National Park Service
U.S. Department of the Interior

Great Basin National Park
Nevada

LEHMAN CAVES MANAGEMENT PLAN

Environmental Assessment

July 2019

Cover Photo: Trail through the Cypress Swamp, Lehman Caves, Great Basin National Park. Photo by Dave Bunnell.

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Abbreviations and Acronyms

ARPA – Archaeological Resources Protection Act
BLM – Bureau of Land Management
CEQ - Council on Environmental Quality
EA – Environmental Assessment
ESA – Endangered Species Act
GMP – General Management Plan
GRBA – Great Basin National Park
NEPA – National Environmental Preservation Act
NHPA – National Historic Policy Act
NPS – National Park Service
NRCS – Natural Resources Conservation Service
NRHP – National Register of Historic Places
NSS – National Speleological Society
SHPO – State Historic Preservation Office
SNPLMA – Southern Nevada Public Lands Management Act
USFS – United States Forest Service
USFWS – United States Fish and Wildlife Service
USGS – United States Geologic Survey

INTRODUCTION

Great Basin National Park is proposing to implement a plan for management of Lehman Caves. This plan would improve safety with improved trail lighting and better communications, install new infrastructure that would have less impact on the cave (lint curbs, lighting, airtight doors, elevated walkways), protect native species with permanent decontaminations stations, offer additional types of cave tours, fully document historic resources in the cave, and remove old trail debris from the cave. Other items in the plan would expand cave education and outreach, encourage more research in the cave, and update the cave map.

Two separate cave management plans are being prepared, one for Lehman Caves, the developed cave in GRBA that has been visited since 1855 and has over 30,000 visitors a year; and one for the 39 known wild, undeveloped caves in the park and the karst terrain, where additional caves may be found. Separating these two plans makes it easier to specify the very different management strategies for them.

For specific projects mentioned in this document, but not fully described nor assessed for impacts, site and/or project-specific environmental compliance will be completed in the future as appropriate.

BACKGROUND

Lehman Caves was opened for recreational visits in 1885, making it the longest-visited show cave in Nevada. Lehman Caves National Monument was designated on January 24, 1922 by President Warren G. Harding to protect “certain natural caves, known as Lehman Caves…which are…of unusual scientific interest and importance…”. On October 27, 1986, under Public Law 99-565, the Lehman Caves National Monument was “abolished and the lands incorporated within the Great Basin National Park”.

Lehman Caves is located in the northern part of Great Basin National Park (GRBA). The park encompasses over 77,000 acres of the South Snake Range (Figure 1), which is in east-central Nevada. The nearest large cities are Salt Lake City, Utah, 234 miles to the northeast, and Las Vegas, Nevada, 291 miles to the southwest. The park is surrounded by land managed by the Bureau of Land Management (BLM) and private land.

Lehman Caves is one of over a dozen caves in the National Park Service to offer cave tours. About 30,000 visitors tour the cave each year. The cave is known for its concentrated speleothems, including over 300 cave shields. The cave trail is about one-third of a mile long, and the total length of the cave is about two miles (Figure 2). Visitation to the cave is by ranger-guided tour only. Tours are available year-round. Although the historic name is “Lehman Caves,” it is just one cave.

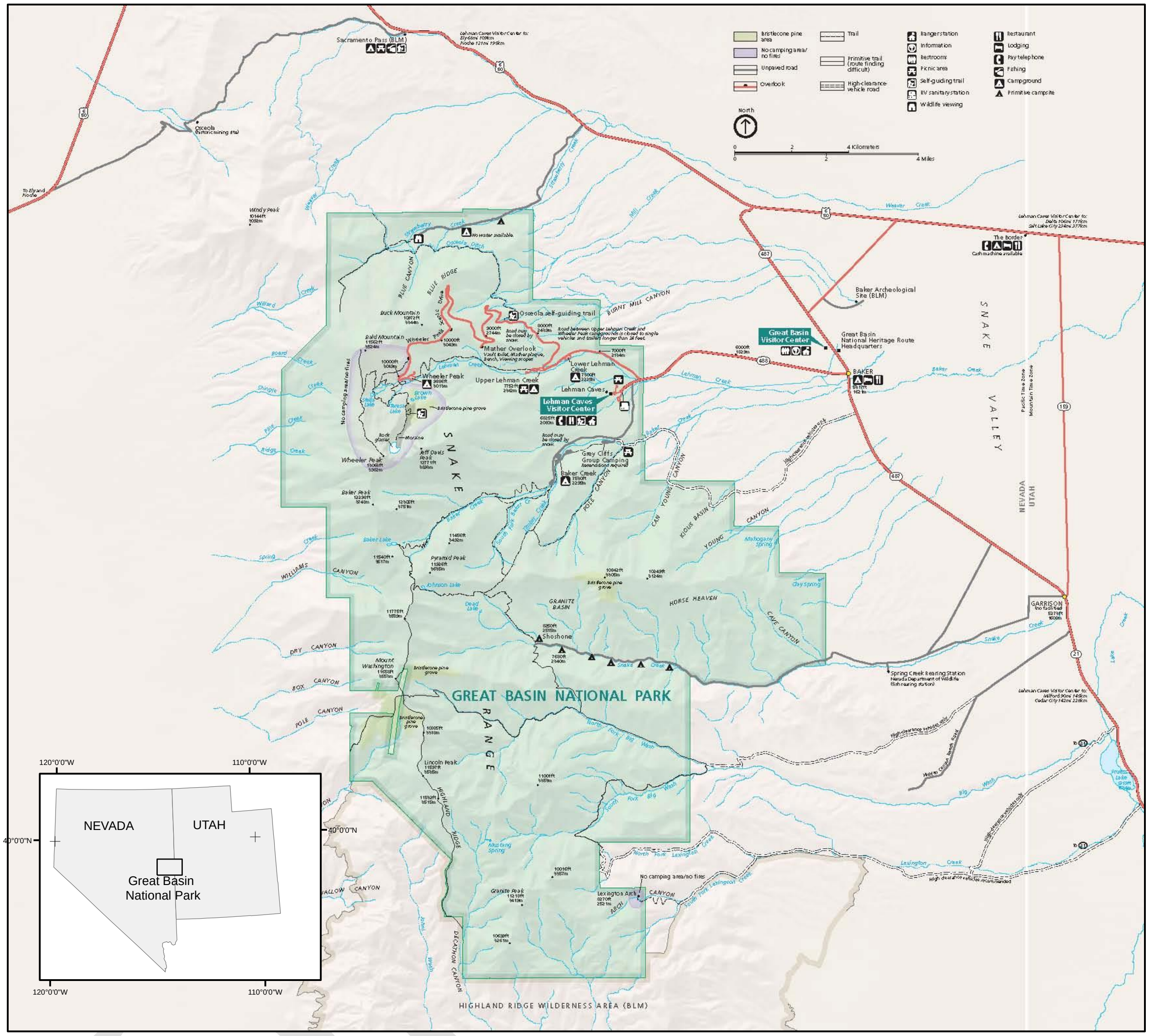


Figure 1. Great Basin National Park is located in east-central Nevada and includes over 77,000 acres in the South Snake Range, as well as 80 acres near the town of Baker used as an administrative site.

PURPOSE

The purpose of developing a Lehman Caves Management Plan (LCMP) is to create an integrated approach to manage Lehman Caves. This plan includes infrastructure, natural resource management, interpretation and education, maintenance, and administration of the cave. The duration of the plan is 15-20 years, although adjustments may be made as determined by the adaptive management process.

NEED

By completing this plan, GRBA will meet NPS guidelines of having an approved cave management plan for the park. National Park Service policy directs parks to develop cave management plans to uphold its mission to protect and preserve park resources for future generations to experience and enjoy. The Park's General Management Plan (NPS 1991) calls for a cave management plan to be prepared for all cave and cave resources in the park. The Great Basin National Park Foundation

Document (NPS 2015) was written to provide basic guidance for planning and management decisions. One of the fundamental resources identified in the document was caves, karst, and cave-forming processes, including Lehman Caves. Geology, hydrology, biology, paleontology, and archeology are called out. The Foundation Document notes that the park has limited cave management guidance and calls for the development of a cave and karst management plan.

