MGS/DGS COOPERATIVE OFFSHORE
SAND RESOURCES STUDY

INTERIM REPORT FOR YEAR 2

INITIAL IDENTIFICATION OF POTENTIAL SAND RESOURCES

Submitted by

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Introduction

The cooperative agreement between the Maryland Geological Survey, the Delaware Geological Survey, and the Minerals Management Service was established to encourage and expedite an inventory of offshore sand resources for beach nourishment. The area investigated was to be that offshore of the states of Delaware and Maryland in Federal waters roughly between three and ten miles off the coast. As beach nourishment projects have increased in frequency over the last ten years, the known resources close to shore within state waters have been steadily depleted. The projected need for additional resources and the lack of information about those resources in federal waters has been recognized and addressed by this cooperative effort.

The Delaware portion of this project has two main objectives. The first objective is to identify areas of potential sand resources that meet established textural criteria for use as beach nourishment material (Ramsey, 1988; Appendix A this report). The second objective is to understand the stratigraphic and sedimentologic context of these resources in order to provide a model for exploration for additional resources as needed.

The first year of the cooperative work focused on initial data collection and some analysis. Seventeen cores were collected off of Delaware (Figure 1). Core sites were selected by preliminary analysis of 172 line kilometers of 3.5 kHz seismic profiles collected aboard the Maryland Geological Survey's RV Discovery in 1992 (Figure 1). The cores were split and described (Appendix B) and samples were selected for textural analysis, clay mineralogy, pollen analysis, radiocarbon dating, and amino acid racemization analysis (of shell samples). Previously published and unpublished geologic data from the offshore were gathered. An additional 1270 line kilometers of seismic data (Appendix C) and a few additional core descriptions were added to the data base.

The second year of cooperative work has concentrated on data analysis with some additional collection of seismic data. Another 150 kilometers of 3.5 kHz seismic data were collected aboard the RV Discovery in 1993. The rest of this report summarizes progress and data analysis and interpretation for the first two years of this cooperative project.

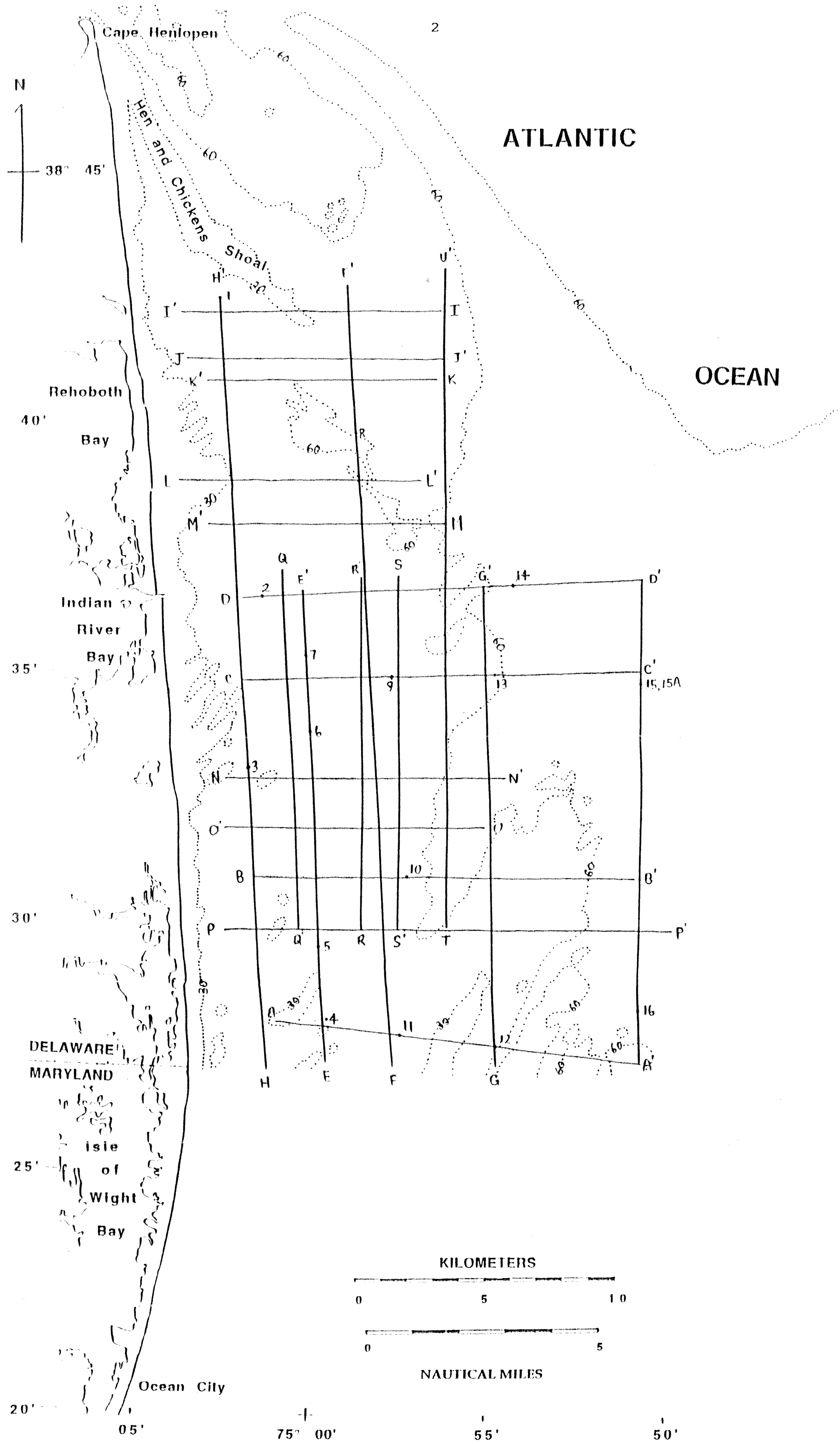

Figure 1. Location of seismic lines and core locations. Cores are numbered consecutively from 1 through 16.

Textural Analysis of Offshore Sands

Ramsey (1988) compiled previously published and unpublished data on the textures of the "natural" beach sands found along Delaware's Atlantic Coast (Appendix A). Based on analysis of these data, criteria were established for preferred textures for sands to be used for beach nourishment. Based on an assumption that beach sands are in some state of equilibrium with prevailing wave, current, and wind conditions on the coast, the textures preferable for beach nourishment should be at least as coarse as those historically on the beach. Finer textures would likely be quickly removed from the beach profile. Sands coarser than the native sands could be used, but beyond a certain point coarser sands may oversteepen the beach profile as it adjusts to wave and current conditions. A range of textural criteria were suggested based on the information available: median grain size between 1.5 and 0.5 phi (medium to coarse sand), sorting of less than 0.5 phi (well sorted), and skewness with a negative value (more coarse than fine sands within a population).

These textural criteria are used as a general range for suitable sands to be designated as offshore resources. It is recognized of course that within any one core or locality a wide variety of textures will be encountered. In addition, the dredging process for extraction of the sands will mix the sands and to some degree winnow out the finer fraction in the process. A slightly coarser sand will be delivered to the beach than that actually encountered at the resource site. Some flexibility is allowed in the textural criteria, but as a rule they should serve as a reasonable guideline for suitable beach nourishment sands.

One hundred sand samples were taken from 15 of the 17 Delaware Geological Survey 1992 offshore cores (Appendix D). One foot sample intervals were chosen unless there were marked changes in texture that required closer sampling. Each initial sample weighed approximately one hundred grams. The coarse and fine fractions, >1 phi and <-4 phi were removed through wet sieving. The coarse fraction was retained, dried, and weighed to determine the gravel percentage. The sand fraction was dried and weighed to determine its percentage. The fine fraction was not retained. Weight loss of this fraction was considered to be the mud percentage. The sand fraction was then split and a 5 gram sample retained for size analysis. Grain size analyses of the sand fraction were conducted by the Rapid Sediment Analysis (RSA) technique at the Maryland Geological Survey. Data from the sand size analysis was used to calculate the mean, standard deviation (sorting), and skewness for the sands.

Based on grain size analysis of the core samples and initial interpretation of seismic profile characteristics of the associated sand bodies, two areas have been identified as having potential sand resources for beach nourishment (Figure 2). The northern area is situated east of Indian River Bay and includes cores 2, 6, 7, 9, and 13. The top 16 feet of DGS 92-2 (Pj45-01) contain sands suitable for beach nourishment, but the lower two feet are too fine. DGS 92-7 (Pk51-01) contains fine-grained sands, but the average phi size of all sample intervals suggests that the material could be used as a sand resource. DGS 92-9 (Qk13-01) seems to indicate an area of excellent resource potential. The fine grained intervals are only 0.1 phi above the recommendations for Delaware beach nourishment sands. These three core sites are situated above or within paleovalleys which are generally thought to be fine-grained sediment sinks. One possible reason for these coarser sand deposits is that tidal delta sediments filled the paleovalleys during lower sea level stands (Belknap and Kraft, 1985).

DGS 92-13 (Pl51-01) includes mixed finer and coarser material. Some intervals have coarse sands, but others are too fine. The phi values suggest that there is potential use for these sands for beach replenishment. The surrounding area should be studied in more detail for the distribution of sand. DGS 92-6 (Qk21-01), similar to core 7, is silty in the middle and the sands are too fine for beach replenishment. The upper six feet and lower five feet may, however, be used for nourishment.

The southeastern part of the study area, at the northern end of Fenwick Shoal also seems to have suitable material for beach replenishment. DGS 92-11 (Rk33-01) has sand textures, including negative skew, similar to those recommended for Delaware beaches. DGS 92-12 (Rl31-01) is finer grained in the lower nine feet, but the upper seven feet are more coarse and may be used for replenishment material. The other cores either contain sands too fine for replenishment or the layers meeting specifications are too thin for feasible retrieval.

Geologic Framework

Stratigraphic framework

Previous studies of the offshore stratigraphy of Delaware have focused on Delaware Bay and the interpretation of the paleodrainage and paleogeography of the Delaware River (Sheridan et al., 1974; Belknap and Kraft, 1985; Knebel and Circe, 1988, and Knebel et al., 1988). The inner shelf of Delaware's Atlantic Coast is roughly a right triangle with its apex at Cape Henlopen and widens to the south and east. The outer boundary is defined by the drowned Delaware River valley that is expressed as a deep bathymetric feature trending to the southeast toward the shelf edge. The focus of this study is this triangle of the inner shelf. The Quaternary geologic history of this area is linked to the drainage history of the ancestral Delaware River (Sheridan et

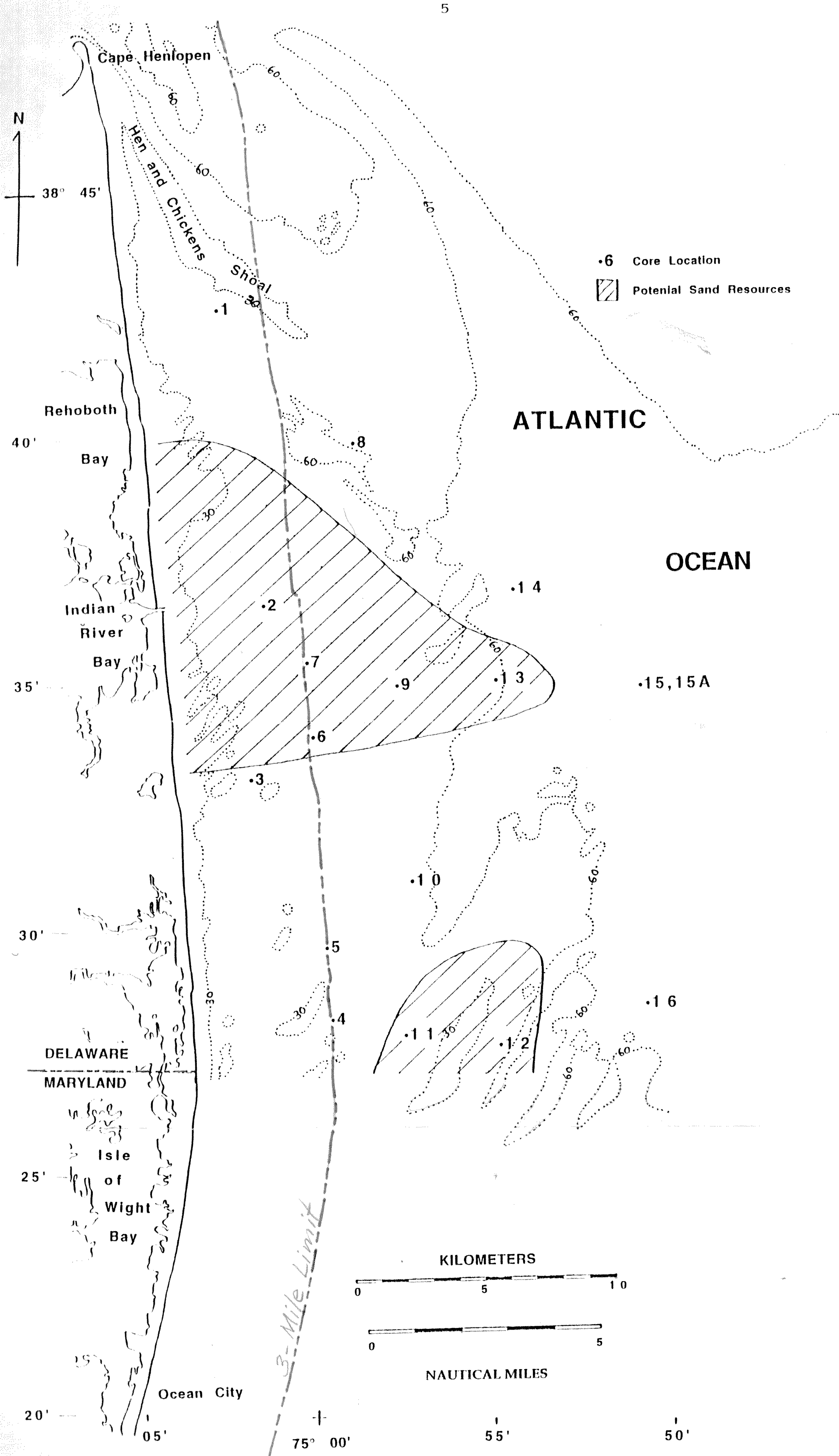

Figure 2. Areas identified as potential sand resources for beach nourishment.

al., 1974; Twichell et al., 1977; Belknap and Kraft, 1985; Chrzastowski, 1986).

In the southern part of this triangle off of Delaware and off of adjacent Maryland, distinctive bathymetric high features (shoals) are found scattered throughout the shelf (Moody, 1964; Field, 1979; Toscano et al., 1989). These features have been the primary target for sand resources for beach nourishment (Toscano et al., 1989; Wells, 1994). They become less numerous and are not present just north of the projected offshore state line of Maryland and Delaware. In the absence of such features additional attention is given to the shallow subsurface for sand bodies with potential resources. The identification of the ancestral drainage patterns of the Delaware River and its tributaries then becomes critical for developing a stratigraphic model for exploration for resources.

Seismic data were used to ascertain subsurface features (Figure 3). Figure 4 is a portion of a seismic line showing the edge of a paleovalley thinning out against an antecedent high (paleointerfluve) along with a core site on the edge of the paleovalley. Using the seismic lines, a preliminary sketch of incised paleovalleys and the interfluves observed on the Delaware inner continental shelf has been constructed. The subsurface is dominated by a trellis-dendritic drainage of the Delaware Valley incised during one or several periods of Pleistocene low sea levels (Belknap and Kraft, 1985). Commonly sands are found in the interfluves where older (Pliocene) sand and gravel deposits are preserved (Beaverdam Formation). Paleovalleys have been carved into these older deposits as streams have migrated across the shelf during low stands of sea level during the Quaternary. These paleovalleys tend to be filled with finer-grained material (Belknap and Kraft, 1985; Chrzastowski, 1986). Interestingly, at least three of the cores with possible resource potential are situated within paleovalleys. These are located in an area that is likely an offshore extension of Pleistocene deposits mapped onshore as the upper Omar Formation (Ramsey and Schenck, 1990). The sands could possibly be the result of tidal deltas that were the last stages of deposition in the paleovalleys.

Age control

In addition to stratigraphic position, two methods of age determination have been employed: amino acid racemization and radiocarbon dating. A third method, palynostratigraphy (Groot, 1991; Groot et al., 1994) is currently being conducted. Age determinations are important for correlation between cores and interpretation of the extent and thickness of beds that may have potential resources.

Amino acid racemization age estimations are determined by analysis of amino acids in preserved skeletal material.

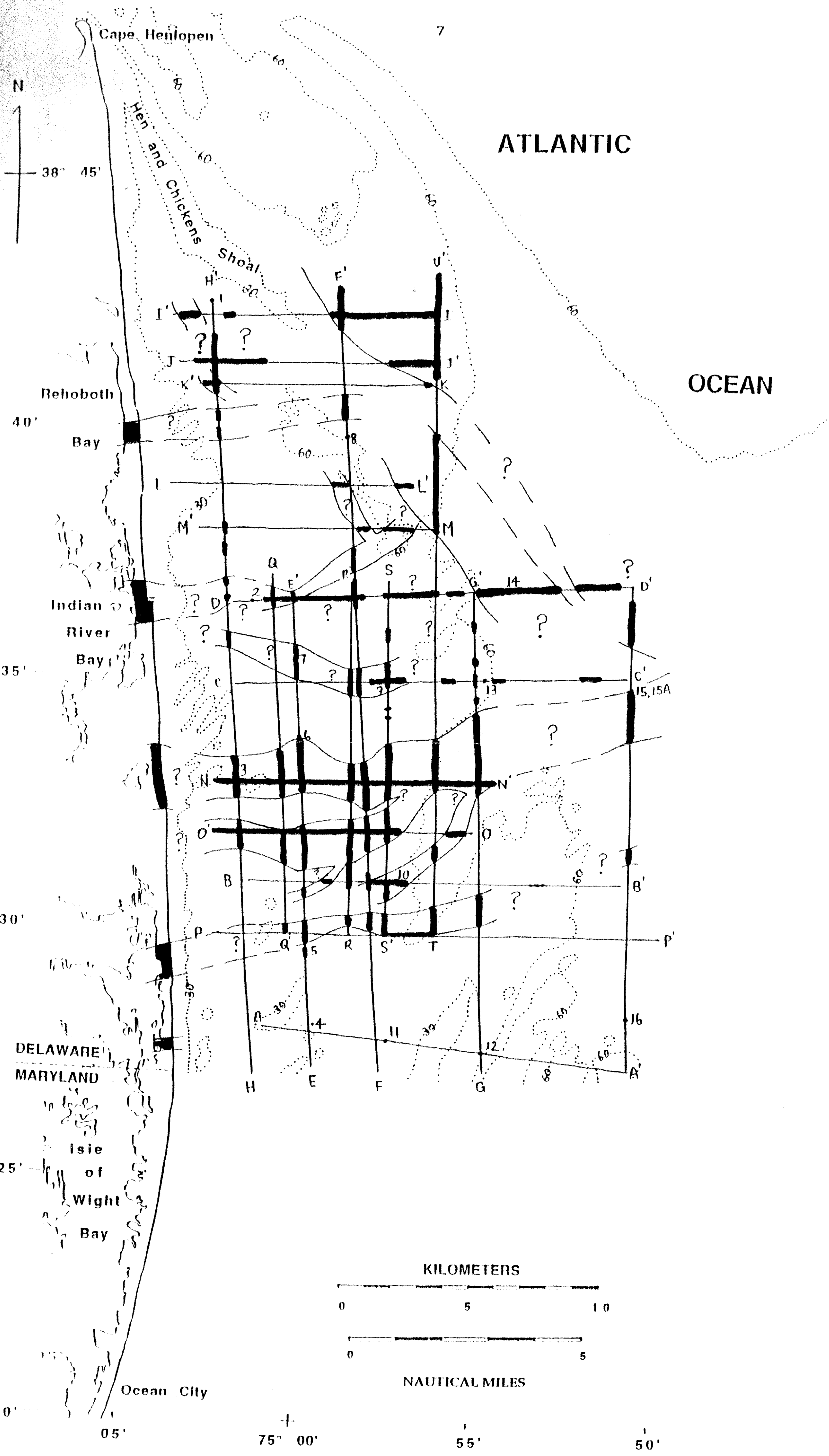

Figure 3. Locations of seismic data used to ascertain subsurface features.

