Division Control No. LRB/87

SAND AND GRAVEL FOR BEACH NOURISHMENT IN POINT PELEE SEDIMENTS, LAKE ERIE

by

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NWRI Contribution No. 87-98

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Environment Canada

LAKES RESEARCH BRANCH

TECHNICAL NOTE

DATE: December 1987 REPORT NO: 87-

TITLE: Sand and gravel for beach nourishment in Pt. Pelee sediments, Lake Erie

AUTHOR: N.A. Rukavina

REASONS FOR REPORT: Request from J. Shaw, Project Coordinator, Point Pelee Study

STUDY FILE NO: Study 82021

1.0 INTRODUCTION

This note responds to a request by J. Shaw, Project Coordinator of the Point Pelee Study, for information on the grain size of sediment offshore from Pelee Point in Lake Erie so that its usefulness as material for beach nourishment can be assessed (Appendix 1). The requirement is for sand and gravel with a median size greater than 1.0 mm (Bishop, pers. commun.). Sites with sediment meeting that criterion were identified in the data files of the nearshore sediment surveys of 1974 and 1975 (Rukavina and St. Jacques 1978, Rukavina unpublished data), and an estimate of the volume of sediment available was computed from related jetting and core data.

2.0 BACKGROUND

The nearshore zone of the Pelee area of Lake Erie was surveyed in 1974 and 1975 (Rukavina and St. Jacques 1978, Rukavina unpublished data). Grab samples of surface sediment collected on a 2-km grid and a small number of jet borings and cores were used to map the thickness and stratigraphy of the deposit. Figure 1 shows the distribution of recent and glacial sediments in the area. The sand and gravel area extends offshore from the Point to the international boundary and is bounded on the west and east by finer-grained sediments and on the north by exposed glacial tills.

The surface-sediment samples were collected with the Shipek grab sampler (Sly 1979). Maximum recovery was 10 cm and the upper 3 cm were used as a standard subsample for grain-size analysis. Thickness and stratigraphy of the deposit were measured by jet-boring to refusal (Rukavina and LaHaie, 1977) and impact coring (Sly 1979). Appendix 2 lists the sample, jet and core locations, depths and collection dates.

The grain-size distribution of surface-sediment samples and cores was determined by the standard procedure of the NWRI Sedimentology Laboratory (Duncan and LaHaie 1979); sieve and settling-tube methods were used for analysis of the sand and gravel fraction. Size statistics were computed by the SIZDIST program (Sandilands and Duncan 1980) in PHI units, a logarithmic transform of particle size in mm. Appendix 3 lists the Phi values and equivalent metric values. Size date were stored in a computer file supported by a retrieval program (SELECT) which can extract data for a given range of any single size statistic or group of statistics.

3.0 COMPUTATION OF VOLUMES

The requirement is for sediment with a median size greater than 1 mm, i.e. more than 50 per cent by weight in the size fraction coarser than 1 mm. Seven samples in the size file for surface-sediment samples meet this requirement (Figure 2, Appendix 4). None of the 6 sediment cores collected in the same general area (Figure 2, Appendix 5) has material in the required size range. Core size data have been included, however, because they show that grain size at the surface agrees within 10 percent with average grain size for the entire core. This provides the rationale for using surface grain size in estimating subsurface sediment volume.

Sediment thickness is known at 2 of the 7 sample sites: a 1.75 m jet value at site E1127 and 6 cm over till in the Shipek sample from site E1199. Thickness at the remaining sites was estimated from jet data collected at 5 sites in the same general area (Figure 2, Appendix 6). Average thickness adjusted to exclude underlying glacial sediment (slow penetration) is 3.2 m.

