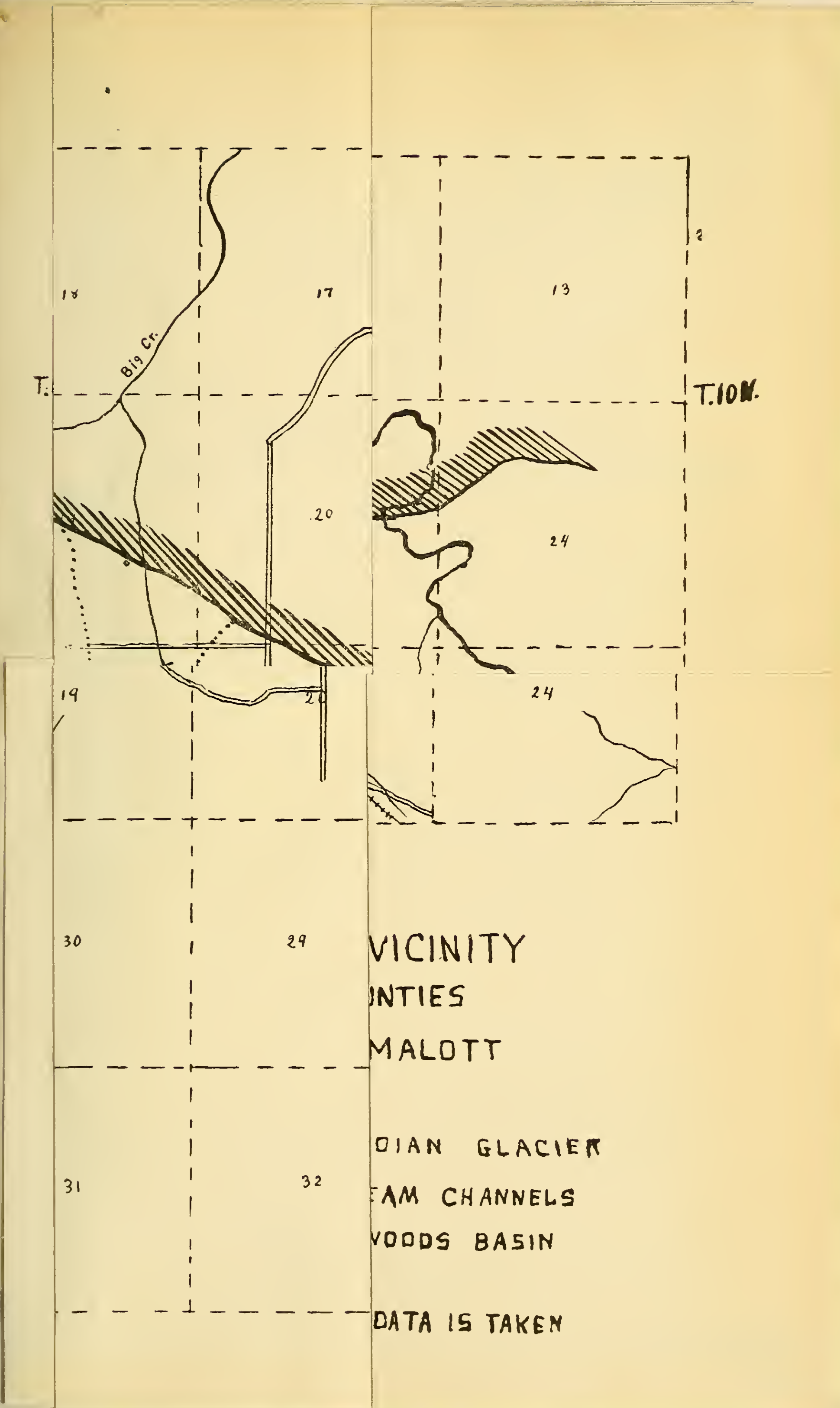

18
17
13
Big Cr.
T.
T.10N.
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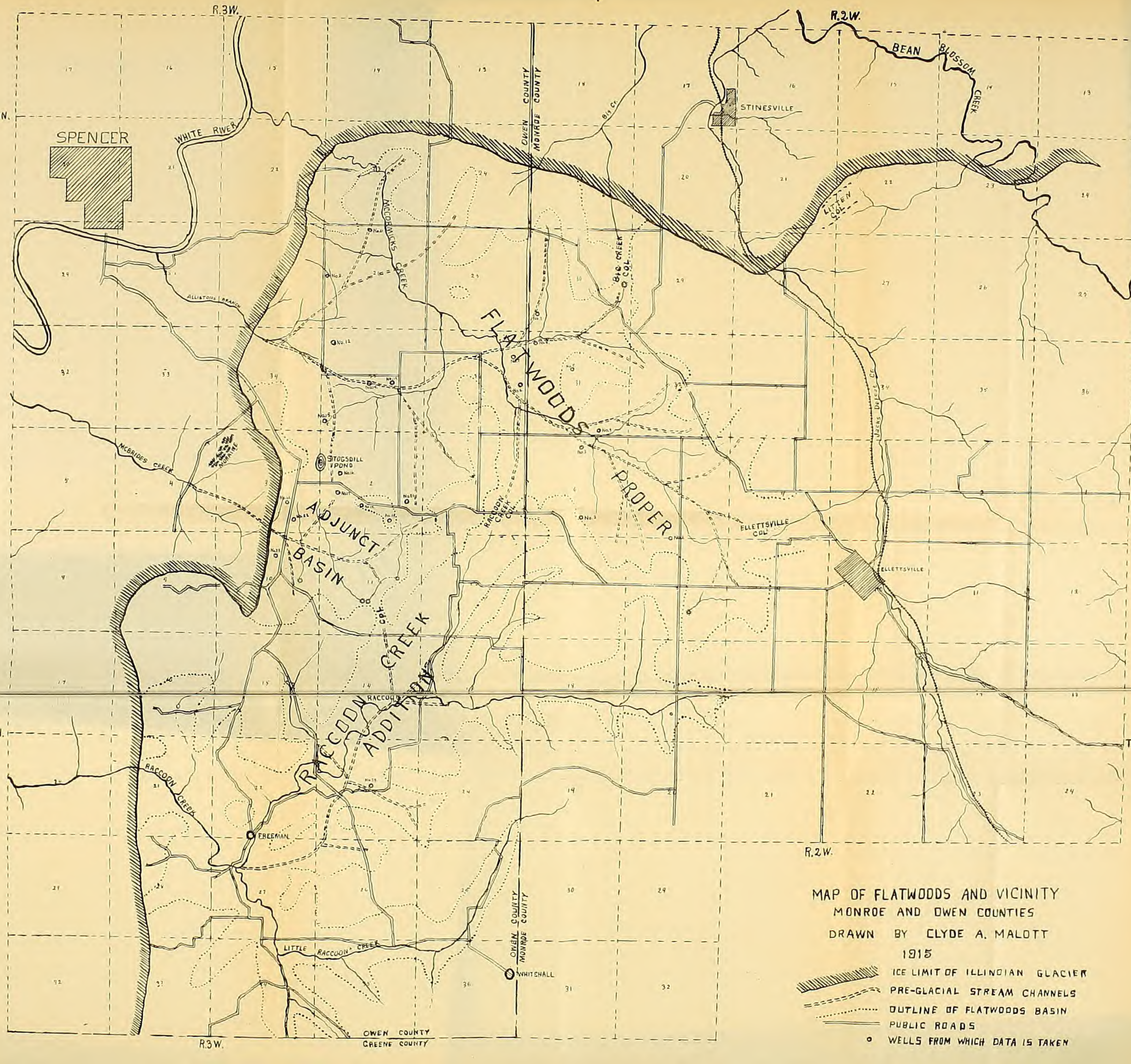
VICINITY
MALOTT
GLACIER
CHANNELS
BASIN
DATA IS TAKEN


MAP OF FLATWOODS AND VICINITY
MONROE AND OWEN COUNTIES
DRAWN BY CLYDE A. MALOTT
1915
ICE LIMIT OF ILLINOIAN GLACIER
PRE-GLACIAL STREAM CHANNELS
OUTLINE OF FLATWOODS BASIN
PUBLIC ROADS
WELLS FROM WHICH DATA IS TAKEN
R.3W.
R.2W.
T.10N.
T.9N.
SPENCER
WHITE RIVER
STINESVILLE
BEAN BLOSSOM CREEK
OWEN COUNTY
MONROE COUNTY
FLATWOODS PROPER
ADJUNCT BASIN
RACCOON CREEK ADDITION
STOGSDILL POND
ELLETTSVILLE
ELLETTSVILLE COL.
BIG CREEK COL.
LITTEN COL.
RACCOON CREEK COL.
MCCORMICKS CREEK
MCBRIDES CREEK
ALLISTONS BRANCH
RACCOON CREEK
LITTLE RACCOON CREEK
FREEMAN
WHITEHALL
GREENE COUNTY

The Flatwoods Region of Owen and Monroe Counties, Indiana.

