Manuscript - Road materials in south-central Illinois. 1930

ST. JOSEPH MO.
CHILLICOTHE MO.
COLBY KANS.

JEFFERSON CITY MO
WICHITA KANS
VAUGHN N.M.

COPPER HARBOR MICH.
OSHKOSH WIS.
MILWAUKEE WIS.

KANSAS CITY MO
DENVER COL
SAN FRANCISCO CAL.

KANSAS CITY MO
PUEBLO COL.
SACRAMENTO CAL

SPRINGFIELD MO.
OKLAHOMA CITY OKLA
LOS ANGLES CAL

DETROIT MICH.
JACKSON MICH.
GARY IND.

BOSTON MASS
ALBANY N.Y.
CLEVELAND OHIO

ATLANTIC CITY N.J.
PHILADELPHIA PENN.
CANTON OHIO

NASHVILLE TENN
ATLANTA GA.
NAPLES FLA.

MEMPHIS TENN.
JACKSON MISS.
NEW ORLEANS LA.

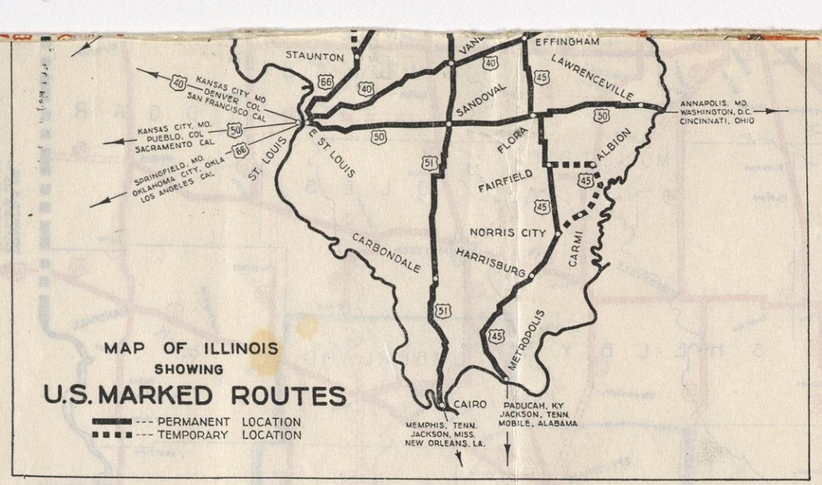
PADUCAH KY
JACKSON TENN
MOBILE ALA

INDIANAPOLIS IND.
COLUMBUS OHIO
ATLANTIC CITY N.J.

ANNAPOLIS MD.
WASHINGTON D.C.
CINCINNATI OHIO

REVISED TO:- FEBRUARY 1, 1929

FEBRUARY 1, 1929
-W.A.COMER-



and 2 miles west of Route 3.

Giant City Park is in Jackson and Union Counties, about 9 miles south of Carbondale, and 2 miles east of Route 2.

Old Salem Park is located in Menard County, 3 miles south of Petersburg, on Route 43-A.

Shabbona Park, in LaSalle County, is on Route 23, 14 miles north of Ottawa.

Starved Rock Park is on Route 7-A, about 6 miles west of Ottawa.

The University of Illinois is located in the cities of Champaign and Urbana, which are served by Routes 10, 25, and 39.

White Pine Forest State Park is in Ogle County, midway between Routes 2 and 26. It is approximately 6 miles east of Polo and 7 miles west of Oregon.

Pavement—Miles.	1465.90	6252.36	7718.26

UNDER CONTRACT—NOT COMPLETED ON FEBRUARY 1, 1929

Class	State Aid	Bond Issue	Total
Pavement—Miles.	85.40	594.65	680.05
Grading—Miles...	3.21	178.28	181.49
Bridges—Number.	15	178	193

WORLD'S RECORDS

1. 1305 Miles of Pavement in One Year.
2. 70.7 Miles of Pavement in One Week.
3. 2669 Feet of 18-Foot Pavement in One Day with One **Mixer.**

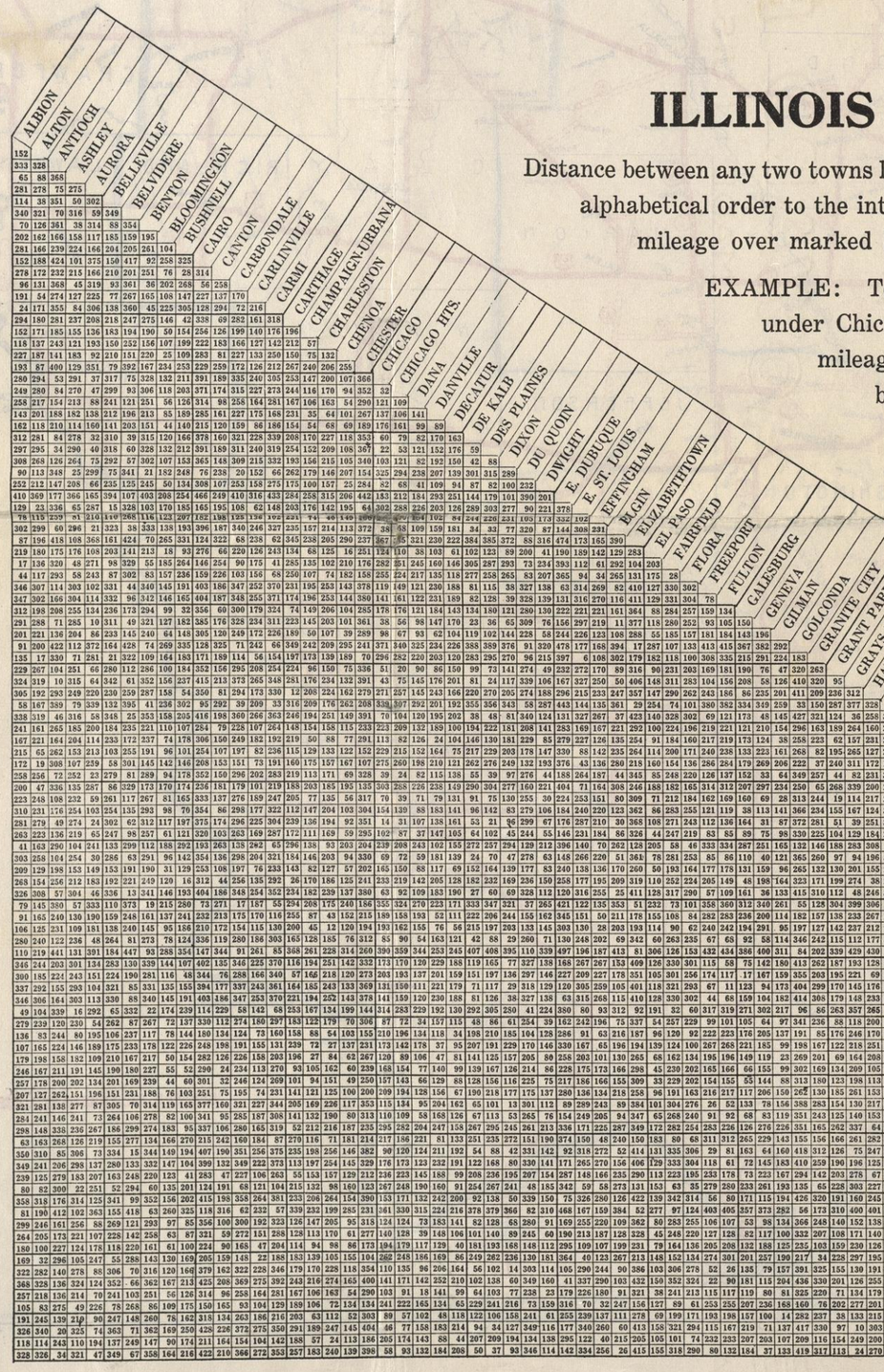
ILLINOIS HIGHWAY DISTANCE SCHEDULE

Distance between any two towns listed in the chart at the left may be found by tracing down the vertical column of the first in alphabetical order to the intersection with the horizontal column of the second, where the figure represents the highway mileage over marked State highways by the shortest route or combination of routes.

EXAMPLE: To find the distance between Chicago and East St. Louis, follow down the vertical column under Chicago (first in alphabetical order) to the horizontal column opposite East St. Louis. The mileage shown at the intersection of the two columns is 302, the distance between the two cities by the shortest route.

The points listed are chosen for their strategic locations on the State highway system, rather than because of size or importance of the places. Distances are computed over final locations of all routes, and allowance should be made for any temporary routes or detours shown on the map on the opposite side.

All distances given are based on actual survey lengths where available. In attempting to check distances given in the chart, it should be remembered that speedometer readings will vary, and small differences may be accounted for by this fact. Because of the hundreds of calculations necessary, it is possible that some errors have occurred in the schedule, and the Department will welcome advice of any found.



ROAD MATERIALS IN SOUTH-CENTRAL ILLINOIS

F. T. Thwaites, 1930

Introduction. The area surveyed by the writer in south-central Illinois in 1929 and 1930 comprises approximately 5151 square miles and consists of Marion, Jefferson, Washington, Wayne, Richland, Clay, Jasper, Effingham, and Cumberland Counties with parts of Fayette, Clinton, and St. Clair Counties. This survey was a "detailed reconnaissance" covering 20 to 70 square miles a day, a rate of progress which precluded much work on foot. Locations were kept on Post Office maps except where U. S. Geological Survey quadrangles are avialable.

TOPOGRAPHY

General. The district surveyed shows the following physiographic types: (a) drift plain, locally much eroded, (b) drift-mantled rock hills, locally altered by postglacial erosion, (c) morainal hills and ridges, (d) valley terraces and flood plains, and (e) sand dunes. These features have been described by MacClintock (1), to whose preliminary survey the mapping done by the writer added much detail.

(1) MacClintock, Paul, Physiographic divisions of the area covered by the Illinoian drift-sheet in southern Illinois: Illinois State Geological Survey, Rept. Investigations, No. 19, pp. 1-25, 1929

Drift plain. The characteristic feature of the northern part of the area is a vast drift or till plain. Where uneroded this plain is very gently undulating. Such undulations are so slight that they cannot be seen by the eye but they served to locate the original streams. Uneroded remnants of the plain now form the divides; of these the largest are those between the major streams, the Kaskaskia, Little Wabash, and Embarrass ("Ambraw") Rivers. These large streams have cut valleys with a maximum width of over two miles. Adjacent to these valleys dissection of the plain has reduced it to a maze of dendritic steep sided valleys with a maximum depth of slightly less than 100 feet. In places where the valleys run east and west the north sides are almost

invariably the gentler. This is ascribed to the less favorable conditions for tree growth on th dry sunny side which has led to much more erosion than on the forested shady side. Going south on any of the uneroded sections of the drift plain it is found that the flat surface is progressively more and more broken by low mounds which megge insensibly into hills and ridges. The plain extends along the valleys into the hills, which in Southern Marion and in Jefferson Counties are the dominant feature of the land scape. The problem of mapping the exact border of the drift plain is in many places a difficult one since the line of division is indefinite.

Rock hills. Rising from a foot to 100 feet above the drift plain are rock cored hills which vary from a few rods to many miles in width. Most of these betray their origin not only by exposures of rock and discoveries of rock in wells but also by the dendritic outline of their bases. The rock hills are smooth and have rather gentle slopes except where ravines have been eroded in the bottoms of the broad smooth mature preglacial depressions. There is a distinct topographic unconformity between these postglacial valleys and the drift-mantled older topography just as there is between the uneroded parts of the drift plain and the postglacial ravines in it. Some of the broader rock uplands are so smooth that they are easily mistaken for drift plain. Other hills areas are so low that discrimination from true plain is exceedingly difficult.

Moraines. Some of the hills which rise from the drift plain are not known to contain rock cores. The outlines of these hills may be circular, or elliptical; some of them are long linear ridges. In some instances it is probable that there is a rock nucleus which at it does not come near enough the surface to have been found in the shallow wells of this region. In a few cases stream cutbanks and ravines definitely show that there is no rock above the base of the hill. Hills of this type are found in eastern Clinton County and in parts of Marion County. In northeastern Fayette County and northwestern Effingham

County is a long drift ridge about 40 feet high which trends northeast. Isolated drift hills in southern Jasper County have elliptical outlines and trend west; these may possibly be drumlins although not so mapped. A line ofopronounced knobs about 100 feet high lies along the west side of the Little Wabash Valley in southeastern Wayne County. It is the most striking morainic topography of Illinoian age known east of Kaskaskia River In northern Cumberland County the Shelbyville Moraine of Early Wisconsin age forms a broad ridge about 75 feet high. One shallow kettle hole is reported in this moraine, but none were found in the older moraines.

Terraces and flood plains. Practically all the valleys of the district, both in the Wisconsin and in the Illinoian drifts, have relatively flat flood plains. These flats extend almost to the headwaters and in many places are well developed in valleys only a few feet deep. The maximum width of the flood plains is over two miles. Most of them are subject to overflow several times a year. In times of low water the streams meander in channels with a maximum depth of 15 feet. In some places the sides of the valleys are terraced. The best developed terraces are found in the valley of the Kaskaskia in St. Claire and western Washington Counties. Small remnants of deeply dissected terraces are found near Centralia and along the valley of the Little Wabash in Effingham and northern Clay Counties. Gravel terraces are abundant in the valleys of central Cumberland County.

Sand dunes. Sand dunes are abundant on the bluffs of the left or eastern banks of the Kaskaskia and Embarrass Rivers. Their maximum height is about 30 feet.

GEOLOGY-BED ROCK

General statement. The entire district surveyed by the writer is underlain by Pennsylvanian sediments which comprise in order of abundance, shale, sandstone, limestone, and coal. All except a part of eastern St. Clair County

is underlain by the McLeansboro formation. As the surface of the bed rock is irregular, exposures are confined to certain definite parts of the district and are most abundant in the hills. Many postglacial valleys have been eroded completely through the drift into the underlying sediments. Since the purpose of the survey was road materials, little time could be devoted to examination of outcrops except as they display limestone or hard sandstone. Little time could be spent on foot traverses of streams and ravines where most exposures are located. In spite of these circumstances, however, the writer found that with increasing experience in such work he could get a fairly good idea of the stratigraphic succession and the structure of certain limited areas. In some counties a definite horizon could be traced for considerable distances but over wide areas lack of exposures, at least of recognizable markers, left huge gaps in knowledge of the bed rock. In several localities strong suggestions of anticlinal structure were found, some of which may be worth further study for oil possibilities. The data collected, however, is not sufficient to allow of the compilation of a geologic section of the entire district. Local details are contained in the county reports.

GEOLOGY-DRIFT

Introduction. All of the district surveyed by the writer, with the exception of part of northern Cumberland County, is mantled by glacial drift of the Illinoian stage. The exception contains the Shalbybille Moraine of the Early Wisconsin substage. These two drift sheets are easily distinguished by the vastly greater erosion and weathering of the former than of the latter. No section was found which displays the two drifts one above the other. In Fayette, Effingham, and Cumberland Counties MacClintock (1) has found several exposures which display a drift below the Illinoian and much older than that drift sheet. Although a few new exposures were discovered by the writer,

(1) MacClintock, Paul, Recent discoveries of pre-Illinoian drift in southern Illinois: Illinois State Geological Survey, Rept. of Investigations, No. 19, pp. 27-57, 1929

the area underlain by this pre-Illinoian drift was not extended.

Illinoian Drift

Drift plain and ground moraine. The drift plain or ground moraine of Illinoian age is not confined to the area where a pre-Illinoian drift is present. Drift sufficiently thick to cover all of the preexisting hills is necessary for accumulation of level ground moraine. A second requirement is till which contains enough clay to slide readily when first deposited and therefore supersaturated with water. An additional factor may be stagnation and slow melting of the ice sheet in country of low relief without vigorous ice drainage. The observed paucity of boulders on drift plains in southern Illinois may be due to two causes, (a) sinking into the soft clay till, and (b) destruction of surficial boulders by weathering. The first suggestion seems to be supported by finding boulders in deep stream cuts and on hills outside the drift plains. Drift mantled hills of rock are another phase of ground moraine. It is suggested that on hills the till dried out much faster than on the lowlands and that mud slides could not remove all the deposit. One of the most striking phenomena of the hills is the relatively slight amount of erosion compared with that of the plains. This may be accounted for by (a) greater soak-in because so many of the hills are underlain by sandstone beneath rather thin drift which has weathered to silttil, and (b) greater distance from drainage lines.

Moraines. One of the most striking phenomena of the Illinoian drift is the scarcity of moraines. Within the area surveyed by the writer such occur only (a) near Kaskaskia River and (b) along a part of Little Wabash River. In the first named district the moraines trend northeast, a direction not in harmony with the deployment of a Michigan Lobe. The alternatives are (a) these ridges were deposited by the Kewatin Lobe and later overridden by the Michigan Lobe or (b) they were marginal deposits on the northwest side of an Erian lobe. Not a single striation was found by the writer to test these hypotheses,

but the following evidences support the second view. (a) The moraine west of Little Wabash River in Wayne County trends north, (b) logs of wood in the base of the Illinoian till near Effingham trend northwest, (c) shove in gravel deposits overlain by till near Effingham seems to indicate a westward movement, and (d) as far as the writer could tell in field examination the erratics in the Illinoian drift are quite different from those of the Wisconsin drift of this area, which undoubtedly came from the Lake Michigan basin. This matter of the erratics can never be solved by ordinary percentage pebble counts but demands matching of rocks with those of known origin. On the other hand, it is hard to see how a lobe of ice could extend from Lake Erie into southern Illinois without covering the reentrant of the drift margin south of Indianapolis. It was at first thought that the shove of some boulders in the top of the pre-Illinoian drift southwest of Effingham ment a southerly movement, but the coincidence of this direction with that of the grader which made the cut throws much doubt on this conclusion. The rarity of recessional moraines in the Illinoian drift may be explained by stagnation of the ice after its maximum. Cessation of motion would result in the gradual dissppation of the ice sheet into a sea of mud without running streams. Lacking such, kames would be rare except in the moraine at the maximum and without motion till moraines could not be built. The only kames which project above the general surface are a few east of Vandalia and those of the Wayne County moraine. This latter feature consists of till interbedded with much sand and gravel in most of which the bedding cannot be distinguished. These deposits may have been laid down in crevasses either in or at the margin of a stagnant ice block. It is possible that the cause of crevassing was the valley to the east but since similar formations do not occur in similar topographic positions elsewhere in the area the determining cause was local and exceptional. No extensions of this moraine are reported by the party working to the south of this area.

Interbedded assorted drift. Gravel, sand, and silt in lenses and masses within the till have been found in many places in the Illinoian of this area. Most of the localities are in the bluffs of the larger streams, but this does not ~~in all places~~ indicate a necessary genetic connection between assorted drift and valleys ~~but that~~ for there conditions for exposure are best. The assorted deposits vary from isolated masses (drift boulders) a few inches across to strata many feet thick which underlie areas measured in many hundreds of acres. The smaller masses, most of which are more or less rounded and have disturbed bedding, were unquestionably transported by moving ice doubtless before the maximum of the ice sheet. The larger deposits also show some effects of ice shove although most of them are in situ. As a rule isolated boulders of sediments are most abundant close to large lenses. Gravel and sand beds are most abundant and largest in eastern Fayette and western Effingham Counties, that is near to the northwestern border of the postulated Erian Lobe. Under this explanation, the assorted deposits would represent marginal outwash covered with till by continued advance or rather readvance of the ice. Some of them, particularly the poorly sorted deposits west of Effingham, may be crevasse fillings formed at the margin of the advancing ice. Some deposits which show extensive inclined bedding may be deltas. Some of the instances of burial by till may have been caused by mud flows rather than by ice movement. Much of the gravel is quite stony and yet free from large boulders; this is related to the prevailing size of stones in the till and to the fact that the waters which deposited the gravels must have been confined to rather narrow channels.

Erosional terraces. The valley of the Little Wabash in Effingham and northern ~~Clay Counties contains~~ a distinct but deeply dissected terrace 20 to 30 feet above the floodplain. This terrace is everywhere covered with loess between which and the underlying till occur patches of silt, sand, and gravel.

It seems to the writer to be an old valley floor whose dissection was due to either (a) climatic change or (b) distrophic movement. Study of a more extended area will be required to settle this point. A somewhat similar feature was found northeast of Centralia. It is covered with loess which lies on gumbotil.

Alteration of drift. The Illinoian drift has been deeply weathered. On poorly drained parts of the drift such as the drift plain, gumbotil was formed and where the subsoil drainage was good, as on the rock hills, particularly on sandstone, silttil developed (2). Adjacent to masses and beds of sand and

(2) Leighton, M. M., and MacClintock, Paul, Weathered zones of the drift-sheets of Illinois: Jour. Geology, vol. 38, pp. 28-53, 1930; Illinois State Geol. Survey, Rept. Investigations, No. 20, 1930

gravel a red color instead of the normal yellowish gray seems to be characteristic although by no means universal. In many places the Illinoian gravels are so altered by weathering that separation from weathered till is very difficult.

Loess. Almost the entire area of uneroded Illinoian drift as well as the gentler slopes and erosional terraces is covered with loess. The thickness of this mantle decreases from west to east. Along the Kaskaskia it is so thick that exposures of the underlying drift are rare, but in the eastern part of the district weathering has incorporated most of what loess was ever present with the underlying weathered till as shown by the presence of small pebbles close the surface. In StClair County a suggestion was found of two loesses, but sections showing this are rare. It may be suggested that the loess which is found over most of the area is the older or Sangamon loess.

