



Lincoln Boyhood National Memorial

Geologic and Soil Resources Inventory Summary



The court of the Memorial Visitor Center in Lincoln Boyhood National Memorial, featuring commemorative panels and inscriptions honoring the life and legacy of President Abraham Lincoln. The panels were sculpted from "Indiana Limestone," known formally as the Mississippian Salem Limestone. Paleontological resources at Lincoln Boyhood National Memorial are preserved in a cultural context within the Salem Limestone, including fossil marine invertebrates (foraminifera, corals, bryozoans, mollusks, and crinoids) and microfossils. The Salem Limestone is also utilized in other sites honoring President Lincoln, including the Lincoln Memorial in Washington, D.C. NPS photograph.

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Abstract

This document summarizes the status of National Park Service (NPS) Geologic Resources Inventory (GRI) and Soil Resources Inventory (SRI) deliverables for Lincoln Boyhood National Memorial. It also provides information on current geology and soil resources management concerns, with a focus on identified inventory needs related to geologic heritage, geohazards, and related soil features and processes. This document is intended to assist park staff with prioritizing technical assistance or new inventory and assessment funding requests in the near term (roughly 1–5 years).

The GRI hosted a baseline scoping meeting for Lincoln Boyhood National Memorial in 2010. Baseline bedrock and surficial geologic maps were delivered to the park in 2011 and updated in 2023. SRI delivered a legacy soil database and map to the park in 2007. The most up-to-date soil data for the national memorial is available through [Web Soil Survey](#).

Lincoln Boyhood National Memorial’s geologic heritage is ingrained in its Indigenous connections, paleontological resources, historical landscape impact of the Hoosier frontier, and commemorative stones honoring the Lincoln family as well as the life and legacy of President Lincoln. Geologic hazards identified in the park include climate change, disturbed lands (e.g., land use and development, mineral resource extraction), flooding, mass wasting (e.g., slumps, rockfalls, or rockslides), radon, seismicity, swelling clays, and toxicological soils. The geologic and soil resources inventory needs for the park include various data and/or GIS needs related to the inventory and monitoring of cultural resources and fossils, in addition to soil mapping needs.

Additional guidance for park staff regarding proposal processes and timeframes for the new Inventories and Assessment (I&A) program is available on the [GSRI](#) and [I&A](#) SharePoint sites.

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Background of the GSRI

The Geologic and Soil Resources Inventory (GSRI) aids in the collection of new data and derives new information from existing data regarding the presence, absence, abundance, distribution, and significance of geologic or soil features or processes to inform park management decisions and planning. The GSRI also includes the legacy Geologic Resources Inventory (GRI) and Soil Resources Inventory (SRI) programs.

In the late 1990s, the GRI and SRI programs were established as two of the 12 original baseline inventories in the Inventory and Monitoring (I&M) program. These baseline inventories compiled existing information, acquired new information, and helped establish a minimum level of data across the more than 270 parks that are part of the [I&M networks](#). For both GRI and SRI, the primary deliverable was a digital geospatial information system (GIS) map. Between the 1990s and early 2020s, in addition to a digital map, GRI scoping summaries, geologic map posters, and GRI reports were produced for most of the 270 parks. GRI and SRI baseline inventory products are available through the [NPS Geodiversity Atlas](#) and the [NPS DataStore](#). These products are designed to enhance stewardship of park resources by providing valuable information about soils, geologic formations, hazards, and links between geology, history, and other natural resources.

The GRI and SRI are now unified as one inventory, the GSRI, under the Inventories & Assessment (I&A) Program. The I&A Program, and henceforth the GSRI, operates under a park-proposed inventory strategy in which parks submit natural resource inventory and assessment project proposals to the Project Management Information System (PMIS) during the Servicewide Comprehensive Call (SCC). Park staff should refer to the [GSRI SharePoint](#) and [I&A Program SharePoint](#) for instructions on how to submit a project proposal including basic eligibility requirements, evaluation criteria, and the approval and implementation process.

As of 2025, the GSRI is in the process of completing baseline inventories for I&M parks and transitioning to the I&A model of accepting park-proposed projects from all NPS units. During this transition period, 13 parks, including Lincoln Boyhood National Memorial (“LIBO,” also referred to as the “national memorial” herein) were identified as not having a baseline GRI report. This GSRI summary serves as a substitute for a baseline GRI report and is intended to support the park’s participation in the I&A Program. As such, it summarizes the status of GRI and SRI deliverables for OBRI and provides information on current geology and soils resource management concerns with a focus on identifying inventory needs. Information in this summary was compiled from existing reports, meetings with park staff, and the best professional judgment from GSRI and Washington Support Office (WASO) Geologic Resources Division (GRD) geoscientists.

Baseline GSRI Products

Geology

The following baseline GSRI products are available for Lincoln Boyhood National Memorial: (1) a scoping summary (KellerLynn 2010), (2) geologic map data in a geographic information system (GIS) format, (3) a poster displaying the geologic map data; and (4) a GSRI summary (this document). These products are available via the “Geologic Resources Inventory Project for Lincoln Boyhood National Memorial” on the NPS DataStore accessed through the Integrated Resource Management Applications (IRMA) portal at: <https://irma.nps.gov/DataStore/Reference/Profile/2175789>.

Geologic maps provide information on the distribution of bedrock units, surficial units, and geologic structures such as faults and folds. These maps are invaluable for understanding potential hazards (e.g., landslides, earthquakes), guiding resource management, and evaluating the suitability of areas for infrastructure, trails, and visitor use. Information provided in baseline GSRI products is not a substitute for site-specific investigations. Ground-disturbing activities should neither be permitted nor denied based upon the information provided in these products. Minor inaccuracies may exist regarding the locations of geologic features relative to other geologic or geographic features in the Geologic map data or on the posters.

Scoping Meeting

The Geologic Resources Division held a GRI scoping meeting for Lincoln Boyhood National Memorial on June 28, 2010, at the Bailly Ranger Station in Indiana Dunes National Lakeshore, Porter, Indiana. The scoping meeting brought together NPS staff and geologic experts who reviewed and assessed available geologic maps, developed a geologic mapping plan, and discussed geologic features, processes, and resource management issues. Participants at the meeting included NPS staff from the National Memorial and the Geologic Resources Division, and cooperators from the Indiana Geological Survey and Colorado State University. A scoping summary (KellerLynn 2010) summarizes the findings of that meeting. The scoping summary is available on the NPS DataStore at:

<https://irma.nps.gov/DataStore/Reference/Profile/2250323>.

Geologic Map Data

Two geospatial Geologic map datasets are available for Lincoln Boyhood National Memorial: a bedrock geologic map and a sensitive geologic data (e.g., mine point features). The Geologic map data can be downloaded from the NPS DataStore at the following links:

- Bedrock geology: <https://irma.nps.gov/DataStore/Reference/Profile/2176329>
- Sensitive geologic data (NPS access only):
<https://irma.nps.gov/DataStore/Reference/Profile/2296826>

The Geologic map data was compiled by the GRI team in 2011 and updated in 2023. The GRI team did not conduct original geologic mapping but compiled existing geologic information (i.e., paper maps and/or digital data) into the Geologic map data. Scoping participants and the GRI team identified the best available source maps based on coverage (area mapped), map scale, date of mapping, and compatibility of the mapping to the current geologic interpretation of an area.

More information about the Geologic map data can be found in the files accompanying the data. The “GIS readme file” explains the available file formats for the Geologic map data, how to use the different file formats, and where to find more information about the GIS data model. The “ancillary map information document” shows the coverage of the data, lists the geologic maps or GIS data used to produce the Geologic map data, the map units and map unit descriptions (including descriptions from all source maps), and additional information about the source maps.

The source maps below were used to produce the Geologic map data for the parks:

- Hutchinson, H. C. 1959. Distribution, structure, and mined areas of coal in Spencer County, Chrisney Quadrangle, Indiana. Indiana Geological Survey, unpublished working maps, scale 1:24,000.

- Hutchinson, H. C. 1959. Distribution, structure, and mined areas of coal in Spencer County, Dale Quadrangle, Indiana. Indiana Geological Survey, unpublished working maps, scale 1:24,000.
- Hutchinson, H. C. 1959. Distribution, structure, and mined areas of coal in Spencer County, Holland Quadrangle, Indiana. Indiana Geological Survey, unpublished working maps, scale 1:24,000.
- Hutchinson, H. C. 1959. Distribution, structure, and mined areas of coal in Spencer County, Santa Claus Quadrangle, Indiana. Indiana Geological Survey, unpublished working maps, scale 1:24,000.
- Weber, L., B. Meyer, N. Eaton, and P. Irwin. 2010. Surface coal mines in Indiana (Indiana Coal Mine Information System or CMIS). Indiana Department of Natural Resources, Indiana Geological Survey, vector digital data, scale 1:24,000.

GRI Poster

A poster with the geologic map data draped over a shaded relief image of the park and surrounding area were created by the GSRI team (Thornberry-Ehrlich 2026). The GRI poster is not a substitute for the geologic map data but is supplied as a helpful tool for office and field use and for users without access to ArcGIS. Not all GIS feature classes are included on the posters, and geographic information and selected park features have been added. GIS features classes left off the posters include mine point features. Digital elevation data and added geographic information are not included in the Geologic map data but are available online from a variety of sources. The GRI poster is available on the NPS Datastore at:

<https://irma.nps.gov/DataStore/Reference/Profile/2318796>.

GSRI Summary

This summary presents information about the park’s geologic setting and history, geologic heritage, and geologic resource management. It synthesizes information from the 2010 scoping meeting, 2025 follow-up meeting, park planning documents, and additional geologic research. The GSRI summary is available on the NPS Datastore at: <https://irma.nps.gov/DataStore/Reference/Profile/2318797>.

Soils

Soil maps provide information on soil types, including scores of different characteristics and management considerations, including linear extensibility (“shrink-swell”) potential, erosion potential, soil stability, suitability for site development, suitability for recreation development (e.g., trails), and many other topics. Perrone (2023) provides an overview of the use of soil data at the NPS WASO level and lists soil data currently available in the Natural Resources Conservation Service (NRCS) [Web Soil Survey](#) website along with NPS-specific uses for the data. The NRCS plans to complete all soil survey areas in the US by 2026 (Thompson et al. 2020).

The most up-to-date soils data for LIBO is available via Web Soil Survey, which is updated and maintained regularly. Management-focused maps for the park or potential project areas can be developed on demand on the website. The Web Soil Survey homepage gives instructions for how to view and download soil data. The Web Soil Survey data are broken down into county-level soil survey areas. Each soil survey area is assigned a code and a name. LIBO includes one soil survey area that is complete (Table 1). To view the soil data on the Web Soil Survey website, use the navigation pane on the left side of the homepage to select the soil survey “Area of Interest (‘AOI’)” tab. Under the “National Park Service” dropdown menu, select LIBO to view the soil data for the national memorial. The AOI icon along the top of the screen allows users to select

specific areas of the map and generate detailed soil data (e.g., soil suitability and limitations, soil properties, soil qualities, and ecological sites). Use the “Soil Map” tab at the top to view the soil map and the “Soil Data Explorer” tab to view additional soil data, including linear extensibility and suitability for development. See additional Web Soil Survey guidance and FAQs or contact the NRCS state soil scientist for technical assistance.

Initial soil mapping by the NPS Soil Resources Inventory (SRI) was updated for LIBO in 2007 and is available on the NPS DataStore at: <https://irma.nps.gov/DataStore/Reference/Profile/1048922>.

Table 1. Web Soil Survey areas related to LIBO.

Web Soil Survey Area Code	Web Soil Survey Area Name	Status
IN147	Spencer County, Nebraska	Complete

Possible Future GSRI Products

As the GSRI integrates into the I&A program, future GSRI products will be determined by the project proposals submitted by the parks. Moving forward, the GSRI program will accept proposals for inventory projects that:

- Collect new data or derive new information from existing data regarding the presence, absence, abundance, distribution, and significance of geologic heritage, soil features or processes, or geohazards.
- Include features or processes on an individual feature- or landscape-scale.
- Include groups of features or maps of multiple features in a defined area of management needs.
- Are a snapshot in time and may set a baseline for monitoring or assessment.
- Typically include a geospatial (GIS) component.

GSRI project examples:

- Features and processes eligible for funding through the GSRI program include cave/karst, geothermal, paleontological (fossils), landslides and rockfall, other geohazards (e.g., avalanche, permafrost, volcanoes, earthquakes, tsunami, sinkholes), eolian, erosion, soil suitability and limitations for use, soil properties and qualities, ecological site descriptions, and other geologic or soil features or processes of management interest.
- The GSRI will accept proposals for new baseline map products, such as funding a traditional geologic (bedrock or surficial) or soil mapping effort, especially at new or expanded parks outside the original 270 I&M parks. Parks requesting these products will need to indicate a management need, which the baseline data will support.