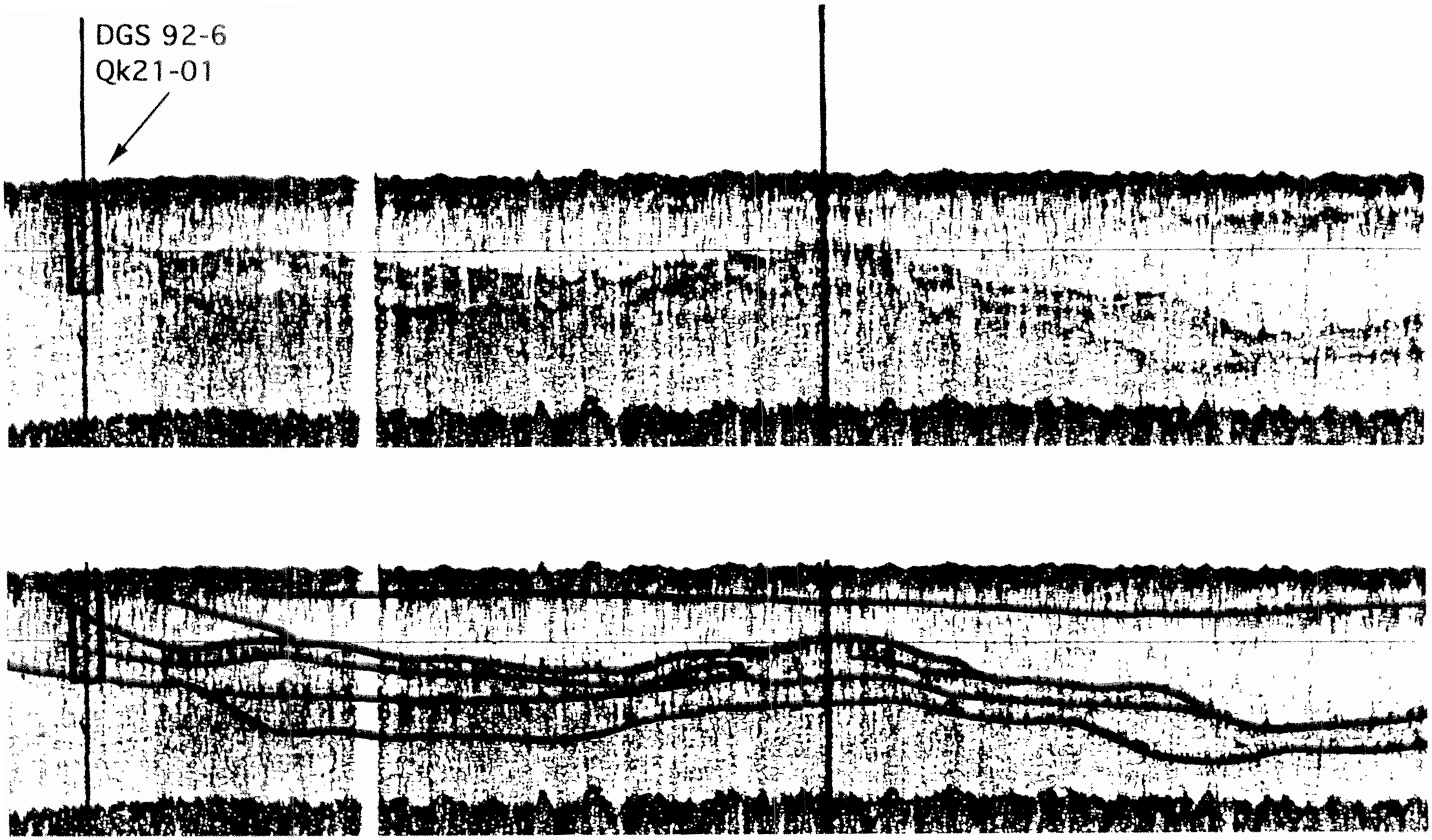

Figure 4. Portion of a seismic line used in the identification of a paleovalley and paleointerfluve.

Racemization is a digenetic process in which the original proteins are hydrolyzed into lower molecular weight polypeptides and free amino acids. "Left-handed" (L-) amino acids commonly found in the original skeletal material are converted to a mixture of (L-) and "right-handed" (D-) amino acids. The initial presence of (D-) amino acids is negligible, and D/L values increase from 0.0 in living samples to an equilibrium, usually 1.0 in "infinite" age samples. The amount of time to equilibrium depends upon both the sample type and temperature as apparent rates of racemization vary for different taxa and increase with higher temperature (Wehmiller, 1993). It is possible to use these D/L values for age estimations because the apparent racemization rates can be applied to kinetic models, most often using first-order reversible kinetics (Wehmiller, 1993). Basically, (L-) amino acid conversion to (D-) amino acids is initially more rapid, and slows down over the time to equilibrium (pers. comm., John Wehmiller). Knowing these apparent rates of racemization for different genera and temperatures allows for age estimations, the term best suited to avoid misrepresentation of inherent uncertainties in the dating method (Coleman et al., 1987).

D/L values can be plotted versus time to construct a zonation scheme based on clustering of values. Aminozones are constructs, "whereby relative ages are assigned to recognized clusters of D/L ratios from samples within a region having similar temperature histories (Groot, et al., 1990, p. 10)." For the Delmarva region, several aminozones have been recognized (Wehmiller et al., 1988; Toscano et al., 1989). The most prominent of these is zone IIa (100,000 +/- 25,000 yrs BP).

Shell samples were collected from 79 intervals in the cores. Samples chosen for initial analysis included those most likely to be below major reflectors, interpreted from the seismic data, in order to determine chronostratigraphy of the various units. Several genera have been analyzed in the study of these cores and include *Mercenaria, Spisula, Astarte, Ensis,* and *Venericardia.* Alloisoleucine/Isoleucine values were determined using High Performance Liquid Chromatography (HPLC) at the University of Delaware. The initial results (Appendix E) indicate that many of the shells are Holocene age. Core Rl25-01 (DGS 92-16), however, had at least two or three shells that appear to be of Pleistocene age. The highest A/I value, 0.439, was on a *Mercenaria* fragment within the 1.8-2.0′ depth interval (sample CW93-070-6). Lower A/I values deeper in the core suggest that reworking of older material into the Holocene deposits may be fairly significant in some locations.

Two samples from core 14 (Pl41-01) and two samples from core 10 (Qk43-01) were selected for radiocarbon dating (refer to core logs in Appendix B for depths and lithology sampled). The samples from core 14 yielded Holocene ages of 7,970 +/- 80 RCYBP

(Beta-67541) and 9,170 +/- 80 RCYBP (Beta 67542) based on a half-life of radiocarbon of 5568 years. These samples and their depth below sea level fit well with the sea level curve of Belknap and Kraft (1985). The samples from core 10 (Beta-67543 and Beta-67544) were dated at greater than 42,200 and 46,000 RCYBP, respectively, indicating minimal age estimates and a Pleistocene age.

Initial results of the age determinations, then, indicate that the much of the sand sampled in the cores is of Holocene age, but Pleistocene age deposits were also penetrated. Pollen from the clays in the cores will enhance the ability to correlate between cores and to differentiate between Holocene and Quaternary age sediments.

Archaeological sites

Initial analysis side-scan sonar survey conducted with a portion of the 1992 seismic survey did not reveal any potential areas of archaeological interest other than one possible shipwreck already located previously (B. Conckwright, Maryland Geological Survey, pers. comm.). The important archaeological component of this work will be the identification of the channels and interfluves. The interfluves will likely be the site of ancient native American camping grounds (highlands) located near freshwater or tidal streams (Kraft, 1976).

Summary

Two areas of potential resources have been identified. The first is the area of and surrounding Fenwick Shoal. The second is offshore of Rehoboth and Indian River Bays. This is a significant area due to the paucity of potential resources closer to shore in an area that has had recent demand for beach nourishment material.

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Appendix A

Beach Texture Report

DELAWARE GEOLOGICAL SURVEY

Texture of Beach Sands-Atlantic Coast of Delaware

An Initial Report of SEASIP

July 12, 1988

Introduction-

As part of the investigation for on-land sources of beach nourishment material, the South-East Area Sand Inventory Project (SEASIP), this summary and interpretation of data concerning the textures of Delaware Atlantic beach sand has been prepared. "Sand" is a precisely defined term in geologic practice, refering to rock fragments between 2 millimeters and 1/16 millimeter in size. Because the size of particles that accumulate to form geologic deposits are sensitive to the currents that carry the fragments, sampling, laboratory, and statistical techniques have been devised to measure sand sizes and the distribution of sand-size "populations" (i.e., texture). Even without these complex measures, it has long been observed that there are differences between sands in rivers, dunes, and beaches. "Beach sand" is identifiable because its texture is developed by the agitation and sorting of waves, currents, and winds. It is adjusted to its environment; fine particles are washed offshore or blown into dunes and larger particles accumulate in the area of highest energy in the surf zone. The remaining sand on the beach is adjusted to the energy and currents between low and high tides.

Proper identification of geologic material suitable for beach nourishment requires that the textural properties of sand on the Atlantic Coast beaches of Delaware be characterized. The properties include sand grain size, sorting (deviation about the mean), and skewness (degree of asymmetry of the distribution). Material placed on the beach as nourishment should be similar texturally to that on the natural beach. The textures of sand represent the size and sorting that are stable under average wave and current activity. Nourishment material should have similar textures to sand presently on the beach in order to enhance stability. Material considerably finer could be rapidly removed by wind or waves once placed on the beach. Material considerably coarser may change the character of the beach profile and reduce beach width.

Purpose-

The purpose of this report is to characterize Delaware Atlantic Coast beach sand based on data generated during previous investigations. Recommendations of acceptible ranges of textural properties of sand to be used for beach nourishment should be based on these characteristics.

Data Base-

Data were compiled from ten previous studies of beach sand from Delaware's Atlantic Coast (Table 1). The period of sampling covered 55 years (1929 to 1984). The number of sample sites range from a minimum of two to a maximum of twenty-four for the individual studies. Most of the data were reported by the U. S. Army Corps of Engineers. Additional data were obtained from M. S. theses from the Department of Geology of the University of Delaware.

Table 1. Sources of data of beach sediment texture.

YEAR	SOURCE AND YEAR PUBLISHED	# LOCALITIES SAMPLED	BEACH SITE	TIME OF YEAR SAMPLED
1929	A.C.E. (1966)	2	MHW	November
1936	A.C.E. (1966)	24	MT	Unknown
1950	A.C.E. (1966)	5	MHW	November
1953	A.C.E. (1966)	2	MT	June
1954	A.C.E. (1966)	24	PFL	August-October
1964	A.C.E. (1966)	12	PFL	June-August
1974	A.C.E. (1975)	2	PFL	Spring
1980	McDonald (1981)	4	PFL	Unknown
1983	A.C.E. (1984)	2	PFL?	May
1984	Toscano (1986)	2	PFL	Summer

A.C.E.- Army Corps of Engineers

MHW- mean high water
MT- mid-tide
PFL- across profile

Treatment of Data-

In order to detect trends in sand textures along the Atlantic coastline of Delaware, data from 40 segments, one kilometer in length, were compiled and tabulated. Segment boundaries are the Universal Transverse Mercator 1000 meter north-south coordinates. Each segment was numbered consecutively from north to south from 1 to 40 (Figure 1) and grain size and sorting data for each segment were tabulated (Tables 2, 3; Appendix B). Of the 40 segments, nine have not been sampled and eight others had only been sampled once.

Size and sorting data are presented in terms of phi size, a log scale of grain size in millimeters (Appendix A). Data originally reported in millimeters were converted to phi (Tables 2 and 3, Appendix B). It should be noted that because of the nature of its statistics, the phi grade scale values decrease as textures become coarser and sediments become better sorted. Verbal descriptors (e.g., coarse, well-sorted) are given in the tables. Skewness is not presented in tabular form. Data from earlier reports were given in log of skewness, whereas, later works reported skewness based on phi parameters (a system that uses a different log scale). Conversion between systems is not statistically rigorous, but permits some comparisons for the present purpose. General statements about skewness are made in the discussion of data.

Tables 2 and 3 (Appendix B) present the average of the data reported from a particular profile whether from a single sample or a series of samples across the profile (Table 1). The averages represent the average median or mean grain size (Table 2) and sorting (Table 3) for the stations sampled. Sizes, along with sorting and skewness, reflect the textural characteristics of the beach sand at the sample locality. These data, however, can only be used as an approximation for the beach textures. Variability in sampling methodology, location of samples on the beach, textural analysis methodology (sieving or rapid settling analysis), formulas used in calculating the textural data, and the time of year of sampling all affect the results. Nevertheless, the data provide a general characterization of the north-south distribution of average beach textures over the last 55 years. Further, the historical data are significant because later nourishment projects have altered the natural, stable, sand texture.

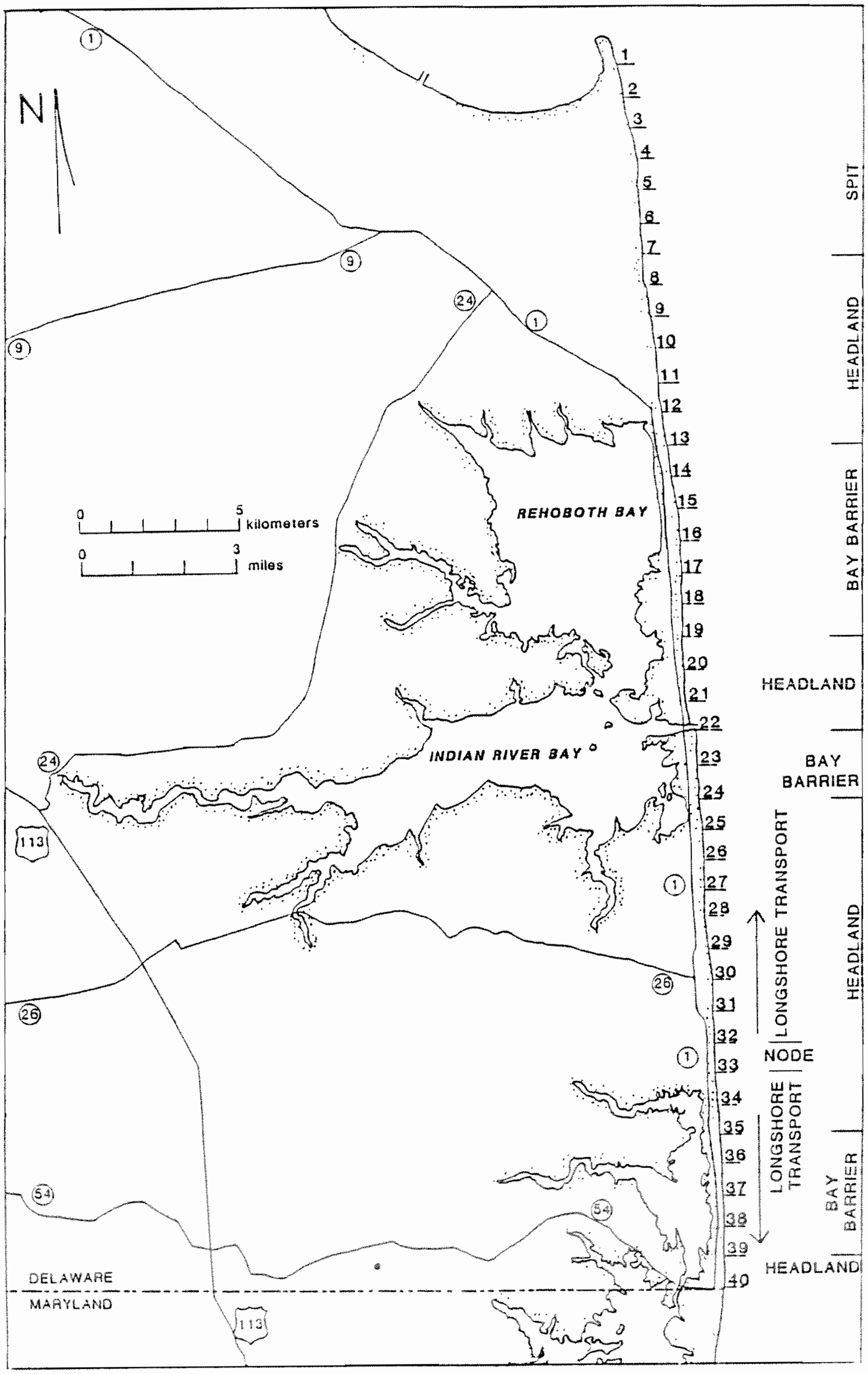


Figure 1. Geomorphic and cultural features of the Atlantic Coast of Delaware. Segments used in data compilation are marked by lines at segment boundaries.

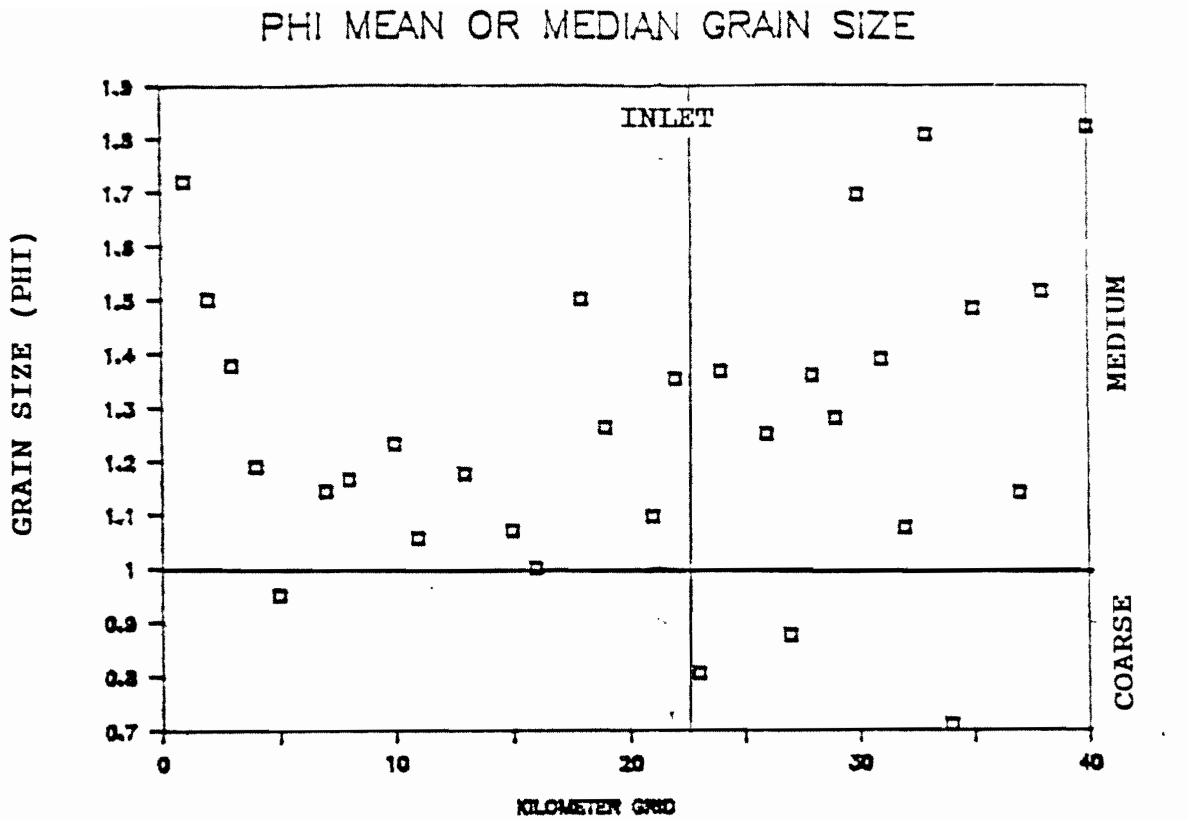
The data for each one kilometer segment were averaged to give mean grain sizes and sorting. The coastline was also divided into segments north and south of Indian River Inlet, north and south of the longshore transport node (approximately at South Bethany), and geomorphic position (spit, headland, bay barrier) (Figure 1). These groupings were selected in order to determine if variations along the coast correspond to "natural" elements (position of the inlet or node) or to sand sources (headlands) and sinks (spit, barriers) along the coast.

Discussion-

The yearly averages do not show any significant trends through time. Samples taken during 1936 were from the mid-tide level, a zone that normally contains sand coarser than the average over the entire beach profile. Data from the entire profile for 1954, however, are not significantly different from that of the mid-tide zone of 1936 (1.11 phi versus 1.04 phi). 1964 samples contained finer sand than those of previous years (1.68 phi). The finer size may reflect the nourishment of beaches following the 1962 storms.

Figure 2 shows the distribution of mean size and sorting along the Delaware coast. The sands fall within the medium sand-size range and are well to moderately well sorted. An average size for the entire coast is 1.26 phi (+/- 0.27 phi) (medium sand) with an average sorting of 0.45 phi (well sorted). McDonald (1981) reported values from +0.29 (fine skewed) to -0.28 (coarse skewed) with a median skewness of +0.09 (near symmetrical). The Army Corps of Engineers (1975), however, reported values of +0.36 to +1.79 (strongly fine skewed) with averages around +1.00 (strongly fine skewed). These values may show the problems of conversion of data from differing scales. Beach sands are commonly symmetrical to negatively skewed (i.e., a population has more coarser than finer grains). McDonald's (1981) skewness values are likely representative of sands along Delaware's Atlantic Coast.

The distribution of grain size and sorting along the coast shows a slight fining trend from north to south with a correlative increase in sorting. The effect of Indian River Inlet appears to be local. Sand on the immediate south side is coarser than the beach average and coarser than that on the adjacent north side of the inlet. The position of the longshore transport node and geomorphic features appear to have little to no effect on grain size and sorting. An exception is that the sands on Cape Henlopen spit are finer-grained and slightly less sorted than those to the south.



