SCHOOL OF CIVIL ENGINEERING

JOINT HIGHWAY RESEARCH PROJECT

JHRP-78/3

ENGINEERING SOILS MAP OF HENDRICKS COUNTY, INDIANA

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PURDUE UNIVERSITY
INDIANA STATE HIGHWAY COMMISSION

Final Report

ENGINEERING SOILS MAP OF HENDRICKS COUNTY, INDIANA

TO: H. L. Michael, Director
Joint Highway Research Project

April 4, 1978

File: 1-5-2-61

FROM: D. G. Shurig, Research Associate
Joint Highway Research Project

Project: C-36-51B

The attached report entitled "Engineering Soils Map of Hendricks County, Indiana" completes a portion of the project concerned with development of county engineering soils maps of the State of Indiana. This is the 61st report in the series. The report was prepared by Professor D. G. Shurig, Joint Highway Research Project.

The soils mapping of Hendricks County was performed primarily by using the soil survey map sheets published by the Soil Conservation Service, United States Department of Agriculture in the soil survey of Hendricks County. Airphoto interpretation techniques were used to supplement the pedological data. The resulting engineering soils map is presented as a blackline print.

Respectfully submitted,

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by

D. G. Shurig
Research Associate

Joint Highway Research Project

Project No.: C-36-51B

File No.: 1-5-2-61

Prepared as Part of an Investigation

Conducted by

Joint Highway Research Project
Engineering Experiment Station
Purdue University

in cooperation with the

Indiana State Highway Commission

Purdue University
West Lafayette, Indiana
April 4, 1978

ENGINEERING SOILS MAP OF HENDRICKS COUNTY, INDIANA

INTRODUCTION

Development of an engineering soils map of Hendricks County was the primary goal of this project. The map is appended to this report; the report supplements the engineering soils map information.

The detailed pedological soils maps published in the 1974 Soil Survey of Hendricks County by the United States Department of Agriculture Soil Conservation Service in cooperation with the Purdue University, Agricultural Experiment Station (3) were the single most important sources of data used in the project. These agricultural soils map sheets, at a scale of 1:15,840, were assembled to form a mosaic map of Hendricks County. Careful study of the soil series descriptions enabled the grouping of the series into appropriate land form and parent material categories. Preliminary land form and parent material boundaries were then delineated on the mosaic map.

Routine airphoto interpretation techniques supplemented the pedological data. Aerial photographs were examined and the preliminary boundaries checked and modified, if necessary, to produce final land form and parent material boundaries. The photographs were contact prints at an approximate scale of 1:20,000. Date of photography was 1937.

The final land form and parent material boundaries were graphically reduced to produce the engineering soils map (1 inch = 1 mile). Symbols were used to delineate the parent materials as grouped according to land form and origin. Textural symbols were superimposed to indicate the relative compositions of the parent materials. The map also includes a set of soil profiles which indicate the general soil profiles of topographically high and low sites in the land form parent material areas.

Each profile shows the general range in depth and texture of each soil horizon, the A-, B-, and C-horizons, the latter being the parent material. The soil texture classification system used in the map profiles is that of the Indiana State Highway Commission. The ISHC system differs slightly from the USDA system so that the use of USDA textures have to be converted to the ISHC textures - for example, a USDA classified loam could be a loam or clay loam under the ISHC system.

The soil profiles drawn on the left side of the engineering soils map have been numbered. Areas on the soils map have corresponding numbers to indicate the soil profile for that particular area in the field.

In the text of the report pedological soil names have been provided for each parent material soil area shown on the map. In Appendix B quantitative engineering soil test data is provided for each pedological soil name. In Appendix C qualitative data as to soil problems and certain advantageous soil uses are provided according to pedological soil names.

DESCRIPTION OF AREA

General

Hendricks County is located in central Indiana - see Figure 1. Danville, the county seat, is 18 miles west of Indianapolis.

County dimensions average about 21 miles in the north-south direction and about 20 miles east-west. The actual total area is 417 square miles.

> "Farming, mainly cash grain and livestock, is the main enterprise in the county. Corn and soybeans are the main crops. The most common practice is to feed the corn to hogs and cattle and to market the livestock.
>
> Much of the county has poor natural drainage and needs extensive systems of artificial drainage.
>
> In the past few years, industrial and housing developments have expanded in the eastern part of the county (3)".

Table 1. Some Significant Population Data for Hendricks County

Population Cities and Towns	Population 1970	Population 1960	Percent Change '60 - '70
Amo	422	437	-3.4
Brownsburg	5,186	4,478	15.8
Clayton	736	653	12.7
Coatesville	453	497	-8.9
Danville	3,771	3,287	14.7
Lizton	397	366	8.5
North Salem	601	626	-4.0
Pittsboro	867	826	5.0
Plainfield	8,211	5,460	50.4
Stilesville	352	361	-2.5
Cities & Towns	20,996	16,991	23.6
Rural Areas	32,978	23,905	38.0
County Total	53,974	40,896	32.0

	PROJECT	VOLUME ACRE FT	AREA ACRES
1	SALEM DAM	798	74
2	SCOTTSBURG RESERVOIR DAM	650	93
3	LIBERTY RESERVOIR DAM		8
4	LAKE LEMON	8,800	1,550
5	SEYMOUR WATER COMPANY DAM (REPAIRS)		
6	CEDARVILLE RESERVOIR DAM	1,550	1,200
7	MUSCATATUCK-NORTH VERNON DAM	2,050	185
8	MORSE RESERVOIR DAM	21,150	1,375
9	MUNCIE WATER WORKS DAM		
10	FERDINAND WATER WORKS DAM	112	10.5
11	PAOLI WATER WORKS DAMS (4)	14	4
		9	3
		7	2
		7	3
12	KOKOMO WATER WORKS OFF-CHANNEL RESERVOIR DAM	758	34
13	CORYDON WATER WORKS DAM (REPAIR AND RAISING CREST)	9	
14	BEAVER CREEK LAKE DAM, JASPER	2,770	205
15	U.S. GYPSUM CO., OFF-CHANNEL RESERVOIR DAM	123	12.5
16	GEORGETOWN RESERVOIR DAM	158	
17	OSGOOD DAM	92	25
18	TEMPORARY RESERVOIR FOR WESTPORT	20	
19	GREENSBURG RESERVOIR DAM	48	11
20	FRENCH LICK RESERVOIR DAM	93	.5
21	LANESVILLE RESERVOIR DAM	125	13.5
22	KOKOMO RESERVOIR DAM	3,370	520
23	COAL PROCESSING RESERVOIR DAM, SULLIVAN COUNTY	325	180
24	HOLLAND RESERVOIR DAM	179	23
25	CORYDON RESERVOIR DAMS (2)	76	27
		119	38
26	WASHING AND RECIRCULATING RESERVOIR, WARRICK COUNTY		80
27	MUNCIE RESERVOIR DAM	22,000	1,275
28	WESTPORT RESERVOIR DAM	52	
29	BATESVILLE RESERVOIR DAM	2,100	200
30	RICHMOND RESERVOIR DAM	3,095	175
31	CHRISNEY LAKE DAM	101	20
	TOTAL	78,939	7,263.5

NOTE:
78,939 VOLUME ACRE FEET EQUAL 25.72 BILLION GALLONS OF STORAGE

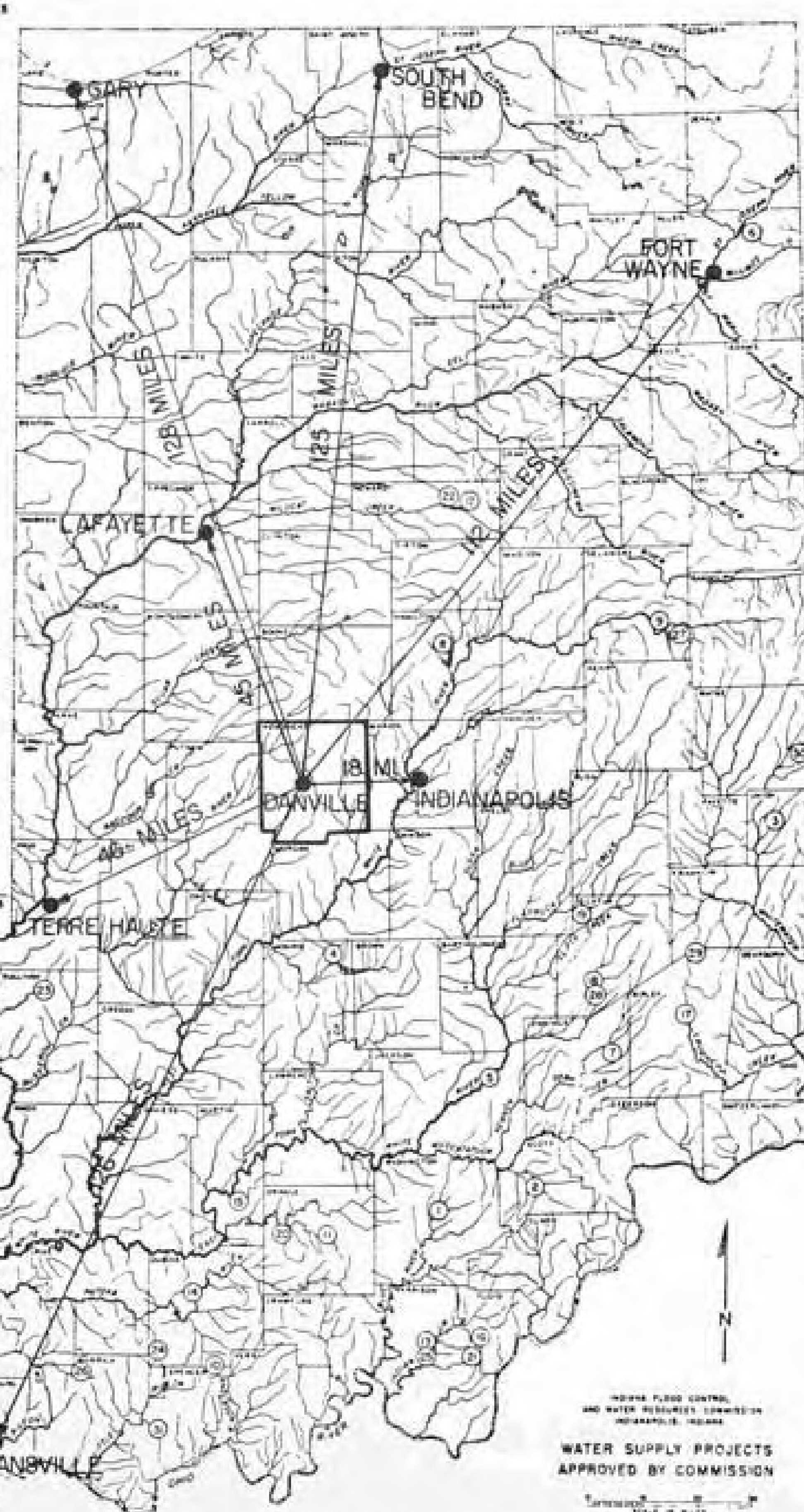


Figure 1. Location of Hendricks County and Danville, the county seat, relative to: (1) state boundaries, (2) other counties, (3) several cities, (4) major streams and (5) some water supply projects shown on a 1961 map - from Reference 9.

DRAINAGE FEATURES

Regional drainage features in and around Hendricks County are shown in Figure 1. All of the drainage ways in Hendricks County eventually reach the West Fork of White River, with the exception of one small portion in the northwest, which drains to Raccoon Creek and thence to the Wabash River - see Figure 1.

Drainage features of Hendricks County are shown in Figure 2, "Drainage Map - Hendricks County, Indiana", prepared by the Joint Highway Research Project (JHRP), Purdue University, 1954 (6). Larger scale maps of one mile to the inch, or two miles to the inch, can be obtained by contacting JHRP, School of Civil Engineering. Both the large and small maps are two dollars each plus tax but no postage charge.

Interstate routes I-74, I-70, and I-65 were constructed after the drainage map was printed and so they do not appear on the drainage map. Undoubtedly drainage for the interstate produced numerous changes in the immediate vicinity and, of course, these do not show on the map. There has also been considerable other road construction and the development of housing, industry and ditching to produce drainage changes since 1954.

The principal stream in Hendricks County is White Lick Creek. This creek has its headwaters in Boone County about three miles north of the Hendricks County line. It flows in a southerly direction throughout the entire length of Hendricks County and is located about five or six miles inside the eastern county boundary. White Lick Creek and its tributaries, West Fork, East Fork, Abner Creek, and Clark's Creek drain the eastern half of Hendricks County.

The southwestern portion of Hendricks County is drained by Mill Creek, the East Fork of Mill Creek, Mud Creek, Crittenden Creek and Miller Creek. The northwestern portion of the county is drained by the West, East, and Middle Forks of Big Walnut Creek and Ramp Run. These creeks also flow mainly southwesterly.

CLIMATOLOGICAL SUMMARY

The nearest weather station to Hendricks County is in Greencastle, in Putnam County, on the western border of Hendricks County. The following two pages contain a climatological summary of Putnam County temperature

FIG. 2. DRAINAGE MAP OF HENDRICKS COUNTY

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU
IN COOPERATION WITH PURDUE AGRICULTURAL EXPERIMENT STATION
CLIMATOGRAPHY OF THE UNITED STATES NO. 20 – 12

LATITUDE 39° 39' N.
LONGITUDE 86° 51' W.
ELEV. (GROUND) 835 Ft.

