APPENDIX B

Aggregate Selection

URS CALCULATION SHEET	PROJECT: IP-Riegelwood Cell 2 Liner System				JOB NO. 31826746	
	SUBJECT: Filter Media Calculations				SHEET NO. 1 of 5	
	ORIGINATED BY Lenore Gaier	DATE 5/14/2009	CHECKED BY Rich Lowe	DATE 6/1/2009	CALC. NO.	REV. NO.

Case 1

2' Sand Blanket	B
Protective Cover	
Filter Media	F

Determine the aggregate size of the filter media

1 $D_{15F} / D_{15B} > 4$

where: $D_{15B} = 0.17 - 0.075$ (from sand blanket curve)

$D_{15F} = 4 * 0.17 = 0.68$

$D_{15F} = 4 * 0.075 = 0.30$

Therefore D_{15F} lower limit = 0.68

2 $D_{15F} / D_{85B} \leq 9$

where: $D_{85B} = 0.73 - 0.53$ (from sand blanket curve)

$D_{15F} = 9 * 0.73 = 6.57$

$D_{15F} = 9 * 0.53 = 4.77$

Therefore D_{15F} upper limit = 6.57

3 $D_{50F} / D_{50B} < 25$

where: $D_{50B} = 0.39 - 0.28$ (from sand blanket curve)

$D_{50F} = 25 * 0.39 = 9.75$

$D_{50F} = 25 * 0.28 = 7.0$

Therefore D_{50F} limits = 9.75 - 7.0

4 $D_{15F} / D_{15B} < 20$

where: $D_{15B} = 0.17 - 0.075$ (from sand blanket curve)

$D_{15F} = 20 * 0.17 = 3.4$

$D_{15F} = 20 * 0.075 = 1.5$

Therefore D_{15F} upper limit = 3.4

(since 3.4 is less than 6.57 no need to plot as upper limit)

5 Coefficient of Uniformity

$Cu = D_{60}/D_{10}$ where: $D_{60} = 0.42$ and $D_{10} = 0.14$ (from sand blanket curve)

$Cu = .42/.14 = 4.2$

Since $Cu = 4.2 > 4$ therefore $D_{15F}/D_{15B} = 40$

$D_{15F} = 40 * 0.17 = 6.8$

$D_{15F} = 40 * 0.0.075 = 3.0$

Therefore D_{15F} upper limit = 6.8

(since 6.8 is greater than 6.57 it's the new upper limit)

Case 1 (cont)

2' Sand Blanket Protective Cover	B
Filter Media	F

6 Plot the limits

D_{15F} lower limit = 0.68

D_{15F} upper limit = 6.8

D_{50F} limits = 9.75 - 7.0

According to Table 1005-1 #78 stone falls within the calculated limits of the filter media. Therefore #78 stone can be used as the filter media. RKL

URS	PROJECT				JOB NO.	
	IP-Riegelwood Cell 2 Liner System				31826746	
	SUBJECT				SHEET NO.	
	Filter Media Calculations				3 of 5	
CALCULATION SHEET	ORIGINATED BY	DATE	CHECKED BY	DATE	CALC. NO.	REV. NO.
	Lenore Gaier	5/14/2009	Rich Lowe	6/1/2009		

Case 2

Filter Media	B
#57 Stone	F

Determine if #57 Stone is adequate as filter material below the filter media.

1 $D_{15F} / D_{15B} > 4$

where: $D_{15B} = 4 - 2.5$ (from #78 stone curve)

$D_{15F} = 4 * 4 = 16$
$D_{15F} = 4 * 2.5 = 10$

Therefore D_{15F} lower limit = 16

2 $D_{15F} / D_{85B} \leq 9$

where: $D_{85B} = 11 - 7.8$ (from #78 stone curve)

$D_{15F} = 9 * 11 = 99$
$D_{15F} = 9 * 7.8 = 70.2$

Therefore D_{15F} upper limit = 99

3 $D_{50F} / D_{50B} < 25$

where: $D_{50B} = 7.9 - 4.8$ (from #78 stone curve)

$D_{50F} = 25 * 7.9 = 197.5$
$D_{50F} = 25 * 4.8 = 120$

Therefore D_{50F} limits = 197.5 - 120

4 $D_{15F} / D_{15B} < 20$

where: $D_{15B} = 4 - 2.5$ (from #78 stone curve)

$D_{15F} = 20 * 4 = 80$
$D_{15F} = 20 * 2.5 = 50$

Therefore D_{15F} upper limit = 50
(The new upper limit for D_{15F} is 50 not 99)

5 Coefficient of Uniformity

$Cu = D_{60}/D_{10}$ where: $D_{60} = 8.2$ and $D_{10} = 3.5$ (from #78 stone curve)

$Cu = 8.2/3.5 = 2.34$

Since Cu = 2.34 its not < 1.5 and not > 4 then no further calculations for D_{15F} needs to be done

Case 2 (cont)

Filter Media	B
#57 Stone	F

6 Plot the limits

D_{15F} lower limit = 16

D_{15F} upper limit = 50

D_{50F} limits = 197.5 - 120

According to Table 1005-1 #57 stone falls within the calculated limits.
Therefore #57 stone can be used as the filter media. ✓ RKL

URS	PROJECT				JOB NO.	
	IP-Riegelwood Cell 2 Liner System				31826746	
	SUBJECT				SHEET NO.	
	Filter Media Calculations				5 of 5	
CALCULATION SHEET	ORIGINATED B	DATE	CHECKED BY	DATE	CALC. NO.	REV. NO.
	Lenore Gaier	5/14/2009	Rich Lowe	6/1/2009		