Wisconsin Drift.

Terminal moraine. The Shelbyville moraine of the Early Wisconsin drift extends a few miles into the northern part of Cumberland County. It appears to be composed wholly of till. Its smooth topography is explicable by mud flows of the freshly deposited drift. During its formation the ice sheet was

undoubtedly in motion for otherwise it could not have built such a wide ridge.

Outwash. The streams which carried the water from the wastage of the Early Wisconsin ice in Cumberland County were aggraded with sandy gravel. The deposits were laid down in bars on the insides of curves. Such are well preserved along the valley of Hurricane Creek. Valleys which carried water when the ice margin had melted back north of the Shelbyville moraine were eroded because the sediment had been deposited farthern north. This left terraces of the earlier filling which are 10 to 30 feet above the modern floodplain. At the same time drainage outlets were cut throught the moraine. The gravels were worked over and in part concentrated into new bars. Some were deposited in the new floodplain. At the present time outwash is still being concentrated by the streams into gravel bars on the insides of curves. Such are common on Embarrass River in northern Jasper County. Beyond the area of deposition of coarse material during the maximum stand of the ice the grades of the modern and glacial streams either coincide closely or else the shrunken streams of today have built up their beds above the former positions concealing the true outwash under modern alluvial deposits. Throughout this belt the chief proof of the presence of glacial floods is the huge meander scars which indent the valley walls of the Kaskaskia and Embarrass Rivers. Although the Little Wabash carried glacial drainage, as demonstrated by outwash terraces in northwestern Cumberland County, it does not show such large meander scars as do the other valleys.

Lake deposits and valley filling. Marked terraces are found in the lower part of the Kaskaskia Valley. These differ from the terraces near the border of the Wisconsin drift in being composed of clay, silt, and only a little sand. Extensive borings confirmed the theory of Shaw (3) that these deposits

(3) Shaw, E. W., Preliminary statement concerning a new system of Quaternary lakes in the Mississippi basin: Jour. Geology, vol. 19, pp. 481-491, 1911; Newly discovered beds of extinct lakes in southern and western Illinois: Illinois State Geological Survey, Bull. 20, pp. 139-157, 1915

were laid down in slack waters held in by the more rapid deposition of outwash in the Mississippi Valley than in any of its tributaries. The different levels were probably due to the several advances and retreats of the Wisconsin ice sheet. During each retreat the outwash dam was eroded by clear waters and during each advance it was renewed. Erosion in consequence of these changes of local base-level caused the terraces. The filling of the lower parts of the ~~other~~ valleys which did not carry any drainage from the ice was caused in the same way, but no terraces seem to have been formed, possibly because erosion during times of ice retreat was not fast enough. The alluvium of the flood plain of Skillet Fork, Wayne County, consists of about 7 feet of non-calcareous silt overlying calcareous silt and fine sand. The source of the carbonate is not evident except that it might have been derived from unweathered Illinoian till. Many of the valley flats are now being actively aggraded, doubtless in part as a result of deforestation of the hills and cultivation of adjacent uplands. In the smaller streams there are many bars of poorly sorted sandy dirty gravel, as well as lenses of sandy gravel interbedded with the silt and clay of the floodplain. These gravels are coarser and more abundant in Effingham and Cumberland Counties than in the rest of the area, a fact apparently correlated with a more stony till than elsewhere.

Alteration of drift. The Wisconsin till is only moderately altered by weathering. On the slopes of the Shelbyville moraine postglacial erosion has just about kept pace with weathering. The outwash terraces are altered more than the till both on account of their porosity and the flat surface which preserves the residium. There is one to four feet of sticky clay with resistant pebbles on top of these terraces. The valley filling and slack water terraces also betray their Wisconsin age by relatively slight weathering.

Loess. The Wisconsin drift has a very thin loess cover where any is present. The only definite loess noted by the writer consists of some thin layers above the weathered zone on a few of the outwash terraces of Cumberland County.

ROAD MATERIALS

Limestone. The most important road material found in the bed rocks of this district is limestone. A considerable part of the shales would make good road material on a sandy subgrade but on the clays of Illinois are of no value whatever Beds of limestone in the McLeansboro formation are most commonly found immediately over either a coal or a black slaty shale. Few of them reach six feet in thickness and the observed maximum in this district is ten feet. The greatest difficulty in working the limestone beds is heavy stripping, for almost all of the known exposures are in the bottoms or the sides of postglacial ravines. In the few places where limestones occur below relatively flat areas at a depth where stripping would be feasible it seems probable that weathering has made extensive inroads on this soluable rock. The position of the ravine outcrops makes drainage expensive in almost all locations. Exploration of limestone deposits was confined to examination of the best exposures and delimitation of districts in which more intensive prospecting would be justified. At the date of the survey no crushed rock for roads was being produced in the district. An attempt in northwestern Cumberland County ended in failure some years ago. Several quarries were producing or had recently produced ground agricultural limestone in Washington, Effingham, and Richland Counties. Of these, the first named is undoubtedly the largest producer and has the greatest reserves. Were it not for the nearness of Washington County to the large shipping quarries of the St. Louis area, it would undoubtedly be able to produce a large amount of local road material. Reserves in Effingham, Cumberland, and Clay Counties are not inconsiderable, but competition with local gravel in the first two will undoubtedly preclude development on any large scale. Indeed, it may prove more to the benefit of the region to conserve all the limestone deposits for agricultural use instead of depleting them for road construction.

Sandstone. In some parts of the area portions of the sandstone are well

enough, cemented to make a possible source of crushed rock. Careful study showed, however, that hard rock has a very irregular horizontal and vertical extent so that attempts to develop this material on a large scale would almost certainly lead to many disappointments. It might possibly be used for very small projects in western Clay County. The softer sandstones are too fined grained to make sand-clay roads.

Gravel. Workable deposits of gravel are found in three parts of the area: (a) eastern Fayette and western Effingham Counties, (b) southeastern Wayne County, and (c) Cumberland County. Of these the first two show gravels of Illinoian age and the last Wisconsin outwash. The known Illinoian gravels are very stony and are well sorted. A large part of them could be used for road surfacing without any treatment but some are cemented by calcite into a hard conglomerate and would require crushing. Unfortunately, many of the deposits are covered with till or disintegrated gravel so that expense of stripping would be considerable especially when opened on a large scale. Exploitation is proceeding in Effingham County, but in Fayette County nearness to the free gravel pit on the State Prison Farm north of Vandalia has retarded development of several large deposits of good quality. The Wayne County deposits have never been opened up even for local use. They suffer from local prejudice in favor of washed outwash gravel from the Wabash bottoms. Roads have been surfaced with shipped-in material within half a mile of excellent local deposits. The outwash in Cumberland County is fully equal in quality to many of the gravels used extensively in the northern part of the State although it has fallen into disfavor locally and most of the pits have been abandoned. It requires screening to reduce the sand content and needs careful stripping to remove the sticky clay on top. Except in parts of Effingham, Cumberland, and northern Jasper Counties creek and river gravels are insufficient in quantity to be considered for large projects. Even in these localities their recovery requires a large amount of work so that the resulting product is hand picked. In wet seasons

many deposits cannot be worked at all. In spite of the high cost of working stream gravels and their mediocre quality they have two advantages: (a) they are continually renewed by the streams, and (b) they are widely distributed and thus shorten the haul to any given project. The writer is of the opinion that still other deposits of gravel can be opened up in the district once the interest of the inhabitants is aroused in digging. The slight development of gravel resources in southern Illinois compared with the through exploration in the north is a revelation to one familiar with conditions elsewhere. Apparently conditions have been going from bad to worse judging from the abandonment of many pits and quarries. Doubtless depression in agriculture and coal mining coupled with the drougth of 1930 are the causes of the pessimissim of ~~all~~ the local inhabitants.

Summary. Of the counties surveyed by the writer the following appear to possess adequate supplies of road materials for surfacing State Aid roads: Fayette, Effingham, Cumberland, Washington, and Wayne. The following counties have a little local material, enough to surface relatively small local projects: Clay, Marion, Jefferson, Richland, and Jasper. Areas with no local material whatever are the eastern parts of St.Clair and Clinton Counties.

ROAD MATERIALS OF CLAY COUNTY, ILLINOIS

F. T. Thwaites, Associate Geologist, 1930

Introduction. Clay County, Illinois, contains about 466 square miles. It was covered with the assistance of D. D. Utterback in 8 working days or at the rate of about 58 square miles a day. Such a speed was rendered possible by the soils map and by the relativly few rock exposures which occur. The work sufficed to outline the districts in which further exploration is worth while. Large areas of undissected plain and of river bottom did not require any examination. Mr. Virgil Van Dyke, County Superintendent of Highways was visited but could supply little information.

Topography. Clay County may be divided into (a) drift plain, a large portion of which is dissected by ravines and valleys with a maximum depth of over 50 feet, (b) hills, which range from some scarcely preceptible to the eye to some over 50 feet above the adjacent plain, and (c) alluvial bottoms. Hills are confined to the southern and western parts of the county. The two most prominent areas of hills are (a) just south of Clay City and (b) Oak Mound northeast of Zenia. The sides of the Little Wabash valley, which locally is over 2 miles wide, exhibit in a few places a much dissected terrace about 20 feet above the floodplain. The mapping of this feature was by no means complete since there are no topographic maps within the county. For the same reason there is no information on elevations and relief.

Geology-bed rock. The bed rock of Clay County is the McLeansboro formation of Pennsylvanian age. It consists of sandstone, shale, limestone, and coal. Outcrops are common only in the western part of the county. Most of the hills seem to be made up of sandstone or sandy shale. The known exposures of limestone lie along a nearly straight line from Dismal Creek in Sec. 25, T. 5 N., R. 5 E. west of south to Sec. 29, T. 3 N., R. 5 E. At least two, more likely three, and possibly four different beds are represented, representing as many different cycles of deposition. The work done was insufficient to determine

the complete stratigraphic section which can only be done with the aid of borings. The following sections will serve to illustrate the points important for road materials.

(1) Rattlesnake Den, Crooked Creek, Secs. 11 and 14, T. 4 N., R. 5 E.

Sandstone, fine grained, micaceous, yellowish gray, hard, calcareous, possibly base of an upper cycle	3 feet
Shale, mottled yellow and brown, possibly an underclay	1
Shale, clay, bluish gray	3
Shale, sandy, micaceous, calcareous concretions	2
Shale, clay, bluish gray, calcareous concretions	10
Limestone, hard, light gray, fossiliferous, locally with up to 1½ feet soft bluish gray marl at base	3½-10
Coal	5/6
Shale, bluish gray, micaceous passing below into sandy bluish gray shale, weathered to yellowish gray	25

The strata exposed along Crooked Creek east and west of this point form a low arch which pitches to the north and whose known elevation is about 20 feet.

(2) NW¼NW¼ Sec. 13, Same township as (1).

Limestone, hard, bluish gray, weathers yellow, massive, no fossils	6 feet
Shale, clay, blue	15
Conglomerate, pebbles of limestone, shale, concretions	5
Limestone, gray, heavily bedded, fossiliferous	10
Coal and underclay	3
Shale, sandy, micaceous	5

It is clear that the lower limestone is the same as at Rattlesnake Den and to make sure the outcrop was walked out between the two points. A black shale is exposed in the eastern part of the same section as (2) but could not be found in the same section with the upper limestone. It contains many large calcareous concretions and is well shown in the following section.

(3) Northwest corner Sec. 15, same township as other sections.

Shale, black, slaty, calcareous concretions	4 feet
Coal, poor	1/6
Underclay, gray	1
Shale, black, some concretions, slaty	4
Shale, bluish gray, calcareous concretions	6

An interesting feature of the last locality is a small thrust fault with N-S strike. Normal faults of possibly 10 feet displacement and the same strike were noted in SE corner Sec. 12, T. 4 N., R. 5 E. It is noteworthy that the

that the upper limestone in Section (2) is not associated with a coal or black shale. It is probably a "shale limestone" like some of the beds in Jasper County and is very lenticular. In the north part of Sec. 19, T. 4 N., R. 6 E. are several ledges and an old quarry all of which show very hard clacareous sandstone five to six feet thick; it has been mistaken for limestone by some of the farmers. In NE¼NE¼ Sec. 20, same township, boulders of gray fossiliferous limestone occur in a ravine. This may be the locality erroneously recorded in NW¼NW¼ of the same section by Lamar. This deposit is shown by Section (1) to overlie the Rattlesnake Den limestone for it is certainly above the hard calcareous sandstone at the top of that column. Thus there seem to be three distinct limestones in this neighborhood. In SE¼SW¼ Sec. 25, T. 5 N., R. 5 E. limestone is exposed in an abandoned and washed out road both north and south of Dismal Creek. The rock resembles the lower limestone of Rattlesnake Den in that it is hard, gray, and fossiliferous where fresh. The top 2 feet of the 8 feet exposed north of the creek has weathered to a porous texture and the fossils are present in it only as moulds and casts as in dolomite. No associated beds are now exposed but Lamar reported gray shale above and 8 inches of coal below. The correlation of this limestone is uncertain.

(4) Creek bank, SE¼ Sec. 29, T. 3 N., R. 5 E.

Limestone, hard, dark gray, brittle, fossiliferous	2 feet
Shale, black, slaty, calcareous concretions, thin coal at bottom	1½
Sandstone, light gray, fine grained, very calcareous, hard	1
Sandstone, yellowish gray, soft	7

The limestone of the last section is probably different from any of the others Very hard micaceous calcareous sandstone is found in several other places among which may be listed.

Roads in north part Sec. 30, T. 3 N., R. 6 E. Sample No. 12

NW¼NW¼ Sec. 10, T. 4 N., R. 5 E.

East 40's, Sec. 7, T. 5 N., R. 5 E.

Geology-drift. Clay County is covered with Illinoian ground moraine which consists almost entirely of clay till. Most of this till flowed while wet forming a nearly level plain which subsequent erosion has dissected over large areas. This plain slopes toward the south faster than the grade of the streams so that the depth of valleys decreases toward the south side of the county. The largest valley is that of the Little Wabash. In some places a terrace could be found along this valley. The single observed exposure on this terrace showed a weathered silt similar to that of the present flood plain. Judging from the large amount of weathering and erosion which this feature has undergone it is pre-Wisconsin in age. It may be similar to the old terraces of the Centralia quadrangle. The exact origin is not known but it is certainly not a depositional feature like an outwash terrace. In some places rock hills were not covered deeply enough by the drift but that they projected above the level of the till plain. Considerable attention was given to a search for the possible northward continuation of the terminal moraine of southeastern Wayne County. It was considered possible that the ridge south of Clay City is this moraine but an exposure of shale on one of the highest hills seems to disprove the suggestion. Moreover, the ridge has a dendritic outline and has little red till and no kame gravel. It was also suggested that the curving ridges in the east part of T. 3 N., R. 5 E. are terminal moraines. So far as could be ascertained, these ridges, which are less than 50 feet high, show neither rock outcrops or good drift exposures. To the south they merge into known rock hills. It is possible that their shape reflects a structure in the underlying bed rocks for it is decidedly unlike the normal rock hill outline. More or less weathered sands and gravels are common in the district along the Little Wabash and west to the county line in the northern townships of the county. So far as road cuts and observed washes indicate, these deposits are very small lenses and boulders in the till. In many places they are intimately

mixed with till as though by a readvance of the ice over outwash or kames. None of these gravels form hills or reach the surface except in the sides of ravines.

Road materials-limestone. The most important deposits of limestone which could be worked for road material are (a) at and near Rattlesnake Den on Crooked Creek and (b) on Dismal Creek. It was reported that the latter was once worked to surface a street in Louisville which has since been paved. This locality is thought by the writer to offer better possibilities for development than the Crooked Creek deposits. The limestone forms a terrace on both sides of the creek and it seems fair to estimate that fully 75,000 cubic yrds could be recovered under not over 10 feet of drift. Thorough testing with thedrill is needed. At Rattlesnake Den conditions for quarrying are favorable on the ends of several spurs and in some of the ravines. Sample 11 represents the material of the lower bed. The upper layer was not sampled on account of the weathered condition of the outcrops. The writer estimates that the total reserve in the upper bed is about 10,000 cubic yards and in the lower possibly 60,000 cubic yards scattered in several places for fully two miles along the creek. The Dismal Creek limestone was not sampled because of the poor exposure. A favorable factor in the development of both the Dismal Creek and Crooked Creek deposits is the coal which, if the quarrying is carried on skillfully, could be recovered to furnish fuel for crushing and posaibly a surplus for the local market.

Road materials-sandstone. The hard calcareous sandstone which is so abundant in the western part of the county is of doubtful utility but Sample 12 was taken for a test. It came from a place where some rock had recently been quarried in a road cut in SE¼NE¼ Sec. 30, T. 3 N., R. 6 E. No attempt was made to estimate the reserves of this kind of rock since experience in good exposures indicates that its lateral and vertical extent is exceedingly irregular.

From the persistance of exposures in some localities in this county, however, it seems possible that moderate amounts of this kind of rock could be quarried. If any locality is considered for development much more careful testing is needed than in the case of limestone. The Illinois Central Railroad Company owns the SE¼NE¼ Sec. 7, T. 5 N., R. 5 E., near Edgewood, and has apparently held onto this tract for many years with the idea of developing a ballast quarry. The only exposures are in a road cut and in some abandoned quarries just south of this 40. It seems impossble to make a reliable estimate of the reserve in this property.

Road material-gravel. No deposits of gravel which were found seemed extensive enough to warrent exploration. It has been noted in other localities that large gravel deposits invariably form considerable secondary deposits where washed down hills in road gutters and ravines. Such reworked material was not found. On the other hand, some of the gravel is of good quality and it may well be that someone may yet stumble onto a small workable deposit suitable for local use. A further difficulty is that much of the material has been so highly weathered that it is of a gumbo-like consistancy and would not improve a road with a heavy clay subgrade. Small deposits of postglacial creek gravels occur throughout a large part of the county and are used by farmers for concrete work. These materials are so small in total amount and so scattered in distribution that no attention was given to them. In Effingham County, however, creek gravels have been used to surface a considerable amount of road, so that developement on a small scale may yet take place in Clay County.

Conclusion. The writer recommends serious consideration of the Dismal Creek and Crooked Creek limestone deposits taking into consideration the coal beneath and the use of screenings for agricultural limestone which now costs $2.10 per ton at the railroad. The sandstone deposits may be used for small nearby projects if the sample tested shows that the high cost of quarrying and crushing would be justified. Few deposits of large size are known. Some

small drift gravel deposits may yet be found in the northwestern part of the county and a little creek gravel could easily be used especially during a dry season when the bottoms of the creeks are easily entered.

Aug. 17, 1930

ROAD MATERIALS OF CLINTON COUNTY, ILLINOIS, EAST OF KASKASKIA RIVER

F. T. Thwaites, 1929

Introduction. The portion of Clinton County assigned to the writer to work with the assistance of Frank Byrne consists of about 150 square miles. It was covered in two and a half working days or at the rate of 60 square miles a day. Work was concentrated on hills and rock outcrops avoiding large flat areas. The excessive speed was justified by the paucity of road materials and of chances to find them. The Carlyle-Centralia folio was not found to be of any material help for it is too vague and generalized for our needs but the topographic base map speeded up the work immensely. Aid was received from J. T. Goldsmith of Huey, the County Superintendent of Highways for he was familiar with all explorations in the area.

Topography. Eastern Clinton County consists of a drift plain or ground moraine from which knolls and short ridges rise to a maximum heigth of 100 feet above adjacent lowlands. The west side of the area is bounded by the edge of the bottoms of the Kaskaskia River. The bluffs here are 20 to 40 feet high, much lower than in Fayette County to the north. Their outline is a series of scallops, evidently meander scars formed when the river once carried vastly more water than it does today. No definite evidences of terraces could be found along the bluffs, although as this problem was not assigned to the writer little search was made for such features. The smaller streams have alluvial bottoms which are subject to overflow. These flats have a maximum width of nearly a mile; they extend up almost to the headwaters of the streams. Little attention was devoted to detailed mapping of these areas. In a number of places isolated hills rise from the valley bottoms. These and some low spur ends were called terraces by Shaw but it is possible that they really are remnants of the pre-loess valleyfloors. This problem was not fully investigated since the importance

of the terraces as sources of road material is nil. It is very doubtful if there are any terraces of aggradation. The ridges which rise from the drift plain occur in all parts of the area but are most abundant in a belt roughly parallel to the Kaskaskia River in the southwestern part of the district. Their ~~slopes~~ sides in few instances exceed five degrees slope except where cut into by either the Kaskaskia meander scars or by postglacial ravines. The average relief of the area is low for few valleys exceed 30 feet in depth.

Geology. The bed rocks of eastern Clinton County are the Pennsylvanian shales, sandstones, and limestones. Outcrops are rare on account of the slight depth of the valleys. The glacial drift consists of till in which only a few layers and masses of sand were observed. The till is overlain by from a foot to 10 feet of loess. The possibility was considered that the hills might contain gravel. Ravines, railway cuts, road cuts, and borings to a maximum depth of over 10 feet failed to find anything but till below the loess. According to Mr. Goldsmith no wells have found any gravel in these hills. Our borings were in Boston Hill, Sec. 33, T. 2 N., R. 2 W., and the hill in Secs. 34, and 35 of the same township. Judge Farrell of Carlyle reported gravel in Corcoran Hill in Sec. 17, same township, but careful examination of ravines at the spot he described found nothing but silttil which, as is well known, somewhat resembles weathered sandy gravel. No direct evidence was found of more than one age of drift.