An estimate of the volume of the size fraction coarser than 1 mm was computed for each of the 6 sites in which the surface sediment met the size requirements. Underlying assumptions were that 1) each site was representative of the surrounding 4 km^2 area, the unit size of the sampling grid; 2) the grain-size of surface sediment applied throughout the entire thickness of the sediment column; and 3) average sediment thickness as determined by jetting for the area as a whole was a reasonable approximation of thickness at those sites for which there were no direct measurements. Volume was computed as the product of the grid unit area (4 km^2), the measured or estimated thickness, and the proportion of the size distribution in the size range coarser than 1 mm. Results are listed in Table 1 and mapped in Figure 3. Table 1 also includes a very conservative estimate of volume based on the actual thickness of sediment in the Shipek sample. Cumulative volumes based on jet thickness and sample thickness are respectively 40 million cubic metres and 860 thousand cubic metres. The larger value is considered to be the more realistic estimate.

4.0 REFERENCES CITED

Duncan, G.A. and Lahaie, G.G. 1979. Size analysis procedure used in the Sedimentology Laboratory, NWRI. Unpubl. Manual, National Water Research Institute, Burlington, Ontario.

Rukavina, N.A. and LaHaie, G.G. 1977. Measurements of thickness of nearshore sands by hydraulic jetting. Technical Note 77-13, Hydraulics Division, National Water Research Institute, Burlington, Ontario.

Rukavina, N.A. and St. Jacques, D.A. 1978. Lake Erie nearshore sediments, Point Pelee to Port Burwell, Ontario. Scientific Series 99, Inland Waters Directorate, National Water Research Institute, Burlington, Ontario.

Sandilands, R.G., and Duncan, G.A. 1980. SIZDIST - A computer program for size analysis. Technical Note 80-08, Hydraulics Division, National Water Research Institute, Burlington, Ontario.

Sly, P.G. 1979. Equipment and techniques for offshore survey and site investigations. Proceedings, First Canadian Conference on Marine Geotechnical Engineering, April 1979, Calgary.

TABLE 1: COMPUTATION OF SEDIMENT VOLUMES COARSER THAN 1 MM

SITE	AREA, KM2	%>1 MM SIZE	JET THICKNESS, METRES	SAMPLE THICKNESS, CM	VOLUME ESTIMATE MAX M^3 X 1000	MIN
E1119	4	66	3.2	8	8400	210
E1127	4	61	1.8	8	4300	200
E1146	4	83	3.2	2	11000	66
E1190	4	74	3.2	5	9500	150
E1199	4	78		6	190	190
E1250	4	50	3.2	2	6400	40
				TOTAL VOLUME	40000	860