Geologic Setting and History

Park Establishment and Setting

Lincoln Boyhood National Memorial (LIBO) is located near the Indiana–Kentucky border (Ohio River) approximately 64 km (40 mi) east of Evansville, Indiana, and 129 km (80 mi) west of Louisville, Kentucky, in the aptly named Lincoln City, Spencer County, southwestern Indiana. Established on 19 February 1962, the 80 ha (200 ac) national memorial commemorates the pioneer farm where the 16th President of the United States, Abraham Lincoln, lived from the age of 7 to 21 (National Park Service 2017; Jones et al. 2024). During these formative years, young Abraham helped his father transform the wilderness into suitable farmland and became proficient in wielding an axe. More importantly, the Indiana farm is where Abraham learned about life and death, and grew to become the man who would become President. In 1816, the Lincoln family—including father Thomas, mother Nancy, sister Sarah, and Abraham—left Kentucky for the new frontier of southern Indiana and established a new livelihood near Little Pigeon Creek. During the fall of 1818, when Abraham was nine years old, an outbreak of milk sickness (poisoning by milk from cows that have eaten white snakeroot) claimed the lives of his mother, uncle, aunt, and neighbors (National Park Service 2017). Today, the memorial landscape of LIBO encompasses the former site of the Lincoln family farm (Cabin Site Memorial), the marked gravesite of Nancy Hanks Lincoln (Pioneer Cemetery), the Memorial Visitor Center, as well as several miles of nature trail (Lincoln Boyhood Trail, Boyhood Nature Trail, Lincoln Spring Trail, Trail of Twelve Stones) that interpret and honor the boyhood, life, and legacy of Abraham Lincoln. Prior to its establishment, the national memorial was previously known as Nancy Hanks Lincoln Memorial and managed as part of Lincoln State Park. The state park was established in 1932 and is governed by the Indiana Department of Natural Resources to provide recreational opportunities and interpretive programs that supplement the mission of LIBO.

The national memorial is situated within the Boonville Hills division of the Southern Hills and Lowlands physiographic region, an unglaciated area of southern Indiana characterized by moderate hills or bottomlands (especially along the Ohio River) underlain by sedimentary strata of the Pennsylvanian Raccoon Creek Group (Figure 1; see Table 2 for a geologic time scale; Gray 2000; Tripp et al. 2024). Bedrock is typically present at shallow depth and outcrops are common (Gray 2000). The Boonville Hills have been mined extensively for coal, and much of the land surface has been modified in the eastern portion adjacent to LIBO (Gray 2000; Tripp et al. 2024). The surficial geology of the Boonville Hills consists of glacial outwash, glaciolacustrine (glacial lake) sediments, colluvium, and eolian (wind) deposits, in addition to modern alluvium associated with the Ohio River and its tributaries (Tripp et al. 2024). The geology and soils underlying LIBO create a landscape defined by steep sloping hills dissected by narrow ravines, as well as gently undulating topography (Jones et al. 2024).

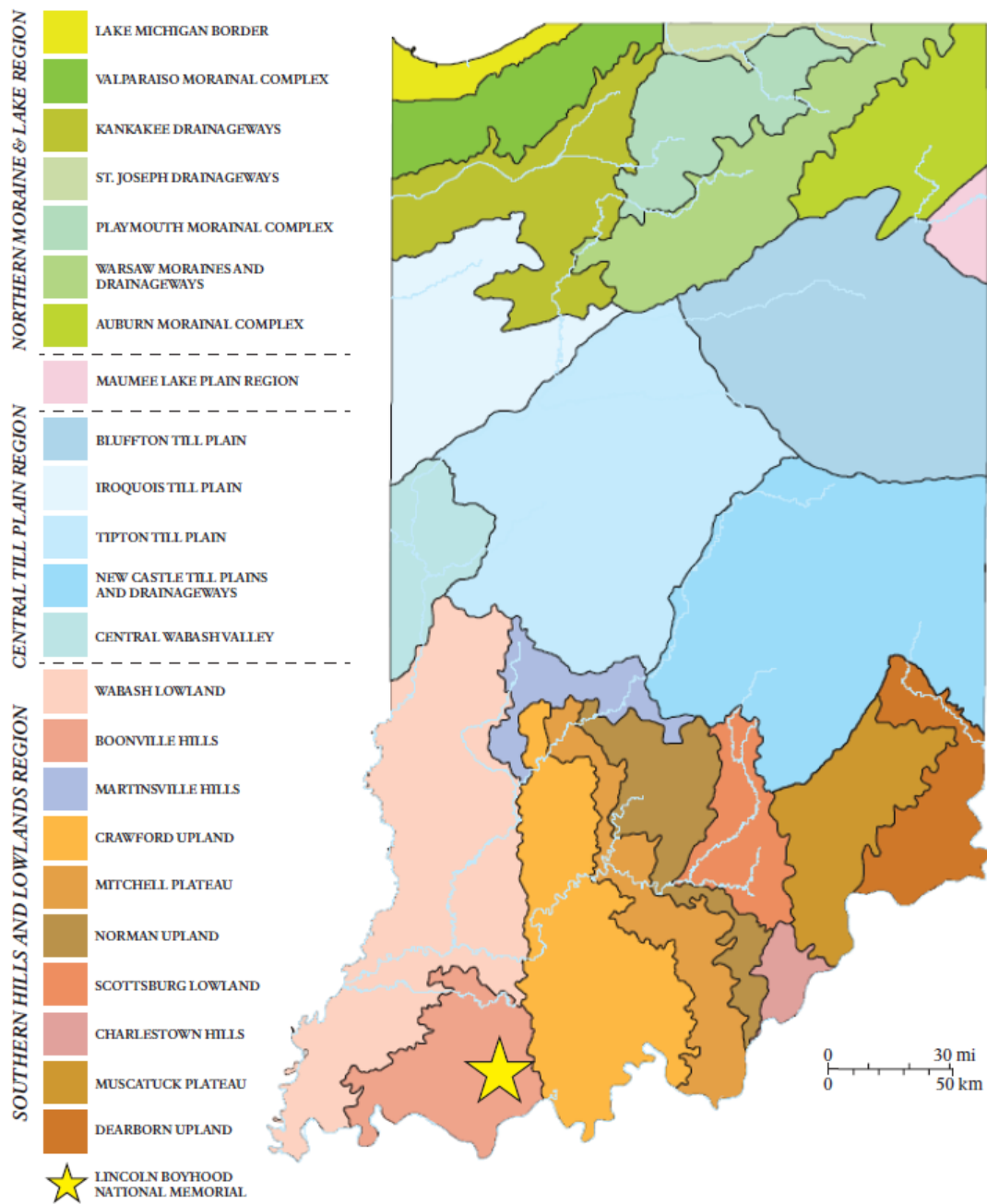


Figure 1. Physiographic province map of Indiana. The national memorial (yellow star) is located in the Boonville Hills division of the Southern Hills and Lowlands region, an area of southwestern Indiana defined by moderate relief hills or bottomlands flanking the Ohio River. Figure created by Tim C. Henderson (Colorado State University) and modified from Gray (2000).

Table 2. Geologic time scale.

Eon	Era(s)	Period(s)	Epoch(s)	MYA
Phanerozoic	Cenozoic	Quaternary (Q)	Holocene (H)	0.0117–today
Phanerozoic	Cenozoic	Quaternary (Q)	Pleistocene (PE)	2.6–0.0117
Phanerozoic	Cenozoic	Neogene (N)	Pliocene (PL)	5.3–2.6
Phanerozoic	Cenozoic	Neogene (N)	Miocene (MI)	23.0–5.3
Phanerozoic	Cenozoic	Paleogene (PG)	Oligocene (OL)	33.9–23.0
Phanerozoic	Cenozoic	Paleogene (PG)	Eocene (E)	56.0–33.9
Phanerozoic	Cenozoic	Paleogene (PG)	Paleocene (EP)	66.0–56.0
Phanerozoic	Mesozoic	Cretaceous (K)	Upper, Lower	145.0–66.0
Phanerozoic	Mesozoic	Jurassic (J)	Upper, Middle, Lower	201.3–145.0
Phanerozoic	Mesozoic	Triassic (TR)	Upper, Middle, Lower	251.9–201.3
Phanerozoic	Paleozoic	Permian (P)	Lopingian, Guadalupian, Cisuralian	298.9–251.9
Phanerozoic	Paleozoic	Pennsylvanian (PN)	Upper, Middle, Lower	323.2–298.9
Phanerozoic	Paleozoic	Mississippian (M)	Upper, Middle, Lower	358.9–323.2
Phanerozoic	Paleozoic	Devonian (D)	Upper, Middle, Lower	419.2–358.9
Phanerozoic	Paleozoic	Silurian (S)	Pridoli, Ludlow, Wenlock, Llandovery	443.8–419.2
Phanerozoic	Paleozoic	Ordovician (O)	Upper, Middle, Lower	485.4–443.8
Phanerozoic	Paleozoic	Cambrian (C)	Furongian, Miaolingian, Series 2, Terreneuvian	538.8–485.4
Proterozoic	Neoproterozoic (Z)	Ediacaran, Cryogenian, Tonian	n/a	1,000–538.8
Proterozoic	Mesoproterozoic (Y)	Stenian, Ectasian, Calymmian	n/a	1,600–1,000
Proterozoic	Paleoproterozoic (X)	Statherian, Orosirian, Rhyacian, Siderian	n/a	2,500–1,600
Archean	Neo-, Meso-, Paleo-, Eo-archean	n/a	n/a	4,000–2,500
Hadean	n/a	n/a	n/a	~4,600–4,000

Geologic History

Paleozoic Era (323.2 million to 307.0 million years ago): Shifting Seas and Orogenies

The sedimentary bedrock underlying the national memorial consists of the Early to Middle Pennsylvanian Raccoon Creek Group, a sequence of soft shales, sandstones, limestones, and coal beds deposited roughly 323 million to 307 million years ago. These rocks record a diverse suite of marine and terrestrial environments that prevailed along the fluctuating shoreline of an ancient inland sea (KellerLynn 2010). During the Pennsylvanian Period, the present-day area of LIBO was part of a gently dipping, tropical shelf within the Illinois Basin, a large, elliptical depositional and structural basin extending across considerable portions of Illinois, Indiana, and Kentucky (Figure 2; Leighton et al. 1990; Fielding et al. 2020). The Raccoon Creek Group preserves cyclical sedimentation cycles, often referred to as “cyclothem,” that were likely caused by eustasy (global sea level change) driven by the waxing and waning of glacial ice (Archer et al. 2016; Fielding et al. 2020). The effects of sea level change were amplified along low-angle coastal systems, causing rapid shoreline incision or inundation (Archer et al. 2016; Fielding et al. 2020). According to Archer et al. (2016), economic Pennsylvanian coal deposits of the Illinois Basin commonly exhibit evidence of cataclysmic burial resulting from marine flooding events, including entire forests of upright *in situ* tree trunks preserved in mudstone. During periods of sea level fall, river systems would incise downward into exposed sediments of the coastal plain or shelf, creating thick, elongate fluvial sequences of sandstone, gravel, and mudstone referred to as incised valley fills (Fielding et al. 2020).

The depositional context of the Raccoon Creek Group and other similar-aged strata of the midcontinent were impacted not only by sea level change but also by orogenic (mountain-building) activity along the eastern margin of North America. The Appalachian orogenic system that created the Appalachian Mountains consists of three main stages of evolution (in order from oldest to youngest): (1) the Taconic orogeny, approximately 490 million to 430 million years ago; (2) the Acadian orogeny, about 430 million to 345 million years ago; and (3) the Appalachian orogeny, circa 330 million to 275 million years ago (Allred and Blum 2021). The uplift of the Appalachian Mountains created the supercontinent Pangea but also provided a fresh source of detritus that was carried deep into the continental interior, including the Illinois Basin (Kissock 2017). Large fluvial systems distributed sediments hundreds of miles to the west, where they are now famously preserved in places such as the Grand Canyon (Gehrels et al. 2011; Kissock 2017). Several studies utilizing detrital zircon analyses have determined that Early to Middle Pennsylvanian rocks, such as the Raccoon Creek Group, record the uplift of the Appalachians and contain its recycled remains (Kissock et al. 2017; Allred and Blum 2021)

Within LIBO, the Raccoon Creek Group consists of (from oldest to youngest) the Mansfield (**PNbm**), Brazil (**PNbm**), and Staunton (**PNs**) formations. Although not depicted in the GSRI GIS data, mapping by Tripp et al. (2024) has differentiated the distribution of the Mansfield and Brazil formations. The Mansfield Formation predominantly consists of sandstone with lesser amounts of shale and several discontinuous coal horizons (Tripp et al. 2024). Building stone of the Mansfield Formation is informally referred to as the “St. Meinrad sandstone” and was sourced from quarries in nearby St. Meinrad; these rocks were utilized in the construction of the Cabin Site Memorial and Memorial Visitor Center (see “Commemorative Stones”; O’Bright 1987; McEnaney 2001; National Park Service 2012, 2021). Several formally named coal beds or members of the Mansfield Formation have stratotypes (exposure locations where rock units were first named or described) in surrounding Spencer County, Indiana. The Mariah Hill Coal Bed of the Mansfield Formation

was named after coal seams located southeast of the community of Mariah Hill, about 10.5 km (6.5 mi) away from LIBO (Franklin and Wanless 1944; Shaver et al. 1970, 1986). Another coal horizon, the St. Meinrad Coal Bed of the Mansfield Formation, was first described from coal mined near St. Meinrad (Franklin and Wanless 1944; Shaver et al. 1970, 1986). Additionally, the Fulda Limestone Member of the Mansfield Formation is derived from fossiliferous limestone exposures approximately 11 km (7 mi) east of LIBO (Franklin and Wanless 1944; Shaver et al. 1970, 1986).

