

FIGURE 1.—Index map of Delaware showing location of the Harbeson Quadrangle.

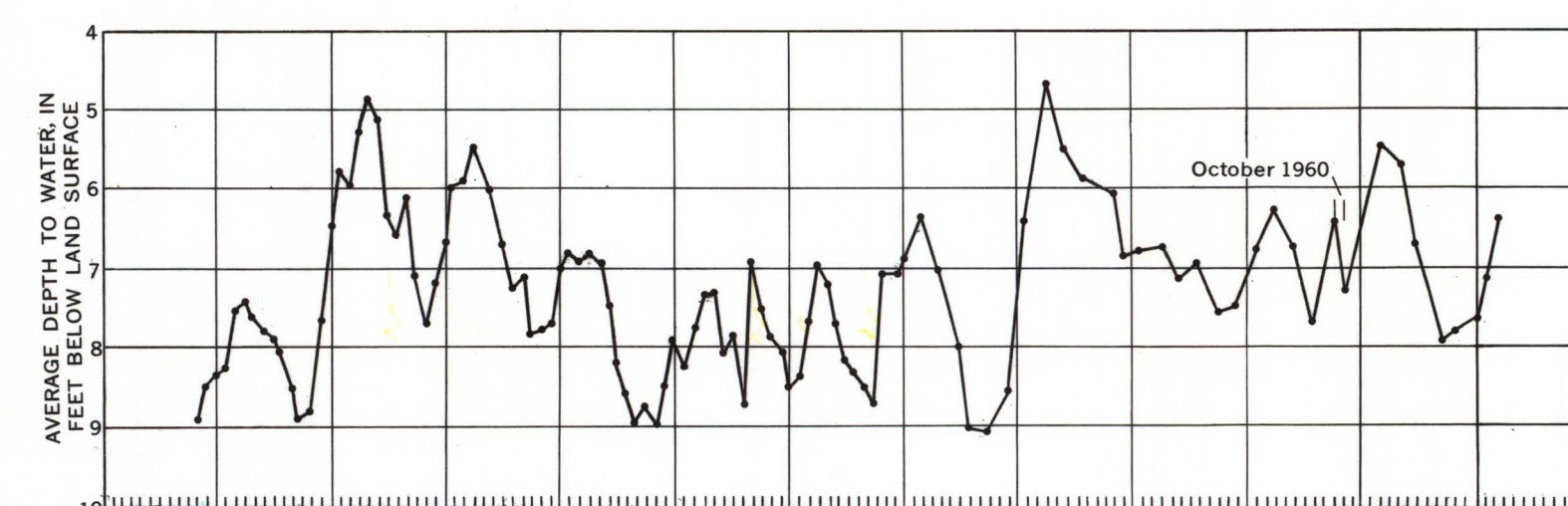


FIGURE 2.—Hydrograph showing average depth to water in 13 water-table wells in Delaware

General classification	Granular materials (25 percent or less passing a No. 200 sieve)							Silt-clay materials (more than 25 percent passing a No. 200 sieve)					
Coefficient of classification	A-1			A-2				A-4	A-6	A-7			
Group classification	a	b	A-3	4	5	6	7	A-4	A-6	A-7	8	9	A-8
Sieve analysis													
Percent passing													
No. 10 sieve	10 max.												
No. 20 sieve	10 max.	10 max.	10 max.	51 min.									
No. 40 sieve	10 max.	29 max.	29 max.	10 max.	19 max.	35 max.	35 max.	35 min.	38 min.	38 min.	38 min.	38 min.	38 min.
Characteristics of fraction passing No. 40 sieve													
Liquid limit													
Plasticity index													
Group index*	6 max.	5 max.	Nonplastic	10 max.	41 min.	10 max.	41 min.	40 max.	41 min.	40 max.	41 min.	40 max.	41 min.
Group index†	0	0	0	0	1 max.	11 min.	11 min.	10 max.	11 min.	10 max.	11 min.	11 min.	11 min.
Group index‡	0	0	0	0	0	4 max.	8 max.	12 max.	16 max.	16 max.	20 max.	20 max.	20 max.
General subsurface index													
Subgrade	Excellent			Good		Fair		Poor		Very poor		Unsuitable	
Material													
Well-sorted gravelly sand and gravel				Clean sand				Poorly sorted, clayey sand and gravel		Silty soil		Plastic silt	
				Coarsely sandy gravel						Plastic clay		Shale; thin bedded	