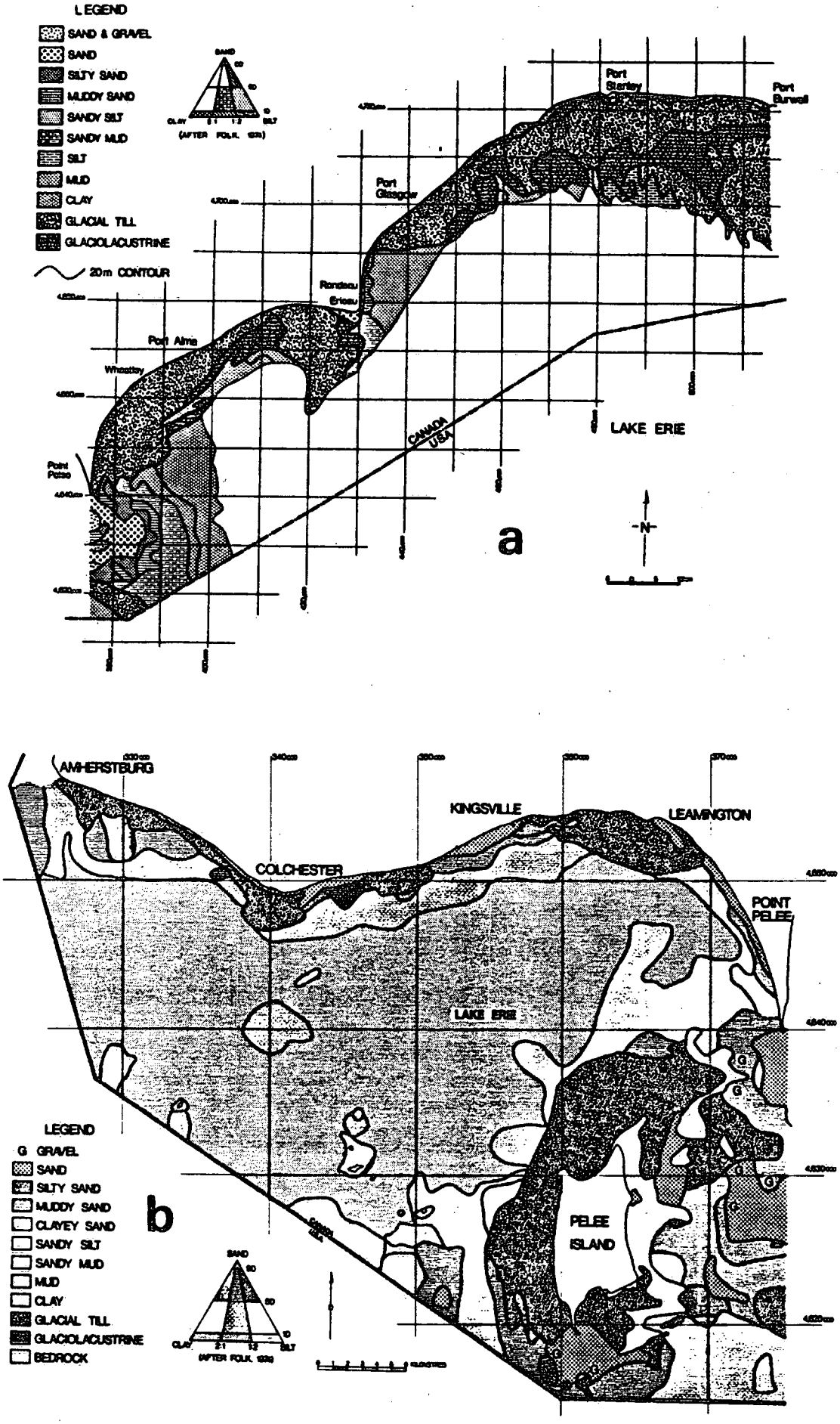
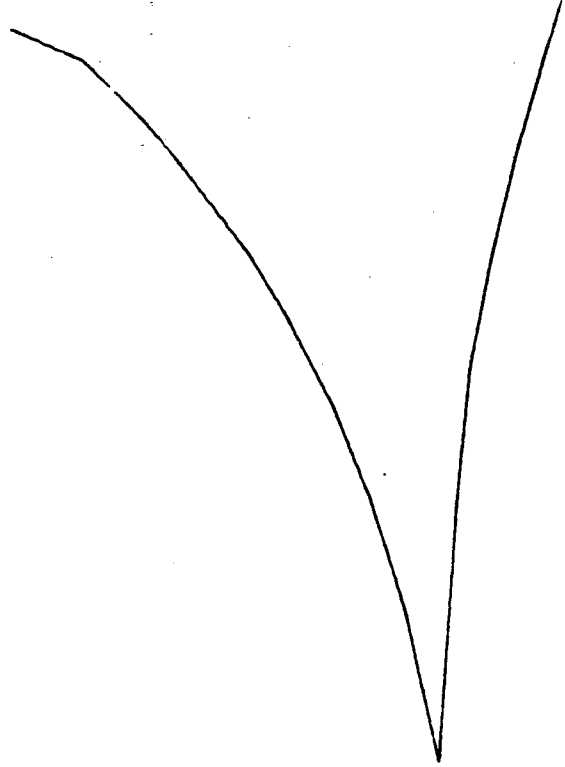