CLIMATOLOGICAL SUMMARY

STATION GREENCASTLE, INDIANA

MEANS AND EXTREMES FOR PERIOD 1934-1963

Month	Temperature (°F)							**	Precipitation Totals (Inches)									Mean number of days					Month
	Means			Extremes				Mean degree days				Snow, Sleet					Precip. .10 inch or more	Temperatures					
																		Max.		Min.			
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Mean	Greatest daily	Year	Mean	Maximum monthly	Year	Greatest daily	Year		90° and above	32° and below	32° and below	0° and below	
(a)	30	30		30		30		30	30	30		30	30		30		10	27	27	27	27	
Jan.	38.0	21.2	29.6	71	1950	-13	1940	1073	3.00	4.36	1950	4.8	15.9	1956	5.4	1937	5	0	10	26	2	Jan.
Feb.	41.0	23.0	32.0	73	1957	-20	1951	913	2.33	2.28	1956	4.7	19.4	1961	9.0	1960	6	0	6	23	1	Feb.
Mar.	50.3	30.9	40.7	81	1945	-8	1943	763	3.48	2.39	1953	4.3	19.8	1960	7.5	1953	7	0	2	18	*	Mar.
Apr.	63.1	41.8	52.4	89	1954	19	1950+	378	3.81	2.47	1956	0.7	6.1	1940	6.0	1940	7	0	0	6	0	Apr.
May	73.8	51.7	62.8	93	1962+	28	1947	149	4.85	3.58	1961	T	T	1960+	T	1960+	8	1	0	*	0	May
June	83.3	61.1	72.2	105	1954	39	1945	27	5.30	6.50	1952	0	0		0		7	6	0	0	0	June
July	87.2	64.0	75.6	108	1936	46	1937	0	3.59	4.63	1962	0	0		0		6	10	0	0	0	July
Aug.	86.0	62.6	74.3	102	1955	42	1934	0	3.56	5.12	1934	0	0		0		5	9	0	0	0	Aug.
Sept.	79.4	55.0	67.2	106	1954	28	1942	81	3.85	6.33	1950	T	T	1951+	T	1951+	4	4	0	*	0	Sept.
Oct.	68.5	44.9	56.7	93	1953	19	1962+	291	2.66	2.30	1959	T	1.2	1962	1.0	1962	6	*	0	3	0	Oct.
Nov.	51.3	33.1	42.2	85	1950	-6	1950	681	3.29	2.35	1938	1.8	7.1	1950	5.0	1950	6	0	2	15	*	Nov.
Dec.	39.8	23.6	31.7	70	1959	-14	1951	1017	2.51	2.16	1956	5.1	13.3	1963	6.5	1943	6	0	8	24	1	Dec.
Year	63.5	42.7	53.1	108	July 1936	-20	Feb. 1951	5373	42.21	6.50	June 1952	20.9	19.8	Mar. 1960	9.0	Feb. 1960	76	30	28	116	4	Year

(a) Average length of record, years.

T Trace, an amount too small to measure.

** Base 65°F

+ Also on earlier dates, months, or years.

* Less than one half.

CLIMATE OF GREENCASTLE, INDIANA

Greencastle, located in Putnam County in West Central Indiana, has an invigorating climate because of the frequent changes of the weather. Pleasant, cloudless days are interspersed with some rainy days throughout the year. Monsoon rains are unknown but rainfall is usually adequate in all seasons favoring a diversified agriculture. In the summer when moisture utilization is high, a dry month of below normal rainfall affects lawns, pastures, and crops.

Weather changes every few days come from the passing of weather fronts and associated centers of low and high air pressure. In general, a high brings lower temperatures, lower humidity and sunny days. An approaching low brings increasing temperatures, increasing southerly wind, higher humidity, and commencement of rain or showers. This activity is greatest in the spring and least in late summer and early fall.

Precipitation is rather evenly distributed throughout the year, a happy contrast to some areas of the United States that have a "dry season" and require irrigation to maintain green vegetation. The table of monthly rainfall for past years in this report shows the variation of rainfall that may be expected. There is a tendency for spring and early summer rains to exceed winter precipitation. The spring rains are very reliable insuring near maximum soil moisture going into summer when evaporation losses exceed rainfall and dry soils become more probable. A severe drought has never been experienced. About one-third of the annual rainfall flows into streams and out of the area. Future needs may require conservation of this water.

The probability for unusually heavy rains in just a few hours is indicated by a weather study of the area:

Frequency in 100 years	Rain in 1 hour	6 hours	12 hours
4	2.4	4.0	4.6
10	2.1	3.3	3.8
20	1.7	2.8	3.2

Snowfall has varied reception. None occurs in the summer. Some winters have much snow and others have very little. An occasional snow storm may hamper travel and clog roads but at the same time the snow blanket protects winter grains from the very cold air that invariably follows. Heaviest snow storms are those out of the southwest. As they swirl northeastward, abundant moisture flows in from the Gulf of Mexico. A storm out of the northwest, with an inward flow of colder, drier air, leaves less snow. Some mid-winters are thus cold but snowfall is normal or less.

Relative humidity is not measured at this station but estimates are possible from the climatology of the area. Relative humidity varies on sunny summer days from a percent in the 40's in the early afternoon to the 90's about sunrise. Relative humidity rises and falls much as temperature does during a typical day but the highest percent usually occurs with the minimum temperature and the lowest percent with the maximum temperature. A cold front is next in importance in changing relative humidity downward.

Winds blow most frequently from the southwest, however, in one or two of the winter months, prevailing winds are northwest. Damaging winds have three sources. In the order of diminishing area coverage but increasing intensity, they are: lows passing through the region, thunderstorms, and tornadoes. Only 6 tornadoes have been reported in the county since 1916. Very few were of sufficient size to injure people and property. Thunderstorms, including incidences of lightning and thunder, occur about 47 days of the year. Most of these occur in the spring and early summer. They are seldom so severe as to cause loss of life, property, or crops. Death dealing smog or fog is unknown.

Heating degree days in the above table provide a comparative number for calculating heating requirements between different places and different times. Fuel consumption for heating is proportional to degree day totals, so a month with twice the heating degree days of another month requires twice as much fuel for heating. Degree days for a single day are obtained by subtracting the mean temperature from 65 degrees.

The growing season (defined here as the number of days between the last spring and first fall temperature of 32°) averages 175 days in length. The season is 195 days or more in 10% of the years, 185 days or more in 25% of the years, less than 165 days in 25% of the years, and less than 155 days in 10% of the years.

Many days of the year are nearly ideal in temperature. A few days in the summer when temperatures exceed 90, or decline below zero in the winter, tend to obscure this fact. The fall season is considered by many as the best time of year for outdoor activities. Spring is also a favorite season but actually this season has more days of rain and thunderstorms. In the fall the atmosphere in total seems more quiet. Air and soil temperatures are nearer in agreement than any other time of the year, thus, convective activity is diminished. Many days are sunny and showers are less frequent.

Lawrence A. Schaal
Weather Bureau State Climatologist
Purdue University, Agronomy Department
Lafayette, Indiana

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1934	34.0	24.1	37.0	52.4	65.8	77.2	80.2	72.9	65.0	56.2	45.8	29.6	53.6
1935	31.0	33.8	47.8	49.1	57.6	67.1	76.5	74.6	65.5	55.0	41.3	25.1	52.0
1936	22.0	22.3	44.6	47.6	65.0	71.8	82.0	79.5	69.6	54.2	38.5	35.8	52.7
1937	33.2	31.3	37.8	51.4	62.2	70.2	75.0	75.4	65.7	53.0	39.4	29.2	51.6
1938	29.0	39.8	48.2	54.5	61.8	68.9	74.5	74.7	68.2	58.7	45.6	33.6	54.8
1939	35.3	32.5	44.1	49.2	66.2	72.0	74.0	72.6	71.8	58.2	41.7	35.8	54.3
1940	15.9	32.2	38.4	49.7	59.0	72.4	74.2	74.7	64.2	59.0	41.4	37.0	51.8
1941	30.9	28.0	34.8	57.9	65.6	71.3	75.0	74.3	69.6	59.2	45.0	38.6	54.3
1942	30.1	28.8	44.6	56.6	62.8	70.9	74.9	71.8	64.6	56.8	44.3	28.7	53.1
1943	30.8	34.7	37.9	50.8	62.2	76.4	75.0	74.6	62.6	55.2	40.2	30.6	52.4
1944	34.4	34.7	38.6	51.5	68.8	75.6	76.0	75.0	68.0	56.2	45.6	24.8	54.2
1945	25.0	34.6	53.4	55.1	59.0	69.2	73.2	73.4	68.8	54.3	44.0	26.2	53.0
1946	31.2	38.0	54.2	55.2	60.4	72.0	75.3	70.0	67.2	60.3	47.5	37.4	55.6
1947	34.6	24.6	34.8	52.5	59.6	69.4	71.0	80.1	67.8	63.8	38.2	33.5	52.5
1948	23.0	32.7	42.2	57.0	62.0	74.0	76.3	74.2	68.4	55.2	47.1	33.4	53.8
1949	34.9	35.1	41.1	51.7	64.5	75.4	80.2	74.6	62.2	60.4	42.8	35.2	54.8
1950	37.1	32.7	37.0	48.4	65.4	70.9	73.4	71.3	64.8	59.9	36.9	23.8	51.4
1951	30.5	30.1	38.3	49.2	66.6	70.9	74.9	72.6	63.8	58.3	34.5	29.9	51.3
1952	32.2	35.3	40.1	53.5	61.7	76.9	77.2	71.8	66.6	51.2	44.8	34.4	53.8
1953	32.9	36.0	43.2	48.2	64.7	77.0	76.0	75.3	68.5	60.0	44.4	32.7	54.9
1954	29.9	39.5	37.8	56.7	59.0	76.8	78.4	75.1	70.8	56.4	41.1	31.7	54.5
1955	27.2	31.6	41.4	58.5	63.5	66.9	80.4	78.0	71.5	56.2	38.8	29.6	53.6
1956	27.8	33.1	41.0	49.6	63.5	73.3	74.4	74.1	65.8	60.5	42.2	37.6	53.6
1957	23.1	36.5	40.7	53.3	63.8	73.3	75.2	74.6	65.0	52.5	43.3	35.7	52.9
1958	28.8	23.9	35.7	53.0	61.8	67.8	75.2	72.9	66.2	55.1	44.6	23.2	50.5
1959	24.2	31.5	39.1	53.8	66.5	72.5	74.8	77.4	69.5	54.7	37.8	36.0	53.1
1960	30.8	27.9	26.0	56.7	59.0	69.3	72.8	74.6	70.9	55.0	43.9	25.6	51.1
1961	26.6	35.3	43.8	46.4	57.0	69.3	74.2	73.1	70.7	56.7	41.9	28.7	51.9
1962	24.3	30.8	38.8	51.3	69.9	72.5	73.6	73.2	63.5	57.1	42.3	26.3	51.8
1963	18.7	22.1	43.2	54.7	61.3	72.2	74.2	71.0	66.2	63.1	45.7	19.3	50.8
1964	31.2	29.5	39.4	56.3	67.0								

STATION HISTORY

This study of local climate is possible because a citizen of the community generously donated for many years a few minutes a day, seven days a week, reading and recording weather information from government instruments. The present observer is Grafton J. Longden, Jr. His weather station has been located one mile east of the Greencastle post office since January 22, 1947. Earlier observers, dates of service, and location if known are: Guy Wilson, September 10, 1895 to June 30, 1898; H. A. French, April 25, to August 31, 1899; H. V. Brown, September 1, 1899 to July 31, 1905; William Blanchard, November 1, 1905 to October 4, 1906; E. Hawkins, August 1, 1915 to December 31, 1915, at 18 South Vine Street; J. P. Allen, January 7, 1916 to June 21, 1924; John H. Goddard, June 21, 1924 to February 20, 1928, 3 blocks west of the post office; Ernest Rice Smith, February 21, 1928 to November 22, 1943, and September 1, 1946 to January 20, 1947, 3/4 mile southeast of the post office at 309 Greenwood Avenue; Kenneth W. Bennett, November 23, 1943 to January 31, 1944, 0.4 mile south of the post office at 10 Park Street; and Orrin H. Smith, April 19, 1944 to August 31, 1946, 3/4 mile southwest of the post office at 310 Greenwood Avenue. Some of the time exposure of instruments was non-standard being over cultivated ground in the period of 1928-1943, and 1946-1947. The variation of station elevation above sea level at these locations is probably not significant climatologically.

EXTREMES AND DATES OF OCCURRENCE (1895-1963)

Month	Highest Temperature		Lowest Temperature		Greatest Daily Precipitation		Greatest Monthly Snowfall	
Jan.	71	1/26/50	-21	1/12/18	4.56	1/4/50	19.5	1918
Feb.	74	2/10/32	-20	2/2/51	2.48	2/25/26	19.9	1905
Mar.	86	3/24/29	-8	3/8/43	3.82	3/25/04	26.5	1906
Apr.	90	4/11/30+	17	4/1/23	3.40	4/11/22	6.1	1940
May	95	5/30/19	28	5/9/47	4.18	5/30/05	0.5	1897
June	105	6/27/34	36	6/16/17	6.50	6/21/12		
July	108	7/8/36	41	7/20/29	4.63	7/14/62		
Aug.	105	8/5/18	42	8/29/34	5.12	8/19/34		
Sept.	106	9/6/54	26	9/26/28	6.35	9/1/50	T	1951
Oct.	5	10/2/19	18	10/29/25	3.27	10/12/01	1.2	1962
Nov.	2	11/1/50	-6	11/25/50	2.35	11/18/38	7.1	1950
Dec.	70	12/28/59	-18	12/28/24	2.60	12/13/01	13.3	1963