The overlying Brazil Formation is a sequence of shales, sandstones, paleosols (ancient soils), and coal horizons (Tripp et al. 2024). These rocks are mapped along the eastern and central portions of LIBO, including the Living Historical Farm. The stratotype of the Buffaloville Coal Member of the Brazil Formation is located roughly 2.4 km (1.5 mi) southeast of the national memorial near the community of Buffaloville (Franklin and Wanless 1944; Shaver et al. 1970, 1986). The Staunton Formation consists of sandstone, shale, and some limestone, with as many as eight discernable coal beds (Tripp et al. 2024). The formation is divided into four formally named members, including the economic Seelyville Coal Member. The Staunton Formation underlies the southernmost portion of the national memorial, including Pioneer Cemetery and the Memorial Visitor Center.

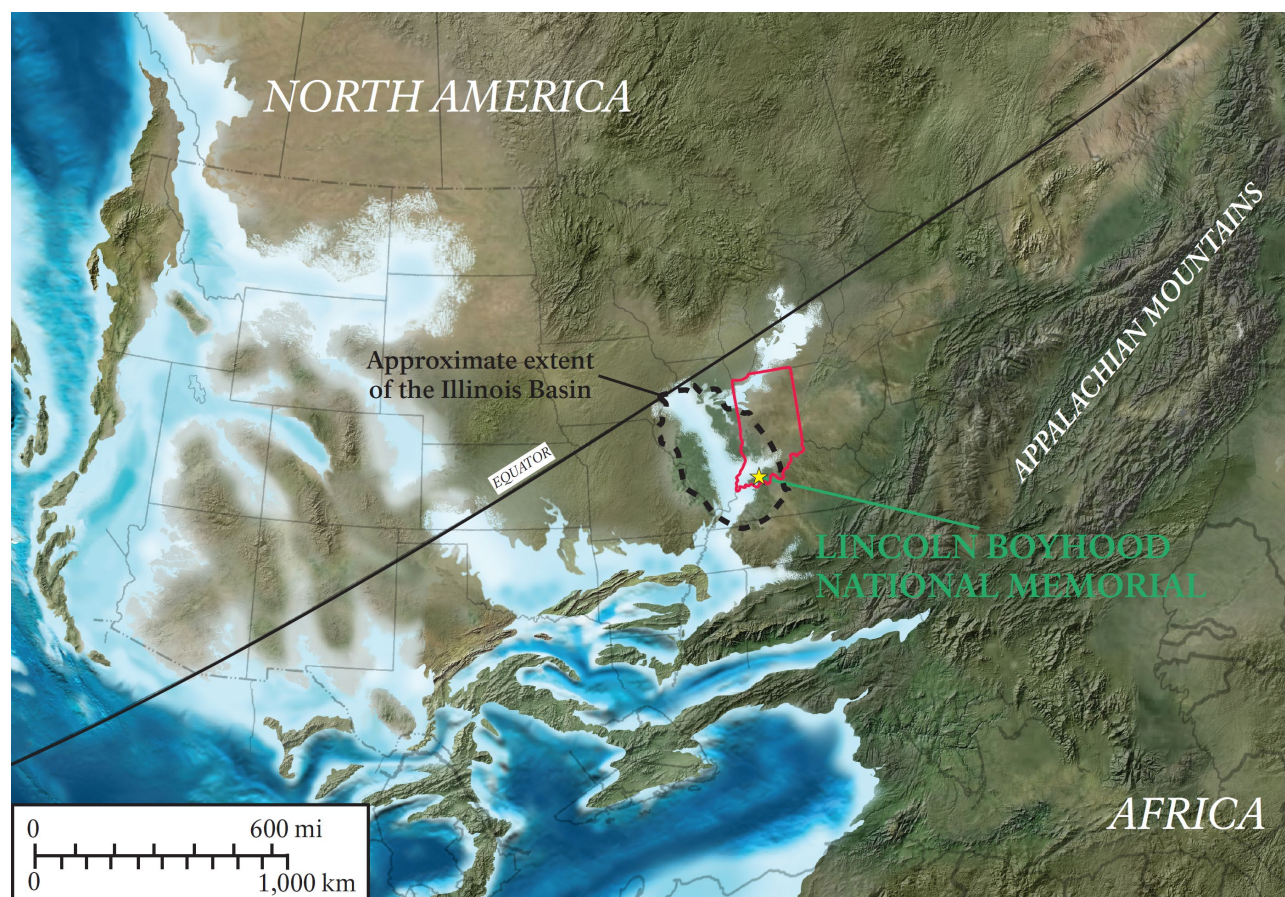


Figure 2. Paleogeographic reconstruction of North America during the early Pennsylvanian Period. Approximately 323 million to 307 million years ago, the state of Indiana (red outline) was a tropical setting located near the equator. The national memorial (yellow star) was situated along the gently dipping coastline of an inland sea within the Illinois Basin, an elongate structural and depositional basin containing economic quantities of oil, gas, and coal. North American Key Time Slices © 2013 Colorado Plateau Geosystems Inc., modified by Tim C. Henderson (Colorado State University).

Cenozoic Era (2.58 million years ago to present): The Ice Age

The modern landscape of the national memorial and the surrounding Boonville Hills is a product of Quaternary glacial, lacustrine, eolian, and fluvial processes. Extensive, thick glaciers of the Laurentide Ice Sheet advanced southward across the United States multiple times during the Pleistocene Epoch (2.58 million to 11,700 years ago), beveling mountains, scouring valleys, and releasing massive amounts of till (unconsolidated, poorly sorted rock material) and meltwater when they receded at the end of the Ice Age (Figure 3). Although LIBO occupies an unglaciated portion of Indiana, the influence of glaciers is evident in the distribution and abundance of unconsolidated surficial deposits of clay, sand, and gravel. Even though the national memorial was never glaciated, the southern limits of the Illinoian (190,000 to 130,000 years ago) and Wisconsin (29,000 to 14,000 years ago) glaciations were within 45 km (28 mi) and 110 km (68 mi), respectively (Gray 2000; Tripp et al. 2024). In the Pakota River valley (Dubois County) north of LIBO, the Illinoian glaciation deposited roughly 46 m (150 ft) of stratified clay, silt, sand, and gravel associated with glacial Lake Patoka (Fuller and Clapp 1904; Tripp et al. 2024). At the end of the Wisconsin glaciation, large amounts of glacial outwash, colluvium, and eolian sand accumulated within and adjacent to the Ohio River valley (Tripp et al. 2024).



Figure 3. Paleogeographic reconstruction of North America during the Late Pleistocene Epoch. Approximately 12,000 years ago, large portions of the northern United States—including Indiana (red outline)—were covered by the extensive Laurentide Ice Sheet. The national memorial (yellow star) was located near the southernmost extent of the ice sheet but was never inundated by glaciers. North American Key Time Slices © 2013 Colorado Plateau Geosystems Inc., modified by Tim C. Henderson (Colorado State University).

Geologic Heritage

Geologic heritage (also called “geoheritage”) is the idea that the geology of a place is an integral part of its history and cultural identity. In 2015, the National Park Service's GRD, in cooperation with the American Geosciences Institute, published a booklet introducing the American experience of geoheritage, geodiversity, and geoconservation: *America's Geologic Heritage: An Invitation to Leadership*. This publication introduced key principles and concepts of America's geoheritage, which are the focus of ongoing collaboration and cooperation on geologic conservation in the United States. The booklet includes the following five big ideas:

- America’s geologic landscape is an integral part of its history and cultural identity, and Americans have a proud tradition of exploring and preserving geologic heritage.
- America’s geologic heritage, as shaped by geologic processes over billions of years, is diverse and extensive.
- America’s geologic heritage holds abundant values—aesthetic, artistic, cultural, ecological, economic, educational, recreational, and scientific—for all Americans.
- America’s geologic heritage benefits from established conservation methods developed around the world and within the United States.
- America’s geologic heritage engages many communities, and involvement by individuals will ensure its conservation for future generations.

Indigenous Connections

In southern Indiana, counties bordering the Ohio River and lower Wabash River valleys preserve evidence of early human occupation dating back nearly 10,000 years (Mauck and McKelway 1996). These river settings provided a means of sustenance, transportation, and trade that have persisted to the present day. Other hydrological features in proximity to LIBO—including the Lincoln Spring—were not only attractive to early pioneers such as the Lincoln family but were vital to Indigenous cultures of the bottomlands adjacent to the river. In Ralph Gray’s (1952, pg. 157) National Geographic article titled *Vacation Tour Through Lincoln Land*, the author mentions a serendipitous discovery of “...a perfectly shaped Indian arrowhead” along the Trail of Twelve Stones in proximity to Nancy Hanks Lincoln’s gravesite. Early archeological investigations of LIBO performed during the 1960s recovered a limited quantity of Indigenous materials in the northern portion of the national memorial near the Cabin Site (Larrabee 1967; Larrabee and Kardas 1968). Additional shovel-test surveys conducted from 1997 to 1999 revealed at least 15 Indigenous sites consisting of low-density lithic scatters (rock fragments) probably associated with temporary camps, foraging, or hunting; most of these materials were waste associated with the procurement of flaked stone tools (Frost and Stadler 2000; National Park Service 2005). According to the National Park Service (2021), the Delaware and Peoria tribes may have potential cultural affiliations with the area now known as LIBO, but additional ethnographic surveys need to be performed (see “Inventory Needs”).

Commemorative Stones

The national memorial contains numerous commemorative stones associated with the Lincoln family, including Nancy Hanks Lincoln's gravesite (Pioneer Cemetery), the Cabin Site, the Memorial Visitor Center, as well as the Trail of Twelve Stones. In the spirit of Hoosier pride, many of these building stones were sourced locally from the state of Indiana; however, some represent samples collected from places honoring President Lincoln's life and accomplishments.

Nancy Hanks Lincoln's Gravesite

The gravesite of Nancy Hanks Lincoln has experienced many changes since her passing in 1818 when Abraham Lincoln was only nine years old. After President Lincoln's assassination in April 1865, the Indiana farm site garnered interest and became a place to honor both him and his mother; sadly, some items such as cabin logs and stones were pilfered as mementos (National Park Service 2012, 2017, 2021). Although it is believed the Lincoln family initially decorated her grave with fieldstones at the head and foot, these simple markers disappeared in the following decades (HRA Gray and Pape, LLC 2002). Shortly following the assassination (circa 1874), a group of local Rockport businessmen erected a 0.6 m (2 ft)-tall stone marker at Nancy Hanks Lincoln's grave that was inscribed with her name (O'Bright 1987). However, this stone also disappeared within a few years. The first permanent and official gravestone of Nancy Hanks Lincoln was laid in November 1879 and is an Italian marble tombstone purchased by South Bend businessman Peter E. Studebaker (McEnaney 2001; HRA Gray and Pape, LLC 2002; National Park Service 2021). Measuring approximately 0.6 m (2 ft) tall, the lancet-shaped monument is inscribed with the words, "Nancy Hanks Lincoln | Mother of President Lincoln | Died Oct. 5, A.D. 1818 | Aged 35 years | Erected by a friend of her martyred son 1879" (Figure 4a). In 1902, J.S. Culver donated a stone marker carved from an excess piece of Early Devonian Quincy Granite left over from the construction of the Lincoln Tomb in Springfield, Illinois. Now known as the "Culver stone," it was originally placed next to Nancy Hanks Lincoln's grave until it was relocated to the Trail of Twelve Stones in 1933 (Figures 4b, c; see "The Trail of Twelve Stones"). The marker measures roughly 1.2 m (4 ft) by 1.0 m (3.3 ft) by 0.7 m (2.2 ft), and rests upon a stone base measuring 1.4 m (4.5 ft) by 1.8 m (6 ft; HRA Gray and Pape, LLC 2002). The stone is inscribed as follows: "Nancy Hanks Lincoln | In Memoriam | This stone from Lincoln's Tomb in Springfield, Illinois was presented by a grateful people in contribution to his mother".



