PEAT DEPOSITS OF PAMLIMARLE PENINSULA DARE, HYDE, TYRRELL, AND WASHINGTON COUNTIES NORTH CAROLINA

1983

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Prepared for
U. S. Department of Energy
Contract DE-AC18-79FC14693
and
North Carolina Energy Institute

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ABSTRACT

Approximately 582 sq mi of the Pamlimarle peninsula in northeastern North Carolina are underlain by peat that has less than 25% ash. The peat occurs in broad shallow depressions up to 10 ft thick and in narrow former stream channels up to 16 ft thick. The average thickness is about 4 ft.

Total peat resources in the 582 sq mi (373,000 acres) are about 278 million tons of moisture-free peat. The deposits greater than 4 ft thick occupy an area of 273 sq mi (175,000 acres) containing 196 million tons of peat.

The peat lies to the east of an old shoreline, the Suffolk Scarp, and occurs at elevations from 20 ft to sea level. There is a topographic break at 5 to 10 ft elevation which separates the deposits into a higher Western Area and a lower Eastern Area.

Western and Eastern area peat differ in some respects. The higher elevation Western Area peats are slightly more decomposed and less fibrous, have a higher Btu/lb (median of 10,300 vs 9,500), have less ash (mean of 6% vs 10%), have more carbon (median of 61% vs 57%), have less moisture (mean of 81% vs 88%), have a higher bulk density, and have less sulfur (median of 0.2% vs 0.4%).

Two main types of peat are present: (1) a brown, decomposed somewhat fibrous peat usually found at the base of the thicker peats, and (2) a black, fine-grained, highly decomposed peat that usually overlies the more fibrous peat. Undecomposed logs and stumps are common.

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I. INTRODUCTION

A peat survey was made of the peninsula lying between Pamlico River to the south, Albemarle Sound to the north, and Pamlico Sound to the east. This general area has been referred to as the East Dismal Swamp, as the Albemarle-Pamlico peninsula, and as the Dare County peninsula. We choose to coin a new word for the area -- the Pamlimarle peninsula, which combines Pamli - from Pamlico, and - marle from Albemarle.

This report is a continuation of a series of reports being prepared on the peat deposits of North Carolina (Ingram and Otte, 1980, 1981a, 1981b).

A. Location

The peat swamps of the Pamlimarle peninsula are located on the lower Coastal Plain of northeastern North Carolina. Peat is found in Washington, Tyrrell, Dare, and Hyde counties. The deposits are located on 27 7 1/2 minute orthophotographic or topographic quadrangle maps with a scale of 1:24,000: Buffalo City, Columbia East, Creswell, Creswell SE, East Lake, East Lake SE, Engelhard East, Engelhard NE, Engelhard NW, Engelhard West, Fairfield, Fairfield NE, Fairfield NW, Fort Landing, Frying Pan, Long Shoal Point, Manns Harbor, New Lake, New Lake NW, New Lake SE, Plymouth East, Ponzer, Pungo Lake, Roper South, Scotia, Stumpy Point, and Wanchese. Persons interested in the details of these deposits should obtain the above orthophotographic maps from the North Carolina Geological Survey, P.O. Box 27687, Raleigh, N.C. 27611, and enlarge Plate 1 to fit these maps. The deposits in general lie south of U.S. Highway 64, north and west of U.S. 264, and east of N.C. 32 and 99. N.C. Highway 94 between Columbia and Fairfield runs north-south through the middle of the area. Access to the deposits is by the state and county roads shown on Plate I and by numerous privately owned canal maintenance roads.

B. Methods

1. Field Methods

Soils maps were used as guides in locating potential peat deposits. Areas mapped as histosols (organic soils with greater than 25% organic matter) were investigated. In areas where peat (greater than 75% organic matter) was found, samples were taken at one-foot vertical intervals using a Macaulay peat sampler, a Davis peat sampler, or a screw auger from the surface down into the underlying mineral sediment (sand or clay). Over 4000 samples were collected from over 1100 sites. Site locations were plotted on orthophotographic maps.

At selected sites, larger samples (about 1 pint) were collected for proximate and ultimate chemical analyses and for heating value determinations. At other selected sites, samples of known volume (200 cc) were taken with a Macaulay sampler for bulk density determinations.

2. Laboratory Methods

The moisture and ash content of nearly all samples (about 4500) were determined by heating about 10 g in 17 ml flat-bottom combustion crucibles at 105°C until moisture-free (about 16 hours), and then by heating at 550°C until all organic material was burned (about 1 hour).

Samples for bulk density (moisture-free weight per unit in site volume) determinations were collected with a Macaulay sampler with an inside diameter of 1 5/8 in. (40.13 cm). One-foot sections of the Macaulay core (200 cc) were placed in pre-weighed containers and then heated to constant weight (about 3 days). The calculated bulk density expressed as g/cc when multiplied by 1359 will give the bulk density as tons per acre-foot.

Proximate analyses (moisture, volatile matter, fixed carbon, and ash), ultimate analyses (carbon, hydrogen, oxygen, nitrogen, and sulfur), and heating value (Btu/lb) were made by the Coal Analysis Laboratory, U.S. Department of Energy, Pittsburgh, Pennsylvania, and Grand Forks, North Dakota.

II. TOPOGRAPHY AND DRAINAGE

Just west of the peat deposits and just off the map shown on Plate I is a north-south trending sand ridge with elevations of 40 to 50 ft. The eastern side of this sand ridge is the Suffolk Scarp with a toe elevation of about 20 ft. The surface east of the Suffolk Scarp is known as the Pamlico Terrace or Pamlico Surface. The Pamlico Surface slopes gently eastward from elevations of about 20 ft on the west to sea level on the east. The area between Lake Phelps, Pungo Lake, and Alligator Lake (or New Lake) is a plateau-like surface with elevations mainly from 15 to 20 ft. The mean water level in these lakes is about 10 ft. Just to the east of this plateau-like surface the elevation drops in a distance of about 5 mi from 15 to 5 ft. East of longitude 76°15' (just west of N.C. Highway 54) the elevations are mainly less than 5 ft.

The main Pamlico Surface has been dissected by streams that flow toward the margins of the peninsula into Albemarle Sound, Pamlico River Estuary, Pamlico Sound, and Alligator River.

Many miles of canals and ditches have been cut through the peat swamps. These canals and ditches increase the rate of surface run-off and lower the water table in the immediate vicinity. Because of the low hydraulic conductivity of the peat, however, the effect of canals on drainage of the peat dies out rapidly away from them.

III. PEAT RESOURCES

Plate I is a map that shows the location and thickness of peat with less than 25% ash. The patterns of distribution are different in the western and the eastern parts, the change occurring approximately along the 76°15' longitude line just west of N.C. Highway 94 or approximately along the 5 ft contour line. The 76°15' longitude line will be used to separate the peat deposits into the Western Area and the Eastern Area. In the Western Area peat is found mainly at elevations of 10 to 20 ft in broad shallow basins with very few buried narrow stream channels. In the Eastern Area peat is found mainly at elevations of less than 5 ft. Although there are some broad shallow basins, the Eastern Area has numerous, relatively narrow, peat-filled stream channels.

A. Peat Types

Peat is an accumulation of dead plant matter in swamps. The plant matter gradually rots and decomposes. The degree of decomposition is related to the percentage of fibers (plant particles larger than 0.15 mm). As peat decomposes the fibers are changed into microscopic particles. Cohen (1979) microscopically determined the volume percentage of fibers in 98 samples from the area (see Table 1). In another study, the Peat Institute of Leningrad, U.S.S.R., estimated the degree of decomposition of peats from First Colony Farms to be from 45 to 60% (Campbell, 1981). These results show that most of the peats are moderately to highly decomposed, but that

TABLE 1--Fiber Content of Pamlimarle Peats

	Percent Fibers		
	100-67% (Fibric Peat)	67-33% (Hemic Peat)	33-0% (Sapric Peat)
Western Area	0	33	67% of samples
Eastern Area	16	33	51

From Cohen, 1979

the peats in the Western Area are somewhat more decomposed that those in the lower-lying Eastern Area.

Two main types of peat are present: (1) an upper brownish-black, fine-grained, highly decomposed sapric peat, and (2) a lower dark reddish-brown, decomposed fibrous sapric peat.

The black sapric peat dominates the upper 3 to 4 ft. As collected in the field this peat appears to have very little macroscopic plant debris. When wet-sieved through a 0.5 mm sieve, however, a fair amount of wood fibers and charcoal fragments is revealed.

The brown, more fibrous peat is usually found beneath the black sapric peat in the deeper parts of the narrow peat-filled channels and the basal parts of broad shallow basins.

Both peat types contain large amounts of wood in the form of fallen logs and swamps. The wood seen in the canal banks is mainly Atlantic white cedar and cypress. The wood is most concentrated in the thicker peat, except for the basal few feet in the deep channels where the peat is relatively wood free. Except for these channel areas, wood can be found from the base of the peat to the ground surface. No attempt was made to study the geographic distribution of wood in the peat, but wood was encountered by our sampling probes in most areas. Cohen (1979) determined the wood content of 2x2x2 ft volumes at 8 localities and of 2x2x4 (depth) ft volumes at 2 localities. The wood content by dry weight ranged from 2 to 57% with an average of 18%.

The contact between the peat and the underlying mineral sediment is usually a transitional one with the transition zone normally being less than a foot thick. The transition zone may be 2 or 3 ft thick in the channels, however.

Over most of the area, if low-ash peat is found at the surface, the low-ash peat will be found continuously to the base of the peat layer and to the top of the mineral sediment. Along the margins of the Alligator River estuary and the floodplain of the Alligator River proper, there are often layers of high ash peat or mineral sediment layers within the peat that were probably introduced by storm or flood high water. These details cannot be shown by the isopachs on Plate 1.

