
24	BULK	66-68	SM	N/A	35.6	41.9	27.5	-	-	-	-	-	
25	SPT	68-69	-	N/A	-	-	-	-	-	-	-	-	
26	BULK	70-73	-	N/A	-	-	-	-	-	-	-	-	
27	SPT	74-75	-	N/A	-	-	-	-	-	-	-	-	
28	BULK	75-77	-	N/A	-	-	-	-	-	-	-	-	
29	BULK	81-83	-	N/A	-	-	-	-	-	-	-	-	
30	BULK	83-86	SC	N/A	21.8	43.5	35.0	-	25	14	11	-	
31	BULK	86-88	-	N/A	-	-	-	-	-	-	-	-	
32	SPT	88-89	-	N/A	-	-	-	-	-	-	-	-	
33	BULK	90-93	-	N/A	-	-	-	-	-	-	-	-	
34	BULK	95-98	-	N/A	-	-	-	-	-	-	-	-	
35	SPT	98-99	-	N/A	-	-	-	-	-	-	-	6.5	
36	BULK	100-103	SM	N/A	39.6	42.0	18.4	X	Non-Plastic			-	
37	BULK	105-108	-	N/A	-	-	-	-	-	-	-	-	
38	SPT	108-109	-	N/A	-	-	-	-	-	-	-	-	
39	BULK	110-113	-	N/A	-	-	-	-	-	-	-	-	
40	BULK	115-118	SM-SC	N/A	31.1	44.6	24.3	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-52

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-52

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
41	BULK	118-120	SM	N/A	33.9	50.2	15.9	-	-	-	-	-	
42	BULK	123-128	-	N/A	-	-	-	-	-	-	-	-	
43	SPT	128-129	SC	N/A	6.4	52.4	41.2	-	31	17	14	9.1	
44	BULK	130-135	SM	N/A	26.4	47.8	25.8	-	Non-Plastic			-	
45	BULK	135-138	-	N/A	-	-	-	-	-	-	-	-	
46	SPT	138-139	CL	N/A	-	-	-	-	34	17	17	7.7	
47	BULK	140-145	SL	N/A	22.4	41.3	36.3	X	26	14	12	-	
48	BULK	150-153	SM	N/A	13.3	67.3	19.4	X	Non-Plastic			-	
49	-	-	-	-	-	-	-	-	-	-	-	-	
50	-	-	-	-	-	-	-	-	-	-	-	-	
51	BULK	155-158	SM	N/A	12.2	68.7	19.1	X	Non-Plastic			-	
52	BULK	160-163	-	N/A	-	-	-	-	-	-	-	-	
53	BULK	165-169	SM	N/A	15.3	70.2	14.5	-	Non-Plastic			-	
54	BULK	170-174	-	N/A	-	-	-	-	-	-	-	-	
55	BULK	175-177	SM	N/A	10.2	64.8	25.0	X	Non-Plastic			-	G _S =2.81
56	BULK	180-181	SW-SM	N/A	40.1	51.8	8.1	X	17	14	3	-	G _S =2.77
57	BULK	185-188	SM	N/A	9.0	72.6	18.4	X	Non-Plastic			-	
58	BULK	190-195	CL-ML	N/A	16.4	31.6	52.0	X	23	17	6	-	G _S =2.82
59	BULK	195-198	-	N/A	-	-	-	-	-	-	-	-	
60	BULK	200-204	CL	N/A	0.0	21.7	78.3	X	29	19	10	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-52

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD-83-52

SAMPLE 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 (%)	
61	BULK	205-208	SM-SC	N/A	6.3	46.8	-	22	18	4	-		
62	SPT	208-209	SM	N/A	7.4	75.6	17.0	-	-	-	-	13.2	
63	BULK	210-215	SW-SM	N/A	17.5	73.5	9.0	-	Non-Plastic			-	
64	BULK	215-218	SP-SM	N/A	0.7	89.4	9.4	-	-	-	-	-	
65	SPT	218-219	SM	N/A	0.0	86.8	13.2	-	-	-	-	-	
66	BULK	222-225	-	N/A	-	-	-	-	-	-	-	-	
67	BULK	225-228	SM	N/A	13.6	68.1	18.3	-	Non-Plastic			-	
68	SPT	228-229	SM	N/A	0.0	55.5	44.5	-	-	-	-	20.5	
69	BULK	230-235	SM	N/A	14.2	66.7	19.1	-	-	-	-	-	
70	BULK	235-238	-	N/A	-	-	-	-	-	-	-	-	
71	SPT	238-239	SM	N/A	13.8	68.7	17.5	-	-	-	-	6.1	
72	BULK	240-245	SM	N/A	29.5	52.0	18.5	-	-	-	-	-	
73	BULK	245-248	-	N/A	-	-	-	-	-	-	-	-	
74	SPT	248	SM	N/A	37.6	53.6	8.9	-	-	-	-	-	
75	BULK	250-255	SM	N/A	27.8	56.3	15.9	-	-	-	-	-	
76	BULK	255-258	-	N/A	-	-	-	-	-	-	-	-	
77	-	-	-	-	-	-	-	-	-	-	-	-	
78	BULK	258-261	SM	N/A	32.5	45.7	21.8	-	Non-Plastic			-	
79	BULK	261-269	-	N/A	-	-	-	-	-	-	-	-	
80	SPT	268	SM	N/A	23.9	63.8	12.3	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-52

Gusitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO. HD-83-52

SAMPLE 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 (%)	
81	BULK	268-271	SM	N/A	37.2	50.6	12.2	-	-	-	-	-	
82	BULK	274-278	-	N/A	-	-	-	-	-	-	-	-	
83	SPT	278-279	-	N/A	-	-	-	-	-	-	-	-	
84	BULK	278-281	SM	N/A	21.8	64.3	13.9	X	-	-	-	-	G _s =2.74
85	BULK	282-286	-	N/A	-	-	-	-	-	-	-	-	
86	BULK	286-288	SP-SM	N/A	39.4	50.2	10.8	-	-	-	-	-	
87	BULK	288-292	-	N/A	-	-	-	-	-	-	-	-	
88	BULK	295-298	SP-SM	N/A	35.3	54.0	10.7	-	-	-	-	-	
89	SPT	298	-	N/A	-	-	-	-	-	-	-	-	
90	BULK	298-302	-	N/A	-	-	-	-	-	-	-	-	
91	BULK	302-307	GP-GM	N/A	47.5	42.1	10.4	X	-	-	-	-	
92	BULK	307-308	SM	N/A	31.2	47.7	21.1	X	-	-	-	-	
93	SPT	308-309	-	N/A	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. HD83-52

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

HD83-53

SAMPLE 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 (%)	
1A	BULK	10-19	SM	0.0	13.4	73.2	13.4	-	-	-	-	-	
1	BULK	19-22	SM	0.0	18.3	53.6	28.1	-	16	16	0	-	
2		-	-	-	-	-	-	-	-	-	-	-	
3	BULK	30-32	SC-SM	0.0	27.2	31.9	40.4	X	22	16	6	-	G _S =2.72
4	BULK	36-38	SC	0.0	30.6	33.6	35.8	X	25	15	10	-	
5	SPT	38-39	GC	0.0	39.3	25.7	35.0	X	36	17	19	12.6	
6	BULK	45-47	SC-SM	0.0	28.2	43.5	28.3	X	20	14	6	-	G _S =2.71
7	BULK	57-58	-	-	-	-	-	-	-	-	-	-	
8	BULK	60-62	SC	15.8	26.4	35.4	22.4	-	24	15	9	-	
9	BULK	66-68	-	-	-	-	-	-	-	-	-	-	
10	BULK	70-72	SC	0.0	33.2	40.6	26.2	X	21	13	8	-	
11	BULK	66-68	-	-	-	-	-	-	-	-	-	-	
12	BULK	80-82	SC	0.0	29.3	44.1	26.6	-	19	11	8	-	
13	BULK	86-88	-	-	-	-	-	-	-	-	-	-	
14	BULK	90-92	SC	0.0	40.1	41.8	18.1	-	22	14	8	-	
15	BULK	96-98	-	-	-	-	-	-	-	-	-	-	
16	BULK	100-102	GC	0.0	36.4	34.3	29.3	-	22	14	8	-	
17	BULK	106-108	-	-	-	-	-	-	-	-	-	-	
18	BULK	110-112	GC	0.0	42.4	27.9	29.7	-	25	16	9	-	
19	BULK	116-118	-	-	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No.

HD83-53

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

HD83-53

Remarks:

Boring No. HD83-53

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

WW#3

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY		L.L.	P.L.	PI.		
1	BULK	3-5	SM	0.0	20.9	51.6	27.5	-	-	-	-	-	
2	BULK	8-10	SM	0.0	24.6	44.2	31.2	-	-	-	-	-	
3	BULK	13-15	SM	0.0	16.9	44.2	33.9	-	Non-Plastic				
4	BULK	18-20	SM	0.0	8.8	48.5	42.7	-	-	-	-	-	
5	BULK	23-25	-	-	-	-	-	-	-	-	-	-	
6	BULK	28-30	SM	4.8	31.3	41.6	22.3	-	-	-	-	-	
7	BULK	33-35	SM-SC	0.0	28.6	43.4	28.0	-	19	14	5	-	
					17.8	49.4	32.8						
8	BULK	38-40	SM-SC	0.0	19.5	47.8	32.7	-	18	14	4	-	G _S =2.72
					16.3	46.8	36.9						
9	BULK	43-45	SM	0.0	15.1	45.8	39.1	-	-	-	-	-	
10	BULK	48-50	SM	0.0	17.1	53.2	29.7	-	-	-	-	-	
11	BULK	50-51	SM	4.0	17.3	39.5	39.2	-	-	-	-	-	
12	BULK	57	SM	0.0	8.2	53.3	38.5	-	-	-	-	-	
13	BULK	60-61	SM	0.0	24.8	45.8	29.4	-	-	-	-	-	
14	BULK	70-71	SM	0.0	12.2	38.8	49.8	-	-	-	-	-	
15	BULK	78-79	ML	0.0	1.1	10.6	88.3	-	-	-	-	-	
16	BULK	82-83	ML	0.0	2.5	26.7	70.8	-	-	-	-	-	
17	BULK	88-89	SM	0.0	23.7	40.1	36.2	-	-	-	-	-	
18	BULK	93-94	SM	0.0	4.4	46.3	49.3	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. WW#3

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

WW#3

SAMPLE NO.	SAMPLE TYPE	DEPTH (FEET)	UNIFIED SOIL CLASSIFICATION SYSTEM	PARTICLE SIZE ANALYSIS					ATTERBERG LIMITS			MOIST. CONTENT	REMARKS
				SIEVE ANALYSIS (%)				HYDRO-METER TEST				W _c (%)	
				COBBLE	GRAVEL	SAND	SILT/CLAY						
19	BULK	98-99	SM	0.0	27.2	24.8	43.0	-	-	-	-	-	
20	BULK	103-104	GM	0.0	41.4	38.9	19.7	-	-	-	-	-	
21	BULK	108-109	SM	0.0	25.0	43.7	31.3	-	-	-	-	-	
22	BULK	112-113	SM	0.0	19.8	45.5	34.7	-	-	-	-	-	
23	BULK	118-117	SM	0.0	5.1	61.6	33.3	-	-	-	-	-	
24	BULK	123-124	SM	16.9	18.7	44.8	19.6	-	-	-	-	-	
25	BULK	128-129	GM	0.0	40.4	39.2	20.4	-	-	-	-	-	
26	BULK	134-135	SM	0.0	27.6	53.4	19.0	-	-	-	-	-	
27	BULK	137-138	GP-GM	0.0	64.4	30.3	5.4	-	-	-	-	-	
28	BULK	143-144	CL	-	-	-	-	-	43	23	20	-	
29	BULK	156-157	ML	0.0	1.1	43.5	55.4	-	-	-	-	-	
30	BULK	157 ⁵	ML	0.0	0.3	39.1	57.4	-	-	-	-	-	
31	BULK	159-160	SM	0.0	19.1	72.4	18.5	-	-	-	-	-	
32	BULK	161-162	SM	0.0	17.7	51.0	31.3	-	-	-	-	-	
33	BULK	164-167	GP	0.0	48.3	46.8	4.9	-	-	-	-	-	
			GM	0.0	47.8	37.7	14.7	-	-	-	-	-	
34	BULK	174-175	-	-	-	-	-	-	-	-	-	-	
35	BULK	175-176	-	-	-	-	-	-	-	-	-	-	
36	BULK	176-177	-	-	-	-	-	-	-	-	-	-	
37	BULK	177-178	-	-	-	-	-	-	-	-	-	-	

Remarks:

LAB TEST SUMMARY

Boring No. WW#3

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

BORING NO.

[illegible]

Remarks:

LAB TEST SUMMARY

Logging No. WW#3

Susitna Hydroelectric Project

HARZA-EBASCO

SUSITNA JOINT VENTURE

3. GRADATION CURVES

3.1 River Channel

3.1.1 Main Dam

3.1.2 Upstream Cofferdam

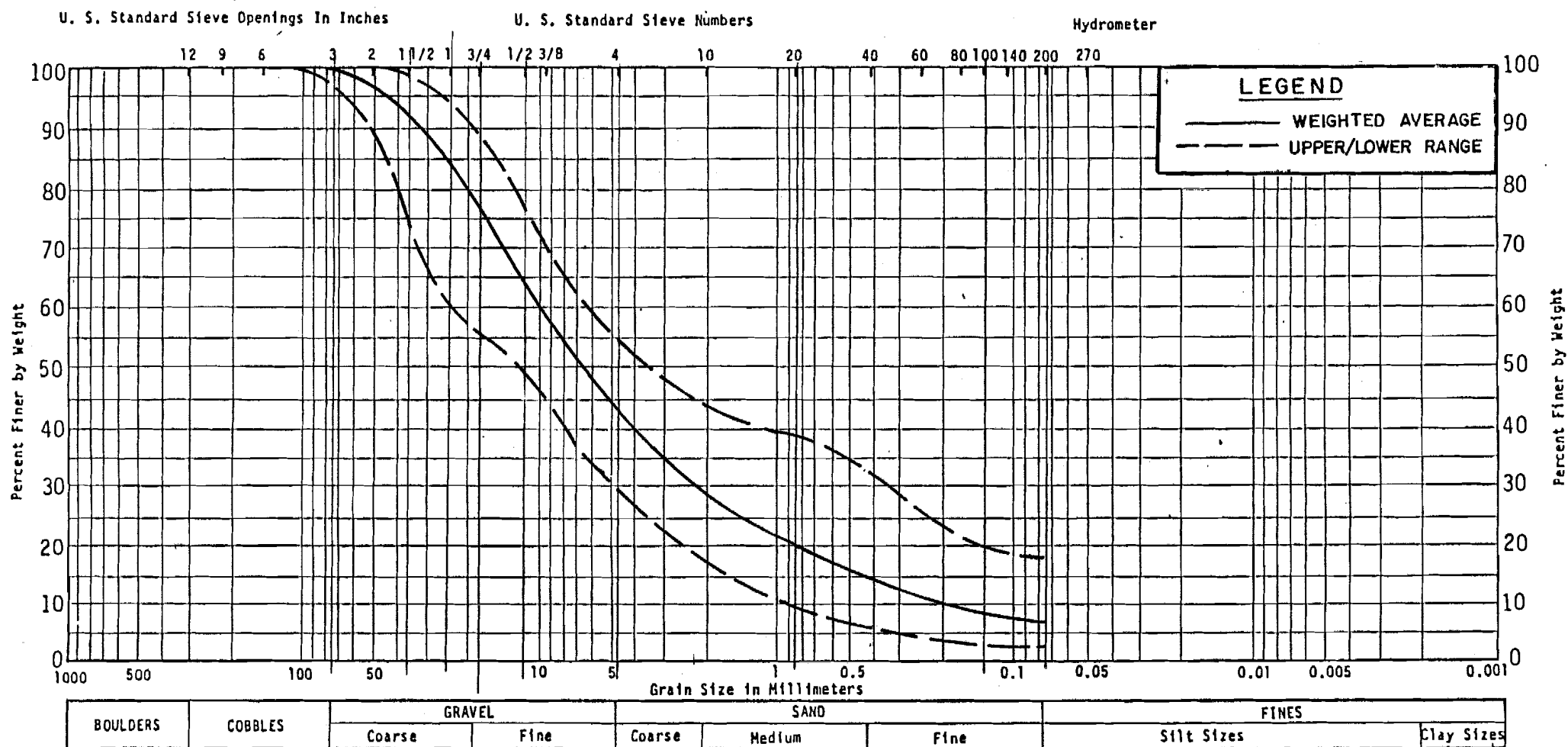
3.1.3 Downstream Cofferdam

3.1.4 Portals

3.2 Relict Channel

3.1 RIVER CHANNEL

GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)
MAIN DAM	HD 83	39	20.8	WELL GRADED SANDY GRAVEL (GW-GM)
CENTERLINE	10-13,			
	42-46			

COMMENT: 48' OF SAMPLE

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA DEVELOPMENT
RIVER CHANNEL
DAM AXIS FDN. AREA
SANDY GRAVEL GRADATION
HARZA-ERASSCO SUSITNA JOINT VENTURE
DATE AUG 1983
FIGURE D1

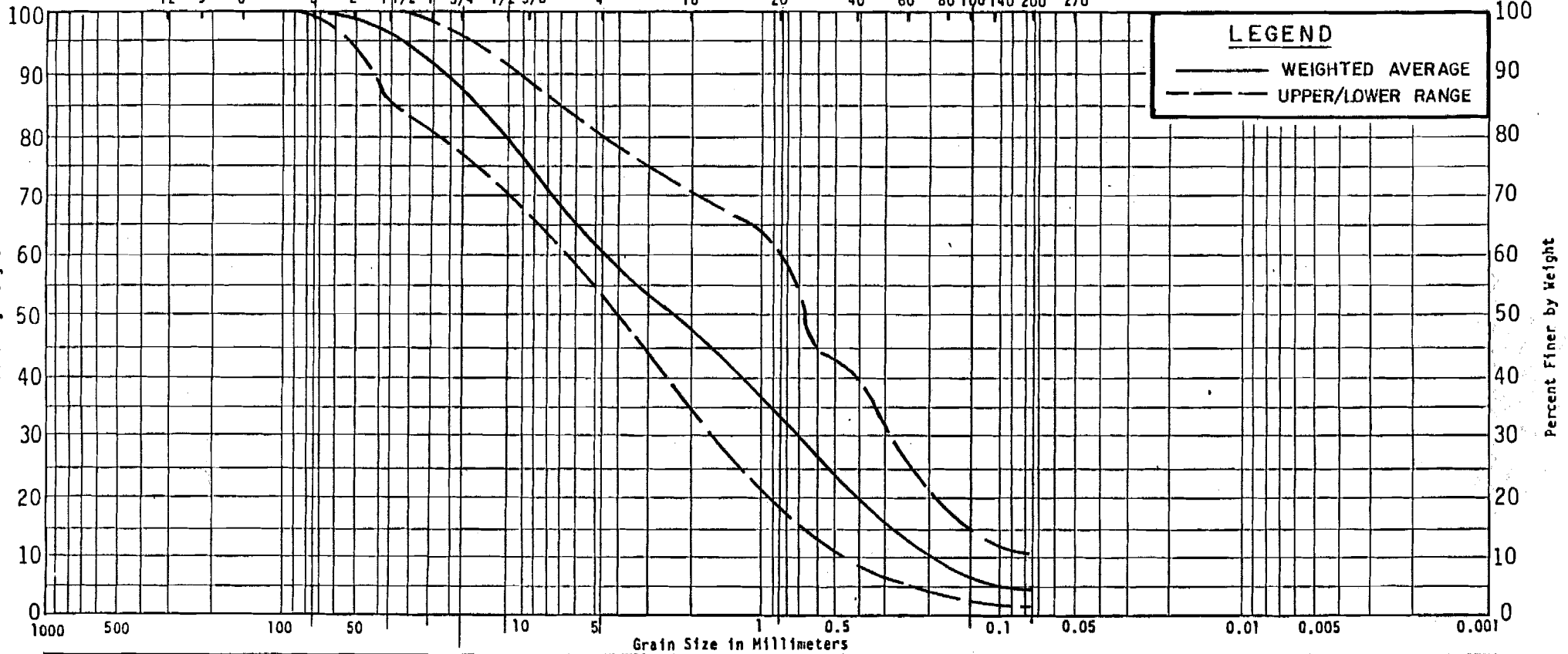
GRADATION SIZE ANALYSIS

U. S. Standard Sieve Openings In Inches

U. S. Standard Sieve Numbers

Hydrometer

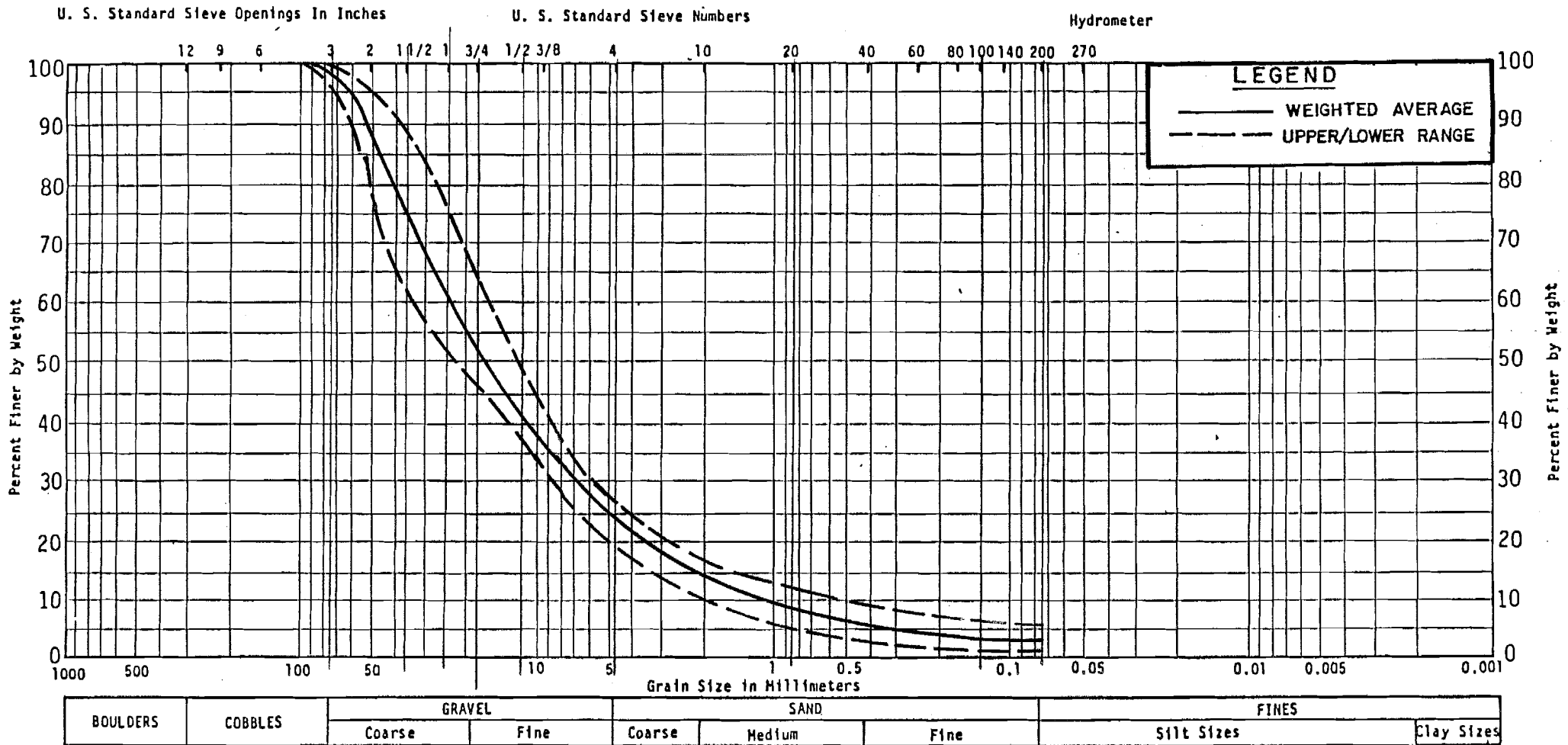
12 9 6 3 2 1 1/2 1 3/4 1/2 3/8 4 10 20 40 60 80 100 140 200 270