Figure 4. Nancy Hanks Lincoln's gravestone and the Culver stone. A) Nancy Hanks Lincoln's grave is marked by a lancet-shaped marble tombstone purchased by Peter E. Studebaker and erected in 1879. B) The Culver stone was donated by contractor J.S. Culver, who carved an excess piece of granite (Early Devonian Quincy Granite) left over from the construction of the Lincoln Tomb in Springfield, Illinois. C) Prior to its relocation to the Trail of Twelve Stones in 1933, the Culver stone sat adjacent to Nancy Hanks Lincoln's grave. NPS photographs.

The Cabin Site Memorial

“My father, at the death of his father, was but six years of age, and he grew up literally without education. He removed from Kentucky to what is now Spencer County, Indiana, in my eighth year. We reached our new home about the time the State came into the Union. It was a wild region, with many bears and other wild animals still in the woods. There I grew up.” – Abraham Lincoln to Illinois businessman and close friend Jesse W. Fell, 20 December 1859 (Appleman 1961, pg. 1)

Following Indiana’s centennial celebration in December 1916, citizens of Spencer County amassed an effort to identify locations considered significant to the state’s history in anticipation of the county’s upcoming centennial in 1918. Local residents assembled at the former site of the Lincoln farm in 1917 to determine the exact location of the family cabin (O’Bright 1987). After the first few shovelfuls of dirt revealed hearthstones and pottery fragments, it was determined the remains of the Lincoln cabin had been found and the county erected a stone marker on the site; today, this marker is located along the Trail of Twelve Stones (see “The Trail of Twelve Stones”; O’Bright 1987; McEnaney 2001; National Park Service 2005, 2021). Beginning in the 1920s, state agencies such as the Indiana Department of Conservation (now the Indiana Department of Natural Resources) led the effort to create a more formal memorial, which was maintained and interpreted as part of Lincoln State Park (formerly the Nancy Hanks Lincoln Memorial). As part of the preparations for the Cabin Site Memorial in 1934, the Civilian Conservation Corps (CCC) excavated the site of the Lincoln cabin and uncovered approximately 150 sandstone hearthstones about 0.5 m (1.5 ft) below the ground surface (McEnaney 2001; HRA Gray and Pape, LLC 2002; National Park Service 2021). The discovery of the hearthstones, which formed a “T”-shaped configuration consisting of three stacked layers of rock, helped substantiate the known location of the cabin (O’Bright 1987; McEnaney 2001). To protect their historic integrity, the CCC recovered the hearthstones without the assistance of heavy equipment, and they were documented, photographed, and stored in a display case at the Cabin Site Memorial (Figure 5). Although the hearthstones were relocated to the State Library Building in Indianapolis during the 1940s, some of them were brought back to LIBO in the 1960s and later incorporated into exhibits inside the Memorial Visitor Center (McEnaney 2001).

Following the excavation of the hearthstones, the CCC constructed a retaining wall around the site, laid a flagstone walkway, and landscaped the grounds (HRA Gray and Pape, LLC 2002; National Park Service n.d.-a, 2021). Both the wall and walkway consisted of “St. Meinrad sandstone” (Pennsylvanian Mansfield Formation) quarried from nearby St. Meinrad; the walkway was later replaced in 1968 with gravel and brick (McEnaney 2001; HRA Gray and Pape, LLC 2002; National Park Service 2021). When designing the Cabin Site Memorial, state officials decided that a cabin reconstruction was inappropriate, and in 1935 a bronze casting of sill logs (base logs that rest upon a cabin’s foundation), a fireplace, and hearthstones were placed on the exact location of the Lincoln family farm (Figure 6).



Figure 5. Historic hearthstones that were discovered at the site of the Lincoln family cabin in 1934. Horace Weber, supervisor of the Civilian Conservation Corps crew working at Lincoln City, crouches over the sandstone hearthstones. The bronze Cabin Site Memorial was placed on the location of the hearthstones in 1935. NPS/LIBO

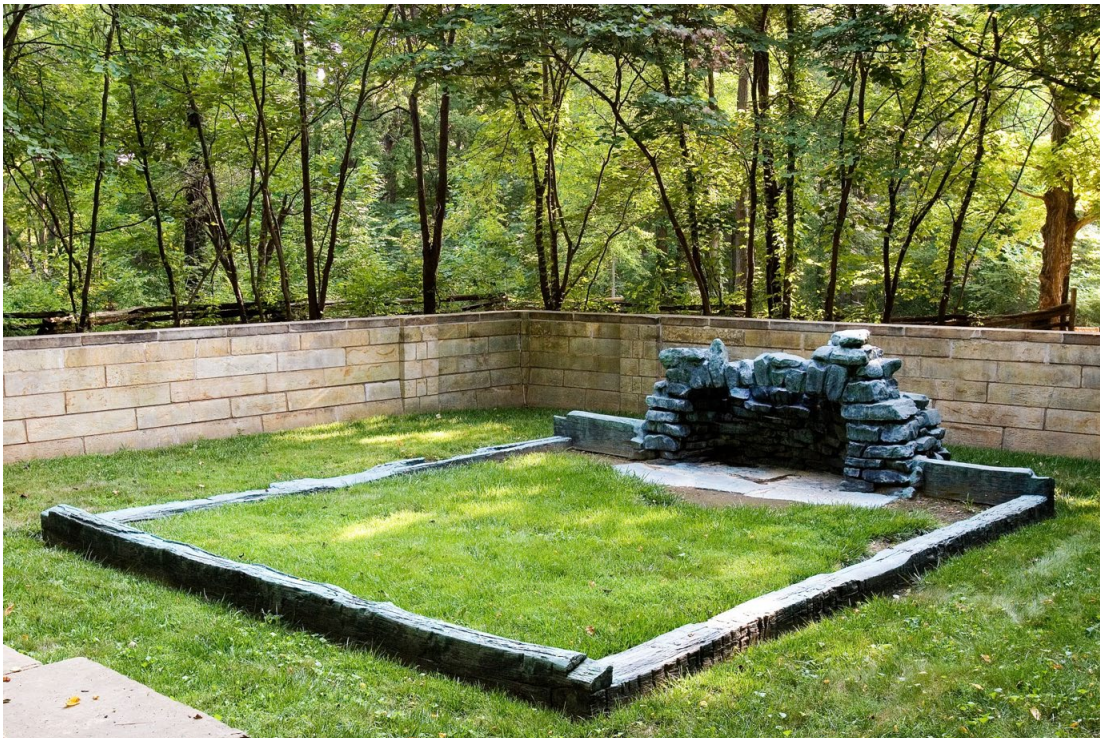


Figure 6. The Cabin Site Memorial. The memorial consists of a bronze casting of sill logs, a fireplace, and hearthstones surrounded by a retaining wall constructed out of sandstone of the Pennsylvanian Mansfield Formation. The sandstone blocks were sourced from quarries in nearby St. Meinrad, Indiana. NPS photograph.

The Memorial Visitor Center

Construction of what is now the Memorial Visitor Center began in 1938 with the goal of creating two memorial halls—the Abraham Lincoln Hall and Nancy Hanks Lincoln Hall—connected by a cloister (semicircular wall) featuring panels depicting Abraham Lincoln’s life and legacy (Figure 7). Descriptions of the panels, which articulate Lincoln’s childhood, adolescence, political ascension, presidency, and heritage, are outlined in Table 3. The original design of the cloister included four large openings that were later modified after the establishment of LIBO. The completion of the Memorial Visitor Center utilized native Indiana building materials and relied upon local craftsmen for tailored wood and stonework (National Park Service 2021). Both memorial halls have interior walls constructed from sandstone of the Pennsylvanian Mansfield Formation, while the panels, pylons, exterior walls, and benches were carved out of “Indiana Limestone” or “New Albany Limestone,” two informal names for the Mississippian Salem Limestone (O’Bright 1987, National Park Service n.d.-b, 2021). The commemorative panels were sourced from the Sare Hoadley Stone Company in Bloomington, Indiana, with each weighing approximately 10 tons and measuring 2.4 m (8 ft) tall by 4.1 m (13.5 ft) wide (O’Bright 1987). The panels were sculpted by Indiana artist Elmer H. “Dan” Daniels, who is also credited with the Lincoln bust on display in the Memorial Visitor Center (Figure 8). Above the panels and cloister entryways are a series of carved inscriptions featuring famous quotes and excerpts taken from Lincoln’s speeches or letters (Table 4).

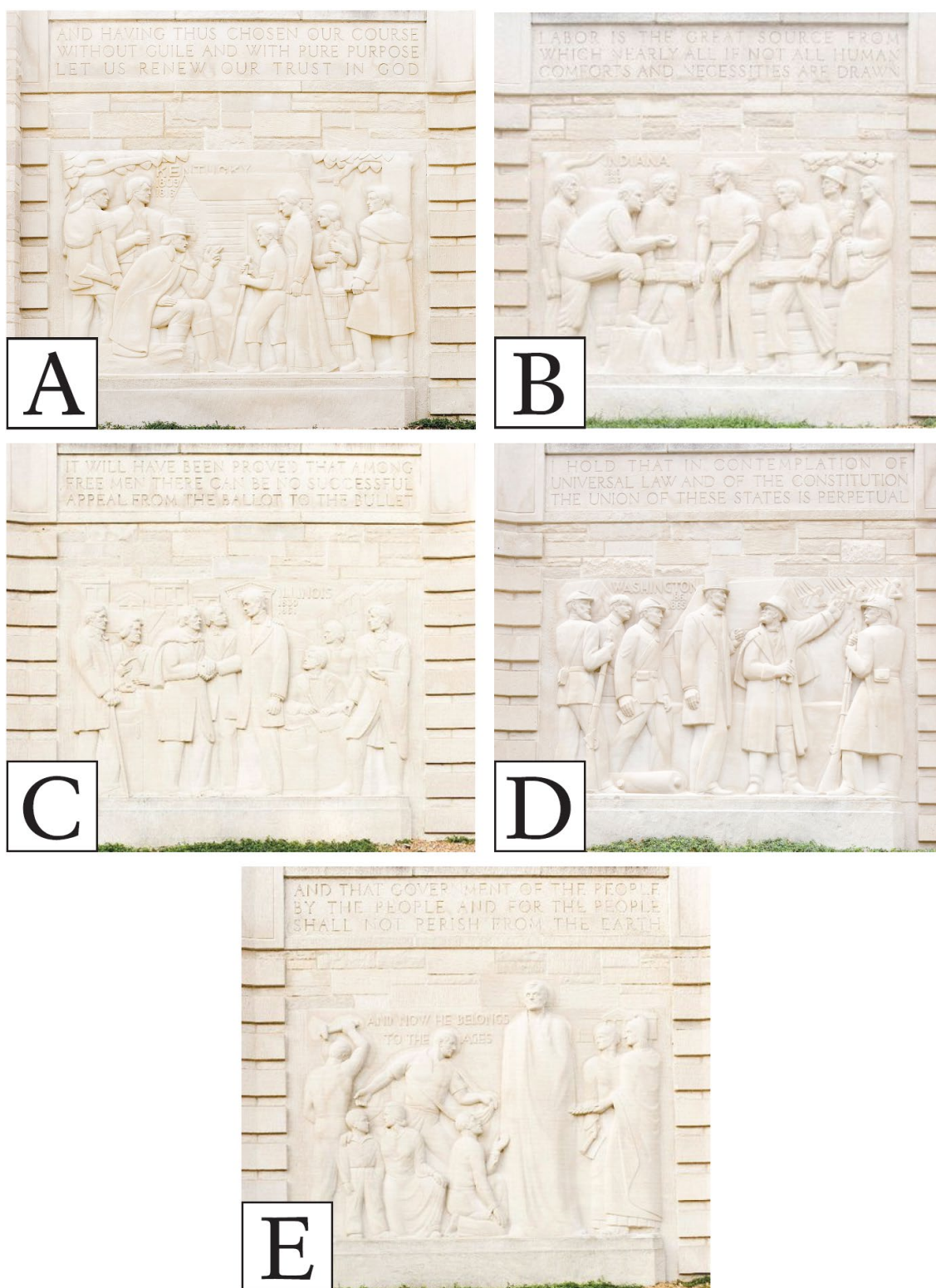


Figure 7. Commemorative panels at the Memorial Visitor Center. Each panel is constructed out of “Indiana Limestone,” a.k.a. the Mississippian Salem Limestone, weighing approximately 10 tons and measuring 2.4 m (8 ft) tall by 4.1 m (13.5 ft) wide. Sculpted by Indiana artist Elmer H. “Dan” Daniels, the panels honor different chapters in the life and legacy of Abraham Lincoln, including A) his childhood years in Kentucky; B) boyhood days in Indiana; C) political ascendancy in Illinois; D) presidency in Washington, D.C.; and E) martyrdom. A detailed description of each panel is provided in Table 3. NPS photographs.