Road materials. The road materials of eastern Clinton County may be described as tersely as were the snakes of Ireland: there are none. A shaly limestone layer about two feet thick outcrops in the bank of Crooked Creek near Joliff School in SW¼, Sec. 1, T. 1 N., R. 1 W. This layer is cut off by preglacial erosion a short distance east of the bridge and to the west the dip carries it below even the lowest water level. It is all covered at flood stage. The quantity available is only a few hundred

cubic yards for to the south the riverbank rises steeply to such a heigth that stripping is out of the question. This rock was not sampled. It might be used to fill mudholes but for surfacing the high clay content would almost undoubtedly cause rapid disintegration if the results of natural weathering are a valid criterion. Mr. Goldsmith reported that similar rock occured in SW¼, SE¼, Sec. 19, same township, where an old milldam was located. Intensive search of the locality described failed to find any trace of the ledge; it is possible that channel changes have obliterated all traces but in any case the banks of the stream are so high, over 10 feet at low water, that the quanity of available rock would be negligable. Drift gravels seem to be either absent or else so heavily covered with till that exploitation would be impossible. If the drift ridges are terminal or recessional moraines outwash should be found adjacent. Mr. Goldsmith reported that an oil test south of Huey showed a very little gravel at a considerable depth. It is possible that the lack of outwash and kame gravels is due to overriding of the moraines by later glaciation. The form of the ridges suggests deposition by ice which came from the north or northwest. If so a later glaciation from the ~~north or~~ northeast would explain the observed facts including the discontinuity of the ridges. The area examined was too limited to test this hypothesis.

Conclusion. Attempts to develop local supplies of road surfacing material in eastern Clinton County are not warranted by the facts at hand. The known limestones are too thin, too heavily covered, and of too poor quality for profitable use. If any drift gravels exist the cover is entirely too great for exploitation. Postglacial creek gravels are negligable.

Associate Geologist,

Mt. Vernon, Illinois

Sept. 8, 1929

ROAD MATERIALS OF CUMBERLAND COUNTY, ILLINOIS
F. T. Thwaites, Associate Geologist, 1930

Introduction. Cumberland County, Illinois, consists of 336 square miles. It was surveyed with the assistance of D. D. Utterback in 5 working days or at the rate of about 67 square miles a day. The work was made more rapid than it otherwise would have been by (a) previous surveys by George E. Ekblaw and W. C. Krumbein, (b) the soils map which delimited the sand dunes, river bottoms, and outwash terraces, and (c) the large amount of drift plain which required little examination. A small part of the county south of Greenup has been surveyed by the U. S. Geological Survey. Several efforts were made to get in touch with J. A. Decker, County Superintendent of Highways, without success.

Topography. Almost all of Cumberland County is a drift plain cut by valleys which have a maximum depth of more than 50 feet. The undissected part of the plain is diversified by a few small hills whose maximum elevation is about 20 feet. A portion of the northern edge of the county consists of low rolling hills which rise to about 75 feet above the plain to the south. Stream valleys with wide flat floors occur throughout the central part of the county and their headwaters extend back into the hilly tract. Within several of the larger valleys there are terraces 10 to 30 feet above the adjacent floodplains. In a few places the bluffs east of the Embarrass (locally spelled phonetically Ambraw) River are topped by low sand knolls and ridges. The lowest part of the county is less than 510 feet above the sea but the highest point has not been measured. Steep slopes are confined to valley sides.

Geology-bed rock. Cumberland County is underlain by the McLeansboro formation of the Pennsylvanian. This consists of shale, sandstone, limestone, and coal. Outcrops are most common in the deepest valleys for instance in the bluffs of the Embarrass; there are, however, a few in the drift plain are of the northwestern part of the county. No line of division between different cycles of deposition was observed by the writer. Worthen (p.101) reports a black

shale with a thin coal on Webster Creek in Sec. 33, T. 9 N., R. 8 E. but it was not searched for by the present writer as there is no associated limestone. Worthen (p.100) reports a good section of strata in the bluff at the west bridge head on Route 11 west of Greenup but changes in the river seem to have obscured this exposure. At present the best outcrops seems to be on Route 131 both sides of the crossing of the Embarrass bottoms northwest of Greenup. The following section is adapted from notes by Lamar, who did not locate the place correctly.

Composite section in cuts on Route 131, Sec. 2 and 3, T. 9 N., R. 9 E.

Limestone, hard, gray, thin bedded, nodular, fossiliferous	3 feet
Shale, clay, greenish gray	4
Shale, sandy, gray to yellowish gray, light gray	6
Sandstone, fine grained, light gray, thin bedded	4
Shale, sandy, brownish gray to dark gray	about 20

Only one limestone is found in the county, that shown above. It is exposed in several places on the west bluffs of the Embarrass north of Greenup but since the overlying beds are not present the true thickness of the limestone is unknown. Lamar reports 9½ feet near Rock Ford in SW¼NW¼ Sec. 14, T. 10 N., R. 9 E. but investigation by the writer failed to confirm this figure from exposures now open. Incidentally this location is erroneous in Lamar's report; his description would place the spot in the middle of the river bottoms. Most of the known outcrops show less than 3 feet of limestone. Worthen reports that this formation is not associated with any coal or black shale and is overlain by sandstone and sandy shale. The strata along the Embarrass valley are slightly inclined down to the northeast. In the eastern part of the county there are many oil wells on the west side of the LaSalle anticline.

Geology-drift. Gumberland County contains drifts of three different stages of glaciation. The oldest is pre-Illinoian in age and is described by MacClintock in Report of Investigations No. 19. A high cut bank on the Embarrass River in Sec. 7, T. 10 N., R. 10 E. does not seem to show the pre-Illinoian. The Illinoian drift forms the surface of the bulk of the county.

A few deep postglacial valleys have uncovered the underlying pre-Illinoian. The surface of the Illinoian has been altered to gumbotill on the poorly drained flats and to silttil where underdrainage is better as along the sides of the larger valleys. The Illinoian drift is covered with a thin mantle of loess which in few places exceeds 5 feet in thickness, and which is not present on many steep valley sides. Almost all of the Illinoian drift is till. Where sand and gravel is present it occurs in relatively small lenses or isolated masses. Adjacent to many of these deposits a red color is developed by weathering which differs markedly from the normal yellowish gray of silttil. A good exposure showing this color relation is found in the great cut on Route 131 just northwest of Greenup. Sand and gravel were noted in Illinoian drift at the following places: (a) E½ post and center, Sec. 25, T. 9 N., R. 7 E., (b) NW¼NW¼ Sec. 17, T. 9 N., R. 8 E., (c) NE¼NW¼ Sec. 16, same township, (d) NE¼NE¼ and center Sec. 6, same township, (e) center Sec. 32, T. 10 N., R. 8 E., (f) SE¼SE¼ Sec. 27, same township, (g) NW¼SW¼ Sec. 32, T. 10 N., R. 10 E., (h) center Sec. 31, T. 10 N., R. 10 E., (i) SE¼SE¼ Sec. 27, same township. Most of the deposits are small and are underlain and overlain by till. The Early Wisconsin drift with a fresh light textured gray till and a rolling topography is in sharp contrast with the older Illinoian. No good exposure of a contact between the two drifts could be discovered in the time available. There are a few gentle depressions in the Early Wisconsin terminal moraine which is a part of the Shalbyville Moraine. Its surface has been slightly dissectdd and the larger valleys which carried glacial waters are wide with broad flat bottoms. Very little gravel and sand was discovered in the Early Wisconsin terminal moraine. At the time of either the advance or the maximum of the Early Wisconsin glacial invasion the waters from the melting ice laid down extensive deposits of rather sandy gravels along the streams which drained the ice front. These streams comprise in Cumberland County (a) a tributary of the Little Wabash in the northwestern corner of the county, (b) Muddy Creek, (c) Cottonwood Creek, (d) Embarrass River, and (e)

~~, Cumberland, 30nly in the deeper valleys made by postglacial erosion~~

Hurricane Creek. The upper surface of the deposits was not everywhere a plain but there were bars up to 10 feet in heigth. The grade of the outwash deposit was steeper than that of the present shrunken streams. When the ice front receeded to the north the waters cleared themselves of their load farther north and when they reached Cumberland County eroded the previously deposited gravels. This process led to the formation of terraces whose elevation above the present water level decreases downstream from the moraine until they merge into the modern floodplain. Gravels were also laid down in the valleys which the glacial waters cut through the terminal moraine. Outwash which was eroded was redeposited at lower levels beneath the floodplain. Terrace remnants are found along the Embarrass to within 2½ miles of the south county line where the single example rises only some 10 feet above the adjacent floodplain. The glacial floods caused the rivers and creeks to meander in curves vastly larger than the small bends of today. The insides of these curves doubtless contain gravel concentrates as do similar places along the modern meanders. Loss of volume in the streams must have caused aggradation burying the coarser reworked outwash beneath sand and silt. During the time shortly after the erosion of the outwash westerly winds blew much sand onto the eastern bluffs of the Embarrass. The resulting dunes were later weathered and locally buried by a pebbleless silt which resembles loess. A thin cover of loess is also found on the gravel terraces in some places but the writer did not notice any loess on the Wisconsin terminal moraine.

Road material-limestone. Some years ago an attempt was made to develop a limestone quarry near Neal in SE¼NE¼ Sec. 17, T. 10 N., R. 8 E. Near this point limestone is exposed in the creek bed for over a mile as it seems to dip east at the same slope as the stream. The thickness of the bed could, therefore, not be measured. It was tested with a pit before the county purchased the land but the excavation is now caved and the quarry, which it is said did not reach the bottom of the limestone, is filled with water. It is reported

that there was much trouble with drainage. The workings are in the bottom of a shallow ravine close to the upland. Sample 18 shows the rock but was taken from a car abandoned in the quarry as the ledge is now almost entirely concealed. Fresh rock would undoubtedly be harder. Only a portion of the rock which was stripped was taken out (about 1500 cubic yards). It was used on local roads to fix bad places. The quarry has been idle for several years following a dispute over financial matters. On the assumption that the bed is 6 feet thick it is concluded that about 20,000 cubic yards could be secured here with not over 8 feet cover. Other known outcrops of this limestone are either too thin a bed or too close to gravel to warrent working. In SE¼NW¼ Sec. 14, T. 10 N., R. 9 E the limestone may exceed 8 feet in thickness but the outcrop is in a deep ravine so that only some 2,000 cubic yards could possibly be recovered. In NW¼NW¼ Sec. 29, T. 10 N., R. 10 E. Louis Henderson is excavating disintegrated limestone for agrucultural use. The deposit consists of boulders of weathered limestone mixed with till as though moved by the ice. It is of no value for road material.

Road material-gravel. Gravel is the cheapest and most abundant road material in Cumberland County. The known workable gravels fall into two general classes: (a) postglacial stream gravels in bars, and (b) Early Wisconsin outwash gravels. The former occur in relatively small scatted deposits which are renewed with every flood. It is impossible to form any reliable estimate of the amount available. Stream gravels have been worked extensively especially in a dry year like 1930 when it is easy to get at them. They are taken out either with shovels or scrapers so that the resulting product is essentially hand picked. Long stretches of road and the streets of Greenup have been improved with stream gravels. Sample 26 was taken to illustrate the general nature of these deposits. Stream gravels are not entirely confined to valleys which carried glacial waters. In other valleys they are relatively small and of poorer quality. Outwash gravels are commonly used are taken from a vertical bank with no opportunity

for selection. The top one to four feet of the terraces is weathered to a sticky brown clay with comparatively few pebbles of resistant rocks. In some cases this weathered top was taken with the gravel. Fresh gravel is illustrated by a number of samples. It is fairly sandy, well assorted, and has moderately rounded pebbles in which limestone seems to predominate. Bedding is horzontal with some cross bedding which dips downstream in nearly all instances. None of the cross bedding affects more than a foot or two of strata. Few stones reach 2 inches in diameter except in the far northern part of the county where some exceed 6 inches. Layers of yellowish gray silt up to 6 inches thick are common. These represent the filling of ponds or abandoned stream channels of the glacial floodplain. Several of the best deposits are distinct bars located on the insides of curves in the glacial stream. Here the gravels are coarsest. The gravel deposits extend below the water table and this lower portion was not included in the estimates of reserves. It must consist of fresh gravel since it has been kept wet ever since deposition. Old abandoned pits are soom covered with a layer of hard yellowish brown clayey sand similar to that found on top of the terraces. The different pits are so similar in geology that they are best tabulated. Present samples designated by T.; Ekblaw's by E.

Location	Owner	Remarks	Reserve, cu yds	Sample
NE¼SW¼ Sec. 30, T. 11 N., R. 7 E.	County	Worked	1,000,000	E4 T17
NW¼NW¼ Sec. 27, T. 11 N., R. 10 E.	Bentsley	Abandoned	240,000	- -
NE¼SE¼ Sec. 28, same	Walters	Idle	500,000	- T24
SE¼SE¼ Sec. 28, same	Schaefer	Abandoned	?	- -
SE¼SE¼ Sec. 32, same	Short	Abandoned	240,000	- T25
NW¼NW¼ Sec. 1, T. 10 N., R. 9 E	Lawyer	Working	1,550,000	E6 T17
SE¼SW¼ Sec. 11, same	County	Abandoned	15,000,000	E3 T22
NE¼SE¼ Sec. 14, same	Cady	Abandoned	160,000	- -
SW¼SW¼ Sec. 5, T. 10 N., R. 10 E.	Hanley	Abandoned	240,000	- T23

This list does not include a number of small pits operated occasionally by farmers for their own use. Undeveloped deposits of outwash gravel were not

examined in detail but were mapped from the soils map and reports from farmers.

Location	Remarks	Reserve, cu. yds.
SE¼ Sec. 27, T. 11 N., R. 8 E.	Terrace at Johnstown	1,000,000
SW¼SW¼ Sec. 28, T. 10 N., R. 8 E.	North of Route 131	Small
N part Sec. 30, T. 11 N., R. 7 E.		Small
SE¼SE¼ Sec. 32, T. 11 N., R. 9 E. and E part Sec. 5, T. 10 N., R. 9 E.	Sample 19	800,000
Secs. 17 and 20, T. 10 N., R. 9 E.	Cottonwood Creek	500,000
Secs. 26, 27, 34, T. 11 N., R. 9 E.	Embarrass River	5,000,000
Secs. 25, 36, T. 11 N., R. 9 E.	South of Diana	4,000,000
Secs. 7, 8, 18, T. 10 N., R. 10 E.	Hurricane Creek	250,000
SE¼SW¼ Sec. 26, T. 10 N., R. 9 E.	Embarrass River	Small
NE¼NW¼ Sec. 28, T. 11 N., R. 10 E.	Hurricane Creek	Small
SE¼ Sec. 21, T. 9 N., R. 9 E.	Embarrass River	Small

Conclusion. It is clear that the total amount of outwash gravel in Cumberland County is enormous. The writer thinks that the estimates given above are conservative, although it is possible that some parts of the terraces may be very sandy. No estimate is possible of gravel beneath floodplains, nor in bars in existing streams. It is a notable fact that road builders are turning from outwash gravel to stream gravel as is demonstrated by the long list of abandoned gravel pits. The sole pit which was ever equipped with machinery to screen the gravel, the county pit in Sec. 11, T. 10 N., R. 9 E., is among these. Reports from farmers and others universally condemn the outwash gravels. "Too much clay," "too much gumbo,", "roads cut up in spring", are common statements. Objections to outwash or pit gravel are as follows: (a) the first roads were surfaced with too thin a layer of gravel, (b) the first roads are now old and the gravel has worked into the sub grade, (c) much weathered gravel containing very sticky clay was used as a binder, (d) most of the gravel used was not screened, (e) creek gravels are more widely distributed than are gravel pits and therefore haul is shorter for many pro-

jects, (f) more persons have creek gravel for sale than own pits so there is more political pressure to use stream gravel, (g) some of the complaints are doubtless excuses to get out of the expense of improved roads which have been accentuated by the recent agricultural depression. It seems possible that the condition of the faces in abandoned pits is not due entirely to slump but to weathering of the gravel since cessation of work. If this is correct some clay may have developed from weathering of the gravel since it was placed on the roads. To check this point extra samples were taken of pit gravel when fresh, of weathered pit gravel, and of stream gravel. The gravels are, however, not unlike those used with good results in the northern part of the state and the writer can see little reason why screened gravel taken from pits which have been stripped should not make a satisfactory road. The settlement of the controversy lies, however, more in the field of engineering than of geology. It seems unlikely that the limestone deposits of Cumberland County will ever be worked for anything but agricultural use.

Sept. 10, 1930

3 S., R. 1 W., was most closely investigated. Here rock like that in the quarry could be developed but the amount in sight is only about 4,000 cubic yards since the outcrop is in the side of a deep ravine. At the east there is a narrow and abrupt fold in the limestone which locally raises it fully 15 feet above the normal position; the strike of the fold is apparently about N-S. Other locations, all with heavy stripping, are reported (a) in the center of Sec. 16, between the creek and the railroad, (b) the NW¼NW¼ of the same section, (c) the middle of the north line of Sec. 17, (d) near the railroad bridge in NE¼ Sec. 21, and (e) in the SW¼ Sec. 9. None of these was considered worth detailed examination since the reserves could not be estimated without more development work.

Beaucoup Creek district. A small quarry has recently been opened on the site of a long-abandoned building stone quarry in NE¼NW¼ Sec. 34, T. 2 S, R. 2 W. The operator is Samuel Kaser of Nashville. The limestone, which is represented by Sample 3, is similar to that at Radom. However, erosion has thinned the bed to less than 5 feet; its thickness under cover is not known. The overburden does not exceed 5 feet of glacial drift. Power is supplied by a steam tractor and an old Ford engine pulls cars from the quarry to the pulverizer. Only approximately 1500 cubic yards are actually in sight with less than 10 feet stripping but the total potential reserve of the vicinity is unquestionably much larger since outcrops are common along Beaucoup Creek and its western tributaries both above and below this point. At most of these outcrops, however, it is impossible to find the thickness of the bed and at the great majority which were visited by the writer the overburden is excessive. Outcrops occur as far south as NE¼NE¼ Sec. 3, T. 3 S., R. 2 W but appear to be confined to the west side of the creek.

Section 9 district. In the NW¼ Sec. 9, T. 2 S., R. 2 W. a considerable exposure of limestone occurs in the bottom of a rather wide creek valley. Englemann states that the limestone is 7 feet thick but at present the old

quarry is filled with stream wash so that it is impossible to verify this figure. If the bed is really two yards thick then possibly as much as 50,000 cubic yards might be found beneath not much over 5 feet of earth. The extent to which erosion and weathering have removed part or all of the limestone cannot be estimated from existing information but the location is well worthy of exploration. Englemann reports similar exposures in NW¼ Sec. 10 of the same township but the writer was unable to find them.

Nashville district. An old quarry, now entirely concealed by earth, is reported in the ~~middle of the east half~~ SW¼ SE¼ of Sec. 31, T. 2 S., R. 2 W.

Beaucoup district

Englemann reported limestone at the northeast corner of Sec. 27 of the same township which was not found by the writer and the limestone in the southeast quarter of the same section is under prohibitive cover. In T. 2 S., R. 3 W. quarries were once operated in the SE corner of Sec. 20 and the adjacent SW¼ of Sec. 21, in NE¼ Sec. 21, and the SE¼ Sec. 22. All of these are now concealed by earth which has accumulated since they were abandoned by the early settlers. These localities are attractive since the valleys in which the workings were are so wide that stripping would not be heavy. It is absolutely impossible to estimate the reserves since the thickness of rock is unknown. The pit at the large quarry in NE¼NW¼ Sec. 13, same township, is still open and a pile of blocks of limestone may be seen near the gate, but the ledge is concealed. It seems probable that stripping was very heavy, probably over 10 feet. Shaw in the New Athens-Okawville Folio reports that fossils were colledted from the Shoal Creek limestone"in the hillsides about midway between Elkton and Oakdale." Considerable time was devoted to looking for this vaguely located outcrop without finding it; it is possible that the collection was made from glacial boulders. Limestone was formerly ground in SE¼NE¼ Sec. 6, T. 3 S., R. 2 W. but investigation showed that the material had been transported by the ice. The same explanation applied at several localities where

the complete stratigraphic section. At Rattlesnake Den on Crooked Creek in Secs. 11 and 14, T. 4 N., R. 5 E. the section is as follows:

Sandstone, fine grained, micaceous, hard, calcareous	3 ft
Shale, mottled, yellow and brown (underclay?)	1
Shale, clay, bluish gray	3
Shale, sandy, micaceous, calcareous concretions	2
Shale, clay, bluish gray, calcareous concretions	10
Limestone, hard, light gray, fossiliferous, locally with up to 1½ feet soft bluish gray marl below	3½- 10
Coal	– 10 inches
Underclay, gray	1½
Shale, blue, micaceous	10

In NW¼NW¼ Sec. 13, same township, the section is as follows:

Limestone, hard, bluish gray, weathers yellow, ~~laminated~~ massive, no ~~few~~ fossils	6 ft
Shale, blue, clayey	15
Conglomerate with pebbles of limestone, shale, etc.	max. 5
Limestone, heavily bedded, gray, fossiliferous	10
coaled Underclay ~~with possible coal~~	3
Shale, sandy, micaceous	5

In the east part of the same section there are several exposures of a black slaty shale with abundant calcareous concretions in the lower part. which lies above the upper limestone of the last section ~~The relations of the three sections~~

At the northwest corner of Sec. 15, same township the section in a ravine is:

Shale, black, slaty with calcareous concretions	4 ft
Coal, poor	– 2 inches
Underclay, gray	1
Shale, black, slaty, some concretions	4
Shale, bluish gray, calcareous concretions	6

The relations of the four sections ~~are~~ not fully known ~~unknown. A Confusing factors~~ are (a) ~~lack of data on elevations and (b) faulting.~~ A small thrust fault is found at the last named locality ~~and it is probable that other concealed faults might confuse all correlations.~~ and a small normal fault in SE corner Sec 12, T 4N, R 5E which serve to confuse correlations. East of Rattlesnake Den there is a well marked anticline which plunges to the north. ~~The failure to find the black slaty shale in the better sections also renders conclusions very difficult.~~ To south In the north part of Sec. 19, T. 4 N., R. 6 E. are several ledges and an old quarry in alluvium which show a very hard calcareous sandstone ~~which must be~~ five to six feet thick; it has been thought to be a limestone by some of the farmers. In NE¼NE¼ Sec. 20, same township, boulders of gray fossiliferous limestone occur in a ravine.