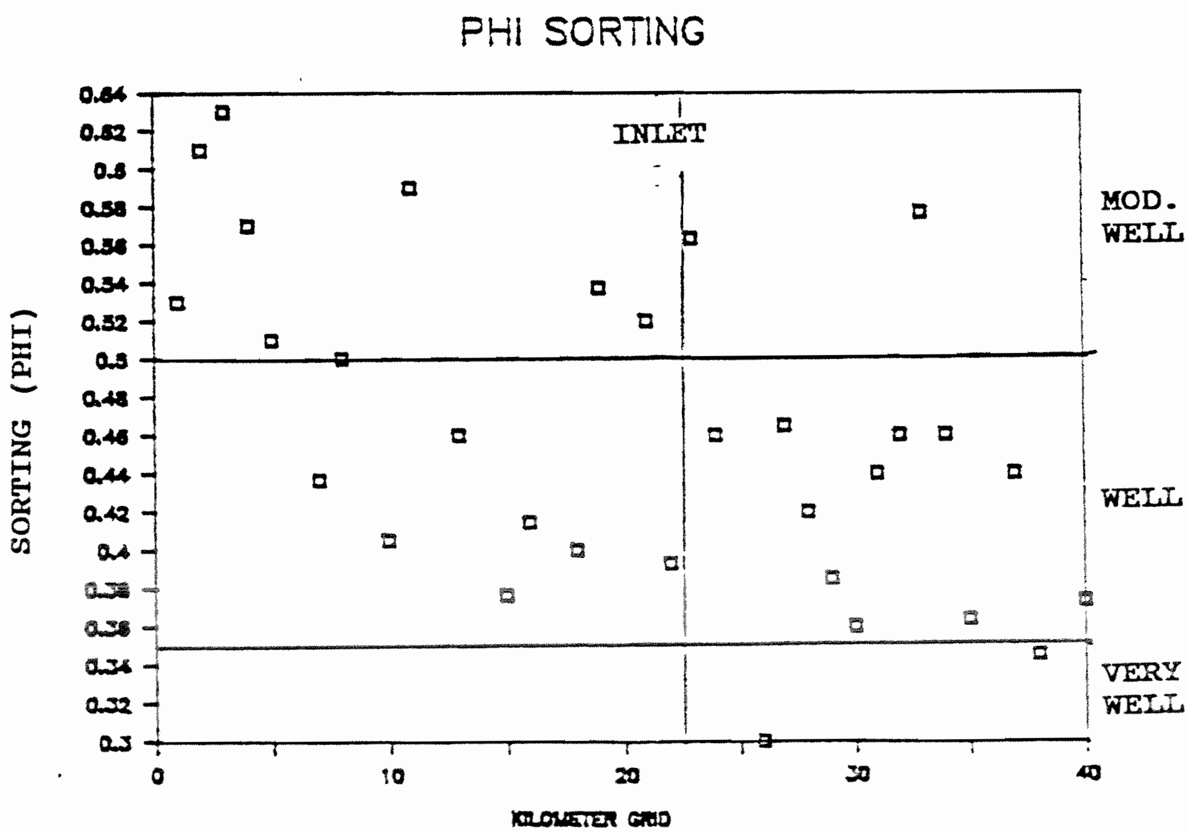


Figure 2. Phi mean and sorting of beach sand along Delaware's Atlantic Coast.

Recommendations-

Based on the data presented herein, it is our preliminary recommendation that sand placed on Delaware beaches should be in the coarse sand or the coarse half of the medium sand range of the standard Wentworth grade scale, and be well sorted or very well sorted. In precise statistical terms, the sand should meet these specifications:

Median grain size- 1.5 to 0.5 phi units

Sorting- 0.5 or less phi sorting

Skewness- negative value desirable

If these basic parameters are accepted, standardized measurement techniques can be provided to select appropriate source material and assure quality control during beach nourishment. It is anticipated that firm agreement on specifications will be necessary as objective bases for accepting or rejecting material offered for beach nourishment.

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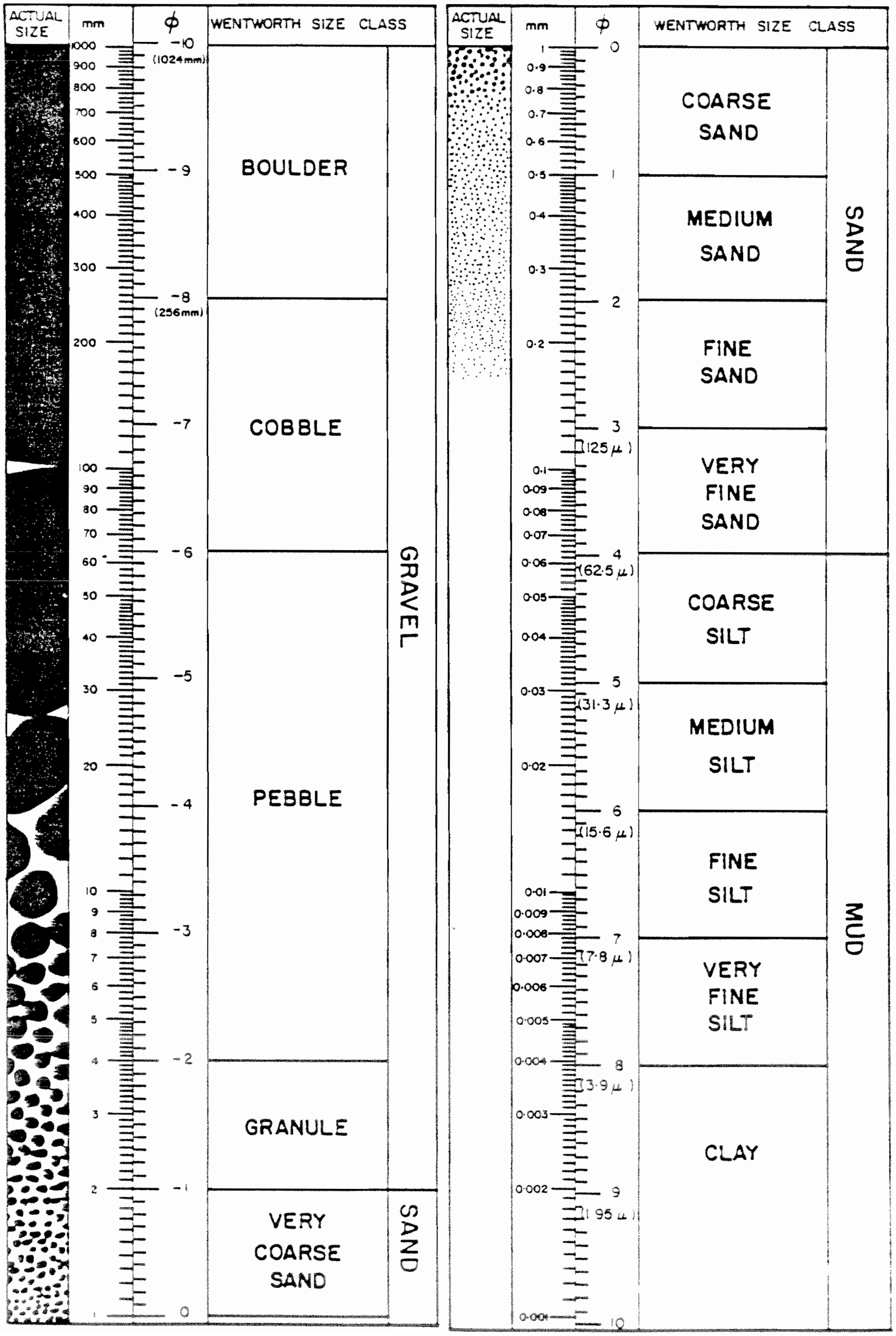
Appendix A. Phi and Millimeter Size Ranges and Wentworth Classification (from Lewis, 1984, p. 59)


ACTUAL SIZE
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BOULDER
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0·001
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7
(7·8 μ)
8
(3·9 μ)
9
(1·95 μ)
10
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
COARSE SILT
MEDIUM SILT
FINE SILT
VERY FINE SILT
CLAY
SAND
MUD

Appendix B. Textural Data for Delaware Atlantic Coast Beach Sand

Table 2. Size data (in phi).

1 KM GRID	1929	1936	1950	1953	1954	1964	1974	1981	1983	1984	AVERAGE	N INLET	N NODE	SPIT
1						1.75				1.69	1.72			
2				1.5							1.50			
3	1.45		1.9	0.98	0.98	1.58					1.38			
4					1.19						1.19			
5					0.95						0.95			1.31
6														(0.25)
7		1.28			0.65	1.5					1.14			
8		1.3			1.03						1.17			HEADLAND
9														
10		1.35	1.5		0.74		1.34				1.23			
11		0.88			0.79	1.5					1.06			1.16
12												1.21		(0.06)
13		0.91	1.7		0.92						1.18	(0.21)		
14														BAY BARRIER
15		0.56			1.14	1.51					1.07			
		0.85									0.85			
16		1.07			0.93						1.00			
17														1.11
18		1.5									1.50			(0.24)
19		0.72			0.91	1.89				1.53	1.26		1.22	HEADLAND
20													(0.23)	
21		1.05			0.71				1.53		1.10			1.24
22		0.97			1.39	1.7					1.35			(0.11)
23		0.76			0.85						0.81	S INLET		BAY BARRIER
24		0.84			1.41	1.85					1.37			1.09 (0.28)
25														HEADLAND
26		1.25									1.25			
27		0.65			1.1						0.88			
28								1.36			1.36			
29		1.35			0.9	1.71		1.16			1.28			1.27
30			2.2		1.19						1.70			(0.32)
		1.3			1.3						1.30			
31					1.9			0.88			1.39		S NODE	
32		1						1.15			1.08	1.30		
33					1.85	1.79	1.78				1.81	(0.32)		
34		0.71									0.71			
35		1.45			1.52						1.49			BAY BARRIER
36													1.37	
37		1.14									1.14		(0.35)	1.38
38		1.35			1.47	1.73					1.52			(0.17)
39														
40	1.75	1.5	2.32		1.3	2.24					1.82			HEADLAND
														1.82 (0.40)
YEAR AVG.	1.6	1.07	1.92	1.24	1.13	1.73	1.56	1.14	1.53	1.61	1.26 AVG			

1.45 AVERAGE OF YEAR AVERAGES

1.82 MAX
0.27 STD (standard deviation)
0.71 MIN
33 Number stations sampled

Table 3. Sorting data (in phi).

1 KM GRID	1929	1936	1950	1953	1954	1964	1974	1981	1983	1984	AVERAGE	N INLET	N NODE	SPIT
1						0.42				0.64	0.53			
2				0.61							0.61			
3	0.55			0.82	0.65	0.42					0.63			
4					0.57						0.57			
5					0.51						0.51			0.55
6														(0.06)
7		0.37			0.54	0.4					0.44			
8		0.45			0.55						0.50			HEADLAND
9														
10		0.32			0.49						0.41			
11		0.57			0.48	0.47	0.84				0.59			0.49
12												0.50		(0.07)
13		0.46			0.46						0.46	(0.08)		
14														BAY BARRIER
15		0.32			0.34	0.47					0.38			
		0.55									0.55			
16		0.43			0.4						0.42			0.44
17														(0.07)
18		0.4									0.40			
19		0.55			0.54	0.56				0.5	0.54		0.47	HEADLAND
20													0.09	
21		0.41			0.63						0.52			0.48
22		0.35			0.39	0.44					0.39			(0.06)
23		0.37			0.79				0.53		0.56	S INLET		BAY BARRIER
24		0.36			0.58	0.44					0.46			0.51 (0.05)
25														HEADLAND
26		0.3									0.30			
27		0.45			0.48						0.47			
28								0.42			0.42			
29		0.31			0.41	0.39		0.43			0.39			0.42
30					0.36						0.36			(0.07)
		0.35			0.39						0.37			
31					0.34			0.54			0.44		S NODE	
32		0.41						0.51			0.46	0.42		
33					0.41	0.36	0.96				0.58	(0.07)		
34		0.46									0.46			
35		0.36			0.28	0.45					0.36			BAY BARRIER
36													0.43	
37		0.44									0.44		(0.07)	0.38
38		0.37			0.32						0.35			(0.04)
39														
40	0.38	0.36			0.38	0.38					0.37			HEADLAND
														0.38 (0.00)
YEAR AVERAGE	0.47	0.41		0.72	0.47	0.43	0.90	0.48	0.53	0.57				

0.55 AVERAGE OF YEAR AVERAGES

<0.35	very well sorted
0.35-0.50	well sorted
0.50-0.71	mod. well sorted
0.71-1.0	moderately sorted

0.46	AVG
0.63	MAX
0.08	STD
0.30	MIN
33	Number of stations sampled

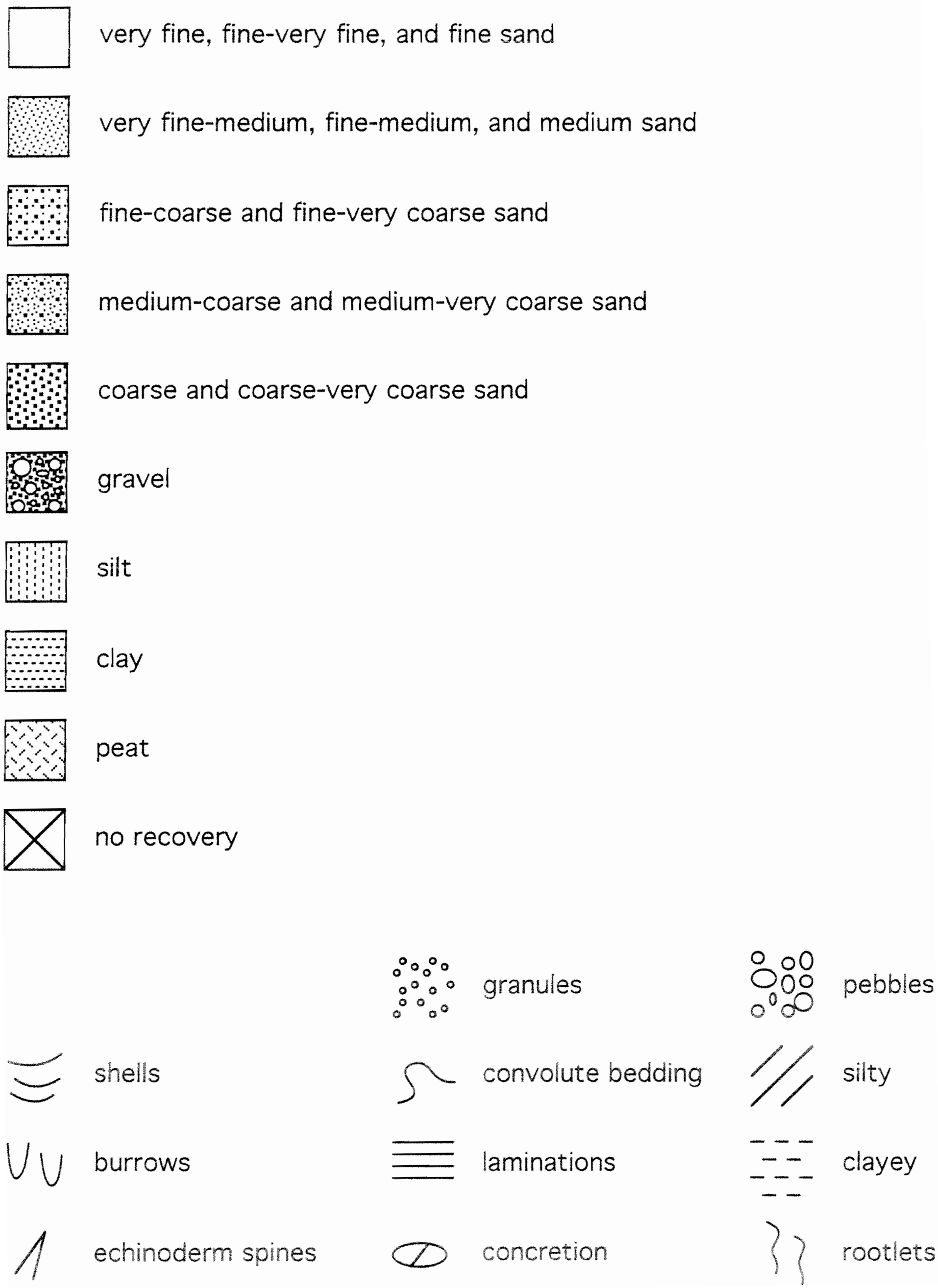
(Standard deviation)

Appendix B

Core Descriptions

DGS ID	LOCAL ID	LATITUDE	LONGITUDE	CORE DEPTH	ALTITUDE	DATE DRILLED	QUADRANGLE
Oj23-02	DGS 92-1	38°43'05.7"	75°02'00.0"	16.0'	-33.5'	11/15/92	REB
Pj45-01	DGS 92-2	38°36'39.1"	75°00'50.5"	18.0'	-41.1'	11/16/92	BEB
Qj24-03	DGS 92-3	38°33'15.0"	75°01'23.3"	17.0'	-39.8'	11/16/92	BEB
Rk21-01	DGS 92-4	38°28'11.9"	74°59'14.5"	15.0'	-51.0'	11/14/92	FWS
Rk11-01	DGS 92-5	38°29'33.3"	74°59'24.2"	19.5'	-46.4'	11/14/92	FWS
Qk21-01	DGS 92-6	38°33'43.0"	74°59'33.3"	20.0'	-49.6'	11/16/92	FHN
Pk51-01	DGS 92-7	38°35'15.1"	74°59'35.7"	20.0'	-44.5'	11/16/92	FHN
Pk12-01	DGS 92-8	38°39'45.3"	74°58'24.1"	18.0'	-60.1'	11/15/92	OCL
Qk13-01	DGS 92-9	38°34'54.0"	74°57'20.5"	20.0'	-56.8'	11/16/92	FHN
Qk43-01	DGS 92-10	38°31'05.9"	74°57'00.0"	11.6'	-56.0'	11/14/92	FHN
Rk33-01	DGS 92-11	38°27'53.9"	74°57'11.8"	10.8'	-57.6'	11/14/92	FWS
Rl31-01	DGS 92-12	38°27'35.9"	74°54'29.5"	16.2'	-53.9'	11/14/92	FWS
Pl51-01	DGS 92-13	38°35'06.2"	74°54'38.3"	14.0'	-64.2'	11/16/92	FHN
Pl41-01	DGS 92-14	38°36'55.2"	74°54'23.8"	20.0'	-72.5'	11/15/92	FHN
Pl55-01	DGS 92-15	38°35'00.3"	74°50'41.7"	2.7'	-82.9'	11/15/92	SOM
Pl55-02	DGS 92-15A	38°35'00.3"	74°50'41.7"	1.1'	-82.9'	11/15/92	SOM
Rl25-01	DGS 92-16	38°28'47.6"	74°50'41.9"	11.8'	-75.5'	11/14/92	SOU

SYMBOLS


very fine, fine-very fine, and fine sand
very fine-medium, fine-medium, and medium sand
fine-coarse and fine-very coarse sand
medium-coarse and medium-very coarse sand
coarse and coarse-very coarse sand
gravel
silt
clay
peat
no recovery
granules
pebbles
shells
convolute bedding
silty
burrows
laminations
clayey
echinoderm spines
concretion
rootlets

ABBREVIATIONS

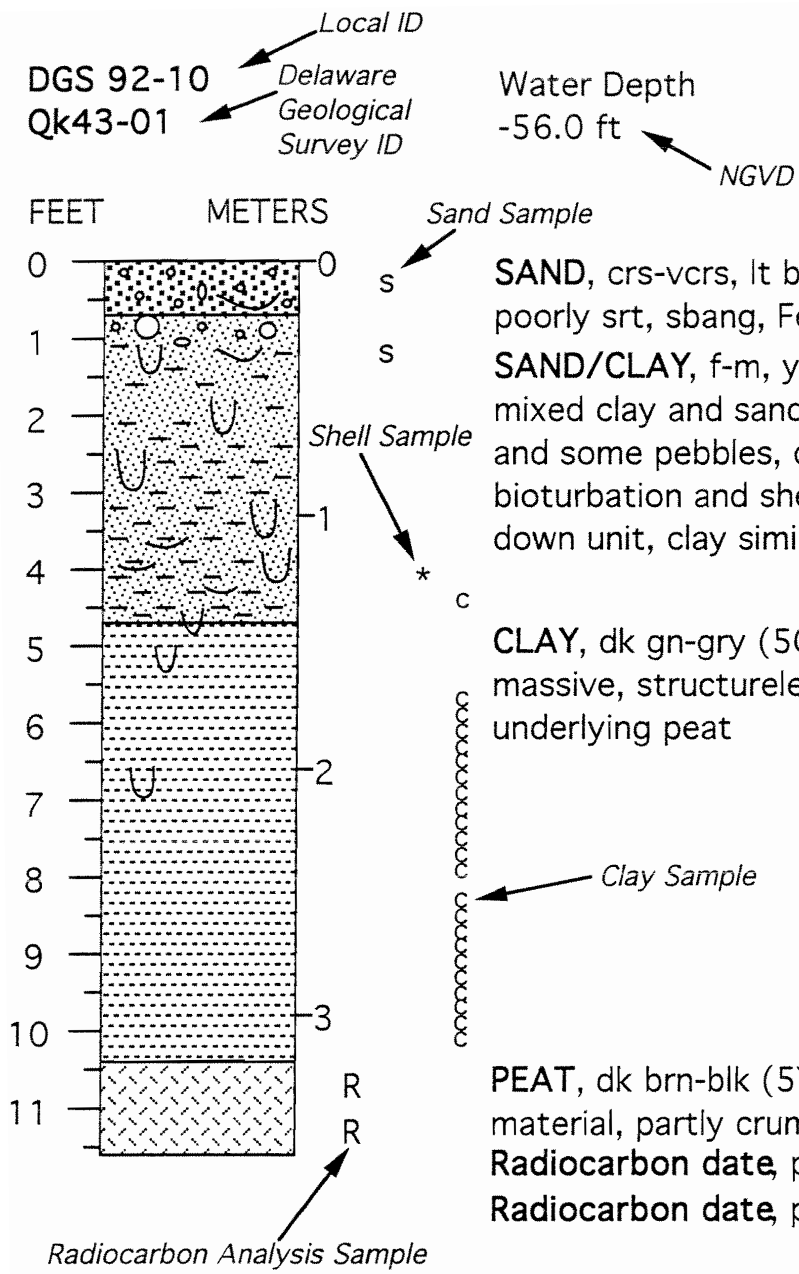
abd	abundant
blk	black
brn	brown
cmt	cemented
cpct	compact
crs	coarse
dk	dark
f	fine
gn	green
gry	grey
lt	light
m	medium
mod	moderate(-ly)
olv	olive
or	orange
org	organic
pk	pink
pred	predominantly
prob	probably
sbang	subangular
sbrndd	subrounded
scat	scattered
srt	sorted
thk	thick
v	very
vcrs	very coarse
vf	very fine
w/	with
yel	yellow

Swanson, R. G., 1985, Sample examination manual: Methods in exploration series. American Association of Petroleum Geologists, Tulsa, 35 p.