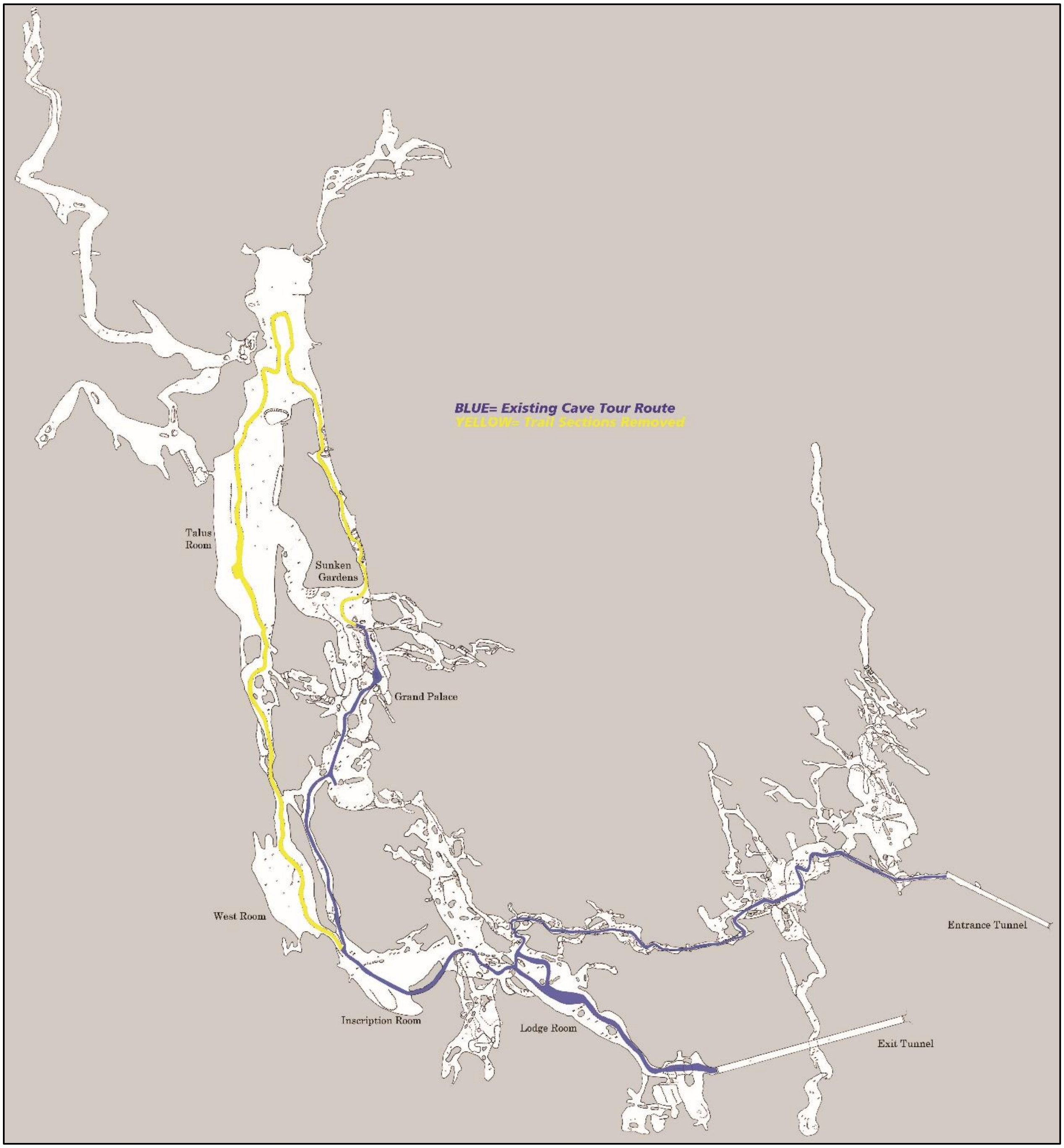


Figure 2. Plan map of Lehman Caves, showing over 10,000 feet of passageway. The blue line highlights the current cave tour, while the yellow line shows the historic tour through the Talus Room and West Room, which was conducted from 1961-1981. The map was drafted by the Salt Lake Grotto in 1959 under the direction of Dale Green.

PROJECT GOALS

The primary goal of the Lehman Caves Management Plan is to manage the cave in a manner that will preserve and protect cave resources and processes while allowing for respectful recreation and scientific use. More specifically, the intent of the plan is to manage Lehman Caves to maintain its geological, scenic, educational, cultural, biological, hydrological, paleontological, and recreational resources in accordance with applicable laws, regulations, and current guidelines such as the FCRPA, 43 CFR Part 37, and National Park Service Management Policies.

Objectives

1. Provide high quality visitor experiences so that visitors to Lehman Caves safely enjoy and are satisfied with the availability, accessibility, diversity, and quality of park facilities, services, and appropriate recreational opportunities. Visitors would have the opportunity to visit the cave on guided tours for an educational and interpretive experience. Support cave and karst systems education and outreach.

2. Regulate or prohibit uses that would cause resource damage to cave systems. These uses may include land actions (e.g., surface disturbance above or near caves or projects that change the hydrologic systems connected to the cave), research (e.g., archaeological or paleontological), and commercial uses.

3. Protect and preserve biodiversity. Cave life will have access to the cave by maintaining connectivity between the surface and sub-surface. Exotic species (e.g., algae) will be removed periodically. Staff would also work to protect the cave from white-nose syndrome and other emerging diseases.

4. Manage the cultural resources and cultural landscape of Lehman Caves through documentation and preservation to allow for longevity, preservation, interpretation, and future research. In addition, research and record the ethnographic information for the cave.

5. Prioritize safety for both staff and visitors in and out of the cave. The cave would be a safe environment with access to necessary equipment, appropriate Job Hazard Analysis (JHA), and work-appropriate Standard Operating Procedures (SOPs). Each staff member would have a clear understanding of job duties, appropriate actions, SOPs, and where to receive more information to best serve park operations in the cave.

6. Design and utilize infrastructure that reduces maintenance, enhances longevity, and has minimal impact on the cave. Remove past infrastructure and repair damage.

7. Encourage, facilitate, and conduct high-quality scientific study of cave and karst resources.

8. Use partnerships and volunteer resources where feasible to augment park staff resources. Develop and foster communications, cooperation, and volunteerism with interested publics, Federal agencies, Native American Tribes, local governments, and academic institutions. Utilize partners and volunteer assistance for inventory, monitoring, surveys, maintenance, lint clean up, and restoration.

RELATED LAWS, LEGISLATION AND MANAGEMENT GUIDELINES

The Lehman Caves Management Plan is consistent with the following documents outlining park management goals and objectives:

- Great Basin National Park Foundation Document (2015)
- Great Basin National Park General Management Plan (1991)
- Great Basin National Park Resource Management Plan (1999)
- Great Basin National Park Legislation (1986)

Additional NPS and federal policy guiding this plan include:

- Federal Cave Resource Protection Act of 1988 (FCRPA)
- National Park Service Organic Act (1916)
- NPS Management Policies (2006)
- National Historic Preservation Act of 1966
- The Archaeological Resources Protection Act 1979 (ARPA)
- Native American Graves Protection and Repatriation Act 1990 (NAGPRA)
- National Parks Omnibus Management Act of 1998

A number of specific NPS regulations apply to cave management at GRBA and have been considered in the preparation of the Cave Management Plan. Key regulations include:

Closures and Public Use Limits (36 CFR 1.5)
Permits (36 CFR 1.6)
Preservation of natural, cultural, and archeological resources (36 CFR 2.1)
Research Specimens (36 CFR 2.5)
Cave Management (43 CFR 37)

ISSUES AND IMPACT TOPICS

Scoping
A list of issues and concerns related to the project were identified through park internal scoping and through the public scoping process.

ISSUES AND IMPACT TOPICS IDENTIFIED FOR FURTHER ANALYSIS

Based on scoping, the following issues and impact topics were identified and retained for further analysis:

- Biological-Species of Special Concern (Bats, Cave Invertebrates)
- Biological-Non-native species (White nose syndrome, algae)
- Cultural-Cultural landscapes (Prehistoric/historic structures)
- Cultural-Ethnographic Resources (Museum collections)
- Geological (Bedrock, speleothems, karst)
- Human Health and Safety (Communications, elevated trail heights, lighting)
- Socioeconomic (Number of visitors)
- Visitor Use and Experience and Visitation
- Water Quality

ALTERNATIVES

INTRODUCTION

This chapter discusses two alternatives (No Action and Proposed Action) for Lehman Caves management at Great Basin National Park. The Proposed Action was developed by an interdisciplinary team of park staff.

DESCRIPTION OF ALTERNATIVES

Alternative 1– No Action Alternative. The No Action Alternative would continue park operations without any major changes. Communications would remain unreliable, using the park radio system. Cave infrastructure would be fixed as possible. Lighting would not be changed from the 1977 system that is currently in place. Lint would not be controlled by lint curbs or other means, except for annual lint camps consisting of volunteers coming for a weekend to pick lint off speleothems. Trails would stay in place, including those disrupting hydrologic function. Interpretive tours would consist of the current 60-minute (Lodge Room) and 90-minute (Grand Palace) tours. White-nose screening would continue by questioning visitors and treating those that identify as having visited other caves. Limited resource management and research would continue.

Alternative 2 – Implement Lehman Caves Management Plan. As actions identified in the plan are implemented, safety would be improved by installing better trail lighting, communications, and tread on cave trails. A new cave lighting system would be installed, updating the 1977 cave lighting system that is currently not functioning well. This new lighting system would not only provide better trail lighting, it would also light cave features better and reduce algal growth near cave lights. Lint would be better controlled by grates at the cave entrance, lint curbs along selected sections of trails, and more frequent cleaning. Natural airflow in the cave would be restored by installing a door at the entrance to the West Room from the Inscription Room. This connection was blasted open in 1961. Hydrologic function would be restored by removing the current sand/gravel/asphalt/concrete trail and putting in a fiberglass walkway that would allow cave water to flow under it. Permanent decontamination stations would be installed at both the entrance and exit tunnels to decontaminate all visitors for white-nose syndrome. Additional interpretive tours, such as wild cave tours, lantern tours, and special event tours would be added as funding and staffing allowed.

A summary of management actions is found in Table 1.

Table 1. Timeline for implementation of action items identified in Section 4 of the Lehman Caves Management Plan. In parentheses are references to the sections above where the reader can find more information. Pg. 89-90, LCMP.

Category	Currently In Place or within Fiscal Year	FY2020-2024	FY2025 and beyond
Safety	• Read and follow JHAs (4.1.a) • Use proper PPE (4.1.a) • Conduct annual cave rescue training (4.1.a)	• Install better communications (4.1.c) • Move cave repeater inside cave and wire to visitor center (4.1.c)	• Create fire break/thinning above the cave (5.0)

Category	Currently In Place or within Fiscal Year	FY2020-2024	FY2025 and beyond
	• Offer CPR and first aid training (4.1.a) • Carry radio (4.1.a) • Share safety messages to visitors (4.1.b) • Clean nonslip surfaces (4.2.a) • Coordinate with Visitor and Resource Protection for all emergency situations (4.14)	• Improve trail lighting (4.2.b)	
Infrastructure	• Replace cave tunnel doors (4.2.c) • Inspect cave entrance biennially (4.2.e) • Inspect tunnels biennially (4.2.f) • Install carpet in tunnel and clean weekly (4.2.g) • Hold annual lint camps (4.2.h) • Conduct annual algae cleaning (4.2.h) • Conduct annual cave pool cleaning (4.2.h) • Clean cave trail on limited basis (4.2.h) • Ensure cave key accountability (4.2.l)	• Thoroughly clean trails, focusing on tread (4.2.a) • Add additional tread to cave trails where needed (4.2.a) • Install lint curbs (4.2.a & 4.2.g) • Improve trail and feature lighting (4.2.b) • Remove old cave lighting systems (4.2.b) • Add West Room door to restore airflow (4.2.c) • Extend Sunken Garden platform (4.2.d) • Improve tunnel lighting (4.2.f) • Elevate Cypress Swamp-Grand Palace trail (4.2.d) • Elevate King's Bathtub trail (4.2.d) • Install grates outside tunnels	• Investigate holograms (4.2.j) • Install Intrusion Detection System (4.2.l)