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

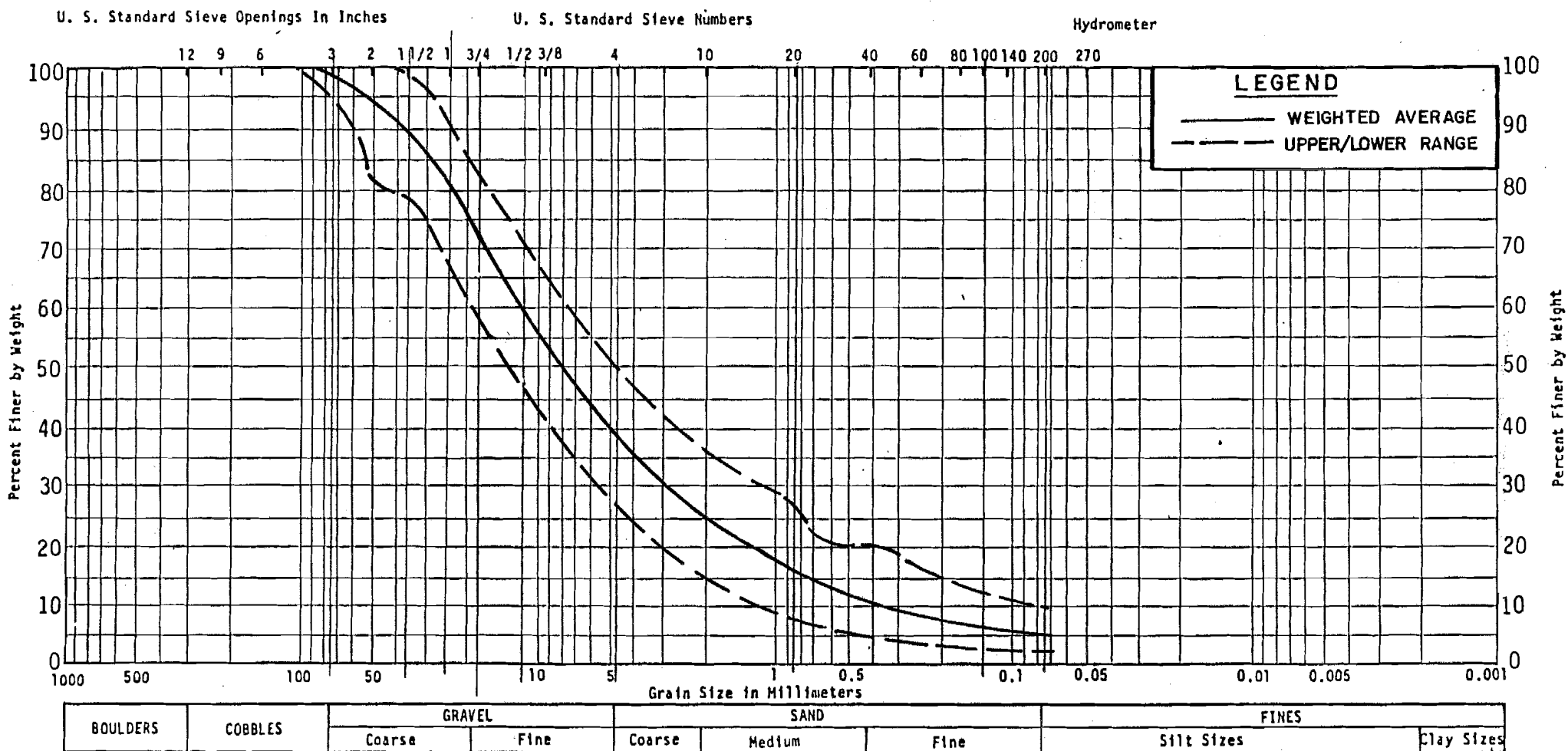
LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RIVER CHANNEL DAM AXIS FDN. AREA GRAV. SAND GRADATION		
MAIN DAM	HD 83 10,	18	12.8	POORLY GRADED GRAVELLY SAND,			
CENTERLINE	11, 13, 42-45			(SP-SM)			
COMMENT: 72' OF SAMPLE					HARZA-EMSCO	DATE AUG 1983	FIGURE D2

GRADATION SIZE ANALYSIS



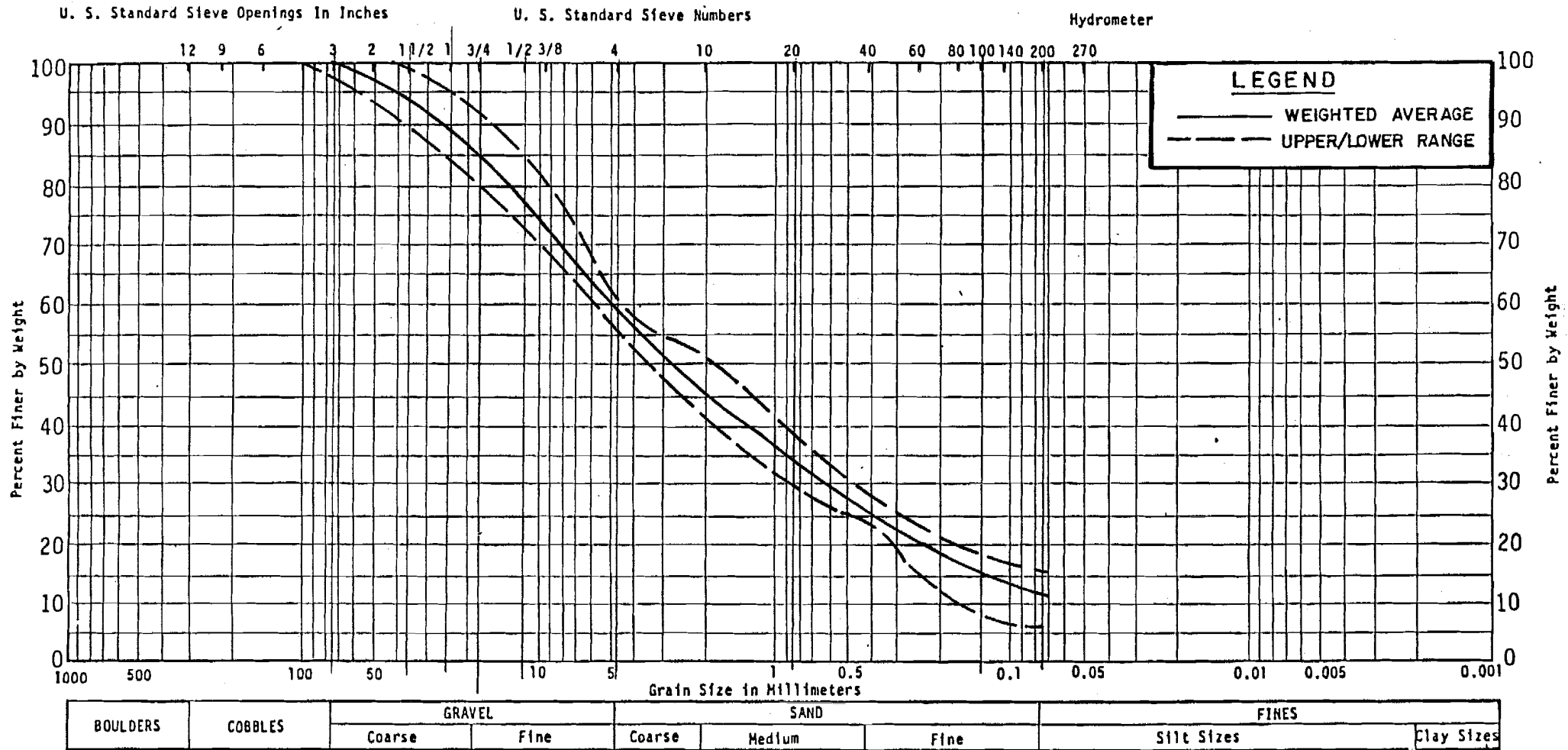
LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY			
UPSTREAM	HD 83-37 & 38	10	39.4	WELL GRADED GRAVEL, (GW)	SUSITNA HYDROELECTRIC PROJECT			
SHELL					WATANA DEVELOPMENT			
					RIVER CHANNEL			
					AREA U/S OF DAM AXIS			
					GRAVEL GRADATION			
COMMENT: 41' OF SAMPLE					HARRIS-ERASCO SUSITNA JOINT VENTURE	DATE AUG 1983	FIGURE D3	

GRADATION SIZE ANALYSIS



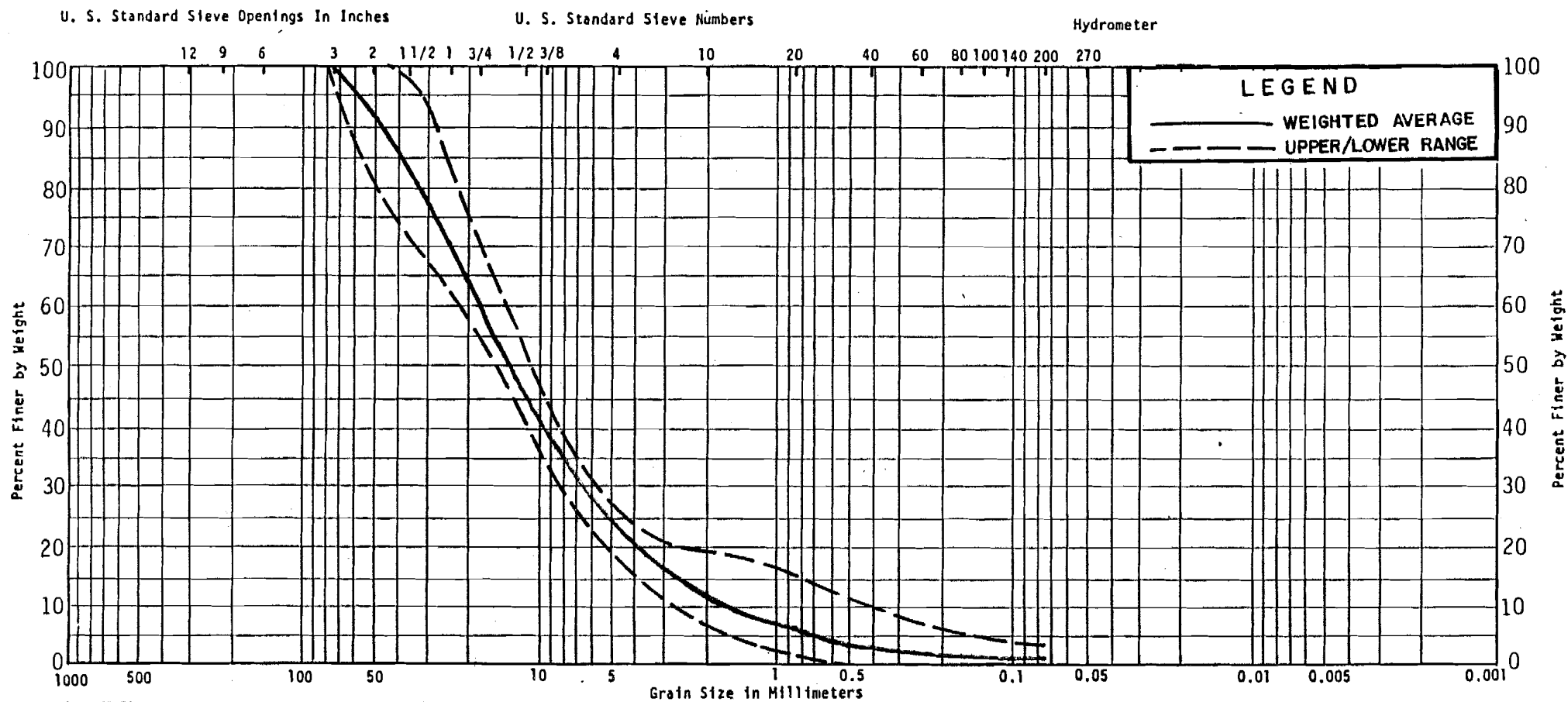
LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
UPSTREAM	HD 83-37-39	25	23.5	WELL GRADED SANDY GRAVEL,	SUSITNA HYDROELECTRIC PROJECT		
SHELL				(GW-GM)	WATANA DEVELOPMENT		
					RIVER CHANNEL		
					AREA U/S OF DAM AXIS		
					SANDY GRAVEL GRADATION		
COMMENT: 97' OF SAMPLE					HARZA-EMSCO	DATE AUG 1983	FIGURE D4
					SUSITNA JOINT VENTURE		

GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RIVER CHANNEL AREA U/S OF DAM AXIS GRAVELLY SAND GRADATION			
UPSTREAM	HD 83-38, 39	3	15.6	WELL GRADED GRAVELLY SAND, (SM)				
SHELL								
COMMENT: 9' OF SAMPLE					HAZA-EMSCO SUSITNA JOINT VENTURE			
					DATE		FIGURE	
					AUG 1983		D5	

GRADATION SIZE ANALYSIS



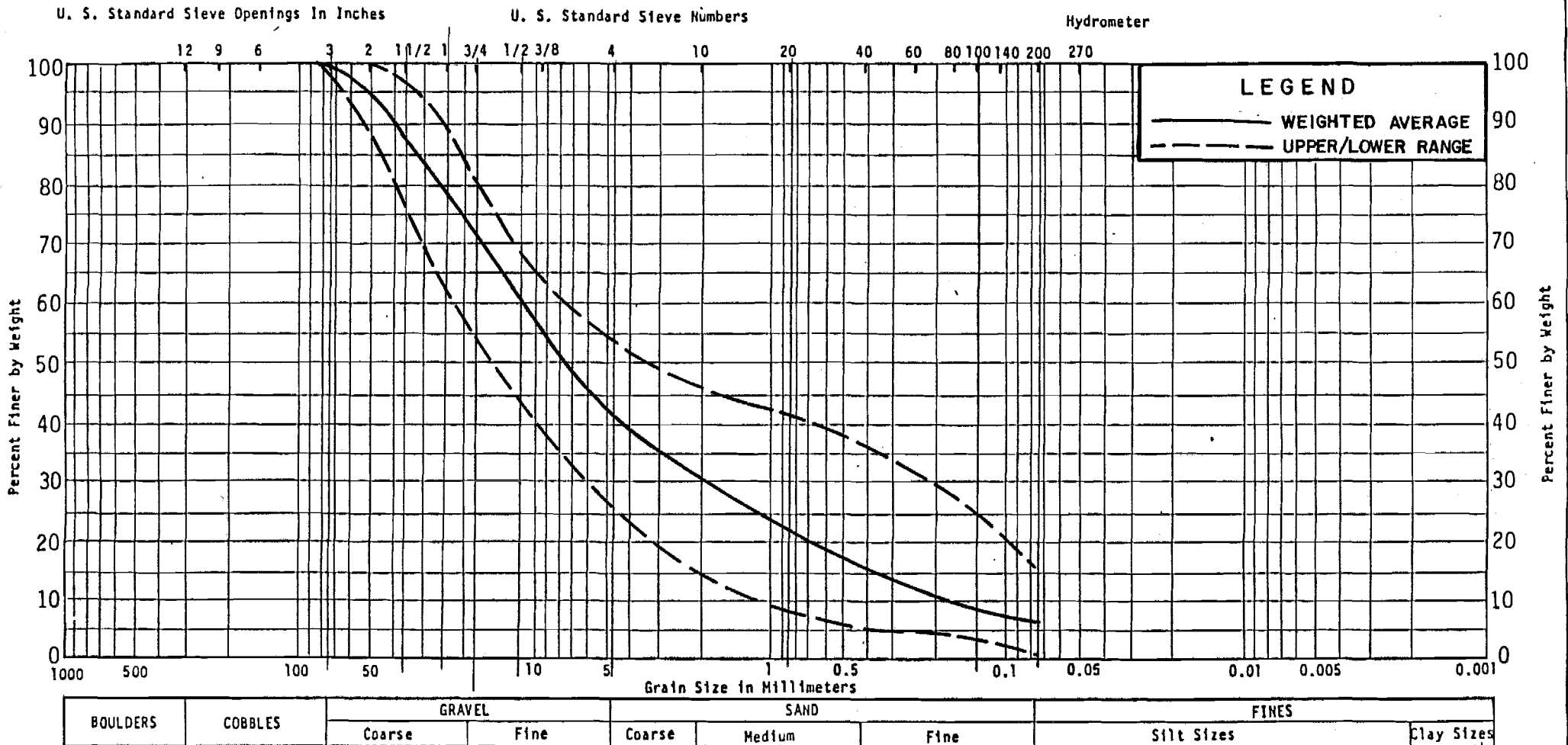
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)
UPSTREAM	HD 83- 17, 19,	7	30.8	WELL GRADED GRAVEL, (GW)
COFFERDAM	20, 21, & 22			

COMMENT: 24' OF SAMPLE

ALASKA POWER AUTHORITY	
SUSITNA HYDROELECTRIC PROJECT	
WATANA DEVELOPMENT	
RIVER CHANNEL	
U/S COFFERDAM FDN.	
GRAVEL GRADATION	
HAZARDOUS	DATE
INDIANA JOINT VENTURE	AUG 1983
FIGURE	D6

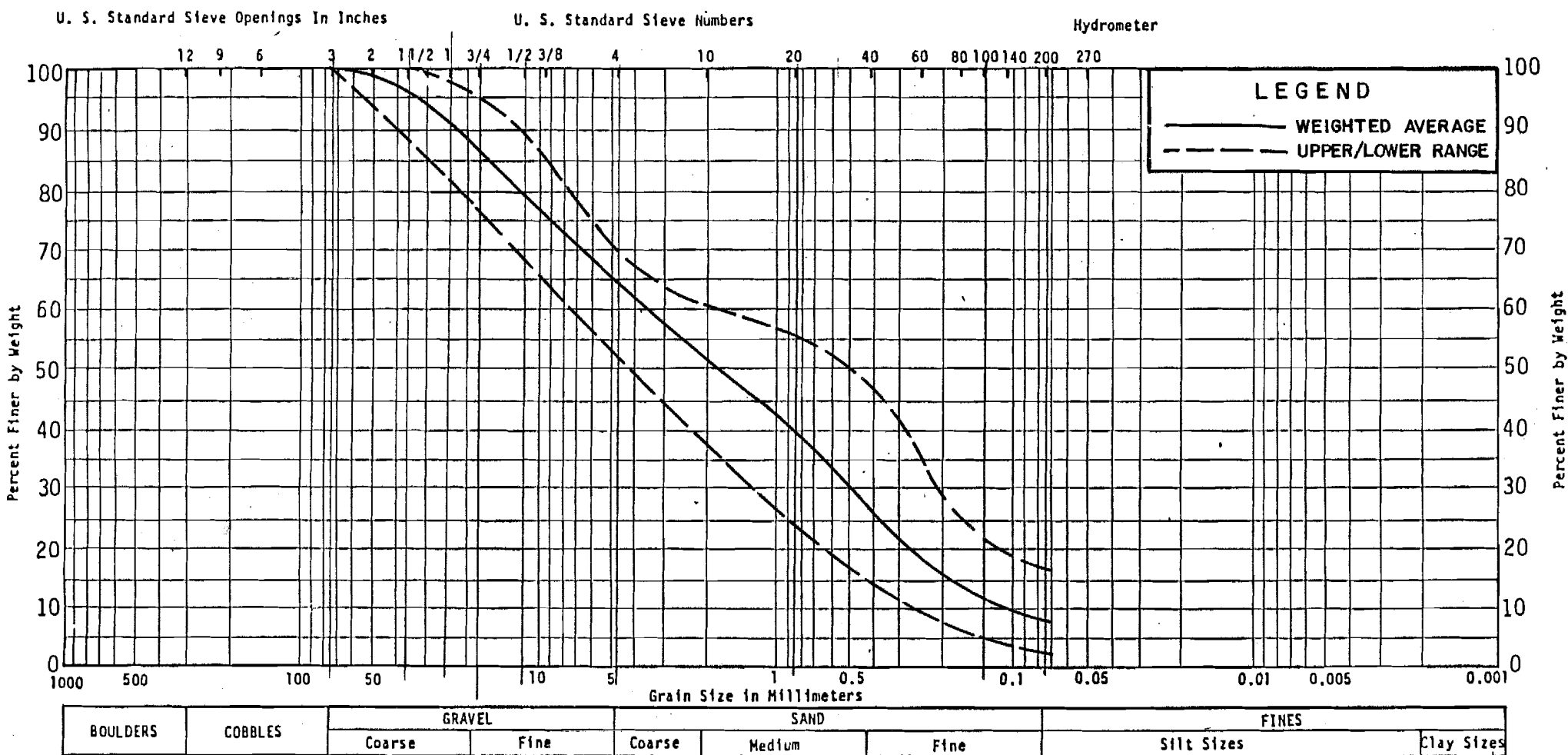
GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)
UPSTREAM	HD 83-17-23	32	25.1	WELL GRADED SANDY GRAVEL,
COFFERDAM	B 41			(GW-GM)
COMMENT: 99' OF SAMPLE				

