U.S. Department of the Interior
National Park Service

Mammoth Cave National Park
Edmonson, Hart, and Barren Counties, Kentucky

REHABILITATE CAVE TOUR TRAILS

Environmental Assessment

October 2009

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SUMMARY

The National Park Service is preparing an Environmental Assessment for the rehabilitation of public cave tour trails at Mammoth Cave National Park. This project proposes to reconstruct existing cave trails to improve safety, durability and protection of natural and cultural resources. Cave passageways vary greatly in width, height, slope, features, and humidity. Treatment applied on the trails would be site specific. In some places only minor changes may be needed, while in others more comprehensive solutions would be applied.

Upon completion of this project, the cave tour trails would provide safer walking surfaces for park visitors; reduce or eliminate the impact of lint and dust on delicate cave resources; and protect cave resources by keeping visitors on defined trails and away from sensitive cave resources.

The project includes reconstruction of the trail surface, installation or replacement of steps, upgrade of safety rails, installation of lint guards along the edges of the trails, and where necessary installation of lights to provide a safe walking area. The trail surface would be reconstructed in many areas using a combination of concrete pavers, PolyPavement™, boardwalk, soilcrete, and other suitable and sustainable trail surface materials.

The preferred alternative, which would rehabilitate public cave tour trails, would have no impact on wetlands and floodplains, socioeconomic environment, prime and unique farmlands, and environmental justice. Impacts to macrobiotic resources would be temporary to short-term, minor and adverse. Impacts to rare, threatened and endangered species and species of special interest would be temporary to short-term, negligible to minor, and adverse. Impacts to microbiotic resources would be negligible and adverse temporarily, and minor and beneficial in the long-term. Impacts to cave climate would be temporary, negligible, and adverse. Impacts to physical cave features would be minor and adverse, and minor and beneficial in the long-term. Impacts to water resources would be temporary, negligible, and adverse. Impacts to cultural resources would be negligible and adverse, and minor and beneficial in the long-term. Impacts to visitor use and experience would be minor and adverse temporarily, and minor and beneficial in the long-term. Impacts to public health and safety would be minor and beneficial in the long-term.

Note Regarding Public Comment

The Environmental Assessment is made available on the Planning, Environment, and Public Comment (PEPC) web site at the following address: http://parkplanning.nps.gov/. If you wish to comment on the Environmental Assessment, you may submit comments through the PEPC web site. For those without access to the internet send comments to the name and address below. This Environmental Assessment will be on public review for 30 days. Please note that names and addresses of people who comment become part of the public record. If you would like your name and/or address withheld, please state this prominently at the beginning of your comment. All submissions from individuals, organizations, and businesses will be made available in their entirety for public inspection.

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ACRONYMS AND ABBREVIATIONS

BMP	Best Management Practices
CAM	Cave Atmospheric Monitoring
CCC	Civilian Conservation Corps
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CA	Candidate Species
D	Delisted
DO	NPS Director’s Order
E	Endangered
EA	Environmental Assessment
FPPA	Farmland Protection Policy Act
GMP	General Management Plan
H	Historic
KSNPC	Kentucky State Nature Preserves Commission
M	Managed but not listed
MACA	Mammoth Cave National Park
MYA	Million years ago
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NRHP	National Register of Historic Places
NPS	National Park Service
NSS	National Speleological Society
PE	Presumed Extinct
PL	Public Law
SC	Special Concern
SOMC	Species of Management Concern
T	Threatened
T&E	Threatened and Endangered
USC	United States Code
USFWS	United States Fish and Wildlife Service

1.0 PURPOSE AND NEED

1.1 PURPOSE AND NEED FOR ACTION

The National Park Service (NPS) has decided to prepare an Environmental Assessment (EA) for the rehabilitation of public cave tour trails at Mammoth Cave National Park (MACA or Park). This project proposes to reconstruct existing cave trails to improve safety, durability and protection of natural and cultural resources.

Approximately 12 miles of tourist trails in Mammoth Cave were constructed by the Civilian Conservation Corps (CCC) in the 1930s. The CCC crews widened tour paths and used cave sediments to level the rocky cave floor. Until 1995, borrow pits within the caves provided the materials needed to repair cave trails. Material was later brought in from outside the cave. Neither of these is a sustainable practice in the cave environment. The decision not to use materials from inside the cave, and not to import sediments from outside the cave, has left Mammoth Cave with few options for maintaining the cave trails. A variety of options have been tried including placing carpeting and cord mats over potholes. This has not affected the accelerating number of potholes along the tour routes in the cave.

While the potholes may be small, the low light levels and the large size of the tours make them hard for visitors to avoid. The existing trail facilities in the cave have raised safety concerns for visitors and concerns for the protection of the cave's delicate natural and cultural resources.

During the colder half of the year, the dirt trail surfaces in the cave dry out, and tours create clouds of dust. This dust falls on sensitive cultural and natural resources in the cave. Many of the cave features and formations in the cave are now covered with a coating of dust. A more durable trail surface is needed that would substantially reduce or eliminate the current problem with dust.

Lint is also a major problem in Mammoth Cave. The lint from thousands of visitors' clothing accumulates on the natural and cultural resources in the cave and is an unnatural source of energy for some biota living in the cave. This disrupts the delicate balance that exists in a cave environment. Installation of lint curbs will help confine this foreign material to the trail and reduce its impact on the cave's natural and cultural resources.

In many areas the edges of the cave trails are poorly defined, and the cave walls and features are within relatively easy reach of visitors. In many of these same areas, there are artifacts from the pre-historic and historic activity in the cave. Because the edges of the trails are poorly defined, park visitors on cave tours may unknowingly disturb these artifacts. Reconstruction of the trails in the cave would keep visitors on the trails and away from cave resources.

The 270 foot elevator shaft has not been used by visitors since 2002 when the elevator got stuck with a park guide in it. Thus the park has not been able to provide access to mobility impaired visitors to the cave for the past seven years. Although the elevator is not currently open to visitors, it is still used by park staff and the food concessionaire in the Snowball Dining Room. There is a need to improve the elevator and to correct the inadequate airlock associated with the elevator shaft. There is also a need to provide access to mobility impaired visitors either at the Elevator Entrance or at another location near the visitor center and the Historic Entrance.

1.2 PROJECT BACKGROUND

Mammoth Cave National Park is located in south central Kentucky, approximately midway (100 miles) between Louisville, Kentucky and Nashville, Tennessee in Edmonson, Hart, and Barren counties (Figure 1). The park has 52,830 surface acres, over 365 miles of surveyed cave passages making Mammoth Cave the longest known cave system in the world, and offers internationally renowned examples of karst topography. This vast cave system holds the world's most diverse cave ecosystem with over 130 faunal species that use the cave on a regular basis. An extensive archeological record of prehistoric Native Americans and remnants of early American industrial activity mark Mammoth Cave as a historically and prehistorically significant place. For almost two hundred years, it has also been a destination for a continuing stream of tourists who have shaped the local economy and cultural landscape.

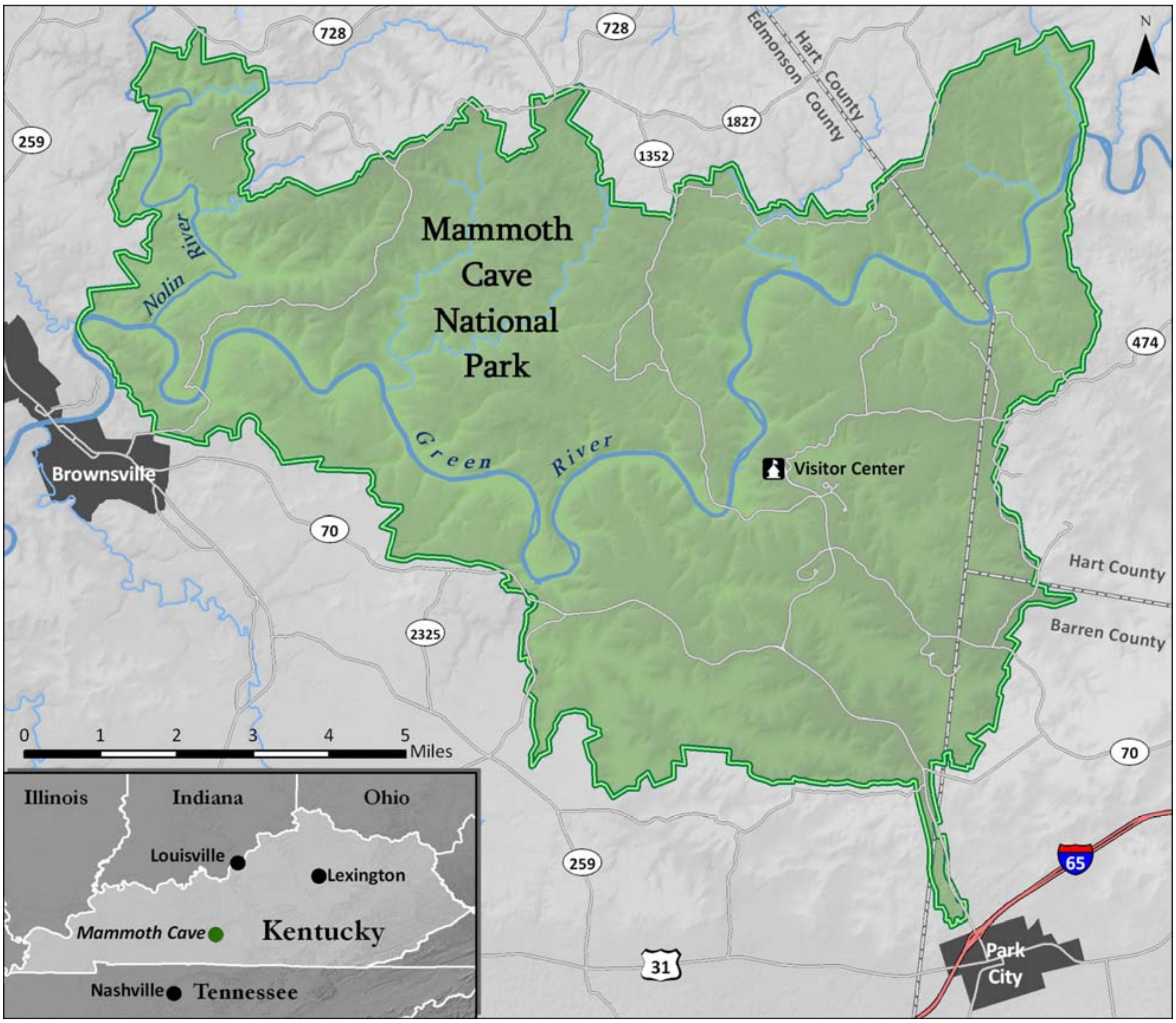

Figure 1. Mammoth Cave National Park and Vicinity Map

Mammoth Cave National Park is located within the Interior Low Plateaus of the Interior Plains physiographic province. The southern portion of the Park (south of the Green River) lies within the Central Kentucky Karst portion of the Pennyroyal Plateau (also known as the Mississippi Plateau) while the northern portion lies within the Chester Upland of the Western Coal Field. These two sections of the park are considerably different in terms of hydrology, vegetation, and soil geomorphology as a direct result of their distinct geological histories. The principal cave formations that occur in the park, including the Mammoth Cave System, are found on the south side of the Green River.

Five levels occur in Mammoth Cave. It is entered via the Historic Entrance, the only natural entrance used by visitors to enter the cave. Beyond the Rotunda, Broadway Avenue drops into the second level, while the first level continues as Gothic Avenue. The third and fourth levels are represented by passages of smaller cross-sectional dimensions, and the Rivers are found in the deepest, or fifth level, of the cave. Artificial entrances used by visitors to enter the cave are the New Entrance, Frozen Niagara Entrance, Carmichael Entrance, and Violet City Entrance.

Early in the twentieth century, just before establishment of the park, visitors could tour up to 32 miles of the cave on relatively rudimentary trails using kerosene lanterns. In anticipation of an estimated doubling of cave visitation resulting from National Park status, approximately 12 miles of trails (i.e., the current trails) were developed by the CCC in the late 1930's. Additional entrances to the cave were created allowing for 3-4 hour trips, versus 6-7 hour trips. Electric lights were installed along tour routes in stages between 1917 and 1965, and later updated in 2005-2006. In recent years, park staff have installed short stretches of boardwalks and paving stone-paths as prototype walking surfaces.

The wider trails were surfaced with cave sediment and the new entrances provided the capability of taking larger tour groups. Visitation didn't just double as anticipated. In 2000, cave visitation was 10 times greater than in 1934 when the CCC began work in the cave. Except for areas with specific problems, there have not been comprehensive plans for rehabilitation or upgrade of the cave trail system since 1941.

Beginning in the 1930s, dry sediments in upper passageways of Mammoth Cave were used to make and maintain tourist trails. A dusting salt (calcium chloride crystals) was applied each year to harden the trail surface. In 1995, the park discontinued use of the cave sediments because they contain a historic record of activity on the surface and below. Use of the salt, a substance foreign to the natural cave, ceased as well. A different type cave trail surface was needed that would protect cave resources by leaving them intact and by not introducing foreign sediments to the cave environment.

In 1997 park staff installed two prototypes along short sections of the cave trail:

- a boardwalk along Broadway, built of untreated wood and recycled plastic decking, and following the contour of the cave floor;
- hexagonal paving stones in the Rotunda with 18-inch lint rails on either side of the trail.

Without the application of salt to harden them, deterioration of the remaining cave trails increased. Pot holes developed along most tour routes; various ineffective remedies were tried.

One impact from excavating sediments was the aesthetic damage that it caused to the section of cave where material was excavated. However, irreversible harm was also done to the resources associated with those sediments. Potential habitats for cave biota, the geologic record within the sediments, archaeological and historical artifacts and their inherent record, as well as paleontological resources were lost or severely damaged (Fry and Olson, 1999).

Cold, dry air pouring into the cave in winter dries out the sediment-based trails. As large tour groups pass with as many as 120 people per tour, clouds of dust disperse and settle throughout the passage. Over time a thick patina of dust is deposited on the cave features. Varying cave atmospheric conditions contribute to disintegration of the trail and can create rough walking surfaces. In some areas cold, dry air breaks up the surface and in other locations dripping condensation leads to pitting and slick spots.

Visitors introduce a wealth of minute particles into the cave environment. This includes lint, skin cells, hair, dust, and a host of foreign materials that are inadvertently sloughed-off as people move through the cave. While these objects are small in size, their cumulative weight can be measured in pounds and they fuse into layers and mats of biomass. Most significantly, this material can potentially harbor microscopic organisms that are detrimental to both the natural and cultural features within the cave.

In 1995, the Park cleaned the dust and mold from the formations in the Snowball Room. In 1997, the Park developed and constructed a prototype walkway on the Historic Route as part of a demonstration project that would be more compatible with the cave environment. The primary goals were to eliminate the excavation of cave sediments for trail construction, to control the migration of potentially harmful lint introduced by visitors, eliminate dust created by sediment-based trails, and reduce the opportunity for graffiti and vandalism (Fry and Olson, 1999). In 2008, the old unsafe Mammoth Dome Tower was replaced with a new one.

The new paver prototype walkways were deemed mostly successful; however, there are aspects/attributes of the boardwalks that the Park is not completely satisfied with, such as increased noise in the cave when visitors walk on it. Hardened trail surfaces were constructed without excavating or otherwise exploiting the cave's resources. Without cave sediment for a tread, dust is no longer a problem, although dirt is tracked onto the new surfaces from the remaining sediment-based segments. Within weeks of their completion, lint and other materials had visibly accumulated at the base of the lint curbs where it does not disperse throughout the passage and is easily collected. Furthermore, with the channelized flow gained through the lint curbs and railings, potential violators have been less likely to damage cave walls or other resources. Tour logistics and interpretation have continued as before with no noticeable changes. Safety problems were corrected with a consistent and predictable surface as visitors are able to look around at the cave as they walk instead of watching their feet. However, the new boardwalk structures now visually dominate that section of the cave, possibly impacting the cultural landscape.

1.3 PARK PURPOSE AND SIGNIFICANCE

Mammoth Cave National Park was established as a national park in 1941, designated as a World Heritage Site in 1981, and as an International Biosphere Reserve in 1990. According to 16USC, Section 404-4045, the Park was established "…to preserve the cave system, including Mammoth Cave, the scenic river valleys of the Green and Nolin rivers, and a section of the hilly country of south central Kentucky."
The Park is significant for the following:

- The many types of geologic features are the products of a unique set of conditions found nowhere else. Mammoth Cave is the core of one of the best-understood karst areas in the world.
- The Park provides an abundance of recreation opportunities, surface and subsurface.
- It contains most of the longest known cave system in the world.
- The Park and the surrounding area are believed to support one of the most diverse cave biota in the world, with 138 species that use the cave on a regular basis, some of which are found nowhere else.
- The saltpeter works in Mammoth Cave are a good example of a technology that was important in the early history of the United States.
- The Park contains an unusual variety of ecological niches that provide habitat for an abundance of plants and animals, including protected and endangered species.
- The Park contains a rich diversity of flora reflected in rare species, disjunct northern communities, remnant prairie and old growth communities.
- The Park contains a quantity of primary cultural resources, which have been valuable in the understanding of human interaction with the natural environment prehistorically from the paleo-

Indians (over 12,000 years ago) to the Mississippian period (900-1500), and historically from early settlement (1774-1825) to the depression era (1929-1941).

The following mission statements were created as broad statements of the mission requirements established by Congress in the Acts that created the NPS and Mammoth Cave National Park.

National Park Service Mission

The NPS preserves unimpaired the natural and cultural resources and values of the National Park System for the enjoyment, education, and inspiration, of this and future generations. The Service cooperates with partners to extend the benefits of natural and cultural resources conservation and outdoor recreation throughout this country and the world.

Mammoth Cave National Park Purpose

The purpose of Mammoth Cave National Park is to protect and preserve for the future the extensive limestone caverns and associated karst topography, scenic riverways, original forests, and other biological resources, evidence of past and contemporary lifeways; to provide for public education and enrichment through scientific study; and to provide for development and sustainable use of recreation resources and opportunities.

1.4 LAWS, REGULATIONS, AND POLICIES

The following laws and associated regulations provided guidance for the development of this EA, design of the preferred alternative, analysis of impacts, and creation of mitigation measures to be implemented as part of the preferred alternative.

The NPS Organic Act (1916) and the General Authorities Act (1970) prohibit impairment of park resources and values. The *NPS Management Policies, 2006* (NPS, 2006) uses the terms “resources and values” to mean the full spectrum of tangible and intangible attributes for which the park was established and is managed, including the Organic Act’s fundamental purpose and any additional purposes as stated in the park’s establishing legislation. The impairment of park resources and values may not be allowed unless directly and specifically provided by statute. The primary responsibility of the NPS is to ensure that park resources and values will continue to exist in a condition that will allow the American people to have present and future opportunities to enjoy them.

The evaluation of whether impacts of a preferred alternative would lead to an impairment of park resources and values is included in this EA. Impairment is more likely when there are potential impacts to a resource or value whose conservation is:

- necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;
- essential to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or
- identified as a goal in the park’s General Management Plan (GMP) or other relevant NPS planning documents.

NPS Management Policies, 2006 addresses caves in Section 4.8.2.2, “The Service will manage caves in accordance with approved cave management plans to perpetuate the natural systems associated with the caves, such as karst and other drainage patterns, air flows, mineral deposition, and plant and animal communities. Wilderness and cultural resources and values will also be protected."

Furthermore "Parks will manage the use of caves when such actions are required for the protection of cave resources or for human safety."

The Federal Cave Resources Protection Act of 1988 secures, protects, and preserves significant caves on Federal lands for the perpetual use, enjoyment, and benefit of all people. It also fosters increased cooperation and exchange of information between governmental authorities and those who utilize caves located on Federal lands for scientific, education, or recreational purposes.

NPS Management Policies, 2006, also states that "The National Park Service will provide visitor and administrative facilities that are necessary, appropriate, and consistent with the conservation of park resources and values. Facilities will be harmonious with park resources, compatible with natural processes, esthetically pleasing, functional, energy- and water-efficient, cost effective, universally designed, and as welcoming as possible to all segments of the population. Park facilities and operations will demonstrate environmental leadership by incorporating sustainable practices to the maximum extent practicable in planning, design, siting, construction, and maintenance."

Section 9.1.3 addresses Construction and states that "The Service will incorporate sustainable principles and practices into design, siting, construction, building materials, utility systems, recycling of all unusable materials, and waste management. Best management practices will be used for all phases of construction activity, including pre-construction, actual construction, and post-construction."

Section 9.3, Visitor Facilities, states "While striving for excellence in visitor services, the NPS will limit visitor facility development to that which is necessary and appropriate… When visitor facilities are found to be necessary and appropriate within a park, they will be designed, built, and maintained in accordance with accepted NPS standards for quality, and the NPS commitment to visitor satisfaction."

1.5 SCOPING

Scoping is an open process that determines the breadth of environmental issues and alternatives to be addressed in an EA. Scoping involves obtaining internal and external input on project-related issues from resource specialists and the public, respectively.

For public scoping, a letter, a newsletter, and a news release describing the project and requesting public input on the proposed alternatives was issued to private parties and State, Federal, and local agencies on April 24, 2009. The external scoping period ended on May 26, 2009. A public scoping summary report can be found in Appendix A.

1.6 THE ENVIRONMENTAL ASSESSMENT

This EA analyzes the environmental impacts that would result from the alternatives considered, including the No Action Alternative. This EA has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code (USC) 4321 et seq.), the Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations (CFR) 1500 through 1508) for implementing NEPA, and the NPS NEPA compliance guidance handbook (DO-12, *Conservation Planning, Environmental Impact Analysis, and Decision-making*). The intent of this document is to also meet the requirements for protection of cultural resources, including the National Historic Preservation Act

(NHPA), the Antiquities Act, the Reservoir Salvage Act, and the Archaeological Resources Protection Act.

1.7 IMPACT TOPICS

Issues and concerns with this project are grouped into distinct impact topics to aid in analyzing environmental consequences, which allows for a standardized comparison of alternatives based on the most relevant information. The impact topics were identified on the basis of federal laws, regulations and orders, *NPS Management Policies, 2006,* and NPS knowledge of potentially affected resources. A brief rationale for selecting or dismissing each topic is provided below.

1.7.1 Impact Topics Analyzed in this Environmental Assessment

Macrobiotic Resources
Mammoth Cave contains macrobiota which could be disturbed by cave trail rehabilitation activities. Macrobiota are living organisms (plants and animals) large enough to be seen with the naked eye. This impact topic is addressed in accordance with *NPS Management Policies, 2006,* Chapter 4, which directs the NPS to minimize human impacts to native animals, populations, communities, and ecosystems.

Rare, Threatened, or Endangered Species and Species of Interest
Construction activities could temporarily displace special status species from the immediate vicinity of the project site. The Endangered Species Act of 1973 requires disclosure of impacts of federal actions on all federally protected threatened or endangered species. *NPS Management Policies, 2006* requires assessment of impacts to certain rare, candidate, declining and sensitive species.

Microbiotic Resources
Microbes or their habitats could be affected by trail reconstruction. Microbiota are living organisms (i.e., bacteria, fungi) that are not large enough to be seen with the naked eye. This impact topic is addressed in accordance with NPS Reference Manual #77, which directs the NPS to prevent the disturbance of microbial communities through minimum impact caving techniques.

