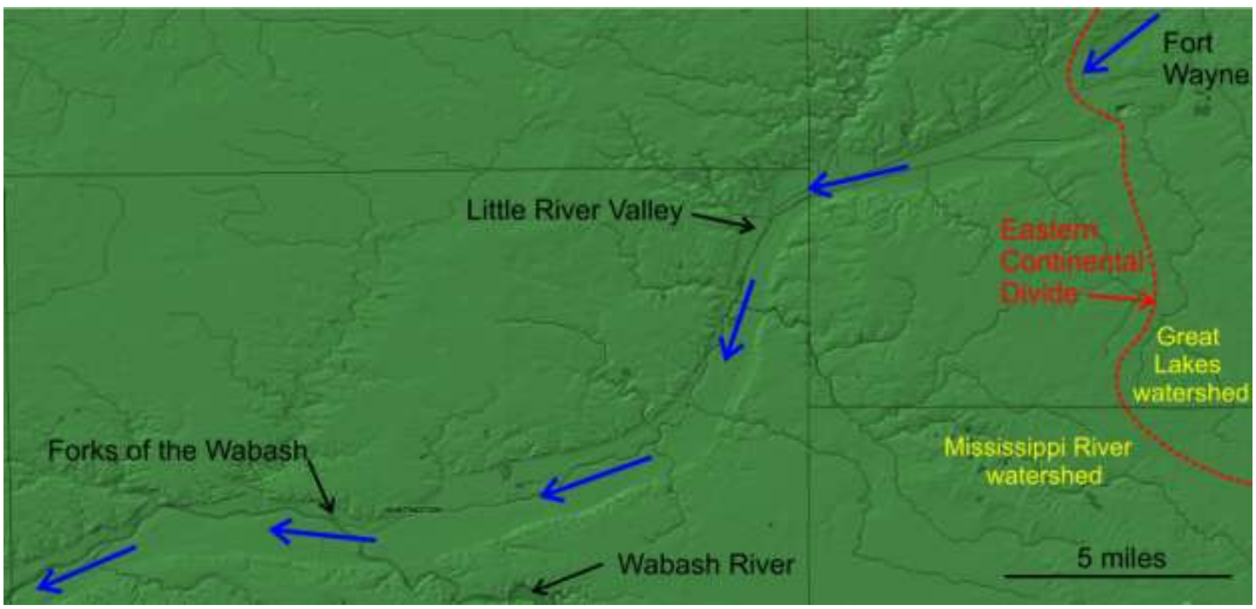
**GEOLOGY OF THE LITTLE RIVER VALLEY**
**Geography**
The Little River Valley is one of the most striking physiographic features in the eastern Great Lakes. The valley extends about 24 miles from the west bank of the St. Marys River in Fort Wayne to the forks of the Wabash River, just west of the City of Huntington. Its name derives from the fact that the 'Little' River is the smaller of the two forks of the modern Wabash River, but from a geological perspective, this is somewhat misleading. Though the Little River is indeed a small stream, it occupies a massive, glacially-cut sluiceway known to geologists as the Wabash-Erie Channel, whose scale dwarfs the valley occupied by the 'main' fork of the Wabash River many times over. From the air, the Wabash-Erie Channel resembles a huge scar on the landscape, extending southwestward for about 30 miles from the western apex of the Maumee Lake Plain, through downtown Fort Wayne and southwest Allen County, to the confluence with the main stem of the Wabash River at the forks. The eastern continental drainage divide, which separates the Great Lakes and Mississippi River drainages, crosses the channel just west of the St. Marys River. The Little River occupies that portion of the Wabash-Erie Channel west of the divide. In historical times, the floor of the Little River Valley was dubbed "The Great Marsh" because it comprised a vast wetland complex covering some 25,000 acres.



*On this digital elevation model, the Wabash-Erie Channel stands out as a deep, broad trough running between Fort Wayne and Huntington. The blue arrows signify the final, massive outburst of glacial meltwater that carved the valley into its present form, as described later in this narrative.*

Near the St Marys River, the valley has 2 distinct, sub-parallel segments: 1) the wide, north channel, which includes Eagle Marsh, is sometimes referred to as the Fort Wayne Outlet, because it forms the head of the Wabash-Erie Channel at the Maumee Lake Plain; 2) the narrower southern segment originates at the St Marys River near Waynedale. The two segments are separated by the rolling, sandy upland historically known as the Sand Point, and by a smaller upland just to the west of that, known as Midway Island. The two channel segments gradually coalesce in the vicinity of Fox Island, and continue downstream as one broad channel to Huntington.

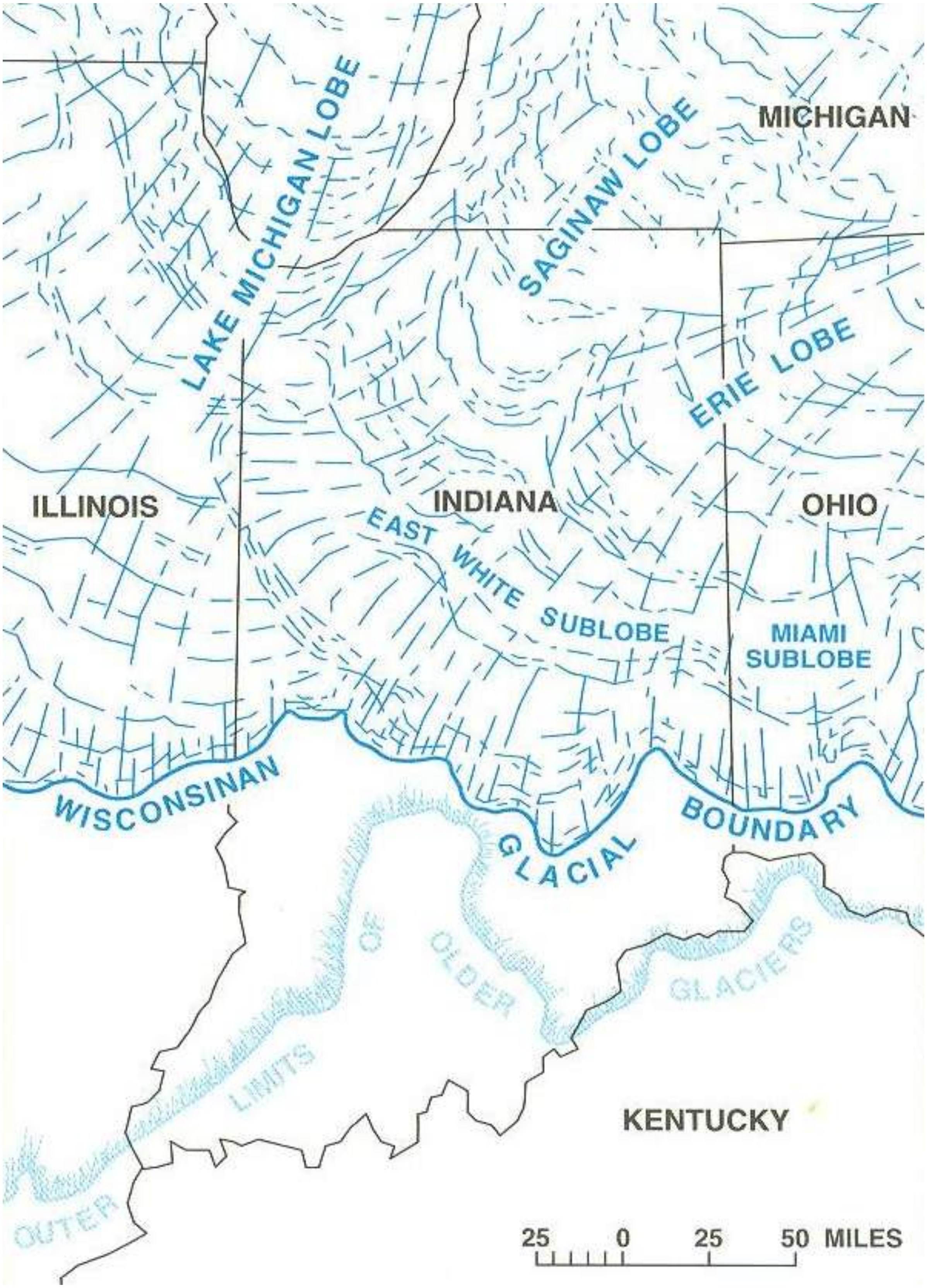
One of the first things the attentive visitor notices is the absence of any large stream commensurate with the broad, flat valley bottom, which is up to 2 ½ miles wide and lies between 75 and 125 feet lower than the adjacent uplands. This is the quintessential example of what geologists call an "underfit" valley: the modern stream within it (the Little River) is miniscule in comparison to the size of the valley, meaning that the valley must have been cut by a vastly larger river that existed in the geologic past but not today. Such a relationship implies a complex geologic history characterized by dramatic, even catastrophic, events. As it turns out, the geologic story of the valley is a fascinating tale with many twists and turns, involving enormous discharges of icy meltwater, constantly shifting drainages, and the repeated filling and exhumation of the valley with sediment over time. These events ushered in a remarkable series of rapid (by geologic standards) environmental changes, which explain why the Little River Valley possesses such a distinctive and ecologically valuable natural environment. In fact, it would be accurate to say that the ecological significance and the rich human history of the Great Marsh are both indelibly linked to the geological evolution of the valley.

**Origin and Geologic History**

***Earliest Events:*** The Little River Valley owes its current form to geologic events that occurred within a several-thousand-year span of time during and shortly after the close of the Pleistocene, or Ice Age—in other words, it is a relatively recent feature on the vast geologic time scale—but the geologic record beneath the valley extends back some 400 million years or more.