Clyde A. Malott.

EXTENT AND TOPOGRAPHY.

Lying between Ellettsville, Monroe County, and Spencer, Owen County, Ind., is a strip of territory some six miles long and averaging about two miles wide, which has been the object of considerable curiosity and study. It is a low level basin nearly surrounded by higher land, yet having several openings in the surrounding periphery of hills.

The surface of the region is mainly an ash-colored soil of a fine texture, containing very little sand. It is in reality a silt region at the surface, and its outline is clearly discernible at the margin of the basin. This silt region, or its outline, is the principal means of determining the margin of the region, as indicated by the map. It coincides for the most part with the foot of the hills surrounding the basin. Here and there in the basin a hill rises out of the silt region somewhat as an island out of the water, and frequently a hill-like peninsula protrudes out into the region, rising high above the ash-colored silt margin.

The silt margin lying about the foot of the hills is rather uniform in height, averaging close to the 760-foot contour line, excepting at the northeast margin, where it extends much higher. This region of the Flatwoods area is also exceptional in regard to the periphery. Elsewhere, except at the openings, the hills surrounding the area rise rather suddenly above the basin; but here the margin is scarcely discernible, as the slope is very gradual and seems rather to fade out instead of being abrupt. This phnomenon is one of considerable importance and will be discussed later.

Lying in the long axis of the region is McCormicks Creek. This stream drains about nine-tenths of Flatwoods. Its head is about seven hundred fifty feet above sea level, one and one-half miles west of Ellettsville. The first few miles of its course is over the flat plain of the basin, which gyies it but little fall. After leaving Section 36, T. 10 N. R. 3 W., the fall increases slightly, and soon after entering Section 26, T. 10 N., R. 3 W., the stream has cut down to bed rock. The road leading east and west along the north side of Section 26 is practically the margin of Flatwoods in this vicinity. On this road a shallow ford crosses the creek on the 700-foot contour line, over a solid rock floor. From the source of the stream to this ford, a distance of about five miles, the stream has a fall of about fifty feet. It enters White River about two miles below, at an elevation of 540 feet above sea level. Thus the last two miles of the stream have a fall of 160 feet. Practically the entire last two miles of the course is over a solid rock bed. The region presents some of the most rugged and beautiful scenery in the State. The stream courses down a veritable gorge which is but little wider than the stream itself. Many cascades occur, and about a mile below the ford a fall of about 12 feet occurs. In low water the stream cascades over this fall, but when the water is high it rushes over with a roar that can be heard for some distance. Above the falls the floor of the gorge is swept clean of debris, but below, the gorge is wider, and in many places is chocked with the rock debris that has been carried from above or has fallen from the almost vertical walls on either side.

Just east of the source of McCormicks Creek is the source of a small branch which leads northeast through an opening in the rim of the basin and empties into Jacks Defeat Creek. This stream drains but little of Flatwoods, as indicated by the map. Its source is about the same height as the McCormicks Creek source, and its mouth, one and one-third miles northeast, comes out at about 670 feet above sea level, thus giving it a fall of eighty feet.

Another break in the rim of the basin occurs in Section 30, T. 10 N., R. 2. W., about two miles southwest of Stinesville. This opening is narrow and its surface is below the 760-foot contour line. To the north of the narrow opening is a wide flat plain similar to the Flatwoods, having a silt surface of the same nature. This flat is drained into Big Creek. The narrow opening itself is practically bed-rock at the surface. Sinks occur in it. A small portion of Flatwoods is drained into a deep sink near the northwest part of this section. The water that goes into this sink undoubtedly passes under the narrow opening and comes out into Big Creek below, as several springs occur in the upper part of this creek. Just to the west of this narrow opening is a high hill capped with sandstone, which is at least sixty feet higher than the opening. The silt line can be distinctly seen on practically all sides of this hill, coming slightly above the 760-foot contour line.

About one and one-half miles southwest of Ellettsville in the southeast corner of Section 8, T. 9 N., R. 2 W., is a sink which has a small stream entering it, and draining about one-half square mile of Flatwoods. This stream has lowered this corner of Flatwoods considerably below the general level. The water that goes into the sink flows out about a half mile to the southwest from a couple of large springs which drain into Raccoon Creek.

Perhaps the most interesting opening in the periphery of the basin occurs in Section 1, T. 9 N., R. 3 W. This opening leads into a tributary of Raccoon Creek, and is at least a third of a mile wide. To the east of it is a high hill or ridge attaining a maximum height of 910 feet, and on the west another ridge reaches above the 880-contour line. The floor of the opening itself is twenty-five feet or more below the silt-line on the sides of the hills. This opening is really a connection between Flatwoods proper and a continuation of it in the Raccoon Creek Valley. Consideration will be given it later.

There is yet another outlet to the Flatwoods region, which at first was very puzzling to the writer. At the western extremity of the basin Allistons Branch reaches into it by many deep and narrow tributaries. These tributaries are almost invariably headed by seepage springs which come out into the sandy material in which the tributaries are cut. The basin itself is some higher at this western part. The basin cannot be said to have a margin at this western limit; it ends more or less abruptly in the tributaries of Allistons Branch. If it ever had a peripheral margin at this end it has been effaced by the V-shaped valleys leading into Allistons Branch. The writer intends to prove that this western end never had a distinct margin, that is, like the so clearly identified ones on the southern and northern periphery of the region.

From the silt line at the foot of the hills, the slope of the basin is generally inward toward the mathematical center. The lowest part of the basin (not considering the valley and channel of McCormicks Creek) is along the Monroe-Owen County line, between sections 31 and 36, T. 10 N., and branching off from this along the southern part of section 31 and and along the northern part of section 36. This region is very fertile, being almost entirely a black loamy soil. The white silt of the bordering regions passes under this black soil. But farther out into the black soil, the silt underneath almost pinches out. The low region containing the black soil was undoubtedly the centre of the basin in former times, even as it is now. This low-lying, fertile region is very near the 720-foot contour line; thus it is some forty feet below the silt line at the foot of the hills surrounding.

It was said that the slope of the basin is generally toward the mathematical center; this is not true specifically, as there are some exceptions. Several places considerably elevated occur. The large one in Section 31, T. 10 N., R. 2 W. reaches to the height of 795 feet, approximating the peripheral regions. A well shows that bed rock is near the surface of this old monadnock. In section 36, west of the above, a long arm-like island projects out into the basin, and near the south of the middle of the section a notch occurs in the arm, which almost separates the north end, leaving a round-like knob projecting some forty feet above the basin. This elevation also has bed-rock in it near the surface. Section 25, T. 10 N., R. 3 W. has two elevations some twenty feet above the general level of the basin. It was not determined whether these had bed-rock near the surface, but indications are, especially in the western one, that it is there at a shallow depth. The elevation on the section line between sections 26 and 35, T. 10 N., R. 3 W. is a rounded knoll about twenty-five feet above the general level of the basin. Indications are that it contains no bed-rock. The northern part of Section 6, T. 10 N., R. 2 W., contains a slight elevation, perhaps twelve feet above the low-lying area adjacent. A deep well proves that it contains no bed-rock. Southeast in section 5, and entering section 8, is a long elevation parallel to the long axis of the basin and about twenty feet high. A well proves that this one also contains no bed-rock.

While dealing with the irregularities of the surface of the basin, attention must be called to the depression at the southwestern edge of Flatwoods, on the section line between sections 2 and 3, T. 9 N., R. 3 W. This depression, containing about two acres, is the site of a small lake which is being rapdly filled by in-wash and vegetation. The elevation of the surface of this small lake, bearing the name of Stogsdill Pond, is about 770 feet. It is enclosed on three sides by sloping banks which reach thirty feet above the water. It is open on the north.