DGS 92-10
Qk43-01

Water Depth
-56.0 ft

Latitude N38° 31' 05.9"
Longitude W74° 57' 00.0"



SAND, crs-vcrs, lt brn (5Y 5/6), shell fragments, poorly srt, sbang, Fe stained

SAND/CLAY, f-m, yel-gry (5Y 7/2), grading from mixed clay and sand base to sandy top w/ abd granules and some pebbles, quartzose, heavy minerals, bioturbation and shell fragments, *Ensis*, more common down unit, clay similar to that of the underlying unit

CLAY, dk gn-gry (5G 4/1), rarely bioturbated, sticky, massive, structureless, sharp contact w/ the underlying peat

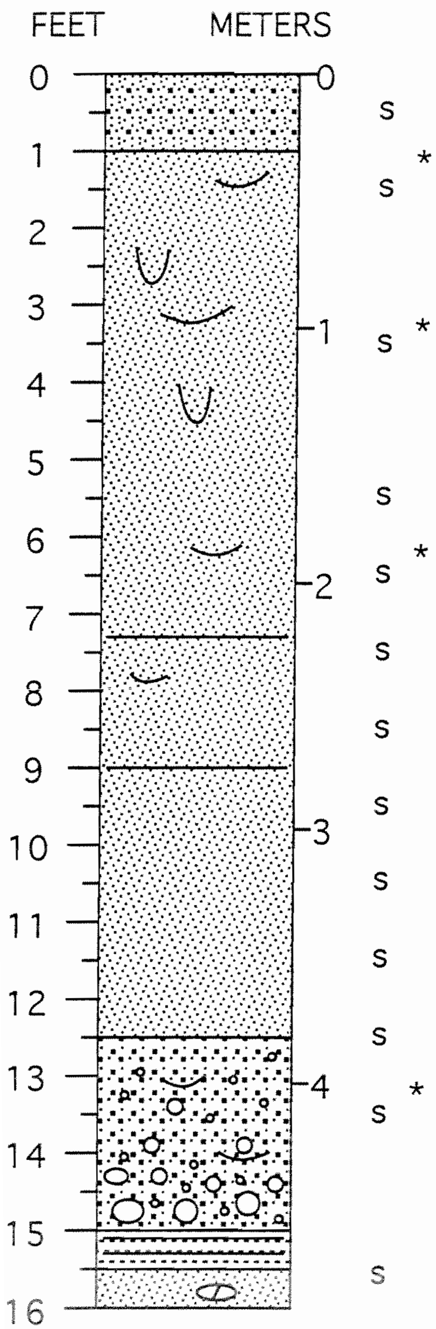
PEAT, dk brn-blk (5YR 2/1), visible wood and plant material, partly crumbly
Radiocarbon date, peat, 10.5'-10.8', >46,000 years BP
Radiocarbon date, peat, 10.8'-11.6', >42,000 years BP

Reported in radiocarbon years before 1950 A.D. (RCYBP) using a half-life of 5568 years. Quoted errors are from counting of the modern standard, background, and sample analyzed, and represent one deviation statistics.

DGS 92-1
Oj23-02

Water Depth
-33.5 ft

Latitude N38° 43' 05.7"
Longitude W75° 02' 00.0"



SAND, m-crs, yel-gry (5Y 7/2), sbrndd, mod srt, quartzose, heavy minerals, trace muscovite, structureless

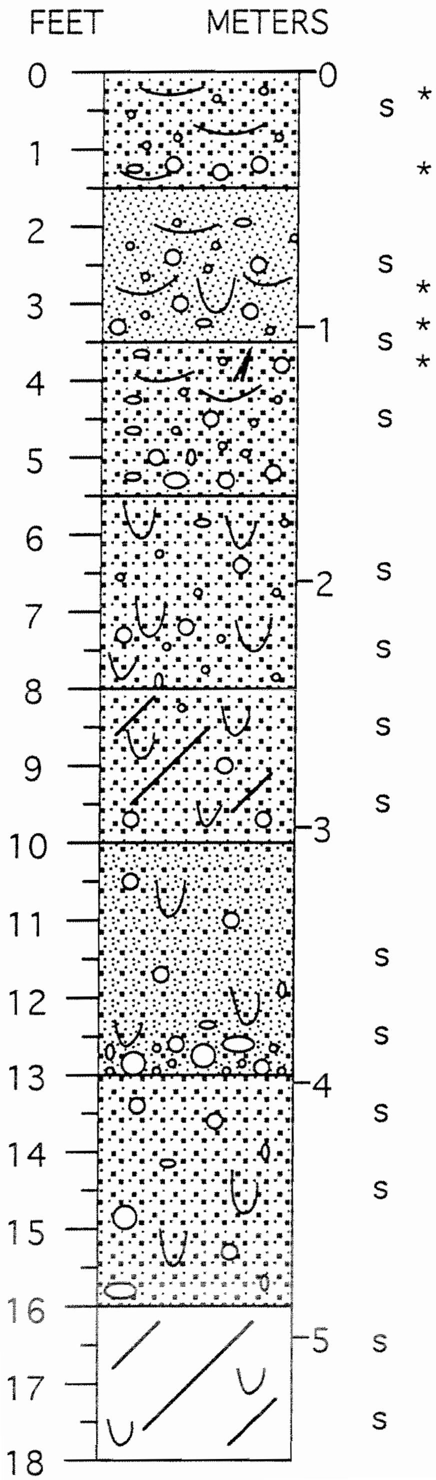
SAND, f-m, yel-gry (5Y 7/2), sbrndd, mod to well srt, quartz grains, heavy minerals, and muscovite, burrows rare, filled w/ clay, rare mollusk shell fragments, *Spisula*, color laminations 6.0'-12.5'

SAND, f-vcrs, abd granules, scat pebbles to 5 cm, yel-gry (5Y 7/2), mod to v poorly srt, fining upward, rare mollusk shells, *Spisula*, *Ensis*, pebbly base is lt brn (5YR 5/6)

CLAY, pale yel-gn, f-m sand laminations

SAND, f-m, dk yel-or (10YR 6/6), 6 cm diameter hollow concretion lined w/ dk material, prob Mn oxide, 15.0'-16.0' fining upward

DGS 92-2	Water Depth	Latitude	N38° 36' 39.1"
Pj45-01	-41.1 ft	Longitude	W75° 00' 50.5"



SAND, f-crs, quartz and chert pebbles to 2 cm, yel-gry (5Y 7/2), poorly srt, broken and intact shells, *Spisula*, *Crepidula*, *Crassostrea*, heavy minerals, fining upward

SAND, f-m, pebbles to 1.5 cm, yel-gry (5Y 7/2), granules, poorly srt, shell fragments, *Spisula*, heavy minerals, burrows rare

SAND, f-crs, granules, chert and quartz pebbles, yel-gry (5Y 7/2), sbrndd to sbang, poorly srt, abd shell fragments to 3 cm, *Spisula*, *Mercenaria*, *Anomia*, echinoderm spines, 3.0'-5.1' fining upward

SAND, f-crs, pebbles and granules, pale yel-or (10YR 1/6) to dk yel-or (10YR 6/6), more cpct than sands above, mod to poorly srt, color prob due to Fe oxide staining, bioturbated

SAND, f-crs, scat pebbles, silty (5-10%), pale yel-or (10YR 1/6), poorly srt, bioturbated

SAND, m-vcrs, granules, pebbles to 3 cm, especially toward base, yel-gry (5Y 7/2), poorly to mod srt, burrows, 12.8'-13.0' granule layer, 12.0'-13.0' fining upward

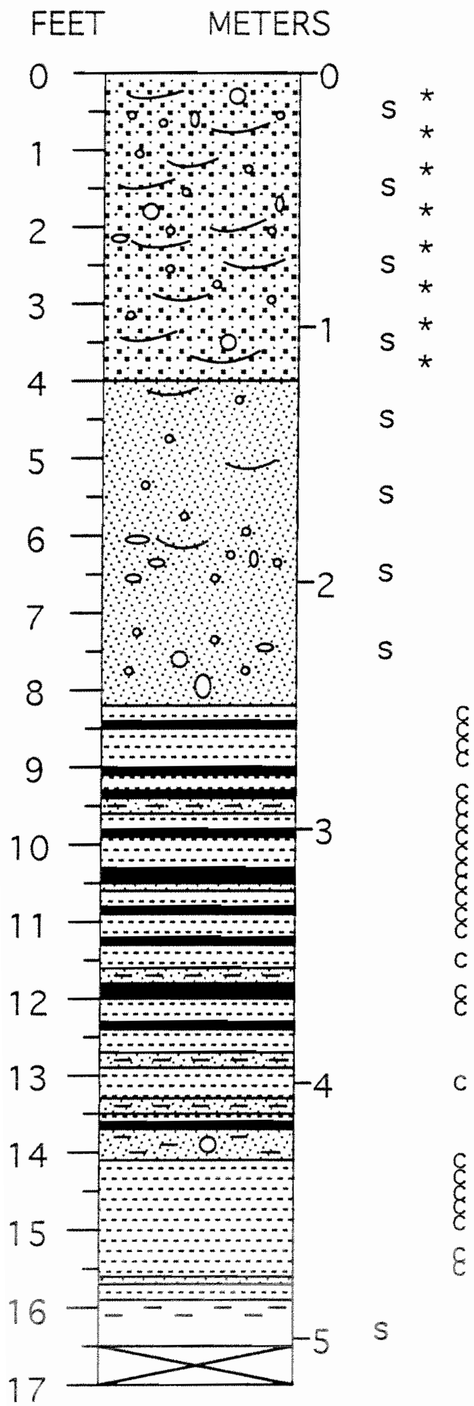
SAND, f-crs, pebbles to 2.5 cm, yel-gry (5Y 7/2), sbang, poorly srt, burrows

SAND, f-vf, silty, yel-gry (5Y 7/2), heavy minerals (2-3%), bioturbated

DGS 92-3
Qj24-03

Water Depth
-39.8 ft

Latitude N38° 33' 15.0"
Longitude W75° 01' 23.3"



SAND, f-vcrs, granules, rare pebbles, yel-gry (5Y 7/2), whole and broken shell fragments, *Crepidula*, *Spisula*, *Mercenaria*, quartzose sand, sbang, mod to poorly srt, heavy minerals (2-3%), micaceous

SAND, f-m, scat granules, pebbles near base, yel-gry (5Y 7/2), mod to well srt, sbang to sbrndd, heavy minerals, 4.0'-6.5' fining upward and contains shell fragments, *Spisula*, *Mercenaria*, 6.5'-7.2' no granules, overlies a clay unit, sharp lower contact

CLAY, dusky brn (5YR 2/2) to dusky yel-brn (10YR 2/2), sticky, sand lenses 0.5-10 cm thk w/ f-m quartzose sand, blk org rich layers a few mm to 2 cm thk, no visible org matter, sharp lower contact

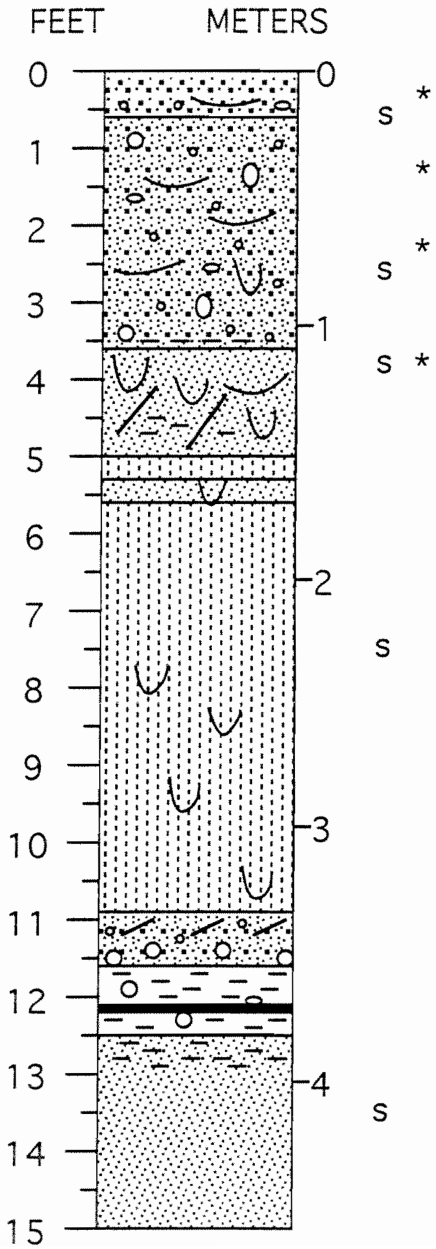
SAND, f, dk brn, top clayey, quartzose, well srt

NO RECOVERY

DGS 92-4
Rk21-01

Water Depth
-51.0 ft

Latitude N38° 28' 11.9"
Longitude W74° 59' 14.5"



SAND, f-crs, yel-gry (5Y 7/2), poorly srt, sbang, micaceous, shelly, *Spisula*, *Mercenaria*, *Anomia*, *Crassostrea*, pebble and granule base, fining upward

SAND, m-vcrs, pebbles and granules, poorly srt, shell fragments, scat mica flakes, sbrndd to sbang, bioturbated, otherwise massive, bottom of unit defined by a thin clay layer

SAND/SILT, f-m, pred f, sbrndd to sbang, mod srt, shell fragments, micaceous, bioturbation caused infiltration of clay and silt at base

SILT, lt gry (N7), micaceous, f-m sand unit 5.3'-5.6', poorly srt and bioturbated, brn-or oxidized patches

SAND, m-vcrs, quartz and chert pebbles to 2.5 cm, poorly srt, granular, fining upward

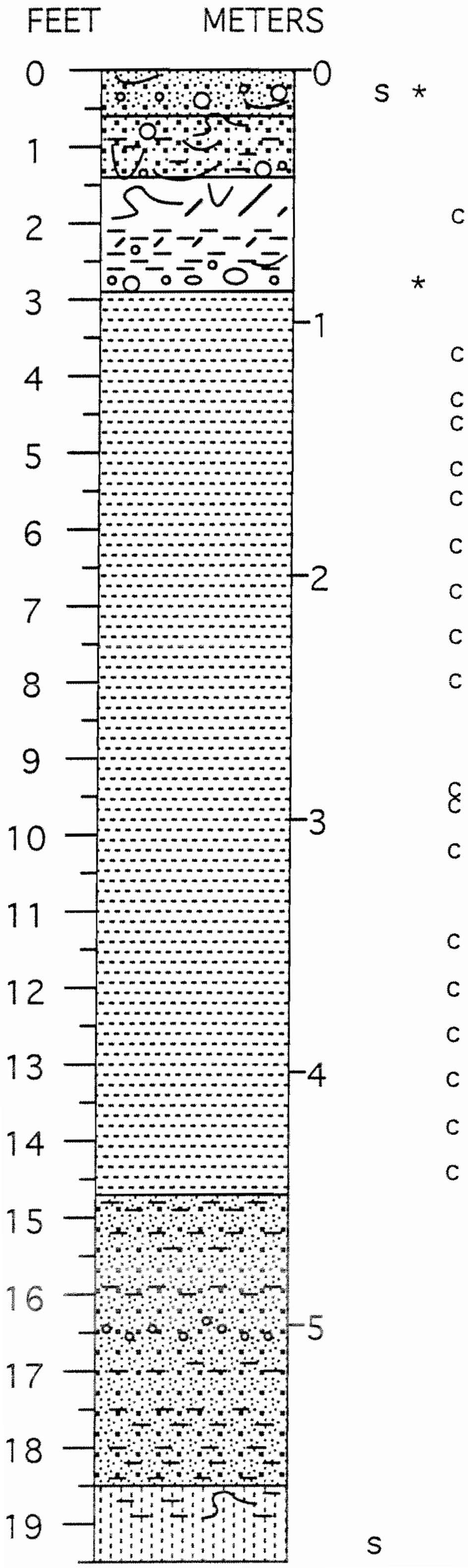
SANDY CLAY, olv blk (5Y 2/1), scat pebbles to 1.5 cm, org rich w/ blk streaks, gradational lower boundary, clay to sand

SAND, f-m, lt gry (N7), well srt, micaceous, fining upward

DGS 92-5
Rk11-01

Water Depth
-46.4 ft

Latitude N38° 29' 33.3"
Longitude W74° 59' 24.2"



SAND, m-crs, granules, pebbles, and shell fragments, *Spisula*, *Crepidula*, yel-gry (5Y 7/2), mod to poorly srt, pebbles in crude bedding

SAND, f-crs, yel-gry (5Y 7/2), granular, poorly defined mud/sand layering, pebbly, shell fragments, *Spisula/Mercenaria*?, bioturbated, convolute bedding

CLAY/SILT/SAND intercalations, pebbly/granular base, well defined clay/silt bedding, fining upward, top is bioturbated, convolute bedding

CLAY, olv gry (5Y 3/2), cpct, massive, v rare and thin (0.25-0.5 cm) yel-or silt laminations

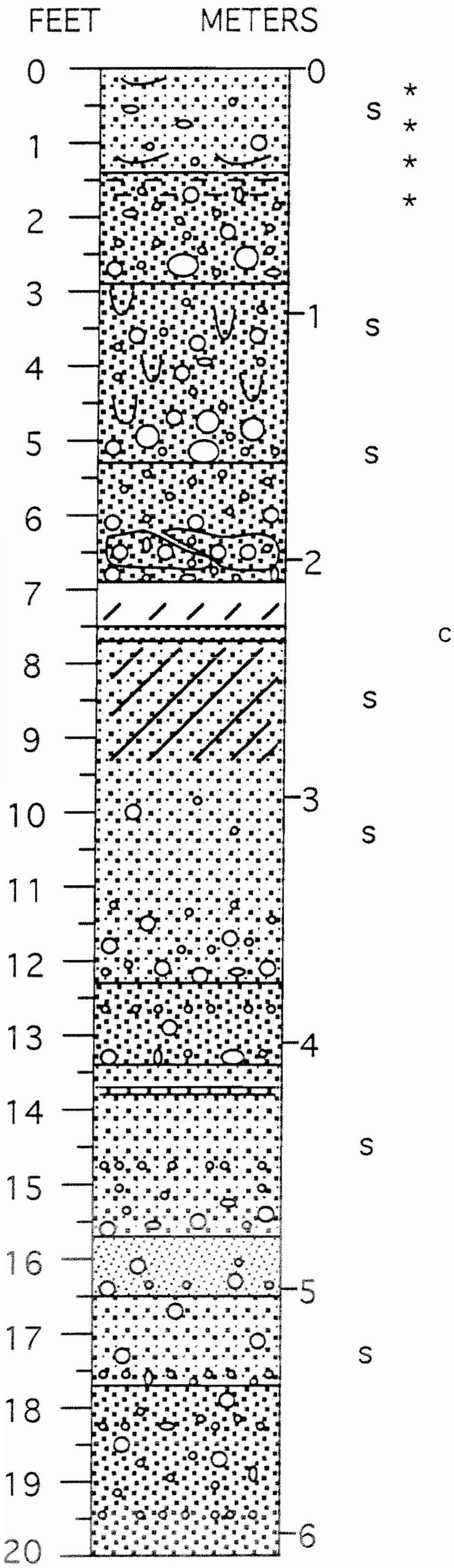
SAND/CLAY interlayering, pred m-crs sand, rare granule layers, mod to poorly srt, poorly to well defined bedding from sand/clay intercalations

SILT, yel-gry (5Y 7/2), streaks of f sand and clay, clay/silt convolute laminations

DGS 92-6
Qk21-01

Water Depth
-49.6 ft

Latitude N38° 33' 43.0"
Longitude W74° 59' 33.3"



SAND, f-vcrs, granules, yel-gry (5Y 7/2), quartzose, sbang, poorly srt shells and fragments, *Crepidula*, *Spisula*, scat pebbles (0.25-0.45 cm)

SAND, crs-vcrs, gry-or-pk (5YR 7/2), granules and pebbles to 4.5 cm, v poorly srt, blk-gry sandy/pebbly clay lens on top, 0-2.9' fining upward, *Spisula*

SAND, crs-vcrs, dk yel-or (10YR 6/6), Fe stained, abd granules and pebbles at base, fining upward, middle is churned by bioturbation and mixed w/ dk blk-gry sand

SAND, crs-vcrs, lt olv gry (5Y 5/2), quartz pebbles to 3 cm, 10 cm clast of cmt m sand and pebbles near base, layer more cmt than adjoining beds, silica, Fe, and Mn oxide cements, fining upward

SAND/SILT/CLAY, f-vf, yel-gry (5Y 8/1), lt olv gry (5Y 6/1) clay, coarsening upward

SAND, f-vcrs, yel-gry (5Y 8/1), mod to well srt, quartzose, structureless, pebbly and granular base, fining upward, top is silty

SAND, crs, yel-gry (5Y 8/1), quartzose, pebbly base, thin granule layer12.7'-12.8', fining upward

SAND, f-crs, yel-gry (5Y 8/1), granular, pebbly base, granule layer 14.8', fining upward, thin laminations of heavy minerals