Continental glaciers first entered Indiana more than 780,000 years ago, but the record of these early ice sheets is extremely fragmentary because each succeeding glaciation tended to remove the deposits left by earlier ones. Long interglacial periods characterized by temperate climates and much weathering and erosion also aided this process. As a result, all of the glacial deposits and associated landforms in and around the Little River Valley date from the most recent period of glacial activity, which is known as the Late Wisconsin Stage.

***Late Wisconsin Glaciation:*** Late Wisconsin glaciers first entered northeastern Indiana about 22,000 ybp (years before present) and continued to affect the region until about 14,000 ybp, when the ice sheet withdrew into Ohio. The part of the ice sheet that affected the Little River Valley is called the Erie Lobe, because the ice flowed down the axis of the Lake Erie basin and entered the area from the east.



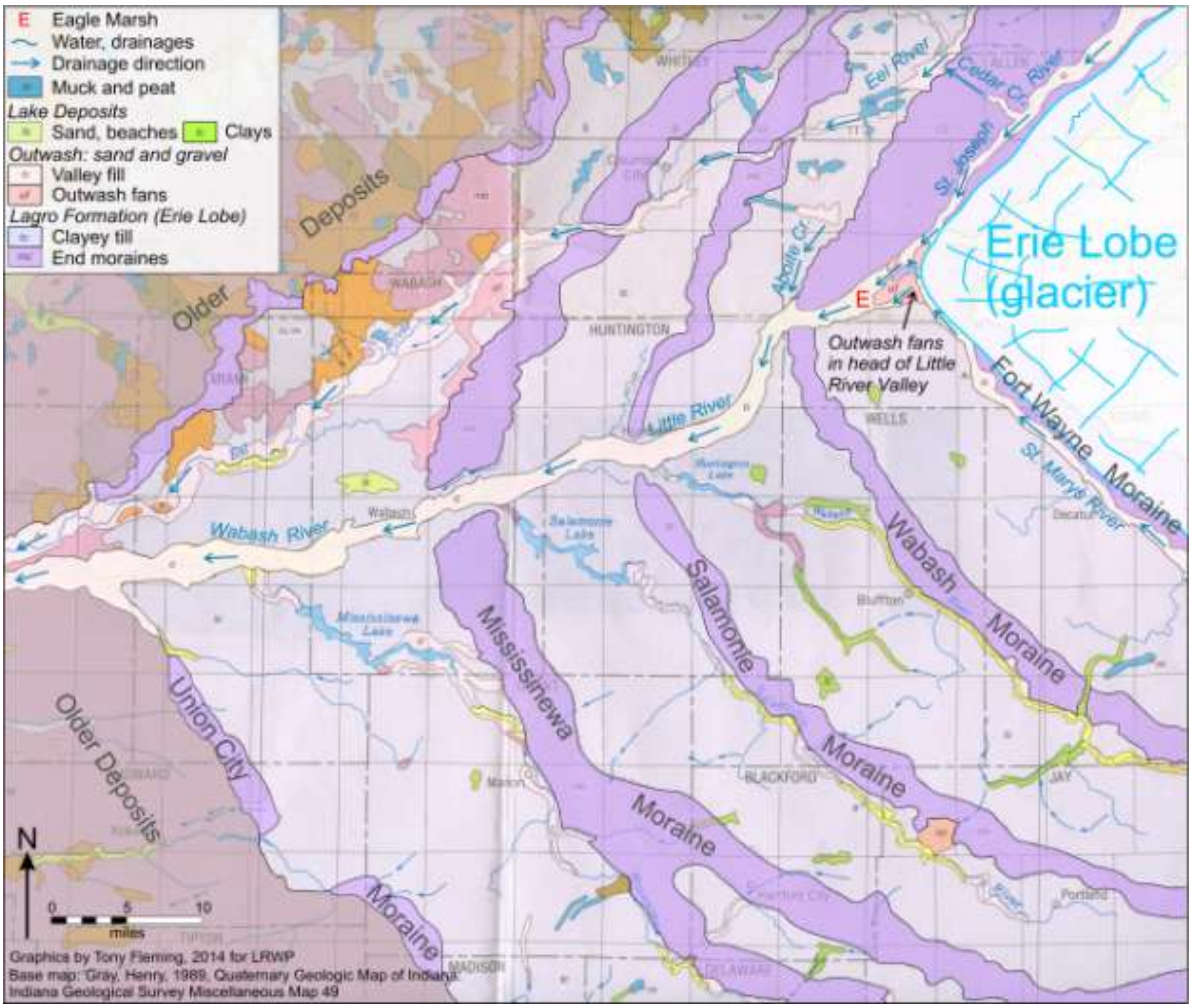

*Late Wisconsin ice lobes in Indiana. Diagram courtesy of the Indiana Geological Survey.*

Two major episodes of Erie Lobe glaciation are recognized in the Late Wisconsin deposits in the vicinity of the Little River Valley. During the first of these, the ice sheet advanced as far as south-central Indiana and eastern Illinois before slowly receding. This episode produced the hard, stony tills and associated sand and gravel units known as the Trafalgar Formation, which occupy a large part of the surface of central Indiana and occur throughout Allen County in the subsurface. These deposits occur beneath the floor of the Wabash-Erie Channel at many places.

About 17,000 ybp, the Erie Lobe receded back into the eastern Great Lakes, allowing a large glacial lake to form in front of the ice margin. This period is called the Erie Interstadial, and significant amounts of silt and clay accumulated throughout the basin of the interstadial lake. When the Erie Lobe subsequently readvanced towards Indiana during the second episode of glaciation, the ice sheet incorporated a large volume of the silt and clay into its sediment load as it overrode the lake bed. The result is the distinctive series of clay-rich glacial tills—known in Indiana as the Lagro Formation—that cover most of the northeast part of the state, and are the primary soil-forming material on uplands. At its maximum extent, this second glacier reached as far south as Muncie and as far west as Logansport. The ice margin receded slowly back towards the Erie basin, its retreat punctuated by the series of 5 looping end moraines that encircle northeast Indiana: the Union City, Mississinewa, Salamonie, Wabash, and Fort Wayne Moraines. The age of the Lagro Formation in Indiana is thought to be between 16,000 and 14,000 years. The clayey till from this latest event is not present in the bottom of the Little River Valley, because of later erosion, but it does comprise most of the valley walls and adjacent uplands. The uplands that bound the north side of the Little River Valley from Aboite Creek to Fort Wayne, and which make up a large part of its watershed, are historically referred to as the Wabash "Moraine", but in fact, this massive landform consists of a stack of multiple end moraines and related ice-marginal drainages that reveal an interesting history of ice margin retreat and drainage evolution in that area.

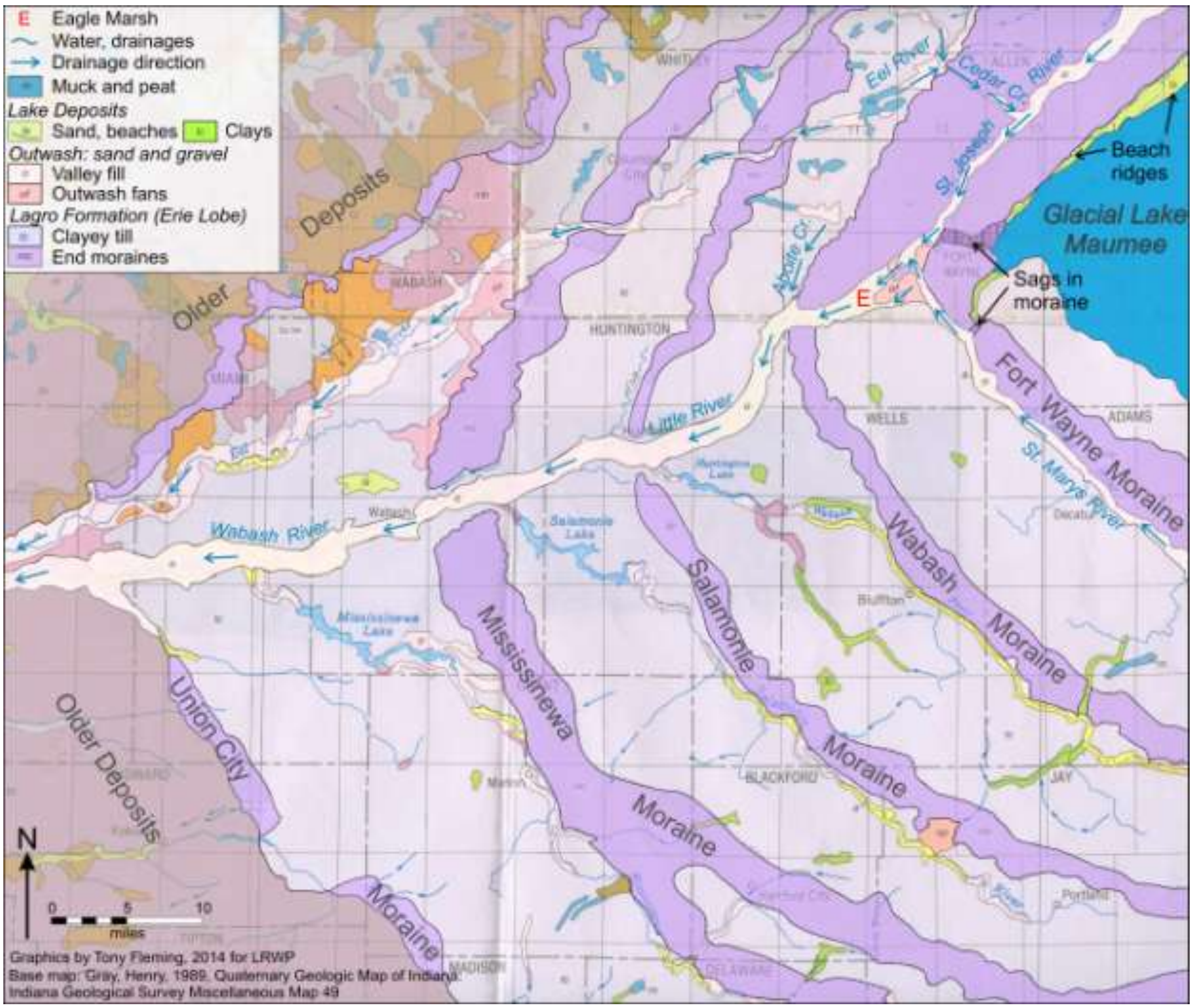
*Stony, hard, loam-textured till of the Trafalgar Formation (left) is present at shallow depth beneath parts of the Wabash-Erie Channel, particularly in the Fort Wayne Outlet section. Clayey till of the Lagro Formation (right) is the dominant material beneath the adjacent uplands. The high clay content commonly imparts a gray, waxy appearance, which contrasts sharply with the underlying sand and gravel seen in the photo. Photos by Tony Fleming.*