Cave Climate
The cave climate (temperature, relative humidity, airflow) could be affected by construction activities and cave lighting. This impact topic is addressed in accordance with *NPS Management Policies, 2006*, Chapter 4, which directs the NPS to return human-disturbed areas to natural conditions and processes, and with NPS Reference Manual #77.

Physical Cave Features
Mammoth Cave contains geologic, mineralogical, and aesthetic values that could be impacted by trail rehabilitation. This impact topic is addressed in accordance with *NPS Management Policies, 2006,* Chapter 4, which directs the NPS to maintain and restore the integrity of geologic resources, and with NPS Reference Manual #77, which directs the NPS to establish levels of maximum acceptable cumulative impact to caves.

Paleontological Resources
Mammoth Cave contains paleontological resources that could be impacted by trail rehabilitation. Paleontological resources are addressed in accordance with *NPS Management Policies, 2006*, Chapter 4, which directs NPS to protect, preserve, and manage paleontological resources, including both organic and mineralized remains in body or trace form, for public education, interpretation, and scientific research. It also states that the Service will study and manage paleontological resources in their paleoecological

context (that is, in terms of the geologic data associated with a particular fossil that provides information about the ancient environment).

Water Resources
Mammoth Cave contains dripping water, springs, pools, and underground rivers that could be impacted by trail reconstruction. NPS *Management Policies*, *2006* requires protection of water quality consistent with the provisions of the Clean Water Act of 1977, a national policy to restore and maintain the chemical, physical, and biological integrity of the nation's waters and to prevent, control, and abate water pollution.

Cultural Resources
Archeological and historic resources in Mammoth Cave could be impacted by trail rehabilitation. The NPS is required to, "preserve collections of prehistoric and historic material remains, and associated records, recovered under the authority of the Antiquities Act (16 U.S.C. 431-433), the Reservoir Salvage Act (16 U.S.C. 469-469c), section 110 of the National Historic Preservation Act (16 U.S.C. 470h-2), or the Archaeological Resources Protection Act (16 U.S.C. 470aa-mm)" (36 CFR Part 79). These regulations, promulgated under the authority of the Secretary of Interior, apply to findings made by historic preservation professionals that meet qualification standards for Federal projects.

Visitor Use and Experience
Visitor use and experience could be affected through noise, aesthetics, and trail closure effects during construction, and reconstructed trail surfaces and other trail features post-construction. This impact topic is addressed in accordance with the 1916 Organic Act and with *NPS Management Policies, 2006*, Chapter 8, which directs the NPS to impose management controls on all park uses and to provide appropriate, high quality opportunities for visitors to enjoy the parks.

Public Health and Safety
Public health and safety would be affected with trail improvements and repairs as the current safety concerns would be addressed. This impact topic is addressed in accordance with *NPS Management Policies, 2006*, Chapter 8, which directs the NPS to seek to provide a safe and healthful environment for visitors and employees.

1.7.2 Impact Topics Dismissed from Further Consideration

Soils
Mechanical deposits that comprise cave sediments differ substantially from soils found in surface contexts. They are not considered to be soils because they have not been subjected to soil forming processes. Impacts to cave sediments are considered under the Physical Cave Features topic.

Wetlands and Floodplains
Executive Order 11990, *Protection of Wetlands*, requires an examination of impacts to and protection of wetlands. Executive Order 11988, *Floodplain Management*, requires all Federal agencies to take action to reduce the risk of flood loss, to restore and preserve the natural and beneficial values served by floodplains, and to minimize the impact of floods on human safety, health, and welfare. The NPS Director's Order (DO) 77-1 (Wetland Protection) implements Executive Order 11990 and DO 77-2 (Floodplain Management) implements Executive Order 11988. The proposed project area is not located near or in any wetlands or floodplains; therefore this topic was dismissed from consideration.

Soundscape
Mammoth and Great Onyx caves are generally very quiet and most of the sounds that are present outside of human interaction is related to moving water. The cave soundscape could be impacted during the

construction phase of trail rehabilitation and through the selection of surface types, materials, and construction techniques. However, impacts would be temporary and of low intensity during trail rehabilitation. Some surface types, such as boardwalks that may be installed on trails, would be noisy when large tour groups walk over them, but there are other noises from tour groups that also occur and the boardwalk noise would be transient as tours move through the cave. The proposed action would not substantially affect natural ambient sound in the long-term. Therefore, soundscape was dismissed as an impact topic in this EA. The impacts of noise on macrobiota, special status species, and visitor experience are discussed under each of those topics.

Socioeconomic Environment

Construction activities associated with the action alternative would have short-term, negligible impacts on the local economy due to temporary increases in employment opportunities and revenues for local businesses and government during construction. A private construction contractor would likely be hired to conduct construction activities. Construction-related benefits to the local economy through wages, overhead expenses, material costs, and profits would last only the duration of construction, and would be minimal. No long-term impacts on the local economy would occur as a result of the project. Therefore, this topic was dismissed from further analysis in this EA.

Prime and Unique Farmlands

In August 1980, the Council for Environmental Quality (CEQ) directed that Federal agencies must assess the effects of their actions on farmland soils classified by the U.S. Department of Agriculture's Natural Resources Conservation Service as prime or unique. Prime or unique farmland is defined as soil that particularly produces general crops, such as common foods, forage, fiber, and oil seed; unique farmland produces specialty crops, such as fruits, vegetables, and nuts. Since the project area does not meet the definition of farmland as stated in Title 7, Chapter 73, Section 4201 (c)(1) of the Farmland Protection Policy Act (FPPA), it is not applicable to the FPPA. Therefore, the topic of prime and unique farmlands was dismissed as an impact topic in this EA.

Environmental Justice

Presidential Executive Order 12898, *General Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, requires all Federal agencies to incorporate environmental justice into their missions by identifying and addressing the disproportionately high and/or adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. The proposed project would not have disproportionate health or environmental effects on minorities or low-income populations or communities as defined in the US EPA's Draft Environmental Justice Guidance (July 1996). Therefore, Environmental Justice was dismissed as an impact topic in this EA.

2.0 ALTERNATIVES CONSIDERED

CEQ regulations for implementing NEPA require that Federal agencies explore and objectively evaluate all reasonable alternatives to the preferred alternative, and to briefly discuss the rationale for eliminating any alternatives that were not considered in detail. This chapter describes a range of reasonable alternatives, including the No Action Alternative, the Preferred Alternative, and an alternative that was considered and eliminated from further analysis.

2.1 Alternative A – No Action

Under the No Action Alternative, existing cave trails would not be rehabilitated. This alternative would require periodic, and possibly increased, trail maintenance to insure that potential safety concerns, such as potholes, and continuing trail deterioration are maintained at acceptable conditions. CEQ regulations (40 CFR 1502.14) require the assessment of the No Action Alternative in NEPA documents. The No Action Alternative provides a basis for comparing the management direction and environmental consequences of the other action alternatives and must be considered in every EA.

2.2 Alternative B – Rehabilitate Cave Trails (NPS Preferred Alternative)

Under Alternative B, cave tour trails within Mammoth Cave and Great Onyx Cave would be rehabilitated (Figure 2). Cave tour trails would be evaluated and reconstructed as appropriate. Current cave tours, length of routes, and tour features are listed in Table 1.

This project would reconstruct existing cave trails to be safe, durable, and protect natural and cultural resources. Cave passageways vary greatly in width, height, slope, features, and humidity. Treatment applied on the trails will be site specific. In some places only minor changes would be made, while in others more comprehensive solutions would be applied. The new cave tour trails would provide safe walking surfaces for park visitors; significantly reduce or eliminate the impact of cave visitors (lint and dust) on delicate cave resources; and protect cave resources by keeping visitors on defined trails and away from cave resources.

The project includes reconstruction of trail surfaces, installation or replacement of steps, upgrade of safety rails, installation of lint guards along the edges of the trails, and where necessary installation of lights to provide a safe walking area. This project may include improvements to the elevator, such as upgrades to the existing shaft, along with modifications to the airlock. Though related to this project, a separate study is being finalized to develop alternatives for providing future access to the cave for mobility impaired visitors.

Detailed reconstruction features would be designed for specific trail segments during the design phase of the project after the EA is completed. Design features would prescribe the trail surface to be used for each trail segment, using a combination of concrete pavers, PolyPavement™, boardwalk, soilcrete, existing packed dirt, or other suitable and sustainable trail surface materials. The average trail tread width would be 8 feet, but in some areas could be more or less than 8 feet. Reconstruction would follow the current trail alignment on the majority of trail segments. Very few areas would need the trail to be shifted; where shifts would be required, it is more likely that the realignment would be vertical rather than horizontal. Some trails would be designed so as to improve accessibility for mobility impaired visitors. An engineering survey of the public tour trails (DDS Engineering, 2008) has been completed which would provide trail data and schematics necessary for the design phase.

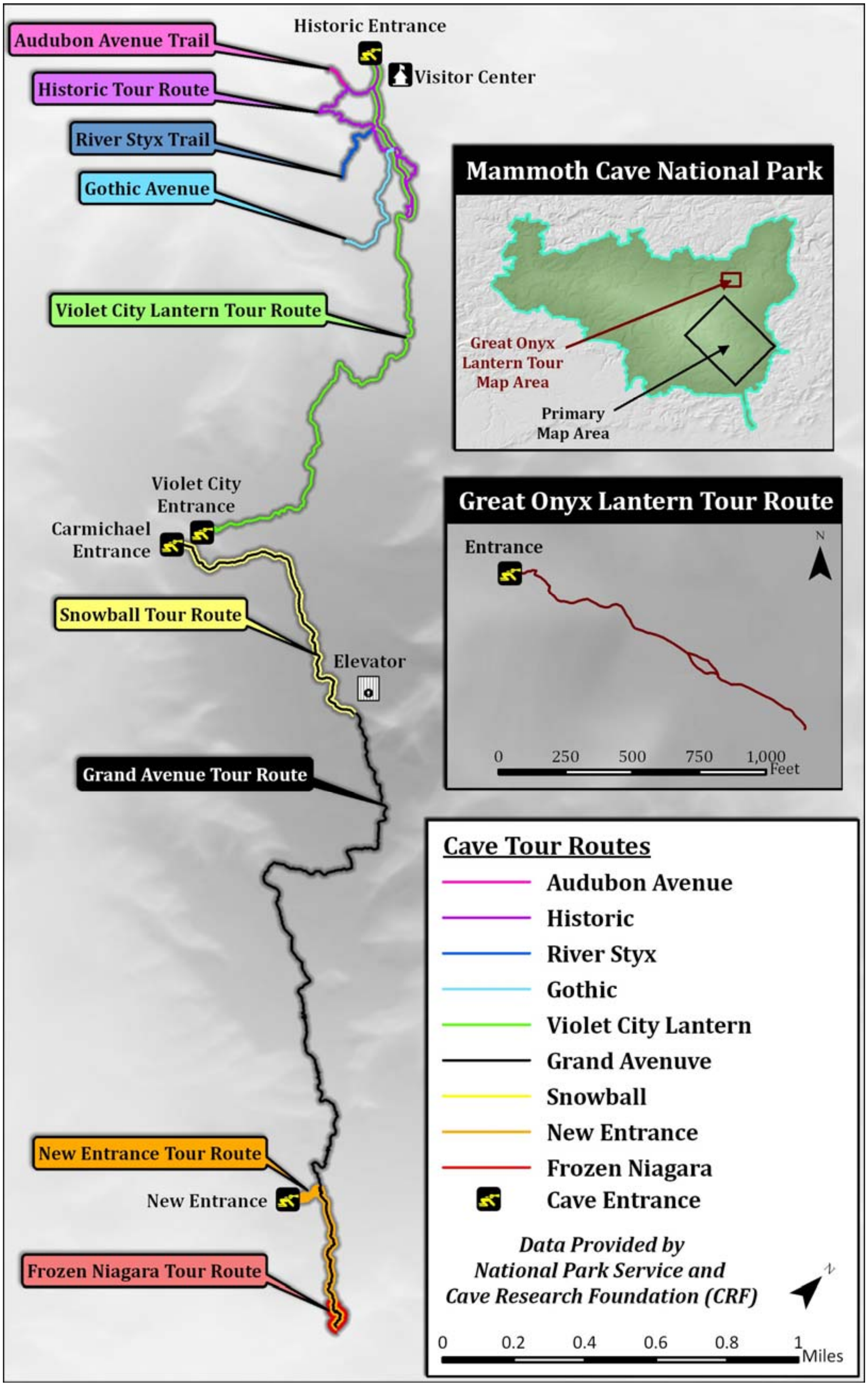

Figure 2. Mammoth Cave National Park Cave Tour Routes

Table 1. Summary of Cave Tour Routes at Mammoth Cave National Park

Cave Tour Route	Estimated Distance	Overlap with Other Tours
Historic Tour Route (includes Audubon and Rafinesque)	10,068 linear feet	Mammoth Cave Discovery, Mammoth Passage, River Styx, Star Chamber
River Styx Trail	1,358 linear feet	
Gothic Avenue	4,640 linear feet	Star Chamber
Violet City Lantern Tour Route (Giants Coffin to Violet City Entrance)	8,623 linear feet	Star Chamber
Snowball Tour Route (Cleaveland Avenue)	4,920 linear feet	Grand Avenue, Wild Cave
Grand Avenue Tour Route (Snowball to Grand Central Station)	15,750 linear feet	New Entrance, Frozen Niagara, Wild Cave
New Entrance Tour Route (steps)	425 linear feet	Introduction to Caving
Frozen Niagara Tour Route (NY Subway to Frozen Niagara Entrance)	4,290 linear feet	Grand Avenue, New Entrance, Wild Cave, Focus on Formations, Intro to Caving
Great Onyx Lantern Tour Route	2,650 linear feet	

Estimated time for the reconstruction of trails would be 36 to 48 months. Staging areas for material and equipment would be limited and would not be located on the edges of trails where cultural and natural resources could be damaged. The work may be phased so that cave tours can continue to operate with minimal interruption. The Park may be able to narrow certain trails and work on them while tours pass by, but other trail sections would need to be temporarily closed to tours during construction.

2.3 ALTERNATIVES CONSIDERED BUT DISMISSED

CEQ regulations for implementing NEPA require that Federal agencies explore and objectively evaluate all reasonable alternatives, and briefly discuss the rationale for eliminating any alternatives that were not considered in detail. This section describes alternatives that were considered and eliminated from further study. The rationale for elimination is given below.

2.3.1 Establish tour routes in other previously toured caves within the park

Several caves within the park were tourist attractions prior to the creation of the park (1941). These caves have simple trails, often narrow paths made of cave sediments. Some of their trails are very steep, some rocky, some low, and some along deep pits. Most of the infrastructure constructed to support visitation such as handrails and stairs were made from wood, which is now 50+ years old. Most of these cave entrances are in remote sections of the park; walking trails or roads would need to be constructed on the surface to access the cave entrances. Upon consideration of tour logistics and needed construction (efficiency of serving visitors, number of people/tour, number of guides/tour, lighting method, transportation to the entrance, length of tour in time and distance, guide training, compelling story of this cave, maintenance, trail tread/handrail construction), park staff found this alternative undesirable and costly; it was dismissed from further consideration.

2.3.2 Construct new entrances into Mammoth Cave

Construction of new entrances into Mammoth Cave would require assessment of the potential environmental impacts that would result from blasting or drilling an unnatural opening into the cave. Existing entrances used on cave tours are adequate to serve visitor use at current visitation levels, with the exception of providing accessibility for the mobility impaired – which may require some level of modification to facilitate access.

2.3.3 Construct new trail in previously untoured parts of Mammoth Cave

Tours of Mammoth Cave travel through approximately 10 miles of its total 367-mile length. The toured miles are considered representative of other sections of the cave. Constructing new trail in previously undisturbed passageways would require detailed assessment of the potential impacts to both natural and cultural resources as well as the overall environmental impacts. Park staff found this alternative undesirable and costly; it was dismissed from further consideration

2.3.4 Open tours along previously toured routes within Mammoth Cave

Tours have been conducted in Mammoth Cave since 1816. Most of the present tour routes traverse the most famous places in the cave and are visitor favorites. Some of the previously toured routes have sediment-trails constructed by the CCC; most are without electric lights or modern handrails. These trail routes have potential, but at the present time are not a priority; they would most likely need updating and rehabilitation. The available cave trail system is adequate to serve visitor use at current visitation levels. Park staff found this alternative undesirable and costly; it was dismissed from further consideration

2.4 ENVIRONMENTALLY PREFERRED ALTERNATIVE

In accordance with DO-12, the NPS is required to identify the "environmentally preferred alternative" in all environmental documents, including EAs. The environmentally preferred alternative is determined by applying the criteria suggested in NEPA, which is guided by the CEQ. As stated in Section 2.7 (D) of the NPS DO-12 Handbook, "The environmentally preferred alternative is the alternative that will best promote the national environmental policy expressed in NEPA (Section 101(b))." This environmental policy is stated in six goal statements, which include:

1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
2. Assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings;
3. Attain the widest range of beneficial uses of the environment without degradation, risk to health and safety, or other undesirable and unintended consequences;
4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain wherever possible, an environment which supports diversity and variety of individual choice;
5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and
6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (NEPA, 42 USC 4321-4347).

In sum, the environmentally-preferred alternative is the alternative that, not only results in the least damage to the biological and physical environment, but also that best protects, preserves, and enhances historic, cultural, and natural resources.

As evaluated against the CEQ regulations, Alternative B is the Environmentally Preferred Alternative. The No Action Alternative represents the current situation of deteriorating cave trail conditions with the potential for increasing damage to natural and cultural resources and increasing detrimental effects on visitor safety. This alternative would not uphold the NPS mandate to administer and protect Mammoth Cave for the enjoyment of natural and cultural resources in a manner that leaves these resources unimpaired, while maintaining safe visitor use standards.

The Environmentally Preferred Alternative is Alternative B because it surpasses the No Action Alternative in realizing the full range of national environmental policy goals as stated in §101 of NEPA. The cave tour trails would provide safe walking surfaces for park visitors; significantly reduce or eliminate the impact of cave visitors (lint and dust) on delicate cave resources; and protect cave resources by keeping visitors on defined trails and away from cave resources. In conclusion, Alternative B provides the highest level of protection of natural and cultural resources while providing for a safe visitor experience.

2.5 Mitigation Measures

For all action alternatives, Best Management Practices (BMPs) and mitigation measures would be used to prevent or minimize potential adverse effects associated cave trail rehabilitation. These practices and measures would be incorporated to reduce the magnitude of impacts and ensure that major adverse impacts would not occur. Mitigation measures undertaken during project implementation would include, but would not be limited to, those listed below. The impact analysis in the "Environmental Consequences" section was performed assuming that these BMPs and mitigation measures would be implemented as part of all action alternatives.

- To the extent possible, construction activities in areas with sensitive wildlife would be timed to avoid sensitive wildlife periods, such as breeding seasons and bat hibernation periods.

- Construction equipment (limited to propane or electric powered equipment) could leak fluids, introduce noise pollution, and emit pollutants. To minimize this possibility, equipment would be checked frequently to identify and repair any leaks, mufflers would be checked for proper operation, and only equipment that is within proper operating specifications would be used.

- All excess debris and foreign material resulting from project construction activities would be removed from the cave for legal and proper disposal.

- Dust abatement measures would be implemented to minimize the spread of dust during trail reconstruction.

- Trail work would be planned so as to still allow tours to pass, rather than close trails. If a trail must be closed, work would proceed as expeditiously as possible.

- Cave rehabilitation personnel and equipment may be subject to stringent decontamination protocols to prevent the introduction and spread of the white-nose syndrome bat disease.

- Areas identified to have moderate-potential for archeological/paleontological resources in Mammoth and Great Onyx caves would be monitored during trail construction activities by a qualified archaeologist or paleontologist to prevent disturbance of highly significant deposits and to recover samples of scientifically important materials. Significant deposits would include dense concentrations of torch remains beyond the normal background of torch charcoal that is scattered throughout the cave and/or archaeological materials of rare occurrence in the cave such as cordage, textile fragments, paleofeces, bone deposits, and other artifacts associated with intensive periods of prehistoric or historic activity in the cave.

- Recommendations for areas identified to have high potential for archeological/paleontological resources in Mammoth and Great Onyx caves include a broad range of possible actions, all of which are designed to minimize the impact of proposed trail rehabilitation construction on intact archaeological or paleontological deposits. Among these options are 1) monitoring by a qualified archaeologist or paleontologist; 2) avoidance (though in some locations this may not be possible); 3) burial of deposits to preserve them from impact; 4) bridging over significant areas or otherwise altering the trail construction techniques to minimize disturbance of deposits; or 5) data recovery through expanded archaeological or paleontological excavations. At a minimum monitoring would be conducted in high-potential areas.

- Structures needed for trail rehabilitation, such as curbs, railings, signs, and stairs, would be designed and located to minimize adverse impacts on the character and features of the cultural landscape. New facilities would be compatible with the historic character and material of the landscape.

- All work that may affect cultural landscapes is evaluated by a historical landscape architect and other professionals, as appropriate.

2.6 COMPARISON OF ALTERNATIVES

Table 2 compares the potential environmental impacts resulting from the alternatives. Potential impacts are provided according to environmental resource topic. The *Environmental Consequences* section of this EA contains a detailed discussion of these potential impacts by resource topic.

Table 2. Summary Comparison of Environmental Consequences

Impact Topic	Alternative A: No Action	Alterative B: Preferred Alternative
Macrobiotic Resources	long-term, negligible, local, direct adverse impacts from continued human presence and increased trail maintenance	temporary to short-term, minor, local, direct adverse impacts from trail reconstruction activities, continued human presence, and trail maintenance
Rare, Threatened, or Endangered Species and Species of Interest	long-term, negligible, local, direct adverse impacts due to continued human presence and increased trail maintenance	temporary to short-term, negligible to minor, local, direct adverse impacts from trail reconstruction activities; and long-term, negligible adverse impacts from continued human presence and trail maintenance
Microbiotic Resources	long-term, negligible, local, direct adverse impacts from increased trail maintenance and a continuing influx of lint as an energy source	temporary, negligible, local, direct adverse impacts due to trail reconstruction activities; and long-term, minor, local, direct beneficial impacts due to the reduction of lint as an energy source
Cave Climate	no new impacts	temporary, negligible, local, direct adverse impacts from trail reconstruction activities; long-term minor, beneficial impacts with the refurbished airlock at the bottom of the elevator
Physical Cave Features	long-term, moderate, local, direct adverse impacts due to continuing damage to cave formations by visitors and from lint and dust accumulation	long-term, minor, local, direct adverse impacts due to damage from trail reconstruction; and long-term, minor, beneficial impacts from reduced vandalism, lint and dust accumulation
Paleontological Resources	long-term, minor, localized, direct adverse impacts from disturbance of paleontological resources by visitors straying off trails and from continued accumulation of lint and dust	long-term, negligible, localized direct adverse effects from trail rehabilitation and long-term, minor, beneficial impacts as a result of the reduction of dust, lint, and vandalism
Water Resources	long-term, negligible, localized, direct adverse impacts from continued water seeping into the cave via the elevator shaft, the VC airshaft in Houchin's Narrows and at other bore holes	temporary, negligible, localized, direct adverse impacts from possible contamination during construction activities; direct adverse impacts from continued water seeping into the cave via the elevator shaft would continue, as well as the VC airshaft in Houchin's Narrows and at other bore holes, unless the elevator work

Impact Topic	Alternative A: No Action	Alterative B: Preferred Alternative
		to be completed involves capturing the water and removing it or the shaft is sealed. Temporary, localized, direct adverse impacts from construction activities conducted in the water at the Lake Lethe area.
Cultural Resources	long-term, minor, localized, direct adverse impacts from disturbance of cultural artifacts by visitors straying off trails and from continued accumulation of lint and dust	long-term, negligible, localized direct adverse effects from trail rehabilitation and long-term, minor, beneficial impacts as a result of the reduction of dust, lint, and vandalism
Visitor Use and Experience	long-term, minor, direct adverse impacts due to deteriorating trail conditions	temporary, minor, direct adverse impacts from noise and inconvenience during construction; long-term, moderate, beneficial impacts from improved trail conditions; and possibly long-term, minor, adverse impacts from introduced man-made trail features.
Public Health and Safety	long-term, minor, direct adverse impacts as cave trails continue to deteriorate	long-term, moderate, direct beneficial impacts due to improved walking surfaces and other safety features on public cave tour trails

3.0 AFFECTED ENVIRONMENT

This chapter describes the existing environment and current conditions of resources in Mammoth Cave that are analyzed in this EA. Topics discussed are macrobiotic resources, threatened and endangered species, microbiotic resources, cave climate, physical cave features, water resources, cultural resources, visitor use and experience, and public health and safety. These resources have the potential to be affected by cave tour trail rehabilitation.