Fig. 1. Sediment distribution, 1974(a) and 1975(b) surveys



JE195

E1119

CE22 E1127 JE196 CE53 JE199

CE54

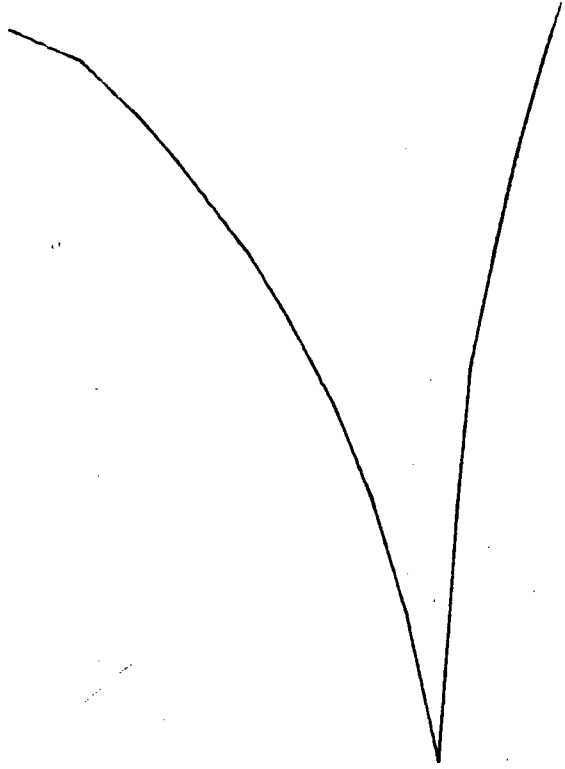
(4630000 370000) JE197 E1146 JE200 (4630000 385000)

E1250 CE55

CE56 CE21

E1190

FIG. 2. SITE MAP E1199



8400 + 210

4300 + 200

(4630000+370000)

11000 + 66

(4630000+385000)

6400 + 40

9500 + 150

MAX + MIN M^3X1000

190 + 190

FIG. 3. VOLUME ESTIMATES OF >1 MM SIZE

Appendix 1

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MEMORANDUM | **NOTE DE SERVICE**

TO / À	M. Charlton Lakes Research Branch NWRI
FROM / DE	Project Coordinator Point Pelee Study

SECURITY - CLASSIFICATION - DE SÉCURITÉ
OUR FILE/NOTRE REFERENCE
YOUR FILE/VOTRE REFERENCE
DATE June 1, 1987

SUBJECT / OBJET: POINT PELEE LONG-TERM SOLUTIONS STUDY

The Point Pelee study is an inter-agency evaluation of shore management solutions to control further erosion at Point Pelee National Park on Lake Erie, which could result in extensive flooding to adjacent dyked agricultural land if no preventative action is taken.

Some of the alternatives being considered will require expertise in lake bed and beach sediments of the Point Pelee region. Because of Dr. Rukavina's knowledge of sediment dynamics from past studies in this area, I would like to ask for his participation in the study as it would be a welcome contribution. I estimate that about 5 person-days of his time would be needed between now and September.

As a further request, we have an immediate requirement for a point plot of the offshore sediment data (median grain size) at Point Pelee.

I look forward to discussing the possibilities of Dr. Rukavina's participation. Thank you.

J. Shaw

J. Shaw

c.c. C. Bishop
N. Rukavina

Appendix 2: Site data

SITE	DATE	UTM NORTHING	UTM EASTING	DEPTH,M (IGLD)
SHIPEK SAMPLES				
E1119	07-16-74	4636009	376010	6.0
E1127	07-16-74	4634018	376007	6.7
E1146	07-16-74	4630014	378016	11.5
E1190	06-10-74	4619952	377997	11.5
E1199	06-10-74	4617909	381912	11.2
E1250	06-10-74	4628040	372068	9.1
JETS				
JE196	08-10-74	4634008	375993	6.2
JE197	08-10-74	4629998	376011	10.7
JE199	08-10-74	4633996	380041	10.2
JE200	08-10-74	4630004	380007	11.4
CORES				
CE21	08-22-75	4624035	380193	12.5
CE22	08-26-75	4633952	374036	11.7
CE53	08-26-76	4633996	379980	10.6
CE54	08-26-76	4632016	377982	6.2
CE55	08-26-76	4628011	378105	9.8
CE56	08-26-76	4624010	378123	12.2