Case 3

# 57 Stone	B
HDPE perforated pipe	F

Determine if drain pipe perforations are adequately sized

1 D_{85F} / hole diameter > 1.0 to 1.2

where: D_{85B} = 26 - 20 (from #57 stone curve)

hole diameter = 1/2" = 12.7 mm

20 / 12.7 = 1.6 > 1.2

Therefore hole diameter of 1/2" is adaquate ✓

RKL

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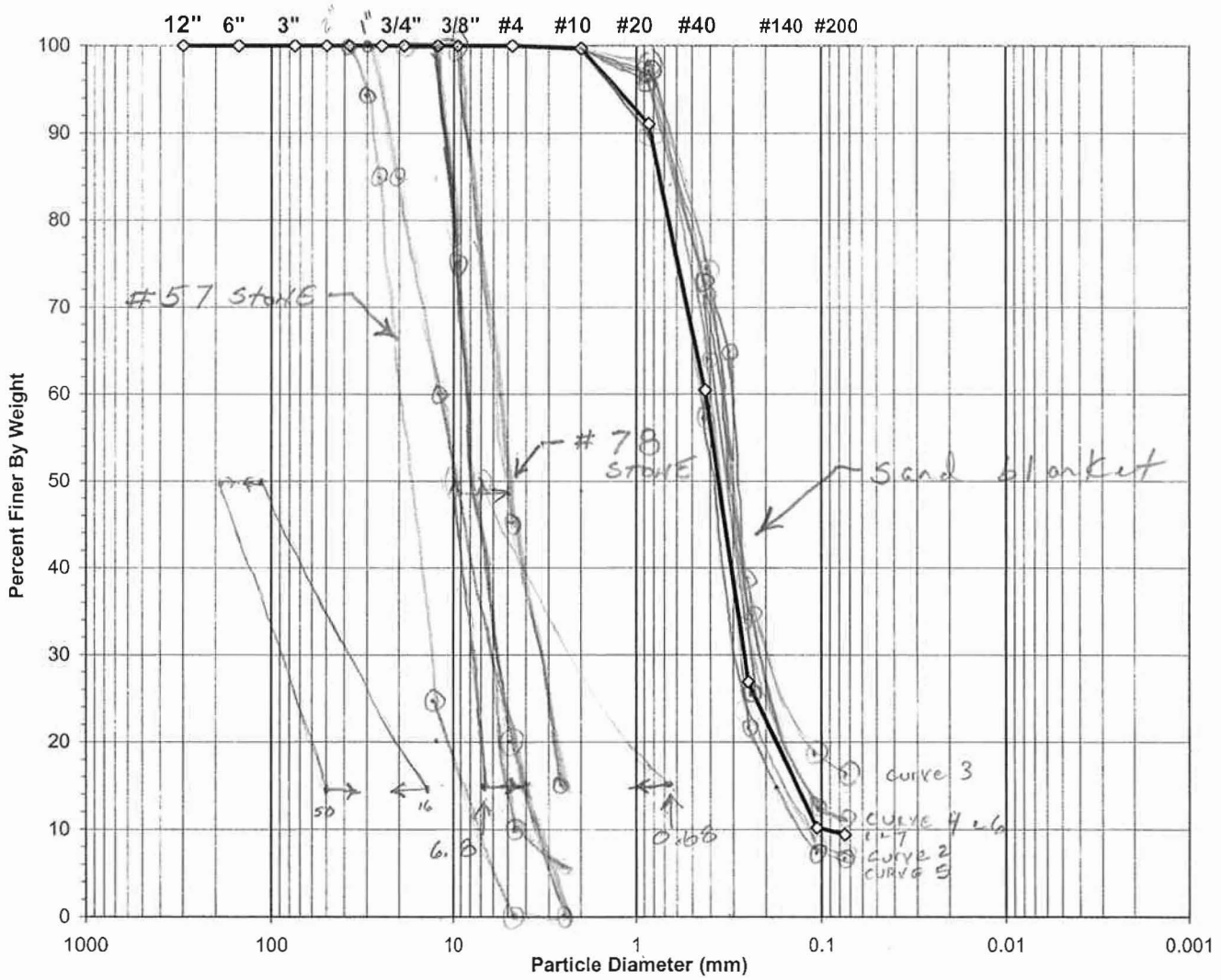
INTEGRITY IN TESTING

SIEVE ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	G.N. RICHARDSON & ASSOC.	Boring No.	8/25/03
Client Reference	I.P. RIEGELWOOD	Depth (ft)	CELL 1
Project No.	2003-511-10	Sample No.	PC8
Lab ID	2003-511-10-02	Soil Color	**TAN**

	SIEVE ANALYSIS		*HYDROMETER*
USCS	gravel	sand	silt and clay



USCS Symbol	***sp-sm, ASSUMED***	**D60 =**	**0.4**	**CC =**	**1.7**
USCS Classification	***POORLY GRADED SAND WITH SILT***	**D30 =**	**0.3**	**CU =**	**4.3**
		D10 =	**0.1**		

Tested By ES Date 09/13/03 Checked By DAJ Date 9-17-03

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *C:\2003 Projects\2003-511 GNR\[2003-511-10-02 Sieve.XLS]Sheet1*

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TABLE 1005-1
AGGREGATE GRADATION, COARSE AGGREGATE

STD SIZE #	PERCENTAGE OF TOTAL BY WEIGHT OF PASSING																REMARKS
	2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#8	#10	#16	#30	#40	#50	#80	#100	#200	
4	100	90-100	20-55	0-15		0-5										0-*0.6	Asphalt Plant Mix Pavement
467M	100	95-100		35-70		0-30	0-5									0-*0.6	Asphalt Plant Mix Pavement
5		100	90-100	20-55	0-10	0-5										0-*0.6	AST Mat coat, Sediment Control Stone
57		100	95-100		25-60		0-10	0-5								0-*0.6	Str. Conc., Shoulder Drain, Sediment Control Stone
57M		100	95-100		25-45		0-10	0-5								0-*0.6	P. C. Concrete Pavement
6M			100	90-100	20-55	0-20	0-8									*	AST
67			100	90-100		20-55	0-10	0-5								0-*0.6	Str. Conc., Asphalt Plant Mix Pavement.
78M				100	98-100	75-100	20-45	0-15								0-*0.6	Asphalt Plant Mix Pavement, AST Weep Hole Drains, Str. Concrete
14M						100	35-70	5-20		0-8						*	* AST
ABC		100	75-97		55-80		35-55		25-45			14-30				4-12**	Aggregate. Stabilization Aggregate/Base Course Asphalt Plant Mix Pavement
ABC(M)		100	75-100		45-79		20-40		0-25							0-12**	Maintenance Stabilization