Table 3. Commemorative panel descriptions at the Memorial Visitor Center. Descriptions are taken from O'Bright (1987).

Panel	Description
Kentucky panel	1809–1816: The Childhood Years of Lincoln. The Kentucky panel illustrates the years of Lincoln's life spent on the Sinking Spring and Knob Creek farms. On the far left, dressed in the style of the frontier is Jesse LaFollette, grandfather of Wisconsin Senator Robert M. LaFollette and neighbor of the Lincolns at Knob Creek. Beside him stands Thomas Lincoln, father of the President. Seated is Dr. Christopher Columbus Graham, doctor, scientist, and visitor at the Lincoln home. His stories fascinated Abe, who is pictured here at the age of seven. Behind the boy is his mother, Nancy Hanks Lincoln. Sarah, his only sister, stands at the churn. On the far right is Caleb Hazel, Lincoln's second schoolteacher.
Indiana panel	1816–1830: The Boyhood Days of Lincoln. This panel depicts Lincoln as a youth, but fully grown and capable of doing a man's job. At the extreme left is James Gentry, wealthy farmer and merchant. Abe was a frequent visitor in his home. Next to him is Josiah Crawford. Lincoln worked for him for three days to pay for a book he borrowed which was damaged by rain. Behind Abe, "The Railsplitter," holding a hewn log are Aaron Grigsby, husband of Lincoln's sister, and Dennis Hanks, his mother's cousin. To the right is James Gentry's son, Allen, who was Lincoln's companion on a trip down the Mississippi River to New Orleans. Beside him is Thomas Lincoln's second wife, Sarah Bush Lincoln.
Illinois panel	1830–1861: The Years of Political Ascendancy. Here Lincoln is shown receiving congratulations from his friends and associates on his election to the United States House of Representatives in 1846. John Stuart, his first law partner, is on the left. Next is Stephen T. Logan, a later law partner. Grasping Lincoln's hand is his close friend, Joshua Speed, the merchant. Between Lincoln and Speed is William Herndon. To the right and behind the beardless Lincoln sits editor Simon Francis. The woman behind him is Mary Todd Lincoln, and the last figure is Lincoln's friend, Orville H. Browning, who served as United States Senator and in the cabinet of Andrew Johnson as Secretary of the Interior.
Washington panel	1861–1865: The Years of Command. In the Washington panel the sculptor has chosen Lincoln's career as Civil War President for his subject. The President is pictured with General Ulysses S. Grant at Grant's headquarters in Petersburg, Virginia, near the close of the war. The other figures are soldiers symbolic of the many brave men who made victory possible.
Central panel	"And Now He Belongs to the Ages." These historic words of the President's Secretary of War, Edwin M. Stanton, are a reminder of the heritage left to the men and women of all time to come. The figures in the panel represent some of the people to whom Lincoln will forever belong—the farmer, the laborer, the family, the freedman. At the right of Lincoln stands Cleo, Muse of History, holding a scroll on which the deeds of the Emancipator are recorded. Beside her is Columbia offering the wreath of laurel, tribute of a nation to its leader. In the background a cabin and the White House serve as symbols of American opportunity.

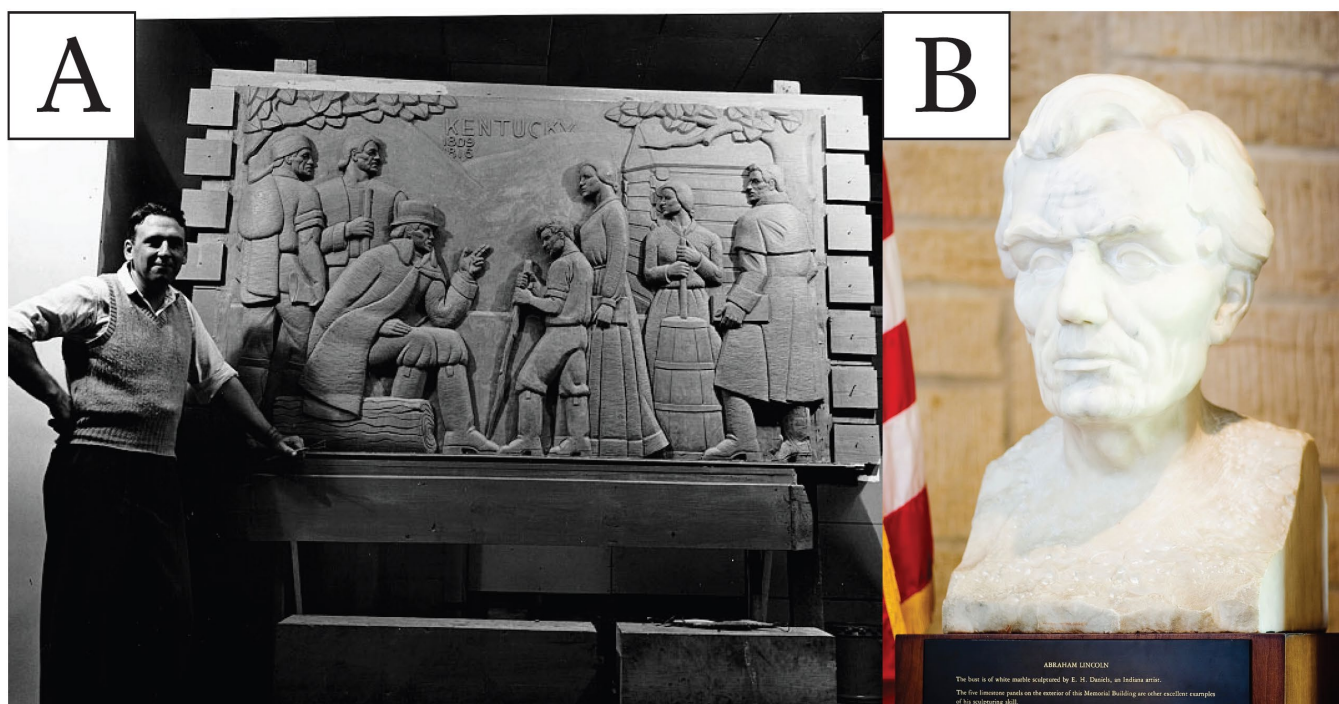


Figure 8. Indiana artist Elmer H. “Dan” Daniels. A) The artist is photographed standing next to his half-scale model of the Kentucky panel. Daniels was chosen to sculpt the Lincoln commemorative panels based on a bust of Abraham Lincoln that he sculpted out of marble in 1939. B) The marble bust is on display in the Memorial Visitor Center. NPS photographs.

Table 4. Inscriptions above the commemorative panels and cloister entryways at the Memorial Visitor Center.

Inscription # and theme	Quote, source, and date
No. 1 – A Supreme Being	“And having thus chosen our course, without guile, and with pure purpose, let us renew our trust in God.” – Message to Congress, 4 July 1861
No. 2 – Peace	“To do all which may achieve and cherish a just, and lasting peace among ourselves, and with all nations.” – Second inaugural address, 4 March 1865
No. 3 – Labor	“Labor is the great source from which nearly all, if not all, human comforts and necessities are drawn.” – Cincinnati address, 17 September 1859
No. 4 – Liberty	“Surely each man has as strong a motive now, to preserve our liberties, as each had then, to establish them.” – Message to Congress, 4 July 1861
No. 5 – Democracy	“And that government of the people, by the people, and for the people, shall not perish from the earth.” – Gettysburg Address, 19 November 1863
No. 6 – Friendship	“We must not be enemies. Though passion may have strained, it must not break our bonds of affection.” – First inaugural address, 4 March 1861
No. 7 – Law and Order	“It will then have been proved that among free men there can be no successful appeal from the ballot to the bullet.” – Letter to Illinois politician and political ally James C. Conkling, 26 August 1863
No. 8 – Right and Duty	“Have faith that right makes might, and in that faith, let us to the end, dare to do our duty as we understand it.” – Cooper Institute address, 27 February 1860
No. 9 – The Union	“I hold that, in contemplation of universal law and of the Constitution, the Union of these States is perpetual.” – First inaugural address, 4 March 1861

The Trail of Twelve Stones

The Trail of Twelve Stones is a wooded trail that was constructed from 1933 to 1934 to serve as a physical and symbolic link connecting the Pioneer Cemetery to the Cabin Site Memorial. As the name implies, the trail features various rocks or stones collected from places representing the different stages or events of Abraham Lincoln’s life, such as his birth, boyhood (including the loss of his mother), early career, marriage,

presidency, and death (Figure 9). Table 5 is an interpretive guide to the twelve stones, each of which is listed in the National Register of Historic Places. Information within the table was sourced from O'Bright (1987) and the National Park Service (n.d.-c).



Figure 9. Commemorative stones along the Trail of Twelve Stones. Each stone was collected from various buildings or locations linked to the life and legacy of Abraham Lincoln, including A) the birthplace stone [stone 1]; B) the Vincennes stone [stone 4]; C) the White House stone [stone 7]; D) the Gettysburg rock [stone 9]; E) the Old Capitol stone [stone 10]; and F) the Washington, D.C., house stone [stone 11]. Detailed descriptions of each stone are provided in Table 5. NPS photographs.

Table 5. Interpretive guide to the Trail of Twelve Stones.

Stone #	Description
1	The birthplace stone. This stone was brought to LIBO from Lincoln's birthplace (the Sinking Spring farm – see Abraham Lincoln Birthplace National Historical Park) located near Hodgenville, Kentucky. Lithology: Mississippian St. Louis Limestone (Moore 1968)
2	Spencer County memorial monument. From 1917 to 1934, this stone monument marked the location of the log cabin where the Lincoln family lived for 14 years. Today, the cabin is located roughly 91 m (300 ft) west of the monument. An inscription carved into the stone reads, “Spencer County memorial to Abraham Lincoln, who lived on this spot from 1816–1830.”
3	The Jones store rock. Young Abraham Lincoln worked many different jobs growing up, including as a clerk in a local store owned by William Jones roughly 4.8 km (3 mi) west of the national memorial in Jonesboro, Indiana. This stone was taken from the foundation of the Jones store.
4	The Vincennes stone. This slab is one of the foundation stones from a print shop and newspaper building (the Western Sun) in Vincennes, Indiana, where Lincoln first witnessed a printing press while his family moved from Indiana to Illinois.
5	The Berry-Lincoln store stone. From 1831 to 1837, Lincoln resided at New Salem, Illinois, supporting himself as a clerk, mill hand, soldier, storekeeper, postmaster, and surveyor. In 1832, Lincoln bought a half-interest in a store with William F. Berry. This stone is one of the foundation stones from the Lincoln-Berry store.
6	The Lexington, Kentucky bricks. By the 1840s, Lincoln was an up-and-coming lawyer in Springfield, Illinois. During this time, Lincoln met a charming young Kentucky woman, Mary Ann Todd, whom he married in November 1842. These bricks are from the spacious girlhood home of Mary Ann Todd, which was in Lexington, Kentucky.
7	The White House stone. The Executive Mansion (the White House) was the Lincoln family's home from March 1861 until the President's assassination in April 1865. This stone was formerly a part of the White House. Lithology: Paleocene Aquia Sandstone
8	The Anderson Cottage stone. The Anderson Cottage was President Lincoln's “Summer White House,” located about 4.8 km (3 mi) from the Executive Mansion; today, the site is designated as the President Lincoln and Soldiers' Home National Monument. While in residence at the Anderson Cottage in 1862, President Lincoln penned the famous Emancipation Proclamation. This stone was taken from the Anderson Cottage.
9	The Gettysburg rock. On 19 November 1863, President Lincoln spoke briefly at the dedication of a national cemetery at Gettysburg, Pennsylvania. This boulder was brought to LIBO from the Civil War battlefield at Gettysburg (see Gettysburg National Military Park). Note: President Lincoln did not stand on this stone at Gettysburg. He spoke from a wooden platform especially constructed for the dedication.
10	The Old Capitol stone. This stone was part of the Old Capitol building in Washington, D.C., where President Lincoln gave his second inaugural address. Lithology: Paleocene Aquia Sandstone
11	The Washington, D.C., house stone. This piece of red sandstone was part of the original column which supported the front porch of the Peterson House , the residence where President Lincoln died.
12	The Culver stone. Contractor J.S. Culver donated this piece of excess granite—salvaged from the construction of the Lincoln Tomb (Springfield, Illinois)—to serve as a headstone for Lincoln's mother, Nancy Hanks Lincoln. Dedicated October 1902, the stone originally sat next to Nancy's grave (and the official 1879 Studebaker headstone) until it was moved to the Trail of Twelve Stones in 1933. Lithology: Early Devonian Quincy Granite

Lincoln Family Connections to the Hoosier Frontier

When the Lincoln family moved to southern Indiana in the winter of 1816, they navigated an untamed wilderness that was largely unsettled and different from today. At the time, a small community was established along Little Pigeon Creek, which was populated by thousands of passenger pigeons (hence its name), deer, antelope, bears, wolves, groundhogs, rabbits, mink, weasels, wild turkey, opossums, and wildcats (HRA Gray and Pape, LLC 2002). Several key elements of the natural landscape likely influenced Thomas Lincoln's decision when he staked his claim to the Hoosier family farm plot. The ideal farm needed

to have a steady, reliable source of freshwater, suitable soil for growing crops, a means to transport goods or supplies, and safe, dry land. The site of the Lincoln family cabin (Cabin Site Memorial) was in an upland, oak-hickory forest area less than 0.3 km (0.2 mi) away from what is now Lincoln Spring, a vital groundwater spring underlain by the Pennsylvanian Brazil Formation. Thus, Thomas Lincoln’s decision adhered to the tradition of southern Indiana’s early settlers to select higher ground within proximity to springs and forests for settlement (HRA Gray and Pape, LLC 2002).