The south bank of Stogsdill Pond is the lowest opening to a sort of an adjunct to the Flatwoods basin. The surface of this adjunct slopes gradually from the bank of the pond for about one and one-fourth miles to the south, and in its lowest place, a series of sinks jutting against the bed-rock hills at the south, comes down to the 700-foot contour line. This adjunct basin is about as broad as long. It is drained mainly by two southward extending streams that come to the series of sinks at the south end. A third but much smaller southward flowing stream drains the western side. It also disappears in a sink in the southwest corner of the region. The western edge, near the middle of sections 3 and 10, ends abruptly in the rapidly headward-etching streams of the headwaters of McBrides Creek. The eastern rim is the ridge of highland which has been mentioned as the western rim of the opening extending into the Raccoon Creek Valley. This same ridge turns to the west and forms the southern rim of the adjunct basin also, and beneath which the waters of the region flow in their underground passage. This small adjunct basin undoubtedly once had a smooth and gentle slope from the southern rim of the western part of Flatwoods proper to the high ridge at the south, but subsequent drainage through sinks at the southern end has eroded it into three main grooves with many smaller tributary grooves. The slope began at the north at an elevation of more than 800 feet, and ended at the southeastern corner at 740 feet. The west part of the southern end was somewhat higher, perhaps 760 feet. It was lowest at the southeast corner, because at this place there is an opening in the bed-rock ridge, which leads to Raccoon Creek. This opening will be called into account later.

We are now ready to go back to the broad opening in the middle of the southern periphery of the basin, and see the extension of the Flatwoods basin to the south. As has been said before, the floor of this opening is slightly below 740 feet, and that the silt line extends as high as 760 feet. Soon after leaving the opening, the silt line on the side of the ridges becomes more or less indistinct, since erosion has either erased it or covered it over. Still farther south not only the silt line is removed, but much of the one-time basin-flat itself is removed. The flat, however, can be traced for four and one-half miles south and some west down the valley, or rather above the valley of Raccoon Creek. The creek here turns abruptly and flows to the northwest, at a right angle to the course above. Modified portions of the old flat are distinct for two or more miles northwest of the sharp turn.

It is understood, then, that this Raccoon Creek addition is very much eroded by the present stream and its tributaries. But it is important to notice the elevation of the flat itself. Where it leaves Flatwoods proper, it is somewhat below the 740-contour. The slope is gradually downward from this place to the south. In the vicinity of Freeman the elevation of the flat is 700 feet. This makes a gentle slope down the valley southwest of a little less than ten feet to the mile. The Raccoon Creek addition extends up the creek almost as far east as the eastern margin of Flatwoods proper. The old flat is recognizable for three and one-half miles up Little Raccoon Creek, which enters Raccoon Creek from the southeast near Freeman. The extent and shape of the addition can be seen by consulting the map. It contains in all about eight square miles. Thus this addition and the adjunct south of Stogsdill pond make an area approximating that of Flatwoods proper.

While dealing with the Raccoon Creek addition of the Flatwoods basin, it must be emphasized that it occurs only in remnants. There are, however, quite large areas, sometimes a quarter-section or more, that have suffered little erosion. In such cases, or in cases where much smaller areas are preserved, there occurs the same flat, ash-colored, crawfish soil that is so characteristic of Flatwoods proper. Second to these flats, the most striking physiographic feature is the terraces resulting from the streams cutting down into the flat. The terraces begin almost immediately after entering the gap from Flatwoods proper. Here they begin at zero, but soon become quite a distinct feature. They grow higher very rapidly, so to speak, as the stream cuts down into the flat to the south. At Freeman, four and one-half miles below the gap, the stream has cut down one hundred feet below the old flat, and the terraces are accordingly one hundred feet above the stream. But in this vicinity there are many places where the terraces are indistinct, as they are so eroded that they no longer appear as terraces. This condition occurs in the immediate vicinity of Freeman. Beyond a slight bed-rock hill to the east of Freeman, however, the flat is distinctly discernible, and the terraces show beautifully above the small tributary streams that are etching their way into it.

UNDERGROUND INFERENCES AS REVEALED BY WELLS AND BORDERING REGIONS.

Having dealt somewhat with the extent and topography of the Flatwoods region, we shall now turn to a slightly different phase. Perhaps the most interesting particulars of the region are the underground inferences as they are revealed by the wells of the region and by the places along the western margin, which have suffered erosion by the rapidly encroaching streams from the west. Data from shallow wells, while revealing interesting sub-surface particulars, are not sufficient to give the shape of the pre-existing basins of the region. The deep wells, the wells which reach bed-rock, are important in this respect. There are only a few such wells; enough, however, were found to reveal an intelligent idea of the shape of the pre-existing basins, and the character of the material filling them. These things are of the utmost importance for working out the history of the region, which was the chief reason of time and attention being given to the area.

The easternmost part of the region is very probably not filled to a great depth. The sinks that abound indicate that bed-rock is near the surface. Sections 4, 9 and 8 contain sinks; these sections are at the eastern margin, and it might be easily deduced that the bed-rock is near the surface.

Well No. 1. Out some distance in the basin, on the southern line of Section 5, T. 8 N.. R. 2 W., near the headwaters of McCormick's Creek, is a well at Mr. Fife's which is twenty odd feet deep. This well furnishes a copious supply of water which comes from sand underlying a shallow surface stratum of soil. This well proves that the elongated elevation is a product of the forces which made the topography of the region, and not a remnant or hill in the former basin.

Well No. 2. This well is situated in the middle southern part of Section 6, T. 9 N., R. 2 W., and is on the edge of the silt line at the foot of the hill. It is sixteen feet deep and reaches solid stone. The material through which it passes seems to be entirely the outwash or talus from the hill rising up behind it.

Well No. 3. Middle northern part of Section 6, T. 9 N., R. 2 W., at W. Stone's. Surface elevation 730 feet. The depth of this well was not ascertained but reports indicate that it is of considerable depth to bed-rock.

Well No. 4. Southwestern part of Section 31, T. 10 N., R. 2 W., at H. Heady's. Surface elevatoin, 723 feet. Depth. 14 feet. Soil, with streaks of yellow and blue containing fine sand, 12.5 feet. Caked sand, of a yellowish sugary appearance when wet, becoming like brittle sandstone upon drying, 1.5 foot.

Well No. 5. This well is in the high hill to the north of well No. 4. It reaches bed-rock at a shallow depth.

Well No. 6. On the county line, middle eastern part of Section 36,

T. 10 N., R. 3 W., at Mr. Whitsell's. Surface elevation, 720 feet. Depth, 12 feet. Under a shallow surface soil occurs a blue clay which contains very fine, angular sand grains. These grains are invisible to the eye, though they may be felt when the dry material is rubbed between the finger and thumb. This very fine sandy clay is very tough, tenacious, and slightly sticky when wet, and of a distinct blue color. On exposure to the air it takes on a brownish-grey hue. When dry it is an ash color. Applicaton of muriatic acid shows that it is highly charged with calcium carbonate. (This detailed description is given because this material is often encountered in the lower parts of wells. Hereafter it will be designated as blue clay. It will be further discussed later.)

Well No. 7. One-fourth mile north of well No. 6, at the residence of B. Smith, is a well which reaches bed-rock at a depth of 12 feet. The surface elevation is 720 feet.

Well No. 8. One-eighth mile northeast of well No. 7, N. W. corner of Section 31, T. 10 N., R. 2 W., at C. Wampler's. Surface elevation. 720 feet.

Soils	17 feet.
Imbedded logs	1 foot.
Clay	8 feet.
Gravel and sand	1 foot.
Limestone	

Well No. 9. One-eighth mile north of No. 8. southwest corner of Section 30. Surface elevation, 720 feet. Depth to stone, 51 feet.

Soil and clay	18 feet.
Sand and gravel	4 feet.
Blue clay	29 feet.
Limestone	

In the northwest corner of Section 25 and leading far into Section 24, T. 10 N., R. 3 W., is an arm or extension of the Flatwoods basin, which is filled very little. Sinks are very numerous, showing limestone in many places. The general elevation of this extension is 740 feet.

Well No. 10. In the northwest part of Section 26, T. 10 N., R. 3 W., at Frank Marshall's. Surface elevation, 725 feet. Depth to stone. 47 feet.

Sandy clay soil	40 feet.
Sand and gravel	4 feet.
Soil	3 feet.
Limestone	

Mr. Marshall also has a dug well; it is twenty feet deep. It seems to be in clay soil except near the bottom, where sand occurs. A stick was found in this sand.

Some twenty-five rods east of Mr. Marshall's drilled well is the ford on the road across McCormicks Creek, where rock outcrops at 700 feet. Bed-rock was struck at least twenty-two feet lower than this in the Marshall well. Farther up McCormicks Creek, about three-quarters of a mile, bed-rock is to be seen in the creek bed, and just above, two remarkably large springs pour forth clear, cool limestone water, indicating that bed-rock is near the surface.

Well No. 11. Middle western part of Section 26, one-half mile southwest of No. 10. Surface elevation, 740 feet. Depth to stone, 110 feet.

Soil	20 feet.
Sand	16 feet.
Blue clay	74 feet.
Limestone	21 feet

Well No. 12. Northwest corner Section 35, one-half mile south of No. 11. Surface elevation, 740 feet. Depth to stone, 74 feet.