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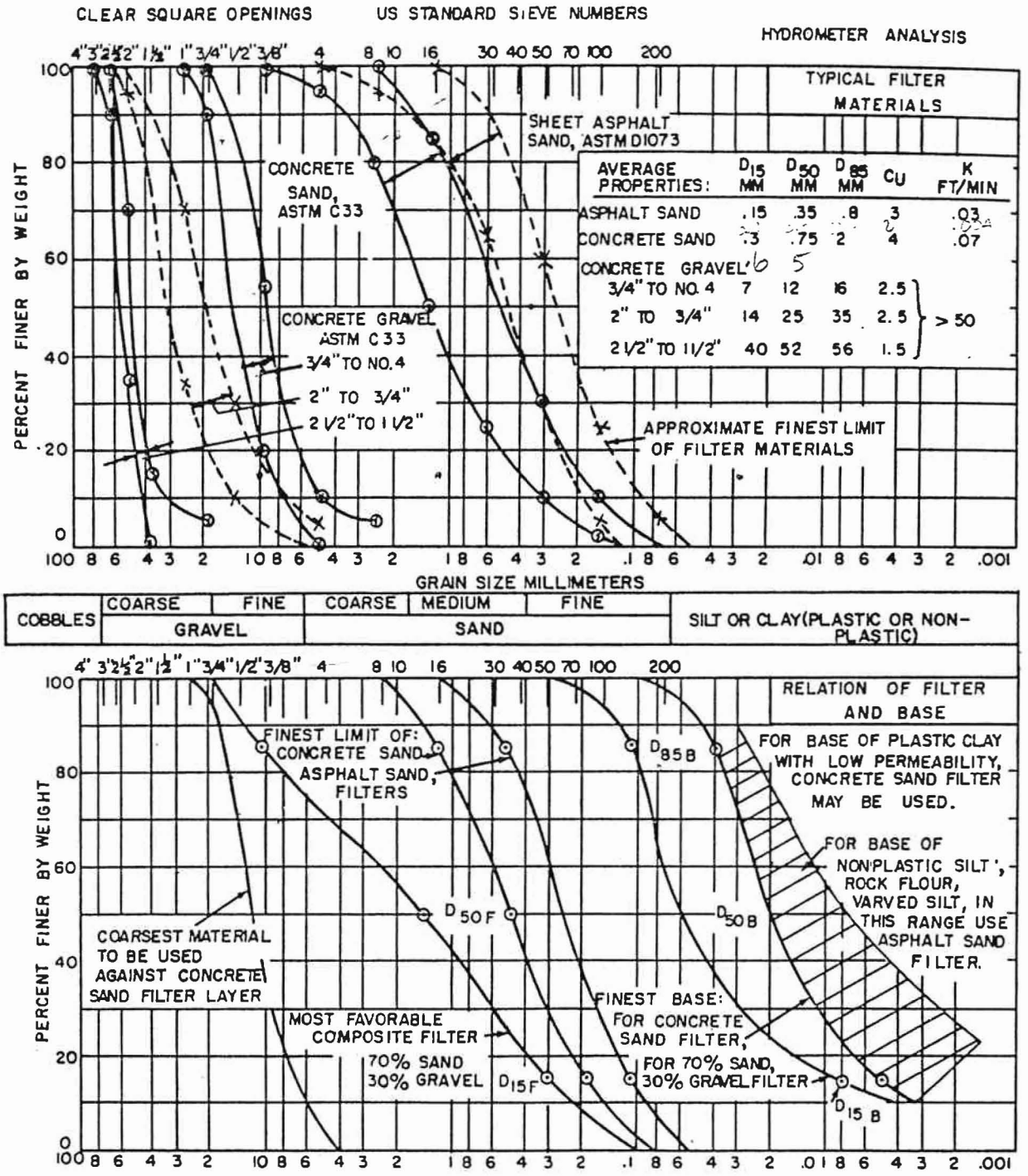


AVERAGE PROPERTIES:	D_{15} MM	D_{50} MM	D_{85} MM	C_U	K FT/MIN
ASPHALT SAND	.15	.35	.8	3	.03
CONCRETE SAND	.3	.75	2	4	.07
CONCRETE GRAVEL	6	5			
3/4" TO NO. 4	7	12	16	2.5	> 50
2" TO 3/4"	14	25	35	2.5	> 50
2 1/2" TO 1 1/2"	40	52	56	1.5	> 50

General requirements:

1. To avoid head loss in filter: $\frac{D_{15F}}{D_{15B}} > 4$, and permeability of filter must be large enough to suffice for the particular drainage system.
2. To avoid movement of particles from base: $\frac{D_{15F}}{D_{85B}} < 5$, $\frac{D_{50F}}{D_{50B}} < 25$, $\frac{D_{15F}}{D_{15B}} < 20$

   These are not good guidelines see "Sherard et al June 84 ASCE Geotech Journal"

   For very uniform base material ($C_u < 1.5$): D_{15F}/D_{85D} may be increased to 6
   For broadly graded base material ($C_u > 4$): D_{15F}/D_{15B} may be increased to 40
3. To avoid movement of filter in drain pipe perforations or joints:
   D_{85F}/slot width > (1.2 to 1.4) D_{85F}/hole diameter > (1.0 to 1.2)
4. To avoid segregation filter should contain no sizes larger than 3".
5. To avoid internal movement of fines, filter should have no more than 5% passing No. 200 sieve.

