

APPENDIX 3.5-M

Detailed Soil Pit Descriptions
Flambeau Project, Ladysmith, WI

Description of Soil Pit KWC-1

Horizon	Description
1	0 to 6 inches, brown (7.5 YR 4/2) silt loam; dry; moderate medium platy breaking to moderate medium subangular blocky; few fine faint yellowish red (5 YR 5/6-5/8) interpedal mottles; common roots; abrupt smooth boundary.
2	6 to 10 inches, dark grayish brown (10 YR 4/2) heavy silt loam; dry; weak medium platy; few medium distinct yellowish red (5 YR 5/6-5/8) interpedal mottles; 10-20% gravel; abrupt wavy boundary.
3	10 to 20 inches, dark brown (10 YR 3/3) gritty sandy loam to silt loam; dry; weak medium platy; common coarse distinct dark reddish brown to yellowish red (5 YR 3/4-4/6) interpedal mottles; abrupt wavy boundary.
4	20 to 23 inches, dark reddish brown (5 YR 2.5/2) silt loam; dry; moderate medium platy; common fine prominent reddish yellow (7.5 YR 7/8) intrapedal mottles and common coarse distinct dark reddish brown (5 YR 3/4) interpedal mottles; common roots; trace of woody charcoal; appears to be a buried A1 horizon; abrupt wavy boundary.
5	23 to 26 inches, pinkish gray (7.5 YR 6/2) silt loam; dry; very weak medium platy breaking to very weak medium subangular blocky; common fine distinct brown (7.5 YR 4/4) intra- and interpedal mottles; appears to be a buried A21 horizon; abrupt wavy boundary.
6	26 to 44 inches, light gray (10 YR 7/2) silt loam; dry; weak medium platy breaking to very weak fine subangular blocky; common medium to coarse distinct dark brown (7.5 YR 3/4) and strong brown (7.5 YR 5/8) inter- and intrapedal mottles; appears to be a buried A22 horizon; abrupt wavy boundary.
7	44 to 66 inches, brown (7.5 YR 4/4) light sandy clay loam; dry; very weak medium platy breaking to weak fine subangular blocky; firm; dark reddish brown (2.5 YR 3/4) clay and iron oxide bridges between grains; 20-40% gravel; appears to be a buried B2 in horizon; abrupt smooth boundary.
8	66 to 74+ inches, dark brown (7.5 YR 3/4) light sandy clay loam to sandy loam; dry; weak medium subangular blocky; 15-30% gravel; appears to be a buried B horizon.

Described on 10/08/87 by John Thresher. Sample KWC-1 collected from horizons 1 and 2.

Description of Soil Pit KWC-2

<u>Horizon</u>	<u>Description</u>
1	0 to 11 inches, dark brown (7.5 YR 3/4) silt loam; dry; weak fine platy breaking to weak very fine subangular blocky; common roots; abrupt smooth boundary.
2	11 to 19 inches, brown (7.5 YR 4/4 - 5/4) fine sandy loam; dry; very weak fine platy breaking to very weak very fine subangular blocky; few roots; clear wavy boundary.
3	19 to 28 inches, brown (7.5 YR 4/4) fine sandy loam; dry; weak medium platy breaking to medium granular; friable; few roots; abrupt wavy boundary.
4	28 to 51 inches, brown (7.5 YR 4/4) medium loamy sandy; dry; very weak medium platy breaking to medium granular; few medium distinct strong brown (7.5 YR 5/8) intrapedal mottles; abrupt smooth boundary.
5	51 to 62 inches, dark yellowish brown (10 YR 4/4) light sandy clay loam; dry; weak medium platy breaking to weak medium platy breaking to weak fine subangular blocky; weak medium stratified; friable; few medium to coarse prominent dark reddish brown (5 YR 3/4) mottles; abrupt wavy boundary.
6	62 to 77+ inches, dark brown (7.5 YR 3/4) coarse sand and sandy gravel; dry; 40-50% gravel overall; weak coarse stratification; friable; weak medium to coarse granular.

Described on 10/08/87 by John Thresher. Sample KWC-2 collected from horizon 1.

Description of Soil Pit KWC-3

<u>Horizon</u>	<u>Description</u>
1	0 to 10 inches, dark reddish brown (5 YR 3/2) fine sandy loam; dry; weak fine platy breaking to weak fine granular; friable; common roots; abrupt wavy boundary.
2	10 to 19 inches, brown (7.5 YR 4/4) fine sandy loam; dry; weak fine stratified breaking to weak fine subangular blocky; clear smooth boundary.
3	19 to 52 inches, strong brown (7.5 YR 4/6) fine sandy loam; dry; friable to firm; weak medium platy breaking to fine subangular blocky; common medium distinct reddish yellow (5 YR 7/8) interpedal mottles; abrupt smooth boundary.
4	52 to 68 inches, reddish brown (5 YR 4/4) light sandy clay loam; dry; weak fine platy breaking to fine crumb; friable; many medium distinct yellowish red (5 YR 5/6-5/8) mottles; abrupt smooth boundary.
5	68 to 74+ inches, brown (7.5 YR 4/4) silty clay loam; dry; moderate medium platy; 25 to 30% gravel; many coarse prominent yellowish red (5 YR 5/6-5/8) interpedal mottles.

Described on 10/08/87 by John Thresher. Sample KWC-3 collected from horizon 1. The central till sample KWC-4 was collected from horizon 4.

Description of Soil Pit KWC-4

Horizon	Description
1	0 to 5 inches, dark reddish brown (5 YR 2.5/2) medium loamy sandy; dry; moderate medium platy; very friable; common roots; abrupt wavy boundary.
2	5 to 11 inches, dark reddish brown (5 YR 3/4) medium sandy loam; dry; friable; medium granular; clear smooth boundary.
3	11 to 23 inches, strong brown (7.5 YR 4/6) medium sandy loam; dry; friable; fine to medium granular; diffuse smooth boundary.
4	23 to 51 inches, brown (7.5 YR 5/4) medium loamy sand; dry; very friable; fine crumb; weak medium stratification; few medium to coarse faint reddish yellow (7.5 YR 6/8) mottles; abrupt smooth boundary.
5	51 to 55-71 inches, brown (7.5 YR 4/4) light fine sandy clay loam wedge; dry; weak medium platy breaking to weak fine subangular blocky; few fine to coarse distinct reddish yellow (7.5 YR 6/6-6/8) root mottles; 15-20% gravel; abrupt smooth boundary.
6	55-71 to 74+ inches, strong brown (7.5 YR 4/6) medium to coarse loamy sand wedge; dry; weak coarse cross-stratified; loose.

Described on 10/08/87 by John Thresher. Sample KWC-4 collected from horizons 1 and 2.

Description of Soil Pit KWC-5

Horizon	Description
1	0 to 6 inches, very dark brown (7.5 YR 2/2) gritty silt loam; dry; friable; weak medium platy breaking to weak fine subangular blocky; common roots; clear smooth boundary.
2	6 to 12 inches, dark brown (7.5 YR 3/2) gritty silt loam; dry; weak medium platy breaking to fine to medium subangular blocky; friable; clear smooth boundary.
3	12 to 17 inches, dark brown (7.5 YR 3/4) light sandy clay loam; moist; moderate medium platy breaking to weak fine subangular blocky; many very fine to fine distinct strong brown (7.5 YR 5/8) mottles; stiff; abrupt wavy boundary.
4	17 to 42 inches, brown (7.5 YR 4/2) fine gritty sandy clay loam; moist; weak medium platy breaking to fine crumb; stiff; 3-5% gravel; many coarse prominent red (2.5 YR 4/6-4/8) mottles; weak medium stratification; abrupt wavy boundary.
5	42 to 70+ inches, dark reddish brown (5 YR 3/4) gritty medium sandy clay loam; moist; massive breaking to weak fine to medium granular; stiff; 5-7% gravel; common coarse faint to distinct yellowish red (5 YR 4/6-5/8) mottles.

Described on 10/08/87 by John Thresher. Sample KWC-5 collected from horizons 1 and 2.

Description of Soil Pit KWC-6

<u>Horizon</u>	<u>Description</u>
1	0 to 6 inches, black (10 YR 2/1) firm sandy loam; moist; friable; medium crumb; common roots; few medium faint dark yellowish brown (10 YR 4/6) mottles; abrupt wavy boundary.
2	6 to 16 inches, dark brown (7.5 YR 3/4) fine sandy loam; wet; friable; non-sticky; medium crumb; common medium distinct reddish brown (5 YR 5/4) mottles; diffuse smooth (almost glossic) boundary.
3	16 to 32 inches, dark reddish brown (5 YR 3/4) medium loamy sand; wet; friable to firm; medium granular; weak fine stratification; common medium distinct dark red (2.7 YR 3/6) mottles; abrupt smooth boundary.
4	32 to 49+ inches, dark reddish brown (5 YR 3/4) gritty sandy clay loam; wet; massive breaking to fine to medium subangular blocky; 20-30% gravel; common coarse distinct reddish yellow (5 YR 6/8-7/8) mottles.

Described on 10/09/87 by John Thresher. Standing water at 44 inches. Sample KWC-6 collected from horizons 1 and 2.

APPENDIX 3.5-N

Sample Composite and Measurement Methods, Results,
and Quality Control
Flambeau Project, Ladysmith, WI

TABLE NO. 1
 TOPSOIL, TILL, SANDSTONE, AND SAPROLITE
 COMPOSITING DATA

Topsoil Compositing Data

Sample Location	Wet Weight	Dry Weight
Topsoil - West (Composite)		
KWC-1	3,483.4	2,682.2
KWC-1	3,025.8	2,329.9
KWC-1	3,288.9	2,532.4
KWC-2	3,417.7	2,631.6
KWC-2	2,650.0	2,040.5
KWC-2	<u>4,370.7</u>	<u>3,365.4</u>
TOTAL	20,236.5 (gms)	15,582.0 (gms)
Topsoil - Central (Composite)		
KWC-3	3,553.0	2,735.8
KWC-3	3,225.8	2,483.9
KWC-3	4,351.7	3,350.8
KWC-4	4,266.7	3,285.4
KWC-4	3,919.5	3,018.0
KWC-4	<u>4,241.8</u>	<u>3,266.2</u>
TOTAL	23,558.5 (gms)	18,140.1 (gms)
Topsoil - East (Composite)		
KWC-5	4,652.0	4,000.7
KWC-5	3,524.8	3,031.3
KWC-5	3,219.8	2,769.0
KWC-6	3,847.2	3,308.6
KWC-6	4,008.0	3,446.9
KWC-6	<u>3,333.3</u>	<u>2,866.6</u>
TOTAL	22,585.1 (gms)	19,423.1 (gms)

TABLE NO. 1 (Cont.)

Type I Soil (KWR Soils) Compositing Data

Sample	Color	Texture (USDA)	Wet Weight	Dry Weight
KWR-1	5YR3/3	sil-sicl	1,068.7	958.6
KWR-2	*	sil-sicl	1,174.2	1,053.2
KWR-3	7.5YR4/4	sil	955.4	857.0
KWR-4	7.5YR4/6	l	906.1	812.8
KWR-5	5YR3/4	sl-l	1,031.8	925.5
KWR-6	7.5YR3/4	sl	1,074.5	963.8
KWR-7	5YR3/3	l	1,115.5	1,000.6
KWR-8	5YR4/6	sl	1,058.7	949.6
KWR-9	5YR3/4	sl	1,173.6	1,052.7
KWR-10	7.5YR3/4	sl	<u>1,106.6</u>	<u>992.6</u>
TOTALS			10,665.1 (gms)	9,566.4 (gms)

*Base color is 5YR4/4 but includes mff 5YR5/8 mottles.

TABLE NO. 1 (Cont.)

Till Compositing Data

Boring No.	Sample No.	Sample Depth (ft)	Wet Weight	Dry Weight
Till - West Compositing Data				
B-S1	SS1	5- 7	321.5	288.6
B-S1	SS2	10-11.5	646.2	580.1
B-S1	SS2	10-12	1,183.1	1,062.1
B-S1	SS3	15-17	714.2	641.1
B-S2	SS1	5- 7	1,607.8	1,443.3
B-S2	SS2	10-11	842.4	756.2
B-S2	SS3	12-13.4	1,544.9	1,386.8
B-WC1	SS2	2- 4	3,669.4	3,294.0
B-WC1	SS4	6- 8	3,780.1	3,393.4
B-WC1	SS5	8-10	2,318.8	2,081.6
B-WC1	SS5	10-12	3,104.6	2,787.0
B-WC1	SS6	12-14	4,330.0	3,887.0
B-WC1A	SS3	4- 6	<u>4,465.6</u>	<u>4,008.8</u>
TOTALS			28,528.6 (gms)	25,610.0 (gms)
Till - East Compositing Data				
B-S4	SS2	5- 7	1,908.9	1,727.2
B-S4	SS3	10	2,100.2	1,900.3
B-S4	SS5	15-17	616.5	557.8
B-S4	SS6	20-22	1,425.2	1,289.5
B-S5	SS2	10-12	203.3	184.0
B-S5	SS3	15-17	930.8	842.2
B-S5	SS5	20-21	600.5	543.3
B-S5	SS6	22-24	581.4	526.0
B-WC3	SS2	5- 6.5	1,763.5	1,595.6
B-WC3	SS5	20-21.5	2,058.2	1,862.3
B-WC3	SS6	25-26.5	3,250.4	2,941.0
B-WC3A	SS3	7- 9	2,555.6	2,312.3
B-WC3A	SS7	12-14	<u>3,164.1</u>	<u>2,862.9</u>
TOTALS			21,158.6 (gms)	19,144.4 (gms)

TABLE NO. 1 (Cont.)

Till - Central Compositing Data

Boring No.	Sample No.	Sample Depth (ft)	Wet Weight	Dry Weight
B-S3	SS2	5- 6.5	461.5	415.4
B-S3	SS3	10-11.5	407.0	366.3
B-S3 *	SS6	19.5-21	574.0	516.6
	ST	21-22		
B-S3	--	24.5-26	442.1	397.9
B-WC2	SS3	4- 6	3,150.7	2,835.6
B-WC2	SS9	17-19	3,509.4	3,158.5
B-WC2A	SS5	8-10	4,395.7	3,956.1
B-WC2A	SS8	14-16	3,519.1	3,167.2
B-WC2A	SS12	22-24	4,319.9	3,887.9
KWC-4	--	8-10	<u>3,718.9</u>	<u>3,347.0</u>
TOTALS			24,498.3 (gms)	22,048.5 (gms)

* B-S3 is a composite of SS6 and ST. Individual weights of these two samples were not recorded.

TABLE NO. 1 (cont.)

Sandstone Compositing Data

Boring No.	Sample No.	Sample Depth (ft)	Wet Weight	Dry Weight
Sandstone - West Compositing Data				
B-S1	SS4	17-18	883.2	776.8
B-S1	SS5	19-21	777.9	684.2
B-S1	SS6	21-23	<u>1,514.3</u>	<u>1,331.8</u>
TOTALS			3,175.4 (gms)	2,792.8 (gms)
Sandstone - Central Compositing Data				
B-S3	--	27	369.0	320.2
B-WC2	SS12	25-26	2,076.9	1,802.3
B-WC2	SS13	26-28	2,866.8	2,487.8
B-WC2	SS14	28-30	533.7	463.1
B-WC2	SS15	29.0-29.5	<u>596.2</u>	<u>517.4</u>
TOTALS			6,442.6 (gms)	5,590.8 (gms)
Sandstone - East Compositing Data				
B-S4	SS17	39-41	2,835.2	2,509.2
B-S4	SS18	41-43	2,523.8	2,233.6
B-S4	SS19	43-45	2,890.9	2,558.4
B-S5	SS10	40-42	1,166.8	1,032.6
B-WC3	SS7	10.0-11.5	2,299.6	2,035.2
B-WC3	SS9	34.0-35.5	2,342.7	2,073.3
B-WC3	SS10	35.5-38	3,449.6	3,052.9
B-WC3	SS11	38.5-39.5	<u>1,737.5</u>	<u>1,537.7</u>
TOTALS			19,246.1 (gms)	17,032.9 (gms)

TABLE NO. 1 (Cont.)