Well No. 13. East of the center of Section 35, T. 10 N., R. 3 W. Surface elevation, 735 feet. Depth, 22 feet. This well seems to be entirely in a reddish sand.

Well No. 14. Center of Section 35, one-eighth mile west of No. 13, at John Leonard's. Surface elevation 735 feet. No stone reached at a depth of 116 feet.

Soil	1 foot.
White sand, with small pebbles infrequently	80 feet.
Blue clay	36 feet.

Well No. 15. Southwest corner of Section 35, one-half mile southwest of No. 14, in an open field. Dug well. Surface elveation, 745 feet. Depth, 41 feet.

Well No. 16. One-eighth mile east of Stogsdill Pond, Section 2. Surface elevation, 820 feet. This well is 40 feet deep, and is entirely in a reddish sand containing some water-worn gravels. This well contain no water.

Well No. 17. One-sixteenth mile south of No. 16. Surface elevation, 795 feet. This well was reported by two persons to be 80 feet deep, in a reddish sand its entire depth. The writer is inclined to believe there is some mistake regarding its depth. It is not likely over 50 feet deep.

Well No. 18. One-eighth mile southeast of No. 17, at Geo. Myers'. Surface elevation, 825 feet. Depth to stone, 25 feet, in seemingly the residual limestone soil.

Well No. 19. One-fourth mile southeast of No. 18, on high, rounded hill, at Amos Barker's residence. Surface elevation, 860 feet. This well encountered Chester sandstone at a shallow depth.

Well No. 20. One-fourth mile northeast of No. 19. Surface elevation, 825 feet. This well penetrates almost pure sand to a considerable depth.

Well No. 21. Middle of southeast ¼ Section 3, T. 9 N., R. 3 W., at A. Evans'. Surface elevation, 780 feet. Depth, 42 feet.

Soil	18 feet.
Reddish sand (quicksand)	24 feet.

Well No. 22. One-fourth mile south of No. 21, at C. R. Ellis's. Surface elevation, 775 feet. Depth to stone, 51 feet.

White to yellow soil	18 feet.
Water-worn gravel and sand	6 feet.
Quicksand	27 feet.
Limestone	92 feet.

Well No. 23. Middle of northern one-half Section 10, one-half mile south of No. 22, at the County Farm. Surface elevation, 765 feet. This well penetrates soil and sand nearly fifty feet.

Well No. 24. Center of Section 23, T. 9 N., R. 2 W., at A. O. Collins'. Surface elevation, 690 feet. Depth to stone, 88 feet.

Red sand and clay	35 feet.
Blue clay	53 feet.
Limestone	1 foot.

This completes the number of wells from which data was secured. The reader can see at once that the greater number of them reveal the fact that Flatwoods was in former times a basin much deeper than it is now. It seems that the basin was rather deep at the northern part of Section 6, as indicated by well No. 3. This deep portion extended northwest, entering Section 36, and thence northward, but went northward for only a short distance, along the present channel of McCormicks Creek, until it turned westward as indicated by the shallow bed-rock in well No. 7. Wells No. 8 and No. 9 indicate that a tributary channel passed near the southwest corner of Section 30. This channel probably entered the main channel near the northern middle of Section 36. The bed-rock outcrop along McCormicks Creek in the southeast part of Section 26 indicates that the region to the northeast was high, very probably a divide between the tributary just mentioned and the one that undoubtedly came from the northeast of section 24. Wells Nos. 10, 11 and 12, by their depth to bed-rock, reveal a channel region running south and southwest from section 23, from near where McCormicks Creek leaves the Flatwoods region. A A small tributary in bed-rock flowing its water in the up-stream direction, just west of where McCormicks Creek turns west in section 23, also indicates that a channel once went southwest from this region. There is no doubt in the mind of the writer that this region and also the long extension north into section 24, was drained to the west and north through a well developed underground system. Well No. 14 shows that the ancient surface was more than 116 feet below the present surface, and more than eighty-five feet below the bed of McCormicks Creek a mile to the north. At this place the old stream channel must not have been far from the 600 foot contour line.

The western border of Flatwoods in the region of the headwaters of Allistons Branch reveals facts in harmony with those shown by the wells. The tributaries of this creek are etching their way slowly into the Flatwoods region. The etching is slow because the slope is away from them, thereby causing practically all the water, except that which falls immediately into them, to flow in the opposite direction. These tributaries are deep, V-shaped valleys or ravines in the sandy material at this margin of the region. A typical ravine may be found just south of the middle of section 27. It begins at an elevation of 760 feet, and descends rapidly to a depth of sixty feet or more. The sandy banks on either side are very steep. Small erratic boulders may be found in the narrow bottom, amid which trickles water seeping from the sandy banks near the bottom. The descent continues rapidly until near the 620 foot contour. A small valley flat then begins to appear, and soon the main stream is reached. The entire length of this ravine is less than one-fourth mile, and a descent of at least 150 feet has been made. The slope away from the Flatwoods region towards White River, much cut up by etching ravines, is very rapid; this makes the banks or sides of the etching ravines higher near their heads than farther down.

The great amount of sandy material at the head waters of Allistons Branch indicates that the old channel found and traced westward by the wells had its course entering Allistons Branch near its head-waters. The present Allistons Branch, then, is the lower part of the main stream that in former times principally drained the area now occupied by Flatwoods. The map showing the main drainage, the main channel and its tributaries, are inferences that can scarcely be avoided. There are indications, however, that portions were drained by underground channels to other streams; as, for instance, the extreme southeast corner, the eastern part of section 30 and the portions already mentioned near the northwest corner of the region. The sinks of these portions are evidences that their drainage was as it is now, and was only temporarily interfered with by the forces that destroyed the old drainage. Very probably other portions of considerable area were drained into the main channel from underground passages, the water coming to the surface farther down in the form of springs.

Next, the relation of Flatwoods proper with the adjunct south of Stogsdill Pond will be considered. The lack of any deep well immediately west of Stogsdill Pond leaves the data somewhat incomplete, but this portion has an elevation of 820 feet, and it seems likely that bed-rock is much higher here than either to the north or to the south. Bed-rock outcrops at 760 feet one-half mile west of this portion, and it is found at 800 feet in Mr. Myer's well one-half mile southeast. Thus it is very probable that there was a divide between Flatwoods proper and the small adjunct to the south. It must have been very low near Stogsdill Pond, for wells Nos. 16 and 17 penetrate sand their entire depth, and No. 17 was said to be eighty feet deep, but, as said before, the writer doubts the reputed depth of this well.

The region east of the Myer's well seems to have been considerably filled, as indicated by well No. 20, and the sharp ravines which are etching their way in the flat area near by. Examinations of these ravines show that they contain no bed-rock, but were rather grooved into the stratified sand and fine gravel of which the flat area is composed.

In the extreme southwest corner of section 1 is also a filled area, but farther east bed-rock is found, and on top of the ridge there is no sign of silt or sandy material. Undoubtedly the head of a stream reached into this corner, near where the present stream is endeavoring to clean out the filled-in material. Thus the evidence shows that a divide with a very irregular summit once separated the adjunct basin from Flatwoods proper.

Turning to the western edge of the adjunct basin, we find sharp V-shaped valleys or ravines of McBrides Creek etching their way into the body of the flat in the same manner that the tributaries of Allistons Branch are etching their way into the western edge of Flatwoods proper. These ravines descend almost suddenly a hundred feet below the level of the flat. In several places the structure of the material can be seen. The upper fifteen to twenty feet is a fine, white soil, characteristic of the surface of the Flatwoods region. Underneath this, is reddish sand with layers of fine gravel alternating with the much thicker layers of sand. Water comes from the sand and gravel into the ravine, making them miry in the bottom. These ravines, in conjunction with the wells (Nos. 21, 22, and 23) clearly reveal that the region has been filled, and that the adjunct basin had a broad outlet, or opening, to the west. McBrides Creek must have extended much farther east, draining in all probability the greater part of the adjunct, and having its tributaries reaching to the divide between the adjunct and Flatwoods proper.

It might be mentioned that the streams in section 11 have cut themselves down into the filled material at least fifty feet and leave the old flat above as a beautiful terrace. The material of this terrace is shown in an excellent manner along the steep western side of the middle stream. It is as follows:

Soil	12 feet
Red sand..................................	25 feet
Blue clay.................................	5 feet

McBrides Creek undoubtedly had its upper portion and upper tributaries taken away from it by the forces that remade the topography of the region. But it is rapidly working its way back into its old domain in the same manner that Allistons Branch is trying to recapture its old basin. The rapidity with which these tributaries etch back into the filled material can be seen in a single ravine just north of C. R. Ellis' house in the middle of the southeast quarter section 3. The main stream flows parallel with the road, and the short tributaries come into it at right angles. These tributaries are, in fact, just immense gullies only a few rods long, but with the depth easily forty feet. The water during showers gushes into these ravines and carries away the easily transported sand at the bottom, leaving the soil above to slump into the ravine, which is then in turn rapidly carried away. These ravines grow directly in proportion to the amount of water entering them at their head. Mr. Ellis stated that eleven years ago, the head of the particular ravine mentioned above was at least sixty feet west of the road. Now, it is at the very road ditch, and immediately descends twenty-five feet. If nothing should interfere with it, it would in a short time destroy the road here by etching into it.