SAND, f-m, yel-gry (5Y 8/1), granular w/ tan pebbles at base, fining upward

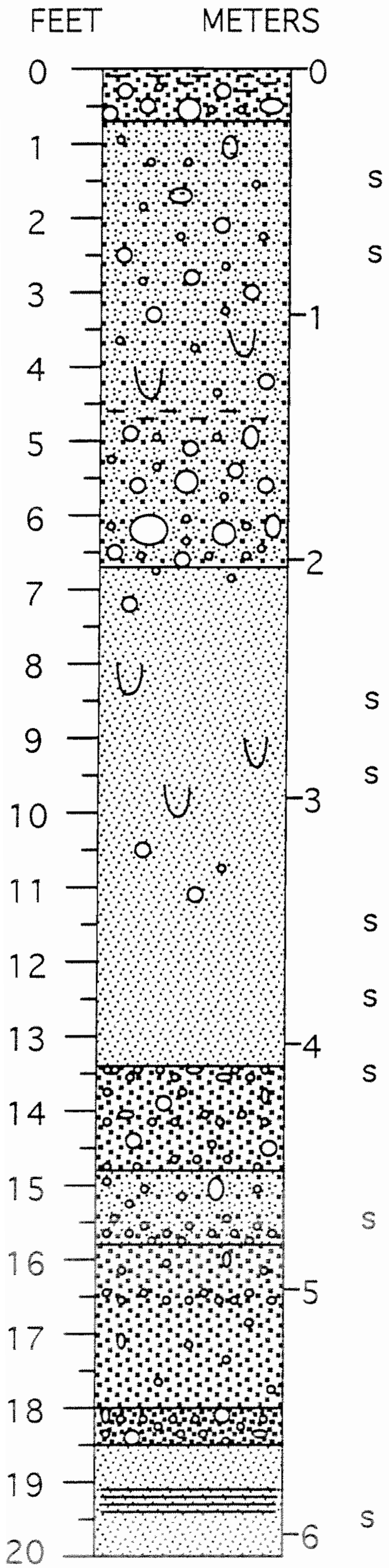
SAND, f-vcrs, yel-gry (5Y 8/1), granular base, scat pebbles to 2 cm, fining upward

SAND, crs-vcrs, yel-gry, (5Y 8/1), granules and pebbles to 1 cm, fining upward sequences 17.7'-18.4' and 18.7'-19.3'

DGS 92-7
Pk51-01

Water Depth
-44.5 ft

Latitude N38° 35' 15.1"
Longitude W74° 59' 35.7"



c **SAND**, crs-vcrs, pebbly, yel-gry (5Y 7/2), poorly srt, sticky clay layer, lt olv gry (5Y 5/2), roughly defined fining upward sequence

SAND, m-vcrs, abd granules, scat pebbles to 7 cm, somewhat cmt gravelly base, similar to 5.3'-6.9' in Qk21-01, yel-gry (5Y 7/2), poorly to mod srt, scat clay clasts, bioturbated, roughly defined fining upward sequence

SAND, f-m above 13.4', crs-vcrs below 13.4', yel-gry (5Y 8/1), mod to well srt, rare granules and pebbles in upper portion, rarely bioturbated, quartzose, trace opaques, lower portion has sbrndd to sbang grains, well defined granular layering at the base w/ pebbles to 2 cm, fining upward

SAND, m-vcrs, granular, yel-gry (5Y 8/1), poorly srt, rare pebbles, well defined fining upward sequence

SAND, crs-vcrs, granular, yel-gry (5Y 8/1), poorly srt, quartzose, 15.8'-16.5' fining upward

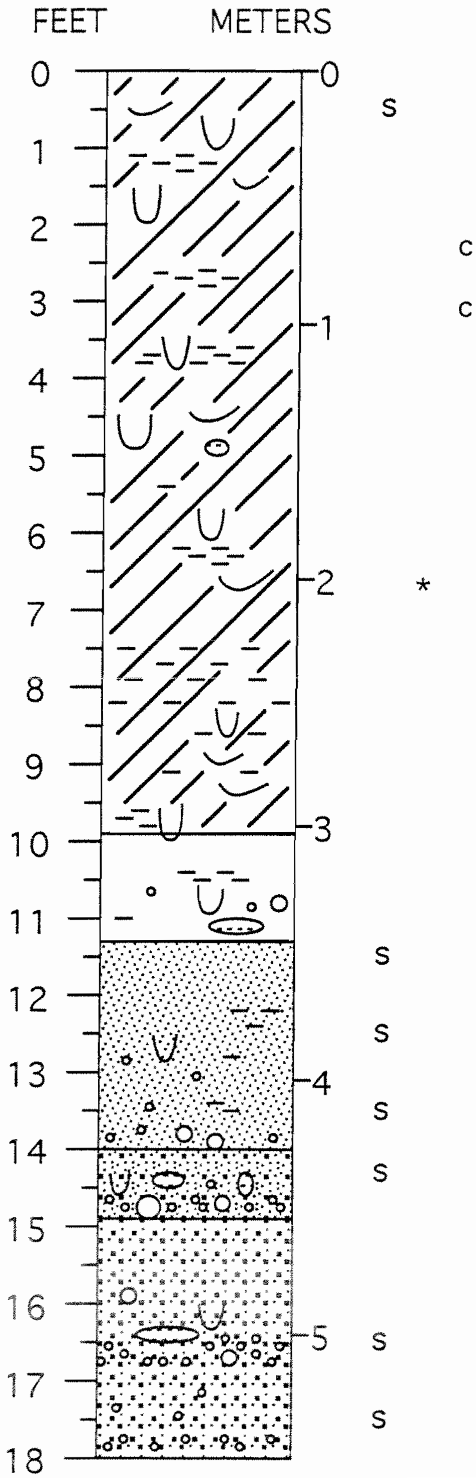
GRAVEL, sandy, granular, yel-gry (5Y 7/2), poorly srt

SAND, f-m, abd crs grains, yel-gry (5Y 8/1), mod srt, sbang, micaceous, thin laminations of heavy minerals

DGS 92-8
Pk12-01

Water Depth
-60.1 ft

Latitude N38° 39' 45.3"
Longitude W74° 58' 24.1"



SAND/SILT, vf, mod brn (5YR 4/4-5YR 3/4), bioturbated, shelly fragments <2 mm, scat micaceous clay lenses

SAND, f, scat m-crs, yel-gry (5Y 7/2), rare granules, pebbles, mod to poorly srt, bioturbated, olv gry clay lenses

SAND, f-m, yel-gry (5Y 8/1), mod to well srt, sbang, rare clay lenses, rare pebbles in lower portion, may be fining upward sequence

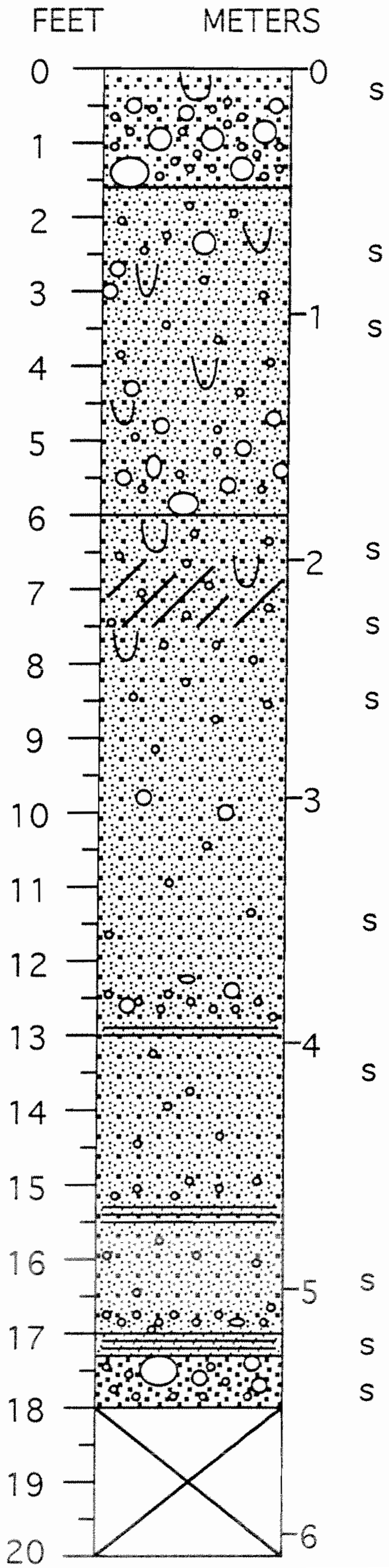
SAND, m-crs, granules and pebbles to 2.5 cm near base, yel-gry (5Y 8/1), sbang, poorly srt, quartzose, fining upward

SAND, f-vcrs, granular layers, yel-gry (5Y 8/1), mod to poorly srt, quartzose, rare olv gry clay lenses, fining upward

DGS 92-9
Qk13-01

Water Depth
-56.8 ft

Latitude N38° 34' 54.0"
Longitude W74° 57' 20.5"



SAND, f-vcrs, abd granules and pebbles to 7 cm, yel-gry (5Y 7/2), poorly srt, sbang, bioturbated, fining upward, one pebble has attached bryozoan coral, scat pebbles stained yel-or

SAND, m-crs, scat granules and pebbles to 3 cm common at base, yel-gry (5Y 8/1), mod to poorly srt, sbang, bioturbated, clay-filled burrows, fining upward

SAND, m-vcrs, scat granules and pebbles, yel-gry (5Y 8/1), sbang, poorly to mod srt, rare granule layers, granule base, rare bioturbation, well defined heavy mineral layers

SAND, m, yel-gry (5Y 8/1), sbrndd to sbang, well srt, well defined heavy mineral layers

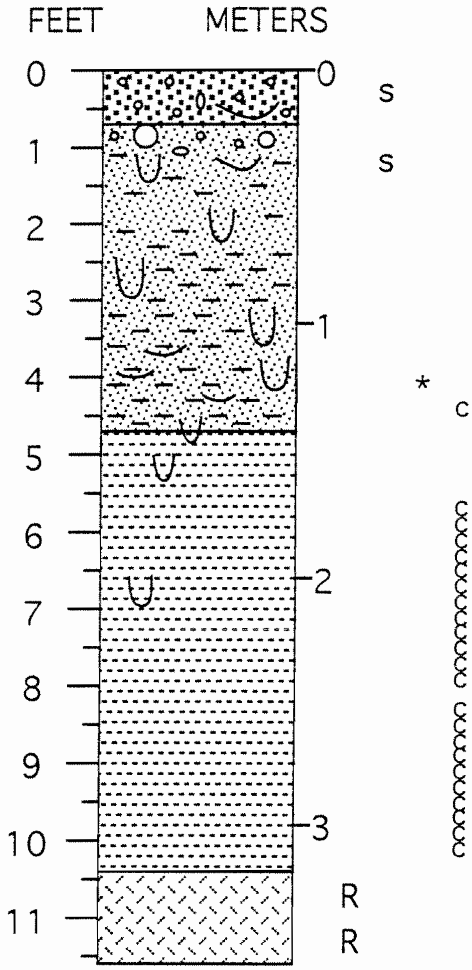
GRANULES/SAND, vcrs, yel-gry (5Y 7/2), pebbles to 7 cm at top of layer, quartz and chert grains, sbang, poorly srt, coarsening upward

NO RECOVERY

DGS 92-10
Qk43-01

Water Depth
-56.0 ft

Latitude N38° 31' 05.9"
Longitude W74° 57' 00.0"



SAND, crs-vcrs, lt brn (5Y 5/6), shell fragments, poorly srt, sbang, Fe stained

SAND/CLAY, f-m, yel-gry (5Y 7/2), grading from mixed clay and sand base to sandy top w/ abd granules and some pebbles, quartzose, heavy minerals, bioturbation and shell fragments, *Ensis*, more common down unit, clay similar to that of the underlying unit

CLAY, dk gn-gry (5G 4/1), rarely bioturbated, sticky, massive, structureless, sharp contact w/ the underlying peat

PEAT, dk brn-blk (5YR 2/1), visible wood and plant material, partly crumbly

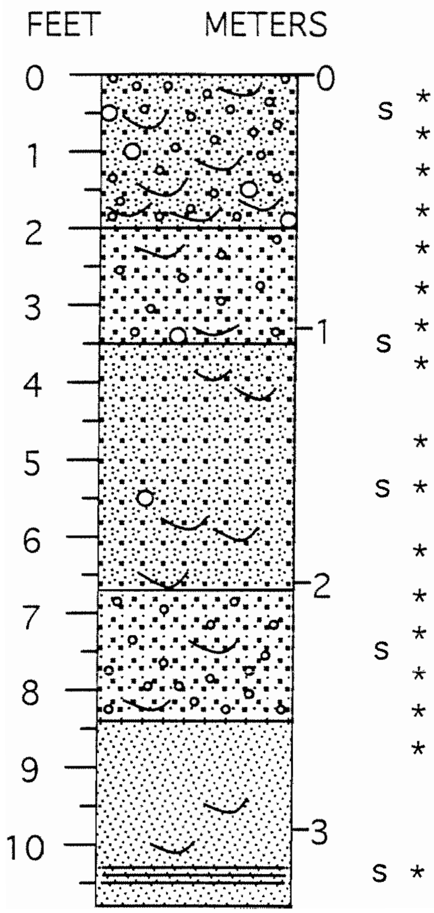
Radiocarbon date, peat, 10.5'-10.8', >46,000 years BP

Radiocarbon date, peat, 10.8'-11.6', >42,000 years BP

DGS 92-11
Rk33-01

Water Depth
-57.6 ft

Latitude N38° 27' 53.9"
Longitude W74° 57' 11.8"



SAND, m-vcrs, abd granules, rare pebbles, lt brn (5YR 6/4) to yel-gry (5Y 7/2), sbang to sbrndd, poorly srt, quartz and chert, abd whole shells and fragments, *Spisula*, *Mercenaria*

SAND, f-crs, rare granules, yel-gry (5Y 7/2), sbang to sbrndd, mod to poorly srt, rare shell fragments, *Spisula*, *Anomia*, *Crepidula*, heavy minerals

SAND, m-crs, mod yel-brn (10YR 5/4), sbang, mod srt, abd heavy minerals, rare shell fragments, *Spisula*, rare pebbles, dk oxidized patches

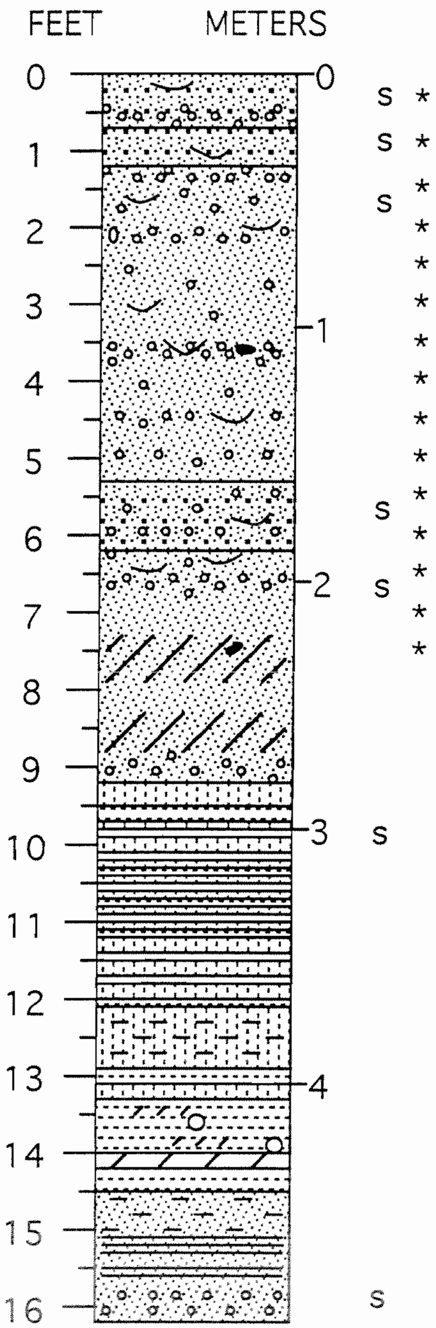
SAND, f-crs, granules, yel-gry (5Y 7/2), heavy minerals, shell fragments, *Spisula*, *Anomia*, poorly srt

SAND, f-m, scat crs, lt yel-brn (10YR 5/4), well srt, rare shell fragments, *Spisula*, *Ensis*, *Crepidula*, *Mercenaria*, thin laminations of heavy minerals

DGS 92-12
RI31-01

Water Depth
-53.9 ft

Latitude N38° 27' 35.9"
Longitude W74° 54' 29.5"



SAND, m-crs, abd granules, dk yel-or (10YR 6/6) to lt brn (5YR 5/6), poorly to mod srt, sbang, rare shell fragments, *Spisula*, fining upward

SAND, m-crs, m gry (N5) to yel-gry (5Y 7/2), well srt, *Spisula*

SAND, f-m, scat crs, abd granules, usually in layers, quartzose, chert, yel-gry (5Y 7/2), well to mod srt, sbang to sbrndd, shell fragments, *Spisula*, *Ensis*, *Anomia*, generally in granule layers, abd heavy minerals, anthropogenic coal within 4.5'-4.6' granule layer, 2.2'-3.8' fining upward

SAND, m-crs, granule layer, lt brn (5YR 5/6), poorly srt, sbang, whole shells and fragments, *Spisula*

SAND, vf-m, abd granules, mostly in layers, yel-gry (5Y 7/2), silty layers, anthropogenic coal 7.5'-7.6', 6.2'-6.7' and 9.2'-8.0' are fining upward sequences, *Spisula*

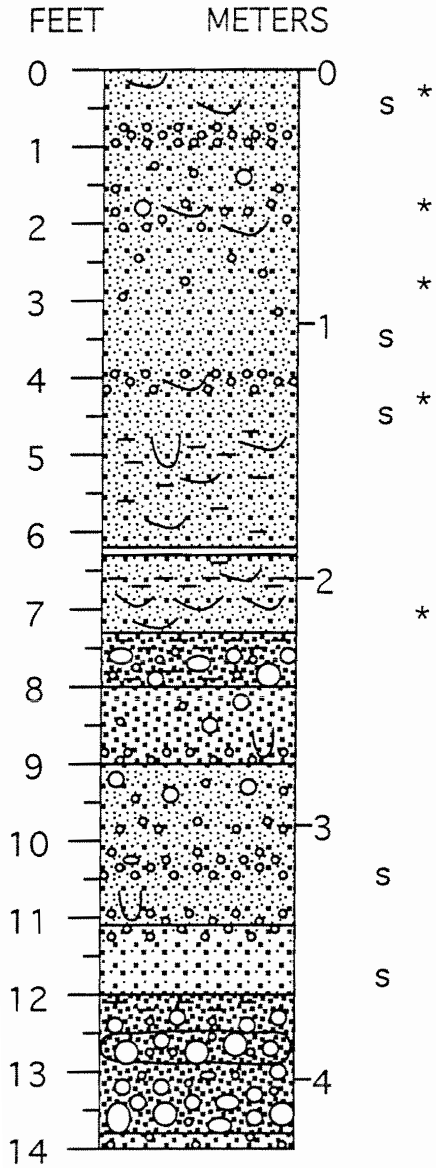
SILT/CLAY interlayering, lt gry (N6-N7) silt, micaceous, olv gry (5Y 3/2) clay layers v thin to 5 cm thk, sandy base w/ a few pebbles to 2 cm, gradational lower boundary, clay to sand

SAND, m-crs, lt-m gry, sbang, poorly to mod srt, granules in layers and scat, clay laminations

DGS 92-13
PI51-01

Water Depth
-64.2 ft

Latitude N38° 35' 06.2"
Longitude W74° 54' 38.3"



SAND, m-crs, abd granules in upper 2.5', usually in crs layering, rare pebbles, lt brn (5YR 6/4), mod to poorly srt, quartzose, chert, heavy minerals, rare mica, and scat shell fragments, *Spisula*, *Astarte*, *Polynices*, generally in granule layers, base is shelly, 3.2'-4.0' is orange, could be due to water saturation, clay layer 6.2'-6.3', 0-1.0' and 1.0'-2.0' are fining upward sequences

GRAVEL, 7.3'-7.6' is clayey, olv gry (5Y 3/2), pebbles 2.5-3 cm, poorly srt, crs sand and granule matrix, lt brn (5YR 6/4) to yel-gry (5Y 7/2)

SAND, crs, abd granules, especially at base, lt brn (5YR 5/6) to dk yel-or (10YR 6/6), poorly to mod srt, fining upward

SAND, m-vcrs, top pebbly, yel-gry (5Y 8/1), 9.8'-10.2' is crs-vcrs, gry-or (10YR 7/4)

SAND, f-crs, yel-gry (5Y 8/1), mod to well srt, coarsening upward

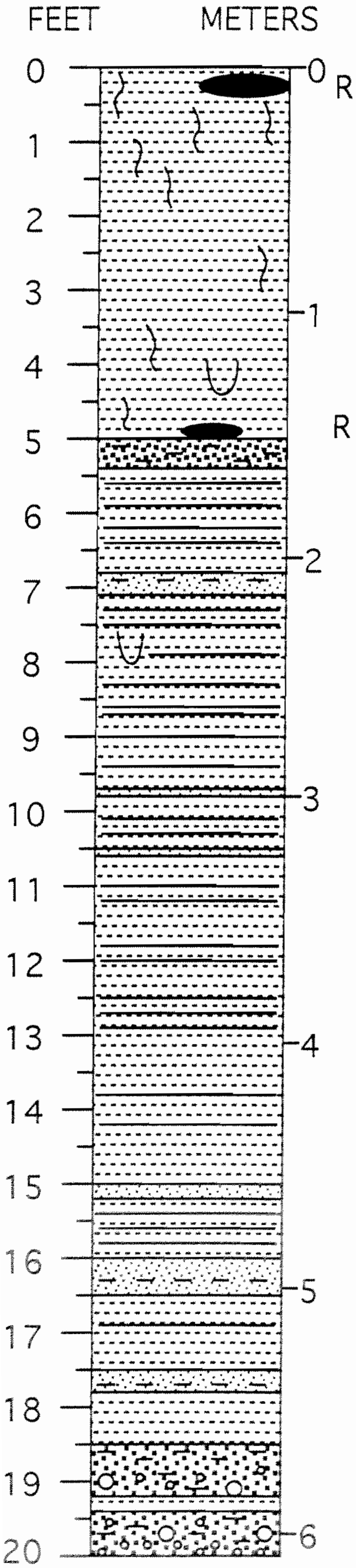
GRAVEL, yel-gry (5Y 7/2), 12.0'-12.3' orange and v clayey, 12.5'-12.8' well cmt and lt gry, pebbles to 3 cm in well srt m sand matrix, unit poorly srt w/ vcrs sand and granule matrix, pebbles to 5 cm at base, fining upward sequence

