POST-GLACIAL DRAINAGE DIVERSIONS IN A PORTION OF NORTH CENTRAL ILLINOIS

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ABSTRACT. — The drainage system in north-central Illinois bears evidence of several marked drainage diversions in post-glacial times. Original drainage in this area, which was consequent on the glacial landscape, has been extensively modified by the capture of low gradient streams by their more dynamic neighbors. Two streams in particular, Indian Creek and Kyte River, have extended their drainage at the expense of their lower gradient neighbors, Green River, South Branch of Kishwaukee River, and Little Vermilion River.

Stream piracy is the process whereby a stream is able to divert the drainage of a portion of another stream system into its own system (Thornbury, 1969, p. 148). Stream piracy most commonly occurs where two adjacent streams have markedly different gradients, such that the higher gradient stream is able to extend itself headward and intercept a portion of the lower gradient stream. The flow of the lower gradient stream above the point of interception is thereafter diverted into the higher gradient stream by virtue of the latter's lower level. The result is an expansion of the pirating drainage system at the expense of the pirated.

Conditions conducive to stream piracy existed in north-central Illinois following the retreat of the Pleistocene ice sheets. While the glacial ice occupied the land, extensive deposition of glacial drift at the base and margins of the ice completely buried and obliterated the pre-existing bedrock drainage courses. With the retreat of the ice, new drainage systems came into existence on the irregular surface of the drift sheets. For the most part these immediately post-glacial streams were immature consequent streams, flowing down the highly variable regional slopes. In these circumstances marked disparities in stream gradients between adjacent stream courses were common. In particular, those streams confined between end moraines such as to give them long circuitous courses tended to have low gradients. In contrast, those streams favorably located such that they followed a more direct route to the same destination tended to have higher gradients.

PHYSIOGRAPHIC SETTING

The physiographic setting of the area under discussion is shown in Figure 1. It encompasses parts of three physiographic districts, the

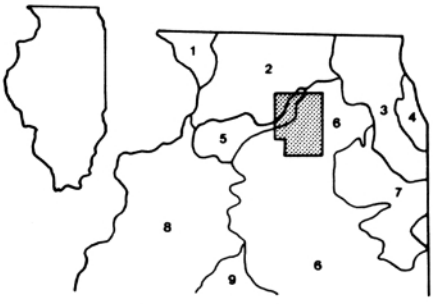

FIGURE 1. Location of study area (stippled). Numbers refer to physiographic districts. 1) Driftless Area; 2) Rock River Hill Country; 3) Wheaton Morainal Country; 4) Chicago Lake Plain; 5) Green River Lowland; 6) Bloomington Ridged Plain; 7) Kankakee Plain; 8) Galesburg Plain; 9) Springfield Plain.

Rock River Hill Country, the Green River Lowland, and the Bloomington Ridged Plain (Leighton, Ekblaw, and Horberg, 1948).

The Rock River Hill Country, which occupies a small portion of the northwestern part of the area, is characterized by low, hilly topography. In contrast to the Green River Lowland and the Bloomington Ridged Plain, glacial drift is thin and bedrock exposures are numerous. Drainage patterns tend to be dentritic, reflecting the erosional homogeneity of the bedrock. Within the study region, the lower course of Kyte River forms the principal drainage in the district. This portion of Kyte River is unique among streams in the Rock River Hill Country in that it flows almost completely on glacial drift. The situation which has led to this condition is the existence beneath the Kyte River of a buried preglacial valley (Horberg, 1950). Apparently Kyte River has been developed following the more easily erosible materials occupying this former valley, and some of its dynamic character can be attributed to this relationship.

The Green River Lowland occurs as a narrow belt of low relief topography to the southeast of the Rock River Hill Country. Most of the Green River Lowland is developed on glacial outwash, although locally bedrock highs protrude through the drift. None of the current streams, however, are controlled in position by the bedrock highs. The Green River Lowland is currently drained by two streams, Green River in the south, and the upper course of Kyte River in the north. The divide between the two is ill-defined.