Category	Currently In Place or within Fiscal Year	FY2020-2024	FY2025 and beyond
		(4.2.g) • Clean cave trail weekly/monthly (4.2.h) • Install permanent decon stations (4.2.i)	
Visitation, Interpretation, Education	• Conduct up to 20 tours per day (4.3.a) • Offer 30, 60, 90-minute tours (4.3.b) • Offer limited LED lantern tours (4.3.b) • Hold annual formal training (4.3.d) • Conduct WNS visitor screening and decon (4.3.g) • Update LCVC exhibits (4.3.f) • Allow cave reservations online (4.3.h) • Record all visitors who enter cave (4.3.k) • Use social media to share information about cave (4.3.i)	• Conduct a carrying capacity study (4.3.a) • Offer additional types of tours (4.3.b) • Add cave staff (4.3.c) • Invite tribes to share perspective for training (4.3.d) • Produce video of cave for training purposes (4.3.d) • Offer virtual cave tours (4.3.e) • Install outdoor TV for WNS message (4.3.g) • Conduct distance learning (4.3.j)	• Install additional exterior exhibits about the cave (4.3.f)
Biological Resources	• Limit disturbance to bats (4.4.a) • Maintain quiet under the natural entrance (4.4.a) • Maintain bat partnerships (4.4.a) • Monitor bat use (4.4.a) • Share information	• Design exhibits about bats (4.4.a) • Fill bat data gaps (4.4.a) • Develop WNS plan (4.4.b) • Install permanent decontamination stations (4.2.i) • Encourage more biological research	

Category	Currently In Place or within Fiscal Year	FY2020-2024	FY2025 and beyond
	about biological resources (4.4.a) • Conduct WNS surveillance (4.4.b) • Conduct climate monitoring (4.4.b) • Conduct invertebrate monitoring (4.4.c) • Have human-wildlife protocols in place (4.4.d) • Leave animal carcasses in place (4.4.e)	in cave (4.4.c)	
Cultural Resources	• Entrance area off limits (4.5) • Leave historic artifacts in place (4.5) • Tours will be quiet under the natural entrance (4.5)	• Assess soils above entrance tunnel (4.5) • Remove excess non-native stone from natural entrance room (4.5) • Fully document historic resources (4.5) • Investigate National Register of Historic Places application (4.5)	
Geologic Resources	• Develop SOPs for cave restoration (4.6.b) • Repair speleothems (4.6.b)	• Conduct photo monitoring (4.6.a) • Remove old trail debris from cave (4.6.b) • Encourage more paleontological research (4.7)	
Other	• Continue to allow scientific research in cave (4.8) • Monitor cave climate (4.9) • Continue	• Encourage more research in cave (4.8) • Seek highly detailed cave map with plan, profile,	

Category	Currently In Place or within Fiscal Year	FY2020-2024	FY2025 and beyond
	partnerships with NSS and other organizations (4.10) • Allow after-hours tours on paved trail (4.11) • Allow off-trail trips with guidelines (4.11) • Allow exploration, no speleothems broken, with permit (4.11) • Allow photography and special use permits (4.12) • Update cave map (4.13)	and cross sections (4.13)	

PRELIMINARY OPTIONS AND ACTIONS CONSIDERED BUT DISMISSED

Options which were inconsistent with NPS policy and mandates, which did not meet the purpose and need of the Lehman Caves Management Plan, which would have severe impacts upon park resources, or which were impossible to achieve due to logistical or technical reasons were eliminated from further analysis.

The following options were discussed but dismissed from further consideration:

1. Allowing the public to visit Lehman Caves without a tour guide
2. Extending paved trails into additional parts of the cave

These options were not given further consideration because they would not allow the park to meet its policy mandate and management goals to protect resources for future generations. Caves that have open-visitation policies experience more vandalism (e.g., Carlsbad Caverns). Lehman Caves has dense cave speleothems very close to the cave trail, and tour size has already been limited as it was noted that very large tours with unsupervised people at the back tend to have more vandalism. Constructing paved trails puts a lot of impact on the delicate cave environment. The current half-mile paved trail includes the most decorated parts of the cave that have sufficient room for a group to stand in and reach.

AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter describes existing environmental conditions and potential impacts of proposed actions on nine impact categories at Lehman Caves:

These impact categories were identified through the scoping process as those potentially affected by managing Lehman Caves. Impacts of actions proposed in this environmental assessment are considered for each impact category based on the following:

- Type of impact: beneficial or adverse
- Duration of impact: short-term or long-term
- Intensity of impact: negligible, minor, moderate, or major
- Context of impact: site-specific, park-wide, or regionally

BIOLOGICAL RESOURCES –SPECIES OF MANAGEMENT CONCERN (CAVE INVERTEBRATES)

Affected Environment

Numerous invertebrates have been found in Lehman Caves. The first systematic study of cave biology was completed in the 1960s by the Desert Research Institute (Desert Research Institute 1968). After those studies, very little was done with regards to cave biota until 2006, when a cave bioinventory was funded by the National Park Service (Taylor et al. 2008). This bioinventory focused on cave invertebrates.

Figure 3. A *Microcreagris grandis* pseudoscorpion was first found in Lehman Caves and is endemic to the South Snake Range.

For arachnids, three orders, including Acari (mites), Pseudoscorpions, and Araneae (spiders) are known. Probably the most iconic creature in Lehman Caves is the Lehman Caves Pseudoscorpion - *Microcreagris grandis* (Figure 3). It was discovered in the 1930s by Park Custodian T.O. Thatcher, but it wasn't identified until 1962 by Dr. W. B. Muchmore (Muchmore 1962). Males and females have different appearances, with the females lighter in color. Pseudoscorpions molt numerous times over their lifetime. They most commonly found near the Natural Entrance, but have been documented in the Talus Room and Gypsum Annex. They are also found in other caves in the park, including high elevation caves

(Taylor et al. 2008). Pseudoscorpions are the top invertebrate predator, thus they are a keystone species for the cave.

Additional cave invertebrates include Hexapoda, which includes at least eight different species of Collembola, or springtails. The most numerous invertebrate in Lehman Caves are springtails. Springtails are an extremely important part of the cave ecosystem as a prey item (Taylor et al. 2008).

Figure 4. This 0.5-cm long millipede, *Nevadesmus ophimontis*, is found in Lehman and other nearby caves but nowhere else in the world.

Several other invertebrate species new to science have been found in Lehman Caves. In 2006, a new genus of millipede was identified from Lehman Caves, as well as several nearby caves, *Nevadesmus ophimontis* Shear (Figure 4). This tiny, all-white millipede was first found in the cave near the Queen's Bathtub adjacent to the trail (Shear 2009). Flies (order Diptera) can be numerous in the cave. In some locations, dead flies have been covered with calcite and are now part of cave formations. In 2010, a fly was collected under the natural entrance and it was discovered to be a new species, *Megaselia necpleuralis* (Disney et al. 2011).

Other invertebrates are also seen in the cave. Cave crickets of the genus *Ceuthophilus* are occasionally spotted in the entrance and exit tunnels and near the natural entrance area. Various beetles and spiders are also seen near the entrances.

Species of management concern for Lehman Cave include the endemic species, the pseudoscorpion, *Microcreagris grandis*, the millipede *Nevadesmus ophimontis*, and the fly *Megaselia necpleuralis*. These species are 3 of the known 12 endemic cave invertebrates in the park. They are found in other caves, Lehman Cave is the easiest cave to access to see them. These species are of concern as they are only found in caves in one mountain range in the world.

Lehman Cave is considered a guano-based ecosystem. Bats, packrats, and other animals that come and go from the cave leave nutrients in the form of guano. Cave invertebrates are able to use those nutrients. The development of Lehman Cave into a show cave in 1885 changed the ecosystem. People coming into the cave leave behind hair, skin cells, and lint from their clothing. They may also leave behind food, such as crumbs or items that fall from their pockets. In 1941, cave lighting was installed in the cave. These artificial light sources also provide an unnatural habitat for cave biota. The lights cause lampenflora, a combination of algae, mosses, and bryophytes, to grow near them. The lampenflora can elevate numbers of cave biota in some places. Stark (1969) found Collembola (springtails) at 30.5% of the 200 lights studied, and an oligochaete worm at 10% of the lights. Recent biomonitoring finds springtails always on an algae-covered rock next to a light by the Queen's Bathtub.

Alternative 1-No Action: Impacts on Cave Invertebrates

Impact Analysis
Under Alternative 1 -No Action, cave invertebrates would continue to receive the same amount of attention, with quarterly biomonitoring by park staff. Cave tours with over 30,000 people a year would continue, with little done for lint abatement. The abundance of lampenflora/algae near some of the lights would continue to offer an artificial food source for cave invertebrates, which is a direct, adverse, long-term, minor, site-specific impact to them.

Cumulative Impacts
Cave tours (recreational use) and associated lighting are ongoing impacts. These are already addressed under the No Action Alternative impact analysis. Restoration and lint camps have the potential to negatively impact cave biota through habitat disturbance and direct mortalities.

Conclusion
Not implementing the Lehman Caves Management Plan and continuing under the status quo could result in direct, adverse, long-term, minor, site-specific impacts to species of management concern.

Alternative 2- Proposed Action: Impacts on Cave Invertebrates
Impact Analysis
Under Alternative 2, implementing the LCMP would result in a new cave lighting system that would lessen algae in the cave. This would reduce the artificial food source for cave invertebrates.

Installation of the new lighting system, along with elevating sections of trail, installing lint curbs, and other infrastructure upgrades could cause short-term, minor adverse effects to cave invertebrates. Many cave invertebrates are able to move short distances in the cave and are likely to avoid areas of disturbance. The infrastructure upgrades would take place over approximately 9,000 square feet of cave. The total size of the cave is approximately 100,000 square feet, so approximately 9% would be affected. This disturbance would likely last for approximately 1 week per 300 square feet. Mitigations would include looking for cave invertebrates before disturbance and relocating them to protect them.

The LCMP will encourage more biological research in the cave, which would help the park better understand the natural history of cave invertebrates. This lack of data hampers management.

Cumulative Impacts
Cave tours (recreational use) and associated lighting are ongoing impacts. These are already addressed under the No Action Alternative impact analysis. Restoration and lint camps have the potential to negatively impact cave biota through habitat disturbance and direct mortalities.

Conclusion
Alternative 2 would increase a direct, adverse, short-term, minor, site-specific effect to cave invertebrates when infrastructure is being upgraded, but would have a direct, beneficial, long-term, minor, site-specific effect to cave invertebrates.