ALASKA POWER AUTHORITY		
SUSITNA HYDROELECTRIC PROJECT		
WATANA DEVELOPMENT		
RIVER CHANNEL		
U/S COFFERDAM FDN		
SANDY GRAVEL GRADATION		
HAHLA-ERASCO SUSITNA JOINT VENTURE	DATE AUG 1983	FIGURE D7

GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)
UPSTREAM	HD 83-	18	11.2	POORLY GRADED GRAVELLY SAND
COFFERDAM	17-23, & 41			(SP - SM)

COMMENT: 47' OF SAMPLE

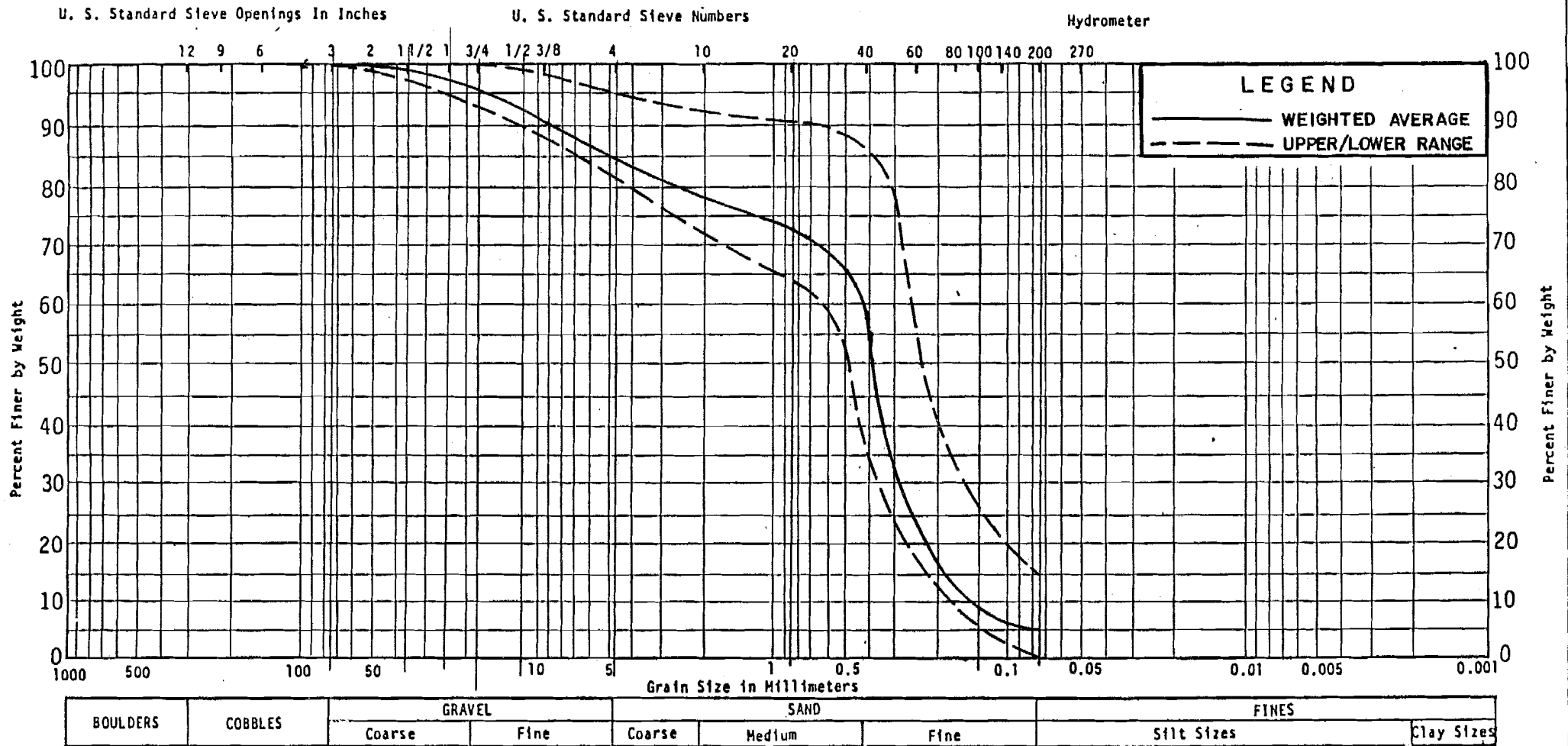
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA DEVELOPMENT
RIVER CHANNEL
U/S COFFERDAM FDN.
GRAVELLY SAND GRADATION

ISAHA-ERASCO
SUSITNA JOINT VENTURE

DATE
AUG 1983

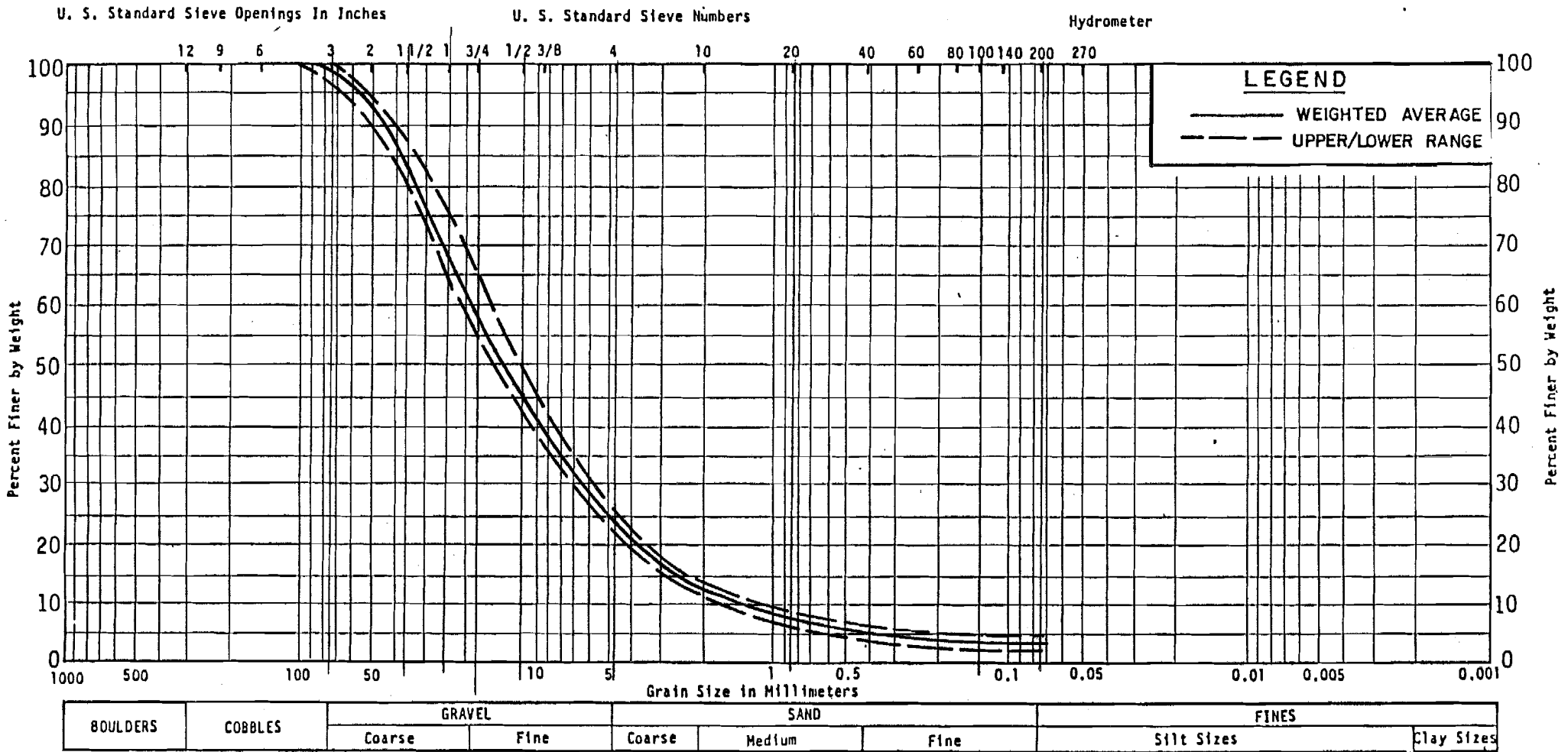
FIGURE
D8

GRADATION SIZE ANALYSIS



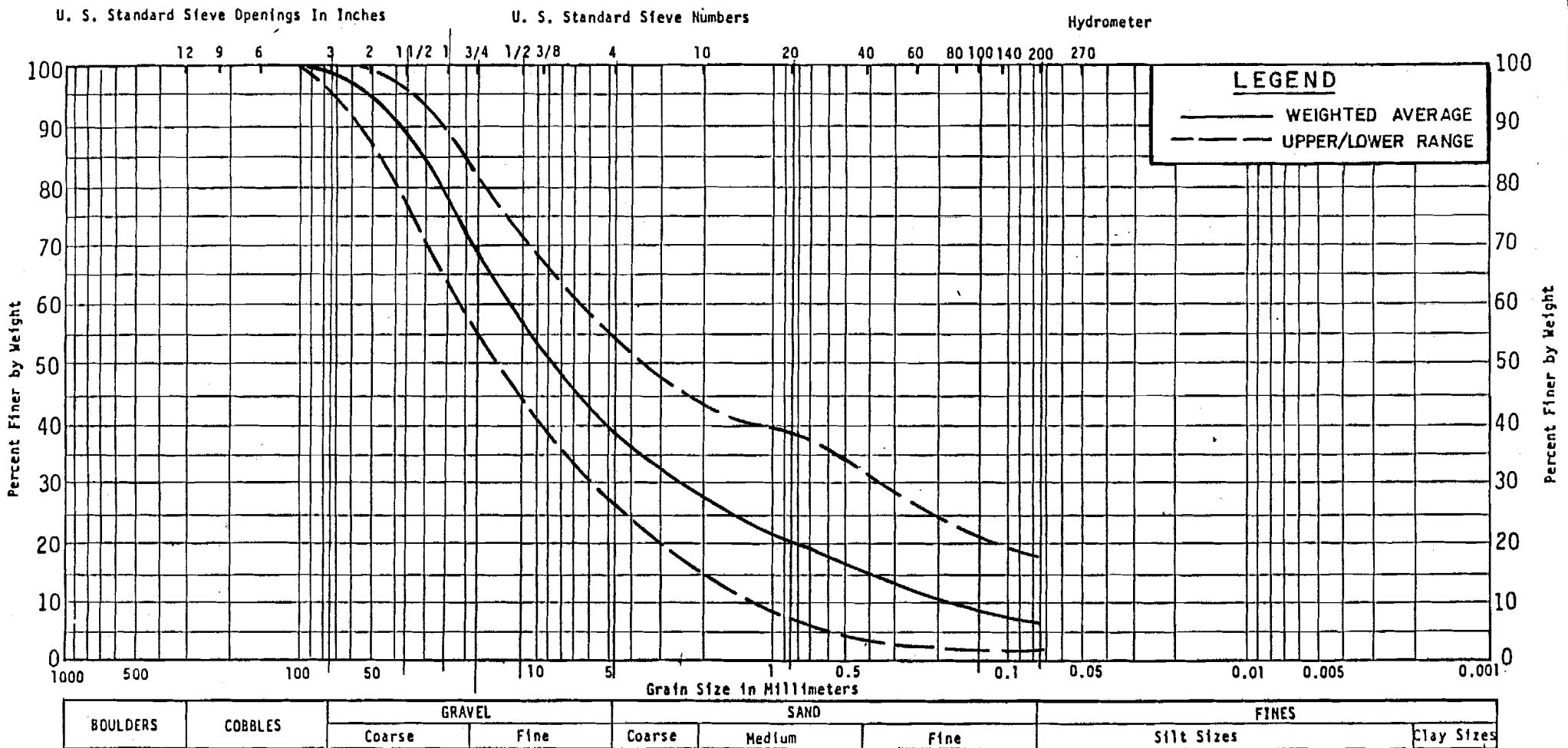
LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RIVER CHANNEL U/S COFFERDAM FDN. SAND GRADATION					
UPSTREAM	HD 83-19 B 21	4	3.7	POORLY GRADED SAND, (SP-SM)						
COFFERDAM										
COMMENT: 8' OF SAMPLE					MANA-EMSCO	DATE	FIGURE			
					SUSITNA JOINT VENTURE	AUG 1983	D9			

GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RIVER CHANNEL D/S COFFERDAM FDN. GRAVEL GRADATION			
DOWNSTREAM	HD 83-27,	3	37.4	WELL GRADED GRAVEL, (GW)				
COFFERDAM	29, & 31							
COMMENT: 8' OF SAMPLE					HAZA-ERASCO SUSITNA JOINT VENTURE			
					DATE AUG 1983			
					FIGURE D10			

GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)
DOWNSTREAM	HD 83-24	40	28.0	POORLY GRADED SANDY GRAVEL,
COFFERDAM	31, & 47			(GW-GM)

COMMENT: 138' OF SAMPLE

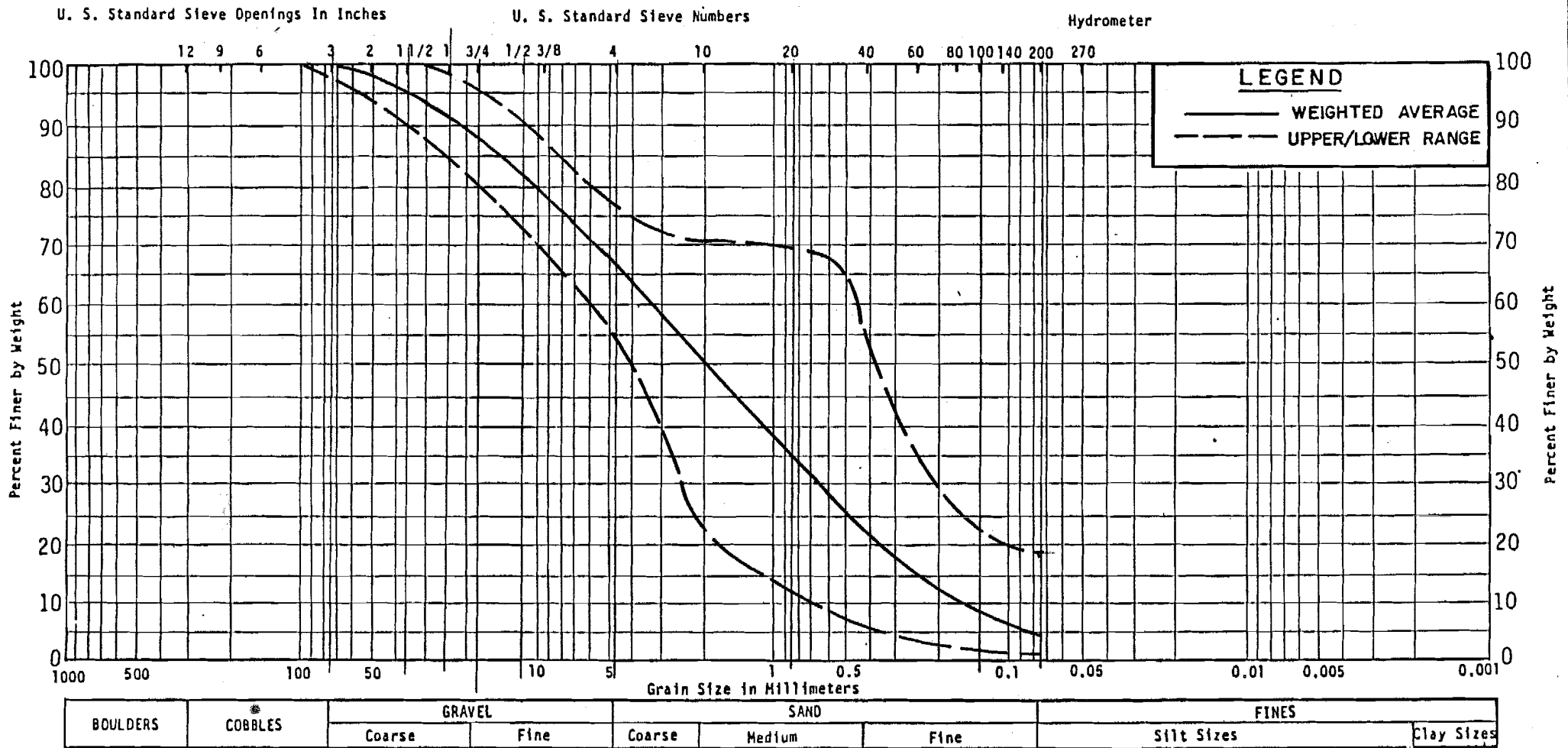
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA DEVELOPMENT
RIVER CHANNEL
D/S COFFERDAM FDN.
SANDY GRAVEL GRADATION