The larger portion of the study area lies in the Bloomington Ridged Plain, a district which is characterized by broad, rolling morainic ridges with intervening wide stretches of relatively flat ground moraine and outwash plain. Three distinct end moraines occur in the study area portion of the district, the Bloomington, Arlington-Elburn, and Farm Ridge Moraines (Figure 2). The Bloomington Moraine is the largest of the three and forms the principal drainage divide in the region. Crest elevations on the Bloomington moraine generally exceed 950 feet and rise 250 to 300 feet above the Green River Lowland. The Arlington-Elburn Moraine lies to the southeast of the Bloomington Moraine, and, except at the center of the area where it locally overrides the back portion of the Bloomington moraine, is separated from it by a distinct ground moraine lowland. The highest portions of the Arlington-Elburn Moraine rise to elevations in excess of 950 feet, although its crest common-

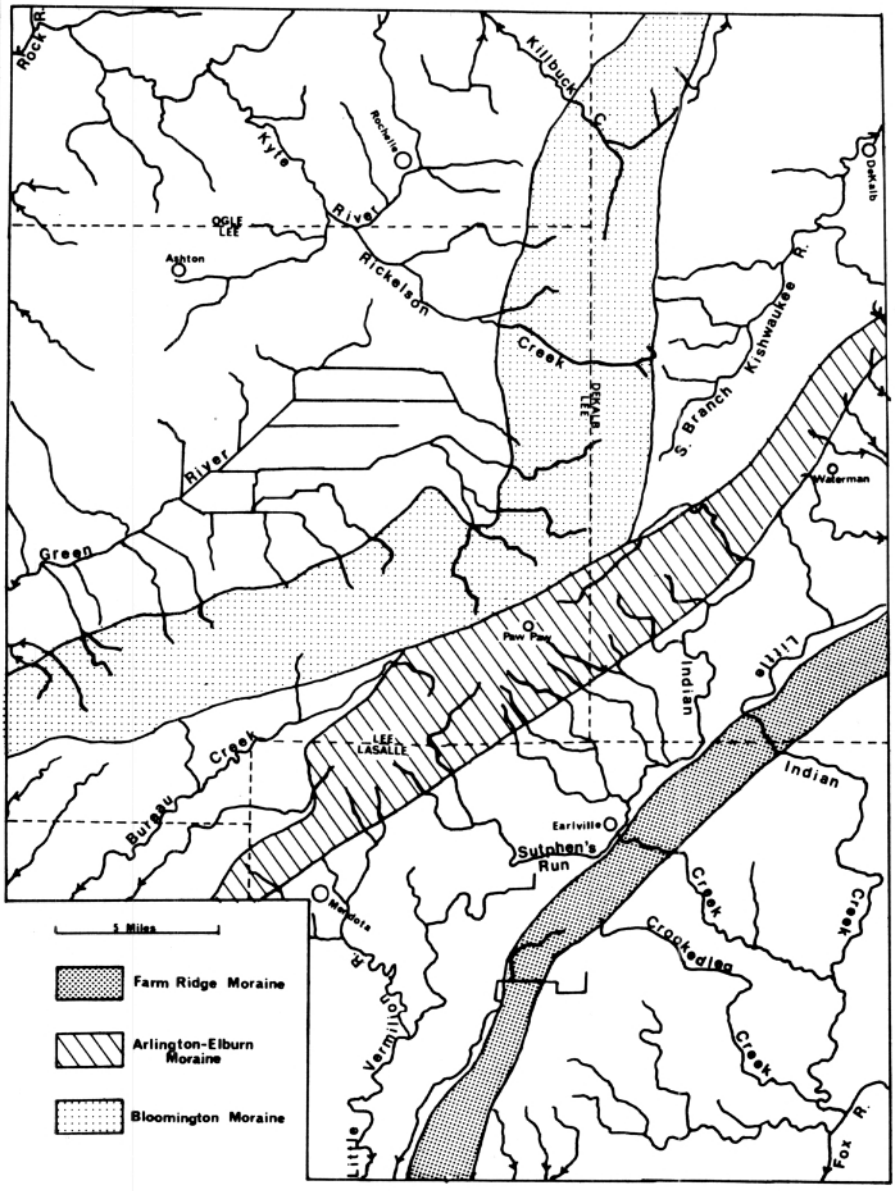

FIGURE 2. Present-day drainage system.