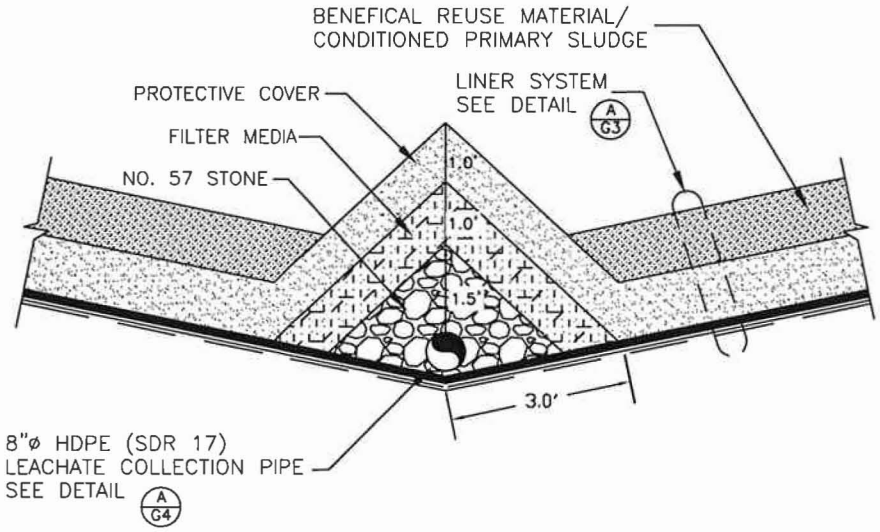
this is also conservative

FIGURE 8-8
Design Criteria for Protective Filters

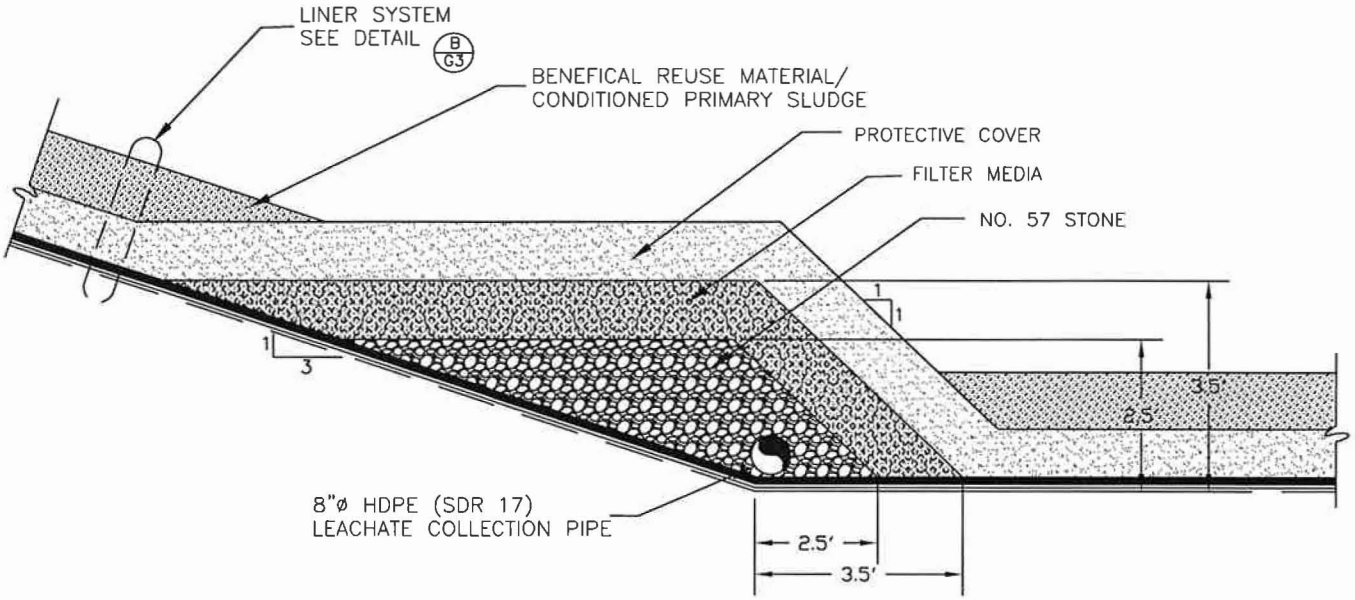
$\frac{D_{15F}}{D_{85B}} \leq 9$ OK in general

From: Design Manual, Soil Mechanics, Foundations, + Earth Structures, NAVFAC DM-7, 1971

(8)



TYPE 2 – IN VALLEY



TYPE 1 – ALONG TOE

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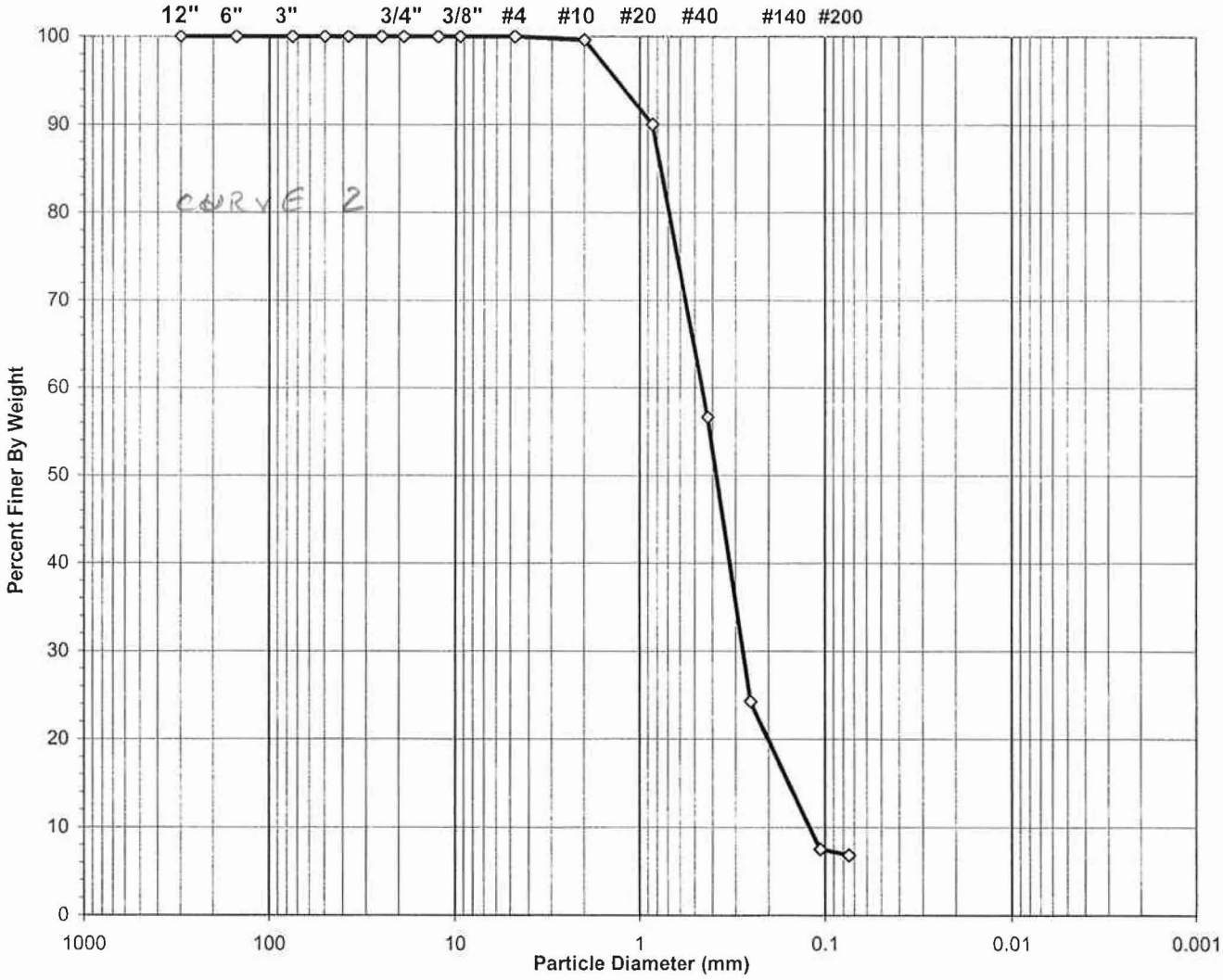
SIEVE ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	G.N. RICHARDSON & ASSOC.	Boring No.	8/24/03
Client Reference	I.P. RIEGELWOOD	Depth (ft)	CELL 1
Project No.	2003-511-10	Sample No.	PC7
Lab ID	2003-511-10-01	Soil Color	**BROWN**