3.1 MACROBIOTIC RESOURCES

Mammoth Cave is one of the cave biodiversity hotspots in the world, with approximately 130 regularly occurring species roughly divided between troglobites, trolophiles, and trogloxenes (Poulson, 1992). Troglobites are fully cave adapted and cannot survive in surface habitats. Troglophiles are species that can complete their life cycle in both cave and surface habitats, and trogloxenes use caves for refuge or may come in to prey upon other species (Olson, 2003). One-third of the fauna is aquatic and two-thirds is terrestrial; taxonomically, arachnids dominate the terrestrial fauna and crustacea dominate the aquatic fauna (Culver and Sket, 2000).

The cave environment can be separated into a twilight zone near the entrance, a middle zone of complete darkness and variable temperature, and a zone of complete darkness and constant temperature in the deep interior. The twilight zone has the largest and most diverse fauna; the middle zone has several very common species which may commute to the surface; and the deep cave contains obligate cave fauna.

Thirteen species of bats have been documented at the Park, eight of which use the cave. Mammoth Cave was formerly one of the largest bat hibernacula in the world. Indiana bats (*Myotis sodalis*), and to a lesser extent gray bats (*M. grisescens*), were prominent species in Mammoth Cave only 150 years ago, but are today federally listed as endangered (see **Rare, Threatened, or Endangered Species and Species of Interest** below). Little brown bats (*M. lucifugus*) were also abundant with the big brown bat (*Eptesicus fuscus*), while the tri-colored bat (*Pipistrellus subflavus*) was less common. Rafinesque’s big eared bat (*Plecotus rafinesquii*) populations were never large, but are today a species of concern (Olson, 2003). Development of the cave has reduced or eliminated these bat colonies in Mammoth Cave.

Woodrats and raccoons were formerly abundant in Mammoth Cave, and though today are reduced, their feces still support specialized communities (Olson, 2003). Latrines of the Eastern woodrat (*Neotoma floridana*) sustain larva of the fly *Psychoda*, the fungus gnat *Bradysia*, and the beetle *Ptomaphagus hirtus,* which are preyed upon by the rove beetle *Quedius*. Raccoon feces support a similar community.

Several amphibians occur in the cave. The Northern slimy salamander (*Plethodon glutinosus*) is often found in the twilight zone of the cave. The zigzag salamander (*Plethodon dorsalis*) occurs seasonally in sinkholes and in shallow cave passages. Long-tailed salamanders (*Eurycea longicauda*) have occasionally been seen along the Echo River in Mammoth Cave. Cave salamanders (*Eurycea lucifuga*) are frequently encountered in moist twilight zones.

The fish of the Echo, Styx, and Roaring rivers include two troglobites, the southern cavefish (*Typhlichthys subterraneus*) and the northern cavefish (*Amblyopsis spelaea*); a habitual trogloxene, the spring cavefish (*chologaster agassizi*); and occasional trogloxenes and accidentals.

Aquatic worms in the cave include two troglobitic planarians (flatworms) occurring in temporary drip pools or shallow flowing streams, nematodes in muddy lake and pool bottoms, parasitic worm, rotifers, oligochaete worms (*Aeolosoma*) in wet rotting wood, tardigrades (*Macrobiotus*), and tubificid worms in temporary pools and wet silt of banks of underground streams. Worm castings and tracks are also visible on mud banks of cave streams. These organisms are preyed upon by the troglobitic beetles *Pseudanophthalmus striatus*, *P. menetriesi*, and *Neaphaenops tellkampfi* (Olson, 2003).

The troglobitic snail *Antroselates spirales* can be found under large stones in shallow riffles, and *Charychium stygium* is common on wet cricket guano on flowstone and ledges. Some troglophilic snail species occur in rotting timber and leaves.

Sixteen species of copepods (*Maraenobiotus, Moraria, Nitocra,* and *Parastenocaris*), tiny shrimp-like crustaceans, have been recorded in the streams and pools of the Mammoth Cave system, the majority of which are not restricted to the cave. Troglophiles and accidentals get washed in from the Green River and are found in River Styx, Echo River, Roaring River and springs. The cave also contains species of ostracods, such as *Cambarus tenebrosus*; aquatic isopods, such as the widespread *Asellus stygius* common in shallow flowing water; terrestrial isopods which occur as troglophiles; and amphipods such as *Stygobromus* in small backwater or residual pools and films of trickling water; and the troglophilic amphipod *Crangonyx packardi* in springs on the cliff above River Styx.

Two crayfish and one atyid shrimp are found in Mammoth Cave. The cave crayfish *Orconectes pellucidus* occupies habitats ranging from base level to tiny streams and can travel out of water if necessary. *Cambarus tenebrosus,* a troglophilic crayfish, is rare in Mammoth Cave. The federally endangered Kentucky cave shrimp (*Palaemonias ganteri*) occurs in residual flood pools of the Roaring River and other water courses in the Mammoth Cave system.

There are three species of pseudoscorpions. *Pseudozaona mirabilis* occurs near entrances and *Kleptochthonius cerberus* on guano coated flowstone. The cave contains a troglobitic harvestman (daddy longlegs) *Phalangodes armata* and many species of spiders. The most conspicuous spider in Mammoth Cave is the cave orb weaver (*Meta menardi*). Usually this species spins webs not far from cave entrances, but in Mammoth Cave, it can be found at remote sites near trash cans beside the tour trails near the Snowball Dining Room where it feeds on flies that are attracted by food scraps. *Cybaeus giganteus* spin irregular webs under stones and in holes on the floor.

Several species of ticks and mites, one species of troglobitic millipede, small centipedes, and the collembolans (springtails) *Tomocerus, Hypogastrura, Sinella,* and *Arrhopalites* are found in the cave. *Folsomia cavicola* is the most common collembolan in the cave. Diplura, which are two-pronged bristletails, occur on wet flowstone and cricket guano. Four species of cave crickets are found in the Mammoth Cave region, but only two are cave inhabitants. Camel crickets (*Ceuthophilus stygius*) are common near cave entrances in the twilight zone. The common cave cricket (*Hadenoecus subterraneus*), a trogloxene, disperses in warmer months, but otherwise aggregates in favored spots in the cave. Beneath the "roosting sites" of cave crickets a layer of guano develops which serves as a food source of considerable importance in the cave. Cave crickets have the highest density of any species in Mammoth Cave. Several species of troglophilic diptera (flies) and species of fleas from bats can also be found.

Coleoptera (beetles) include several troglobitic species. The blind cave beetle *Neaphaenops tellkampfii* roams widely throughout the cave system usually in damp silty areas. *Neaphaenops tellkampfii* feeds heavily on the eggs and nymphs of the cave cricket, *Hadenoecus subterranus*. The Surprising Cave Beetle (*Pseudanophthalmus inexpectatus*), previously a federal candidate species that has been known to occur in a small cave room adjacent to the project area near the top of Mammoth Dome, is a species of management concern.

Naturally occurring plant life in Mammoth Cave includes algae and fungi. The unwanted growth of lamp flora is a direct result of using fluorescent lamps in close proximity to wet surfaces. These plants could not grow without the artificial lighting. Smith and Olson (2007) identified 28 species of lamp flora, including mosses, ferns, cyanobacteria, and algae. Lamp flora has flourished for decades since the introduction of lighting systems, which has resulted in some damage to cave resources. These pioneer species typically modify the rock surface they inhabit by producing carbonic acid (Smith and Olson, 2007). This weak acid is corrosive especially to cave formations, which are characteristically limestone. This dissolution of cave formations can have irreversible damage on speleothems. The recent installation of a new cave lighting system has greatly reduced the growth of lamp flora on cave formations.

3.2 RARE, THREATENED, OR ENDANGERED SPECIES AND SPECIES OF INTEREST

Special status species at Mammoth Cave National Park include ten species that are federally listed as endangered, three species that are candidates for federal listing, two species that were recently delisted from federal listing, 20 species that are only listed by the Kentucky State Nature Preserves Commission (KSNPC), and 15 species that are not listed anywhere but managed by the Park as Species of Management Concern (SOMC). Of these 50 species, there is potential for 12 of them to occur at or near the project site (Table 3); these are described below.

The Commonwealth of Kentucky does not have a state listing per se. The KSNPC listing is regarded as the state's listing, but technically the KSNPC listing does not carry any legal authority, as would a "typical" state listing (Moore, 2009). KSNPC species are further listed as endangered, threatened, special concern, etc.

NPS guidance for Species of Management Concern states that they are "Other species that the park considers a species of management concern including, but not limited to, keystone species, indicator species, species harvested for sport, commercial, subsistence, or personal use, native species classified as pests, species that are deliberately and actively managed, and species for which there are significant expenditures."

The Indiana bat (*Myotis sodalis*), federally listed as endangered, is a temperate, insectivorous, migratory bat that hibernates colonially in caves and mines in the winter. In spring, reproductive females migrate and form maternity colonies where they bear and raise their young in wooded areas. Both males and females return to hibernacula in late summer or early fall to mate and enter hibernation (USFWS, 2007). The species was originally listed as in danger of extinction under the Endangered Species Preservation Act of 1966, and is currently listed as endangered under the Endangered Species Act of 1973, as amended.

The Gray bat (*Myotis griescens*) is federally listed as endangered and occupies a limited geographic limestone karst area of the southeastern United States. Prior to major declines, individual hibernating populations contained from 100,000 to 1.5 million or more bats (USFWS, 1982). With rare exceptions, gray bats live in caves year-round and migrate seasonally between hibernating and maternity caves. During the winter gray bats hibernate in deep, vertical caves. In the summer, they roost in caves which are located along rivers. The gray bat was added to the U.S. List of Endangered and Threatened Wildlife and Plants on April 28, 1976. Gray bats are endangered largely because of their habit of living in very large numbers in only a few caves, and as a result, they are extremely vulnerable to disturbance.

Table 3. Special Status Species at Mammoth Cave National Park.

Scientific Name	Common Name	Status *	Potential to occur at Project Site?
Amphibians			
Cryptobranchus alleganiensis	Hellbender	KSNPC-SC	No
Birds			
Haliaeetus leucocephalus	Bald Eagle	D	No
Fish			
Amblyopsis spelaea	Northern Cavefish	KSNPC-SC	Yes
Chologaster agassizi	Spring Cavefish	SOMC	Yes
Typhlichthys subterraneus	Southern Cavefish	KSNPC-SC	Yes
Invertebrates			
Alsmidonta marginata	Elktoe	SOMC	No
Cumberlandia monodanta	Spectaclecase	CA and KSNPC-E	No
Epioblasma obliquata	Catspaw	E	No
Epioblasma triquetra	Snuffbox	SOMC	No
Hadenoecus subterraneus	Cave Cricket	SOMC	Yes
Hemistena lata	Cracking Pearlymussel	E	No
Fusconaia subrotunda	Longsolid	SOMC	No
Lampsilis abrupta	Pink Mucket	E	No
Lampsilis ovata	Pocketbook	KSNPC-E	No
Leptodea leptodon	Scaleshell	E and KSNPC-PE	No
Neaphaenops telkampfi	Cave Beetle	SOMC	Yes
Obovaria retusa	Ring Pink	E	No
Orconectes pellucidus	Mammoth Cave Crayfish	KSNPC-SC	Yes
Palaemonias ganteri	Kentucky Cave Shrimp	E	Yes
Pleurobema clava	Clubshell	E	No
Pleurobema plenum	Rough Pigtoe	E	No
Pleurobema rubrum	Pyramid Pigtoe	KSNPC-E	No
Plethobasus cyphyus	Sheepnose	CA and KSNPC-E	No
Pseudanophthal inexpectus	Surprising Cave Beetle	KSNPC-T	Yes
Quadrula cylindrical	Rabbitsfoot	KSNPC-T	No
Villosa ortmanni	Kentucky Creekshell	KSNPC-T	No
Villosa lienosa	Little Spectaclecase	KSNPC-SC	No
Mammals			
Myotis grisescens	Gray Bat	E	Yes
Myotis sodalis	Indiana Bat	E	Yes
Lontra Canadensis	North American River Otter	SOMC	No
Neotoma magister	Allegheny Woodrat	SOMC	Yes
Plecotus rafinesquii	Rafinesque's Big-eared Bat	KSNPC-SC	Yes
Reptiles			
Crotalus horridus	Timber Rattlesnake	SOMC	No
Vascular Plants			
Castanea dentata	American Chestnut	KSNPC-E	No
Comus florida	Flowering Dogwood	SOMC	No

Scientific Name	Common Name	Status *	Potential to occur at Project Site?
Cypripedium parviflorum	Yellow Lady's-slipper	KSNPC-T	No
Cypripedium reginae	Showy Lady's-slipper	KSNPC-H	No
Epioblasma triquetra	Snuffbox	KSNPC-E	No
Fusconaia subrotunda	Longsolid	KSNPC-SC	No
Gymnopogon ambiguus	Bearded Skeletongrass	KSNPC-SC	No
Helianthus eggertii	Eggert's Sunflower	D	No
Hydrastis canadensis	Goldenseal	SOMC	No
Juglans cinerea	Butternut	KSNPC-SC	No
Lespedeza capitata	Round-headed Buschclover	KSNPC-SC	No
Lesquerella globosa	Short's Bladderpod	CA	No
Panax quinquefolius	American Ginseng	SOMC	No
Silphium terebinthinaceum	Prairie Rosinweed	SOMC	No
Silene regia	Royal Catchfly	KSNPC-E	No
Tsuga canadensis	Eastern Hemlock	SOMC	No
Ulmus american	American Elm	SOMC	No

* E = Federally listed as Endangered; CA = Federal Candidate Species for listing; D = Delisted from federal listing; SOMC = Species of Management Concern; KSNPC = Kentucky State Natural Preserves Commission – E (endangered), T (threatened), SC (special concern), H (historic) or PE (presumed extinct)

Mammoth Cave once housed one of the largest hibernating colonies of bats yet identified, with an estimated 9-13 million bats (primarily *M. sodalis* and *M. grisescens*). With the arrival of European settlers in the central portion of the Indiana bat's range in the late 1700s and early 1800s, land conditions and natural resource usage began to change dramatically and undoubtedly affected the species' local and presumably regional abundance (USFWS, 2007). The abundance of hibernating bat populations almost certainly declined after settlers discovered large deposits of nitrates or saltpeter, essential for making gunpowder, and began year-round mining operations within some of the major hibernacula. By the 1820s, tourism had become lucrative at several major hibernacula and increased rapidly over the next 100 years. Mammoth Cave alone still held "millions" of bats in 1850 after being subjected to disturbance from saltpeter mining, tourism, and impacts associated with cave entrance alterations and restricted airflow. Mammoth Cave has not contained a viable winter population of Indiana bats since the species was first described in 1928. At this time no Indiana or Gray bats are know to hibernate in the historic section of Mammoth Cave or other cave locations within the project area.

White-nose Syndrome in bats, a devastating disease that was documented in the Northeastern US in 2007, has spread to caves as close as Virginia (USFWS, 2009). Sick, dying and dead bats in unprecedented numbers in and around caves and mines have been found from Vermont to Virginia. While they are in the hibernaculum, affected bats often have white fungus on their muzzles and other parts of their bodies. They may have low body fat. These bats often move to cold parts of the hibernacula, fly during the day and during cold winter weather when the insects they feed upon are not available, and exhibit other uncharacteristic behavior. Despite continuing research, the source of the fungus and the mechanisms for spreading the disease to bats and or caves are still not understood. The park, in cooperation with the USFWS, has implemented stringent protocols to prevent the introduction and spread of white-nose syndrome in bats and has established an educational outreach program for park visitors.

The entire known population of the Kentucky cave shrimp (*Palaemonias ganteri*), federally listed as endangered, occurs only in streams in base level passages in the cave system. Its reduced eyes and lack of pigmentation indicate that the species has had a long history of subterranean existence. These tiny crustaceans feed on bacteria, protozoa and other minute organisms that live on organic matter that wash into cave streams. The Kentucky cave shrimp, like other aquatic cave life, is vulnerable to degradation of water quality in its habitat. Contamination of groundwater by siltation and chemicals from agricultural land, inadequate sewage treatment, oil and gas development, and toxic spills could extinguish the species. The Kentucky cave shrimp was listed as endangered and critical habitat was designated on November 14, 1983. Critical habitat consists of a stream in a base level cave passage characterized by abundant quantities of organic matter and sediments of coarse silt and very coarse to very fine sand (Federal Register, 1983).

The Northern cavefish (*Amblyopsis spelaea*), a KSNPC special concern species, is depigmented and lacks eyes, but is sensitive to light and vibrations caused by disturbances in their watery environment. It inhabits subterranean waters which have consolidated mud-rock substrates in shoals and silt-sand substrates in pools but are more often found in caves with uniform silt-sand substrates. It feeds on tiny invertebrates found in the underground rivers. The southern cavefish (*Typhlichthys subterraneus*), a KSNPC special concern species, also lacks pigment and eyes, but does not respond to light. Spring cavefish (*Chologaster agassizi*), a species of management concern, live underground but emerge above ground in springs; they are active in springs at night and usually retreat underground during the day. Because cavefish are located at or near base level, they are vulnerable to virtually any disturbance in the watershed brought about by natural forces or human activities. Threats include ground water contamination, sedimentation, alteration of surface runoff patterns, construction of impoundments, and quarrying (NatureServe, 2009). Urbanization and suburban housing, municipal sewage treatment plants, confined animal operations, and transportation routes may threaten water quality.

The Cave cricket (*Hadenoecus subterraneus*), a species of management concern, is a key species upon which many other cave species depend on for food (Poulson et al., 1995). Cave crickets occur in high densities at many cave entrance sites. They forage outside caves at night and return to caves to roost, digest food, and defecate. Cricket feces accumulate under roosts and are the food base for the cricket guano community.

Mammoth Cave crayfish (*Orconectes pellucidus*), a KSNPC special concern species, has a slender form, lack of pigmentation, and greatly reduced non-functional eyes. It occupies habitats ranging from base level to tiny streams, and can travel out of water if necessary.

The Surprising Cave beetle (*Pseudanophthal inexpectus*), a KSNPC special concern species, is a small, eyeless, troglobitic insect that belongs to the ground beetle family Carabidae. The species is predatory, feeding upon other small cave invertebrates such as spiders, mites, and millipedes. This species was removed as a candidate for federal listing in 2007.

The Allegheny woodrat (*Neotoma magister*), a species of management concern, is a troglophile. It can do well in any cave-like environment but is not restricted to caves. It is primarily nocturnal and prefers to live in solitary dens. Woodrats build caches of berries, fruits, nuts, and vegetation. Scats are deposited in special latrine areas, apparently used by more than one individual over a long period of time. Their feces, usually found in the twilight zone, support specialized communities in the cave.

Rafinesque's big-eared bat (*Plecotus rafinesquii*), a KSNPC special concern species and candidate for federal listing, is a year-round resident in Kentucky, probably moving only short distances between summer and winter roosting sites (KBWG, no date). Most individuals hibernate in caves singly or in small clusters. From spring through fall, roosting may occur in small caves, abandoned building, hollow trees, and under bridges. Rafinesque’s big-eared bats are thought to use forest and forest edge areas for foraging, preying mostly on moths, which they frequently eat at roost sites. This species has likely declined to some degree due to disturbance of roosting sites. Hibernating bats can be awakened by excessive human visitation, causing the bats to use up important fat reserves. Likewise, when maternity colonies are disturbed, female bats may abandon young.

There is potential for the twelve rare, threatened or endangered species and species of special interest described here to occur in areas where the project would occur. Cavefish, crayfish, and Kentucky cave shrimp could occur where trail rehabilitation would include the River Styx portion of the trail. However, these aquatic species could be also affected by changes to local groundwater quality due to changes at other trail locations. The surprising cave beetle would most likely be encountered on the Great Onyx Tour route, but could occur in other places as well. Cave crickets, woodrats, and cave beetles could be found in various areas where trail work would occur. Both gray bats and Indiana bats are known to have used the Historic Entrance in the past and may still be present occassionally. The Rafinesque's big-eared bat does not generally use the tour entrances and there is no evidence that they did so in the past (Toomey III, 2009).

3.3 MICROBIOTIC RESOURCES

Microbiotic communities can exist in the low-energy environment present deep within large cave systems. Cave protozoa are troglophiles because they live and reproduce not only in caves, but also in cool, dark, moist microhabitats outside of caves. There is a particular population of protozoan species associated with cave waters.

A wide range of soil microorganisms enter caves in dripping water, but relatively few survive for more than a few weeks (Barr, 1985). Most cave protozoans belong to a small number of flagellate, ameba, and ciliate species that are repeatedly encountered in various cave waters. Protozoans may also occur in hygropetric habitats – the thin film of water covering cave walls and dripstone. From what is known of Mammoth Cave protozoans, there is no indication of special modification or adaptation to the cave environment among these organisms. Nematodes, harpacticoid copepods, and creeping rotifers occur in cave pools and streams but have not been studied in detail. Although there are no photosynthetic producers in cave communities, bacteria and fungi, through decomposition of organic material washed into caves, act as secondary producers, transforming the material into a form that can be utilized by troglobites.

The “Shrimp Pools" in the Roaring River passage contain species belonging to the genera *Phacus*, *Paramecium*, *Halteria*, *Difflugia*, and *Peranema*. Counts are lowest in spring following annual floods (Barr, 1985). As summer continues, counts rise, reaching their maximum just prior to the first flood of winter. The Kentucky cave shrimp feeds on microorganisms by straining bottom muds through their mouthparts. Bacterial and fungal decomposition of stream-borne detritus provides food that can be utilized by small, threadlike segmented worms (enchytraeids and tubificids, and other undescribed troglobitic species) that burrow through the mud of stream banks.

Since 1994, studies of cave microbiology have accelerated in number, complexity of techniques used, and depth of the results obtained (Barton and Northup, 2007). The field has moved from being sparse and largely descriptive in nature, to rich in experimental studies yielding fresh insights into the nature of microbe-mineral interactions in caves. Barton and Northup (2007) provide an account of such new studies in caves around the world. For example, the density, activity, and diversity of bacteria indigenous to subsurface karstic material in Mammoth Cave National Park were studied using minimally disruptive, on-site procedures (Rusterholz and Mallory, 1994). The bacterial community in the karstic sediments sampled exhibited a high degree of diversity having no dominant strain. Two hundred thirty seven strains were recovered and genera identified included, *Arthrobacter, Brevibacterium, Bacillus, Cornyebacterium, Actinomyces, Aureobacterium, Chromobacterium,* and *Mycobacterium*.