There is no doubt in the mind of the writer that McBrides Creek at one time extended eastward to the very divide between the adjunct basin and Raccoon Creek, but evidence shows that probably most of the water that fell into its upper portion was carried by underground drainage either to the lower part of the stream or to the east and to the south to Raccoon Creek. At present practically all the water falling into the adjunct basin goes into Raccoon Creek, mainly through the sinks at the southeast corner of the adjunct region. Two very large springs come out about a mile south of where the water enters these sinks, which in all probability are outlets of underground channels beginning at the sinks in section 11.

The Raccoon Creek addition of Flatwoods may be treated in a few words. This region was the site of an old stream which followed the same valley that the present stream does. The present stream, as stated before, has cut itself down into the old flat and in some places has removed much of the filled-in material. Raccoon Creek, however, does not reach bed-rock until it is at least 100 feet below the old flat, as found in the southern part of section 26. Yet there is a short distance that the stream passes over rock in a rather constricted place in the middle northeast part of the same section. This portion of the stream has evidently been cut since the time that the old valley was filled. The old stream evidently passed to the east of this place, as indicated on the map.

The faces of the terraces have but few portions that show the material of the terraces, but the few that are shown, and the rock structure of the higher areas, along with the sinks in the terrace flat, reveal the ancient drainage lines in a very able manner. The small tributary entering Raccoon Creek just north of the mouth of Little Raccoon Creek once extended nearly three-fourths of a mile farther east than it does now. It is making heroic efforts to recapture its old drainage basin: it is being aided by underground drainage, much material having been carried away leaving great sinks in the one-time flat. A small tributary no more than one-fourth mile long enters Raccoon Creek from the east in the middle of section 23. This tributary is a very small one in comparison to its predecessor. The old tributary extended nearly two miles eastward. Practically all of this region is now drained by sinks, which have caused the old flat to be considerably depressed locally. Well No. 24 is near the site of this old tributary. It shows the filled-in material to be eighty-eight feet deep; that makes the old tributary somewhat below the present level of Raccoon Creek, where the present tributary enters. But not more than thirty rods to the northeast of the well, limestone outcrops. This indicates that the long hill protruding westward from section 24 was continued as the northern divide of the old tributary.

THE PRE-GLACIAL GEOLOGY OF FLATWOODS.

In considering the geology of the Flatwoods region, it is thought best to divide it into two main divisions. The first division includes the rock structure of the region and the subsequent history up to the Pleistocene. The second division begins with the Pleistocene and takes in all up to the present. The rock structure of the region and immediate vicinity is of Middle Mississippian age with some Pennsylvanian bordering closely on the west. The stratigraphy of the region will be given a brief treatment.

Knobstone Group. Just to the east of the region in the valley of Jacks Defeat Creek, are the upper portions of the thick Knobstone Group of shales and sandstones. The area of its outcrop in Indiana is a strip of territory some twenty-five miles wide, extending north, northwest from Floyd County to Benton Countyy. This formation consists of compact, insoluble, impervious sandstones and shales, aggregating a thickness from 400 to 600 feet. The topography of the outcrop, resulting from the peculiar weathering of the rocks, is of a distinct type. The rocks absorb water readily, but transmit it poorly, so that they are easily shattered by freezing and thawing. The region is weathered and eroded into deep, steep-sided valleys of very pronounced relief. Brown County affords a typical example of Knobstone topography. Another characteristic of this group of rocks is the general absence of fossils, such being present only very locally. It seems that the shales and sandstones were laid down in impure, muddy waters, which were not on the whole very favorable for the life of water-breathing animals.

Harrodsburg Limestones. Overlying the Knobstone is the Harrodsburg limestone, with a thickness varying from sixty to 100 feet. This limestone consists of several heavy bedded layers of hard, gray to blue, often highly crystalline stone. There are occasional intercalated thin beds of shale. In some sections a very cherty layer occurs. The top member of this stone often is very massive, and its texture is very similar to the oölitic bed overlying. Geodes are characteristic. The limestone as a whole is very folliliferous, showing that life was abundant when it was laid down. The area of outcrop is narrow and intermingles with the western edge of the Knobstone, often capping outliers of the latter. It has no distinct topography outside of the fact that sinks occur in it, which never occur in the Knobstone, and rarely in the formation above it.

Salem Limestone. Superior to the Harrodsburg formation is the famous Salem limestone known as the Oölitic, or Bedford limestone. It is an excellent building stone, and is known as such all over the United States. Typical outcrops of it occur along the valley of Jacks Defeat. The stone is usually massive, with few indications of bedding, varying from a few feet up to eighty and ninety feet in extreme cases. The stone typically is a porous stone composed of nearly pure calcium carbonate. It is made up principally of broken animal remains and several species of Protozoa, among which the main one is Endothyra baileyi. These have all been cemented together in a loose manner. The area of its outcrop is characterized by long, gentle slopes, rounded hills and general undulating topography.

Mitchell Limestone. The Mitchell limestone is the one that we are mostly concerned with, since practically the entire basin of the Flatwoods region is in this stone. It ranges in thickness from a few feet in its northern outcrop to 250 feet in the southern part of the State. The stratigraphy of this formation is rather varied, as there are rarely two successive layers alike. In general it consists of impure limestones and calcareous shales, usually thin. Many layers are very hard, and weather white, sometimes small slabs having the appearance of bleached bone, and on being struck have a metallic ring. Such layers usually have numerous right-angled joint cracks, and are semi-lithographic, breaking wth a subconcoidal fractiure. The upper members of this formation are usually a beautiful oölitic structure. As a rule the limestone is fossiliferous. The area of the outcrop of the Mitchell limestone extends over a broad plain which narrows to the north and pinches out in Montgomery County. It is essentially a cave-bearing formation, containing some of the most famous caves in the world. Wyandotte and Marengo caves of Crawford County and Mammoth cave of Kentucky are in this stone. The region of its outcrop is pitted with sinks, and underground drainage is a distinct and noticeable feature. Lost River of Orange County is a typical example of an underground stream in the Mitchell area. Hundreds of sinks occur on the borders of the Flatwoods region, where the filled material is relatively thin. These sinks connecting with under-channels are the sources of many springs that abound in and at the borders of the region.

Chester Group. On the high hills at the borders of the Flatwoods region shales and shaley sandstones overlie the Mitchell. These are usually about twenty-five feet thick, and upon them is a limestone usually about three feet thick in the Flatwoods exposures. This group is known as the First, or Lower Chester. On top of the First Chester limestone occur a series of shales and sandstones, consisting of a portion of the Second Chester group. This group is capped by a limestone, its last member. At no place in the immediate vicinity of Flatwoods was the top of the Second Chester found.

The above general outlined stratigraphy is found in the Flatwoods region and portions directly connected with it. Some attention now will be given to local details.

The general dip of the rock of the Bloomington Quadrangle, in which a portion of Flatwoods occurs, is on the average twenty feet to the mile to the west, southwest. In regard to the dip of the rock structure in the Flatwoods region, the following data reveal an interesting feature:

Contract of Mitchell and First Chester, south side Flatwoods:

In 920-foot hill, N. W. ¼, sec. 16, T. 9 N., R. 2 W	870
In 900-foot hills, S. ½, sec. 7, T. 9 N., R. 2 W	845
In W. part of hill N. W. ¼, sec. 7, T. 9 N., R. 2 W	820
In centre of S. ½, sec. 1, T. 9 N., R. 3 W	800
One-half mile N. of above	805
S. W. side of hill, S. E. ¼ sec. 2, T. 9 N., R. 3 W	800
Middle N. of N. W. ¼ sec. 3, T. 9 N., R. 3 W	720

North side of Flatwoods:

In 810-foot hill, Middle sec. 30, T. 10, N., R. 2 W	790
Chambers Hill, middle of line, sec. 24-25, T. 10 N., R. 3 W	810

The data along the southern side of Flatwoods reveals an average dip of thirty-feet to the mile along a line which is as much in the direction of the strike as in the direction of the dip. Again, going from the eastern contacts toward the western, the data indicates that the first two-thirds of the distance has a dip of twenty feet to the mile, and the ramaining distance a dip of fifty feet to the mile. The data on the north side is very meagre, as there are only a few hills high enough to reach the Mitchell and Chester contact. Only the eastern half of the north side is represented by contacts. Here, two contacts were found, but these reveal a rather striking feature. The two contacts are one and one-fourth miles apart, the west one being a mile west and one-half mile north of the eastern contact. Judging from the general dip of the rock structure, one would expect the western contact to be several feet lower than the eastern one. But the reverse is true, the eastern contact is actually twenty feet lower.