ly is less than 900 feet. The third moraine, the Farm Ridge, is the lowest and least distinct of the three, rising only 25 to 50 feet above the adjacent lowlands.

Each of the three moraines marks the outer limits of separate glacial ice advances into the region from the southeast. The limits of the moraines are mappable on the basis of their distinct till compositions. In age, the Bloomington Moraine is the oldest and the Farm Ridge Moraine the youngest. All three moraines are of Wisconsinan (Woodfordian) age.

There are four distinct lowlands separating the three moraines. Between the Bloomington and Arlington-Elburn Moraines are two lowlands separated by a high divide at the position of the overriding of the Arlington-Elburn Moraine on the Bloomington Moraine (Figure 2). To the north lies the DeKalb Basin, which is drained by South Branch of Kishwaukee River, and to the south lies the Bureau Creek Lowland, which is drained by Bureau Creek. The lowland separating the Arlington-Elburn and Farm Ridge Moraines is the Mendota Lowland. It is currently drained by portions of several drainage systems, the major streams of which are Little Vermilion River, Indian Creek, Little Indian Creek, Somonauk Creek, Big Rock Creek, and Little Rock Creek. The lowland to the southeast of the Farm Ridge moraine is the Fox River Lowland. It is drained by portions of the same drainage systems as the Mendota Lowland, with the exception of the Little Vermilion River system.

Relief in the lowland regions is very small. Values of 10 feet per square mile are not uncommon. Correspondingly, stream segments within the lowland regions tend to have very low gradients, and before settlement extensive swampy areas occurred in these lowlands. Currently, most of these swamps have been drained by the installation of field tile and the artificial entrenchment and straightening of the stream channels. As a result, all the lowland streams, although they continue to have low gradients, have higher gradients than in their original state.

Recognition of Stream Piracy

Several criteria allow the recognition of stream piracy. Foremost of these in the study area is the occurrence of drainage contrary to the region slope. Indian Creek (Figure 2) serves as an example. At two positions Indian Creek flows through moraines, the Farm Ridge and Arlington-Elburn, from the front side of the moraines to the back. In both cases the height of land occurs at the crest of the moraine and Indian Creek in its segments between the crest and the front of the moraine flows up the regional slope. Furthermore, in both cases Indian Creek diverges from lowlands in front of the moraines to pursue its course through the moraines.

Piracy can generally further be recognized if an "elbow of piracy" exists (Lander, 1968, p. 1055). Most commonly a pirating stream intercepts its competitor at right angles. After diversion occurs the point of interception is marked by a right angle bend in the new extended stream, termed the "elbow of piracy."

A third criterion is the presence of an abandoned valley segment crossing a narrow divide between streams (Thornbury, 1969, p. 149), particularly when it occurs in conjunction with an elbow of piracy. If the piracy has occurred recently such that post-piracy has not effaced the abandoned valley segment, this is the most convincing of the evidences for piracy. Fortunately in the study area most of the stream piracy has occurred sufficiently recently that abandoned valleys now forming divides are common.

Occasionally after piracy a small segment of the low gradient stream downstream from the point of interception will reverse its flow and join the drainage of the high gradient stream. In such a case the new divide between the pirating and pirated streams will be formed on the low gradient stream below the actual point of interception at the point where reversal of drainage occurred. Evidence of reversal of drainage is obtained where tributary streams join a main stream at an obtuse rather than the normal acute angle. This is referred to as "barbed drainage" (Thornbury, 1969, p. 120), and at least one good example occurs in the study area.