This is probably the locality erroneously placed in NW¼NW¼ same section by Lamar. The relations of this deposit seem to place it above the hard calcareous sandstone ~~which appears to lie~~ in stratagraphically above the Rattlesnake Den limestone. Thus we must have not less than three different limestones in this locality of which the middle one is not associated with a coal or black shale. In Sec. 25, T. 5 N., R. 5 E. limestone is exposed both north and south of Dismal Creek, ~~Thexhadxixx~~ mainly in an abandoned washed-out road. The rock is hard and fossiliferous resembling the Rattlesnake Den limestone except that the top 2 feet of the 8 foot ledge weathers to a ~~cottony~~ porous texture with the fossils present only as moulds and casts as in dolomites. This limestone was not sampled on account of the poor exposure. No associated beds are exposed at present but Lamar reported 8 inches of good coal below and gray shale above. This bed may not correspond to any mentioned above. In SE¼ Sec. 29, T. 3 N., R. 5 E. a creek bank exposes :

Limestone, hard, dark gray, brittle, fossiliferous	at least 2 ft
Shale, black, slaty, limestone concretions; ~~with~~ coal seam at bottom	1½
Sandstone, light gray, very calcareous, hard	1
Sandstone, yellowish gray, soft	7

Very hard gray micaceous calcareous sandstone is found in a number of localities. Among ~~these~~ when may be listed:

Roads in north part Sec. 30, T. 3 N., R. 6 E.
Sample No. 12

NW¼NW¼ Sec. 10, T. 4 N., R. 5 E.

East 40s Sec. 7, T. 5 N., R. 5 E.

A moulding sand pit was recently been opened on or close to the county line in Sec 18, T 4N, R 5E; it was not visited but from work done in 1929 is understood to be in a soft sandstone

ROAD MATERIALS OF EFFINGHAM COUNTY, ILLINOIS

F. T. Thwaites, Associate Geologist, 1930

Introduction. Effingham County, Illinois, consists of 486 square miles. It was surveyed with the assistance of D. D. Utterback in 9 working days or at the rate of 54 square miles a day. Work was facilitated by the soil map and some highway project maps. Thanks are due to Mr. George T. Austin, County Superintendent of Highways, for information.

Topography. Except for the northwestern corner which is part of the Kaskaskia basin, Effingham County is drained by the Little Wabash River and its tributaries. Almost the entire county is drift plain, a large part of which is untouched by erosion. The plain is diversified in the western part of the county by (a) The Mound, northwest of Altamont, (b) a low ridge to the south, and (c) a ridge which trends northeast-southwest northwest of Beecher City. In the eastern part of the district there are a few low swells which scarcely deserve separation from the surrounding level plain. The Mound rises to an elevation of 681 feet above sea level or about 70 feet above the adjacent plain. It is undoubtedly the highest point in the county. The highest measured elevation on the drift plain is 654 and the lowest part of the county is considerably below 500 feet. Steep slopes are confined to the sides of valleys, some of which are fully 75 feet deep. The valleys of the Little Wabash and some of its larger tributaries show a poorly developed terrace 20 to 30 feet above the flat floodplain. The stream beds are incised in the floodplains to a maximum depth of over 15 feet.

Geology-bed rock. Effingham County is underlain by the McLeansboro formation of the Pennsylvanian; this consists of sandstone, shale, limestone, and coal. Rock exposures are most abundant southwest and southeast of Effingham. Deposits of not less than three cycles of deposition were discovered. The highest limestone bed is found over a large part of the county and was given the field name "Mason limestone." Among other localities the following good outcrops show this limestone: (a) S½ post Sec. 26, T. 9 N., R. 5 E., (b) SE¼SE¼ Sec. 35, T. 7 N., R. 4 E., (c) SW¼SE¼ Sec. 12, T. 6 N., R. 5 E., (d) SE¼NE¼ Sec. 28, T. 6 N., R. 6 E.

The Mason limestone is not known to exceed two feet in thickness. On account of its wide distribution and definite characteristics which enable its easy recognition it is an excellent key horizon. The following section, taken at locality (a) above, on Shoal Creek, shows this formation.

(1) Bridge on Shoal Creek, S¼ post, Sec. 26, T. 9 N., R. 5 E.

Shale, clay, yellowish gray	4 feet
Limestone, gray when fresh, weathers yellowish gray, fossiliferous, top weathered, lower part one bed	2
Shale, clay, gray	1½
Shale, black, slaty	3½
Limestone, black to gray, sandy, thick parts lightest color	1/6 to 1 1/3
Coal, impure	1/3 to ½
Underclay, gray to black, grading irregularly down into bluish gray calcareous shale with limestone concretions	5

Other sections show that the underlying shale passes downward into sandy shale and sandstone of undetermined thickness. An excellent exposure of mud cracks in the black shale filled with sand from the underlying bed is found at NE¼SE¼ Sec. 14, T. 6 N., R. 5 E. What is probably the next underlying limestone is exposed on the right bank of Big Creek as shown in the following section.

(2) Cut bank on Big Creek, SW¼NW¼ Sec. 30, T. 7 N., R. 5 E.

Shale, blue, clay	10 feet
Limestone, firm, dark blue, very shaly, one bed	½ to 1
Shale, black, slaty	½ to 1
Shale, blue, clay, top resembles underclay	4

What seems to be the same limestone as in the last section, (2), is exposed in NW¼NE¼ Sec. 26, T. 7 N., R. 4 E. on Big Creek. It is there 4 feet thick and is underlain by coal. An outcrop showing underlying beds was reported by Lamar in the same section but could not be found after diligent search. What the writer regards as a still lower limestone, but which may be the same as the latter one described above, is exposed along Fulfer and Lime Creeks from SE¼ Sec. 11, T. 6 N., R. 4 E., to the east line of Sec. 7, T. 6 N., R. 5 E. The following section illustrates this formation

(3) Ravine on left bank of Lime Creek west of bridge, NE¼NE¼ Sec. 18, T. 6 N., R. 5 E.

Shale, sandy, not examined in detail, base concealed	about 20 feet
Limestone, hard, brittle, light gray, somewhat fossiliferous, layers massive but breaks into thin irregular fragments	3/4
Coal	

Underclay, top only seen ------

The distibution of these outcrops, if they are correctly interpreted, suggests a dome or anticlinal nose which plunges toward the north of east.

Geology-drift. Aside from the ridge northwest of Beecher City, Effingham County is entirely covered with ground moraine of the Illinoian glaciation. MacClintock (Report of Investigations No. 19, 1929) has discovered an older drift beneath the Illinoian. Several of his exposures were visited by the writer who also discovered a few new ones. It is noteworthy that north of the apparent limit of the pre-Illinoian rock exposures are much less common than to the south and that those which do occur are all in very deep valleys. A log of wood in the base of the Illinoian drift was found which lay in a position which suggested a movement toward the northwest. Within the area of the pre-Illinoian the writer noticed some erratics which resemble those of proved Lake Michigan lobe drift. The Illinoian till has suffered considerable weathering and erosion since the deposition of the till plain. Gumbotil is widespread on the uplands. An excellent section showing the poorly drained soil profile was noted in a washed out road gutter in Sec. 6, T. 7 N., R. 6 E. Most of the drift is mantled with a few feet of loess. The hills which rise from the till plain consist of two classes: (a) ridges which trend NE-SW, and (b) irregular or rounded elevations. The first class is best illustrated by the ridge northwest of Beecher City and the second by The Mound near Altamont. The first class are undoubtedly terminal moraines but whether they are a part of the Illinoian drift or overridden pre-Illinoian moraines is not clear. If the former the ice must have moved toward the northwest during the Illinoian and if the latter then the pre-Illinoian, despite the evidence of erratics, must have come from the northwest and therefore have been the Keewatin Kansan. In this connection the writer desires to point out that percentage studies of glacial pebbles and boulders cannot alone solve the question of the derivation of a given drift but that erratics must be matched with rocks of known source.

Geology-gravel deposits. Postglacial river and creek gravels seem to be

much more abundant in Effingham County than in neighboring counties to the south. This is probably because drift gravel is much more common and the till is on the whole decidedly more stony than farther south. The headwaters of the Little Wabash received glacial outwash deposits during the time the ice stood at the Shelbyville moraine but on the recession of the Early Wisconsin ice glacial waters seem to have removed any gravels which were deposited in Effingham County and to have redeposited them in the bed of the river where they are now found in bars on the insides of bends. The Little Wabash could never have carried as large a volume of water as did both the Kaskaskia and Embarrass Rivers for its valley lacks clear evidence of the huge meander scars formed by glacial floods in the other adjacent valleys. Drift gravels both in undisturbed beds and in transported masses (gravel boulders) are abundant throughout ne arly the whole of the county, especially near to large streams. This distribution is most marked in the belt of gravels which trends approximately NE-SW along the right bank of the Little Wabash from a short distance south of Route 11 to near the north side of T. 8 N. It should be recalled, however, that discovery of gravels is possible only where the drift plain has been dissected so that this relation may be in no way related to origin but simply to conditions for exposure. Almost all the observed gravels are decidedly stony, well assorted, and contain relatively few layers of sand. In few places are there boulders in the gravel and most of the stones are less than two inches in diameter. Some gravels are of the open-work style without any sand between the pebbles; this is most common in sizes of from ¼ to ½ inch diamter stones. The size of stones is apparently related to the size of pebbles in the till which does not contain many large stones or boulders. Transported gravels can be distinguished by the disturbance of the strata. Such masses may be many feet across. Surface weathering has so altered many gravels that there is no definite way of telling from present exposures whether they are in situ or transported by the ice; only deep digging can answer this question. Gravels in situ are found in several gravel pits and a few road cuts. In every outcrop noted the bedding is predominately well assorted.

horizontal. Cross-bedding dips in almost every direction except north and varies widely in direction in the same exposure. In few cases does it affect more than a few feet of strata. Weathering has disintegrated many of the stones and stained considerable parts of the gravel with iron and manganese oxides. Calcite conglomerate is very common in layers and large masses of irregular form. In several places till overlies the gravel and a number of exposures were found which show an irregular basement of till below the gravels. In one instance, the Arnold pit, a layer of till about 18 inches thick lies at an angle in the gravels. In another pit, Hankins, the overlying till rests on an undulating and locally faulted surface of gravel suggesting shove from the southeast by overridding ice. At this pit alone is there any definite suggestion of topographic expression of the gravels. There the deposit appears to form an irregular esker-like ridge about 200 yards long which projects out into the Little Wabash bottoms toward the southeast. In other places where the gravel is known on spur ends the topography is not unlike that due to normal postglacial erosion. The question of the origin of the deposits is important in estimating reserves and finding extensions of the known deposits. The bedding suggests outwash as does the assortment. On the other hand, the cross bedding is so variable in direction, the basement below the gravels so irregular, and the known deposits so limited in exposures that it seems impossible to ascribe the gravels to an overridden bed of normal outwash. Moreover, the gravels are so much more stony than is the Wisconsin outwash of adjacent counties that confined currents of water are suggested. It is not even certain that the deposits were all overridden by the ice. There is no suggestion of a time of weathering before overridding, where such occurs, so that the gravels must be of Illinoian rather than pre-Illinoian age although a study of the pebbles may throw much light on this possibility. It seems most likely that the gravels were deposited in marginal crevasses or in spaces alongside stagnant ice blocks which lay in the Little Wabash valley. They are transitional between normal outwash and kames; possibly they were once pitted outwash which was locally buried

either by readvance of the ice or by mud flows of the freshly deposited till.

Geology-Little Wabash terrace. The terrace of the Little Wabash vally is for the most part so deeply covered with loess that its interior cannot be studied effectively. It has suffered so much erosion that its topographic expression is hard to grasp. In SE¼SE¼ Sec. 5, T. 6 N., R. 6 E. a cut on Route 25 shows 4 feet of loess resting on a few feet of sandy gravel and silt which in turn lies on weathered till. It is certain that (a) the terrace is pre-Wisconsin in age, and (b) it is not due to valley filling. It may be either (a) remnants of an old valley floor which through distrophic or climatic change was dissected previous to the more recent filling which made the present flood plains, or (b) portions of the original valley bottom left on the melting of the Illinoian ice possibly because the main valley was filled with stangnant ice. The writer leans to the first view for the terrace level seems to be everywhere the same and there is not enough associated stratified drift to warrent the assumption of a kettle origin of the larger valleys. Moreover, the steepness of the valley sides above the terrace remnants is not in harmony with the known consistancy of newly deposited clay till; mud flows would have seriously altered any kettles left in such material and certainly some would not have been made into valleys by subsequent erosion. The Little Wabash terrace is also found in Clay County to the south and similar terraces were noted in the Centralia quadrangle in Marion County.

Road materials-limestone. Neither the Mason limestone, nor the Big Creek limestone is of any value for road material. The former is too thin, nowhere exceeding two feet and the only known place that the latter is thick enough to work the stripping is prohibitive. The lowest, or "Fulfer Creek" limestone could be developed at several localities. At present the only ~~operating~~ quarry is that operated by Winter and Son in NE¼SE¼ Sec. 11, T. 6 N., R. 4 E. It is being reopened after a failure a few years ago and is ~~operated~~ worked for agricultural lime only. Power is supplied by a steam tractor and rock is hauled to the pulverizer with a small truck. The bed is about 4 feet thick and lies on nearly a foot of

good coal. Stripping is not much over 5 feet over a large area adjacent and the writer estimates that possibly as much as 75,000 cubic yards could be quarried under the valley flat to the south of the present opening. Water troubles would be serious. Much more rock could be found farther downstream in bluffs and ends of spurs but no estimate was made of the quanity. Blasting is done with auger holes in the underlying coal thus destroying a valuable by-product which sells for double the price of the pulverized limestone ($2.00 a ton). 5 cents a ton royalty is paid to the land owner and stone is being placed on the stock pile ready for the pulverizer at $1.00 a ton. It is interesting to note that Worthen (p.183) reports that stone from this quarry was used on the National Road, now Route 11, and "has undergone the test of twenty-five years, and is very much cracked by frost." The land is still in the hands of the same family as in Worthen's day. On Lime Creek there is a large amount of limestone. In NE¼NE¼ Sec. 18, T. 6 N., R. 5 E. fully 15,000 cubic yards could be developed under moderate cover on the east bank of the creek alone..

Road material-gravel. Gravel is by all means the best and most abundant road material in Effingham County. Two general classes of gravels have been developed: (a) creek gravel from bars in existing streams, and (b) drift gravel from pits or banks, as they are locally known. The county is noteworthy for the large amount of gravel road constructed with local material although most of the work has consisted of short stretches to remidy particularly bad road conditions. The dry season of 1930 greatly facilitated the use of creek gravels. These gravels are very sandy and do not pack well at first. After use for some time they make a fair road for light traffic. Farmers get from 15 to 25 cents a yard for creek gravel. The small quanity available at any one point and the scattered nature of most of the deposits, which consist of bars in the insides of stream bends, preclude the use of this resource for large projects. It is rare that more than 200 cubic yards can be obtained within a quarter of a mile unless the stream is very large. It seems possible that an average of ½ cubic yard could be obtained

per yard of stream. The total amount of postglacial gravel is doubtless large but this does not remove the objections stated above. The gravels are renewed in time by concentration from adjacent wash. A much more important resource is the glacial gravel which has been exploited in five gravel pits. The largest is Wyckhoff's in N½NW¼ Sec. 25, T. 8 N., R. 5 E. Here not less than 2000 cubic yards has been excavated. The gravel is rather poorly sorted and is quite stony with some calcite conglomerate and boulders. At the north side the gravel rests on bluish gray till near the bottom of the pit but elsewhere there is no sign that the bottom of the deposit has been reached. The pit has not been used for some time and could not be sampled on account of extensive slumping. The gravel shows in the road on the south side of the hill so that the reserve may reach 1,600,000 cubic yards. The Chadwell pit is situated in SE¼SW¼ Sec. 23, same township and the deposit extends into the SW¼SE¼ of the section. Here the gravel is better sorted, sandier, and less altered by weathering (Sample 16). The reserve is at least 800,000 cubic yards and there are no springs to indicate the bottom of the deposit. The Homan pit is in SE¼SE¼, Sec. 21, same township, in a ravine in the till plain. The gravel is better sorted and much more cemented than in any of the other pits (Sample 21). Blasting would be needed for any large operations and some of the conglomerate might have to be crushed but the gravel makes excellent surfacing. Toward the west it is overlain by several feet of gumbotil. Some silt layers are present. The reserve is at least 200,000 cubic yards with no sign of the bottom. The Hankins pit is on a spur of the Little Wabash bluffs in NE¼SE¼ Sec. 2, T. 7 N., R. 5 E. About 800 cubic yards have been taken out. At present there is a cover of 7 feet of compact gray till which has to be blasted. Just why work was started where this till is present instead of farther southeast along the ridge is not clear. The gravel (Sample 14) is more like that of the Wyckhoff pit in that sorting is relatively poor. Silt or clay is struck at the bottom of 10 feet of gravel it is is not certain that this is the bottom of the deposit or a layer within the gravel. The reserve is estimated

at 80,000 cubic yards. The Arnold pit in SW¼NW¼ Sec. 11, same township as last, consists of four small excavations one of which disclosed an 18 inch bed of till dipping toward the northeast. Springs and exposures show a till bottom which dips in the same direction but a well 16 feet deep just east of the pit found no gravel. Some till overlies the gravel. The gravel is stained yellow (Sample 15) and makes excellent surfacing. Bedding is obscure. No estimate of the reserve is possible. Only a few hundred cubic yards are "in sight". Truck haul is possible from all of the pits after slight improvement of the roads. At no pit is there any excavating machinery or has any attempt been made to improve the gravel by screening or crushing. The prevailing price is 10 cents a cubic yard at the pit. Good showings of gravel worthy of test pitting occur in (a) NW¼NE¼ Sec. 11, and NW¼NW¼ Sec. 12, T. 8 N., R. 5 E., (b) NW¼NW¼ Sec. 27, and NE¼NE¼ Sec. 28, T. 7 N., R. 7 E., (c) NE¼SE¼ Sec. 11, T. 8 N., R. 6 E., (d) SE¼SE¼ Sec. 11, T. 7 N., R. 5 E., (e) NW¼NE¼ Sec. 13, T. 8 N., R. 5 E., and (f) SE¼NW¼ Sec. 4, T. 7 N., R. 5 E. The last named locality is evidently what Worthen mentions (p.177) as "On National road, 3 miles west of Ewington.", stating that 12 feet of sand and gravel was then exposed beneath and above till. The gravel is now poorly exposed and is reported to contain a large amount of clay. Worthen also mentions "regular beds of ferruginous drift conglomerate 2 to 3 feet in thickness" in Secs. 17 and 30, T. 8 N., R. 5 E. which were not found by the writer. Besides the above mentioned localities a great number of showings of gravel were either noted in road cuts and animal burrows or were reported to the writer by inhabitants of the county. It seems reasonable to suppose that most of these are merely small lenses or boulders in the till such as are seen in many cut banks and road cuts. Some of them may lead to the discovery of large deposits. Extensive test pitting will be needed to try out these showings. Once the interest of the inhabitants is aroused to the value of drift gravel it will not be long before many more workable gravel deposits will be uncovered. The geologist can tell little at present since most of the known deposits have no surface expression and springs may just as well

come from thin lenses as from thick deposits of gravel. Drift gravel conglomerate is a very favorable indication of gravel deposits and should be carefully investigated. A so-called gravel pit in SE¼SE¼ Sec. 22, T. 7 N., R. 5 E. was investigated and found to be a shale deposit which is of no value for surfacing clay roads.

Conclusion. The writer is confident that sufficient drift gravel is present in Effingham County to take care of the need for road surfacing for many years to come. Intensive prospecting is justified throughout most of the county on account of the geographic limitation of the known deposits to a small area west of Effingham. However, if no good gravels can be found elsewhere truck haul from existing pits will probably prove cheaper than shipped in gravel or local limestone. The limestone of the Fulfer Creek valley is situated some miles from known gravel deposits and so might pay for local use. It is also possible, although hardly probable, that some limestone might be developed at the abandoned coal mines in N½SW¼ Sec. 20, T. 6 N., R. 4 E. Most of the limestone deposits of the county will prove of value for agricultural lime only.