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1934	1.28	0.49	2.41	2.38	1.13	3.44	2.53	10.35	6.92	0.27	3.65	2.07	36.92
1935	2.47	0.46	2.14	1.75	8.05	3.97	4.34	2.34	2.86	1.08	4.59	1.58	35.59
1936	1.24	2.63	1.79	3.64	1.52	0.66	1.14	2.34	6.76	4.69	3.90	2.96	33.27
1937	8.74	1.79	2.19	5.58	4.38	5.28	3.00	4.30	3.34	6.90	1.47	3.76	50.89
1938	1.17	3.08	9.25	5.92	6.05	5.07	7.42	4.95	1.26	1.04	4.37	2.11	49.65
1939	5.69	3.78	3.89	6.24	1.98	5.76	3.62	1.93	0.79	2.40	1.65	1.19	38.92
1940	1.91	2.15	1.79	6.14	4.05	5.51	1.00	5.35	1.21	1.42	4.13	3.11	37.79
1941	1.33	0.83	1.13	2.77	2.47	14.32	1.37	1.81	4.10	6.92	3.62	1.79	42.66
1942	1.38	4.03	3.08	3.05	3.86	2.70	4.73	2.65	2.68	1.44	5.42	2.27	44.72
1943	1.27	1.11	2.67	2.57	11.58	1.85	3.33	2.79	4.50	1.34	3.38	1.84	38.21
1944	0.26	2.75	3.61	7.04	3.45	4.30	2.51	3.89	1.43	1.75	3.05	1.36	34.87
1945	0.63	2.28	7.90	4.35	5.61	8.23	7.82	4.11	6.50	2.27	4.59	2.94	52.23
1946	1.60	2.96	2.32	1.21	11.00	1.88	1.89	3.51	1.44	2.31	3.77	3.88	37.83
1947	3.49	0.19	2.20	5.99	4.44	7.36	2.43	8.64	5.29	2.10	1.65	1.32	45.72
1948	2.18	2.15	7.41	2.18	3.45	4.77	4.90	-	3.59	2.52	5.23	3.21	-
1949	7.53	2.38	3.33	-	3.79	5.22	4.23	2.99	1.58	5.08	1.12	3.46	-
1950	13.68	4.59	3.83	4.73	1.10	6.29	3.18	1.32	14.32	1.20	5.62	2.10	61.45
1951	2.76	-	-	3.28	3.84	5.54	9.04	2.20	2.49	3.67	3.16	-	-
1952	3.23	2.39	5.21	4.15	3.41	9.11	2.24	2.66	2.72	0.36	3.28	2.07	40.87
1953	2.45	1.46	6.19	3.38	3.94	4.48	3.58	1.20	0.92	2.20	1.33	1.73	35.22
1954	2.32	2.17	3.25	2.27	2.64	1.80	2.87	3.18	1.23	4.62	1.49	2.78	31.03
1955	2.81	2.24	3.37	3.63	4.46	4.04	4.11	0.83	7.58	4.05	4.21	0.91	42.44
1956	1.41	5.23	1.50	5.09	5.04	3.12	2.82	3.45	1.61	2.18	3.11	4.58	41.72
1957	3.48	7.23	2.02	6.98	6.43	10.30	3.58	5.69	1.31	4.08	4.68	7.23	57.96
1958	1.49	0.54	1.52	2.61	6.07	8.33	7.00	4.17	4.79	2.09	4.39	0.16	40.58
1959	3.97	3.30	3.38	5.48	2.09	2.40	2.11	3.68	3.77	4.17	3.12	2.99	40.44
1960	2.42	3.73	1.43	1.56	5.21	6.71	2.00	4.54	2.33	1.39	2.09	2.29	36.88
1961	0.94	2.40	6.00	3.07	6.47	5.84	2.73	5.49	3.49	2.48	3.39	2.73	45.45
1962	4.52	2.32	3.48	1.60	5.99	2.93	6.18	3.02	11.02	1.63	1.45	1.40	47.54
1963	1.13	0.70	8.12	3.13	2.59	1.58	5.13	4.79	0.14	0.16	2.45	0.89	30.83
1964	1.51	2.15	6.46	8.39	1.82								

PROBABILITY OF LOW TEMPERATURES IN SPRING AND FALL

Minimum Temp.	Percent of occurrence after the date in spring					Percent of occurrence before the date in fall				
	90%	75%	50%	25%	10%	10%	25%	50%	75%	90%
40	5/5	5/12	5/20	5/28	6/4	9/16	9/22	9/28	10/4	10/10
36	4/23	5/1	5/9	5/15	5/21	9/21	9/27	10/4	10/11	10/17
32	4/14	4/20	4/27	5/4	5/10	10/5	10/11	10/19	10/27	11/2
28	3/25	4/1	4/10	4/19	4/26	10/16	10/23	10/31	11/8	11/15
24	3/6	3/15	3/25	4/4	4/13	10/27	11/2	11/9	11/16	11/22
20	2/26	3/7	3/16	3/25	4/3	11/4	11/12	11/20	11/28	12/6
16	2/13	2/23	3/6	3/17	3/27	11/16	11/25	12/4	12/13	12/22

This table summarizes for a 30-year period the dates when low temperatures such as 32°F. last occurred in the spring and first occurred in the fall. The average date is given in the 50% column. The table shows that the last temperature of 32° or lower in the spring occurs after May 4 in 25% of the years, and before October 11 in the fall. Probabilities for other temperatures are indicated. Reference: "Risks of Freezing Temperatures--Spring and Fall in Indiana," by L. A. Schaal, J. E. Newman, and F. H. Emerson.

and precipitation covering a 29-year period (1934-1963) prepared by the Greencastle station. Data was compiled by the U. S. Department of Commerce, Weather Bureau, in cooperation with the Purdue Agricultural Experiment Station.

GLACIAL GEOLOGY

Ice covered Hendricks County during at least three glacial ages - Kansan, Illinoian and Wisconsin. At present , essentially only Wisconsin drift is exposed at the surface. At least two ice sheets moved across Hendricks County in the Wisconsin age. All glacial land forms were produced by ice and meltwater during the Tazewell Subage. The ice sheets were of the East White Sublobe of the Ontario-Erie Lobe - see Figure 3. The first ice sheet reached the farthest south, five to ten miles south of Hendricks County's southern border, about 21,000 years ago. This ice left a drift material called the Center Grove Till Member (Trafalgar Formation). (5) See Figure 4.

Early geology maps show the Champaign Morainic System crossing Hendricks County. The mapping was done without the use of presently available high quality topographic maps and without the use of airphotos. In 1965, Wayne (5) wrote as follows: "During the past decade stratigraphic and physiographic studies in central Indiana have provided convincing evidence that the Champaign and Bloomington Moraines of Illinois cannot be traced east of the interlobate reentrant in western Indiana." Wayne further states that the readvancing East White Sublobe crossed and buried the Champaign and Bloomington Moraines and left few readily traceable moraines between the Wabash River, on the north, and the Wisconsin glacial boundary on the south. (5)

After a study of topographic maps, recent agricultural maps and the aerial photographs, this author agrees with Wayne -- at least on the moraine situation in Hendricks County.

The glacial drift materials in Hendricks County are primarily clayey, silty and sandy. There is a minimum of gravel and most of it is fine. Most of the outwash areas are not sharply defined in the field or on the airphotos. It is felt that this is because the materials are mostly fine grained and/or are shallow deposits of materials. It is also felt that the areas would not be good sources for large supplies of construction aggregates and that the areas do not have good internal drainage.

The following information on the depth of bedrock is quoted from a

Fig. 3. Map showing glacial lobes and sublobes of Indiana. Terminology from Horberg and Anderson, 1956. (5)

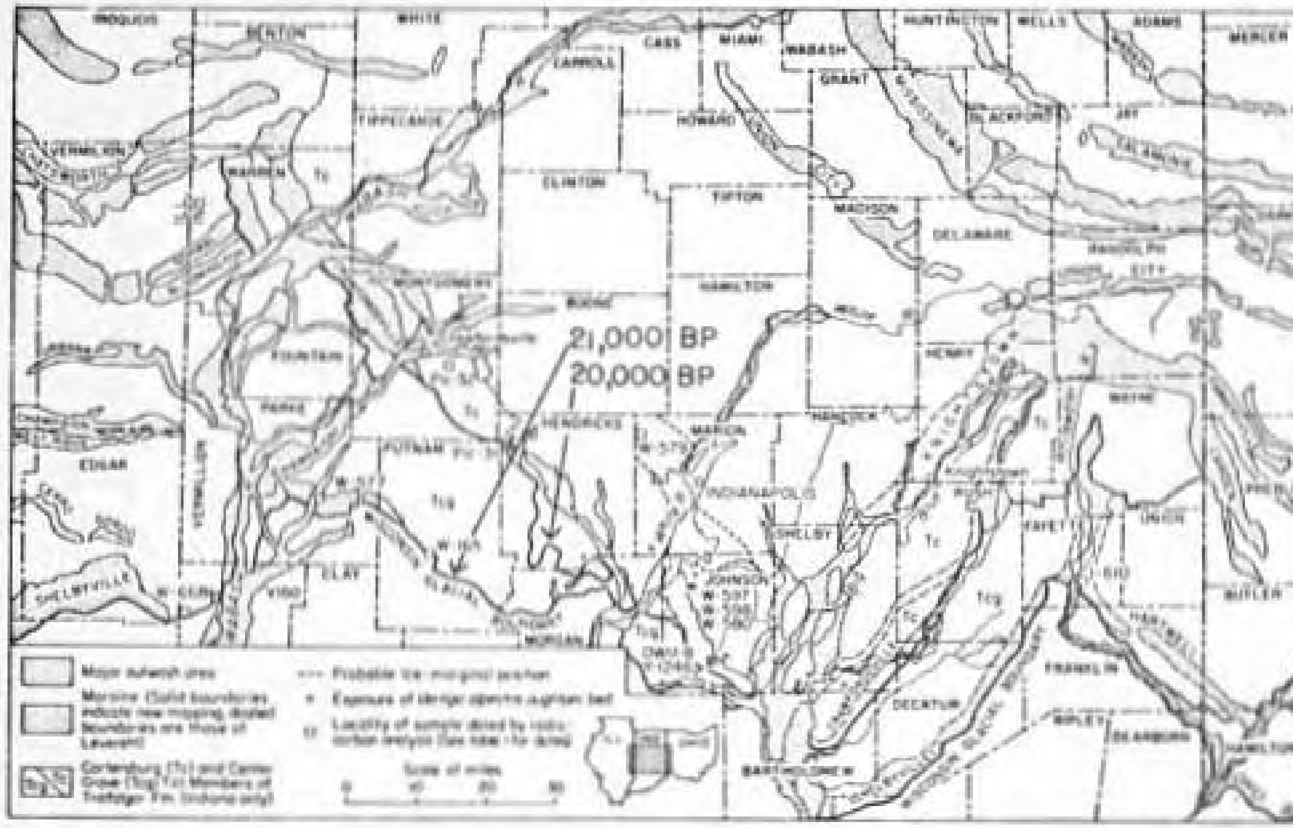


Fig. 4 -- Map showing glacial geology of central Indiana and adjacent parts of Illinois and Ohio. Moraine names in parentheses are Leverett's names for moraines that have not been restudied. (5)

thesis by Fowler (1). Figure 5 is a reduced copy of Fowler's glacial drift thickness contour map.

Figure 5 shows the variations in glacial drift thickness throughout the county.

> "The drift is thickest over a buried preglacial valley in the northern part of the county. One refraction seismic record in the vicinity of North Salem shows a depth of 279 ft. to bedrock, and near Brownsburg several other wells in the same buried valley penetrated drift for a distance of 235 to 250 ft.
>
> "Drift is also very thick in the southeastern section of Hendricks County where wells have gone from 135 ft. to more than 175 ft. without striking bedrock. In this area the increased thickness of the drift is caused by deposition in a preglacial valley or is a reflection of the low bedrock altitudes of the Scottsburg lowland.
>
> "Other areas of thick drift are found along preglacial valleys buried beneath the Danville ridge moraine where wells reach depths of 160 to 200 ft. before encountering bedrock. In western and south-central Hendricks County, glacial deposition averages from 50 to 60 ft. in depth but in several places (for example: sec. 16, T. 14 N., R. 1 E.) bedrock lies within 6 ft. of the surface."

BEDROCK GEOLOGY

Figure 6 shows a generalized bedrock geology map of Hendricks County (7). The county is located on the northeastern flank of the Illinois basin. Regional dip of the bedrock is a few degrees west-southwest. Because of the dip, younger rocks, Mississippian Age, are generally west and older rocks, Devonian Age, are generally east. New Albany Shale (mostly black shale) is the uppermost of the Devonian beds. It is the oldest rock in the county and underlies the northeastern corner. The Borden Group (Lower Mississippian) underlies most of the county and the rock types include mainly: shales, siltstones and sandstones.

The Devonian and Lower Mississippian shales (of low weather resistance) make up the Scottsburg Lowland in the southern unglaciated portion of Indiana. The harder Mississippian siltstones and sandstones compose the higher Norman Upland to the west of the lowland. Former highlands and lowlands in Hendricks County are now obliterated with glacial drift.