Indian Creek Piracy

Within the Bloomington Ridged Plain most of the major streams follow courses along the fronts of moraines. This is a relic condition dating from glacial times when the channels were originally formed by meltwaters gathering at the ice margin and flowing longitudinally along the moraine front. With the retreat of the glaciers, these channels remained to form the trunk streams of the post-glaciar drainage system.

Indian Creek and its principal tribuatry, Little Indian Creek, flow contrary to this pattern (Figure 2). Indian Creek rises in front of the Arlington-Elburn Moraine near the village of Paw Paw in eastern Lee County and flows northeastward along the front of the moraine in a normal position for six miles. South of Shabbona in DeKalb County, however, it executes a right angle bend and passes through the moraine in a valley as much as 60 feet deep. Once through the moraine it again makes a right angle bend and flows southwestward in an open valley, eventually crossing the ground moraine basin of the Mendota Lowland until it occupies a moraine front position along the Farm Ridge Moraine. At Earlville in La Salle County it once more makes a right angle bend and passes through the Farm Ridge Moraine in a narrow-walled valley 50 feet deep. Beyond the Farm Ridge Moraine, Indian Creek crosses the Fox River Lowland in a normal fashion until entering the Fox River at Wedron in La Salle County.

Little Indian Creek displays a similar anomaly in the regional drainage pattern by likewise crossing through a moraine. Little Indian Creek rises on the backside of the Arlington-Elburn Moraine southwest of Waterman in DeKalb County. From its head, it crosses the Mendota Lowland to occupy a normal moraine front position along the Farm Ridge Moraine. Northeast of Leland, however, it makes a right angle bend and passes through the

Farm Ridge Moraine. The two right angle bends of Indian Creek and the right angle bend of Little Indian Creek are elbows of piracy.

The anomalous cross - moraine drainage patterns of Indian and Little Indian Creeks are the result of three separate stream piracies (Figures 2-4), the sequence of which can be re-established on the basis of the topographic clarity of the piracy evidences. Initially, in immediate post-glacial times, the north-flowing South Branch of Kishwaukee River drained the bench region at the juncture of the Bloomington and Arlington-Elburn Moraines, and the long, narrow, moraine-confined Mendota Lowland was drained by an extended south-flowing Little Vermilion River (Figure 3). Gradients of both of these streams in their original state were probably very low. The drop in elevation along the extended South Branch of Kishwaukee River in a six-mile straight-line course from near Paw Paw to south of Shabbona was only 5 feet. The drop in elevation along the extended Little Vermilion River in the 16-mile straight-line distance from the head of the current Little Indian Creek to the divide between Sutphen's Run and the headwaters of the Little Vermilion system was 25 feet. Allowing for some irregularities in the channel courses due to meandering, as well as some recent downcutting, both of these streams therefore probably originally had gradients of less than one foot per mile.

The first piracy occurred when a tributary to the extended Little Vermilion River worked its way headward through the Arlington-Elburn Moraine south of Shabbona in DeKalb County and intercepted the upper portion of South Branch of Kishwaukee River at position (1) on Figure 3. Reconstruction of the original slope on the backside of the Arlington-Elburn Moraine indicates that the headward advancing tributary had a gradient of approximately 40 feet per mile, contrasting sharply with the less than one foot per mile gradient of the South Branch of the Kishwaukee River. This diversion probably occurred shortly after the establishment of the original drainage, as the divide between Indian Creek and South Branch of Kishwaukee River at this point is currently 40 feet above Indian Creek, indicating an extended period of downcutting on the part of Indian Creek since diversion.

The second diversion occurred when Little Indian Creek eroded headward past the crest of the Farm Ridge Moraine and intercepted the Little Vermilion River at position (2) on Figure 3. The new divide was found immediately downstream on the pirated stream. It is currently marked by a broad mile-and-a-half long abandoned channel, the floor of which is 5 to 8 feet above the level of the present two streams.