HAZARD-ERASCO
SUSITNA JOINT VENTURE

DATE
AUG 1983

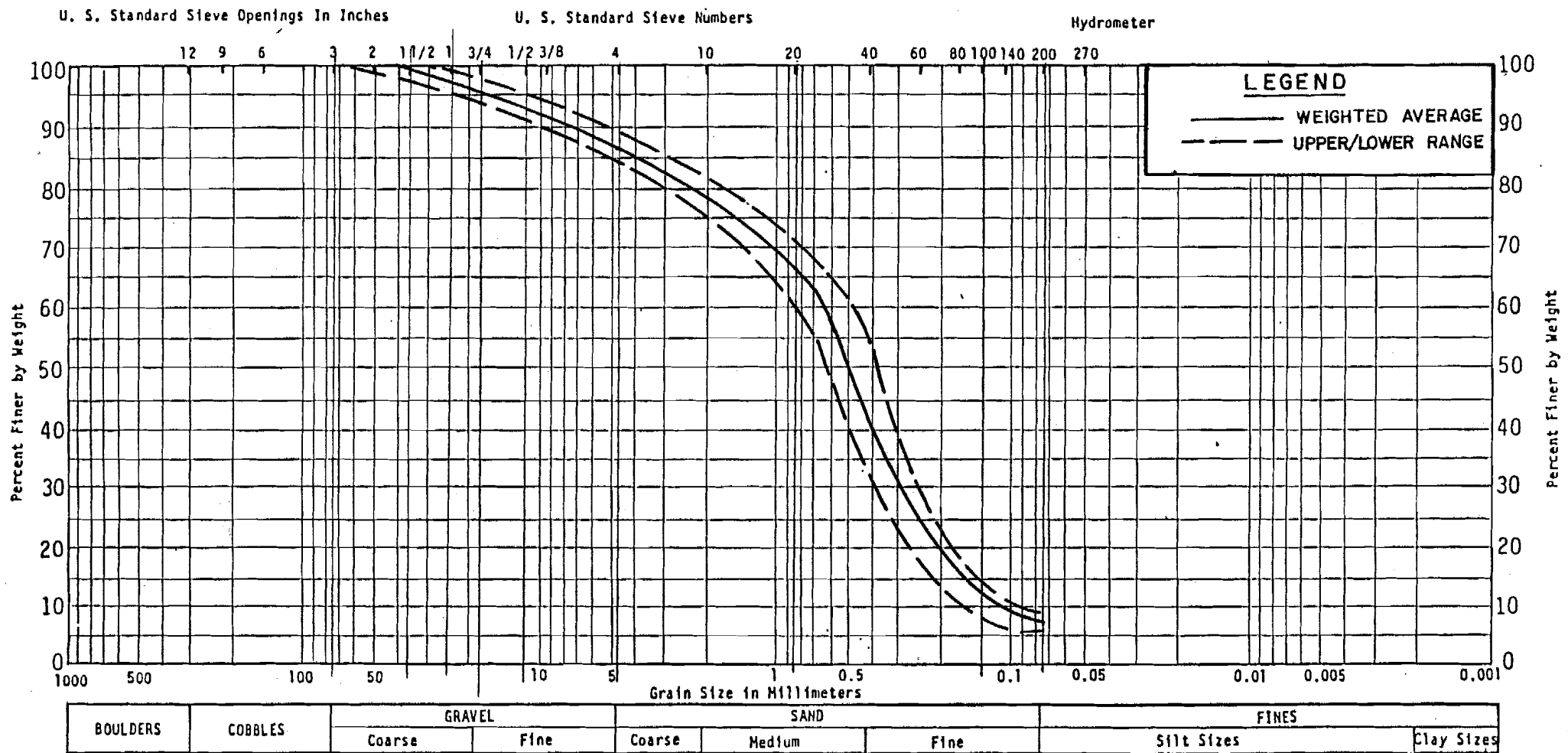
FIGURE
DII

GRADATION SIZE ANALYSIS



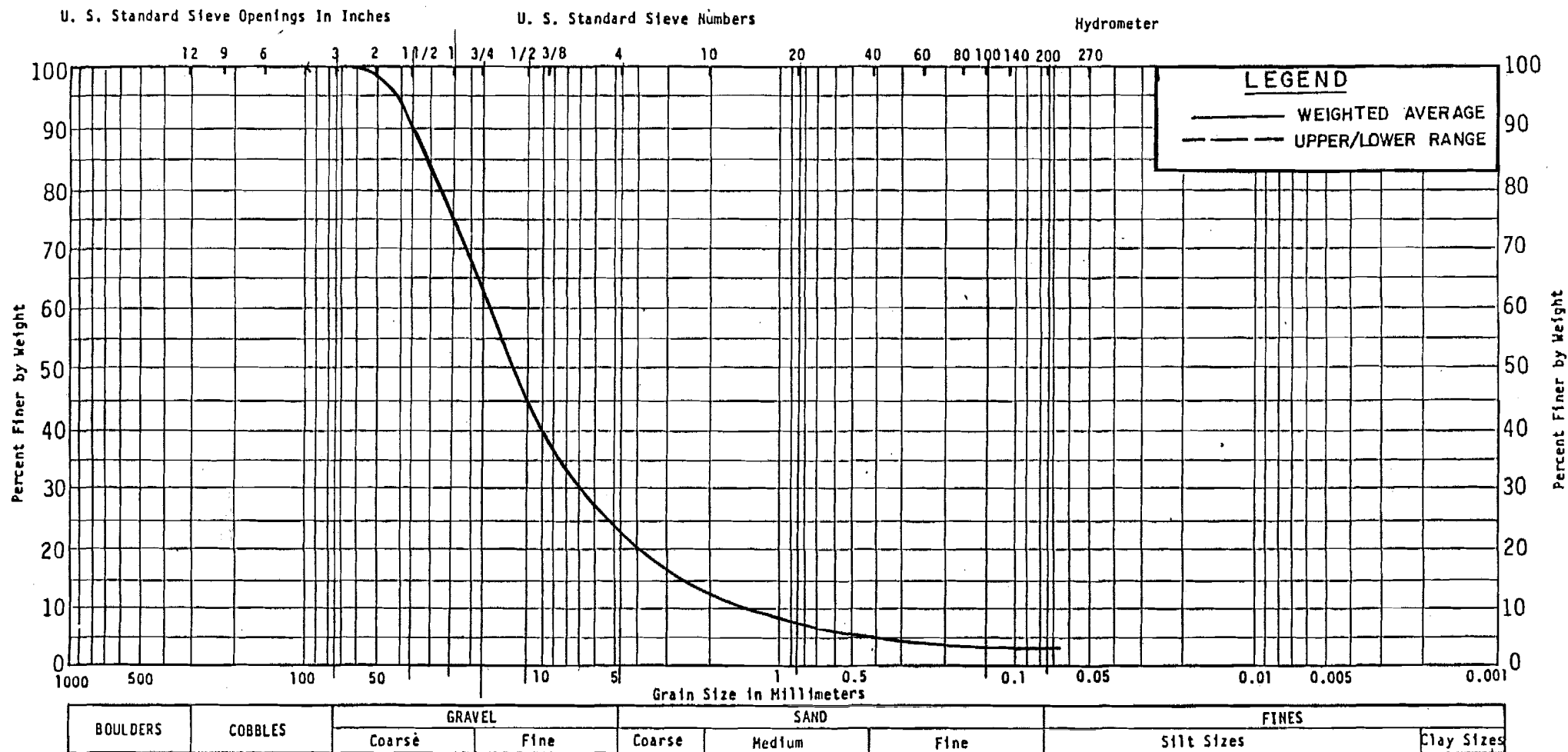
LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
DOWNSTREAM	HD 83- 25,	11	8.6	POORLY GRADED GRAVELLY SAND,	SUSITNA HYDROELECTRIC PROJECT		
COFFERDAM	26, 28, 30, 31,			(SP - SM)	WATANA DEVELOPMENT		
	47				RIVER CHANNEL		
COMMENT: 38' OF SAMPLE					D/S COFFERDAM FDN		
					GRAVELLY SAND GRADATION		
					HAZIA-ERASCO	DATE	FIGURE
					SUSITNA JOINT VENTURE	AUG 1983	D12

GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RIVER CHANNEL D/S COFFERDAM FDN. SAND GRADATION		
DOWNSTREAM	HD 83-28, 47	2	3.8	POORLY GRADED SAND,			
COFFERDAM				(SP-SM)			
COMMENT: 2' OF SAMPLE					HAZEL-ERASSCO	DATE	FIGURE
					SUSITNA JOINT VENTURE	AUG 1983	D13

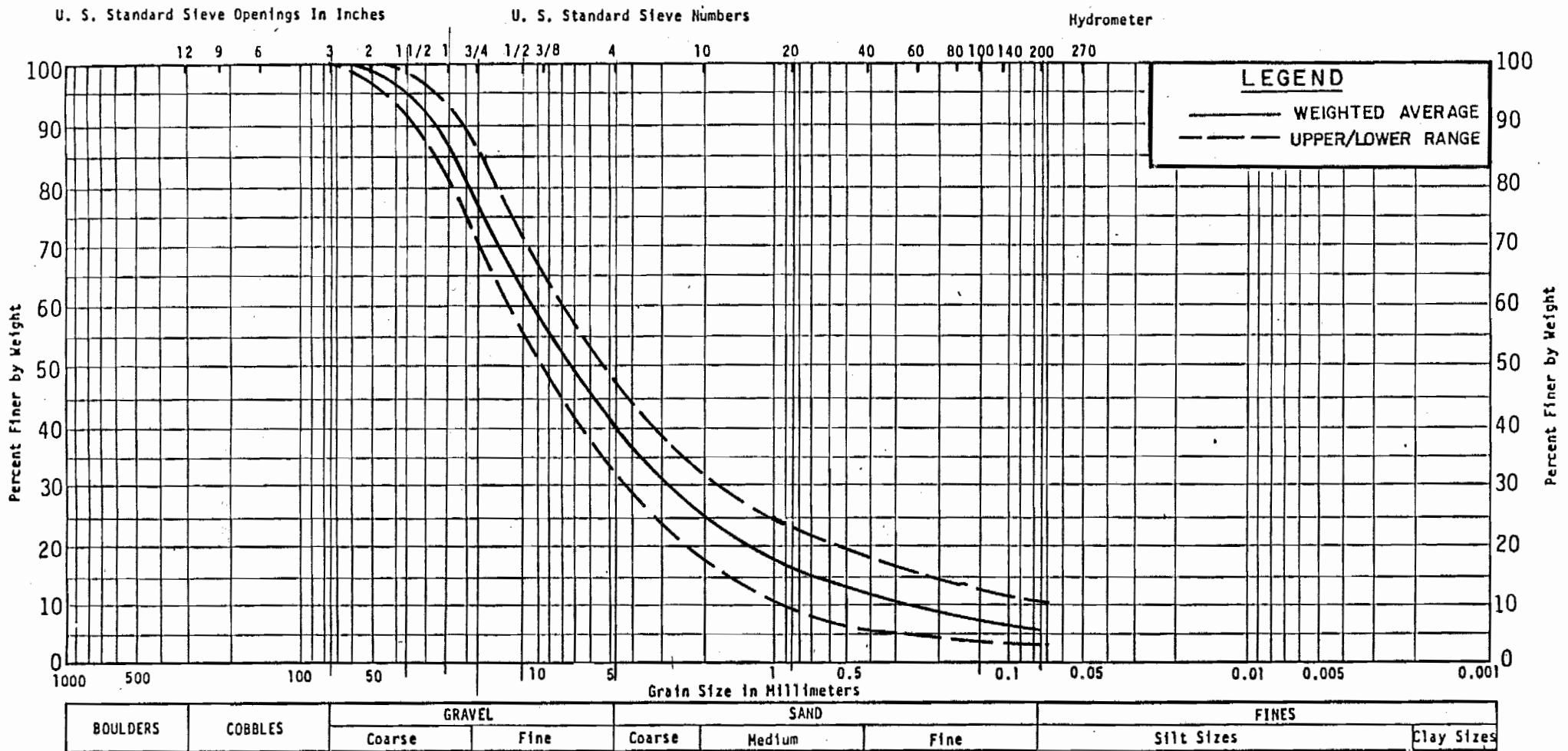
GRADATION SIZE ANALYSIS



LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)
DOWNSTREAM	HD 83-32	1	29.9	WELL GRADED GRAVEL, (GW)
PORTAL				
COMMENT: 3' OF SAMPLE				

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA DEVELOPMENT
RIVER CHANNEL
D/S PORTAL AREA
GRAVEL GRADATION
HARZA-ERASCO SUSITNA JOINT VENTURE DATE AUG1983 FIGURE DI4

GRADATION SIZE ANALYSIS

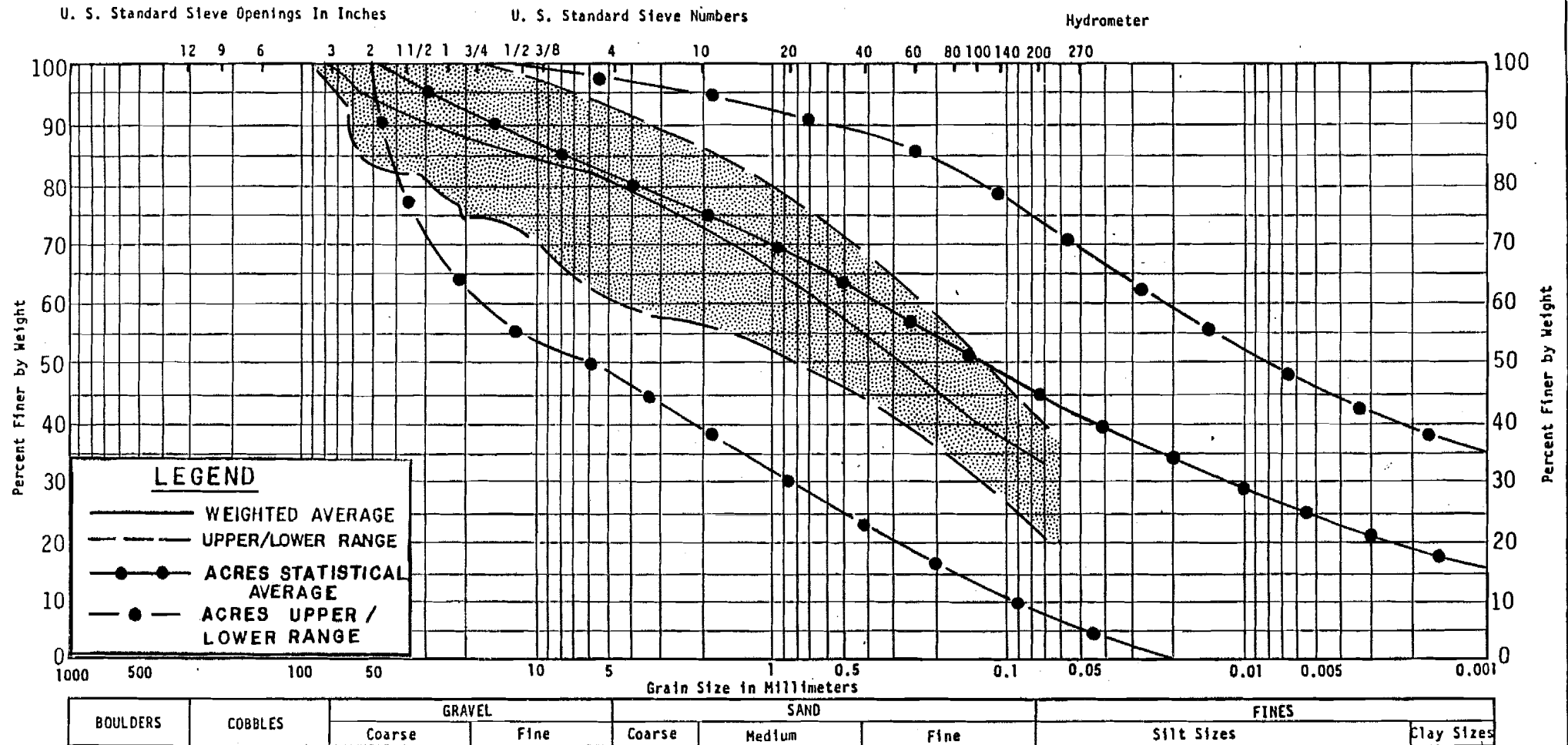


LOCATION	BORING NO.	NO. OF SAMPLES	% FRACTURE + 3/4"	CLASSIFICATION (USC)
DOWNSTREAM	HD 83-32-34	5	21.5	WELL GRADED SANDY GRAVEL,
PORTAL				(GW-GM)
COMMENT: 16' OF SAMPLES				

ALASKA POWER AUTHORITY		
SUSITNA HYDROELECTRIC PROJECT		
WATANA DEVELOPMENT		
RIVER CHANNEL		
D/S PORTAL AREA		
SANDY GRAVEL GRADATION		
HANZA-ERABCO SUSITNA JOINT VENTURE	DATE AUG 1983	FIGURE D15

3.2 RELICT CHANNEL

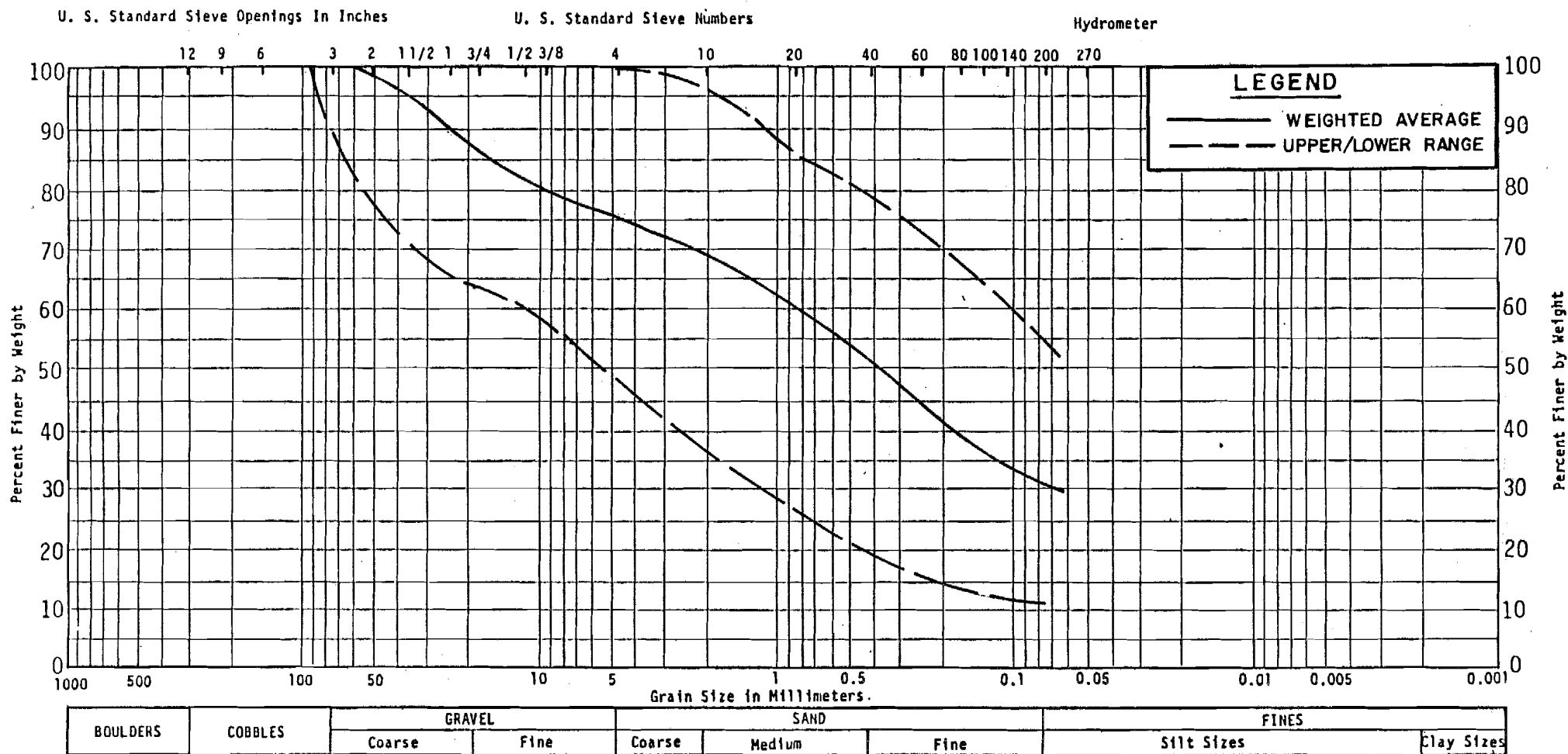
GRADATION SIZE ANALYSIS



BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)
WW-3	8	13	SILTY SAND, (SM)

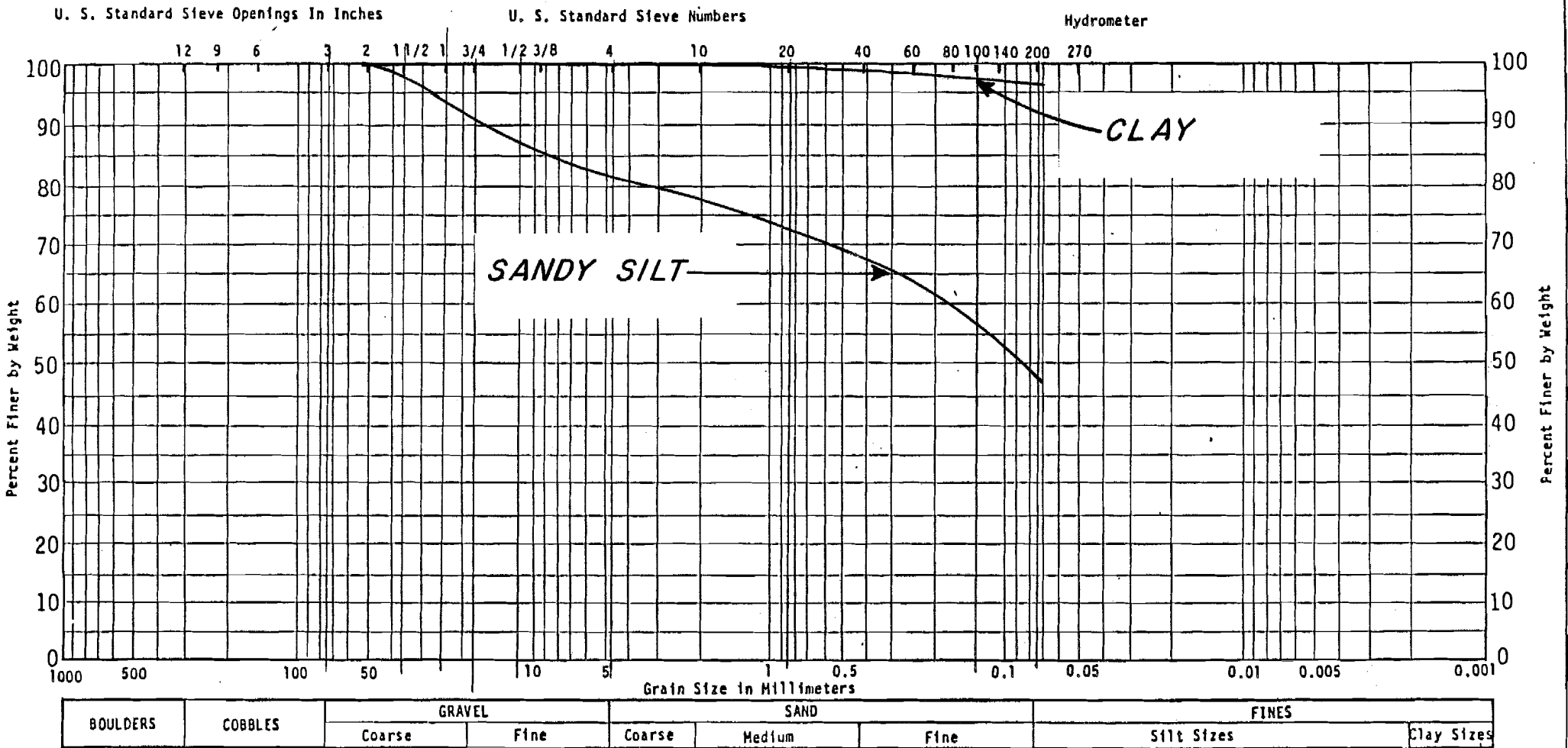
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA DEVELOPMENT
RELICT CHANNEL.
UNIT M GRADATION RANGE
SILTY SAND
ALASKA-EMSCO SUSITNA JOINT VENTURE
DATE AUG 1983
FIGURE D 16

GRADATION SIZE ANALYSIS



BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
HD83-1,3,4,6,9	91	223		SUSITNA HYDROELECTRIC PROJECT		
				WATANA DEVELOPMENT		
				RELICT CHANNEL		
				UNIT G GRADATION RANGE		
				SILTY GRAVELLY SAND		
				HAZEL-ERASSCO	DATE	FIGURE
				INDIANA JOINT VENTURE	AUG 1983	D 17

GRADATION SIZE ANALYSIS



MATERIALS	NO. OF SAMPLES	FEET OF SAMPLE	% MAT'L IN SECTION	ALASKA POWER AUTHORITY	
SANDY SILT	4	6	50	SUSITNA HYDROELECTRIC PROJECT	
CLAY	4	6	50	WATANA DEVELOPMENT	
TOTALS	8	12	100	RELICT CHANNEL	
				UNIT J GRADATION SUMMARY	
				HSR/A-ES4000	DATE
				SUSITNA JOINT VENTURE	AUG 1983
					FIGURE
					D18

GRADATION SIZE ANALYSIS

U. S. Standard Sieve Openings In Inches

U. S. Standard Sieve Numbers

Hydrometer

12 9 6 3 2 1 1/2 1 3/4 1/2 3/8 4 10 20 40 60 80 100 140 200 270

LEGEND

— WEIGHTED AVERAGE
- - - UPPER/LOWER RANGE

Percent Finer by Weight

Grain Size in Millimeters

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

BORING NO.