B. Composition and Heating Value

Table 2 summarizes and the Appendix gives details of the proximate and ultimate analyses of Pamlimarle peats.

1. Moisture

For 4230 samples from 923 sites in the Pamlimarle area, the moisture content ranged up to 95% with the peats from the Western Area having a mean of 81% and the peats from the Eastern Area having a mean of 88% (Table 3 and 4). The moisture content is related to 5 variables: (1) depth, (2) total thickness of peat, (3) distance from drainage sites, (4) precipitation and evapotranspiration, and (5) degree of peat decomposition.

TABLE 2--Summary of Composition and Heating Value of Pamlimarle Peats with less than 25% Ash

	Western Area			Eastern Area		
	Low	Median	High	Low	Median	High
BTU/LB*	8,100	10,300	11,100	7,600	9,500	10,500
% H_2O	—	81**	94	—	88**	95
PROXIMATE ANALYSIS*						
% Volatiles	50	61	67	50	61	65
% Fixed Carbon	26	35	39	24	33	42
% Ash	1	3	22	2	5	24
ULTIMATE ANALYSIS*						
% C	49	61	64	46	57	62
% H	4.0	5.1	6.0	4.1	5.1	5.9
% O	22	30	32	25	30	35
% N	1.0	1.2	2.0	1.0	1.6	2.1
% S	0.1	0.2	0.6	0.2	0.4	2.9
% Ash	1	3	22	2	5	24

Western Area - 85 samples; Eastern Area - 49 samples.

* Moisture-free basis

** Mean of 1665 samples in Western Area and of 2561 samples in Eastern Area.

TABLE 3--Mean Moisture Percentage of Western Area of Pamlimarle Peats related to Depth and Total Thickness of Peat (1669 samples from 393 sites)

Depth (ft)	Total Peat Thickness (ft) 1	2	3	4	5	6	7	8	9	10	>10	Mean of Means
0-1	74.1	71.5	74.8	71.8	74.5	76.0	78.2	71.2	78.0	78.2		74.8
1-2		77.8	78.7	78.9	80.7	82.3	82.7	78.8	82.9	81.8		80.5
2-3			80.5	82.5	83.0	84.2	84.4	83.3	80.5	83.8		82.8
3-4				83.2	83.4	84.7	85.7	83.1	86.0	83.9		84.3
4-5					82.8	84.9	86.2	85.3	86.9	85.8		85.3
5-6						83.6	85.5	83.4	86.7	85.6		85.0
6-7							84.3	82.2	85.0	87.4		84.7
7-8								83.2	85.6	82.4		83.7
8-9									85.6	83.3		84.4
9-10										83.8		83.8
>10												
Mean of Means	74.1	74.6	78.0	79.1	80.9	82.6	83.9	81.3	84.1	83.6		82.9 / 80.2

Mean of all 1669 samples = 80.8%. Mean weighted for area = 79.5%.

TABLE 4--Mean Moisture Percentage of Eastern Area of Pamlimarle Peats related to Depth and Total Thickness of Peat (2561 samples from 530 sites)

Depth (ft)	Total Peat Thickness (ft) 1	2	3	4	5	6	7	8	9	10	>10	Mean of Means
0-1	85.4	82.3	84.4	82.8	81.6	85.4	87.8	88.2	91.0	89.7	87.1	86.0
1-2		84.3	87.5	86.5	86.8	88.2	89.0	89.6	91.7	90.3	89.4	88.3
2-3			87.3	87.5	88.3	89.1	90.3	89.9	91.7	90.5	89.8	89.4
3-4				87.0	89.5	89.8	90.4	90.0	91.8	91.1	90.5	90.0
4-5					88.5	89.9	90.6	90.3	91.5	91.1	90.5	90.3
5-6						89.4	90.9	89.6	91.6	91.2	90.3	90.5
6-7							90.8	90.3	91.6	90.9	90.5	90.8
7-8								90.1	91.6	91.2	90.7	90.9
8-9									91.4	91.2	90.6	91.1
9-10										90.9	90.5	90.7
>10											90.1	90.1
Mean of Means	85.4	83.3	86.4	86.0	86.9	88.6	90.0	89.8	91.5	90.8	90.0	89.8 / 88.1

Mean of all 2561 samples = 88.4%. Mean weighted for area = 87.0%.

The moisture content in general increases with depth. In the Western Area the moisture content increases from an average of about 75% in the first foot to about 85% at depths greater than about 5 ft. In the Eastern Area the moisture content increases from an average of about 86% in the top foot to about 91% at depths below about 5 ft (Tables 3 and 4). Variations in moisture content are greatest in the upper 3 to 5 ft, the "active" zone through which the water table moves up and down.

The total thickness of peat may have some control over the moisture content. In the Western Area the average moisture content increases from about 74% where the peat is 1 ft thick to about 84% where the peat is 10 ft thick. In the Eastern Area the average moisture content increases from about 85% where the peat is 1 ft thick to about 91% where the peat is 10 ft thick. This relationship, however, may merely be a restatement of the relation of moisture content to depth (Tables 3 and 4).

Near drainage ditches and canals the top 2 or 3 ft has a lower moisture content than peat away from the ditches and canals. The effect is more noticeable near the deeper and older canals; but the effect of drainage dies out rapidly usually within 20 to 100 ft.

Elevation may also influence the drainage and therefore the moisture content. The peats of the Western Area, where the peats are at an elevation of 10 to 20 ft, have a lower mean moisture content (81%) than the peats of the Eastern Area (88%) where the peats are at an elevation of less than 5 ft.

The difference in moisture content between the Western and Eastern Areas may also be influenced by the degree of decomposition of the peats. Less decomposed (more fibrous) peats have a higher Water Holding Capacity than less decomposed peats. The peats of the Eastern Area are somewhat more fibrous than the peats of the Western Area and therefore should have a higher moisture content.

The lower and more variable moisture content of the top 3 to 5 ft is probably related to flucuations in the water table as the result of changing relationships between precipitation and evapotranspiration and the irreversible collapse of capillary openings as water is removed from the peat. The commonly observed change in moisture content at 3 to 5 ft probably represents the maximum lowering of the water table. Once partially dehydrated, the peat cannot fully rehydrate. (Also see Gilliam and Skaggs, 1981 and Daniels, 1981.)

The moisture content also varies with seasonal changes in precipitation and evapotranspiration. In general the moisture content is higher in winter than in summer. During summer months when temperatures are high and vegetation is fully "greened," evaporation and transpiration are greatest, and the moisture content of the near surface peats decreases. During winter months when temperatures are low and most of the swamp vegatation is dormant, evapotranspiration is low and the water content of the peat can be partially replenished.

2. <u>Ash</u>

For 4230 samples with ash content less than 25%, the mean ash content is 8.3% on a moisture-free basis. The mean ash content of the Western Area is somewhat lower (6.4%) than that of the Eastern Area (9.6%) (Tables 5 and 6). The average high ash content of the Eastern Area peats is caused primarily by the samples collected along the margins of Alligator River estuary and Alligator River proper where flood and storm generated high waters have caused the deposition of inorganic sediments in the peat swamps. Away from Alligator River and away from the margins and bases of the peat bodies, ash contents of less than 5% are common.

For peats less than 6 or 7 ft thick, there is usually a transition zone between the peat and the underlying mineral sediment. For peats thicker

TABLE 5--Mean Ash Percentage of Western Area of Pamlimarle Peats related to Depth and Total Thickness of Peat (1669 samples from 393 sites)

Depth (ft)	Total Peat Thickness (ft) 1	2	3	4	5	6	7	8	9	10	>10	Mean of Means
0-1	10.1	8.1	7.6	7.3	5.4	5.4	4.8	4.2	3.9	2.8		6.0
1-2		11.3	8.4	6.5	4.2	4.4	3.7	2.4	3.8	2.0		5.2
2-3			11.2	7.7	4.1	3.8	3.4	2.0	2.6	2.0		4.6
3-4				11.4	6.0	4.6	3.2	2.5	2.7	2.3		4.7
4-5					9.8	4.4	3.3	2.7	2.9	1.7		4.1
5-6						9.9	4.8	3.7	3.6	2.6		4.9
6-7							8.2	4.6	4.4	3.2		5.1
7-8								9.0	9.7	6.6		8.4
8-9									14.4	6.2		10.3
9-10										9.4		9.4
>10												
Mean of Means	10.1	9.7	9.1	8.2	5.9	5.4	4.5	3.9	5.3	3.9		6.6 \ 6.3

Mean of all 1669 samples = 6.4%. Mean weighted for area = 7.0%.

TABLE 6--Mean Ash Percentage of Eastern Area of Pamlimarle Peats related to Depth and Total Thickness of Peat (2561 samples from 530 sites)

Depth (ft)	Total Peat Thickness (ft) 1	2	3	4	5	6	7	8	9	10	>10	Mean of Means
0-1	14.5	12.2	9.4	8.1	7.8	10.2	8.4	9.2	9.8	13.9	11.4	10.4
1-2		12.9	8.1	6.9	5.8	6.4	8.2	7.5	8.8	13.5	8.5	8.7
2-3			11.0	8.4	5.9	8.5	8.7	10.0	8.2	10.3	8.5	8.8
3-4				11.6	7.7	7.2	9.1	8.4	8.1	9.6	8.3	8.8
4-5					12.3	9.0	9.0	8.9	7.8	10.7	7.3	9.3
5-6						13.0	9.4	9.1	9.1	11.2	6.7	9.8
6-7							12.3	9.4	9.9	11.8	6.8	10.0
7-8								14.7	12.1	11.9	8.2	11.7
8-9									17.4	13.5	9.9	13.6
9-10										17.7	12.1	14.9
>10											15.6	15.6
Mean of Means	14.5	12.6	9.5	8.8	7.9	9.0	9.3	9.7	10.2	12.4	9.4	10.3 \ 11.0

Mean of all 2561 samples = 9.6%. Mean weighted for area = 10.5%.

than 6 or 7 ft, the transition zone may be 2 to 4 ft thick. The ash content is also higher around the margins of the deposits.