Geologic evidence obtained in the subsurface of southwestern Allen County and further downstream in the Wabash Valley suggests that a major west-bound drainage existed in the vicinity of the Little River Valley throughout the Late Wisconsin Stage. At times, the drainage took the form of a major, subaerial sluiceway draining away from the ice margin, but at other times, it appears to have consisted of one or more large, ice-walled channels within the ice sheet—in other words, streams that were bounded by walls of ice hundreds of feet high, and which acted as a sort of internal plumbing system within the glacier. In any event, by the time the Erie Lobe began to retreat from Indiana, the stage was set for a remarkable series of events that would shape the Little River Valley into one of the most unique and history-rich natural areas in the state, and which continue to influence many aspects of modern life in the 'Summit City'. The following series of diagrams illustrate the major events that shaped the landscape in and near the Little River Valley following the retreat of the Erie Lobe from northeastern Indiana.



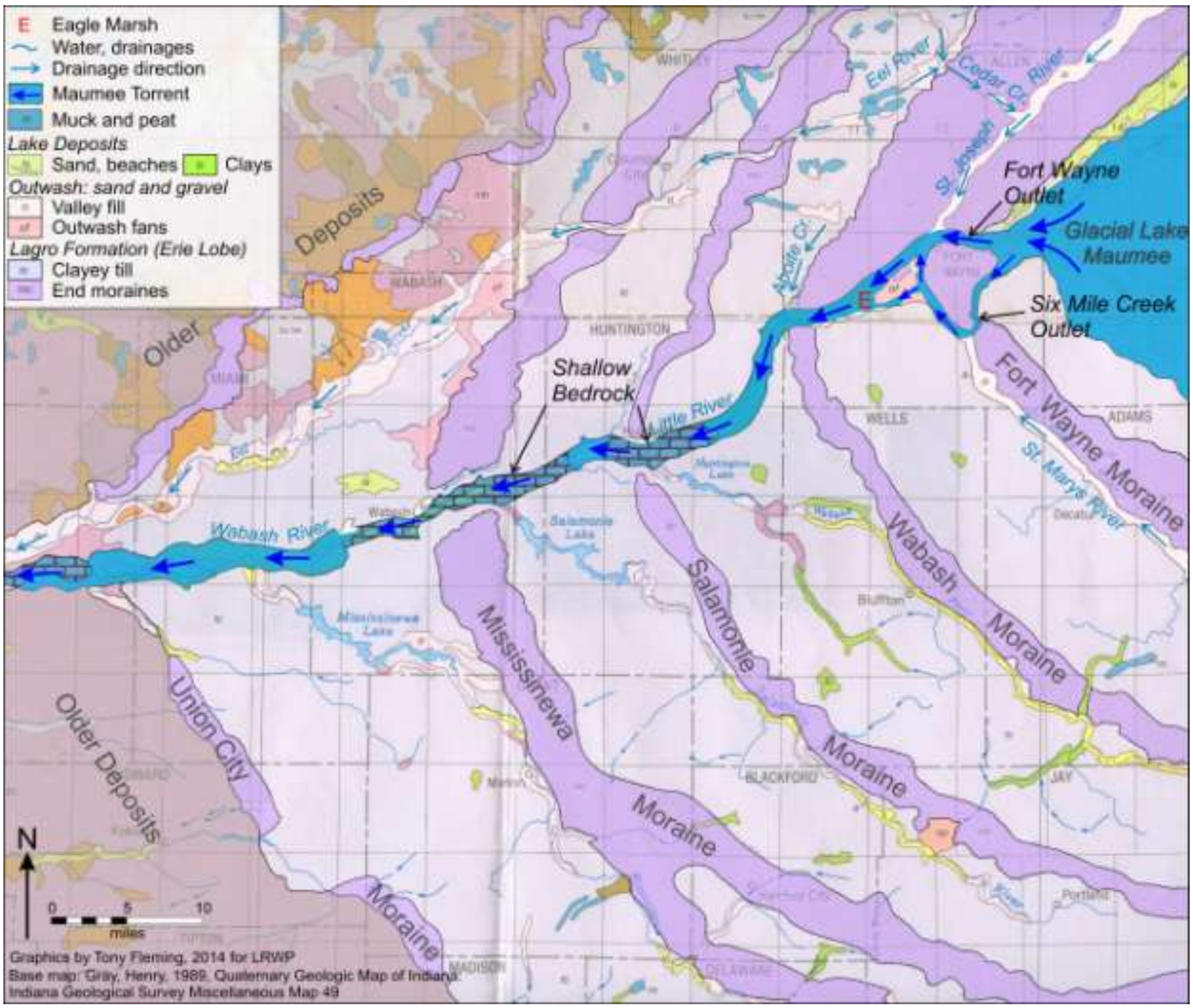

***The Fort Wayne Moraine and Early Little River Drainage:*** The Little River Valley was well established as a major glacial sluiceway by the time the Erie Lobe retreated to Fort Wayne, about 14,500-15,000 ybp. The Fort Wayne Moraine is the innermost moraine of the series, and forms the rolling uplands inboard of the St. Marys and St. Joseph Rivers. These two rivers originated as ice-marginal channels that drained meltwater emanating from the melting ice front; together, they outline the arcuate shape of the terminus of the Erie Lobe as it stood at Fort Wayne. During this time, drainage was southwest, directly down the Little River Valley. In other words, the St. Marys and St. Joseph Rivers were part of the Wabash River drainage, a relationship marked today by terraces of sand and gravel that hang on the walls of the Little River Valley from Fort Wayne to Huntington and comprise small remnants of a much larger body of outwash that filled the valley, and which was later eroded away.

It was also during this period that the upland known as the "Sand Point" formed: most of this upland is a series of outwash fans — landforms analogous to alluvial fans and composed of sand and gravel — deposited in the head of the Little River Valley by meltwater issuing from the ice front. The outwash fans may have extended completely across the head of the Little River Valley, but later erosion by meltwater stripped away most of the fans, leaving only a fragmental record from which we can piece together the rather complicated history of the ancestral St. Marys River as the ice margin oscillated back and forth across this area. We can also infer that the Little River Valley had begun to differentiate into north and south channels by this time, with the Sand Point lying between them.




***Glacial Lake Maumee:*** The Erie Lobe subsequently retreated back into the Lake Erie basin, and a large glacial lake formed between the retreating ice front and the recently-deposited Fort Wayne Moraine, which acted like a dam to impound the lake. At times, Glacial Lake Maumee may have held a volume of water comparable to or even greater than modern Lake Erie. Major beach ridges that parallel Indiana State Highway 37 northeast of Fort Wayne mark high stands of the lake, at about 780-800 feet above sea level. Glacial Lake Maumee and its successor lakes had several stages that coincided with the waxing and waning of the ice sheet and the opening and closing of different outlets; the history of these early forerunners of Lake Erie is a fascinating story (see "The History of Lake Erie" by Michael Hansen, in the Fall, 1989 Ohio Geology Newsletter, at http://www.dnr.state.oh.us/Portals/10/pdf/newsletter/Fall89.pdf).

While Glacial Lake Maumee slowly grew in size behind the Fort Wayne Moraine, the St. Joseph and St. Marys Rivers continued to drain southwest to the Wabash River via the Little River Valley. The Little River was not so little, and the valley bottom was characterized by an active alluvial environment of shifting sandbars, islands, floodplains, and river channels as the river reworked the outwash that had been left by earlier glacial meltwaters. The predominant vegetation on the more stable portions of the freshly deglaciated terrain was probably a spruce-alder-birch forest, punctuated by boreal wetland meadows on the active floodplains. Incidentally, it was during this time that Cedar Creek captured the drainage from the upper Eel River, an event which markedly increased the flow of the St. Joseph River and the volume of water it delivered to the Little River Valley.