Saprolite Compositing Data

Boring No.	Sample No.	Sample Depth (ft)	Wet Weight	Dry Weight
B-S2	ST	30-31.5	3,298.7	2,896.6
B-S3	SS10	39.5-41	301.2	264.5
B-S3	--	44.5-46	305.5	268.3
B-S3	--	49.5-50.5	442.2	388.3
B-S3	--	50.5-51.5	392.0	344.2
B-S3	--	51-53	1,010.9	887.7
B-S4	SS20	45-47	1,725.9	1,515.5
B-S4	SS21	47-50	3,627.7	3,185.5
B-S4	--	47-50	512.2	449.8
B-S4	SS21	47-50	491.9	431.9
B-S4	SS22	50-51.5	268.1	235.4
B-S4	ST24	53-54.1	1,553.8	1,364.4
B-S4	ST24	54-56	1,290.8	1,133.4
B-S5	C1	58-62	1,705.3	1,497.4
B-S5	C1	58-62	2,035.5	1,787.4
B-S5	C1	62-67	2,232.3	1,960.2
B-S5	C1	62-67	2,093.1	1,838.0
B-WC1	SS7	14-16	4,603.7	4,042.5
B-WC1	SS8	16.5-18	2,605.2	2,287.6
B-WC1	SS9	18-19.5	1,296.8	1,138.7
B-WC1	SS9	18-19.5	2,172.0	1,907.2
B-WC1A	SS10	18.5-19.5	927.1	814.1
B-WC1A	SS10	18.5-19.5	1,149.1	1,009.0
B-WC1B	SS7	14-16	843.6	740.8
B-WC1B	SS10	17.5-18.5	1,685.6	1,480.1
B-WC3	C1	42-43	3,460.4	3,038.6
B-WC3	C1	43-44	2,360.3	2,072.6
TOTALS			44,390.9 (gms)	38,979.7 (gms)

METHODS USED IN CALCULATING DATA PRESENTED IN TABLE NO. 2

Waste Rock Chip Axial Lengths, Volumes and Surface Areas

- The three principal orthogonal axes of each rock chip were measured to the nearest millimeter. These include the median (b), the long (c), and the short (a) axes.
- The single chip maximum volume and surface area were calculated using the mean chip axial lengths. The maximum volume and surface area assume that the three measured orthogonal axes are the principal axes of a rectangular parallelepiped.
 - Single chip maximum volume (in cm^3) = $a \times b \times c$.
 - Single chip maximum surface area (in cm^2) = $(a \times b \times 2) + (a \times c \times 2) + (b \times c \times 2)$.
 - Maximum total chip volume and maximum total chip surface area = single chip maximum volume x number chips and single chip maximum surface area x number chips, respectively.
- The corrected total volume of the chips was calculated by dividing the total mass of the chips (TABLE NO. 5 - APPENDIX 3.5-N) by the average specific gravity. (Bulk specific gravity (saturated-surface-dry) = 2.57).
- The numerical mean single chip maximum surface area for all waste rock samples is 2.1 ± 0.4 (cm^2) ($n=78$) times the single chip maximum density. It is assumed that the actual chip surface area will also bear a similar relationship to the actual chip density. This demonstrated relationship was utilized in the calculation of the corrected total surface area.
 - The corrected total surface area was calculated by multiplying the maximum total surface area by the quotient of the corrected total volume divided by the maximum total volume.

TABLE NO. 2

Rock Chip Axial Lengths, Volumes and Surface Areas

DDH	Sample Depth	Geologic Unit	Axial Lengths		Number Chips	Axial Ratio a:b:c	Maximum Volume Single Chip	Corrected Total Volume	Maximum Surface Area Single Chip	Total Chips	Corrected Total Surface Area
			Median	Short							
22-6	209-219	2a	3.2 ± 0.7	5.1 ± 1.5	28	0.5:1.0:1.6	27.7	352.6	60.9	1,705	775.1
22-17	123-128	2a	2.9 ± 0.9	4.7 ± 0.9	34	0.6:1.0:1.6	24.5	602.4	54.6	1,856	1,342
22-17	131-138	2a	2.9 ± 1.0	4.4 ± 1.0	21	0.7:1.0:1.5	24.2	348.6	53.3	1,119	767.6
22-17	145-147	2a	3.9 ± 0.7	5.0 ± 0.9	16	0.6:1.0:1.3	42.9	357.0	78.2	1,251	650.6
22-30	171-176	4c	3.7 ± 1.3	5.0 ± 1.8	21	0.6:1.0:1.4	40.7	432.5	75.3	1,581	800.0
22-56	149-157	3a	3.5 ± 1.1	4.9 ± 1.7	45	0.6:1.0:1.4	36.0	1,061.1	69.6	3,132	2,051
22-56	157-160	3a	3.3 ± 1.0	4.5 ± 1.0	25	0.6:1.0:1.4	28.2	374.9	59.3	1,482	788.1
22-57	69-79	2c	4.2 ± 0.4	5.4 ± 0.9	30	0.4:1.0:1.3	36.3	691.2	76.1	2,283	1,449
22-70	140-150	2c	3.2 ± 0.9	4.7 ± 1.4	48	0.7:1.0:1.5	33.1	877.3	64.8	3,110	1,717
22-70	150-160	2c	3.5 ± 0.9	5.0 ± 1.5	43	0.6:1.0:1.4	38.5	1,081	72.4	3,113	2,032
22-70	150-160	2c	4.1 ± 0.5	5.6 ± 1.5	27	0.7:1.0:1.4	66.6	900.9	102.2	2,759	1,382
22-86	59-70	2c	2.5 ± 1.0	3.6 ± 1.4	32	0.6:1.0:1.4	12.6	296.8	35.1	1,123	826.6
22-86	70-78	2c	3.3 ± 1.1	5.7 ± 2.4	57	0.4:1.0:1.7	24.5	975.4	61.0	3,477	2,438
22-90	72-80	2b	3.8 ± 0.7	5.8 ± 1.7	31	0.6:1.0:1.5	46.3	664.7	84.4	2,616	1,212
22-90	80-95	2b	3.4 ± 1.0	4.8 ± 1.8	51	0.6:1.0:1.4	32.6	834.9	65.4	3,335	1,674
22-98	50-55	2b	3.1 ± 1.2	3.8 ± 1.2	15	0.5:1.0:1.2	17.7	160.9	44.3	664.5	402.7
	(ft)		(cm)	(cm)	(cm ³)	(cm ²)	(cm ³)	(cm ³)	(cm ²)	(cm ²)	(cm ²)
					17,279		10,012		34,606		20,308

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TABLE NO. 2 (Cont.)

DDH	Sample Depth	Geologic Unit	Axial Lengths		Number Chips	Axial Ratio a:b:c	Maximum Volume Single Chip	Corrected Total Volume	Maximum Surface Area Single Chip	Total Chips	Corrected Total Surface Area
			Median	Short							
22-1	120-174	2a	3.1 ± 0.6	5.0 ± 1.8	59	0.5:1.0:1.6	24.8	898.9	56.9	3,357	2,063
22-32	92-96	2a	3.6 ± 0.9	4.9 ± 1.0	35	0.6:1.0:1.4	35.3	846.7	69.3	2,426	1,662
22-32	96-100	2a	3.7 ± 0.8	5.8 ± 1.6	23	0.6:1.0:1.6	47.2	440.7	84.7	1,948	1,790.5
22-38	58-63	2a	3.4 ± 0.8	5.8 ± 1.6	31	0.6:1.0:1.7	37.5	811.8	74.4	2,306	1,610
22-56	140-149	3a	3.8 ± 0.9	5.4 ± 1.2	33	0.7:1.0:1.4	53.4	887.5	88.9	2,934	1,478
22-62	52-62	4c	3.4 ± 0.9	4.7 ± 1.1	38	0.7:1.0:1.4	38.4	840.4	70.8	2,690	1,549
22-62	62-72	4c	3.2 ± 1.0	5.2 ± 2.0	38	0.7:1.0:1.6	34.9	1,055	68.6	2,607	2,074
22-62	72-80	4c	3.7 ± 1.0	4.8 ± 1.0	36	0.7:1.0:1.3	46.2	993.8	79.7	2,869	1,714
22-68	130-135	1a	3.6 ± 0.9	5.4 ± 1.7	28	0.6:1.0:1.5	38.9	546.6	74.9	2,097	1,053
22-68	162-175	4c	3.4 ± 1.1	4.9 ± 1.7	52	0.7:1.0:1.4	40.0	988.0	73.2	3,806	1,808
22-94	115-120	2c	4.0 ± 0.7	5.7 ± 1.9	22	0.7:1.0:1.4	59.3	915.6	96.0	2,112	1,482
	(ft)		(cm)	(cm)	(cm ³)	(cm ²)	(cm ³)	(cm ³)	(cm ²)	(cm ²)	(cm ²)
					15,632		9,225		29,152		17,248
22-17	128-131	2a	3.0 ± 0.7	4.3 ± 0.5	30	0.6:1.0:1.4	23.2	586.1	52.1	1,563	1,316
22-17	138-145	2a	3.8 ± 0.8	5.0 ± 0.6	33	0.6:1.0:1.3	41.8	536.2	76.7	2,531	984.1
22-17	152-157	2a	3.6 ± 0.9	4.7 ± 0.3	27	0.6:1.0:1.4	33.8	612.9	67.0	1,809	1,215
22-17	157-162	2a	3.6 ± 1.0	5.1 ± 0.8	27	0.6:1.0:1.4	36.7	586.1	71.5	1,931	1,142
22-30	165-171	4c	3.7 ± 0.9	4.8 ± 0.9	45	0.6:1.0:1.3	39.1	1,028	72.9	3,281	1,916
22-51	130-131	2c	2.8 ± 0.8	5.6 ± 1.5	47	0.5:1.0:2.0	22.0	743.7	54.9	1,856	1,580
22-68	121-130	1a	3.8 ± 0.7	5.2 ± 0.9	38	0.6:1.0:1.4	43.5	1,159	79.1	3,006	2,108
22-78	58-65	1a	3.1 ± 0.9	4.6 ± 1.3	31	0.7:1.0:1.5	27.1	318.7	57.8	1,792	679.8
22-94	78-83	2c	3.4 ± 0.8	5.1 ± 1.3	27	0.7:1.0:1.5	41.6	697.5	75.5	2,039	1,266
22-94	130-140	2c	4.0 ± 0.8	5.6 ± 1.3	30	0.8:1.0:1.4	67.2	844.4	102.4	3,072	1,287
22-98	53-65	1a	2.6 ± 0.8	5.0 ± 1.8	36	0.5:1.0:1.9	18.2	413.9	47.3	1,703	1,076
22-99	55-70	1a	2.9 ± 0.9	4.6 ± 1.5	33	0.6:1.0:1.6	21.3	427.9	50.7	1,673	1,018
22-99	76-82	1a	3.7 ± 0.8	4.9 ± 1.4	30	0.6:1.0:1.5	39.9	643.0	74.1	2,223	1,194
	(ft)		(cm)	(cm)	(cm ³)	(cm ²)	(cm ³)	(cm ³)	(cm ²)	(cm ²)	(cm ²)
					14,960		8,597		29,203		17,058

3.51-N-9

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TABLE NO. 2 (Cont.)

DDH	Sample Depth	Geologic Unit	Axial Lengths		Axial Ratio a:b:c	Number Chips	Maximum Volume		Corrected Total Volume	Maximum Surface Area		Corrected Total Surface Area
			Long	Short			Single Chip	Total Chips		Single Chip	Total Chips	
						WR-4						
22-6	219-229	2a	3.3 ± 0.4	2.0 ± 0.7	0.6:1.0:1.3	36	28.4	1,022	558.6	58.8	2,117	1,157
22-16	123-130	1a	4.7 ± 1.3	1.9 ± 0.6	0.4:1.0:1.6	66	18.3	1,208	910.8	48.2	3,181	2,398
22-17	162-165	2a	3.0 ± 1.1	1.9 ± 0.3	0.6:1.0:1.5	17	32.3	549.1	451.7	65.9	1,120	1,132
22-17	165-169	2a	3.1 ± 0.8	1.8 ± 0.6	0.6:1.0:1.4	27	25.1	677.7	513.9	55.3	1,493	1,526
22-17	171-177	2a	3.3 ± 1.0	1.8 ± 0.6	0.6:1.0:1.4	44	27.3	1,201	708.5	58.8	2,587	1,905
22-27	85-90	2b	3.6 ± 1.1	2.5 ± 1.1	0.7:1.0:1.7	31	54.0	1,674	1,128	91.2	2,827	824.3
22-27	100-105	2b	3.7 ± 0.8	2.2 ± 0.6	0.6:1.0:1.7	24	49.7	1,193	464.1	88.3	2,119	2,240
22-49	180-190	2a	3.5 ± 0.8	1.6 ± 0.7	0.5:1.0:1.5	56	28.6	1,602	720.5	63.2	3,539	1,146
22-68	145-149	1a	4.0 ± 0.8	2.8 ± 0.9	0.7:1.0:1.3	21	59.4	1,247	1,008	94.5	1,984	1,902
22-69	154-162	4c	3.5 ± 1.1	2.3 ± 1.0	0.7:1.0:1.3	37	36.2	1,339	1,008	68.9	2,527	2,93.8
22-69	37-40	1a	3.7 ± 0.9	1.9 ± 0.8	0.5:1.0:1.4	18	34.4	619.2	146.7	44.8	2,016	1,249
22-69	42-46	1a	2.9 ± 0.8	1.5 ± 0.7	0.5:1.0:1.4	45	17.8	801.0	496.3	47.5	1,900	1,469
22-69	46-50	1a	3.0 ± 0.9	1.2 ± 0.5	0.4:1.0:1.6	40	17.3	692.0	534.9	47.5	1,900	1,469
22-70	160-170	2c	4.4 ± 0.2	3.5 ± 1.2	0.8:1.0:1.7	19	114.0	2,166	941.0	147.7	2,806	1,219
22-70	170-180	2c	4.4 ± 0.8	2.7 ± 1.2	0.7:1.0:1.4	29	59.0	1,711	1,082	95.0	2,755	1,742
22-94	62-72	1a	3.9 ± 0.8	2.5 ± 1.2	0.7:1.0:1.5	31	49.5	1,534	975.6	85.1	2,638	1,678
22-94	110-115	2c	3.6 ± 1.0	2.5 ± 1.2	0.7:1.0:1.5	37	51.3	1,898	969.3	84.8	3,138	1,603
22-99	70-76	1a	4.3 ± 0.4	2.1 ± 0.2	0.5:1.0:1.4	18	52.4	943.2	500.5	92.3	1,661	881.4
			(cm)	(cm)			(cm ³)	(cm ³)	(cm ³)	(cm ²)	(cm ²)	(cm ²)
							22,077	13,124	41,648	25,237		
							(cm ³)	(cm ³)	(cm ³)	(cm ²)	(cm ²)	(cm ²)

TABLE NO. 2 (Cont.)

