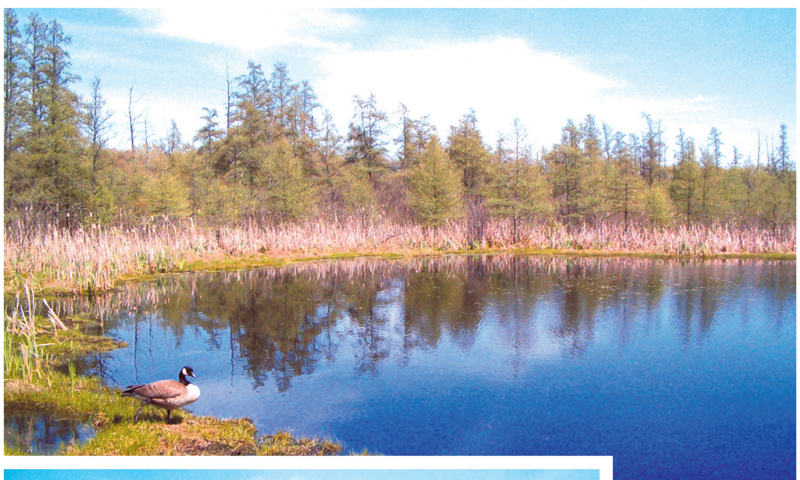
State of Illinois
Rod R. Blagojevich, Governor

Illinois Department of Natural Resources
Illinois State Geological Survey

Guide to the Geology of Moraine Hills, Glacial Park, and Volo Bog Areas, McHenry and Lake Counties, Illinois

Wayne T. Frankie, James J. Miner, Steven E. Benton, Geoffrey E. Pociask, Eric T. Plankell, Andrew J. Stumpf, and Russell J. Jacobson



Geological Science
Field Trip Guidebook 2007A

April 14, 2007
May 5, 2007

Cover photo: *From upper left clockwise: View of open water area along Volo Bog Interpretive Trail; Meyer Material Company, Pit 26 (photograph by B. B. Curry); boardwalk along Lake Defiance Interpretive Trail looking toward the lake and overlooking shallow marsh, to deep marsh, to shallow open water; Camelback Kame, along Deerpath Trail, Glacial Park, McHenry County Conservation District (all photographs by W. T. Frankie except Meyer Material Company).*

Geological Science Field Trips The Illinois State Geological Survey (ISGS) conducts four tours each year to acquaint the public with the rocks, mineral resources, and landscapes of various regions of the state and the geological processes that have led to their origin. Each trip is an all-day excursion through one or more Illinois counties. Frequent stops are made to explore interesting phenomena, explain the processes that shape our environment, discuss principles of earth science, and collect rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers who prepare earth science units. Grade school students are welcome, but each must be accompanied by a parent or guardian. High school science classes should be supervised by at least one adult for every ten students.

The inside back cover shows a list of guidebooks of earlier field trips. Guidebooks may be obtained by contacting the Geoscience Education and Outreach Section, Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, IL 61820-6964. Telephone: 217-244-2427 or 217-333-4747. This information is on the ISGS home page: http://www.isgs.uiuc.edu.

Four USGS 7.5-minute Quadrangle maps (Fox Lake, McHenry, Richmond, and Wauconda) provide coverage for this field trip area.

ISGS Illinois State Geological Survey

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

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PREFACE

Rapid and widespread population growth in northeastern Illinois during the last two decades has increased the competition for land that is suitable for residential and commercial development. It has also increased the demand for clean, reliable water supplies and aggregate resources to support the area's explosive growth in population, housing, and road construction. Northwestern Lake County and northeastern McHenry County are focal points for this rapid growth. County, township, and municipal governments have realized their need for accurate and detailed information about the surface and subsurface geologic materials, the vast majority of which were deposited by glaciers during the last 25,000 years. These glaciers traversed the area several times during this period, reshaping the landscape each time and leaving behind a variety of landforms and sediment types that manifest themselves in the morainic hills, river valleys, sand and gravel quarries, abundant lakes, and the wetlands, bogs, and marshes that are characteristic of the region.

Of special concern are the location, extent, and character of sand and gravel deposits that serve as a source of aggregate material for construction and that contain significant aquifers (sources of groundwater) pumped by cities and towns and private landowners. Essentially all of the water consumed in this region is obtained either from the unconsolidated glacial sediments overlying bedrock or from deeper bedrock formations. The shallow sand and gravel deposits are the most important in the field trip area. Although these deposits are found consistently throughout the region, there unfortunately is relatively little detailed information available regarding their overall lateral extent, thickness, and other physical characteristics or their distribution with other fine-textured sediments (also mostly of glacial origin) that do not hold groundwater. Collectively, these deposits determine the availability, quality, resupply, sustainable yield, and potential for contamination of the aquifers.

In response to the growing need for reliable geological information, the Illinois State Geological Survey (ISGS) has conducted over the last two decades increasingly more detailed geologic mapping of the glacial and fluvial sediments throughout northeastern Illinois. In 1999, the ISGS joined with the U.S. Geological Survey and the state geological surveys of Indiana, Ohio, and Michigan to initiate the Central Great Lakes Geologic Mapping Coalition. The Coalition initiated a new detailed regional mapping project, the Illinois portion of which is currently focused on Lake County. The goal is to map in three dimensions the sediments from land surface to top of bedrock at a scale of 1:24,000 (one map inch represents 2,000 feet on the ground), the largest (most detailed) scale yet undertaken by the ISGS for a county. The sediment thickness ranges from about 100 feet near the Lake Michigan shoreline to more than 350 feet in western Lake County and eastern McHenry County. As of the end of March 2007, the subsurface geology has been mapped by ISGS for about 40% of Lake County and bordering parts of McHenry, Kane, and Cook Counties. The surficial geology has been mapped for about 70% of this area. The information obtained is available in the form of surficial geology maps, computer-generated three-dimensional models, and maps of aquifers already being used by county, township, and municipal officials.

Additionally, the ISGS geologists and hydrogeologists working on this project have made presentations to the various governmental agencies and municipalities at board meetings and public forums to better inform them of our program and to provide an update of our current results in order that the ISGS staff can better understand their needs and help them understand how the mapping information could be used to support addressing issues in their work. These map products are useful for general land use planning and in assisting with more specific problems related to water-well construction, contamination of groundwater and surface water, identification and protection of recharge areas, and a variety of other applications related to preservation and restoration of natural areas and design and construction of new building and roads.

CONTENTS

MORAINE HILLS AND VOLO BOG AREA

INTRODUCTION

The Moraine Hills State Park and Volo Bog field trip area is located in eastern McHenry County and western Lake County in northeastern Illinois. The landscape of this area is dominated by glacial sediments deposited during the most recent glaciation, the Wisconsin Episode. Associated with these glacial deposits are a large number of wetlands, many of which are unique, occurring only in northeastern Illinois. The field trip examines several different glacial landforms and the connection between the wetlands of northeastern Illinois and the region's geologic history of glaciation.

In part of northeastern Illinois, glacial deposits vary from 100 to 300 feet thick, entirely covering and obscuring the bedrock within the field trip area. The underlying bedrock in this area is the Silurian age dolomite (fig. 1). The majority of deposits found above this dolomite are glacial in origin.

GLACIATION

During the last 1.8 million years, encompassing the Pleistocene Epoch, the Earth's surface experienced several periods of climate cooling that led to the expansion of mountain and polar ice masses into the lower latitudes. During the most recent cooling event in the northern hemisphere, starting approximately 25,000 years ago, these ice masses (glaciers) spread outward from their centers of ice accumulation in subarctic and high mountain regions and covered vast areas of North America and Europe. Figure 2 shows the various glacial episodes and deposits in Illinois.

Prior to glaciation, the Illinois landscape consisted of rolling hills, bisected by well-integrated drainage systems. A present-day comparison can be found beyond the glacial limit in the driftless area in Jo Daviess County and in the extreme southern portion of Illinois. The glaciated landscapes, in contrast, have been essentially reshaped beyond recognition of their earlier appearance; the scraping of the glaciers obliterated the landforms they traveled over and filled most preglacial valleys.

It is difficult to perceive a vertical height of ice close to 1,500 feet thick covering northeastern Illinois (Clark et al. 1996). Imagine a 1,500 foot block of ice moving across today's landscape. Do you think it might produce some changes? During the Wisconsin Episode, glaciers of this thickness overrode the area, reshaping the landscape. These glaciers carried large amounts of rock fragments and sediment consisting of sand, silt, and clay that were transported, often for hundreds of miles from their original source locations.

The field trip area presents numerous opportunities to observe the various types of landforms and deposits left by the Wisconsin Episode glaciers. To fully understand and appreciate the complexity of continental glaciation and the resultant landforms and deposits, an introduction to the terminology that glacial geologists use in describing these features and deposits is included along with a simplified discussion of the processes involved in the deposition of glacial sediments and the shaping of the glacial landscape.

Glacial Processes

The geologic work of a glacier can be divided into three processes:

Erosion. Under the weight of the ice sheet hundreds to thousands of feet thick, glaciers detach material from the surface by crushing the underlying bedrock. Once the material is loosened from the surface, ice can pluck the rock by freezing around and into fractures and then lifting the rock from the surface. The rock embedded in the ice gouges and smoothes the underlying bedrock surfaces by abrasion. Striations are fine scratches that are found on rocks carried within the glacier and left in bedrock by abrasion. On a larger scale, the striations in bedrock indicate the direction of ice movement. The constant abrasion of exposed rock also creates polished bedrock.

Transport. As glaciers move outward from their accumulation centers, eroded rock fragments and sediment are frozen onto and carried up into the ice. Typically, as the glacier moves forward (advances), the incorporated materials move upward and toward the front of the ice margin, much like a conveyor belt. These materials are carried in discrete layers (sediment bands) in the ice and are laid down on the land surface as the glacier melts away. Material can be carried for long distances, thousands of miles, from their original location of entrainment.

Deposition. The laying down of sediment once carried by a glacier is known as deposition. When ice melts, it deposits the material that it has been carrying. The material deposited by a glacier is called till and comprises angular particles of all sizes, from boulders to clay. The material is unsorted and lacking in stratification (layering).

SYSTEM OR SERIES	Hydrogeologic units and thickness	Graphic log	Rock type	Water-yielding characteristics
PLEISTOCENE	Drift (0–400 ft)		Unconsolidated glacial deposits, loess, and alluvium	Water yields variable, largest from thick outwash deposits in western part of county
SILURIAN	Niagaran-Alexandrian (0–100 ft)		Dolomite, very pure to very silty; cherty; shale partings toward base	Yields moderate to large supplies where creviced and overlain by permeable sand and gravel; productivity lessens with thinning of dolomite and thickening of shale
ORDOVICIAN	Maquoketa (0–200 ft)		Shale, green and blue with limestone and dolomite beds	Yields small to moderate supplies from dolomite and fractured shale
	Galena-Platteville (0–300 ft)		Dolomite with shale in middle; limestone and chert in lower part	Yields moderate to large supplies only in areas where not overlain by Maquoketa, as near Union and Marengo
	Glenwood-St. Peter (200–350 ft)		Sandstone, fine to coarse grained; shale at top; locally cherty; red shale at base	Yields small to moderate quantities of water
	Prairie du Chien (100 ft ±)		Dolomite, sandy, cherty, interbedded with sandstone	Yields small amounts of water from sandstone and crevices in dolomite
CAMBRIAN	Eminence-Potosi Franconia (200 ft ±)		Dolomite, white, fine grained Sandstone, fine to medium grained	Yields small amounts of water from crevices in dolomite and sandstone
	Ironton-Galesville (100–300 ft)		Sandstone, fine to medium grained, well sorted	Most productive aquifer in Cambrian-Ordovician aquifer system; can yield large supplies of water
	Eau Claire (200–450 ft)		Shale and siltstone, dolomitic	Shales generally not water yielding; acts as a confining layer at base of Cambrian-Ordovician aquifer system
	Mt. Simon (275 ft in NW to 950 ft in SE)		Sandstone, coarse grained, lenses of shale and siltstone	Yields moderate amounts of water; water quality generally good within McHenry County, but deteriorates with depth
PRECAMBRIAN			Granite, red	Not water-yielding

Figure 1 Generalized column of rock formations in McHenry County.

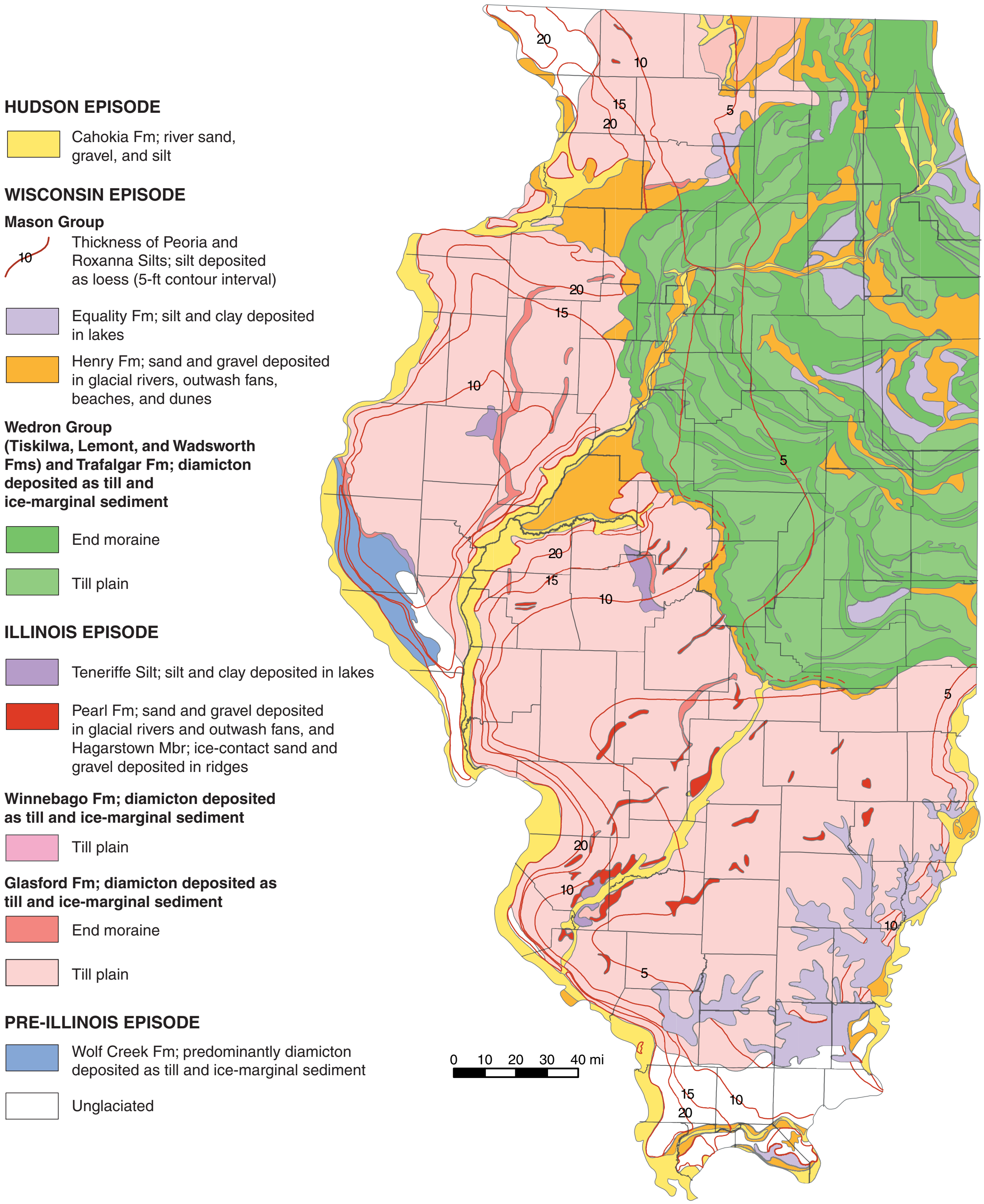


Figure 2 Generalized map of glacial deposits in Illinois (modified from Willman and Frye 1970).

Glacial Deposits

In general, glacial deposits consist primarily of (1) till—pebbly clay, silt, and sand with boulders, deposited directly from melting glaciers; (2) outwash—mostly sand and gravel, deposited by the flowing meltwater rivers; (3) lacustrine deposits—silt and clay that settled out in quiet-water lakes and ponds; and (4) loess—windblown sand and silt.

Till. Glacial drift is the general term applied to debris (sediment and rock fragments) eroded from the surface and deposited by glaciers. When the ice becomes so burdened by its load, it deposits this mixture of fine- and coarse-textured materials in place as glacial till (fig. 3). Till is unsorted and unstratified drift, generally unconsolidated, composed of a variety of earth materials ranging in size from clay to boulders. The rock fragments are typically rounded and polished, and characteristically striated. Till is deposited directly by and underneath a glacier without subsequent reworking by meltwater. Till composes the many moraines lying across northeastern Illinois.

Erratics, glacially transported rock fragments, are often found lying on the surface of moraines. Many Illinois erratics are igneous and metamorphic rocks that were carried by the glaciers southward from bedrock outcrops located north of Lake Superior in Canada.

Outwash. At the margin of the glacier, massive amounts of debris were deposited as the ice stagnated and melted in place. Meltwater from the ice washed through the accumulated debris, transporting and depositing sediment out ahead of the decaying glacier as stratified drift. The coarsest of this water-transported material, sand and gravel (outwash), was deposited near the ice front (fig. 3). The outwash is sorted and stratified.

Lacustrine Deposits. Finer material (silt and clay) was deposited by meltwater farther from the ice margin in streams or settled from suspension in the quiet waters of glacial lakes (fig. 3). These lakes eventually drained, as channels were eroded through blocks of ice or sediment. In Illinois, drainage from glacial lakes fed rivers that drained into the proto-Illinois and Mississippi Rivers that flowed to the Gulf of Mexico.

Loess. As the glaciers melted, river valleys and morainal uplands were exposed to strong, cold, and dry winds blowing off the ice sheet. With little or no vegetation to hold silt and fine sand-sized particles in place, the winds picked up these particles and distributed them downwind. The deposits of these windblown sediments, known as loess, mantle most of Illinois.

GLACIAL LANDFORMS

Moraines. More than 50 successive and distinct end moraines marking the position of ice margins during the Wisconsin Episode have been mapped in Illinois (fig. 4). An end moraine formed by the accumulation of drift at the glacier margin when the rate of advance and the rate of melting of a glacier were essentially in balance. As more and more material was carried forward (transported) to the edge of the glacier, it melted out and piled up to form a ridge—the end moraine. In some places, large gaps in the moraines were eroded where large discharges of meltwater were carried in subglacial or proglacial channels.

If the rate at which the glacier melted was greater than the rate at which the glacier moved ice and debris forward, the glacier receded. A common misconception is that glaciers flow backward, but the advance or retreat of glaciers is controlled by the differences between the rates of melting at the margin and the rates of ice accumulation and transport from the centers of ice accumulation to the north. The Wisconsin glacier advanced and retreated several times across northeastern Illinois. End moraines mark positions where the ice margin stood for decades to several hundreds of years. The surface relief along the top of the end moraines, which is generally greater than that of the till plains, is commonly referred to as swell-and-swale topography.

When melting exceeded the rate of advance, the sediments held within the ice were deposited (melted out) directly onto the landscape. The flatter areas behind (up-ice from) end moraines are called ground moraines or till plains. The surface of the till plain may be almost level or slightly rolling. This low-relief, undulating landscape characteristic of the moraines of a continental glacier, exhibits gentle slopes and well-rounded hills interspersed with shallow depressions.

In front of the end moraine, where debris may have melted out of stagnant ice blocks or where meltwater deposited sediments along confined channels and into shallow depressions, a hummocky to undulating landscape is observed. The land surface, referred to as knob-and-kettle topography, is characterized by a disordered assemblage of hummocks, mounds, or ridges of glacial sediment interspersed with irregular depressions, pits, or kettles that are commonly undrained and that may contain swamps or ponds.

Kettles

Depressions (often water-filled) called kettles are common within the field trip area (fig. 5). Kettles are characteristic of end moraines and contribute to the

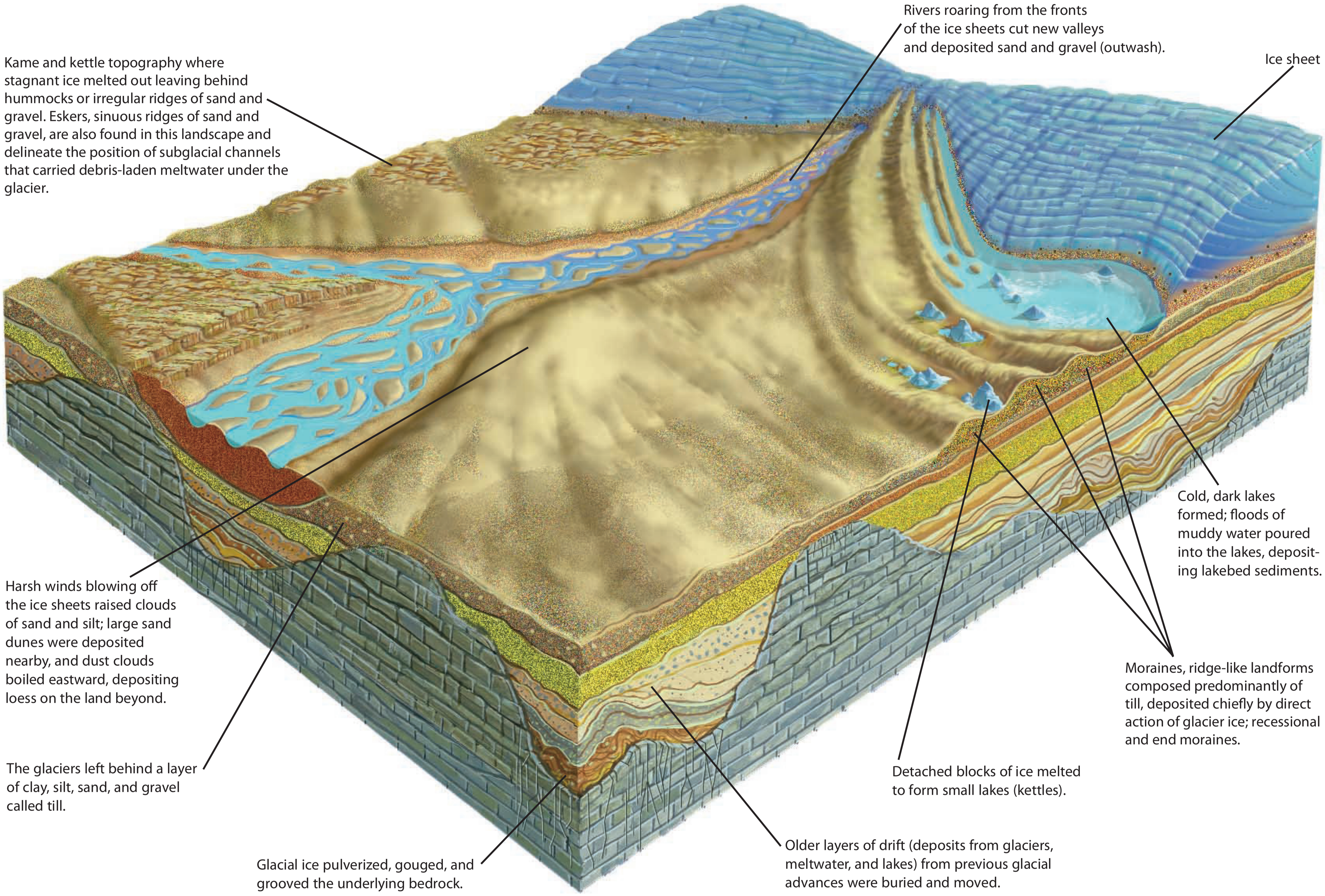


Figure 3 Block diagram of continental glacier showing the relationships of glacial deposits and landforms (J.M. Evans, U.S. Geological Survey). During advance of the ice sheets (about 10,000 to 1,800,000 years ago), the glacial landscape of Illinois was a foreboding and barren place. In this scene, melting along the front edge of the continental ice sheet feeds water and sediment into a river and a glacial lake, while cold winds blow silt and fine sand across the barren landscape.

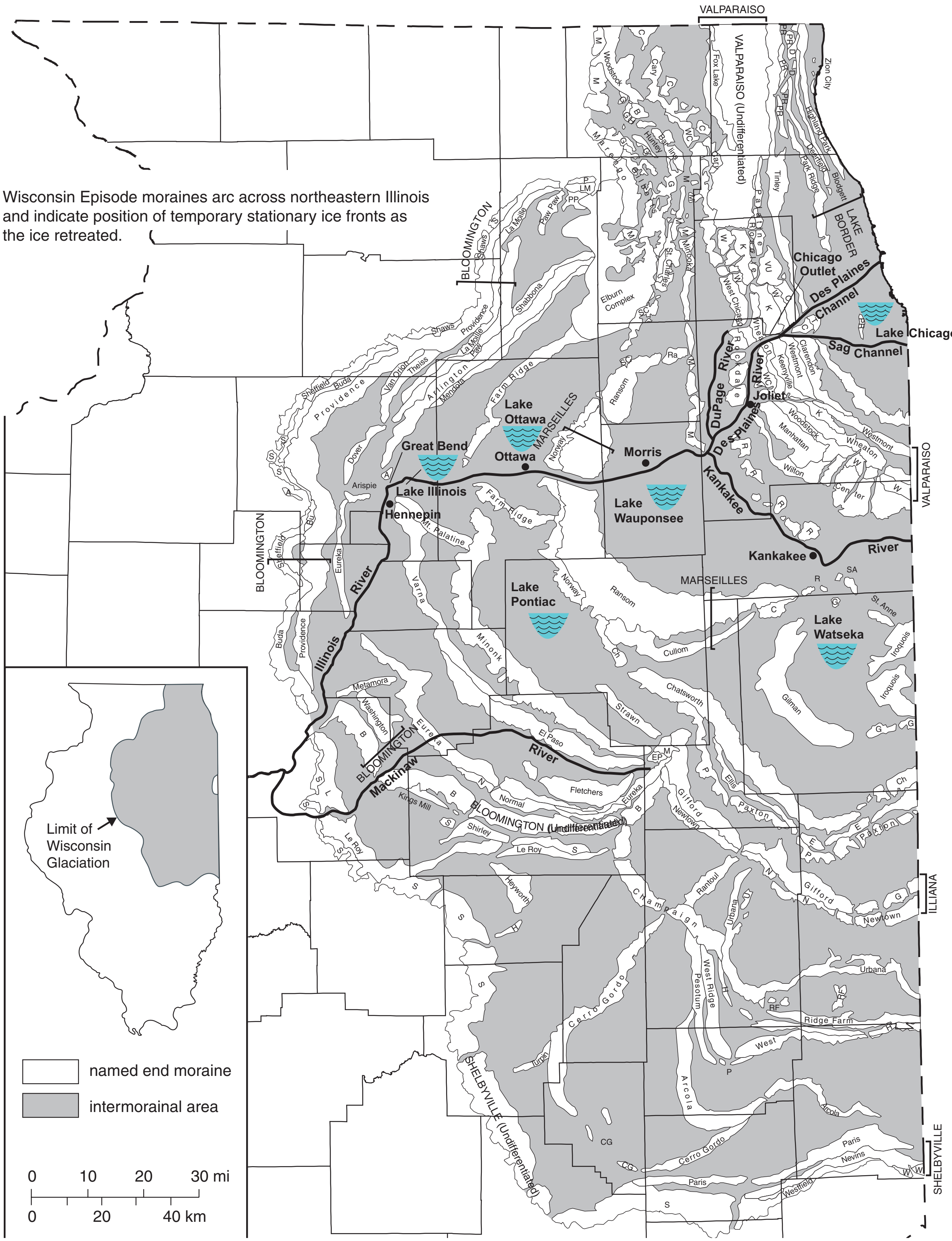


Figure 4 Areal distribution of Wisconsin Glacial Episode moraines of the Wedron Group in Illinois (modified from Hansel and Johnson 1996).