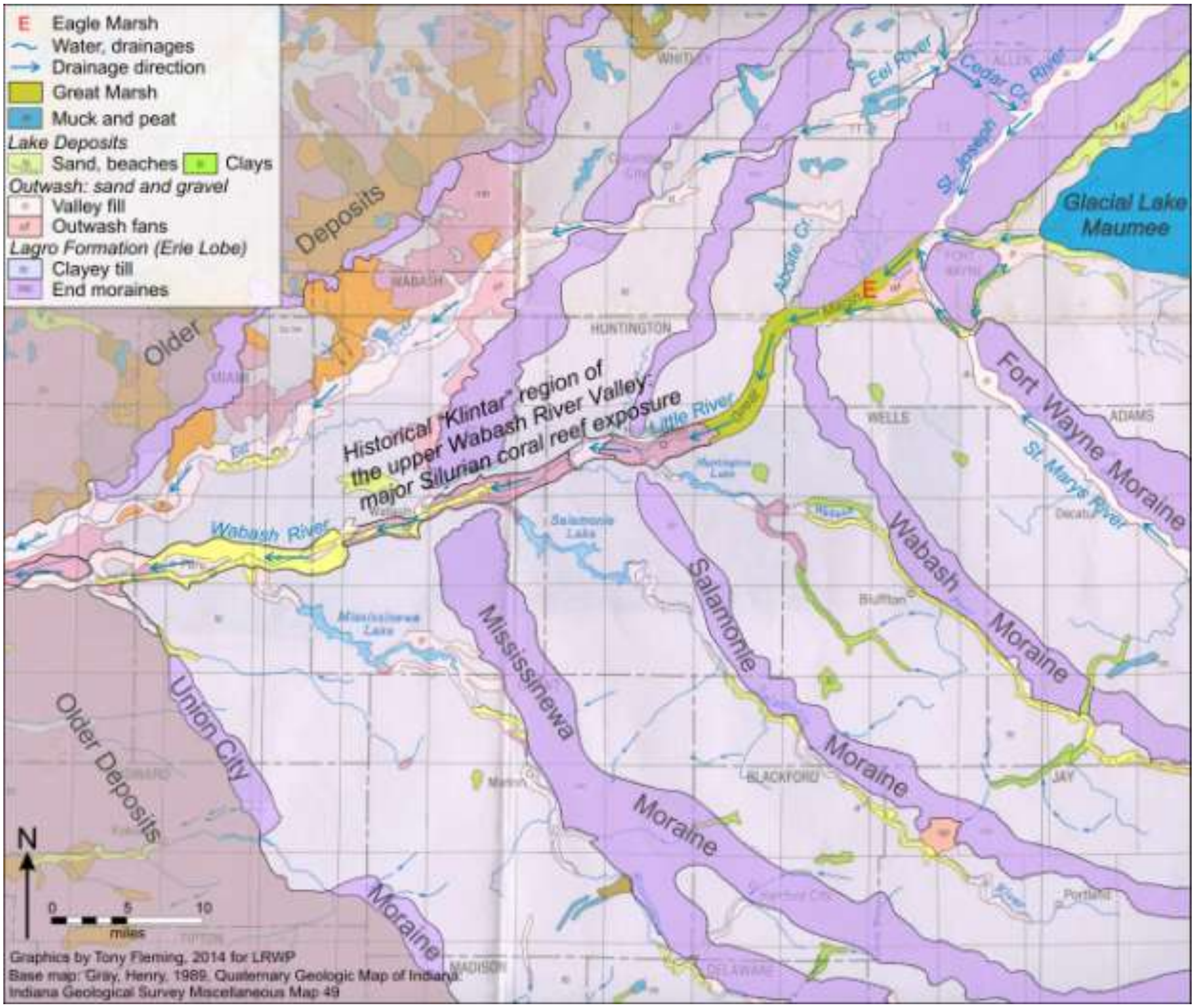



***The Maumee Torrent:*** Approximately 14,000 ybp, the surface of Lake Maumee reached its highest level at about 800 feet elevation. The waters overtopped a sag in the Fort Wayne Moraine near what is now downtown Fort Wayne and began draining westward down the Little River Valley. Any number of geologic processes could have triggered the final rise in lake level that caused it to overtop the moraine: an increase in the rate of glacial melting, the closing of another outlet further east, or east-to-west tilting of the lake basin due to differential rebound as the weight of the glacier was relieved are all possible causes, as is a minor readvance of the glacier further east in the basin. In any event, the soft, saturated till of the moraine was no match for the power of the water, which quickly eroded a large outlet, unleashing a flood of unimaginable proportions, commonly referred to as the

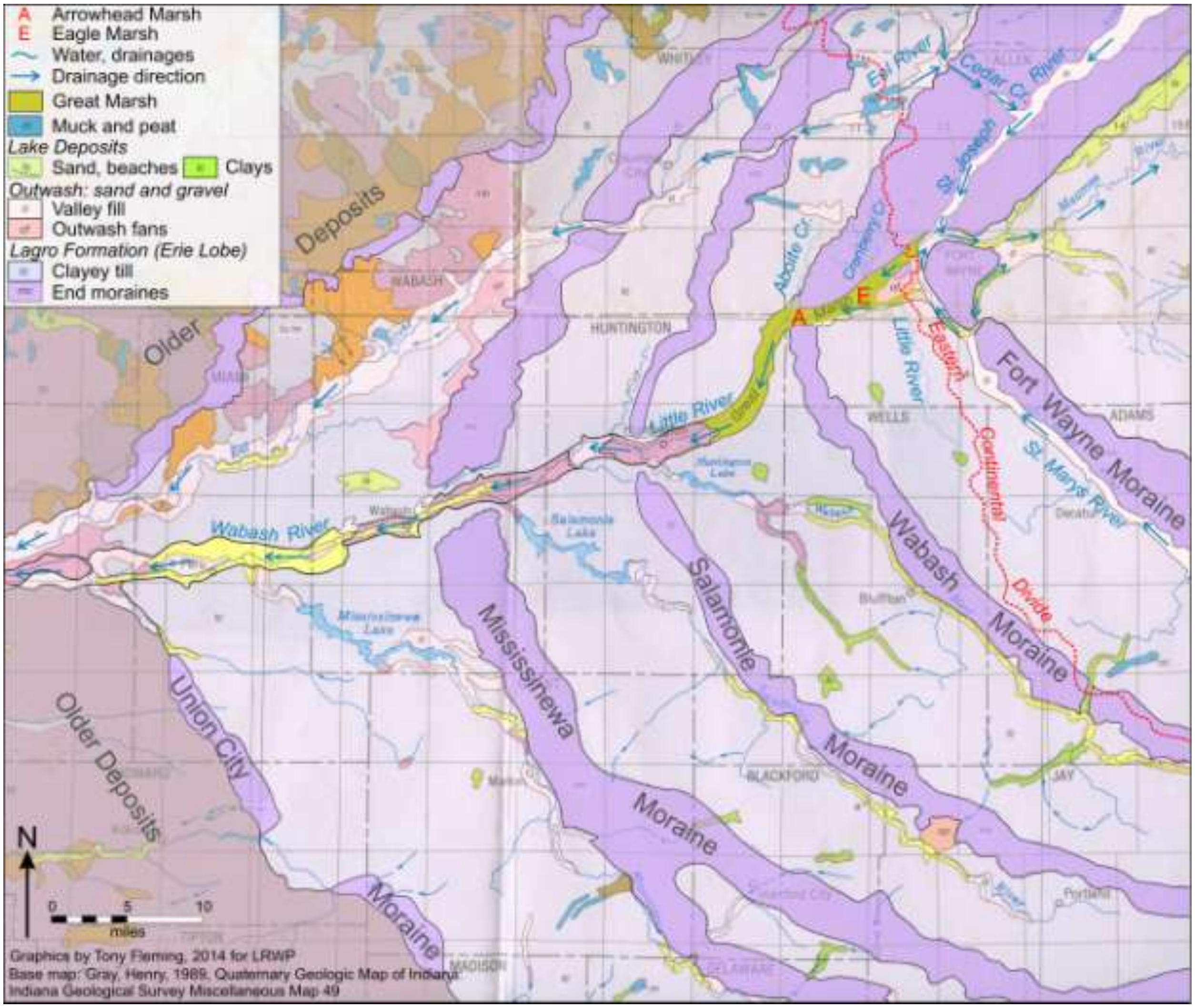
“Maumee Torrent”.  A secondary outlet also opened at the same time along what is now Six-Mile Creek, causing lake water to spill into the St. Marys River and thence down the south channel of the Little River Valley. A large part of Glacial Lake Maumee rushed down the Wabash-Erie Channel in a matter of days or weeks—billions of gallons of frigid water filled the channel from wall to wall and scoured the bottom clean. The force of the torrent was concentrated in the North Channel, or Fort Wayne Outlet, which was scoured down to some 20-30 feet below the present-day floor of the valley. In fact, the entire Little River Valley was severely scoured; the torrent stripped away nearly all of the earlier outwash and alluvial sediment, leaving the valley floored by a barren surface on the hard lower till, with scattered boulders littering the surface. Most of the large outwash fan deposited earlier in the head of the valley also was scoured away, leaving only the Sand Point itself and a few remnant gravelly terraces high on the valley walls to stand as mute testimony to the earlier alluvial environment. The impact of the torrent was felt tens, or even hundreds of miles downstream. Boulder gravels found along the Wabash River in Miami, Cass, and Carroll Counties, for example, exhibit sedimentary structures indicative of immense power.

This initial outburst only partially emptied Glacial Lake Maumee. There is abundant evidence, in the form of well-developed beach ridges in northwest Ohio, of a series of progressively lower lake levels. The existence of the ridges at lower elevations clearly indicates that some of the later and lower stages of Lake Maumee were sufficiently long lived to build up prominent beaches.

Shallow limestone bedrock underlying the Little River Valley in the vicinity of Huntington acted as a hard sill that ultimately limited the depth of scouring by the Maumee Torrent. In fact, the unique bedrock-walled gorge section of the upper Wabash Valley in Huntington and Wabash Counties, with its many spectacular coral reefs, owes its existence to the Maumee Torrent, which exhumed the bedrock from beneath tens of feet of glacial outwash. It is also possible that the outlet of Glacial Lake Maumee became hung up on the much harder, overconsolidated tills of the Trafalgar Formation, which are widely present at shallow depth along the modern river valleys in Fort Wayne.