DDH	Sample Depth	Geologic Unit	Axial Lengths		Axial Ratio a:b:c	Number Chips	Maximum Volume		Corrected Total Volume	Maximum Surface Area		Corrected Total Surface Area
			Long	Short			Single Chip	Total Chips		Single Chip	Total Chips	
						WR-5						
22-6	229-239	2a	3.0 ± 0.7	1.6 ± 0.6	0.5:1.0:1.5	22	22.1	486.2	252.0	51.9	1,142	591.9
22-15	60-66	2b	3.3 ± 1.3	1.7 ± 0.6	0.5:1.0:1.4	39	26.4	1,030	880.1	58.2	2,270	1,940
22-16	105-115	1a	3.7 ± 1.0	1.9 ± 0.3	0.5:1.0:1.4	34	37.3	1,268	883.6	73.4	2,496	1,739
22-18	65-73	2a	3.9 ± 0.8	2.1 ± 1.0	0.5:1.0:1.3	41	41.8	1,714	1,149	77.6	3,182	2,133
22-32	115-120	2a	3.8 ± 0.9	2.1 ± 0.5	0.6:1.0:1.3	43	40.7	1,750	1,037	76.1	3,272	1,939
22-35	39-49	1a	2.7 ± 0.9	1.2 ± 0.6	0.4:1.0:2.5	59	21.7	1,280	886.8	58.7	3,463	2,399
22-35	50-55	1a	2.7 ± 0.9	1.3 ± 0.5	0.5:1.0:2.6	46	24.2	1,113	794.6	62.2	2,861	2,042
22-38	61-66	2a	2.9 ± 1.0	1.5 ± 0.6	0.5:2.0:1.8	53	22.2	1,177	819.5	53.6	2,841	1,978
22-38	66-73	2a	3.1 ± 1.0	1.1 ± 0.6	0.4:1.0:1.8	61	18.8	1,147	781.9	53.0	3,233	2,204
22-38	73-80	2a	3.1 ± 1.0	1.1 ± 0.7	0.3:1.0:1.7	68	17.7	1,204	1,056	50.5	3,434	3,311
22-49	65-81	2a	3.2 ± 0.8	1.3 ± 0.8	0.4:1.0:1.5	68	20.0	1,360	1,063.4	51.5	3,502	2,481
22-49	82-99	2a	3.9 ± 0.8	1.5 ± 1.4	0.6:1.0:1.4	31	52.7	1,634	1,054	88.6	2,747	2,481
22-66	60-70	2b	3.3 ± 0.8	1.5 ± 0.5	0.4:1.0:1.8	54	28.7	1,550	961.4	65.6	3,542	2,197
22-66	70-78	2b	2.9 ± 0.9	1.4 ± 0.7	0.5:1.0:2.1	52	24.4	1,269	856.4	59.7	3,104	2,095
22-75	47-50	1b	4.1 ± 0.6	2.3 ± 0.7	0.6:1.0:1.2	17	48.1	817.7	518.1	84.1	1,430	906.1
22-90	95-100	2b	2.6 ± 0.7	1.0 ± 0.8	0.4:1.0:1.5	34	9.88	335.9	270.2	32.6	1,108	891.3
22-90	100-110	2c	3.1 ± 1.0	1.5 ± 0.6	0.5:1.0:1.5	27	21.4	577.8	482.3	51.6	1,393	1,163
22-90	72-78	2c	3.1 ± 1.0	1.9 ± 1.3	0.6:1.0:1.4	41	25.3	1,037	692.5	54.8	2,247	1,500
22-98	65-70	1a	3.9 ± 0.8	2.1 ± 0.4	0.5:1.0:1.5	14	46.7	653.8	353.3	84.8	1,187	641.4
22-98	70-80	1a	3.1 ± 0.9	1.6 ± 0.5	0.5:1.0:1.8	10	28.3	283.0	161.3	63.5	635.0	361.9
			(cm)	(cm)			(cm ³)	(cm ³)	(cm ³)	(cm ²)	(cm ²)	(cm ²)
							21,687	14,853	48,089	34,286		
							(cm ³)	(cm ³)	(cm ³)	(cm ²)	(cm ²)	(cm ²)

TABLE NO. 2 (Cont.)

DDH	Sample Depth	Geologic Unit	Axial Lengths		Axial Ratio a:b:c	Number Chips
			Median	Short		
WM-1 Rock Chip Axial Lengths						
22-27	195-206	1c	3.9 ± 0.5	4.9 ± 1.1	2.1 ± 0.6	20
22-38	184-194	1c	3.2 ± 0.5	4.2 ± 0.8	1.5 ± 0.2	49
22-38	194-203	1c	3.1 ± 0.6	4.3 ± 0.9	1.5 ± 0.2	67
22-65	95-109	2a	3.6 ± 1.0	4.7 ± 1.0	2.1 ± 0.2	42
22-69	93-100	2a	3.6 ± 0.9	4.4 ± 1.1	1.1 ± 0.6	58
22-73	167-175	1c	3.1 ± 1.0	5.0 ± 1.3	1.8 ± 0.4	42
22-73	175-183	1c	3.8 ± 0.9	5.0 ± 1.1	1.7 ± 0.5	50
22-73	183-185	1c	3.6 ± 0.7	5.0 ± 1.2	1.4 ± 0.5	28
22-76	85-95	1c	3.9 ± 0.9	4.9 ± 1.1	2.2 ± 0.8	38
22-82	139-246	1c	3.9 ± 0.8	5.1 ± 1.0	2.0 ± 0.5	36
22-82	146-149	1c	3.6 ± 1.1	4.6 ± 1.2	1.7 ± 0.8	26
22-85	271-280	1c	3.7 ± 0.9	5.8 ± 1.1	1.0 ± 0.5	63
22-93	85-94	2b	3.7 ± 0.8	5.0 ± 1.0	1.4 ± 0.5	52
22-96	94-100	2b	3.6 ± 0.8	4.9 ± 1.0	1.6 ± 0.5	36
22-96	140-144	1a	3.8 ± 0.9	5.1 ± 1.1	1.7 ± 0.6	25
22-96	144-153	1a	3.7 ± 0.9	4.7 ± 1.0	1.4 ± 0.8	36
22-96	153-160	1c	3.4 ± 1.0	4.8 ± 0.9	1.8 ± 0.4	46

TABLE NO. 3
Boring No. and Depth Interval of Each Waste Rock Sample Composited for Specific Gravity Determination

Boring Number	Depth Interval (feet)	Boring Number	Depth Interval (feet)	Boring Number	Depth Interval (feet)
22-1	129-174	22-38	184-194	22-76	85-95
22-6	209-219	22-38	194-203	22-78	58-65
22-6	219-229	22-49	65-81	22-82	139-146
22-6	229-239	22-49	180-190	22-82	146-149
22-15	60-66	22-51	130-135	22-85	271-280
22-16	105-115	22-56	140-149	22-86	59-70
22-16	123-130	22-56	149-157	22-86	70-78
22-17	123-128	22-56	157-160	22-90	72-80
22-17	128-131	22-57	52-72	22-90	80-90
22-17	131-138	22-62	52-62	22-90	90-100
22-17	138-145	22-62	62-72	22-90	100-110
22-17	145-147	22-62	72-80	22-93	85-94
22-17	152-175	22-65	95-109	22-93	94-100
22-17	157-162	22-66	60-70	22-94	62-72
22-17	162-165	22-66	70-78	22-92	72-78
22-17	165-169	22-68	121-130	22-94	78-83
22-17	171-177	22-68	130-135	22-94	110-115
22-18	65-73	22-68	145-149	22-94	115-120
22-27	85-90	22-68	154-162	22-94	130-140
22-27	100-105	22-68	162-175	22-96	140-144
22-27	195-206	22-69	37-40	22-96	144-153
22-30	165-171	22-69	42-46	22-96	153-160
22-30	171-176	22-69	46-50	22-98	50-55
22-32	92-96	22-69	93-100	22-98	55-65
22-32	96-100	22-70	69-79	22-98	65-70
22-32	115-120	22-70	140-150	22-98	70-80
22-35	39-49	22-70	150-160	22-99	55-70
22-35	50-55	22-70	160-170	22-99	70-76
22-35	61-66	22-70	170-180	22-99	76-82
22-38	58-63	22-73	167-175	WC2	34.9-39.5
22-38	66-73	22-73	175-183		
22-38	73-80	22-73	183-185		
22-38	92-99	22-75	47-50		

Specific Gravity Results - Waste Rock*

A = Weight of oven-dry test sample in air (g)
A₁ = Weight of air-dry test sample in air (g)
B = Weight of saturated-surface dry sample in air (g)
C = Weight of saturated test sample in water (g)

A = 7104 g
A₁ = 7233 g
B = 7526 g
C = 4595 g

Bulk specific gravity (air-dry) = $A_1/B-C = 2.47$
Bulk specific gravity (oven-dry) = $A/B-C = 2.42$
Bulk specific gravity (saturated-surface-dry) = $B/B-C = 2.57$
Apparent specific gravity (air dry) = $A_1/A_1-C = 2.74$
Apparent specific gravity (oven-dry) = $A/A-C = 2.83$
Percent Absorption (air-dry) = $[B-A_1/A_1] \times 100 = 4.1\%$
Percent Absorption (oven-dry) = $[B-A/A] \times 100 = 5.9\%$
Approximate Effective Porosity (air-dry) = $(B-A_1)/(B-C) = 10.0\%$
Approximate Effective Porosity (oven-dry) = $(B-A)/(B-C) = 14.4\%$

* Test performed 2/18/88 - 2/22/88

Calculation of Estimated Error for
Waste Rock Specific Gravity Determination

A. Direct Measurements

1. Weight Determinations

Accuracy of balance - ± 1 g

Values are presented as 4 significant digits
(e.g., 7104 ± 1 g)

B. Calculations

1. Specific Gravity

Values are presented as 3 significant digits
(e.g., 2.47 ± 0.01)

The least accurate of the values used in the specific gravity equations contains 4 significant digits. The specific gravity is presented with only 3 significant digits to account for error due to loss of sample during saturation. Assuming 1% moisture in the air-dried waste rock composite, the maximum loss of sample during saturation was 0.8% of the original air-dried weight.

Modifications to ASTM Test Designation: C127-84
for Specific Gravity Determination of Waste Rock Composite

- 1) The sample was not oven-dried prior to saturation with water.
- 2) The saturated-surface-dry weight was obtained after obtaining the weight of the saturated sample in water.
- 3) The temperature of the distilled water in which the sample was weighed was 20° C.

Calculation of Estimated Error for
Overburden Specific Gravity Determinations

A. Direct Measurements

1. Weight Determinations

Accuracy of balance - ± 0.1 g

Values are presented as 4 significant digits
(e.g., 691.4 g ± 0.1)

2. Temperature

A calibrated laboratory thermometer (accurate to 1° C) was utilized for the test. The temperature of the volumetric flask filled with water (W_a , observed) was used to compile values of W_a for the range of temperatures expected during the test (see paragraph 6.2 in ASTM Test Designation: D854-83). The value, W_a , varies by 0.1 g within the range of temperatures present during the tests.

Values of W_a are therefore presented as 4 significant digits (e.g., 691.0 ± 0.1).

B. Calculations

1. Sample Weight

Sample weights ranged from 38.7 to 64.2 grams. The sample weight values are presented with 3 significant digits. The sample weight value is the least accurate value in the specific gravity equation.

2. Specific Gravity

Carrying 3 significant digits, the least accurate of the parameters in the specific gravity equation results in specific gravity values being ± 0.01 .

Modifications to ASTM Test Designation: D854-84
for Specific Gravity Determination of Overburden Samples

1. The scale used was sensitive to 0.1 grams.

Specific Gravity Results - Overburden*

<u>Sample No./Description</u>	<u>Specific Gravity</u>
Till East #1	2.67
Till East #2	2.67
Till Central #1	2.73
Till Central #2	2.69
Till West #1	2.71
Till West #2	2.74
Saprolite #1	2.65
Saprolite #2	2.69
Saprolite #3	2.65
Sandstone Composite	2.65

*Results are given for water @ 20° C.

Foth & Van Dyke and Associates Inc.

2737 S. Ridge Road P. O. Box 19012 Green Bay, WI 54307-9012 414/497-2500

REPORT OF: SIEVE ANALYSIS OF COARSE TO FINE AGGREGATES

PROJECT: Waste Characterization

SCOPE I.D. #: 87K10

DATE TYPED: 1-26-89

REPORTED TO: Kennecott Explorations

REPORT NUMBER: 1

Specific Gravity, Density, and Grain Size
Determinations of Topsoil, Overburden, and Waste Rock Materials
Flambeau Project, Ladysmith, WI

TEST PERFORMED IN GENERAL ACCORDANCE OF ASTM: D1140

GENERAL DATA:

SAMPLE LOCATION:

DATE SAMPLED: 12/27/88

SAMPLE NUMBER: Soil Composite - Type 1

DATED RECEIVED: 12/28/88

DEPTH OF SAMPLE:

SOURCE OF SAMPLE:

SAMPLED BY: John Thresher

MUNSELL COLOR CODE: 7.5 YR. 3/4

LABORATORY DATA:

DATE TESTED: 12/30/88

24 HRS. TURN AROUND YES NO

TESTED PERFORMED BY: KAS

WASHED GRADATION YES NO

REVIEWED BY: P.O. Kepler 1-3-89

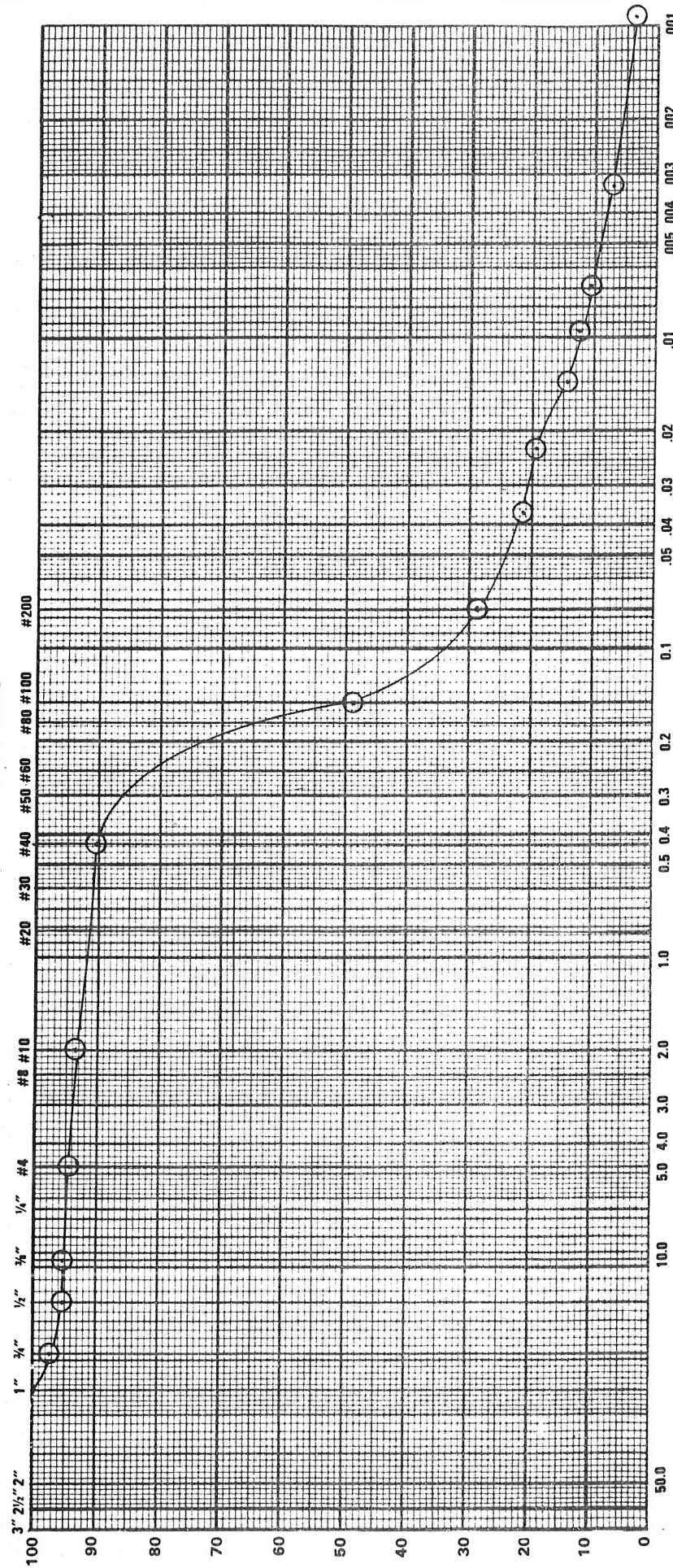
WEIGHT OF TEST SAMPLE 407.8 GRAMS

SIEVE SIZE	WEIGHT RETAINED (gms)	% RETAINED	% PASSING	PROJECT SPECIFICATION % PASSING BY WEIGHT	SOURCE OF SPECIFICATION
3"					
1½					
1	0	0	100		
¾	10.8	2.6	97.4		
½	7.4	1.8	95.6		
¾	0	0	95.6		
#4	3.9	1.0	94.6		
10	3.6	0.9	93.7		
40	14.3	3.5	90.2		
100	168.4	41.3	48.9		
200	81.9	20.1	28.8		
PAN	117.9	28.9			