Appendix 3: PHI size vs metric size

PHI/METRIC CONVERSION TABLE

PHI	MM	MICRONS
-8.0	256.000	
-7.5	181.019	
-7.0	128.000	
-6.5	90.510	
-6.0	64.000	
-5.5	45.255	
-5.0	32.000	
-4.5	22.627	
-4.0	16.000	
-3.5	11.314	
-3.0	8.000	
-2.5	5.657	
-2.0	4.000	
-1.5	2.828	
-1.0	2.000	2000.00
-0.5	1.414	1414.21
0.0	1.000	1000.00
0.5	0.707	707.11
1.0	0.500	500.00
1.5	0.354	353.55
2.0	0.250	250.00
2.5	0.177	176.78
3.0	0.125	125.00
3.5	0.088	88.39
4.0	0.063	62.50
4.5	0.044	44.19
5.0	0.031	31.25
5.5	0.022	22.10
6.0	0.016	15.63
6.5	0.011	11.05
7.0	0.008	7.81
7.5	0.006	5.52
8.0	0.004	3.91
8.5	0.003	2.76
9.0	0.002	1.95
9.5	0.001	1.38
10.0	0.001	0.98
10.5	0.001	0.69
11.0	0.000	0.49
11.5	0.000	0.35
12.0	0.000	0.24

Appendix 4: Size data for surface-sediment samples

1119 SIEVE,SETT.TUBE,PIPET,SEDIGRAPH SAMP WT= 27.5192

PHI	PCT.	CUMPCT.	
-4.00			
	13.71		**********
-3.50		13.71	
	12.98		**********
-3.00		26.69	
	2.41		**
-2.50		29.10	
	9.74		**********
-2.00		38.84	
	7.55		********
-1.50		46.39	
	10.34		**********
-1.00		56.73	
	7.61		********
-.50		64.34	
	2.10		**
0.00		66.44	
	11.03		**********
.50		77.47	
	3.15		***
1.00		80.63	
	4.20		****
1.50		84.83	
	6.83		*******
2.00		91.66	
	6.83		*******
2.50		98.49	
	1.05		*
3.00		99.54	
	0.00		
3.50		99.54	
	0.00		
4.00		99.54	
	.46		
4.50		100.00	
	0.00		
*****		100.00	

12/11/87

MEAN	ST.DEV.	SKEWNESS	KURTOSIS	
-1.12	1.99	.16	-1.01	KRUMBEIN + PETTIJOHN (1938) MOMENT MEASURES FOR SIZE RANGE -3.5 TO 4.5 PHI
-1.11	2.12	.16	.72	FOLK GRAPHIC STATISTICAL PARAMETERS FOLK AND WARD,1957

PERCENTILES MEDIAN -1.33 5TH -3.82 16TH -3.41 25TH -3.07
75TH .39 84TH 1.40 95TH 2.24

PCT. GRAVEL 56.73 SAND 42.81 SILT (PIPETTE) .46 CLAY (PIPETTE) 0.00
(SEDIGRAPH) .46 (SEDIGRAPH) 0.00

GRAVEL+SAND 99.54 SILT/(SILT+CLAY) 100.00 GRAV+SAND/SILT+CLAY 217.41

LABELS SHEPARD -SAND FOLK(GMS)-SANDY GRAVEL (SCS)-

E1127 SIEVE,SETT.TUBE,PIPET,SEDIGRAPH SAMP WT= 24.1986

12/11/87

PHI	PCT.	CUMPCT.	
-3.50			
	16.55		**********
-3.00		16.55	
	9.79		**********
-2.50		26.34	
	9.17		*********
-2.00		35.51	
	8.17		********
-1.50		43.68	
	8.86		*********
-1.00		52.54	
	6.60		*******
-.50		59.14	
	1.91		**
0.00		61.05	
	10.81		**********
.50		71.86	
	8.90		*********
1.00		80.77	
	8.59		*********
1.50		89.35	
	6.04		******
2.00		95.39	
	2.86		***
2.50		98.26	
	.64		*
3.00		98.89	
	0.00		
3.50		98.89	
	0.00		
4.00		98.89	
	0.00		
4.50		98.89	
	0.00		
5.00		98.89	
	.08		
5.50		98.97	
	.37		
6.00		99.34	
	.66		*
6.50		100.00	
	0.00		
*****		100.00	