	SIEVE ANALYSIS		*HYDROMETER*
USCS	gravel	sand	silt and clay



USCS Symbol	***sp-sm, ASSUMED***	**D60 =**	**0.5**	**CC =**	**1.4**
USCS Classification	***POORLY GRADED SAND WITH SILT***	**D30 =**	**0.3**	**CU =**	**3.8**
		D10 =	**0.1**		

Tested By ES Date 09/13/03 Checked By DAJ Date 9-17-03

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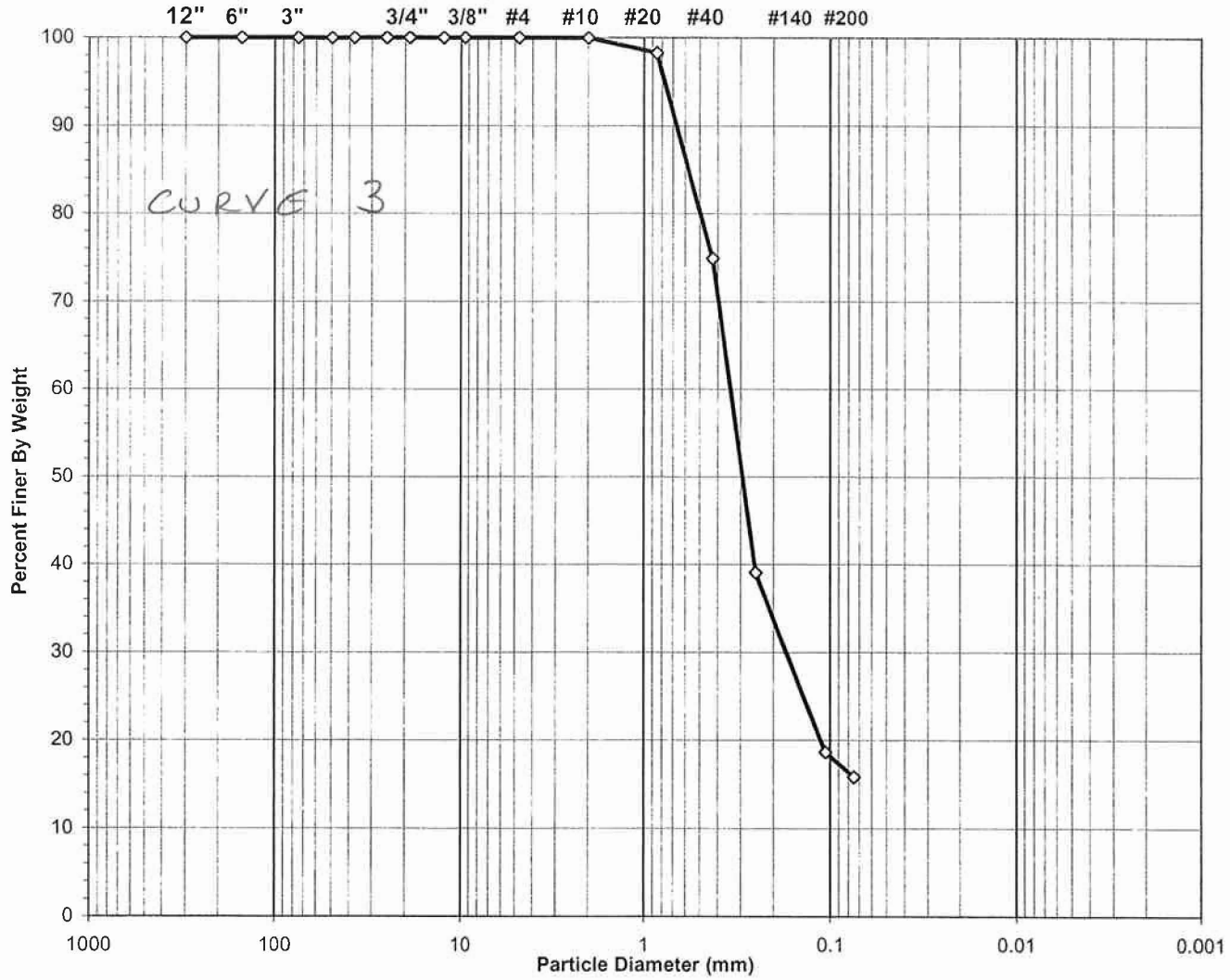
SIEVE ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	G.N. RICHARDSON & ASSOC.	Boring No.	NA
Client Reference	I.P. RIEGELWOOD	Depth (ft)	NA
Project No.	2003-511-11	Sample No.	PC6
Lab ID	2003-511-11-01	Soil Color	**BROWN**

USCS	SIEVE ANALYSIS		HYDROMETER
	gravel	sand	silt and clay



USCS Symbol ***sm, ASSUMED***

USCS Classification ***SILTY SAND***

Tested By DJK Date 09/08/03 Checked By DAJ Date 9-9-03

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *C:\2003 Projects\2003-511 GNR\[2003-511-11-01 Sieve.XLS]Sheet1*