NO. OF SAMPLES

FEET OF SAMPLE

CLASSIFICATION (USC)

HD83-1

4

6

SANDY SILT, (SM)

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

WATANA DEVELOPMENT

RELICT CHANNEL

UNIT J GRADATION RANGE

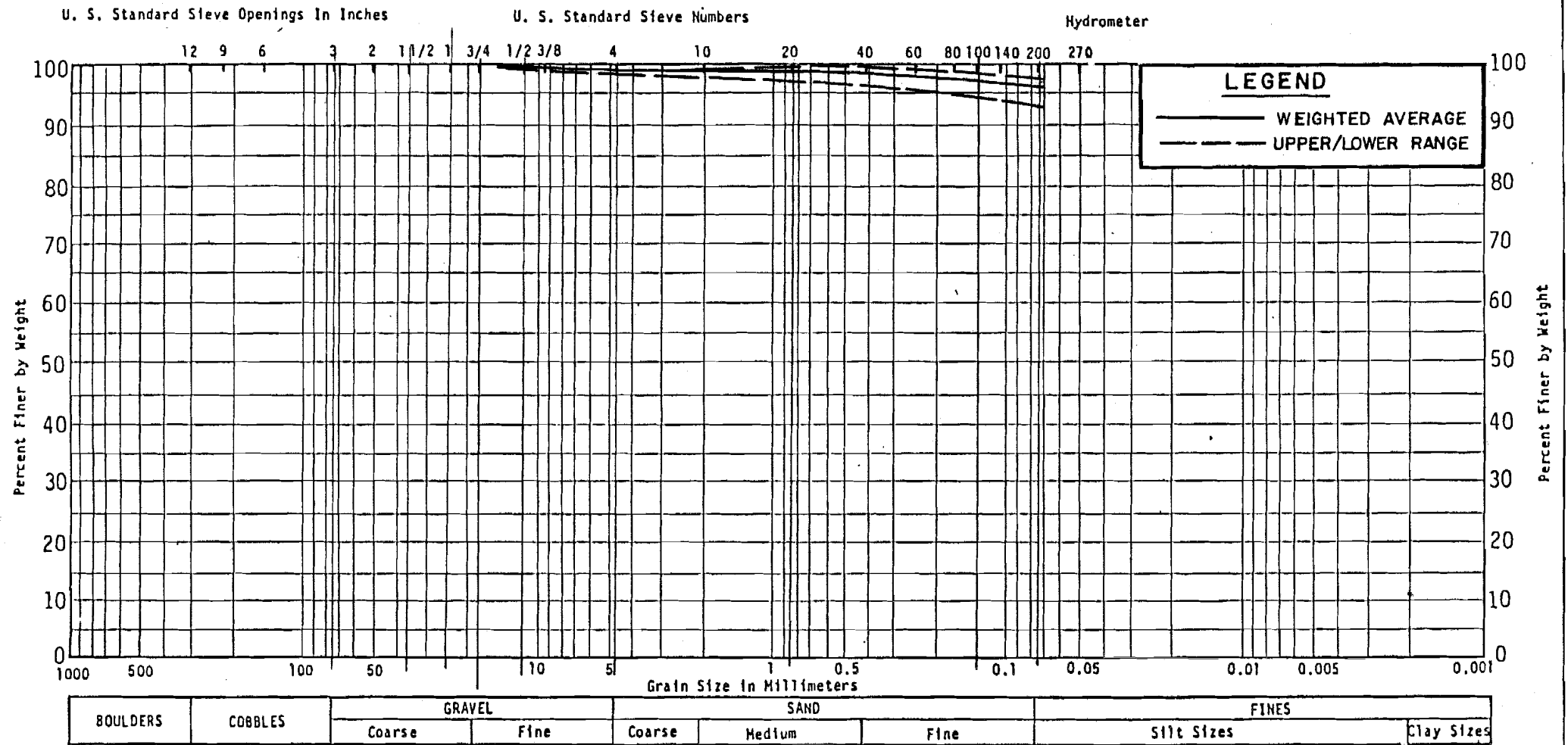
SANDY SILT

HAZEL-ELSON
ENGINEERING

DATE
AUG 1983

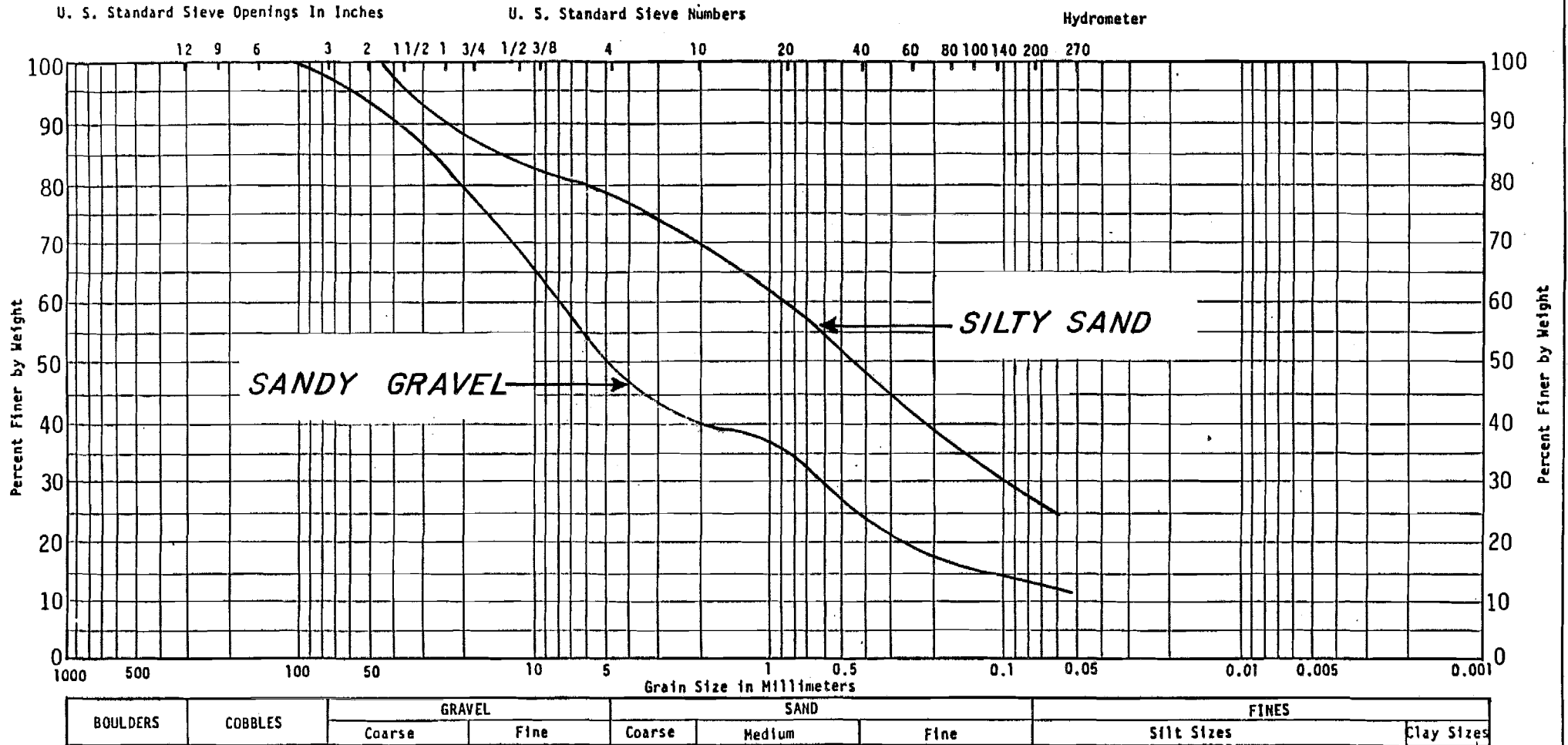
FIGURE
D 19

GRADATION SIZE ANALYSIS



BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY	
HD83-1	4	6	CLAY, (CL)	SUSITNA HYDROELECTRIC PROJECT	
				WATANA DEVELOPMENT	
				RELICT CHANNEL	
				UNIT J GRADATION RANGE	
				LEAN CLAY	
				HAZILA-ERBICO SUSITNA JOINT VENTURE	DATE AUG 1983
					FIGURE D20

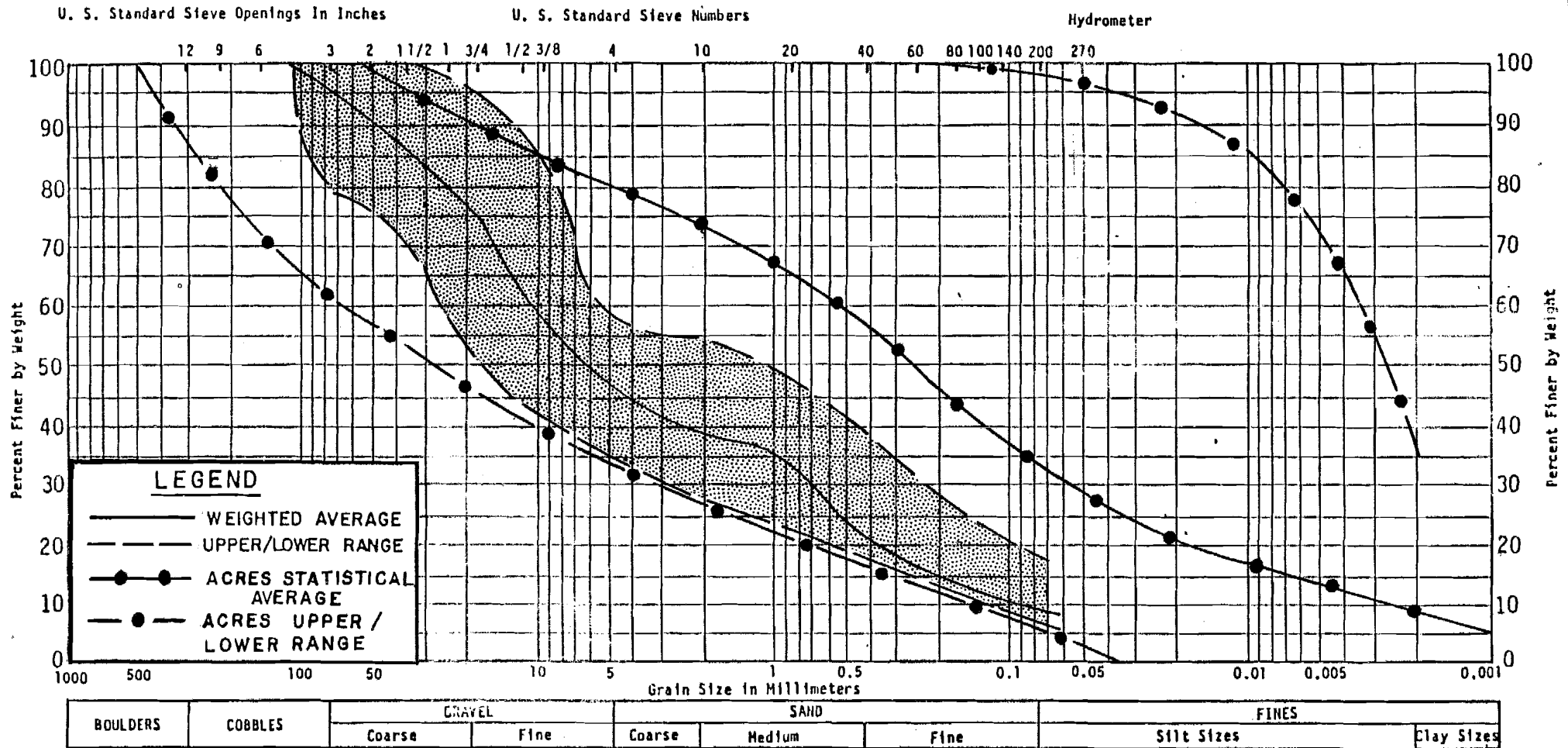
GRADATION SIZE ANALYSIS



MATERIAL	NO. OF SAMPLES	FEET OF SAMPLE	% MAT'L IN SECTION
WELL GRADED SANDY GRAVEL	10	26	26.3
WELL GRADED SILTY SAND	35	73	73.7
TOTALS	45	99	100

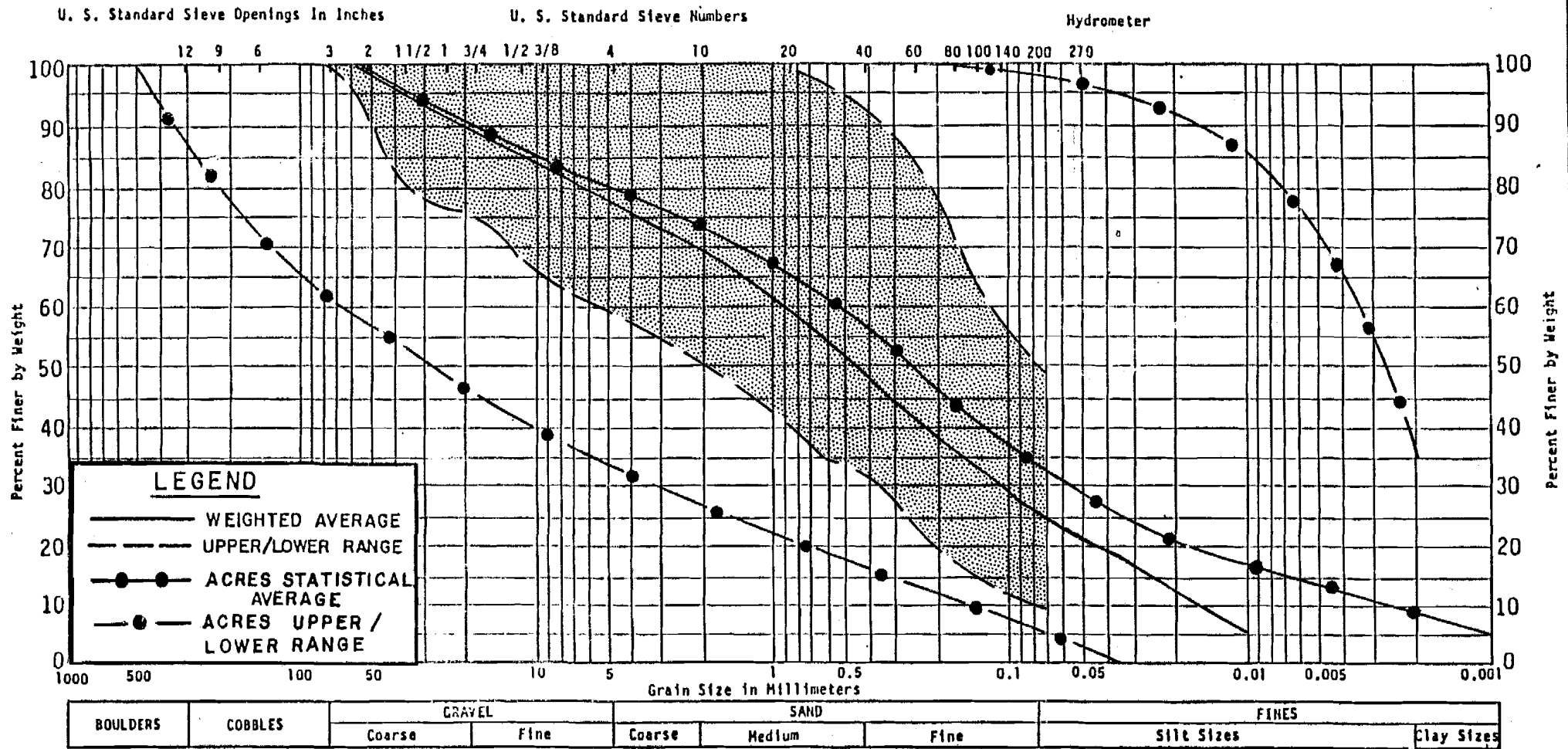
ALASKA POWER AUTHORITY		
SUSITNA HYDROELECTRIC PROJECT		
WATANA DEVELOPMENT		
RELICT CHANNEL		
UNIT E/F GRADATION		
SUMMARY		
ASRA-ESASCO SUSITNA JOINT VENTURE	DATE AUG 1983	FIGURE D 21

GRADATION SIZE ANALYSIS



BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
H D 83- 2, 4, 9, 49,	10	26	SANDY GRAVEL (GP/GM)	SUSITNA HYDROELECTRIC PROJECT		
52, & WW-3				WATANA DEVELOPMENT		
				RELICT CHANNEL		
				UNIT E/F GRADATION RANGE		
				SANDY GRAVEL		
				DESIGN-EMASCO	DATE	FIGURE
				SUSITNA JOINT VENTURE	AUG 1983	D22

GRADATION SIZE ANALYSIS



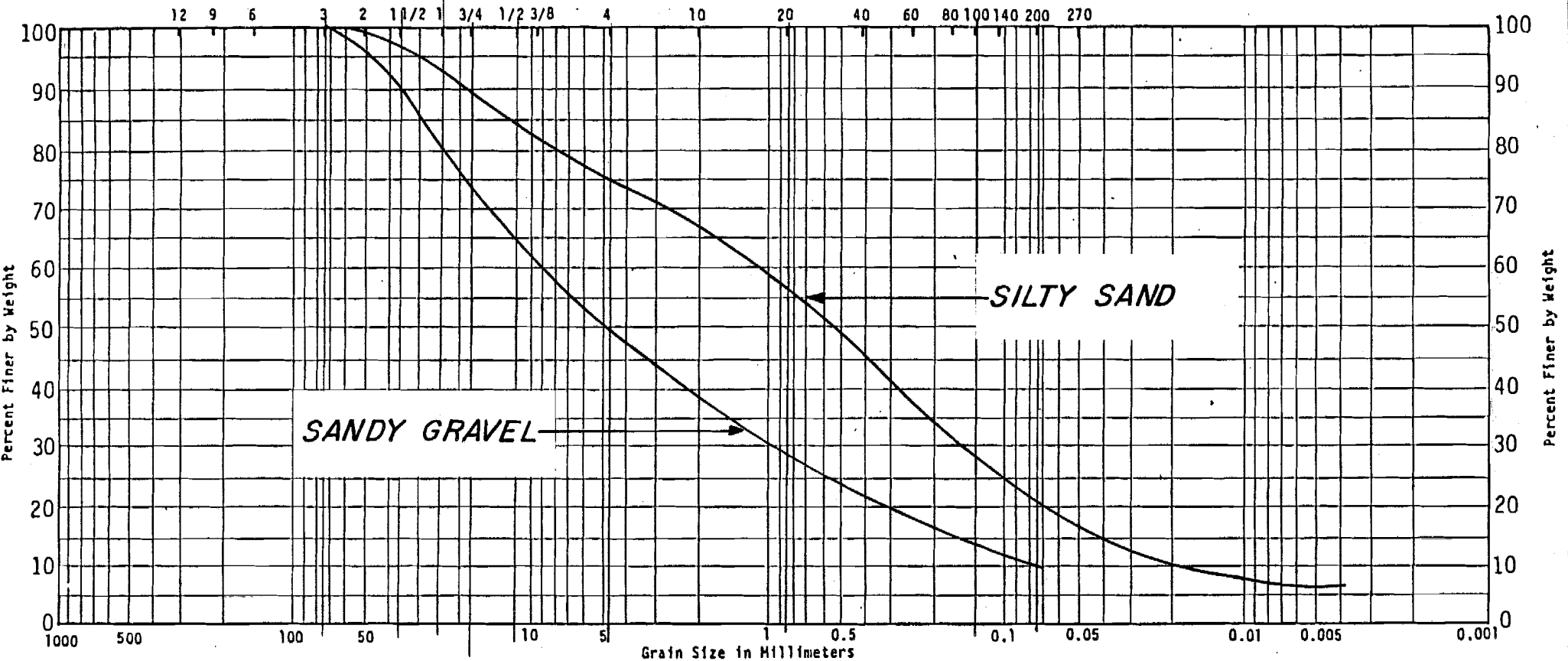
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT	
HD 83-1,2,4,5,8, 9,50-528WW-3	35	73	SILTY SAND, (SM)		
				RELICT CHANNEL UNIT E/F GRADATION RANGE SILTY SAND	
				ALASKA-EMSCO SUSITNA JOINT VENTURE	DATE AUG 1983
				FIGURE D23	