SAND, vcrs, granules, yel-gry (5Y 7/2)

DGS 92-14
PI41-01

Water Depth
-72.5 ft

Latitude N38° 36' 55.2"
Longitude W74° 54' 23.8"



CLAY, dusky yel-brn (10YR 2/2), sticky, wet, org material at top and bottom of unit, rootlets, rare sand-filled burrows, top 3 cm sandy

Radiocarbon date, org material, 0-0.4 ft, 7970 +/- 80 years BP

Radiocarbon date, org material, 4.8-5 ft, 9170 +/- 80 years BP

GRAVEL, olv gry (5Y 3/2), poorly srt, crs sand and granule matrix, clayey, sharp erosional contact w/ the underlying clay unit

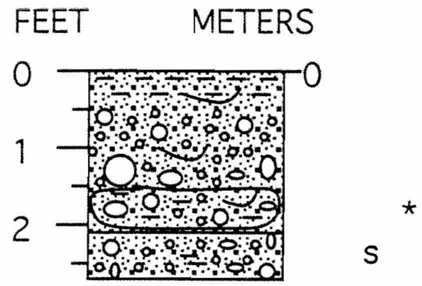
CLAY, olv gry (5Y 3/2), sticky w/ thin f-m, mod srt, sand laminations up to 10 cm thk, but most <1 cm, rare burrows filled w/ sand, bottom of unit more crs sand, transitional lower boundary, sequence from 5.4'-20.0' fining upward w/ clays and pulses of sand, may be a shifting tidal channel

SAND, crs-vcrs, granules, pebbles, lt gry, generally clayey, well defined clay layers within the unit

DGS 92-15
PI55-01

Water Depth
-82.9 ft

Latitude N38° 35' 00.3"
Longitude W74° 50' 41.7"



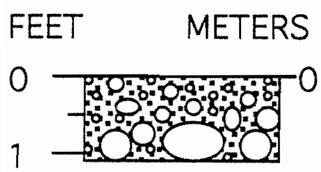
SAND, m-crs, abd granules and pebbles to 4.5 cm, mod brn (5YR 3/4 to 5YR 4/4), poorly srt, shell fragments, *Spisula/Mercenaria*?, top clayey, micaceous, 0-1.6' fining upward, 1.6'-2.1' similar composition as above sands, but grains weakly cmt w/ clay and Fe

SAND, m-vcrs, abd granules and pebbles, yel-gry (5Y 8/1), v poorly srt, sbang grains

DGS 92-15A
PI55-02

Water Depth
-82.9 ft

Latitude N38° 35' 00.3"
Longitude W74° 50' 41.7"

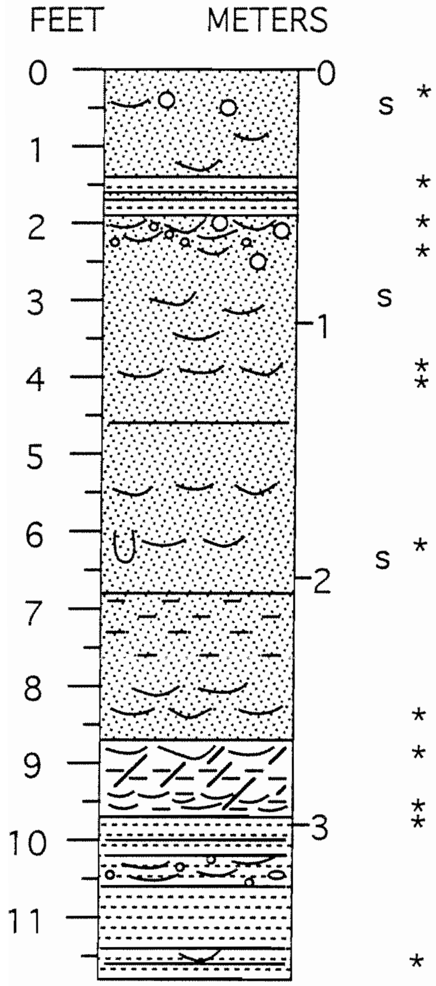


SAND/GRANULES/GRAVEL, vcrs, yel-gry (5Y 8/1), poorly srt, sbrndd to sbang grains, quartz, chert, and schist pebbles, quartz, feldspar, chert, and mica sand, fining upward, may be the result of settling, max cobble 10-12 cm, core is a jet retry w/ top 6.0' below the sea floor

DGS 92-16
RI25-01

Water Depth
-75.5 ft

Latitude N38° 28' 47.6"
Longitude W74° 50' 41.9"



SAND, f-m, brn (5YR 6/4), micaceous, well srt, rare shell fragments, *Spisula*, rare pebbles, top 2 cm and 0.9'-1.5' lt gry

CLAY, olv gry (5Y 3/2), thin m-crs sand layer

SAND, f-m, scat crs, lt gry (N7) to yel-gry (5Y 7/2), heavy minerals, well defined horizons of gastropods, *Nassarius*, 4.0', 5.5', and 6.3' and mollusk shells, *Spisula*, *Mercenaria*, *Astarte*, *Venericardia*, single clay lamination

SAND, f-m, lt brn (5YR 6/4), well srt, clayey top, micaceous, heavy minerals, concentration of mollusk shells at base, *Mercenaria*, *Astarte*

SILT/SAND, vf, lt gry (N7), clay lenses, distinct layers w/ mollusk shells, *Spisula*, *Astarte*, *Ensis*, *Crassostrea*, range from 0.5-8.0 cm, unit has sharp lower boundary

CLAY, olv gry (5Y 3/2), crs sand laminations w/ shell concentrations, *Astarte*, *Mercenaria*, *Venericardia*, *Spisula*

Appendix C

Seismic Data Summary

Summary Table of Offshore Delaware Seismic Data

Agency	Ship	Year Collected	Data Type	Trackline	Length
University of Delaware	RV Annandale	1974	250-1000 Hz Uniboom source and 7.5 kHz Raytheon transducer	**bel74**	270 km
University of Delaware, Marine Studies/Geology	RV Cape Henlopen	1990	3.5 kHz Datasonics SPB-5000 from VIMS	**hen90a**	250 km
University of Delaware, Marine Studies/Geology	RV Cape Henlopen	1990	3.5 kHz Datasonics SPB-5000 from VIMS	**hen90b**	250 km
University of Delaware, Marine Studies/Geology	RV Cape Henlopen	1992	Geopulse Uniboom, 350 J, band width 300-4000 Hz	**hen92**	500 km
Delaware Geological Survey	RV Discovery Maryland Geological Survey	1992	3.5 kHz Datasonics, hydrophone array on a sled	**seisdgs92-93**	172 km
Delaware Geological Survey	RV Discovery Maryland Geological Survey	1993	3.5 kHz Datasonics, towfish from VIMS	**seisdgs92-93**	150 km

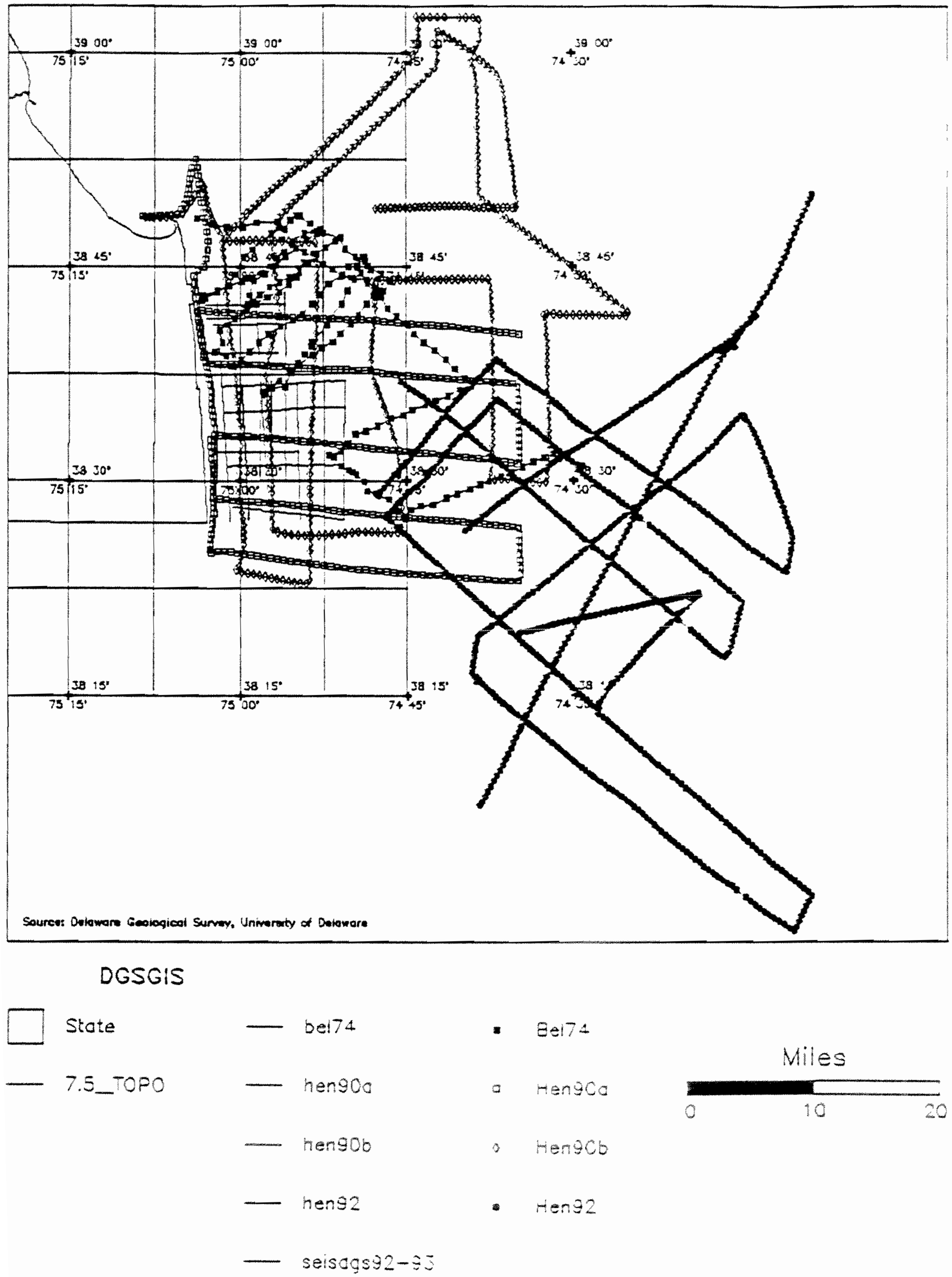
Length (km) of DGS Offshore Delaware Seismic Profiles

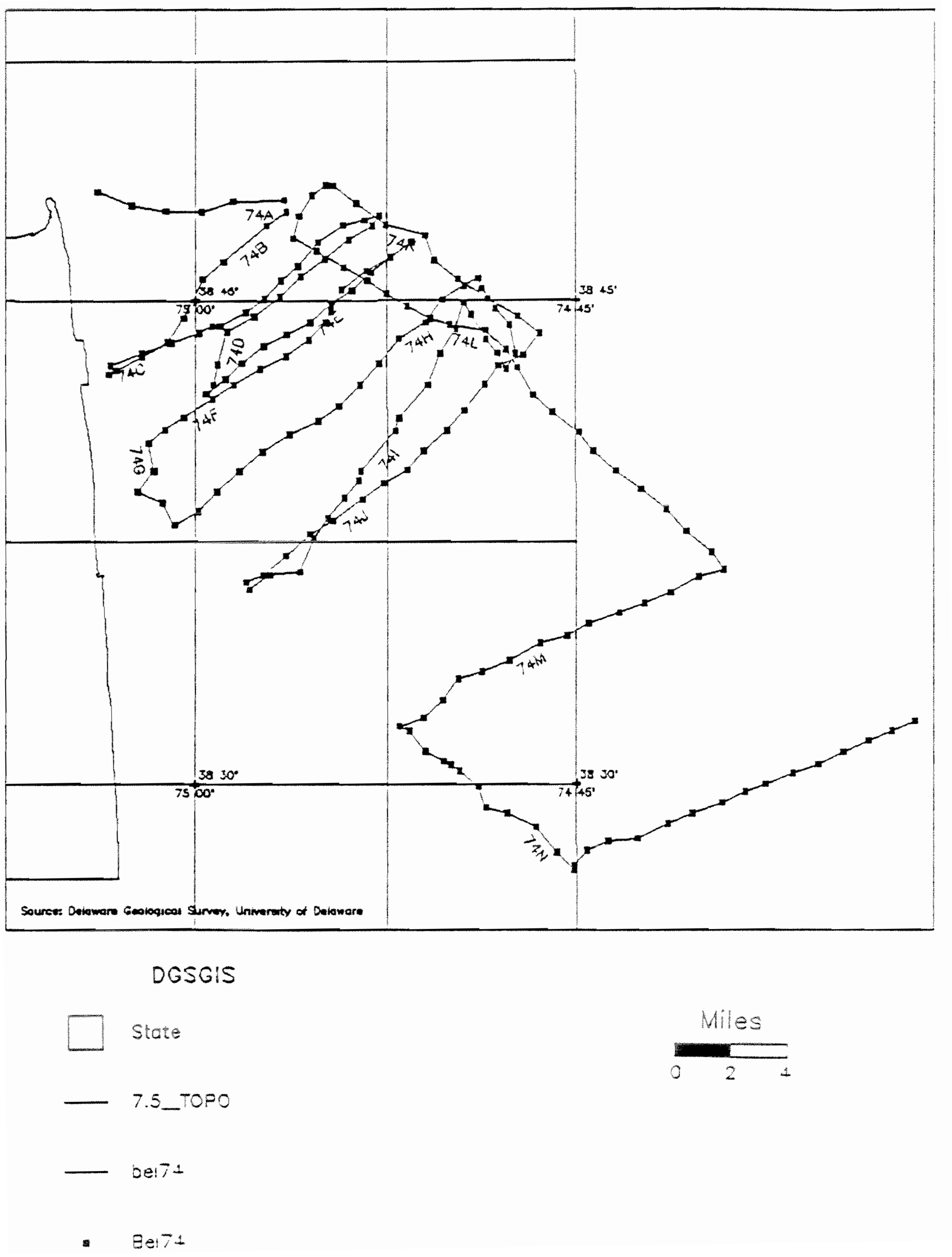
1992

Line	Length (km)
A	14.3
A'-B'	7.0
B	15.1
B'-D'	11.2
C	15.6
D	16.0
E	17.4
F	29.1
G	17.8
H	28.6
Total 1992	172.1

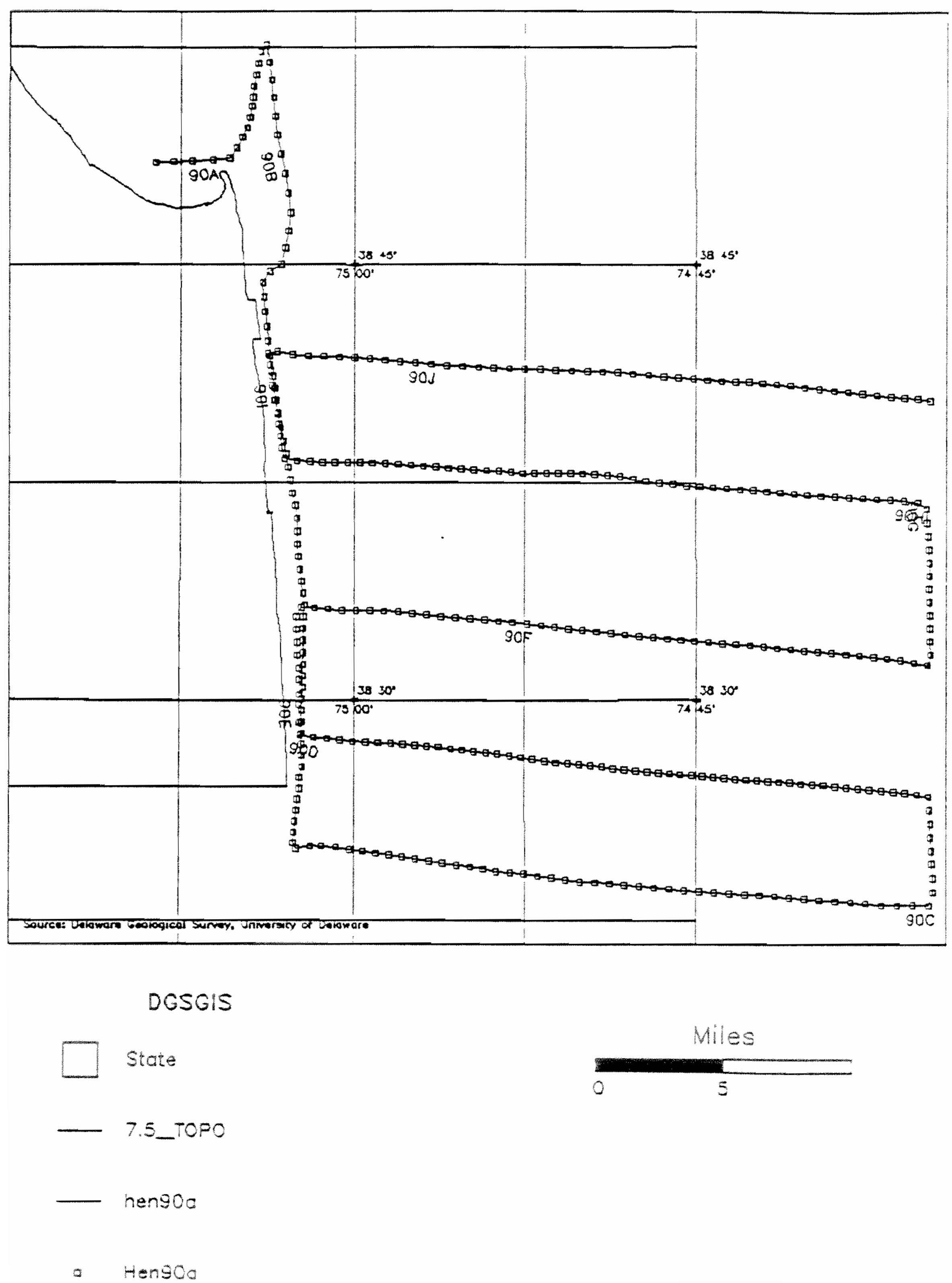
1993

Line	Length (km)
I	10.4
J	10.2
K	9.0
L	9.5
M	9.4
N	11.0
O	10.1
P	17.3
Q	13.2
R	12.9
S	13.0
T-U	24.3
Total 1993	150.3
Total 92-93	322.4

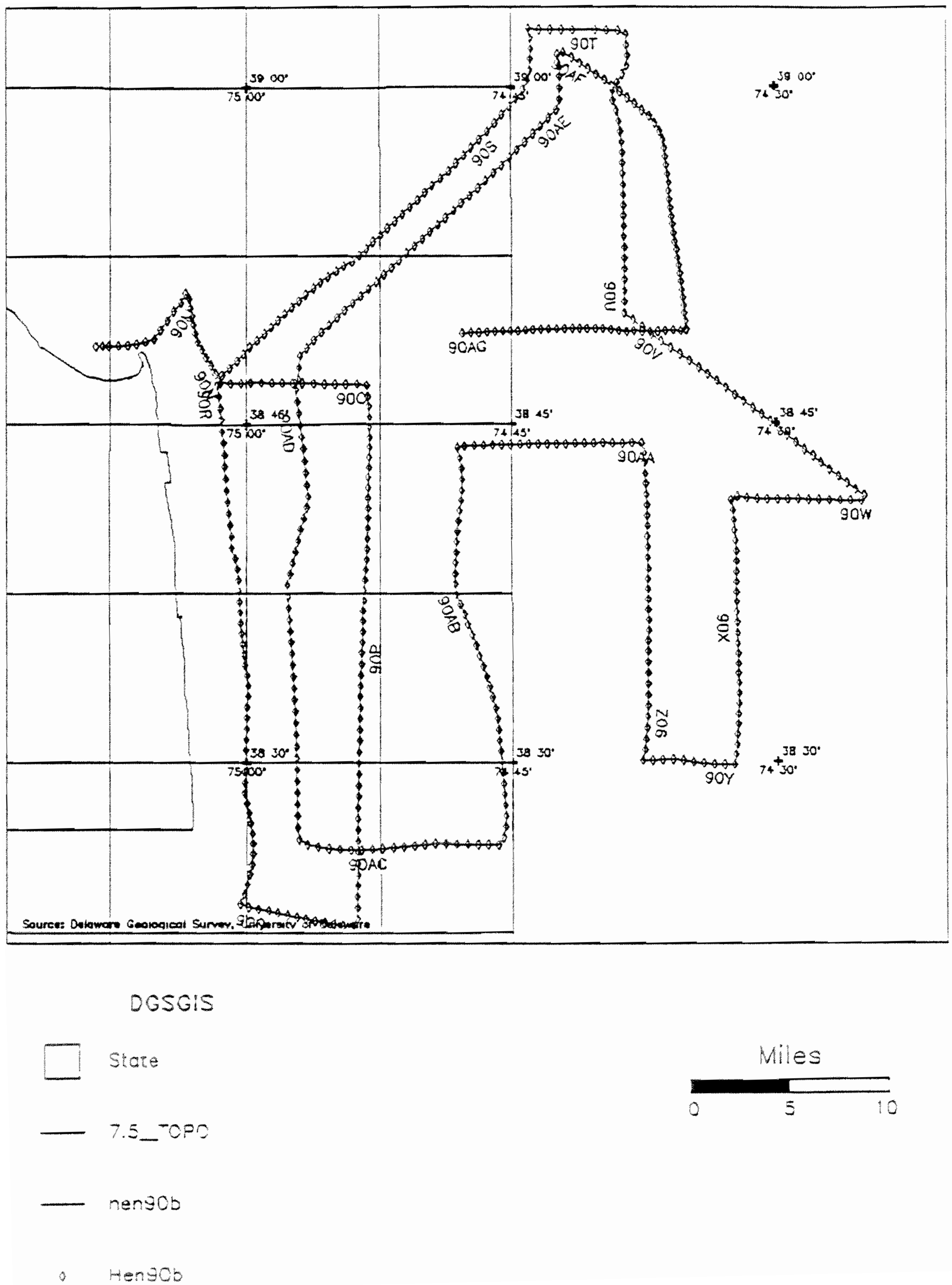

39 00'
75 15'
75 00'
74 45'
74 30'
38 45'
38 30'
38 15'
Source: Delaware Geological Survey, University of Delaware
DGSGIS
State
7.5_TOPO
bel74
hen90a
hen90b
hen92
seisdgs92-93
Bel74
Hen90a
Hen90b
Hen92
Miles
0
10
20