Aug. 31, 1930

ROAD MATERIALS OF FAYETTE COUNTY, ILLINOIS, EAST OF KASKASKIA RIVER

F. T. Thwaites, 1929

Introduction. The area surveyed by the writer with the assistance of Frank Byrne in 1929 comprises that part of Fayette County which lies east of the bottoms of Kaskaskia River. This region is rudely triangular in shape increasing from a width of two miles on the north line of the county to 18 miles at the south line of Township 5 North; in addition there is a township which projects to the east at the southeast corner of the county and a half township along the Kaskaskia southwest of the remainder of the area. The approximate area of this tract is 325 square miles. It was surveyed in about 16 days or at the rate of about 20 square miles a day. Aid was received from J. V. Wadell, former County Highway Superintendent and from a large number of inhabitants of the district.

Topography. Fayette County east of the Kaskaskia lies in the region of eroded drift plain. The local relief is nowhere over 80 feet but large portions of the district are dissected into a maze of steep-sided valleys with many tributary ravines and gullies. Where valleys trend east and west the slopes on the north side are almost everywhere much more gentle than those on the opposite side; this is ascribed to better conditions for vegetation which restrains erosion on the damper shady side. All the larger valleys have flat floors which extend from near their sources down to merge with the Kaskaskia bottoms; these valley flats range from a few rods to over half a mile in width. These flats were not mapped in detail and the narrower ones are not shown. The writer estimates that fully half of this area has been affected by erosion. The largest undissected area is along the eastern and southern sides of the county. A very large part of the original drift surface was a plain; this plain showed some depressions without outlet a few of which are still preserved. It also displayed broad gentle undulations or possibly terraces

whose form with available information can in most cases only be guessed. Rising above the level of the drift plain of clay till are a number of ridges and low knolls. The best developed ridge is in the far northeastern part of the county; its heigth is about 30 feet and it may be traced for about 6 miles within Fayette County southwest from the boundary corner. South of this locality the most marked knolls are a group of five immediately south of Route 11 at Bluff City on the Kaskaskia bluffs. The maximum elevation of these hills is estimated at 60 feet above the general level and considerably more than that above the adjacent streams. Most of the remaining mounds are much lower; some indeed are so faint that it is only because crops grow better on them than on adjacent flats or because they were chosen as the sites for farmhouses that one can distinguish them. Their diameter ranges from a few rods to half a mile. The mounds and ridges have been mapped as terminal moraine deposits although it is easily seen that few of them form any definite system or pattern insofar as present information indicates. Borings were made in some of the mounds; in the majority silt til is found below the loess. There are a few sand dunes along the Kaskaskia bluffs; a few of these are covered by loess.

Geology. The bed rocks of the area consist of Pennsylvanian sediments, mainly shale, with some layers of sandstone and a very little limestone. Very few outcrops occur for over most of the area a mantle of drift from 20 to over 100 feet thick effectually conceals the underlying formations. The only exposures are in ravines, valleys, and road cuts. The glacial drift consists almost entirely of very clayey till; there is only a little sand and gravel in the form of (a) lenses or beds on top of or within the till, and (b) transported masses or "boulders" within the till. Some fine silt is also found in the same relations The drift uplands and much of the valley sides are covered with from a few inches to several feet of loess. The loess is thickest along the Kaskaskia bluffs. The drift can be ascribed to two distinct glaciations the deposits of the earlier of which were much weathered before the coming of the later ice.

Road materials. The purpose of the present survey is to describe deposits of materials suitable for road surfacing and if possible to discover previously unknown deposits. It was recognized from the results of previous work that material suitable for concrete paving aggregate is rare if present at all. Materials occuring in Fayette County which are suitable for surfacing consist of (a) limestone, and (b) gravel. Gravels consist of (1) drift deposits, and (2) postglacial stream gravels.

Limestone. The limestone beds of the Pennsylvanian are noted for their lenticular character and soft sandy composition. There is every gradation from micaceous calcareous sandstone to pure limestone, and where exposures are good lateral variations in the character and thickness of a bed are easily observed. Discovery of a limestone outcrop, therefore, does not mean much with regard to expectable reserve. Search for outcrops was made along the roads which cross deep stream valleys and in ravines and creek beds near to known and reported exposures. All outcrops which were found lie in the bottoms of ravines or at best well down the slopes of valley sides. It is only in the beds of the wider valleys and on narrow spurs that quarries could be opened. No quarries are now in operation within the area although years ago attempts were made to work stone northwest of La Clede. Heavy stripping for the very slight thickness of the known limestone beds is the main objection to development in this region. In almost all instances an outcropping ledge passes under 15 feet of cover within a few rods from its edge. A condition which must also be considered was demonstrated by some of the early road material work in Wisconsin. Under a cover of soil and drift solution has undoubtedly made serious inroads on these thin layers; in some cases it might well be found that the exposed rock is nearly all that is left. Four feet is the maximum demonstrated thickness of any limestone bed within the area. What is the least discouraging locality is the exposures in gullies of a 4 foot limestone in NW¼, SE¼, Sec. 3, T. 5 N., R. 4 E., northwest of La Clede. Possibly 4,500

cubic yards

cubic yards might be obtained without more than 10 feet of overburden but careful testpitting is needed before any attempt at development. A quarry was once operated along a 500 foot face of a limestone outcrop in SW¼. SW¼, Sec. 2, same township and a smaller one just to the south in NW¼, NW¼, Sec. 11. The former obtained flagstones from several 4 to 8 inch layers separated by shale. This deposit was worked back to nearly 10 feet of overburden and may be regarded as worthless for road material on account both of thick stripping and the necessity of hand picking the material to separate from the shale. The quarry to the south obtained a very calcareous sandstone which is not well suited for road material. A limestone layer less than 2 feet thick outcrops in the road near Old Loogootee in SW¼, NW¼, Sec. 32, T. 6 N., R. 3 E. and more of the same rock occurs in SE¼, NW¼, same section. Extensive search along the creek bank failed to find a continuous bed which could be exploited. This locality might possibly furnish less than 1000 cubic yards of rock provided heavy stripping were removed and workings carried along the outcrop for nearly half a mile. Several outcrops of limestone were found in Sections 25, 27, and 34, T. 8 N., R. 3 E. All occur in deep ravines and so far as could be ascertained the bed is very uneven in thickness ranging from a mere trace to not over three feet. It is very doubtful that more than a few hundred cubic yards could be quarried without excessive stripping and that only by working several separate openings. A thin layer of limestone, the cap rock of a coal, was observed in a ravine at the foot of the Kaskaskia bluffs in NW¼, NW¼, Sec. 23, T. 9 N., R. 3 E. It is covered by nowhere less than 5 feet of overburden. It lies so low in the bluffs that little could be learned of its thickness or extent.

What may be the same bed outcrops in the bank of the Kaskaskia in NE¼, NE¼, Sec. 28, same township; the stripping is prohibitive for even very limited development.

Gravel. At the present time the only drift gravel which is being worked is the pit on the farm belonging to Mrs. Sawyer, in SW¼, SW¼, Sec. 27, T. 8 N., R. 2 E. on the north slope of an isolated hill within the Kaskaskia bottoms. Gravel is also shown in an abandoned pit in NE¼, NW¼, Sec. 34, same township, on the east side of the hill. Weathered pebbly sand is found in several ravines and road cuts on the same hill. There may be no till above the sands and gravels but this fact is far from certainly established. The gravel where exposed is quite stony and very well graded; few pebbles exceed two inches in diameter so that the material could for the most part be used without screening. However, a considerable part of the deposit, particularly at the old pit, is cemented into a conglomerate by calcite so that crushing would be needed. The deposit appears from the limited exposures to be a delta or delta kame in which the foreset beds dip to the southeast. It is not possible from existing data to estimate the total reserve; if the deposit underlies the entire hill to the thickness shown at the pit there might be 2,500,000 cubic yards. Inasmuchas a considerable portion of the hill must be expected to be either sand, till, loess, or weathered clayey gravel none of which materials could be used, it seems safer to estimate the probable extent of the deposit at not over 50,000 cubic yards. This deposit is worthy of first consideration of any in the area. Large ledges of cemented stony gravel similar to that of the Sawyer pit occur in SE¼, NW¼, Sec. 35, and NW¼, NW¼, Sec. 36, same township, on the divide between two creeks. Both these exhibit strata which dip toward the east. It is not possible to discover if these two ledges are parts of the same deposit or exactly how much stripping overlies the gravels. If the deposit is continuous there might easily be 4,000,000 cubic yards, much of it under a cover of at least 30 feet, but without exploration either by deep test pits or better by drilling it is impossible to reach a definite conclusion. Certainly several thousand cubic yards could easily be removed with proper machinery and the construction of not much over half a mile of road. Truck

haul would be possible from both these deposits and the Sawyer pit after relatively slight improvement of existing roads. Southwest of the above deposits a layer of outwash gravel and sand was noted in several cuts and ravines in Secs. 4 and 5, T. 7 N., R. 2 E., especially in NW¼NE¼, Sec. 5. The material is very sandy and in many places is much weathered so that the content of clay is very large. The deposit is about 10 feet thick and is overlain by not less than 10 feet of till and rests on till. Accepting all exposures as part of the same layer, a fact which is far from proved, a total potential reserve of 6,000,000 cubic yards may be estimated. It is certain that many thousand cubic yards could be obtained along slopes and spurs where the cover is slight but it is not clear that all the material so found is suitable for surfacing clay subgrades. The quality of this deposit, or deposits as the case may be, is decidely inferior to that of the gravel conglomerate type mentioned above. Similar outwash lenses in till, for the most part entirely too thin or too sandy for use, are common in the Kaskaskia bluffs. In SE¼, NW¼, Sec. 35, and NE¼, NE¼, Same section, T. 7 N., R. 1 E., and SE¼, NW¼, Sec. 1, T. 6, N., R. 1 E. are some small deposits of sandy gravel which might possibly be used to a very limited extent but could not be worked on a large scale on account of the heavy cover. A lens of very sandy material was observed in a road cut in SW¼, NE¼, Sec. 36, T. 6 N., R. 1 E. Other occurences of the same doubtful character are located in SW¼, NE¼, Sec. 8, T. 7 N., R. 3 E., and NE¼, SE¼, Sec. 5, T. 5 N., R. 2 E. It is the opinion of the writer that none of these very sandy deposits can ever be used because weathering has made so much clay in the sand that when mixed with more clay from the subgrade the results would be very unsatisfactory. An instance of sliding due to clay and sand mixed is that in the cut on Route 142 northeast of La Clede. The highest hill east of Bluff City was explored by boring to a maximum depth of 14 feet. Road cuts and pits for moulding sand were also examined. Nothing but much weathered pebbly sand could be found but further exploration is recommended for the hills are evidently kamos.

Sandy gravels, all of them very dirty, occur in the banks, beds, and bars of existing streams throughout most of the area. Few single deposits contain over 10 cubic yards and many are covered with alluvial sands and silts which are rich in organic matter. No attention was devoted to these deposits since they have no value for any project of magnitude.

Conclusion. Development of local limestone deposits in eastern Fayette County cannot be recommended on the basis of present knowledge although it is possible that extensive testpitting might disclose the fact that a few thousand cubic yards could be recovered without excessive cost. The supply of local gravel in the region north of Route 11 seems ample for all foreseeable demands provided funds can be obtained for exploration and development. The quality of the better deposits will be found to be satisfactory. South of Route 11, however, the haul is so long from local deposits that material shipped in by rail may prove more economical.

F. J. Thwaites

Centralia, Illinois,

September 1, 1929

ROAD MATERIALS OF JASPER COUNTY, ILLINOIS

F. T. Thwaites, Associate Geologist, 1930

Introduction. Jasper County, Illinois, contains 484 square miles and was covered with the assistance of D. D. Utterback in 6½ working days or at a rate of nearly 70 square miles a day. Such an excessive speed was justified by the large areas of drift plain and river bottom which needed little examination. The County Highway Superintendent was visited but could furnish no information in addition to that already secured in the field.

Topography. Jasper County consists of (a) drift or till plain which slopes gently toward the southeast and is locally much dissected by valleys, (b) rock hills, mainly not over 50 feet high, and which are confined to the western part of the county, and (c) river bottoms, chiefly in the valley of the Embarrass (locally spelled phonetically, Ambraw) River. The river bottoms and the adject bluffs, a part of the coutheastern corner of the county, and an irregular area north of Newton are covered by maps of the U. S. Geological Survey. A Feature of the Embarrass Bluffs on the east side of the valley is a more or less continuous line of low sand dunes which consist of knolls and rare enclosed depressions. Another striking phenomenon of the same bluffs is the large meander scars; one just southeast of Newton and another north of St. Marie have nearly cut through into tributary valleys and one north of Newton seems to have done so long ago. The lowest elevation is the county is slightly below 440 and the highest probably exceeds 600 feet above tide. Steep slopes are confined to the sides of valleys and ravines.

Geology-bed rock. All of Jasper County is underlain by the McLeansboro formation of Pennsylvanian age. This consists of sandstone, shale, limestone, and coal. Rock exposures are most abundant in the southwestern and central parts of the area and seem to be lacking in the eastern and northwestern portions. Deposits of not less than two and more likely three cycles of deposition are present. The following sections reveal the salient points of the

stratigraphy.

(1) Creek bank in NW¼NW¼ Sec. 31, T. 8 N., R. 9 E.

Shale, yellowish gray, clayey	5 feet
Shale, firm, clayey, dark bluish gray, calcareous	3
Shale, black, slaty	2½
Coal, hard, good	½
Underclay, locally absent	½
Shale, blusish gray, clayey, calcareous, thin layers of nodular limestone	3
Sandstone, very fine, dark gray, shaly, micaceous, calcareous	½
Shale, dark blue, clayey, slightly calcareous	5

(2) Creek bed and road cuts in SE¼SE¼ Sec. 12, T. 7 N., R. 8 E.

Shale, sandy, yellowish gray	about 15 feet
Shale, clayey, yellowish gray, iron concretions, possibly including some weathered limestone	5
Shale, black, slaty	1
Shale, gray, calcareous	10
Limestone, gray, weathers yellowish gray, nodular, few fragmental fossils	2
Sandstone, firm, yellowish gray	1

(3) Cut bank of Crooked Creek in SW¼NW¼ Sec. 27, T. 7 N., R. 10 E.

Limestone hard, dark gray, weathers light gray, fossiliferous, only one layer seen	1½ feet
Shale, black, slaty	3
Shale, dark black, coaly	2
Shale, bluish gray, clayey, limestone concretions	3

(4) Bank of Embarrass River, Peterson Park, Newton, SE¼SW¼ Sec. 31, T. 7 N., R. 10 E.

Shale, clayey, bluish gray	5 feet
Shale, black, slaty	2½
Limestone, gray, hard, concretionary, few fossils	1
Shale, gray, clayey, poorly exposed	8
Sandstone, gray, fine grained, micaceous, hard, very calcareous	1
Shale, gray, to blusish gray, micaceous, interbedded with thin layers of sandstone like that above	10

The last section should be compared with that given by Worthen; some of the beds that he reported could not be discovered.

(5) Cut bank just south of road, NE¼NE¼ Sec. 17, T. 5 N., R. 8 E.

Shale, clayey, bluish gray	5 feet
Shale, sandy, yellowish gray	1½
Shale, clayey, blue	1½
Shale, or soft marly limestone, yellowish gray	3
Limestone, hard, yellowish gray, nodular, no fossils	1½
Shale, clayey, blue	5

Black slaty shale is exposed in the road cut a short distance northeast of the last section and higher than its top. The interval between the limestone and the base of the black shale was measured in NW¼SE¼ of the same section and found to be 19 feet.

It is presumed by the writer that all the sections thus far given represent the same horizon. If this is correct the limestone below the black shale either occurs at different distances below it or is not everywhere the same bed. It is probably a lenticular deposit which occurs at different stratigraphic levels. The following section is the only one in which more than one black shale-coal horizon was noted.

(6) Cut bank in NW¼SE¼ Sec. 20, T. 5 N., R. 8 E. (see p. 7)

Shale, black, slaty, limestone concretions	6 feet
Shale, clayey, bluish gray	1
Concealed	9
Shale, clayey, blue, lower layers very dark	4
Limestone, dark bluish gray, fossiliferous	½
Coal	1/3
Underclay, grading into blue clay shale below	5
Shale, gray, clayey	2

It is thought that the black shale cannot be the same as that seen to the north and northwest but that the coal correlates with this other shale. In fact in Sec. 17 it was noted that coal and black shale occur at the same level on opposite sides of a valley. The strata do not appear to be exactly horizontal in the southwestern part of the county which makes correlation difficult. Two distinct types of limestone are present in the county: (a) bluish gray fossiliferous, almost invariably located just above a coal and black shale horizon, (b) detrital, and (c) nodular gray non-fossilferous or very sparingly fossiliferous located in beds of shale. If all the outcrops of this ~~second~~ last kind of limestone are the same the correlation given above us correct. In some places, as on Crooked Creek northeast of Newton, it seems probable that the nodular limestone lies only a few feet above the fossilferous limestone of Sec. 27, T. 7 N., R. 10 E, but good exposures are lacking. If this is correct then the section (3), given for this locality is really a lower horizon than the black shale which overlies the nodular limestone. This may be the coal horizon which is mined

southeast of Newton along Brush Creek and distinct from the coal of Sec. 31, T. 8 N., R. 9 E.(1). The nodular limestone would then lie below the base of the last section listed above (Sec. 20, T. 5 N., R. 8 E.(6)), thus giving the three cycles of deposition. However, the slight vertical limits of the known exposures, the lack of data from borings, and the lack of paleontological studies leave exact correlation an impossibility at present.

Geology-drift. The entire area of Jasper County consisted before erosion of ground moraine of the Illinoian drift. Almost all of this deposit was thick enough to flow while wet and thus form a nearly featureless drift plain. Rock hills high enough to project occured south and northwest of Newton. Some of the smaller hills west of Embarrass River may possibly be drumlins but are so indistinct that this is only offered as a suggestion. If they are drumlins the movement of the ice was toward the west. The drift is entirely devoid of marginal deposits which show at the surface. The only assorted material which could be found consists of small lenses of silt, sand, and fine gravel. Many of these show the results of shove by the ice but it is very hard to see what direction this came from. In a very few spots the till has weathered to a reddish brown instead of the normal yellowish brown tint. This may be due to the presence of these lenses of more porous material. Gumbotil is abundant beneath flat uplands but is not exposed in many places. A mantle of loess from a few inches to a few feet in thickness covers most of the uneroded drift. The flat bottoms of the valleys are due primarly to filling subsequent to erosion to a greater depth than at present. In the Embarrass valley this filling consists of sand and sandy gravel deposited as outwash from the Early Wisconsin glacier. The age is clearly demonstrated by the relatively slight amount of weathering compared with that shown on adjacent uplands. The coarseness of the material decreases downstream so that gravel is not uncommon near the north line of the county and sand and silt alone are present ~~farther downstream than~~ below Newton. In the tributaries of the Embarrass and in the valleys which drain into the Little

Wabash in the southwestern part of the county, silt, sand, and a little gravel derived from the erosion of the nearby till make up the fill. The bluffs east and northeast of the Embarrass bottoms are lined and locally entirely covered with sand dunes. These are all quiscent unless disturbed by man and have a silty cover due possibly to weathering and possibly in part to deposition of finer wind-blown material on top of the sand. Much of the sand was weathered to a reddish yellow color. Evidently the Embarrass once carried vastly more water than at normal stages of today for it cut meander scars several times as wide as any of the bends of the present. At this time, which must have been during the retreat of the Early Wisconsin ice from the headwaters, westerly and southwesterly winds blew sand from the floodplain to make the dunes. This could probably not have occured during the maximum of the ice since then northerly anticyclonal winds must have blown off the ice sheet. If such winds were present the dunes they left are not now evident. The exact extent of the dunes could not be mapped in the time available since there is no soil map of Jasper County.

Road materials-limestone. No limestone have been quarried in Jasper County since very early days. In the entire western part of the county no layer over 2 feet thick was encountered. On Limestone, Creek, Secs. 17 and 18, T. 5 N., R. 8 E., the bed is 18 inches thick. A four foot bed of impure limestone at Newton reported by Worthen could not be found nor did anyone seem to know of it. On Crooked Creek and its tributaries only slightly more encouragement can be given. On the Leo Kerner farm in NE¼SE¼ Sec. 21, T. 7 N., R. 10 E. Worthen reports 4 feet of limestone (locality inferred from a vague description). Mr. Kerner states that he drilled to a depth of 4 feet in limestone without reaching its bottom. The rock is nodular and non-fossilferous, very soft and weathers easily. The exposures are too poor to permit sampling. The writer is convinced that the rock is too soft for road material although it may be well adapted for agricultural use. In SW¼SW¼ Sec. 15, same township, a ledge in a road leading down to the bottoms shows between 3 and 4 feet of both detrital

and massive limestone. The exposure is too limited to permit sampling or an intelligent estimate of the reserve but it seems to the the only place in the county where exploration would be justified and the only locality where detrital limestone is present. Judging from the erratic distribution of this kind of limestone in other counties the bed will undoubtedly vary greatly in thickness from place to place.