GRADATION SIZE ANALYSIS

U. S. Standard Sieve Openings In Inches

U. S. Standard Sieve Numbers

Hydrometer

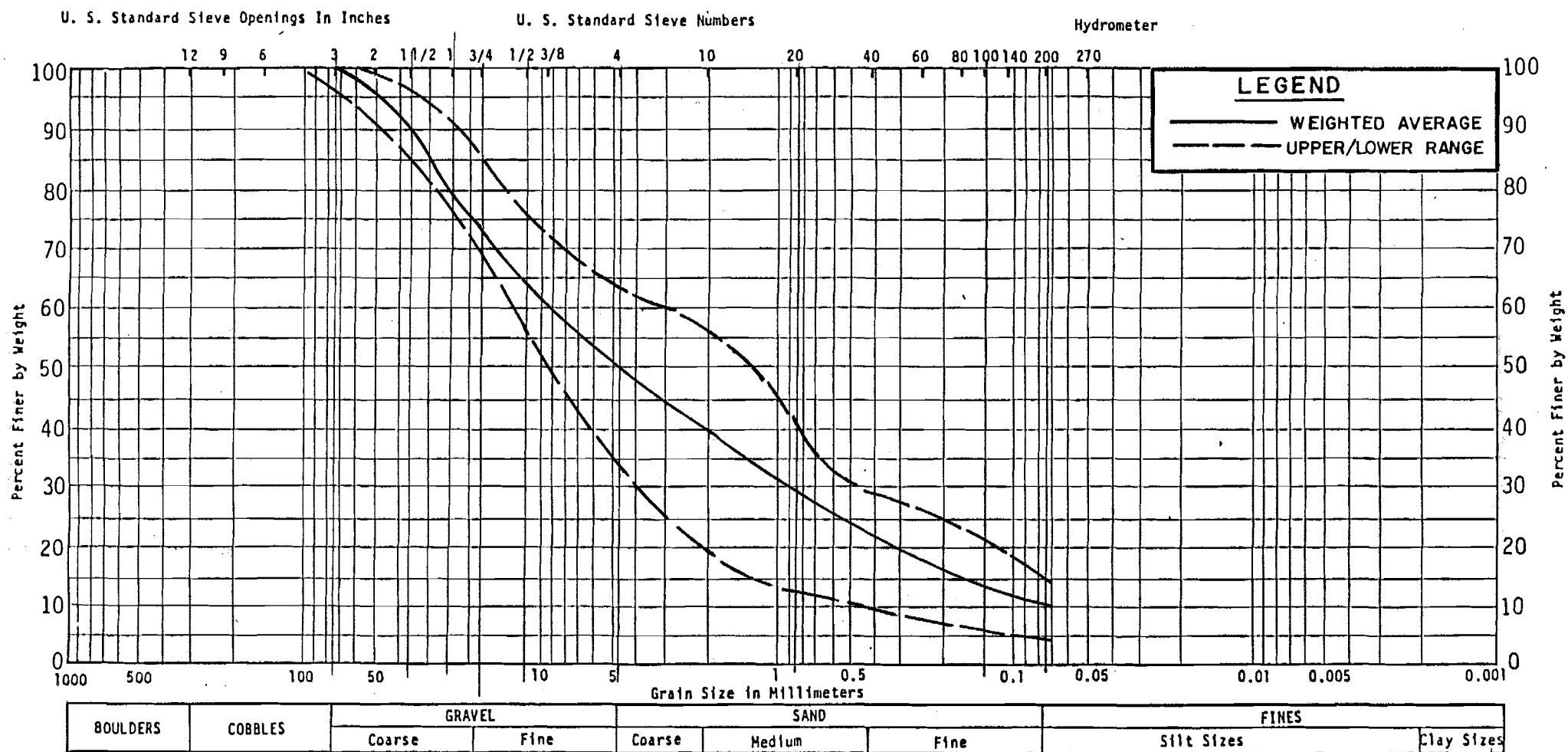


BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		Coarse	Fine	Coarse	Medium	Fine	Silt Sizes	Clay Sizes

MATERIAL	NO. OF SAMPLES	FEET OF SAMPLE	% MAT'L IN SECTION
WELL GRADED SANDY GRAVEL	5	11	18.7
WELL GRADED SILTY SAND	17	48	81.3
TOTALS	22	59	100

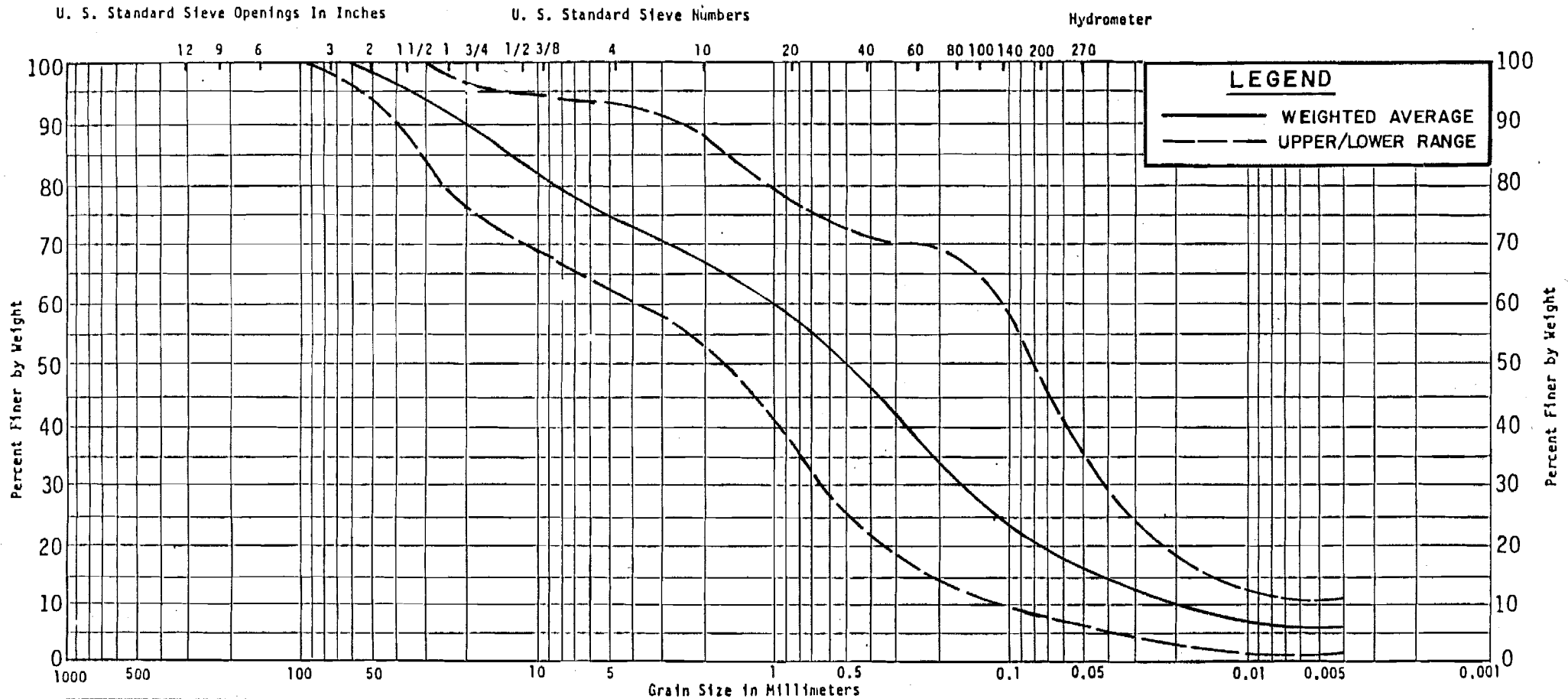
ALASKA POWER AUTHORITY		
SUSITNA HYDROELECTRIC PROJECT		
WATANA DEVELOPMENT		
RELICT CHANNEL		
UNIT I GRADATION		
SUMMARY		
HAZARD-ERDCO SUSITNA JOINT VENTURE	DATE AUG 1983	FIGURE D 24

GRADATION SIZE ANALYSIS



BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY	
HD83-5,6,52	5	11	WELL GRADED SANDY GRAVEL, (GW-GM)	SUSITNA HYDROELECTRIC PROJECT	
				WATANA DEVELOPMENT	
				RELICT CHANNEL	
				UNIT I GRADATION RANGE	
				SANDY GRAVEL	
				ALASKA-ESABCO SUSITNA JOINT VENTURE	DATE AUG 1983
					FIGURE D25

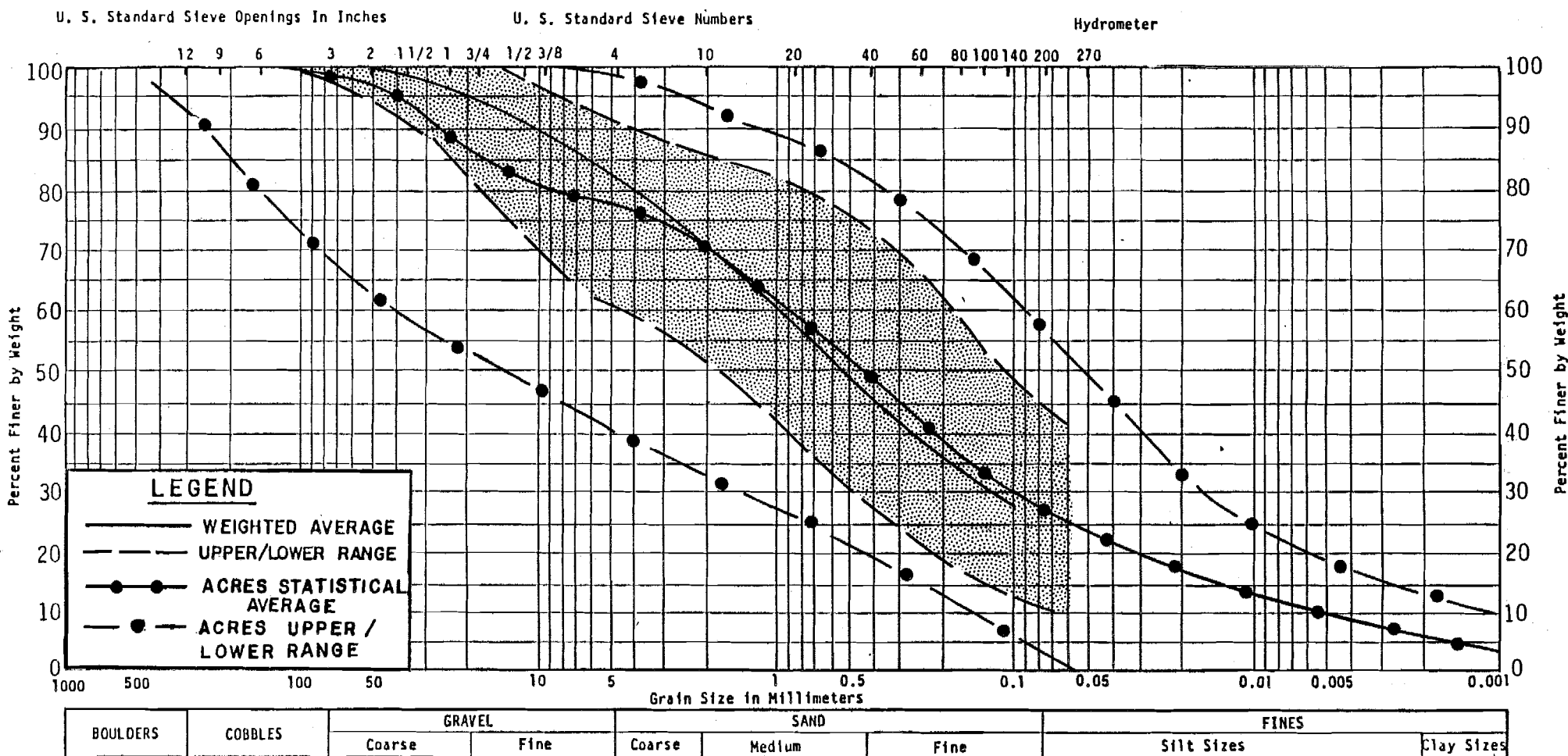
GRADATION SIZE ANALYSIS



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

BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY				
HD83-1,5,6,8,52	17	48	WELL GRADED SILTY SAND, (SM)	SUSITNA HYDROELECTRIC PROJECT				
				WATANA DEVELOPMENT				
				RELICT CHANNEL				
				UNIT I GRADATION RANGE				
				SILTY SAND				
				HAZEL-ELABCO	DATE	FIGURE		
				INDIANA JOINT VENTURE	AUG 1983	D 26		

GRADATION SIZE ANALYSIS



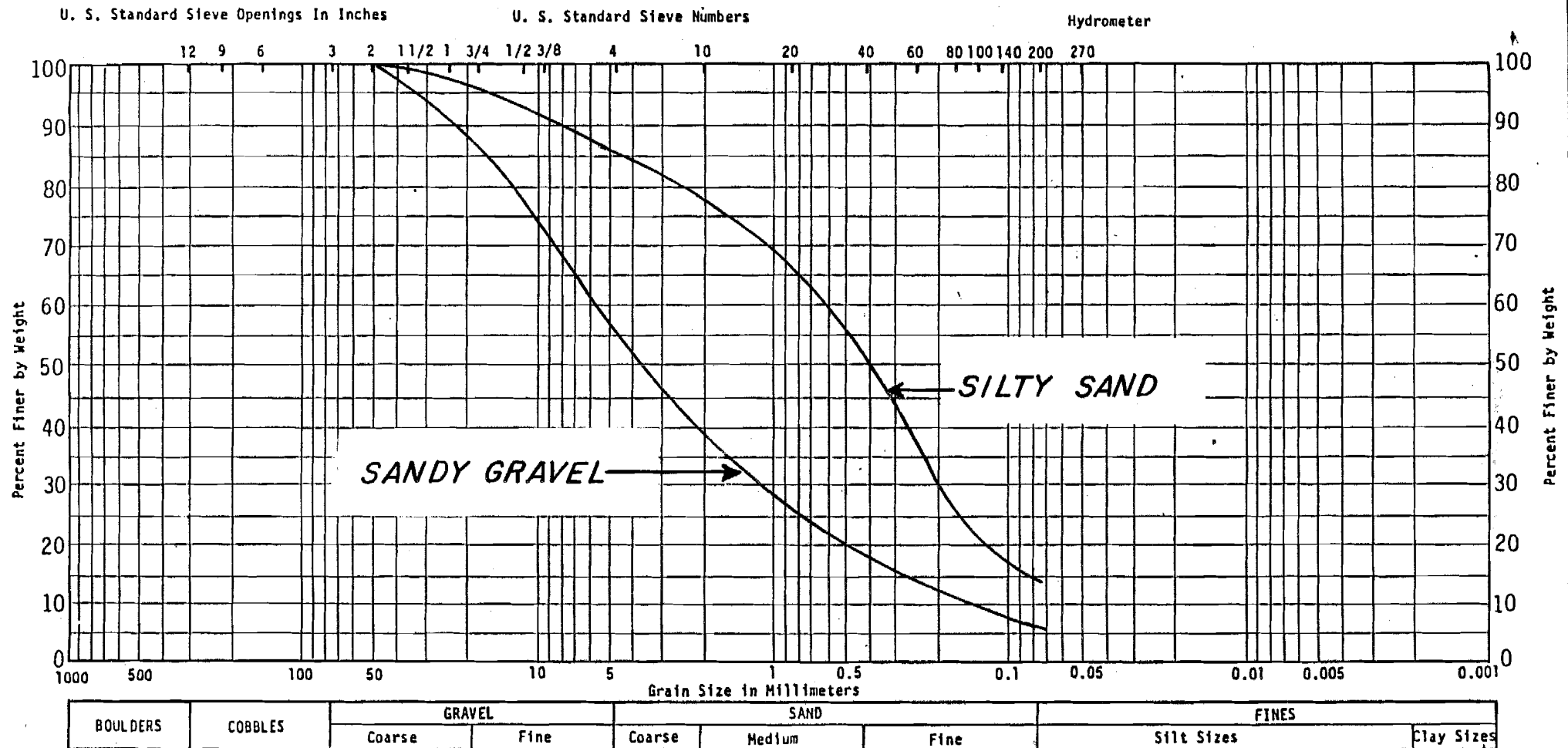
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RELICT CHANNEL UNIT C GRADATION RANGE SILTY SAND	
HD83-4, 52, 53,	8	27	SILTY SAND ₁ (SM)		
a WW-3					

HEARZ-ERABCO
SUSITNA JOINT VENTURE

DATE
AUG 1983

FIGURE
D27

GRADATION SIZE ANALYSIS



MATERIALS	NO. OF SAMPLES	FEET OF SAMPLE	% MAT'L IN SECTION	ALASKA POWER AUTHORITY		
WELL GRADED SANDY GRAVEL	6	10	32.3	SUSITNA HYDROELECTRIC PROJECT		
WELL GRADED SILTY SAND	10	21	67.7	WATANA DEVELOPMENT		
TOTALS	16	31	100	RELICT CHANNEL		
				UNIT H GRADATION		
				SUMMARY		
				HAZARD-ESBSCO	DATE	FIGURE
				SUSITNA RIVER VENTURE	AUG 1983	D 28

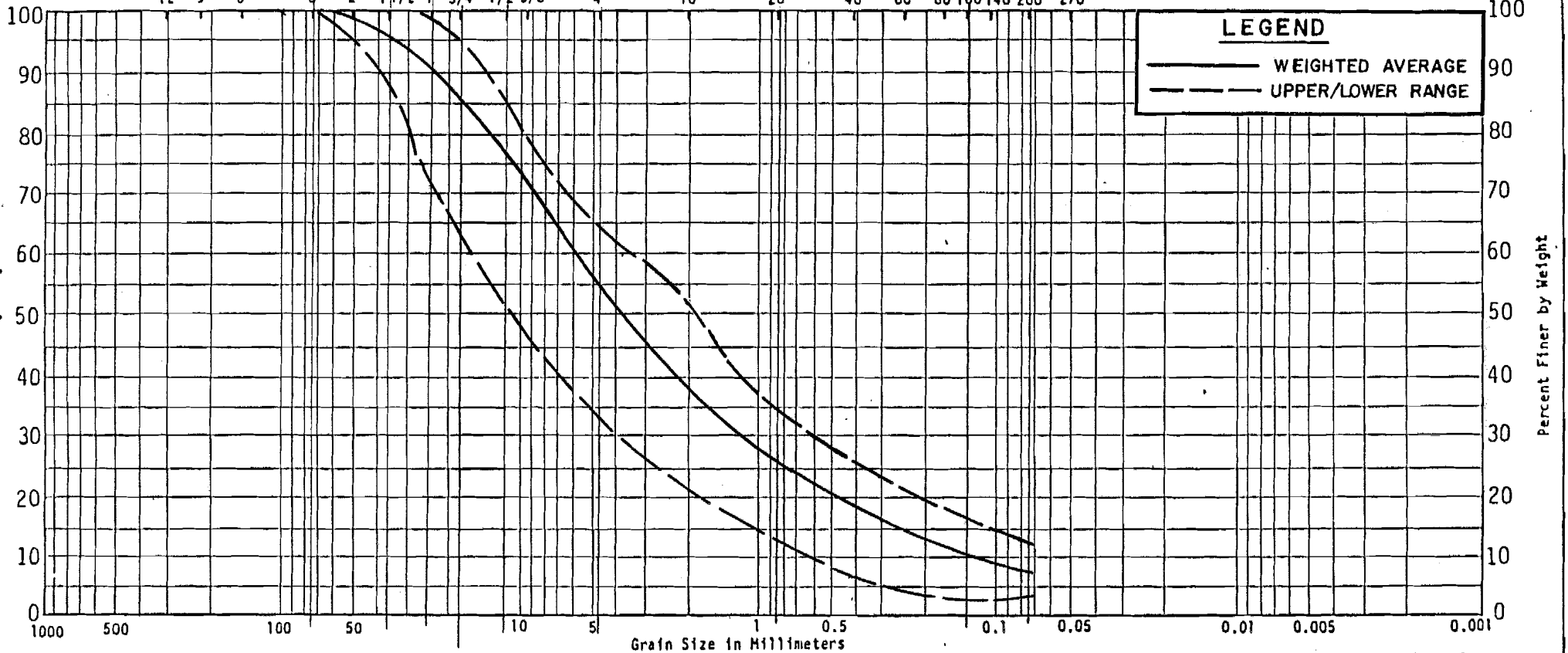
GRADATION SIZE ANALYSIS

U. S. Standard Sieve Openings In Inches

U. S. Standard Sieve Numbers

Hydrometer

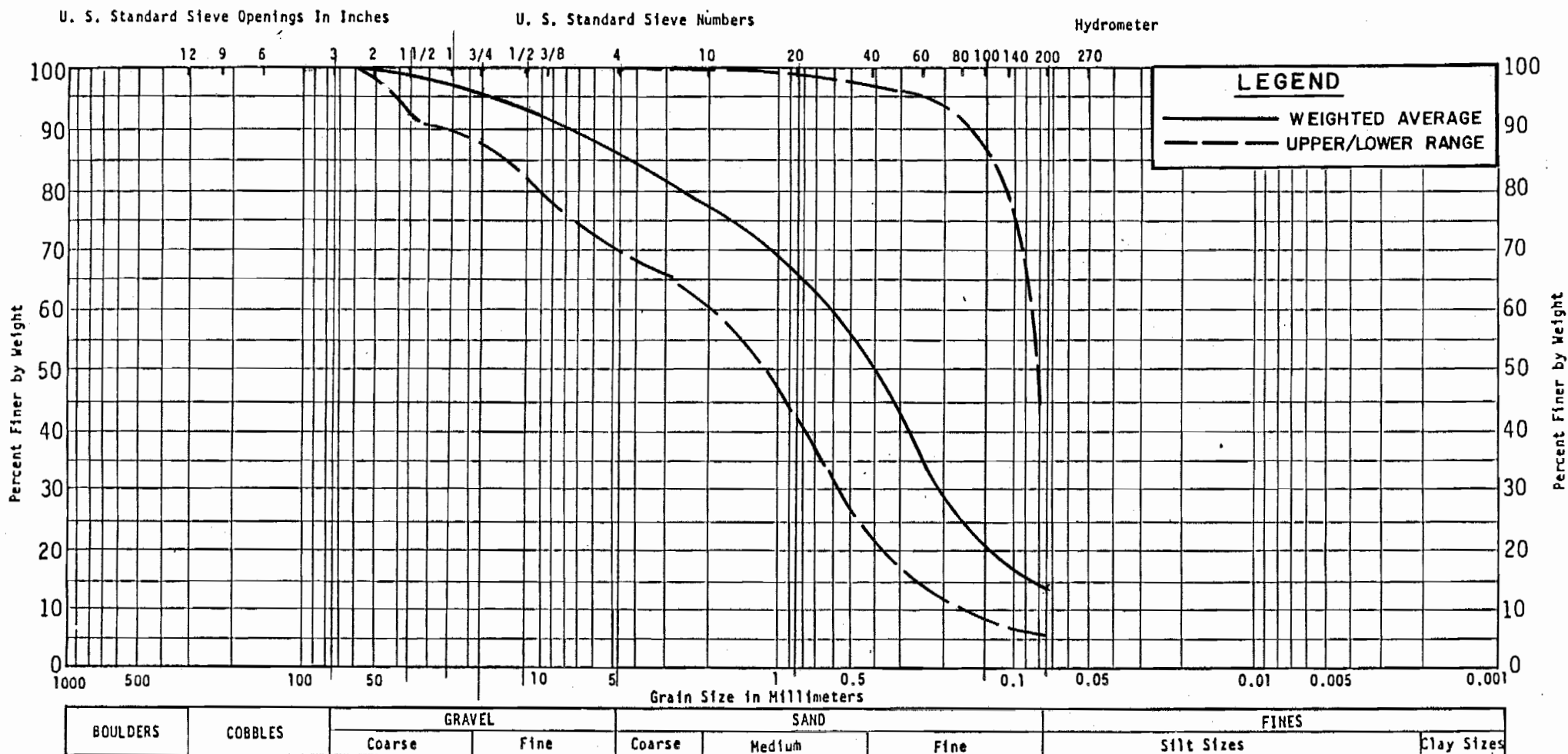
12 9 6 3 2 1 1/2 1 3/4 1/2 3/8 4 10 20 40 60 80 100 140 200 270