TOPOGRAPHY AND PHYSIOGRAPHY

The topography and physiography are entirely the result of

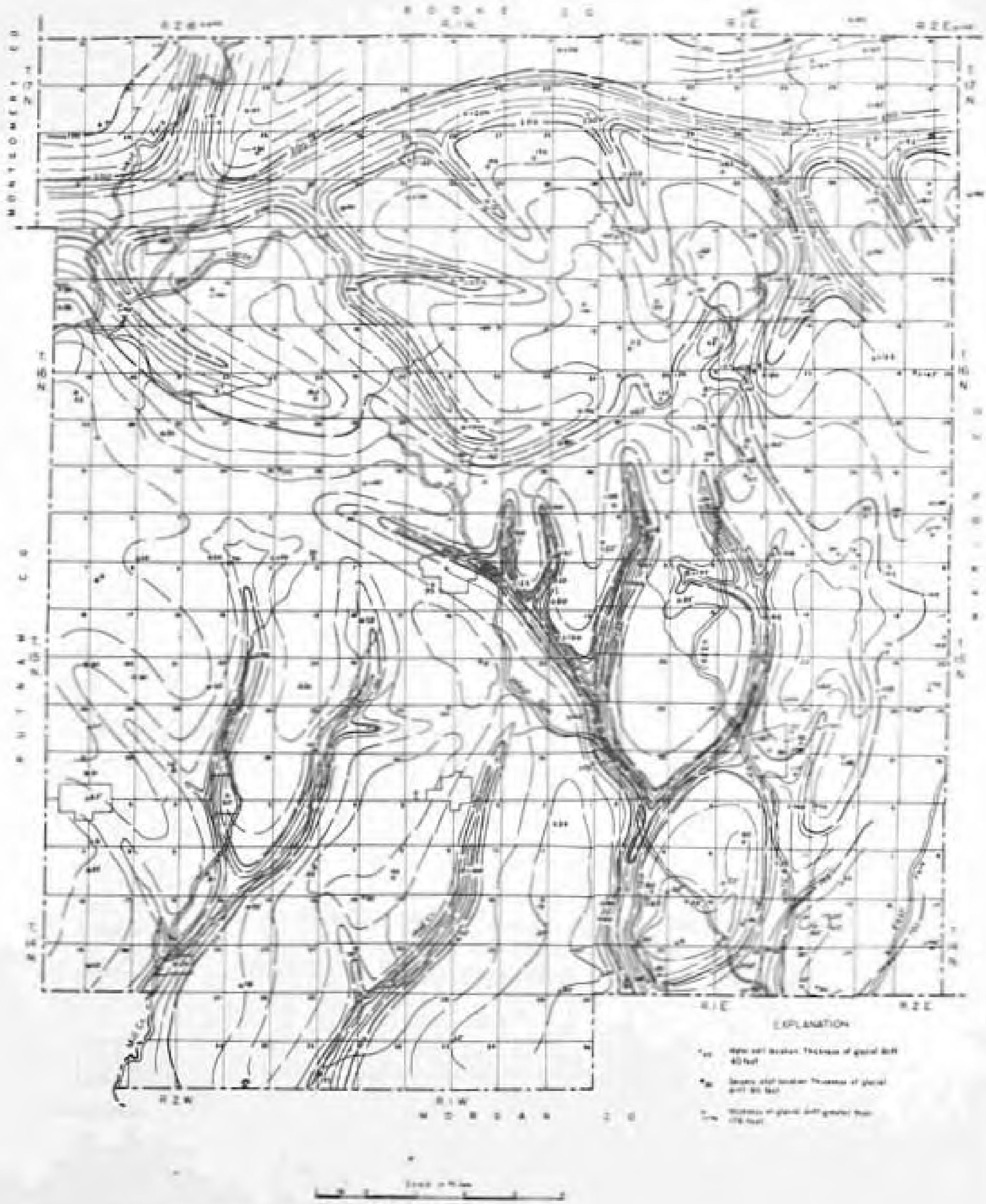
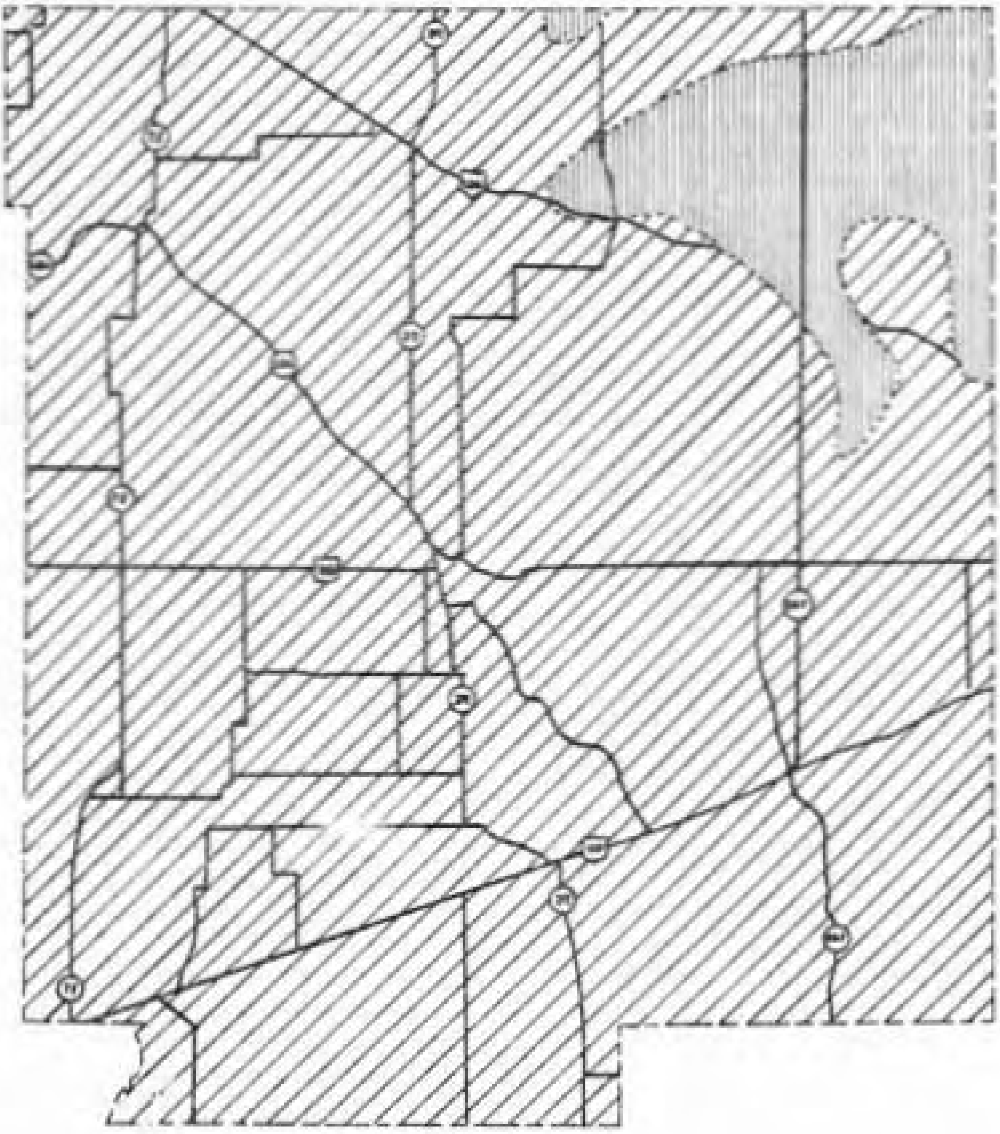


Fig. 5. GLACIAL DRIFT THICKNESS MAP OF HENDRICKS COUNTY
(W. E. FOWLER - 1953)



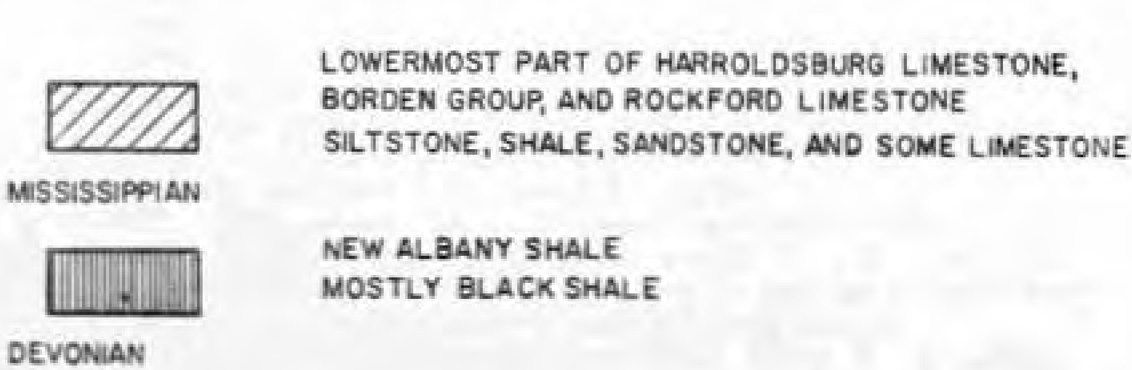
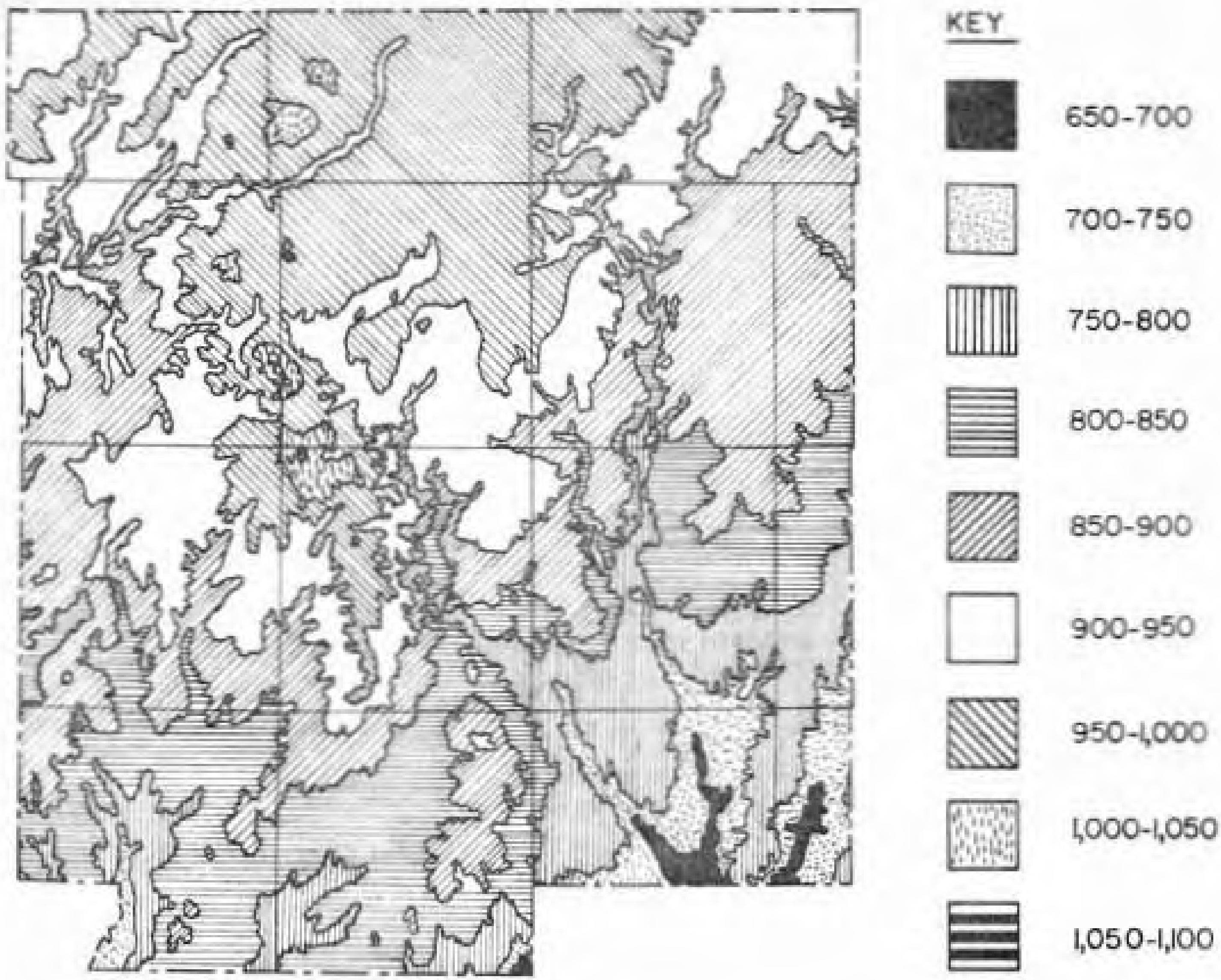


FIG. 6 BEDROCK GEOLOGY OF—HENDRICKS COUNTY (7)

glaciation. Surface features include: 1. till plains 2. ridge moraines 3. flood plains 4. terraces 5. outwash plains 6. lacustrine plains and 7. kames and eskers.

The maximum altitude of the county is 1045 ft. above sea level, the minimum is 690. The total maximum relief is 355 ft. Maximum local relief is 120 ft. See the generalized topography map shown in Figure 7. The following information is quoted from a masters thesis by W. E. Fowler - reference (1).

> "The Danville ridge moraine, extends through central Hendricks County from just north of Cartersburg nearly to North Salem and rises about 100 ft. above most of the county to the northeast. Its western and southwestern slopes are very moderate and its boundary is hard to map. Kames and low morainic hills outline the extensions of this moraine from North Salem, north of the county line and from Cartersburg, southeast to the county line.
>
> "The Danville ridge moraine is a high hummocky ridge which reaches an altitude of approximately 1045 ft. near Danville and declines to 885 ft. on the northwest and 780 ft. on the southeast. It stands from 50 to 100 ft. above the till plain to the northeast and merges gently into the till plain on the southwest. In Townships 15 and 16 North, Range 2 West, the moraine stands about 50 ft. above the level till plain on the west, so that in this area a sharp topographic break exists on both sides of the moraine. The moraine is most prominent is sec. 20, T. 16 N., R. 2 W., where it stands conspicuously above a flat lacustrine plain just behind and northwest of it. The Danville moraine may be traced to the northwest and southeast by means of numerous kames and scattered hummocky hills upon it.
>
> "The Champaign (now called Crawfordsville) ground moraine has a gently undulating sag-and-swell topography (local relief of 10 ft.) with altitudes varying from 960 ft. at the north to 720 ft. at the south. The natural drainage is very poor, particularly in the northeastern part of the county, where many small muck pockets are found (most are too small to map). The poor drainage has necessitated ditching, tiling, and dredging. South of the Danville moraine the Champaign (Crawfordsville) ground moraine is more rolling and, because of greater local relief, drainage lines are better developed.
>
> "Throughout the northeastern and west-central parts of the county the ground moraine topography is characteristically a succession of slight swells and swales with low, broad divides, usually without definite trends.
>
> "In the southeast and northwest parts of the county, the relief is much more pronounced and here the till plain has been deeply dissected by White Lick Creek and by Big Walnut Creek respectively. These valleys are much deeper than is common for streams of their volume. This may be attributed to the fact that they discharge into the deep valleys of the White and Eel rivers and therefore have the low outlets and steep gradients that are favorable to rapid erosion.



SCALE 1:250,000
(CONTOUR INTERVAL 50')

FIG. 7 TOPOGRAPHIC MAP OF HENDRICKS COUNTY

"There are extensive outwash terraces along all major streams in Hendricks County. Some of the Mill Creek valleys have low, broad terraces which merge so gradually with the uplands that it is difficult to map the boundaries of the terraces. The terraces along White Lick Creek, West Fork of White Lick Creek, and Big Walnut Creek below North Salem are nearly level benches 20 to 50 ft. above the bottom lands whose contact with the upland is generally well defined. Terraces on the tributaries of Big Walnut Creek north of North Salem are more difficult to delineate."

In the extreme southern part of the southeastern quadrant of the county are two lacustrine plain areas - flat lowland areas. The lake beds were formerly portions of glacial lakes Eminence and Hazelwood. The size and location of these lakes is shown in Figure 8. Several other lacustrine plain areas - flat lowlands up to two or three square miles in area and with indistinct boundaries are located in the northwestern quadrant. They have generally elongated shapes and some side branches indicative of former ponding in valleys.

Several outwash plains - also low flat areas, also in the western half of the county - are near the lake plain areas described above. Both the lacustrine plains and the outwash plains are described in more detail in the materials section.

Small kames and eskers (the latter are so short they are more like crevass fillings) have small area bases and are so low that they are barely discernible on the airphotos. They are distributed toward each of the four corners of the county.