The proximity to Little Pigeon Creek also provided access to freshwater and the Ohio River, a critical means available to farmers for shipping their goods. When Abraham was growing up, he took several jobs piloting ferryboats across the Anderson River or navigating flatboats loaded with produce (e.g., corn, flour, pork, honey, hay, whiskey, lumber) down the Ohio and Mississippi rivers to New Orleans (Donald 1995; National Park Service 2010; HRA Gray and Pape, LLC 2002). These manually powered wooden vessels measured about 3 m (10 ft) wide by 12 m (40 ft) long and drifted downstream on river currents; the operator would “steer” using a long oar or pole (HRA Gray and Pape, LLC 2002). At age nineteen, Abraham was hired by local storekeeper James Gentry to take a flatboat from Little Pigeon Creek to New Orleans, a momentous occasion marking his first departure from Indiana without his family. During this trip, Lincoln witnessed a large slave auction on the docks, an experience that greatly disturbed him, and one that he would never forget (National Park Service 2010; see also [Lincoln Boyhood National Memorial Experiences | US National Park Service](#)).

The soils of LIBO were perhaps one of the determining factors in the Lincoln family’s choice to abandon the Indiana farm. According to the National Park Service (2021), LIBO is dominated by the Wellston-Zanesville soil series, characterized by moderate-to-low permeability and low fertility. These soils are largely the product of the previous Ice Age, and formed slowly by the weathering, alteration, and reworking of glacial outwash, eolian, and colluvium deposits (Tripp et al. 2024). Upon hearing of the fertile soils of the Sangamon River valley (Macon County, Illinois) that required little to no backbreaking cultivation work—as well as rumors of another outbreak of milk sickness—the Lincoln family decided to pack up their belongings and move westward (Donald 1995).

Paleontology

Paleontological resources (fossils) are any evidence of life preserved in a geologic context (Santucci et al. 2009). They may be body fossils (any remains of the actual organism, such as bones, teeth, shells, or leaves) or trace fossils (evidence of an organism’s activity, such as nests, burrows, tracks, or feces). Fossils may occur in rocks or unconsolidated deposits, in museum collections, or in cultural contexts, such as building stone. Although the Pennsylvanian Racoon Creek Group is known to be fossiliferous throughout Indiana and surrounding Spencer County, there are currently no documented fossil occurrences within LIBO (Hunt et al. 2008). Based on the paleontological potential of the underlying Mansfield, Brazil, and Staunton formations, it is recommended that future field studies of the national memorial be conducted that may identify fossiliferous exposures (Hunt et al. 2008; see “Inventory Needs”).

In the spirit of Hoosier pride, the national memorial was constructed utilizing building stone sourced locally from Indiana quarries, including the fossiliferous Mississippian Salem Limestone—referred to informally as the “Indiana Limestone” or “New Albany Limestone.” The Memorial Visitor Center’s decorative panels, pylons, exterior walls, and benches consist of sculpted blocks of Salem Limestone that provide excellent

“exposures” of fossil marine invertebrates (foraminifera, corals, bryozoans, mollusks and crinoids) and microfossils (O’Bright 1987; Hunt et al. 2008). Salem Limestone is a popular building stone throughout the United States and was utilized in the construction of several state and federal buildings or memorials, including the Lincoln Memorial in Washington, D.C. (Withington 1998; see also [Why Indiana Limestone Is One of America's Most Prized Building Materials | Smithsonian Magazine](#)). Fossils preserved at LIBO are considered valuable NPS resources found in a cultural resource context and offer valuable opportunities to educate, interpret, and connect to other sites honoring President Lincoln. Kenworthy and Santucci (2006) provide an overview of this topic and examples of building stones that display fossils, including the “Indiana Limestone.”

Geologic Resource Management Issues and Inventory Needs

This section briefly summarizes the geologic resource management issues, inventory needs, and geologic hazards that have been identified by discussions with LIBO staff. Geologic resource management issues refer to problems related to geologic resources. Inventory needs are highlighted to summarize what is currently known and what is needed to ensure good management of LIBO. Geologic hazards refer to notable hazards stemming from geologic features or processes that may require active management. Refer to the [Guidance for Resource Management SharePoint](#) for more information regarding geologic resource management.

The NPS GRD has developed an article series (<https://www.nps.gov/articles/series.htm?id=FA0A8F89-CD67-1CCE-5A6608B444E8A7C0>; accessed June 2025) that summarizes the laws, regulations, and policies that specifically apply to geologic and soil resources or processes. These protection measures were established to maintain the integrity of these resources or processes while minimizing the impacts of natural or anthropogenic activity.

Summary of Geologic and Soil Hazards

The natural resources that attract visitors to a park (e.g., waterfalls, steep terrain, and caves) may also be hazardous. Geologic hazards, or “geohazards,” are naturally occurring, dynamic geologic processes that have the potential to cause damage, loss of property, injury, or loss of life. The Natural Hazards Handbook (NPS 2025) provides a process and information to help teams and decision-makers identify, avoid, and mitigate risks associated with natural hazards and their effects on planned and proposed facility investments. The handbook supports reviews made during the regional or bureau investment review board (BIRB) process. Managers should apply the guidance in the handbook to identify options to manage natural hazard risks throughout all levels of facility planning and design. The handbook is maintained and updated by the Associate Director for Park Planning, Facilities, and Lands (PPFL).

Table 6 includes selected geologic and soil hazards listed in Part 1 of National Park Service (2025). The GSRI team has added additional hazards where appropriate for the park. Part 2 outlines the process to follow and decisions to be made throughout the project, if a potential hazard is identified in Part 1. Contact the NPS GRD with any questions.

Table 6. Geologic and soil hazards checklist. This checklist includes selected hazards listed in Part 1 of National Park Service (2025).

Hazard	Examples of Risk or Secondary Hazard	Best Professional Judgment	Sources of Geohazard Information
Earthquake	Falling objects Collapsing structures Inoperability of major building systems (e.g., power, sewer, water) Trigger to other hazards (e.g., landslides) Human injury or casualty	Known hazard (high; DOI SHIRA)	Braile (2009) Cox et al. (2003) Ellsworth et al. (2015) Frankel et al. (2009) Fuller (1912) Gold et al. (2019) Gomberg and Schweig (2006) Haase et al. (2011) McBride et al. (2002) Merino et al. (2010) The New Madrid Seismic Zone U.S. Geological Survey US Department of Interior (DOI) Strategic Hazard Identification and Risk Assessment (SHIRA) Risk Mapper Report US Geological Survey (USGS) Earthquake Catalog USGS Earthquake Hazard Probability Map (Petersen et al. 2023)
Slope movements (also called “mass wasting”)	Landslides (e.g., rockfalls, rockslides, slumping, or creep) Damage or destruction of park infrastructure (e.g., roads, trails, buildings) Damage to or loss of natural or cultural resource sites or features Human injury or casualty	Potential hazard (low; DOI SHIRA)	DOI SHIRA Risk Mapper Report USGS Landslide Inventory and Susceptibility
Permafrost	Not applicable	Not applicable	Not applicable
Cave/karst	Not applicable	Not applicable	Not applicable
Shrink/swell soils	Damage to infrastructure “Heaving” of ground beneath roads, trails, or structures Increased susceptibility to slope movements	Potential hazard (low to moderate; Web Soil Survey)	USDA Web Soil Survey
Coastal storm surge/sea or lake level change/shoreline erosion	Not applicable	Not applicable	Not applicable
Tsunami	Not applicable	Not applicable	Not applicable

Hazard	Examples of Risk or Secondary Hazard	Best Professional Judgment	Sources of Geohazard Information
Riverine flood	Flooding driven by storms, prolonged rainfall, or snowmelt Inundation of low-lying regions along the Ohio River Valley Enhanced mass wasting susceptibility Enhanced flow regimes capable of carrying large amounts of unconsolidated rock, soil, and woody debris Destruction of infrastructure (e.g., roads, trails, buildings, utilities) Stream bank erosion or channel incision Stream channel migration Damage or destruction of potential cultural and paleontological sites Damage or destruction of sensitive ecological habitats Human injury or casualty	Known hazard (extreme; DOI SHIRA)	Casto (2009) DOI SHIRA Risk Mapper Report Federal Emergency Management Agency (FEMA) Map Service Center HRA Gray and Pape, LLC (2002) KellerLynn (2010) O'Bright (1987)
Flash flood	Not applicable	Not applicable	Not applicable
Volcanic eruption	Not applicable	Not applicable	Not applicable
Hydrothermal activity	Not applicable	Not applicable	Not applicable
Radon	Health hazard	Potential hazard (moderate – Zone 2; US EPA)	Otton (1992) US Environmental Protection Agency (EPA) Map of Radon Zones by State
Toxicological soil (arsenic ¹ , cadmium ² , lead ¹ , selenium ³ , and <i>Bacillus anthracis</i> [causes anthrax] ⁴)	Health hazard	¹ Potential hazard (very high) ² Potential hazard (high) ³ Potential hazard (moderate) ⁴ Potential hazard (low)	DOI SHIRA Risk Mapper Report

Climate Change

Although climate change planning is beyond the scope of this GSRI summary, a discussion of climate change is included because of the potential disruption it may cause to the national memorial's resources, including geologic resources. The climate at LIBO is already changing; all future climate model projections include temperatures above the recent historical average (1979–2012), and average annual precipitation is anticipated to be highly variable (Climate Change Response Program 2024; Jones et al. 2024). Forecasted climate scenarios for LIBO include exacerbated extreme weather events, including periods of heightened drought as well as more frequent or intense storms and enhanced flooding. Projected increases in several variables (e.g., air temperatures, evaporation rates, drought, precipitation) may negatively affect wildfire occurrence and aquifer recharge, as well as watershed quality and flow. These modifications to water availability are likely to impact additional geologic processes (e.g., landslides, erosion), in addition to ecological processes (e.g., invasive species, phenology), visitation, and park management procedures (Climate Change Response Program 2024). Invasive species of ecological concern for LIBO include Japanese honeysuckle (*Lonicera japonica*), common periwinkle (*Vinca minor*), European privet (*Ligustrum vulgare*), multiflora rose (*Rosa multiflora*), crownvetch (*Securigera varia*), and autumn olive (*Elaeagnus umbellata*; see Jones et al. 2024 for a more complete listing). These exotic species often outcompete and displace native plants, altering community structure and subsequently affecting the amount and quality of available habitat. In addition to invasive species, climate change may accelerate the replacement of vulnerable species such as northern catalpa (*Catalpa speciosa*), eastern white pine (*Pinus strobus*), and swamp white oak (*Quercus bicolor*; Jones et al. 2024). These impacts to stabilizing vegetation could significantly enhance soil erosion and reduce habitat availability throughout LIBO.

Climate change manifestations that may intensify geologic hazards include the following:

- Increased average temperatures
- Increased frequency and intensity of storms
- Increased frequency and magnitude of fires
- Increased susceptibility to landslides
- Increased extreme weather scenarios, including drought and flooding
- Loss of stabilizing vegetation, leading to enhanced erosion and reduced habitat availability

Disturbed Lands

Disturbed lands occur where natural conditions and processes have been directly impacted by development, including facilities, mining, roads, dams, and campgrounds; agricultural activities such as farming, grazing, timber harvest, and irrigation ditches; and overuse or inappropriate use. Lands disturbed by human activity often cause long-lasting problems that affect other resources. Many of these disturbances obliterate soil profiles, exacerbate the invasion of exotic plants, result in contamination of water and soil, or cause erosion and sedimentation. These damages, in turn, frequently impair the quality of habitats, disrupt ecosystem functions, and cause problems for parks managing areas like wildlands. The national memorial has a long history of disturbed lands dating back over 200 years that encompasses land use and development—including the cultivation of the Lincoln family farm, growth of Lincoln City, establishment of Lincoln State Park, and modern reforestation efforts by the NPS—as well as mineral resource extraction.