The third diversion was the largest of the three. It occurred when the original Indian Creek cut headward through the Farm Ridge Moraine east of Earlville (position (3) on Figure 3) and captured approximately 110 square miles of drainage area which previously had been part of the extended Little Vermilion system. A conceptual view of this piracy is shown on Figure 4. Unlike the two earlier diversions, the divide between the pirating and pirated

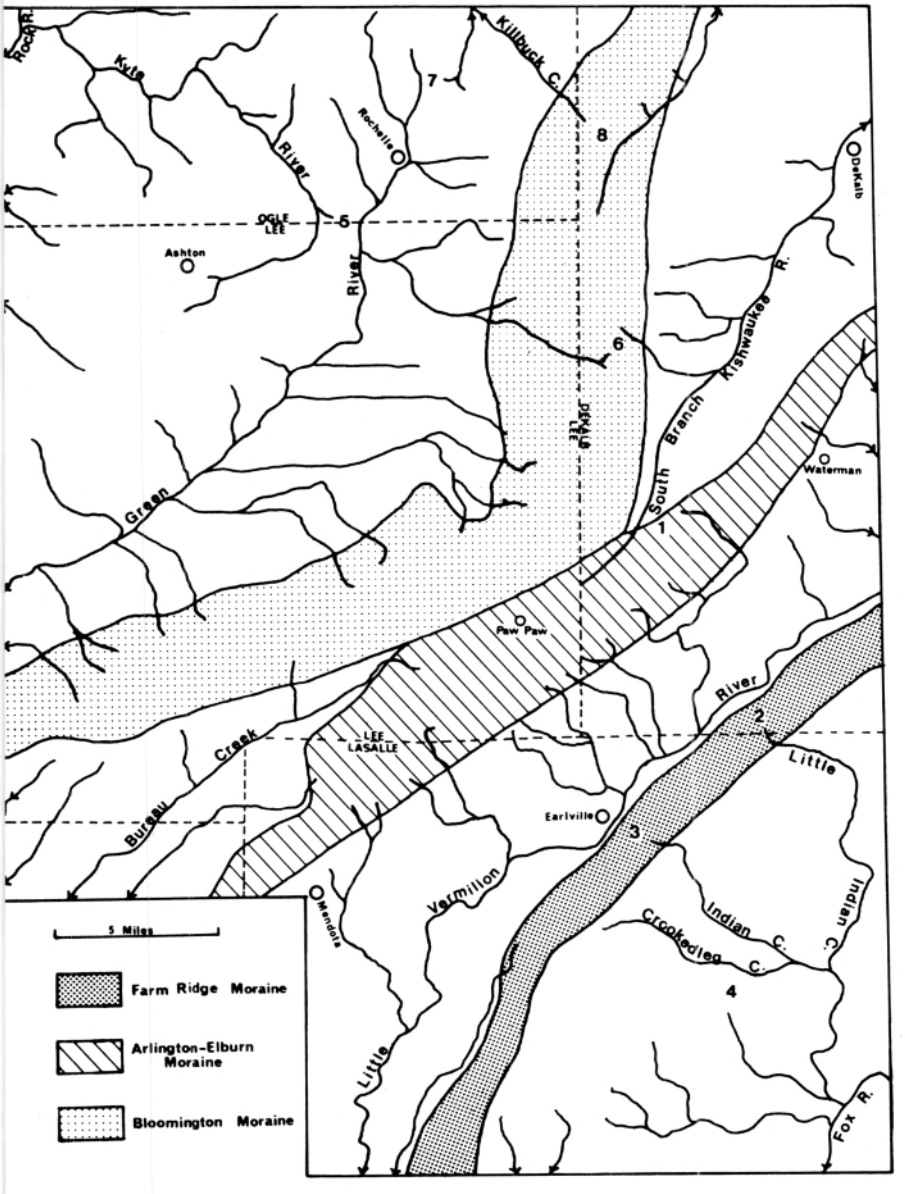

FIGURE 3. Reconstructed post-glacial drainage system.