BIOLOGICAL RESOURCES –SPECIES OF MANAGEMENT CONCERN (BATS)

Affected Environment

Bats are critical components of cave ecosystems, their guano and carcasses provide critical subsidies to nutrient limited cave ecosystems. All bats in Great Basin National Park are insectiviorous. Insectivorous bats consume vast quantities of nocturnal insects (such as moths and beetles) estimated to provide $3.7 - $53 billion dollars per year in pest control to agriculture in North America. Although several species of bats are documented roosting in Lehman Caves, Townsend's big-eared bat life history revolves around caves and mines. Past declines in Townsend's big-eared bat populations have been attributed to disturbances in caves, including commercialization and the development of show caves such as Lehman Caves (Pierson and Rainey 1998). However recent improvements in cave and mine management; particularly bat compatible closures and gates, have allowed the species to stabilize and increase in the western US since 1980 (Hammerson et al. 2017). The natural entrance of Lehman Caves has been altered several times during the last century. It was sealed shut in 1959 and remained closed for almost 40 years. In 1998, a bat compatible cupola was installed to allow natural debris, bats, and other wildlife to enter Lehman Caves. Bats have rediscovered Lehman Caves after nearly a century of exclusion and populations appear to be increasing.

Figure 2. Cluster of approximately 25 Townsend big eared bats. Clusters typically form to maximize thermal environment for developing pups. Photo by Joseph Danielson.

Big-eared bats in Lehman Caves are part of a larger metapopulation. This metapopulation relies on subterranean roosts on the landscape to complete their life cycle. Roost switching is an important and poorly understood aspect of the metapopulation dynamics of Townsend's big-eared bats. During maternity season, roost switching occurs in response to variety of stimuli. For example, females sometimes carry their young to new caves after human disturbance or to find more favorable microclimates. Females actively thermoregulate, choosing optimal temperatures and microclimates for gestation, parturition, and pup rearing. Variable surface and cave temperatures likely play a role in roost switching. When pups become volant, the entire colony may move to cooler roosts to minimize energy expenditure.

Male and female big-eared bats separate for much of the summer. Males are less dependent on caves than females and summer in cooler roosts in cracks and crevices to conserve energy via daily torpor. Females emerge from hibernation and move to warmer roosts for gestation, parturition, and pup rearing. Gestation and maternity roosts are often located at cave entrances, in the twilight or sunlit zones, where warmer temperatures facilitate growth of pups. To save energy and conserve heat, females and pups form clusters in maternity roosts. Unlike hibernacula, maternity roosts are identifiable by fresh guano, which accumulates under clustered bats. Young bats can fly at two and a half to three weeks of age and are fully weaned by six weeks age. Maternity colonies break up in August. Swarming and mating are poorly documented in Townsend's big-eared bats but likely occur in the fall outside the hibernacula.

Historically, Townsend's big-eared bats likely hibernated exclusively in caves (Sherwin et al. 2009). Currently, the Nevada hibernacula with the largest numbers of bats are in mines, where multiple openings and levels facilitate air flow and cold conditions required for Townsend's big-eared bat hibernation. During hibernation most big-eared bats are solitary or clustered in small groups. Big-eared bats hibernate in the open which makes them highly detectible during winter surveys. Individuals arouse frequently and change locations during the winter. Guano is typically absent from hibernacula.
Townsend's big-eared bats tagged at Lehman and Pictograph Caves have been recaptured at hibernacula in Chief Mine and Forgotten Cave, 16 and 11 miles distant from their capture site, respectively. While this suggests that hibernacula in the park are limited, a handful of big-eared bats hibernate in Lehman Caves and this number may be increasing. This suggests that conditions in Lehman Caves are suitable for hibernating bats.

Although roosting bats seem to have adapted to the presence of cave tours, tours are an adverse, long term, minor impact. During cave tours, maintaining quiet and low lights under the natural entrance is an important mitigation to minimize disturbance to bats.

Alternative 1-No Action: Impacts on Bats

<u>Impact Analysis</u>
Under the No Action alternative, bats would continue to be monitored by park staff, through acoustic monitoring, roost surveys, and PIT tag arrays. The park would maintain bat partnerships with Nevada Department of Wildlife, Bureau of Land Management, academic partners, and Nevada Bat Working group. PIT tag arrays would continue to operate and data would be downloaded monthly. Bats would continue to be monitored in Lehman Caves using roost loggers to document high frequency echolocation calls and bat distribution in the cave.

<u>Cumulative Impacts</u>
Cave tours and associated lighting are ongoing impacts. These are already addressed under the No Action Alternative

<u>Conclusion</u>
Not implementing the Lehman Caves Management Plan and continuing under the status quo could result in continuation of indirect, adverse, long-term, minor, site-specific impacts to Townsend's big eared bats, a species of management concern. Townsend's big-eared bats seem to be increasing locally, and Lehman Caves is an important for these metapopulations as a maternity roost, transitional habitat, night roost and occasional hibernaculum. Currently bat use is limited to the

natural entrance, the entrance tunnel and occasionally the Gothic Palace and Civil Defense Passage. Although cave tours and lighting could play a factor in bat distribution, climate seems to be the major determinant of bat use in Lehman Caves.

Alternative 2- Proposed Action: Impacts on Bats

Impact Analysis

Implementation of the proposed action would have some short term, direct, adverse minor impacts on bats. Construction noise and vibrations could disturb hibernating bats and maternity clusters, potentially causing bats to abandon Lehman Cave temporarily. Without mitigation, these impacts could result in abandonment of pups, causing mortality, and reducing recruitment and population growth. Mitigation, monitoring, and timing of construction under the natural entrance will be important to minimize construction impacts to bats. Installation of the new, more functional lighting system would maximize darkness in Lehman Caves, potentially allowing bats to exploit portions of the cave currently not utilized. This would be a long term, beneficial, minor impact. During construction, impacts to bats would be short term, adverse, and minor. Mitigation of construction timing (seasonal and diurnal) and intensity (lights and noise) would reduce these impacts to negligible. Long term impacts of an improved lighting system would be beneficial, long-term, and minor potentially opening up portions of Lehman Caves to bat use.

Cumulative Impacts

Cave tours and associated lighting are ongoing impacts. These are already addressed under the No Action Alternative.

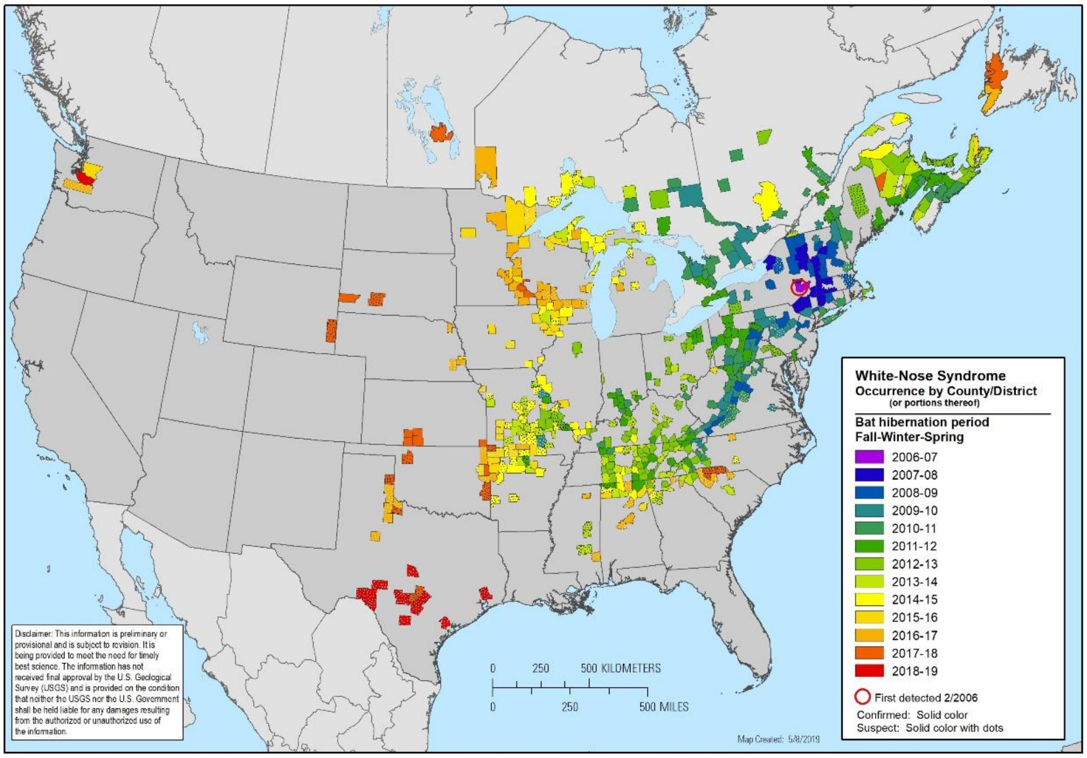
Conclusion

The LCMP will encourage continued and additional research on bats, which would help the park better understand the roosting switching, thermal preferences, and metapopulation dynamics of Townsend's big-eared bats. This lack of data hampers management but will improve management through better understanding of bat distribution and roost use on the larger landscape.

BIOLOGICAL-NON-NATIVE SPECIES (WHITE NOSE SYNDROME)

Affected Environment

White-nose syndrome (WNS) is a disease in bats caused by the fungal pathogen *Pseudogymnoascus destructans* (Pd). WNS has caused mortality rates of up to 100% in some bat populations and has killed over 5.7 million bats in the eastern United States. WNS likely arrived in New York State from Europe in 2007 and has spread as far west as Washington state. Predictive models suggest WNS could arrive in the park by 2025 (Maher et al. 2012; Ihlo 2013). The park currently does not allow any clothing, footwear, or gear that has been in a county with WNS to enter any wild caves. Clothing, footwear, and gear that has been in caves in non-WNS areas must be decontaminated before entering any park caves, and between trips in any park caves. Visitors to Lehman Caves are screened for previous visits to caves and mines. If visitors have been in caves or underground mines in areas of documented WNS, their clothing and other items are decontamined before they enter Lehman Caves. The park follows the latest USFWS decontamination protocols, available at: https://www.whitenosesyndrome.org/topics/decontamination .



Citation: White-nose syndrome occurrence map - by year (2019). Data Last Updated: 5/8/2019. Available at: https://www.whitenosesyndrome.org/static-page/wns-spread-maps.

Figure 3. Current map of White Nose Syndrome documentation by county and year in the United States. Map is current as of 8 May 2019 and updated regularly at https://www.whitenosesyndrome.org/

Alternative 1-No Action: Impacts on White Nose Syndrome

<u>Impact Analysis</u>
Under Alternative 1 -No Action, visitors to Lehman Caves would continue to be screened and footwear decontaminated for WNS. Park employees would continue to follow WNS decontamination protocols. Currently WNS is not found in the park so there are no impacts to bats. In spite of strict adherence to decontamination protocols and guidelines, Pd, the fungal pathogen causing WNS, travels at a rate of approximately 500 miles per year (citation), transported by movements of bats, which can disperse over 10,000 miles during migration (citation). Eventually when Pd arrives at Lehman Caves, the impacts and susceptibility of park bats to WNS will have to be reassessed. When Pd arrives, decontamination of visitors and park staff leaving Lehman Caves may be warranted to minimize the rate of spread of WNS to uncontaminated regions.