Land Use and Development

In the early 19th century, Thomas and Abraham Lincoln cleared approximately 16 ha (40 ac) of the original oak-hickory forest for agricultural purposes (KellerLynn 2010). Although these years taught Abe the lessons of hard work and honed his proficiency with the axe, they mark the beginning of a long history of anthropogenic modification that impaired the original wilderness state. After the Lincoln family moved to Illinois in 1830, additional deforestation and cultivation practices likely contributed to changes in erosion and drainage patterns (HRA Gray and Pape, LLC 2002). The advent of railroad technology spurred the growth of Lincoln City (est. 1881) during the 1870s, which at one point had a population of roughly 2,000 residents; today, LIBO is still traversed by the Southern Railway Evansville Mainline and the Southern Railway Cannelton Spurline. At the beginning of the 20th century, land that is now considered LIBO was occupied by several Lincoln City structures, including eleven houses, seven barns, and twenty outbuildings, as well as a restaurant, garage, hotel, church, and school (O'Bright 1987). The 1917 Spencer County memorial marker dedicated in honor of the Lincoln family cabin site once sat on the Lincoln City school playground and served as home plate during softball games (McEnaney 2001; National Park Service 2021; see "Trail of Twelve Stones"). During the development of Indiana's statewide park system in the 1920s, these structures were removed in preparation for Lincoln State Park and the Nancy Hanks Lincoln Memorial.

The construction of Nancy Hanks Lincoln Memorial lasted from roughly 1927 to 1945, and was guided by nationally recognized landscape architect Frederick Law Olmstead Jr. The creation of the memorial—including the allée, plaza, memorial building (now the Memorial Visitor Center), Cabin Site Memorial, and Trail of Twelve Stones—required the relocation of state highway 162 and the installation of a drainage system and water reservoir, as well as significant recontouring that removed roughly 0.9 m (3 ft) of topsoil (Mauk and McKelway 1996; O'Bright 1987; KellerLynn 2010). In addition, roughly 40,000 hardwood trees and shrubs were planted with the assistance of the CCC (O'Bright 1987; National Park Service 2021). Although the memorial landscape was designed to be in harmony with nature and included significant reforestation, the efforts to recontour the site were particularly damaging to LIBO's cultural resources (see "Paleontological and Cultural Resources").

Following the establishment of LIBO in 1962, the NPS introduced several land use changes impacting the national memorial's management, interpretation, biological integrity, and natural aesthetic. Several major landscape modifications have taken place including (1) a secondary relocation of state highway 162 during the 1960s (and subsequent obliteration in 1993); (2) modernization of the Memorial Visitor Center from 1965 to 1966; (3) establishment of the Living Historical Farm in 1968; and (4) contemporary forest restoration practices. The historical farm was created as part of an interpretive program developed in partnership with the US Department of Agriculture and the Smithsonian Institution (National Park Service 2005, 2021). Although the farm represents a working pioneer homestead analogous to the 1816–1830 Lincoln family farm, its construction also contributed to the degradation of sensitive cultural resources (National Park Service 2021). A significant resource management goal of LIBO is to promote the restoration and success of the oak-hickory forest that the Lincoln family encountered upon their arrival in Indiana; the rationale for forest restoration is to create a landscape comparable to what Abraham had known as a boy and helped shape his character (National Park Service 2005; Jones et al. 2024). Within the last decade, the national memorial has initiated several projects to improve forest composition and structure, including invasive species management, understory vegetation removal, and controlled burning, as well as planting roughly 5,000 oak and sage bark hickory seedlings (National Park Service 2011; Jones et al. 2024).

Since the 1950s, there has been an accelerated increase in urbanization surrounding the national memorial that has introduced several ecological concerns. The transition from rural to urban land around LIBO is reflected by a nearly 330% increase in housing densities and a 20% decline in farm acreage between 1950 and 2000 (Hansen and Gryskiewicz 2003). Urbanization is promoting habitat fragmentation, exacerbating the spread of invasive species, and introducing impermeable surfaces (e.g., sidewalks, roadways, parking lots) that concentrate the effects of runoff and pollution (Jones et al. 2024). Additionally, these land use changes can adversely impact visitor experiences by degrading natural resources such as night skies, soundscapes, scenery, and wildlife (Hansen and Gryskiewicz 2003; Jones et al. 2024).

Mineral Resource Extraction

The national memorial is in the Boonville Hills division of the Southern Hills and Lowlands physiographic region, an area of southern Indiana within the coal- and hydrocarbon-rich Illinois Basin (Gray 2000; Tripp et al. 2024). The Pennsylvanian Raccoon Creek Group contains several high-quality (i.e., low sulfur), economically important coal horizons that are locally exposed at the surface and may have attracted early settlers to the region. One notable coal horizon—the Buffaloville Coal Member of the Brazil Formation—was named after and mined in nearby Buffaloville, Indiana, approximately 2.4 km (1.5 mi) southeast of the national memorial (Shaver et al. 1970, 1986). According to KellerLynn (2010), although no large-scale coal mining has occurred in LIBO, there may have been some historical coal harvesting for personal use at the northern end of the national memorial. Surrounding LIBO are numerous coal mines that are now considered AMLs; one of these features is Weber Lake in adjacent Lincoln State Park (see National Park Service 2023). In addition to coal, several oil and gas wells occur in the vicinity of LIBO. These wells may produce from underlying Mississippian strata (e.g., Chesterian and Valmeyeran series) but also the Devonian–Mississippian New Albany Shale (Mast and Howard 1990). The New Albany Shale is an unconventional shale gas reservoir that is widely distributed throughout the Illinois Basin and was named after thick exposures of shale along the banks of the Ohio River in New Albany, Indiana (Shaver et al. 1970; Comer et al. 2006; KellerLynn 2010). Modern advances in petroleum exploration, drilling technology, and hydraulic fracturing (“fracking,” a technique used to produce natural gas from low permeability shales) have significantly increased Indiana’s recovery of shale gas from unconventional reservoirs such as the New Albany Shale (see [Oil & Gas Statistics](#) | [Indiana Department of Natural Resources](#)).

Although coal mining and hydrocarbon development occur outside the boundaries of LIBO, these activities may adversely impact or threaten the integrity of its natural resources and scenery. Coal mining and hydrocarbon development are associated with greenhouse gas emissions and pollution that can contaminate the air, surface water, or groundwater, resulting in a wide range of health implications (Masood et al. 2020; Black et al. 2021). The likelihood and extent of contamination is heavily dependent on the geological formation being targeted and how operations or waste are managed. Large amounts of freshwater are required for hydraulic fracturing operations, which can stress regional aquifers and raise concerns regarding groundwater availability, contamination, and land subsidence. Additional potential issues regarding coal mining or unconventional oil and gas development include noise and light pollution, habitat destruction, and human-induced seismic activity (Masood et al. 2020; Black et al. 2021).

Flooding

When Thomas Lincoln was staking his Indiana claim in 1816, he was careful to select an upland, forested area that was safe from the discouraging effects of flooding (see “Lincoln Family Connections to the Hoosier Frontier”). According to HRA Gray and Pape, LLC (2002), the lands adjacent to the Lincoln farm in Township 4 S., Range 5 W., Section 33 were chiefly bottomland prone to flooding. Flood hazard maps generated by FEMA corroborate this information and indicate properties situated along Little Pigeon Creek are considered within the 100-year flood zone, a designation that predicts a given area will experience at least one major flood recurrence every century (or a 1% annual chance; see [Flood Data Viewers and Geospatial Data | FEMA](#)). Although Little Pigeon Creek is now a channelized ditch used for irrigation and flood control, flooding is not considered a significant issue because streamflow has decreased in recent years (KellerLynn 2010). However, major storm events can lead to significant flooding along the Ohio River and its tributaries. The infamous flood of January 1937, or the “Ohio River Great Flood,” surpassed all prior floods along the Ohio River Valley. Excessive rain over an eleven-day period delivered nearly 38 cm (15 in) of water to Evansville, Indiana, and decimated cities including Jeffersonville (Indiana), Louisville (Kentucky), and Portsmouth (Ohio; Casto 2009; see also [The Ohio River Great Flood | National Weather Service](#)). Although most of the destruction was focused along the Ohio River floodplain, the massive flood still impacted properties surrounding LIBO and managed to kill several trees in nearby Gentryville (O’Bright 1987).

Mass Wasting

The term “mass wasting” is used to describe downhill movements of rock, soil, or ice and includes several types of landslide phenomena, including debris (or snow) avalanches, rockslides (mobile masses of coherent rock), debris flows (mobile masses of water-laden rock or soil), slumping or slope creep (downhill movement of soil), and rockfalls. Although the topography of LIBO is hilly, with roughly 21 m (70 ft) of relief at Pioneer Cemetery where Nancy Hanks Lincoln is buried, hillslope processes such as landslides are not an issue for park managers (KellerLynn 2010). Some slumping does occur along the steepened slopes of nearby strip mines, but these are abandoned mineral lands not associated with the national memorial.

Radon

Radon is a naturally occurring gas created by the decay of radioactive elements present in many rocks. Although radon is almost always present in small amounts in soil and rocks, some types of rock (e.g., volcanic rocks, granites, dark shales, phosphate-rich rocks, and metamorphic rocks) have the potential to produce above-average amounts of radon gas that can pose a known health risk (Otton 1992). According to the US Environmental Protection Agency (EPA) map of radon zones, Spencer County is identified as a zone of moderate potential (zone 2) for elevated indoor radon levels greater than or equal to 2 pCi/L but less than or equal to 4 pCi/L (see <https://www.epa.gov/radon/epa-maps-radon-zones-and-supporting-documents-state>; accessed December 2025). The EPA has guidance for radon mitigation.

Seismicity

Earthquakes are generated by fault movements and can cause violent ground shaking capable of generating landslides, ground subsidence, liquefaction (destabilization of water-laden sediments), and infrastructural damage including buildings, roads, and trails. The closest seismic monitoring stations to LIBO are located approximately 48 km (30 mi) west in Evansville, Indiana ([EarthScope Seismic Station Map](#)). Braile (2009)

describes the following methods and vital signs for understanding earthquakes and monitoring seismic activity: (1) monitoring earthquakes, (2) analysis and statistics of earthquake activity, (3) analysis of historical and prehistoric earthquake activity, (4) earthquake risk estimation, (5) geodetic monitoring and ground deformation, and (6) geomorphic and geologic indications of active tectonics. The GRD Seismic Monitoring website (<https://go.nps.gov/geomonitoring>) and the USGS Earthquake Hazards website (<http://earthquake.usgs.gov/>) provide more information.

The national memorial is located adjacent to the New Madrid seismic zone, one of the most seismically active areas east of the Rocky Mountains (Figure 10). The New Madrid seismic zone encompasses part of the upper Mississippi River Valley and is characterized by a network of buried faults (including the Reelfoot Rift) which likely began forming during the Neoproterozoic Era approximately 560 million years ago (Pollitz and Mooney 2014; Elling et al. 2022). Although these faults developed due to rifting that extended and thinned the crust, they have been reactivated by modern plate tectonic processes (see [The New Madrid Seismic Zone | U.S. Geological Survey](#)). The New Madrid seismic zone poses a considerable hazard to several states, including (in alphabetical order) Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri, and Tennessee, but can produce powerful earthquakes that can be felt hundreds of miles away (Petersen et al. 2023). During the winter of 1811–1812, the seismic zone generated a series of devastating earthquakes over several months, including three large earthquakes (estimated between magnitude 7 and 8) that caused shaking as far away as Charleston, South Carolina, Hartford, Connecticut, and New Orleans, Louisiana (Fuller 1912; Frankel et al. 2009; Ellsworth et al. 2015). Thus, it is likely that Abraham Lincoln and his family felt these tremors during their time in Kentucky prior to moving to what is now LIBO. The epicenters of these infamous quakes were located close to the city of New Madrid, Missouri, and are the namesakes of the seismic zone.

The geologic record reveals that the New Madrid seismic zone has repeatedly produced major earthquakes over the past 4,500 years, including similar magnitude events as those produced during the winter of 1811–1812. Large paleoearthquakes generated within the seismic zone are associated with ground failures (e.g., landslides, subsidence, soil liquefaction), sackungen (gravitational ridgetop failures), or sand blows (eruptions of subsurface sand and water due to liquefaction) that develop due to violent ground shaking (Gomberg and Schweig 2006; Frankel et al. 2009; Gold et al. 2019). Sand blows were created during the 1811–1812 seismic events but also occur in surficial deposits dating back to around 2350 BC, 900 AD, and 1450 AD (Gomberg and Schweig 2006; Frankel et al. 2009; Cox et al. 2013; Gold et al. 2019). The size and areal distribution of these features indicate these paleoearthquakes were similar in location and magnitude as the 1811–1812 seismic events. Based on several key pieces of evidence, including the geologic record, modern seismic data, and GPS monitoring, geologists estimate the chance of having an earthquake similar to the 1811–1812 events in the next 50 years is about 7–10%, whereas the chance of a magnitude 6 or larger earthquake in the next 50 years is between 25 and 40% (Gomberg and Schweig 2006; Frankel et al. 2009).