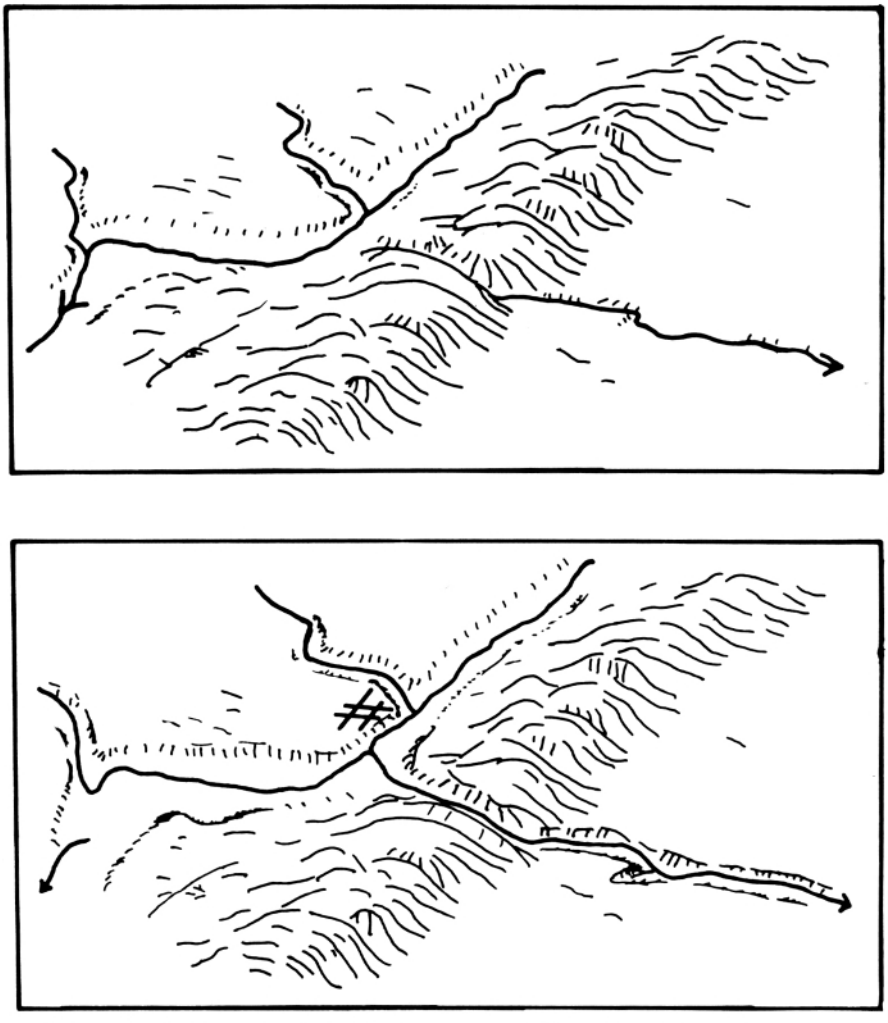

FIGURE 4. Progression of stream piracy at Earlville. Top: before piracy; bottom: after piracy.

streams did not develop at the point of interception. Rather, the divide formed downstream on the pirated stream, causing the intervening stretch of the river (Sutphen's Run) to reverse its flow. The recentness of this diversion is witnessed by the hairpin, barbed turn in Sutphen's Run and the freshness of the abandoned valley which forms the divide between Sutphen's Run and the headwaters of the Little Vermilion system. The highest portion of this divide is currently less than 5 feet above the level of the two streams.