REMARKS:

GRAIN SIZE DISTRIBUTION CURVE

U.S. STANDARD SIEVE SIZES



PERCENT FINER THAN SIZE SHOWN

PARTICLE SIZE IN MILLIMETERS

GRAVEL		SAND		SILT		CLAY	
COARSE	FINE	COARSE	MEDIUM	FINE	COARSE	FINE	CLAY
% = 2.6	% = 2.8	% = 0.9	% = 3.5	% = 61.3	% = 23.4	% = 5.5	

PROJECT: Waste Characterization - Kennecott Explorations

DATE: 1-3-89 SAMPLE NO.: 1

LOCATION SAMPLED: Soil Composite - Type 1

APPROVED BY: *RRR*

ELEV. OR DEPTH:

DRAWN BY: POK

ATTEBERG LIMITS: LL _____ PL _____ PI _____

COEFFICIENTS: Cc = _____ Cu = _____

10.3

SAMPLE SOURCE:

DATE SAMPLED: 12-27-88

MUNSELL COLOR CODE: 7.5 YR. 3/4

SOIL CLASSIFICATION (ASTM: D2487) SILTY SAND, fine grained, a little gravel, dark brown. (SM)

FORM #411 SL (2/87)

Foth & Van Dyke

Engineers/Architects

2737 S. Ridge Road
P. O. Box 19012
Green Bay, Wisconsin 54307-9012
414/497-2500

PROJECT NO.: _____

JOB NO.: 87K10

DATE: February 29 to March 8, 1988

REPORT NO.: 1

REPORT OF ANALYSIS OF AGGREGATES

ARCHITECT/ENGINEER: Foth & Van Dyke CONTRACTOR: _____

PROJECT: Kennecott Geotechnical SOURCE: _____

REPORT OF TESTS OF: Verification of Sandstone Composite Sample

Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifications
3-Inch				
2-Inch				
1 1/2-Inch				
1-Inch	0	0	100	
3/4-Inch	34.3	0.8	99.2	
1/2-Inch	33.3	0.8	98.4	
3/8-Inch	34.7	0.8	97.6	
No. 4	70.5	1.7	95.9	
No. 8				
No. 10	113.7	2.7	93.2	
No. 16				
No. 20	566.3	13.6	79.6	
No. 30				
No. 40	1088.9	26.1	53.5	
No. 50	779.3	18.7	34.8	
No. 80	855.8	20.5	14.3	
No. 100	194.3	4.7	9.6	
No. 200	247.8	5.9	3.7	
Pan	147.6	3.5		

RECEIVED AT LABORATORY: February 22, 1988

QUANTITY REPRESENTED: 4167.0 Grams

SUBMITTED BY: John Thresher

SAMPLED FROM: Sandstone

IDENTIFICATION: East

DATE SAMPLED: Autumn 1987

INTENDED USE: _____

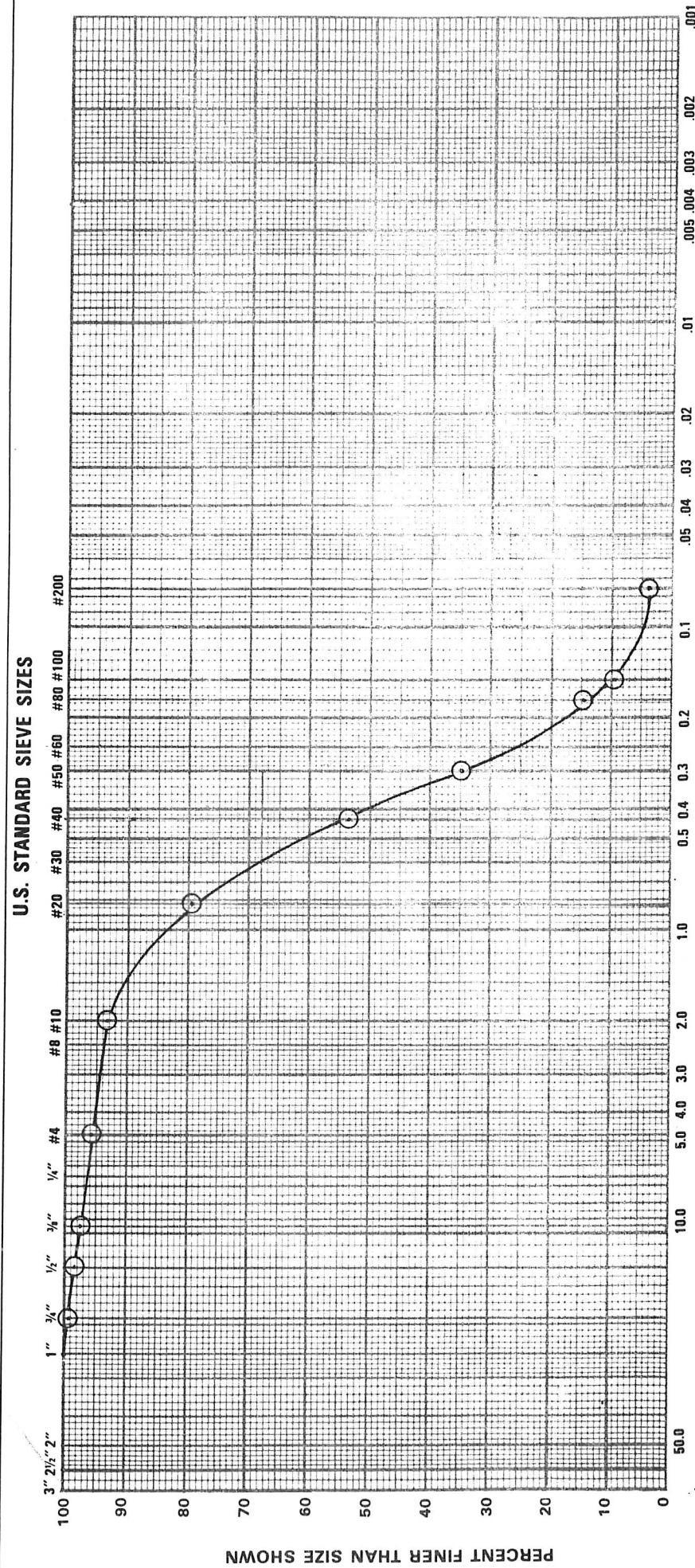
WASHED GRADATION: Yes

PERCENT PASSING NO. 200 SIEVE 3.5 %

COLOR: 10 Yr. 6/8 - brownish yellow

CHECKED BY: *RRR*

GRAIN SIZE DISTRIBUTION CURVE



GRAVEL		SAND		SILT		CLAY	
COARSE	FINE	COARSE	MEDIUM	FINE			
% = 0.8	% = 3.3	% = 2.7	% = 39.7	% = 50.0			% = 3.5

PROJECT: Kennecott Geotechnical
 DATE: 3-10-88 SAMPLE NO.: 1
 LOCATION SAMPLED: Sandstone - East
 DRAWN BY: POK APPROVED BY: RRR
 ELEV. OR DEPTH:
 ATTERBERG LIMITS: LL PL PI SAMPLED MOISTURE CONTENT (%):
 COEFFICIENTS: Cc = 1.1 Cu = 3.2
 SAMPLE SOURCE: Munsell Color Code: 10 YR. 6/8 DATE SAMPLED: Autumn, 1987
 SOIL CLASSIFICATION (ASTM: D2487): SAND, fine to medium grained, a little gravel, brownish yellow (SP)

FORM #411 SL (2/87)

Foth & Van Dyke
 Engineers/Architects
 2737 S. Ridge Road
 P. O. Box 19012
 Green Bay, Wisconsin 54307-9012
 414/497-2500

PROJECT NO.:
 JOB NO.: 87K10
 DATE: February 29 to March 7, 1988
 REPORT NO.: 2

REPORT OF ANALYSIS OF AGGREGATES

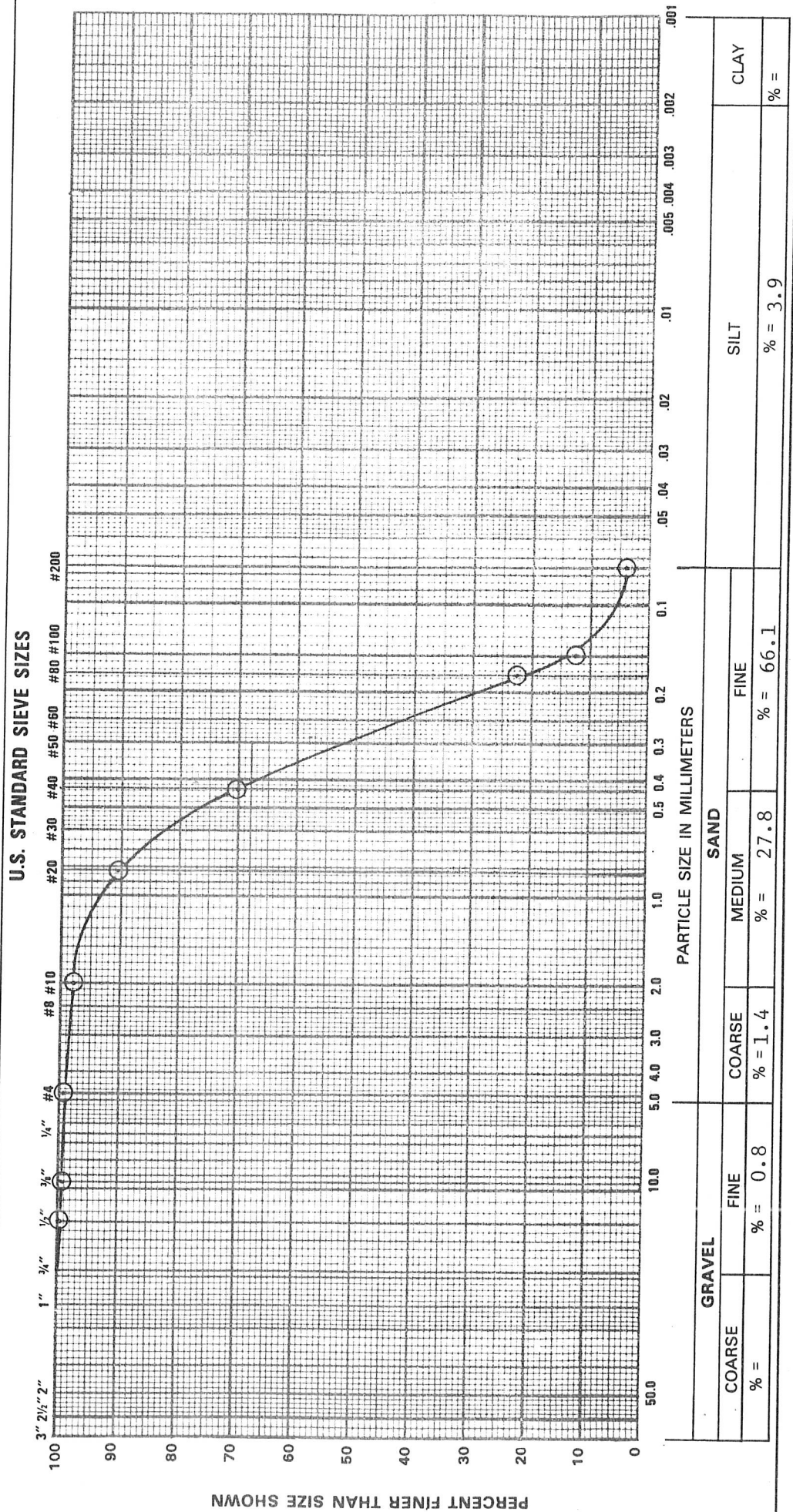
ARCHITECT/ENGINEER: Foth & Van Dyke CONTRACTOR:
 PROJECT: Kennecott Geotechnical SOURCE:
 REPORT OF TESTS OF: Verification of Composite Sandstone Sample

Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifi-cations
3-Inch				
2-Inch				
1 1/2-Inch				
1-Inch				
3/4-Inch	0	0	100	
1/2-Inch	2.5	0.2	99.8	
3/8-Inch	1.1	0.1	99.7	
No. 4	5.5	0.5	99.2	
No. 8				
No. 10	15.4	1.4	97.8	
No. 16				
No. 20	85.9	7.6	90.2	
No. 30				
No. 40	229.6	20.2	70.0	
No. 50				
No. 80	541.2	47.7	22.3	
No. 100	113.5	10.0	12.3	
No. 200	95.9	8.4	3.9	
Pan 37.3 + 7.4	44.7	3.9		

RECEIVED AT LABORATORY: February 22, 1988
 QUANTITY REPRESENTED: 1135.4 grams
 SUBMITTED BY: John Thresher
 SAMPLED FROM: Sandstone
 IDENTIFICATION: Central
 DATE SAMPLED: Autumn 1987
 INTENDED USE:
 WASHED GRADATION: Yes
 PERCENT PASSING NO. 200 SIEVE 3.9 %
 COLOR: 10 YR. 6/6 - brownish yellow

CHECKED BY: RRR

GRAIN SIZE DISTRIBUTION CURVE



PROJECT: Kennecott Geotechnical DATE: 3-10-88 SAMPLE NO.: 2

LOCATION SAMPLED: Sandstone - Central ELEV. OR DEPTH: DRAWN BY: POK APPROVED BY: RRR

ATTERBERG LIMITS: LL PL PI SAMPLED MOISTURE CONTENT (%): COEFFICIENTS: Cc = 1.0 Cu = 2.7

SAMPLE SOURCE: MUNSSELL COLOR CODE: 10 YR. 6/6 DATE SAMPLED: Autumn, 1987

SOIL CLASSIFICATION (ASTM: D2487) SAND, fine to medium grained, brownish yellow (SP)

FORM #411 SL (2/87)

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 414/497-2500

PROJECT NO.:
 JOB NO.: 87K10
 DATE: February 29 to March 3, 1988
 REPORT NO.: 3

REPORT OF ANALYSIS OF AGGREGATES

ARCHITECT/ENGINEER: Foth & Van Dyke CONTRACTOR:
 PROJECT: Kennecott Geotechnical SOURCE:
 REPORT OF TESTS OF: Verification of Composite Sandstone Sample

Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifi-cations
3-Inch				
2-Inch				
1 1/2-Inch				
1-Inch				
3/4-Inch	0	0	100	
1/2-Inch	17.5	2.7	97.3	
3/8-Inch	6.8	1.0	96.3	
No. 4	9.3	1.4	94.9	
No. 8				
No. 10	23.2	3.5	91.4	
No. 16				
No. 20				
No. 30				
No. 40	222.6	33.7	57.7	
No. 50				
No. 80				
No. 100	310.4	47.0	10.7	
No. 200	46.4	7.0	3.7	
Pan	24.3	3.7		