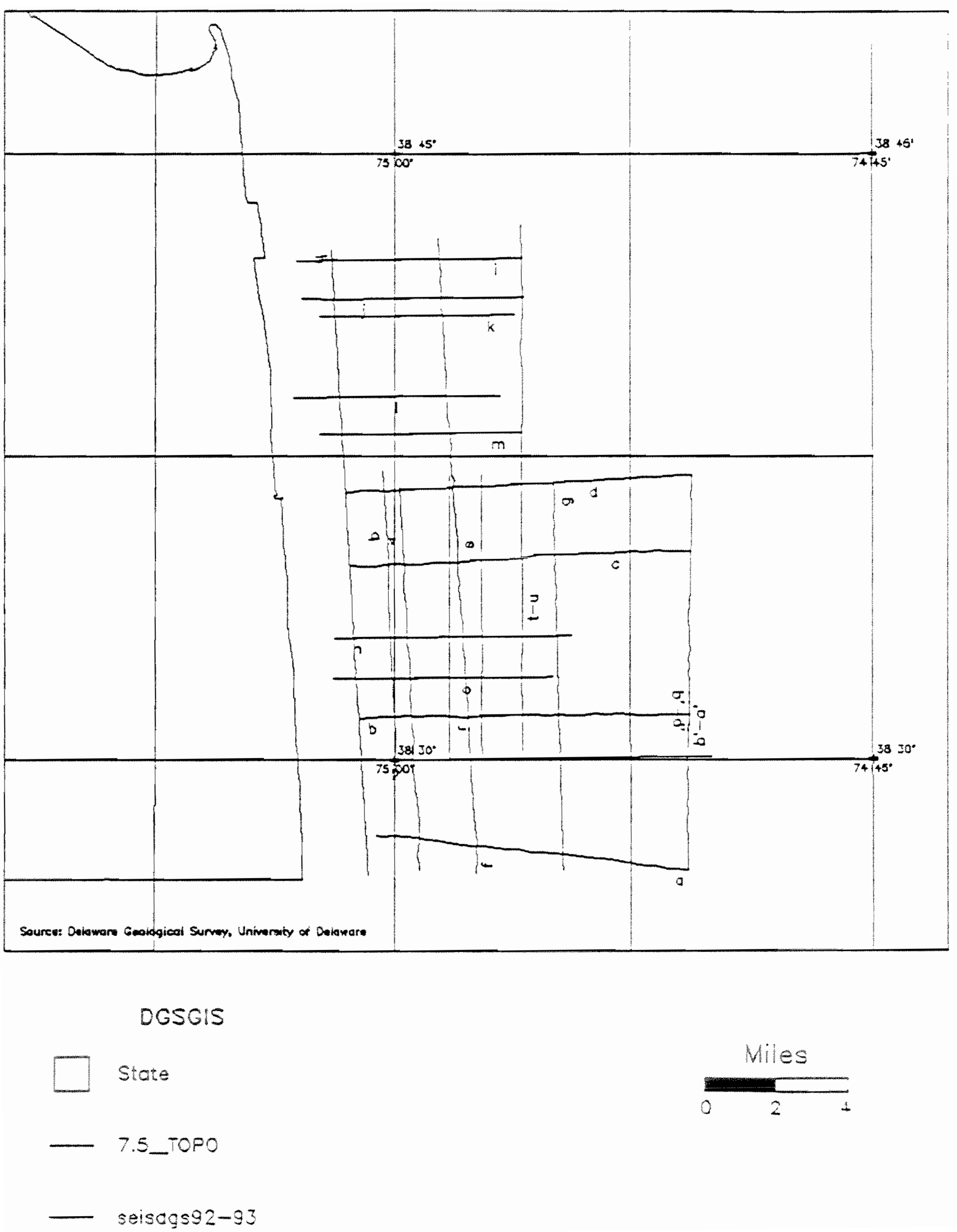
74A
74B
74C
74D
74E
74F
74G
74H
74I
74J
74K
74L
74M
74N
38 46'
75 00'
38 45'
74 45'
38 30'
75 00'
38 30'
74 45'
Source: Delaware Geological Survey, University of Delaware
DGSGIS
State
7.5_TOPO
bei74
Bei74
Miles
0
2
4



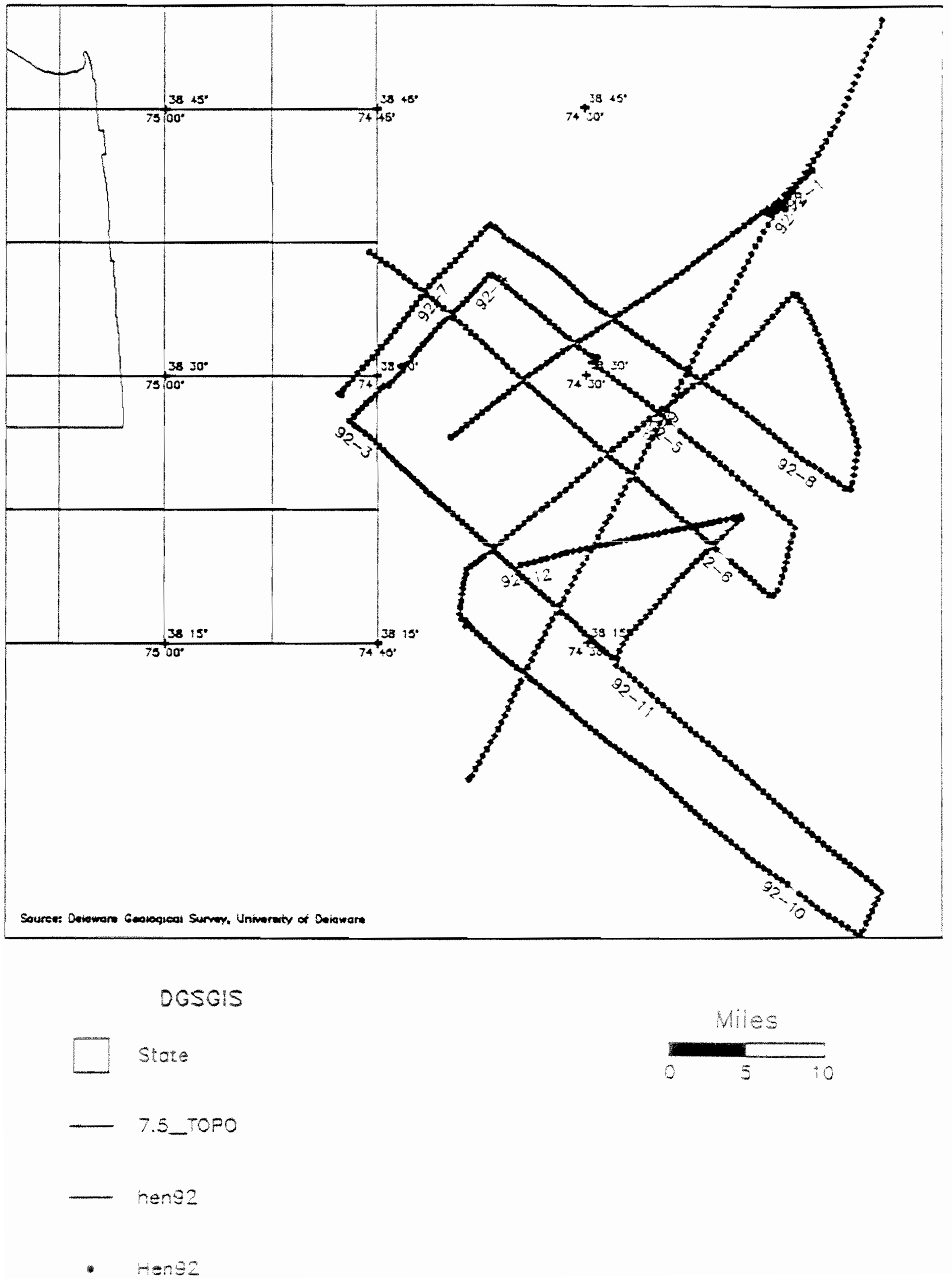
90A
90B
38 45'
75 00'
74 45'
90J
90I
90F
38 30'
90D
90C
Source: Delaware Geological Survey, University of Delaware
DGSGIS
State
7.5_TOPO
hen90a
Hen90a
Miles
0
5



90T
90S
90AE
90U
90AG
90V
90W
90AA
90O
90R
90AD
90AB
90P
90X
90Z
90Y
90AC
39 00'
75 00'
74 45'
74 30'
38 45'
38 30'
Source: Delaware Geological Survey, University of Delaware
DGSGIS
State
7.5_TOPO
nen90b
Hen90b
Miles
0
5
10



38 45'
75 00'
38 46'
74 45'
38 30'
75 00'
38 30'
74 45'
Source: Delaware Geological Survey, University of Delaware
DGSGIS
State
7.5_TOPO
seisdgs92-93
Miles
0
2
4


38 45'
75 00'
38 45'
74 45'
38 45'
74 30'
38 30'
75 00'
38 15'
75 00'
38 15'
74 45'
92-1
92-7
92-3
92-5
92-8
92-12
92-6
92-11
92-10
Source: Delaware Geological Survey, University of Delaware
DGSGIS
State
7.5_TOPO
hen92
Hen92
Miles
0
5
10

Appendix D

Texture Data Summary

DGSID	DGS SAMPLE #	RSA SAMPLE #	SAMPLE INTERVAL (FEET)	INITIAL WEIGHT (GRAMS)	WEIGHT -1 PHI (GRAMS)	WEIGHT -2 PHI (GRAMS)	WEIGHT +4 PHI (GRAMS)	WEIGHT SILT + CLAY (GRAMS)	WEIGHT SAMPLE FOR RSA (GRAMS)	%PEBBLES (AS A % OF RSA WEIGHT)	%GRAVEL	%SAND	%MUD
Oj23-02	60799	S1	0-1	111.51	0	0	110.56	0.95	5.01	0.00	0.00	99.15	0.85
Oj23-02	60796	S2	1-2	120.31	0	0	119.52	0.79	4.99	0.00	0.00	99.34	0.66
Oj23-02	60796	S3	3-4	130.44	0	0	129.89	0.55	5.05	0.00	0.00	99.58	0.42
Oj23-02	60796	S4	5-6	92.48	0	0	91.71	0.77	4.98	0.00	0.00	99.17	0.83
Oj23-02	60797	S5	6-7	122.72	0	0	121.64	1.08	5.03	0.00	0.00	99.12	0.88
Oj23-02	60797	S6	7-8	134.76	0	0.28	131.3	3.18	5	0.00	0.21	97.43	2.36
Oj23-02	60797	S7	8-9	114.18	0	0	110.69	3.49	5.01	0.00	0.00	96.94	3.06
Oj23-02	60797	S8	9-10	107.73	0	0.12	104.25	3.36	5.03	0.00	0.11	96.77	3.12
Oj23-02	60797	S9	10-11	96.67	0	0	92.85	3.82	5.05	0.00	0.00	96.05	3.95
Oj23-02	60798	S10	11-12	120.87	0	0	114.69	6.18	5.04	0.00	0.00	94.89	5.11
Oj23-02	60798	S11	12-13	144.21	0	0	108.09	36.12	5.01	0.00	0.00	74.95	25.05
Oj23-02	60798	S12	13-14	108.26	0.26	0.56	96.21	11.49	5.06	5.14	0.52	88.87	10.61
Oj23-02	60798	S13	15-15.7	131.31	0	0.66	53.36	77.29	5.04	0.00	0.50	40.64	58.86
Pj45-01	60803	S14	0-1	113.12	0.45	54.66	58.21	0.25	4.99	9.02	48.32	51.46	0.22
Pj45-01	60803	S15	2-3	109.2	0	2.88	104.92	1.4	4.99	0.00	2.64	96.08	1.28
Pj45-01	60800	S16	3-4	101.25	0.72	28.59	69.92	2.74	5.01	14.37	28.24	69.06	2.71
Pj45-01	60800	S17	4-5	119.02	0.45	30.37	86.64	2.01	4.99	9.02	25.52	72.79	1.69
Pj45-01	60800	S18	6-7	128.08	0.903	26.46	93.01	8.61	5.02	17.99	20.66	72.62	6.72
Pj45-01	60800	S19	7-8	101.05	0.28	29.57	64.14	7.34	5.02	5.58	29.26	63.47	7.26
Pj45-01	60801	S20	8-9	123.38	0	4.56	112.69	6.13	5.01	0.00	3.70	91.34	4.97
Pj45-01	60801	S21	9-10	161.51	0.25	6.2	147.71	7.6	4.98	5.02	3.84	91.46	4.71
Pj45-01	60801	S22	11-12	93.41	0.243	3.05	86.34	4.02	5	4.86	3.27	92.43	4.30
Pj45-01	60801	S23	12-13	110.34	0.677	2.33	103.58	4.43	5.02	13.49	2.11	93.87	4.01
Pj45-01	60802	S24	13-14	125.85	0.262	15.55	103.98	6.32	5.03	5.21	12.36	82.62	5.02
Pj45-01	60802	S25	14-15	96.08	0.549	14.87	77.24	3.97	4.97	11.05	15.48	80.39	4.13
Pj45-01	60802	S26	16-17	143.29	0	0	132.25	11.04	5.02	0.00	0.00	92.30	7.70
Pj45-01	60802	S27	17-18	133.12	0.214	5.55	115.38	12.19	5	4.28	4.17	86.67	9.16
Pk12-01	60823	S28	0-0.5	103.47	0	0.2	78.87	24.4	5.06	0.00	0.19	76.22	23.58
Pk12-01	60825	S29	11-12	149.45	0	0.13	139.58	9.74	4.99	0.00	0.09	93.40	6.52
Pk12-01	60825	S30	12-13	118.75	0.08	0.8	106.91	11.04	5.03	1.59	0.67	90.03	9.30
Pk12-01	60825	S31	13-14	116.88	0	0.69	110.46	5.73	5.07	0.00	0.59	94.51	4.90
Pk12-01	60826	S32	14-14.5	126.62	0.08	0.21	122.95	3.46	5	1.60	0.17	97.10	2.73
Pk12-01	60826	S33	16-17	140.94	0	0	138.89	2.05	5	0.00	0.00	98.55	1.45
Pk12-01	60826	S34	17-18	141.3	0.14	5.19	132.78	3.33	5	2.80	3.67	93.97	2.36
Pk51-01	60819	S69	1-2	84.45	4.63		70.87	8.95			5.48	83.92	10.60
Pk51-01	60819	S70	2-3	114.32	11.28		92.55	10.49			9.86	80.96	9.18
Pk51-01	60820	S71	8-9	142.01	2.75		125.72	13.54			1.94	88.53	9.53
Pk51-01	60820	S72	9-10	145.44	1.04		130.59	13.81			0.71	89.79	9.50
Pk51-01	60821	S73	11-12	116.79	3.57		103.32	9.9			3.05	88.47	8.48
Pk51-01	60821	S74	12-13	87.84	0.78		78.31	8.75			0.89	89.15	9.96
Pk51-01	60821	S75	13-14	65.7	8.27		52.6	4.83			12.59	80.06	7.35
Pk51-01	60822	S76	15-16	111.38	16.29		91.78	3.31			14.63	82.40	2.97
Pk51-01	60822	S77	19-20	88.64	0.32		82.46	5.86			0.36	93.03	6.61
Pl51-01	60841	S78	0-1	81.49	2.41		78.82	0.26			2.96	96.72	0.32
Pl51-01	60841	S79	3-4	68.65	0.13		67.95	0.57			0.19	98.98	0.83
Pl51-01	60842	S80	4-5	79.27	0.21		77.82	1.24			0.27	98.17	1.56
Pl51-01	60843	S81	10-11	93.77	5.01		84.76	4			5.34	90.39	4.27

DGSID	DGS SAMPLE #	RSA SAMPLE #	SAMPLE INTERVAL (FEET)	INITIAL WEIGHT (GRAMS)	WEIGHT −1 PHI (GRAMS)	WEIGHT −2 PHI (GRAMS)	WEIGHT +4 PHI (GRAMS)	WEIGHT SILT + CLAY (GRAMS)	WEIGHT SAMPLE FOR RSA (GRAMS)	%PEBBLES (AS A % OF RSA WEIGHT)	%GRAVEL	%SAND	%MUD
Pl51−01	60843	S82	11.5−12	69.9	0.33		65.03	4.54			0.48	93.03	6.49
Pl55−01	60848	S35	2−2.5	130.08	0.535	13.69	110.2	6.19	5.04	10.62	10.52	84.72	4.76
Qj24−03	60804	S36	0−1	113.26	0.37	7.22	105.79	0.25	5.01	7.39	6.37	93.40	0.22
Qj24−03	60804	S37	1−2	120.62	0.564	5.88	113.83	0.91	4.96	11.37	4.87	94.37	0.75
Qj24−03	60804	S38	2−3	109.44	0.13	5.54	103.12	0.78	5.03	2.58	5.06	94.23	0.71
Qj24−03	60804	S39	3−4	102.27	0	1.08	99.34	1.85	4.96	0.00	1.06	97.14	1.81
Qj24−03	60804	S40	4−5	107.42	0	0.44	106	0.98	5	0.00	0.41	98.68	0.91
Qj24−03	60805	S41	5−6	152.87	0	0.04	151.21	1.62	5.04	0.00	0.03	98.91	1.06
Qj24−03	60805	S42	6−7	123.81	0	1.05	121.31	1.45	5	0.00	0.85	97.98	1.17
Qj24−03	60805	S43	7−8	93.79	0	0.31	91.57	1.91	5	0.00	0.33	97.63	2.04
Qj24−03	60807	S44	16−16.5	128.42	0	0	114.84	13.58	5.04	0.00	0.00	89.43	10.57
Qk13−01	60827	S83	0−0.5	101.29	31.72		64.44	5.13			31.32	63.62	5.06
Qk13−01	60827	S84	2−3	60.54	1.7		54.87	3.97			2.81	90.63	6.56
Qk13−01	60828	S85	3−4	51.81	0.62		46.11	5.08			1.19	89.00	9.81
Qk13−01	60828	S86	6−7	80.8	2.85		69.43	8.52			3.53	85.93	10.54
Qk13−01	60828	S87	7−8	59.86	1.37		52.56	5.93			2.29	87.80	9.91
Qk13−01	60829	S88	8−9	63.18	0.96		55.56	6.62			1.58	87.94	10.48
Qk13−01	60829	S89	11−12	97.69	3.32		86.33	8.04			3.4	88.37	8.23
Qk13−01	60830	S90	13−14	76.07	3.67		66.44	5.96			4.83	87.34	7.83
Qk13−01	60830	S91	16−16.5	97.37	0.43		87.19	9.75			0.44	89.55	10.01
Qk13−01	60830	S92	17−17.3	52.17	9.2		38.47	4.5			17.63	73.74	8.63
Qk13−01	60830	S93	17.5−18	41.4	5.3		33.79	2.31			12.8	81.62	5.58
Qk21−01	60815	S45	0−1	123.47	0.66	7.38	112.11	3.98	5.04	13.10	5.98	90.80	3.22
Qk21−01	60815	S46	3−4	91.77	0	3.73	84.07	3.97	5.04	0.00	4.06	91.61	4.33
Qk21−01	60816	S47	5−5.3	131.63	0.25	4.62	112.34	14.67	5.01	4.99	3.51	85.35	11.14
Qk21−01	60816	S48	8−9	145.81	0.115	0.17	135.99	9.65	5.07	2.27	0.12	93.27	6.62
Qk21−01	60817	S49	10−10.5	124.75	0.055	1.33	114.73	8.69	5	1.10	1.07	91.97	6.97
Qk21−01	60817	S50	14−15	137.38	0	0.6	130.05	6.73	5.07	0.00	0.44	94.66	4.90
Qk21−01	60817	S51	17−17.5	143.83	0	1.65	133.32	8.86	5.03	0.00	1.15	92.69	6.16
Qk43−01	60831	S52	0−0.5	128.55	0.2	5.22	121.98	1.35	5.11	3.91	4.06	94.89	1.05
Qk43−01	60832	S53	1−1.5	136.12	0.13	0.06	123.36	12.7	5.08	2.56	0.04	90.63	9.33
Rk11−01	60811	S54	0−0.5	94.55	0.17	20.73	70.7	3.12	5	3.40	21.92	74.78	3.30
Rk11−01	60814	S55	19−19.5	115.57	0	0	76.3	39.27	5.03	0.00	0.00	66.02	33.98
Rk21−01	60808	S56	0−1	96.18	0.38	8.69	85.55	1.94	5.03	7.55	9.04	88.95	2.02
Rk21−01	60808	S57	2−3	120.63	0.341	4.6	112.12	3.91	5.03	6.78	3.81	92.95	3.24
Rk21−01	60808	S58	3.5−4	96.73	0	2.27	91.87	2.59	5.04	0.00	2.35	94.98	2.68
Rk21−01	60809	S59	7−8	92.43	0	0	83.54	8.89	5.04	0.00	0.00	90.38	9.62
Rk21−01	60810	S60	13−14	145.55	0	0	139.39	6.16	5.01	0.00	0.00	95.77	4.23
Rk33−01	60837	S61	0−1	128.57	0	1.66	126.06	0.85	5.05	0.00	1.29	98.05	0.66
Rk33−01	60838	S62	3−4	135.15	0.11	0.62	133.19	1.34	5.06	2.17	0.46	98.55	0.99
Rk33−01	60838	S63	5−5.7	121.04	0	0.9	117.62	2.52	5.04	0.00	0.74	97.17	2.08
Rk33−01	60839	S64	7−8	130.94	0	0.41	128.67	1.86	5.04	0.00	0.31	98.27	1.42
Rk33−01	60839	S65	10−10.7	122.51	0	0.44	118.63	3.44	5.03	0.00	0.36	96.83	2.81
Rl25−01	60850	S66	0−1	148.08	0.2	3.08	140.67	4.33	5.01	3.99	2.08	95.00	2.92
Rl25−01	68051	S67	2.5−3.5	119.13	0	0.7	117.65	0.78	5.02	0.00	0.59	98.76	0.65
Rl25−01	60851	S68	6−6.8	142.4	0	0.85	138.28	3.27	4.94	0.00	0.60	97.11	2.30
Rl31−01	60837	S94	0−0.5	59.86	1.53		58	0.33			2.56	96.89	0.55