3.4 CAVE CLIMATE

To classify the climate of the cave, long-term measurement of weather parameters are needed to obtain an average range of conditions over time. Parameters that are typically measured over time to determine cave climate include temperature, barometric pressure, relative humidity, evaporation, wind speed and direction. The climate of a cave system remains constant through time, with mean cave air temperature being approximately equivalent to the mean annual temperature of the surrounding region. Near the entrances of caves, temperatures can vary greatly during the year, with temperatures stabilizing further down the passageways. Seasonal fluctuations in caves may be profound. Cold, dry, winter air flowing into cave entrances adjust to the ambient cave temperature by the process of kinetic energy. Colder, dryer air entering caves can increase the rate of evaporation as much as 200 times that of the same part of the cave in summer (Barr, 1985).

Cave areas are usually separated into a twilight zone near the cave entrance, a middle zone of complete darkness and variable weather, and a zone of complete darkness and constant weather in the deep interior. Most terrestrial troglobites cannot tolerate low relative humidities and disappear from twilight zones in winter.

The cave atmosphere is humid in summer, with relative humidities ranging as low as 80%, but more commonly varying between 95 and 100 percent (Poulson and White, 1969). In the winter months cave temperatures can range from 43 to 55 degrees Fahrenheit at locations beyond the Rotunda. Temperatures at the Historic Entrance to the Rotunda can drop below freezing in the winter months as cold surface air flows into the entrance. Relative humidities during the winter months can range from 50% to 100% depending on the cave location and source of cave air. Evaporation rates are usually low in summer but can be significant in the winter. Air currents and even strong winds occur at great distances from entrances, activated by chimney effects (winds created by temperature differences between the entrance and interior passageways). A resonance phenomenon known as “cave breathing” occurs, in which air currents throb back and forth through constricted passages. It is likely that the size of a cave in relation to the number of openings also plays a big role in the stability of a cave's climate. Airlocks have been installed man-made entrances to stabilize cave atmospheric conditions.

The park’s Cave Atmospheric Monitoring (CAM) program (Jernigan and Fry, 2007), initiated in 1994 and terminated in 2000, collected air temperature and relative humidity every 15 minutes at sites in Houchins' Narrows, Rotunda, Little Bat Avenue, River Hall, Wright's Rotunda, Booth's Amphitheater (3 locations), Corkscrew, Rafinesque Hall, Mushroom Beds, Carmichael Entrance, New Discovery Entrance, Violet City Entrance, Great Onyx (2 locations), and Long’s Cave. Airflow measurements were collected continuously at Houchins’ Narrows in 1996 to 1997 and periodically from 1998 to 1999. The Cumberland Piedmont Network (Woodman et al., 2007) initiated a cave meteorological monitoring network in 2002 collecting air temperature and relative humidity every 15 minutes at Houchins' Narrows, Rotunda, Little Bat Avenue, River Hall, Wright’s Rotunda, Booth’s Amphitheater (2 locations), Gothic Avenue (2 locations), and Corkscrew, and Frozen Niagara. Airflow measurements have been collected periodically at the Houchins' Narrows location.

The number of visitors to Mammoth Cave has increased dramatically between 1934, when the Civilian Conservation Corps began work in the cave, and today. With this ongoing tourism, physical changes have taken place within the cave. Tourist trails have been hardened, cave entrances altered, restrooms built, stairways constructed, an elevator installed, and an underground dining area established. This increased human activity has had effects on the stability of the cave climate of Mammoth Cave. For example, although a cave environment is quite stable, the use of lights could result in minor changes to temperatures, humidity, air movement, and the drying effects of air.

A study near the Snowball dining area was conducted to measure the microclimate of the cave in relation to food preparation and human presence (Trapasso and Kaletsky, 1994). The study found that visitors alone do not appear to have a substantial effect upon the cave climate. Effects of the indirect presence of visitors, however, via the heat and steam released by food preparation activities, along with the heat generated by the operation of certain equipment, were evident.

3.5 PHYSICAL CAVE FEATURES

At more than 365 miles of surveyed cave passages, Mammoth Cave is the longest cave in the world. The elevational range within Mammoth Cave spans approximately 500 feet. The cave's depth below the surface varies a great deal. Except near the naturally lighted Historic Entrance and electrically-lit public tour routes, the cave is in complete darkness. Most parts of the cave are completely silent, except for the sound of dripping and running water or wind blowing through constrictions.

The rock at Mammoth Cave formed from sediments laid down in the Mississippian sea 350 million years ago (MYA) when the land presently within the confines of the park lay at the bottom of a shallow sea, and the cave system started forming about 10 MYA. The shells of decaying organisms, the calcium carbonate in the sea water, and pressure from the building and laying down of sedimentary layers resulted in the creation of a thick layer of limestone. Additionally, several hundred feet of sandstone were deposited by river systems in the same area. When the sea receded, the sandstone and limestone beneath it were exposed. The sandstone and shale "cap" resists water and protects the limestone beneath it. Buckling and warping of the rock layers created cracks, which allowed rainwater to seep into the rock from sinkholes on the surface of the land. Rainwater, acidified by carbon dioxide in the soil, seeped downward through millions of tiny cracks and crevices in the limestone layers. This weak carbonic acid dissolved a network of tiny microcaverns along the cracks. As rainwater continued to enter the system and more limestone was dissolved, the microcaverns enlarged. The sandstone cap on the surface, above the limestone, prevented dissolution of all of the limestone, creating the possibility for creation and preservation of the cave.

Cutting down through this insoluble sandstone cap, surface streams encountered more easily weathered limestone formations. As the water worked its way underground, it dissolved and removed calcium carbonate from the limestone formations, beginning the process of forming the Mammoth Cave-Flint Ridge Cave System. In contrast to depositional processes that create the bedrock matrix of the cave system, the higher passages in the cave system formed first. As base water table levels dropped, sequentially lower passages were formed within the Mammoth Cave system. The lowest and hence newest passages are still flooded at the level of the Green River, but the higher and older passages have stabilized and are largely dry, except for small localized areas of seepage. At the present water table, cave passages are still being formed.

Deposits and sediments found throughout Mammoth Cave were formed as either mineral deposits or mechanical deposits. Mineral deposits found in Mammoth Cave as cave formations are commonly referred to as speleothems. Travertine is a calcium carbonate that is dissolved in water and which precipitates on various surfaces in caves through evaporation or outgassing of carbon dioxide. Travertine can manifest itself in various physical forms such as flowstone, stalactites, stalagmites, columns, helictites, cave popcorn, drapery, and dripstone.

Gypsum occurs in drier passages and forms as a precipitate coating cave walls and ceilings. The precipitate may take several forms, depending on the concentration of mineral salt dissolved in the water, the amount of air flow, and consistency of humidity. It may form as a thin crust, as crystalline fronds known as "flowers", or as needle-shaped crystals. Gypsum may also occur in cave sediments as selenite crystals. Other important mineral deposits include mirabilite and epsomite. Both are salts that crystallize on cave walls, floors, or ceilings.

Mechanical deposition is responsible for many of the mineral-based sediment deposits found in Mammoth Cave (excluding organic-based deposits such as guano). These sediments were either carried into the cave by underground streams and re-deposited, or are the result of mechanical and chemical breakdown of the limestone cave matrix. Sediments deposited through stream action consist of gravel, sand, silt, clay, and sandstone pebbles and contain a record of surface and subsurface events. Most of these sediments were derived originally from surface contexts, resulting from the weathering of insoluble materials such as shale, sandstone, and conglomerates. Most mineral sediment found in Mammoth Cave was probably deposited during the late Pliocene, between about 3.5 and 1.2 MYA, though sediment deposition has been an ongoing process in the lower levels of the cave systems and is still continuing. Breakdown consists of slabs, blocks, or chips of rock that have detached from the cave ceilings or walls due to chemical weathering of joints in the rock matrix and the eventual effects of gravity. Following deposition of these materials, they are subject to further changes through physical, chemical, and biological processes.

Biological factors can also affect cave sediments. Animals that occupy or visit caves can impact cave sediments through burrowing activities or accumulation of fecal material. The most significant biological additions to and alterations of cave sediment derive from accumulation of cricket and bat guano and the ecological community that is supported in this microenvironment. However, other biological alterations of sediments, such as burrowing of insects and worms and the effects of microbes and fungi, take place at a much slower rate within caves than do similar soil-forming processes that occur at the surface. The low biological energy levels in caves make soil formation extremely slow and helps preserve the original sedimentary structure and context of mechanically deposited sediments (Ahler and Crothers, 2007).

3.6 PALEONTOLOGICAL RESOURCES

Investigation of the impact that trail rehabilitation would have on paleontological resources come under the purview of the Federal Cave Resource Protection Act (PL 100-691) of 1988 and its implementing regulations (43 CFR 37). As such, Manzano et al. (2009) conducted a combined evaluation of the effects on both archaeological and paleontological resources. By conducting the paleontological investigations early in the project, the results of these investigations can provide input into the engineering and logistics of trail rehabilitation. This will help minimize impacts to irreplaceable paleontological deposits.

The principal paleontological remains found in Mammoth Cave are remains of various species of bats. They contribute both directly, in the form of bat bones and mummified remains, and indirectly to the paleontological resource base by contributing guano. Other common sources of paleontological remains in Mammoth Cave are raccoon scat, which may contain bat bones, and wood rat feces. Wood rats are common cave dwellers and they may contribute directly to the paleontological resource through their own bones, or indirectly by providing feces. Other sources of paleontological remains are much rarer in caves. These include contributions made by carnivores, especially bears, which hibernate in selected areas and which may also contribute bones from the surface in their feces. Most other taxa that have been found in cave deposits are found in entrance areas or former entrance areas that are now closed. These entrance and paleoentrance areas often have accumulations of sediment in breakdown and debris slopes that contain animal bone. Fish and amphibian remains, and occasional mammal remains, are rarely recovered from sediments that accumulated in caves while they were being formed. These include sediments washed into cave passages through flooding, when the passage was at or near the local base level.

Manzano et al. (2009) conducted a combined evaluation of the effects on both archaeological and paleontological resources. By conducting the paleontological investigations early in the project, the results of these investigations can provide input into the engineering and logistics of trail rehabilitation. This will help minimize impacts to irreplaceable paleontological resources. The survey conducted in Mammoth and Great Onyx caves by Manzano et al. (2009) identified areas of high, medium, and low paleontological potential along selected trail segments.

- Trail areas designated as low potential do not contain significant paleontological deposits. No further paleontological work is recommended for low potential sections of the trail.
- Trial areas identified as moderate potential produced moderate densities of paleontological materials and have higher potential for contributing to the understanding of the noncultural use of the cave. Areas identified to have moderate-potential for paleontological resources in Mammoth and Great Onyx caves would be monitored during trail construction activities by a qualified archaeologist or paleontologist to prevent disturbance of highly significant deposits and to recover samples of scientifically important materials.
- Trail areas recognized as high potential contain significant paleontological deposits. Recommendations for areas identified to have high potential for paleontological resources in Mammoth and Great Onyx caves include a broad range of possible actions, all of which are designed to minimize the impact of proposed trail rehabilitation construction on intact paleontological deposits. Among these options are 1) monitoring by a qualified archaeologist or paleontologist; 2) avoidance (though in some locations this may not be possible); 3) burial of deposits to preserve them from impact; 4) bridging over significant areas or otherwise altering the trail construction techniques to minimize disturbance of deposits; or 5) data recovery through expanded paleontological excavations. At a minimum monitoring would be conducted in high-potential areas.

Great Onyx Cave was previously considered to be devoid of paleontological remains, but significant amounts of bat bone were found by Manzano et al. (2009). This area is considered to have a high potential for significant paleontological remains.

3.7 WATER RESOURCES

Mammoth Cave is at the heart of the South central Kentucky karst, an integrated set of subterranean drainage basins covering more than 400 square miles. The Park is bisected east to west by the Green River, which defines the hydrologic base level and divides the region into two distinct physiographic areas. North of the river an alternating series of limestone and insoluble rocks are exposed with the main limestone strata accessible only near the river and in the bottom of a few deeply incised valleys. This has resulted in rugged topography with streams that alternately flow on insoluble rocks, over waterfalls, enter caves in limestone, and resurge at springs perched on the next lower stratum of insoluble rock. The caves are numerous but are relatively smaller with smaller drainage basins when compared to Mammoth Cave. South of the Green River the surface and subsurface is defined by the Mammoth Cave karst aquifer, a component of which is the Mammoth Cave system. The complex nature of the Mammoth Cave karst aquifer is demonstrated by the number of groundwater basins, sub-basins, and intricate groundwater flow routes throughout the region.

Flow through the Mammoth Cave karst aquifer can be very rapid, on the order of 1,000s to 10,000s of feet per day. Contaminants entering the karst aquifer can thus be rapidly transported unaltered through the conduit system. The karst aquifer is very dynamic, that is, it responds nearly instantaneously to rainfall. Aquifer stage can rise 10's of feet in a matter of hours. In addition, chemical and bacteriological properties of the groundwater can change dramatically following rainfall events. These stage rises can activate high-level overflow routes between groundwater basins and thus direct flow in different directions depending upon aquifer conditions.

The Mammoth Cave karst aquifer owes the majority of its recharge to areas outside the park boundary. This recharge, in the form of precipitation or the injection of liquid wastes, enters the aquifer through numerous sinking streams and countless sinkholes. Because large portions of the upper Green River watershed and the groundwater basins affecting Mammoth Cave National park lie outside park boundaries, activities conducted in these areas greatly influence water quality within the Park. The primary activities that influence the park's water quality include: disposal of domestic, municipal, and industrial sewage; solid waste disposal; agricultural and forestry management practices; oil and gas exploration and production; urban land-use; transportation corridors; and recreational activities.

The Green River flows through the park in a westerly direction, passing just north of the Historic Entrance to Mammoth Cave. Sinking streams and cave streams are part of the river continuum since they are tributaries of base-level rivers (Green and Nolin Rivers) via springs. These distinct but connected aquatic ecosystems are energetically supported by inwashed organic debris from the forest and former barrens ecosystems. Food transport is usually down gradient, but natural backflooding from the river ecosystem through springs into the lower cave streams is also important.

Large streams in the lowest levels of the cave flow into the Green River via springs, the most prominent of which are the Echo River, River Styx, Pike Spring and Turnhole Bend Spring outlets. Much of the cave is dry, and the rivers are found in the deepest level of the cave. Surface water also finds its way into the cave in the vicinity of domepits, which are natural vertical shafts cut by sinking streams subsequent to development of horizontal passages, and in the vicinity of terminal breakdowns, where the passage roof has collapsed because of surface erosion above the cave (Barr, 1967)

Aquatic cave environments include running streams and pools fed by dripping water. The pools are characterized by high pH, high concentration of dissolved carbonates, low content of organic matter suitable for food, and a sparse fauna (Poulson and White, 1969). The running streams, with connections to outside food sources, have a lower pH, are often undersaturated with respect to carbonates, and have a richer fauna.

3.8 CULTURAL RESOURCES

The trail rehabilitation project would be implemented on portions of a known archaeological site that has been determined to contain scientifically and historically significant deposits and is listed on the National Register of Historic Places under Criterion A. While technically not listed as an archeological site per se, one of the most significant cultural resource elements is clearly the high potential to yield information about history and prehistory not available anywhere else, i.e. Criterion D. Therefore, one of the primary cultural preservation goals in the cave is to protect identified and unidentified archeological resources, as well as identified historical structural elements.

The project comes under Section 106 of the National Historic Preservation Act (NHPA), and additional archaeological work was required. Archaeological investigations were conducted in 2008 to determine the degree to which trail rehabilitation efforts would impact archaeological deposits. Manzano et al. (2009) conducted a combined evaluation of the effects on both archaeological and paleontological resources. By conducting the archaeological investigations early in the project, the results of these investigations can provide input into the engineering and logistics of trail rehabilitation. This will help minimize impacts to irreplaceable archaeological deposits.

The oldest of the passageways found in the Mammoth Cave system is the Hippodrome portion of Kentucky Avenue (Ahler and Crothers, 2007). Sediments in this area have been dated to 3.5 MYA. Gothic Avenue and several other portions of the B Level of Mammoth Cave (Main Cave, Historic Tour, Lantern Tour, and much of Kentucky Avenue) contain fill sediments deposited between 2.3 and 1.92 MYA. These dates are on in situ stream-lain cave fill sediments in the passageways. Cave development probably was initiated several million years earlier. Other sediments that overlie them, such as deposits derived from paleoentrances or overlying (but still ancient) bat guano, are likely considerably younger.

Cave deposits, such as gypsum and mirabilite, were mined by prehistoric cavers. Mirabilite has medicinal qualities as a laxative and was used during the prehistoric and historic periods. Nitrate-rich sediments were mined during the historic period to produce saltpeter, which is one of the three principal ingredients used to manufacture gunpowder. Calcium nitrate was extracted from cave sediments and mixed with wood ash to produce saltpeter (potassium nitrate).

Prehistoric use of Mammoth Cave has resulted in the deposition of charcoal, paleofecal specimens, cane torch debris, gourd/squash fragments, faunal remains, and lithic debris. All of these materials are deposited on what would be considered an original cave surface that has not been subjected to the higher rates of sediment accumulation, sediment erosion, and soil formation that characterize surface sediment contexts. When remnants of this surface are found, artifacts are generally considered to be *in-situ*, with disturbance limited mainly to other human actions that occurred post-deposition. However, historic use of the cave through saltpeter mining and trail construction have mixed and impacted cave sediments, including the prehistoric materials deposited on the surface.

The preservation of cultural materials in the cave differs substantially from most conditions found in surface archaeological sites. Perishable cultural materials are unlikely to be preserved in active or wet cave environments, but abandoned or “arrested” cave passages are more likely to preserve perishable cultural material. In these locations, temperature and humidity are more constant, and humidity is lower than levels found in active or wet passages. The term “lower humidity” is used loosely, as abandoned passages commonly have relative humidity levels of only 80 percent compared to 95 to 100 percent in active or wet passages. In Mammoth Cave, the older, higher passages have been largely abandoned and are relatively dry. These include several of the passages targeted for trail rehabilitation (the Historic Tour, Lantern Tour, and Gothic Avenue). Consequently, perishable human artifacts and paleontological materials (i.e., mummified bat remains and guano) may be common in segments of these trails and passages.

Another significant difference between cave and surface depositional environments is that stratigraphy resulting from recent alluvial or colluvial processes (<1.0 MYA) does not occur in upper level contexts of Mammoth Cave. Rather, deposition in these passages is largely a result of human activity or the actions of other organisms. Because sediment deposition is not active in caves except in specific localized contexts (or occurs at a very slow rate compared to surface conditions), the prehistoric surface in a cave is often also the modern surface. That is, prehistoric artifacts can be found alongside historic artifacts. Once any zone of sediment that contains human artifacts (historic or prehistoric) is removed, any remaining sediments that underlie the Holocene surface are considered to be ancient and culturally sterile.

Within the boundaries of Mammoth Cave National Park, 284 archaeological sites have been recorded with the Kentucky Office of State Archaeology, representing past human activity dating from at least 9500 B.C. to the establishment of the Park in 1941 (Ahler and Crothers, 2007). Numerous other sites have been recorded in the ASMIS data base maintained by the NPS. Prehistoric material found in Mammoth Cave includes torch debris (from river cane, weed stalks, or other plant material, including both unburned torch remnants and occasionally the plant fiber ties that held the torch bundles together, torch charcoal scattered on the floor, and torch marks on the walls), human paleofeces, tools (such as digging sticks, mussel shell scrapers, hammerstones for removing mineral deposits from walls and ceilings, and gourd and wooden bowls), bits of cordage and textile fragments (from textile bags used to carry minerals or parts of clothing), climbing poles, and human burials (consisting of mummified remains covered with rock).

Historic material found in Mammoth Cave include remains from operation of saltpeter mining in the very early 1800's which can be seen in various states of disrepair throughout the historic section of the cave (such as ox carts, wooden pipelines, saltpeter leaching vats, and pump towers), stone tuberculosis huts, and rock work constructed by the CCC. The historic sections of Mammoth Cave were designated a Historic District on the National Register of Historic Places in 1991. An area with approximately 12 miles of underground passages, including those portions of the cave that were used for early mining, and medical, exploratory, and commercial purposes are included in the historic district. The district includes five contributing sites: the Historic Entrance, the Carmichael Entrance, the Violet City Entrance, the Frozen Niagara Entrance, and Gothic Avenue (where historic signatures, monuments, and rock walls are found); eleven contributing structures: the Mushroom Beds, Rock Stairs and Walls near Olive's Bower, Saltpeter mining works, Rock Wall at the Bridal Altar, Rock Wall at Jenny Lind's Armchair, Rock Wall at the end of Gothic Avenue, two stone Tuberculin Huts, Albert's Stairway, and the Landing at Crystal Lake; and one contributing object: the cable at Aerobridge Canyon.

Cultural landscapes have not received formal evaluation and treatment, but should be considered as significant where landscape characteristics have retained integrity in a relatively unchanged state since the established periods of significance, i.e. 1816-1941. Evidence of prior construction methods from various historical periods, historic vistas relative to viewing topography of the natural cave, and interpretation of various prehistoric and historic routes are landscape characteristics meriting preservation.

The survey conducted in Mammoth and Great Onyx caves by Manzano et al. (2009) identified areas of high, medium, and low archaeological potential along selected trail segments.

- Trail areas designated as low potential do not contain significant archaeological deposits. No further archaeological work is recommended for low potential sections of the trail.
- Trial areas identified as moderate potential produced moderate densities of archaeological materials and have higher potential for contributing to the understanding of the cultural use of the cave. Areas identified to have moderate-potential for archeological resources in Mammoth and Great Onyx caves would be monitored during trail construction activities by a qualified archaeologist to prevent disturbance of highly significant deposits and to recover samples of scientifically important materials. Significant deposits would include dense concentrations of torch remains beyond the normal background of torch charcoal that is scattered throughout the cave and/or archaeological materials of rare occurrence in the cave such as cordage, textile fragments, paleofeces, bone deposits, and other artifacts associated with intensive periods of prehistoric or historic activity in the cave.
- Trail areas recognized as high potential contain significant archaeological deposits. Recommendations for areas identified to have high potential for archeological resources in Mammoth and Great Onyx caves include a broad range of possible actions, all of which are designed to minimize the impact of proposed trail rehabilitation construction on intact archaeological deposits. Among these options are 1) monitoring by a qualified archaeologist; 2) avoidance (though in some locations this may not be possible); 3) burial of deposits to preserve them from impact; 4) bridging over significant areas or otherwise altering the trail construction techniques to minimize disturbance of deposits; or 5) data recovery through expanded archaeological excavations. At a minimum monitoring would be conducted in high-potential areas.

The archaeological potential in Great Onyx Cave is very minimal (Manzano et al., 2009).

3.9 VISITOR USE AND EXPERIENCE

Since 1816, shortly after nitrate-mining production ceased following the War of 1812, Mammoth Cave has been a tourist attraction. The first tours were led by former saltpeter miners, and later slaves were brought in to guide tours. Ranger lead tours continue today as thousands of visitors are guided through the cave. About ten miles of cave passages are visited in regularly scheduled cave tours.