Having absent contacts for the western part of the north side, the data does not give absolute information, but the indications point decidedly to the fact that a monocline or an anticline, with its long axis extending parallel with McCormicks Creek, exists in the Flatwoods region. This means that Flatwoods proper is an eroded anticline. This interesting structure indicates that the possibilities for oil are much stronger than a guess. However, it is possible and even probable that the anticline is superficial, and does not extend to strata of oil-bearing properties. The only sure method for determining the presence of oil is the drilling of a hole the required depth. The writer, however, is of the opinion that the Flatwoods region has sufficient superficial indications of oil to warrant an experimental hole being made.

An interesting chapter in the pre-glacial geology of the Flatwoods region is found in the physiographic development. Several million years of time lapsed between the time when the later Mississipian deposits of the region were first lifted above sea level and the advent of the glacier in quaternary times. During this time, no deposits were made, indicating that the region was never again subject to such a depression that would reduce it below sea level. There is no rock structure present representing the late Paleozoic, the entire Mesozoic and the early Cenozoic systems. During the lapse of all this time, the area was subject to all the forces of weathering and erosion. Undoubtedly much must have been accomplished in that long interval of time.

It is very likely that the new land surface of the upper Mississippian strata was not raised to any great height above sea level for a long time. The old sea in which the Pennsylvanian rocks west of the area were deposited came and went many times before it left the region forever. In the ages that followed the withdrawal of the old sea, perhaps several peneplains were formed, and each, in turn, destroyed by the subsequent erosion, following the successive uplifts of the area. Only the later of these would be preserved in any recognizable degree.

A study of the topography of the Bloomington Quadrangle shows that there are several rather flat-topped, isolated hills and several long, irregular, flat-topped ridges, all of practically the same height. The hills reaching the 900-foot contour and forming the southern rim of Flatwoods proper, are examples of the isolated hills. A typical example of the flat-topped ridges is found in the region of Kirksville, where the irregular ridge extends for several miles in a north and south direction. These high, flat-topped hills and ridges are undoubtedly the remnants of a former peneplain. which may be correlated; but not absolutely beyond doubt, with that at the base of the Cumberland Plateau, and with its continuation southward and westward into Tennessee, thence northward into Kentucky, where it becomes known as the Lexington Plain. This correlation makes it of early Tertiary age. (J. W. Beede, Features of Subterranean Drainage in the Bloomington Quadrangle. Proceedings of the Indiana Academy of Science 1910. Ditney Folio, Indiana, U. S. Geol. Sur.) Beede has named the peneplain, which these isolated heights represent, the Kirksville peneplain, after the typical development of it at the little village of Kirksville in southwestern Monroe County. Representatives of it occur along the south side of Flatwoods and between the two main branches of Raccoon Creek. Chambers Hill on the north side is also a representative of it.

Succeeding this peneplanation there was an uplift of the region of about 175 feet. The streams went to work again, cutting deep valleys in the Kirksville peneplain. In time the stream reached base-level, and by lateral erosion and beveling by the minor tributaries, local peneplains were developed. The wide expanse west of Bloomington, which continues southward through Lawrence, Washington and Crawford Counties, is the best and most strikingly preserved area representing this peneplanation. This plain is in the Mitchell limestone, and is well represented at Mitchell, Lawrence County. It had its maximum development in late Tertiary times, and is the Mitchell plain of Beede, being so designated by him. (Features of Subterranean Drainage in the Bloomington Quadrangle. The Proceedings of the Indiana Academy of Science, 1910.) Flatwoods at this time was peneplaned, the rim of the higher land and the monadnocks being the remnants of the old Kirksville peneplain. Flatwoods is really a portion of the Mitchell plain. The drainage in late Tertiary times was into White River. The main stream was probably in the long axis of the region with its outlet through Allistons Branch. This main stream and its principal tributaries were in their old age, and were wandering about the plain, being separated from each other and adjoining stream basins by low divides, except locally where remnants of the preceding peneplain persisted.

Near the end of Tertiary time there occurred another upheaval; this time of about 300 feet. The streams immediately began to corrade their channels, and in the course of time the main streams cut their channels to base level in their upper and middle courses. In early Pleistocene times there occurred a depression of about 150 feet, which caused the base level portions of the streams to become filled. Wabash and the White rivers show this in an ideal manner. Bean Blossom and Jacks Defeat creeks are excellent examples of smaller streams which have their lower and middle courses filled as a result of the depression of the land. But even these streams are still corrading their channels in their upper courses. Examples of streams which are still cutting their channels, down in the late Tertiary or the Mitchell plain are found in Stouts Branch and Rocky Branch, north of Bloomington, Clear Creek south of Bloomington, and many other small streams reaching into the Mitchell plain. However, such streams are confined to the margins of this plain, because of the peculiarity of the Mitchell limestone in its tendency for the formation of sinks and subterranean drainage. Only the major drainage lines cross this formation with an open channel. Beede has treated this subject thoroughly in the paper referred to above.

In the Flatwoods region the main stream and main tributaries were about as indicated on the map showing the pre-glacial drainage. Considerable portions of the region, however, were drained by sinks and underchannels, as is characteristic of the Mitchell plain west and southwest of Bloomington. But despite underground drainage, the lower part of the main streams and principal tributaries were cut down to base-level. No doubt many springs came into the streams, being the outlets of the underground channels. At the margins underground drainage undoubtdly carried water to other streams. Instances of this kind have already been given.

At this point it is deemed advisable to give some attention to White River, near the lower end of Flatwoods. Collet in his report on the geology of Owen County (Seventh Annual Report Indiana Geol. Sur., 1875), makes note of the extreme narrowness of the White River valley between Romona and Spencer. He accounts for "The Narrows", as this very constricted portion of the river valley is called, by asserting that this portion of the valley is new, having been formed since the Illinois glaciation. The old channel, he says, was up McCormicks Creek, through the Flatwoods basin, and back to the present channel by way of Raccoon Creek. Leverett says: "The stream (White River) is now occupying a pre-glacial valley for a few miles in southwest Morgan County, and is also in a pre-glacial valley throughout much of its course below Owen County. But in its passage across Owen County it is opening a new valley. It has been suggested that this stream had a subterranean passage across the sink-hole region of Owen County, in which case no well-defined surface channel may have been opened prior to the glacial invasion." (The Illinois Glacial Lobe pp. 104, Monograph XXXVIII, U. S. Geol. Surv.)

Both Collet and Leverett have expressed their belief that White River in its present passage across the Mitchell limestone region is in a new valley. Collet says that the old channel was through McCormicks Creek, Flatwoods basin and Raccoon Creek. Siebenthal, in regard to Collet's idea, says: "The Pleistocene terraces of Bean Blossom Creek clearly prove the pre-glacial valley of that creek to have been practically as it is at present. It is impossible to imagine how it could be cut down to its present depth, while White River, into which it emptied, was running at a level 150 feet higher than now, as it is alleged to have done. Moreover the gorge of McCormicks Creek is clearly post-glacial. And further, it empties into White River at least a mile below the upper end of the "Narrows," whose existence it was brought forward to explain." (Twenty-first Annual Report, Ind. Geol. Surv., 1896, pp. 302). Thus Seibenthal makes it clear that Collet was in error in regard to the ancient channel of White River in the Mitchell limestone region.

Leverett asserts that White River in Owen County is post-glacial, and suggests that the pre-glacial drainage was a series of channels through the limestone region. The writer in his examination of the area found no evidence of an ancient channel on either side of the present river in the limestone region of Owen County; and there is little, if any, evidence of its passage through the region ever having been subterranean.

The constriction of the river just above Spencer is undoubtedly remarkable, and not geologists alone have asked the why of it. Puzzling as the "Narrows" are, they have a rather simple explanation. The valley here is very narrow in comparison to the extremely wide portions above and below. The valley is wide in Morgan County because of the easily eroded Knobstone sandstones and shales, through which the valley has been cut. It is wide in Greene County again on account of the same fundamental reason. Here the valley is in the soft sandstones and shales of the Chester Group and the Coal Measures. In this county, however, the Illinois glacier undoubtedly was an important factor in widening the valley. In Owen County the strata in which the "Narrows" occur, are hard, resisting limestones, which are little disintegrated by weathering and suffer even less by abrasions. The widening of the valley in this region must be carried on mainly by solution, which is a much slower process than those involved in the region above and below. This narrowing of the valley is identical with the appearance of the limestone bluffs in the vicinity of Gosport. The same condition is to be seen on the East Fork of the White River, where the valley is exceedingly wide in the Knobstone region, and becomes almost gorge-like in the limestone region.