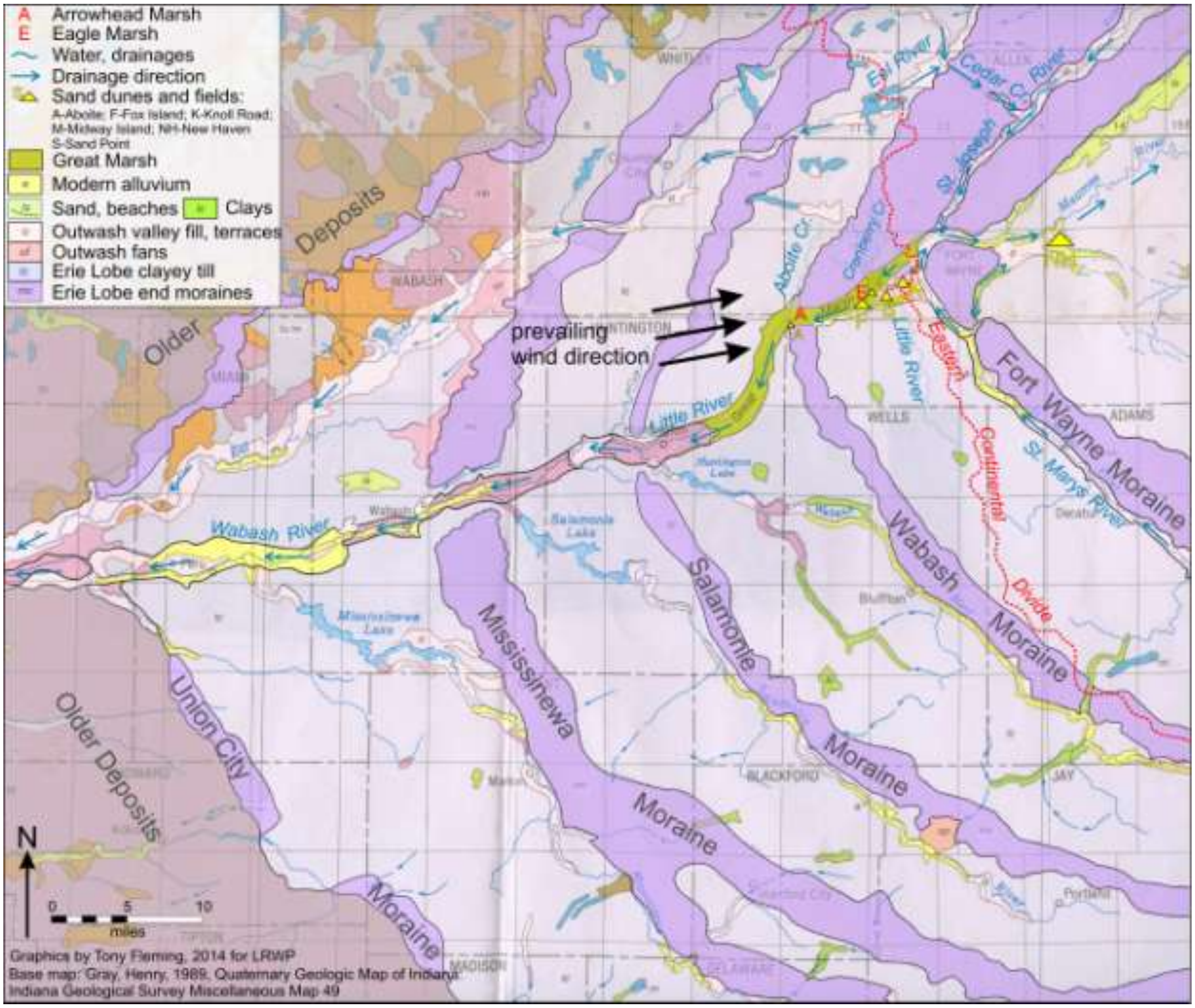

***The Great Marsh Begins:*** The Fort Wayne Outlet continued to act as the primary outlet for the lake for a period of time following the Maumee Torrent, though presumably at a much more moderate flow rate. The St. Joseph and St. Marys Rivers also continued to drain to the southwest, but now they flowed through a vastly altered Little River Valley, a nearly featureless, wide trough stripped clean of loose sediment and punctuated by shallow depressions where the torrent had scooped out softer areas in the underlying glacial sediment. In fact, it is entirely possible there could have been sizable potholes in this landscape, cut by giant boulders that became trapped in swirling eddies in the torrent. Any semblance of a typical river valley was gone, and the waters flowing through this strange landscape spread out over the bottom of the trough, forming irregular depressional lakes and occupying poorly integrated sloughs and channels. Currents were probably slight in this environment, hence sediment carried in by the rivers upstream quickly began filling in irregularities in the floor of the valley. Most of the sand probably fell out near the head of the valley, while silt and clay deposition dominated downstream. In this environment of small paludal lakes and sheet-like water flow, an incipient marsh began to develop. The climate was still relatively cold, at least in the beginning: after all, at 13,500 ybp, the ice front still stood only a couple of hundred miles north and east of Fort Wayne. No fossil pollen record has been recovered from the Great Marsh, but similar records from this period elsewhere in the eastern Great Lakes suggest that the region around the Little River would have been vegetated by species more characteristic of the far north today: boreal sedges and forbs in the marsh, and spruce-fir forest on adjacent uplands.




***Stream Piracy and the Rise of the Eastern Continental Divide:*** Continental glaciers finally receded back from the Great Lakes basin some 10,000 ybp, eventually allowing the St. Lawrence drainage to open eastward to the Atlantic Ocean. Glacial Lake Maumee was a thing of the past, its edges having receded eastward to a position even smaller than the modern shoreline of Lake Erie, and leaving behind a vast, flat lake plain in northwestern Ohio and far eastern Allen County. Sometime after the Great Marsh started to develop in the Little River Valley, the lower reaches of the Maumee River became established near its present mouth at Toledo. The river began to erode headward across the lake plain, eventually breaching the Fort Wayne outlet, where it ultimately "captured" the drainages of the St. Joseph and St. Marys Rivers in a classic act of stream piracy. The abrupt development (in terms of geologic time) of east-bound drainage associated with the Maumee River basically robbed the Little River Valley of the major part of its surface watershed, and left behind the low divide just west of the St Marys River; this divide is part of the much larger eastern continental divide that separates Great Lakes drainage from the Mississippi River-Gulf of Mexico watershed.

The exact timing of this signal event is poorly known—the piracy of the St. Joseph and St. Marys Rivers and the advent of the modern continental divide could, in theory, have occurred anytime between about 10,000 and 6,000 ybp—but it is clear that the floor of the upper Little River Valley had mostly filled in to its present level by the time the Maumee River arrived, because the elevation (750 feet) of the "3 rivers" confluence is only a few feet less than the highest point (757 feet) where the continental divide crosses the north channel. But regardless of the timing of this event, it ultimately led to a much-diminished flow of surface water in the channel, and the creation of a slackwater type of environment in which a few small streams meandered sluggishly through small oxbows and expansive wetlands. With the reduction in surface water input, the discharge of ground water became a significant source of water supporting the wetlands in the upper reaches of the Little River Valley in Allen County, and accumulation of organic sediment (peat and muck) became an important type of sedimentary process in the valley bottom. The cumulative effect of these post-glacial events is that the sequence of post-glacial alluvial sediments below the valley floor exhibits a fining-upward pattern at most places, though there typically is no sharp break in the sedimentary record that marks the change in flow regime associated with the stream piracy.

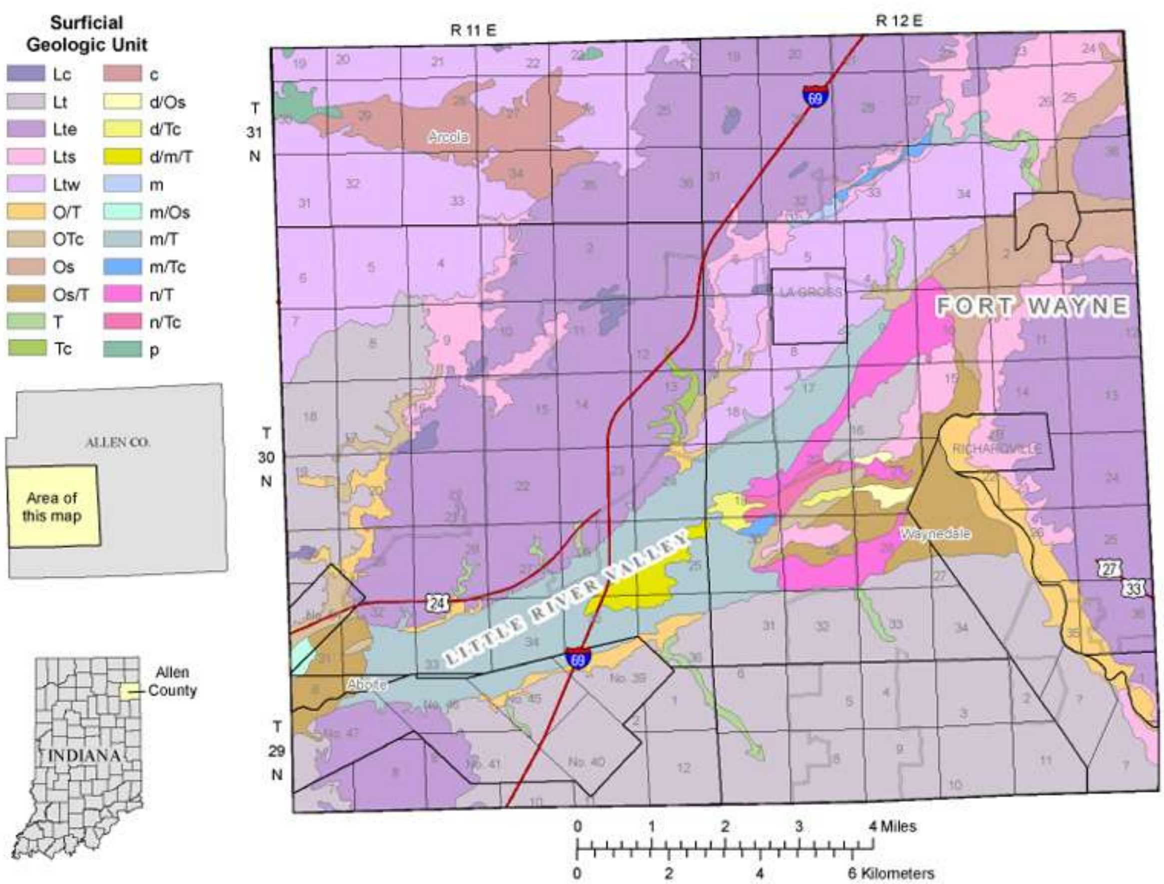
*Alluvial sediments beneath the floor of Eagle Marsh. The upper part of the profile is organic silty clay, presumably deposited in a marsh environment. The lower part is cross bedded sand deposited in a stream channel, possibly during a flood. Photo by Tony Fleming.*