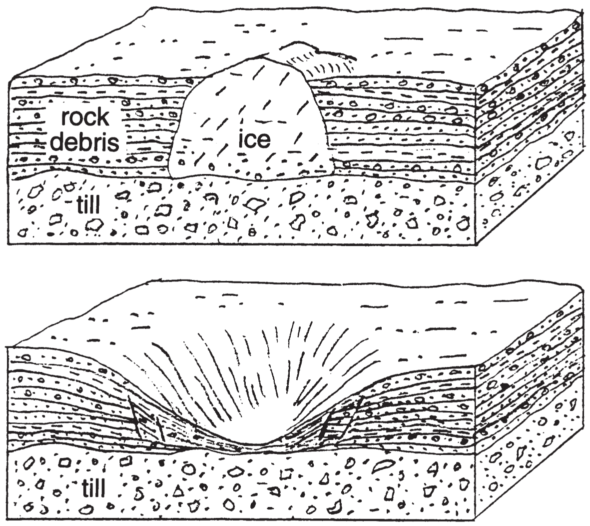


Figure 5 Block diagram of kettle depression. A kettle is formed when a block of ice from a glacier is left behind and is later buried by glacial outwash. When the ice block melts, a depression is formed on the landscape.

hummocky topography known as knob-and-kettle topography that is also typical of some end moraines. Kettles may also occur on an outwash plain in front of end moraines, but less commonly on the till plain behind moraines. Kettles indicate conditions of stagnant ice and are formed during the late melting stages of a glacier. Kettles form when a large block of ice becomes detached or isolated from the melting ice mass; the blocks of ice are subsequently partially or completely buried by the outwash that filled in around them. At some time after burial, the ice blocks melted away, and the overlying outwash cover slumped into the space occupied by the ice, leaving depressions.

A number of kettle lakes and kettle holes (depressions without water) are found within the field trip area.

Kames

Kames are steep-sided low mounds, knobs, hummocks, or short irregular ridges composed of outwash sand and gravel. Kames were deposited where meltwater flowed down a hole or crack on the glacier surface into a subglacial cavity or where a superglacial stream flowed in a depression on the surface of the glacier (fig. 6). Kames are generally found where glaciers stagnated or where large remnant ice blocks were left in front of a receding ice margin.

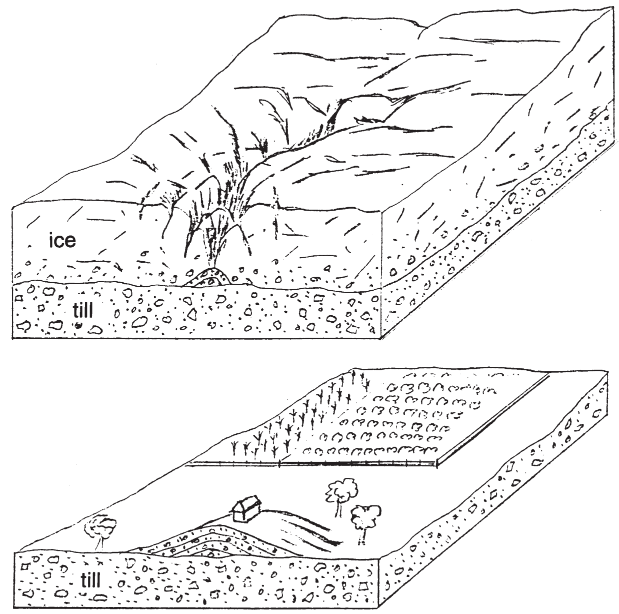


Figure 6 Block diagram of a kame. A kame is formed when meltwater carrying sediment plunges into a crevasse near the ice front and deposits its load of sediment. When the glacier ice finally melts away, the result is a mound of unstratified sand and gravel. Kames come in a variety of sizes and shapes, but commonly have a conical shape.

Eskers

Eskers are long, narrow, sinuous ridges consisting of stratified sand and gravel that represent channel deposits of meltwater streams that flowed in or under a melting glacier (fig. 7). Their preservation indicates that eskers formed in areas of stagnant ice; otherwise, they would have been destroyed by moving ice.

Meltwater, mainly from the surface of the glacier, flowed downward through crevasses and other openings to the base of the ice. There, under hydrostatic pressure, the meltwater enlarged a system of openings to form tunnels that then carried the meltwater flow toward the margin of the melting ice. The tunnels became partially filled with sediment released from the melting glacier, and, when the enclosing ice melted away, the sand and gravel were left standing as elongate ridges.

Eskers generally exhibit signs of branching and meandering, as modern surface streams do today. Eskers mark the position of former meltwater channels. The sand and gravel within the subglacial tunnels were deposited as the meltwater stream gradually slowed and could no longer carry its load of debris. The same principles of stream physics applies to modern rivers.

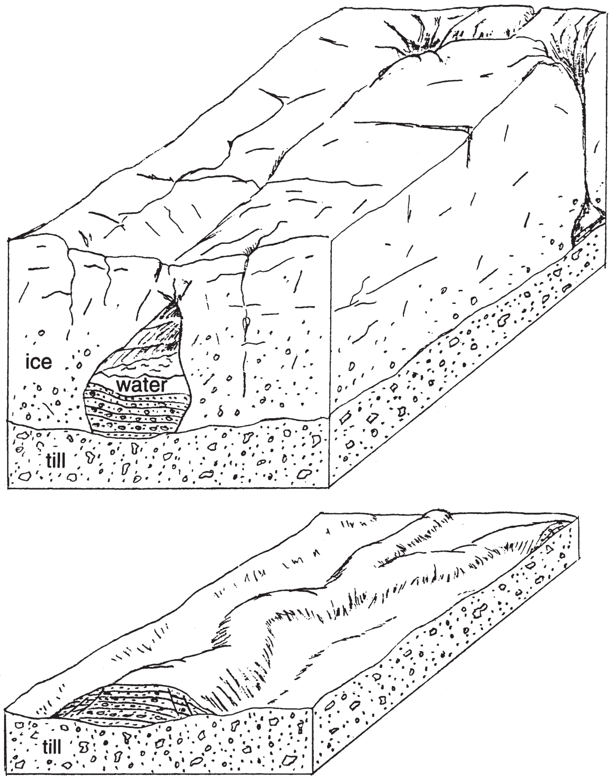
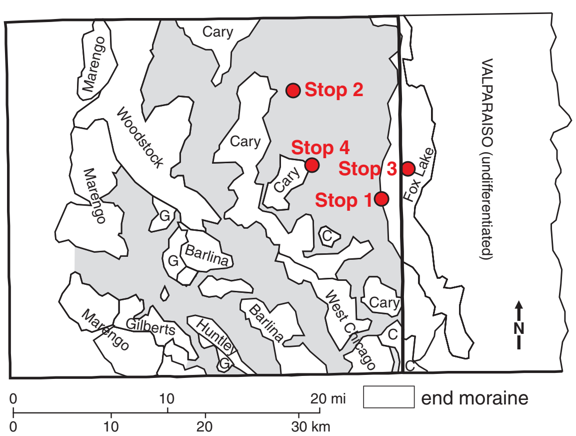


Figure 7 An esker is formed when a meltwater stream carrying sediment develops beneath a glacier. The stream develops a sinuous pattern as it flows under the ice. When the ice melts, the sediment is left as a long, narrow, winding ridge on the landscape.



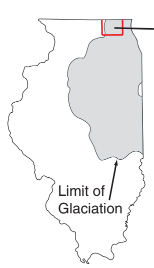


Figure 8 Limit of the Wisconsin glaciation and areal distribution of named moraines of the Wedron Group in the field trip area (modified from Hansel and Johnson 1996).

Although not observed in the field trip area, eskers and kames contain good-quality sand and gravel aggregate that is mined for construction material.

Glacial Stratigraphy

The field trip crosses the area between the Woodstock Moraine to the west and the Valparaiso Morainic System to the east (fig. 8). The geology is predominantly the result of continental glaciers and glacial meltwater of the last (Wisconsin Episode) glaciation. The Lake Michigan lobe of the Laurentide Ice Sheet advanced at least three times between about 25,000 and 12,000 years ago, depositing distinctive glacial tills that comprise units of the Tiskilwa, Lemont (Haeger Member), and Wadsworth Formations (Hansel and Johnson 1996). Lying between these tills are proglacial outwash (Henry Formation) and lacustrine sediments (Equality Formation) that were deposited in front of advancing and receding glaciers. These deposits, mapped from land surface to the top of bedrock, lie in a specific, or stratigraphic, succession that is observed repeatedly throughout northeastern Illinois.

WETLANDS

Because of its wide climate range, Illinois contains many wetland types, from cypress swamps in southern Illinois to bogs and fens in northern Illinois. Variations in hydrogeology also help determine what type of wetland forms, including the local geologic deposits, the topography (shape of land surface) at the site, and the characteristics of the water source that supplies the wetland. These factors help determine the quality of water and the depth and duration of inundation or saturation in the wetland, which can significantly affect which plants and animals are able to live in the site.

This field trip showcases different types of high-quality wetlands in northeastern Illinois and the factors that influenced their formation, such as water source, the hydrogeology that supports the water source, and their effects on the wetland type. We will also very briefly discuss the general history, geologic deposits, and functions of wetlands in Illinois. The following factors influence why wetlands form where they do and what type of wetland occurs. Each of these factors are interrelated, so while it may be easy to see how a particular wetland developed at one site, a different type of wetland may form at another area due to variations in one or more of the other factors.

Water Sources

The source of water that supplies a wetland influences the characteristics of that wetland, both directly and indirectly. The three major sources of water are pre-

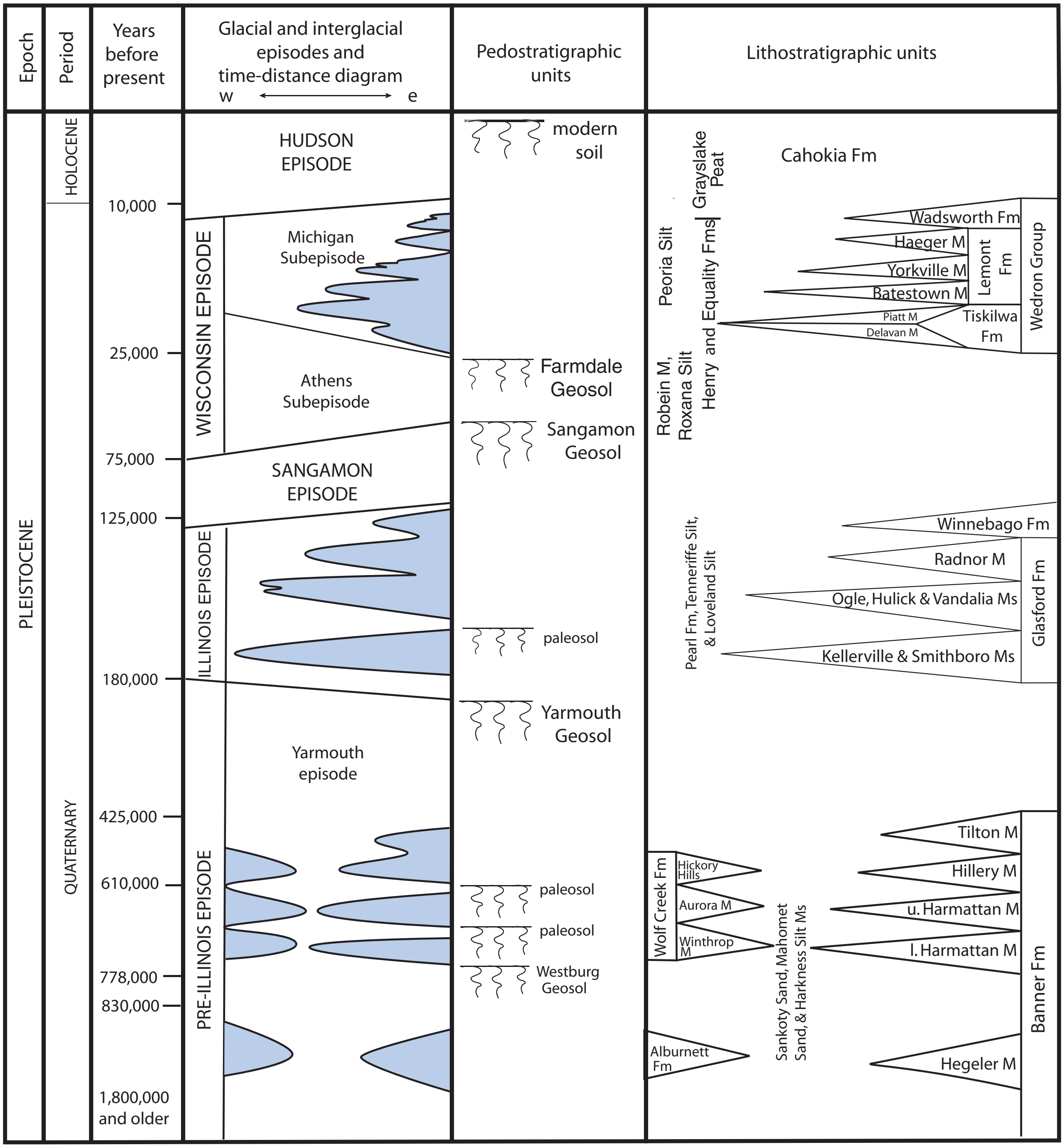


Figure 9 Generalized stratigraphic column of Pleistocene deposits within the field trip area.

cipitation, groundwater discharge, and surface runoff. Note that a wetland can receive water from more than one source, so some wetlands have a mixture of these characteristics.

Precipitation. Wetlands that receive their water mostly or solely from precipitation are called bogs. Bogs generally only form in places where precipitation greatly exceeds evaporation, such as northern or maritime climates. Precipitation generally is low in nutrients and dissolved solids and slightly acidic. Low nutrient levels in the bog water cause low plant productivity, and the lack of dissolved solids (especially buffering materials such as carbonates) allow the bog water to become acidic. Constant saturation in the anoxic (low or no oxygen) conditions helps preserve plant material and build up a peat layer. The acidic conditions eliminate many plants but provide a niche for certain rare plant types. Bogs are rare in Illinois because summer evaporation rates generally exceed precipitation, thus drying out most wetlands, allowing other vegetation to colonize and generally preventing accumulation of peat. During our visit to the Volo Bog Natural Area, we will discuss the hydrogeology that formed the basin and allowed the bog to develop.

Groundwater. Fens are wetlands that receive most of their water from groundwater discharge. Groundwater is enriched in dissolved solids, but does not usually contain large amounts of nutrients such as nitrogen. Thus, productivity in fens is generally low. Depending on the hydrogeology, the groundwater source may flow much or all of the year, thus providing a nearly continuous source of water to the wetland, which helps accumulate peat. In Illinois, most fens are mildly to strongly alkaline due to abundant carbonate minerals dissolved in groundwater from bedrock and surficial geologic deposits. This continuous saturation, cooler summer soil temperatures caused by the discharge, and higher concentrations of dissolved minerals combine to allow some boreal and alkaline-tolerant plant species to thrive while stunting or eliminating others. Like bogs, fens are relatively rare, although northeastern Illinois has a number of fens because of its geologic history. An example of this type of wetland occurs in the Lake in the Hills Fen Nature Preserve and in Pike Marsh at Moraine Hills State Park.

Surface Water. Surface water supports many types of wetlands across the country, from lakes to rivers to oceans. In Illinois, surface-water runoff supports some of the more numerous wetland types, including floodplain forests and some isolated wetlands. Runoff may occur as sheet wash, channelized flow from upland areas, or as overflow from rivers and creeks. Wetlands supported by runoff have more varied character than bogs and fens because the flooding regimes of the individual wetlands differ according to their individual topographic and geologic setting. In Illinois, rainfall and associated runoff are generally seasonal in nature, so wetlands that are dominantly supplied by runoff tend to have seasonal saturation. Long-term drying facilitates the decay of organic materials, and these wetlands generally lack peat deposits. The high silt levels and nutrient concentrations associated with surface runoff generally allow the less particular (weedy) plant species to dominate, because native plants are less adapted to these conditions. A floodplain forest occurs along the Fox River in the western portion of Moraine Hills State Park.

Geologic Setting (Geodiversity)

The type of geologic material that is present at the margin of a wetland greatly affects its character. The geology controls the drainage around and into the wetland by influencing variables such as the rate of infiltration. Clay-rich sediment, for example, inhibits the rapid movement of groundwater both vertically and horizontally, creating conditions favorable for wetlands to form. Alternatively, sandy soils are more permeable and allow more rapid rate of infiltration that would drain surface water.

Geologic materials also affect the quality of water entering a wetland. Groundwater flowing through these deposits leaches minerals from the sediment, changing the chemistry of the water. Some deposits, such as quartz-rich sands, do not readily contribute minerals to the groundwater, whereas water flowing through materials containing limestone and dolomite rock fragments leach greater amounts of minerals, including calcium, magnesium, and iron.

Topography

Topography has direct influences on the location and type of wetland that may form. The slope of the site determines whether surface water collects or drains away. The size (area) and depth of a basin determine how much surface water can be stored, thus affecting how long a wetland remains saturated during the drier periods. The depth and duration of saturation or inundation (collectively called the hydropattern) are two of the most critical factors in determining the type of plants that can inhabit a wetland. The effects of differing hydropatterns on the plant community can be seen at the marsh we will visit at Moraine Hills State Park.

Hydrology

Hydrology is the driving force behind the type of wetland and plant communities that exist. Hydrology is influenced greatly by the geology and topography and also by regional climate and vegetation. For example, as discussed earlier, sandy sediments at land surface tend to allow infiltration and might be less conducive to wetland development than clayey soils. However, the site hydrology (i.e., hydraulic gradient) will determine whether infiltration is allowed at all. If the hydrology allows groundwater to discharge at a site rather than infiltrate, then sandy sediments may facilitate wetlands by allowing copious discharge and long-term saturation. Given this interrelationship, the geology, hydrology, and topography need to be considered together, rather than individually, when evaluating the location, type, and features of a wetland.

Wetlands need to be continuously saturated or inundated for a minimum of 5% of the growing season, which in Illinois is about 9 to 10 days, to meet the federal definition of wetlands (Environmental Laboratory 1987). Although this minimum might be adequate for the driest wetlands (e.g., floodplain forests, wet prairie), it is insufficient for some of the wetter types of wetlands (e.g., fens, bogs, marshes), which need to be inundated or saturated for much longer to maintain their plant communities. During these wet periods, anoxic conditions form in the soil, which help inhibit non-wetland plant species from colonizing the wetland.

Other Factors

In addition to the factors already mentioned, other mechanisms can affect the type and features of a wetland. The biota of a wetland can change the conditions of the wetland in which they live (e.g., the growth of sphagnum mosses increases bog acidity). Also, the accumulation of peat or clays can alter the hydrology of a wetland through time. Wetland features can be altered by the wetland's specific history, such as the history of fire or fire suppression, natural or human-caused disturbance, including invasion of nonnative species. These and other factors are not discussed in detail in these materials.

A BRIEF HISTORY OF WETLANDS IN ILLINOIS

Throughout much of U.S. history, wetlands have been considered to be wastelands, leading to federal and state policies facilitating their drainage. Recently, wetland functions and their value to society have become widely recognized, and policies have shifted toward wetland protection and restoration. Wetland functions include storing floodwater; removing silt, nutrients, and contaminants from surface water; recharging shallow aquifers; maintaining low flows in streams during summer; providing wildlife habitat; and supporting recreational opportunities such as hunting and fishing (National Research Council 1995).

Prior to European settlement, there were about 8.3 million acres of wetlands in Illinois, covering about 23% of the state. Large swaths of wetlands were present, especially in the northeastern quadrant of Illinois and along the major rivers. Today, fewer than 9,000 acres of wetlands remain. Drainage for agriculture has been the driving force behind the losses.

The location of wetlands in Illinois reflects the geologic forces at work, dominated by glaciations that occurred in the last 250,000 years. Wetlands form readily on newly deposited glacial materials, partly due to the disruption of the previous drainage network and to the generally clay-rich nature of glacial sediments in Illinois. Glacial deposits cover about 90% of Illinois and include widespread fine-grained deposits such as glacial till, which facilitated wetland formation. However, many of the wetlands that formed on deposits of older glaciations in western and southern Illinois have drained naturally through time as the river networks stabilized after glaciation.

During the most recent (Wisconsin Episode) glaciation, large areas of wetlands were formed in southern Illinois as glacial sediment clogged the major river systems that carried meltwaters from northeastern Illinois, flooding adjacent tributaries. In northeastern Illinois, glaciers that retreated during this glaciation left a poorly drained landscape containing wet prairies, marshes, lakes, sloughs, and rivers. In this landscape, large areas of wetlands thrived even into the late 1800s, when private drainage schemes reclaimed many of these areas for farmland.

Glaciers and their meltwaters created wetlands in many other ways. They eroded into preexisting rocks and sediments, exposing aquifers and causing groundwater discharge. Meltwaters created vast river floodplains that blocked tributary streams to form lakes and formed new channels and abandoned older ones as sloughs, oxbow lakes, and other backwater areas. The Cache River swamps in southern Illinois, nominated as Wetlands of International Importance under the Ramsar Convention, were formed in the abandoned channel of the ancestral Ohio River after it shifted southward to its present course.

Wetlands hold important mineral resources (peat). Once drained, either naturally or upon human working, fertile organic-rich soils develop that are productive for growing cash crops (such as root crops and leaf vegetables) and bedding plants for the market gardening and horticultural industries. The thick peat deposits infilling wetland depressions are also mined in some parts of Illinois. The peat is used as an additive to soil to increase its fertility and as a source of energy once burned. The coal deposits, one of the state's most valuable mineral resources, accumulated first as peat during the Pennsylvanian time in ancient swamps that existed across large sections of Illinois.

GUIDE TO THE ROUTE

Assemble at the Northern Woods parking lot in Moraine Hills State Park (NW, SE, NW, Sec. 6, T44N, R9E), 3rd P.M., Wauconda 7.5-minute Quadrangle, McHenry County.

You must travel in the caravan. Please drive with headlights on while in the caravan. Drive safely but stay as close as you can to the car in front of you. Please obey all traffic signals and signs. If the road crossing is protected by an Illinois State Geological Survey (ISGS) vehicle with flashing lights and flags, please obey the signals of the ISGS staff directing traffic. When we stop, park as close as possible to the car in front of you and turn off your lights.

Private property. Some stops on the field trip are on private property. The owners have graciously given us permission to visit on the day of the field trip only. Please conduct yourselves as guests and obey all instructions from the trip leaders. So that we may be welcome to return on future field trips, follow these simple rules of courtesy:

- Do not litter the area.
- Do not climb on fences.
- Leave all gates as you found them.
- Treat public property as if you were the owner—which you are!
- Stay off all mining equipment.
- Parents must closely supervise their children at all times.

When using this booklet for another field trip with your students, a youth group, or family, remember that you must get permission from property owners or their agents before entering private property. No trespassing, please.

Four USGS 7.5-minute Quadrangle Maps (Fox Lake, McHenry, Richmond, and Wauconda) provide coverage for this field trip area.

Please note: A large number of the roads and intersections are unmarked. Special attention with regard to the mileages and the route maps will help individuals conducting their own field trips in the future.

STOP 1. Moraine Hills State Park (NW, SW, NE, Sec. 6, T44N, R9E), 3rd P.M., Wauconda 7.5-minute Quadrangle, McHenry County. On the day of the field trip, we will hike the Lake Defiance Self-guided Interpretive Trail. The trail starts at the Park Office and Nature Center.

Miles to next point	Miles from start	
0.0	0.0	Set your trip odometers to 0.0 at the beginning of the loop at the Northern Woods parking lot in Moraine Hills State Park. Follow the main park road to the park entrance along River Road.
2.0	2.0	STOP (one-way). Park entrance and South River Road. Turn right onto River Road.
0.8	2.8	T-intersection from the left (McHenry Dam Road). CONTINUE AHEAD.
0.8	3.6	STOP LIGHT. T-intersection from the left (Charles J. Miller Road). CONTINUE AHEAD.
0.9	4.5	T-intersection from the left (North River Road). TURN LEFT. Chapel Hill Road continues straight ahead.
0.9	5.4	STOP LIGHT. Intersection of River Road and Illinois Route 120. TURN LEFT onto Illinois Route 120. Immediately after the turn, cross the Fox River and enter McHenry (population 24,493). Illinois Route 120 follows Elm Street.

0.2	5.6	STOP LIGHT. Intersection of River Side Drive. CONTINUE AHEAD.
0.2	5.8	STOP LIGHT. Intersection of Green Street. CONTINUE AHEAD.
0.05	5.85	STOP LIGHT. Intersection of Illinois Route 120 (Elm Street) and Illinois Route 31 North (Richmond Road). TURN RIGHT onto Illinois Route 31 North (Richmond Road).
0.1	5.95	STOP LIGHT. T-intersection from the right (Pearl Street). CONTINUE AHEAD.
0.45	6.4	STOP LIGHT. Intersection of McCullom Lake Road. CONTINUE AHEAD.
0.35	6.75	STOP LIGHT. Intersection of Blake Road. CONTINUE AHEAD.
0.55	7.3	STOP LIGHT. Intersection of Diamond Drive. CONTINUE AHEAD.
0.8	8.1	STOP LIGHT. T-intersection from the right (Johnsburg Road). CONTINUE AHEAD.
0.55	8.65	T-intersection from the right (Pioneer Road). CONTINUE AHEAD.
1.15	9.8	STOP LIGHT. Intersection of Ringwood Road. CONTINUE AHEAD.
2.0	11.8	Crossroad intersection (Illinois Route 31/Richmond Road and Harts Road). TURN LEFT onto Harts Road. Entrance to Glacial Park Conservation Area.
0.3	12.1	Cross Prairie Trail North bike trail. This trail follows an old abandoned railroad and is one of the rails-to-trails projects.
0.8	12.9	T-intersection. TURN RIGHT into Wiedrich Barn parking lot.