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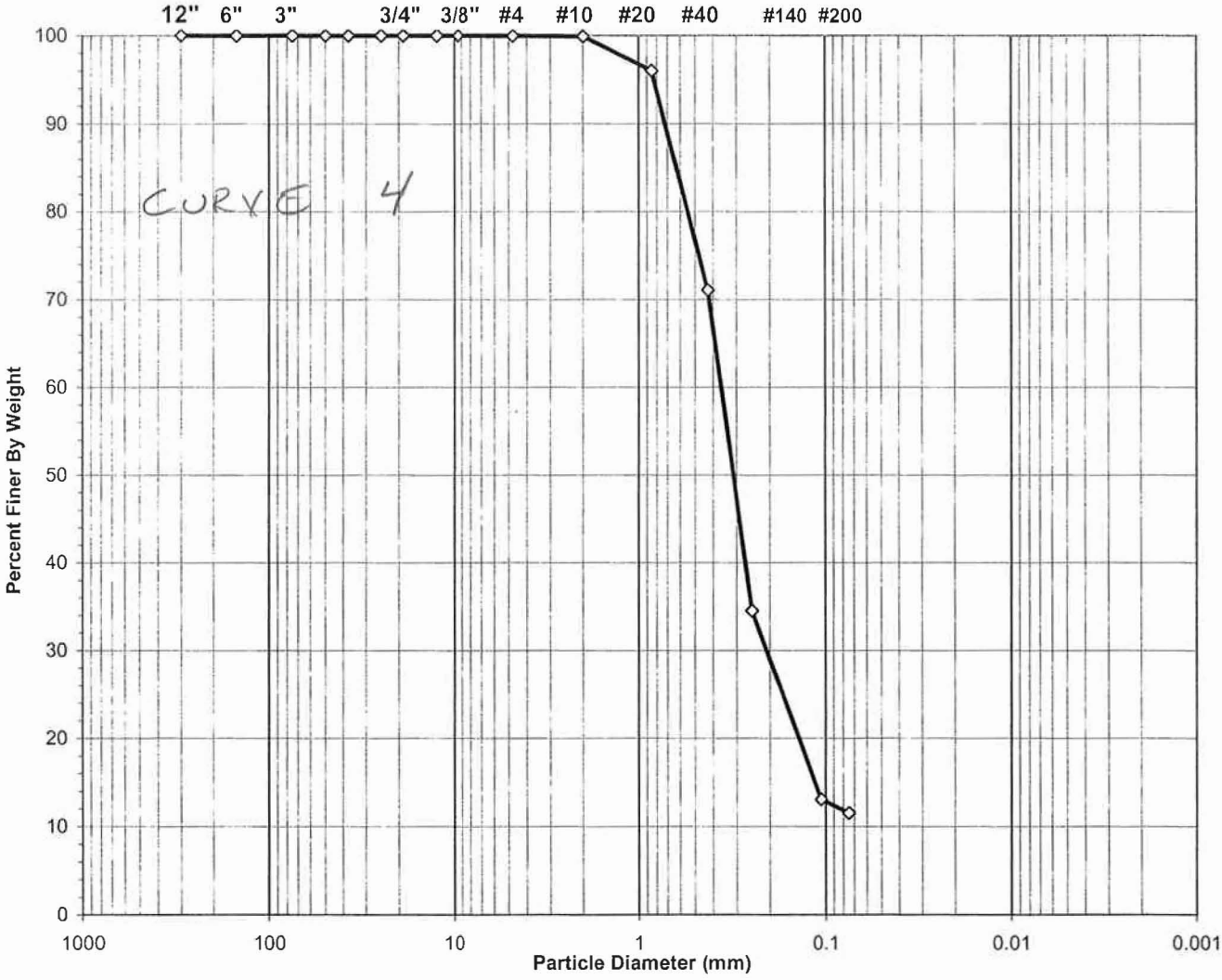
SIEVE ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	G.N. RICHARDSON & ASSOC.	Boring No.	CELL 1
Client Reference	I.P. RIEGELWOOD	Depth (ft)	8/12/03
Project No.	2003-511-09	Sample No.	PC-5
Lab ID	2003-511-09-02	Soil Color	**LIGHT BROWN**