Furthermore, if the valley in the limestone region were post-glacial there would be very little alluvium below the present channel. This is not the case. Wells at Spencer prove that the alluvium is at least 100 feet deep, just as it is in the wide regions of the valley.

White River Valley, then, in its passage across the limestone region of Owen County is not a new opening. It is the same valley that is seen in the wide portions of both Morgan and Greene counties. It is the same valley that has carried the waters of the basin above since the time that the present fundamental topographic features were initiated. In fact this part of the valley and channel is more nearly where it has always been than any part either above or below, for the simple reason that at this point the Illinois glacier but little more than crossed the valley, while both above and below, it crossed for many miles farther, and deranged the drainage accordingly.

We are now ready for the final chapter of the history of the Flatwoods region, the chapter which really gives the explanation of the Flatwoods phenomena.

THE GLACIAL HISTORY OF FLATWOODS.

It is not the writer's purpose to give here a treatise on glaciers and glaciation, nor to give an intricate and detailed history of the period of glaciation known to have been present in the Flatwoods region. The purpose here rather is to show the relations of the edge of the Illinois ice-sheet to the Flatwoods region and immediate vicinity, and show how it was responsible for the peculiar phenomena of the area. For an intimate knowledge of glaciology and its broad relationships, the reader's attention must be given to the many text-books and matter dealing specifically with such phases. That glaciation has taken place over very large areas of the world is no longer a theory. The most obtuse have long been convinced of that fact. The most important phase concerning glaciation before the scientific world today, is the manner in which it took place in specific areas. The most interesting features of this phase of glaciation occur in the phenomena existing along the border, or near the border, of the one-time ice-sheet edge. The Flatwoods region belongs to this phase.

Leverett has given a detailed account of the drift border in southwestern Indiana. The drift border through Greene, Owen and Monroe counties, he credits to C. E. Siebenthal. "From near Scotland (southern Greene County) it has a course slightly east of north to the valley of Plummers Creek, in section 9, T. N., R. 4 W. North of this creek it makes an eastward protrusion of about two miles into a lowland tract known as the American Bottom, reaching section 36, T. 7 N., R. 4 W. North of this lowland the course of the boundary is west of north to the valley of Richland Creek, in section 9, T. 7 N., R. 4. W. It follows the east bluff for about three miles and crosses to the west side of the creek in section 35, T. 8 N., R. 4 W. It follows nearly the west bluff to section 17, T. 8 N., R. 3 W., passing about a mile southeast of the village of Newark. The boundary makes an eastward protrusion of about a mile into Richland Creek valley in section 16, from which the course is northward into Owen County. Entering Owen County in section 33, T. 9 N., R. 3 W., the boundary leads northeastward past Freeman post office and crosses into Monroe County in section 6, T. 9 N., R. 2 W. The course continues northeastward through northern Monroe County, the boundary being about two miles north of Ellettsville and one mile north of Modesto, and coinciding nearly with Indian Creek valley from mouth to source." (Monogr. XXXVIII, U. S. Geol. Surv., pp. 34-38.)

The above detailed line of the glacial limit places the whole of the Flatwoods region well within the limits of the drift line. While it is not the intention of the writer to disprove the general limit of the drift as interpreted by Leverett, there must be some variation made in the Flatwoods region. Perhaps it should be made clear that in the detailed work done by the writer, searching attention was given to the probable advance of the ice-sheet itself, rather than to the exact drift line. In interpreting the Flatwoods phenomena the position of the advance of the ice-sheet itself is of fundamental importance. This line of advancement, as given below, was determined not only by the presence of erratic boulders and rocks, but by stratified outwash material as well. Of the two phenomena, perhaps the latter is the more important.

A close examination of the hills or rather ridge extending eastward along the northern part of section 15, T. 9 N., R 3 W., thence northeast through section 11 and into section 1, shows that the ice-sheet never crossed beyond. Evidence is plentiful in showing that the ice rested against this ridge and remained close to it for some time. The west side of the small adjunct is an outwash plain, which in the headwaters of McBrides Creek shows the coarse layers of stratified gravel alternating with both coarse and fine sand. About a mile west of the Stogsdill Pond is the remnants of an old moraine, showing the last stand made by the ice front. The coarse sand found in the ridge, dividing Flatwoods proper from the adjunct, is partly outwash material and partly the result of the ice-front itself in pushing material against the ridges, which the water later worked over. Undoubtedly a tongue of the ice-front pushed up to the very upper tributaries of the old stream, the lower part of which is now represented by McBrides Creek, but that it never crossed the ridge between the old stream and Raccoon Creek to the east is certain.

To the north the ice came up the White River slope and pushed up the old stream, draining the region now occupied by Flatwoods proper. It may have come up this old stream as far east as the Owen-Monroe County line, and even some distance farther, but for the most time it must have remained near the western border of the present Flatwoods. Alliston's Branch has been eating its way into an old outwash plain since the withdrawal of the ice from the region. It has erased the moraines, if any were formed, and has taken considerable of the head of the outwash plain. It is this outwash material, covered with later silt, that makes the slope of the western part of Flatwoods toward the centre of the region. It is evident from this that the ice-front for the most part did not extend beyond the headwaters of Alliston's Branch, in sections 26 and 35, T. 10 N., R. 3 W.

No outwash material or erratic boulders were found in the extension of the Flatwoods basin into section 24, or on Chambers Hill, but erratic boulders were found in the northern part of section 23 on the White River slope, away from the high periphery at this part of Flatwoods. It is improbable that this immediate portion was ever covered with ice, or if it was, only for a short time.

The headwaters of Big Creek in sections 24, T. 10 N., R. 3 W., and 19, T. 10 N., are in outwash material, and erratic boulders are common. But these conditions are not found on the Flatwoods side of the divide. It is very probable that the ice-front never got over this divide, although the waters came freely into the Flatwoods region over this divide in the southwest corner of section 19.

But little attention was given to the probable front of the ice east of Big Creek, but indications are that it pushed up Jacks Defeat valley to near the middle of section 28, T. 10 N., R. 2 W. Its maximum advance east of Jacks Defeat was probably where indicated by Leverett. Yet it seems to the writer, for reasons that will appear later, that for the greater time it must not have been farther south than the middle of sections 21 and 22, T. 10 N., R. 2 W.

The line of the advance of the ice-sheet south of Freeman was probably as indicated by Leverett. The advance was somewhat east of Freeman and continued northeast to near the southwest corner of section 23, T. 9 N., R. 3 W., where it turned northwest, jutting against the high ridge extending northward and northwest to the southeast corner of section 9. Here the ice crossed the ridge and protruded eastward, as already described. But it is not likely the ice-front was east of Freeman during the time of the formation of the basin flat. The material of the flat west of Freeman is principally sand, and quite likely is the lower end of an outwash plain.

Although the above details show the tracing of a line for the advance of the ice-front, it must be continually borne in mind that the ice-front was not irregular in outline, but that it was constantly changing in a sort of backward and forward movement, due to the seasonal changes in temperature. This line, as described above, has practcially all of the Flatwoods region outside of the ice limit, and in some places several miles within the limit placed by Leverett. Some glacial material was found well outside the limit as traced above, but it was material carried there by currents of water, and is not to be interpreted as being direct evidence of the presence of ice. Again, it is possible that the extreme limit of the ice-sheet came as far as indicated by Leverett. But it is quite evident that it was not advanced that far when the flat topography of Flatwoods was formed.

Having determined the advance of the ice-front, it is easy to picture the fluviatile conditions that existed during the presence of this great ice barrier. Streams of water, sometimes constricted and sometimes in broad sheets, poured out from the ice sheets in the summer seasons, and worked over the sandy debris, which the ice continually brought forward from the nearby sandstone hills. This debris was made into the outwash plains already mentioned as being along the headwaters of Alliston's Branch and McBride's Creek. In the adjunct basin the water from the ice carried material south and southeast from the region of accumulation, filling this basin to the level of the narrow outlet south of section 11. The water in being concentrated through this opening undoubtedly cut it down considerably. The material in the wide terrace southeast of this opening contains but little material foreign to the immediate vicinity, but there is an abundance of limestone, chert and sandstone material in the debris. Where the stream has cut a fresh place in the terrace these materials are shown in abundance.