STOP 2. Glacial Park Conservation Area (SE, SW, NE, Sec. 32, T46N, R8E), 3rd P.M., Richmond 7.5-minute Quadrangle, McHenry County. On the day of the field trip, we will hike the 2.1-mile Deerpath Trail.

0.1	13.0	Leave STOP 2. Exit parking lot. TURN LEFT onto Harts Road.
0.9	13.9	Cross Prairie Trail North bike trail.
0.3	14.2	STOP (two-way). Crossroad intersection (Illinois Route 31/Richmond Road and Harts Road). TURN RIGHT onto Illinois Route 31/Richmond Road.
1.9	16.1	STOP LIGHT. Intersection of Ringwood Road. CONTINUE AHEAD.
1.75	17.85	STOP LIGHT. Intersection of Illinois Route 31 (Richmond Road) and Johnsburg Road. TURN LEFT onto Johnsburg Road.
0.6	18.45	Flashing yellow light. Intersection of Riverside Drive. CONTINUE AHEAD.
0.75	19.2	T-intersection from the left (Spring Grove). CONTINUE AHEAD.
0.1	19.3	STOP (four-way). Intersection of Chapel Hill Road to the right and St. Johns Avenue to the left. TURN RIGHT onto Chapel Hill Road.

0.3	19.6	Cross Fox River.
0.4	20.0	T-intersection from the left (Bay Road). TURN LEFT onto Bay Road.
1.3	21.3	T-intersection from the right (Cuhlman Road). TURN RIGHT onto Cuhlman Road.
0.7	22.0	STOP (two-way). T-intersection (Cuhlman Road and Lincoln Road). TURN LEFT. CAUTION: Traffic from the right does not stop.
0.9	22.9	Enter Lake County. Lincoln Road becomes Sullivan Lake Road.
0.2	23.1	T-intersection from the left (Brandenburg Road). Unmarked intersection. TURN LEFT onto Brandenburg Road. A small sign for Volo Bog is located on the northeast corner of the intersection.
0.4	23.5	T-intersection from the right (entrance to Volo Bog State Natural Area). TURN RIGHT into parking lot.

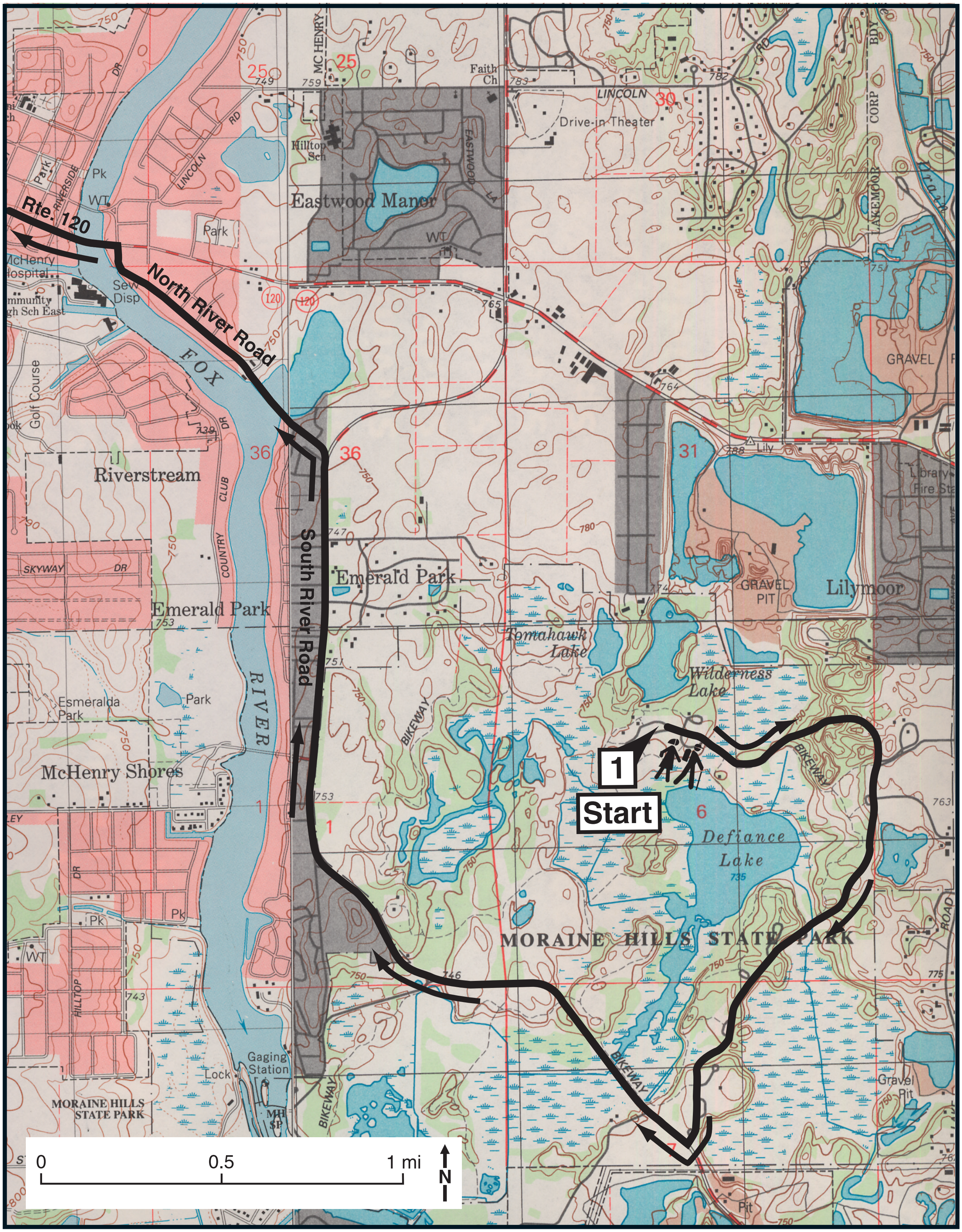
STOP 3. Volo Bog State Natural Area (SW, SW, NE, Sec. 28, T45N, R9E), 3rd P.M., Wauconda 7.5-minute Quadrangle, Lake County. This will be our lunch stop. After lunch, we will visit the Visitor Center and hike the Volo Bog Interpretive Trail.

0.1	23.6	Exit parking lot and TURN LEFT onto Brandenburg Road.
0.4	24.0	STOP (one-way). T-intersection (Sullivan Lake Road). TURN RIGHT onto Sullivan Lake Road.
0.4	24.4	Enter McHenry County, Sullivan Lake Road becomes Lincoln Road.
0.7	25.1	STOP (two-way). T-intersection from the left (Cuhlman Road). CONTINUE AHEAD on Lincoln Road. CAUTION: Oncoming traffic does not stop.
1.4	26.5	STOP (four-way). Intersection of Lincoln Road and Chapel Hill Road. TURN LEFT onto Chapel Hill Road. McHenry Outdoor Theater, one of the state's few remaining drive-in theaters, is located at southeast corner of this intersection.
0.6	27.1	STOP LIGHT. Intersection of Chapel Hill Road and Illinois Route 120. TURN RIGHT onto Illinois Route 120.
1.1	28.2	STOP LIGHT. Intersection of North River Road. CONTINUE AHEAD.
0.1	28.3	Cross Fox River.
0.1	28.4	STOP LIGHT. Intersection of Riverside Drive. CONTINUE AHEAD.
0.2	28.6	STOP LIGHT. Intersection of Green Street. CONTINUE AHEAD.
0.05	28.65	STOP LIGHT. Intersection of Illinois Route 120 (Elm Street) and Illinois Route 31 north (Richmond Road). CONTINUE AHEAD. Follow Illinois Route 120 (Elm Street).

0.35	29.0	STOP LIGHT. Intersection of Illinois Route 120 (Elm Street) and Illinois Route 31 South (Front Street). CONTINUE AHEAD, follow Illinois Route 120 (Elm Street).
0.1	29.1	Cross single set of railroad tracks. CAUTION: Unguarded; signal lights only.
0.05	29.15	STOP LIGHT. Intersection of Crystal Lake Road. CONTINUE AHEAD.
0.25	29.4	STOP LIGHT. Intersection of Oak Drive. CONTINUE AHEAD.
0.4	29.8	STOP LIGHT. Intersection of Meadow Lane. CONTINUE AHEAD.
0.9	30.7	STOP LIGHT. Intersection of Ringwood Road. CONTINUE AHEAD.
0.3	31.0	STOP LIGHT. Intersection of Dot Street. CONTINUE AHEAD. Meyer Material's main office is located on the left.
0.8	31.8	Valley View Elementary School is on the left.
0.3	32.1	Prepare to turn left; move into the turning lane.
0.1	32.2	Entrance to Meyer Material Pit 26 on the left. TURN LEFT. The entrance to the sand and gravel pit is directly across from the Ostend Cemetery.

STOP 4. Meyer Material Company Pit 26 (NW, NW, NW, Sec. 29, T45N, R8E), 3rd P.M., McHenry 7.5-minute Quadrangle, McHenry County. We will view the deposits in this gravel pit and discuss the importance of the sand and gravel industry in McHenry County.

End of road log.


Rte. 120
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South River Road
1
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Eastwood Manor
Riverstream
Emerald Park
McHenry Shores
Tomahawk Lake
Wilderness Lake
Defiance Lake
Lilymoor
MORAINE HILLS STATE PARK
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Drive-in Theater
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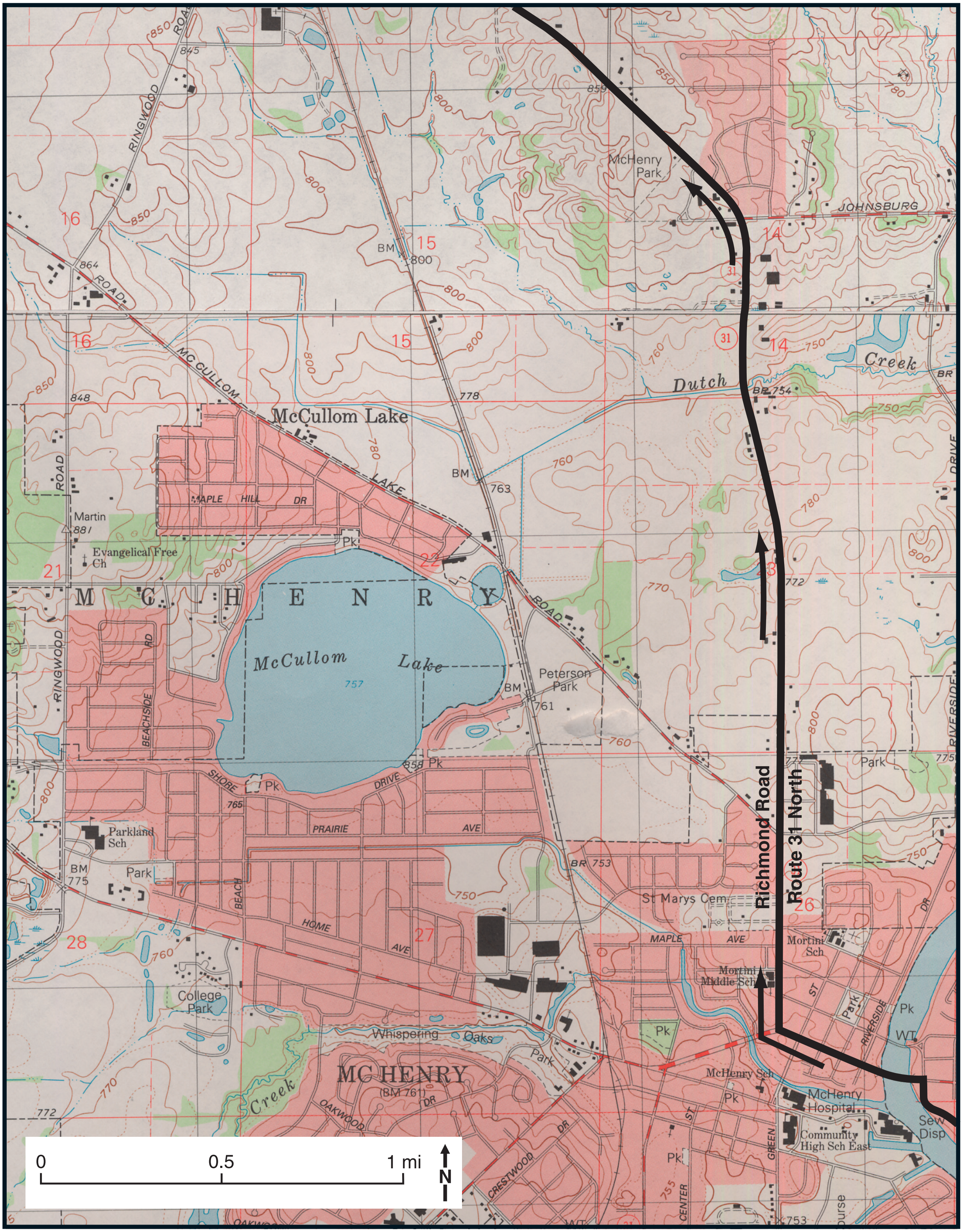
Richmond Road
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McCullom Lake
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MC HENRY
Dutch Creek
Peterson Park
St Marys Cem
Parkland Sch
College Park
Whispering Oaks Park
Mortini Middle Sch
Mortini Sch
McHenry Sch
McHenry Hospital
Community High Sch East
Sew Disp
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Evangelical Free Ch
JOHNSBURG
RINGWOOD ROAD
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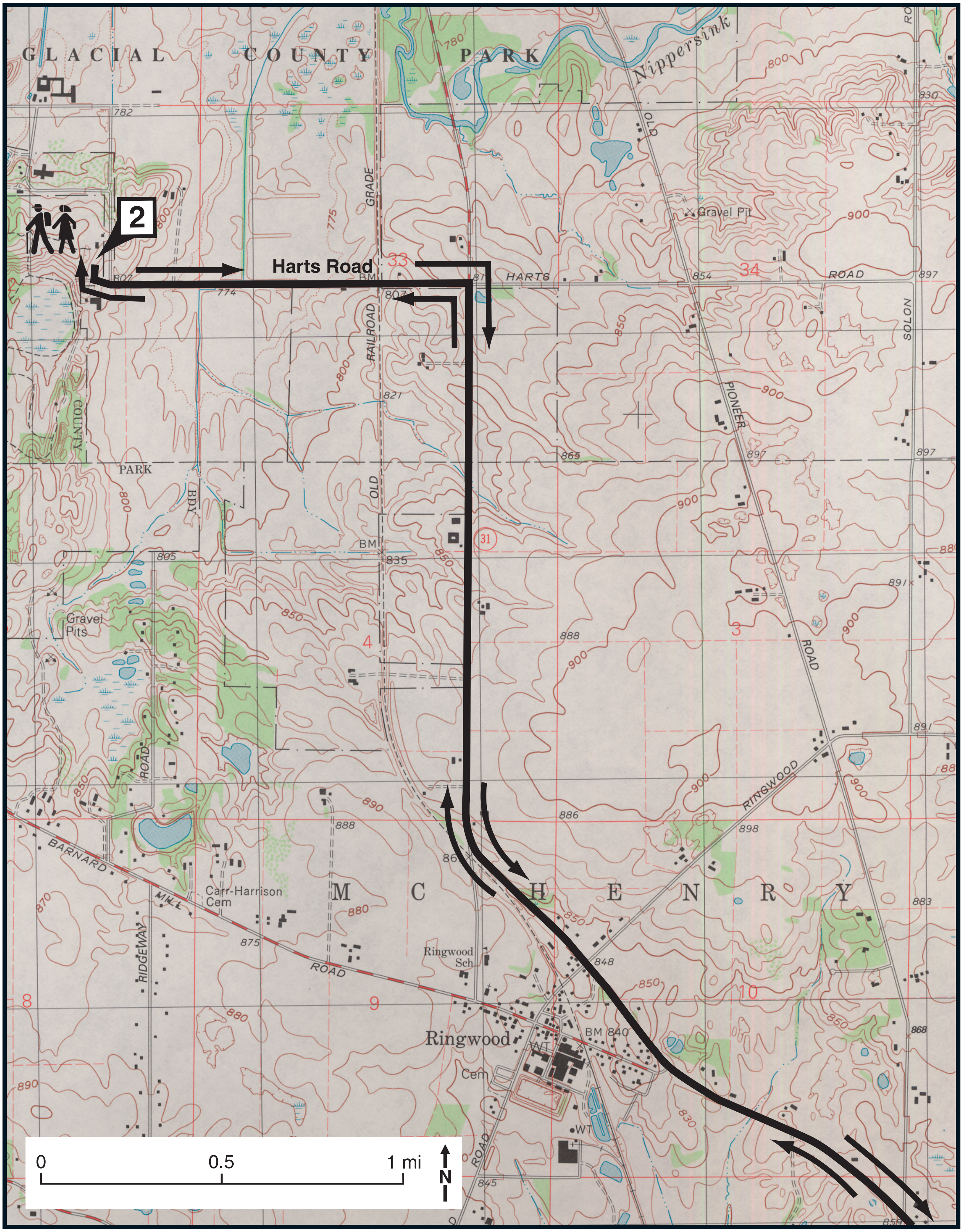
GLACIAL COUNTY PARK
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RAILROAD
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Gravel Pits
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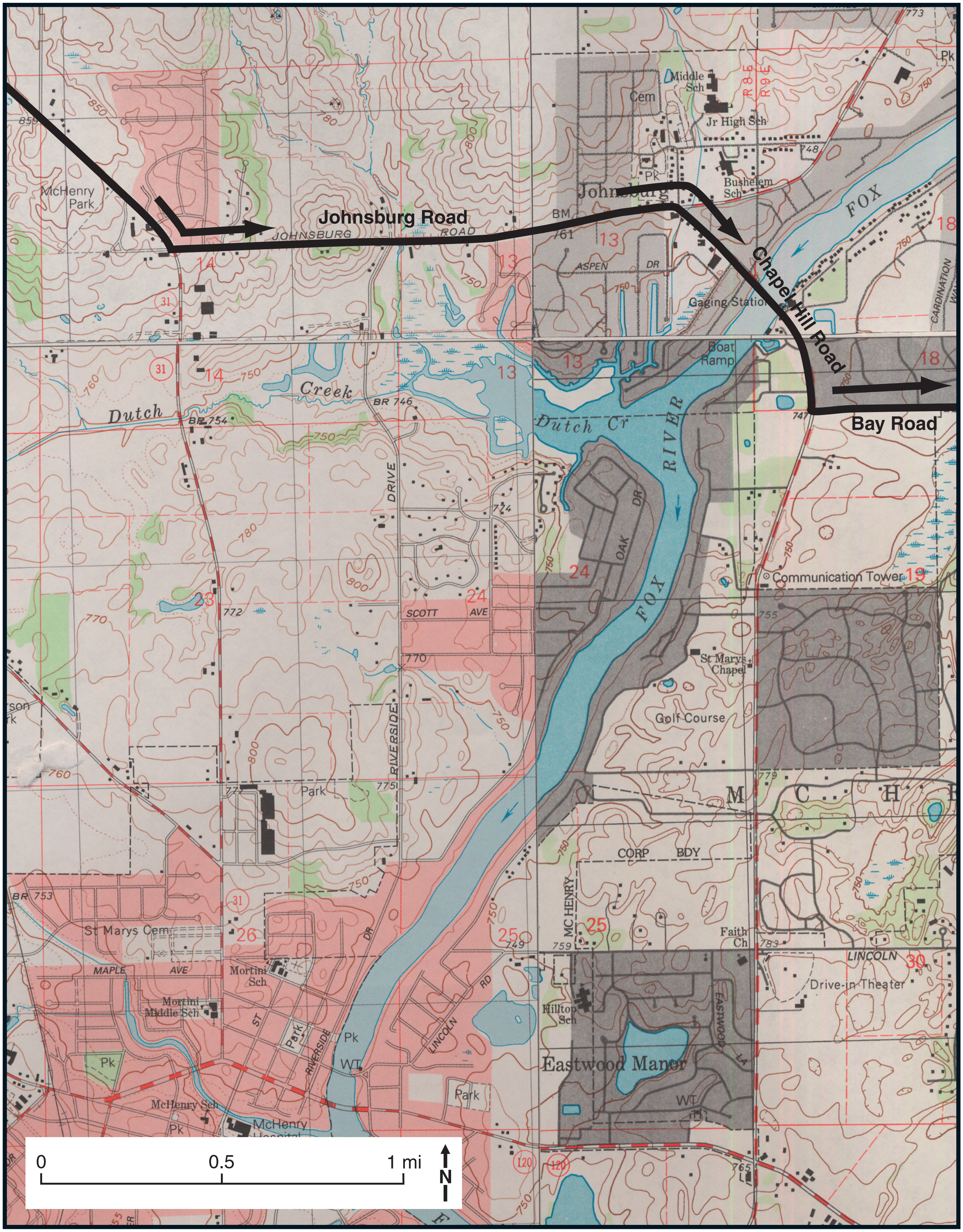
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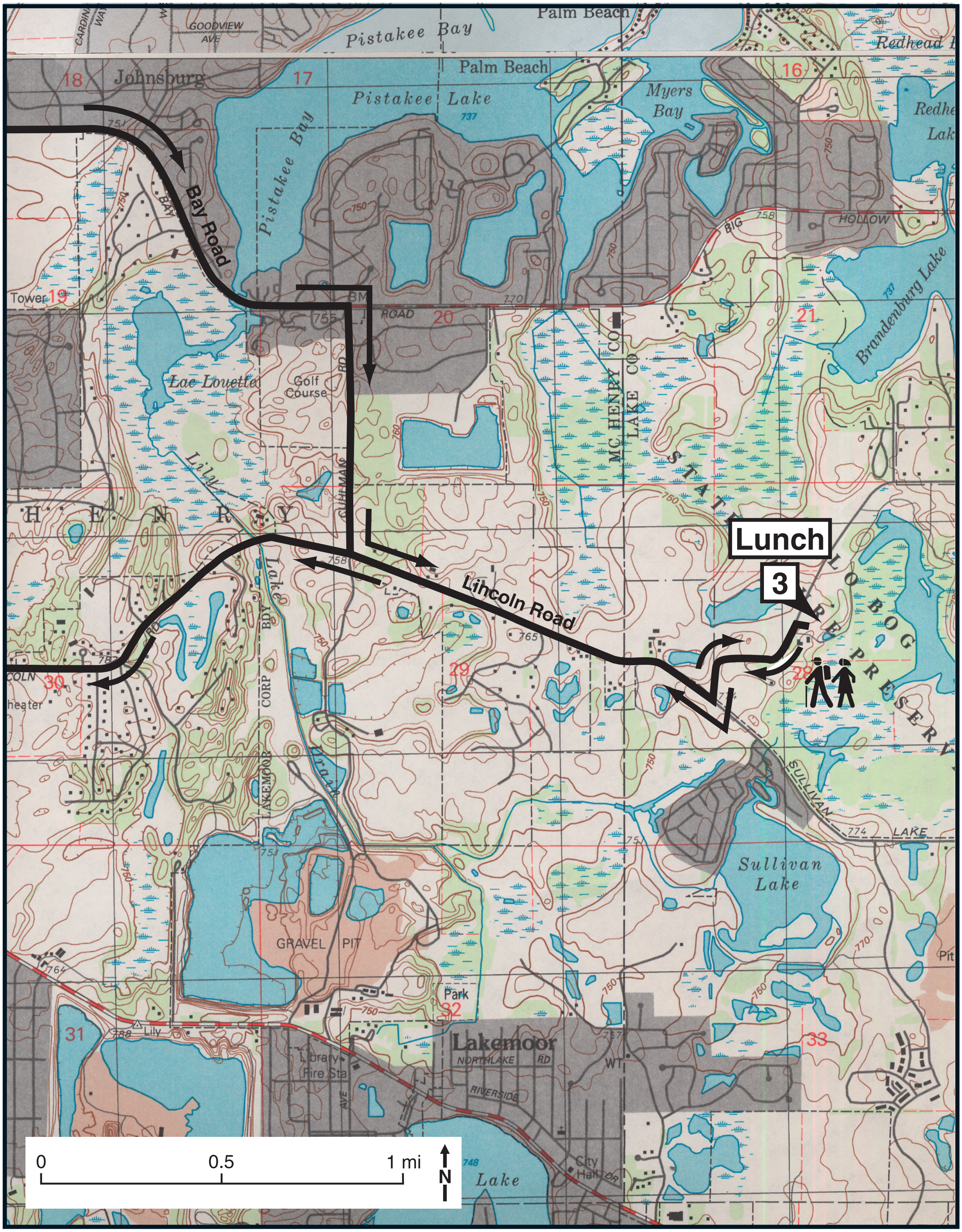
Palm Beach
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Redhead
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Pistakee Lake
Myers Bay
Redhead Lake
Pistakee Bay
Bay Road
BIG HOLLOW
Brandenburg Lake
Tower
ROAD
Lac Louette
Golf Course
MC HENRY CO
LAKE CO
Lily Lake
Lunch
3
Lincoln Road
STATE
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PRESERVE
Sullivan Lake
SULLIVAN LAKE
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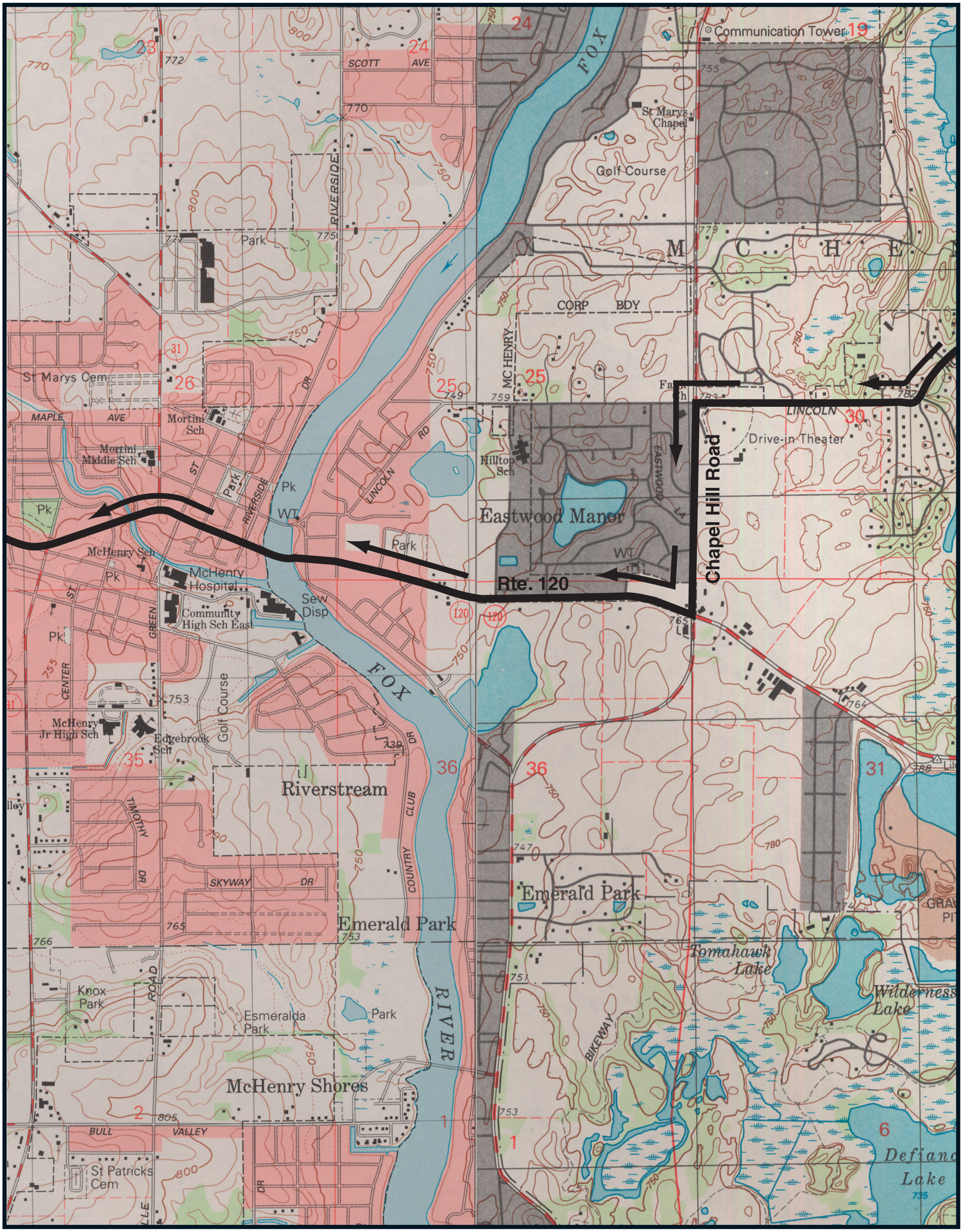
Communication Tower
St Marys Chapel
Golf Course
SCOTT AVE
RIVERSIDE DR
FOX
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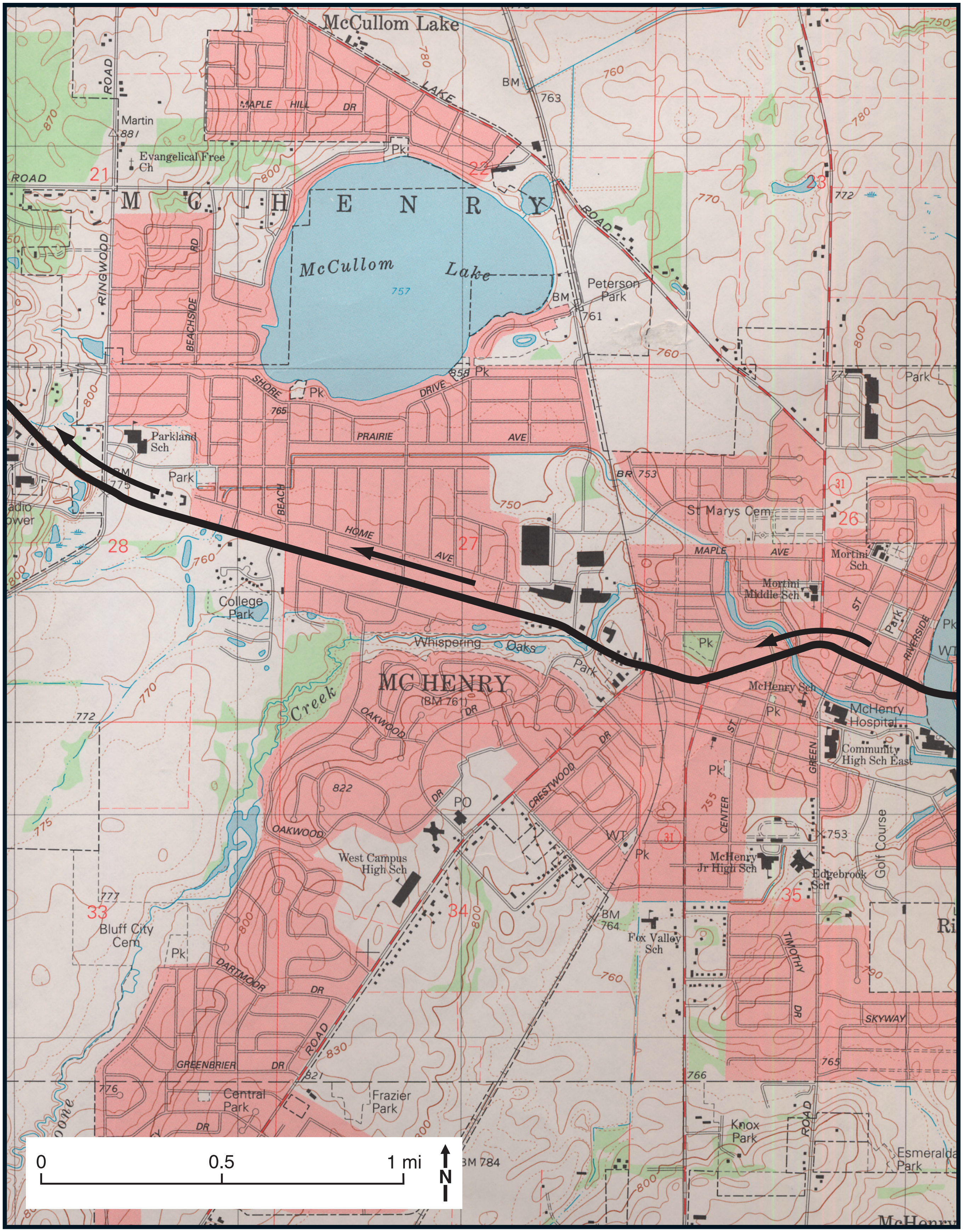
CORP BDY
MC HENRY
St Marys Cem
MAPLE AVE
Mortini Sch
Mortini Middle Sch
Park
Pk
WT
LINCOLN RD
Hilltop Sch
Eastwood Manor
EASTWOOD LA
LINCOLN
Drive-in Theater
Chapel Hill Road
Rte. 120
McHenry Sch
McHenry Hospital
Community High Sch East
Sew Disp
CENTER ST
GREEN ST
Golf Course
McHenry Jr High Sch
Edgebrook Sch
Riverstream
COUNTRY CLUB DR
TIMOTHY DR
SKYWAY DR
Emerald Park
Emerald Park
Tomahawk Lake
Wilderness Lake
Knox Park
ROAD
Esmeralda Park
RIVER
BIKEWAY
McHenry Shores
BULL VALLEY
St Patricks Cem
Defiance Lake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Parkland Sch
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BEACH
HOME AVE
St Marys Cem
MAPLE AVE
Mortini Sch
Mortini Middle Sch
College Park
Whispering Oaks
Park
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MC HENRY
(BM 761)
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CRESTWOOD DR
McHenry Sch
McHenry Hospital
Community High Sch East
GREEN
CENTER
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McHenry Jr High Sch
Edgebrook Sch
Golf Course
West Campus High Sch
Bluff City Cem
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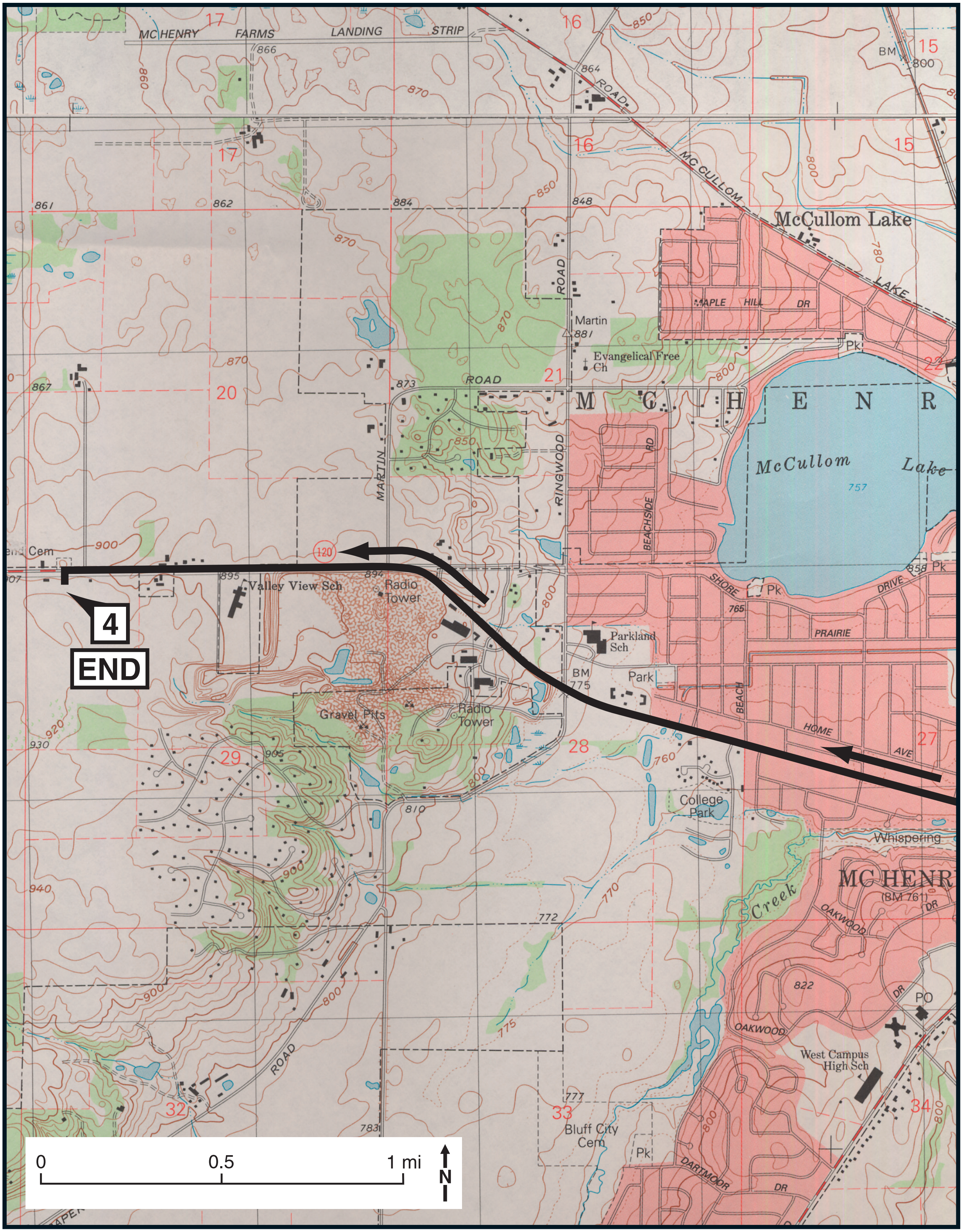
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STOP DESCRIPTIONS