MEAN	ST.DEV.	SKEWNESS	KURTOSIS	
-.87	1.90	.29	.18	KRUMBEIN + PETTIJOHN (1938) MOMENT MEASURES FOR SIZE RANGE -3.0 TO 6.5 PHI
-.99	1.86	.14	.67	FOLK GRAPHIC STATISTICAL PARAMETERS FOLK AND WARD,1957

PERCENTILES MEDIAN -1.14 5TH -3.35 16TH -3.02 25TH -2.57
75TH .68 84TH 1.19 95TH 1.97

PCT. GRAVEL 52.54 SAND 46.35 SILT (PIPETTE) 1.11 CLAY (PIPETTE) 0.00
(SEDIGRAPH) 1.11 (SEDIGRAPH) 0.00

GRAVEL+SAND 98.89 SILT/(SILT+CLAY) 100.00 GRAV+SAND/SILT+CLAY 89.29

LABELS SHEPARD -SAND FOLK(GMS)-SANDY GRAVEL (SCS)-

E1146 12 974 SIEVE,SETT.TUBE,PIPETTE(2) SAMP WT= 39.8578

PHI	PCT.	CUMPCT.	12/11/87
-4.50			
	9.92		**********
-4.00		9.92	
	21.30		**********
-3.50		31.23	
	22.77		**********
-3.00		53.99	
	11.76		**********
-2.50		65.76	
	7.00		*******
-2.00		72.75	
	4.89		*****
-1.50		77.64	
	3.45		***
-1.00		81.09	
	1.81		**
-.50		82.89	
	.13		
0.00		83.02	
	2.45		**
.50		85.47	
	1.93		**
1.00		87.40	
	2.84		***
1.50		90.24	
	5.03		*****
2.00		95.27	
	1.93		**
2.50		97.20	
	1.42		*
3.00		98.62	
	.39		
3.50		99.01	
	0.00		
4.00		99.01	
	.99		*
8.00		100.00	
	0.00		
*****		100.00	

MEAN	ST.DEV.	SKEWNESS	KURTOSIS	
-2.37	1.89	.68	.69	KRUMBEIN + PETTIJOHN (1938) MOMENT MEASURES FOR SIZE RANGE -4.0 TO 4.0 PHI
-2.25	1.96	.62	1.36	FOLK GRAPHIC STATISTICAL PARAMETERS FOLK AND WARD,1957

PERCENTILES MEDIAN -3.09 5TH -4.25 16TH -3.86 25TH -3.65
75TH -1.77 84TH .20 95TH 1.97

PCT. GRAVEL 81.09 SAND 17.92 SILT (PIPETTE) .99 CLAY (PIPETTE) 0.00
(SEDIGRAPH) 0.00 (SEDIGRAPH) 0.00

GRAVEL+SAND 99.01 SILT/(SILT+CLAY) 100.00 GRAV+SAND/SILT+CLAY 99.65

LABELS SHEPARD -SAND FOLK(GMS)-GRAVEL (SCS)-

E1190 SIEVE,SETT.TUBE,PIPET,SEDIGRAPH SAMP WT= 39.2141

12/11/87

PHI	PCT.	CUMPCT.	
-4.00			
	35.59		**********
-3.50		35.59	
	19.19		**********
-3.00		54.78	
	12.62		**********
-2.50		67.40	
	2.05		**
-2.00		69.45	
	1.03		*
-1.50		70.48	
	1.76		**
-1.00		72.24	
	1.32		*
-.50		73.56	
	.30		
0.00		73.86	
	1.49		*
.50		75.35	
	3.73		****
1.00		79.08	
	3.58		****
1.50		82.66	
	4.92		*****
2.00		87.58	
	3.88		****
2.50		91.46	
	4.62		*****
3.00		96.08	
	1.64		**
3.50		97.72	
	.30		
4.00		98.02	
	.53		*
4.50		98.55	
	.60		*
5.00		99.14	
	.20		
5.50		99.34	
	0.00		
6.00		99.34	
	.66		*
6.50		100.00	
	0.00		
*****		100.00	