	SIEVE ANALYSIS		*HYDROMETER*
USCS	gravel	sand	silt and clay



USCS Symbol ***sp-sm, ASSUMED***

USCS Classification ***POORLY GRADED SAND WITH SILT***

Tested By DJK Date 08/20/03 Checked By DAJ Date 8-21-03

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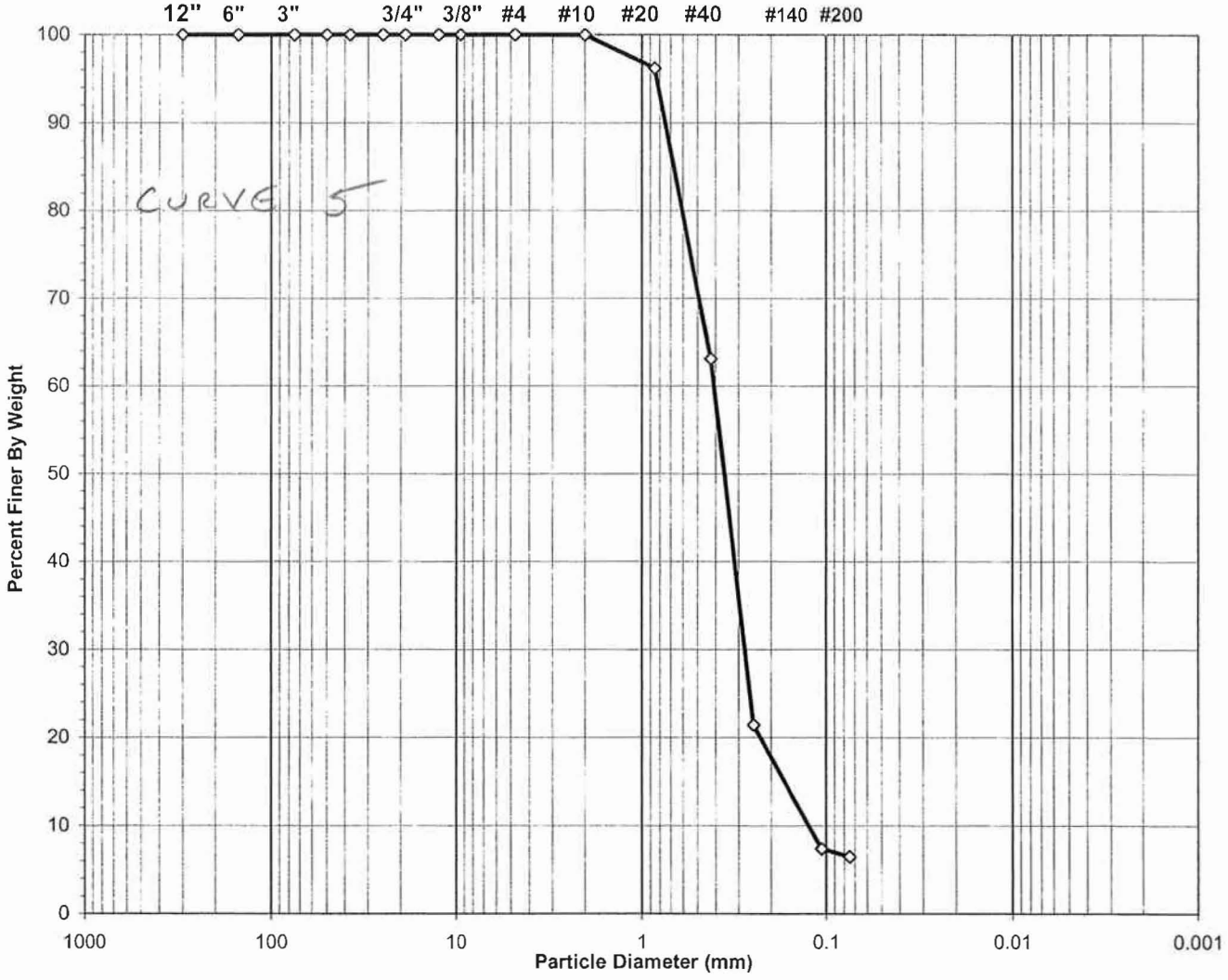
SIEVE ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	G.N. RICHARDSON & ASSOC.	Boring No.	CELL 1
Client Reference	I.P. RIEGELWOOD	Depth (ft)	8/6/03
Project No.	2003-511-09	Sample No.	PC-4
Lab ID	2003-511-09-01	Soil Color	**DARK BROWN**

	SIEVE ANALYSIS		*HYDROMETER*
USCS	gravel	sand	silt and clay



USCS Symbol	***sp-sm, ASSUMED***	**D60 =**	**0.4**	**CC =**	**1.5**
USCS Classification	***POORLY GRADED SAND WITH SILT***	**D30 =**	**0.3**	**CU =**	**3.3**
		D10 =	**0.1**		

Tested By DJK Date 08/20/03 Checked By DAJ Date 8-21-03

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *C:\2003 Projects\2003-511 GNR\[2003-511-09-01 Sieve.XLS]Sheet1*

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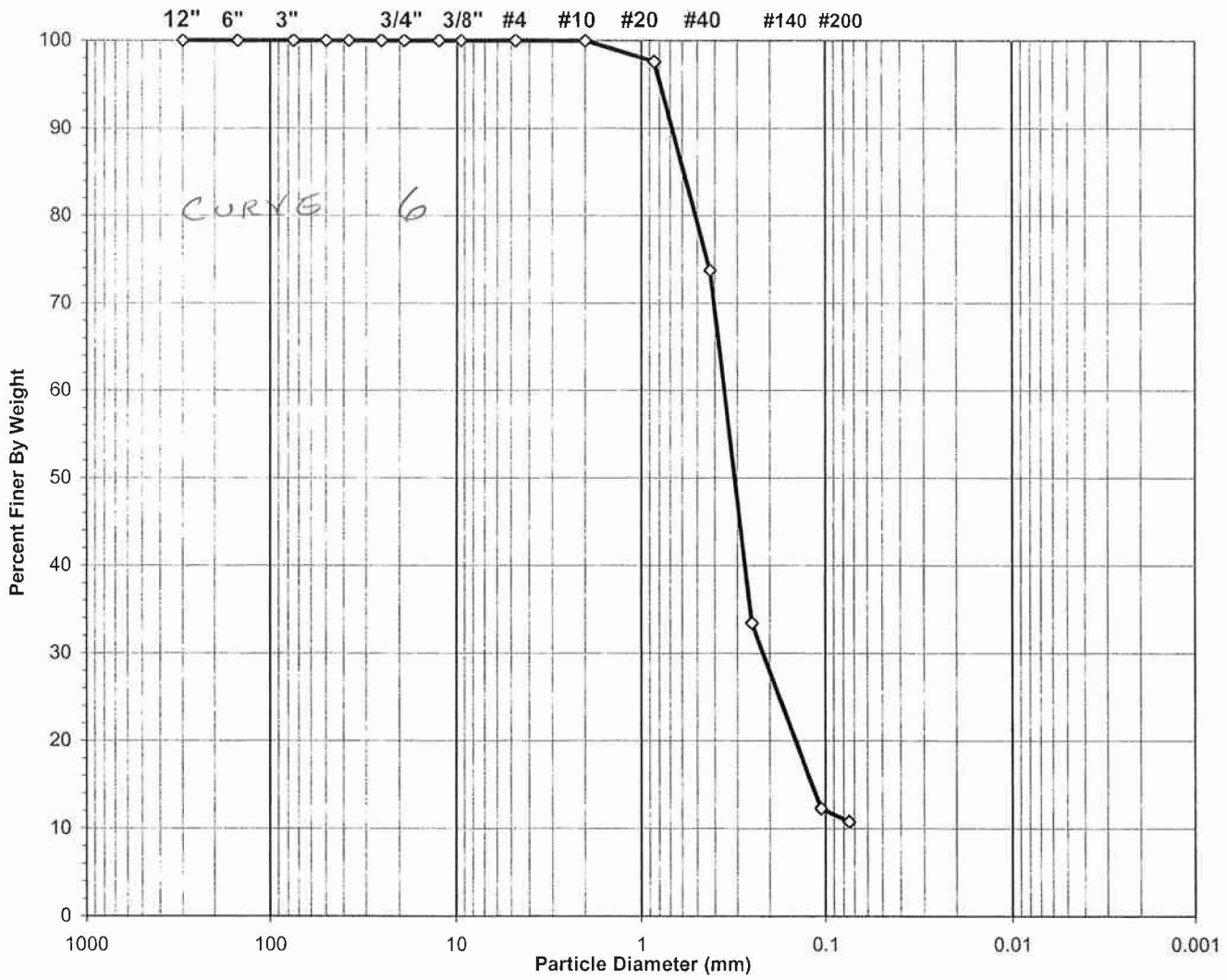
SIEVE ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	G.N. RICHARDSON & ASSOC.	Boring No.	CELL 1
Client Reference	I.P. RIEGELWOOD	Depth (ft)	7/30/03
Project No.	2003-511-08	Sample No.	PC-3
Lab ID	2003-511-08-01	Soil Color	**BROWN**