¹Plasticity index of A-7.5 subgroup is equal to or less than the liquid limit minus 30.
²Plasticity index of A-7.6 subgroup is greater than the liquid limit minus 20.
³The group index is calculated according to the following formula: Group index = $0.5a + 0.005ac + 0.01b$ in which: a = That portion of the percentage passing No. 200 sieve greater than 35 percent and not exceeding 75 percent, expressed as a positive whole number (1 to 40); b = That portion of the percentage passing No. 200 sieve greater than 15 percent and not exceeding 55 percent, expressed as a positive whole number (1 to 40); c = That portion of the numerical liquid greater than 40 and not exceeding 60, expressed as a positive whole number (1 to 20); d = That portion of the numerical plasticity index greater than 10 and not exceeding 30, expressed as a positive whole number (1 to 20).

TABLE 3.—Results of laboratory analyses of soil samples

Liquid limit: N_L , nonliquid											Plasticity index: N_P , nonplastic						
Sample ID and site nos.	Depth of cored samples (m)	Mechanical analyses										Liquid limit ¹	Plasticity index ²	Moisture-density ³		Classification HRB ⁴	Map symbol
		Cumulative percent by weight passing sieve		Percent by weight										Maximum density (ha. per cu. in.)	Optimum moisture (percent by weight)		
		3/4 in.	No. 4 (4.75 mm.)	No. 10 (2.0 mm.)	No. 20 (0.85 mm.)	No. 40 (0.425 mm.)	No. 60 (0.25 mm.)	No. 100 (0.15 mm.)	Silt (0.002 to 0.0075mm)	Clay (<0.00075 mm)							
232	0-4	100	99.8	99.6	99.1	97.0					NL	NP			A-2-4 (3)	AM3	
	4-27	100	99.8	99.6	99.3	96.1					NL	NP	125	8	A-2-4 (3)		
	27-43	100	99.7	99.6	99.3	96.1					NL	NP	131	8	A-2-4 (3)		
233	0-3	100	99.7	99.6	99.1	98.0					NL	NP			A-2-4 (3)	AM2	
	3-7	100	99.6	99.5	98.9	97.2					NL	NP			A-2-4 (3)		
	27-54	100	97.7	96.5	94.6	20.1					NL	NP			A-2-4 (3)		
234	0-4	100	99.8	99.6	99.1	97.0					NL	NP			A-2-4 (3)	AM2	
	4-10	100	99.9	99.8	99.5	98.0					NL	NP	124	6	A-2-4 (3)		
	24-48	100	99.4	97.6	95.7	23.0		15	6	NL	NP	127	7	A-2-4 (3)			
235	0-3	100	99.3	99.0	98.3	96.1					NL	NP			A-2-4 (3)	AM2	
	3-10	100	99.7	99.6	99.3	98.0					NL	NP			A-2-4 (3)		
	7-28	100	99.7	99.6	98.8	15.1					NL	NP			A-2-4 (3)		
236	0-4	100	99.8	99.6	99.1	97.0					NL	NP			A-2-4 (3)	AM3	
	4-10	100	99.8	99.6	99.3	96.1					NL	NP			A-2-4 (3)		
	23-40	100	99.8	99.9	99.9	9.9					NL	NP			A-2-4 (3)		
237	0-4	100	99.4	99.4	98.4	96.1					NL	NP			A-2-4 (3)	AM2	
	18-27	100	98.6	96.4							NL	NP			A-2-4 (3)		
	27-33	100	99.6	99.6	99.6	96.1	17.1				NL	NP			A-2-4 (3)		
238	0-3	100	99.7	99.3	98.9	96.1					NL	NP			A-2-4 (3)	AM2	
	3-10	100	99.9	99.8	99.4	98.2					NL	NP			A-2-4 (3)		
	20-39	100	99.6	99.3	98.4	22.6			28	33	14	124	10	A-2-4 (3)			
239	0-3	100	99.9	99.9	99.8	98.2					NL	NP			A-2-4 (3)	AM26	
	3-20	100	99.9	99.9	99.8	98.2					NL	NP			A-2-4 (3)		
	23-30	100	99.6	99.6	98.6	19.7					NL	NP			A-2-4 (3)		
260	0-4	100	99.8	99.8	98.8	96.1					NL	NP			A-2-4 (3)	AM24	
	4-23	100	99.8	99.8	99.8	96.1					NL	NP			A-2-4 (3)		
	32-53	100	99.9	99.9	99.3	21.3		14	28	25	8	128	11	A-4 (1)			
261	0-4	100	99.4	98.8	98.8	96.1					NL	NP			A-2-4 (3)	AM2	
	4-23	100	99.4	98.8	98.8	96.1					NL	NP			A-2-4 (3)		
	28	100	99.6	99.2	98.4	14.4					NL	NP			A-2-4 (3)		
2B	8-54			99.7	98.5	14.4					NP	<10			A-2-4 (3)	AM24	
	54-70			99.7	98.5	14.4					NP	<10			A-2-4 (3)		
	70-84			99.8	98.6	14.4					NP	<10			A-2-4 (3)		
1C	0-14		99.3	92.8	83.0						<40	<10			A-4 (1)	AM24	
	14-27		99.9	98.8	95.0						<40	<10			A-2-4 (3)		