At the present time the average

valley gradient, exclusive of streams meanders, along the Little Vermilion system from the divide south of Sutphen's Run to its mouth on the Illinois River is 9.6 feet per mile. This compares well with the average valley gradient of Indian Creek, which from the same divide to its mouth on the Fox River is 9.8 feet per mile, and suggests that equilibrium between the two competing systems has now been attained.

A fourth, and somewhat unusual case of stream piracy has recently occurred on a small tributary to Indian Creek, Crookedleg Creek. Crookedleg Creek formerly flowed into Indian Creek above its confluence with Little Indian Creek (Figure 3). Another tributary to Indian Creek has cut headward across the Fox River Lowland and diverted Crookedleg Creek two miles above its former mouth into a new channel to the south (Figure 2). A prominent abandoned valley connecting Crookedleg and Indian Creeks at the elbow of piracy marks the former course of Crookedleg Creek.

Kyte River Piracy

The majority of streams in the Rock River Hill Country district are cut into the thinly covered bedrock of the district. An exception occurs with Kyte River. In pre-glacial times an eastward flowing stream drained the region now drained by the westward flowing Kyte. This valley became blocked with glacial drift, probably during the early Wisconsinan ice advances. With the retreat of the ice, Kyte River became established into the soft glacial fill of the old valley, and rapidly extended itself headward toward the Green River Lowland. Currently the gradient of Kyte River in its segment within the Rock River Hill Country is 7.31 feet per mile.

The initial drainage in the Green River Lowland entered the Green River, which then extended northward beyond Rochelle (Figure 3). Green River originated during the Bloomington Glaciation when it served to transport meltwater longitudinally along the outwash plain which was developing in front of the Bloomington Moraine. Consequently then, as now, Green River had a low gradient. Since settlement most of Green River has been canalized and artificially straightened to assist drainage for agricultural purposes, and its present gradient is therefore steeper than in its natural state. Nevertheless, Green River still has an average gradient over its 115 straight-line course of less than 1.5 feet per mile.

The more dynamic Kyte River intercepted the Green River at a point south of Rochelle along the Lee-Ogle County Line, forming an elbow of piracy and diverting approximately 82 square miles of the headwaters of Green River. Both the height of this divide, which today is about ten feet above the two streams, and the rounding of the elbow of piracy, suggest that the diversion occurred fairly early in post-glacial times.

Other Piracy Cases

Several lesser cases of stream piracy also occur in the study area. These are represented by positions (6), (7), and (8) on Figure 3. At

position (6), Rickelson Creek, currently a tributary to Kyte River but formerly a tributary to Green River, has eroded headward through the Bloomington Moraine to capture several small eastward-flowing former tributaries to South Branch of Kishwaukee River. The headwaters of Rickelson Creek currently drain as much as 2 miles east from the crest axis of the Bloomington Moraine.

At position (7), a tributary to north-flowing Killbuck Creek has captured a part of the former southward-flowing Green River drainage, and at position (8), Killbuck Creek has captured a segment of Owen's Creek which formerly flowed through a low portion of the backside of the Bloomington Moraine. The divide between Killbuck and Owens Creeks is also marked by a low, abandoned valley.

Future Piracies

Barring man's intrevention, several additional cases of stream piracy are imminent in the study area. The foremost of these is the impending capture of the headwaters of Indian Creek northeast of Paw Paw by one or more of the tributaries to Indian Creek which drain directly off the back of the Arlington-Elburn Moraine (Figure 2). Currently two of these tributaries, which have gradients in excess of 100 feet per mile near their heads, approach within ½ mile of the main Indian Creek channel.

In the vicinity of Waterman and northeast (Figure 2), Somonauk, Little Rock, and Big Rock Creeks are currently extending themselves headward through the Arlington- Elburn Moraine and will eventually intercept and capture a portion of South Branch of Kishwaukee River. On the west side of the DeKalb Basin, Rickelson and Killbuck Creeks may also be expected to continue the attrition of the drainage of the Kishwaukee system as they erode headward through the Bloomington Moraine.

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