About 87.5 percent of visitation occurs between March and October. June, July and August are the busiest months. Cave tour numbers peaked in the 1970's. In order to provide a higher-quality visitor experience and to better protect cave resources, tour sizes are smaller today than they were two or more decades ago. Cave visitation includes cave tours, environmental education programs, community service tours, and special events. In 1999, 434,711 visitors entered Mammoth and Great Onyx Cave. The number of visitors to the caves decreased somewhat to 355,676 in Fiscal Year 2008 (Table 4), but is estimated to increase to 400,000 in FY 2009.

Table 4. Mammoth Cave Tour Visitor Use Statistics

Tour Name	Maximum # of Visitors Allowed per Tour	# of Tours in 2008	# of Visitors in 2008
Community Service Tour		6	135
Discovery Tour (Self-guided)	unlimited	63	23080
Environmental Education Tour		155	6482
Frozen Niagara Tour	40	1310	32890
Grand Avenue Tour	80	409	23220
Great Onyx Lantern Tour	38	71	1636
Historic Tour	120	1276	94940
Introduction to Caving Tour	20	166	2234
Mammoth Passage Tour	40	1490	34668
New Entrance Tour	120	1698	107454
River Styx Cave Tour	40	68	2700
Snowball Tour	40	328	9038
Star Chamber Tour	40	140	4787
Trog Tour (for children)	12	71	747
Violet City Lantern Tour	40	294	8258
Wild Cave Tour	14	181	2081
Special Events		1 event	479

The greatest numbers of visitors enter the cave on the New Entrance Tour and the Historic Tour (as shown for 2008 in Table 4). The Trog, Wild Cave, and Introduction to Caving tours generally have the lowest numbers of participants, partly due to the smaller tour sizes and partly to the more physically demanding nature of these tours. The Park tries very hard not to turn visitors away from cave tours. If tours are full, the Discovery Tour, which is self-guided, is made available for visitors to experience the cave.

Mammoth Cave is known more for its length and large passages than for its cave formations. However, it does have areas decorated with calcite speleothems and extensive areas with gypsum and other crusts, flowers, and related forms. Mammoth Cave's physical challenges, its vast, silent, dark passages, and spectacular beauty afford visitors of all backgrounds and levels of experience the opportunity to experience a world like no other. Tours range from one-hour tours covering less than one mile of cave to six-hour wild cave tours which cover approximately five miles of cave and offer visitors a taste of caving. Table 1 in the Alternative Chapter lists all the tours currently offered. There are no tours offered to mobility impaired visitors since the elevator entrance was removed from public use in 2002.

3.10 PUBLIC HEALTH AND SAFETY

Cave resources contain such features and conditions as confusing passages, low ceilings, loose rocks, unstable floor material, ledges and pits, tight constrictions, conditions conducive to hypothermia, and radon gas exposure. These are part of the natural environment which the Park preserves. Naturally occurring radon gas comes from surrounding soil and rock strata. Greatest exposure (95%) is due to the byproducts or progeny emanating from radon gas. Radon gas contributes only 5% of the exposure and is considered negligible in terms of human exposure. Employee exposure is the main concern, visitor exposure is negligible.

Existing trail facilities in the cave have raised safety concerns for visitors since their construction in the late 1930's. High visitation and the challenges of maintaining safe conditions have resulted in several trail closures in the past while trail work was being completed. Current safety hazards on the tour routes include potholes and slick or slippery trail surfaces and stairs. Pothole formation on cave tour trails has been accelerating despite a variety of options that have been tried to maintain/prevent them, including placing carpeting and cord mats over potholes. While the potholes may be small, the low light levels and the large size of the tours make them hard for visitors to avoid. Many more visitors step in potholes and twist an ankle and/or fall down than are officially reported. Fifty-nine cave carry-outs associated with injuries to park visitors on cave tours have occurred in the last six years.

There is no radio communication or cellular phone communication inside the cave, which would delay the initiation of search and rescue operations. The park, however, does have regular hard-line phone service within most toured section of the cave, except for on the Wild Cave tour and Great Onyx Lantern Tour. Only certain areas of the Wild Cave Tour are extremely remote, and it could take highly skilled cavers several hours to reach an injured visitor and hand-carry them from the cave; skilled cavers would not be required to assist injured visitors on other tours.

4.0 ENVIRONMENTAL CONSEQUENCES

This section describes the environmental consequences associated with the alternatives. It is organized by impact topic for analysis. These topics focus on the presentation of the affected environment and environmental consequences and allow a standardized comparison between alternatives.

4.1 METHODOLOGY

NEPA requires consideration of context, intensity, and duration of impacts, direct or indirect impacts, cumulative impacts, and measures to mitigate for impacts. NPS policy also requires that "impairment" of resources be evaluated in all environmental documents.

Overall, the NPS based the following impact analyses and conclusions on the review of existing literature and Mammoth Cave National Park studies, information provided by experts within the NPS and other agencies, professional judgments and park staff insights, and public input.

4.1.1 General Impact Definitions

Potential impacts are described in terms of type (beneficial or adverse), context, duration, intensity, and impairment. The following general definitions were used to evaluate the context, intensity, duration, and cumulative nature of impacts associated with project alternatives. Impairment is discussed below. The specific criteria used to rate the intensity and duration of potential impacts for each resource topic are presented within each resource area impact analysis in this chapter.

Context of Impact

Context is the setting within which an impact is analyzed, such as local, park-wide, or regional. CEQ requires that impact analyses include discussions of context. Localized impacts are those that affect the resource area only on the project site or its immediate surroundings, and would not extend park-wide or into the region.

Intensity of Impact

Impact intensity is the degree to which a resource would be beneficially or adversely affected by an action. Impact intensities are quantified as negligible, minor, moderate, or major. Resource-specific criteria used to rate the intensity of project impacts are presented within each resource area impact analysis.

Duration of Impact

The duration of impact is analyzed independently for each resource because impact duration is dependent on the resource being analyzed. Depending on the resource, impacts may last as long as construction takes place, or a single year, or longer. For purposes of analysis, impact duration is measured as temporary, short-term and long-term. Temporary impacts would occur during trail rehabilitation only. Once construction has ended, resource conditions are likely to return to preconstruction conditions. Short-term impacts would extend past the construction phase, but would not last more than a couple of years, at most. Long-term impacts would likely last more than two years, or over the lifetime of the project.

Direct verses Indirect Impacts

Direct effects are impacts caused by the alternative(s) at the same time and in the same location as the action. Indirect effects are impacts caused by the alternative(s) that occur later in time or farther in distance than the action, but still reasonably foreseeable. An indirect impact could occur because of a change to another resource or impact topic.

4.1.2 Cumulative Impact Scenario

CEQ regulations (40 CFR 1508.7) require the assessment of cumulative impacts in the decision-making process for Federal projects. A cumulative impact is an impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of which agency (Federal or non-Federal), organization, or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time.

Cumulative impacts are considered for all alternatives and are presented at the end of each impact topic discussion analysis. To determine potential cumulative impacts, projects in the vicinity of the proposed project site were identified. Potential projects identified as cumulative actions included any planning or development activity that was currently being implemented or that would be implemented in the reasonably foreseeable future.

These cumulative actions are evaluated in the cumulative impact analysis in conjunction with the impacts of each alternative to determine if they would have any additive effects on natural resources, cultural resources, or visitor use. Because some of these cumulative actions are in the early planning stages, the evaluation of cumulative effects was based on a general description of the project. Known past, current, and reasonably foreseeable future projects and actions in the vicinity of the project area are described below.

Past and Present Projects and Actions

- Historic Use – Portions of the cave were used for prehistoric mining, early saltpeter mining, collection of minerals, medical (tuberculosis experiment), exploratory (exploration and early cave tours), and commercial purposes, and CCC construction projects (including the current trail system). Damage to irreplaceable cave features occurred during the early periods of cave use, including graffiti, smoke deposits from torches and fires.
- Cave Electric Project – The underground cave electric and telephone systems were reconstructed along 6.7 miles of cave trails within Mammoth Cave. The project replaced the cave electric supply, control systems, and lights with a modern system. The use of electric lighting for cave tours has allowed the growth of mosses, fungi and algae in the cave which may eventually spoil the natural beauty of some of the unique formations. The new lighting system was designed to reduce/eliminate to the extent possible the lamp flora problem that the previous system created.
- Mammoth Dome Tower – The old tower was replaced with a new one.
- Bat Gates – Entrance gates which restricted air flow were in place until 1990, when an open-grid gate was installed at the Historic Entrance.
- Prototype Cave Trail – The project replaced cave sediment trail surfaces with a hardened surface and installed lint curbs and railing, thus eliminating the use of cave sediments for trail construction, controlling the migration of potentially harmful lint introduced by visitors, eliminating dust created by cave sediment based trails, and reducing the opportunity for graffiti and vandalism with the channelized flow gained through the lint curbs and railings.

- Echo River Tour – This tour was discontinued, the wooden boardwalk thru this section of cave was removed, and the remaining short section of metal walkway requires refurbishment or replacement.
- Restrooms – Were constructed in the cave at three locations. They are useful to visitors during long cave tours, but associated problems include blocking of natural air flow and water leaks from the surface via bore holes.
- Artificial Entrances – Five artificial entrances were constructed to provide access to various areas of the cave, including the Carmichael Entrance, Violet City Entrance, New Entrance, Frozen Niagara Entrance (prior to Park establishment), and the Elevator Entrance. Gates on several cave entrances were designed to allow natural air flow and movement of cave fauna. Several of the artificial entrances were refitted with airlocks to prevent microclimatic changes, especially drying, which can harm speleothems and cave organisms. The current elevator shaft allows water to seep into the cave and is thought to cause impacts to the Snowball room.
- Water System – This 2005 project replaced the old CCC era water supply system with a modern system to meet the needs of the park for potable water and for fire protection and to eliminate leaks and improve reliability.
- Regional Sewer System – Federal, state and local authorities cooperated to develop a regional sewer system in the area to reduce pollutants from reaching the groundwater.
- Oil and Gas Wells – Were drilled in this area. Those inside the Park were abandoned when it was established and have since been formally closed. In adjacent areas, oil and gas exploration has increased recently and with this the risks of spillages into the Park's groundwater system.
- Sinkholes – Of major environmental concern is the extensive sinkhole plain to the south and east of the Park. Run-off from this area flows via underground streams into the Green River. Illegal dumping of wastes into sinkholes outside of the park continues to be a concern. Any changes in the quality or quantity of water may adversely affect the unique aquatic life in the underground streams and alter natural cave development.
- Service Station – All parking lots, and associated contaminants, within Mammoth Cave National Park drain into the cave system, including the lot surrounding the service station near the main campground. Gasoline sale will be discontinued in 2009 and tanks will be removed.
- Parking Lot Filters – Oil, grit, and metal removal filters were constructed and are functional on all major parking lots within the Park to remove parking lot contaminants from entering the cave with draining water. Dye tracing has traced the trajectories that ground water can travel.
- Rehabilitate Visitor Center and Exhibits – Beginning in 2007, renovation of the visitor service and fee collection facilities began. The project involves renovation of existing buildings and construction of new buildings. Work associated with this project includes reconstruction of the exterior and roof of the existing Visitor Center Building; reconstruction of the first floor of the existing visitor center to create new exhibit space, office space, and book sales space; reconstruction of the basement to include showers, park library, employee break room, and wild cave staging area; installation of a cistern to collect rain water and solar panels; and construction of the structures for the Historic Entrance and the Bus Tour Staging areas.
- Cave Tours – Are offered year round (except on Christmas day) to visitors wishing to experience the cave.
- Continuing Cave Exploration
- Research and Monitoring Activities

<u>Future Projects and Actions</u>

- Accessibility Study /Analysis to Provide Handicap Access to Mammoth Cave – This is a pre-design study which is being finalized to develop alternatives for function and location(s) to provide future handicap access into Mammoth Cave. Individuals with handicaps do not currently have access to Mammoth Cave. From about 1973 to 2002 people in wheelchairs were taken into the cave on the freight elevator to the Snowball Dining Room; however, the condition of that elevator is such that it is no longer being utilized for any visitor access as any elevator failure that leaves the car stuck in the shaft requires occupants to climb a ladder out of the 270 foot shaft or to be rescued using ropes and haul systems. An Environmental Assessment will be prepared to determine how and where access to the cave maybe provided to mobility impaired visitors.

- Concession Prospectus – The Park will be soliciting for concession operators for services including bus transportation of visitors, food service in the cave, camp store, and hotel operation. Some services could affect how cave trails are used because visitors stop to eat in the Snowball Dining Room. It can also affect future surface activities, construction, which can contribute inputs to groundwater reaching the cave.
- Green River Crossing Project – This project involves alternatives to improve traffic flows and provide a safe and reliable way to cross the Green River at the Green River Ferry site within the park. The planning process for this project is currently underway and a draft Environmental Assessment is being prepared. Low water conditions have occurred in the Green River at the ferry site several times in recent years. During these periods ferry operations are curtailed or shut down. When this occurs there is no direct access to the area inside and outside of the park on the north side of the Green River within Mammoth Cave National Park. Consequently, visitors, park neighbors and emergency vehicles are forced to drive an additional 40 miles to reach areas on the north side of the Green River. In addition, there are several functions occupying the same space as the ferry on the south and the north side of the river. They include, ferry boat operations, recreational boat and canoe use, and access to the southside trails.
- Reconstruct Main Entrance Road Park City to Chaumont – The Park City Road is a major park access road. Large areas of the existing paved surface are experiencing wear along the pavement edges, severe rutting, the presence of potholes, and rapidly increasing pavement deterioration. This project entails the rehabilitation of the 3 mile Park City Road, which begins at Park City and ends at Chaumont.
- Replace Headquarters Campground Shower Facility – This project involves replacing the existing shower facility in the Service Center with a new shower facility or with facilities located inside the campground. The new facility or facilities would be located for convenience of campers and would meet all handicap accessibility requirements. The existing shower facility is over 40 years old, has not aged well, and is not large enough to meet demand in the mornings and evenings whenever the Headquarters Campground is operating above 50% capacity.
- Headquarters Campground Rehabilitation – The Headquarters Campground has been in place for 40 years and needs to be rehabilitated. The existing camping loops and comfort stations would remain but every campsite would be rehabilitated. The total number of sites could increase and several of the sites would be designed to accommodate recreational vehicles. Water would be provided at most campsites. Electrical services would be provided at all the campsites in two loops. Stormwater drainage problems would be corrected to improve usability and camping conditions.
- Renovate Elevator To Ensure Safe Cave Operations – This project would replace the existing elevator control system with a new system that will function in the wet elevator shaft environment; remove / replace the relays, controls and lights located in the elevator shaft with new water tight equipment; provide a backup system to move the elevator to the top of the shaft in the event of a failure of the primary drive system; replace / modify the existing elevator cab as needed to accommodate the overall elevator renovation. The elevator is in a shaft that is 270 feet deep and provides access from the surface to the Snowball Dining Room Area of Mammoth Cave.
- Rehab Unsafe Lighting System and Poor Airlock At Snowball Room and Elevator – This project would refurbish the antiquated lighting system for the Snowball Room cave passage and the access passage from the elevator, and restore the original air flow patterns in the passage by replacing the current inadequate airlock. The old florescent lighting fixtures would be removed, new conduit wiring and switching would be installed, lighting would be designed to enhance cave passage resources

while minimizing heat impact on mineral formations. A handicapped accessible door system would be installed within the existing air lock structure.
- Development of a proposed Single-Track Bike Trial – This project involves the development and construction of a single-track loop trail east of the Green River Ferry Road-North and on the ridge west of Big Hollow for bicycling and hiking. Bicycle use would also be allowed on a connector trail to be constructed from the new trailhead and parking area to the Mammoth Cave International Center for Science and Learning, the Maple Springs Group Campground and the Maple Springs Trailhead.

4.1.3 Impairment of Park Resources

In addition to determining the environmental consequences of the Proposed Action and the No Action alternative, the NPS *Management Policies 2006* and DO-12 require analysis of potential effects to determine if actions would impair a park's resources.

The fundamental purpose of the National Park System, established by the Organic Act and reaffirmed by the General Authorities Act, as amended, begins with a mandate to conserve park resources and values. NPS managers must always seek ways to avoid or minimize to the greatest degree practicable adverse impacts on park resources and values. However, the laws do give NPS management discretion to allow impacts to park resources and values when necessary and appropriate to fulfill the purposes of a park, as long as the impact does not constitute impairment of the affected resources and values. Although Congress has given NPS management discretion to allow certain impacts within parks, that discretion is limited by statutory requirement that the NPS must leave park resources and values unimpaired, unless a particular law directly and specifically provides otherwise. The prohibited impairment is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including opportunities that otherwise would be present for the enjoyment of those resources or values. An impact to any park resource or value may constitute an impairment. However, an impact would more likely constitute an impairment to the extent it affects a resource or value whose conservation is:

- Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;
- Key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or
- Identified as a goal in the park's Master Plan or General Management Plan (GMP) or other relevant NPS planning documents.

Impairment may result from NPS activities in managing the park, visitor activities, or activities undertaken by concessionaires, contractors, and others operating in the park. In this section, a determination on impairment is made in the conclusion statement of each resource area for each alternative. The NPS does not analyze the potential for impairment of recreational values/visitor experience (unless impacts are resource based), socioeconomic values, or park operations.

4.2 MACROBIOTIC RESOURCES

The thresholds of change for the intensity of an impact on macrobiotic resources are defined as follows:

<u>Negligible:</u> Macrobiotic resources would not be affected or the effects would be at or below the level of detection, and the changes would be so slight that they would not be of any measurable or perceptible consequence to the species' population within the project area. There would be no observable or measurable impacts to wildlife species, their habitats, or the natural processes sustaining them. Impacts would be well within the range of natural fluctuations.

Minor: Effects to macrobiotic resources would be detectable, although localized, small, and of little consequence to the species' population within the project area. Impacts would be detectable, but they would not be expected to be outside the natural range of variability and would not be expected to have any long-term effects on native species, their habitats, or the natural processes sustaining them. Population numbers, population structure, genetic variability, and other demographic factors for species may have small, short-term changes, but long-term characteristics remain stable and viable. Occasional responses to disturbance by some individuals could be expected, but without interference to feeding, reproduction, or other factors affecting population levels. Sufficient habitat would remain functional to maintain viability of all species within the project area. Impacts would be outside of critical reproduction periods for sensitive species.

Moderate: Effects to macrobiotic resources would be readily detectable and project area-wide with consequences at the population level. Mortality or interference with activities necessary for survival can be expected on an occasional basis, but is not expected to threaten the continued existence of the species in the project area. Impacts on wildlife species, their habitats, or the natural processes sustaining them would be detectable, and they could be outside the natural range of variability for short periods of time. Population numbers, population structure, genetic variability, and other demographic factors for species may have short-term changes, but would be expected to rebound to pre-impact numbers and to remain stable and viable in the long-term. Frequent response to disturbance by some individuals could be expected, with some negative impacts to feeding, reproduction, or other factors affecting short-term population levels. Sufficient habitat would remain functional to maintain variability of all wildlife species within the project area. Some impacts might occur during critical periods of reproduction or in key habitat for sensitive native species.

Major: Effects to macrobiotic resources would be obvious and would have substantial consequences to wildlife populations within the project area. Extensive mitigation measures would be needed to offset any adverse effects and their success would not be guaranteed. Impacts on and wildlife species, their habitats, or the natural processes sustaining them would be detectable, and they would be expected to be outside the natural range of variability for long periods of time or permanent. Population numbers, population structure, genetic variability, and other demographic factors for species might have large, short-term declines with long-term population numbers significantly depressed. Frequent responses to disturbance by some individuals would be expected, with negative impacts to feeding, reproduction, or other factors resulting in a long- term decrease in population levels. Loss of habitat may affect the viability of at least some native species within the project area.

4.2.1 Impacts of Alternative A (No Action Alternative)

Impacts Analysis

As there would not be any new actions under Alternative A, there would not be any new impacts on cave macrobiota. There would not be additional human activity in the area for construction activities, so cave fauna would not be affected beyond current disturbance from visitor tours passing through the cave and maintenance activities. As trails continue to deteriorate, however, trail maintenance could increase, thus somewhat increasing the frequency of disturbance of cave biota. Lamp flora would remain undisturbed and continue to grow under existing cave lighting, although this growth has been reduced with the new cave lighting system.

Cumulative Effects

Macrobiota in Mammoth Cave, including bats, woodrats, amphibians, cave crickets, spiders, beetles, and springtails, are subject to disturbance and displacement from past, present and future visitor use, trail maintenance, cave exploration, and research activities.

Surface activities affect water infiltrating into the cave. Chemicals and other toxins occurring in cave water adversely affect underground aquatic life and fauna that drink the water. Dye traces have shown a direct hydrologic link between parking lot runoff and certain cave passages, which may have led to contamination of cave drip water in the past. Parking lot filters currently in place reduce or prevent parking lot contaminants from entering the cave with draining water. The regional sewer system developed in the area also contributes to stopping pollutants reaching the groundwater. Nearby oil and gas exploration poses risks of spillage into the Park's groundwater system. Illegal dumping of wastes into sinkholes outside of the park contaminates groundwater.

The recent installation of a new cave lighting system has greatly reduced the growth of lamp flora on cave formations. The new lighting system was designed to reduce/eliminate to the extent possible the lamp flora problem that the previous system created.

Cumulatively, these past, present and future actions would have minor, adverse impacts on macrobiotic resources. Alternative A would contribute negligible, adverse cumulative impacts on macrobiotic resources. In combination, these actions would result in minor, adverse cumulative impacts on macrobiotic resources.

Conclusion

Alternative A would likely result in long-term, negligible, local, direct adverse impacts on macrobiotic resources from continued human presence and increased trail maintenance. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park’s GMP or other relevant NPS planning documents, there would be no impairment of the Park’s resources or values with respect to macrobiotic resources.

4.2.2 Impacts of Alternative B (Preferred Alternative)

Impacts Analysis

Noise and human presence during construction activities for rehabilitation of cave tour trails and improvements to the elevator would cause temporary displacement and disturbance of cave wildlife such as bats, racoons, amphibians, springtails, spiders, and beetles. Only a short section of the project trails occur in the lowest section of the cave where fish, crayfish, or other aquatic species living in streams are found. Aquatic worms and other aquatic species, which occur in temporary drip pools, can be found in many parts of the cave. Disturbance of aquatic species would likely be minimal, if at all, as wet areas would be avoided if possible during construction and trails that flood regularly would be worked on during dry periods.

Although construction would occur over a 24 to 36 month period, work activities and disturbance of wildlife in any one section of the cave would be substantially shorter. Construction would take place in passages where noise and disturbance associated with cave tours is already a daily occurrence. Those species that do not tolerate disturbance are unlikely to be present in the project area. Other species are expected to return to project sites after construction is completed. Impacts on macrofauna would be localized and limited to the immediate area of trail reconstruction.

Propane may be needed to operate some of the mechanical equipment used for trail reconstruction; therefore, there is some risk of an accidental spill, which could adversely affect groundwater quality, and hence aquatic species. To prevent accidental fuel or chemical spills, no fuels would be stored at the project site. An emergency spill kit, containing absorption pads, absorbent material, a shovel or rake, and other cleanup items, would be readily available on-site in the event of an accidental spill. Thus, there is a very low likelihood that contaminants that could harm aquatic cave macrobiota would enter groundwater from the actions in this alternative.