***Dust Storms and Sand Dunes:*** Several small fields of sand dunes dot the valley bottom in a linear chain of 'islands', so named by early settlers because they stood above the vast marshy bottomlands and offered the only consistently dry ground to farm and establish homesteads in the valley. The most familiar of these are located at Fox Island (F), Midway Island (M, on whose northern edge Eagle Marsh Woods is situated), Sand Point (S), and along Knoll Road (K), while less prominent individual dunes and dune fields occur near Aboite (A), in the head of the Fort Wayne Outlet east of New Haven (NH), and elsewhere. Most of the dunes are "longitudinal dunes"—so named because their long dimensions parallel the prevailing winds and the direction of sand transport—and their orientations indicate that the wind blew the sand in from the west-southwest. The tallest dunes stand about 25-35 feet above the floor of the valley, and the largest dune fields (at Fox Island, Knoll Road, and Sand Point) occupy less than a square mile. All of the dune fields are found near sources of sand. For example, the dunes at Sand Point sit directly atop the remnant outwash fan that underlies that area, which could easily have furnished the source of sand. Similarly, a body of sand and gravel that underlies the valley floor near the mouth of Aboite Creek could have furnished the sand that makes up the dunes in that area and, perhaps, at Fox and Midway Islands.

The age and origin of the dunes are speculative. The dunes are clearly younger than most of the mucky and peaty marsh sediments that floor the valley, because borings made at Fox and Midway Islands show that the sand overlies these deposits. This relation rules out the possibility that the dunes might have formed on the barren landscape that was left immediately after the Maumee Torrent. But whether the dunes were deposited before or after the Maumee River drainage became established in Fort Wayne is an open question. And their presence prompts an even larger question: 'What caused the dunes to form in the first place?' After all, sand generally does not blow around on a wet, vegetated landscape such as the Great Marsh. In other words, the presence of the dune fields would seem to indicate that the sand sources they came from were largely, if not entirely, unvegetated.

Since this is scarcely the case today, the logical extension of this line of inquiry is that the dunes mark a period characterized by a vastly different and drier climate than the current one, when forest communities receded from the region and sparsely vegetated prairies were the dominant ecological community in the Little River Valley. Such a condition existed throughout parts of eastern and central North America some 6,000-7,000 ybp, during a period when the geologic record is dominated by plant species and fossil pollen indicative of a warmer and drier climate. This interval is variously termed the 'altithermal' or 'post-glacial thermal optimum', and seems to be the most likely time when the dunes in the valley could have formed. Such a relatively recent origin for the dunes is further supported by the fact that they are little modified by erosion, and still retain their original, depositional form. During the altithermal period, the Little River Valley would have at times been a distinctly inhospitable place, as blowing sand and dust storms blanketed the landscape! Once this comparatively brief interval ended, however, a humid climate quickly returned, and by the time the early explorers arrived, the dunes were blanketed by a rich hardwood forest.




*Surficial geology of southwestern Allen County. Source: Indiana Geological Survey*

***A Messy Geologic Setting:*** The series of geologic events that shaped the Little River landscape left a complicated record of cross-cutting drainages and landforms of different ages, each characterized by a somewhat different sequence of sedimentary deposits. The complexity of the modern landscape is suggested by the variety and distribution of surficial deposits shown on the modern geologic map of Allen County, a portion of which centered on the Little River Valley is reproduced above. You can learn much more about the geology beneath the local landscape, and the glacial history of the region, by visiting the interactive geologic map of Allen County hosted on the Indiana Geological Survey website. For purposes of this discussion, however, we've simplified the geologic picture somewhat on the accompanying map of the upper Little River Valley, so as to present it in a way that relates more directly to the natural and human history of the Little River Valley.

**The Great Marsh: European Settlement to the Present**

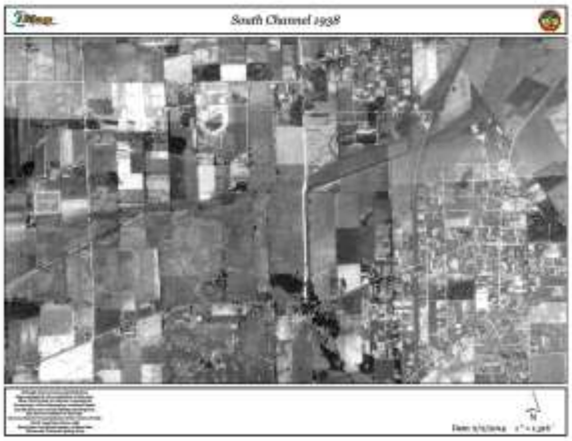
***Historical Geology:*** The most recent chapter in the geologic story is that of the modern landscape as it appeared to the first European explorers who arrived in the Little River Valley, and its subsequent modification to make way for agriculture and urban development over the ensuing centuries. Of necessity, this part of the story takes place at the intersection of geology, ecology, and human history. Geology — particularly its hydrological aspects — plays a central role in both the ecology of the Great Marsh, and in the patterns of human settlement and use of the region. The accompanying map of the upper Little River Valley shows some of the key aspects of this relationship, depicting the main geological elements in and around the valley, along with major ecological and historical features through time. The map was compiled on a topographic base map; to learn more about topography and topographic maps click here.

***Early Hydrologists:*** When explorers ventured up the Wabash River from western Indiana in the early 1700's, they encountered a vast marsh that covered virtually the entire floor of the Little River Valley between Huntington and Fort Wayne. The marshy expanse was broken only by a few, small wooded dunes, or "islands". In time, this wetland became known as the "Great Marsh", and while it presented a major impediment to settlement, it also acted as a navigable waterway of great strategic value, not only to the early settlers and traders, but also to the Native Americans of the region. In all but the driest times, it was feasible to canoe up the river from the forks of the Wabash to a position just northwest of Fox Island. From there, the portage followed the slightly drier terrain along the northern edge of the valley to the St. Marys River, crossing the continental divide in the process. Some accounts also describe the ability to canoe all the way to the St. Marys during wet periods that typically occurred between late winter and early summer, whereas other less fortunate travelers sometimes had to portage the entire 24 miles when making the trip during the dry late summer and fall months. These early accounts are the first to suggest the seasonal hydrology of the Great Marsh. The continental divide near the east end of the portage later became the high point along the Wabash & Erie Canal, hence Fort Wayne was dubbed the 'Summit City'—a somewhat ironic term, since the 'summit' it refers to actually is only a few feet above the lowest elevation in the whole regional landscape!

*The bed of the Wabash & Erie Canal near Arrowhead Prairie. Photo by Tony Fleming.*

***The Miami in the Little River Valley:*** Native Americans plied the waterways of the Little River Valley long before European settlers arrived, and continued to do so well into the 1800's. Much has been written about 'Kekionga', the Native American village at the Three Rivers confluence that served as a hub of Native American commerce for the same physiographic reasons that the Little Wabash portage became the focal point of competing European interests. Here, we simply point out two lesser-known places along the continental divide whose significance to the Miami stems from their geological underpinnings.

The potential use by the Miami of the south channel as an alternate portage, or water route, between the St. Marys River and Little River is particularly intriguing, given their choice of location for the Pinšewa (Richardville) House and the fact that the Miami selected the south side of the valley for the majority of the reserves granted by the Treaties of 1818 and 1826 (this latter feature is not readily evident on the map, but beginning with "Branstetters Reserve" in the extreme southwest corner, an almost continuous line of Miami reserves extended down the south side of the valley to Huntington and beyond). In light of this particular geography, a reasonable person could readily infer that the Miami made regular use of the south channel as a primary travel route, though there is scant documentation to that effect. It is known that Richardville maintained a primitive dam on the small tributary creek leading from behind the Pinšewa House to the St. Marys River, whose purpose seems to have been to back up the water to the continental divide that lay just to the west in the south channel, thereby facilitating a nearly continuous canoe route to the Wabash River system. Only a short portage somewhere in the vicinity of what is now Ardmore Avenue would have been necessary to reach the Little River, if that. The original topography in the bottom of the south channel was extremely subtle, and today, it is significantly obscured by drainage diversions, roads, and filling with quarry spoil, so it isn't entirely clear where the continental divide originally crossed it. The use of the dam by Richardville suggests that the location wasn't static, even back then.