3. Heating Value

The heating value of 134 samples with less than 25% ash was determined (Appendix, Table 2).

Peats of the Western Area have a higher heating value (median of 10,300 Btu/lb, moisture-free) than the peats of the Eastern Area (median of 9,500 Btu/lb). The difference is probably related to 2 variables: (1) Ash Content - As peat is diluted with ash components, the heating value declines. Eastern Area peats in general have more ash than Western Area peats. (2) Degree of Decomposition - More highly decomposed peats have a higher heating value. Western Area peats in general are somewhat more highly decomposed (less fibric, more sapric) than Eastern Area peats.

With the exception of one sample, all samples with less than 25% ash had heating values greater than 8,000 Btu/lb.

4. Proximate Analyses (See Table 2 and Appendix)

Except for the slightly higher ash content of the Eastern Area peats, proximate analyses of peats from the two areas are very similar. The volatile matter ranges from 50 to 67% with a median of 61%. The fixed carbon ranges from 24 to 42% with a median of 34%.

5. Ultimate analyses (See Table 2 and Appendix)

The major elements (carbon, hydrogen, and oxygen) in the peat decrease as ash increases. The carbon content ranges from 46 to 64% with a median of 59%. The carbon content of the Western Area peats (median of 61%) is higher than that of the Eastern Area peats (median of 57%). This is consistent with the fact that the Western Area peats have a higher heating value and are more highly decomposed. Western and Eastern Area peats have similar hydrogen (5.1%) and oxygen (30%) contents.

The major potential environmental pollutants in peat are nitrogen and sulfur. The nitrogen content ranges from 1.0% to 2.1% with a median of 1.4%. Nitrogen values are somewhat higher in the Eastern Area peats (median of 1.6%) than those of the Western Area peats (median of 1.2%).

The sulfur content ranges from 0.1% to 2.9% with a median of 0.3%. Of the 134 analyses only 4 had values greater than 1.0%. The highest sulfur values are found at the base of the deep channel-fill peats in the Eastern Area. Apparently these deep channels have been subjected to marine or brackish water during their development with the sulfur coming from the $-SO_4^{--}$ found in marine waters. The Eastern Area peats in general have a slightly higher sulfur content than the Western Area peats mainly because they are at a lower elevation and are more subjected to the influence of marine waters.

6. pH

Peats in the area are nearly always acidic.

Cohen (1979) reports pH values of the Pamlimarle peats ranging from 3.5 to 7.5 with most in the 5.2 to 5.9 range. The higher pH values are found in areas near bodies of brackish water. Barnes (1981) states that the natural pH of organic soil in the area to be mainly in the range of 3.5 to 4.1.

C. Physical Properties

1. Water-Holding Capacity

Cohen (1979) reports the average water-holding capacity of peats from the Western Area as being about 725% and from the Eastern Area as being about 1150%. Since the Eastern Area peats are the more fibrous, they should have higher water-holding capacities.

2. Hydraulic Conductivity

Water saturated peat has a very low hydraulic conductivity. Water is removed from natural peat primarily by evaporation and by plant transpiration. The physical flow of water through fine-grained hemic to sapric peats is very limited except perhaps through some macropores or cracks in the top few feet. Water saturated peat has a very low permeability and can act as an effective barrier to water movement.

Few quantitative measurements have been made on the hydraulic conductivity of peat in this area. Badr and Skaggs (1978, in Gilliam and Skaggs, 1981, and Barnes, 1981) measured a flow of 0.02 m/day (0.8 inch/day) and state that the flow may be as low as 0.002 m/day (0.1 inch/day). Lohman (1972, in Daniel, 1981) measured an average vertical flow of 0.03 m/day (1.2 inch/day) through a 12 ft section of peat and organic soil near Pungo Lake but concluded that the hydraulic conductivity is higher in the top few feet and lower in the basal 6 or 7 ft.

Daniel (1981) concludes that "the low hydraulic conductivity of peat prevents rapid lateral drainage..., and the principal cause of the rise and fall of ground water levels is precipitation and evapotranspiration." The water table can move up and down through the "active" zone 3 to 5 ft (Daniel, 1981; Gilliam and Skaggs, 1981). Our studies confirm this as the moisture content of peat is highly variable in the top 3 to 5 ft becoming less variable at greater depths.

3. Bulk Density

a. General

The bulk density of a given volume of in situ peat is controlled by the relative abundance and specific gravity of 4 elements: (1) organic peat matter, (2) inorganic mineral matter, (3) water, and (4) open air-filled spaces. The specific gravity of highly compacted, moisture-free peat matter is probably close to 1.0. Approximately 10 g of very low ash (1%) sapric North Carolina peat was compressed into 1.25 inch diameter cylinders with a pressure of 25 tons. The specific gravity was 1.07. The specific gravity of most minerals (quartz, feldspar, clay) in peat is about 2.6.

Since the dominant component of most in situ peat is water, the bulk density is controlled mainly by the water content and the open air-filled spaced if some of the water has been removed by drainage or evapotranspiration. The determination of the water content of several thousand samples of North Carolina peat shows that the water content, and therefore the bulk density, is related to 5 variables: (1) depth, (2) total thickness of peat, (3) distance from drainage sites, (4) precipitation and evapotranspiration, and (5) degree of peat decomposition. See section II-B-1 on "Moisture."

Because the water content of peat is highly variable, the bulk density of peat is also highly variable.

b. North Carolina Peat

The bulk densities of 888 samples of North Carolina peats were determined (Table 7 and Fig. 1). Bulk densities ranged from 50 to 400 tons, moisture-free, per acre-foot with a median of 170 and a graphic mean of 177.

When a frequency distribution curve of bulk densities is plotted on probability paper (Fig. 2), two populations are apparent. The break between the two occurs at 120 tons/acre-foot, which corresponds to a moisture content of 91 1/2%. The meaning of these 2 populations is unknown.

Table 7 shows the relation of bulk density to depth and total thickness. Three trends are apparent: (1) bulk density decreases with depth, (2) bulk density decreases as peat becomes thicker, and (3) for any given depth and thickness, bulk densities are extremely variable.

When bulk density is plotted against moisture content, an almost linear relationship is shown (Fig. 3 and Fig. 4). The points on Figure 3 that fall distinctly below the line are mainly for samples taken at depths of less than 3 ft. At shallow depths water can apparently be removed by drainage and evapotranspiration without concurrent compaction. Except for peat in the top 3 or 4 ft, the bulk density of peat can be estimated if the moisture content is known. At shallow depths using moisture content to estimate bulk density will give values that are too high. It has been shown empirically that if moisture contents are known, Figure 3 can be used to estimate bulk densities <u>if</u> estimates for the 0 to 2 ft thickness are reduced by 20% and <u>if</u> estimates for the 2 to 4 ft thickness are reduced by 10%.

D. Quantity of Peat

In order to calculate the amount (weight) of peat present, the volume of peat must be multiplied by the bulk density (moisture-free weight per unit volume). Volumes were calculated from isopach maps on a scale of 1:24,000. Areas, determined with a Lasico Model L1250D rolling disc planimeter, were multiplied by average thicknesses between isopach lines (lines connecting points of equal thickness) to obtain volumes.

1. Bulk Density

The accuracy of the calculation of the weight of peat depends on the accuracy of the bulk density used. Unfortunately, the bulk density of peat is highly variable, but some kind of average must be determined in order to

TABLE 7 -- Bulk Density of North Carolina Peats
related to Depth and Thickness of Peat
(Mean bulk density in moisture-free tons per acre-ft with standard deviation.
Number of samples in parentheses. A total of 888 samples from 66 sites.)

Depth (ft)	Total Peat Thickness (ft): 1	2	3	4	5	6	7	8	9	10	> 10	Mean of means
0-1	—	—	201±11 (6)	160±42 (23)	—	173±31 (10)	—	—	—	—	—	178±21 (39)
1-2		—	251±29 (17)	192±48 (42)	176±41 (24)	182±50 (20)	130±33 (15)	172±32 (10)	149±35 (3)	161±19 (3)	88±17 (6)	167±45 (140)
2-3			285±63 (18)	226±63 (57)	195±54 (39)	196±42 (27)	174±37 (17)	181±40 (18)	111±20 (3)	143±31 (3)	91±17 (9)	178±59 (191)
3-4				243±63 (57)	197±52 (39)	194±50 (30)	166±32 (18)	178±36 (18)	123±16 (3)	179±19 (3)	95±27 (9)	172±46 (177)
4-5					184±49 (39)	198±61 (30)	141±19 (18)	182±48 (18)	90±1 (2)	158±6 (3)	108±20 (9)	152±41 (119)
5-6						184±59 (33)	135±32 (18)	159±42 (18)	89±12 (3)	144±31 (3)	108±15 (9)	136±34 (84)
6-7							139±32 (18)	156±40 (18)	113±6 (3)	154±19 (3)	95±17 (9)	131±27 (51)
7-8								164±67 (18)	111±1 (3)	189±5 (3)	99±11 (9)	141±43 (33)
8-9									108±2 (3)	153±13 (3)	101±12 (8)	121±28 (14)
9-10										155±7 (3)	103±12 (9)	129±37 (12)
> 10											120±16 (28)	120 (28)
Mean of means	est. 250	est. 250	246±42 (41)	205±37 (179)	188±10 (141)	187±10 (150)	148±18 (104)	170±11 (118)	112±19 (23)	160±15 (27)	100±9 (105)	147 183

For All Samples:

Median = 170
Graphic Mean = 177
Graphic Standard Deviation = 65

1982

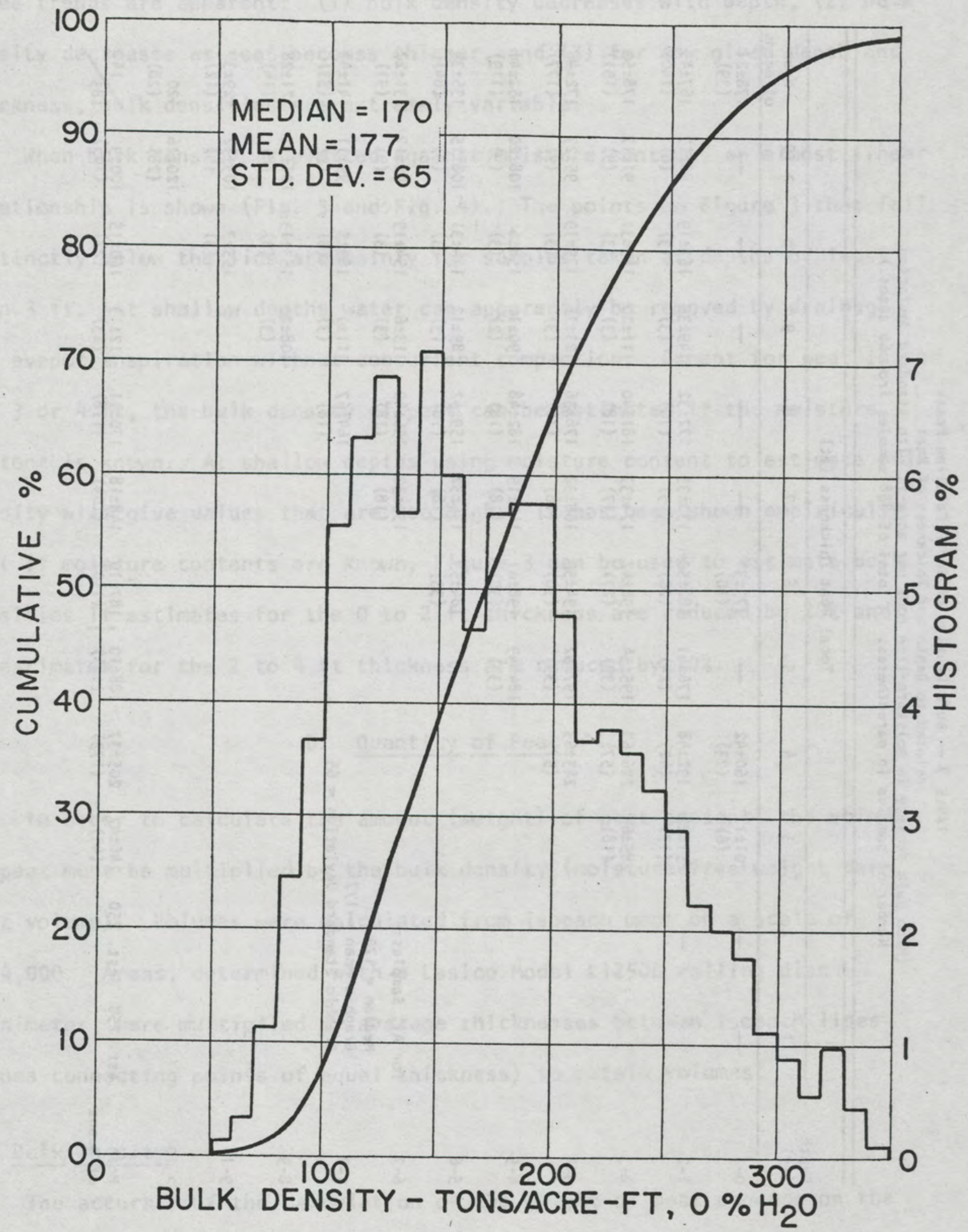


FIG. 1--Histogram and cumulative curve of bulk densities of North Carolina peats.

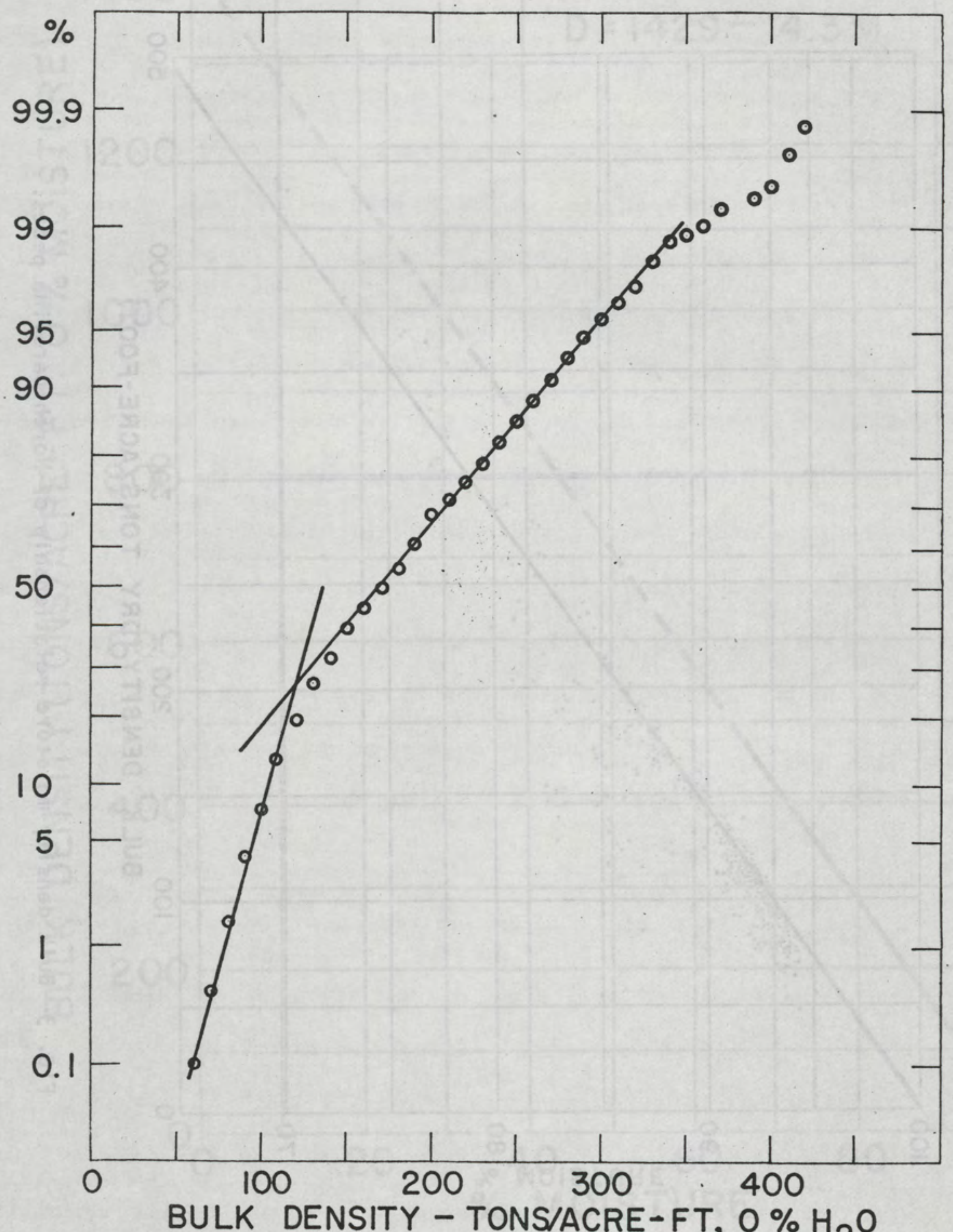


FIG. 2--Cumulative curve on probability paper of bulk densities of North Carolina peats.