Turning to the eastern side of the region, we find conditions which aided greatly in the making of the Flatwoods region as it appears today. White River was within the ice limit of the glacier and was at this time frozen with all of its upper tributaries. and incorporated within the glacier itself. Practically all of the tributaries beyond Bean Blossom were within this great ice clasp. The greater part of the Bean Blossom area, however, was free to gather its waters before the ice-front in the summer seasons at least. But the outlet and a few miles of the lower portion of this stream were within the ice limit. Consequently a lake gathered before the ice-front, both from the melting ice and the drainage of Bean Blossom basin. The water soon reached the height of the lowest point in the divide between Bean Blossom and Jacks Defeat Creek. This seems to have been about one and a half miles southeast of Stinesville, near the middle of sections 21 and 22, T. 10 N., R. 2 W., on the farm of Jack Litten. Here occurs a col nearly one-fourth mile wide, which comes down at least 100 feet below the height of the divide south of this place. The elevation of the col is 715 feet. Locally this col is known as the "Valley." Since it is on the farm of Mr. Litten, the writer proposes to call it the Litten Col.

The water on passing through the Litten Col came into Jacks Defeat valley, but again it had to lodge against the ice wall until it had found an outlet. This was found just northwest of Ellettsville through the deep col, which has been described as the southeastern opening of the Flatwoods region. This opening shall be henceforth called the Ellettsville Col. The water however was not confined to this col alone; it came over the divide to the north, especially through the region where a small stream leads from the extreme southwest corner of section 33, T. 10 N., R. 2 W. This brought the water coming from the Bean Blossom region and also that coming from the melting ice into the Flatwoods region. In the first part of this paper it was mentioned that the slope of the eastern Flatwoods region was very gentle from the periphery, and that the deposits extended much higher at this side of the basin than anywhere else. These features, along with the presence of geode fragments in Raccoon Creek valley, were instrumental in the investigation of the possibility of the entrance of the Bean Blossom waters.

After entering the Flatwoods region an outlet for the inflowing waters, mingling with that which was coming from the western ice-front, was found through the opening near the Owen-Monroe County line in section 1. This outlet, which might be designated as the Raccoon Creek Col, has already been described. But again the waters were to be checked by the ice-front in the Raccoon Creek Valley near Freeman. There must have been an outlet, either under the ice or around it, in the vicinity of Freeman near the 700-foot contour line; but such an outlet was not discovered. The terraces come to that height here, and slope from the above regions, indicating that the outlet at the time that the terrace-flat was formed could not have been either higher or lower.

Since the outlet in the Freeman vicinity was at the 700-foot contour line, it is easy to see the terraces representing the old lake bottom would not be any higher at this point, but that they should be higher above this point. This is true, as has already been described. The terraces up Little Raccoon Creek also get twenty-five or thirty feet higher in the upper region, where they fade out into the recent alluvium.

It is quite probable that for some time the waters entered Raccoon Creek just south of the Reeves School through a col on the section line, between sections 8 and 17, T. 9 N., R. 2 W. This col is about 770 feet in elevation, and is barely above the level of the silt line on the periphery of the region. During the time the water went through this col, the ice was advanced far enough east to obstruct the passage-way through the Raccoon Creek col.

In section 30, T. 10 N., R. 2 W., there is a connection through a narrow opening in the periphery of the Flatwoods basin to the outwash plain at the headquarters of Big Creek. No doubt waters came through this opening into the Flatwoods region. The silt flat on the Big Creek side of the opening comes up to the level of the opening, while on the Flatwoods side it is much lower, due to the sinks at this place. No doubt that at one time the slope was gradually away from this opening on the south side.

It is evident that the fluviatile conditions existed for a long time, long enough to fill practically the entire stretch from the place of the entrance of the waters into the region to where they left in the vicinity of Freeman, with the material which has been described. These waters, being so intimately connected with the glacier, carried much of its material, and it is possible that at times large pieces of floating ice carried glacial material; thus one may expect to find glacial pebbles and even small boulders in any part of the region covered by these waters.

Indications show that for a long time there were no rapidly flowing waters in the Flatwoods region. In nearly all of the deeper wells and in many of the shallow ones the very fine sandy blue clay, which has been described in well No. 6 is characteristic of the lower material. This blue clay is thicker, perhaps, than any other material laid down. It can be seen in the bottom of the middle branch in the small adjunct of the Flatwoods region. Here it is as described, but reveals another feature quite important. Where it has weathered, or has been eroded, it shows laminae, indicating that it is a water-laid material. This delicate bedding of lamination cannot be detected in the clay when it is cut into. The elevation of this material as found in the wells is as follows (See map for location of wells):

Well No. 5	715
Well No. 7	690
Well No. 10	680
Well No. 11	700
Well No. 14	660
Well No. 24	655
In Flatwoods Adjunct	705

In other wells it never occurred, or was not identified as such. These figures show that the surface of this material was not actually flat, but that it was even flatter than the present surface of Flatwoods. It is very probable that before later material was deposited upon it, it was eroded in places and in other places was entirely washed away. Generally, either sand or gravel overlies it, indicating that rapid flowing waters followed the long period of quiet waters in which the clay was deposited.

The next step in the history of the Flatwoods region comes with the deposition of the loess material. This fine, close-textured, ash-gray-to-white material composes the present surface of the region, except where the long duration of swamps has built up a black soil, which in some places is several feet deep over the top of the loess. The loess is somewhat uncertain as to its exact time and manner of deposition, and also as to the origin of the material. It was in all probability deposited not so very long after the disappearance of the Illniois glacier. Its thickness varies greatly in the Flatwoods region. Usually it is very thick at the margin of the old lake, being as much as twenty or even thirty feet; but in the centre of the region it is much thinner, at times being scarcely discernible. It is thicker at the margin because it has been washed from the hills adjacent. In the interior, perhaps much of it has been incorporated with organic material in the making of the black soils.

In connection with the history of Flatwoods, McCormicks Creek adds a very fascinating chapter. After the withdrawal of the ice, the lowest outlet was still the Raccoon Creek col. The region in the vicinity of the headwaters of Alliston's Branch was thirty feet or more higher than the Raccoon Creek col, having been built up by a possible moraine and the outwash plain already described. Therefore, the waters lowered to the level of the Raccoon Creek col. The water within the region was the site of a shallow lake, not being any deeper than the lowest place below the Raccoon Creek col. But the waters soon fell below the level of this opening, because of the opening of the old sinks near the margin of the region. These sinks were not covered deeply by the silt and sand, and consequently soon opened their old channels which had been filled or partly filled. It is very likely that the sinks formed in the northwestern margin or portion of the region in section 23, T. 10 N., R. 3 W., were the lowest and were, perhaps, the first to be opened on account of the static head at this place. These sinks had been draining this immediate portion of the Flatwoods basin long before the advent of the Illinois glacier, and it is quite likely that a thorough drainage, though underground, was already established along the line of the present McCormick's Creek Gorge. It can be easily seen that below the lower part of the gorge the valley bcomes wider, and on approaching the river it is a filled valley. This clearly shows that a pre-glacial tributary of White River occupied the region below the gorge of McCormick's Creek. The underground drainage merely had to develop through the narrow divide, composed entirely of Mitchell limestone. The great static head given the waters which reached into the southern part of section 23, in connection with a favorable dip of the rock, insured underground drainage. Moreover, the nature of the rock as exposed in the gorge would make this drainage not only apt, but very rapid. The hard Mitchell limestone in the upper part of the gorge is a continual occurrence of small irregular folds and dips, and even small faults, all being more or less disrupted and broken. Then below comes in a structure of loose, brecciated, highly argillaceous limestone, which is very easily eroded and carried away. This material is so loose that it can actually be torn from place by the bare hands. It is exposed in the falls and in the sides of the perpendicular cliffs below.

Thus, the present drainage of Flatwoods was initiated through the present McCormick's Creek by underground drainage. On account of the peculiar structure of the rock and the great fall, the drainage soon became open, somewhat as it is at present.

While the above outlined drainage through McCormick's Creek was in progress the middle part of Flatwoods remained a shallow lake. But finally the stream cut down enough to drain the region, with the exception of the middle portion and several small isolated depressions. Stogsdill Pond is one of the remaining representatives of these isolated depressions. The middle portion remained a great swampy morass for ages, and was even such at the time of the coming of the white man. It has since had the timber removed and better drainage instituted. The fine muck soil resulting from the long continued swampy conditions is now the most fertile part of the Flatwoods region.

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(NOTE 2. It was the writer's intention that a contour map accompany this paper, and data was gathered with that end in view, but press of time has precluded its preparation.)