MEAN	ST.DEV.	SKEWNESS	KURTOSIS	
-1.86	2.50	.59	.02	KRUMBEIN + PETTIJOHN (1938) MOMENT MEASURES FOR SIZE RANGE -3.5 TO 6.5 PHI
-1.75	2.39	.76	.69	FOLK GRAPHIC STATISTICAL PARAMETERS FOLK AND WARD,1957

PERCENTILES MEDIAN -3.12 5TH -3.93 16TH -3.78 25TH -3.65
75TH .38 84TH 1.64 95TH 2.88

PCT. GRAVEL 72.24 SAND 25.78 SILT (PIPETTE) 1.98 CLAY (PIPETTE) 0.00
(SEDIGRAPH) 1.98 (SEDIGRAPH) 0.00

GRAVEL+SAND 98.02 SILT/(SILT+CLAY) 100.00 GRAV+SAND/SILT+CLAY 49.40

LABELS SHEPARD -SAND FOLK(GMS)-SANDY GRAVEL (SCS)-

E1199 SIEVE,SETT.TUBE,PIPET,SEDIGRAPH SAMP WT= 22.4884

12/11/87

PHI	PCT.	CUMPCT.	
-4.00			
	10.15		**********
-3.50		10.15	
	11.99		**********
-3.00		22.14	
	5.12		*****
-2.50		27.25	
	9.86		**********
-2.00		37.12	
	12.58		**********
-1.50		49.69	
	15.21		**********
-1.00		64.91	
	12.77		**********
-.50		77.67	
	.47		
0.00		78.14	
	14.69		**********
.50		92.83	
	4.20		****
1.00		97.03	
	1.40		*
1.50		98.43	
	.47		
2.00		98.90	
	.23		
2.50		99.13	
	0.00		
3.00		99.13	
	0.00		
3.50		99.13	
	0.00		
4.00		99.13	
	0.00		
4.50		99.13	
	.07		
5.00		99.20	
	.80		*
5.50		100.00	
	0.00		
*****		100.00	

MEAN	ST.DEV.	SKEWNESS	KURTOSIS	
-1.50	1.53	.36	1.66	KRUMBEIN + PETTIJOHN (1938) MOMENT MEASURES FOR SIZE RANGE -3.5 TO 5.5 PHI
-1.52	1.55	-.01	.87	FOLK GRAPHIC STATISTICAL PARAMETERS FOLK AND WARD,1957

PERCENTILES MEDIAN -1.49 5TH -3.75 16TH -3.26 25TH -2.72 75TH -.60 84TH .20 95TH .76

PCT. GRAVEL 64.91 SAND 34.22 SILT (PIPETTE) .87 CLAY (PIPETTE) 0.00 (SEDIGRAPH) .87 (SEDIGRAPH) 0.00

GRAVEL+SAND 99.13 SILT/(SILT+CLAY) 100.00 GRAV+SAND/SILT+CLAY 113.74

LABELS SHEPARD -SAND FOLK(GMS)-SANDY GRAVEL (SCS)-

SIEVE,SETT.TUBE,PIPET,SEDIGRAPH SAMP WT= 28.2482

PHI	PCT.	CUMPCT.	
			12/11/87
	22.58	22.58	**********
	7.50	30.08	********
	12.99	43.07	**********
	1.69	44.76	**
	2.25	47.01	**
	2.05	49.06	**
	1.01	50.07	*
	0.00	50.07	
	2.07	52.14	**
	14.93	67.08	**********
	8.30	75.37	********
	9.54	84.91	**********
	10.79	95.70	**********
	1.24	96.94	*
	.41	97.36	
	0.00	97.36	
	.08	97.44	
	.50	97.94	
	0.00	97.94	
	.99	98.93	*
	.50	99.42	
	.58	100.00	*
	0.00	100.00	