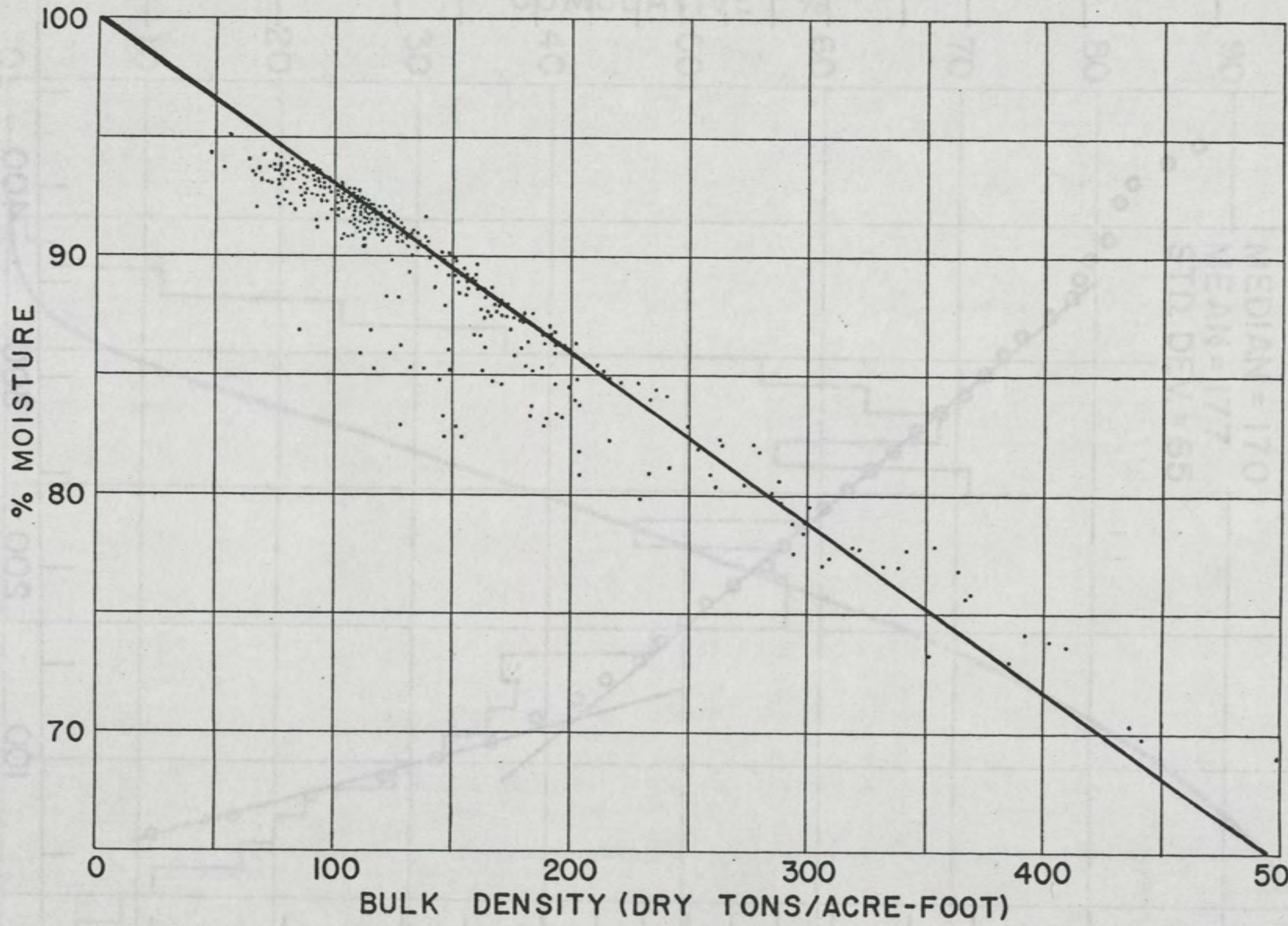


FIG. 3--Bulk density-moisture relationship of North Carolina peats.

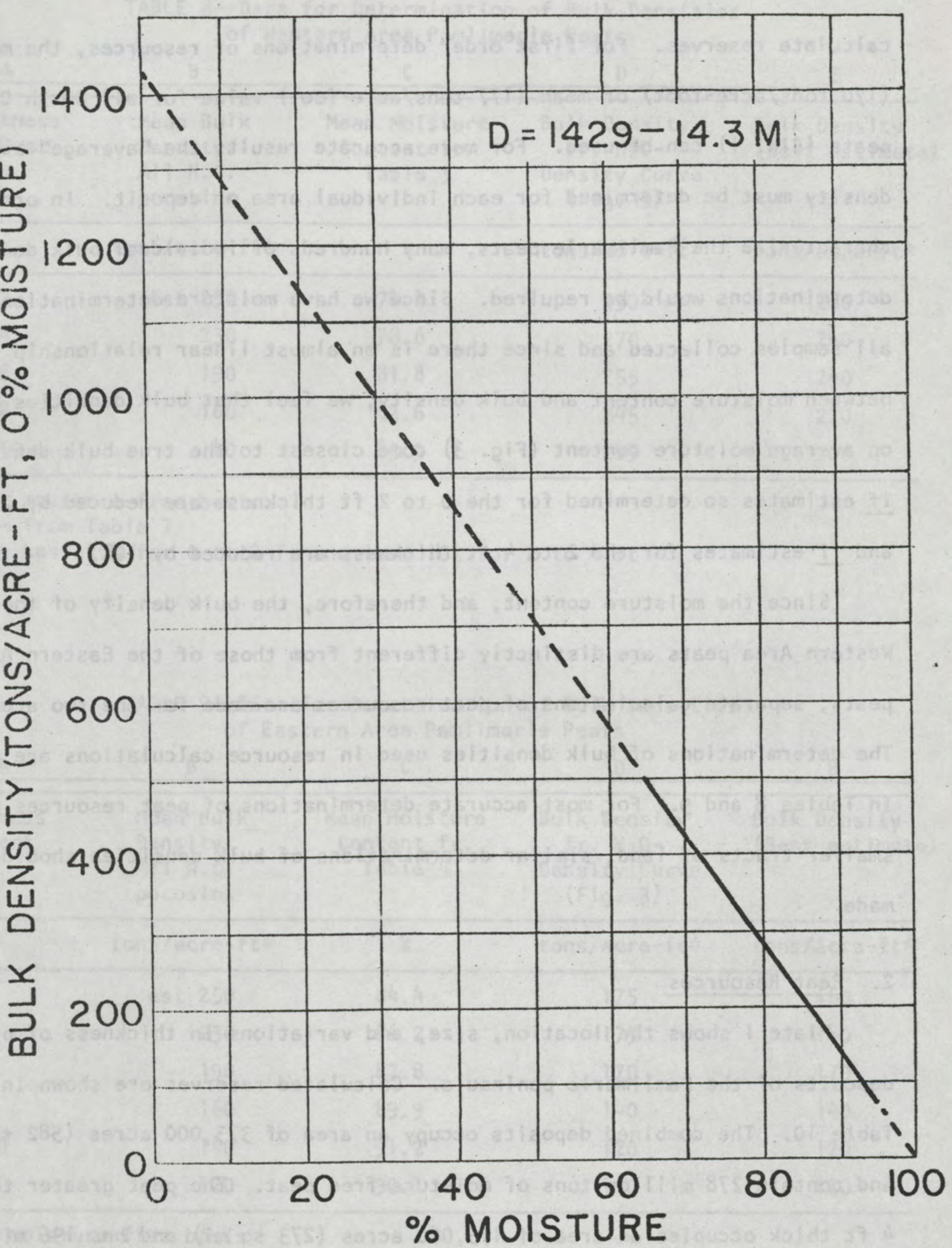


FIG. 4--Extrapolated bulk density-moisture relationship of North Carolina peats.

calculate reserves. For first order determinations of resources, the median (170 tons/acre-foot) or mean (177 tons/acre-foot) value for all North Carolina peats (Fig. 1) can be used. For more accurate results the "average" bulk density must be determined for each individual area or deposit. In order to characterize the Pamlimarle peats, many hundreds of individual bulk density determinations would be required. Since we have moisture determinations on all samples collected and since there is an almost linear relationship between moisture content and bulk density, we feel that bulk densities based on average moisture content (Fig. 3) come closest to the true bulk densities _if_ estimates so determined for the 0 to 2 ft thickness are reduced by 20% and _if_ estimates for the 2 to 4 ft thickness are reduced by 10%.

Since the moisture content, and therefore, the bulk density of the Western Area peats are distinctly different from those of the Eastern Area peats, separate calculations of peat resources are made for the two areas. The determinations of bulk densities used in resource calculations are shown in Tables 8 and 9. For most accurate determinations of peat resources on smaller tracts of land, similar determinations of bulk densities should be made.

2. Peat Resources

Plate I shows the location, size, and variations in thickness of peat deposits of the Pamlimarle peninsula. Calculated reserves are shown in Table 10. The combined deposits occupy an area of 373,000 acres (582 sq mi) and contain 278 million tons of moisture-free peat. The peat greater than 4 ft thick occupies an area of 175,000 acres (273 sq mi) and has 196 million tons of peat.

TABLE 8--Data for Determination of Bulk Densities of Western Area Pamlimarle Peats

A	B	C	D	E
Thickness of Peat	Mean Bulk Density. All N.C. pocosins	Mean Moisture Content fr. Table 3	Bulk Density fr. H_2O-Density Curve (Fig. 3)	Bulk Density (Best estimate)
ft	tons/acre-ft*	%	tons/acre-ft*	tons/acre-ft*
0-2	est 250	74.4	290	280
2-4	230	78.6	270	260
4-6	190	81.8	255	240
6-8	160	82.6	245	220
8-10	140	83.9	225	200

* - moisture-free basis
B - from Table 7
D - Less 20% for 0 to 2 ft and less 10% for 2 to 4 ft

TABLE 9--Data for Determination of Bulk Densities of Eastern Area Pamlimarle Peats

A	B	C	D	E
Thickness of Peat	Mean Bulk Density All N.C. pocosins	Mean Moisture Content fr. Table 4	Bulk Density fr. H_2O-Density Curve (Fig. 3)	Bulk Density (Best estimate)
ft	tons/acre-ft*	%	tons/acre-ft*	tons/acre-ft*
0-2	est 250	84.4	175	180
2-4	230	86.2	175	180
4-6	190	87.8	170	170
6-8	160	89.9	140	140
8-10	140	91.2	120	120
>10	120	90.1	140	120

* - moisture-free basis
B - from Table 7
D - Less 20% for 0 to 2 ft and less 10% for 2 to 4 ft

TABLE 10--Peat Resources in Pamlimarle Peninsula

Thickness ft	Area 10^3 acres	Weight 10^6 tons (moisture-free)
A. Western Area		
>0	128	124
>2	99	116
>4	67	91
>6	28	44
>8	5	8
>10	1	2
B. Eastern Area		
>0	245	154
>2	176	141
>4	108	104
>6	62	66
>8	27	31
>10	10	12
C. Total		
>0	373	278
>2	274	258
>4	175	196
>6	90	110
>8	32	40
>10	10	14

E. Geologic History

About 100,000 years ago the sea retreated from its shoreline position along the Suffolk Scarp just to the west of the present peat deposits exposing the former relatively flat sea floor. The present land surface, some of which is covered by peat, that slopes from the base of the Suffolk Scarp to present sea level is this former sea floor and is known as the Pamlico Terrace or Surface.