USCS	SIEVE ANALYSIS		HYDROMETER
	gravel	sand	silt and clay



USCS Symbol ***sp-sm, ASSUMED***

USCS Classification ***POORLY GRADED SAND WITH SILT***

Tested By DJK Date 08/05/03 Checked By DAJ Date 8-5-03

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *C:\2003 Projects\2003-511 GNR\[2003-511-08-01 Sieve.XLS]Sheet1*

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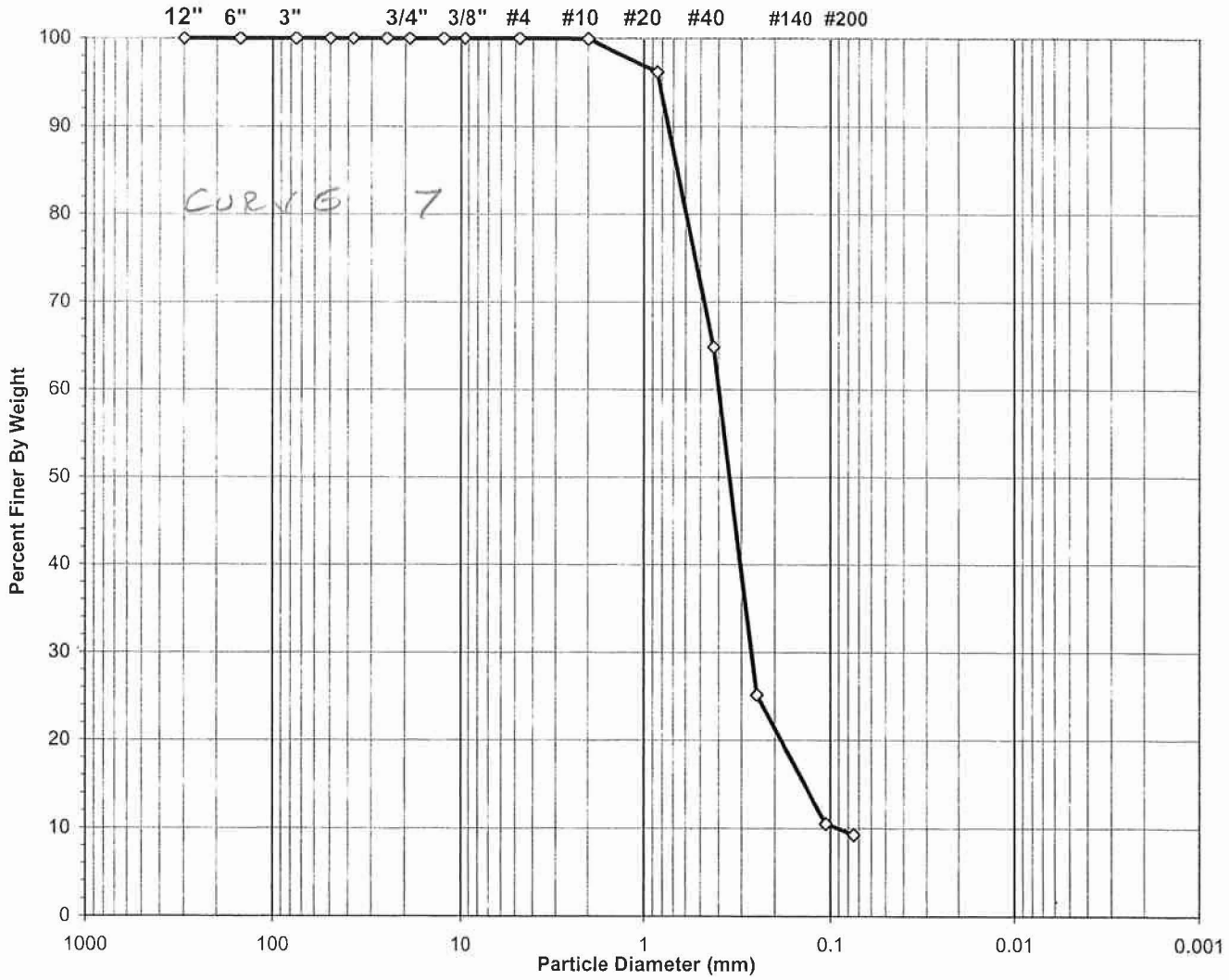
SIEVE ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	G.N. RICHARDSON & ASSOC.	Boring No.	PC-2
Client Reference	I.P. RIEGELWOOD	Depth (ft)	7/23/03
Project No.	2003-511-07	Sample No.	IP-CELL 1
Lab ID	2003-511-07-01	Soil Color	**GRAYISH-BROWN**

USCS	SIEVE ANALYSIS		HYDROMETER
	gravel	sand	silt and clay



USCS Symbol	***sp-sm, ASSUMED***	**D60 =**	**0.4**	**CC =**	**1.9**
USCS Classification	***POORLY GRADED SAND WITH SILT***	**D30 =**	**0.3**	**CU =**	**4.3**
		D10 =	**0.1**		

Tested By DJK Date 07/29/03 Checked By DAJ Date 7-29-03

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *C:\2003 Projects\2003-511 GNR\[2003-511-07-01 Sieve.XLS]Sheet1*

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