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

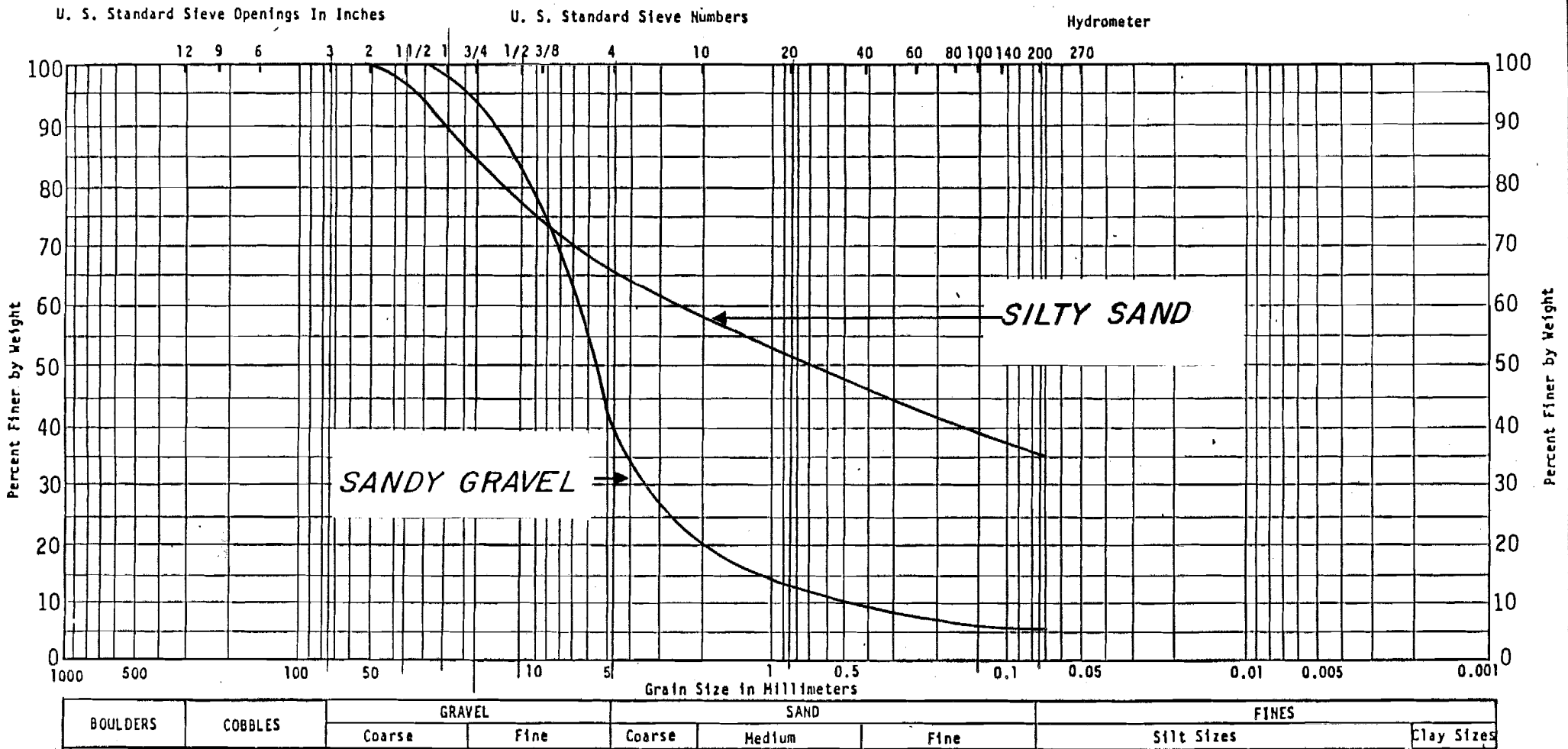
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
HD83-1, 3, 5	6	10	WELL GRADED SANDY GRAVEL, (GW - GM)	SUSITNA HYDROELECTRIC PROJECT		
				WATANA DEVELOPMENT		
				RELICT CHANNEL		
				UNIT H GRADATION RANGE		
				SANDY GRAVEL		
				HAZARD-EROSCO	DATE	FIGURE
				SUSITNA JOINT VENTURE	AUG 1983	D29

GRADATION SIZE ANALYSIS



BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY				
HD83-1,8,52,WW-3	10	21	WELL GRADED SILTY SAND, (SM)	SUSITNA HYDROELECTRIC PROJECT				
				WATANA DEVELOPMENT				
				RELICT CHANNEL				
				UNIT K GRADATION RANGE				
				SILTY SAND				
				HARZA-ESABCO	DATE	FIGURE		
				SUSITNA JOINT VENTURE	AUG 1983	D 30		

GRADATION SIZE ANALYSIS



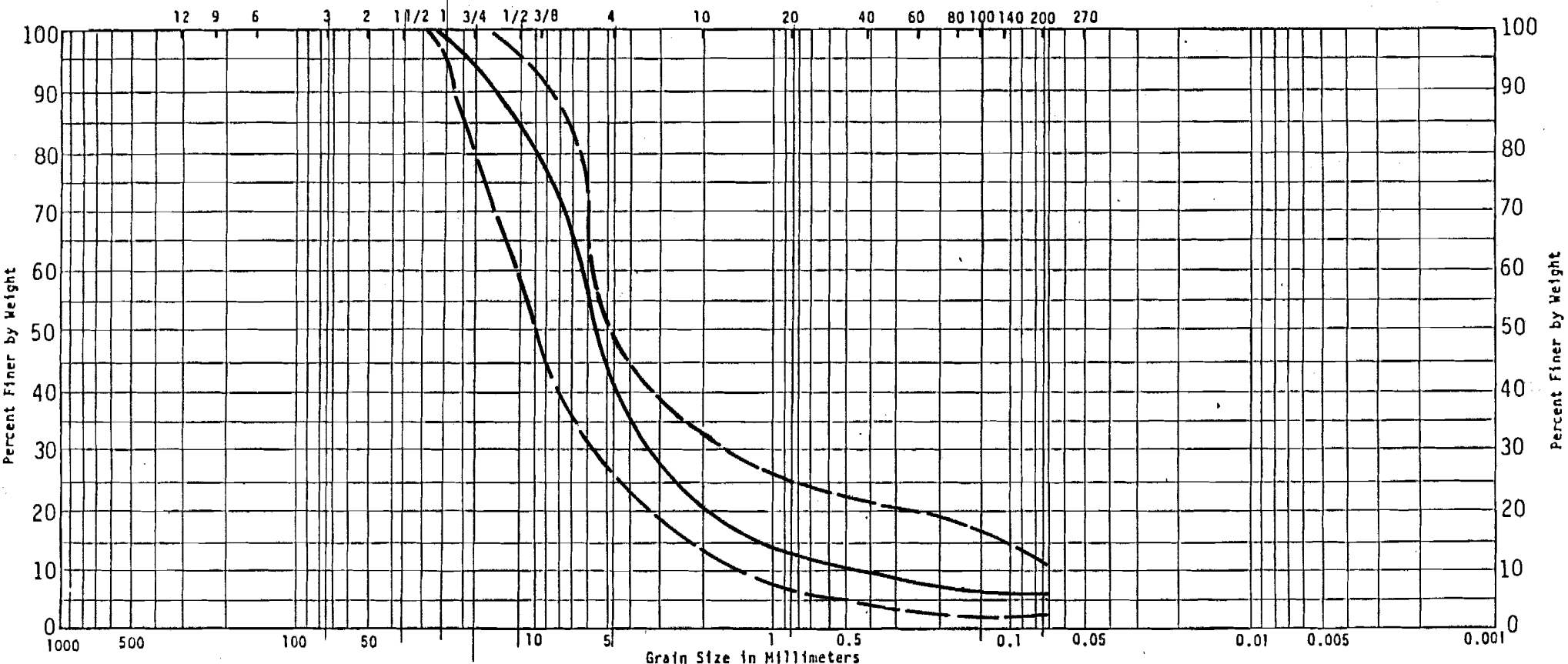
MATERIAL	NO. OF SAMPLES	FEET OF SAMPLE	% MAT'L IN SECTION	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RELICT CHANNEL UNIT K GRADATION SUMMARY	
POORLY GRADED SANDY GRAVEL	7	7	70		
SILTY SANDY GRAVEL	2	3	30		
TOTALS	9	10	100		
				HERRA-ERABCO SUSITNA JOINT VENTURE	DATE AUG-1983
					FIGURE D31

GRADATION SIZE ANALYSIS

U. S. Standard Sieve Openings In Inches

U. S. Standard Sieve Numbers

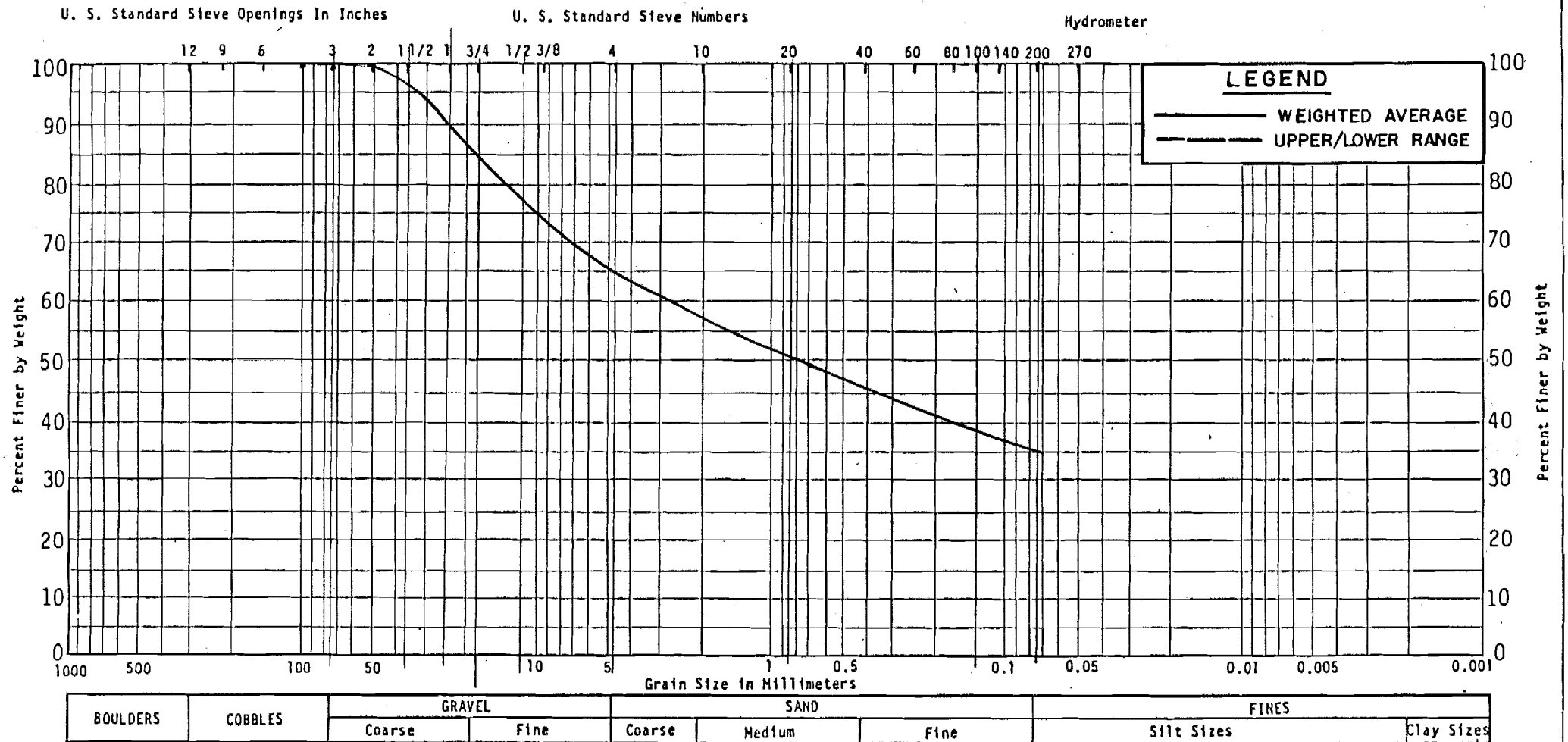
Hydrometer



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

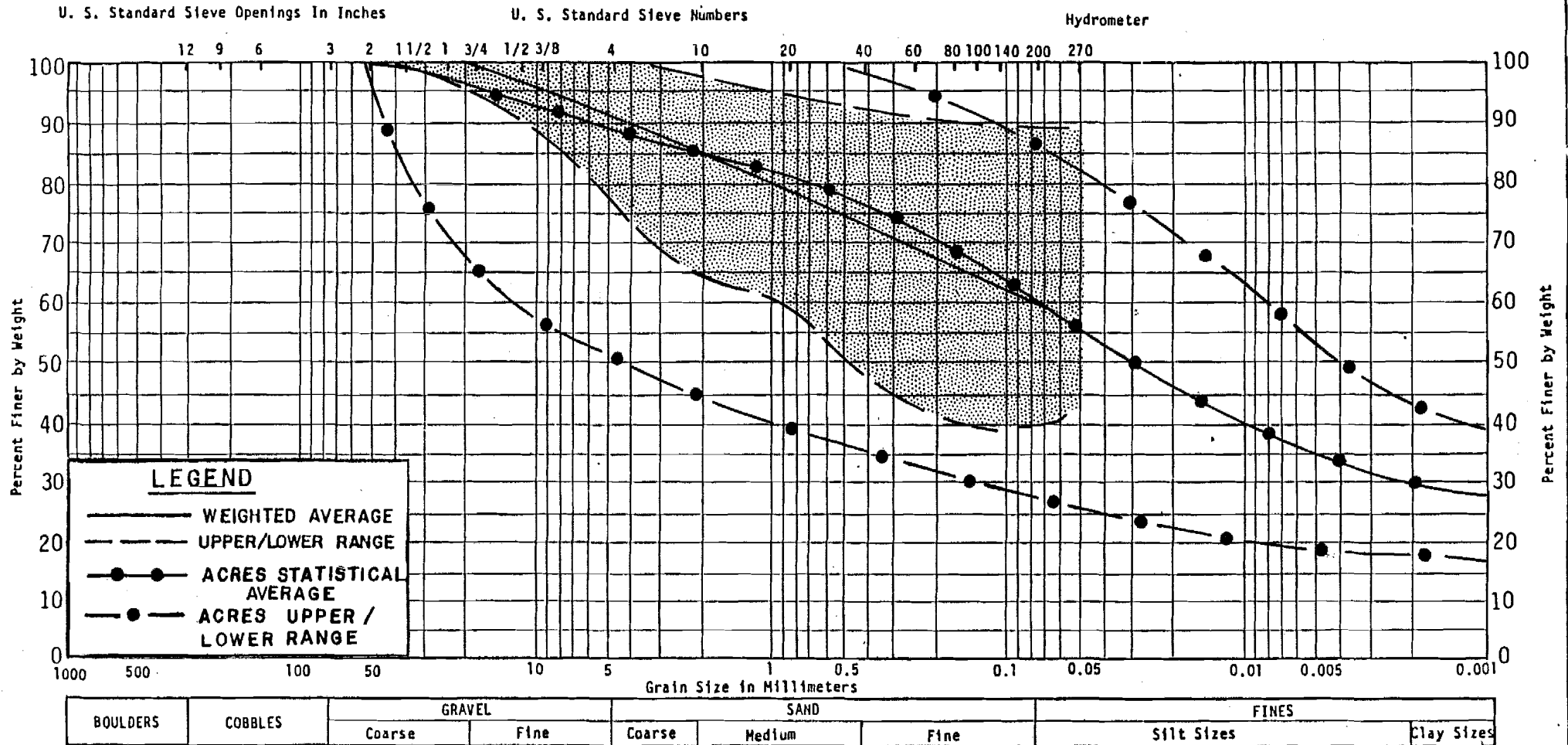
BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY SUSITNA HYDROELECTRIC PROJECT WATANA DEVELOPMENT RELICT CHANNEL UNIT K GRADATION RANGE SANDY GRAVEL				
HD83-1	7	7	POORLY GRADED SANDY GRAVEL (GP-GM)					
HAZA-ESBCCO SUSITNA JOINT VENTURE				DATE	AUG 1983	FIGURE	D32	

GRADATION SIZE ANALYSIS



BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY				
HD83-1	2	3	SILTY SANDY GRAVEL, (GM)	SUSITNA HYDROELECTRIC PROJECT				
				WATANA DEVELOPMENT				
				RELICT CHANNEL				
				UNIT K GRADATION RANGE				
				SANDY GRAVEL				
HARRIS-ESABCO				DATE	FIGURE			
SUSITNA JOINT VENTURE				AUG 1983	D33			

GRADATION SIZE ANALYSIS



BORING NO. NO. OF SAMPLES FEET OF SAMPLE CLASSIFICATION (USC)

WW-3

4

4

SANDY SILT, (ML)

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

WATANA DEVELOPMENT

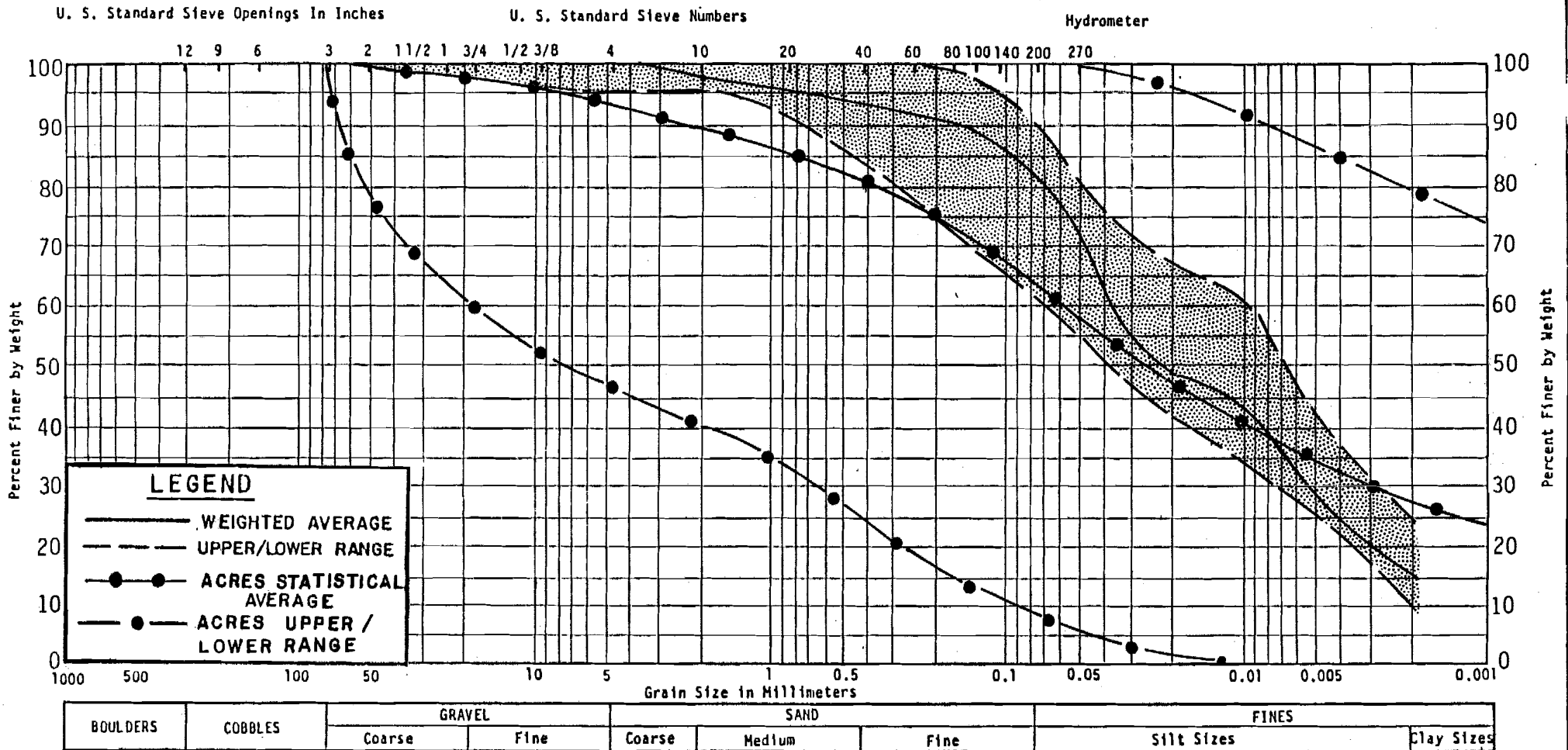
**RELICT CHANNEL
UNIT D' GRADATION RANGE
SANDY SILT**

HANZA-ESABCO
SUSITNA JOINT VENTURE

DATE
AUG 1983

FIGURE
D 34

GRADATION SIZE ANALYSIS



BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)
------------	----------------	----------------	----------------------