RECEIVED AT LABORATORY: February 22, 1988

QUANTITY REPRESENTED: 660.5 grams

SUBMITTED BY: John Thresher

SAMPLED FROM: Sandstone

IDENTIFICATION: West

DATE SAMPLED: Autumn 1987

INTENDED USE:

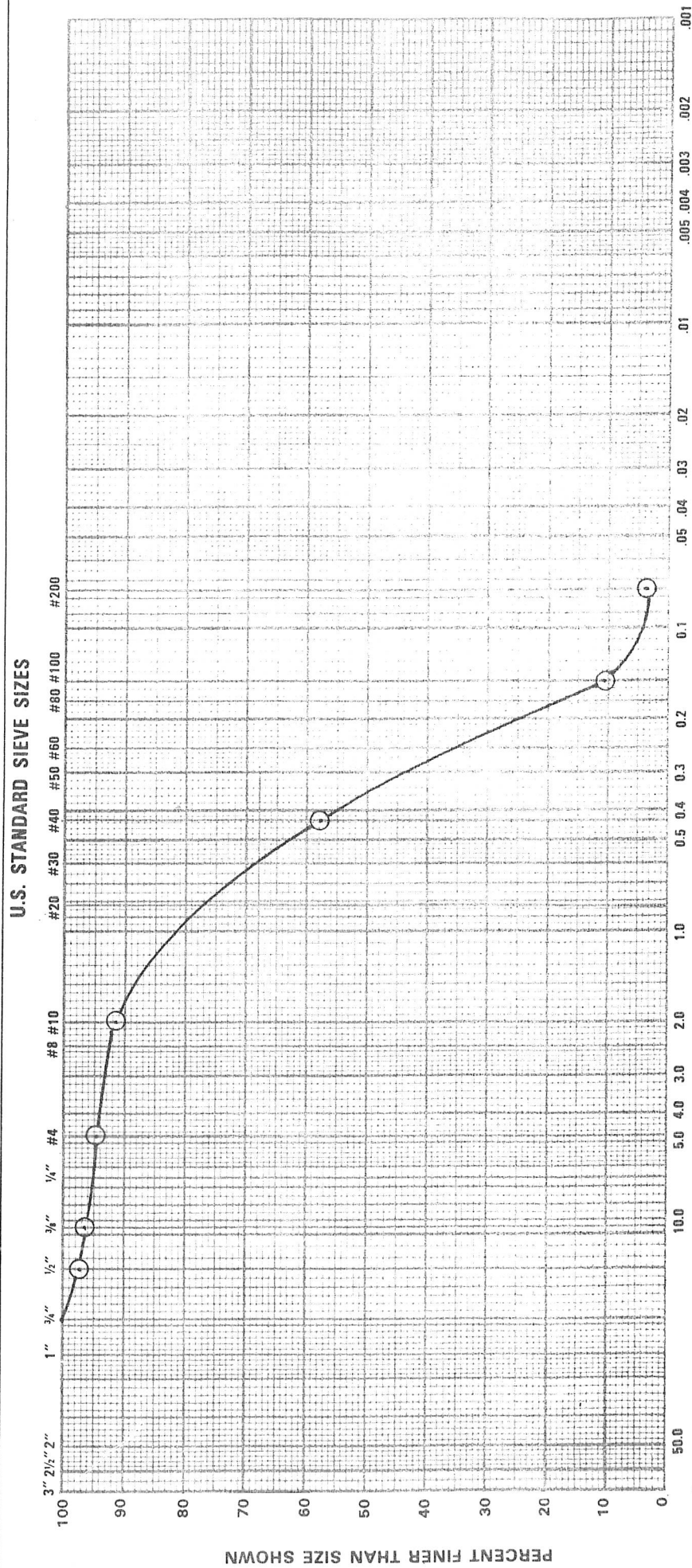
WASHED GRADATION: Yes

PERCENT PASSING NO. 200 SIEVE 3.7 %

COLOR: 10 YR. 6/6 - brownish yellow

CHECKED BY: RRR

GRAIN SIZE DISTRIBUTION CURVE



GRAVEL		SAND		SILT		CLAY	
COARSE	% = 5.1	COARSE	% = 3.5	FINE	% = 54.0	FINE	% = 3.7

PROJECT: Kennecott Geotechnical
 LOCATION SAMPLED: Sandstone - West
 ATTERBERG LIMITS: LL ___ PL ___ PI ___
 SAMPLE SOURCE: _____
 DATE: 3/10/88 SAMPLE NO.: 3
 DRAWN BY: POK APPROVED BY: RRR
 COEFFICIENTS: Cc = 0.8 Cu = 3.1
 MUNSSELL COLOR CODE: 10 YR. 6/6
 SOIL CLASSIFICATION (ASTM: D2487): SAND, fine to medium grained, a little gravel, brownish yellow (SP)

FORM #411 SL (2/87)

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 414/497-2500

PROJECT NO.: _____
 JOB NO.: 87K10
 DATE: February 29 to March 7, 1988
 REPORT NO.: 4

REPORT OF ANALYSIS OF AGGREGATES

ARCHITECT/ENGINEER: Foth & Van Dyke CONTRACTOR: _____
 PROJECT: Kennecott Geotechnical SOURCE: _____
 REPORT OF TESTS OF: Verification of Composite Till Sample

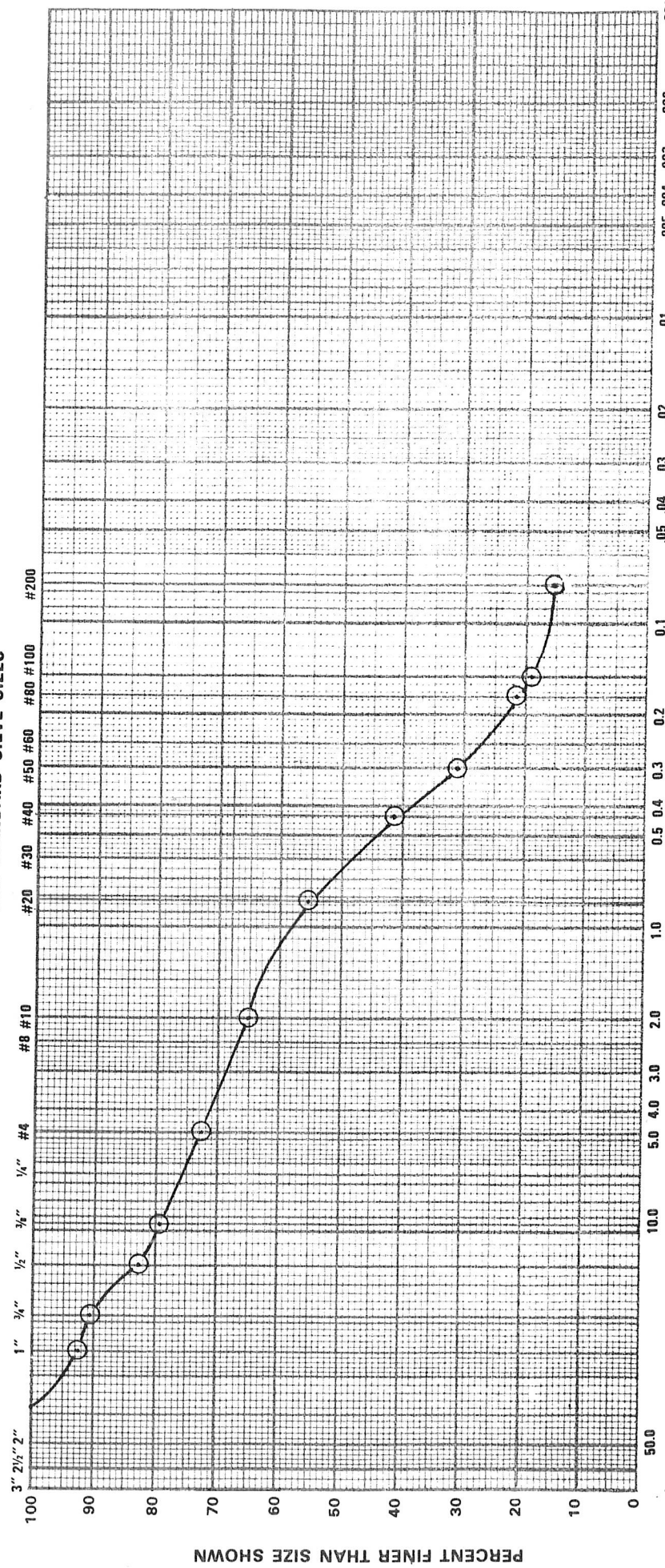
Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifications
3-Inch				
2-Inch				
1 1/2-Inch	0	0	100	
1-Inch	183.7	7.5	92.5	
3/4-Inch	44.5	1.8	90.7	
1/2-Inch	191.3	7.8	82.9	
3/8-Inch	93.4	3.8	79.1	
No. 4	155.3	6.3	72.8	
No. 8				
No. 10	190.6	7.7	65.1	
No. 16				
No. 20	234.6	9.5	55.6	
No. 30				
No. 40	351.2	14.2	41.4	
No. 50	261.8	10.6	30.8	
No. 80	232.1	9.4	21.4	
No. 100	58.2	2.4	19.0	
No. 200	108.1	4.4	14.6	
Pan	361.0	14.6		

RECEIVED AT LABORATORY: February 22, 1988
 QUANTITY REPRESENTED: 2465.7 grams
 SUBMITTED BY: John Thresher
 SAMPLED FROM: Till
 IDENTIFICATION: East
 DATE SAMPLED: Autumn, 1987
 INTENDED USE: _____
 WASHED GRADATION: Yes
 PERCENT PASSING NO. 200 SIEVE 14.6 %
 COLOR: 7.5 YR. 3/4 - dark brown

CHECKED BY: RRR

GRAIN SIZE DISTRIBUTION CURVE

U.S. STANDARD SIEVE SIZES



PERCENT FINER THAN SIZE SHOWN

PARTICLE SIZE IN MILLIMETERS

GRAVEL		SAND		SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	% =
% = 9.3	% = 17.9	% = 7.7	% = 23.7	% = 26.8	% =

PROJECT: Kennecott Geotechnical
 LOCATION SAMPLED: Till - East
 ATTERBERG LIMITS: LL _____ PL _____ PI _____
 SAMPLE SOURCE: _____
 DATE: 3/10/88 SAMPLE NO.: 4
 DRAWN BY: POK APPROVED BY: RRR
 COEFFICIENTS: Cc = _____ Cu = _____
 MUNSELL COLOR CODE: 7.5 YR. 3/4
 SOIL CLASSIFICATION (ASTM: D2487) SILTY SAND W/GRAVEL, fine to medium grained, dark brown (SM)

FORM #411 SL (2/87)

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PROJECT NO.: _____
 JOB NO.: 87K10
 DATE: February 29 to March 8, 1988
 REPORT NO.: 5

REPORT OF ANALYSIS OF AGGREGATES

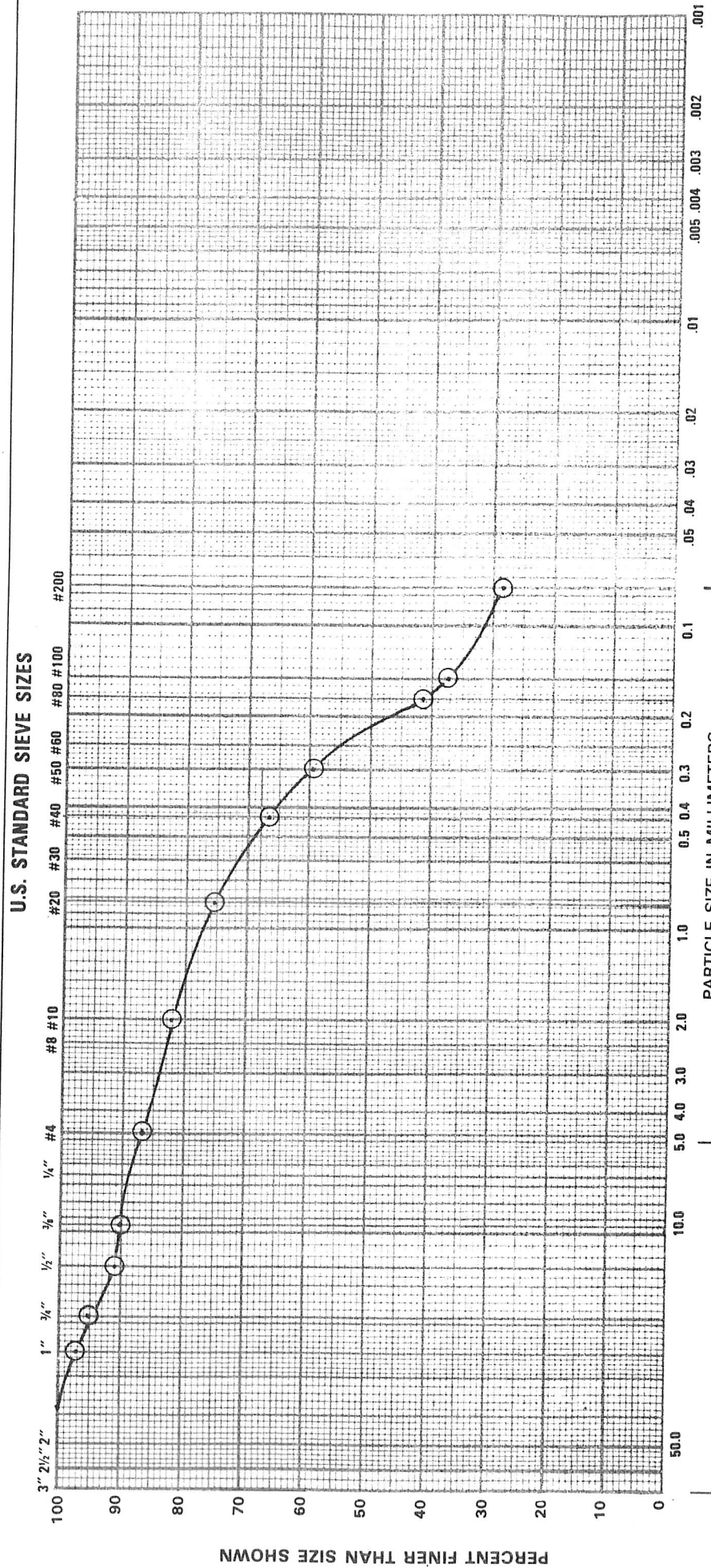
ARCHITECT/ENGINEER: Foth & Van Dyke CONTRACTOR: _____
 PROJECT: Kennecott Geotechnical SOURCE: _____
 REPORT OF TESTS OF: Verification of Composite Till Sample

Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifi-cations
3-Inch				
2-Inch				
1 1/2-Inch	0	0	100	
1-Inch	95.4	2.9	97.1	
3/4-Inch	63.8	1.9	95.2	
1/2-Inch	140.6	4.2	91.0	
3/8-Inch	26.8	0.8	90.2	
No. 4	110.6	3.3	86.9	
No. 8				
No. 10	157.8	4.8	82.1	
No. 16				
No. 20	227.1	6.8	75.3	
No. 30				
No. 40	287.0	8.6	66.7	
No. 50	249.1	7.5	59.2	
No. 80	590.9	17.8	41.4	
No. 100	134.1	4.0	37.4	
No. 200	305.7	9.2	28.2	
Pan	934.1	28.1		