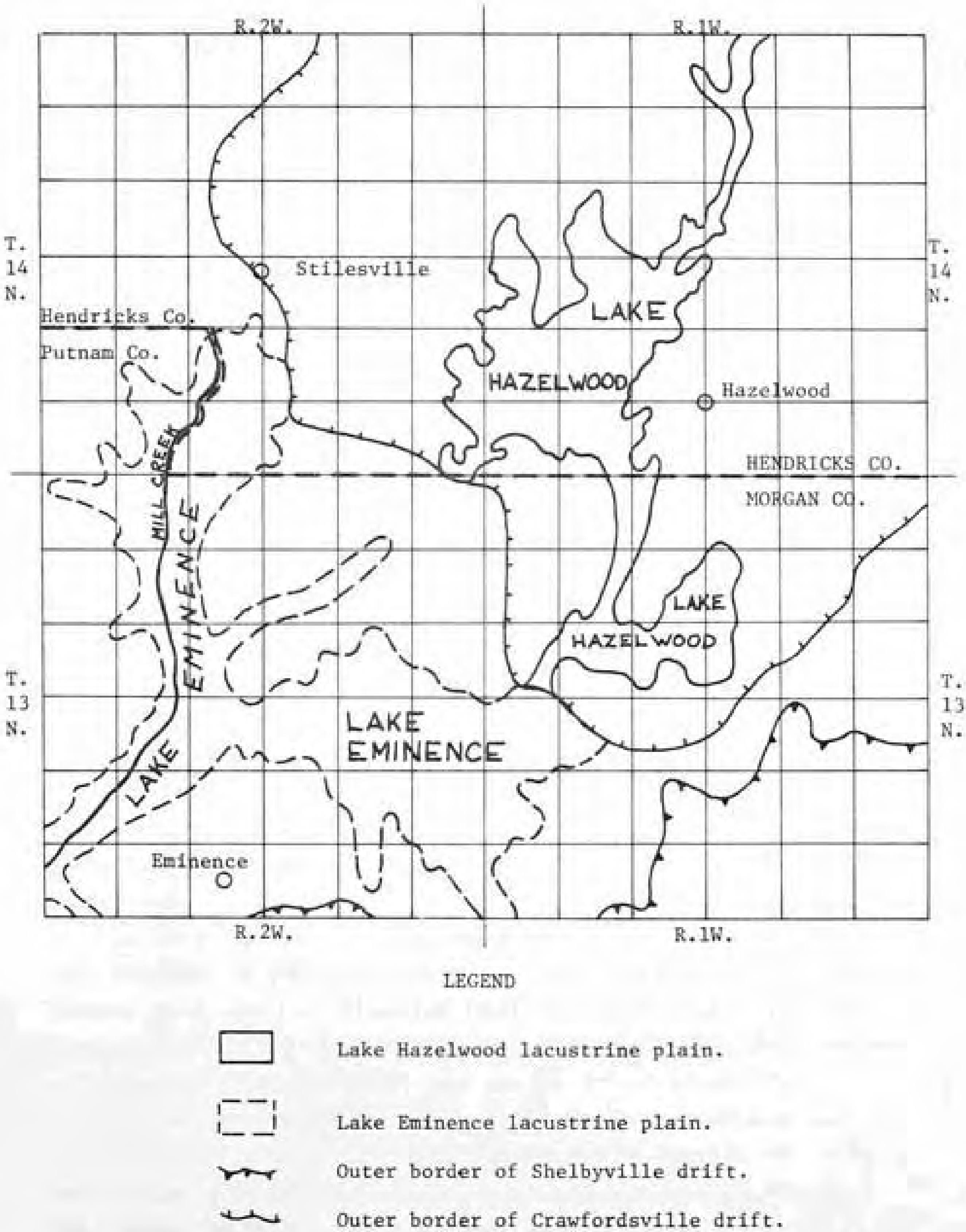


Fig. 8. Sketch map showing areal distribution of lacustrine plains which mark the sites of Lake Eminence and Lake Hazelwood.

ENGINEERING SOIL AREAS

The soils of Hendricks County can be divided into three major groups: (I) glacial or ice-contact soil deposits, (II), fluvial or water-deposited soils, and (III) muck deposits. In the discussion that follows, each of the major groups is further subdivided into land form parent material groups. These groups are futher subdivided into soil textural groups for which, ISHC soil classification and pedological names are also provided. Using the pedological names, and Appendices A, B and C, engineering properties and problems for all soil areas can be obtained.

I. GLACIAL DEPOSITED MATERIALS

The land forms of glacial, or ice-contact deposits in Hendricks County include ground moraines, ridge moraines, kames and eskers.

GROUND AND RIDGE MORAINES - Silty Clay Texture

Basically the county is a till plain with numerous streams cutting down below the till plain level and a small ridge moraine area, around Danville, rising about 50 - 100 ft. above the till plain level. Most of this upland area has a silty clay parent material with less than 18 in. of loess cover. A narrow band of till plain, along the western county border, has a loess cover of 20 to 40 in. and is discussed separetely in the next section.

The largest area of land form parent material in the county is a till plain area (see the map in the pocket of this report). This till plain of Wisconsin ground moraine covers about three quarters of the county area.

On the attached engineering soils map, in the left margin, general soil profiles for topographic highs and lows in the large ground and ridge moraine areas have been drawn and designated profile set No. 1. The bounded areas on the map, containing No. 1, have high and low position soil profiles similar to those sketched in Profile Set No. 1.

The parent material (C-horizon material) is most often a loam or a clay loam (ISHC classification) and most often is found at an average depth range of 24 in. to 50 in. -- as indicated by profile set No. 1. The steeper the soil slopes - the shallower the top of the C-horizon. For some of the steepest slopes (25 - 50 percent) - the C-horizon may be found at a depth of 14 in. Top of the B-horizon is usually found between

6 in. and 18 in. and may be either a loam, clay loam, clay or silty clay. B-horizons in the topographic lows are generally more clayey and thicker than B-horizons in the higher positions. A-horizon material is either a silt loam, silty clay loam, silty clay or clay and average thickness ranges from about 6 in. to 18 in.

Quantitative engineering soils data and data on engineering soil problems and uses in the particular ground moraine area are provided in Appendices B and C. To obtain information on soils in gently undulating till plains look up information on the Miami soils (in highest areas), Crosby soils (between highs and lows), Brookston soils (low areas) and the Kokomo soils (depressions and drainage ways in the general low areas of Brookston areas.) For information on the properties of steeply sloping soils (25 - 75 percent slopes) between drainage ways and uplands - look up Hennepin soils. The higher flatter soils above and contacting the Hennepin soils are usually Miami.

Reference 10 is an ISHC soils report for the R-O-W area of new SR 267, Hendricks County, four miles north of U. S. 40. Numerous shallow borings indicate the following soil types: Clay loams A-6, clay A-7 and some sandy loams A-2-4. A mile stretch of I-70 starting at the Morgan county line also shows A-6, A-7 and A-4 soils (14).

GROUND MORAINE, LOESS COVERED - Silty Clay Texture

Along the west side of the county is a strip of land averaging two to three miles wide that is ground moraine covered with about 20 in. to 40 in. of loess (windblown silt). The area on the soils map is designated with four loess symbol markings (like + signs) per square mile. The area is also designated by the No. 2 on the map which also is the number of the soil profile set for the area.

A field inspection of the area shows the silty surface soils are not pure silts but rather silt loams, silty clay loams (highs), and silty clays and clays (lows) - all with at least traces of sand and gravel particles. The clay and fine sand particles were transported with the silt and frost action forced up sand and gravel particles from the underlying till. Typically, surface soils (A-horizon) have a depth range of 6 in. to 20 in.

Generally the B-horizon shows two layers that grade into each other. The upper part of the B-horizon is usually silty clay or clay in both high and low positions. The lower part of the B-horizon in the upper position is usually clay and the lower part of the low position is either silt loam or silty clay loam. The bottom of the B-horizon (top of the C-horizon) ranges between depths of 24 in. and 70 in.

For engineering soils data on topographic highs in the area look in Appendices B and C under Fincastle soils. For data on lows - use data on Ragsdale soils.

Referrences 12 and 13 are ISHC soil reports at locations in this mapped soil area. At SR 75 and County Road 100 N. five 6- to 7-ft. borings show silty clay over sandy or silty clay loam.

KAMES AND ESKERS

In general, kames and eskers in Hendricks County are relatively small both in area and height. Most of them shown on the engineering soil maps are so low, and so small in area, that they were hardly discernible on the airphotos. Several have been completely mined out and some others have been nearly exhausted. Others are so small that they would supply aggregate (mostly sand) for only very minor local operations. Most of the kames are located in the western half of the county - north central and south central areas.

Kames and eskers are encircled by dashed lines on the soils map. They have the soil profile of the high of Profile Set No. 4. Parent material is mostly sand with some gravel. Engineering soils data are found in Appendices B and C under the Fox or Ockley soils. Ockley soils have the thicker loess cover.

II FLUVIAL DEPOSITED MATERIALS

The fluvial or water deposited materials in Hendricks County include: (1) alluvium or recent flood plain deposits along streams, (2) stream terrace deposits, (3) valley train deposits -- deposits along streams lacking typical water-cut terrace land forms, (4) glacial sluiceways deposits -- relatively long and narrow valley train deposits, (5) outwash plain deposits and (6) lacustrine plain (lake bed) deposits.

ALLUVIAL PLAINS - Stratified Silts, Fine Sand and Clays Texture

All the streams in Hendricks County are designated creeks (rather than rivers). All the creek valleys, however, were once glacial sluiceways for larger volumes of meltwater and, therefore, the alluvial plains, or flood plains, of the creeks are relatively wide - up to 3/4 mi. wide in several places. The system of streams having the greatest total floodplain areas are White Lick Creek and its branches - in the eastern half of the county. The next largest system of floodplains is that of Mill Creek and its branches in the southwest corner. Third largest is Big Walnut Creek and its tributaries in the northwest.

Parent material, at a depth of 30 in. to 60 in., is usually stratified loams and sandy loams or loams and clay loams. B-horizon materials may be silt loam, silty clay loam, clay loams or loam. Top of the B-horizon is between 7 in. and 20 in. A-horizon materials are usually silt loams or clay loams.

Engineering data on the alluvial soils are found in Appendices B and C. For information on topographic highs in the flood plain, look under Genessee soil, and for low level soils - see Shoals soils.

TERRACES, OUTWASH PLAINS, VALLEY TRAINS, AND GLACIAL SLUICEWAYS

The terraces are stream cut benches adjacent to the larger stream flood plains. Outwash plains are usually on upland areas and may not be in contact with streams or they may have some partial contact with streams. Valley trains are outwash deposits in valleys showing essentially no, or little, bench development. The sluiceways could be considered as very small valley trains. They are narrow and elongated - usually a few tens-of-feet wide and hundreds, or thousands, of feet long. Because of their small size, they naturally contain less outwash material than valley trains.

All the granular outwash in the county is divided into two groups herein. The coarser parent material, of the two groups, classifies as a gravelly sand under the ISHC classification system and the finer parent material classifies as a sandy loam.

(A) Stratified Gravelly Sand Texture

In Appendix A, these are engineering soils data on six modal soil samples taken in Hendricks County. A representative sample of the coarser granular material was taken from the Ockley soil series. An examination of sieve analyses, on the C-horizon material, is shown below:

Gravel	=	31%	(100% passed 1 in. sieve and 94% passed 3/4 in.)
Sand	=	61%	(about half coarse and half fine)
Silt	=	7%	
Clay	=	1%	

The above granular composition (gravelly sand - ISHC) conforms with the near-surface materials that the author has seen in several pits in both, Hendricks and Boone Counties (Boone is adjacent and north). The implications are that good coarse stream gravels, of abundant supply, are not to be had in Hendricks County - at least near the surface. It is possible that coarser materials may be found at deeper depths, and then probably below the water table.

They could be in some of the old glacial sluiceways - most of which are now under floodplains.

On the engineering soils map, the terraces of coarser granular outwash are marked with the number 4 and also sand and gravel symbols. Most of the sand and gravel terraces are in the northwest, along Walnut Creek and its branches, and in the southeast along White Lick Creek and its branches. The biggest gravel operation is owned by U. S. Aggregates just south of Plainfield in the floodplain of White Lick Creek. In general - gravel pits are relatively scarce around the county.

Pedologically, the primary soil series in the coarser granular areas are Fox and Ockley. The A-horizon may be either: silt loams, silty clay loams, silty clay or clay. Depth to the B-horizon top, generally ranges between 5 and 18 in. The B-horizon usually has clays or clay loams over gravelly clays. The top of stratified sand and gravel, C-horizon, generally starts at a depth of 30 to 60 in. For engineering properties characteristics and use of these soils see Fox and Ockley soils in Appendices B and C.

Borings for I-70 for about four miles west of the Marion County line show: dense sandy loams A-2-4 (probably near stream areas) and some silty and clay soils A-4 and A-6 (4) probably in ground moraine areas. See Reference (11).

(B) Stratified Silts, Silty Sands and Clays Texture

The other group of finer granular material is represented by the, Whitaker, Rensselaer and Martinsville soil series - see the soil analyses of the C-horizon of these materials in Appendix A. Using the sieve analysis data of two modal soil samples, in Hendricks County, the parent material of the Rensselaer assumes an ISHC classification of sand and the parent material of the Martinsville has a sandy loam classification - see data below.

RENSSELAER			MARTINSVILLE		
Gravel	= 1%	(fine)	Gravel	= 3%	(mostly fine)
Sand	= 86%	(mostly fine)	Sand	= 62%	(mostly fine)
Silt	= 10%		Silt	= 28%	
Clay	= 3%		Clay	= 7%	
ISHC Class	= Sand		ISHC Class	= Sandy Loam	

On the engineering soils map, several terraces and outwash plains that are underlain by the sand and sandy loam outwash are marked with the number 5 and also symbols for sand and silt. The largest terraces areas are along Mill Creek and East Fork of White Lick Creek - both in the southern half of the county. There is a large sandy and silty outwash plain in the west central part of the county and a smaller one in the southeast corner.