HD83-4-6, 49

9

17

SILTY CLAY, (ML/CL)

& WW-3

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

WATANA DEVELOPMENT

**RELICT CHANNEL
UNIT G GRADATION RANGE
SILTY CLAY**

115812A-ES0000
JULIANA JOINT VENTURE

DATE
AUG 1983

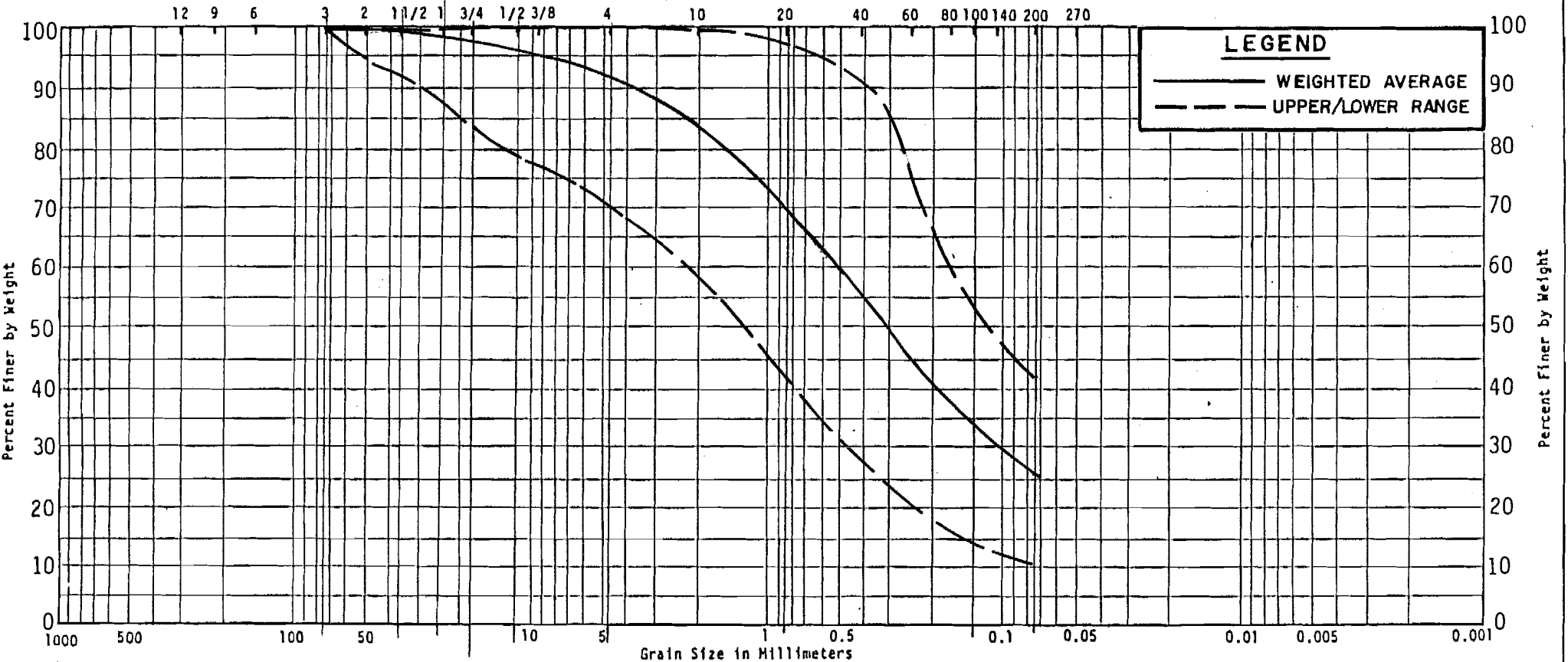
FIGURE
D 35

GRADATION SIZE ANALYSIS

U. S. Standard Sieve Openings In Inches

U. S. Standard Sieve Numbers

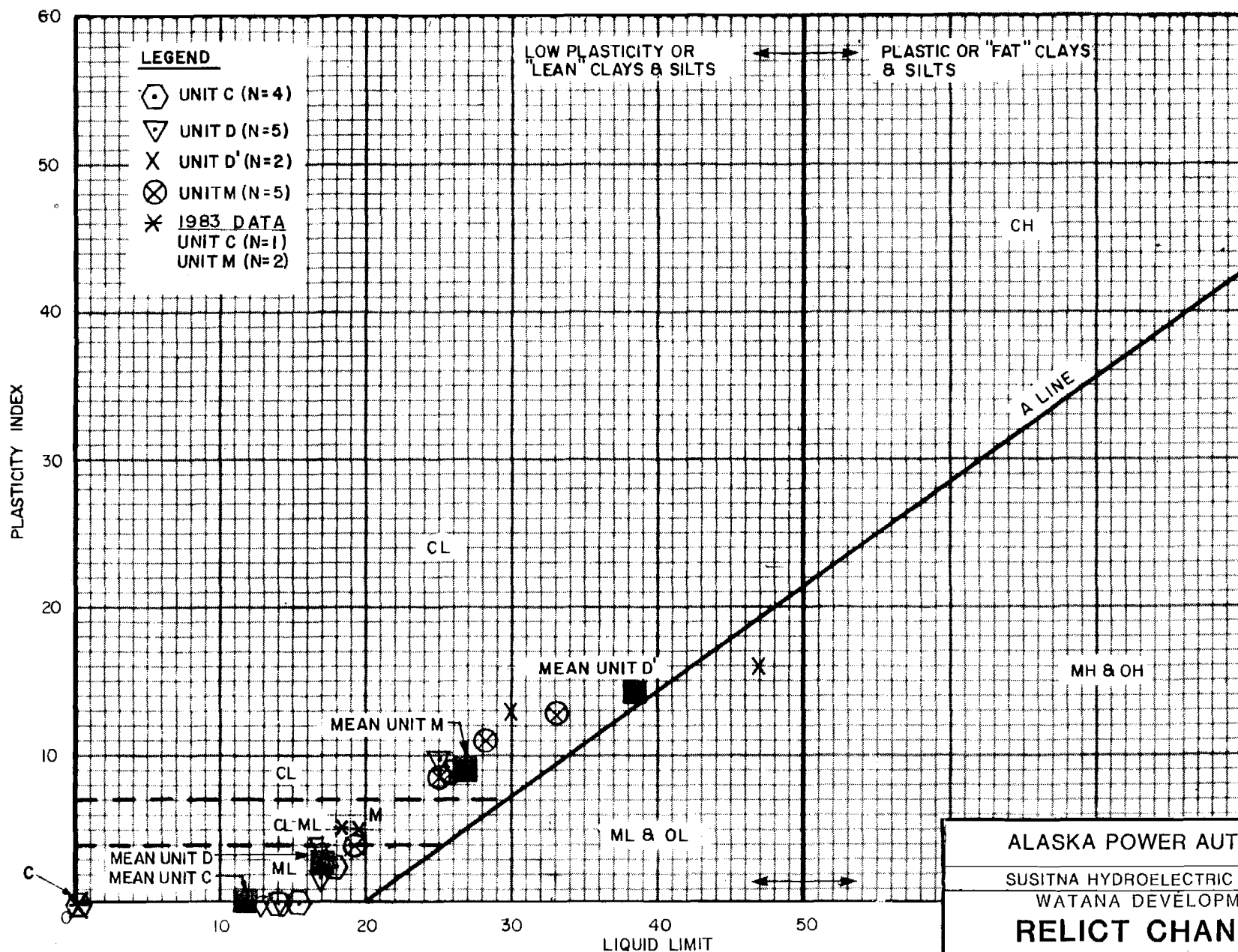
Hydrometer



Grain Size in Millimeters

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

BORING NO.	NO. OF SAMPLES	FEET OF SAMPLE	CLASSIFICATION (USC)	ALASKA POWER AUTHORITY		
HD83-2,5,6	18	23	WELL GRADED SILTY SAND, (SM/SM-SC)	SUSITNA HYDROELECTRIC PROJECT		
				WATANA DEVELOPMENT		
				RELICT CHANNEL		
				UNIT E GRADATION RANGE		
				SILTY SAND		
				HAZAL-EMSCO SUSITNA JOINT VENTURE	DATE AUG 1983	FIGURE D 36



TEST PERFORMED ON MATERIAL PASSING
NO. 40 SIEVE IN ACCORDANCE WITH
ASTM D423-66 (1972) AND D424-59 (1971)

(INCLUDES ALL TESTS 1978-1982)

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

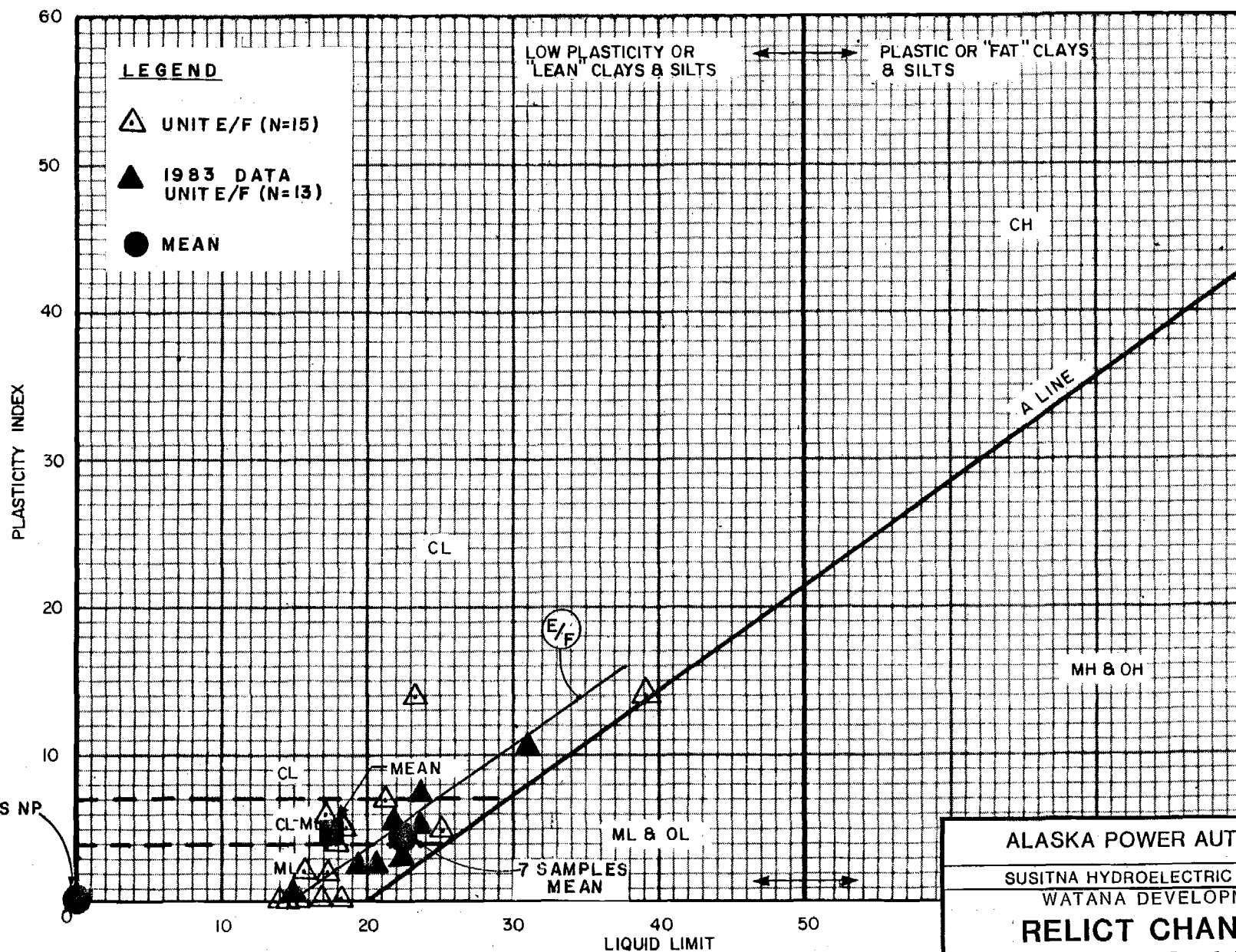
WATANA DEVELOPMENT

RELICT CHANNEL **MATERIALS ABOVE UNIT E** **PLASTICITY SUMMARY**

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG 1983

FIGURE
D37



TEST PERFORMED ON MATERIAL PASSING
NO. 40 SIEVE IN ACCORDANCE WITH
ASTM D423-66 (1972) AND D424-59 (1971)

(INCLUDES ALL TESTS 1978-1982)

ALASKA POWER AUTHORITY

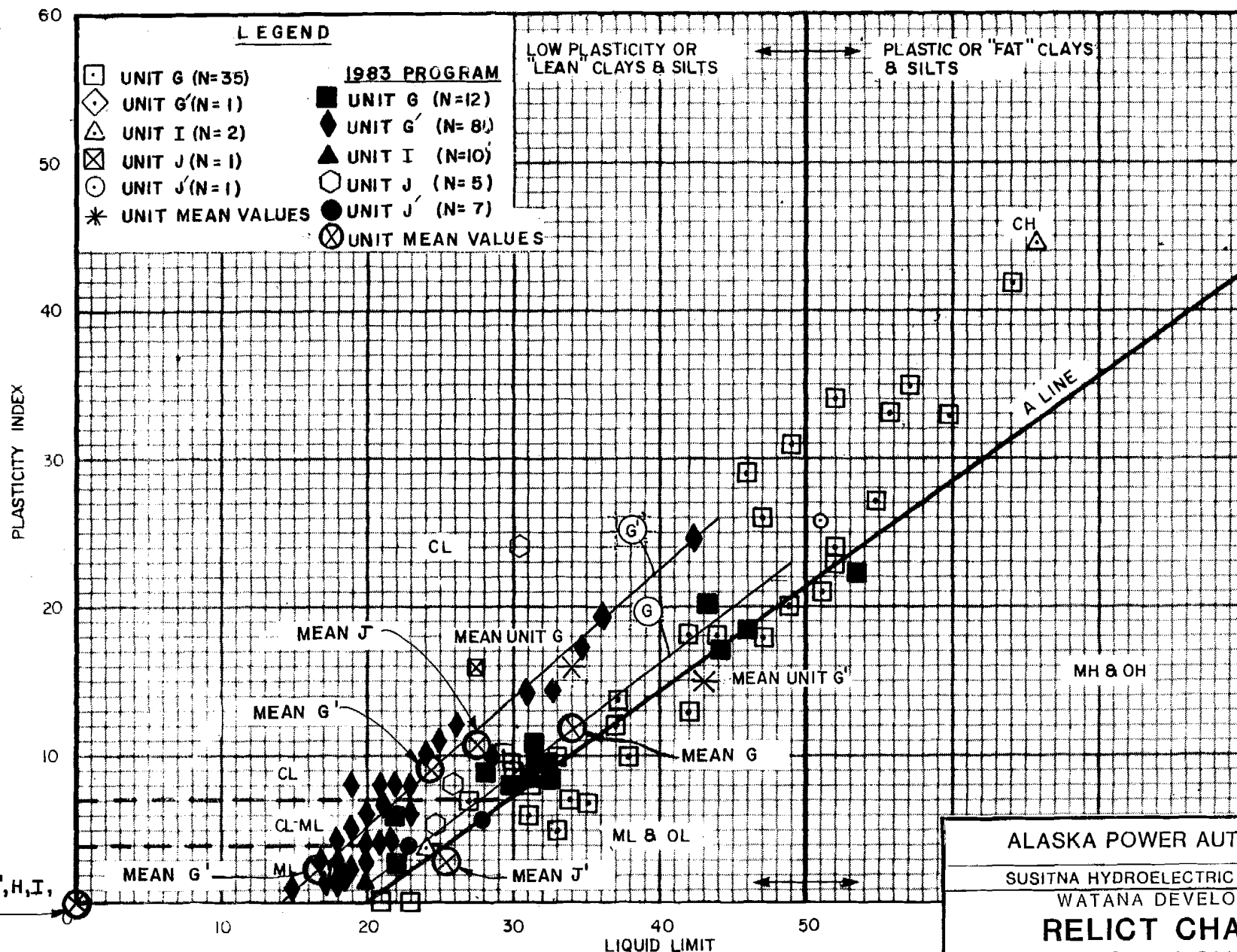
SUSITNA HYDROELECTRIC PROJECT
WATANA DEVELOPMENT

**RELICT CHANNEL
RANGE OF PLASTICITY
UNITS E/F**

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG 1983

FIGURE
D38



TEST PERFORMED ON MATERIAL PASSING
NO. 40 SIEVE IN ACCORDANCE WITH
ASTM D423-66 (1972) AND D424-59 (1971)

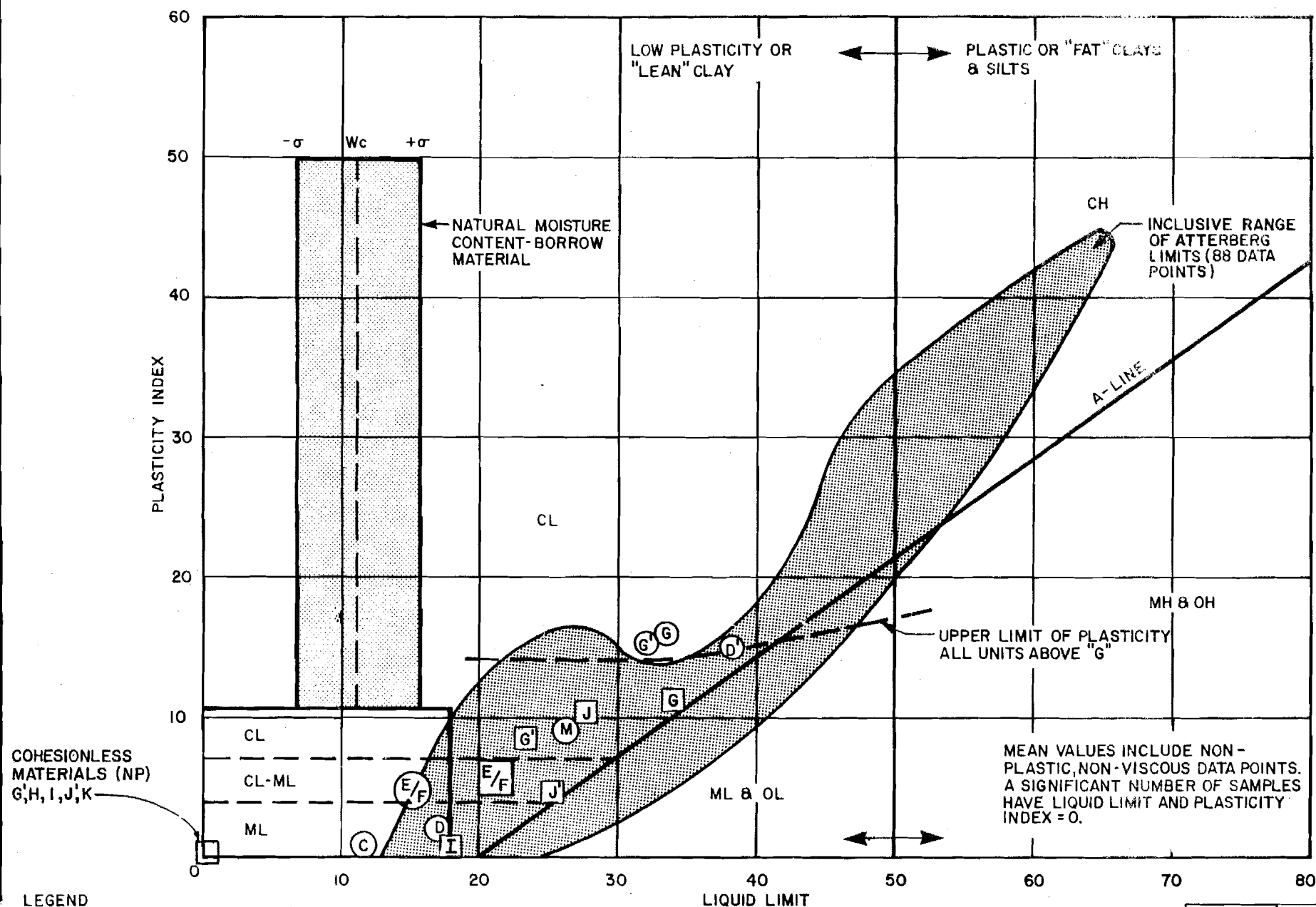
(INCLUDES ALL TESTS 1978-1982)

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
WATANA DEVELOPMENT
RELICT CHANNEL
MATERIALS BELOW UNIT E/F
PLASTICITY SUMMARY

HARZA-EBASCO
SUSITNA JOINT VENTURE

DATE
AUG 1983

FIGURE
D39



WATANA DEVELOPMENT

**RELICT CHANNEL MATERIALS
PLASTICITY SUMMARY**

AUG 1983 FIGURE D 40

HARZA-EBASCO
SUSITNA JOINT VENTURE