Road material-gravel. No drift gravels of consequence were located in Jasper County. Although the hills in Secs. 21 and 28, T. 7 N., R. 14 W. show some red till there seems to be little prospect of finding gravel in them. Usable, although very sandy gravel was found in several bars in the Embarrass River from the north line of the county south for about 6 miles. It is very difficult to estimate the contents of these bars or to sample them for the material varies rapidly both horizontally and vertically. The writer estimated that possibly 25,000 cubic yards of gravel might be recovered along the river in this county; if anything this figure is too optomistic. The only workable deposits are on the insides of bends in the river and are postglacial concentrates of pebbles scattered through the very sandy glacial outwash which is exposed in cut banks opposite the bars. There seem to be no true outwash terraces or gravel concentrated by glacial waters. Almost all the known deposits are covered at high water and would have to be worked with either a dredge or a drag line. Postglacial gravels on other streams are too small in amount to be used except for very small local projects.

Conclusion. The limestone deposits of Jasper County, with the possible exception of some along Crooked Creek, are all too thin to permit of working except on the smallest scale for local projects or for agricultural use.

Some of the soft limestom or marl associated with the nodular limestone of the Limestone Creek localities might be worked for agricultural purposes to good advantage since it could be used without the high cost of pulveriging. Unfortunately, the known exposures are all in steep slopes. The gravels of the Embarrass bottoms might easily be worked for small projects not far from the river. They would require screening and would not pack well until mixed with clay from the subgrade.

Aug. 24, 1930

Addendum

A revisit to Section No. 6 (SE¼ Sec. 20, T. 5 N., R. 8 E.) showed that more strata could be found by digging into the bank above the black shale. The following should therefore be added above the section.

(6) Continued above part on P. 3.

Shale, gray, clayey, weathers yellowish gray	3 feet
Limestone and calcareous or marly shale, yellowish gray, hard layers nodular. light gray	3
Shale, greenish gray, clayey	4

In a cut bank farther south a layer of hard limestone outcrops with some yellowish gray marl above. This is at a lower elevation that the limestone in Section 6 above. The available data leave correlations uncertain.

ROAD MATERIALS IN NORTH HALF OF JEFFERSON COUNTY, ILLINOIS

F. T. Thwaites, 1929

Introduction. The north half of Jefferson County, Illinois, comprises 8 full townships or approximately 288 square miles. This area was surveyed with the assistance of Frank Bryne in approximately 9 working days or at the rate of about 32 square miles per day. The rate of progress is slower than in the county to the north largely because of the lack of large areas of flat land, also because of rainy weather. Aid was received from James Payne, County Superintendent of Highways at Mt. Vernon as well as from a number of inhabitants of the county.

Topography. Jefferson County has a maxmum relief of over 200 feet with local differences of elevation of over 100 feet in many localities. The topography of the county is divisible into (a) eroded drift plains, (b) drift-mantled rock hills, and (c) alluvial valley bottoms. It is evident that the region had considerably more relief in preglacial time than it has today. When it was glaciated the ice left a relatively thin mantle of drift which sufficed to obliterate the older topography only in the main valleys. In the larger valleys the drift was left in the form of nearly level plains. Most of the hills and ridges projected above the level of these plains and were left with a cover of for the most part less than 20 feet of drift; possibly they were also smoothed somewhat by glacial abrasion but of this there is little definite evidence. Subsequent erosion has cut up both plains and hills with numerous ravines and valleys. The postglacial erosion features contrast sharply with the mature forms of the rock hills and a distinct topographic unconformity exists between the two kinds of surface. Although the rock hills rise to a maximum elevation of over 100 feet above the drift plains differentiation of hills from plains is not everywhere easy. In the parts of the county where the topography has not yet been surveyed the mapping of this line is in many places very difficult. The amount of rock hill country increases

toward the east side of the county. From the agricultural standpoint the rock hills are far superior to the drift plains. The drainage pattern seems to have been little disturbed by glaciation. Postglacial erosion has made some valleys fully a mile in width. In relatively recent geologic time the valleys have been filled with alluvium forming level floors which extend along almost all the stream valleys almost to their sources. These flats are nearly all subject to floods. Along the valley sides there are in some places vague suggestions of terraces. Examination of sections shows that in all probability these are remnants of former valley floors formed at times when downcutting was slow or ceased; nowhere were any terraces of aggradation discovered.

Geology. Jefferson County is underlain by Pennsylvanian shale, sandstone, limestone, and coal. Rock exposures in ravines and road cuts are very abundant throughout the rougher portions of the hill country but are not at all common in the eroded drift plains. Sandstone and sandy shale are very common in roadside and ravine exposures but the new cuts along the Illinois Central Railroad in the eastern part of the county display much shale. Outcrops of coal and coaly shale are rather common. Mining is done at a number of places by farmers and it is reported that strip mining was once attempted north of Mt. Vernon. Limestone is very rare. The drift consists of till which is overlain by a few feet of loess. In the hill country the till has weathered into silttil except in some of the small valleys where gumbotil was formerd. In some places gumbotil seems to have formed on shale and silttil on sandstone; time was lacking to check this point. The drift plains are covered with gumbotil except in the immediate vicinity of some of the larger valleys where silttil is found. Excellent drift sections are now seen in the cuts on the new Illinois Central line. An interesting feature is a mass of coal somewhat over a foot thick and 20 feet or more in length which is found within the till in

NW¼, NW¼, Sec. 21, T. 1 S., R. 2 E. The only suggestion of two ages of drift was discovered in a road cut in SE¼. SE¼, Sec. 13, T. 2 S., R. 2 E. where there is a mass of a peaty substance associated with a sand bed in the till. This black material, however, may not be peat but decomposed coal. It has been deformed by ice movement.

Road materials. According to Mr. Payne Jefferson County is virtually devoid of material suitable for road surfacing. Postglacial stream gravels are found in a number of the smaller streams but the deposits are too small for exploitation. No drift gravel deposits which contain more than a few cubic yards were discovered. A farmer reported that he found showings of gravel in his fields in NW¼, NW¼, Sec. 16, and NE¼, NE¼, Sec. 17, T. 1 S., R. 2 E. but that no testpit had ever been sunk. Adjacent road cuts show nothing but small pockets of sand and fine gravel which have been disturbed by ice movement. Extensive exploration would be needed to verify the report but it seems very unlikely that a large deposit exists. Mr. Payne stated that the most encouraging locality in the county for limestone is Sec. 25, T. 1 S., R. 2 E. At least two farmers once talked of development of agricultural limestone in this section but their work went no farther than sending samples for analysis. A full day was spent on the location with the result that no more than two and a half feet of limestone was found in place. In the southwestern part of the section the limestone layer is divided by 6 inch shale partings into at least theree separate layers. Despite the most intensive search no rock could be found save in the bottoms of deep ravines where quarrying is out of the question. This location is condemned without reservation. Limestone is also found, mainly as float, along the west side of SW¼, Sec. 6, T. 2 S., R. 2 E. There is no evidence of a layer more than 15 inches thick but the exposures are very poor. The location was examined with the owner, Mr. H. F. Piper.

A layer of limestone about a foot thick was noted in a ravine in SE¼, NW¼, Sec. 31, T. 2 S., R. 2 E. but no extension of the deposit could be discovered in the vicinity. It is possible that sand from some of the sandstones could be used to improve clay roads but for the most part it appears to be too fine grained for such use.

Conclusion. Road surfacing in Jefferson County will have to be done with shipped-in material unless something not now known is discovered within the area which seems very unlikely.

Associate Geologist,

Mt. Vernon, Illinois,

Sept. 14, 1929

ROAD MATERIALS IN THE SOUTH HALF OF JEFFERSON COUNTY, ILLINOIS

F. T. Thwaites, Associate Geologist, 1930

Introduction. The following report is a supplement to that on the north part of the county which was prepared in 1929. In June, 1930, work was resumed with the assistance of D. D. Utterback. 8 U. S. townships, approximately 288 square miles, were covered in 7 working days at a rate of about 41 square miles a day. Nearly all the commonly travelled roads were run but owing to the paucity of road materials only a little foot work was done. Areal mapping was confined to the same physiographic types as in 1929. The south half of the county contains more large alluvial flats than does the north part, as well as considerable areas of drift plain. The southeastern corner differs from the areas of rock hills seen farther north in having large nearly level uplands which are hard to discriminate from the till plains which fill the larger valleys. Locally big glacial boulders are common and the writer was inclined to think that these are different types of rock than is the case farther north. Not enough study was devoted to this phase of geology to settle this question.

Limestone. Through an oversight in 1929 all of the limestone localities recorded by Englemann in the old Worthen Survey reports were not entered on the map. It having been supposed that they had been caused the writer to fail to check some places wherelimestone might be found. Some of the locations secured from Dr. Weller in 1929 could not be checked in the field. Judging from known exposures, however, the writer is positive that little of economic imprtance could have been overlooked. Contrary to Englemann's conclusion that only one limstone and associated coal is found throughout the county, the writer is certain that at least two distinct formations are present.

The limestones found in Range 1 East, in the western part of the county, appear very similar to those seen on Crooked Creek, northeast of Centralia and described in the 1929 report on Marion County. These rocks are for the most part very impure and thin bedded. In most exposures a thin coal with associated black shale and underclay is found immediately beneath the limestone bed. In the southern part of the county the contours on Coal No. 6 given in Cooperative Bull. 15 show a dip of 400 feet between the west line and Mt. Vernon. Such a structure would carry the limestone of the western townships far below the surface in a few miles. In the northern part of the county the dip may well be less steep but even then the limestone found north of Mt. Vernon is so different in character that it seems certain that it is a younger formation. Englemann's localities are tabulated below with comments.

Township 1 South, Range 1 East

Northwest ¼ Sec. 14 2 feet of impure limestone-not searched for
Southeast ¼ Sec. 25 15 inches of limestone on east bank of creek near the south line-not searched for

Both of the above localities would appear to be of little economic importance.

Township 2 South, Range 1 East

North part Sec. 8 Loose blocks of limestone- possibly glacial
Southwest ¼ Sec. 9 Cooley Branch, limestone float-possibly glacial

Township 3 South, Range 1 East

Northeast ¼ Sec. 6 Near church, loose blocks of limestone- probably glacial boulders
Northeast ¼ Sec. 7 4 to 16 inches of limestone-see description below
West part Sec. 9 3 feet limestone-not seen, does not show in roads or in float along streams
Northeast ¼ Sec. 17 2 feet limestone-not seen in roads or stream float

Township 1 South, Range 2 East

South part Sec. 30 and north part Sec. 31 Limestone float-appears to be glacial drift from the western limestone formation

Southwest ¼ Sec. 25 5 feet limestone-explored intensively without finding any such thickness, see 1929 report
Northwest ¼ Sec. 28 Just south of road where it enters Jordan Prairie-not searched for but judging from other locality can be of little value

The writer wishes to suggest that the intensive search of the early settlers for limestone and coal probably led to the discovery of nearly all the possible localities. In the day of the Worthen Survey many excavations were open which have long since been abandoned and, moreover, the present aggradation of the creek bottoms by field wash had only begun. These facts, coupled with the rather vague land descriptions of the earlier survey, make it hard for the modern geologist to check all of the older work. The best limestone location noted by the present party in Jefferson County is on the line between Secs. 7 and 8, T. 3 S., R. 1 E. about 1/8 mile from the north line. Sample No. 2 was taken here. The section shows nearly 4 feet of a hard, although rather shaly limestone, the top of which is badly weathered. About a foot of good coal is found below. Toward the east a conglomerate cuts down through the limestone so that the reserve is problematical. However, limestone is shown in two ravines and, unless cut out by erosion to a greater extent than appears probably the case, at least 5,000 cubic yards could be obtained with a stripping of less than 5 feet. This locality is well worthy of more exploration for the cover is much less than is common and the distance from the road is slight. Englemann found several other outcrops in this vicinity but extensive search of road grades and stream beds failed to confirm them. According to Cooperative Bull. 15 this locality lies within a fault zone, a fact which closely spaced jointing in some shale ledges seemed to confirm. It is probable that the limestone beds will be found to be very erratic is distribution in this vicinity. Sample No. 1 was taken from a limestone bed similar to that described above but apparently not much over 2 feet thick; it is located in NW¼ NE¼ Sec. 24 T. 4S., R. 1 E. and was not seen by Englemann. The recoverable amount is uncertain but probably does not exceed a few hundred cubic

yards. In SE¼ SE¼ Sec.35, T. 3 S., R. 1 E. about a foot of limestone was found in a creek bed. This locality is about a mile west of Waltonville. Although the bed is very thin the stripping over a consierable area is not over 2 feet so that several hundred cubic yards could easily be secured. No sample was taken. This layer is different from those seen elsewhere in Range 1 east. It is quite probable that not less than three limesones are present in this range in the southern half of the county.

Gravel. Drift gravels are exceedlingly scarce in southern Jefferson County. It is hard to visualize the conditions of wastage of the ice sheet in topography of such fair relief which would lead to so little assortment of the drift. In the eastern part of T. 3, R. 1 E. some lenses and transported masses of very sandy gravel were noted but none which, even at the surface, could be considered a road material. Postglacial stream gravels have been worked by farmers who have used the material for concrete with fair results. The small size of individual deposits and the sandy and clayey nature of the material preclude large scale exploitation. No roads have been surfaced with stream gravels.

Conclusion. Exploration for the development of local road material in Jefferson County is warrented only in connection with projects in the western or southwestern part of the county. The best locality is in northwestern T. 3 S., R. 1 E. where considerable limestone of fair quality could be produced.

July 21, 1930

ROAD MATERIALS OF MARION COUNTY, ILLINOIS

F. T. Thwaites, 1929

Introduction. Marion County contains 16 full townships or approximately 576 square miles. The county was covered by the writer assisted by Frank Byrne in 14 days, an average of 41 square miles a day. Several things enabled such a speed. A considerable part of the area is covered by accurate topographic maps which enable the geologist to avoid undissected prairies and to concentrate on valleys where exposures of drift and rock may be expected. The soils map also helped in the same way in the areas where the topography has not been surveyed. Mapping of the alluvial bottoms follows the soils map. All roads which cross the deeper valleys were traversed by car and wherever discovery of important deposits seemed likely foot work was done. Mr. W. L. Baker, County Superintendent of Highwasys, kindly spent a full day with the party visiting limestone quarries. The Carlyle-Centralia folio proved too vague and generalized to be of material help.

Topography. Marion County can be divided into two distinct types of topography: (a) eroded drift plain with a few knolls apparently composed of drift, and (b) drift-mantled rock hills and ridges. The boundary between the two types is not definite at all places and where the country has not been surveyed topographically it is in many places impossible to map it accurately. The drift plain runs among the rock hills which rise above it to a maximum of about 100 feet. It is also difficult to differentiate between drift and rock hills; the former do not exceed 60 feet in heigth and show a pronounced northeast-southwest alignment and orientation unlike the rock hills. The hills east of Kinmundy are transitional in character; they display a northeast-southwest elongation suggesting moraines or possibly drumlins, but rock was found at 12 feet depth

in the old coal shalft at Kinmundy. Lack of time forbad any serious attempt to get well records on the ridges and besides most of the farms seem to use cisterns instead of wells. On the whole, it seems plausible to call these rock rather than drift hills. On the other hand, one hill, that In Secs. 18 and 19, T. 2 N., R. 3 E., southeast of Salem, seems to be largely drift since a stream has undercut one side very deeply without disclosing rock. The soils report states that their 40 inch borings struck rock on most ridges. The largest undissected areas of gumbotil plain or prairie are west and northwest of Salem. Dissection is most advanced in the southeastern part of the county between and on the flanks of the rock hills. In many places there is very complex erosion topography. Several streams have picturesque rock banks or "Dalles". The maximum relief is over 150 feet but there are few valleys over 50 feet deep. Almost all the streams have flat alluvial bottoms, most of them subject to flood, and which range from a few rods to nearly a mile in width. In a few places there are indistinct terraces along the larger streams. These were ascribed by Shaw to aggradation but the one which was drilled by our party shows gumbotil under the loess. It may be a remnant of the pre-loess valley floor. It is practically certain that there are no depositional terraces. The abnormal course of Dum Creek, east of Salem is probably due to diversion by glacial drift.

Geology. The bed rocks of Marion County are Pennsylvanian shales, sandstones, and limestones; rarely a thin seam of coal occurs. Outcrops are fairly abundant, especially in ravines and road cuts. A few ledges were also noted in bluff faces. Sandstone is most common in the southeastern part of the county and shale in the northwestern part. Thin layers of limestone are found in the northeastern and southwestern parts. The glacial drift consists of glacial till with a few layers and masses of sand, silt, and gravel. A cover of one to ten feet of loess mantles most

of the area. The loess seems to be thickest on some of the ridges. No evidence was discovered of more than one age of drift.

Road materials. Materials suitable for coarse aggregate in concrete paving are not present in Marion County in sufficient amount to warrant development. The only material suitable for surfacing roads is limestone. No commercial drift gravel is known and the postglacial gravels along streams are negligible in amount. The only important limestone beds outcrop in the vicinity of Omega in T. 3 N., R. 4 E. At two places in that township attempts have been made to crush limestone for agricultural use but both have been abandoned. In both localities it was found that so much sledge work was needed to prepare material for the small pulverizer that the operators could not compete with shipped-in material. At one place a vastly exaggerated idea of the thickness of the bed seems to have prevailed; doubtless the owners were misled by loose blocks in the talus. At neither place did operations extend to the stage of stripping. In SW¼, SW¼, Sec. 19 two small openings were once worked but neither exposed a good section of the bed. The writer visited the locality with Mr. Baker and followed the outcrop for about a mile east and southeast into Sec. 30. Nowhere could over 4 feet of ledge be found. The rock where not weathered is of good quality and on several spurs over a thousand cubic yards could be obtained without more than 10 feet of overburden. In a few places as much as 3,000 cubic yards could be quarried without more than 7 feet of stripping. On the north line of Sec. 19 amd the south line of Sec. 29 what appears to be the same layer is not over a foot or two thick so that lateral thinning limits the area in which development is possible. The layer could not be followed more than a few feet into the township to the west where it seems to be cut out by preglacial erosion. This deposit is worthy of exploration by testpitting and blasting out faces but can at best be of only local utility. Another quarry was formerly operated in

SW¼, NW¼, Sec. 9, same township. This is either the same or an extension of the deposit reported in Bull. 46 as in Section 8, T. 4 N., R. 4 E. which is clearly an erronious description. In the NE¼, NW¼, and SE¼, NW¼, same section (Sec. 9), a thickness of 5 feet or more of limestone is exposed. The first named locality is on an isolated hill with nowhere more than 10 feet of overburden. Approximately 10,000 cubic yards could be quarried here and an old road leading to the highway could be imporved so as to allow of truck haul. At the locality originally worked stripping is much heavier. This place was also visited with Mr. Baker; it is decidedly the most encouraging location in the county and is worthy of careful exploration. Further work would doubtless locate more small deposits in the vicinity but such would be either thinner or much more difficult of access. Unless uncovered by digging and blasted into fresh rock it is difficult to draw accurate conclusions and many natural ledges are misleading on account of slumping. To the northwest the limestone bed thins out to about a foot, and to the east it seems to be cut out by preglacial erosion. Several outcrops of limestone were found north and northeast of this place but nowhere is there over a foot of hard rock. In Secs. 3, 4, and 9, T. 1 N., R. 1 E., east of Central City, two layers of limestone outcrop along Crooked and Racoon Creeks. The upper bed is 4 to 6 feet thick, thinly laminated, and very shaly. Portions are firm and brittle so that the material might possibly be suitable for temporary surfacing or filling of mudholes. It was not sampled. The chief objection to development is the heavy stripping. All exposures are in the sides of steep bluffs but it is barely possible that the layer might be reached on low spurs in NE¼, Sec. 9 although it is probable that stripping would be heavy there as well. Another bed lies less than 10 feet lower; it is 2½ to 4 feet thick but contains much clay. In SE¼, SE¼, Sec. 4 possibly 3,500 cubic yards might be obtained at the foot of the bluff provided erosion previous to the valley filling did not

cut out the bed close up to the foot of the steep slope. This layer was not sampled as it seems to be of poor quality as well as hard to quarry. In addition, the Central City outcrops are so close to a railroad that exploitation does not seem to be possible in view of the foregoing objections. In NE¼, NE¼, Sec. 36, same township, a bed of limestone not much over a foot thick was investigated. It outcrops in the bottom of a deep ravine and locally thins out to nothing. It is of no value but the marked westward dip strongly suggests a dome on the known anticlinal nose southeast of Centralia which might well repay investigation for oil.

Mine refuse. The coal mines of Marion County have no large dumps of refuse but dispose of waste at once. It is reported that some even pay the freight to get rid of this material. Many miles of streets and some country roads have been surfaced with unburned refuse and with cinders from the boilers but there is no unused reserve of either of these materials.

Conclusions. Local surfacing material is so limited in amount in Marion County that Mr. Baker does not recommend that the County purchase a crushing plant. He advises that citizens be interested in private development. The deposits near Omega, northeast of Salem, are so small that at best they could only surface a few miles of road in their immediate vicinity. For this purpose development is recommended as the quality of rock is good. The Central City deposits are so unfavorably situated for exploitation and are of such inferior quality that competition with shipped-in material seems out of the question.

Associate Geologist

Mt. Vernon, Illinois,

Sept. 8, 1929

ROAD MATERIALS OF RICHLAND COUNTY, ILLINOIS

F. T. Thwaites, Associate Geologist, 1930

Introduction. Richland County, Illinois, contains approximately 360 square miles. It was covered by the writer with the assistance of D. D. Utterback in about 6½ working days or at the rate of 55 square miles a day. The writer is greatly indebted to Mr. Clark R. Noe of Olney for records of test drilling which greatly facilitated the work. Mr. Edward Phillips, County Superintendent of Highways, spent a day in the field with the party showing localities where gravel had been reported; the writer appreciated this aid very highly.