Soil series found in the sandy and loamy outwash area are: Rensselaer, Whitaker and Martinsville. A general profile description (ISHC soil classification) covering all three soil situations is as follows: A-horizon 6-19 in. of either silt loam, clay loam or loam: B-horizon is composed of two or more of the following, clay loams, silt loams and sandy loams: the top of the C-horizon ranges between a depth of 36 to 60 in. and is composed of stratified: sands, loam sands, sandy loams, loams and silt loams.

LACUSTRINE PLAINS

A. STRATIFIED FINE SANDS, SILTS AND CLAYS TEXTURE

Most of the lacustrine plains in Hendricks county were formed when the lower end of old glacial sluiceways where blocked at their intersections with larger streams. The larger streams, becoming overloaded with outwash, dropped the overload along their lengths and dammed incoming streams. Incoming streams backed up and also ponded along their low sides. Some streams even ponded in their source areas. Because of ponding along major glacial sluiceways, and the presence of large volumes of fairly fast water, considerable fine sand, lesser silt and some clay settled in the lakebed areas. The materials settled as stratified: fine sands, loamy sands, fine sandy loams, silt loam and loams.

The largest lakebed area is located near the south central county border - geologically it is known as glacial Lake Hazelwood. This portion of the lake used to connect with another portion in Morgan County. In the southwestern corner of the county, the smaller lakebed along Mill Creek is the remains of glacial Lake Eminence - it had its major area to the south in Morgan County. There are also a number of lakebeds (about 1/2 to nearly 3 sq. miles) in the northwestern quadrant of the county. These also contain mainly stratified fine sands and silts.

Material classification, soil pedological names and engineering properties are similar to the finer outwash granular materials described in the section immediatly previous.

B. STRATIFIED SILTS AND CLAYS TEXTURE

About half the area of a lakebed, about two miles northwest of

Danville, appears to be more silty and clayey than all the other lakebeds in the county. On the soils map the area is indicated by a number 6 (also profile number) and silt and clay symbols. This more silty and clayey area (about 1/2 mile sq.) is shown to contain the Mahalasville soil series according to field studies by soil scientists. In Appendix B, find the test data for the Mahalasville soil and its indicated engineering soil properties.

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APPENDIX A

The table below which is a copy of Table 6 in Referrence 3, "presents test data on samples of six soil series in the county. These samples were tested by standard procedures in the laboratories of the Joint Highway Research Project at Purdue University. The samples do not represent all the soils in Hendricks County, nor do they include the entire range of characteristics of any series sampled. Not all layers of each profile were sampled. The test results, however, have been used as a general guide in estimating the engineering properties of the soils in the county. Tests were made for moisture-density relationships, liquid limit, and plastic limit. Texture was determined by mechanical analysis." (3)

Engineering

[Tests performed by Soils and Pavement Design Laboratory, Joint Highway Research Project, School of Civil Engineering, Purdue University,

Soil name and location of sample	Parent material	Report No.	Depth	Moisture-density data [1]	
				Maximum dry density	Optimum moisture
			Inches	*Pounds per cubic foot*	*Percent*
Crosby silt loam: NE¼ sec. 23, T. 15 N., R. 1 W. (Modal).	Glacial till of Wisconsin age.	2-1	0-10	103	20
		2-5	24-33	104	19
		2-7	37-50	130	9
Fincastle silt loam: NW¼ sec. 10, T. 15 N., R. 2 W. (Modal).	Loess over glacial till of Wisconsin age.	6-1	0-9	101	21
		6-2	20-29	104	19
		6-3	52-68	125	10
Genesee silt loam: SW¼ sec. 10, T. 14 N., R. 2 W. (Modal).	Alluvial material.	7. 1	0-11	97	23
		7-2	21-32	106	18
		7-3	32-48	120	12
Martinsville loam: SE¼ sec. 21, T. 14 N., R. 1 W. (Modal).	Loamy stratified outwash over silt and sand.	3-1	0-9	108	17
		3-4	15-28	116	14
		3-9	60-86	122	12
Ockley silt loam: SW¼ sec. 9, T. 16 N., R. 2 W. (Modal).	Loamy outwash over sand and gravel covered with a thin layer of loess.	5-1	0-9	104	19
		5-5	24-34	109	17
		5-8	58-68	118	13
Rensselaer clay loam: NW¼ sec. 28, T. 14 N., R. 1 W. (Modal).	Loamy outwash over sand, silt, and a little fine gravel.	4-1	0-8	100	22
		4-4	28-38	107	17
		4-7	60-72	115	14

[1] Based on AASHO Designation: T 99-57 Method A (*1*).
[2] Mechanical analyses according to the AASHO Designation: T 88-57 (*1*). Results obtained by this procedure may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method

test data

West Lafayette, Indiana, in accordance with standard methods of test of the American Association of State Highway Officials (AASHO)]

Mechanical analyses [2]											Liquid limit	Plasticity index	Classification	
Percentage passing sieve—							Percentage smaller than—						AASHO [3]	Unified [4]
1 in.	¾ in.	⅜ in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
-----	-----	-----	100	99	95	77	70	54	20	13	31	9	A-4(8)	CL
-----	-----	100	98	96	92	67	60	48	32	24	56	30	A-7-6(17)	CH
100	99	96	93	88	78	51	43	30	17	13	22	8	A-4(3)	CL
-----	-----	-----	100	99	96	93	70	49	16	10	34	10	A-4(8)	ML
-----	-----	-----	-----	100	99	96	87	65	34	25	56	30	A-7-6(19)	CH
-----	-----	100	97	94	86	68	58	45	30	20	23	8	A-4(7)	CL
-----	-----	-----	-----	-----	100	90	70	45	18	11	33	8	A-4(8)	ML
-----	-----	-----	-----	100	99	65	51	36	17	10	30	11	A-6(7)	CL
-----	-----	-----	-----	100	99	42	30	22	9	8	19	2	A-4(2)	SM
100	97	95	94	93	84	58	55	41	17	11	27	7	A-6(5)	ML-CL
-----	100	97	94	90	77	44	40	36	24	21	36	17	A-6(4)	SC
-----	-----	100	99	97	85	35	24	15	7	5	([5])	-----	A-2-4(0)	SM
-----	-----	-----	-----	100	98	90	83	58	18	10	32	8	A-4(8)	ML
100	98	98	94	86	68	43	35	28	20	14	50	31	A-7-6(9)	SC
100	94	87	79	70	42	9	7	5	2	1	-----	([5])	A-1-6(0)	SW-SM
-----	-----	100	99	97	87	64	58	52	30	19	46	21	A-7-6(12)	CL
-----	100	99	97	93	82	59	55	47	30	24	53	27	A-7-6(14)	CH
-----	-----	-----	100	99	90	13	8	5	3	3	-----	([5])	A-2-4(0)	SP

and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for use in naming the textural class of a soil.

[3] Based on AASHO Designation: M 145-49 (*1*).

[4] Based on MIL-STD-619B (*6*).

[5] Nonplastic.

Estimated Soil Properties Significant To Engineering

(From Referrence 3)

[An asterisk in the first column of this table indicates that at least one mapping unit in the series is made up of two or more kinds of soil. fully the instructions for referring to other series. The sign

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Brookston: Br	[1] 0-1	0-18	Silt loam	ML or CL	A-4 or A-6
		18-50	Clay loam	CL	A-6
		50-60	Loam	ML or CL	A-4
Bs	[1] 0-1	0-36	Silty clay loam	OL or CL	A-7
		36-50	Clay loam	CL	A-6
		50-60	Loam	ML or CL	A-4
*Crosby: CrA, CsB2. For Miami part of CsB2, see Miami series.	1-3	0-17	Silt loam	ML or CL	A-4 or A-6
		17-33	Silty clay loam and clay loam	CL or CH	A-7
		33-60	Loam	CL or SC	A-4
Fincastle: FcA	1-3	0-9	Silt loam	ML or CL	A-4 or A-6
		9-29	Silty clay loam	CH	A-7
		29-42	Clay loam	CL	A-6
		42-68	Loam	CL or SC	A-4
Fox: FoA, FoB2, FoC2	>6	0-14	Loam	ML	A-4
		14-31	Clay loam and gravelly clay loam	SC or CL	A-6
		31-60	Sand and gravel	SW-SM	A-1
FxC3	>6	0-24	Clay loam	SC or CL	A-6
		24-60	Sand and gravel	SW-SM	A-1
Genesee: Gn	>6	0-21	Silt loam	ML	A-4
		21-32	Loam	CL or SC	A-6
		32-60	Sandy loam	SM	A-2 or A-4
Genesee, sandy variant: Gs	>6	0-25	Sandy loam	SM	A-2 or A-4
		25-60	Medium sand	SM or SW-SM	A-1
Hennepin: HeF	>6	0-14	Loam	CL or ML	A-4
		14-60	Loam	CL or SC	A-4
Mahalasville, clayey subsoil variant: Mc	[1] 0-1	0-15	Silty clay loam	OH or CH	A-7
		15-52	Silty clay	CH	A-7
		52-66	Silty clay loam	CH	A-7
		66-72	Silt loam	ML	A-4
Martinsville: MeA, MeB2	>6	0-13	Loam	CL	A-4
		13-53	Clay loam, sandy clay loam, and sandy loam.	CL or SC	A-4
		53-60	Stratified silts, loam, sandy loam, and sand	ML or SM	A-2 or A-4
Miami: MmB2, MmC2, MmD2, MmE2	>6	0-8	Silt loam	ML or CL	A-4 or A-6
		8-31	Clay loam and silty clay loam	CL or CH	A-6 or A-7
		31-60	Loam	CL or SC	A-4
MsB3, MsC3, MsD3	>6	0-24	Clay loam	CL or CH	A-6 or A-7
		24-60	Loam	CL or SC	A-4

See footnotes at end of table.

SOIL LEGEND

Each soil symbol consists of 2 or 3 letters; for example Br, CrA, or FcA. If slope is given in the soil name, the third letter, A, B, C, D, E, or F indicates the class of slope. Symbols without a slope letter are those of nearly level soils. A final number 2 or 3 in the symbol indicates that the soil is eroded or severely eroded respectively.

SYMBOL	NAME
Br	Brookston silt loam, overwash
Bs	Brookston silty clay loam
CrA	Crosby silt loam, 0 to 3 percent slopes
CsB2	Crosby-Miami silt loams, 2 to 6 percent slopes, eroded
FcA	Fincastle silt loam, 0 to 3 percent slopes
FoA	Fox loam, 0 to 2 percent slopes
FoB2	Fox loam, 2 to 6 percent slopes, eroded
FoC2	Fox loam, 6 to 12 percent slopes, eroded
FxC3	Fox clay loam, 6 to 12 percent slopes, severely eroded
Gn	Genesee silt loam
Gs	Genesee sandy loam, sandy variant
HeF	Hennepin loam, 25 to 50 percent slopes

The different soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow care-
> means more than; the sign < means less than]

Percentage passing sieve— No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction	Frost-heave potential	Shrink-swell potential
			Inches per hour	*Inches per inch of soil*	*pH*		
90-100	90-100	75-85	0.63-2.00	0.22-0.24	6.6-7.3	Moderate to high	Low.
95-100	85-95	70-90	0.06-0.20	0.15-0.19	6.6-7.3	Moderate	Moderate.
90-100	75-90	60-75	0.20-0.63	0.10-0.19	[2] 7.4-8.4	Moderate	Low.
100	90-100	85-95	0.20-0.63	0.21-0.23	6.6-7.3	Moderate	Moderate.
95-100	85-95	70-90	0.06-0.20	0.15-0.19	6.6-7.3	Moderate	Moderate.
90-100	75-90	60-75	0.20-0.63	0.10-0.19	[2] 7.4-8.4	Moderate	Low.
95-100	90-100	75-90	0.63-2.00	0.22-0.24	5.1-7.3	Moderate to high	Low.
95-100	85-95	65-85	0.06-0.20	0.18-0.20	6.0-6.5	Moderate	Moderate.
85-95	70-85	35-65	0.20-0.63	0.05-0.10	[2] 7.4-8.4	Moderate	Low.
95-100	90-100	75-95	0.63-2.00	0.22-0.24	6.1-6.5	Moderate to high	Low.
100	90-100	85-100	0.06-0.20	0.18-0.20	5.1-5.5	Moderate	Moderate.
95-100	85-100	65-85	0.06-0.20	0.15-0.19	6.6-7.3	Moderate	Moderate.
85-95	70-90	35-70	0.20-0.63	0.05-0.10	[2] 7.4-8.4	Moderate	Low.
85-95	85-100	50-75	0.63-2.00	0.20-0.22	6.1-6.5	Moderate	Low.
90-100	75-90	35-70	0.63-2.00	0.19-0.21	5.6-7.3	Moderate	Moderate.
50-70	20-45	5-15	>20.00	<0.08	[2] 7.4-8.4	Low	Low.
90-100	75-90	35-70	0.63-2.00	0.19-0.21	5.6-7.3	Moderate	Moderate.
50-70	20-45	5-15	>20.00	<0.08	[2] 7.4-8.4	Low	Low.
95-100	90-100	75-90	0.63-2.00	0.22-0.24	7.3-7.8	Moderate to high	Low.
90-100	75-100	45-65	0.63-2.00	0.17-0.19	7.3-7.8	Moderate	Low.
90-100	70-100	25-45	2.00-6.30	0.11-0.13	[2] 7.4-8.4	Moderate	Low.
90-100	70-100	25-45	2.00-6.30	0.13-0.15	6.6-7.3	Moderate	Low.
85-100	70-90	5-10	6.30-20.00	<0.08	7.4-7.8	Low	Low.
85-95	70-85	50-65	0.63-2.00	0.20-0.22	6.6-7.3	Moderate	Low.
85-95	70-85	35-65	0.63-2.00	0.05-0.19	[2] 7.4-8.4	Moderate	Low.
100	95-100	95-100	0.20-0.63	0.21-0.23	6.5-7.3	Moderate	Moderate.
100	95-100	95-100	0.06-0.20	0.11-0.13	6.5-7.3	Moderate	Moderate.
100	95-100	95-100	0.20-0.63	0.18-0.20	7.4-7.8	Moderate	Moderate.
100	95-100	90-100	0.20-0.63	0.20-0.22	[2] 7.4-8.4	Moderate to high	Low.
85-100	80-95	50-75	0.63-2.00	0.20-0.22	6.6-7.3	Moderate	Low.
90-100	70-90	40-75	0.63-2.00	0.15-0.19	5.1-6.5	Moderate	Moderate.
85-100	70-90	30-70	0.63-2.00	0.17-0.20	[2] 7.4-8.4	Moderate	Low.
95-100	90-100	75-90	0.63-2.00	0.22-0.24	6.6-7.3	Moderate to high	Low.
95-100	85-95	65-85	0.63-2.00	0.15-0.20	5.1-6.0	Moderate	Moderate.
85-95	70-85	35-65	0.63-2.00	0.05-0.19	[2] 7.4-8.4	Moderate	Low.
95-100	85-95	65-85	0.63-2.00	0.15-0.19	5.1-6.0	Moderate	Moderate.
85-95	70-85	35-65	0.63-2.00	0.05-0.19	[2] 7.4-8.4	Moderate	Low.