About 18,000 years ago sea level was about 400 ft below present sea level. During the interval of lowered sea level, the Pamlico Surface was dissected by stream erosion resulting in a dendritic pattern of stream valleys. For the past 18,000 years sea level has been rising. Initial peat development began about 10,000 years ago during the time of rising sea level in shallow lakes and open freshwater marshes that mark the courses of the dendritic valley systems. The fibrous peat, which appears to have been formed from a variety of types of aquatic vegetation, accumulated in the shallow lakes and marshes. These blocked channels became filled with peat and flooding of the adjacent low-lying areas began. This flooding created a large, flat wetland on which a swamp forest became established and in which the vegetation, that eventually became the black sapric peat, accumulated. Although the region has passed through a complex series of environmental and vegetational changes, the above sequence of events explains the general pattern of black sapric peat overlying brown more fibrous peat. The warm humid climate of the area has resulted in peat vegetation becoming decomposed to high decomposed. (See Daniel, 1981; Ingram and Otte, 1980, 1981a, 1981b; Oaks and Whitehead, 1979; Whitehead and Oaks, 1979).

ACKNOWLEDGEMENTS

Thanks go to Andy Allen, Steve Barnes, and R. N. Campbell of First Colony Farms, Inc., Creswell, N.C., for their friendly cooperation in sharing their information on peat with us. Steve Barnes, Soils Scientist, most willingly made available to us the results of his years of work on the organic soils and peats of the area.

REFERENCES CITED

Badr, A. W. and Skaggs, R. W., 1978, The effect of land development on the physical properties of some North Carolina organic soils: Paper No. 18-2537, 1978 winter meeting, Am. Soc. Agr. Eng., Chicago.

Barnes, J. S., 1981, Agricultural adaptability of wet soils of the North Carolina Coastal Plain, p. 225-237, in Richardson, C. J., Ed., Pocosin Wetlands: Stroudsburg, Pa., Hutchinson Ross Pub. Co.

Campbell, R. N., Jr., 1981, Peat for energy program - First Colony Farms, Inc., p. 214-224, in Richardson, C. J., Ed., Pocosin Wetlands: Stroudsburg, Pa., Hutchinson Ross Pub. Co.

Cohen, A. D., 1979, Peat deposits of the Albemarle-Pamlico peninsula, North Carolina: Report to North Carolina Energy Institute, 50 p.

Daniel, C. C., III, 1981, Hydrology, geology, and soils of pocosins, p. 69-108, in Richardson, C. J., Ed., Pocosin Wetlands: Stroudsburg, Pa., Hutchinson Ross Pub. Co.

Gilliam, J. W. and Skaggs, R. W., 1981, Drainage and agricultural development - effect on drainage waters, p. 109-124, in Richardson, C. J., Ed., Pocosin Wetlands: Stroudsburg, Pa., Hutchinson Ross Pub. Co.

Ingram, R. L. and Otte, L. J., 1980, Peat deposits of Light Ground Pocosin, North Carolina: report to U.S. Dept. Energy, 24 p.

______, 1981a, Peat deposits of Croatan Forest, North Carolina: report to U.S. Dept. Energy, 20 p.

______, 1981b, Peat deposits of Dismal Swamp, North Carolina: report to U.S. Dept. Energy, 25 p.

Lohman, S. W., 1972, Ground water hydraulics: U.S. Geol. Survey Prof. Paper 708, 70 p.

Oaks, R. Q. and Whitehead, D. R., 1979, Geologic setting and origin of the Dismal Swamp, southeastern Virginia and northeastern North Carolina, p. 1-24, in Kirk, P. W., Ed., The Great Dismal Swamp: Charlottesville, Univ. Press of Virginia.

Whitehead, D. R. and Oaks, R. Q., 1979, Developmental history of the Dismal Swamp, p. 25-43, in Kirk, P. W., Ed., The Great Dismal Swamp, Charlottesville, Univ. Press of Virginia.

APPENDIX

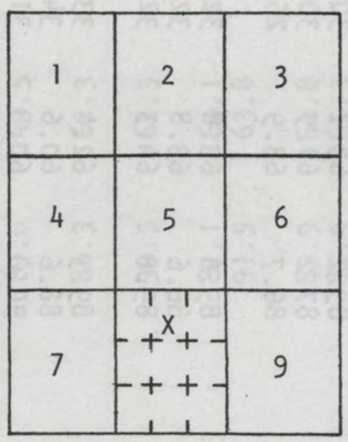
PROXIMATE AND ULTIMATE ANALYSES

OF

PAMLIMARLE PENINSULA PEATS

Arranged alphabetically by topographic quadrangle

Location on a topographic quadrangle is given by the following scheme:



Location of X is 8-2

Analyses marked FC were provided by First Colony Farms, Inc., Creswell, N.C.

All other analyses were performed by U.S. Department of Energy laboratories at Pittsburgh, Pennsylvania, or Grand Forks, North Dakota.

Site No. (Depth-ft)	County	Topographic Quad.	H_2O %	Moisture Free: Vola-tile %	Fixed Carbon %	Ash %	H %	C %	N %	S %	O %	BTU/lb
A28 (0-2)	Dare	Buffalo City: 1252	87.9	61.3	27.6	11.1	5.1	51.8	1.6	0.8	29.6	8870
(2-4)			90.9	62.1	34.2	3.7	5.2	57.4	1.2	0.5	31.9	9600
(4-6)			90.1	60.0	37.2	2.8	5.2	58.3	1.2	0.6	32.1	9630
(6-8)			89.5	58.1	37.8	4.2	5.0	58.1	1.6	1.4	29.8	9490
FC4 (0-2)	Tyrrell	Creswell SE: 916	85.2	63.7	30.1	6.2	5.5	55.7	1.6	0.2	30.8	9780
(2-5)			87.2	61.9	30.7	7.4	5.4	57.9	1.5	0.4	27.4	10020
(5-8)			86.7	63.9	25.6	10.8	5.9	56.6	1.6	0.5	24.6	10230
AP522 (2-4)	Tyrrell	Creswell SE: 9658	85.6	63.8	32.8	3.4	5.6	58.5	1.7	0.3	30.5	9990
(4-6)			86.6	63.8	32.6	3.5	5.8	61.5	1.4	0.3	27.5	10670
(6-8)			85.8	64.3	32.7	3.0	5.9	61.6	1.3	0.3	27.9	10630
AP207 (0-2)	Dare	East Lake SE: 2672	89.3	62.4	33.6	4.1	5.3	57.5	1.8	0.4	30.9	9740
(2-4)			88.6	60.6	34.7	4.7	5.3	58.1	1.7	0.4	29.8	9880
(4-6)			90.0	60.8	31.9	7.3	5.4	56.1	1.8	0.6	29.9	9360
AP234 (0-2)	Dare	East Lake SE: 8357	88.2	63.7	33.0	3.3	5.6	59.0	1.3	0.3	30.5	10050
(2-4)			89.0	62.3	34.6	3.2	5.3	58.3	1.3	0.4	31.6	9650
(4-6)			86.1	61.5	34.3	4.2	5.3	57.2	1.7	0.4	31.2	9730
FC6 (0-2)	Dare	East Lake SE: 878	86.6	63.6	32.4	4.0	5.3	56.5	2.0	0.3	31.9	9320
(2-4)			87.9	61.3	34.8	3.9	5.1	56.3	1.7	0.4	32.6	9540
(4-7)			89.5	64.1	30.7	5.2	5.5	57.1	1.5	0.4	30.3	9980

Site No. (Depth-ft)	County	Topographic Quad.	H_2O %	Moisture Free									
				Volatile %	Fixed Carbon %	Ash %	H %	C %	N %	S %	O %	BTU/lb
AP127 (0-2)	Hyde	Engelhard E: 1521	72.0	59.8	28.5	11.6	5.2	52.7	1.6	0.4	28.6	8940
(2-4)			87.3	62.8	33.7	3.4	5.2	57.6	1.7	0.3	31.8	9690
(4-6)			88.5	63.5	33.7	2.8	5.0	54.9	1.3	0.3	35.7	10050
(6-8)			90.6	63.2	32.7	4.1	5.2	57.2	1.8	0.4	31.3	9830
(8-10)			90.8	62.2	30.2	7.6	5.2	56.2	1.7	0.8	28.5	9860
(10-12)			88.0	56.3	23.9	19.8	4.5	46.5	1.8	0.2	27.2	8130
FC49 (0-3)	Dare	Engelhard NE: 179	89.6	49.5	26.5	24.0	4.1	45.6	1.2	0.2	24.8	7650
FC48 (0-4)	Dare	Engelhard NE: 234	86.3	62.3	34.1	3.7	5.1	58.3	1.4	0.2	31.2	9790
FC47 (0-6)	Dare	Engelhard NE: 242	90.5	62.3	35.2	2.5	4.1	57.8	1.4	0.2	33.8	9620
AP626 (0-2)	Dare	Engelhard NE: 5699	81.1	60.1	31.8	8.1	4.7	54.2	1.7	0.6	30.7	9170
(2-4)			91.5	63.8	33.7	3.0	5.0	59.1	1.4	0.5	30.9	9970
FC5 (0-2)	Dare	Engelhard NE: 593	83.9	64.8	31.8	3.4	5.6	59.7	1.2	0.3	29.8	10390
(2-6)			85.4	65.3	30.7	4.0	5.9	60.5	1.0	0.4	28.2	10570
FC50 (0-6)	Dare	Engelhard NW: 433	93.3	65.4	30.2	4.4	5.6	56.7	1.9	0.4	30.8	9800
FC45 (0-3)	Dare	Engelhard NW: 615	90.8	61.7	28.7	9.7	5.4	52.4	2.1	0.4	30.0	9040
FC46 (0-5)	Dare	Engelhard NW: 693	90.3	57.2	33.2	9.6	5.6	53.6	1.4	0.2	29.5	8790
FC46B (0-5)	Dare	Engelhard NW: 693	91.1	63.6	33.0	3.4	5.1	55.7	1.6	0.2	33.8	9330