STOP 1. Moraine Hills State Park (NW, SW, NE, Sec. 6, T44N, R9E), 3rd P.M., Wauconda 7.5-minute Quadrangle, McHenry County. On the day of the field trip, we will hike the Lake Defiance Self-guided Interpretive Trail. The trail starts at the Park Office and Nature Center.

Park History

Artifacts found on the park property indicate the presence of humans in the area within 1,000 years of the last (Wisconsin) glacier's retreat. Seasonal habitation of the park area extends back to approximately 4,000 B.C. Native American tribes that occupied or passed through the area include the Potawatomi, Sauk, Fox, and possibly the Miami and Winnebago. The Sauk and Fox tribes, originally from what is now Canada, claimed ownership of the land at the time of European settlement.

Horace Long was the first known settler in the park area, and he occupied a portion of what is now the southeast corner of the park. Part of the stone foundation from his cabin still stands along the main park road.

In 1907, the original McHenry Dam was built, and a hand-operated lock was constructed. The facilities were donated to the people of Illinois in 1924, and construction of a new concrete block dam began in 1934. In the early 1960s, a portion of the park property on the west bank of the Fox River was provided for the locks and managed by the Division of Water Resources.

In 1939, the State of Illinois made the initial land acquisition of 15 acres for the McHenry Dam State Park, located on the east bank of the Fox River. The State began the acquisition of the area known as Lake Defiance in 1971. During spring 1975, the construction of the park facilities began, and in October of 1976, Moraine Hills State Park officially opened. Moraine Hills offers a variety of plant species that have occupied this area for thousands of years. Roughly half of the park's 2,200 acres is composed of wetlands and lakes (fig. 10). The other half consists of moraines dominated by hardwood forest. Portions of the park's unique habitats are specific to a particular type of plant species.

Natural Features

A 48-acre lake near the center of the park was formed when a large portion of ice broke away from the main glacier and melted. Lake Defiance is gradually filling in with peat from its unstable shoreline. The lake is one of the few glacial lakes in Illinois that has remained largely undeveloped, maintaining a near-natural condition.

Pike Marsh, a 115-acre area in the southeast corner of the park, is home to many rare plants. Its outer fen area (a very rare marsh wetland) includes Ohio goldenrod, Kalm's lobelia, dwarf birch, and hoary willow. Cattails and bulrushes grow in its interior. Pike Marsh also supports one of the state's largest known colonies of pitcher plants, which attract, trap, and digest insects.

The 120-acre region known as Leatherleaf Bog is an excellent example of kettle-moraine topography. In geologic terms, a kettle is a depression formed when an isolated block of glacial ice melts. The bog consists of a floating mat of sphagnum moss and leatherleaf surrounded by a water moat. Marsh fern, marsh marigold, St. John's wort, and several species of willow put down roots here. Both Pike Marsh and Leatherleaf Bog are dedicated nature preserves and are protected by law.

Leatherleaf is a green shrub common to bogs and wetlands. Because of its high acidity, it is sometimes the first bog plant forming floating mats around the edge. The rate of advance of Leatherleaf has been recorded in Massachusetts at 1 foot per decade.

Wetland Management

Moraine Hills offers three examples of wetland enhancements: Yellowhead Marsh, Black Tern Marsh, and Opossum Run Marsh are all kettle lakes with human-regulated water levels. Through wetland management, each part of the park has its own water level, depending on the vegetation and wildlife desired. Specific water levels are achieved through the use of board gates where water naturally drains from the marshes and lakes. Water level at Yellowhead Marsh has been kept high recently to increase the population of muskrats living in the marsh and decrease the population of cattails along the shoreline through drowning.

Lake Defiance is both naturally and human-regulated. It uses board gates to regulate the overall water level; however, on the southwest corner of the lake is a 200-yard beaver dam that keeps water level 18 inches higher than normal.

Human activity around the park has also affected water levels. The three lakes to the north were once supplied by a constant flow of fresh water from a gravel pit settling pond. After the gravel pit stopped production

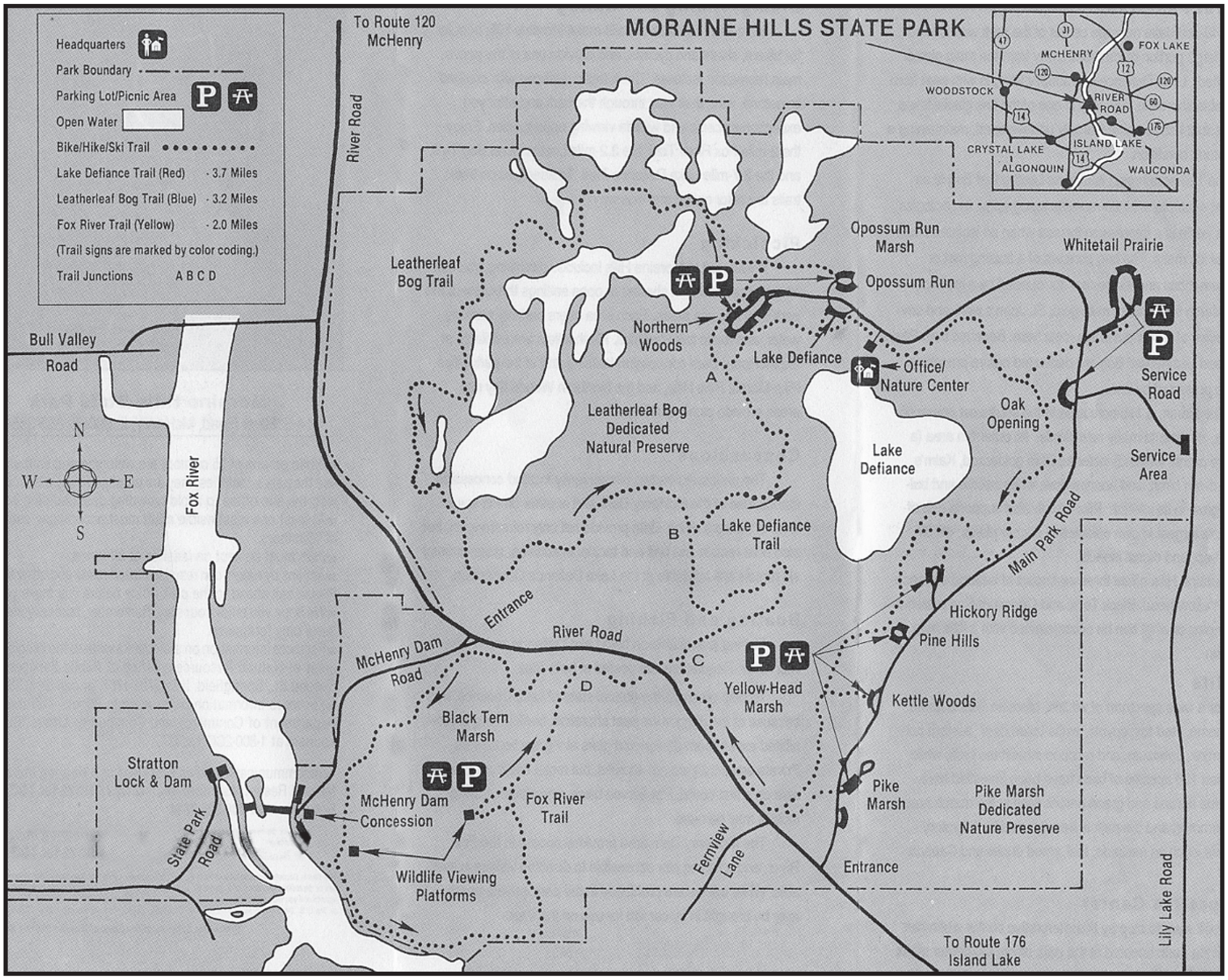

Figure 10 Moraine Hills State Park (Illinois Department of Natural Resources 1996).

in that area, the settling pond dried up. Subsequently, the lakes within the northern portion of the park lost substantial water level. The depth of Tomahawk Lake decreased from 8 feet and stocked with fish to 1 foot. Warrior Lake and Wilderness Lake went from 1 foot deep to marshland. Throughout the park, the marshes drain into Lake Defiance through natural gravity driven flow or through 1 of 15 human-made ditches and then into the Fox River.

Geology

Moraine Hills derives its name from the geologic landform known as a moraine, which is composed of sediment deposited by a glacier that includes clay, silt, and sand particles with rock fragments from pebble to boulder size. The park lies along the western edge of the Fox Lake Moraine (fig. 8). Following the Wisconsin Episode, as ice melted from the area, the sand and gravel deposits (kames) were left behind. The kames make up the park's wooded hills and ridges.

The topography and geology of Moraine Hills State Park are the result of the last major advance of Wisconsin Episode glaciers 16,000 years ago (Hansel and Johnson 1996). The topographic map (fig. 11) shows that the park landscape consists of steep-sided hills surrounding basins. The geologic map (fig. 12) shows that the hills are composed of sand and gravel of the Henry Formation and some Haeger Member till, and the basins are infilled by Grayslake Peat (fig. 9). This topography and geology are the result of the glacier becoming stagnant after advancing. As a result, the glacier collapsed into blocks of ice surrounded by streams that carried away meltwaters from the ice blocks and from the subsequent glacial advance that stopped just east of this area. The streams deposited sand and gravel around the ice blocks. After the ice blocks melted, these areas became depressions that are now occupied by Lake Defiance and the other lakes and marshes in the park. Diamicton is present in places, deposited as subglacial till or along former ice margins. The Grayslake Peat in

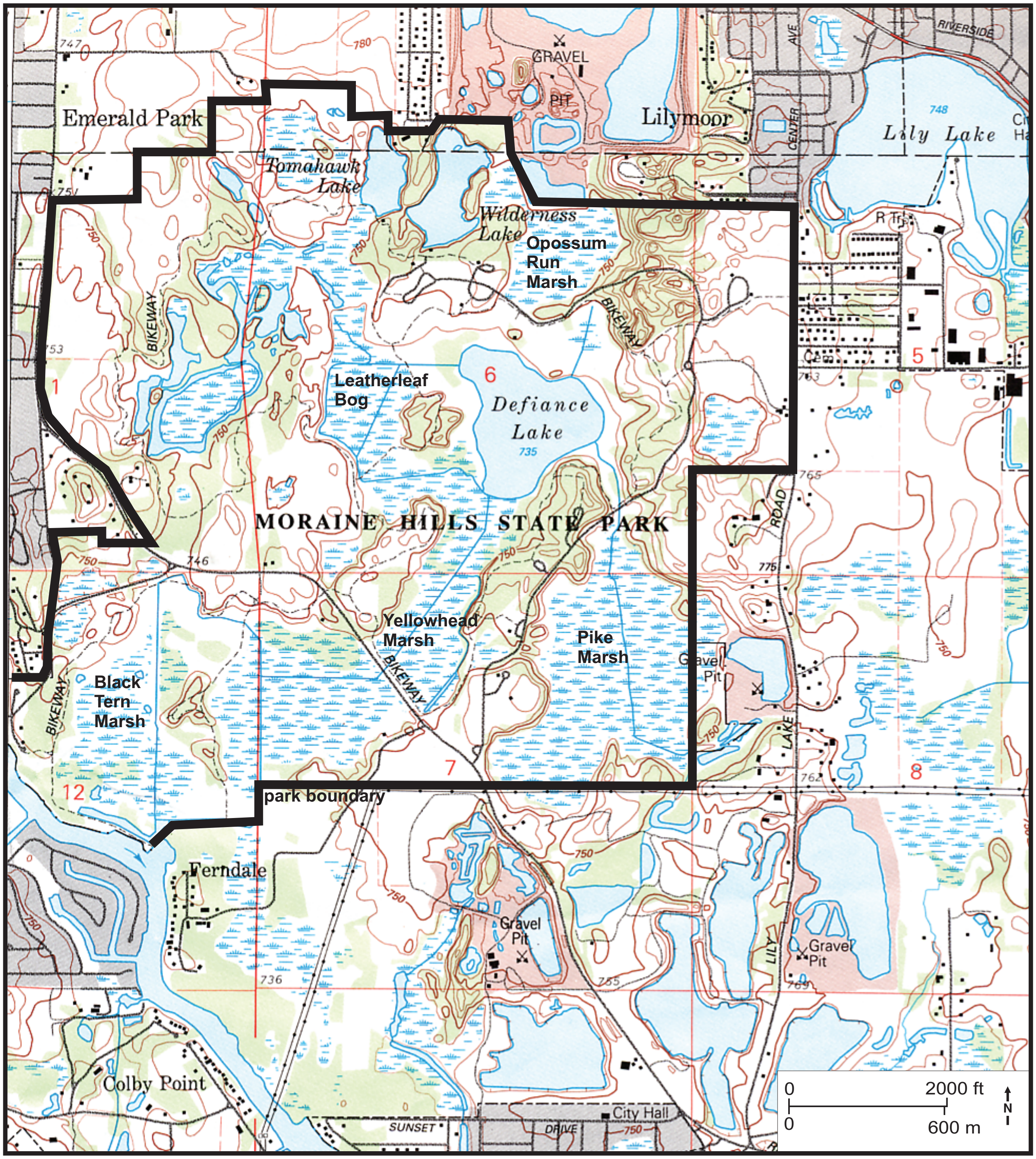

Figure 11 Topography of Moraine Hills State Park (U.S. Geological Survey 1993).

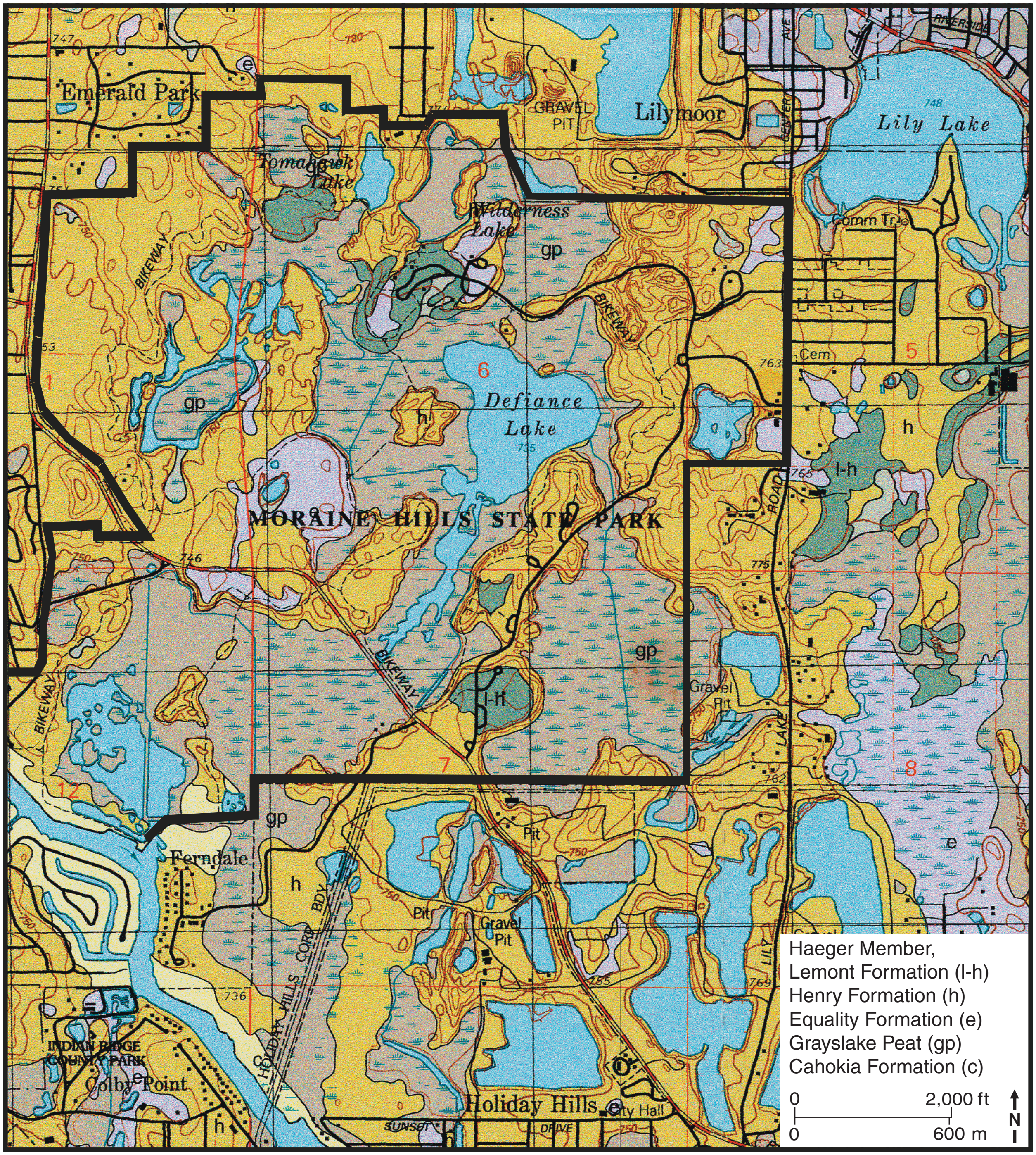

Figure 12 Surficial geology of Moraine Hills State Park (Stumpf et al. 2004).

this and other basins in the area (figs. 9 and 12) began to form about 12,500 ^{14}C years BP to about 9,000 ^{14}C years BP.