Alternative 2- Proposed Action: Impacts on White Nose Syndrome

Impact Analysis

The impacts of the proposed action and the no-action alternatives on WNS are similar. As Pd is primarily transported by bats, the proposed action will not differ from the no action alternative in impacts.

BIOLOGICAL-NON-NATIVE SPECIES (ALGAE)

Affected Environment

The overwhelming number of plants, lichens, and mosses are found at or near the artificial lights in the cave. Stark (1969) found 77.5% of the 200 lights studied contained algae, 20.5% had mosses, and 75% had evidence of fungi. Collectively, we are calling these lampenflora, with the nickname algae, as it is the predominant feature.

Figure 4. Lampenflora, a combination of algae, moss, and bacteria, which grows unnaturally in the cave due to the presence of cave lights.

In 2006, a National Park Foundation grant provided funding a comparison of different LED bulbs, compact florescence, and incandescent bulbs. Different types of light bulbs were studied for use in the cave to reduce the amount of lampenflora (algae, moss, bacteria) that grows near lights (Figure 4). To restrict lampenflora, LEDs in the 592-595 nm wavelength can be used. In-cave testing, however, showed that this wavelength produced an unnatural appearing orange/red light that disguised the true colors of the cave and had safety concerns due to the dim light on trails.

In 2009, it was decided to change all the lightbulbs in the cave to LED lightbulbs. Optiplex and Enlux brands were chosen. Lampenflora still exists at many cave lights but the patch size and density have been greatly reduced. Further reductions are accomplished through the annual cleaning of lampenflora with a 10% bleach solution.

A second multi-park study was completed in 2011. Both studies showed that light-emitting diodes (LEDs) were the preferable light source as they emitted less heat than incandescent or compact fluorescent light bulbs.

Alternative 1-No Action: Impacts on Non-Native Species--Algae

Impact Analysis

Under Alternative 1 -No Action, no changes to cave lights would be made. Most of the cave lights would continue to be LED full spectrum lights. An annual cleaning of algae with a 10% bleach solution would continue. The abundance of algae near some of the lights would continue to offer an artificial food source for cave invertebrates, which is a direct, adverse, minor impact to them.

Cumulative Impacts
Cave tours and associated lighting are ongoing impacts. These are already addressed under the No Action Alternative.

Conclusion
Not implementing the Lehman Caves Management Plan and continuing under the status quo would continue non-native algal growth. This would result in direct, adverse, localized, long-term, minor impacts to the cave environment due to non-native species.

Alternative 2- Proposed Action: Impacts on Non-Native Species--Algae
Impact Analysis
Under Alternative 2, implementing the LCMP would result, if funding is found, in a new cave lighting system that would lessen algae in the cave. LED lights with limited wavelengths would be used to reduce the light available for algae to grow. This would reduce the artificial food source for cave invertebrates. The resulting impacts to the cave environment would be direct, beneficial, localized, long-term, and minor.

Cumulative Impacts
Cave tours and associated lighting are ongoing impacts, but a changed lighting system would reduce these overall cumulative impacts as described above.

Conclusion
Alternative 2 would result in direct, beneficial, localized, long-term, and minor impacts to the cave environment due to the reduction of non-native species.

CULTURAL-CULTURAL LANDSCAPES (PREHISTORIC/HISTORIC ARCHAEOLOGICAL RESOURCES, HISTORIC STRUCTURES)

Affected Environment
Lehman Caves has been a landscape of cultural activity in the prehistoric as well as the through the historic past (1968, 50 years ago). Archaeological investigation of the cave began in the 1937. S.M. Wheeler reported on excavations in the natural entrance area. Bones were found and identified as Native American. No evidence of long-term occupation was reported.

In 1963 Charles Rozaire of Nevada State Museum also excavated about 30% of the natural entrance area. More bone fragments and evidence of burned wood charcoal were found. The report concluded the bones were scattered and were probably not intentionally buried in the locations where they were found. Radiocarbon dating techniques were new and the dates returned were inconclusive.

Absolom Lehman's cave "discovery" in the 1880s and breaking formations to explore deeper into the cave began the era of touring and scientific interest. Since that time, episodes of "improvements" added trails, stairs, tunnels, and eventually lighting. Each infrastructure addition was part of the growing interest for public cave tours. Visitors also left their marks. Inscriptions recorded names of visitors and dates of events. Items left in the cave either intentionally, like coins tossed in pools of water, or sandals and flash bulbs lost in passing, became artifacts of the recreational touring. Various activities were held in the cave including; fraternal rites, concerts, weddings, dances, and filming for a planetary science fiction movie. All of these artifacts, infrastructure, and activities are part of the cultural landscape of Lehman Caves.

Alternative 1- No Action: Impacts on Cultural landscapes (prehistoric/historic archaeological resources and historic structures)

Impact Analysis

Under Alternative 1 -No Action, current cave activities affecting cultural landscapes (prehistoric/historic archaeological resources and historic structures) will continue. Cultural resources are a finite non-renewable resource, once damaged they cannot be replaced. Cave tours can have a negative impact. Inscriptions can be directly damaged by touching, rubbing, or indirectly damaged by introduction of lint and lights promoting algal growth on organic ink inscriptions. Other cave activities requiring special use permits, park-sponsored activities, and infrastructure changes are conducted on a case by case decision. Damage to the archaeological deposits can occur during cave cleaning, and infrastructure activities. Currently there are no specific guidelines to protect the cultural landscape. Under this alternative there would be negative, minor, direct and indirect long-term, impacts.

Cumulative Impacts

Cumulative impacts to cultural landscapes (prehistoric/historic archaeological and historic structures) may cause permanent loss of cultural landscape resources. Each damage incident reduces the overall archaeological information and historic value. Continuing the current practices will result in cumulative, negative, moderate, direct and indirect impact.

Conclusion

Under current practices there is no scientific information for identifying carrying capacity and resource protection. Issuing cave activity permits, and implementing infrastructure changes on a case-by-case basis does not provide adequate protection for the cultural landscape. Current practices have a negative impact on the cultural landscape. These impacts are irreversible, therefore continuing these practices will result in negative, cumulative, long term, moderate to major negative impacts to the cultural landscape (prehistoric/historic archaeological resources and historic structures).

Alternative 2- Proposed Action: Impacts on Cultural landscapes (prehistoric/historic archaeological resources and historic structures.

Impact Analysis

Under Alternative 2, implementing the LCMP would result in improved documentation of the cultural landscape including both the prehistoric and historic archaeological components. The LCMP desired future condition for Lehman Caves cultural resources is to protect them throughout the cave. This includes protection and restricted access for the natural entrance area. In addition carrying capacity studies would consider impacts to cultural resources and provide baseline for monitoring and condition assessment of sensitive resources.

Cumulative Impacts

Establishing cave tour capacity and permitting guidelines that include the need to protect cultural resources would reduce the cumulative negative impacts to sensitive cultural resources.

Conclusion

Overall, the complete documentation of the historic landscape (prehistoric/historic archaeological resources and historic resources), and consideration of those resources when establishing guidelines for tour capacity, and special permitting proposed in Alternative 2 would result in direct, beneficial, long-term, and moderate impacts to the cultural landscape (prehistoric/historic archaeological resources and historic structures).

CULTURAL-ETHNOGRAPHIC RESOURCES

Affected Environment

The South Snake Mountain Range is recognized by area Shoshone, Goshute, and Paiute Tribes as part of their cultural use area. Both the physical and spiritual aspects of the cave hold great importance for the Tribes and are ethnographic resources. Some Tribal members have expressed that use of the cave for tours has disrupted the activity of spiritual beings. In addition, Tribal members indicated cave formations were sometimes used in doctoring ceremonies. Some aspects of cave importance are only discussed among appropriate Tribal people.

In 1998 bones removed during archaeological excavation in the 1930s and 1960s were returned to the natural entrance area of the cave. Tribal representatives placed the people who were returned in a stone crypt. The crypt was sealed to prevent further disturbance. Currently the crypt area is off-limits to everyone, including researchers and staff. Excess stone from the crypt was left in the cave. Soils above the entrance tunnel that may contain ethnographic material are not currently monitored and may erode from the excavation areas.

Tribes requested access to the cave to conduct ceremonies for the ones placed there. The area remains a place of deep respect for the Tribes and request for respect and as little disturbance or disruption is also requested. Contact with the Tribes continues on an infrequent basis. Executive order 13007 requires NPS to provide reasonable access for Tribes to use sacred sites for ceremonial purposes.

Alternative 1- No Action: Impacts on Ethnographic resources.

Impact Analysis

Under Alternative 1 -No Action, current cave activities affecting ethnographic resources are expected to continue. Cave tours would continue to pass below the natural entrance crypt burial area. Guidance requests visitors and tour guides show respect for the area by passing quietly and not disturbing the ones in the crypt. Excess stone from the crypt would be left in place and soils potentially containing ethnographic resources would not be monitored or stabilized. Current impacts are negative, minor, indirect and direct, and long-term. Under this alternative there would be no change.

Cumulative Impacts

Cave tours and associated audible disturbance are ongoing impacts. These impacts are indirect, negative, minor, and long-term, for the ethnographic resource.

Conclusion

The no action alternative would continue current practices. Ethnographic resources would continue to experience negative indirect impacts from cave tours. Soils potentially containing ethnographic resources could erode causing negative, direct, long-term, localized minor impacts. Overall the no action alternative would result in negative, indirect and direct, long-term, cumulative, minor impacts.

Alternative 2- Proposed Action: Impacts on Ethnographic resources.

Impact Analysis

Under Alternative 2, implementing the LCMP, cultural resources including ethnographic resources would be protected. This includes the crypt area that would continue to be off-limits to everyone, including researchers and staff. The excavation area would continue to be restricted. Tours will be quiet as they pass under the natural entrance. Cultural sensitivity training for park staff by Shoshone representatives is recommended. Tribes would be given access to Lehman Caves for prayer and ceremony. Consultation with tribes for ceremony is ongoing and a process will be developed as communication proceeds. These actions are expected to provide better protection for ethnographic resources and impacts will be direct and indirect, beneficial, minor, and long-term.