Additional lint rails and/or trail improvements have the potential to disrupt cave fauna movements. However, without specific design elements at this point, it is unclear what species may be affected and to what extent.

Trail improvements would not change the use patterns of the trails (i.e., the numbers and frequency of public cave tours would continue at current levels). Thus, there would not be any additional changes in disturbance or displacement of wildlife due to human presence after trail work is completed under this alternative.

Lamp flora would remain undisturbed and continue to grow under existing cave lighting, although this growth has been reduced with the new cave lighting system. Even if additional lighting is added to trail routes, it would consist of a system that would not promote growth of lamp flora.

Cumulative Effects

Macrobiota in Mammoth Cave, including bats, woodrats, amphibians, cave crickets, spiders, beetles, and springtails, are subject to disturbance and displacement from past, present and future visitor use, trail maintenance, cave exploration, and research activities.

Surface activities affect water infiltrating into the cave. Chemicals and other toxins occurring in cave water adversely affect underground aquatic life and fauna that drink the water. Dye traces have shown a direct hydrologic link between parking lot runoff and certain cave passages, which may have led to contamination of cave drip water in the past. Parking lot filters currently in place reduce or prevent parking lot contaminants from entering the cave with draining water. The regional sewer system developed in the area also contributes to stopping pollutants reaching the groundwater. Nearby oil and gas exploration poses risks of spillage into the Park's groundwater system. Illegal dumping of wastes into sinkholes outside of the park contaminates groundwater.

Lamp flora would remain undisturbed and continue to grow under existing cave lighting, although this growth has been greatly reduced with the new lighting system. The new lighting system was designed to reduce/eliminate to the extent possible the lamp flora problem that the previous system created.

Cumulatively, these past, present and future actions would have minor, adverse impacts on macrobiotic resources. Alternative B would contribute minor, adverse cumulative impacts on macrobiotic resources. In combination, these actions would result in minor, adverse cumulative impacts on macrobiotic resources.

Conclusion

There would be temporary to short-term, minor, local, direct adverse impacts on macrobiotic resources from trail reconstruction activities under Alternative B. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park’s GMP or other relevant NPS planning documents, there would be no impairment of the Park’s resources or values with respect to macrobiotic resources.

4.3 RARE, THREATENED, OR ENDANGERED SPECIES AND SPECIES OF INTEREST

The thresholds of change for the intensity of an impact on rare, threatened, or endangered species and species of interest are defined as follows:

Negligible: The action could result in a change to a population or individuals of a species or designated critical habitat, but the change would be so small that it would not be of any measurable or perceptible consequence and would be well within natural variability. This impact intensity equates to a USFWS "no effect" or "may affect, not likely to adversely affect" determination for federally listed species.

Minor: The action could result in a change to a population or individuals of a species or designated critical habitat. The change would be measurable, but small and localized and not outside the range of natural variability. Mitigation measures, if needed to offset the adverse effects, would be simple and successful. This impact intensity equates to a USFWS "may affect, not likely to adversely affect" or "may affect, likely to adversely affect" determination for federally listed species.

Moderate: Impacts on sensitive or listed species, their habitats, or the natural processes sustaining them would be readily detectable. Listed or sensitive plants or breeding animals of concern are present; animals are present during particularly vulnerable life-stages such as migration or juvenile stages; mortality or interference with activities necessary for survival can be expected and could threaten the continued existence of the species in the park unit, but impacts would not extend to the broader geographical range of a species. Mitigation measures, if needed to offset adverse effects, would be extensive and likely successful. This impact intensity equates to a USFWS "may affect, likely to adversely affect" determination for federally listed species.

Major: The action would result in a noticeable effect to viability of multiple populations of a species or resource or designated critical habitat. Impacts on a sensitive or listed species, critical habitat, or the natural processes sustaining them would be detectable, both in and out of the park. Loss of habitat might affect the viability of at least some species. Extensive mitigation measures would be needed to offset any adverse effects and their success would not be guaranteed. This impact intensity equates to a USFWS "may affect, likely to jeopardize the continued existence of a species or adversely modify critical habitat for a species" determination for federally listed species.

4.3.1 Impacts of Alternative A (No Action Alternative)

Impacts Analysis

As there would not be any new actions under Alternative A, there would not be any new impacts to the rare, threatened or endangered species and species of special interest that have the potential to occur near the project site. There would not be additional human activity in the cave for construction activities, so rare and listed species would not be affected beyond current disturbance from visitor tours passing through the cave and maintenance activities. As trails continue to deteriorate, however, trail maintenance could increase, thus somewhat increasing the frequency of disturbance of special status species.

Cumulative Effects

Rare, threatened or endangered species and species of special interest are subject to disturbance and displacement from past, present and future visitor use, trail maintenance, cave exploration, and research activities.

Surface activities affect water infiltrating into the cave. Chemicals and other toxins occurring in cave water adversely affect the three species of cave fish, the Kentucky cave shrimp, and the Mammoth Cave crayfish, and species that may drink the water, such as the three special status bats. Dye traces have shown a direct hydrologic link between parking lot runoff and certain cave passages, which may have led to contamination of cave drip water. Parking lot filters currently in place reduce or prevent parking lot contaminants from entering the cave with draining water. The regional sewer system developed in the area also contributes to stopping pollutants reaching the groundwater. Nearby oil and gas exploration poses risks of spillage into the Park's groundwater system. Illegal dumping of wastes into sinkholes outside of the park contaminates groundwater.

Cave modifications that affected the thermal regime of the cave in the past may have affected the suitability of the cave to support hibernating Indiana bats include alterations to accommodate tourists, erection of physical barriers (e.g., doors, gates) to control cave access, and saltpeter mining. Entrance gates caused significant modification of the airflow and climate in the cave, which, in turn, profoundly affected quality of the cave as a roost for bats, and also physically restricted the access of bats to the cave, which may have resulted in direct mortality. Restrictive entrance gates were in place until 1990, when an open-grid gate was installed at the Historic Entrance. The negative effects of cave modifications were compounded by physical disturbance of hibernating bats during commercial, recreational, scientific, or educational purposes. Because the Indiana bat and the Gray bat congregate in large numbers, these species have been inherently vulnerable to loss or degradation of hibernation habitat.

Cumulatively, these past, present and future actions would have moderate, adverse impacts on rare, threatened or endangered species, and species of special interest. Alternative A would contribute negligible, adverse cumulative impacts on these special status species. In combination, these actions would result in moderate, adverse cumulative impacts on rare, threatened or endangered species and species of special interest.

Conclusion

There would be long-term, negligible, local, direct adverse impacts to rare and listed species as a result of the Alternative A due to continued human presence and increased trail maintenance. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to rare, threatened or endangered species and species of special interest.

4.3.2 Impacts of Alternative B (Preferred Alternative)

Impacts Analysis

There is potential for rare, threatened or endangered species and species of management concern to occur in areas where trail rehabilitation would occur. Cavefish and the Mammoth Cave crayfish are frequently found in River Styx and the Lake Lethe area where trail rehabilitation would occur. The Kentucky cave shrimp has not been observed in the Lake Lethe area, but is known to be present in downstream areas of River Styx. In addition, there is some limited possibility that these aquatic species could also be affected by changes to local groundwater quality due to changes at other trail locations. The surprising cave beetle would most likely be encountered on the Great Onyx Tour Route, but could occur in other places as well. Cave crickets, woodrats, and cave beetles could be found in various areas where trail work would occur.

Both Gray bats and Indiana bats are known to have used the Historic Entrance and historic section of Mammoth Cave in the past and may be present on occasion in the area. At this time no Indiana or Gray bats are know to hibernate in the historic section of Mammoth Cave or other cave locations within the project area. The Rafinesque's big-eared bat does not generally use toured sections of the cave or entrances, and there is no evidence that they did so in the past. Cave trail rehabilitation personnel and equipment may be subject to stringent decontamination protocols to prevent the introduction and spread of white-nose syndrome in bats. If introduced prior to the start of this project, bats weakened by the disease might be more sensitive to otherwise minor disturbance from cave trail activities. Seasonal restrictions to cave trail rehabilitation activities may be necessary to protect bats. However, there is a very low possibility that these bats could be present during trail rehabilitation, thus this alternative is not likely to adversely affect Indiana, Gray, or Rafinesque's big-eared bats.

Noise and human presence during construction activities for rehabilitation of cave tour trails and improvements to the elevator would cause temporary displacement and disturbance of special status species, including bats if present, woodrats, cave crickets, and cave beetles. Although construction would occur over a 24 to 36 month period, work activities and disturbance of rare and listed species in any one section of the cave would be substantially shorter. Construction would take place in passages where noise and disturbance associated with cave tours is already a daily occurrence. Species are expected to return to project sites after construction is completed. Impacts would be localized and limited to the immediate area of trail reconstruction.

Only a short section of the project trails occur in the lowest section of the cave where cavefish, crayfish, and the Kentucky cave shrimp may occur. Although some trail portions flood regularly, trail work would not be conducted during those periods; it would only be conducted when trails are mostly dry. Disturbance of aquatic species would likely be minimal as streams and wet areas would be avoided if possible during construction, except for the Lake Lethe area where work activities would occur in the water. There are also very limited potential effects related to runoff from other areas of trail reconstruction; however, as most passages are dry, the few wet areas do not change significantly during wet periods. No adverse effects are expected related to the aquatic special status species.

Propane may be needed to operate some of the equipment used for trail reconstruction; therefore, there is some risk of an accidental fuel or chemical spill, which could adversely affect groundwater quality. To prevent accidental fuel or chemical spills, no fuels would be stored at the project site. An emergency spill kit, containing absorption pads, absorbent material, a shovel or rake, and other cleanup items, would be readily available on-site in the event of an accidental spill. Thus, there is a very low likelihood that contaminants that could harm special status aquatic cave species would enter groundwater from the actions in this alternative.

Trail improvements would not change the use patterns of the trails (i.e., the numbers and frequency of public cave tours would continue at current levels). Thus, there would not be any additional changes in disturbance or displacement of special status species due to human presence after the trail work is completed under this alternative.

Cumulative Effects

Rare, threatened or endangered species and species of special interest are subject to disturbance and displacement from past, present and future visitor use, trail maintenance, cave exploration, and research activities.

Surface activities affect water infiltrating into the cave. Chemicals and other toxins occurring in cave water adversely affect the three species of cave fish, the Kentucky cave shrimp, and the Mammoth Cave crayfish, and species that may drink the water, such as the three special status bats. Dye traces have shown a direct hydrologic link between parking lot runoff and certain cave passages, which may have led to contamination of cave drip water. Parking lot filters currently in place reduce or prevent parking lot contaminants from entering the cave with draining water. The regional sewer system developed in the area also contributes to stopping pollutants reaching the groundwater. Nearby oil and gas exploration poses risks of spillage into the Park's groundwater system. Illegal dumping of wastes into sinkholes outside of the park contaminates groundwater.

Modifications that affected the thermal regime of the cave in the past, and thus the ability of the cave to support hibernating Indiana bats include alterations to accommodate tourists, erection of physical barriers (e.g., doors, gates) to control cave access, and saltpeter mining. Entrance gates caused significant modification of the airflow and climate in the cave, which, in turn, profoundly affected quality of the cave as a roost for bats, and also physically restricted the access of bats to the cave, resulting in direct mortality. Restrictive entrance gates were in place until 1990, when an open-grid gate was installed at the Historic Entrance. The negative effects of cave modifications were compounded by physical disturbance of hibernating bats during commercial, recreational, scientific, or educational purposes. Because the Indiana bat and the Gray bat congregate in large numbers, these species have been inherently vulnerable to loss or degradation of hibernation habitat.

Cumulatively, these past, present and future actions would have moderate, adverse impacts on rare, threatened or endangered species, and species of special interest. Alternative B would contribute negligible, adverse cumulative impacts on these special status species. In combination, these actions would result in moderate, adverse cumulative impacts on rare, threatened or endangered species and species of special interest.

Conclusion

Alternative B would likely result in temporary to short-term, negligible to minor, localized, direct adverse impacts on special status species from trail reconstruction activities. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park’s GMP or other relevant NPS planning documents, there would be no impairment of the Park’s resources or values with respect to rare, threatened or endangered species and species of special interest.

4.4 MICROBIOTIC RESOURCES

The thresholds of change for the intensity of an impact on microbiotic resources are defined as follows:

Negligible: Changes in microbial counts are at the lowest levels of detection or undetectable. Water resources (where microbiotic communities occur) are not manipulated by the project.

Minor: Changes in microbial counts are slight, but detectable. Water resources are manipulated by the project for less than one year, resulting in no permanent changes.

Moderate: Changes in microbial counts are readily detectable. Water resources are manipulated by the project for more than one year, resulting in few permanent changes in any one area.

Major: Changes in microbial counts are severely adverse or of exceptional benefit. Water resources are manipulated by the project for more than one year resulting in many permanent changes in any one area.

4.4.1 Impacts of Alternative A (No Action Alternative)

Impacts Analysis

As trail reconstruction would not be conducted under Alternative A, there would not be any new impacts on microbiotic resources. Although trail maintenance could increase as trail conditions continue to deteriorate, water sources and disturbance of microbiota would be avoided if possible. Additionally, the ongoing influx of untrapped lint from cave visitors would continue to provide an unnatural energy source for microbes; such increased microbial action, in turn, has the potential for substantial damage to cave resources.

Cumulative Effects

Microbiotic resources are subject to impacts from past, present and future manipulation and contamination of water resources. Surface activities affect water infiltrating into the cave. Dye traces have shown a direct hydrologic link between parking lot runoff and certain cave passages, which may have led to contamination of cave drip water. Parking lot filters currently in place reduce or prevent parking lot contaminants from entering the cave with draining water. The regional sewer system developed in the area also contributes to stopping pollutants reaching the groundwater. Nearby oil and gas exploration poses risks of spillage into the Park's groundwater system. Illegal dumping of wastes into sinkholes outside of the park contaminates groundwater. Chemicals and other toxins occurring in cave water may adversely affect microbiotic resources in Mammoth Cave.

Cumulatively, these past, present and future actions would have minor, adverse impacts on microbiotic resources. Alternative A would contribute negligible adverse cumulative impacts on microbiotic resources. In combination, these actions would result in minor, adverse cumulative impacts on microbiotic resources.

Conclusion

Alternative A would result in long-term, negligible, local, direct adverse impacts to microbiotic resources from increased trail maintenance and a continuing influx of lint as an energy source. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to microbiotic resources.

4.4.2 Impacts of Alternative B (Preferred Alternative)

Impacts Analysis

Microbiotic resources are expected to be found in greatest numbers in or near water sources. Impacts on microbiota would likely be minimal, if at all, as wet areas would be avoided if possible during construction, except for the Lake Lethe area where work activities would occur in the water. There are also very limited potential effects related to runoff from other areas of trail reconstruction; however, as most passages are dry, the few wet areas do not change significantly during wet periods, and work would not be conducted during wet periods, runoff would not likely occur. The potential effect of chemicals on these organisms is not yet known, but cave microbiota may be threatened if chemicals and other contaminants enter in cave waters. Microbiota occurring on the thin film of water covering cave walls and dripstone would not be impacted as contact with these surfaces would be avoided during trail work.

Fuel products (propane, oils, and lubricants) may be needed to operate some of the equipment used for trail reconstruction; therefore, there is some risk of an accidental fuel or chemical spill, which could adversely affect groundwater quality. To prevent accidental fuel or chemical spills, no fuels would be stored at the project site. An emergency spill kit, containing absorption pads, absorbent material, a shovel or rake, and other cleanup items, would be readily available on-site in the event of an accidental spill. Thus, there is a very low likelihood that contaminants that could harm microbiota would enter groundwater from the actions in this alternative.

Under this alternative, lint curbs would be installed in some of the project area, which would restrict the spread of lint. Additionally, accumulated lint would be taken away, which would improve conditions with removal of this unnatural material in the cave. This decrease in the availability of lint as an energy source would likely have beneficial effects by restoring microbial counts to more natural levels in many parts of the cave.

Additional lint rails and/or trail improvements have the potential to disrupt cave microbiota movements. This issue would be considered as specific design elements are developed along sensitive locations with in the cave.

Cumulative Effects
Microbiotic resources are subject to impacts from past, present and future manipulation and contamination of water resources. Surface activities could affect water infiltrating into the cave. Dye traces have shown a direct hydrologic link between parking lot runoff and certain cave passages, which may have led to contamination of cave drip water. Parking lot filters currently in place reduce or prevent parking lot contaminants from entering the cave with draining water. The regional sewer system developed in the area also contributes to stopping pollutants reaching the groundwater. Nearby oil and gas exploration poses risks of spillage into the Park's groundwater system. Illegal dumping of wastes into sinkholes outside of the park contaminates groundwater. Chemicals and other toxins occurring in cave water may adversely affect microbiotic resources in Mammoth Cave.

Cumulatively, these past, present and future actions would have minor, adverse impacts on microbiotic resources. Alternative B would contribute negligible, adverse cumulative impacts on microbiotic resources. In combination, these actions would result in minor, adverse cumulative impacts on microbiotic resources.

Conclusion
There would be temporary, negligible, local, direct adverse impacts to microbiotic resources as a result of Alternative B due to trail reconstruction activities; and long-term, minor, local, direct beneficial impacts due to the reduction of lint as an energy source. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to microbiotic resources.

4.5 CAVE CLIMATE

The thresholds of change for the intensity of an impact on cave climate are defined as follows:

Negligible: Human-caused changes in airflow, temperature, or relative humidity are at the lowest levels of detection or undetectable and no other resources are affected.

Minor: Human-caused changes in airflow, temperature, or relative humidity are slight but detectable, and no other cave resources are affected.

Moderate: Human-caused changes in airflow, temperature, or relative humidity are readily detectable, and other cave resources are temporarily affected.

Major: Human-caused changes in airflow, temperature, or relative humidity are readily detectable, and other cave resources are permanently affected.

4.5.1 Impacts of Alternative A (No Action Alternative)

Impacts Analysis
As no trail reconstruction would occur under Alternative A, there would not be any new impacts on the climate of Mammoth or Great Onyx caves. Effects on cave climate from cave tours, trail lighting, and trail maintenance would continue at current levels.

Cumulative Effects
Past and ongoing cave tours, trail maintenance, cave exploration, and research activities have and continue to contribute to altering the climate in Mammoth Cave. Food services in the Snowball dining room affect cave climate through the heat and steam released by food preparation activities and from the heat generated by the operation of certain kitchen equipment. With the upcoming Concessions Prospectus, operation of the food service at the Snowball Dining Room may have different effects on cave climate. Existing restroom facilities have associated problems with blocking of natural air flow, which has also affected cave climate. Rehabilitation of the lighting system and poor airlock at the Snowball Room and elevator would restore the original air flow patterns in the passage and minimizing heat emanating from old lighting fixtures.

Five artificial entrances were constructed to provide access to various areas of the cave, including the Carmichael Entrance, Violet City Entrance, New Entrance, Frozen Niagara Entrance (prior to Park establishment), and the Elevator Entrance, were constructed to provide access to various areas of the cave. Additionally the Historic Entrance pathway has been enlarged and gated. Entrance gates caused significant modification of the airflow and climate in the cave before they were refitted with airlocks to prevent cave climatic changes, especially drying, which can harm speleothems and cave organisms. Placement of an open bat gate on the Historic Entrance likely caused significant changes in airflow during winter, allowing dense, cold, dry air to move virtually unimpeded into the cave system. However, this altered airflow was mitigated using panels of plexiglass to reduce influx of cold air to approximate pre-disturbance rates. Gates on several cave entrances were designed to allow natural air flow and movement of cave organisms. Although these entrances are carefully controlled, they continue to alter air flow and change the cave climate.

Cumulatively, these past, present and future actions would have moderate, adverse impacts on the cave climate. As no new actions that would occur under Alternative A, there would not be any contribution to cumulative impacts on cave climate. In combination, these actions would result in moderate, adverse cumulative impacts on cave climate.

Conclusion
Alternative A would not result in any impacts on cave climate. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other

relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to cave climate.

4.5.2 Impacts of Alternative B (Preferred Alternative)

Impacts Analysis

Under Alternative B, public tour trails in Mammoth Cave would be rehabilitated and the elevator may be improved. Activity during trail reconstruction, such as use of additional lighting and equipment with electric or propane engines, would temporarily radiate heat, possibly affecting temperature and humidity locally near the segment of trail being reconstructed. Any changes in cave climate, however, would return to ambient conditions once construction activities cease. If additional lighting is added to any trail routes, there could be a slight increase in heat output; however, given that an extensive lighting system is already in place, any heat output from additional lights would not likely be detectable. The inadequate air lock at the bottom of the elevator, which may be refurbished, would have beneficial effects on cave climate.

Cumulative Effects

Past and ongoing cave tours, trail maintenance, cave exploration, and research activities have and continue to contribute to altering the climate in Mammoth Cave. Food services in the Snowball dining room affect cave climate through the heat and steam released by food preparation activities and from the heat generated by the operation of certain kitchen equipment. With the upcoming Concessions Prospectus, operation of the food service at the Snowball Dining Room may have different effects on cave climate. Existing restroom facilities have associated problems with blocking of natural air flow, which has also affected cave climate. Rehabilitation of the lighting system and poor airlock at the Snowball Room and elevator would restore the original air flow patterns in the passage and minimizing heat emanating from old lighting fixtures.

Five artificial entrances were constructed to provide access to various areas of the cave, including the Carmichael Entrance, Violet City Entrance, New Entrance, Frozen Niagara Entrance (prior to Park establishment), and the Elevator Entrance, were constructed to provide access to various areas of the cave. Additionally the Historic Entrance pathway has been enlarged and gated. Entrance gates caused significant modification of the airflow and climate in the cave before they were refitted with airlocks to prevent cave climatic changes, especially drying, which can harm speleothems and cave organisms. Placement of an open bat gate on the Historic Entrance likely caused significant changes in airflow during winter, allowing dense, cold, dry air to move virtually unimpeded into the cave system. However, this altered airflow was mitigated using panels of plexiglass to reduce influx of cold air to approximate pre-disturbance rates. Gates on several cave entrances were designed to allow natural air flow and movement of cave organisms. Although these entrances are carefully controlled, they continue to alter air flow and change the cave climate.

Cumulatively, these past, present and future actions would have moderate, adverse impacts on the cave climate. Alternative B would contribute negligible, adverse cumulative impacts on cave climate. In combination, these actions would result in moderate, adverse cumulative impacts on cave climate.

Conclusion

There would be temporary, negligible, local, direct adverse impacts to cave climate as a result of trail reconstruction activities under Alternative B. There would also be long-term, minor, local, direct beneficial impacts with the refurbished airlock at the bottom of the elevator. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the

Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to cave climate.

4.6 PHYSICAL CAVE FEATURES

The thresholds of change for the intensity of an impact on physical cave features are defined as follows:

Negligible: Cave features are damaged with use of the cave, but the effects are not visually detectable.

Minor: Cave features are damaged with use of the cave, the effects are visible under close examination, but they can be cleaned or repaired.

Moderate: Cave features are damaged with use of the cave, are plainly visible, but can be cleaned or repaired.

Major: Cave features are damaged with use of the cave, are plainly visible, but are either not cleanable or irreparable.