	56-72		99.9	98.9	85.0	10.9					<40	<10			A-2-4 (3)		
1D	0-12		99.9	99.8	99.7	98.6					<40	<10			A-2-4 (3)	AM2	
	12-42		99.9	99.8	99.7	98.6	99.1	22.8			<40	<10			A-2-4 (3)		
	59-73		99.9	99.8	99.7	98.6	99.1	22.8			<40	<10			A-2-4 (3)		
2A	0-10		99.1	81.4	62.5						<40	<10			A-2-4 (3)	AM2	
	10-27		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
	44-72		100	98.1	28.1						<40	<10			A-2-4 (3)		
2B	0-10		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)	AM26	
	10-27		100	99.6	96.6						29	12			A-6 (6)		
	82-72		100	99.6	96.6						<40	<10			A-2-4 (3)		
2C	0-10		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)	AM24	
	10-27		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
	53-73		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
2D	0-12		99.1	82.1	27.1						<40	<10			A-2-4 (3)	AM24	
	12-46		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
	46-72		100	99.8	92.9	26.1					<40	<10			A-2-4 (3)		
2E	10-36		99.9	99.1	92.0						<40	<10			A-2-4 (3)	AM2	
	36-72		99.9	99.1	92.0						<40	<10			A-2-4 (3)		
	72-84		99.9	99.1	92.0						<40	<10			A-2-4 (3)		
3A	0-14		99.7	89.4	38.4						<40	<10			A-4 (3)	AM14	
	14-23		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
	38-72		99.1	52.0	11.5						<40	<6			A-1-15 (3)		
3B	0-10		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)	AM2	
	10-23		99.4	77.7	23.9						<40	<10			A-2-4 (3)		
	50-72		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
3C	0-14		99.6	83.6	34.6						<40	<10			A-2-4 (3)	AM2	
	14-23		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
	50-72		100	91.3	24.1						NL	NP			A-2-4 (3)		
3D	0-12		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)	AM2	
	12-31		99.8	82.6	21.6						<40	<10			A-2-4 (3)		
	31-72		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
3E	0-12		97.4	79.1	26.1						<40	<10			A-2-4 (3)	AM2	
	12-42		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
	42-72		99.5	62.7	19.0						<40	<10			A-2-4 (3)		
4A	0-14		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)	AM26	
	14-28		99.9	97.1	86.1						31	14			A-6 (10)		
	48-72		99.4	37.6	7.4						<40	NP			A-3 (3)		
4C	0-14		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)	AM24	
	14-50		99.1	91.3							21	9			A-3 (3)		
	50-72		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
4D	0-10		100	75.1	17.1						<40	<10			A-2-4 (3)	AM24	
	10-23		99.9	89.9	39.9						<40	<10			A-2-4 (3)		
	44-83		100	93.0	39.2						28	NP			A-4 (1)		
5A	0-13		99.8	81.8	21.8						<40	<10			A-2-4 (3)	AM2	
	13-41		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
	41-72		99.5	80.9	13.1						<40	<10			A-2-4 (3)		
5B	16-42		99.1	87.1	37.5						<40	<10			A-2-4 (3)	AM2	
	42-72		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
	0-12		99.9	80.0	11.1						<40	<10			A-2-4 (3)		
5E	0-20		99.8	89.4	14.2						<40	<10			A-2-4 (3)	AM2	
	20-72		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
	50-72		99.9	89.4	21.3						<40	<10			A-2-4 (3)		
6A	14-48		99.8	81.8	37.8						<40	NP			A-4 (1)	AM24	
	48-72		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
	0-10		99.0	78.1	30.9						<40	<10			A-2-4 (3)		
6B	10-23		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)	AM12	
	23-72		97.7	46.1	24.1						<40	<6			A-1-15 (3)		
	38-72		99.4	71.6	7.6						<40	NP			A-3 (3)		
6D	0-10		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)	AM2	
	10-23		99.9	98.9	95.0	10.9					<40	<10			A-2-4 (3)		
	10-42		97.3	87.7	19.7						<40	<10			A-2-4 (3)		