Site No. (Depth-ft)	County	Topographic Quad.	H_2O %	Moisture Free: Volatile %	Fixed Carbon %	Ash %	H %	C %	N %	S %	O %	BTU/lb
AP73 (0-2)	Hyde	Fairfield: 2986	33.8	53.7	42.1	4.2	4.5	60.2	1.4	0.2	29.6	9960
(2-4)			78.5	58.3	39.6	2.1	4.5	62.2	1.1	0.2	29.9	10300
(4-6)			83.8	60.7	36.1	3.2	4.8	60.3	1.2	0.3	30.1	10220
(6-8)			63.9	16.1	9.5	74.4	1.4	18.8	0.5	0.1	4.8	2560
AP158 (1-2)	Hyde	Fairfield NE: 8474	77.2	61.2	33.2	5.6	4.9	55.8	1.7	0.2	31.8	9380
(2-4)			86.8	61.4	33.2	5.4	4.9	55.8	1.6	0.4	31.9	9440
(4-6)			88.8	61.1	32.1	6.8	4.8	55.3	1.6	0.4	31.0	9460
(6-8)			89.6	59.3	28.8	11.9	4.8	52.6	1.7	0.9	28.1	9100
A63 (2-4)	Hyde	Fairfield NE: 9436	84.1	53.6	29.7	16.7	4.1	49.4	1.3	0.6	27.8	8270
(4-6)			87.5	56.4	34.1	9.5	4.3	54.5	1.3	0.7	29.9	9090
(6-8)			89.5	62.8	34.1	3.1	4.9	58.2	1.4	0.6	31.8	9900
(8-10)			90.0	63.9	29.8	6.3	5.3	57.8	1.5	1.1	28.0	10160
(10-12)			89.7	61.9	30.6	7.5	5.0	55.4	1.4	2.6	28.1	9700
(12-14)			90.7	61.4	28.9	9.7	4.9	52.9	1.5	2.9	28.1	9250
AP121 (0-2)	Tyrrell	Fairfield NW: 2736	78.8	60.7	32.6	6.7	4.7	53.9	1.6	0.9	32.2	9070
(2-4)			86.9	59.1	35.6	5.3	4.3	56.6	1.5	0.7	31.6	9520
(4-6)			86.7	59.1	34.8	6.1	4.5	56.6	1.7	0.7	30.4	9540
AP637 (0-2)	Tyrrell	Frying Pan: 1541	85.6	60.9	31.4	7.7	5.0	55.8	1.7	0.3	29.5	9560
(2-4)			90.1	60.5	29.8	9.7	5.1	53.6	1.8	0.4	29.4	9270
(4-6)			90.4	54.3	27.6	18.1	4.4	47.3	1.7	0.5	28.0	8060
FC2 (0-2)	Tyrrell	New Lake: 226	81.0	66.9	28.3	4.8	5.4	57.9	2.0	0.3	29.6	10010
(2-3)			84.4	66.4	29.1	4.5	5.8	60.5	1.5	0.2	27.5	10690
(3-6)			86.3	66.0	29.2	4.8	5.7	61.8	1.4	0.2	26.1	10850
(6-9)			85.1	63.3	26.5	10.2	5.6	58.7	1.1	0.3	24.1	10580

				Moisture Free									
Site No. (Depth-ft)	County	Topographic Quad.	H_2O %	Volatile %	Fixed Carbon %	Ash %	H %	C %	N %	S %	O %	BTU/lb
AP347 (0-2)	Hyde	New Lake: 4745	76.6	59.0	38.9	2.1	4.4	59.8	1.4	0.2	32.1	9940
(2-4)			81.8	59.9	38.5	1.6	4.6	61.7	1.1	0.2	30.8	10360
(4-6)			85.3	61.9	36.3	1.8	5.1	60.8	1.2	0.3	30.8	10320
(6-8)			85.7	62.4	34.8	2.8	4.9	60.2	1.2	0.3	30.6	10350
(8-10)			84.5	59.3	31.3	9.4	5.0	56.9	1.2	0.4	27.1	9870
FC60 (1-4)	Hyde	New Lake : 876	82.4	50.7	27.0	22.3	4.4	48.1	1.5	0.4	22.3	8360
FC59 (1-7)	Hyde	New Lake: 887	88.3	61.6	34.4	4.0	5.4	59.0	1.7	0.4	29.5	10200
FC9 (0-5)	Washington	New Lake NW: 146	85.7	59.8	36.6	3.6	5.0	60.9	1.2	0.2	29.1	10240
FC8 (0-6)	Washington	New Lake NW: 149	85.8	60.7	37.7	1.6	5.0	62.1	1.1	0.2	29.9	10400
FC27 (0-5)	Washington	New Lake NW: 164	86.6	59.1	38.1	2.7	5.0	61.1	1.2	0.2	29.6	10300
FC21 (0-8)	Washington	New Lake NW: 175	84.7	60.2	37.6	1.2	5.1	61.8	1.0	0.2	29.6	10330
FC28 (0-6)	Washington	New Lake NW: 183	87.7	58.0	37.2	4.9	4.8	58.7	1.1	0.2	30.2	9780
FC33 (0-8)	Washington	New Lake NW: 186	87.8	61.3	37.3	1.4	5.1	61.4	1.0	0.2	30.8	10350
FC1 (0-1)	Washington	New Lake NW: 241	80.3	57.5	39.5	3.0	4.8	60.9	1.4	0.1	29.8	10080
(1-3)			84.3	61.3	36.4	2.3	5.7	61.2	1.1	0.1	29.6	10430
(3-6)			83.8	63.4	33.9	2.7	5.8	61.4	1.0	0.2	28.9	10430
FC16 (0-6)	Washington	New Lake NW: 248	87.0	60.3	37.7	2.0	5.0	61.5	1.0	0.2	30.2	10360

Site No. (Depth-ft)		County	Topographic Quad.	H_2O %	Moisture Free								
					Vola-tile %	Fixed Carbon %	Ash %	H %	C %	N %	S %	O %	BTU/lb
FC17	(0-6)	Washington	New Lake NW: 271	87.4	61.1	36.5	2.4	5.1	61.4	1.1	0.2	29.8	10120
FC2	(0-1)	Washington	New Lake NW: 273	81.5	60.6	36.2	3.2	5.2	58.3	1.5	0.2	31.6	9820
	(1-2)			84.8	58.9	38.4	2.7	5.0	60.5	1.2	0.2	30.4	10170
	(2-4)			87.5	59.8	36.5	3.7	5.2	60.4	1.2	0.2	29.3	10280
	(4-6)			85.5	62.6	34.4	3.0	5.5	60.2	1.0	0.2	30.1	10430
FC18	(0-5)	Washington	New Lake NW: 274	86.7	60.5	37.7	1.8	5.2	61.9	1.1	0.2	29.8	10400
FC7	(0-5)	Washington	New Lake NW: 412	84.0	61.6	36.0	2.4	5.2	61.6	1.0	0.2	29.5	10250
FC10	(0-6)	Washington	New Lake NW: 414	87.4	60.7	37.1	2.2	5.1	61.8	1.1	0.2	29.4	10390
FC34	(0-7)	Washington	New Lake NW: 423	87.8	61.6	37.1	1.3	5.1	62.2	1.0	0.2	30.1	10460
FC35	(0-6)	Washington	New Lake NW: 425	86.7	61.5	36.8	1.6	5.0	61.7	1.0	0.2	30.3	10410
FC20	(0-6)	Washington	New Lake NW: 436	88.1	60.9	36.3	2.8	5.0	60.3	1.0	0.2	30.7	10040
FC11	(0-5)	Hyde	New Lake NW: 441	85.7	57.1	33.8	9.2	4.8	58.6	1.2	0.2	26.0	9790
FC12	(0-4)	Hyde	New Lake NW: 444	84.3	61.7	34.7	3.5	5.3	60.8	1.2	0.3	28.8	10340
FC36	(0-6)	Hyde	New Lake NW: 452	85.3	61.4	37.0	1.5	5.2	61.5	1.1	0.2	30.4	10270
FC37	(0-4)	Hyde	New Lake NW: 458	86.7	60.0	32.6	7.4	5.3	59.0	1.1	0.2	26.8	10100
FC23	(0-5)	Hyde	New Lake NW: 468	85.5	60.7	36.4	2.9	5.2	61.9	1.2	0.2	28.6	10580

Site No. (Depth-ft)	County	Topographic Quad.	H_2O %	Moisture Free: Volatile %	Fixed Carbon %	Ash %	H %	C %	N %	S %	O %	BTU/lb
FC22 (0-5)	Hyde	New Lake NW: 463	87.3	62.1	36.5	1.4	5.2	62.4	1.1	0.2	29.6	10750
FC38 (0-6)	Hyde	New Lake NW: 481	86.5	61.8	36.2	2.0	5.3	61.7	1.2	0.2	29.5	10380
FC39 (0-7)	Hyde	New Lake NW: 487	87.7	61.3	36.7	2.1	5.2	61.5	1.1	0.2	29.8	10370
FC24 (0-4)	Hyde	New Lake NW: 492	86.8	59.4	36.3	4.5	5.1	60.3	1.2	0.2	28.6	10280
FC25 (0-5)	Hyde	New Lake NW: 498	86.6	62.1	36.0	1.9	5.3	61.7	1.2	0.2	29.6	10620
FC19 (0-6)	Washington	New Lake NW: 511	87.4	60.7	37.6	1.7	5.2	61.5	1.0	0.2	30.3	10330
FC40 (0-6)	Hyde	New Lake NW: 713	85.3	62.0	35.4	2.6	5.1	61.4	1.0	0.2	29.5	10460
FC26 (0-5)	Hyde	New Lake NW: 732	86.2	62.4	35.1	2.5	5.5	61.8	1.2	0.2	28.8	10700
FC30 (Windrow)	Hyde	New Lake NW: 765	66.6	58.4	35.0	6.6	4.8	57.8	1.5	0.2	29.1	9410
AP805 (2-4)	Hyde	New Lake NW: 9626	51.4	59.6	38.3	2.1	4.7	61.4	1.2	0.2	30.4	10320
(4-6)			74.9	63.1	35.0	1.9	5.2	61.1	1.2	0.3	30.8	10530
(6-8)			84.0	61.3	35.0	3.7	5.0	59.6	1.3	0.6	29.8	10170
FC51 (0-3)	Hyde	New Lake SE: 119	81.2	50.1	31.5	18.4	4.0	51.4	1.3	0.2	24.6	8400
FC56 (?)	Hyde	New Lake SE: 169	84.8	45.4	28.2	26.3	3.6	46.2	1.2	0.1	22.5	7580