4.6.1 Impacts of Alternative A (No Action Alternative)

Impacts Analysis

As there would not be any new actions under Alternative A, there would not be any new impacts on physical cave features. However, without trail rehabilitation, cave walls and features along certain trail segments would remain within relatively easy reach of visitors, and damage to cave walls and speleothems would continue. Lint from visitors on cave tours would continue to accumulate, forming a layer of material and providing an energy source to microscopic organisms that can cause substantial damage to natural physical features within the cave. Clouds of dust would continue to form from tours walking on cave sediment trail surfaces. This dust would continue to have adverse impacts by forming a coating on sensitive speleothems in the cave.

Cumulative Effects

Due to the lack of natural regenerative processes, Mammoth and Great Onyx caves are nonrenewable resources; impacts are cumulative and some may be permanent. Damage to irreplaceable cave features occurred during the early periods of cave use, including graffiti, smoke deposits from torches and fires. Later impacts include the physical degradation of cave surfaces from construction of cave trails and other CCC era structures, visitation throughout the cave, and inadvertent or deliberate damage to speleothems or other cave features. Some speleothems are extremely fragile and are particularly vulnerable to breakage. The Park installed a fence around fragile speleothems located right next to the trail on the Frozen Niagara Route to prevent damage. Human presence in the cave always results in the deposition of a small amount of detritus consisting of hair, skin cells, and lint from clothing. Human travel stirs up fine sediments that settle onto adjacent cave surfaces. This redistributed dust can build up over time and affect cave aesthetics and damage delicate speleothems.

A prototype walkway on the Historic Route was constructed in 1997 as part of a demonstration project that would be more compatible with the cave environment. The primary goals were to eliminate the use of cave sediments for trail construction, to control the migration of potentially harmful lint introduced by visitors, eliminate dust created by cave sediment based trails, and reduce the opportunity for graffiti and vandalism. Hardened trail surfaces were constructed without exploiting the cave's resources. Without cave sediment for a tread, dust was no longer a problem, although dirt is tracked onto the new surfaces from the remaining sediment-based segments. Within weeks of their completion, lint and other materials had visibly accumulated at the base of the lint curbs preventing dispersal throughout the passage. With the channelized flow of tour groups gained through the lint curbs and railings, potential damage to cave walls or other resources is reduced.

Food services and water seeping into the cave via the elevator shaft may have impacted cave formations in the Snowball dining room, which was cleaned of the dust and mold in 1995.

Electric lighting along trails has encouraged the unnatural growth of algae and other lamp flora. The green color of the algae is unsightly and unnatural, and does not give cave visitors a true impression of the natural cave environment. The algae also produce organic acids that can cause degradation of bedrock and speleothems. Lamp flora would continue to grow under existing cave lighting, however, the new lighting system was designed to reduce/eliminate to the extent possible the lamp flora problem that the previous system created.

Cumulatively, these past, present and future actions would have moderate, adverse impacts on the physical cave features. Alternative A would contribute moderate, adverse cumulative impacts on physical cave features. In combination, these actions would result in moderate, adverse cumulative impacts on physical cave features.

Conclusion

There would be long-term, moderate, local, direct adverse impacts to physical trail features in Alternative A due to continuing damage to cave formations by visitors and from lint and dust accumulation. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to physical cave features.

4.6.2 Impacts of Alternative B (Preferred Alternative)

Impacts Analysis

Construction activities during trail rehabilitation have the potential to damage physical cave features from the use of equipment moving materials, an increased number of workers in the cave, and surface disturbance on and adjacent to trails. BMPs would be employed to insure that speleothems are avoided and protected from damage and that cave walls and floors are not impacted inadvertently. However, some areas of cave walls and floors would be adversly impacted due to trail reconstruction elements, such as drilling into rock to install new lint curbs, hand rails, or stairs. Employing mitigation measures recommended by Manzano et al. (2009) for areas that have medium and high potential to produce scientifically significant paleontological materials (described in **section 2.5 Mitigation Measures** of this EA) would avoid or greatly reduce adverse impacts to paleontological resources.

Very little trail realignment would be expected under Alternative B. If any realignment occurs, it would predominantly consist of vertical rather than horizontal shifts in trail segments. Any trail realignment could adversely impact cave walls or floors, but vertical changes would have fewer impacts as they would consist of installing stairs or bridges to get visitors from one level of the cave to another rather than shifting a trail from one horizontal cave surface to another.

Under Alternative B, trail rehabilitation would reduce lint and dust and the opportunity for graffiti on cave walls and vandalism of cave resources. In areas where the edges of the cave trails are poorly defined, there would be measures taken, such as lint curbs or hand rails, to better define the trail. In other areas, a hardened surface may be enough to define the trail. Well defined trails would be expected to reduce the numbers of visitors who wander off the trails and cause damage to physical cave features. Lint curbs would accumulate lint along the curbs in certain sections of the cave where they are installed, preventing lint from spreading and covering cave formations in those areas. Dust would be abated on trail segments where the surface would be replaced with paving stones or other hardened surfaces. However, some trails may still maintain cave sediment surfaces in areas where dust is not a big problem. Thus dust clouds caused by visitors walking on trails would be overall controlled in the cave, and greatly reduced in some areas; but since dust would track onto the hardened surfaces from the remaining sediment-based segments, it would not likely be completely eliminated. Trail rehabilitation would have beneficial impacts on physical cave features by greatly reducing the detrimental effects of lint, dust, and vandalism.

Cumulative Effects

Due to the lack of natural regenerative processes, Mammoth and Great Onyx caves are nonrenewable resources; impacts are cumulative and some may be permanent. Damage to irreplaceable cave features occurred during the early periods of cave use, including graffiti, smoke deposits from torches and fires. Later impacts include the physical degradation of cave surfaces from construction of cave trails and other CCC era structures, visitation throughout the cave, and inadvertent or deliberate damage to speleothems or other cave features. Some speleothems are extremely fragile and are particularly vulnerable to breakage. The Park installed a fence around fragile speleothems located right next to the trail on the Frozen Niagara Route to prevent damage. Human presence in the cave always results in the deposition of a small amount of detritus consisting of hair, skin cells, and lint from clothing. Human travel stirs up fine sediments that settle onto adjacent cave surfaces. This redistributed dust can build up over time and affect cave aesthetics and damage delicate speleothems.

A prototype walkway on the Historic Route was constructed in 1997 as part of a demonstration project that would be more compatible with the cave environment. The primary goals were to eliminate the use of cave sediments for trail construction, to control the migration of potentially harmful lint introduced by visitors, eliminate dust created by cave sediment based trails, and reduce the opportunity for graffiti and vandalism. Hardened trail surfaces were constructed without exploiting the cave's resources. Without cave sediment for a tread, dust was no longer a problem, although dirt is tracked onto the new surfaces from the remaining sediment-based segments. Within weeks of their completion, lint and other materials had visibly accumulated at the base of the lint curbs preventing dispersal throughout the passage. With the channelized flow of tour groups gained through the lint curbs and railings, potential damage to cave walls or other resources is reduced.

Food services and water seeping into the cave via the elevator shaft may have impacted cave formations in the Snowball dining room, which was cleaned of the dust and mold in 1995. Water seeping into the cave via the old visitor center airshaft maybe impacting resources in Houchin's Narrows.

Electric lighting along trails has encouraged the unnatural growth of algae and other lamp flora. The green color of the algae is unsightly and unnatural, and does not give cave visitors a true impression of the natural cave environment. The algae also produce organic acids that can cause degradation of bedrock and speleothems. Lamp flora would continue to grow under existing cave lighting, however, the new lighting system was designed to reduce/eliminate to the extent possible the lamp flora problem that the previous system created.

Cumulatively, these past, present and future actions would have moderate, adverse impacts on the physical cave features. Alternative B would contribute negligible adverse and minor, beneficial cumulative impacts on physical cave features. In combination, these actions would result in minor, adverse cumulative impacts on physical cave features.

Conclusion
There would be long-term, minor, local, direct adverse impacts to physical cave features in Alternative B due to trail reconstruction, and long-term, minor, beneficial impacts from reduced vandalism, lint and dust accumulation. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to physical cave features.

4.7 PALEOTOLOGICAL RESOURCES

The thresholds of change for the intensity of an impact on paleontological resources are defined as follows:

Negligible: The impact on paleontological sites or individual resources is at the lowest levels of detection, barely perceptible and not measurable.

Minor: The impact on paleontological resources is measurable or perceptible, but it is slight and localized within a relatively small area of a site or group of sites.

Moderate: The impact on paleontological resources is measurable and perceptible, but does not diminish the integrity of the resource.

Major: The impact on paleontological resources is substantial, noticeable, and permanent, and is either severe or of exceptional benefit.

4.7.1 Impacts of Alternative A (No Action Alternative)

Impacts Analysis
As there would not be any new actions under Alternative A, there would not be any new impacts on paleontological resources. However, since the edges of some cave trails are poorly defined, park visitors on cave tours would continue to stray off trail, which may disturb paleontological resources in the cave. Additionally, without containment of lint and abatement of dust, lint and dust would continue to accumulate on paleontological resources. Layers and mats of lint harbor microscopic organisms that could cause damage to exposed paleontological features within the cave; artifacts under trails would not be affected.

Cumulative Effects
Past, present, and future impacts to paleontological resources include lint and dust accumulation, accidental or intentional damage, and natural degradation in the cave environment. Lint, as well as factors such as changes to airflow, pH and temperature, disrupts the delicate balance that exists in a cave environment, and there is potential for damage to paleontological resources from microbial action that is made possible by energy provided in the form of lint and other materials. Additionally, paleontological resources in the cave may have been affected by past and current projects such as operation of the snowball dining facilities, restroom installation, the cave electric upgrade, and construction of prototype cave trails.

The primary trail fill material used in Mammoth Cave is redeposited cave sediments placed on a coarse bed of broken rock. Such trail construction occurred on most of the existing walking paths, although in some spots trail fill was placed with little modification to the original cave floor. This occurred where rock fall was not exposed at the surface or where historic removal of rock fall exposed basal cave fill sediment. Given the method of trail fill composition and placement, all prehistoric paleontological material within this context is considered redeposited.

Cumulatively, these past, present and future actions would have minor, adverse impacts on paleontological resources in the cave. Alternative A would contribute negligible adverse cumulative impacts on paleontological resources. In combination, these actions would result in minor, adverse cumulative impacts on paleontological resources.

Conclusion
Alternative A would likely result in long-term, minor, localized, direct adverse impacts on paleontological resources from disturbance of artifacts by visitors straying off trails and from continued accumulation of lint and dust. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to paleontological resources.

4.7.2 Impacts of Alternative B (Preferred Alternative)

Impacts Analysis
Under Alternative B, cave tour trails would be rehabilitated. During trail reconstruction, the potential exists for paleontological resources to be affected by surface disturbance on and adjacent to trails as there are numerous paleontological resources in parts of the caves which could be impacted. However, employing mitigation measures recommended by Manzano et al. (2009) for areas that have medium and high potential to produce scientifically significant paleontological materials (described in **section 2.5 Mitigation Measures** of this EA) would avoid or greatly reduce adverse impacts to paleontological resources. Additionally, locations containing significant sensitive resources would be excluded from trail work to insure that absolutely no impacts would occur.

Under Alternative B, trail rehabilitation would reduce lint and dust and the opportunity for vandalism of cave resources. In some areas where the edges of the cave trails are poorly defined, there would be measures taken, such as lint curbs or hand rails, which would better define the trail. In other areas, a hardened surface may be enough to define the trail. Well defined trails should reduce the numbers of visitors who wander off the trails and cause damage to paleontological resources. Lint curbs would accumulate lint along the curbs in certain sections of the cave where they are installed, preventing lint from spreading and covering paleontological resources in those areas. Dust would be abated on trail segments where the surface would be replaced with paving stones or other hardened surfaces. However, some trails may still maintain cave sediment surfaces in areas where dust is not a big problem. Thus dust clouds caused by visitors walking on trails would be controlled overall in the cave, and greatly reduced in some areas; but since dust would track onto the hardened surfaces from the remaining sediment-based segments, it would not likely be completely eliminated. Trail rehabilitation would have beneficial impacts on paleontological resources by greatly reducing the detrimental effects of lint, dust, and vandalism.

Cumulative Effects
Past, present, and future impacts to paleontological resources include lint and dust accumulation, accidental or intentional damage, and natural degradation in the cave environment. Lint, as well as factors such as changes to airflow, pH and temperature, disrupts the delicate balance that exists in a cave environment, and there is potential for damage to paleontological resources from microbial action that is

made possible by energy provided in the form of lint and other materials. Additionally, paleontological resources in the cave may have been affected by past and current projects such as operation of the snowball dining facilities, restroom installation, the cave electric upgrade, and construction of prototype cave trails.

The primary trail fill material used in Mammoth Cave is redeposited cave sediments placed on a coarse bed of broken rock. Such trail construction occurred on most of the existing walking paths, although in some spots trail fill was placed with little modification to the original cave floor. This occurred where rock fall was not exposed at the surface or where historic removal of rock fall exposed basal cave fill sediment. Given the method of trail fill composition and placement, all prehistoric paleontological material within this context is considered redeposited.

Cumulatively, these past, present and future actions would have minor, adverse impacts on paleontological resources in the cave. Alternative B would contribute negligible adverse and beneficial cumulative impacts on paleontological resources. In combination, these actions would result in minor, adverse cumulative impacts on paleontological resources.

Conclusion

Alternative B would have long-term, negligible, localized direct adverse effects on the paleontological resources from possible damage during trail rehabilitation and long-term, minor, beneficial impacts from reduction of dust, lint, and vandalism. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to paleontological resources.

4.8 WATER RESOURCES

The thresholds of change for the intensity of an impact on water resources are defined as follows:

Negligible: Neither water quality nor hydrology would be affected, or changes would be non-detectable or, if detected, would have effects that would be considered slight. Chemical or physical changes to water quality would not be detectable, would be well below water quality standards or criteria, and would be within historical or desired water quality conditions.

Minor: Changes in water quality or hydrology would be measurable, although the changes would be small. No mitigation measure associated with water quality or hydrology would be necessary. Chemical or physical changes to water quality would be detectable, but would be well below water quality standards or criteria and within historical or desired water quality conditions.

Moderate: Changes in water quality or hydrology would be measurable. Mitigation measures associated with water quality or hydrology would be necessary and the measures would likely succeed. Chemical or physical changes to water quality would be detectable, but would be at or below water quality standards or criteria.

Major: Changes in water quality or hydrology would be readily measurable and would have substantial consequences to the project area. Mitigation measures would be necessary and their success would not be guaranteed. Chemical or physical changes to water quality would be detectable and would be frequently altered from desired water quality conditions. Chemical, physical, or biological water quality standards or criteria would be locally exceeded.

4.8.1 Impacts Alternative A (No Action Alternative)

Impacts Analysis

Under Alternative A, there would be no new impacts on water resources as there would not be any new actions in the cave. Water seeping into the cave via the elevator shaft, old Visitor Center airshaft, and other bore holes would continue. These are not a natural pathways for water to enter the cave and are not appropriate due to the impact occurring to the Snowball room, Houchin's Narrows and other locations. Effects on cave water resources from contaminants in surface water infiltrating into the cave would also continue, but water quality would not be expected to change from current conditions.

Cumulative Effects

Past, present, and future chemicals and contaminants from surface activities have the potential to infiltrate groundwater and reach Mammoth Cave in drip water and cause adverse impacts. Dye traces have shown a direct hydrologic link between parking lot runoff and certain cave passages, which may have led to contamination of cave drip water. The parking area surrounding the service station in the Park is of particular concern due to the fueling operation, which will be discontinued in late 2009. Nearby oil and gas exploration poses risks of spillage into the Park's groundwater system. Illegal dumping of wastes into sinkholes outside the park contaminates groundwater. The current Visitor Center renovation project and future concessions operations, campground rehabilitation, and road reconstruction have the potential to contribute inputs to groundwater reaching the cave. BMPs are being implemented for the Visitor Center project which should minimize such inputs, and will likely be used in future projects as well.

Several measures have been taken to reduce or eliminate contamination of groundwater which drips into Mammoth Cave. Parking lot filters that have been installed to reduce or prevent parking lot contaminants from entering the cave. The improved regional sewer system developed in the area also reduces pollutants reaching the groundwater. The Park replaced the old water supply system with a modern system to meet the needs of the park for potable water, fire protection and to eliminate leaks. Stormwater drainage problems would be corrected with a future campground rehabilitation project.

Cumulatively, these past, present and future actions would have minor, adverse impacts on water resources in the cave. Alternative A would contribute negligible adverse cumulative impacts on water resources. In combination, these actions would result in minor, adverse cumulative impacts on physical cave features.

Conclusion

Alternative A would likely result in long-term, negligible, localized, direct adverse impacts to water resources from continued water seeping into the cave via the elevator shaft, old Visitor Center airshaft, and other bore holes. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to water resources.

4.8.2 Impacts of Alternative B (Preferred Alternative)

Impacts Analysis

Trail rehabilitation under Alternative B would avoid wet areas such as running streams and pools fed by dripping water, if possible, during construction activities. Underground rivers rise periodically and flood certain trail sections. Work on such trails would be conducted during dry periods. Any necessary contact with cave water resources would implement BMPs to control erosion, sediment release, and runoff during all construction activities, including work required to occur in water, such as replacement of the metal walkway at Lake Leathe. As most passages are dry, and work would not be conducted during wet periods, runoff would not likely occur. There is very little probability for direct impacts on water resources in most of the cave system; and direct impacts to water at Lake Leathe can be minimized and would be of temporary duration.

Propane may be needed to operate some of the equipment used for trail reconstruction; therefore, there is some risk of an accidental fuel or chemical spill, which could adversely affect groundwater quality. To prevent accidental fuel or chemical spills, no fuels would be stored at the project site. An emergency spill kit such as the Park currently uses, containing absorption pads, absorbent material, a shovel or rake, and other cleanup items, would be readily available on-site in the event of an accidental spill. Thus, there is a very low likelihood that contaminants would enter and contaminate groundwater from the actions in this alternative.

Direct adverse impacts from continued water seeping into the cave via the elevator shaft would continue unless the elevator work to be completed involves capturing the water and removing it or the shaft is sealed. Water would continue to seep into the cave at the Visitor Center airshaft in Houchin's Narrows and at other bore holes.

Cumulative Effects

Past, present, and future chemicals and contaminants from surface activities have the potential to infiltrate groundwater and reach Mammoth Cave in drip water and cause adverse impacts. Dye traces have shown a direct hydrologic link between parking lot runoff and certain cave passages, which may have led to contamination of cave drip water. The parking area surrounding the service station in the Park is of particular concern due to the fueling operation, which will be discontinued in late 2009. Nearby oil and gas exploration poses risks of spillage into the Park's groundwater system. Illegal dumping of wastes into sinkholes outside the park contaminates groundwater. The current Visitor Center renovation project and future concessions operations, campground rehabilitation, and road reconstruction have the potential to contribute inputs to groundwater reaching the cave. BMPs are being implemented for the Visitor Center project which should minimize such inputs, and will likely be used in future projects as well.

Several measures have been taken to reduce or eliminate contamination of groundwater which drips into Mammoth Cave. Parking lot filters that have been installed reduce or prevent parking lot contaminants from entering the cave. The improved regional sewer system developed in the area also reduces pollutants reaching the groundwater. The Park replaced the old water supply system with a modern system to meet the needs of the park for potable water, fire protection and to eliminate leaks. Stormwater drainage problems would be corrected with a future campground rehabilitation project.

Cumulatively, these past, present and future actions would have minor, adverse impacts on water resources in the cave. Alternative B would contribute negligible adverse cumulative impacts on water resources. In combination, these actions would result in minor, adverse cumulative impacts on water resources.

Conclusion
Alternative B would likely result in temporary, negligible, localized, direct adverse impacts on water resources from possible contamination during construction activities. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to water resources.

4.9 CULTURAL RESOURCES

The thresholds of change for the intensity of an impact on cultural resources are defined as follows:

Negligible: The impact on historic and archeological sites or individual resources is at the lowest levels of detection, barely perceptible and not measurable.

Minor: The impact is measurable or perceptible, but it is slight and localized within a relatively small area of a site or group of sites. The impact does not affect the character defining features of the National Register of Historic Places listed historic site and would not have a permanent effect on the integrity of any historic or archeological site.

Moderate: The impact is measurable and perceptible. The impact changes one or more character defining feature(s) of a historic or archeological resource, but does not diminish the integrity of the resource to the extent that the National Register listing is jeopardized.

Major: The impact on historic and archeological sites is substantial, noticeable, and permanent. The impact is severe or of exceptional benefit. For the National Register listed historic site, the impact changes one or more character defining feature(s) of a resource, diminishing the integrity of the resource to the extent that it is no longer eligible for listing in the National Register.

4.9.1 Impacts of Alternative A (No Action Alternative)

Impacts Analysis
As no construction activities would be conducted, no new impacts on cultural resources would occur under Alternative A. However, since the edges of some cave trails are poorly defined, park visitors on cave tours would continue to stray off trail and disturb cultural artifacts from pre-historic and historic activity in the cave. Disturbance of cultural artifacts by visitors would be expected to continue at current levels. This disturbance does not, however, affect the character defining features of the NRHP listed historic site. Additionally, without containment of lint and abatement of dust, lint and dust would continue to accumulate on cultural artifacts. Layers and mats of lint harbor microscopic organisms that could cause damage to exposed cultural features within the cave; artifacts under trails would not be affected.

Cumulative Effects
Past, present, and future impacts to cultural resources include lint and dust accumulation, accidental or intentional breakage and trampling, and natural degradation in the cave environment. Lint, as well as factors such as changes to airflow, pH and temperature, disrupts the delicate balance that exists in a cave environment, and there is potential for damage to cultural resources from microbial action that is made possible by energy provided in the form of lint and other materials. Additionally, cultural resources in the

cave may have been affected by past and current projects such as operation of the snowball dining facilities, restroom installation, the cave electric upgrade, and construction of prototype cave trails.

The primary trail fill material used in Mammoth Cave is redeposited cave sediments placed on a coarse bed of broken rock. Such trail construction occurred on most of the existing walking paths, although in some spots trail fill was placed with little modification to the original cave floor. This occurred where rock fall was not exposed at the surface or where historic removal of rock fall exposed basal cave fill sediment. Given the method of trail fill composition and placement, all prehistoric archeological material within this context is considered redeposited.

Cumulatively, these past, present and future actions would have minor, adverse impacts on cultural resources in the cave. Alternative A would contribute negligible adverse cumulative impacts on cultural resources. In combination, these actions would result in minor, adverse cumulative impacts on cultural resources.

Conclusion

Alternative A would likely result in long-term, minor, localized, direct adverse impacts on cultural resources from disturbance of cultural artifacts by visitors straying off trails and from continued accumulation of lint and dust. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to cultural resources.

4.9.2 Impacts of Alternative B (Preferred Alternative)

Impacts Analysis

Under Alternative B, cave tour trails would be rehabilitated. During trail reconstruction, the potential exists for historic or archeological resources to be affected by surface disturbance on and adjacent to trails as there are numerous cultural resources immediately adjacent to the trails which could be impacted. However, by employing mitigation measures recommended by Manzano et al. (2009) for areas that have medium and high potential to produce scientifically significant historic or prehistoric materials (described in **section 2.5 Mitigation Measures** of this EA), adverse impacts to cultural resources would be avoided or greatly reduced. Additionally, locations containing significant sensitive resources would be excluded from trail work to insure that absolutely no impacts would occur.