Cumulative Impacts

Under Alternative 2, better communication with the Tribes will reduce the cumulative impact of ongoing cave tours and activities by establishing culturally sensitive procedures. Restricted access and stabilizing soils that potentially contain ethnographic material will reduce the continued and cumulative disturbance of the natural entrance area. Impacts will be beneficial, long-term, minor, localized, impacts.

Conclusion

Under Alternative 2, the LCMP would be fully implemented. Ethnographic resources would be protected. The crypt area would be off limits to research and staff minimizing any disturbance. The excavation area would have restricted access. The soils potentially containing ethnographic material would be assessed, monitored, and if necessary stabilized to prevent erosion into the entrance tunnel. Consultation with Tribes would be improved and sensitivity training would provide information for interpretive staff. Overall this alternative would have direct and indirect, beneficial, long-term, minor impact.

CULTURAL- MUSEUM COLLECTIONS

Affected Environment

The National Park Service collects, protects, and preserves objects, artifacts, specimens, and archives and makes them available for use in research. Lehman Caves has prehistoric and historic artifact deposits, biological and geological resources. Items are collected and removed from the cave and reports and data generated through cave studies are entered in the museum collection and archives. All items remain property and responsibility of the National Park Service. Care of those items requires space and curatorial staff to maintain conditions and records for all collections. Museum collections from the cave are housed in the park curatorial space, at Western Archaeological Conservation Center (WACC) an NPS repository, and on loan to various university research institutions. Museum curation space in the park is at capacity.

Alternative 1- No Action: Impact on Museum collections.

Impact Analysis

Under Alternative 1 -No Action, current cave activities that affect museum collections would continue. Artifacts collected and reports and data generated in cave activities and research, add to the museum collection volume. Overcrowding in museum space has a negative impact on collections care. Due to space and staff limitations, this alternative will continue to have a adverse, minor, long-term, localized, impact on museum collections.

Cumulative Impacts
Under Alternative 1 – No Action, it is assumed museum collections from the cave will accumulate. This will continue to have indirect,adverse, minor, long-term, localized, impacts to museum collection capacity and care.

Conclusion
Alternative 1 – No Action will continue current practices that do not take long term storage and staffing requirements for museum collections into consideration. Museum overcrowding and lack of staffing will have indirect, adverse, minor, long-term, localized, impacts on museum collections.

Alternative 2- Proposed Action: Impact on Museum collections.
Impact Analysis
Under Alternative 2- Proposed Action the LCMP will be fully implemented. This plan calls for specific monitoring protocols, encourages more scientific research, and continues a yearly cleaning plan that may recover artifacts. All of these activities add to space and staffing needs for the museum collections. There is no current plan to increase space or staffing to meet these needs, therefore this alternative will have indirect, adverse, minor, long-term, localized effect on museum collection conditions.

Cumulative Impacts
Under Alternative 2- Proposed Action the LCMP will be fully implemented. As identified in the analysis the cumulative impact of this alternative will be indirect, adverse, moderate, long-term, and localized for museum collection.

Conclusion
Alternative 2 will result in increased museum archive collection and artifact collection. Current museum space and staffing will not provide adequate care for current and increasing collections. Therefore, this alternative will have indirect, adverse, minor, localized, long term and cumulative impacts for museum collections.

GEOLOGIC RESOURCES (BEDROCK & SPELEOTHEMS)

Affected Environment
Geologic Resources in the project area likely to be impacted consist primarily of carbonate bedrock and speleothems.

Bedrock
The southern Snake Range consists of a vast array of rock types and ages. Of primary interest for this document is the Middle Cambrian Pole Canyon Limestone, which is more correctly identified as a marble in this location. Lehman Caves is found entirely within this marble (Hose 2018a).

The Pole Canyon Limestone and other Cambrian age units were deposited when the area was a shallow and nearshore marine environment (Drewes and Palmer 1957).

Much later, “The Pole Canyon probably was initially metamorphosed in the late Mesozoic (Jurassic and Cretaceous) during the time of an extraordinarily high geothermal gradients (Miller and Gans, 1989) and nearby granitic intrusions. However, it appears that the Pole Canyon at the cave site is much more strongly metamorphosed than the Limestone described elsewhere in the Snake Range. Therefore, it seems likely that the Pole Canyon Limestone experienced a second, more intense and localized metamorphic event in the Tertiary” (Hose 2018a).

The bedrock is very heavily fractured with abundant joints and faults in the walls and ceilings (Hose 2018a).

Speleothems

Lehman Caves is known to contain a wide variety of and abundant speleothems
Many speleothems are made of calcite ($CaCO_3$). Pool deposits, where calcium carbonate usually crystallizes as calcite, include rimstone, shelfstone, folia, and cave rafts. Flowing and dripping water create gravitationally influenced speleothems of calcite and include cave pearls, flowstone, stalactites, soda straws, stalagmites, columns, and draperies. Speleothems formed by capillary water include helictites, anthodites, shields, and welts (including bulbous stalactites). Evaporative speleothems such as coralloids (cave popcorn is the most common example), frostwork, and gypsum crusts are present in Lehman Caves. Speleothems influenced by microbial activity include moonmilk (Hill and Forti 1997, Palmer 2007).

The biggest growth period for speleothems has been determined by research. “Dennison (2007) used uranium-series dating techniques to determine the age of dozens of stalagmites within Lehman Caves. His dates ranged from 7740 to 466,600 years old with the majority of dates between about 125ka[18] and 250 ka, associating most calcite speleothem growth with “full glacial and full interglacial periods” in the Pleistocene. One stalagmite date by Lachniet and Crotty (2017) is 2.21 Ma old, representing at least some calcite speleothem growth as early as the Pliocene. It appears that very little calcite speleothem growth has occurred since the Pleistocene. An exception is likely to be the abundant cave coral that is probably associated with condensation-corrosion processes and has grown (and, perhaps, still grows) from seasonal condensation” (Hose 2018b).

Hose (2018b) continues: “Research has shown that these speleothems do not grow at an even pace, and that gaps of tens of thousands of years in growth are possible (McGee 2011). Over time, some speleothems lose their color and luster. This often occurs due to drying, which can cause the disintegration of the crystal structure of the speleothem. Bacteria can also break down calcite, often forming moonmilk in the process. Condensation-corrosion can cause speleothems to be worn down where carbon dioxide content is high, with a chalk-white speleothem remaining. Just as oversaturated waters create speleothems, undersaturated water can dissolve them away (Hill and Forti 1997). Speleothems in many different states of formation and dissolution are present in Lehman Caves.”

Alternative 1-No Action: Impacts on Geologic Resources

Impact Analysis

Under Alternative 1, No Action, lint would continue to accumulate on geologic resources in the cave, possibly changing their pH and affecting cave processes, particularly speleothem deposition. The disruption of natural airflow in the cave due to the blasting of the tunnel into the West Room likely causes additional drying and possibly condensation-corrosion of both speleothems and bedrock. Continued No Action may cause direct, adverse, long-term, minor, site-specific impacts to speleothems and bedrock.

Cumulative Impacts
Cave tours and associated lighting are ongoing impacts. These are already addressed under the No Action Alternative.

Conclusion
Continued impacts of tourists inadvertently leaving lint in the cave and cave infrastructure that promotes unnatural airflow in the cave would likely cause direct, adverse, long-term, minor, site-specific impacts to speleothems and bedrock.

Alternative 2- Proposed Action: Impacts on Geologic Resources

Impact Analysis
Under Alternative 2, if funding is found, more lint mitigation would occur, including grates outside cave entrances and lint curbs. This would help keep the lint more contained and easier to clean, which would keep it off speleothems. A door would be installed at the entrance of the West Room to restore natural airflow. This should reduce drying effects and condensation-corrosion in this area. These actions would result in direct, beneficial, long-term, minor, and localized impacts to cave geologic resources.

Cumulative Impacts
Cave tours and associated lighting are ongoing impacts, but improvements in infrastructure would reduce these overall cumulative impacts as described above.

Conclusion
Alternative 2 would result in direct, beneficial, long-term, minor, and localized impacts to the cave geologic resources due to the reduction of lint and unnatural airflow.

HUMAN HEALTH AND SAFETY (COMMUNICATIONS, ELEVATED TRAIL HEIGHTS, LIGHTING)

Affected Environment
Human health and safety in Lehman Caves is a priority. Communications in the cave are possible with park radios in selected areas of the cave. Many areas do not receive radio signals.

The half-mile trail through the cave has been improved since its development in 1885. The initial trail surface was sand, topped with asphalt in from 1955 to 1958. Concrete was placed on top of the asphalt in 1974. Tread and non-slip surfacing were added to sections of the concrete in 1998-2000.

Lehman Caves has had electric lights in it since 1941. In May 1977, the Secondary Electrical Rewiring Project began under a contract with Webber Electric, Inc., and was completed by December 1977 (Moore 1977). All existing cave lighting fixtures, except fixtures in the exit tunnel, were rewired. All lighting fixture outlet boxes were replaced with non-metallic boxes. Six new transformers were installed. New power panels and relay panels were installed at all these transformer locations. A solid-state modular dimming system was installed at the first transformer location to control the three lighting circuits in the Gothic Palace (Trexler 1977 addendum). A new low voltage remote switching system was installed that allowed shorter sections of the tour route to be lighted as tours passed through, thereby inhibiting the growth of algae. This was a major recommendation from Dr. Raymond Lynn, who had been studying the biology of the cave for several years (Moore 1977).The number of lighting sections in the cave was doubled. Twenty-five new switches were installed and 6,250 feet of UF switching cable installed. A total of 13,250 feet of new underground feeder (UF) type circuit cable was installed throughout the cave. A new grounding system was installed throughout the cave and terminated at a new ground rod installed at the existing transformer site near the Visitor Center. (Trexler addendum 1977).

Figure 5. Lampenflora, a combination of algae, moss, and bacteria, which grows unnaturally in the cave due to the presence of cave lights.

During 1999 and 2000, 25 corroding electrical boxes, as well as numerous outlets and lights were replaced with noncorrosive ones. In addition, maintenance staff repaired five light switches (of the eight present in the cave) and four switching relays.

In 2006, a National Park Foundation grant provided funding for some renovation of the cave lighting system. During that year, many light fixtures, receptacles, and switches were repaired or replaced with non-corrosive materials. A comparison of different LED bulbs, compact florescence, and incandescent bulbs was also begun. Different types of light bulbs were studied for use in the cave to reduce the amount of lampenflora (algae, moss, bacteria) that grows near lights (Figure 26). To restrict lampenflora, LEDs in the 592-595 nm wavelength can be used. In-cave testing, however, showed that this wavelength produced an unnatural appearing orange/red light that disguised the true colors of the cave and had safety concerns due to the dim light on trails.