DGSID	DGS SAMPLE #	RSA SAMPLE #	SAMPLE INTERVAL (FEET)	INITIAL WEIGHT (GRAMS)	WEIGHT −1 PHI (GRAMS)	WEIGHT −2 PHI (GRAMS)	WEIGHT +4 PHI (GRAMS)	WEIGHT SILT + CLAY (GRAMS)	WEIGHT SAMPLE FOR RSA (GRAMS)	%PEBBLES (AS A % OF RSA WEIGHT)	%GRAVEL	%SAND	%MUD
RI31−01	60837	S95	0.5−1.2	59	1.46		57.14	0.4			2.47	96.85	0.68
RI31−01	60838	S96	1.2−2.2	73.5	1.68		71.68	0.14			2.29	97.52	0.19
RI31−01	60838	S97	5.2−6.2	75.46	1.15		73.85	0.46			1.52	97.87	0.61
RI31−01	60839	S98	6.2−7.2	68.3	0.55		67.25	0.5			0.81	98.46	0.73
RI31−01	60839	S99	9.4−10.4	71.69	0.08		70.16	1.45			0.11	97.87	2.02
RI31−01	60840	S100	15.7−16.2	80.96	6.24		73.39	1.33			7.71	90.65	1.64

DGSID	INTERVAL (FT)	GRAPHIC MEAN	INCL GRPH STND DEV	INCL GRPH SKEWNESS	GRAPHIC KURTOSIS
Oj23−02	0−1	1.55	0.42	−0.15	1.11
	1−2	1.91	0.27	0.07	1.15
	3−4	1.99	0.29	0.1	1.07
	5−6	2.02	0.26	0.1	1.05
	6−7	2.12	0.3	0.05	1.06
	7−8	2.34	0.37	0.04	1.12
	8−9	2.39	0.35	−0.07	1.22
	9−10	2.55	0.31	−0.07	1.4
	10−11	2.97	0.51	−0.14	1.07
	11−12	2.95	0.47	−0.1	1.21
	12−13	2.81	0.74	−0.35	1.63
	13−14	2.83	1.11	−0.58	0.81
	15−15.7	2.5	0.58	0.09	1.38
	Average	2.38	0.46	−0.08	1.18
Pj45−01	0−1	1.61	0.59	−0.07	1.32
	2−3	1.74	0.48	0.1	1.43
	3−4	1.53	0.62	−0.2	1.02
	4−5	1.52	0.64	−0.15	0.93
	6−7	0.93	0.92	0.12	0.92
	7−8	1.9	0.72	0.3	1.16
	8−9	0.92	0.76	−0.01	1.11
	9−10	1.13	0.75	0.24	1.41
	11−12	1.17	0.58	0.22	1.2
	12−13	0.95			
	13−14	1.57	0.79	0.31	1.36
	14−15	1.05	0.91	0.12	0.91
	16−17	2.24	0.58	0.21	1.1
	17−18	2.27	0.68	0.26	1.01
	Average	1.47	0.69	0.11	1.14
Pk12−01	0−0.5	3.22			
	11−12	2.64			
	12−13	2.52	0.66	0.2	0.99
	13−14	2.08	0.7	0.19	1.28
	14−14.5	2.03	0.56	0.18	1.17
	16−17	2.22	0.64	0.29	1.11
	17−18	1.86	0.88	0.09	1.19
	Average	2.37	0.69	0.19	1.15
Pl55−01	2−2.5	1.62	0.67	0.2	1.62
	Average	1.62	0.67	0.2	1.62
Qj24−03	0−1	1.41	0.82	−0.03	1.1
	1−2	1.42	0.65	0.17	1.14
	2−3	1.74	0.6	0.09	1.2
	3−4	1.98	0.68	0.04	1.17
	4−5	1.93	0.71	−0.04	1.25

DGSID	INTERVAL (FT)	GRAPHIC MEAN	INCL GRPH STND DEV	INCL GRPH SKEWNESS	GRAPHIC KURTOSIS
	5−6	2.09	0.62	0.04	1.26
	6−7	2.23	0.71	0	1.46
	7−8	2.42	0.61	0.09	1
	16−16.5	2.34	0.72	0.18	0.96
	Average	1.95	0.68	0.06	1.17
Qk21−01	0−1	0.98	0.95	−0.09	0.83
	3−4	1.37	0.64	0.1	1.02
	5−5.3	1.26	0.96	0.02	0.8
	8−9	2.19	0.36	0.32	1.51
	10−10.5	2.44	0.53	0.08	1.3
	14−15	1.6	0.73	0.06	1.18
	17−17.5	1.79	0.7	0.11	0.93
	Average	1.66	0.7	0.09	1.08
Qk43−01	0−0.5	1.36	0.52	−0.05	1.14
	1−1.5	2.36	0.65	−0.09	1.59
	Average	1.86	0.59	−0.07	1.37
Rk11−01	0−0.5	1.85	0.52	−0.06	1.37
	19−19.5	2.88			
	Average	2.37	0.52	−0.06	1.37
Rk21−01	0−1	1.5	0.82	0	1.07
	2−3	2.12	0.99	0.15	0.83
	3.5−4	2.12	0.57	0.07	0.99
	7−8	3.44			
	13−14	2.49	0.5	0.19	1.16
	Average	2.33	0.72	0.1	1.01
Rk33−01	0−1	1.45	0.63	−0.16	1.09
	3−4	1.44	0.63	−0.1	0.96
	5−5.7	1.67	0.51	−0.25	1.16
	7−8	1.66	0.6	−0.11	1.09
	10−10.7	1.41	0.91	−0.28	1.15
	Average	1.53	0.66	−0.18	1.09
Rl25−01	0−1	1.94	0.57	−0.05	1
	2.5−3.5	1.94	0.5	0.08	1.14
	6−6.8	2.14	0.49	0.03	1.14
	Average	2.01	0.52	0.02	1.09
Pk51−01	1−2	1.36	0.89	−0.03	1.52
	2−3	1.39	0.77	−0.08	1.18
	8−9	1.67	0.38	0.16	0.22
	9−10	1.81	0.37	0.45	0.21
	11−12	1.74	0.37	0.26	0.24
	12−13	1.88	0.46	0.03	0.34

DGSID	INTERVAL (FT)	GRAPHIC MEAN	INCL GRPH STND DEV	INCL GRPH SKEWNESS	GRAPHIC KURTOSIS
	13–14	1.39	0.72	–0.2	1.01
	15–16	1.14	0.74	0	1.04
	19–20	1.87	0.54	0.08	0.55
	Average	1.58	0.58	0.07	0.7
PI51–01	0–1	1.35	0.55	–0.07	0.57
	3–4	1.55	0.49	–0.05	0.45
	4–5	1.85	0.46	–0.08	0.4
	10–11	1.45	0.67	0.17	0.83
	11.5–12	1.9	0.54	0.16	0.58
	Average	1.62	0.54	0.03	0.57
Qk13–01	0–0.5	1.25	0.64	0.03	0.8
	2–3	1.55	0.51	0.06	0.43
	3–4	1.63	0.68	0.02	0.86
	6–7	1.59	0.67	0.06	0.83
	7–8	1.6	0.65	0.11	0.84
	8–9	1.62	0.68	0.12	0.93
	11–12	1.44	0.63	0.28	0.77
	13–14	1.39	0.53	0.14	0.49
	16–16.5	1.52	0.32	0.24	0.17
	17–17.3	1.57	0.46	0.06	0.45
	17.5–18	0.82	0.67	0.42	0.9
	Average	1.45	0.59	0.14	0.68
RI31–01	0–0.5	1.09	0.73	–0.1	1.07
	0.5–1.2	1.41	0.62	–0.12	0.75
	1.2–2.2	1.36	0.6	–0.05	0.69
	5.2–6.2	1.62	0.56	–0.18	0.63
	6.2–7.2	1.86	0.52	–0.35	0.49
	9.4–10.4	2.47	0.4	0.08	0.25
	15.7–16.2	1.75	0.63	–0.03	0.84
	Average	1.65	0.58	–0.11	0.67

Appendix E

Preliminary Amino Acid Racemization Data

C Williams DGS Shelf Core Project samples November 30 1993

LAB NO	SAMPLE NO	UDAMS NO	COMMENTS
	CW93-001	5118	DGS CORE 92-1 DEPTH 1.0-1.1'
	CW93-002	5118	DGS CORE 92-1 DEPTH 3.0-3.5'
	CW93-003	5118	DGS CORE 92-1 DEPTH 6.0-6.2'
	CW93-004	5118	DGS CORE 92-1 DEPTH 13.0-13.2'
	CW93-005	5119	DGS CORE 92-2 DEPTH 0-0.5'
	CW93-006	5119	DGS CORE 92-2 DEPTH 1.0-1.5'
	CW93-007	5119	DGS CORE 92-2 DEPTH 2.5-3.0'
	CW93-008	5119	DGS CORE 92-2 DEPTH 3.0-3.5'
	CW93-009	5119	DGS CORE 92-2 DEPTH 3.5-4.0'
	CW93-010	5120	DGS CORE 92-3 DEPTH 0-0.5'
	CW93-011	5120	DGS CORE 92-3 DEPTH 0.5-1.0'
	CW93-012	5120	DGS CORE 92-3 DEPTH 1.0-1.5'
	CW93-013	5120	DGS CORE 92-3 DEPTH 1.5-2.0'
	CW93-014	5120	DGS CORE 92-3 DEPTH 2.0-2.5'
	CW93-015	5120	DGS CORE 92-3 DEPTH 2.5-3.0'
	CW93-016	5120	DGS CORE 92-3 DEPTH 3.0-3.5'
	CW93-017	5120	DGS CORE 92-3 DEPTH 3.5-4.0'
	CW93-018	5121	DGS CORE 92-4 DEPTH 0-0.5'
	CW93-019	5121	DGS CORE 92- 4 DEPTH 1.0-1.5'
	CW93-020	5121	DGS CORE 92- 4 DEPTH 2.0-2.5'
	CW93-021	5121	DGS CORE 92-4 DEPTH 3.5-4.0'
	CW93-022	5122	DGS CORE 92-5 DEPTH 0-0.5'
	CW93-023	5122	DGS CORE 92-5 DEPTH 2.5-3.0'
	CW93-024	5123	DGS CORE 92-6 DEPTH 0-0.5'
	CW93-025	5123	DGS CORE 92-6 DEPTH 0.5-1.0'
	CW93-026	5123	DGS CORE 92-6 DEPTH 1.0-1.5'
	CW93-027	5123	DGS CORE 92-6 DEPTH 1.5-2.0'
	CW93-028	5124	DGS CORE 92-8 DEPTH 6.6-6.8'
	CW93-029	5125	DGS CORE 92-10 DEPTH 3.8-4.3'
	CW93-030	5126	DGS CORE 92-11 DEPTH 0-0.5'
	CW93-031	5126	DGS CORE 92-11 DEPTH 0.5-1.0'
	CW93-032	5126	DGS CORE 92-11 DEPTH 1.0-1.5'
	CW93-033	5126	DGS CORE 92-11 DEPTH 1.5-2.0'
	CW93-034	5126	DGS CORE 92-11 DEPTH 2.0-2.5'
	CW93-035	5126	DGS CORE 92-11 DEPTH 2.5-3.0'
	CW93-036	5126	DGS CORE 92-11 DEPTH 3.0-3.5'
	CW93-037	5126	DGS CORE 92-11 DEPTH 3.5-4.0'
	CW93-038	5126	DGS CORE 92-11 DEPTH 4.5-5.0'
	CW93-039	5126	DGS CORE 92-11 DEPTH 5.0-5.7'
	CW93-040	5126	DGS CORE 92-11 DEPTH 5.7-6.5'
	CW93-041	5126	DGS CORE 92-11 DEPTH 6.5-7.0'
	CW93-042	5126	DGS CORE 92-11 DEPTH 7.0-7.5'

C Williams DGS Shelf Core Project samples November 30, 1993

CW93-043	5126 DGS CORE 92-11 DEPTH 7.5-8.0'
CW93-044	5126 DGS CORE 92-11 DEPTH 8.0-8.5'
CW93-045	5126 DGS CORE 92-11 DEPTH 8.5-9.0'
CW93-046	5126 DGS CORE 92-11 DEPTH 10.0-10.
CW93-047	5127 DGS CORE 92-12 DEPTH 0-0.5'
CW93-048	5127 DGS CORE 92-12 DEPTH 0.5-1.2'
CW93-049	5127 DGS CORE 92-12 DEPTH 1.2-1.7'
CW93-050	5127 DGS CORE 92-12 DEPTH 1.7-2.2'
CW93-051	5127 DGS CORE 92-12 DEPTH 2.2-2.7'
CW93-052	5127 DGS CORE 92-12 DEPTH 2.7-3.2'
CW93-053	5127 DGS CORE 92-12 DEPTH 3.2-3.7'
CW93-054	5127 DGS CORE 92-12 DEPTH 3.7-4.2'
CW93-055	5127 DGS CORE 92-12 DEPTH 4.2-4.7'
CW93-056	5127 DGS CORE 92-12 DEPTH 4.7-5.2'
CW93-057	5127 DGS CORE 92-12 DEPTH 5.2-5.7'
CW93-058	5127 DGS CORE 92-12 DEPTH 5.7-6.2'
CW93-059	5127 DGS CORE 92-12 DEPTH 6.2-6.7'
CW93-060	5127 DGS CORE 92-12 DEPTH 6.7-7.2'
CW93-061	5127 DGS CORE 92-12 DEPTH 7.2-7.7'
CW93-062	5128 DGS CORE 92-13 DEPTH 0-0.5'
CW93-063	5128 DGS CORE 92-13 DEPTH 1.5-2.0'
CW93-064	5128 DGS CORE 92-13 DEPTH 2.5-3.0'
CW93-065	5128 DGS CORE 92-13 DEPTH 4.0-4.5'
CW93-066	5128 DGS CORE 92-13 DEPTH 6.9-7.3'
CW93-067	5129 DGS CORE 92-15 DEPTH 1.5-2.0'
CW93-068	5130 DGS CORE 92-16 DEPTH 0-0.5'
CW93-069	5130 DGS CORE 92-16 DEPTH 1.2-1.8'
CW93-070	5130 DGS CORE 92-16 DEPTH 1.8-2.0'
CW93-071	5130 DGS CORE 92-16 DEPTH 2.2-2.5'
CW93-072	5130 DGS CORE 92-16 DEPTH 3.8-4.0'
CW93-073	5130 DGS CORE 92-16 DEPTH 3.9-4.1'
CW93-074	5130 DGS CORE 92-16 DEPTH 6.0-6.2'
CW93-075	5130 DGS CORE 92-16 DEPTH 8.2-8.5'
CW93-076	5130 DGS CORE 92-16 DEPTH 8.7-9.0'
CW93-077	5130 DGS CORE 92-16 DEPTH 9.5-9.7'
CW93-078	5130 DGS CORE 92-16 DEPTH 9.7-9.8'
CW93-079	5130 DGS CORE 92-16 DEPTH 11.5-12.

Sample Number	Lab Number	Core ID	Depth	Genus	A/I Ratio
CW93-002-1	940144	Oj23-02	3.0'-3.5'	*Spisula*	0.032 R
					0.049
					0.136 R
CW93-004-1	940145	Oj23-02	13.0'-13.5'	*Ensis*	0.012
					0.192 R
CW93-022-1	940181	Rk11-01	0-0.5'	*Spisula*	0.014
					0.036 R
CW93-023-1	940182	Rk11-01	2.5'-3.0'	*Merc/Spis?*	0.406 R
CW93-029-1	940141	Qk43-01	3.8'-4.0'	*Ensis*	0.010 R
					0.040 R
CW93-029-2	940142	Qk43-01	3.8'-4.0'	*Ensis*	0.018 R
					0.049 R
CW93-029-3	940143	Qk43-01	3.8'-4.0'	*Ensis*	0.013 R
					0.044
					0.045 R
CW93-033-1	940343	Rk33-01	1.5'-2.0'	*Spisula*	not run
CW93-033-2	940344	Rk33-01	1.5'-2.0'	*Spisula*	0.011
CW93-033-3	940345	Rk33-01	1.5'-2.0'	*Spisula*	0.018
CW93-038-1	940346	Rk33-01	4.5'-5.0'	*Spisula*	0.016
					0.035 R
CW93-038-2	940347	Rk33-01	4.5'-5.0'	*Spisula*	0.007
					0.033 R
CW93-038-3	940348	Rk33-01	4.5'-5.0'	*Spisula*	lost
CW93-043-1	940349	Rk33-01	7.5'-8.0'	*Spisula*	0.002
					0.029 R
CW93-043-2	940350	Rk33-01	7.5'-8.0'	*Spisula*	0.006
					0.039 R
CW93-043-3	940351	Rk33-01	7.5'-8.0'	*Spisula*	0.010
CW93-050-1	940352	Rl31-01	1.7'-2.2'	*Spisula*	not run

Sample Number	Lab Number	Core ID	Depth	Genus	A/I Ratio
CW93-050-2	940353	RI31-01	1.7'-2.2'	*Spisula*	not run
CW93-055-1	940183	RI31-01	4.2'-4.7'	*Spisula*	0.012 R
					0.020 R
CW93-055-2	940184	RI31-01	4.2'-4.7'	*Spisula*	0.039 R
CW93-055-3	940185	RI31-01	4.2'-4.7'	*Spisula*	0.045 R
CW93-060-1	940186	RI31-01	6.7'-7.2'	*Spisula*	no peaks
CW93-063-1	940187	PI51-01	1.5'-2.0'	*Spisula*	0.024 R
CW93-063-2	940188	PI51-01	1.5'-2.0'	*Spisula*	0.024
					0.051 R
					0.025 R
CW93-066-1	940189	PI51-01	6.9'-7.3'	*Spisula*	0.009 R
CW93-066-2	940190	PI51-01	6.9'-7.3'	*Spisula*	0.014
					0.041 R
					0.021 R
CW93-066-3	940191	PI51-01	6.9'-7.3'	*Spisula*	0.026
					0.037 R
					0.051 R
CW93-070-1	940114	RI25-01	1.8'-2.0'	*Astarte*	0.103
CW93-070-2	940135	RI25-01	1.8'-2.0'	*Mercenaria*	0.156
CW93-070-3	940136	RI25-01	1.8'-2.0'	*Astarte*	0.134
					0.147
CW93-070-4	940137	RI25-01	1.8'-2.0'	*Mercenaria*	0.183
					0.173
CW93-070-5	940115	RI25-01	1.8'-2.0'	*Venericardia*	0.153
					0.174 R
CW93-070-6	940116	RI25-01	1.8'-2.0'	*Mercenaria*	0.439
CW93-076-1	940138	RI25-01	8.7'-9.0'	*Astarte*	0.151
CW93-076-2	940139	RI25-01	8.7'-9.0'	*Astarte*	0.115

Sample Number	Lab Number	Core ID	Depth	Genus	A/I Ratio
CW93-076-3	940140	RI25-01	8.7'-9.0'	*Ensis*	0.047
					0.068 R
CW93-079-1	940117	RI25-01	11.5'-12.0'	*Venericardia*	0.081
					0.099
CW93-079-2	940118	RI25-01	11.5'-12.0'	*Mercenaria*	0.314
CW93-079-3	940119	RI25-01	11.5'-12.0'	*Astarte*	0.124

A/I ratios with no notation were calculated using integrated peaks
A/I ratios with "R" notation were calculated from measured peaks
"No peaks" means if there were any, we could not find them
"Not run" means there is no data as yet available for these samples
"Lost" refers to the sample that dried up during hydrolysis due to a poor cap to vial seal