Topography. Richland county consists of four types of topography: (a) drift plain, for the most part considerably cut up by ravines, (b) rock hills, such as those northwest and northeast of Olney, (c) a transition between hills and true level plain where the original surface was gently undulating, and (d) alluvial bottoms. Of these the transitional type, (c), was not mapped separately but was included with the hills to which it seemed more closely allied. A narrow strip along the east side of the county has been surveyed by the U. S. Geological Survey and shown on the Sumner and Hardinville quadrangles. In this area elevations range from below 440 to over 600 feet above sea level. The most prominent hills of the county are those southeast of Cow Ford in the northeastern part of the district. Aside from these hills steep slopes are confined to the sides of ravines.

Geology-bed rock. The bed rock of Richland County consists of the McLeansboro formation of Pennsylvanian age. This consists of sandstone, shale, limestone, and coal. On account of the mantle of drift and the relatively gentle ~~low~~ slopes and low relief of most of the region exposures are not abundant. In the southeastern part of the county the coal borings added considerably to information derived from outcrops. It is apparent that, unless there is faulting, deposits of only two cycles of deposition are exposed. The higher hills are almost without exception composed of sandstone and sandy shale. At lower elevations shales and associated limestone, coal, and black "slate" form a persistant

horizon which has been intensively explored for coal in the southeastern quarter of the county. What is presumably the same stratigraphic level has been traced more or less continuously throughout a large part of the remainder of the county although there are large gaps where it is not known. An exposure was noted at the South ¼ post, Sec. 27, T. 5 N., R. 14 W. Other outcrops are (a) along Big Creek, south of Olney, especially near the crossing of State Route 130 in Sec. 15, T. 3 N., R. 10 E., (b) in a ravine in NE¼NW¼ Sec. 23, T. 3 N., R. 14 W., (c) in a creek bank in NW¼NE¼ Sec. 26, same township, (d) in the strip pits of the Richland Coal Co., in sec. 5, T. 2 N., R. 14 W., (e) in abandoned strip pits in Sec. 32, T. 3 N., R. 14 W. in both SE¼SE¼, and SE¼NW¼, (f) on the road in NW¼NW¼ Sec. 5, T. 2 N., R. 14 W., and (g) in a small pit near South ¼ post, Sec. 16, T. 2 N., R. 14 W., just north of Red Head School. Both exposures and test borings show definitely that this horizon is locally cut out by the deposits of the suceeding cycle. At Cow Ford in SE¼NE¼ Sec. 27, T. 5 N., R. 14 W. this is demonstrated by the presence of sandstones at a much lower elevation that that of the nearby coal mentioned above. It is probable that this condition is very widespread and explains the large number of test holes which found no coal even a very short distance from a known exposure. The limestone which overlies the coal in a normal cycle is distributed very erratically. In the Richland Mine the maximum known thickness of limestone is about 5 feet but throughout most of the pits no limestone whatever is found. This appears to be due to non-deposition rather than to erosion previous to a suceeding cycle for no conglomerate or sandstone is present where the limestone is absent but the sandy shales rest directly on the coal. Three types of limestone occur: (a) solid bluish-gray fossiliferous limestone apparently deposited in reasonably quiet waters, (b) detrital fossiliferous limestone, laminated and cross bedded, apparently a reworked deposit similar in some respects to a conglomerate, and (c) bluish-gray marl or soft calcareous shale apparently a limestone which never became hard. Of these, the first is probably the most widely distributed and

the third occurs mainly between the first type and the underlying coal. The top of the coal undulates through several feet and the limestone deposits appear to be best developed in depressions although such is not the case everywhere. Attention should be directed to the possible agricultural value of the third type, the marl, which if found in sufficient quanity could be used without the expense of crushing which would offset the lower content of carbonate.

Geology, drift. The glacial drift of Richland County consists almost wholly of till of the Illinoian ground moraine. No terminal depsits could be discriminated. The hypothesis that the ridges in the eastern part of the county were the northward continuation of the moraine of southeastern Wayne County was considered and rejected on account of (a) the lack of morainic knolls, kames, and red till, (b) the discontinuous character of the dendritic ridges, and (c) the presence of rock exposures almost to the tops of the highest hills. Some red till occurs on the ridge just west of the Richland Mine in SE¼ Sec. 6, T. 2 N., R. 14 W. but it is by no means as common as in the known moraine. Red till with associated sand and gravel deposits is found at Red Hill in Secs. 20 and 21, T. 4 N., R. 10 E., and at a few other scattered localities. It is suggested that this color instead of the common yellowish brown is due to the presence in morainal deposits of lenses and masses of sand and gravel which affected the amount of and kind of oxidation during weathering as compared with conditions is normal dense till which makes up most of the ground moraine. Since assorted materials are by no means confined to terminal deposits the few occurences of red till similar to that of the moraine in the ground moraine should excite no surprise. Most exposures of the drift display silttill for it is present where most cuts are made. Gumbotil is undoubtedly abundant under the uneroded parts of the till plains. The rock hills are mantled with silttill. The loess is very thin throughout the county and could be definitely distin-

guished in only a few scattered localities.

Road materials-limestone. The most abundant road material in the county is limestone. Workable limestone deposits appear to be confined to the southeastern part of the district. At present the best exposure is in the western part of the strip mine operated by the Richland Coal Company of Olney. Here sample No. 10 was taken in NE¼SW¼ Sec. 5, T. 2 N., R. 14 W. A quarry to supply agricultural limestone was operated at this point long before the coal stripping operations were commenced. It is powered with an old steam tractor which also operates an old locomotive air compressor for drilling and a hoist for the cars from the face to the pulverizer. It is now planned to move the machinery and to haul limestone to the plant with trucks. There is considerable limestone now available on the spoil banks. Limestone is confined to the Clodfelter lease and is entirely absent on the Moore lease farther east than the north-south ¼ line of the section. Of the first 11 test holes drilled near to the existing quarry only 3 found any limestone and the thickest (Hole No. 7) proved to be only 4 feet 2 inches. Of the subsequent holes few found limestone and it has uniformly been thinner than the figure given above, rarely over 2 feet. It seems safe to estimate that an average of 2½ feet of limestone over an area 200 yards long and 60 yards wide might be developed provided the coal will pay for the stripping which will exceed 10 feet in many places. These figures indicate a total potential reserve of only 10,000 cubic yards or much less than claimed by Mr. Clodfelter, the owner of the land. It is obvious that development can only proceed as a side line to coal mining which under present conditions of market and transportation is not very profitable. In the road on the west side of the NW¼NW¼ of the same section 4 feet of limestone is exposed but the cover of drift is more than 15 feet thick only a few yards away and it is impossible to estimate any reserve. Test drilling to the north and northwest of this outcrop on the Harmon and Heath farms failed to find any limestone

at all although the coal is present in some places. The abandoned strip mine in SE¼SE¼ Sec. 32, T. 3 N., R. 14 W. found limestone near the south line of the property. Much of this limestone is very shaly although a considerable part is the hard fossiliferous type. It is estimated that about 5,000 cubic yards of fair rock is contained in the dumps, a considerable portion of which might be slavaged. It is possible that as much more could be found in the upper part of the same ravine as that at the mine in the NE¼NE¼ Sec. 5 of the township to the south. Drilling on the Henry Kuemmel farm immediately west of the abandoned mine disclosed neither limestone nor coal. Strip pits farther north in Sec. 32 show no limestone and its place is taken by sandy shale and sandstone. At the abandoned Silas Bell strip pit in NE¼SE¼ Sec. 11, T. 2 N., R. 14 W. there seems to have been less than a foot of hard bluish gray fossiliferous limestone. Near the strip pit at Red Head School in SE¼SW¼ Sec. 16, same township, no limestone of consequence is found nor did test borings reveal any. On the Martin Weisner farm in NE¼SE¼ and S½SE¼NE¼ Sec. 19, same township, there is a small strip pit which was not visited by the party. Test borings show from a few inches to 4 feet 6 inches of limestone. In spite of the spotted nature of the deposit the encouraging fact is that the thickest limestone is only 2 feet 8 inches from the surface so that further exploration might be justified although there seems no prospect of opening a coal mine. Several other strip mines operated by farmers were visited but none of them found any limestone whatever. The S. J. Albin farm in NE¼ Sec. 30, T. 2 N., R. 14 W. has limestone with a maximum thickness of one foot. A ravine on the Chaplin farm in NW¼NW¼ Sec. 23, T. 3 N., R. 14 W. shows abundant loose blocks of an unusual fine grained yellowish-gray limestone which is irregularly mixed with the usual bluish-gray rock locally suggesting a conglomerate. This deposit is not far above an outcrop of black shale which is covered with shale instead of limestone.

Road materials-sandstone. A resource to which comparatively little atten-

tion was given is the hard calcareous micaceous sandstone. Some of the ledges of this rock are so hard that ~~it~~ the rock is broken with the hammer only with considerable difficulty. So far as observed hardness goes the rock would undoubtedly make a fair road material. The objections to recommending this rock are two: (a) it is not known how far back from the outcrop the hard rock extends and (b) in good exposures similar firm sandstones are known to be very variable in both horizontal and vertical extent. It may well be that the hard phase has developed merely under certain conditions of weathering or of ground water circulation. Under the circumstances it is impossble to estimate the extent of any observed ledge under cover as can be done with most limestone deposits. Hard sandstones were observed in (a) SE¼SE¼ Sec. 17, T. 3 N., R. 14 W., and (b) in the road near east ¼ post, Sec. 7, T. 4 N., R. 14 W in sufficient thickness to possibly justify exploration. It is possible that other localities where this kind of rock is present were passed over in the course of the survey without any particular attention before the possibility of use had been considered. In view of the unfavorable factors the use of hard sandstone is not recommended except as a last resource.

Road materials-gravel. Gravel has been reported at a number of places in Richland County apparently because wash by rain has concentrated more than the usual number of pebbles. Instances of this kind were investigated (a) in SE¼NE¼ Sec. 8, T. 3 N., R. 14 W. and (b) in north part of SE¼ Sec. 17, T. 4 N., R. 10 E. Both localites appear absolutely hopeless. A small amount of gravel occurs as lenses in red till just below the cemetery in NE¼NE¼ Sec. 20, T. 3 N., R. 14 W. Springs around the side of the hill prove the presence of a layer of gravel in till in the west part of Sec. 21, T. 4 N., R. 10 E. near Red Hill on and near to the Enoch farm. Drilling with a post hole auger is reported to have shown two or three feet of assorted material which after washing looked like good gravel. The thinness of the deposit and the heavy cover taken with the large amount of water in the bed make development almost impossible. Postglacial

gravels occur in the beds of creeks throughout the county but the deposits consist of thin bars. For the most part the material is of very poor quality and it is rare that 50 cubic yards could be collected from a quarter of a mile of creek bed. For large scale construction this resource is out of the question although it is renewed from time to time through erosion of adjacent ravines.

Conclusion. Richland County must be included in the area where the development of a large amount of local road material is doubtful. Any attempt at exploitation of the limestone deposits should be preceeded by careful test drilling if disappointment is to be avoided. The most available deposit at present is the broken limestone in the spoil banks of the abandoned strip mine in SE¼SE¼ Sec. 32, T. 3 N., R. 14 W. Next in order is the deposit already opened in the Richland Mine and some small extensions of this deposit may be discovered. It is possible that exploration would be justified at the Weisner farm in Sec. 19, T. 2 N., R. 14 W., and on the Chaplin farm in Sec. 23, T. 3 N., R. 14 W. No other limestone locality seems to offer any encouragement whatever. No usable gravel deposits are known within the county although it is barely possible that small amounts might be developed near Red Hill.

Aug. 17, 1930

Addendum

Since the completion of the above report a small sand and gravel pit has been opened in NW¼NW¼ Sec. 27, T. 4 N., R. 10 E. It shows some stony gravel with few stones larger than ½ inch diameter, a considerable amount of sand, and some layers of yellowish gray silt. This material is covered by about 8 feet of silttil and outcrops along the end of a spur for a distance of less than 300 feet. Since the bottom of the deposit is not exposed it is possible that a small deposit of road material may be developed at this point, but it seems unlikely that more than a few hundred cubic yards of sand and gravel will be found.

Sept. 9, 1930

ROAD MATERIALS IN ST.CLAIR COUNTY, SOUTHEAST OF KASKASKIA RIVER

F. T. Thwaites, 1930

Introduction. The portion of St. Clair County, Illinois, southeast of Kaskaskia River was surveyed by the writer with the assistance of D. D. Utterback in connection with the work in Washington County to the east. It is impossible to estimate accurately the amount of time actually spent on St. Clair County because trips to it were combined with work in the other county. It is thought that about 60 square miles were covered per day and that about two days were devoted to the 115 square miles. This speed was rendered possible by (a) accurate topographic maps, (b) a previous survey of the region, (c) paucity of features important to the present study, and (d) the large amount of river bottoms which did not require much examination.

Topography. Most of the portion of St. Clair County described in the present report is rolling with relatively low relief. Elevations above tide range from below 360 to over 500 feet . The area is shown on the New Athens, Okawville, Baldwin, and Coulterville quadrangles of the U. S. Geological Survey. There is also a large scale unpublished map of the Kaskaskia bottoms. The topgraphic types mapped in the field comprise (a) floodplains, (b) stream terraces, (c) drift or till plains, and (d) rolling uplands where the preglacial rock hills are mantled with drift and loess. Separation of these types is not in all places easy and in a detailed survey would be done by a study of auger borings for which time was not available in the course of the present survey.

Geology-bed rock. Southeastern St. Clair County is underlain by Pennsylvanian rocks, mainly the McLeansboro formation. These rocks are well known from mine shafts and coal borings; they consist of sandstone, shale, limestone, and coal. Only one outcrop was discovered; it is on the road about 3/4 mile east of State Route 13 at Lentzburg (SW¼SE¼ Sec. 6, T. 3 S., R. 6 W.), and consists of sandstone. Fragments of limestone were observed in the dump from a new shallow coal shaft at W¼ post, Sec. 35, T. 2 S., R. 7 W. on the side of Route 13 but no information was secured as to the depth from which they came.

Geology-drift. So far as could be determined the uplands of the area are mantled with till of Illinoian age. No stratified deposits could be found. It must be realized, hoever, that the mantle of loess is relatively thick so that exposures of drift beneath it are less common than in counties farther east. All of the area is regarded by the writer as ground moraine. Shaw, in his New Athens-Okawville folio, seems to have thought that the large ridges were terminal moraines similar to the known moraines west of the Kaskaskia River. The writer differs from this conclusion on account of (a) the low slopes of the ridges, (b) the presence of at least one rock outcrop high up on the slopes, (c) the dendritic or erosional outline of the upland areas, (d) the lack of stratified materials which are common in terminal deposits, (e) the lack of a definite system or alignment of the ridges, and (f) the close similarity of these uplands to those farther east where rock control is a proved fact. The writer does not insist, however, that no morainal deposits exist in this vicinity. It seems possible that the range of hills immediately east of the river, including Dutch Hill, may be part of a low, gentle, eroded terminal. On the other hand, these hills are so different from those west of the Kaskaskia and so like the low rock hills of Washington County that this suggestion seems to the writer to be very poorly supported. Little can be said as to the thickness of the loess since little time was taken for measurments. It probably exceeds 5 feet over nearly all the area. In a road cut in SE¼NE¼ Sec. 8, T. 3 S., R. 6 W. there seem to be two distinct loess deposits of which the younger is unconformable on a much older weathered loess. It is suggested that this exposure may show the eastern edge of the Peorian loess and that the lower, or Sangamon loess may be the only loess present farther east. This interesting speculation could not be followed up on account of lack of time. More attention was directed to the terraces o f the Kaskaskia which occur up to about 40 feet above the present stream. Sand and gravel were reported in some wells and since the Kaskaskia drained the Wisconsin ice the possibility of outwash

seemed to demand attention. Shaw's descriptions and surface exposures lent no encouragement to the idea that coarse materials might occur but nevertheless two auger borings were made. Of these, one in SE¼NW¼ Sec. 5, T. 3 S., R. 7 W. reached clean coarse sand at a depth of 8½ feet. Two feet of sand were penetrated before caving forced the abandoment of the test. Another boring, ¼ mile west of the southeast corner of Sec. 17 of same township, pentrated clay and silt to the total depth of 14 feet, the full length of the available rods. Similar results were found in several holes in Washington County. It is concluded that Shaw was correct in his conclusions as to the orgin of these deposits; they were formed in slcak water or in lakes which were caused by the deposition of Wisconsin outwash in the Mississippi thus blocking the mouth of the Kaskaskia which received less glacial waters for a shorter time than did the larger stream. If any real gravel is present in wells it lies below the slack water deposits and may be either (a) Illinoian outwash or (b) interglacial stream deposit. Erosion of the deposits into at least four distinct terraces probably occured within Wisconsin time, each period of aggradation corresponding to a glacial advance into central Illinois and each period of erosion to a time of glacial retreat out of that district when clear waters cut away the dam in the Mississippi. With existing information it is not possible to correlate these times with recognized moraines farther north. It is felt, however, that Shaw's division of the terraces into two grounps on the basis that the older is in part covered with loess is not justified by the facts. The slight erosion and moderate weathering of all the deposits and the known presence of some loess on Wisconsin drift demonstrate a Wisconsin age for all the terrace deposits

Road materials. The present survey shows that road materials, if present at all in southeastern St. Clair County, are so deeply buried that economical exploitation is out of the question. All highway construction in this area will have to be with material shipped from elsewhere.

July 30, 1930

ROAD MATERIALS OF WASHINGTON COUNTY, ILLINOIS

F. T. Thwaites, Associate Geologist, 1930

Introduction. Washington County, Illinois, consists of about 557 square miles. This area, including about 105 square miles in the adjacent part of St. Clair County, was surveyed by the writer with the assistance of D. D. Utterback between June 28 amd July 11, 1930. The speed of 56 square miles a day was made possible by (a) the topographic maps of the western and southern parts of the county, and (b) the large areas of undissected drift plain where little detailed examination is needed. The County Superintendent of Highways, Mr. O. E. Rabeneck, was visited at Nashville but no information was obtained from him since no local deposits of road material have been developed in the county.

Topography. Four distinct types of topography were mapped in Washington County: (a) drift plains with tabular divides, (b) drift-mantled rolling rock hills, (c) alluvial flood plains, and (d) river terraces. Elevations range from somewhat below 380 feet above tide to considerably above 500 feet but slopes and local relief are for the most part not striking. Only small parts of the county have over 50 feet local relief. Steep slopes are found only along creeks and rivers. The highest point in the county is called Pilot Knob and is situated a short distance east of Oakdale; it is not a conspicious feature.

Geology-bed rock. The bed rock of Washington County is the McLeansboro formation of Pennsylvanian age which consists, in order of magnitude, of shale, sandstone, limestone, and coal. Although borings reveal several limestone members it seems probable that only one of them is exposed, baring a few thin lenticular layers. This is the Shoal Creek limestone and its outcrops occur in a belt which runs southeast from near the middle of the north line of the county to near its southeast corner. Rock exposures are so poor and scattered that the writer was able to form little definite idea of the succession of

strata above and below this limestone. About 15 feet of shale was seen below it and about 10 feet of shale above it in the southeastern part of the county. A thin coal occurs just below the limestone but was not examined in detail. Most of the exposures visited show neither the top nor the base of the limestone. A consideralbe part of the exposures throughout the county consist of sandstone and sandy shale. Published maps, based on coal borings, indicate that the general dip of the strata is townard the northeast but that there are many irregularities.

Geology-drift. The bed rocks of Washington County are covered with a nearly continuous mantle of Illinoian ground moraine. Much of the ground moraine, particularly where it occurs in preglacial valleys, was orginally a nearly level surface or drift plain. Much of the county has suffered some postglacial erosion resulting in branching, steep-sided valleys which in places have cut through into the bed rock. The higher tracts in the county are not moraines for their dendritic outline and the scattering rock exposures in them tell definitely of relative thinnness of the drift and therefore of rock control. The slopes of the ridges, however, are so gentle that outcrops are not at all common. No morainal ridges could be distinguished. The glacial drift consists almost wholly of till mantled with a few feet of loess. The loess is yellowish brown to ashy gray in color and is thickest in the western part of the county. Most exposures show leached and oxidized silttill; gumbotil is not common in exposures for it mainly underlies the flat areas. Few cuts are deep enough to reach the unaltered till. Lenses and masses of sandy gravel are uncommon. The best example noted was in the cut bank of Kaskaskia River in NE¼NW¼ Sec. 33, T. 1 N., R. 3 W. The floodplains and terraces of the streams are underlain by silts and fine sands. Exposures of these beds are poor so that they were explored with borings because it had been suggested that since the Kaskaskia River drained the Wisconsin ice sheet it should have carried outwash. Gravel is reported in the well of the St. Louis Dairy

Co. on Route 15 west of Venedy Station. The four holes put down demonstated that if any gravel is present it lies below the fine sediments, and antedates them in age. The surficial deposits are those of slack waters and not of rapid currents. Shaw's interpretation of these deposits as due to blocking of the mouth of the Kaskaskia by Wisconsin outwash in the Mississippi is thus sustained. Since their formation the river has intrenched itself forming terraces which are not as well developed in Washington County as they are farther down the river. That these quiet water deposits are of Wisconsin and not Illinoian age is demonstated by their slight weathering and dissection. The coarser deposits beneath may be of Illindan or of interglacial age.