In 2009, it was decided to change all the lightbulbs in the cave to LED lightbulbs. Optiplex and Enlux brands were chosen. Lampenflora still exists at many cave lights but the patch size and density have been greatly reduced. Further reductions are accomplished through the annual cleaning of lampenflora with a 10% bleach solution.

A second multi-park study was completed in 2011. Both studies showed that light-emitting diodes (LEDs) were the preferable light source as they emitted less heat than incandescent or compact fluorescent light bulbs.

Between 2008 and 2011, the trail and the electrical lighting system in the Talus Room was removed, including all light fixtures, electrical line, conduit, and the transformer located at the lowest point of the Talus Room.

As of 2016, Lehman Caves has four transformer locations with eight transformers, 265 light fixtures, and 17 switches. Evidence of past lighting systems is still evident in many sections of the cave.

During the winter of 2017-2018, the lights from the Lodge Room to the Exit Tunnel went out after Thanksgiving and were not able to be fixed until about Easter of 2018, despite multiple attempts by maintenance staff. Tours continued through this section, with visitors advised to turn on their own lights to help see the way out of the cave.

Alternative 1- No Action: Impacts on Human Health and Safety

Impact Analysis

Under the No Action Alternative, no changes would be made for human health and safety. Communications would remain spotty. Some sections of the trail would remain slippery. The old lighting system would hopefully continue to work, with fixes as necessary. Wires that go through pools would continue to provide a risk to employee and visitor safety. Some sections of lighting might go out for extended periods of time before being fixed. These impacts are direct, adverse, localized, long-term, and minor to moderate to human health and safety.

Cumulative Impacts

Cave tours and associated lighting are ongoing impacts. These are already addressed under the No Action Alternative.

Conclusion

The No Action Alternative would result in direct, adverse, localized, long-term, and minor to moderate impacts for human health and safety.

Alternative 2- Proposed Action: Impacts on Human Health and Safety

Impact Analysis

Alternative 2, with appropriate funding. Allow for a better communications system in the cave. Either a repeater would be moved into the cave, or a telephone system installed so that cave guides could call out, and potentially important messages (such as about wildfires) could be left on the phone.

Alternative 2 would add additional non-slip surfacing and tread to approximately 200 linear feet of trail. It would also take out and remove two sections of cave trail and replace them with fiberglass, similar to the current stair tread, so that the hydrologic function would be restored. The elevation of the fiberglass trail would be about the same as the old multi-layered trail, thus additional head injuries are not expected.

With a new and improved lighting system in the cave, more emphasis would be placed on lighting up the cave trail, making it safer for cave visitors. Low spots would also be better identified. A railing would be installed along the Rocky Road section, where several low spots dotted with blood and hair exist from people bumping their heads. The railing would help folks maintain their balance as they crouch down.

These impacts on human health and safety for Alternative 2 are direct, beneficial, localized, long-term, and minor to moderate.

Cumulative Impacts
Cave tours and associated lighting are ongoing impacts. These impacts are direct, adverse, localized, long-term, and minor to moderate to human health and safety.

Conclusion
Overall, improvements to communications, the cave trail, and cave lighting as proposed in Alternative 2 would result in direct, beneficial, localized, long-term, and minor impacts to human health and safety.

SOCIOECONOMIC (NUMBER OF VISITORS)

Tour Visitation

Affected Environment
Tours have been conducted through Lehman Caves for over 133 years. Tours began as self-guided and with heavy impact to the geologic cave environment, to tours that include messages to protect the cave environment. The size of ranger guided tours has changed over the years going from ranger guided tours of 100 people during special event to 20 people on a regular tour.

The most popular tour is the Grand Palace Tour which is 90 minutes long and allows visitor to see the entire tour route of the cave. Over the last three years the number of Grand Palace tours has been close to 1200 tours a year, 1,191 in 2016, 1208 in 2017 and 1,177 in 2018. Number of tours given in 2018 were fewer due to a slightly smaller staff size but the number of visitors served was up in 2018 over 2016 and 2017. Visitors on Grand Palace tours in 2016 were 19,764, in 2017 it was 19,264 and in 2018 it was 20,986. All number are based on a fiscal year from October 1 through September 30.

Cave tours draw a high percentage (approximatley 20%) of park visitors versus other ranger programs at most National Park nationwide which have about 11% of visitors participate in ranger programs. This is due in part to the fact that visitors cannot go into the cave without a ranger both for visitor safety and to protect the cave.

The outstanding features of the cave itself and the quality of the ranger programs keep visitors highly satisfied with their cave tour experience. Many regional visitors come back for repeat visits bringing family and friends with them.

Alternative 1-No Action: Impacts on Socioeconomics

Impact Analysis

Under Alternative 1 -No Action, tours would continue as they are now with a 20-person maximum on each tour and up 20 tours a day. The potential for economic growth could become stagnant as the number of people on cave tours or tour types would not change.

Cumulative Impacts
The cave environment would be much the same but numbers or visitors and types of experiences they have with the cave would be limited to present day levels.

Conclusion
No action would have minimal impact in the short term. Programs would stay the same and the number of visitors to the cave would stay the same. In the long term, the limited types of tours may feel restrictive, therefore the impacts on socioeconomics are direct, adverse, localized, long-term, and minor to moderate.

Alternative 2- Proposed Action: Impacts on Socioeconomics

Impact Analysis

Under Alternative 2, implementing the LCMP would result, if funding is found, for the development of new types of cave tours, including a Wild Cave Tour. This draws a different audience to the cave, ones seeking adventure. It can also contribute to some visitors staying in the park and local communities longer as they participate in the different types of cave tours.

Cumulative Impacts
Regular cave tours would also be offered.

Conclusion
Under the Alternative 2, the Proposed Action, the park would offer new, more adventurous experiences like wild cave tours, "behind the scenes" tours, or distance learning programs about the cave. These programs have the potential to draw in additional visitors or contribute to visitors coming the park to stay longer for more diverse activities and increasing income from visitor service in both the park and the local communities. This impact to socioeconomics would be direct, beneficial, localized, long-term, and minor to moderate.

VISITOR USE AND EXPERIENCE AND VISITATION

Affected Environment
Tours have been conducted through Lehman Caves for over 133 years. Tours began as self-guided and with heavy impact to the geologic cave environment, to tours that include messages to protect the cave environment. The size of ranger guided tours has changed over the years going from ranger guided tours of 100 people during special event to 20 people on a regular tour.

Visitation to the park has been increasing therefore demand for cave tours is increasing. Over the last three years the number of visitors attending cave tours has increased overall. In 2016 33,981 visitor went through the cave, 2017 – 36,681 and in 2018 36,114. All number are based on a fiscal year from October 1 through September 30. It is not expected that visitation will decrease in the near future.

Visitors can only go through the cave with a ranger. This is to protect the visitor from harm and the cave resources. It is found that on some tours this does not allow for enough time for the shutterbugs to get all the photos they want to of the cave, or for visitors to experience the cave differently via a lantern tour. The cave is also inaccessible to visitors with limited mobility and who do not have the time or means to travel to such a remote location. Distance learning education and virtual tours for all types of visitors would allow many more visitors to access the cave without impacting the cave through virtual means.

Alternative 1-No Action: Impacts on Visitor Experience

Impact Analysis

Under Alternative 1 -No Action, tours would continue as they are now with a 20-person maximum on each tour and up 20 tours a day. This has allowed us to serve over 36,000 visitors with cave tours but we also turned away 2,253 visitors who wanted to go through the cave but our tours were full.

Cumulative Impacts
The numbers or visitors and types of experiences they have with the cave would be limited to present day levels.

Conclusion
No action would result in the following impacts to visitor experience: direct, adverse, localized, short-term, and minor .Programs would stay the same and the number of visitors to the cave would stay the same. We would still be turning away visitors and have a very limited number of cave options.

Alternative 2- Proposed Action: Impacts on Visitor Experience

Impact Analysis

Under Alternative 2, the Proposed Action, implementing the LCMP would result, if funding is found, for the development of new types of cave tours, including a lantern tours, virtual tours, visitor center exhibits and distance learning. The different tours allow visitor to have multiple experiences with the cave. And for those who cannot access the cave having virtual and replica cave exhibits allows them to have fantastic views, images and experiences that are immersive, though not in the cave.

Cumulative Impacts
Regular cave tours would continue, allowing for some park visitors to have some cave experience.

Conclusion
Alternative 2, the Proposed Action, would allow more people of different abilities and means to access the cave either in person or virtually. This would result in direct, beneficial, localized, long-term, and minor to moderate impacts to visitor experience.

WATER QUALITY

Affected Environment
Lehman Caves has several perennial pools (e.g., Sunken Garden, Grand Palace, bottom of Talus Room, end of Gypsum Annex) and ephemeral pools (e.g., King's and Queen's bathtubs). Basic water quality measurements have been conducted at selected pools quarterly since 2006. These water quality measurements have helped quantify when these pools have water. Of the four pools

measured, the Sunken Garden was the only one with perennial water (Figure 5). The Queen's Bathtub had water in it approximately at half the visits (Figure 6). The pool on the way to the Lost River Passage was wet for seven springs between 2006 and 2016, as well as additional seasons in 2011 and 2014 (Figure 7). The little pool at the top of the transformers by the Cypress Swamp was only wet in 2011 (Figure 8). Basic water quality measurements, including water temperature, dissolved oxygen, specific conductance, and pH were taken at these pools (Table 2). Water quality was consistent with what is expected in cave pools.

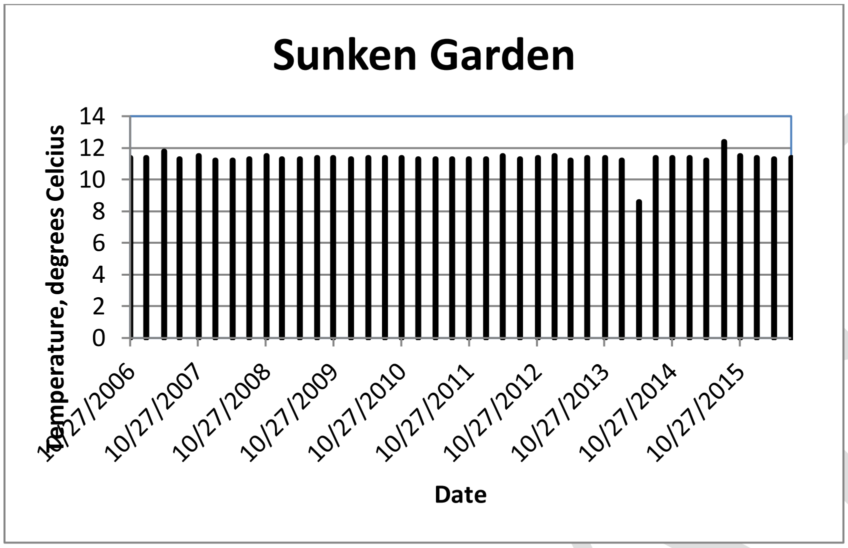


Figure 6. Water temperature at the Sunken Garden pool, measured quarterly from October 2006 to October 2016. This pool had water in it at every visit. Water temperature averaged 11.4°C.