TABLE 4.—Characteristics of the engineering soil types in the Harbeson Quadrangle

Soil type ^a	Description	Origin	Engineering properties				Suitable compaction equipment
			In place	Disturbed ^b	Compaction characteristics		
			Suitability as a subgrade ^c	Suitability as a wearing surface ^d	Suitability as subbase material		
AM12	Nonplastic to slightly plastic, gravelly and sandy soil.	Fluvial deposits of Pleistocene age.	Excellent	Good if surface is A-1. Excellent to good, depending on binder, if surface is A-2.	Excellent	Excellent	Rubber-tired equipment.
AM3	Nonplastic to slightly plastic sandy soil.	Fluvial deposits of Pleistocene age.	Good	Excellent to good depending on binder present.	Good	Good	Rubber-tired equipment.
AM23	Nonplastic, generally poorly graded sandy soil.	Fluvial deposits of Pleistocene age.	Good to fair	Excellent to good depending on binder present if surface is A-2. Fair if surface is A-3.	Good if predominant material is A-2. Fair if predominant material is A-3.	Good if predominant material is A-2. Fair if predominant material is A-3.	Rubber-tired equipment for soil which is predominantly A-2. Vibratory equipment for soil which is predominantly A-3.
AM24	Nonplastic to slightly plastic, sandy and silty soil.	Fluvial deposits of Pleistocene age.	Good if material left after grading is predominantly A-2. Fair if surface is A-2, after grading is predominantly A-4.	Excellent to good depending on binder present, if surface is A-2. Fair to poor if surface is A-4.	Good if predominant material is A-2. Fair if predominant material is A-4.	Good if predominant material is A-2. Fair if predominant material is A-4.	Rubber-tired equipment.
AM28	Nonplastic to highly plastic, sandy and clayey soil.	Fluvial deposits of Pleistocene age.	Good if material left after grading is predominantly A-2. Poor if surface is A-2, after grading is predominantly A-4.	Good if surface is A-2. Poor if surface is A-4.	Pair if predominant material is A-2. Very poor if predominant material is A-4.	Pair if predominant material is A-2. Poor if predominant material is A-4.	Rubber-tired equipment for soil which is predominantly A-2. Sheeps'-foot rollers for soil which is predominantly A-4.
AM3	Nonplastic, poorly graded sandy soil.	Fluvial deposits of Pleistocene age.	Fair	Fair	Fair	Poor	Vibratory equipment.
AM4	Slightly plastic, silty and clayey soil.	Fluvial and possibly eolian deposits of Pleistocene age.	Fair to poor	Fair to poor	Fair to poor	Fair to poor	Rubber-tired equipment.
AM46	Slightly plastic to highly plastic, silty and clayey soil.	Fluvial, paludal, and lacustrine deposits of Pleistocene age.	Good if material left after grading is predominantly A-4. Very poor if material left after grading is predominantly A-6.	Good if surface is A-4. Very poor if surface is A-6.	Poor if predominant material is A-4. Poor if predominant material is A-6.	Poor	Sheeps'-foot rollers.
AR	Alluvial gravel, sand, silt, and clay.	Alluvium of Recent age.	Variable	Variable	Variable	Variable	Variable.
Z	Soil rich in organic material and frequently poorly drained. May be underlain at shallow depths by gravel, sand,	Swamp deposits of Recent age.	Variable	Variable	Variable	Variable	Variable.

¹ Two different soil types may be combined into a single map symbol (AM2/4), but the engineering characteristics of the individual soil types are described separately.