Road Materials-Limestone

General. The Shoal Creek limestone member of the McLeansboro formation appears to be the only workable bed in Washington Coounty. At the time of the writer's survey four quarries were being operated or had recently been operated; all of these were equipped to produce agricultural limestone only. In one instance, a pile of "chat" had been saved for future regrinding.

Radom district. The quarry near Radom in SW¼SW¼ Sec. 16, T. 3 S., R. 1 W. is the best equipped in the county. The limestone is about 6½ feet thick and is represented by Samples 4 and 4A. It is hard and firm although very brittle bluish gray limestone. The overburden is moderate since the workings are in a postglacial valley; it consists of two to ten feet of shale and drift. The writer estimates, without test pitting or boring, that fully 25,000 cubic yards could be developed here with a maximum stripping of less than 10 feet. The locality is close to State Route 2 and truck haul is possible. The quarry is supplied with an oil engine, air drill, and a track from the face to the pulverizer. There are storage bins. Most of the machinery appeared to be in good condition. The present operators are Messers Wilson, Mays, and Steggs of Nashville. Undeveloped localiites in the vicinity occur within a radius of about a mile. Of these one in NW¼NW¼ Sec. 21, T.

3S, R. 1 W., was most closely investigated. Here rock like that in the quarry could be developed but the amount in sight is only about 4,000 cubic yards since the outcrops are in a deep ravine with steep sides. At the east there is a narrow and abrupt fold in the limestone which raises it about 15 feet above its position to the west; the strike appears to be about NW-SE. Other locations, all with heavy stripping, are reported in (a) center Sec. 16, between the creek and the railroad, (b) the E NW¼NW¼ same section, (c) the middle of the north line Sec. 17 (not seen although in open pasture), (d) near the railroad bridge in NE¼ Sec. 21, and (e) SW¼ Sec. 9. None of these was considered worth detailed examination and the only one offering any promise at all is in Sec.17.

Beaucoup Creek district. A small quarry has recently been opened on the site of a long-abandoned building stone quarry in NE¼NW¼ Sec. 34, T. 2 S.,R. 2 W., by Samuel Kaser of Nashville. The limestone (Sample 3) is similar to that at Radom except that it is more weathered. The face being worked is less than 5 feet but the thickness under cover is not known. The overburden is about 5 feet of glacial drift. Power is supplied by a steam tractor and an old Ford engine pulls cars from the quarry to the pulverizer. Approximately 1500 cubic yards are in sight with less than 10 feet stripping but the total amount in the vicinity is unquestionably much greater. Outcrops of limestone are common along the west side of Beaucoup Creek as far south as NE¼NE¼ Sec. 3, T. 3 S., R. 2 W but at most of them the stripping is excessive and it is impossible to measure the thickness of the bed without considerable excavation. Englemann reported limestone at the NE corner Sec. 27, T. 2 S., R. 2 W but this was not checked by the writer.

Section 9 district. In the NW¼ Sec. 9, T. 2 S., R. 2 W. a considerable exposure of limestone occurs in the bottom of a rather wide creek valley. Englemann states that the bed is 7 feet thick but at present the old

quarry is filled with stream wash so that it is impossible to verify this figure without very deep excavation or drilling. If the bed averages 6 feet thick possibly 50,000 cubic yards might be recovered with not much over 5 feet of cover, most of which is not heavily forested. Existing information, however, does not disclose the extent to which weathering and erosion have thinned the bed or even destroyed it entirely. Nevertheless, the locality is worthy of exploration. Englemann reports similar exposures in NW¼ Sec. 10 but the writer was unable to find them or to hear of them from the present inhabitants of the district.

Nashville district. An old quarry, now entirely concealed by earth, is reported in the SW¼SE¼ Sec. 31, T. 2 S., R. 2 W. and Engleman mentions a ledge near the middle of the east half of the same section. Stripping was probably heavy in this locality. Limestone was formerly ground near here in SE¼NE¼ Sec. 6, T. 3 S., R. 2 W. but a visit to the old workings showed that the material was glacial boulders. An old quarry was worked in NE¼NW¼ Sec. 13, T. 2 S, R. 3 W.; the pit is still open and a pile of blocks of limestone may be seen near the gate but the ledge is concealed. It seems probable that stripping was very heavy, 10 feet or more in places. In the same township quarries were once operated in SE corner Sec. 20 and the adjacent SW corner Sec. 21, in NE¼ Sec. 21, and in the SE¼ Sec. 22. All of these are now concealed by earth which has accumulated since they were abandoned by the early settlers. The only trace which can be found at any of them consists of piles of stripping and of stone chips. It is absolutely impossible to estimate the reserves since the thickness of rock is unknown. Nevertheless, the locations are attractive since the valleys in which the workings were are so shallow and wide that stripping would not be heavy. On the other hand, weathering has undoubtedly made heavy inroads on the bed. Considerable time was devoted to a vain search for an outcrop described by Shaw in the New Athens-Okawville Folio as "in the hillsides about midway between Elkton and

Oakdale." It seems possible that he collected fossils from glacial boulders for these are common throughout this district. The same explanation applied at several localities where it was reported that the early settlers had burned lime.

New Minden district. The largest quarry in the county is operated by the New Minden Limestone Corporation in NW¼SW¼ Sec. 18, T. 1 S., R. 2 W. Power is supplied by a steam tractor which also furnishes steam for drilling. Stone is moved by wagon and a gasoline pump drains the pit. The limestone is like that of the other districts (Sample 5) except that it is overlain by 1½ to 2½ feet of alternating limestone and shale which although stripped at present might be saved if the rock were not crushed fine and were screened. Because of difficulties in blasting and drainage not all the rock is now removed; it is probably not much over 6 feet thick. The overburden consists of 3 to 10 feet of glacial drift and alluvial silt. It is estimated that about 38,000 cubic yards could be developed along the valley within the 40 acres on which the quarry is situated and an undetermined amount to the north and to the south. A quarry is operated by W. C. Nierman of Nashville in SW¼NW¼ Sec. 11, T. 1 S., R. 3 W. Only about 3 feet of limestone are now being removed and the bottom of the bed was not exposed when visited. Power is supplied by a steam tractor. Air drilling is used and wagons haul the stone from the quarry. Drainage is by gasoline pumps. Sample 6 was taken here. The reserve with no stripping over 10 feet is thought to be about 20,000 cubic yards. About 30,000 cubic yards of limestone might be developed with no stripping much over 5 feet in SE¼SW¼ Sec. 10, same township. An abortive attempt at opening this deposit was recently made. The area is heavily forested. Limestone was once quarried in NE¼NE¼ Sec. 16 but is now covered.

Summary. The limestone resources of Washington County may be tabulated as follows. It is the opinion of the writer that overestimates due to gaps

in the limestone ~~due to~~ caused by erosion and weathering will be offset by now unknown extensions of the deposits and by the discovery of other localities.

Radom district.	30,000 cubic yards
Beaucoup Creek district	15,000
Sec. 9, T. 2 S., R. 2 W.	50,000
West of Nashville	50,000(?)
New Minden district	75,000
Total potential reserve	220,000 cubic yards

In evaluating the success of the existing quarries, most of which have suffered financial reverses, it is well to realize that they are for the most part operated by more or less inexperienced men. In none is any definite system of operation observable. Workings are irregular in outline and in several places the full thickness of the bed is not utilized. Stripping has been done a little at a time by primative methods. Blasting methods could without much question be improved. Since all locations are in ravines considerable trouble has been had with water; it is necessary to build dikes to divert the wet-weather streams. The writer is firmly convinced that operating methods could be improved so as to produce stone at lower costs than prevail at present. Ground limestone is sold at $1.80 to $2.00 a ton at present and 10 cents a ton royalty is paid to the land owner.

Gravel

General. No drift gravel deposits are reported or could be discovered in Washington County which are large enough or of good enough quality to be worth sampling. Postglacial creek gravels are so small in amount and so poor in quality that little attention was directed to them.

Summary. The writer is convinced that development of local material for road surfacing is feasable in parts of Washington County. Unfortunately all but the New Minden ~~and Sec. 9~~ district except are located so close to railroads

that they come into direct competition with material shipped from the large quarries of the St. Louis and Chester districts. Developent will probably pay only where it cuts down truck haul rather than freight. From the standpoint of the conservation of natural resources, however, it seems possible that it may prove best for the country if the limestone deposits of Washington County are not depleted by their use for road building but are kept for agricultural use.

Aug. 3, 1930

ROAD MATERIALS OF WAYNE COUNTY, ILLINOIS

F. F. Thwaites, Associate Geologist, 1930

Introduction. Wayne County, Illinois, consits of approximately 720 square miles. It was covered with the assistance of D. D. Utterback in 12 working days at the rate of 60 square miles a day. This speed was rendered possible by the large areas of alluvial bottoms and of drift plain nmither of which require detailed examination. No assistance was obtained from the County Highway Commissioner who seems to be commited to the use of shipped-in materials.

Topography. Wayne County consists mainly of low rolling hills which have steep slopes in only a few localities. The greatest relief apparently occurs just north and south of Fairfield and in the southwestern part of the county. Some large hills occur in the southeastern corner of the county. A large part of the rolling topography has such slight relief that it is distinguished only with some difficulty from the eroded drift plain which makes up the major part of the northern portion of the county. The drift plain is diversified by a number of isolated rock hills and ridges which are most common in the northwestern part of the district. Toward the east, near Enterprise, the upland drift plain gives way impreceptibly to lower rolling country similar to that which occurs around Mt. Erie and Wynoose farther to the east. Very flat, low plains, only slightly higher than the alluvial bottoms, occur southwest of Fairfield along Skillet Fork. Some, if not all, of these may be alluvial terraces for they are so low that exposures of the underlying materials are wanting and the purpose of the present study did not seem to the writer to warrent taking time for borings to settle this question. Alluvial flats occur along virtually all of the streams clear up to their headwaters where the bottoms merge into the undissected drift surface. The mapping of these flats follows that of the Soils Map. In normal weather a large protion of the alluvial flats is marshy; some have been dyked to prevent flooding and others have been ditched or tiled to promote drainage. In the rolling country two generations of valleys may be distinguished: (a) drift-mantled preglacial depressions and

(b) postglacial ravines in the bottoms of the older mature valleys. A type of topography which is unusual in southern Illinois is the morainal ridge which borders the bottoms of the Little Wabash on the west from the south line of the county north to the vicinity of Route 15. This consists of striking knob-like hills with a maximum heigth of about 100 feet, many of which have have conical summits and very steep sides. Kettles were not discovered.

Geology-bed rock. Wayne County is wholly underlain by the McLeansboro formation of Pennsylvanian age. This consists in order of abundance of sandstone, shale, limestone, and coal. It has been explored by a number of oil tests the logs of which were not available to the writer. An interesting feature is a flowing fresh water well about 70 feet deep in SE¼SE¼ Sec. 27, T. 2 N., R. 8 E. It doubtless derives water from one of the sandstones. The relatively low relief of most of the district , the small thickness of strata displayed in the bulk of the individual exposures, together with the lack of data on elevations and logs of borings prevented the writer from forming any definite idea of the details of the rock formations, It seems probable that deposits of not less than two cycles are present. On the banks of the Little Wabash in NE¼SE¼ Sec. 21, T. 2 S., R. 9 E. a thick sandstone is seen overlying black shale. This is undoubtedly the exposure mentioned by Worthen as "At the iron bridge on the Little Wabash, on the stage road from Fairfield to Albion". It is especially interesting in showing the irregular cementation of the sandstones parts of which are hard enough to form road material but which change laterally into ordinary soft sandstone. A somewhat similar exposure occurs at the Fairfield waterworks in SE¼SW¼ Sec. 5 of the same township but the deposits of the earlier cycle are not shown. A small strip mine was worked until recently in SE¼SE¼ Sec. 29, T. 2 S., R. 8 E.; there the normal succession above the coal is replaced by sandy shale of the following cycle. A conglomerate which probably divides two cycles was noted on the roadside in SW¼SW¼ Sec. 3,

T. 1 N., R. 5 E. The limestone northwest of Fairfield in west part SW¼ Sec. 30, T. 1 S., R. 8 E also marks the basal part of a cycle. Beds beneath it are not now exposed. Most of the higher hills seem to be formed of sandstone or sandy shale. It proved impossible to get a definite idea as to the dip of the rocks although it was reported to the writer that the main coal seem in the oil tests at Barnhill and at Wayne City was encountered at very nearly the same depth.

Geology-drift. The major part of Wayne County is mantled with from a few feet to many feet of till which was deposited as the ground moraine of the Illinoian glacier. This drift was not thick enough to conceal all of the preexisting topography except in the larger valleys and over a considerable part of the northern portion of the county. In the valleys and on the larger uplands, which were probably fairly level before glaciation, the drift, which is a very clayey till, flowed out as mud to form a fairly level surface or drift plain. Over much of the county, however, a few high rock hills either projected through the plain or came so close to the surface that their presence is now made known by slight mounds or by gently rolling areas. Since deposition, the drift has been greatly altered by weathering and erosion. Most cuts show silttill and there are a few exposures of gumbotil, a material which undoubtedly is common beneath the flat areas. There is very little loess. The deposits beneath the alluvial flats were well exposed at the time of the survey in a ditch which was being excavated along Skillet Fork south of Boyleston. Here the top 7 feet is a gray non-calcareous silt; below follows 3 feet of yellowish gray leached gumbosilt on an equal thickness of dark bluish gray material of the same kind. These deposits lie upon 5 feet of gray calcareous silt interbedded with fine yellowish gray sand. The terminal moraine along the west side of the Little Wabash offers the greatest interest of all features in the county. It is made of till and gravel. The till contains many lenses and masses of sand and gravel. A characteristic feature is a reddish gray color irregularly mingled with and capped by light gray; portions of the till are yellowish gray as is normal to this region.

The alteration due to weathering extends deeper than 30 feet, the depth of the largest ravine observed by the writer. Gravel is exposed in many ravines and road cuts but at the surface has been weathered to a sticky red clay with abundant small stones so that its true nature is hard to see. Below 5 to 10 feet from the surface is found farily fresh stony gravel with scattered boulders and masses of conglomerate cemented with calcite. Boulders are decidedly more common in the terminal moraine than elsewhere in the region. In part this seems to be explicable by the steep slopes since in the cut bank of the Little Wabash near Wynoose in SW¼NE¼ Sec. 20, T. 2 N., R. 9 E., it was discovered that boulders are much more abundant at depth than at the surface. This is because of (a) sinking of boulders into the till while it was mud and (b) destruction of many boulders near the surface by weathering. The terminal moraine is from ½ to 3/4 mile wide and is tracable continuously from the south line of the county near the abandoned postoffice of Gum as far north as the ~~line of the~~ Southern Railway. Throughout this distance kames and steep hills are common and red till is exposed in many places. North of the railway, however, morainal topography is developed only in small spots, red till is rare, and the sharp contrast of the moraine ridge with the adjacent smoother rock hills is absent. It seems clear, nevertheless, that the moraine trends northwest and does not join the line of islands in the alluvium which runs northeasterly just north of Route 15. Bed rock is exposed in some of these islands which fact definitely shows that they have no connection with the moraine. It seems possible that the higher part of the ridge in Secs. 25 and 36, T. 1 S., R. 8 E. may be of morainal origin. If so, it is so low that the small knolls observed near the center of Sec. 25 do not serve to make the demonstation as convincing as might be desired. On the uplands around Mt. Erie no trace of morainal topography or of red till could be found. The sharp hill upon which the village stands seems to be part of a ridge which extends farther east and is probably due to rock control. Some of the low rolling tracts along the east side of Range 8

in Townships 1 and 2 North might possibly be regarded as the continuation of the moraine but again convincing evidences such as kames and red till are lacking. At the date of writing nothing is known of the extension of this moraine to the south and it could not be picked up in either Clay or Richland Counties to the north despite the most painstaking search. Such an ending of a terminal moraine, is by no means unprecidented but in the wxperience of the writer is very common. It seems clear that the ice which formed this moraine came from slightly north of east and not from the north as was formerly assumed in this region. A collection of chips from erratic boulders was taken at the cut bank near Wynoose because it was thought that a compairson with stones in the known Lake Michigan drift farther north may solve this question.

Road material-limestone. Worthen reported limestone at several localities in the county, some of them on the authority of Cox who almost invairably located outcrops in a most indefintie manner. The only outcrops which could be checked at the present time are in the middle of the west part of SW¼ Sec. 30, T. 1 S., R. 8 E., about two miles north of Fairfield. Most of the ledge is covered and it was necessary to excavate loose blocks to obtain a sample (No. 7). The thickness of the bed is hard to determine but is reported to have been 4 feet in an exploration boring. On the assumption that the rock is three feet thick about 10,000 cubic yards might be obtained under not over 5 feet of cover. The locality is attractive because of the low slopes. Extensions of the deposit were reported by Worthen but are not known to the present inhabitants of the vicinity. It is reported that over 30 years ago the limestone was crushed and used to surface a street in Fairfield which has since been paved. Since nothing could be learned as to the manner of construction of this street this circumstance cannot be used as a test of the stone. Worthen reported on Cox's authority some outcrops in Secs. 25 and 30 of what the writer inferred to be T. 2 N., R. 7 E. Extended search at the locations failed to reveal any trace of limestone, so that the writer concluded that the ~~locations~~ outcrops were really near the locality where limestone is now known and that the township descriptions were mixed up.

It seems probable that considerably more limestone could be found by drilling along the same elevation as that of the known outcrop.

Road material-gravel. Workable gravel deposits are confined, so far as the observations of the writer go, to the terminal moraine south of the Southern Railway. The bulk of the exposed gravel is very stony although there are few stones over an inch in diameter. Crystalline and local sandstone boulders are scattered through the deposits which are locally cemented with calcite. A large part of the material will pass a half inch screen and a smaller part will pass a quarter inch mesh. Most of the gravel below the surficial weathered zone could be used for surfacing with no treatment other than screening or the removal of large stones with a fork. Samples 8 and 9 represent the better exposed gravels where the relatively fresh zone is exposed. It must be realized that these samples include a larger amount of weathered gravel than would be the case were a deeper face exposed than at present. The localities where gravel is well enough displayed to be sampled are (a) Rainbow Farm hill in NW¼ Sec. 20, T. 2 S., R. 9 E., and (b) Gum hill in NE¼NW¼ Sec. 16, T. 3 S., R. 9 E. It is estimated from present showings that these deposits contain 500,000 and 300,000 cubic yards respectively. So far as could be ascertained none of this material has ever been exploited although several long stretches of gravel road have been built in the immediate vicinity. Where gravel has been washed down the hills adjacent to the exposures the resulting surface is excellent. The gravels are similar to the old weathered gravels which have been used with good success on heavy clay subgrades in Iowa, Wisconsin, and northern Illinois. Gravel of this grade is much easier to maintain with the grader than coarse gravel. The gravel reserves of the moraine are, however, by no means confined to the localities mentioned above although they are undoubtedly the two most

accessible. Gravel showings worthy of further exploration were noted (a) on the high hill on the line between Secs. 19 and 20, T. 2 S., R. 9 E., (b) in NW¼ Sec. 29, same township, (c) along the road on the north line of NE¼ Sec. 7, T. 3 S., R. 9 E., (d) in NW¼ and NW¼SW¼ Sec. 4, same township, (e) in a conical hill near the small cemetery in NW¼NW¼ Sec. 9, same township, (f) at several points in SW¼ Sec. 8, same township, and (g) just west of the center of Sec. 17, same township. In fact, all of the steep-sided, and particularly the conical hills deserve attention. It is also possible that some of the low hills which form islands in the alluvial plain of the Little Wabash east of Gum may prove to contain gravel. In exploring for gravel it is absolutely necessary that pits be carried to a depth of at least 8 feet even on summits in order to gain a correct idea of the fresh material. The writer does not wish to urge exploration on all steep slopes within the county since many such are due to erosion and not to deposition as are the tills of the terminal moraine outlined above. It is entirely possible, however, that other gravel knolls may yet be found outside the limits of the moraine. One hill which somewhat resembles a kame was noted at a small cemetery in NW¼SW¼ Sec. 31, T. 2 S., R. 8 E., about a mile and a half north of Barnhill. It shows no red till and was not closely investigated; it may be simply the end of a spur due to erosion.

Conclusion. The road material resources of Wayne County may fairly be described as adequate in amount for all construction which will ever be undertaken under any foreseeable economic conditions. That the gravel has never been used is doubtless due to its difference from the washed gravel shipped from pits along the Wabash River to the east. It seems that practically all the inhabitants of the region have never seen anything else used for gravel and so have the idea that the local resources are worthless. This impression demands the construction of a trial road with local gravel to demonstrate its quality by actual use. The writer is convinced that it will make a road vastly superior

to roads made with Wabash gravel which does not pack well. A cover of local gravel on top of the coarse gravel already laid would be ideal. It may prove necessary at first to discard from 5 to 8 feet of surface material since the clay of the subgrade will furnish enough binder but later as a deeper face is worked this weathered gravel may undoubtedly be mixed with the fresh gravel without detriment. By working a deep face the amount of stripping can be greatly reduced and in places there will be none. The limestone deposit near Fairfield is a distinct possibility although it probably will prove of greater economic value for agricultural use than for roads.

Aug. 6, 1930