Estimated soil properties

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Ockley:					
OcA, OcB2	>6	0-14	Silt loam	ML or CL	A-4 or A-6
		14-24	Silty clay loam	CL	A-6
		24-48	Clay loam and sandy clay loam	CL or SC	A-6
		48-60	Sand and gravel	SW-SM	A-1
OsA, OsB2	>6	0-8	Silt loam	ML or CL	A-4 or A-6
		8-48	Clay loam	CL	A-6
		48-53	Sand and gravel	SW-SM	A-1
		53-60	Loam	CL or SC	A-4
Ragsdale: Ra	[1] 0-1	0-42	Silty clay loam	OL or CH	A-7
		42-60	Silt loam and loam	ML	A-4
Rensselaer: Rn	[1] 0-1	0-16	Clay loam	CL or CH	A-7
		16-47	Clay loam and sandy clay loam	CH	A-7
		47-72	Loamy sand, sandy loam, and silt loam	SC	A-2 or A-4
Russell: RuB2, RuC2	>6	0-10	Silt loam	ML or CL	A-4 or A-6
		10-25	Silty clay loam	CH	A-7
		25-59	Clay loam	CL or CH	A-6 or A-7
		59-64	Loam	CL or SC	A-4
Shoals: Sh	1-3	0-34	Silt loam	ML	A-4
		34-60	Stratified loam, sandy loam, and sandy clay loam.	SC or SM	A-2 or A-4
Whitaker: Wh	1-3	0-12	Silt loam	ML or CL	A-4 or A-6
		12-30	Clay loam	CL	A-6
		30-48	Sandy clay loam and sandy loam	SC or CL	A-6
		48-60	Stratified loam, sandy loam, and medium sand.	SC or SM	A-2 or A-4
Xenia: XeA, XeB2	3-6	0-12	Silt loam	ML or CL	A-4 or A-6
		12-30	Silty clay loam	CH	A-7
		30-42	Clay loam	CL or CH	A-6 or A-7
		42-60	Loam	CL or SC	A-4

[1] Ponded.

significant to engineering—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Frost-heave potential	Shrink-swell potential
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)					
			Inches per hour	*Inches per inch of soil*	*pH*		
95–100	90–100	75–90	0.63–2.00	0.22–0.24	6.6–7.3	Moderate to high	Low.
90–100	80–95	70–90	0.63–2.00	0.18–0.20	5.6–6.5	Moderate	Moderate.
80–100	65–90	40–75	0.63–2.00	0.19–0.21	5.6–6.5	Moderate	Moderate.
50–70	20–45	5–15	>20.00	<0.08	[3] 7.4–8.4	Low	Low.
100	90–100	75–90	0.63–2.00	0.22–0.24	6.6–7.3	Moderate to high	Low.
90–100	80–95	70–90	0.63–2.00	0.19–0.21	5.6–6.5	Moderate	Moderate.
50–70	20–45	5–15	>20.00	<0.08	[3] 7.4–8.4	Low	Low.
85–95	70–85	45–65	0.63–2.00	0.05–0.19	[3] 7.4–8.4	Moderate	Low.
100	90–100	95–100	0.06–0.20	0.21–0.23	6.1–7.3	Moderate to high	Moderate.
95–100	90–100	85–95	0.20–0.63	0.17–0.22	[3] 7.4–8.4	High	Low.
95–100	75–95	60–80	0.20–0.63	0.17–0.19	6.6–7.3	Moderate	Moderate.
90–100	70–85	50–75	0.06–0.20	0.19–0.21	6.6–7.3	Moderate	Moderate.
90–100	70–95	10–50	0.63–2.00	0.08–0.22	[3] 7.4–8.4	Moderate	Low.
95–100	90–100	85–95	0.63–2.00	0.22–0.24	5.1–7.3	Moderate to high	Low.
95–100	90–100	85–95	0.63–2.00	0.18–0.20	4.6–5.0	Moderate	Moderate.
95–100	85–95	65–85	0.63–2.00	0.15–0.19	5.1–7.3	Moderate	Moderate.
85–95	70–85	35–65	0.63–2.00	0.05–0.19	[3] 7.4–8.4	Moderate	Low.
95–100	90–100	75–90	0.63–2.00	0.22–0.24	6.6–7.3	Moderate to high	Low.
90–100	75–100	10–50	0.63–2.00	0.11–0.19	6.6–7.3	Moderate	Low.
95–100	90–100	65–90	0.63–2.00	0.22–0.24	5.1–7.3	Moderate to high	Low.
95–100	85–95	65–85	0.63–2.00	0.15–0.19	5.1–6.5	Moderate	Moderate.
90–100	70–90	45–55	0.63–2.00	0.14–0.18	6.1–7.3	Moderate	Low.
95–100	70–90	10–50	0.63–2.00	0.07–0.19	[3] 7.4–8.4	Moderate	Low.
95–100	90–100	85–95	0.63–2.00	0.22–0.24	6.6–7.3	Moderate to high	Low.
95–100	90–100	85–95	0.20–0.63	0.18–0.20	5.6–7.3	Moderate	Moderate.
95–100	85–95	65–85	0.20–0.63	0.15–0.19	6.6–7.3	Moderate	Moderate.
85–95	70–85	35–65	0.63–2.00	0.05–0.19	[3] 7.4–8.4	Moderate	Low.

[3] Calcareous.

Interpretation of Engineering Properties

(From Referrence 3)

Interpretations of

[An asterisk in the first column indicates that at least one mapping unit in the series is made up of two or more kinds of soil. The different instructions for referring

Soil series and map symbols	Suitability as source of—			Soil features affecting—			
	Topsoil	Sand and gravel	Road subgrade material	Highway location	Agricultural drainage	Farms ponds	
						Reservoir areas	Embankments, dikes, and levees
Brookston: Br, Bs.	Good in surface layer. Poor in subsoil: moderately fine texture; seasonal high water table.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair to poor stability; seasonal high water table.	Seasonal high water table; subject to frost heave.	Seasonal high water table; slow permeability.	Moderate to slow seepage; seasonal high water table.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.
*Crosby: CrA, CsB2. For Miami part of CsB2, see Miami series.	Good in surface layer. Fair to poor in subsoil: moderately fine texture; seasonal high water table.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair to poor stability; seasonal high water table.	Seasonal high water table; subject to frost heave.	Seasonal high water table; slow permeability.	Moderate to slow seepage; seasonal high water table.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.
Fincastle: FcA.	Good in surface layer. Fair to poor in subsoil: moderately fine texture; seasonal high water table.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair to poor stability; seasonal high water table.	Seasonal high water table; subject to frost heave.	Seasonal high water table; slow permeability.	Moderate to slow seepage; seasonal high water table.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.

See footnotes at end of table.

engineering properties

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the to other series]

Soil features affecting—Continued			Degree and kind of limitation for—		
Grassed waterways	Terraces and diversions [1]	Foundations of buildings	Sewage disposal fields	Sewage lagoons	Sanitary landfills [2]
Soil features favorable; generally not needed.	Soil features favorable; generally not needed, but diversions can be used to channel excess water from higher soils.	Seasonal high water table; subject to ponding; fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Severe: slow permeability; seasonal high water table.	Severe: very poorly drained; seasonal high water table; subject to ponding.	Severe: very poorly drained; seasonal high water table; subject to ponding.
Soil features favorable.	Soil features favorable.	Seasonal high water table; fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Severe: slow permeability; seasonal high water table.	Moderate: somewhat poorly drained; seasonal high water table.	Moderate: somewhat poorly drained; seasonal high water table; use limited to periods when water table is at a depth of more than 48 inches.
Soil features favorable.	Soil features favorable.	Seasonal high water table; fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Severe: slow permeability; seasonal high water table.	Moderate: somewhat poorly drained; seasonal high water table; use limited to periods when water table is at a depth of more than 48 inches.	Moderate: somewhat poorly drained; seasonal high water table; use limited to periods when water table is at a depth of more than 48 inches.

Soil series and map symbols	Suitability as source of— Topsoil	Sand and gravel	Road subgrade material	Soil features affecting— Highway location	Agricultural drainage	Farms ponds: Reservoir areas	Embankments, dikes, and levees
Fox: FoA, FoB2, FoC2.	Fair to good in surface layer. Poor to fair in subsoil: moderately fine to coarse texture.	Good: about 3 feet of overburden on well-graded mixture of sand and gravel.	Poor in subsoil: fair shear strength; good to fair compaction characteristics; medium compressibility; moderate shrink-swell potential; subject to frost heave; fair stability. Very good in substratum: good to fair shear strength; fair to good compaction characteristics; slight compressibility; low shrink-swell potential; low susceptibility to frost heave; fair to poor stability.	Loose sand and gravel easily excavated but sometimes hinders hauling; cuts and fills often needed; difficult to vegetate exposed gravel in road cuts; subject to frost heave.	Natural drainage adequate; not needed.	Rapid seepage in substratum.	Fair stability in subsoil: good to fair compaction characteristics; low permeability when compacted; medium compressibility; good resistance to piping; moderate shrink-swell potential; fair shear strength. Fair to poor stability in substratum: fair to good compaction characteristics; high to moderate permeability when compacted; slight compressibility; fair to good resistance to piping; low shrink-swell potential; good to fair shear strength.
FxC3	Poor to fair in surface layer. Poor to fair in subsoil: moderately fine to coarse texture.	Good: about 3 feet of overburden on well-graded mixture of sand and gravel.	Poor in subsoil: fair shear strength; good to fair compaction characteristics; medium compressibility; moderate shrink-swell potential; subject to frost heave; fair stability. Very good in substratum: good to fair shear strength; fair to good compaction characteristics; slight compressibility; low shrink-swell potential; low susceptibility to frost heave; fair to poor stability.	Loose sand and gravel easily excavated but sometimes hinders hauling; cuts and fills often needed; difficult to vegetate exposed gravel in road cuts; subject to frost heave in subsoil.	Natural drainage adequate; not needed.	Rapid seepage in substratum.	Fair stability in subsoil: good to fair compaction characteristics; low permeability when compacted; medium compressibility; good resistance to piping; moderate shrink-swell potential; fair shear strength. Fair to poor stability in substratum: fair to good compaction characteristics; high to moderate permeability when compacted; slight compressibility; fair to good resistance to piping; low shrink-swell potential; good to fair shear strength.

See footnotes at end of table.

engineering properties—Continued

Soil features affecting—Continued			Degree and kind of limitation for—		
Grassed waterways	Terraces and diversions [1]	Foundations of buildings	Sewage disposal fields	Sewage lagoons	Sanitary landfills [2]
Difficult to vegetate; erosion hazard during construction.	Difficult to vegetate; erosion hazard during construction.	Good to fair shear strength; moderate to low shrink-swell potential; medium compressibility in subsoil; slight compressibility in substratum.	Slight: moderate permeability; possible contamination of ground water.	Severe: porous sand and gravel at depths of 31 to 60 inches; very rapid permeability in sand and gravel.	Severe: porous sand and gravel at depths of 31 to 60 inches; hazard of free leachate flow to ground water.
Difficult to vegetate; erosion hazard during construction.	Difficult to vegetate; erosion hazard during construction.	Good to fair shear strength; moderate to low shrink-swell potential; medium compressibility in subsoil; slight compressibility in substratum.	Slight: moderate permeability; possible contamination of ground water.	Severe: porous sand and gravel at depths of 31 to 60 inches; very rapid permeability in sand and gravel.	Severe: porous sand and gravel at depths of 31 to 60 inches; hazard of free leachate flow to ground water.

Soil series and map symbols	Suitability as source of— Topsoil	Suitability as source of— Sand and gravel	Suitability as source of— Road subgrade material	Soil features affecting— Highway location	Soil features affecting— Agricultural drainage	Soil features affecting— Farm ponds: Reservoir areas	Soil features affecting— Farm ponds: Embankments, dikes, and levees
Genesee: Gn.	Good in surface layer: subject to stream flooding.	Poor to unsuitable: location of sand and gravel spotty; deep overburden; dipper equipment necessary.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; low shrink-swell potential; subject to frost heave; fair stability.	Subject to flooding and frost heave.	Natural drainage adequate; subject to flooding; not needed.	Moderate to slow seepage; subject to flooding.	Fair stability in subsoil and substratum: fair to poor compaction characteristics; moderate to low permeability when compacted; medium to high compressibility; fair resistance to piping; low shrink-swell potential; fair to poor shear strength.
Genesee sandy variant: Gs.	Fair in surface layer. Fair to poor in subsoil: coarse texture; subject to flooding.	Poor to unsuitable; location of sand and gravel spotty; deep overburden; dipper equipment necessary.	Fair to good in subsoil and substratum: fair shear strength; fair compaction characteristics; slight compressibility; low shrink-swell potential; subject to frost heave; fair stability.	Subject to flooding and frost heave.	Natural drainage adequate; subject to flooding; not needed.	Rapid seepage in substratum; subject to flooding.	Fair stability in subsoil and substratum: fair compaction characteristics; high to moderate permeability when compacted; slight compressibility; fair to good resistance to piping; low shrink-swell potential; fair shear strength.
Hennepin: HeF.	Fair in surface layer: thin; steep slopes. Fair to poor in subsoil.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; low shrink-swell potential; subject to frost heave; fair stability.	Cuts and fills needed; difficult to vegetate road cuts; subject to frost heave.	Natural drainage adequate; not needed.	Moderate to slow seepage.	Fair stability in subsoil and substratum: fair to poor compaction characteristics; moderate to low permeability when compacted; medium to high compressibility; fair resistance to piping; low shrink-swell potential; fair to poor shear strength.
Mahalasville, clayey subsoil variant: Mc.	Fair to good in surface layer: moderately fine texture. Poor in subsoil: fine texture; seasonal high water table.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate shrink-swell potential; subject to frost heave; fair to poor stability; seasonal high water table.	Seasonal high water table; subject to frost heave.	Seasonal high water table; slow permeability; stratified silt and clay below depth of 36 inches.	Moderate to slow seepage; seasonal high water table.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate shrink-swell potential; fair to poor shear strength.