Lake Defiance is the largest lake in Moraine Hills State Park. Around the lake margins is a freshwater marsh dominated by grasses and sedges (Mitsch and Gosselink 1986). The marsh is relatively undisturbed because Lake Defiance was privately owned and lightly developed prior to its acquisition by the State of Illinois (Tichacek 1968). Therefore, the marsh is an excellent example of a wetland that likely could have been found around many of the lakes in the region in presettlement times.

Marshes

Marshes are found throughout most of the continental United States and occur in a wide variety of geologic settings. The largest known marsh system in the United States is the Florida Everglades, which once covered an area of 10,000 km^2 (Mitsch and Gosselink 1986). Prairie pothole marshes, which can be smaller than 1 acre, are found from New York to the Dakotas. The greatest concentrations of prairie potholes are in Wisconsin, Minnesota, and the Dakotas, where they are the major nursery for waterfowl. Marshes are also found along streams and rivers, along the Great Lakes shorelines, in the valleys of California, and in the playas of Texas and New Mexico (Mitsch and Gosselink 1986).

Marshes tend to be eutrophic, that is, nutrient-rich and highly productive. They can support large numbers and varieties of plants, insects, and animals. Marshes that have surface-water year round, such as at Lake Defiance, are peat-forming (Mitsch and Gosselink 1986). Unlike bogs, where low pH inhibits decomposition, peat forms in marshes due to the high productivity and relatively low decomposition rate of submerged, dead plant material.

Water levels in marshes are a balance between water inputs and water outputs. Inputs to Lake Defiance and its marsh include groundwater, runoff from the surrounding hills, surface-water flow from Pike Marsh (fig. 11), and precipitation. Outputs from the lake and marsh include evapotranspiration (evaporation from the water or soil surface and the uptake of water by plants) and the flow of water from the lake into the Fox River via a drainage ditch through Yellowhead Marsh (fig. 11). This drainage ditch was dug prior to acquisition of the land for the park in an attempt to drain the marshes for other uses. Natural (beaver dam) and human-built structures in the ditch have mostly reversed its effect on Lake Defiance and the marsh (Illinois Department of Natural Resources, undated pamphlet).

Marshes may have a variety of water sources, including surface water runoff, groundwater discharge, and precipitation. Marshes generally have fluctuating water levels because inputs and outputs to the marsh change seasonally. Water levels tend to be highest during spring because water losses (e.g., evapotranspiration) are relatively low, and inputs (e.g., precipitation and runoff) are high. Water levels are lowest in the summer when evapotranspiration is at its highest (Hensel 1992) and runoff is low. Seasonal fluctuations in the depth of the water table control marsh development. At Moraine Hills, the deeper marshes are inundated for most or all of the year; shallow marshes generally dry out in summer and may only be inundated for short periods in spring. The hydropattern of this marsh (the depth and duration of inundation or saturation) is more controlled by topography (i.e., the height of the marsh above the water table).

Although there are a few other lakes in Moraine Hills State Park, most of the other kettles typically contain wetlands such as Pike Marsh (fig. 11), which contains mostly shallow marsh or wet meadow. The basins in which these marshes developed were likely open water in the past, but the accumulation of peat plus sediment from upland erosion filled them in. Lake Defiance and the other lakes may have been deeper or did not receive as much sedimentation, thus allowing them to remain as lakes. At some point in the future, however, these lakes may come to more closely resemble the other marshes in the park.

Lake Defiance Self-guided Interpretive Trail

A portion of the following information was obtained from the Moraine Hills State Park trail guide leaflet, and description numbers correspond to the numbered posts along the trail. The trail head starts at the Nature Center and Park Office (fig. 13).

1. Lake Overlook. Lake Defiance was formed by the Wisconsin Episode glaciers, which covered northeastern Illinois about 15,000 years ago. As the glacier melted, it left behind large deposits of a mixture of rock, gravel, sand, and clay called glacial till. The rolling hills or moraines throughout the park are made of this material. Scattered within the glacial sediment were many large blocks of ice that melted as the climate continued warming. Depressions (kettles) left by these blocks collected and stored surface water.

Bogs generally developed in poorly drained depressions lying on impermeable substrate or having a high water table, whereas lakes formed in those with good drainage and a sustaining water supply such as a river, stream, or

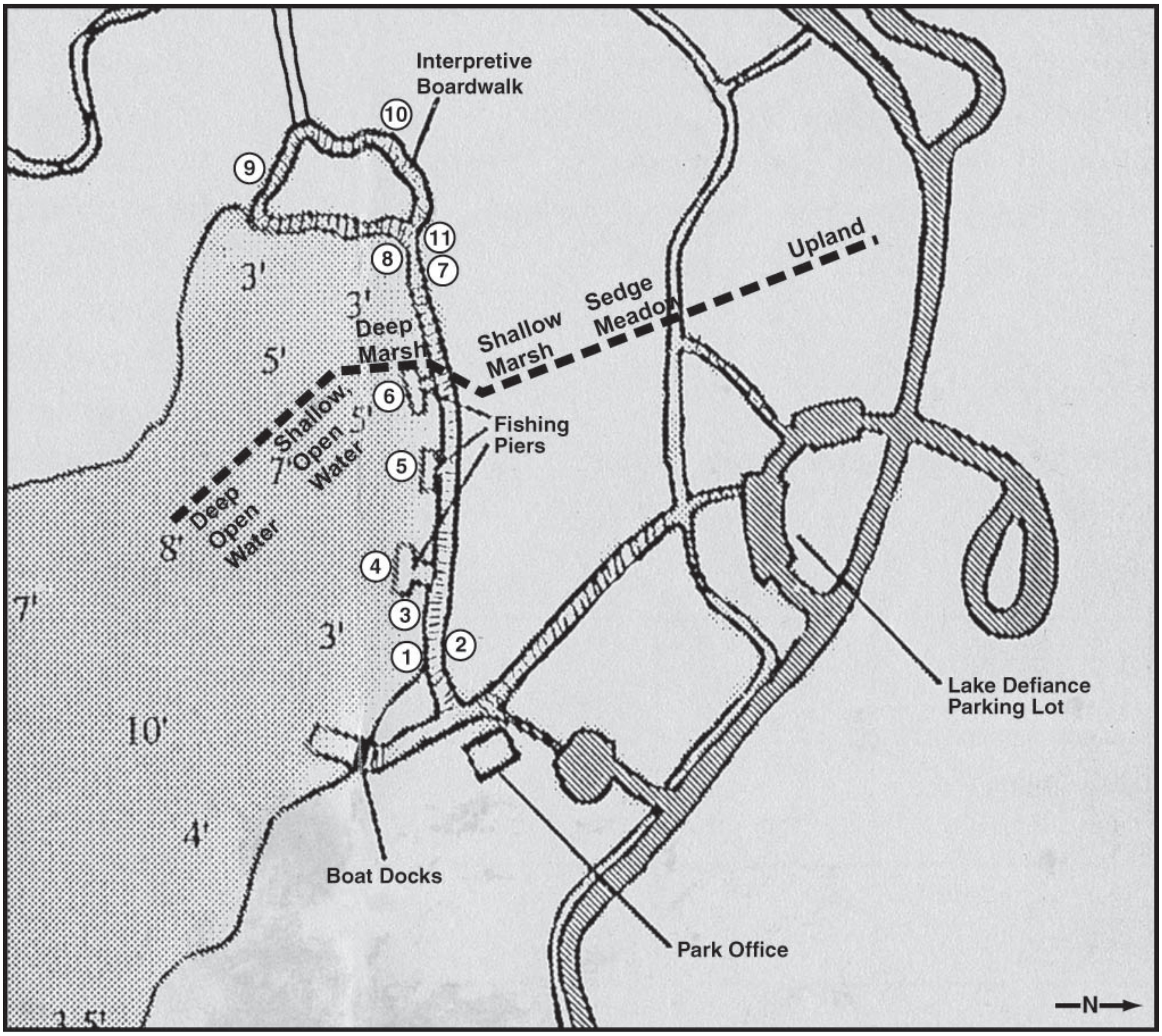

Figure 13 Lake Defiance Interpretive Trail (Illinois Department of Natural Resources, undated).

spring. Lake Defiance is a kettle lake, a deep lake with steep banks. The lake is 47.8 acres in size and up to 18 feet deep. Water enters Lake Defiance from Pike Marsh to the south and from other wetlands to the east.

At Lake Defiance, there are four types of marsh habitat (fig.13), each with a different hydroperiod that determines the types and distribution of vegetation. The areas surrounding the Northern Woods and Lake Defiance parking lots at an elevation of about 750 feet are not wetlands. The lake surface is at an elevation of 735 feet. Decreasing elevation allows the habitat to be inundated more deeply for longer periods each year, which affects how long oxygen is available to the plant roots and limits the type of plants that can inhabit each zone. The effect of the change in elevation on the marsh habitats can be seen from the interpretive boardwalk (figs. 13 and 14). A conceptual cross section of these habitats is shown in figure 15.

2. Reed Canary Grass. Wet meadows have soil that is saturated, but there may be no surface water (Eggers and Reed 1997). Here at Lake Defiance, the wet meadow was likely once dominated by sedges, but is now dominated by reed canary grass. Inundation is often relatively short and is usually at shallow depths. The reed canary grass offers food and cover for some forms of wildlife such as the red-winged blackbird.

3. Willows. As many as 15 species of willow are found in McHenry County. They are often difficult to distinguish, and identification is complicated by their ten-

Figure 14 Boardwalk along Lake Defiance Interpretive Trail. Looking toward Lake Defiance, overlooking shallow marsh, toward deep marsh, to shallow open water (photograph by W. T. Frankie, March 2007).

dency to hybridize. The four main species found around Lake Defiance are pussy willow (*Salix discolour*), black willow *(Salix nigra)*, hoary willow *(Salix candida)*, and heart-leaved willow *(Salix rigida)*. These species are among the easiest to identify.

On the eastern edge of Lake Defiance is the pitcher plant, which is considered endangered at Moraine Hills because too many people have taken it. This green carnivorous plant has pitcher-like leaves that collect water. Insects and other organisms are attracted to the colored lip, land on it, and have difficulty crawling upward because of the recurved hairs. Eventually the insects fall down into the standing water inside the plant and drown. Enzymes secreted by the plant aid it in digestion of the prey, although much of the breakdown is a result of bacterial activity. The plant is able to get additional nutrients this way, especially nitrogenous compounds. Sneak quietly past the willows to the first pier for the best chance of observing waterfowl and other wildlife on the open water!

4. First Pier: Waterfowl and Shorebirds. Sit quietly and patiently and you may be rewarded with an excellent view of wetland birds. Spring and fall migrations are usually the most productive, but the more secretive summer nesting species may also be observed. Twenty-nine species of wetland birds have been spotted within Moraine Hills State Park. Binoculars or a spotting scope make the experience all the better. In the deep (greater than 6 feet), open-water habitat there is little or no vegetation. These areas are not generally classified as wetlands.

5. Second Pier: Open-Water Community. At least 26 species of fish are found in Lake Defiance, including largemouth bass, northern pike, crappie, bluegill, channel catfish, and an endangered darter. A fish barrier from the Fox River excludes carp, a nonnative fish that competes with more desirable fish.

Water lilies, spatterdock, and duckweed are some of the common plants found floating on the surface of Lake Defiance. Along with hornwort (coontail) and other submersed plants, these water plants provide food and cover for many aquatic animals including fish, frogs, and muskrat. During summer, yellow flowers of the tiny carnivorous bladderwort may be seen reaching above the water. Sack-like bladder traps located along the underwater stems capture aquatic invertebrates such as daphnia and rotifers.

6. Third Pier: Wildlife on the Edge. Emergent vegetation provides food and cover for both terrestrial and aquatic wildlife. Cattails, bulrushes, and sedges offer nesting sites and materials for marsh wrens, red-winged blackbirds, and shorebirds such as the Sora rail. Cattails provide food and lodge materials for the muskrat. Frogs hide among duckweed, awaiting a passing insect. Turtles and crayfish forage along the muddy bottom. Fox and weasel hunt the water's edge along with the mink who ventures out from the shore in search of fish, frogs, and even muskrats.

Shallow, open-water habitat is found where surface water is less than about 6 feet deep (Eggers and Reed 1997). This area is classified as wetland (fig. 15). All vegetation growing in this habitat are plants that grow only in wetlands (obligate hydrophytes), including plants such as coontail, water lilies, spatterdock, and duckweed.

Deep marsh is found where surface water is less than about 3 feet deep (Eggers and Reed 1997). This habitat can also been seen from the fishing piers. Vegetation growing in this habitat include those found in shallow, open water and emergent species, such as cattails and bulrush. Deep marsh usually remains inundated during summer.

Another plant encountered is the common milkweed, which has erect stems, opposite or whorled leaves, and small flowers borne in clusters at the top or along the stem of the plant. The colored parts of each flower are organized in two, five-membered whorls. Milkweeds can be divided into two groups: those with broad leaves and those with narrow leaves. Both are characterized by an abundant milky sap called latex and by inflated

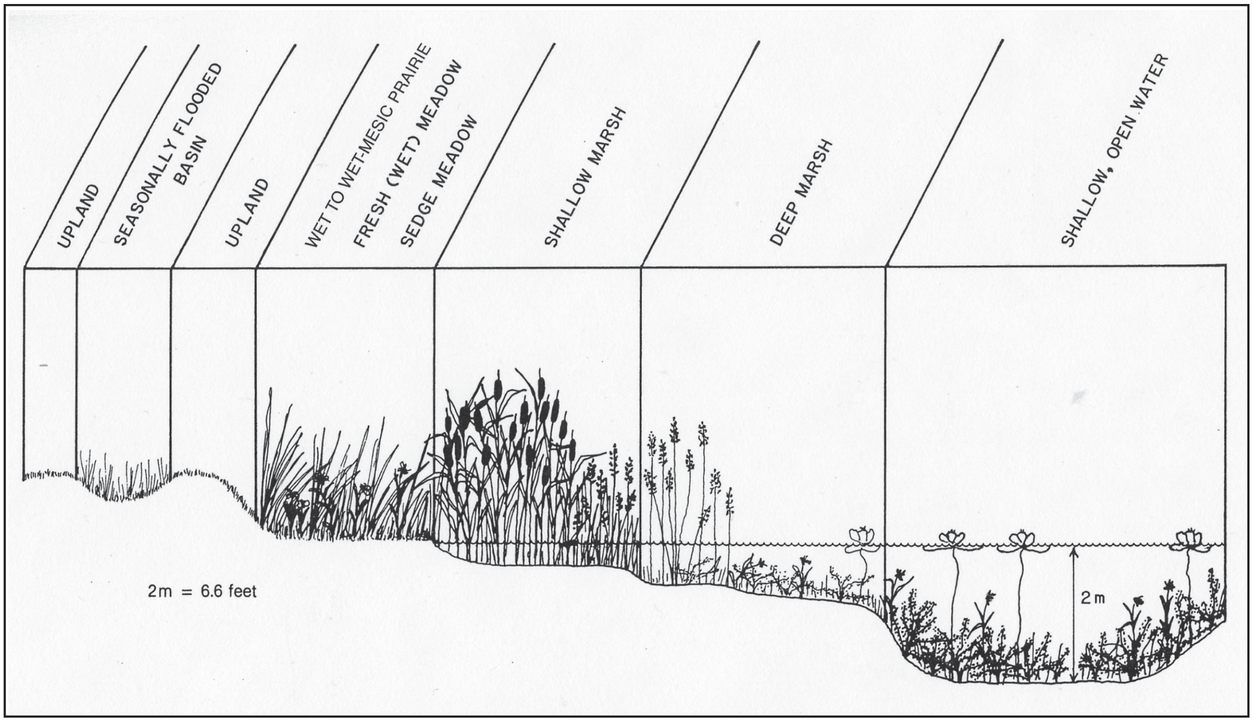

Figure 15 Conceptual cross section of meadow-marsh-open water successions (modified from Eggers and Reed 1997).

fruit pods tightly packed with silky or cottony fuzz. At maturity, the pod cover dries, opens, and releases many large, flat, brown seeds. Each is attached to a bit of the fuzz so that the seed can drift for long distances in gentle currents of air. Milkweed contains glycosides that, when absorbed by Monarch butterfly larvae (whose sole source of food is milkweed foliage) makes the larvae and adult butterflies toxic to birds and other predators. Glycosides are a class of complex chemical compounds in plants that are broken down by plant enzymes into sugars, including glucose and other substances.

Another easily distinguishable plant around Lake Defiance is common cattail. It is characterized by a creeping rootstock; long, flat leaves; flowers in dense cylindrical terminal spikes; and brown, cylindrical fruit with a velvety surface. Cattails are a favorable habitat for red-winged blackbirds and other marsh birds and muskrats. The cattail's rootstock is starch and edible and was eaten by Native Americans and early colonists. Young shoots can be eaten like asparagus, the immature flower spikes can be boiled and eaten like corn on the cob, and the sprouts at the tip of the rootstock can be used in salads or boiled and served as greens.

7. Wetlands: Dynamic Communities. The remains of dead trees tell of rising water levels. Wetlands are dynamic communities and are affected by fluctuations in water levels, which are often caused by the wildlife within them.

8. Beavers, Nature's Water Control Engineers. The water level of Lake Defiance increased when a colony of beavers dammed an outlet to the Fox River. The beavers were allowed to remain, but additional water control structures were installed so park personnel could manage the fish and wildlife that utilize Lake Defiance.

Other plants that occur within the park include goldenrod, sunflower, leatherleaf, common milkweed, and common cattails. Goldenrods are herbs with wand-like stems and stalkless leaves and generally grow to a height of 4 feet, but variations in environmental conditions and species give them a range of 1 to 7 feet. Their yellow flowers are grouped in clusters called racemes.

The sunflower is easily distinguishable by its tall, large solitary flower. Some of the tall-growing forms may attain a height of 12 feet. The daily orientation of the flower to the sun is a direct result of differential growth of the stem. A plant-growth regulator, auxin, accumulates on the shaded side of the plant when conditions of unequal light prevail. Because of this accumulation, the darker side grows faster than the sunlit side. Thus, the stem bends toward the sun. Native Americans extracted safflower oil from the seeds for bread flour, cooking, and for dressing their hair. In the nineteenth century, sunflowers growing near the home were thought to protect the home's inhabitants from malaria.

9. Racoon Island. The name dates back to the 1920s but its origin is unknown. The island, dominated by oaks and surrounded by marshland, lies in Lake Defiance's original lake basin. Off-limits to humans, Racoon Island is good refuge for some of the site's more secretive inhabitants.

In the Moraine Hills area, Haeger till predominates. Walking up into the tree-covered hills, the predominantly sand and gravel till can be seen containing small chunks of igneous and metamorphic rocks carried down from northern Wisconsin and Canada.

The trees you see at Moraine Hills are characteristic of a young hardwood forest consisting of oak and hickory. Their distinctive fruit, the acorn, makes it easy to recognize oak trees. Oaks produce durable, tough wood and are important lumber trees. The wood is used in cabinetry and barrel making and as flooring and veneers. Hickory trees are characterized by their light gray bark. They are about 100 feet tall, often grow among oaks in dry uplands, and have long taproots. Their leaves are compound, with 3 to 17 leaflets that turn bright yellow in autumn. Each tree has male and female flowers; the male is found along the stem in hanging, three-branched catkins, and the female is found at the twig ends in small, petalless clusters. In the future, according to natural forest succession, hard maple and sugar maple will take over when the oak and hickory die out.

10. Stream Channelization. There are enough channelized ditches in Illinois to stretch from Chicago to Mongolia. These ditches are human attempts to rush the water off the land to utilize that land for human needs. Much of the historic sedge meadow surrounding Lake Defiance had been drained and used as a sod farm.

11. Dead Trees. Look for signs of life among these dead trees. The rotting wood provides food for many insects, which in turn attract chickadees, woodpeckers, and nuthatches. Along the north side of the boardwalk is shallow marsh with saturated soils and surface water up to 1 foot deep (Eggers and Reed 1997). Vegetation growing in this habitat are usually all emergent species, such as cattails, bulrushes, and sedges. This area generally dries out for several weeks of the year.

STOP 2. Glacial Park Conservation Area (SE, SW, NE, Sec. 32, T46N, R8E), 3rd P.M., Richmond 7.5-minute Quadrangle, McHenry County. On the day of the field trip, we will hike the 2.1-mile-long Deerpath Trail.

Stop Overview

A portion of the information presented here was combined and modified from several online articles:

http://jove.geol.niu.edu/faculty/fischer/429_info/429trips/NIF/glacial_park.html

http://chicagowildernessmag.org/issues/fall1997/IWglacialpark.html

http://www.chicagowildernessmag.org/issues/winter2001/IWglacialpark.html

Glacial Park, spanning some 2,806 acres, is fondly referred to by some as the "crown jewel" of the McHenry County Conservation District (fig. 16). In all, more than 420 plant species contribute to the beauty and rich biological diversity in the Glacial Park-Lost Valley Marsh area. Examples include Bur oak, White oak, Black oak, and Hill's oak and forbs such as Culver's root, shooting star, and yellow grass. There are also 222 species of birds found regularly in McHenry County. Canada geese, ducks, frogs, turtle and a variety of bird types are observed regularly. Near the wetlands, and around feeding time, raccoons and the occasional coyote visit the area in search of food.

Physical Geography and Topography of Glacial Park

There is a lot of knowledge and enjoyment to be gained from Glacial Park for those with a scientific interest. This park is referred to by some as one of the "12 natural wonders of the Chicago wilderness." The park is located between the north-south–trending Cary and Fox Lake end moraines (fig. 8). The Cary Moraine forms the wooded ridges to the southwest near Wonder Lake. The Fox Lake Moraine forms the more subdued, hummocky (knob-and-kettle) topography that has a surface elevation lower than the outwash plain west of Fox Lake. The Nippersink Creek valley lies between the two moraines.

Kamic Topography. The most notable feature in the park is Camelback Glacial Kame (figs. 16 and 17). This landform, a kame delta, developed where water flowing out in front of a melting glacier entered a proglacial or other ice-marginal lake. It is thought that meltwater

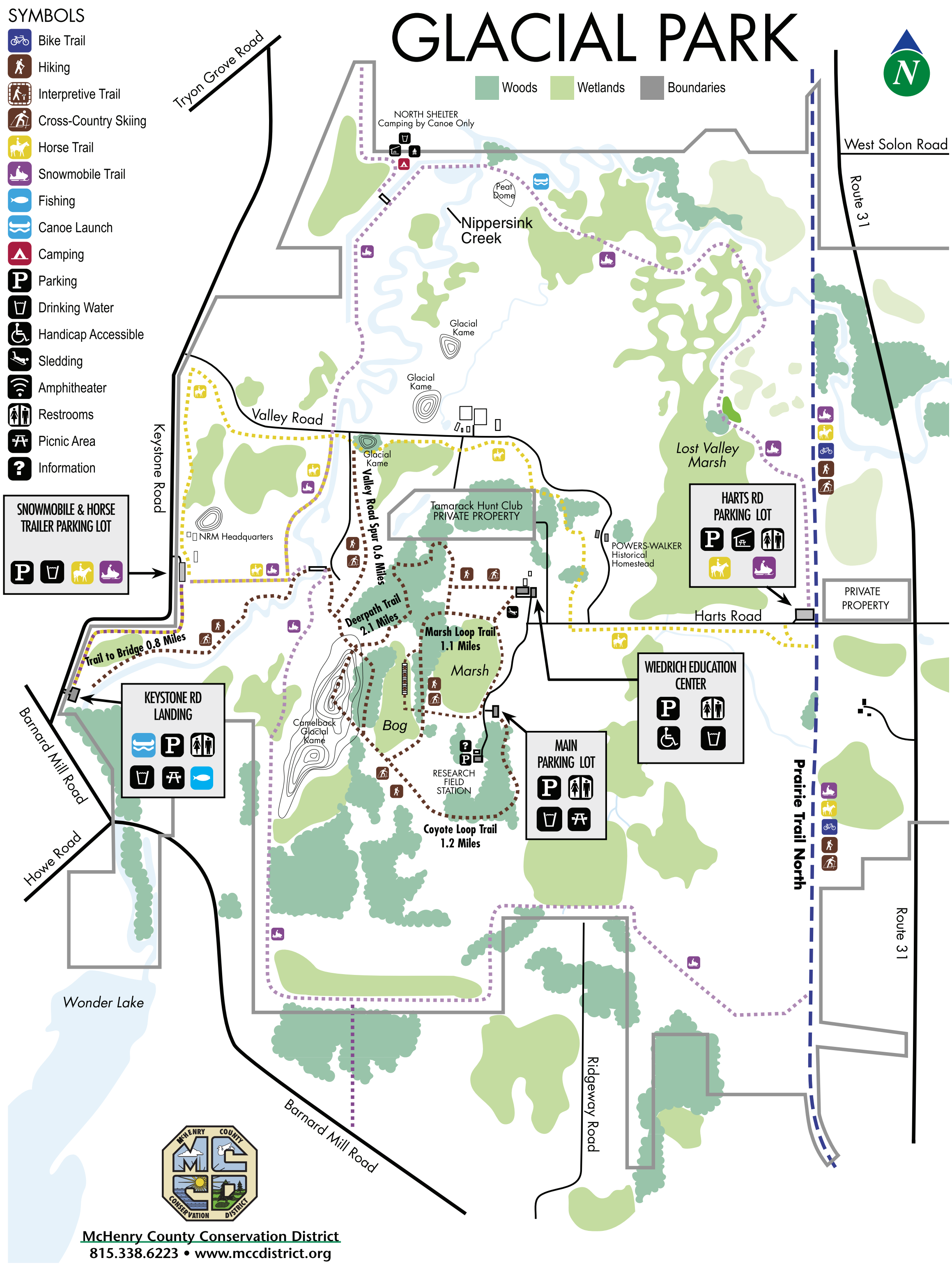

Figure 16 Glacial Park map, McHenry County Conservation District (undated).