RECEIVED AT LABORATORY: February 22, 1988
 QUANTITY REPRESENTED: 3323 grams
 SUBMITTED BY: John Thresher
 SAMPLED FROM: Till
 IDENTIFICATION: Central
 DATE SAMPLED: Autumn, 1987
 INTENDED USE: _____
 WASHED GRADATION: Yes
 PERCENT PASSING NO. 200 SIEVE 28.1 %
 COLOR: 10 YR. 4/4 - dark yellowish brown
 Moisture Content = 10.0%
 (As received)

CHECKED BY: RRR

GRAIN SIZE DISTRIBUTION CURVE



GRAVEL		SAND		SILT		CLAY	
COARSE	FINE	COARSE	MEDIUM				
% = 4.8	% = 8.3	% = 4.8	% = 15.4				
							% = 38.6

PROJECT: Kennecott Geotechnical
 LOCATION SAMPLED: Till - Central
 DATE: 3/10/88 SAMPLE NO.: 5
 DRAWN BY: POK APPROVED BY: RRR
 ELEV. OR DEPTH:
 ATTERBERG LIMITS: LL _____ PL _____ PI _____ SAMPLED MOISTURE CONTENT (%): _____ COEFFICIENTS: Cc = _____ Cu = _____
 MUNSSELL COLOR CODE: 10 YR. 4/4 DATE SAMPLED: Autumn, 1987
 SOIL CLASSIFICATION (ASTM: D2487): SILTY SAND, fine to medium grained, a little gravel, dark yellowish brown, (SM)

FORM #411 SL (2/87)

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PROJECT NO.: _____
 JOB NO.: 87K10
 DATE: February 29 to March 7, 1988
 REPORT NO.: 6

REPORT OF ANALYSIS OF AGGREGATES

ARCHITECT/ENGINEER: Foth & Van Dyke CONTRACTOR: _____
 PROJECT: Kennecott Geotechnical SOURCE: _____
 REPORT OF TESTS OF: Verification of Composite Till Sample

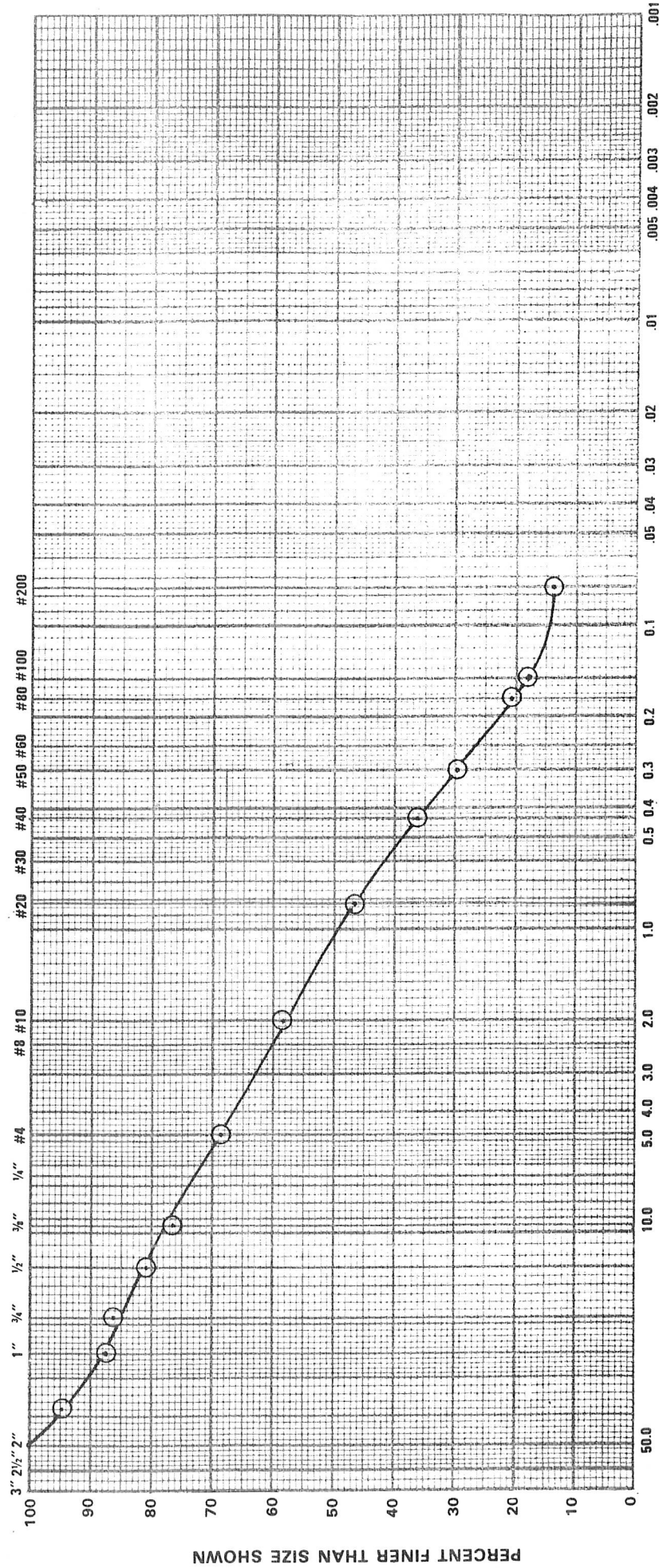
Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifi-cations
3-Inch				
2-Inch	0	0	100	
1 1/2-Inch	141.3	5.1	94.9	
1-Inch	201.5	7.3	87.6	
3/4-Inch	40.5	1.5	86.1	
1/2-Inch	144.6	5.2	80.9	
3/8-Inch	119.9	4.3	76.6	
No. 4	224.2	8.1	68.5	
No. 8				
No. 10	285.6	10.3	58.2	
No. 16				
No. 20	319.1	11.6	46.6	
No. 30				
No. 40	291.3	10.5	36.1	
No. 50	183.4	6.6	29.5	
No. 80	241.9	8.8	20.7	
No. 100	75.5	2.7	18.0	
No. 200	118.9	4.3	13.7	
344.9 Pan† 30.9	375.8	13.6		

RECEIVED AT LABORATORY: February 22, 1988
 QUANTITY REPRESENTED: 2763.5 grams
 SUBMITTED BY: John Thresher
 SAMPLED FROM: Till
 IDENTIFICATION: West
 DATE SAMPLED: Autumn 1987
 INTENDED USE: _____
 WASHED GRADATION: Yes
 PERCENT PASSING NO. 200 SIEVE 13.6 %
 COLOR: 7.5 YR. 3/4 - dark brown

CHECKED BY: RRR

GRAIN SIZE DISTRIBUTION CURVE

U.S. STANDARD SIEVE SIZES



GRAVEL		SAND		SILT		CLAY	
COARSE	% = 13.9	MEDIUM	% = 22.1				
FINE	% = 17.6	FINE	% = 22.5				
COARSE	% = 10.3						

PROJECT: Kennecott Geotechnical
 DATE: 3-10-88 SAMPLE NO.: 6
 LOCATION SAMPLED: Till - West
 DRAWN BY: POK APPROVED BY: RRR
 ATTERBERG LIMITS: LL PL PI
 SAMPLED MOISTURE CONTENT (%):
 COEFFICIENTS: Cc = Cu =
 SAMPLE SOURCE: Munsell Color Code: 7.5 YR. 3/4 DATE SAMPLED: Autumn, 1987

SOIL CLASSIFICATION (ASTM: D2487): SILTY SAND W/GRAVEL, fine to medium grained, dark brown (SM)

FORM #411 SL (2/87)

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PROJECT NO.:
 JOB NO.: 87K10
 DATE: February 29 to March 8, 1988
 REPORT NO.: 7

REPORT OF ANALYSIS OF AGGREGATES

ARCHITECT/ENGINEER: Foth & Van Dyke CONTRACTOR:
 PROJECT: Kennecott Geotechnical SOURCE:
 REPORT OF TESTS OF: Verification of Composite Saprolite Sample

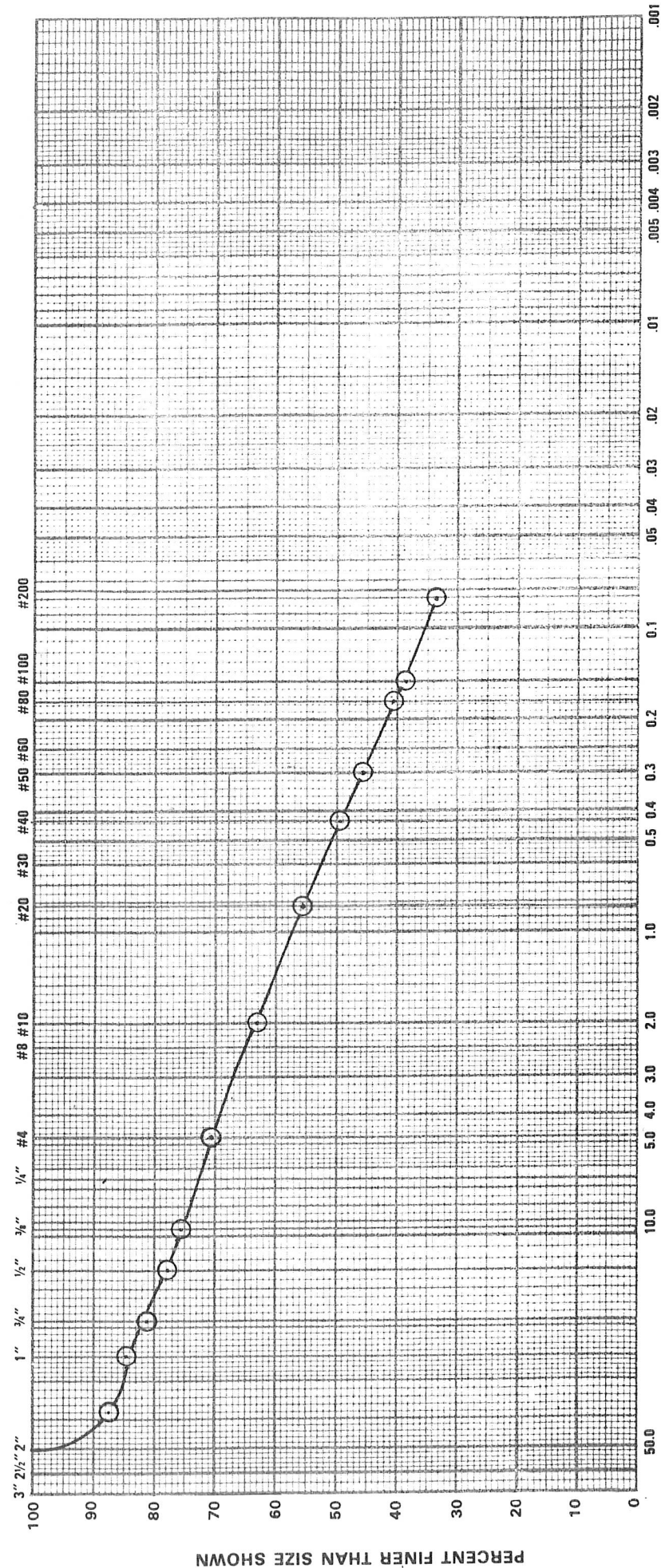
Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifi-cations
3-Inch				
2-Inch	0	0	100	
1 1/2-Inch	348.3	12.5	87.5	
1-Inch	81.7	2.9	84.6	
3/4-Inch	94.7	3.4	81.2	
1/2-Inch	92.8	3.3	77.9	
3/8-Inch	65.1	2.3	75.6	
No. 4	142.4	5.1	70.5	
No. 8				
No. 10	205.4	7.4	63.1	
No. 16				
No. 20	207.9	7.5	55.6	
No. 30				
No. 40	174.7	6.3	49.3	
No. 50	98.4	3.5	45.8	
No. 80	144.5	5.2	40.6	
No. 100	49.9	1.8	38.8	
No. 200	142.2	5.1	33.7	
Pan	936.8	33.6		

RECEIVED AT LABORATORY: February 22, 1988
 QUANTITY REPRESENTED: 2785 grams
 SUBMITTED BY: John Thresher
 SAMPLED FROM:
 IDENTIFICATION: Saprolite
 DATE SAMPLED: Autumn, 1987
 INTENDED USE:
 WASHED GRADATION: Yes
 PERCENT PASSING NO. 200 SIEVE 33.6 %
 COLOR: 10 YR. 6/2 - pinkish gray
 To 10 YR. 6/6 - reddish yellow
 Moisture Content - 12.7%
 (As received)

CHECKED BY: RRR

GRAIN SIZE DISTRIBUTION CURVE

U.S. STANDARD SIEVE SIZES



GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	% =	% =
% = 18.8	% = 10.7	% = 7.4	% = 13.8	% = 15.7		

PROJECT: Kennecott Geotechnical
 DATE: 3/10/88 SAMPLE NO.: 7
 LOCATION SAMPLED: Saprolite
 DRAWN BY: POK APPROVED BY: PRR
 ATTERBERG LIMITS: LL _____ PL _____ COEFFICIENTS: Cc = _____ Cu = _____
 SAMPLE SOURCE: 10 YR. 6/2 to 6/6 DATE SAMPLED: Autumn, 1987
 SOIL CLASSIFICATION (ASTM: D2487) SILTY SAND W/GRAVEL, fine to medium grained, pinkish gray to reddish yellow (SM)
 MUNSSELL COLOR CODE: _____

FORM #411 SL (2/87)

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 414/497-2500

PROJECT NO.: _____
 JOB NO.: 87K10
 DATE: March 7 to 9, 1988
 REPORT NO.: 8

REPORT OF ANALYSIS OF AGGREGATES

ARCHITECT/ENGINEER: Foth & Van Dyke CONTRACTOR: _____
 PROJECT: Kennecott Geotechnical SOURCE: _____
 REPORT OF TESTS OF: Verification of Composite Topsoil Sample

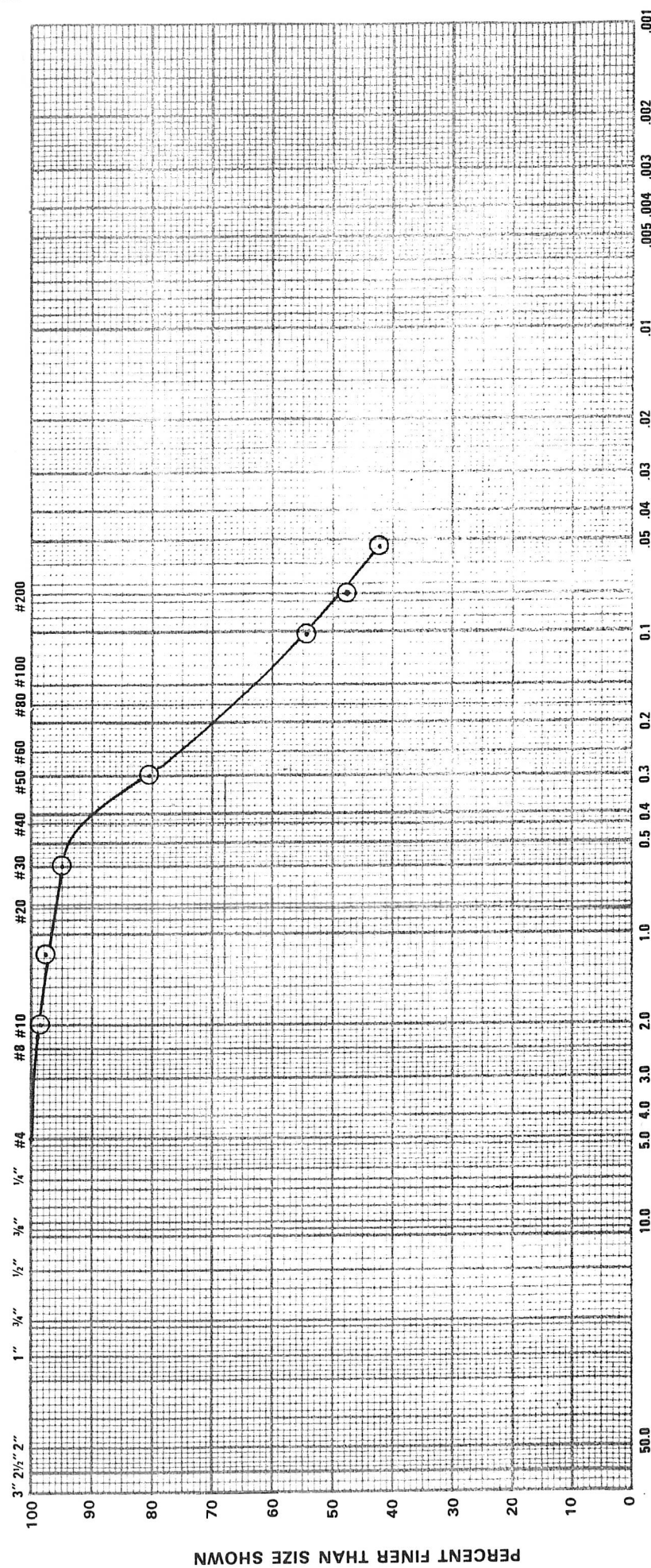
Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifi-cations
3-Inch				
2-Inch				
1 1/2-Inch				
1-Inch				
3/4-Inch				
1/2-Inch				
3/8-Inch				
No. 4			100	
No. 8				
No. 10	7.1	1.4	98.6	
No. 16	3.8	0.8	97.8	
No. 20				
No. 30	14.2	2.8	95.0	
No. 40				
No. 50	73.7	14.8	80.2	
No. 140	130.0	26.0	54.2	
No. 200	32.0	6.4	47.8	
No. 270	28.3	5.7	42.1	
Pan	210.5	42.2		