See footnotes at end of table.

engineering properties—Continued

Soil features affecting—Continued			Degree and kind of limitation for—		
Grassed waterways	Terraces and diversions [1]	Foundations of buildings	Sewage disposal fields	Sewage lagoons	Sanitary landfills [1]
Soil features favorable; generally not needed.	Soil features favorable; not needed because of topography.	Subject to flooding; fair to poor shear strength; low shrink-swell potential; medium to high compressibility.	Severe: subject to flooding; moderate permeability.	Severe: subject to flooding.	Severe: subject to flooding.
Difficult to vegetate; generally not needed.	Not needed..........	Subject to flooding; fair to poor shear strength; low shrink-swell potential; medium to high compressibility.	Severe: subject to flooding; moderately rapid permeability.	Severe: subject to flooding.	Severe: subject to flooding.
Difficult to vegetate; erosion hazard during construction.	Not needed..........	Fair to poor shear strength; low shrink-swell potential; medium to high compressibility.	Severe: slopes too steep; moderate permeability.	Severe: steep slopes severely hinder development of site.	Severe: steep slopes severely hinder development of site.
Soil features favorable; generally not needed.	Soil features favorable; generally not needed, but diversions can be used to channel excess water from higher soils.	Seasonal high water table; subject to ponding; fair to poor shear strength; moderate shrink-swell potential; medium to high compressibility.	Severe: slow permeability; seasonal high water table.	Severe: very poorly drained; seasonal high water table.	Severe: very poorly drained; seasonal high water table; clayey material hinders trafficability and is subject to cracking or drying.

Soil series and map symbols	Suitability as source of—			Soil features affecting—			
						Farm ponds	
	Topsoil	Sand and gravel	Road subgrade material	Highway location	Agricultural drainage	Reservoir areas	Embankments, dikes, and levees
Martinsville: MeA, MeB2.	Good to fair in surface layer. Fair to poor in subsoil: moderately fine texture.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair stability.	Cuts and fills generally needed; subject to frost heave.	Natural drainage adequate; not needed.	Moderate seepage.	Fair stability in subsoil and substratum: fair to poor compaction characteristics; moderate to low permeability when compacted; medium to high compressibility; fair resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.
Miami: MmB2, MmC2, MmD2, MmE2.	Fair to poor in surface layer and in subsoil: moderately fine texture.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair to poor stability.	Cuts and fills needed; subject to frost heave.	Natural drainage adequate; not needed.	Moderate to slow seepage.	Fair to poor stability in substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.
MsB3, MsC3, MsD3.	Poor in surface layer and subsoil: moderately fine texture.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair to poor stability.	Cuts and fills needed; subject to frost heave.	Natural drainage adequate; not needed.	Moderate to slow seepage.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.

See footnotes at end of table.

engineering properties—Continued

Soil features affecting—Continued			Degree and kind of limitation for—		
Grassed waterways	Terraces and diversions [1]	Foundations of buildings	Sewage disposal fields	Sewage lagoons	Sanitary landfills [2]
Soil features favorable.	Soil features favorable.	Fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Slight.	Severe: underlying material too sandy to hold water.	Severe: porous sand and gravel at depth of 48 to 68 inches; hazard of free leachate flow to ground water.
Soil features favorable.	Soil features favorable.	Fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Moderate: moderate permeability.	Moderate where slopes are 2 to 6 percent: moderate permeability. Severe where slopes are 6 to 25 percent: slope severely hinders development of site.	Slight where slopes are 2 to 12 percent. Moderate where slopes are 12 to 25 percent: slope moderately hinders development of site.
Soil features favorable.	Soil features favorable.	Fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Moderate: moderate permeability.	Moderate where slopes are 2 to 6 percent: moderate permeability. Severe where slopes are 6 to 18 percent: slope severely hinders development of site.	Slight where slopes are 2 to 12 percent. Moderate where slopes are 12 to 18 percent: slope hinders development of site.

Soil series and map symbols	Suitability as source of— Topsoil	Sand and gravel	Road subgrade material	Soil features affecting— Highway location	Agricultural drainage	Farm ponds: Reservoir areas	Farm ponds: Embankments, dikes, and levees
Ockley: OcA, OcB2.	Good in surface layer. Fair in subsoil: moderately fine to coarse texture.	Good: at least 3 feet of overburden on well-graded mixture of sand and gravel.	Poor in subsoil: fair shear strength; good to fair compaction characteristics; medium compressibility; moderate shrink-swell potential; subject to frost heave; fair stability. Very good in substratum: good to fair shear strength; fair to good compaction characteristics; slight compressibility; low shrink-swell potential; low susceptibility to frost heave; fair to poor stability.	Loose sand and gravel easy to excavate but sometimes hinders hauling; cuts and fills often needed; difficult to vegetate exposed gravel in road cuts; subsoil subject to frost heave.	Natural drainage adequate; not needed.	Rapid seepage in substratum.	Fair stability in subsoil: good to fair compaction characteristics; low permeability when compacted; medium compressibility; good resistance to piping; moderate shrink-swell potential; fair shear strength. Fair to poor stability in substratum: fair to good compaction characteristics; high to moderate permeability when compacted; slight compressibility; fair to good resistance to piping; low shrink-swell potential; good to fair shear strength.
OsA, OsB2.	Good in surface layer. Fair in subsoil; moderately fine to coarse texture.	Not suitable.	Poor in subsoil: fair shear strength; good to fair compaction characteristics; medium compressibility; moderate shrink-swell potential; subject to frost heave; fair stability. Very good in substratum: good to fair shear strength; fair to good compaction characteristics; slight compressibility; low shrink-swell potential; low susceptibility to frost heave; fair to poor stability.	Cuts and fills needed; subject to frost heave.	Natural drainage adequate; not needed.	Moderate to slow seepage.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.
Ragsdale: Ra.	Good in surface layer. Fair to poor in subsoil; moderately fine texture; seasonal high water table.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair compaction characteristics; medium compressibility; moderate to low shrink-swell potential; subject to frost heave; fair stability; seasonal high water table.	Seasonal high water table; moderately high susceptibility to frost heave.	Seasonal high water table; slow permeability.	Moderate to slow seepage; seasonal high water table.	Fair stability in subsoil and substratum: fair compaction characteristics; moderate to low permeability when compacted; medium compressibility; fair resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.

See footnotes at end of table.

engineering properties—Contin ed

Soil features affecting—Continued			Degree and kind of limitation for—		
Grassed waterways	Terraces and diversions [1]	Foundations of buildings	Sewage disposal fields	Sewage lagoons	Sanitary landfills [2]
Soil features favorable.	Soil features favorable.	Good to fair shear strength; moderate to low shrink-swell potential; medium compressibility in subsoil; slight compressibility in substratum.	Slight: moderate permeability; possible contamination of ground water.	Severe: porous sand and gravel at depth of 48 to 68 inches; very rapid permeability in sand and gravel.	Severe: porous sand and gravel at depth of 48 to 68 inches; hazard of leachate flow to ground water.
Soil features favorable.	Soil features favorable.	Fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Moderate: moderate permeability.	Moderate: lateral seepage through strata of sand and gravel.	Sight.
Soil features favorable; generally not needed.	Soil features favorable; generally not needed, but diversions can be used to channel excess water from higher soils.	Seasonal high water table; subject to ponding; fair to poor shear strength; moderate to low shrink-swell potential; medium compressibility; moderate to high susceptibility to frost heave.	Severe: slow permeability; seasonal high water table.	Severe: very poorly drained; seasonal high water table.	Severe: very poorly drained; seasonal high water table; subject to ponding; silty clay loam and silt loam materials hinder trafficability.

Soil series and map symbols	Suitability as source of—			Soil features affecting—			
	Topsoil	Sand and gravel	Road subgrade material	Highway location	Agricultural drainage	Farm ponds	
						Reservoir areas	Embankments, dikes, and levees
Rensselaer: Rn.	Fair to good in surface layer: moderately fine texture. Poor in subsoil: moderately fine texture; seasonal high water table.	Not suitable.	Poor in subsoil: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate shrink-swell potential; subject to frost heave; fair stability; seasonal high water table. Fair to poor in substratum: fair to poor shear strength; poor compaction characteristics; medium compressibility; low shrink-swell potential; subject to frost heave; poor stability.	Seasonal high water table; subject to frost heave.	Seasonal high water table; slow permeability; sand and gravel substratum.	Moderate to slow seepage; seasonal high water table.	Fair stability in subsoil: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate shrink-swell potential; fair to poor shear strength. Poor stability in substratum: poor compaction characteristics; moderate permeability when compacted; medium compressibility; poor resistance to piping; low shrink-swell potential; fair to poor shear strength.
Russell: RuB2, RuC2.	Fair to good in surface layer. Fair to poor in subsoil: somewhat moderately fine texture.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair to poor stability.	Cuts and fills needed; subject to frost heave.	Natural drainage adequate; not needed.	Moderate to slow seepage.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.
Shoals: Sh	Good in surface layer. Good to fair in subsoil: subject to stream flooding; seasonal high water table.	Poor to unsuitable; location of sand and gravel spotty; deep overburden; dipper equipment necessary.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; low shrink-swell potential; subject to frost heave; seasonal high water table.	Subject to flooding and frost heave; seasonal high water table.	Seasonal high water table; moderate permeability; subject to flooding.	Moderate to slow seepage; subject to flooding; seasonal high water table.	Fair stability in subsoil and substratum: fair to poor compaction characteristics; moderate to low permeability when compacted; medium to high compressibility; fair resistance to piping; low shrink-swell potential; fair to poor shear strength.

See footnotes at end of table.

engineering properties—Continued

Soil features affecting—Continued			Degree and kind of limitation for—		
Grassed waterways	Terraces and diversions [1]	Foundations of buildings	Sewage disposal fields	Sewage lagoons	Sanitary landfills [2]
Soil features favorable; generally not needed.	Soil features favorable; generally not needed, but diversions can be used to channel excess water from higher soils.	Seasonal high water table; subject to ponding; fair to poor shear strength; moderate shrink-swell potential; medium to high compressibility.	Severe: slow permeability; seasonal high water table.	Severe: very poorly drained; seasonal high water table; subject to ponding.	Severe: very poorly drained; seasonal high water table; subject to ponding.
Soil features favorable.	Soil features favorable.	Fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Moderate: moderate permeability.	Moderate where slopes are 2 to 6 percent: moderate permeability. Severe where slopes are 6 to 12 percent: moderate permeability.	Slight.
Soil features favorable; generally not needed.	Soil features favorable; not needed.	Seasonal high water table; subject to flooding; fair to poor shear strength; low shrink-swell potential; medium to high compressibility.	Severe: seasonal high water table; subject to flooding; moderate permeability.	Severe: subject to flooding.	Severe: subject to flooding; somewhat poorly drained; seasonal high water table.

Soil series and map symbols	Suitability as source of—			Soil features affecting—			
	Topsoil	Sand and gravel	Road subgrade material	Highway location	Agricultural drainage	Farm ponds: Reservoir areas	Farm ponds: Embankments, dikes, and levees
Whitaker: Wh	Good in surface layer. Fair to poor in subsoil: moderately fine texture; seasonal high water table.	Not suitable.	Poor in subsoil: fair to poor shear strength; fair to poor compaction characteristics; moderate shrink-swell potential; subject to frost heave; fair stability; seasonal high water table. Fair to poor in substratum: fair to poor shear strength; poor compaction characteristics; medium compressibility; low shrink-swell potential; subject to frost heave; poor stability.	Seasonal high water table.	Seasonal high water table; moderate permeability; stratified silt and sand below depth of 36 inches.	Moderate seepage; seasonal high water table.	Fair stability in subsoil: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate shrink-swell potential; fair to poor shear strength. Poor stability in substratum: poor compaction characteristics; moderate permeability when compacted; medium compressibility; poor resistance to piping; low shrink-swell potential; fair to poor shear strength.
Xenia: XeA, XeB2.	Fair to good in surface layer. Fair to poor in subsoil: moderately fine texture.	Not suitable.	Fair to poor in subsoil and substratum: fair to poor shear strength; fair to poor compaction characteristics; medium to high compressibility; moderate to low shrink-swell potential; subject to frost heave; fair to poor stability.	Cuts and fills generally needed; subject to frost heave.	Natural drainage adequate; generally not needed.	Moderate to slow seepage.	Fair to poor stability in subsoil and substratum: fair to poor compaction characteristics; low permeability when compacted; medium to high compressibility; good resistance to piping; moderate to low shrink-swell potential; fair to poor shear strength.

[1] Not suitable if slope is more than 12 percent.

engineering properties—Continued

Soil features affecting—Continued			Degree and kind of limitation for—		
Grassed waterways	Terraces and diversions [1]	Foundations of buildings	Sewage disposal fields	Sewage lagoons	Sanitary landfills [2]
Soil features favorable.	Soil features favorable.	Seasonal high water table; fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Severe: moderate permeability; seasonal high water table.	Severe: stratified material at depth less than 5 feet allows for possible rapid seepage.	Severe: somewhat poorly drained; seasonal high water table; stratified silty and sandy material at depth less than 60 inches; hazard of free leachate flow to ground water.
Soil features favorable.	Soil features favorable.	Fair to poor shear strength; moderate to low shrink-swell potential; medium to high compressibility.	Moderate: moderately slow permeability.	Moderate: moderately slow permeability.	Moderate: silty clay loam and clay loam texture moderately affects workability.

[2] Onsite study of the underlying strata, water tables, and hazards of aquifer pollution and drainage into ground water need to be made for landfills more than 5 to 6 feet deep.

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ENGINEERING SOILS MAP
HENDRICKS COUNTY
INDIANA

JOINT HIGHWAY RESEARCH PROJECT

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