Figure 17 Camelback Kame, along Deerpath Trail, Glacial Park, McHenry County Conservation District (photograph by W.T. Frankie, March 2007).

flowing down the Nippersink Creek valley dumped debris layer after layer into a large glacial lake. When glacial floods reached the quieter waters of the glacial lake, the velocity dropped so drastically that sediment built distally as a delta. A borrow pit is excavated into these sand and gravel deposits; material excavated from the pit was probably used for construction purposes prior to the land being transferred to a public trust.

The hummocky (knob-and-kettle) topography observed throughout Glacial Park owes its origin to the waning days of a melting glacier. The numerous kames observed along the trails are composed of well-sorted, fine sand deposited by meltwater flowing in subglacial channels or in streams on the glacier surface. In the park, these glaciofluvial deposits lie on older glacial sediments deposited during earlier glacier advances. Test borings and water wells in the area that drilled through the surface sand and gravel penetrated reddish brown, clay-rich till and sub-till glaciofluvial sand and gravels. These sediments compose the northeast-southwest–trending hill that occupies much of Glacial Park. Subsequent ice advances and flowing meltwater would have reshaped the landscape from its original form.

Wetlands. Though a rarity in such a small area, Glacial Park contains all three types of kettle lake remnant wetlands: fens, bogs, and marshes. The park has an elevated fen and well-developed stream, bog, and marsh ecosystems. It also has prairie and oak savanna ecosystems. Many plant and animal communities flourish here; wetlands are the prime ecosystem. Statewide, 40% of Illinois threatened and endangered plant and animal species rely on wetlands. Wetlands help control flooding and protect the water quality. The storage and/or slow release of flood runoff back to streams helps prevent erosion downstream and stabilizes baseflow, thus helping to maintain the water table level and aiding in groundwater recharge. Wetlands also remove sediment, nutrients, and toxic chemicals from runoff water. They are valued for recreational purposes.

The wetland depressions in Glacial Park formed, about 14,000 years ago, around the end of the Pleistocene Epoch. Over time, without stream recharge or channel outflow, these shallow depressions partially dried up to form fens, bogs, and marshes. Fens are alkaline environments, favored by plants such as skunk cabbage. Alkalinity in fens can occur when groundwater percolates up through soil or bedrock and picks up carbonate minerals that later precipitate near the surface. In contrast, bogs are acidic environments. Bogs often contain sphagnum moss and leatherleaf shrubs. Marshes often are inhabited by cattails and by bulrushes. Given enough time, nutrient-rich wetlands may entirely fill with organic matter and dry up.

Nippersink Creek

Another important aspect of Glacial Park is the ongoing mile-long dechannelization project in the Nippersink Creek (fig. 18). In 1951, before the park district bought the land, a 1.8-mile-long section of the creek was channelized to reduce its floodplain. Channelization allowed excess water to run off the fields so they could be used for agriculture and grazing. Nippersink Creek is just a trickle of what it once was. This stream, a misfit or underfit stream, occupies a contrasting much larger valley that once helped drain surging meltwater from the Wisconsin glacier. Nippersink Creek's eastward flow is in the opposite direction of the ancient stream that flowed in this valley during the Pleistocene Epoch. At that time, ice blocked lowlands to the east and caused the ancient stream (the ancestral Fox River) to flow to the west through this valley. Local tributaries did not obtain their present flow orientation until the master river in the region, the Fox River, settled on its more eastern valley. Thus, this valley was originally shaped by the ancient Fox River.

In the Algonquian language, Nippersink means "place of the small waters" due to the profusion of small springs feeding the creek. The north branch of the Nippersink coming in from Wisconsin is one of three state-rated Grade A (high-quality habitat) streams in the Chicago Wilderness region. Its cobble-and-rock bottom is home to several endangered mussels and a number of silt-sensitive fish. Anglers can cast for smallmouth bass, northern pike, carp, or channel catfish in designated fishing areas within the park.

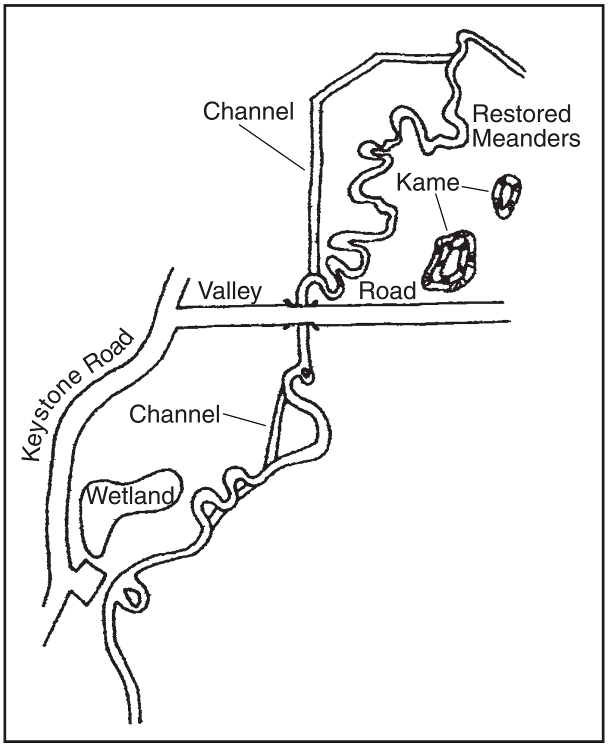

Figure 18 Generalized diagram of meandering (dechannelized) and previous straightened (channelized) flow paths of Nippersink Creek, Glacial Park (McHenry County Conservation District, undated).

Dechannelization

Dechannelization is important to the environment because water flowing at a quick pace through straightened streams causes more erosion on the sides of the creek bed and increases discharge downstream. This increase happens because there is less surface area for drag resistance and discharge increases as a function of (width × depth × velocity). Too much material entering the stream can make it difficult for aquatic life forms to survive. Recreating original stream meanders decreases the stream current and velocity and dissipates the energy of flow over banks. It also helps to create inhabitable pools throughout the length of the stream. Furthermore, in contrast to steep banks that confine upstream floodwater and cause flooding downstream, gently sloped banks allow floodwaters to create temporary wetlands. Restored banks along the Nippersink Creek have been seeded and are sloped with a vertical to horizontal ratio of no steeper than 3:1. Boulders have been placed along the outside curves of the restored meanders, where erosion is expected to be the greatest.

In excavating the old, original channel, the district crew found entire mussel beds still intact containing 1,200 to 1,500 specimens of 16 different species. Within the channelized ditch, only 5 of the most common species of mussels were found, those that can tolerate pollution and silt. Only 2 of those species were found in the shell deposits in the excavated bed of the original healthy stream. In time, some of the rare mussel species are expected to recolonize the restored stream.

Stream Rating

With an overall stream rating of Grade B in 1993, the Nippersink Creek watershed was deemed one of Illinois' highest-quality streams. Stream quality is determined by sampling the stream's fish population. The formula for assigning a stream rating is called an Index of Biotic Integrity and is based on the number of species, the proportion of diseased fish, and the percentage of fish that are intolerant to pollution. This watershed is home to many endangered or threatened life-forms that are sensitive to habitat change, making it increasingly important to restore and maintain native habitat and high stream quality. The stream in Glacial Park is good primarily because it is rural and buffered from industrial pollution and from erosion problems, with the exception of the channelized portions. By 1995, the Nippersink Creek had attained a Grade A rating. The removal of invasive buckthorn, Siberian elm, and box elder, none of which have much value to wildlife, brush cutting, and planting of native oaks were instrumental in creating a healthier Nippersink Creek.

Glacial Park Nature Preserve

Dedicated in October 1992, the 330-acre Glacial Park Nature Preserve is part of a 2,600-acre McHenry County Conservation District site known as Glacial Park. The preserve offers scenic vistas that reveal the glacial heritage of this region. Undisturbed knob-and-kettle topography typical of glacial moraines, kames, dissected outwash terraces, and kettles define the landscape. Exceptional examples of delta kames border the western edge of the preserve. Biological richness characterizes this site. There are more than 420 plant species contributing to five distinct plant communities. The tallgrass savannas are dominated by Bur, White, Black, and Hill's oaks with many forbs such as Culver's root, shooting star, and yellow star grass in the understory. Small patches of dry hill prairies dominated by sideoats gramma and little blue stem occur in the oak openings on the tops of the kames. A 10-acre central kettle features a very high-quality, low shrub bog with leatherleaf and sphagnum moss the dominant plants and poison sumac, cinnamon fern, bog buckbean, and rusty cotton grass among other plants making notable appearances. Fen and sedge meadow community complexes occur in areas receiving large amounts of mineralized groundwater. The largest kettle in the preserve is a 20-acre marsh with cattails, bulrushes, sedges, and grasses. Nine state endangered or threatened plants occur in the preserve. Many species of butterflies, birds, amphibians, reptiles, and mammals can be found throughout this site. The preserve provides habitat for 18 species of state endangered and threatened plants and birds, including least bitterns, sandhill cranes, upland sandpipers, black terns, pied-billed grebes, yellow-headed blackbirds, Henslow's sparrows, and northern harriers. Large-scale restoration of the entire Glacial Park has been under way since 1985, and reestablishment of the original hydrology in previously drained wetlands is part of the restoration project providing outstanding habitat for migratory waterfowl.

DEERPATH TRAIL

The following is modified from the Glacial Park Conservation Area geology brochure for the Deerpath Trail (fig.19). The trail winds through a portion of the preserve. Evidence of the Wisconsin glacier's presence can

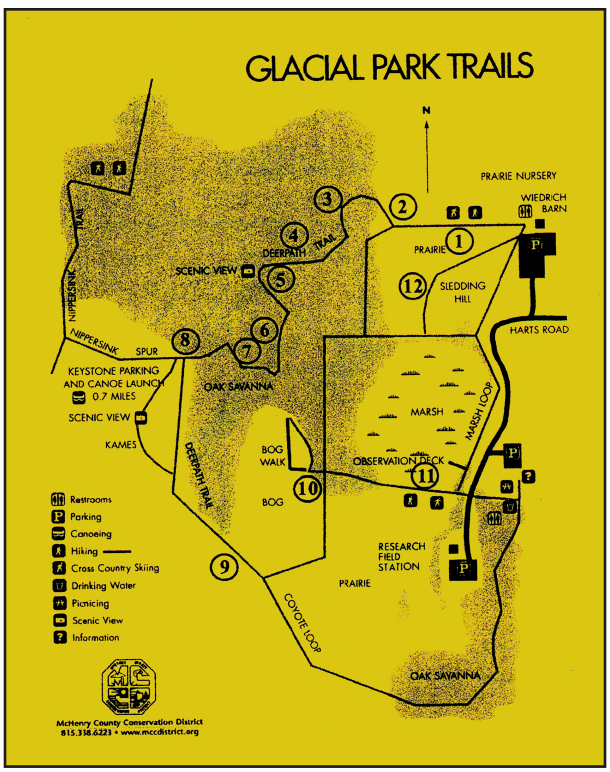

Figure 19 Deerpath Trail (McHenry County Conservation District, undated).

be still seen today. The trail descriptions will help point out glacial landforms and processes. The following numbers and descriptions correspond to the numbered marker posts along the trail.

1. The Kettle Marsh. As you look behind you down the hill, notice the round depression, or kettle (see fig. 5), that is the marsh below. This wetland is neither a lake nor pond but a marsh. You can see some open water, but notice how much vegetation there is. Marshes are defined by emergents, plants that grow with their roots in the muck of the marsh but whose stems grow upward or emerge out of the water and stick up into the air. Compare this marsh habitat with the bog habitat at trail marker number 9.

2. Tallgrass Prairie. This area has been used as pasture and now contains a mixture of pasture plants and prairie plants. It is hoped that one day it will again be a tallgrass prairie, comprising a mix of grasses and flowers, some of which can grow to be 10 feet tall! Despite their size above ground, most of the prairie plant is actually below ground. Roots extend far into the soil, reaching for water and nutrients. Because glaciers deposited so much till, some areas in this region have their bedrock buried as deep as 100 feet under the till! As the till broke down, plants began to grow in the new soil. Prairie plants' extensive root systems continued to develop the till into a rich, fertile soil. Thanks to those fertile prairie soils, this area became one of the top agricultural regions in the nation. As you walk to trail marker 3, notice how the shape of the land (the topography) is changing.

3. The Wisconsin Glacial Episode. The knob-and-kettle topography of northeastern Illinois is due to its location at the margin of glaciers that advanced into the area during the Wisconsin Episode between 25,000 and 12,000 years ago. Scientists have been able to determine the time frame by radiocarbon dating the organic material found in the peat bogs and glacial lake sediment. As you walk to trail marker 4, notice the change in vegetation with topography.

4. Oak-Hickory Savannas. Prairie fires burn hotly and quickly through the flat prairies, but slow as they reach the hill sides. Some trees are able to withstand the prairie fires such as the oak and hickory woodlands you are in now. The junction and resting places along the trails followed by earlier pioneers crossing the vast prairies of Illinois were commonly located where the scattered savannas (sometimes called groves) were located. Do you know of any localities or communities in Illinois with the name "Grove" attached to it? As you walk to marker number 5, take a closer look at the thick, corky bark of the trees around you. Most of these trees are Bur Oaks and Shagbark hickories. Do you think you can tell which are which?

5. Nippersink Creek. Down the valley in front of you are the winding waters of the Nippersink Creek. The creek is just a fragment of the magnificent waterway that drained the meltwaters of the Laurentide Ice Sheet. However, it is no less important today. Creeks offer a valuable source of water to local wildlife and a wetland habitat to aquatic plants and animals. Additionally, the Nippersink Creek is a part of a vast system of wetlands and streams that make up the Fox River watershed. This watershed encompasses almost 1,800 square miles of territory and serves over 90 communities, supplying drinking water, recreation, and flood control. As you walk to marker number 6, notice the large rocks beside the trail.

6. Rocks from Canada. The rocks you have seen along the trail are called glacial erratics. They are fragments of bedrock eroded and transported by glaciers as they advanced into Illinois. If you think they look out of place, you are correct. Some could have been brought here from as far away as Hudson Bay!

7. The Thomas Family. One of the first families to settle in this area, the Thomas family, may not have known to thank the glaciers for the fertile soil and the kettle bog from which they farmed cranberries. Despite such resources, their lives were still not easy, and several of the Thomas children did not live into adulthood. Five gravestones were placed at the base of the large oak in a ceremony in 1995. This is the area thought to be their actual burial site. As you walk to marker 8, look toward the big hill to the south.

8. The Kame. Here you stand at the base of the Camelback Glacial Kame, a glacial hill formed from sand and gravel deposited by a glacier. There is still some dispute about whether this kame was formed by glacial meltwater flowing in front of a glacier, called a kame delta, or whether the sand and gravel were carried down a crack in the glacier's surface in a conical shape, forming a kame complex. In either case, there is no mistake that this is a glacial deposit. As you walk up over the hill to marker 9, notice how much gravel is on the trail. When you stand on top of the kame, close to 100 feet above the surrounding landscape, imagine the mass of ice that stood more than 10 times taller! Nippersink Creek flows through the broad valley below. However, during the latter part of the Wisconsin Episode this valley was filled by a shallow (up to 40 feet deep) proglacial lake called "glacial Lake Wonder."

9. The Kettle Bog. You may see some emergents nearby, but few are found toward the center of the wetland. This kettle wetland is called a kettle bog. Sphagnum moss is the predominant vegetation of the bog, with the leatherleaf plant growing on top of the moss. Notice that you can see no open water from here. The glacial lake that formed here thousands of years ago has since filled in. The lake was low in nutrients and oxygen due to bad drainage. The vegetation that was able to withstand the poor conditions tended to make conditions even poorer for other plant life. For example, the sphagnum moss that dominates the bog absorbs most of the nutrients and oxygen. It also releases hydrogen ions, causing the water to be very acidic. Unable to decay, dead vegetation builds up layer upon layer and, over time, creates a floating mat of vegetation on the surface of the bog. Not much else can survive. As you head to marker 10 to take a closer look at the bog, notice the clearly visible "island" hill savannas to your right.

10. Life in the Bog. As you walk across the bog boardwalk, you will see that, on top of the moss, grows the leatherleaf plant, a shrub that is perfectly suited to survive the bog's harsh environment (fig. 20). In fact, leatherleaf grows in no other type of environment. Be careful not to harm this rare species, which is classified as threatened in the state. Although prolific in this bog, not much leatherleaf remains anywhere else in Illinois.

Walk back to the benches and head downhill to the trail directly across from you to go to marker 11, or follow the trail to the left to marker 12 and back to the Wiedrich Barn parking lot.

11. Plant Life in the Marsh. You are now circling the kettle marsh. Notice how the marsh resembles a bull's-

Figure 20 Leatherleaf Bog, at trail marker 10 along Deerpath Trail, Glacial Park, McHenry County Conservation District (photograph by W.T. Frankie, March 2007).

eye. The concentric circles are made of different types of vegetation. Around the edge is where many of the sedges and grasses grow. As the water deepens, cattails and bulrushes start to grow. Further in are the floating plants, such as lily pads. By identifying the different plants, you can identify differing depths of water. The presence of this bull's-eye pattern proves that this kettle is a sloped depression. The slope of this kettle marsh is different from that of a bog. More importantly, drainage is better, making this kettle more suitable for a marsh community than a bog community. As you walk along the edge of the marsh, look for the plant life and wildlife that might not be able to live here had it not been for the glaciers.

12. A Future Ice Age? As you head back up the hill to the parking lot, imagine the force of glaciers and meltwater required to shape the hills around you. Will the Earth ever see anything like it again? Scientists know that ice ages come in cycles. Variations in the Earth's orbit around the Sun (the Milankovitch Cycle) combined with positive feedbacks from albedo (reflection of sunlight from snow and ice), decreases in carbon dioxide concentrations in the atmosphere, reductions in solar radiation due to meteorite collisions with the Earth, increased volcanism, and the shifting location of continents with uplift of vast mountain regions and changes in the circulation of seawater are thought to have led to past cooling of the Earth's climate. We are presently in an interglacial period of warmer temperatures where most of the Earth's glaciers are in retreat. Past temperature cycles suggest that we might expect another glacial stage in about 23,000 years with progressive cooling from now on. The buildup of carbon dioxide in the atmosphere from fossil fuel combustion ("greenhouse" effect), however, could delay the temperature decrease for 2,000 years or more.

STOP 3. Volo Bog State Natural Area (SW, SW, NE, Sec. 28, T45N, R9E), 3rd P.M., Wauconda 7.5-minute Quadrangle, Lake County. This will be our lunch stop. After lunch, we will visit the Visitor Center and hike the Volo Bog Interpretive Trail.

VOLO BOG STATE NATURAL AREA

The following information is slightly modified from online information from Illinois Department of Natural Resources (dnr.state.il.us/lands/landmgt/parks/R2/volobog.htm).

History

Volo Bog was first documented by W.G. Waterman of Northwestern Illinois University in 1921. The bog was originally named Sayer Bog, after the land's owner, dairy farmer George Sayer. Cyrus Mark, the first director of the Illinois Chapter of The Nature Conservancy, managed a fund-raising campaign that collected $40,000 in donations from school children, groups, and individuals for the purchase of the 47.5-acre bog in 1958. The land was deeded to the University of Illinois, which retained ownership until 1970.

In the late 1960s, land developers threatened Volo Bog's survival. Local citizens formed a Save the Volo Bog committee and worked to ensure the bog's survival. Dr. William Beecher was instrumental in the campaign, which resulted in the transfer of Volo Bog to the Illinois Department of Natural Resources (fig. 21).

Volo Bog was dedicated as an Illinois Nature Preserve in 1970. Three years later, it was registered as a National Natural Landmark with the U.S. Department of the Interior. More than 1,100 additional acres of land have been purchased to protect and enlarge the state preserve, which now includes marshes, prairie restoration areas, woodlands, and two other bogs.

Natural Features

The present landscape of northeastern Illinois was shaped principally by glaciers during the Wisconsin Episode. As glaciers began to melt thousands of years ago, a blanket of unsorted debris, (including clay, sand, gravel and boulders, collectively called glacial till) was deposited. Embedded in the debris were large blocks of ice that broke off the melting glacier; some were carried by meltwater out in front of the ice. As the climate continued to warm, the ice blocks melted, forming kettle depressions that developed into lakes, bogs, and marshes.

Volo Bog was originally a deep, 50-acre lake with steep banks and poor drainage. Research on pollen grains preserved in the bog indicates that the lake began filling with vegetation approximately 6,000 years ago. A floating mat consisting primarily of sphagnum moss

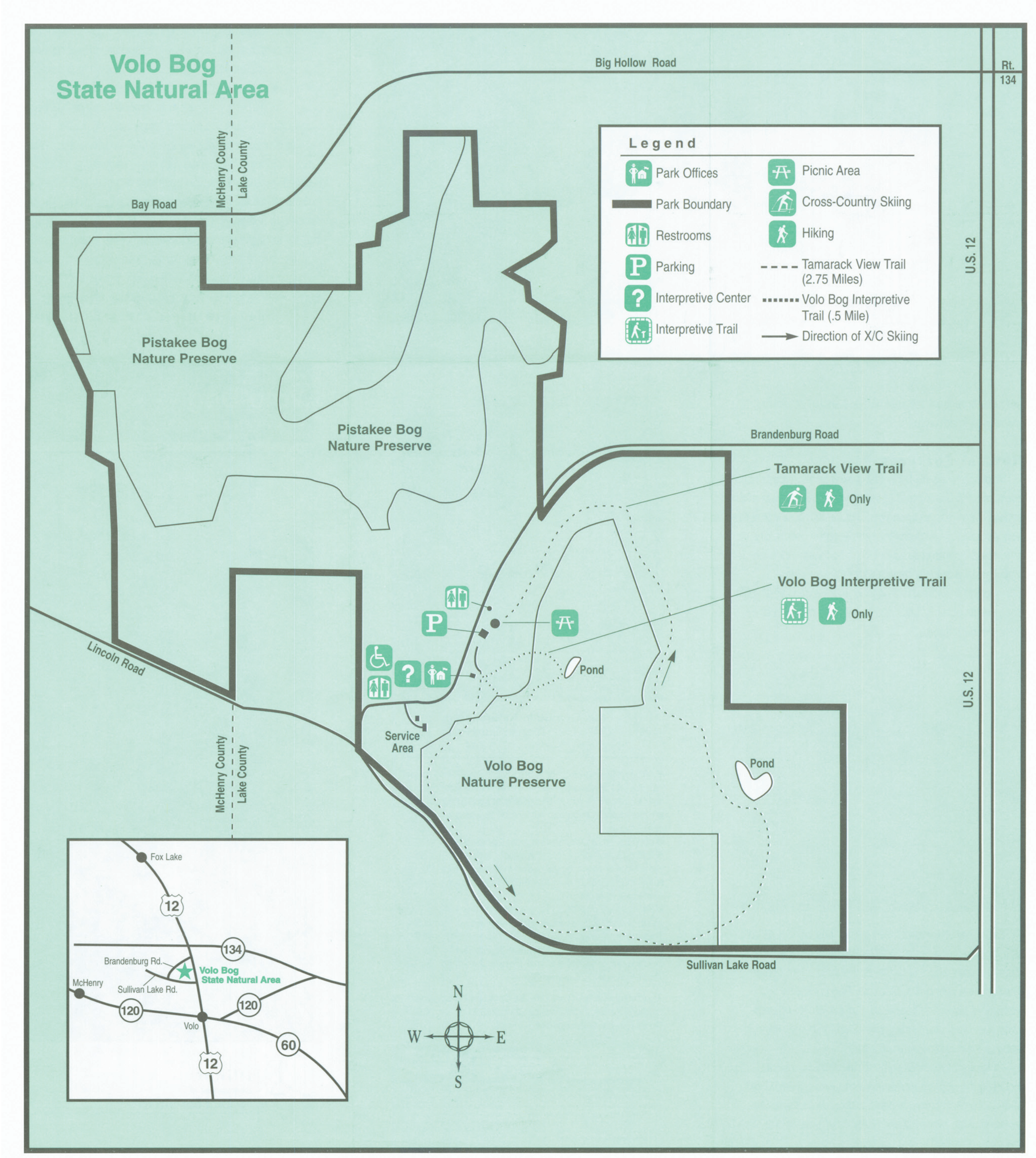

Figure 21 Volo Bog State Natural Area (Illinois Department of Natural Resources 1998).

formed around the outside edges among the cattails and sedges. As these plants died and decomposed, the peat mat thickened, forming a support material for rooted plants. Because of the lack of drainage and the presence of sphagnum moss, the water in the bog became acidic, which limited the types of plants that could survive and thus created the unique plant communities found in the bog.

Volo Bog is significant in that it exhibits all stages of bog succession. A floating mat of sphagnum moss, cattails, and sedges surrounds an open pool of water in the center of the bog. As substrate material thickens, a shrub community dominated by poison sumac and leatherleaf invades the mat. This community is eventually replaced by tamarack forest. Surrounding this forest is a second, more extensive shrub zone that abruptly ends and becomes a marsh/sedge meadow community.

The stages in bog development are divided by a series of circles that can be easily identified. In the middle of the bog is an area of open water (fig. 22). Around that

Figure 22 View of open water area, marker 9 along Volo Bog Interpretive Trail (photograph by W.T. Frankie, June 2006 and March 2007).

is a mat of sphagnum moss and other plants that are so thick in spots a person can walk on top of the mat without falling into the water. The whole mat moves up and down. As a result, such mats are sometimes called "quaking bogs."