RECEIVED AT LABORATORY: February 22, 1988
 QUANTITY REPRESENTED: 516.1 - 16.7 = 499.4 grams
 SUBMITTED BY: John Thresher
 SAMPLED FROM: Topsoil
 IDENTIFICATION: East
 DATE SAMPLED: Autumn, 1987
 INTENDED USE: _____
 WASHED GRADATION: Yes
 PERCENT PASSING NO. 270 SIEVE 42.2 %
 COLOR: 10 YR. 3/2 - very dark grayish brown
 Gravel Content (+#4) = 3.2%
 wt. of +4 material = 16.7 grams

CHECKED BY: PRR

GRAIN SIZE DISTRIBUTION CURVE

U.S. STANDARD SIEVE SIZES



GRAVEL		SAND		SILT		CLAY	
COARSE	% =	COARSE	% =		% =		% =
	1.4	MEDIUM	7.1				
		FINE	43.7				

PROJECT: Kennecott Geotechnical
 DATE: 3/10/88 SAMPLE NO.: 8
 LOCATION SAMPLED: Topsoil - East
 DRAWN BY: POK APPROVED BY: RRR
 ATTERBERG LIMITS: LL ___ PL ___ PI ___
 SAMPLED MOISTURE CONTENT (%): ___ COEFFICIENTS: Cc = ___ Cu = ___
 SAMPLE SOURCE: 10 YR. 3/2
 MUNSSELL COLOR CODE: ___ DATE SAMPLED: Autumn, 1987

SOIL CLASSIFICATION (ASTM: D2487): SILTY SAND, fine grained, very dark grayish brown (SM)
 USDA CLASSIFICATION: SANDY LOAM/LOAM, very dark grayish brown

FORM #411 SL (2/87)

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 414/497-2500

PROJECT NO.: _____
 JOB NO.: 87K10
 DATE: March 3 to 8, 1988
 REPORT NO.: 9

REPORT OF ANALYSIS OF AGGREGATES

ARCHITECT/ENGINEER: Foth & Van Dyke CONTRACTOR: _____
 PROJECT: Kennecott Geotechnical SOURCE: _____
 REPORT OF TESTS OF: Verification of Topsoil Sample

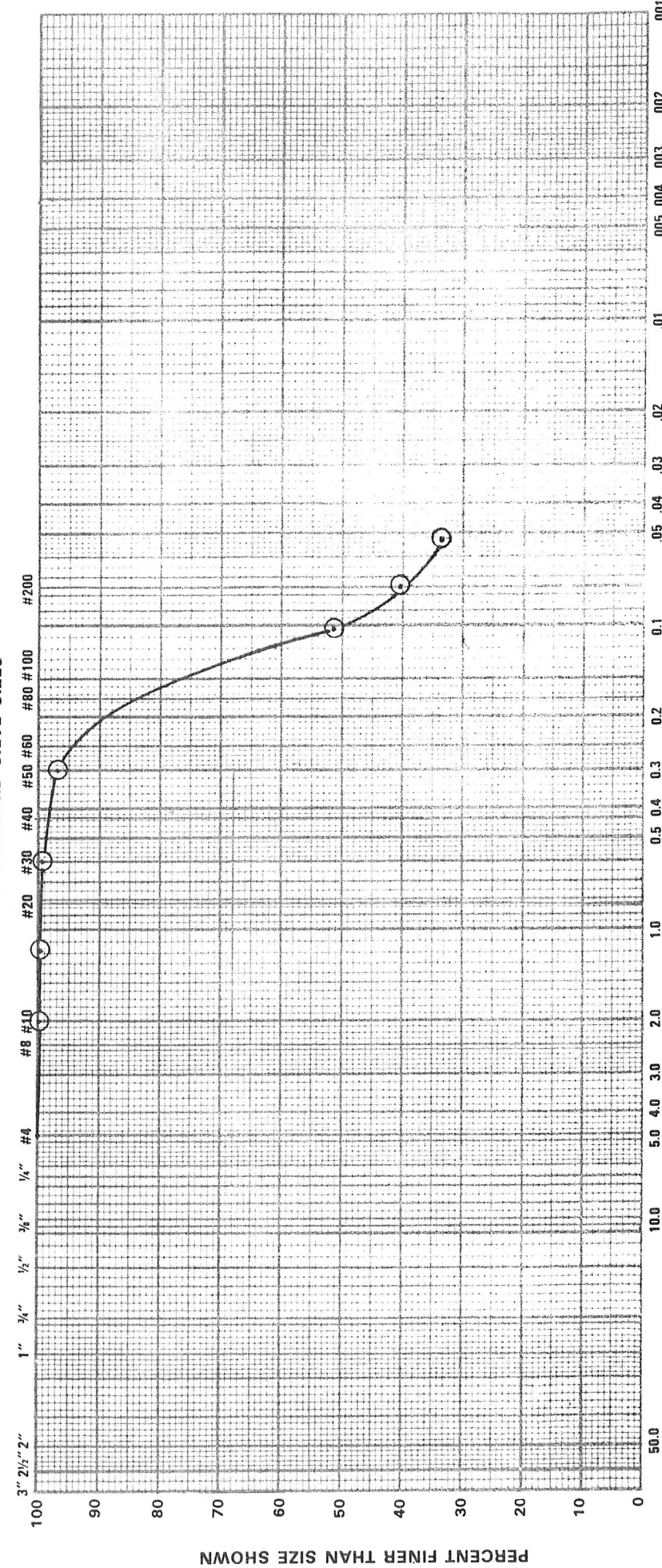
Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifications
3-Inch				
2-Inch				
1 1/2-Inch				
1-Inch				
3/4-Inch				
1/2-Inch				
3/8-Inch				
No. 4	0	0	100	
No. 8				
No. 10	0.7	0.1	99.9	
No. 16	0.8	0.1	99.8	
No. 20				
No. 30	2.7	0.3	99.5	
No. 40				
No. 50	23.4	2.5	97.0	
No. 140	425.5	45.8	51.2	
No. 200	103.5	11.1	40.1	
No. 270	61.7	6.6	33.5	
Pan	311.1	33.5		

RECEIVED AT LABORATORY: February 22, 1988
 QUANTITY REPRESENTED: 929.3 grams
 SUBMITTED BY: John Thresher
 SAMPLED FROM: Topsoil
 IDENTIFICATION: Central
 DATE SAMPLED: Autumn, 1987
 INTENDED USE: _____
 WASHED GRADATION: Yes
 PERCENT PASSING NO. 270SIEVE: 33.5 %
 COLOR: 10 YR. 3/4 - dark yellowish brown
 Gravel Content (+#4) = None

CHECKED BY: RRR

GRAIN SIZE DISTRIBUTION CURVE

U.S. STANDARD SIEVE SIZES



PERCENT FINER THAN SIZE SHOWN

PARTICLE SIZE IN MILLIMETERS

GRAVEL		SAND		SILT	CLAY
COARSE	% =	COARSE	% =	% =	% =
	0.1	MEDIUM	1.9		
	0.075	FINE	57.9		

PROJECT: Kennecott Geotechnical DATE: 3/10/88 SAMPLE NO.: 9
 LOCATION SAMPLED: Topsoil - Central ELEV. OR DEPTH: DRAWN BY: POK APPROVED BY: RRR
 ATTERBERG LIMITS: LL PL PI SAMPLED MOISTURE CONTENT (%): COEFFICIENTS: Cc = Cu =
 SAMPLE SOURCE: 10 YR. 3/4 MUNSSELL COLOR CODE: DATE SAMPLED: Autumn, 1987

SOIL CLASSIFICATION (ASTM: D2487) SILTY SAND, fine grained, dark yellowish brown (SM)
 USDA CLASSIFICATION: SANDY LOAM, dark yellowish brown

FORM #411 SL (2/87)

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 414/497-2500

PROJECT NO.:
 JOB NO.: 87K10
 DATE: March 7 to 9, 1988
 REPORT NO.: 10

REPORT OF ANALYSIS OF AGGREGATES

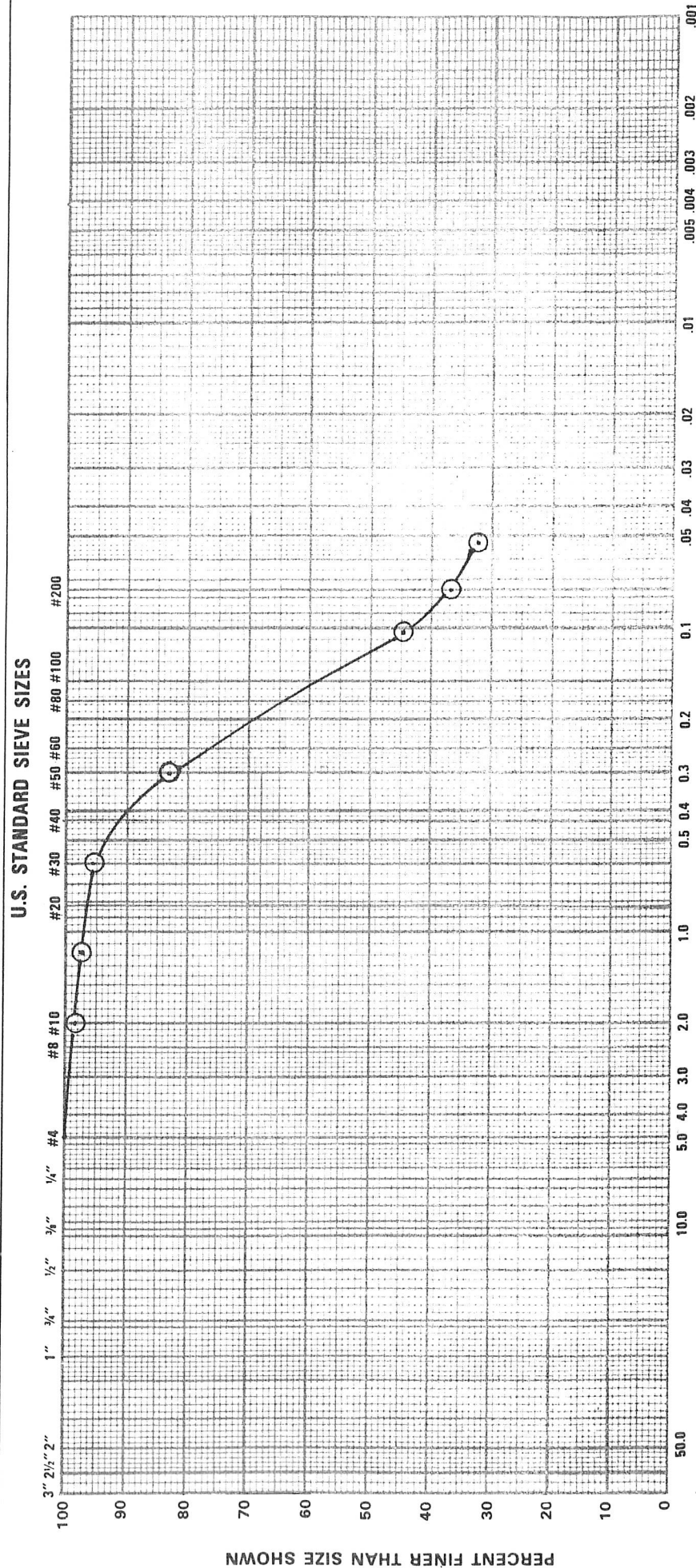
ARCHITECT/ENGINEER: Foth & Van Dyke CONTRACTOR:
 PROJECT: Kennecott Geotechnical SOURCE:
 REPORT OF TESTS OF: Verification of Composite Topsoil Samples

Sieve Size or No.	Weight Retained	% Retained	% Passing	Specifi-cations
3-Inch				
2-Inch				
1 1/2-Inch				
1-Inch				
3/4-Inch				
1/2-Inch				
3/8-Inch				
No. 4			100	
No. 8				
No. 10	7.9	1.4	98.6	
No. 16	5.8	1.0	97.6	
No. 20				
No. 30	11.9	2.1	95.5	
No. 40				
No. 50	71.2	12.5	83.0	
No. 140	217.3	38.3	44.7	
No. 200	44.5	7.8	36.9	
No. 270	26.2	4.6	32.3	
Pan	183.2	32.3		

RECEIVED AT LABORATORY: February 22, 1988
 QUANTITY REPRESENTED: 601.2 - 33.3 = 567.9 grams
 SUBMITTED BY: John Thresher
 SAMPLED FROM: Topsoil
 IDENTIFICATION: West
 DATE SAMPLED: Autumn, 1987
 INTENDED USE:
 WASHED GRADATION: Yes
 PERCENT PASSING NO. 270SIEVE 32.3 %
 COLOR: 10 YR. 3/2 - very dark grayish brown
 Gravel Content (+#4) = 5.5%
 Wt. of +4 material = 33.3 grams
 (includes a 3/4" stone)

CHECKED BY: RRR

GRAIN SIZE DISTRIBUTION CURVE



GRAVEL		SAND		SILT		CLAY	
COARSE	FINE	COARSE	MEDIUM	FINE			
% =	% =	% =	% =	% =	% =	% =	% =
		1.4	8.6	53.1			

PROJECT: Kennecott Geotechnical
 DATE: 3/10/88 SAMPLE NO.: 10
 LOCATION SAMPLED: Topsoil - West
 DRAWN BY: POK APPROVED BY: RRR
 ATTERBERG LIMITS: LL ___ PL ___ PI ___
 SAMPLED MOISTURE CONTENT (%): ___
 COEFFICIENTS: Cc = ___ Cu = ___
 SAMPLE SOURCE: 10 YR. 3/2
 MUNSSELL COLOR CODE: Autumn, 1987
 SOIL CLASSIFICATION (ASTM: D2487) SILTY SAND, fine grained, very dark grayish brown (SM)
 USDA CLASSIFICATION: SANDY LOAM, very dark grayish brown

FORM #411 SL (2/87)

Calculations of the Carryover of Iron and Sulfur During the Grinding Process of the Waste Rock Samples

- The waste rock samples were ground in one of four milling jars made of Burundum (Norton Trademark) enhanced porcelain with Burundum pellets. Jars 1 - 3 were size #0 and Jar 4 was a size #00.
- Samples were ground in order of increasing total sulfur content.
- After the grinding of waste rock samples WR-1 through 3, approximately 100 g of silica sand was ground in each jar. It was observed that the grinding of the silica sand removed essentially all of the dark red, brown and black pigment which had been accumulating in the jars. The pigmentation agents had been scoured by and were entrained within the ground silica sand.
 - Similarly, silica sand was ground in the jars upon completion of the grinding of the WR-4 samples and of the WR-5 and WW-1 samples.
- Jar 4 was used only to grind two samples in the WR-1 through 3 group of samples.
- The contaminated ground silica sand samples were digested in a microwave oven and analyzed for percent total sulfur and iron (ug/g).
- The results of the analyses have been used to estimate the carryover of sulfur and iron from sample to sample during the milling process.
 - The quantity of iron or sulfur in the silica powder (in ug/g) was calculated by multiplying the iron or sulfur concentration (in ug/g as %) by the weight of the silica sand (100 g).
 - The concentration of iron or sulfur carryover within the waste rock samples (ug Fe or S/g sample) was calculated by dividing the quantity of each element in the silica sand by the weight of all of the waste rock samples ground in the jar prior to the grinding of the silica sand.
 - It has been assumed that all of the carryover iron and sulfur had been scoured from the jars and was entrained within the powdered silica sand. Also, it had been assumed that each sample within group (A, B, or C) contributed an equal proportion of the material carried over.