ST.DEV. SKEWNESS KURTOSIS

.73 2.59 .15 -.93 KRUMBEIN + PETTIJOHN (1938) MOMENT MEASURES
FOR SIZE RANGE -3.5 TO 7.0 PHI

.74 2.36 -.08 .54 FOLK GRAPHIC STATISTICAL PARAMETERS
FOLK AND WARD,1957

ILES MEDIAN -.53 5TH -3.89 16TH -3.65 25TH -3.34
75TH 1.48 84TH 1.95 95TH 2.47

GRAVEL 49.06 SAND 48.30 SILT (PIPETTE) 2.64 CLAY (PIPETTE) 0.00
(SEDIGRAPH) 2.64 (SEDIGRAPH) 0.00

SAND 97.36 SILT/(SILT+CLAY) 100.00 GRAV+SAND/SILT+CLAY 36.87

S SHEPARD -SAND FOLK(GMS)-SANDY GRAVEL (SCS)-

ndix 5: Size data for sediment cores

CORE #	INTERVAL	% GRAVEL	% SAND	%SILT+CLAY
CE21	0-5.5 CM	0.00	3.96	96.05
	5.5-14 CM	0.00	82.67	17.33
	14-23 CM	.75	71.30	27.95
	23-33 CM	.13	64.15	35.72
	33-38 CM	0.00	79.61	20.40
	38-41.5 CM	0.00	59.00	41.00
	AVERAGE	.15	60.12	39.74
CE22	0-0.5 CM	0.00	2.23	97.77
	0.5-4.5 CM		NO DATA	
	4.5-13 CM	.22	66.97	32.81
	14-45 CM	1.86	19.20	78.94
	45-75 CM	4.13	23.31	72.56
	75-100 CM	3.95	15.39	80.65
	AVERAGE	2.03	25.42	72.55
CE53	0-7 CM	1.42	98.52	.06
	7-12 CM	38.91	60.76	.33
	12-20 CM	.11	99.70	.19
	20-30 CM	.05	98.40	1.55
	AVERAGE	10.12	89.35	.53
CE54	0-12 CM	0.00	76.98	23.02
	12-25 CM	0.00	99.92	.08
	25-50 CM	.02	99.91	.07
	50-76 CM	.32	99.28	.40
	76-78 CM	0.00	99.69	.31
	78-88 CM	0.00	99.79	.21
	AVERAGE	.06	95.93	4.02
CE55	0-12 CM	.36	99.55	.09
	12-25 CM	.70	99.05	.24
	25-37 CM	0.00	99.63	.37
	AVERAGE	.35	99.41	.23
CE56	0-10 CM	0.00	77.44	22.56
	10-20 CM	0.00	71.90	28.09
	21-50 CM	0.00	10.04	89.96
	50-83 CM	0.00	15.73	84.26
	AVERAGE	0.00	43.78	56.22
AVERAGE SURFACE		.30	59.78	39.93
GRAND AVERAGE		1.89	67.65	30.46

Appendix 6: Jet data on sediment thickness

SITE	DEPTH TO REFUSAL, M	NOTES
JE195	4.25	FAST PENETRATION THROUGH UPPER 3.25 M, THEN SLOW. BOTTOMED ON HARD GLACIAL? SEDIMENT.
JE196	4.00	FAST PENETRATION THROUGH UPPER 1.75 M, THEN ALTERNATING SLOW, FAST TO BASE. LAST 2.25 M OF JET PIPE SHOWS SMEAR OF GLACIAL SEDIMENT. BOTTOMED ON GLACIAL SEDIMENT.
JE197	4.50	FAST PENETRATION THROUGH UPPER 4 M, THEN SLOW. BOTTOMED ON GLACIAL SEDIMENT.
JE199	5.25	FAST PENETRATION THROUGH UPPER 4 M, THEN SLOW. VERY HARD BOTTOM. BOTTOMED ON GLACIAL? SEDIMENT.
JE200	4.00	FAST PENETRATION THROUGH UPPER 3 M, THEN SLOW PENETRATION WITH BOUNCING. BOTTOMED ON GLACIAL SEDIMENT.