*The South Channel in 1938 (left) and 2012 (right). The Pinšewa (Richardville) House is visible at the extreme upper right of the 1938 photo. Today, his canoe route would be through the southern part of the massive limestone quarry, which was just a small gravel pit in 1938. Source: www.acimap.us.*

Another place that was of special significance to the Miami is known as 'The Cranberry'. Located in the far northern reaches of the Little River watershed, the Cranberry consists of a complex of wetlands that straddle the continental divide between the headwaters of Cranberry and Poinsett Creeks. The Cranberry is situated within a prominent topographic sag that circumscribes an arcuate course between Shoaff Lake and the mouth of Cranberry Creek at Eagle Marsh. The sag appears to mark the ice-marginal drainage in front of one or more minor Erie Lobe moraines, and the Cranberry lies right at its summit, in the extreme northwestern part of Wayne Township. Chief Lagro requested that one of his reserves adjoin the Cranberry, whose name presumably derives from the highbush cranberry (*Viburnum triloba*) that populates the shrub swamps there. Much of the Cranberry remained rural through most of the 20th century, due in part to its wetness, and partly because it is geographically isolated by the railroad embankments that run through it. The Cranberry still retains prime examples of the kinds of landscapes and natural communities (wet woods, shrub fens, marsh) that were once common in the uplands in the Little River watershed, but the remaining pieces of this ecosystem are increasingly being encroached upon by housing additions and commercial development.



*The Cranberry in 1938 (left) and 2012 (right). Most of the ponds visible in the 2012 aerial are constructed in former wetlands. Jefferson Pointe is at the lower right. Source: www.acimap.us*

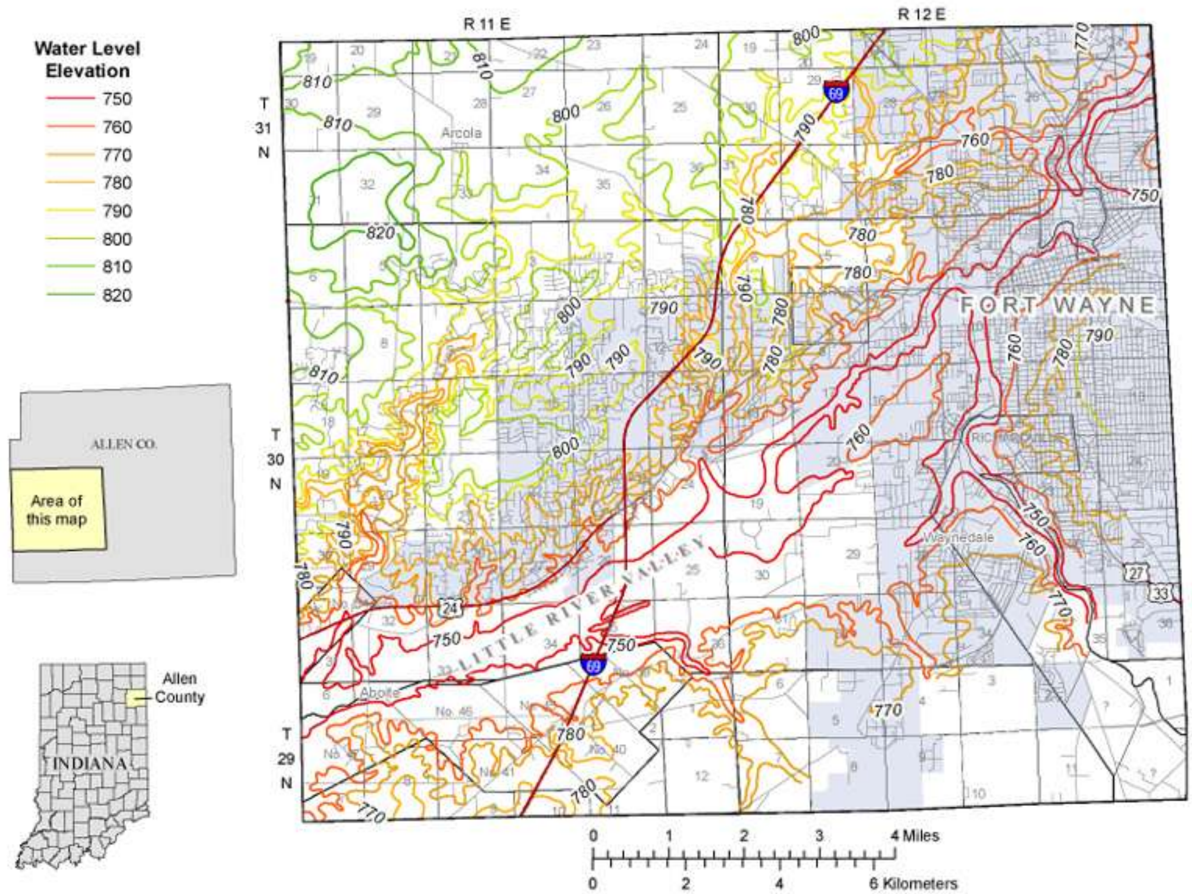
***Hydrology of the Great Marsh Ecosystem:*** The map shows the extent of the marsh and the position of the continental divide as they might have looked around the time the first Europeans arrived here. The location of the actual channel of the Little River through the marsh, and of various small waterways tributary to it, are also depicted. The original configuration of these streams is reconstructed from historical maps and accounts, modern topographic maps, patterns visible on aerial photographs, and direct field observation; it is somewhat speculative at many places due to the large number of meander scrolls and other features that criss-cross the floor of the valley and mark multiple generations of recent stream channels.

*The dark soil tones in the foreground of the field mark the former channel of the Little River along Yohne Road (left). Today, the only evidence of a stream is the unnaturally straight ditch on the other side of the road (right). Photos by Tony Fleming.*

The gradual migration of these small stream channels across the floor of the valley was one of the key geologic processes that continually shaped the ecosystem. The channels formed narrow ribbons of open or semi-open water amidst a sea of grass. They probably supported large numbers of aquatic plants, mussels, and fishes of various sorts, along with a wide range of shore birds that fed on them. The adjacent areas included true marsh—that is, communities dominated by sedges and marsh grasses that were inundated on a continuous or semi-continuous basis—along with large expanses of wet prairie, which stood slightly higher and were inundated only seasonally. The distributions of these different natural communities were determined by subtle changes in elevation across the exceedingly flat valley floor—a differential of mere inches probably determined whether a particular area was open channel, marsh, or wet prairie. In contrast, the sand dunes were islands that stood well above the prevailing water level of the marsh. They supported a completely different ecosystem—a diverse, mesic hardwood forest composed of enormous sugar maples, beech, tulip tree, oaks, and hickories, with a rich understory of spicebush, paw paw, ginseng, and large numbers of wildflowers.


*Spring wildflower display in a climax dune forest in the Little River Valley. Photo by Tony Fleming.*

The water that fed the marsh came from several sources. Some of it came from precipitation that fell directly on the marsh, but an even larger share was derived from several tributaries that drained adjacent uplands. The main stem of the Little River, for example, originated as a series of small upland creeks in northern Wells County, just north of Ossian, and drained a land area of almost 15 square miles. The upland drainage coalesced into a major stream that entered the south channel just below the intersection of Ardmore Road and Lower Huntington Road. The former mouth of the stream is marked by a small but prominent alluvial fan, where sediment carried down from the adjacent upland promptly fell out when the stream encountered the flat bottomland of the south channel. Another sizable tributary was Cranberry Creek, now known by the less poetic name of Graham-McCullough Ditch, which drained an upland area of comparable size on the north side of the valley and debouched into the valley on the north side of Eagle Marsh. But by far the most dramatic influxes of surface water came from large floods on the St. Marys River, which periodically overtopped the low divide at the head of the north channel and sent large sheets of water down the Little River Valley. It is impossible to say how frequently this might have occurred in the natural hydrologic regime, because records have not been kept for long enough to reliably estimate the recurrence interval of such extreme floods. The most recent occurrence (and the only well documented one) was the flood of 1913—the largest ever recorded on the St. Marys River—when an estimated 5,000 cubic feet per second (cfs) spilled over the divide, out of a peak flood flow of 24,000 cfs on the river. To put this in perspective, 5,000 cfs is equivalent to 3.25 billion gallons per day, enough to flood Eagle Marsh to a depth of 14 feet! In this way, the Little River essentially acted as a natural safety valve, thereby lowering the peak flood discharges of the St. Marys River, in this instance by more than 20%.




*Regional ground-water flow map of the Little River watershed. The contours represent lines of equal water-level elevations in the underlying aquifers, and show strong inward gradient towards the valley. Source: Indiana Geological Survey Special Report 57.*

Much of the marsh in the upper valley is inferred to have been fringed by fens, seepage swamps, and other ecosystems supported by the discharge of ground water to the surface. The source of the ground water is sand and/or gravel bodies of various sizes, including the dune fields, the outwash fan at Sand Point, and scattered terraces along the valley walls, all of which act as local aquifers. Precipitation infiltrates the surfaces of these permeable bodies relatively easily, seeps downward to the water table, and then travels laterally to the edge of the valley, where it discharges via springs and seeps. A good example of this process can be seen in Eagle Marsh Woods, where ground-water seepage from the bases of sand dunes is readily visible in most years from late winter to early summer. Additionally, extensive buried sand and gravel aquifers that occur beneath the glacial till and other surficial deposits on nearby uplands are locally truncated along the valley walls or extend out beneath the valley floor. The discharge from these artesian aquifers is potentially substantial and supports at least one fen near Eagle Marsh. In fact, the Little River Valley acts as a regional ground-water discharge area for the entire hydrogeologic system, as there is ample evidence of upwelling ground-water from water-bearing strata at considerable depth below the valley floor, including the limestone bedrock. This is vividly illustrated by the well at Eagle Marsh barn, which flows freely when left uncapped, a condition known as a flowing artesian well.