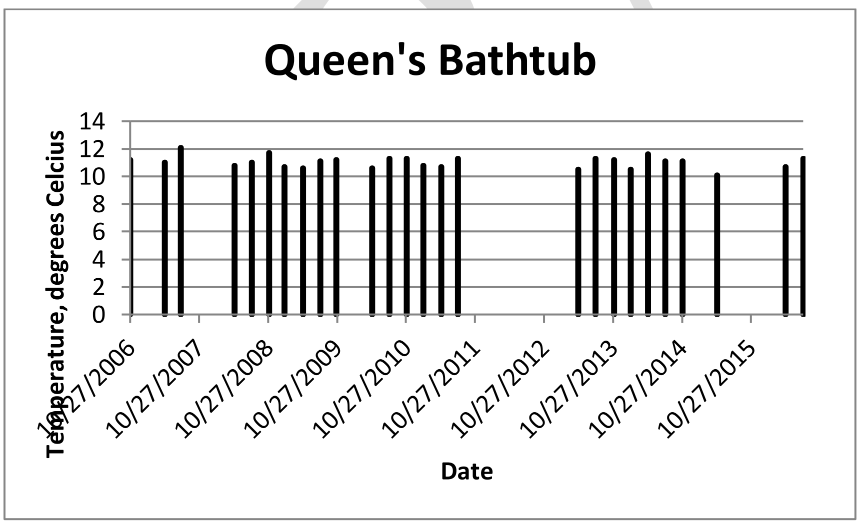


Figure 7. Water temperature in the Queen's Bathtub pool, measured quarterly from October 2006 to October 2016.Water temperature averaged 12.4°C.

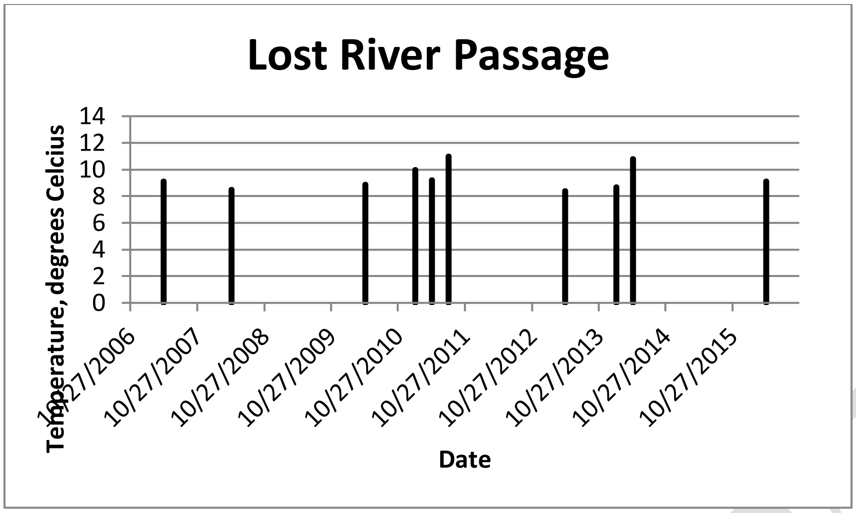


Figure 8. Water temperature in the pool on the way to the Lost River Passage, measured quarterly from October 2006 to October 2016. This pool typically only has water in it during wet springs.Water temperature averaged 9.5°C.

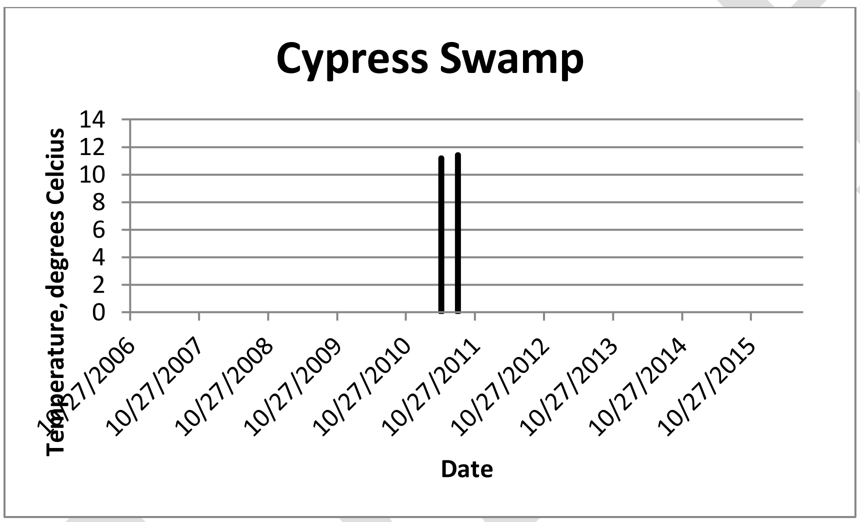


Figure 9. Water temperature in the pool after the Cypress Swamp and above the transformer box, measured quarterly from October 2006 to October 2016. This pool is usually dry and only had water in it for two visits, during the wet spring and summer of 2011. Water temperature averaged 11.3°C.

Table 1. Water quality measurements at selected pools from 2006-2016, averaged over seasons.

Location	# Times measured	Average of Water temp (deg C)	Average of dissolved oxygen (mg/L)	Average of specific conductance (uS/cm)	Average of pH (standard units)
Queen's Bathtub	34	12.4	3.8	355.4	8.0
Cypress Swamp	2	11.3	3.3	573.0	8.1
Sunken Garden	45	11.4	3.7	409.4	8.0
Lost River Passage	15	9.5	4.2	425.6	8.0

More in-depth water chemistry was conducted on the perennial pool in the Sunken Gardens by the USGS as part of a study assessing the water quality of Cave Springs (Prudic and Glancy 2009). The pool water had very little iron, but was higher than nearby springs for most dissolved constituents such as calcium, magnesium, and sodium, which is expected given the nature of the surrounding rock. Stable isotopes of deuterium and Oxygen-18 (18O) were heavier, which means that the water in the cave pool came from local sources, with most from summer precipitation. The cave water also showed evidence of undergoing some evaporation. This is not surprising as the average humidity of some parts of the cave is less than 90%. Based on chlorofluorocarbon analyses, the average age of the water in the Sunken Gardens pool was estimated to be less than 19 years old (Prudic and Glancy 2009).

Alternative 1-No Action: Impacts on Water Quality

Impact Analysis

Under Alternative 1 -No Action, tours would continue as they are now on a half-mile cave tour. The paved cave trail acts as a dam in at least three spots in the cave, not allowing for natural water flow. Electrical wires are close to or in at least two cave pools.

Cumulative Impacts
The current cave operations have a minimal impact to cave water quality.

Conclusion
No action would continue to restrict natural hydrologic processes. Impacts to water quality are direct, adverse, localized, long-term, and minor.

Alternative 2- Proposed Action: Impacts on Water Quality

Impact Analysis

Under Alternative 2, the Proposed Action, sections of cave trail that are currently impeding natural hydrologic flow would be removed and replaced with a slightly elevated trail so that water could flow under the trail. There would be short-term impacts on water quality during construction, estimated to take about six months for trail replacement. This trail replacement would take place in the winter, the driest period in the cave, when some of these pools are seasonally dry. If wet, the water quality would be expected to decline with increased turbidity. Water temperature, pH, and conductivity would be expected to stay the same. A new lighting system would not have electrical wires going through cave pools.

Cumulative Impacts
During construction, cave tours would be limited or excluded from construction areas with pool, thus there should be very few cumulative impacts to water quality.

Conclusion

Alternative 2, the Proposed Action, during construction would have direct, adverse, localized, short-term, and minor impacts to water quality. Following construction, the impacts to water quality would be direct, beneficial, localized, long-term, and minor.

CONSULTATION AND COORDINATION

SCOPING

Internal Scoping

Internal scoping began with an interdisciplinary team meeting in December 2015. Periodic meetings were held through April 2016 to determine content of the plan. Meetings were also held in February and March 2017 and May 2018 to discuss moving the plan forward and NEPA direction.

Public Involvement

Civic engagement to draft the Lehman Caves Management Plan (not the EA) was held from January 13, 2016 to February 26, 2016. One comment from the general public was received, as well as from the tribes (see below). Public scoping for the Proposed Action, the draft Lehman Caves Management Plan was held May 15 to June 14, 2019. Three comments were received, one commenting on the comprehensiveness of the plan, another requesting higher quality graphs, and a third asking for more attention to climate change, white-nose syndrome decontamination procedures, exhibits, and treatment of human remains. A public meeting and site visit was held June 3, 2019 at Lehman Caves. Six members of the public attended. Substantive comments were incorporated as appropriate.

CONSULTATION

Advisory Council on Historic Preservation and Nevada State Historic Preservation Officer

The undertakings described in this document are subject to Section 106 of the National Historic Preservation Act, as amended in 1992 (16 USC Section 470 et seq.). Consultations with the Nevada State Historic Preservation Office (SHPO) were initiated May 2019.

Tribes

On April 21, 2016, three Tribes, Duckwater, Ely, and Confederated Tribes of Goshute, met with Great Basin National Park personnel to discuss the Lehman Caves Management Plan. They supported the plan and provided pertinent information.

U.S. Fish and Wildlife Service

No state or federally listed or candidate species are found in the project area, thus no consultation was needed with the USFWS.

Army Corps of Engineers

No construction was planned in any wetlands or floodplains, thus no consultation was needed with the Army Corps of Engineers.

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There will be a 30-day comment period on the EA. Comments may be submitted online at: http://parkplanning.nps.gov/hydrogeologic, or in writing to the following address:

Planning
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As the nation's principal conservation agency, the Department of the Interior has the responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historic places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. Administration.

NPS 611/101091 March 2010

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