Each season brings its own beauty and wonder to Volo Bog, and seasonal visits allow for observation of a wide variety of plant and animal life. In the spring, fern fiddleheads reveal their beautiful fronds. Bog buckbean and leatherleaf bloom in abundance. A great variety of songbirds, waterfowl, and wading birds stop by as they migrate north to their summer nesting areas. As spring turns into summer, orchids appear, including the delicate grass pink and rose pogonia. Great blue and green-backed herons, sandhill cranes, whitetail deer, mink, muskrat, raccoon, and many other smaller creatures are often observed. Fall is one of the most dramatic seasons and features the gold of the tamarack needles, the red of poison sumac, and the deep green of sphagnum moss. Winter is a good time to try to identify trees and shrubs by their bark. The bright red berries of the winter berry holly and red leaves of the leatherleaf are a striking contrast to the bright whiteness of the snow-covered ground. Animal tracks in the snow provide evidence of life in the bog: deer, muskrat, weasel, and red fox make their homes in the preserve. Periodically, when seed yield to the north is small, crossbills will visit the bog and can be observed cracking open tamarack cones.

Volo Bog: An Overview

About 375 million acres of the Earth's surface is covered by peat bogs in glaciated regions such as found at Volo. In the United States, the Great Lakes region contains many bog communities. Over time, bogs have decreased in size and number due to changes in hydrology, climate, vegetation, settlement disturbance, and land-use changes. Volo Bog is the only remaining tamarack or quaking wetland in Illinois that exhibits all the stages of natural bog succession.

The acidic conditions in the bog waters have developed naturally for several reasons. Bogs have very little decomposition of organic matter, creating a very acidic soil. In this nutrient-poor soil, some plants have adapted by becoming carnivorous, including Venus flytraps and pitcher plants, which trap insects to supplement their photosynthetic diets. Most aquatic plants, fish, and other animals cannot live in acidic water.

The information in the following sections on fens, sedge meadows, marshes, and swamps has been modified from online information (www.twingroves.district96.k12.il.us/wetlands/fen/fen.html).

Fens. Fens are wetlands characterized by continuous sources of groundwater that are rich in magnesium and calcium. This groundwater is contained in glacier-drift aquifers within layers of sand. The groundwater is confined in these layers by impermeable glacial sediments below. Inhibiting downward infiltration, water is then forced to flow laterally through the sand and gravel where it leaches out minerals that contribute to the unique chemical makeup of fens. Sometimes, mineral concentrations are so highly elevated that calcium precipitates out, forming spongy to very porous rock (tufas). Marl, a loose earthy material, is generally composed of a mixture of impure calcium carbonate and clay that precipitates on the bottoms of present-day freshwater lakes and ponds, can also accumulate from excess calcium mixed with other kinds of minerals. The soil in a fen is made up of peat.

The precise definition of a fen is not solely based on the concentration of minerals, but also on the amount of water flow and the surrounding terrain. A fen is distinguished from a bog by the pH. Water in a bog is more acidic, typically around 3.5, whereas a fen is more alkaline with a pH around 5.5. The soil in a fen ranges from pH 7.35 to 8.00. The species of organisms that occupy fens have adapted to these extreme alkaline conditions. Many of the fens in Illinois are found along the Fox River on the slopes of kames, gravel terraces, and glacial moraines.

Sedge Meadows. Sedge meadows are the result of flooding. They are most easily recognized in early spring in low-lying terraces along rivers and streams where a few inches of water collect. During the remaining part of the year, sedge meadows rarely have standing water. Sedge meadows thrive when the soil remains saturated for long periods of time, allowing for the abundant growth of a kind of grass called a sedge. The Egyptians used a special kind of sedge called papyrus to make paper. There are about 150 species of sedge native to Illinois, the most common being the *Carex stricta* (upright sedge).

The soil in this type of meadow is formed from the decomposition of sedges. When a sedge grows, it forms a symmetrical mound or hummock (tussocks) in the water. The soil between the tussocks of *Carex stricta* is composed of peat that accumulates following the decay of underground roots and stems. When peat dries out, it burns easily. As a matter of fact, peat is used in some countries as fuel. Fires are a natural occurrence in a sedge meadows. In years of drought, fires will burn through these wetlands, removing invasive woody plants.

Marsh. A marsh is a wetland that remains saturated for at least half of the year. Typically, a marsh will not have very deep water. The deepest marshes contain floating plants with some leaves submerged that replace algae or duckweed. The typical marsh plant has roots that grow underwater and into the ground and with its stem rising above the water level. This most familiar type of plant is the cattail. In Illinois, marshes survive in many different areas. Some are found in the kettle holes left behind by receding glaciers. Others occupy the shallower, water edges of lakes, rivers, and streams. Along the shore of Lake Michigan, some marshes form in the swales between beach ridges.

Swamp. A swamp is a wetland that features permanent inundation of large areas of land by shallow bodies of water, generally with a substantial number of hummocks, or dry-land protrusions, often regarded as a small forest covered by water. To be classified a swamp, the wetland must contain about 30% tree cover. Over the past century, loggers and developers have inadvertently destroyed more than one-third of swamps. Swamps have three important functions: (1) Swamps control floods; when rivers overtop their banks, swamps help control the overflow by temporarily storing water. (2) Swamps help clean water; plant roots trap water pollutants and sediment that sink and settle on the bottom. (3) Swamps support food chains for a diverse community; plants take in nutrients that later nourish wildlife.

Quaking Bog

Volo Bog is unique in Illinois because it is the only remaining "quaking" bog with open water. It is also one of few places in Illinois where plant communities associated with each stage of bog (hydrarch) succession are located within the same ecosystem (fig. 23). The stages of succession found at Volo Bog are primary and secondary shrub zones, tamarack forest, sedge mat, and open water. At this stop, we will discuss how the area's geology has influenced the development and current conditions of the bog.

A bog is a permanently saturated, peat-accumulating wetland. Because bogs are dominantly supported by precipitation, the water in a bog is acidic and low in nutrients, minerals, and oxygen. Bogs generally form in one of two ways: (1) by accumulation of peat over entire landscapes due to wet and cool conditions (e.g., blanket bogs, generally associated with northern or maritime climates) or (2) through succession where an aquatic habitat such as a kettle lake is transformed as peat accumulates in the kettle. Volo Bog formed through the latter process, terrestrialization. The bog is

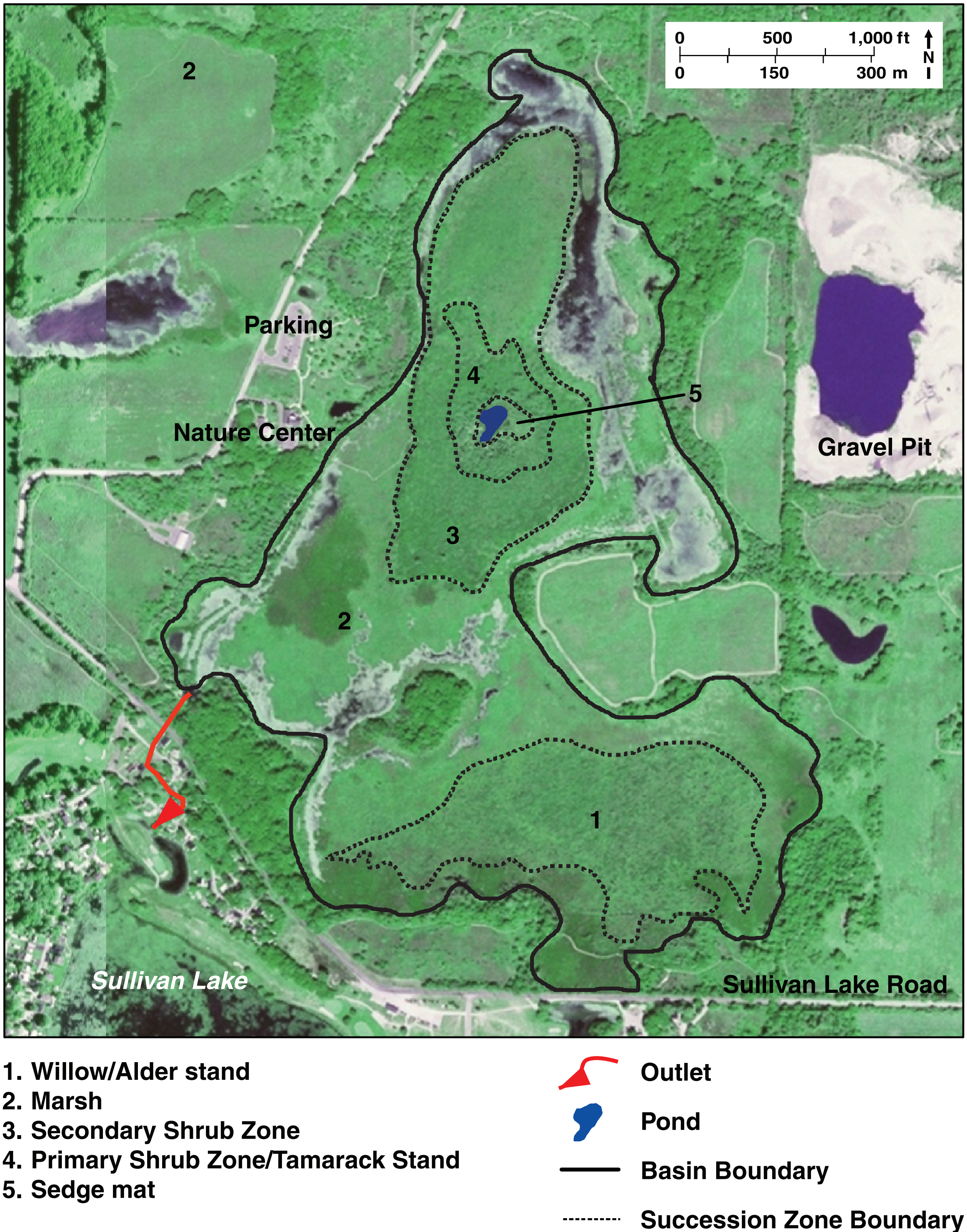

Figure 23 Volo Bog State Natural Area. Map overlay on aerial photography indicating various stages of hydrarch succession (modified from NAIP Imagery, August 2004)

at one stage of this process in which a lake or pond progresses from open water to dry land over time (fig. 24). Illinois has no blanket bogs because summer evapotranspiration greatly exceeds precipitation, which dries out and destroys peat except under special conditions.

Geologic History of Volo Bog

The unique ecosystem at Volo Bog was created by the hydrologic and chemical conditions resulting from glaciation and changes in climate over about the last 25,000 years. These events are summarized in figure 25. The landscape in western Lake County was predominantly formed by glaciers that advanced into the region beginning about 25,000 ^{14}C years BP and that retreated by about 14,000 ^{14}C years BP (Hansel and Johnson 1996). Geologic processes similar to those that formed Moraine Hills State Park (Stop 1) occurred at Volo Bog. During the Wisconsin Episode, glaciers deposited a sandy to gravelly till (Haeger Member of the Lemont Formation, see fig. 9) that composes the till plain surrounding the bog (figs. 8 and 26). The glaciers then stagnated and melted in place, leaving behind scattered ice blocks. A subsequent advance of the glaciers during this same glacial period stopped just east of Volo Bog and formed the Valparaiso Moraine (fig. 8). Meltwater flowing from this glacier margin to the west carried sediment that buried the remnant ice blocks. Eventually, the ice blocks melted, leaving kettle depressions on the outwash. These kettles filled with water and formed open-water lakes. The kettle lake that became Volo Bog was likely fed by runoff from the melting ice, precipitation, and groundwater.

Partially preserved organic material from dead plants has been accumulating as peat in many kettles throughout northeastern Illinois over thousands of years. This peat is classified to the Grayslake Peat (fig. 9). The peat deposit at Volo Bog, the thickest reported in Illinois, is over 30 feet thick near the center of the bog (fig. 27). The geologic record obtained from cores of the peat suggest that water levels in the lake fluctuated with changes in climate during the past 11,000 years. It is likely that the lake dried up at least once, probably around 6,000 years ago, and began to accumulate peat to form the present-day bog probably around 2,000 years ago.\

Bog Development

Terrestrialization tends to occur in basins where sediments, precipitated minerals, and organic debris accumulate and fill lakes. Shallow basins develop more rapidly into marshes or swamps and eventually dry land because they do not have the capacity to store significant amounts of sediment. In deeper basins, such as the

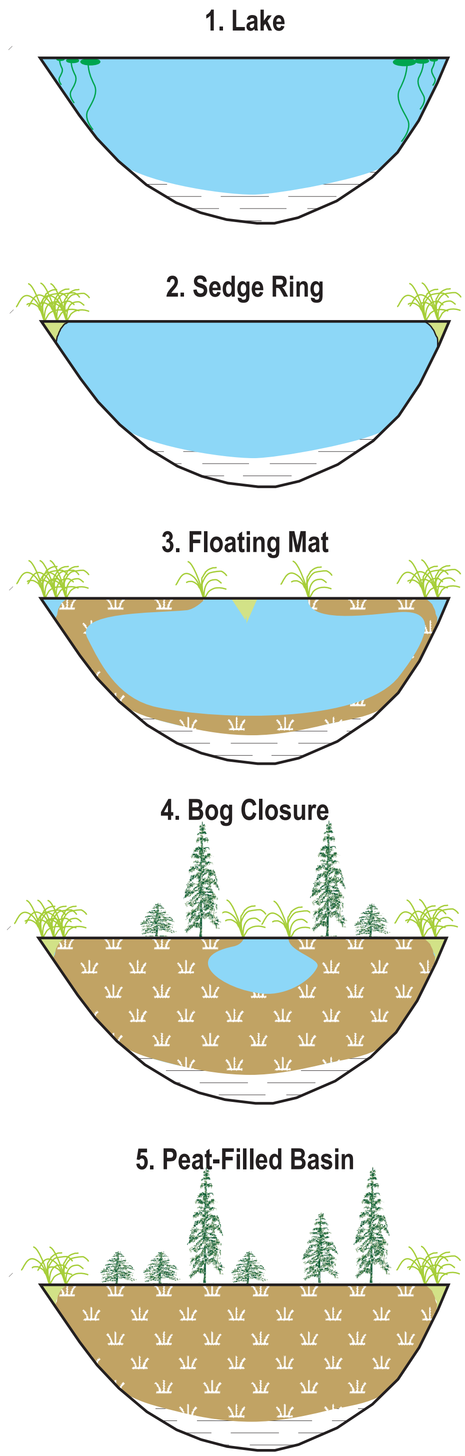

Figure 24 Basic stages of bog succession. Volo Bog likely has followed development similar to stage 1 (lake) through stage 4 (bog closure). Stage 4 represents the current stage of development at Volo Bog (modified from Sallett 2002 and Ritchie 1996).

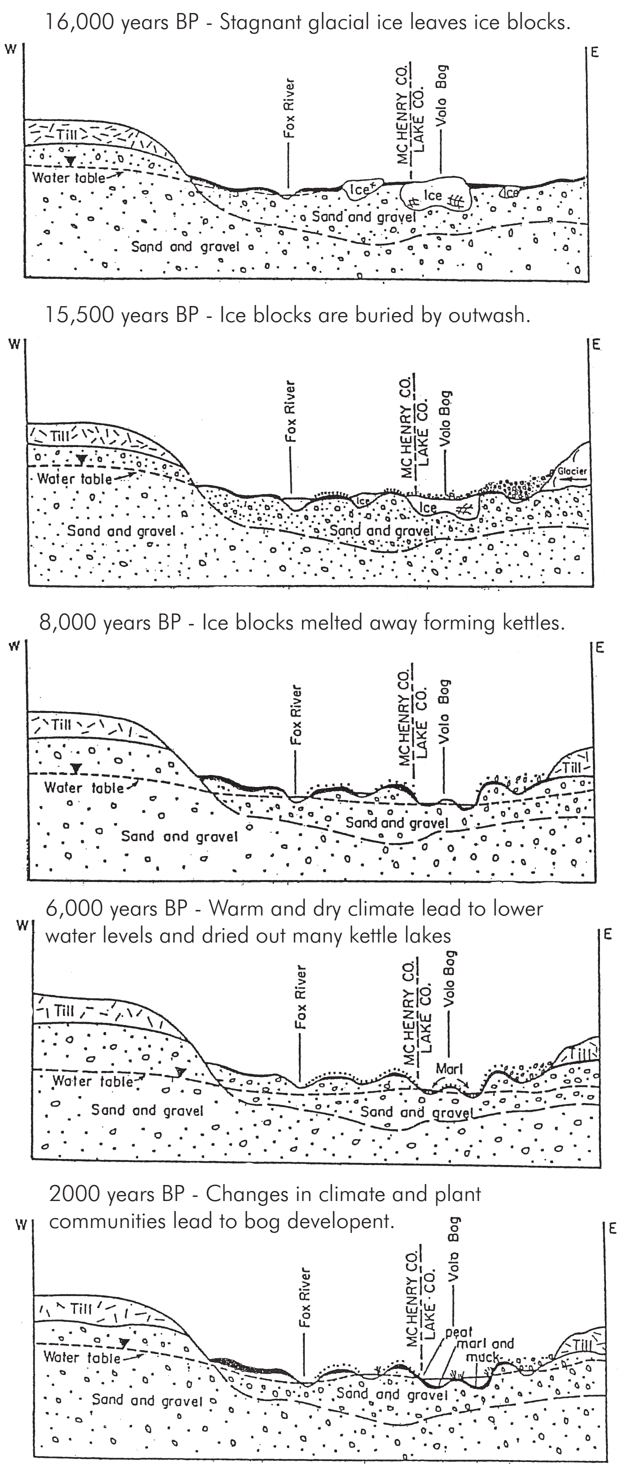

Figure 25 Principal geologic events during the development of Volo Bog (adapted from McCommas et al. 1972). BP, before present.

kettle at Volo Bog, sedges, mosses, and other emergent vegetation initially can only grow in shallow areas at the shoreline. As these emergent plants continue to grow, the dead plant matter they produce over many years forms peat layers that eventually build a significant thickness to form a floating mat along the shore. The sedges and other plants continue to grow on the peat mat, which thickens further and expands in areal coverage toward the center of the lake. Some of the peat decomposes further and settles to the bottom of the lake. Thus, the lake begins to fill both from the shoreline out and from the bottom up until the lake fills with peat (fig. 24).

Bog Succession

Unlike most of the other kettle lakes in the area that remain as open-water lakes (e.g., Lake Defiance at Stop 1) or are filled entirely with peat (e.g., Leatherleaf Bog at Moraine Hills State Park), Volo Bog is the only kettle wetland that shows distinct stages of hydrarch succession including open water. The wetland has developed from an open-water lake to the marsh and bog communities seen today. The plant communities that represent hydrarch succession form concentric circles around the open water at the center of the north part of the basin. The vegetation zones characteristic of hydrarch succession include (from center to edge): open water, sedge mat, a primary shrub zone that includes the tamarack trees, and secondary shrub zone that includes winterberry holly and poison sumac. The zones of hydrarch succession represent a transition from an open-water lake to bog-like conditions (fig. 23).

An open-water lake can transform to a bog when sphagnum mosses colonize the peat mat and begin to alter the ecosystems of the mat itself and the water filling the lake (Crum 1988). Sphagnum mosses alter the ecosystem in which they live by

- modifying water chemistry as they extract minerals and nutrients from the water and produce acids, thus altering water chemistry;
- driving peat accumulation through their own growth and death, building the substrate in which other plants grow; and
- modifying hydrology by limiting the flow of water in and out of the bog and by isolating portions of the bog from the water table through the accumulation of peat.

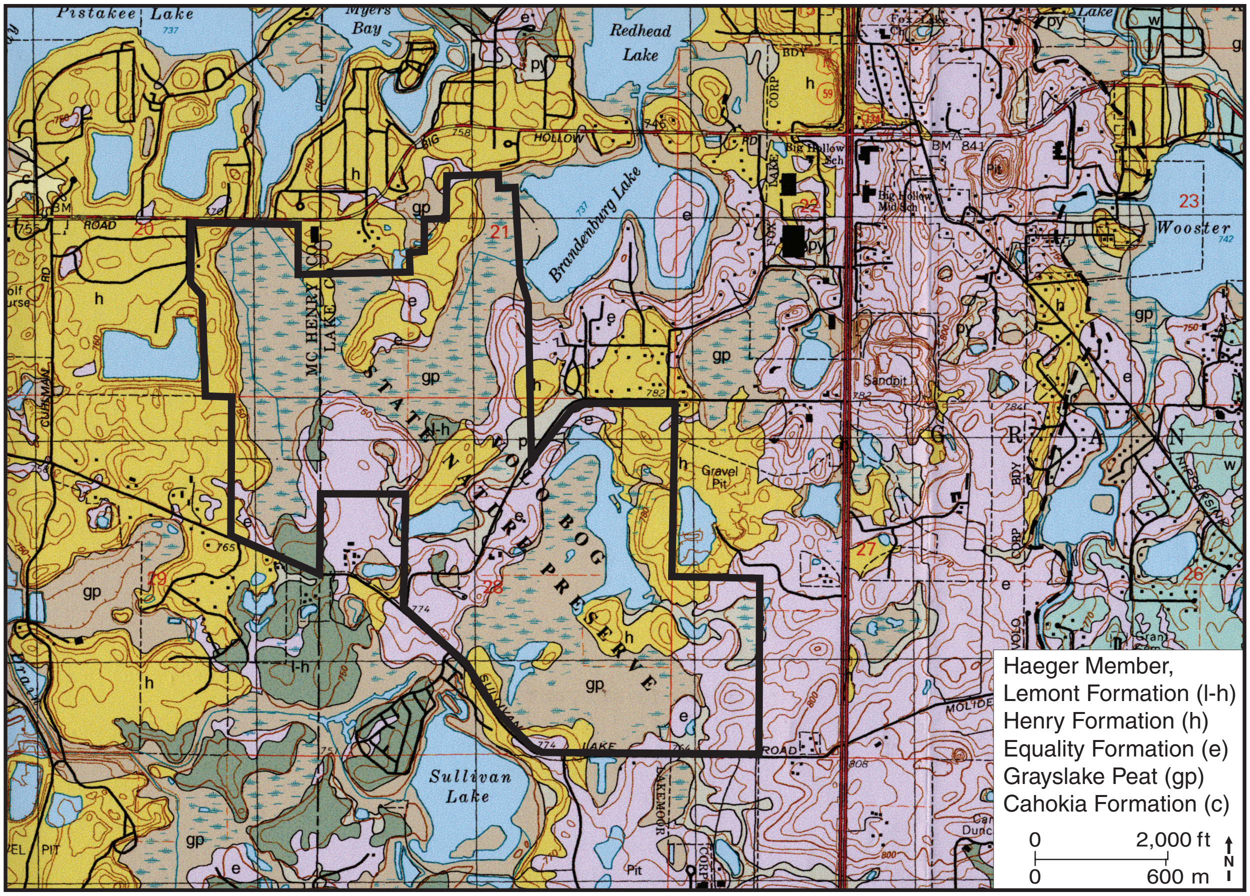

Figure 26 Surficial geology of Volo Bog Nature Preserve (Stumpf et al. 2004).

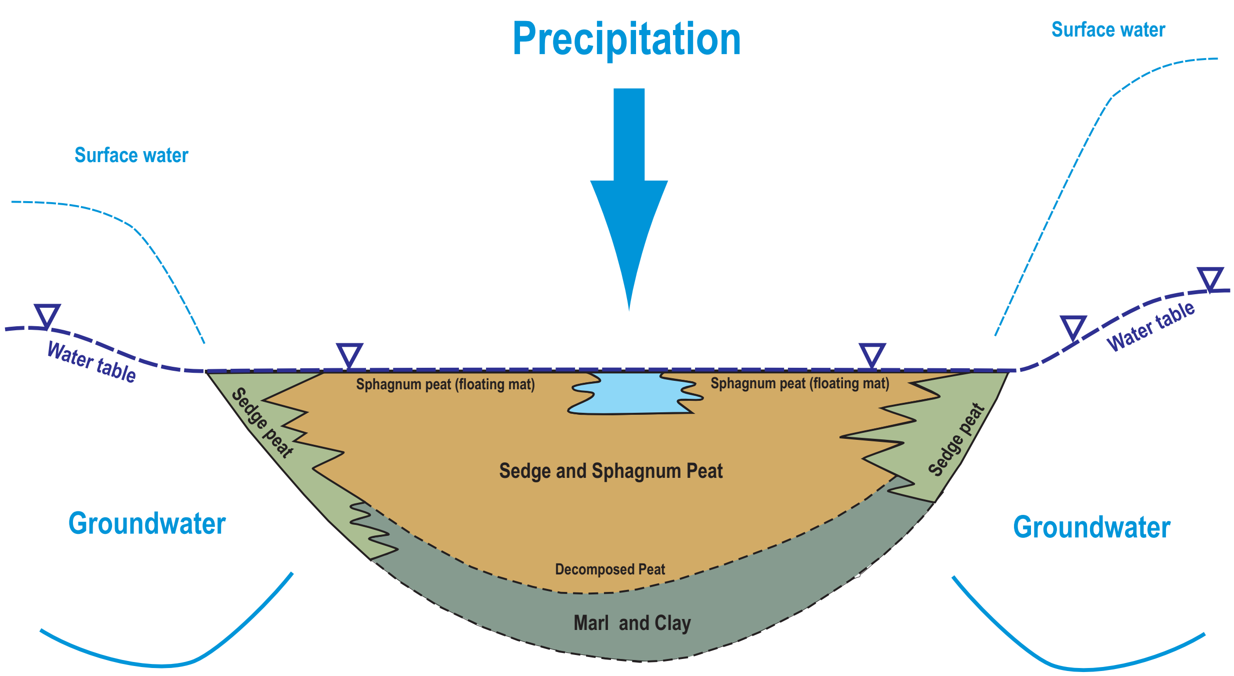

Figure 27 Generalized hydrogeologic cross section through Volo Bog. The size of the arrows indicates relative contribution of water from precipitation, groundwater, and surface runoff (adapted from McCommas et al. 1972).

In addition to the distinct zones of plant communities on the bog surface, the peat and pollen that have accumulated in the basin provide evidence for succession. The pollen of open-water aquatic plants such as bladderwort (Utricularia), pond lilies (Nuphar and Nymphaea), and watershield (Brasenia) has been found within the layers of peat beneath the bog surface. Larger amounts of pollen from these plants were present prior to about 2,000 years ago and decreased thereafter. The decrease in aquatic plants coincided with the increase in sedge (Cyperaceae), suggesting that the open-water lake began its transition from a lake to a bog around 2,000 years ago.