ORTEK
Oneida Environmental Technology Center
2496 West Mason Street
P. O. Box 12435
Green Bay, WI 54307-2435
Telephone: (414) 498-2222

LABORATORY ANALYSIS RESULTS

W.D.N.R. LAB CERT. NO. 405099530

Client Kennecott
Address

Sampled By J. Thresher
P.O. #
Job # 87K10
Report to: B. Burton
Invoice # 1553
Result Sheet No. 39106.01

Name of Rep.
Telephone No. (414) 497-2500

Sample I.D.	WW-1	Jar 1-A	Jar 2-A	Jar 3-A	Jar 4-A
Date Collected	01/12/89	01/12/89	01/12/89	01/12/89	01/12/89
Date Received	01/12/89	01/12/89	01/12/89	01/12/89	01/12/89

Parameters, units ----- Results -----

T. Sulfur, %	34	0.32	0.30	0.18	0.07
Iron, ug/g	450	220	360	410	110
Copper, ug/g	9600				
Manganese, ug/g	19				
T. Chromium, ug/g	31				

Comments:

Signed: David Turiff Date: February 15, 1987

- The mean concentration of iron carryover for all jars and sample sets is 14.2 ug/g. Since the range of iron concentration in samples WR-1 through 5 varied between 30,000 and 40,000 ug/g, the calculated carryover is less than or equal to 0.05% of the iron in the samples.
- The mean concentration of sulfur carryover for all jars used to grind samples WR-1 through 3 is 150.6 ug/g. These samples have a sulfur concentration of 7,000 ug/g, or less sulfur. The mean concentration of sulfur carryover for all jars used to grind the WR-4 samples is 175.4 ug/g. The sulfur concentration of WR-4 samples is 20,000 ug/g. Finally, the mean concentration of sulfur carryover for all jars used to grind the WR-5 and WW-1 samples is 34.5 ug/g. The concentration of sulfur in samples WR-4 and WW-1 varies from 48,000 to 340,000 ug/g.
- The iron carryover appears to have varied randomly from jar to jar and sample set to sample set. This carryover is essentially insignificant.
- The sulfur carryover was greatest for those samples with the lowest sulfur concentration and was lowest for those with the highest sulfur concentration.

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LABORATORY ANALYSIS RESULTS
W.D.N.R. LAB CERT. NO. 405099530

Client Address: Kennecott
Name of Rep. Telephone No.: (414) 497-2500

Sampled By: J. Thresher
P.O. #
Job # 87K10
Report to: B. Burton
Invoice # 1553
Result Sheet No. 39106.02

Sample I.D.	Jar 1-B	Jar 2-B	Jar 3-B	Jar 1-C	Jar 2-C
Date Collected	01/12/89	01/12/89	01/12/89	01/12/89	01/12/89
Date Received	01/12/89	01/12/89	01/12/89	01/12/89	01/12/89

Parameters, units	Results				
T. Sulfur, %	0.33	0.28	0.32	0.15	0.31
Iron, ug/g	190	340	170	390	510

Comments:

Signed: David Turiff Date: February 15, 1989

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LABORATORY ANALYSIS RESULTS
W.D.N.R. LAB CERT. NO. 405099530

Client Address: Kennecott
Name of Rep. Telephone No.: (414) 497-2500

Sampled By: J. Thresher
P.O. #
Job # 87K10
Report to: B. Burton
Invoice # 1553
Result Sheet No. 39106.03

Sample I.D.	Jar 3-C
Date Collected	01/12/89
Date Received	01/12/89

Parameters, units	Results
T. Sulfur, %	0.19
Iron, ug/g	150

Comments:

Signed: David Turiff Date: February 15, 1989

TABLE NO. 4

Calculations of the Carryover of Iron and Sulfur During the Grinding Process of Waste Rock Samples

	WR-1 through 3 Samples			WR-4 Samples			WR-5 and WR-1 Samples			
	Jan 1-A	Jan 2-A	Jan 3-A	Jan 4-A	Jan 1-B	Jan 2-B	Jan 3-B	Jan 1-C	Jan 2-C	Jan 3-C
Number Samples	12	13	13	2	6	6	5	11	12	12
Total Sample Weights (gms)	4,088	3,656	4,088	175.9	2,251	2,191	1,271	5,860	6,229	6,755
Concentration of Fe in Silica Powder (ug)	22,000	36,000	41,000	11,000	19,000	34,000	17,000	39,000	51,000	15,000
Fe Carryover - ug FE/g Sample	5.38	9.85	10.03	62.54	8.44	15.52	13.38	6.66	8.19	2.22
Concentration of S in Silica Powder (%)	0.32	0.30	0.18	0.07	0.33	0.28	0.32	0.15	0.31	0.19
Quantity of S in Silica Powder (g)	0.32	0.30	0.18	0.07	0.33	0.28	0.32	0.15	0.31	0.19
S Carryover - ug S/g Sample	78.3	82.1	44.0	398	147	128	252	25.6	49.8	28.1

3.5-N-46

KEIR

TABLE NO. 5

Waste Rock Sampling and Compositing Data

DDH	Section	Sample Depth (ft)	Geologic Units	Rock Chips	Rock Powder	C/P
A. WR-1 (<0.10% S) Compositing Data						
22-6	410	209-219	2a	906.3	129.3	7.01
22-17	400	123-128	2a	1548.1	221.2	7.00
22-17	400	131-138	2a	895.9	128.0	7.00
22-17	400	145-147	2a	917.5	129.5	7.08
22-30	424	171-176	4C	1111.6	156.5	7.10
22-56	408	149-157	3a	2727.1	391.3	6.97
22-56	408	157-160	3a	963.4	137.6	7.00
22-57	408	52-72	3a	1776.3	253.8	7.00
22-70	418	69-79	2C	2254.6	322.1	7.00
22-70	418	140-150	2C	2777.5	392.4	7.08
22-70	418	150-160	2C	2315.2	331.7	6.98
22-86	402	59-70	2C	762.8	109.0	7.00
22-86	402	70-78	2C	2506.9	357.8	7.01
22-90	418	72-80	2b	1708.3	241.7	7.07
22-90	418	80-95	2b	2145.8	305.8	7.02
22-98	422	50-55	2b	413.6	59.1	7.00
TOTALS				(ft)	25,730.9	3,666.8
				(gms)		(gms)

3.5-N-47

KEIR

TABLE NO. 5 (Cont.)

DDH	Section	Sample Depth (ft)	Geologic Units	Rock Chips	Rock Powder	C/P
B. WR-2 (0.49% S) Compositing Data						
22-1	402	129-174	2a	2310.3	328.7	7.03
22-32	400	92-96	2a	2175.9	310.8	7.00
22-32	400	96-100	2a	1132.5	161.8	7.00
22-38	408	58-63	2a	2086.3	298.0	7.00
22-56	408	140-149	3a	2280.9	325.4	7.01
22-62	420	52-62	4C	2159.7	308.5	7.00
22-62	420	62-72	4C	2711.2	387.3	7.00
22-62	420	72-80	4C	2554.1	364.9	7.00
22-68	422	130-135	1a	1404.8	200.1	7.02
22-68	422	162-175	4C	2539.2	361.7	7.02
22-94	412	115-120	2C	2353.0	339.3	6.93
TOTALS			(ft)	23,707.9	3,386.5	
				(gms)		
C. WR-3 (0.70% S) Compositing Data						
22-17	400	128-131	2a	1506.2	231.7	6.50
22-17	400	138-145	2a	1378.0	211.1	6.53
22-17	400	152-157	2a	1575.1	242.3	6.50
22-17	400	157-162	2a	1506.4	231.1	6.52
22-30	424	165-171	4C	2642.3	405.1	6.52
22-51	404	130-131	2C	1911.2	294.0	6.50
22-68	422	121-130	1a	2978.2	458.2	6.50
22-78	406	58-65	1a	819.1	125.8	6.51
22-94	412	78-83	2C	1792.7	275.8	6.50
22-94	412	130-140	2C	2170.0	335.1	6.48
22-98	422	55-65	1a	1063.6	164.5	6.47
22-99	410	55-70	1a	1099.2	167.9	6.55
22-99	410	76-82	1a	1652.4	254.2	6.50
TOTALS			(ft)	22,094.4	3,396.8	
				(gms)		

3.5-N-48

KEIR

TABLE NO. 5 (Cont.)

DDH	Section	Sample Depth (ft)	Geologic Units	Rock Chips	Rock Powder	C/P
D. WR-4 (2.0% S) Compositing Data						
22-6	410	219-229	2a	1435.5	179.4	8.00
22-16	416	123-130	1a	2340.7	292.0	8.02
22-17	400	162-165	2a	1160.9	145.1	8.00
22-17	400	165-169	2a	1320.6	165.8	7.97
22-17	400	171-177	2a	1820.9	228.3	7.98
22-27	424	85-90	2b	2899.7	362.5	8.00
22-27	424	100-105	2b	1192.8	148.3	8.04
22-49	404	180-190	2a	2604.7	325.6	8.00
22-68	422	145-149	1a	1851.8	231.5	8.00
22-68	422	154-162	4C	2591.3	323.9	8.00
22-69	402	37-40	1a	377.0	46.4	8.13
22-69	402	42-46	1a	1275.5	159.4	8.00
22-69	402	46-50	1a	1374.8	171.9	8.00
22-70	418	160-170	2C	2418.5	302.2	8.00
22-70	418	170-180	2C	2781.8	347.7	8.00
22-94	412	62-72	1a	2507.2	311.9	8.04
22-94	412	110-115	2C	2491.2	310.2	8.03
22-99	410	70-76	1a	1286.2	162.3	7.92
TOTALS			(ft)	33,731.1	4,214.4	
				(gms)		

3.5-N-49

KEIR

TABLE NO. 5 (Cont.)

DDH	Section	Sample Depth (ft)	Geologic Units	Rock Chips	Rock Powder	C/P
E. WR-5 (4.8% S) Compositing Data						
22-6	410	229-239	2a	647.7	104.7	6.19
22-15	416	60-66	2b	2261.9	368.5	6.14
22-16	416	105-115	1a	2270.8	368.8	6.16
22-18	416	65-73	2b	2954.0	480.0	6.15
22-32	400	115-120	2a	2665.4	430.5	6.19
22-35	400	39-49	1a	2279.1	370.6	6.15
22-35	400	50-55	1a	2042.0	332.0	6.15
22-35	400	61-66	1a	2106.1	342.5	6.15
22-38	408	66-73	2a	2009.4	326.7	6.15
22-38	408	73-80	2a	2714.7	441.4	6.15
22-38	408	92-99	2a	2476.0	402.6	6.15
22-49	404	65-81	2a	2707.9	441.1	6.14
22-66	422	60-70	2b	2470.8	401.8	6.15
22-66	422	70-78	2b	2201.0	357.9	6.15
22-75	406	47-50	1b	1331.5	216.5	6.15
22-90	418	95-100	2b	694.5	112.9	6.15
22-90	418	100-110	2b	1239.5	201.5	6.15
22-94	412	72-78	2c	1779.6	290.1	6.13
22-98	422	65-70	1a	907.9	148.0	6.13
22-98	422	70-80	1a	414.6	67.3	6.16
TOTALS				38,174.4 (gms)	6,205.4 (gms)	

TABLE NO. 5 (Cont.)

DDH	Section	Sample Depth (ft)	Geologic Units	Rock Chips	Rock Powder	C/P
F. WW-1 (34% S) Compositing Data						
22-27	424	195-206	1c	847.2	209.6	4.04
22-38	408	184-194	1c	3187.2	796.8	4.00
22-38	408	194-203	1c	4357.6	1089.0	4.00
22-65	402	95-109	2a	2539.1	634.8	4.00
22-69	402	93-100	2a	1767.9	442.0	4.00
22-73	418	167-175	1c	2797.9	699.5	4.00
22-73	418	175-183	1c	3266.6	816.0	4.00
22-73	418	183-185	1c	1023.4	256.3	3.99
22-76	414	85-95	1c	3727.0	931.8	4.00
22-82	410	139-146	1c	3144.7	786.3	4.00
22-82	410	146-149	1c	1392.7	346.9	4.01
22-85	410	271-280	1c	2995.2	733.4	4.08
22-93	416	85-94	2b	2404.4	618.8	3.89
22-93	416	94-100	2b	1609.5	393.2	4.09
22-96	412	140-144	1a	1060.2	265.3	4.00
22-96	412	144-153	1a	2088.8	521.1	4.01
22-96	412	153-160	1c	3055.1	764.5	4.00
TOTALS				41,264.5 (gms)	10,305.3 (gms)	
G. WR-1A (<0.17% S) Compositing Data						
22-136	410	122-123	5		43.6	
22-137	401	82-83	2a		79.4	
22-140	406	140-141	3a		60.1	
22-142	422	135-136	1a		58.9	
22-142	422	142-143	4c		72.7	
22-147	415	98-99	1a		51.8	
22-147	415	109-110	2b		55.3	
TOTAL					421.8 (gms)	

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Engineers
Architects
Planners
Scientists
Economists

Foth & Van Dyke

2737 S. Ridge Road
P. O. Box 19012
Green Bay, WI 54307-9012
414/497-2500

February 3, 1989

Project: Waste Characterization

Scope I.D. 87K10

Reported to: Kennecott Explorations

Report No. 1

GENERAL DATA:

Sample Number:	Soil Composite - Type I
Date Sampled:	12/27/88
Date Received:	12/28/88
Sampled By:	John Thresher

LABORATORY DATA:

Height of Soil:	1 7/16"
Wet Density:	121.9 pcf
Moisture Content:	10.3 %
Dry Density:	110.5 pcf
Date of Test:	January 4, 1989
Tested By:	R. Rouse
Soil Classification:	SILTY SAND, fine grained, a little gravel dark brown (SM)

REMARKS:

The soil composite sample was delivered to the laboratory in a closed freezer bag. To obtain a density of the soil, we performed the following: (1) Placed the soil in a 4" diameter proctor mold. (2) Used a modified hammer and compacted the lift of soil with 25 blows from the hammer. (3) The height of the sample was measured and also the weight of soil in the mold. (4) Sample was placed in an oven for 24 hours at 110°C to obtain the moisture content. (5) Calculations were performed to provide the results noted above.

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