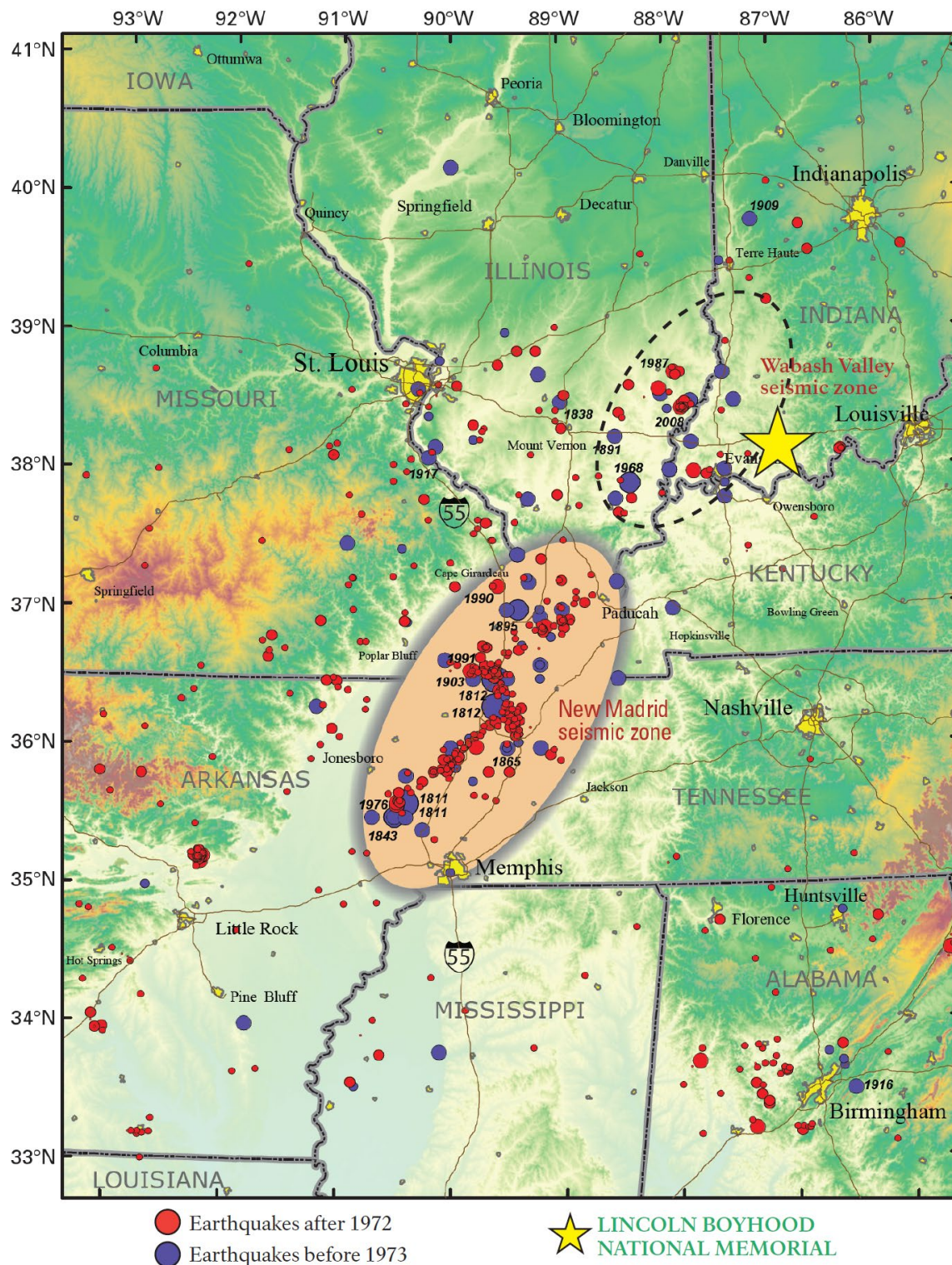


Figure 10. Seismicity map showing past earthquakes of the central US greater than magnitude 2.5. The New Madrid seismic zone (orange polygon) is one of the most seismically active regions east of the Rocky Mountains and has a history of producing powerful, large magnitude events. The Wabash Valley seismic zone (dashed polygon) is interpreted to be the northern extension of the New Madrid seismic zone and is characterized by poorly constrained seismic patterns and a lower recurrence interval. Red circles are earthquakes that occurred after 1972. Blue circles are earthquakes that occurred before 1973. Larger earthquakes are represented by larger circles. Yellow patches show urban areas with populations greater than 10,000. The national memorial (yellow star) is susceptible to persistent earthquakes occurring from within and surrounding the seismic zones. Figure from Frankel et al. (2009).

The Wabash Valley seismic zone is another major seismicity hazard near LIBO, with several associated faults mapped roughly 32 km (20 mi) south of the national memorial (Padgett et al. 2024; Tripp et al. 2024). As the name implies, the seismic zone underlies the lower Wabash River Valley and is believed to be a northern extension of the New Madrid seismic zone (Figure 10; Merino et al. 2010). The Wabash Valley and New Madrid seismic zones share several characteristics, including their age (Precambrian), development (failed rifting), orientation (northeast-trending), and paleoearthquake evidence (ground failures); some authors have theorized the two zones are coupled and transfer stress (Merino et al. 2010; Haase et al. 2011). However, the Wabash Valley seismic zone is a more dispersed earthquake region with poorly constrained seismic patterns and a lower recurrence interval. Based on liquefaction deposits found along riverbanks in southern Indiana and Illinois, the seismic zone is speculated to have generated at least two large-magnitude earthquakes (magnitude 6.0 or greater) over the last 12,000 years: (1) a magnitude 7.5 event near Vincennes, Indiana, approximately 6,100 years ago; and (2) a magnitude 6.7 event near Mt. Carmel, Illinois, approximately 12,000 years ago (Haase et al. 2011). Several other notable earthquakes have occurred since the 1950s, including those in April 2008 (magnitudes 5.2 and 4.7), June 2002 (magnitude 4.6), June 1987 (magnitude 5.2), April 1974 (magnitude 4.7), November 1968 (magnitude 5.5), and November 1958 (magnitude 4.4; McBride et al. 2002; [USGS Earthquake Catalog](#)).

Swelling Clays

Swelling soils, or shrink-swell soils, contain clay minerals such as smectites that are physically affected by water so that they swell when wet and shrink when dry. As swelling clays expand or contract, the change in volume can undermine the integrity of the substrate, increase the susceptibility of slope failure, and cause infrastructural problems along roadways or trails. According to the [USDA NRCS Web Soil Survey](#), numerous soils mapped within LIBO are rated “low” to “moderate” in linear extensibility (a determination of shrink-swell potential; see “Soils”). Linear extensibility ratings are based on the percentage of volume change as soil dries and include four assessment categories: (1) low, <3%; (2) medium, 3–6%; (3) high, 6–9%; and (4) very high, >9%. The ratings for LIBO indicate that swelling clays can cause volume changes capable of damaging buildings, roads, and other structures. Areas of concern include the Living Historical Farm, the Lincoln Spring, and acreage surrounding the Southern Railway Cannelton Spurline and the Southern Railway Evansville Mainline. During the 2025 follow-up meeting, LIBO staff discussed the need for higher resolution, large-scale soil mapping that may better inform park management decision-making (see “Inventory Needs”).

Toxicological Soil

According to the DOI SHIRA Risk Mapper report, soils within the national memorial include potentially hazardous elemental abundances of arsenic, cadmium, lead, and selenium, as well as *Bacillus anthracis*—a naturally occurring soil pathogen known to cause anthrax.

Soil maps show that potentially hazardous concentrations of arsenic, cadmium, lead, and selenium occur within the top 5 cm (2 in) of soil based on 2010 sampling (DOI SHIRA). For more information on naturally occurring arsenic, cadmium, lead, and selenium, and their potential health impacts, visit the US Department of Health and Human Services Agency for Toxic Substances and Disease Registry (see <https://www.atsdr.cdc.gov/>; accessed December 2025).

Anthrax is a rare, naturally occurring disease caused by the bacteria *Bacillus anthracis* that can lead to severe illness in both people and livestock that are exposed to spores. For more information on the public health risks associated with anthrax, visit the US Centers for Disease Control and Prevention's anthrax website (see <https://www.cdc.gov/anthrax/about/index.html>; accessed December 2025).

Geologic Resource Protection

Legislatively Required Geologic Inventories

The NPS GRD has developed an article series ([Series: Geology & Minerals—Resource Laws, Regulations, and Policies](#); accessed June 2025) that summarizes the laws, regulations, and policies that specifically apply to geologic and soil resources or processes. These protection measures were established to maintain the integrity of these resources or processes while minimizing the impacts of natural or human activity.

The core responsibility of the NPS is to preserve and protect park resources, processes, systems, and values unimpaired for present and future generations. According to National Park Service (2006), the NPS will preserve and protect geologic resources, features, and processes as integral components of park natural systems. The goals of the NPS are to assess the impacts of natural processes and human activities on geologic resources; maintain and restore the integrity of existing geologic resources; integrate geologic resources management into NPS operations and planning; and interpret geologic resources for the benefit and enjoyment of park visitors (National Park Service 2006). Various management protection policies applicable to geologic resources, features, and processes are included in National Park Service (2006) and are also organized at the following website: <https://home.nps.gov/subjects/geology/geoheritage-nps-management-policies.htm> (accessed June 2024).

Paleontological and Cultural Resources

The paleontological and cultural resources of LIBO are invaluable and provide a unique window into the geological and historical past. However, these sensitive resources are susceptible to damage, destruction, negligence, or theft and merit appropriate protective measures. Fossils identified within the national memorial are preserved in a cultural context within commemorative building stones of the Mississippian Salem Limestone (see “Paleontology”). Although these fossils are not “exposed” naturally within LIBO, these building stones were utilized in other memorials honoring President Abraham Lincoln (e.g., the Lincoln Memorial in Washington, D.C.) and offer insightful educational opportunities (Withington 1998; Kenworthy and Santucci 2006; Hunt et al. 2008). For additional information regarding paleontological resource laws, regulations, and policies, the NPS GRD developed the following summary article: <https://www.nps.gov/articles/paleontology-legal-instruments.htm> (accessed December 2025).

Cultural resources preserved within LIBO are associated with the Lincoln family as well as the life and legacy of President Lincoln. However, in the nearly 200 years since the Lincoln family moved to Illinois there have been several cases of theft and land disturbance (e.g., forest clearing, agriculture, grazing, fire suppression) that have negatively impacted these resources (Jones et al. 2024). Following President Lincoln’s assassination in 1865, the site of the Lincoln farm attracted attention from admirers but also vandals who removed Nancy Hanks Lincoln’s original gravestone markers and disassembled the former Lincoln cabin for log mementos (HRA Gray and Pape, LLC 2002; National Park Service 2012, 2021). According to KellerLynn (2010), the construction of Nancy Hanks Lincoln Memorial during the 1920s and

1930s required recontouring that removed nearly 0.9 m (3 ft) of topsoil and likely disturbed (and possibly removed) Nancy Hanks Lincoln's remains. Additional excavations and the development of the Living Historical Farm in the 1960s also contributed to the disturbance of cultural resources within LIBO (National Park Service 2021).

Inventory Needs

The following table (Table 7) presents several geologic and soil resources inventory needs that were identified in NPS planning documents or through literature review.

Table 7. List of identified geologic and soil resources inventory needs for the national memorial.

Subject	Inventory Need(s)	Reference(s)
Cultural resources	Perform an ethnographic survey that connects the national memorial's cultural resources to Indigenous Peoples of southern Indiana. According to National Park Service (2021), the Delaware and Peoria tribes may have potential cultural affiliations with the area now known as LIBO, but additional surveys need to be performed.	National Park Service (2021)
Paleontological resources	Perform a paleontological field survey of LIBO. Based on the paleontological potential of the underlying Mansfield, Brazil, and Staunton formations, it is recommended that future field studies of the national memorial be conducted to identify fossiliferous exposures. Additionally, fossils preserved in a cultural context within the commemorative building stones of LIBO should be photographed and documented for management and interpretive reasons.	Hunt et al. (2008)
Soil mapping	Perform high resolution, large-scale soil mapping for LIBO. These mapping efforts will help establish a more complete soil profile and better inform park management decision-making.	2025 follow-up meeting

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