The trail rehabilitation project would occur in portions of the historic district listed on the National Register of Historic Places. However, all precautions would be taken to insure that the character defining features for this listing would not be adversely affected.

Under Alternative B, trail rehabilitation would reduce lint and dust and the opportunity for vandalism of cave resources. In some areas where the edges of the cave trails are poorly defined, there would be measures taken, such as lint curbs or hand rails, which would better define the trail. In other areas, a hardened surface may be enough to define the trail. Well defined trails should reduce the numbers of visitors who wander off the trails and cause damage to cultural resources. Lint curbs would accumulate lint along the curbs, preventing it from spreading and covering cultural resources. Dust would be abated on trail segments where the surface would be replaced with paving stones or other hardened surfaces. However, some trails may still maintain cave sediment surfaces in areas where dust is not a big problem. Thus dust clouds caused by visitors walking on trails would be controlled overall in the cave, and greatly reduced in some areas; but since dust would track onto the hardened surfaces from the remaining sediment-based segments, it would not likely be completely eliminated. Trail rehabilitation would have beneficial impacts on cultural resources by greatly reducing the detrimental effects of lint, dust, and vandalism.

Cumulative Effects

Past, present, and future impacts to cultural resources include lint and dust accumulation, accidental or intentional breakage and trampling, and natural degradation in the cave environment. Lint, as well as factors such as changes to airflow, pH and temperature, disrupts the delicate balance that exists in a cave environment, and there is potential for damage to cultural resources from microbial action that is made possible by energy provided in the form of lint and other materials. Additionally, cultural resources in the cave may have been affected by past and current projects such as operation of the snowball dining facilities, restroom installation, the cave electric upgrade, and construction of prototype cave trails.

The primary trail fill material used in Mammoth Cave is redeposited cave sediments placed on a coarse bed of broken rock. Such trail construction occurred on most of the existing walking paths, although in some spots trail fill was placed with little modification to the original cave floor. This occurred where rock fall was not exposed at the surface or where historic removal of rock fall exposed basal cave fill sediment. Given the method of trail fill composition and placement, all prehistoric archeological material within this context is considered redeposited.

Cumulatively, these past, present and future actions would have minor, adverse impacts on cultural resources in the cave. Alternative B would contribute negligible adverse and beneficial cumulative impacts on cultural resources. In combination, these actions would result in minor, adverse cumulative impacts on cultural resources.

Conclusion

Alternative B would have long-term, negligible, localized direct adverse effects on the cultural resources from possible damage during trail rehabilitation and long-term, minor, beneficial impacts from reduction of dust, lint, and vandalism. Because there would be no major adverse impacts to a resource or value whose conservation is 1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; 2) key to the natural or cultural integrity of the Park or to opportunities for enjoyment of the Park; or 3) identified as a goal in the Park's GMP or other relevant NPS planning documents, there would be no impairment of the Park's resources or values with respect to cultural resources.

4.10 VISITOR USE AND EXPERIENCE

The thresholds of change for the intensity of an impact on visitor use and experience are defined as follows:

Negligible: Changes in visitor use and/or experience would be below or at the level of detection. The visitor would not likely be aware of the effects associated with the alternative.

Minor: Changes in visitor use and/or experience would be detectable, although the changes would be slight. The visitor would be aware of the effects associated with the alternative, but the effects would be slight.

Moderate: Changes in visitor use and/or experience would be readily apparent. The visitor would be aware of the effects associated with the alternative and would likely be able to express an opinion about the changes.

Major: Changes in visitor use and/or experience would be readily apparent and severely adverse or exceptionally beneficial. The visitor would be aware of the effects associated with the alternative and would likely express a strong opinion about the changes.

4.10.1 Impacts of Alternative A (No Action Alternative)

Impacts Analysis

Alternative A would maintain cave trail conditions in their present state. The visitor experience would not change from current conditions, and visitors would continue to experience near slips and falls, or actual accidents, as they walk on slick, potholed, or uneven surfaces. Although there would be no trail rehabilitation, some visitors would be aware of the effects associated with this alternative, specifically deteriorating trail conditions which detract from the experience of touring through the cave. Comments were received during the scoping period from some visitors who do not want the trails hardened or boardwalks installed; they want the natural cave experience, which would continue under this alternative.

Cumulative Effects

Past, current, and future actions have had beneficial impacts on visitor use and experience. Surface and subsurface development, such as construction of trail routes and artificial entrances, the underground restrooms and dining area, and electric lighting along trails were added as visitor convenience at Mammoth Cave. Additionally, the Park offers different tours in Mammoth Cave catering to various visitor needs and abilities. The current and future renovation projects, such as the rehabilitation of the Visitor Center and exhibits, campground and shower improvements, entrance road and Green River crossing improvements, and construction of a bike trail will enhance the visitor experience as visitors access the Park, prepare to embark on cave tours, seek out information, and spend time in the Park. Concessions operations may affect visitor use and experience regarding how the hotel, transportation, and food services are run and may change if new concessionaire is chosen. Renovations to the elevator would provide access from the surface to the Snowball Dining Room Area of Mammoth Cave. An Environmental Assessment will be prepared to determine how and where access to the cave maybe provided to mobility impaired visitors.

Cumulatively, these past, present and future actions would have moderate, beneficial impacts on visitor use and experience. Alternative A would contribute negligible, adverse cumulative impacts on visitor use and experience. In combination, these actions would result in moderate, beneficial cumulative impacts on visitor use and experience.

Conclusion

Alternative A would result in long-term, minor, direct adverse impacts on visitor use and experience due to deteriorating trail conditions. Cumulatively, past, present and future actions would have moderate, beneficial impacts on visitor use and experience.

4.10.2 Impacts of Alternative B (Preferred Alternative)

Impacts Analysis

Trail reconstruction under Alternative B would occur over a period of 36 to 48 months. The work could be phased so that, if some cave tours may be temporarily suspended, other cave tours can continue to operate with minimal interruption. Alternatively, the Park may be able to narrow certain trails and work on them while tours pass by, but other trail sections may need to be closed to tours during construction. Visitor use of the cave may decrease slightly during construction if there are fewer cave tours. There may also be temporary adverse impacts on the visitor experience during trail reconstruction as people may be inconvenienced if they cannot take the tour they want or if the tour they are on passes through a construction zone. However, this project would provide an interpretive opportunity to explain to visitors the long-term benefits of trail rehabilitation. In some sections of the cave, the lint rail associated with the reconstruction of the cave would afford an opportunity to hide the cave electric cabling behind the rail along side of the trail, reducing the visual impact of the unburied main trunk cables.

The sight of construction activities may detract from visitor enjoyment due to visual intrusions from supplies and equipment and as ambient cave conditions would be altered temporarily. The work schedule is still to be determined; for example, the park could require that the work be conducted after hours. Noise from construction would occur during the construction period but would be noticeable mainly in the area where the construction activities are occurring. Visitors on cave tours would only be subject to the noise for a short time. These noises would become less noticeable as the tour group distance increases from the construction site because noise decreases with distance from the source. Additionally, there would likely be increased lighting at the construction site which would temporarily change the conditions under which visitors usually view the cave.

Once trail rehabilitation is complete, there would be long-term beneficial effects on the visitor experience as potholes and other trail surface hazards are corrected, providing visitors with more sure footing. Other improvements, such as installation or replacement of steps, upgrade of safety rails, and installation of lights where necessary would provide safer walking areas so that visitors could focus on the cave and not so much on where they step.

Conversely, some visitors may dislike the new trail improvements if any or too many man-made features are introduced, such as hardened trail surfaces, into previously “natural” areas of the cave. For these visitors, the trail rehabilitation would detract from their visitor experience. Additionally, vertical changes made to the trails would have visual impacts that could detract from the experience of some visitors.

Trail improvements would not change the use patterns of the trails, i.e., the numbers and frequency of public cave tours would continue at current levels. However, some trails would be designed for improved accessibility for mobility impaired visitors, resulting in a beneficial effect. Improvements to the elevator may also allow the Park to start bringing mobility impaired visitors into the cave via this access point, and perhaps reinstating a Mobility Impaired tour. An Accessibility Study currently underway is developing alternatives for function and locations to provide handicap access into Mammoth Cave. A universally accessible tour could be conducted in which people in wheel chairs can join a general tour and not be limited to a segregated tour for the mobility impaired.

Cumulative Effects

Past, current, and future actions have had beneficial impacts on visitor use and experience. Surface and subsurface development, such as construction of trail routes and artificial entrances, the underground restrooms and dining area, and electric lighting along trails were added as visitor convenience at Mammoth Cave. Additionally, the Park offers different tours in Mammoth Cave catering to various visitor needs and abilities. The current and future renovation projects, such as the rehabilitation of the Visitor Center and exhibits, campground and shower improvements, entrance road and Green River crossing improvements, and construction of a bike trail will enhance the visitor experience as visitors access the Park, prepare to embark on cave tours, seek out information, and spend time in the Park. Concessions operations may affect visitor use and experience regarding how the hotel, transportation, and food services are run and may change if new concessionaire is chosen. Renovations to the elevator would provide access from the surface to the Snowball Dining Room Area of Mammoth Cave. An Environmental Assessment will be prepared to determine how and where access to the cave maybe provided to mobility impaired visitors.

Cumulatively, these past, present and future actions would have moderate, beneficial impacts on visitor use and experience. Alternative B would contribute negligible, adverse cumulative impacts and minor, beneficial cumulative impacts on visitor use and experience. In combination, these actions would result in moderate, beneficial cumulative impacts on visitor use and experience.

Conclusion
Alternative B would have temporary, minor, direct adverse impacts on visitor use and experience from noise and inconvenience during construction; long-term, moderate, beneficial impacts from improved trail conditions and possibly long-term, minor, adverse impacts from introduced man-made features.

4.11 PUBLIC HEALTH AND SAFETY

The thresholds of change for the intensity of an impact on public health and safety are defined as follows:

Negligible: Visitor safety would not be affected, or the effects would be at the lowest levels of detection and would not have an appreciable effect on visitor safety. Impacts to public health and safety would not be detectable as measured by standard incident reports or exposure to unsafe conditions.

Minor: The effect would be detectable but would not have an appreciable effect on visitor safety. Impacts to public health and safety would be detectable as measured by standard incident reports or exposure to unsafe conditions, but would not exceed acceptable standards. If mitigation were needed, it would be relatively simple and would likely be successful.

Moderate: The effects would be readily apparent, either significantly adverse or beneficial, and result in noticeable effects to visitor safety within the project area. Impacts to public health and safety would be detectable as measured by standard incident reports or exposure to unsafe conditions. Adverse effects would exceed acceptable standards, but could be mitigated using standard emergency procedures.

Major: The effects would be readily apparent, either severely adverse or exceptionally beneficial, and result in substantial, noticeable effects to visitor safety within the project area. Impacts to public health and safety would be detectable as measured by standard incident reports or exposure to unsafe conditions. Adverse effects would exceed acceptable standards, but could not be mitigated using standard emergency procedures.

4.11.1 Impacts of Alternative A (No Action Alternative)

Impacts Analysis
Under Alternative A, safety hazards would remain on cave tour trails in the form of potholes and slippery or uneven surfaces. Although there have been few reported accidents, without improved trail conditions, more accidents are likely to occur. Routine maintenance and interim trail repairs could reduce safety risks in the short-term, which may put off accidents, but would not eliminate the safety hazards. In the long-term, trail conditions would continue to deteriorate, and visitors would continue to be at risk for possible slips and falls due to uneven trail surfaces and on stairs.

Cumulative Effects
Past, present, and future use of Mammoth Cave would continue to pose some risks to public health and safety because of the physical nature of the cave. Although visitors to the cave are exposed to some dangers, precautions such as trained tour leaders, trail maintenance, and a search and rescue plan would continue to minimize impacts on human health and safety. Cave electric lighting, which was upgraded recently, provides beneficial effects on public health and safety. The prototype cave trail in the Historic

section, which replaced uneven dirt surfaces with hardened surfaces, also provides a safer walking area for visitors. Renovating the elevator would prevent staff and visitors from getting stuck in the elevator and ensure safe cave operations.

Cumulatively, these past, present, and future actions would have minor, adverse impacts on public health and safety. Alternative A would contribute minor, adverse cumulative impacts on public health and safety. In combination, these actions would result in minor, adverse cumulative impacts on public health and safety.

Conclusion

Alternative A would have long-term, minor, direct adverse impacts on public health and safety as cave trails continue to deteriorate.

4.11.2 Impacts of Alternative B (Preferred Alternative)

Impacts Analysis

Under Alternative B, trail rehabilitation would increase the safety of public cave tour trails. Visitors who tour the cave would have reduced risk for slips and falls from uneven and slippery trail surfaces. Reconstructed trail surfaces would provide visitors with more sure footing. Other improvements, such as installation or replacement of steps, upgrade of safety rails, and installation of additional lights would contribute beneficially to improving visitor safety. Accidents would be expected to decrease in the long-term.

Cumulative Effects

Past, present, and future use of Mammoth Cave would continue to pose some risks to public health and safety because of the physical nature of the cave. Although visitors to the cave are exposed to some dangers, precautions such as trained tour leaders, trail maintenance, and a search and rescue plan would continue to minimize impacts on human health and safety. Cave electric lighting, which was upgraded recently, provides beneficial effects on public health and safety. The prototype cave trail in the Historic section, which replaced uneven dirt surfaces with hardened surfaces, also provides a safer walking area for visitors. Renovating the elevator would prevent staff and visitors from getting stuck in the elevator and ensure safe cave operations.

Cumulatively, these past, present, and future actions would have negligible, adverse impacts on public health and safety. Alternative B would contribute moderate, beneficial cumulative impacts on public health and safety. In combination, these actions would result in negligible, adverse cumulative impacts on public health and safety.

Conclusion

Alternative B would have long-term, moderate, direct beneficial impacts on human health and safety due to improved walking surfaces and other safety features on public cave tour trails.

5.0 CONSULTATION AND COORDINATION

5.1 PUBLIC INVOLVEMENT

The purpose of the scoping process, as outlined in CEQ's regulations for implementing NEPA (40 CFR 1501.7), is to determine the scope of issues to be addressed in the EA and to identify significant issues relating to the Proposed Action. The lead agency is required to invite input from Federal, State, and local agencies, affected Native American tribes, project proponents, and other interested parties (Section 1501.7 (a)(1)). To satisfy scoping requirements for this project, scoping letters and a newsletter were mailed out requesting public and agency input on issues to be addressed in the EA.

The public scoping period for the project began on April 24, 2009 and ended on May 26, 2009. Eight comment letters were received from the public during this period. A scoping summary report is included in Appendix A.

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APPENDIX A: Summary of Scoping Comments and Issues

1.0 INTRODUCTION

Approximately 12 miles of tourist trails in Mammoth Cave were constructed by the Civilian Conservation Corps (CCC) in the 1930s. The CCC crews widened tour paths and used cave sediments to level the rocky cave floor. Additional entrances to the cave were created allowing for 3-4 hour trips, versus 6-7 hour trips. Electric lights were installed along tour routes in stages between 1917 and 1965, and later updated in 2005-2006. In recent years, park staff has installed short stretches of boardwalks and paving stone-paths as prototype walking surfaces.

In 2000, cave visitation was ten times greater than in 1934 when the CCC began work in the cave. Except for areas with specific problems, there have not been comprehensive plans for rehabilitation or upgrade of the cave trail system since 1941.

This project would reconstruct cave tour trails within Mammoth Cave and Great Onyx Cave. Cave passageways vary greatly in width, height, slope, features, and humidity. Treatment applied on the trails will be site specific. In some places only minor changes may be needed, while in others more comprehensive solutions will be applied.

The new cave tour trails will:

- Provide safe walking surfaces for park visitors;
- Significantly reduce or eliminate the impact of cave visitors (lint and dust) on delicate cave resources; and
- Protect cave resources by keeping visitors on defined trails and away from sensitive artifacts.

The project includes reconstruction of the trail surface, installation or replacement of steps, upgrade of safety rails, installation of lint guards along the edges of the trails, possible replacement of the boardwalk, and where necessary installation of lights to provide a safe walking area. The trail surface would be reconstructed in many areas using a combination of concrete pavers, PolyPavement™, boardwalk, soilcrete, and other suitable and sustainable trail surface materials.

The cave tour routes to be rehabilitated would include:

- Historic tour route, plus Rafinesque and Gothic Avenues, and the passage to River Styx;
- Violet City Lantern tour route;
- Grand Avenue tour route;
- New Entrance tour route;
- Adjacent passageways previously used for public tours; and
- Great Onyx Cave trails.

The National Park Service (NPS) must follow the National Environmental Policy Act (NEPA) of 1969 to assure consideration of important issues. The trail rehabilitation that is being considered at Mammoth Cave will be analyzed during the NEPA process.

As part of the NEPA process, the proposed improvements will be evaluated in an Environmental Assessment (EA) which will analyze the potential environmental effects of the proposed trail rehabilitation. This analysis will consider impacts to topics such as cave biota, threatened and endangered species, water quality, cultural resources, visitor use, and public health and safety.

This scoping report summarizes and categorizes the input received during the scoping period.

2.0 THE SCOPING PROCESS

The public scoping period is designed to help the NPS determine the appropriate scope of its environmental study of the cave trail rehabilitation project by identifying concerns the public has with the proposed project:

- What alternatives should be considered?
- What other actions should be considered?
- What environmental effects should be considered?
- What steps to reduce potential adverse impacts should be considered?

The period for public input, normally 30 days, began on April 24, 2009. The final deadline for comments to be fully considered in the project analysis was May 26, 2009.

The NPS' Planning, Environmental, and Public Comment (PEPC) website was made available to provide copies of the scoping documents: http://parkplanning.nps.gov/

2.1 Direct Mail

A scoping letter and newsletter was mailed to the 11 individuals, agencies and organizations (Attachment A).

2.2 Email

An email version of the scoping letter and newsletter was sent to 100 email addresses plus to all employees at Mammoth Cave National Park (Attachment B).

2.3 News Media Press Releases

A press release was sent via email to 69 media (i.e. newspaper and radio) contacts (Attachment C).

2.4 Inputs

Both a postal mail address (Mammoth Cave National Park, P.O. Box 7, Mammoth Cave, KY 42259) and the PEPC website (http://parkplanning.nps.gov/) were established for accepting comments.

3.0 SCOPING COMMENTS

3.1 Comments Received

Individuals

For the purposes of this report, a "comment" is defined as a position or question stated within a comment letter. A "comment letter" is defined as any single piece of correspondence. There may be several comments within one comment letter.

There were 8 comment letters received from individual members of the public. All comments were received on the PEPC web site.

Organizations

No comments have been received from organizations.

Agencies

No agency comments have been received.

3.2 Summary of Comments

Five comment letters specifically expressed support for the project, and no letters were in opposition. However, even letters that expressed support brought up concerns and issues. Specific issues and concerns were:

Issue or Concern	Number of Comments
Protect natural features	3
Ensure safety of visitors	3
Improve safety of NPS staff providing tours	1
Negative impacts to historic recreation on Violet City Tour	1
Provide ADA access	1
Rehabilitation should occur only in areas previously touched	1
Impact of dust on cave resources	1
Impact of trail materials on microbiotic resources	1
Negative impact on visitor experience with use of artificial trail surfaces	1

Others who commented offered specific suggestions for trail rehabilitation and design:

Suggestion/Design Elements	Number of Comments
Install lint curbs everywhere	1
Crete pavers should be material of choice	1
Polycrete, soilcement, etc. are not sustainable	1
Boardwalks should not be used	1
Hexagonal pavers should not be used because the do not look natural	1
Specific design element suggestions for the Historic Tour Route	27
Specific design element suggestions for the Violet City Lantern Tour Route	7
Specific design element suggestions for the River Styx Tour Route	7
Specific design element suggestions for the Mammoth Passage /Discovery Tour Route	4
Specific design element suggestions for the Star Chamber / Gothic Avenue Tour Route	2
Specific design element suggestions for the Grand Avenue Tour Route	18
Specific design element suggestions for the New Entrance Tour Route	9
Specific design element suggestions for the Frozen Niagara Tour Route	13
Specific design element suggestions for the Great Onyx Tour Route	2
Specific design element suggestions for the Wild Cave Tour	1

Finally, there were comments about the scoping process itself:

Issue or Concern	Number of Comments
Request for EA	1
Request to remain on mailing list	1

Total number of comments: 110

Attachment A: Mailing List for Scoping Letter and Newsletter

Governor Bill Anoatubby
Chickasaw Nation
Post Office Box 1548
Ada, Oklahoma 74821

Chief Glenna J. Wallace
Eastern Shawnee Tribe of Oklahoma
Post Office Box 350
Seneca, Missouri 64865

Principal Chief Chadwick Smith
Cherokee Nation
Post Office Box 948
Tahlequah, Oklahoma 74465

Chairman Ron Sparkman
Shawnee Tribe
Post Office Box 189
Miami, Oklahoma 74355

Chief George Wickliffe
United Keetoowah Band of Cherokee Indians
Post Office Box 189
Parkhill, Oklahoma 74464

Principal Chief Michell Hicks
Eastern Band of Cherokee Indians
Post Office Box 455
Cherokee, North Carolina 28719

Governor Scott Miller
Absentee-Shawnee Tribe of Indians of Oklahoma
2025 South Gordon Cooper Drive
Shawnee, Oklahoma 74801

Lee Andrews, Field Supervisor
U.S. Fish and Wildlife Service
Kentucky Field Office
330 W. Broadway, Room 265
Frankfort, Kentucky 40601

Mark Dennen, Acting Executive Director
Kentucky State Historic Preservation Office
300 Washington Street
Frankfort, Kentucky 40601

Lewis Cutliff
128 North Mammoth Cave Street
Park City, KY 42160

Morris Blanton
1460 Arthur Road
Brownsville, KY 42210

Attachment B: Email List for Scoping Letter and Newsletter

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kaliav@easternnational.org, gdavisgm@usdol.net, smartin@usdol.net, Nicholas.L.Tunks@usps.gov, ntunks@gmail.com, Janice.M.Bolton@usps.gov, lindag@easternnational.org, Holmes.Earl@jobcorps.org, hardin.susan@jobcorps.org, john.glass@alphacorporation.com, childres.kathy@jobcorps.org, macahotel@usdol.net

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Local elected officials
dgreer@glasgow-ky.com, cityhall@caveland.net, conservator@alltel.net, ectcc@aol.com, hart_co@scrtc.com, brian@scrtc.com, ecfc@mchsi.com, emyers@glasgow-ky.com, hartcoje@mchsi.com, annstewart@glasgow-ky.com, cityhall@parkcity.ky.gov, mayorj@usdol.net

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Government caves
Dale Pate/CAVE/NPS@NPS, CAVE Superintendent@NPS, GRBA Superintendent@NPS, JECA Superintendent@NPS, ORCA Superintendent@NPS, RUCA Superintendent@NPS, TICA Superintendent@NPS, WICA Superintendent@NPS, SEKI Superintendent@NPS, CUGA Superintendent@NPS, phdobbins@fs.fed.us

Park advocates
kentucky@tnc.org, southeast@npca.org, biglee61@hotmail.com, lajuanawilcher@aol.com, tbunnell@glasgow-ky.com, info@peer.org

Kentucky legislators
Johnny.Bell@lrc.ky.gov, Dottie.Sims@lrc.ky.gov, jd951@insightbb.com, david.givens@lrc.ky.gov

Attachment C: Media Email List for Scoping Letter, Newsletter, and Press Release

Media

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