*The Draining of the Great Marsh:* By the 1870's, Fort Wayne had grown from a small outpost to a respectable-sized town. The Little River Valley, which remained largely undeveloped, had come to be known as the 'Marshy Prairie'. A variety of parties began pushing for the marsh to be drained, not least among them being local agricultural interests. Legislation to drain the Great Marsh cleared the state legislature and drainage work began in earnest in the late 1870's. This occurred against the backdrop of a major period of drainage projects and agricultural expansion throughout the state (the Grand Kankakee Marsh also was drained during this time), when wetlands generally were not held in high regard by most of the public. This period gave rise to the first drainage laws, which gave unprecedented power to local units of government to take private property and 'improve' it by implementing vast drainage projects that forever altered the landscape, all at the property owners' expense.

*The Little River in 2010, following a drainage project near the west county line in which nearly all of the streambank vegetation was removed. Many drainage boards still claim that straightening stream channels and removing vegetation reduce sedimentation and result in less flooding, but any modern hydrology textbook will tell you the exact opposite is true. Photo by Tony Fleming.*

After several attempts, by the late 1880's, the Great Marsh was largely drained. In the portion of the Little River Valley shown on the map, this was achieved by creating three main drainage ditches and many minor ones. One of the first drainage projects, completed by 1880, created Fairfield Ditch, which literally decapitated the Little River by diverting its headwaters out of the watershed and into the St. Marys River across from Foster Park. Imitation is the sincerest form of flattery, so one is led to wonder whether this bit of artificial stream piracy was inspired by recent recognition of the earlier geologic history of the Maumee River. In any case, by removing one of the major sources of upland runoff into the valley, the completion of Fairfield Ditch expedited the completion of drainage projects in the rest of the marsh. A second project which had a similar effect was the building of Graham-McCullough Ditch, which contains Cranberry Creek within a massive earthen levy as it crosses Eagle Marsh. For thousands of years, this waterway had been providing the lion's share of the water budget to the north side of the marsh in the vicinity of Eagle Marsh. It also delivered a steady supply of sediment to the marsh, which replenished soil and nutrients, and helped maintain the surface of the marsh. A low alluvial fan rings the former mouth of the creek and attests to its former role in that part of the ecosystem. The other major project, and the one that probably had the most profound effect on the overall shape of the watershed, was the establishment of Junk Ditch. Junk Ditch was created by stringing together pieces of existing drainages with newly excavated ditch segments. The lower, more winding portions of Junk Ditch that lie east of the original continental divide follow a natural drainage to the St. Marys River that appears on several historical maps prior to 1880. Some of the upper sections of the ditch utilize former courses of the Little River drainage, while others are simple, straight channels excavated across the former marsh. All told, the advent of Junk Ditch removed several square miles of former marshlands and adjacent uplands from the Little River watershed and shifted the position of the continental divide westward by as much as 3 miles in some parts of the valley floor.

*Junk Ditch. Photo by Tony Fleming.*

Agriculture quickly expanded across the fertile soil of the old marsh. The wet, mucky soil supported moisture-loving crops such as onions, lettuce, and celery. In fact, the valley became well known for its celery production around the turn of the century. Persistent wetness posed frequent challenges to cultivation, however, and accounts of draft animals submerged up their bellies in the mucky soil were common. These problems continued after vegetable production was abandoned and the fields were converted into the typical grain crop rotation of corn-soybeans-wheat following WW II. Even extensive systems of closely-spaced drainage tile, ditch laterals, and large pumps running 24 hours a day—a costly undertaking in the contemporary industrial farm economy—were sometimes not enough to keep the water at bay and prevent crops from being lost to inundation. One of the ironies of modern farming in the Little River Valley is seeing these elaborate measures for draining the soil juxtaposed with large center-pivot irrigation systems that pump millions of gallons of fossil ground water to irrigate the crops. An unforeseen result of draining and cultivating the mucky soils of the Little River Valley is the loss of organic sediment from the land surface: when the soil surface dries out, the organic matter oxidizes and blows away, leading to a long-term reduction in soil fertility and tilth, and a gradual deflation, or lowering, of the land surface.

***Restoration of the Great Marsh:*** The ongoing challenges to successfully farming the valley bottom in an age of rock-bottom crop prices, coupled with increased local awareness of the many values of wetlands, form the backdrop for the restoration of portions of the Great Marsh. Both the challenges and the opportunities involved in a large-scale restoration are exemplified at Eagle Marsh, one of the largest contiguous wetland restorations ever undertaken in Indiana. The habitat map from the restoration plan shows the layout of natural communities and gives a good sense of how they relate to the current hydrologic regimen.

The restoration is designed to emulate the original bottomland communities of the marsh, while adapting to a condition of relative water scarcity. One of the largest challenges is the lack of a regular source of surface water flowing into the marsh: ditching and channelization of the Little River and Cranberry Creek prevent these streams from interacting hydraulically with the surrounding valley bottom, whereas the various ditches and berms for roadways that cross upstream portions of the valley inhibit the sheet flow of water to downstream portions. As a result, the water budget relies heavily on precipitation falling directly on the marsh, so retaining that water in the marsh is a top priority of the restoration. In addition to decommissioning the extensive drainage infrastructure that existed on the property (e.g., breaking tiles, plugging ditch laterals, removing pumps), earth moving was undertaken to enhance or recreate some of the old meander scrolls. Although these basins are isolated in a hydraulic sense, they help retain water that might otherwise run off; just as importantly, these small areas of open water serve as crucial habitat in the lifecycles of many marsh dwellers ranging from the tiniest insect larva to large shorebirds, and so form a key link in the marsh ecosystem.

*Restored marsh and meander scroll. Fox Island is in the background. Photo by Tony Fleming.*

Another significant unknown involves uncertainties about the hydroperiod of different portions of the marsh. In simple terms, 'hydroperiod' refers to the length of time a particular wetland remains inundated during the course of a typical year: for example, a marsh is typically inundated for all, or almost all, of the year, whereas a wet meadow usually has water standing on the surface for only a portion of the year, while many wet prairies and forested wetlands may be inundated only briefly. In reality, there is much hydrologic variability both within a particular type of wetland and among different types, and factors such as the depth of water and the time of year inundation occurs (i.e., whether and when during the growing season) have a tremendous influence on the type of natural community found in a given wetland. The lack of detailed historical records documenting this kind of information in the original marsh, coupled with the major hydrologic alterations in the valley, leads to considerable uncertainty and suggests that current hydrological conditions are likely to be quite different, and potentially drier and more variable, than those that existed prior to European settlement. One way this uncertainty is being addressed in the restoration is by incorporating extensive prairie areas in the former marsh landscape, composed of plant species which are well adapted to large seasonal swings in moisture availability. Relative to the original landscape, the restored marsh undoubtedly has a greater proportion of wet prairie than true marsh, out of hydrologic necessity. Another adaptation is the use of a highly diverse mix of plants (see seeds planted at Eagle Marsh in 2007 and 2008) which increases the probability of success in a drier or more variable hydrologic system. If some areas turn out to be too dry for certain plants, their place in the ecosystem will be taken by other species better adapted to the prevailing conditions. One of the most interesting aspects of the restoration is seeing how the hydrology of the marsh plays out over the long term, and which species ultimately flourish in which environment—more or less like a grand ecology experiment on a scale never before undertaken.

**References**

Atlas of Indiana, 1876, Map of Allen County: Indiana University-Bloomington.

Ault, C.H., and others, 1973, Guidebook to the geology of some Ice Age features and bedrock formations in the Fort Wayne, Indiana, area: Indiana Geological Survey Guidebook, 62 p.

Bleuer, N.K., and Moore, M.C., 1972, Glacial stratigraphy of the Fort Wayne, Indiana, area and the draining of Glacial Lake Maumee: Proceedings of the Indiana Academy of Sciences, v. 81, p. 195-209.

Bleuer, N.K., and Moore, M.C., 1978, Environmental Geology of Allen County, Indiana: Indiana Geological Survey Special Report 13, 72 p.

Dryer, C.R., 1889, Report on the geology of Allen County: Indiana Department of Geology and Natural Resources Annual Report 16, p. 291-401.

Fleming, A.H., 1994, The hydrogeology of Allen County, Indiana—A geologic and ground-water atlas. Indiana Geological Survey Special Report 57, 111 p.

Forsyth, J.L., 1973, Late-glacial and postglacial history of western Lake Erie: The Compass of Sigma Gamma Epsilon, v. 51 (1), p. 16-26.

Fraser, G.S., and Bleuer, N.K., 1988, Sedimentological consequences of two floods of extreme magnitude in the late Wisconsinan Wabash Valley: Geological Society of America Special Paper 229, p. 111-125.

Hansen, M., 1989, The History of Lake Erie: Ohio Department of Natural Resources-Division of Geological Survey, Ohio Geology Newsletter, Fall, 1989. http://www.dnr.state.oh.us/Portals/10/pdf/newsletter/Fall89.pdf

Helms, 1880. Map of Allen County.

Indiana Geological Survey, 2014, Allen County Geology Interactive Website: http://igs.indiana.edu/allencounty/

Kappler, C.J., 1904, Indian Affairs: Laws and Treaties, Vol. II (Treaties): Washington, D.C., U. S. Government Printing Office (contains the texts of the 1818 and 1826 Treaties with the Miami). http://digital.library.okstate.edu/kappler/Vol2/Toc.htm

Kirschner, F.R., and Zachary, A. L., 1969, Soil Survey of Allen County, Indiana: Washington, D.C., U.S. Department of Agriculture—Soil Conservation Service, 76 p.

Leverett, F., and Taylor, F.B., 1915, The Pleistocene of Indiana and Michigan, and the history of the Great Lakes: U.S. Geological Survey Monograph 53, 529 p.

Paul, H.C., 1969, Drainage of the Little River: Old Fort News, v. 32, 23 p.

**Acknowledgments**

Website content by Tony Fleming, LPG, who appreciates the constructive reviews by Betsy Yankowiak, Tim Skiver, and the late Dr. Jack Sunderman