The Bog Today

The unique topographic and hydrogeologic setting of Volo Bog have allowed the site to transform from open-water lake, to fen, and then bog. A main difference between Volo Bog and other kettle lakes in the region is its high landscape position, which affects the importance and volume of each contributing water source. The high landscape position limits the surface water catchment area and the groundwater contribution area. Thus, inputs from surface water and groundwater are relatively low compared with that from precipitation (fig. 27). The few nutrients and dissolved minerals that enter the bog with surface runoff and groundwater are adsorbed or taken up by organisms at least as quickly as they are replenished. Further, the small amounts of runoff that reach the bog carry less sediment, dissolved minerals, nutrients, and pollutants because of the short distance the runoff travels overland. As a consequence, precipitation contributes a high proportion of water to the bog basin relative to other kettle lakes, and the slightly acidic precipitation allows sphagnum moss to grow. In contrast, most of the other wetlands have much larger catchments that contribute proportionally more surface water and groundwater, thus contributing more sediment, dissolved minerals, nutrients, and pollutants. These inputs cause these wetlands to be more alkaline, in part of the increased dissolved solids that buffer the precipitation, which allows plants other than sphagnum moss to colonize. These inputs also increase the rate of terrestrialization that shortens the life of the wetland.

In addition to the landscape position, the bog is relatively deep and has steep margins, allowing it to accumulate sediment for long periods without becoming completely filled. Its steep exterior margins prevent significant mixing, allowing stagnation and accumulation of acids. Finally, the steep margins prevent rooted plants from growing in the center of the bog, allowing the development of a floating mat. The peat builds out from the edges of the basin, providing a substrate for sphagnum mosses to colonize and forming bog conditions.

In early stages, the bog was a groundwater-fed depression that was colonized by plants that inhabit more alkaline conditions; the wetland might have even been a fen. As a sediment layer is deposited on the basin floor and vegetation and mosses colonized the edges of the basin, and as peat is accumulated, groundwater flow likely became more restricted (see fig. 27). The lower amount of groundwater reaching the basin is filtered by the peat. By the time the inflow reaches the center pond, the chemistry of the groundwater has been altered by acids produced by the plants and mosses. Additionally, as precipitation saturates the bog's surface, the peat increases the acidity of the water, thereby diluting any buffering that the rainwater may provide and allowing acidity to build up. Because of the lack of significant surface runoff and the relatively small groundwater catchment area, precipitation becomes a dominant control on the bog's chemistry.

In summary, the topographic and hydrogeologic setting has facilitated the development of Volo Bog. The landscape position, character of the basin, and dominant influence from precipitation has allowed the bog to transform from an open-water lake, to a fen, and finally a bog following colonization of the basin by sphagnum mosses. The mosses have not only thrived, but also transformed the wetland that is hydrologically isolated and maintains stagnant water conditions. The predominance of sphagnum mosses continues to drive the ecosystem, but eventually the bog will fill in beginning the transition to dry land through peat accumulation and continued inputs from runoff. But for now, the bog continues to support the unique ecosystem we see today.

Volo Bog Interpretive Trail

The following was modified from the Volo Bog State Natural Area spring trail guide leaflet for the interpretive trail (Illinois Department of Natural Resources 1998). The descriptions correspond to the numbered posts along the trail. This half-mile interpretive loop leads visitors through each stage of bog succession.

1. Glacial Beginnings. Volo bog began to form about 12,000 years ago when the Wisconsin Episode glaciers retreated from northeastern Illinois. Large blocks of ice were left behind. As the climate warmed, these ice blocks melted, forming depressions called kettles. Open-lakes, bogs, marshes, and other wetlands formed in these kettles. The original wetland formed because of very poor drainage and steep banks. Due to the stagnant environment, anaerobic (low oxygen) conditions were created, causing slow, incomplete decomposition of organic debris, accumulating peat. The poor drainage also caused a buildup of acids, which further inhibited decomposition. About 6,000 years ago, the lake began to fill in with organic deposits. Eventually, a floating mat of peat, supported by the roots of living plants was established. This mat is now encroaching upon the open water in the middle, filling in from the bottom and margins.

2. Edge of a Kettle. Notice the trees and shrubs extending to the left and right. These mark the edges of the old glacial lake. The Marsh Moat beyond is the outer ring surrounding Volo Bog. This floating boardwalk leads through the marsh moat and four other unique vegetational communities. Passing from one community to the next is like walking backward in time.

3. Muskrats and Red-winged Blackbirds. Spring is a good time to look for muskrat lodges in the marsh. Built of cattails, the lodges are easily seen before the vegetation of summer becomes too thick. A versatile plant, cattail, has leaves and young shoots that provide food for the muskrat and cover for a myriad of other wildlife. Cattails attract insects that are in turn eaten by red-winged blackbirds. Watch for males as they sing and display their red epaulets in defense of their territories. Each polygamous male may have several females nesting in his territory. Look closely for females who are quiet and camouflaged in brown, resembling a big sparrow more than their male counterparts. Listen quietly for a few minutes to discover these and other inhabitants of the marsh.

4. Spring Returns Slowly to the Marsh. As the sun's rays strengthen and progressively warm the bog water, look closely for signs of life returning to the marsh. Can you spot some of last years dried cattail seed heads? Look for new growth of the forked and greater duckweeds, tufted loosestrife, blue flag iris, cursed buttercups, and young cattails.

5. Tall Shrubs. Winterberry holly, the dominant plant in the Tall Shrub Zone, is so named since its berries remain after the leaves have fallen. It flowers in June. Scattered throughout the bog, the smaller dogwood shrubs also occur here. CAUTION: Do not touch the poison sumac. All parts of the plant contain a toxic oily resin called urushiol that may cause a rash worse than poison ivy. Learn to recognize the gray bark and compound leaves!

6. Dead Trees and Ancient Ferns. The tamarack trees here drowned during times of high water. Look for signs of life in the decaying wood. Living tamaracks lie ahead, growing on the floating mat that keeps them just moist enough but never too wet. Look for coiled fiddleheads of ferns as they poke their way through the warming peat soils. Also watch for last year's persistent fertile fronds of the sensitive ferns. Looking like "beads on a stick," spores on these fronds will be released to form the new generation. The cinnamon and royal ferns are two other common species at Volo Bog.

7. Tamaracks and Sphagnum Moss. Tamaracks are unusual pines: they're deciduous! Every fall, their needles turn golden and drop onto the peat surface, releasing tannic acid. Notice how the water is stained brown by these acids. Feel the soft needles as they emerge in clusters on spur-shoots. Look for the young maroon pinecones that are forming and for the older brown ones of last year that have already opened. Tamaracks are a tree of the northern United States and Canada near the southern edge of their range at Volo Bog. Tamaracks are an Illinois threatened species. The tamaracks thrive at this stop in the bog and occupy the floating mat of the Tamarack Zone. Their shallow spreading roots receive a constant amount of soil moisture as the trees float up and down with the changing water levels. Tamaracks were valued by ship builders who used the trunk and a main root (growing at right angles to the trunk) to construct angled supports between the hull and deck.

Sphagnum moss carpets the ground here. Native American Indians took advantage of the absorptive properties of the dried moss by lining their cradle boards. The moss absorbed moisture, much like a diaper. Soldiers of early battles used sphagnum as sterile dressing; acid produced by the moss inhibits bacteria growth.

8. Carnivorous Plants. Look for the carnivorous pitcher plants. Their leaves resemble modified cups or pitchers that hold water. Insects are lured down inside their cavity by the glistening water (pitfall trap) that they mistake for a meal of nectar. Instead, they become a meal themselves, trapped inside the cavity by the slippery leaf surface and the down-pointing hairs. The dead insect decomposes, releasing nitrogen and phosphorous to be absorbed by the plant. The pitcher plant is an Illinois endangered species.

The floating mat gets thinner toward the bog center. Here the tamarack zone grades gradually into a Low Shrub Zone of bog birch, willows, poison sumac and young tamaracks. Many of the plants (starflower, bog buckbean, leatherleaf, bog birch, and little bog willow, to name a few) are rare in Illinois and near the southern extent of their ranges.

9. Open Water and Natural Succession. This pond is all that remains of a kettle lake that once covered about 50 acres (fig. 23). A thin herb mat floats along the edges, thickening as it progresses away from the open center, grading into the low shrub zone, and further to tamarack forest. Today, Volo Bog is the only peat land in Illinois that still has open water at its center. Surrounded by floating mats, this, too, will eventually fill in with peat. This process of one plant community replacing another is called natural succession. In nature, conditions do not remain constant for long! Water in Volo Bog is acidic, measuring pH 4.5 to 6.0. The acids are generated from sphagnum moss, tamarack trees (tannic acid), and acid rain.

A true bog is mineral-poor, as it receives water only from precipitation. By definition, Volo Bog does not entirely qualify because some runoff flows into the wetland from the surrounding hills. Therefore, Volo Bog is classified as a fen. Furthermore, human activities have altered the drainage, establishing more inputs for runoff to the bog and altering several of its outlets. However, the floating peat mat may have the capacity to filter most minerals from the increased inflow before reaching the open water. Remember, nature does not always fit into the categories we humans try to impose!

10. Wetland Wildlife. Sit quietly for a while and watch. Birds call to each other as they migrate through to their northern nesting habitats. Listen for a splash of water where muskrat or tadpole swims. Few fish survive, however, due to low oxygen content in the water.

11. Early "Boggers." As early as 10,000 years ago, humans inhabited northeastern Illinois. They probably settled along the Fox River and the Chain-o-Lakes. Volo Bog and other wetlands away from the larger waterways would have provided good hunting grounds and places to gather cattails, arrowhead roots, blueberries, and other edible plants.

W.G. Waterman (an appropriate name!) first described Volo Bog to the scientific community in 1920. Many scientists followed including William Beecher who first arrived to the outer edge of Volo Bog as a kid on a bicycle. Dr. Beecher's love of nature led him into the directorship of the Chicago Academy of Sciences!

12. Marsh Moat and Wet Meadow. The open water is the result of early attempts to control the water flow in and around Volo Bog. During wet years, water levels rose, and the wetland maintained a marshland containing areas of open water and emergent plants. In drier years, sedges and grasses colonized the bog area forming a cover over the entire basin forming a meadow. Wildlife is abundant in this area. Some of the animals that may be seen include the kingfisher, wood duck, downy woodpecker, leopard frog, mink, beaver, and muskrat.

13. Human Land Use and Lost Cows. In the early 1900s, the area around Volo Bog was grazed by dairy cattle. Volo Bog's Visitor Center is housed in the old dairy barn. Local folk tales tell of cows and horses disappearing. Could they have wandered out onto the floating peat mats in the bog and broken through, never to resurface? The farmer sold his land to a sportsman's club in the 1940s. Go carts, skeet shooting, hunting, and fishing (here in this excavated pond as well in the marsh moat) were popular. None of this was a threat to the ecology of Volo Bog. In 1958, the newly formed Illinois Chapter of The Nature Conservancy purchased Volo Bog. It was turned over to the University of Illinois for management. Many students from the University of Illinois and other colleges visited and studied Volo Bog. In 1970, following threats to Volo Bog from impending development, the State of Illinois took control of this rare wetland and designated it an Illinois Nature Preserve. Volo Bog was designated as a National Natural Landmark in 1973. Today, the Illinois Department of Natural Resources manages Volo Bog to protect the unique ecosystems and its inhabitants for the understanding and enjoyment of today's and future generations.

STOP 4. Meyer Material Company Pit 26 (NW, NW, NW, Sec. 29, T45N, R8E), 3rd P.M., McHenry 7.5-minute Quadrangle, McHenry County. We will view the deposits in this gravel pit and discuss the importance of the sand and gravel industry in McHenry County.

Meyer Material Company Pit 26

This operation is the former West Pit of the McHenry Sand and Gravel Company. It has continually expanded from east to west as additional property was acquired. After 5 to 20 feet of fine-grained material (till and loess) is removed and stockpiled, sand and gravel are excavated above the water table by large front-end loaders (fig. 28). Material is extracted from the base of high walls (generally 30 to 60 feet high) and carried to mobile primary jaw crushers. Boulders larger than 15 inches in diameter are separated out of the aggregate by a steel grate set above the primary crushers. The crushed material is transported by conveyor belt to the processing plant. There are no present plans for dredging any material below the water table because the aggregate is too fine grained for saleable construction products.

A generalized geologic section for the pit area follows:

Peoria Loess
0–2 feet: Silt; includes top soil.

Lemont Formation (Haeger Member)
2–15 feet: Predominantly sandy till (clay, silt and sand with some gravel and boulders; tan colored).

Henry Formation (Beverly Tongue)
15–105 feet: Coarsening-upward sequence of sand and gravel; upper 60 feet coarse to fine gravel and sand with some boulders; lower 30 feet is fine gravel and sand.

Figure 28 Meyer Material Company, Pit 26 (photograph by W.T. Frankie, March 2007).

Tiskilwa Formation
105–205 feet: Predominantly clay and sand, but with some silt, gravel, and boulders; pinkish tan to gray in color.

Bedrock
205–500 feet: Silurian-age dolomite.

The sediments found within this pit are interpreted as outwash fan deposits, mapped as part of the Henry Formation glaciofluvial sediments deposited during the Wisconsin Episode glaciation (fig. 9). For purposes of discussion, outwash fan deposits can be divided into four assemblages (top to bottom, see fig. 29);

1. marginal assemblage, predominantly mud flows;
2. proximal assemblage from extremely high-energy braided streams;
3. medial assemblage from high- to moderate-energy braided streams;
4. from fluvial channel sands, silts, and clays of the distal assemblage.

The sand and gravel deposits being mined from this pit constitute part of an extensive ice marginal complex that formed along the western margin glaciers that advanced into northeastern Illinois. The meltwater flowed along streams on the surface of the glacier or along channels within or beneath the ice carrying debris that is washed and sorted. The meltwater eroded valleys and, in places, water-sculpted existing landforms.

Glacial meltwater floods spread as they left the ice front and formed braided streams that were overloaded with glacial debris consisting of clay, silt, sand, gravel, cobbles, and boulders. These streams, as they continually shifted their channels back and forth across the outwash fan, deposited and reworked the sand and gravel into relatively thin horizontal beds. The coarse sediment is deposited near the ice front; the finer materials are carried further downstream.

A number of sand and gravel pits were examined by ISGS geologists, Cobb and Fraser (1981), as part of their study of the sedimentology of large outwash plain

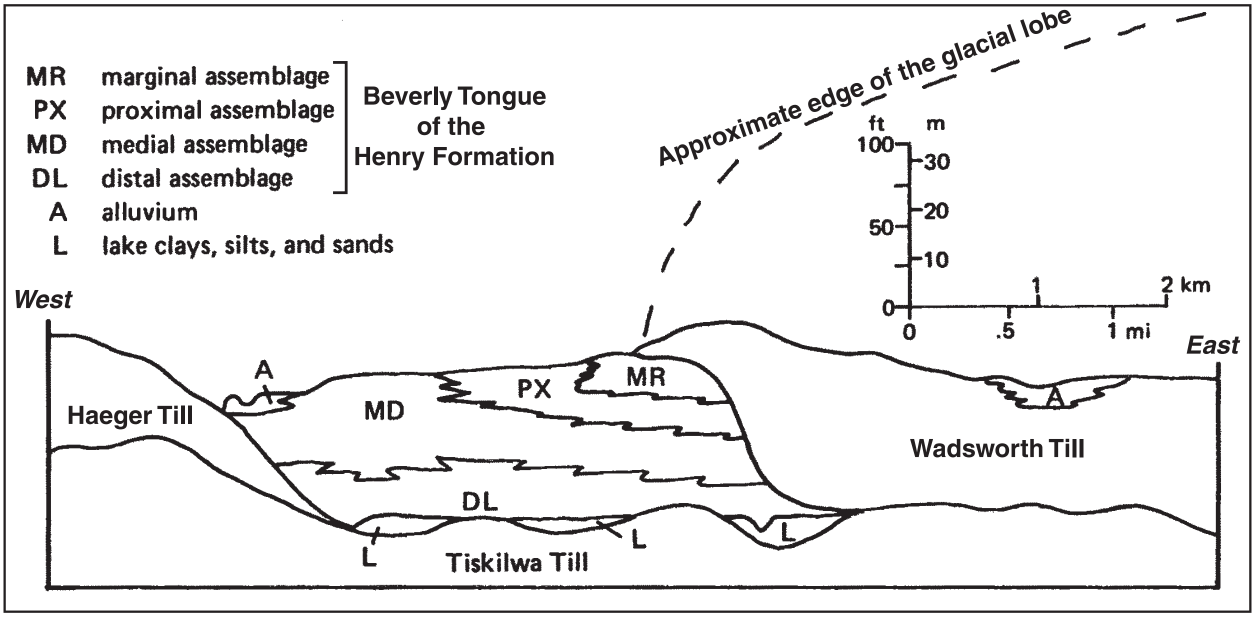

Figure 29 Generalized west-east cross section of the distal, medial, proximal, and marginal outwash assemblages (Beverly Tongue of the Henry Formation) deposited near McHenry. Interpreted and modified from studies conducted by Cobb and Fraser (1981).

deposits of sand and gravel in southeastern McHenry and northeastern Kane Counties. The geologists studied the distribution of sand and gravel (outwash) and compared it with modern fan deposits. Their objective was to determine the possibility of characterizing the textures and distribution of the various sediments in the deposit. This research was invaluable to pit operators wanting to locate the most desirable aggregate, to landowners wanting general information about property owned on outwash plains, and to planners for land-use management.

Cobb and Fraser (1981) noted that this outwash deposit can be characterized into different facies based upon their textural properties: (1) a coarse-grained, highly heterogeneous marginal facies found on the eastern margin of the outwash deposit; (2) a coarse-grained facies containing somewhat less heterogeneous, proximal assemblage present in a zone paralleling the marginal assemblage; (3) a relatively finer-grained and better sorted, the medial assemblage, present in a zone paralleling the western edge of the proximal assemblage; and (4) a fine-grained distal assemblage found beneath the proximal and medial assemblages (fig. 29).Their model of deposition proposes that accumulation began with the deposition of beds of clay, silt, and sand (distal assemblage). As the glacier advanced further, coarser material was progressively deposited, which resulted in a coarsening-upward sequence of sediments (medial, proximal, and marginal assemblages).

Most of the sand and gravel beds being excavated contain a sand-to-gravel ratio of about 1:1. These beds are usually less than 2 feet thick, often discontinuous, and contain slightly wavy interbeds separated by thin sandy zones. Internally the deposits contain few bedding features. These deposits are interpreted as part of the medial assemblage. Most of the gravel is less than 6 inches in diameter. The material generally is well sorted, containing very little silt or clay, and is an excellent material for making both fine and coarse construction aggregate products.

The upper 10 feet of the deposit exposed in the pit contains much more gravel coarser than 6 inches in diameter than is present below and is interpreted as the proximal assemblage of Cobb and Fraser (1981). This assemblage usually contains about 85% gravel, but also more silt and clay than the lower beds.

The upper 10 to 20 feet of the deposit is massive, very gravelly to sandy till. This material is sometimes stripped away and stockpiled for reclamation or used in other stages of the processing system as needed. This material is classified to the Haeger Member of the Lemont Formation and was probably deposited during a later ice advance.

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Illinois State Geological Survey: http://www.isgs.uiuc.edu/

Volo Bog and Moraine Hills State Park information: http://dnr.state.il.us/lands/landmgt/PARKS/index.htm

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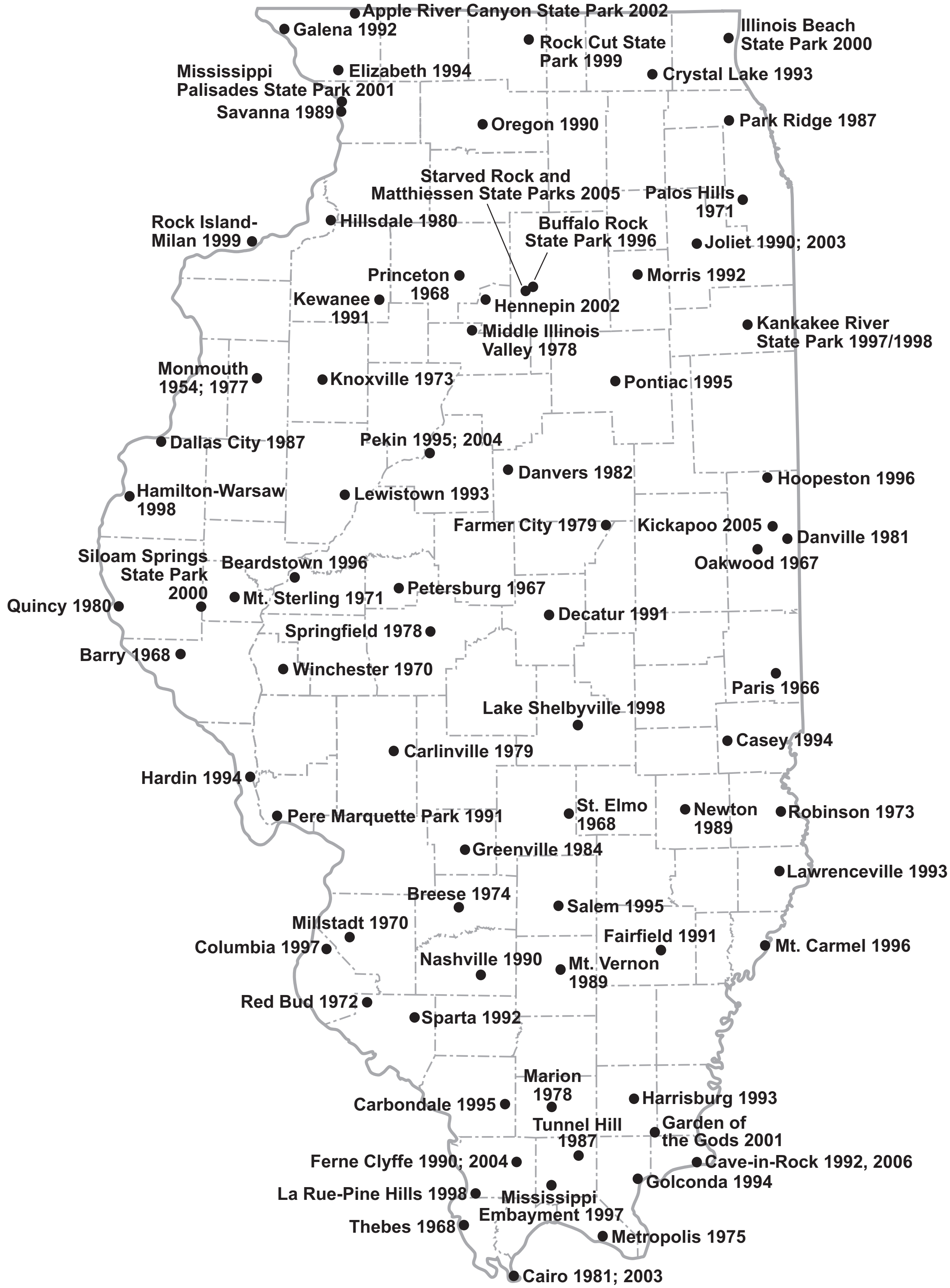

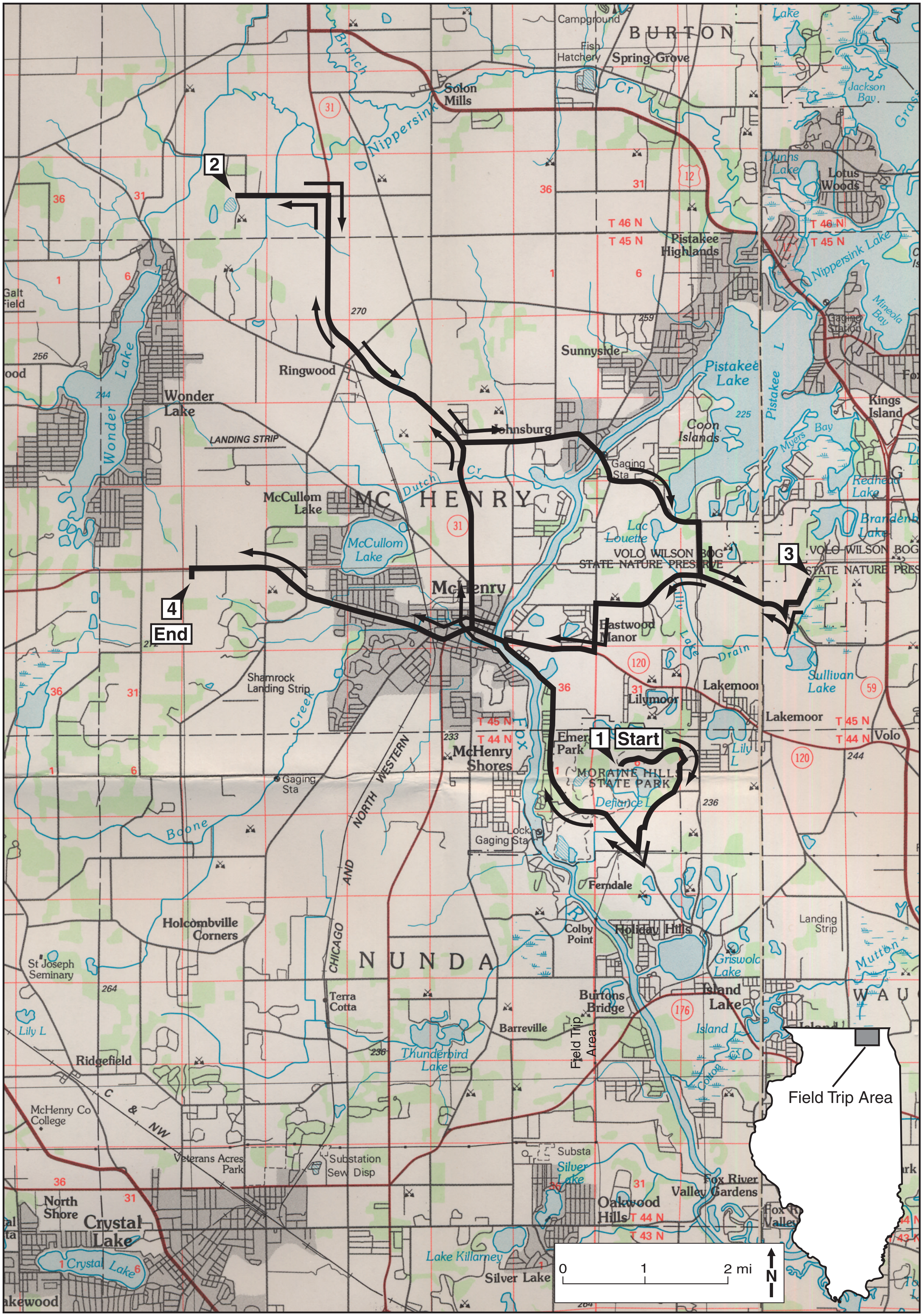
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Lilymoor
Lakemoor
Moraine Hills State Park
McHenry Shores
Ferndale
Holiday Hills
Colby Point
Burtons Bridge
Island Lake
Holcombville Corners
Terra Cotta
Barreville
Ridgefield
McHenry Co College
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