Site No. (Depth-ft)	County	Topographic Quad.		H_2O %	Moisture Free Vola-tile %	Fixed Carbon %	Ash %	H %	C %	N %	S %	O %	BTU/lb
AP43 (0-2)	Hyde	New Lake SE:	1888	72.9	60.9	35.4	3.7	4.5	58.1	1.3	0.2	32.2	9640
(2-4)				83.4	61.0	37.5	1.5	5.1	61.6	1.3	0.2	30.3	10400
(4-6)				85.9	65.2	31.6	3.2	5.7	60.8	1.5	0.3	28.5	10770
(6-8)				78.5	57.4	28.2	14.4	5.0	53.8	1.2	0.3	25.3	9620
FC58 (1-7)	Hyde	New Lake SE:	222	89.8	61.9	34.9	3.2	5.4	60.0	1.6	0.3	29.4	10300
FC57A (2-6)	Hyde	New Lake SE:	223	90.0	62.3	34.6	3.1	5.4	59.8	1.7	0.3	29.6	10260
FC57B (2-5)	Hyde	New Lake SE:	223	88.8	60.1	36.3	3.5	4.8	61.6	1.5	0.3	28.2	10150
FC55 (?)	Hyde	New Lake SE:	254	88.6	59.4	33.8	7.3	4.6	58.6	1.2	0.1	28.2	9770
FC54 (?)	Hyde	New Lake SE:	264	88.8	63.5	33.8	2.7	5.2	60.2	1.6	0.2	30.0	10140
FC52 (0-3)	Hyde	New Lake SE:	286	82.1	36.3	21.6	42.1	3.1	36.1	0.9	0.1	17.54	5860
FC53 (?)	Hyde	New Lake SE:	292	85.7	56.0	34.4	9.6	4.6	57.1	1.4	0.2	27.0	9460
FC62 (1-2)	Hyde	New Lake SE:	382	84.5	53.4	30.3	16.3	4.6	52.8	1.3	0.2	24.7	8910
FC61 (1-2)	Hyde	New Lake SE:	386	80.0	45.8	24.2	30.0	4.0	42.6	1.4	0.2	30.0	7280
AP34 (0-2)	Hyde	New Lake SE:	5572	70.2	59.3	37.4	3.3	4.6	59.6	1.4	0.2	30.9	10000
(2-4)				78.4	58.9	38.3	2.8	4.4	61.0	1.4	0.2	30.2	10160
(4-6)				78.0	62.4	34.5	3.1	5.2	61.0	1.2	0.3	29.4	10200
(6-8)				78.3	62.8	30.0	7.2	5.5	60.0	1.2	0.4	25.7	10710
FC31 (Windrow)	Hyde	Ponzer:	122	61.8	47.0	31.0	21.9	3.9	49.4	1.3	0.2	23.1	8170

				Moisture Free									
Site No. (Depth-ft)	County	Topographic Quad.	H_2O %	Vola-tile %	Fixed Carbon %	Ash %	H %	C %	N %	S %	O %	BTU/lb
FC32 (Windrow)	Hyde	Ponzer: 124	65.5	40.5	24.8	34.8	3.4	40.6	1.1	0.2	20.0	6760
FC44A (1)	Washington	Ponzer: 32	79.8	67.5	30.4	2.2	6.0	63.7	1.0	0.1	27.0	11180
B (1)			80.6	67.0	29.5	3.4	6.0	63.0	1.0	0.1	26.5	11000
C (1)			81.4	67.4	31.4	1.2	6.0	64.2	1.0	0.1	27.4	9710
D (sod)			—	62.2	32.0	5.8	4.8	58.4	1.3	0.1	29.5	9680
E (sod)			—	63.1	32.4	4.5	5.2	60.2	1.2	0.1	28.6	10030
F (sod)			—	63.2	32.2	4.6	4.9	58.8	1.2	0.1	30.2	10000
FC42 (0-5)	Washington	Ponzer: 365	82.4	55.7	32.5	11.8	4.6	56.7	1.0	0.2	25.7	9580
FC41 (0-5)	Washington	Ponzer: 368	84.3	61.2	36.5	2.3	5.1	62.2	1.1	0.2	29.0	10380
FC43 (0-5)	Washington	Ponzer: 394	84.6	60.3	36.6	3.1	5.1	61.5	1.0	0.2	29.0	10270
FC29 (0-5)	Washington	Ponzer: 397	82.9	61.2	35.4	3.4	5.2	61.3	1.1	0.2	28.7	10300
FC13 (0-5)	Hyde	Pungo Lake: 693	84.1	61.4	36.6	2.1	5.0	62.5	1.1	0.2	29.0	10530
FC14 (0-5)	Hyde	Pungo Lake: 696	84.1	61.7	35.5	2.8	5.1	61.8	1.0	0.2	28.9	10520
FC15 (0-4)	Hyde	Pungo Lake: 933	83.0	58.2	35.0	6.8	5.0	60.0	1.2	0.2	26.7	10170

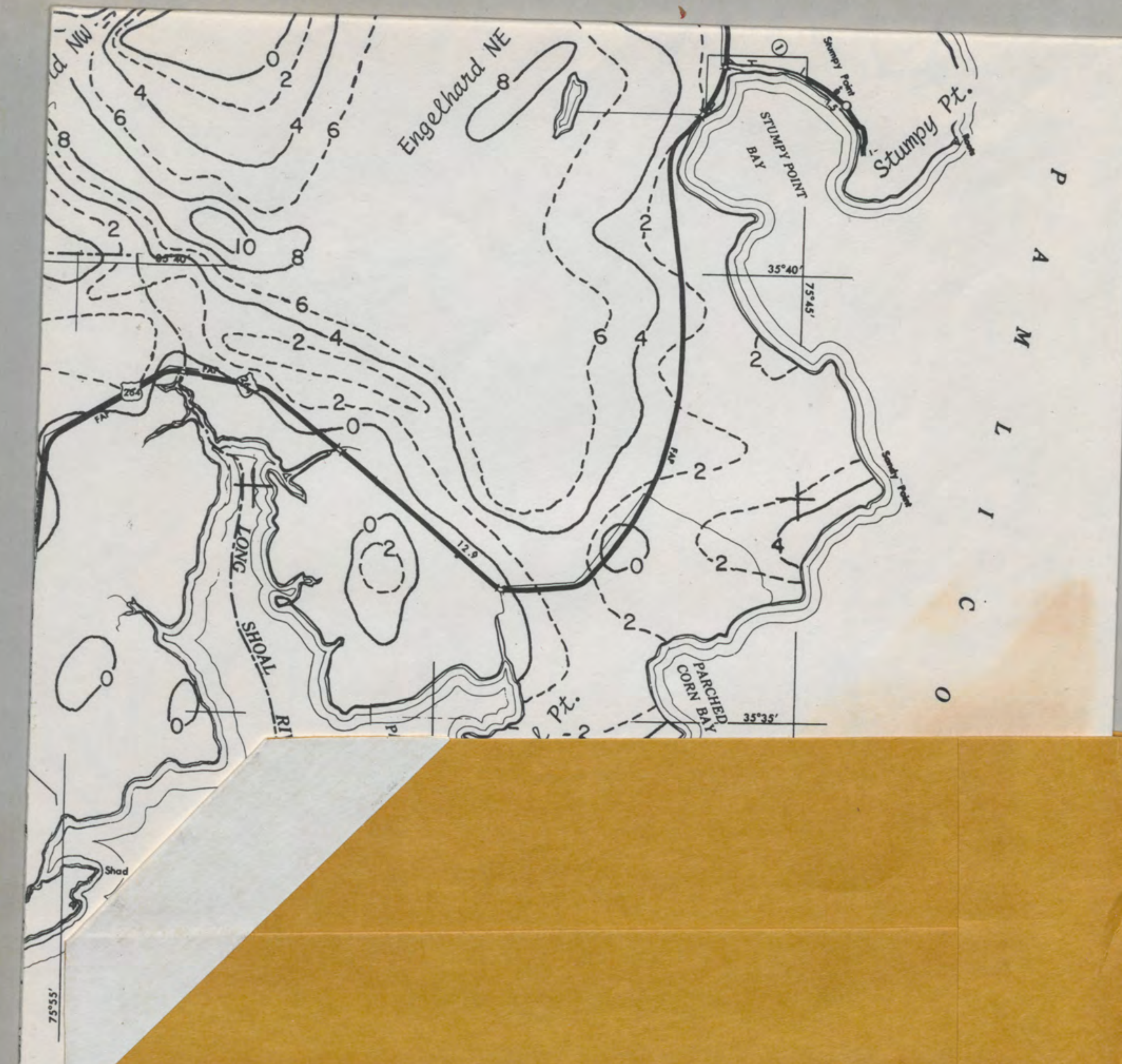

Engelhard NE
STUMPY POINT BAY
Stumpy Pt.
P A M L I C O
LONG SHOAL RI
PARCHED CORN BAY
35°40'
75°45'
35°35'
75°55'
Shad

PLATE I

ISOPACH MAP OF PAMLIMARLE PEAT

2 ft thickness interval.

+'s mark corners of orthophotographic maps.
Names of maps are in script letters.