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Rick S. Toomey

Mammoth Cave International Center for Science and Learning, Mammoth Cave National Park, rick_toomey@nps.gov

Steve Kovar

Mammoth Cave National Park.

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Redevelopment of Historic Tour Cave Trails

Rickard S. Toomey¹, III and Steve Kovar²

¹ Mammoth Cave International Center for Science and Learning, Mammoth Cave National Park

² Mammoth Cave National Park.

Introduction

The renovation of the cave trails of the Historic Tour Route (HTR) is the largest cave project at Mammoth Cave National Park (MACA) since the CCC construction of the cave trails in the 1930s. It is the culmination of over 20 years of project development. When completed in May of 2017, this project will provide cave trails that should not need to be replaced for at least 50 years. The construction budget for the trails renovation is over \$5.8 million. When preparatory development projects, NPS staff evaluation and development time, archaeological and paleontological testing, cave trail surveys, and architectural and engineering design needed to support the project are included, the final cost of the project will be over \$10 million. For the entire construction project, the contractor estimates they will move between 2.5 and 3 million pounds of materials (pavers, concrete, aggregate, sand, steel, composite lumber, etc.) into the cave. This quantity includes approximately 9700 pavers and 190 tons of aggregate.

Project Goals

The goals of the renovation of the HTR trails are as follows:

- 1) Improve visitor experience and safety by providing better and more predictable trail surfaces
- 2) Improve protection of cave resources by keeping visitors on-trail, reducing dust and lint from cave trails, and ending the need to use dirt excavated in the cave to repair cave trails
- 3) Improve maintainability of cave trails and reduce long-term trail maintenance costs.

Issues Addressed by Project

These goals were developed as a response to park needs that had been identified as the trails aged and tour visitation increased. Problems associated with the existing trail surfaces were identified over the past 25 years.

These problems included:

- 1) Slick, steep trail sections where visitors could slip
- 2) Potholes which developed in dirt trails surfaces
- 3) Uneven, bumpy trails surfaces that developed in damp areas
- 4) Visitors easily stepping off the trail because trail edges were sometimes poorly delineated
- 5) Damage to cultural resources when people left tour trail
- 6) Extensive dust coating surfaces and artifacts along upper section of the HTR because dirt trail surfaces to turn in dust in dry conditions and tour passage drives the dust into the air to settle far from the trail
- 7) Barrow pits in sediment banks near the trail as dirt from the cave was used to fill potholes in the trail

Background and Scope of Project

The renovation of the HTR trails consists of upgrading the trail tread and edging (such as lint curbs and handrails). The trail alignment is remaining the same as prior to the renovation. Except for a few small wet and slippery areas where the tread will consist of fiberglass grating (such as what is used on the Mammoth Dome Tower), the project team chose pavers and concrete as trail surfaces. Larger, wider passages (such as Upper Historic and Great Relief Hall) will have concrete pavers as a trail surface. Smaller, narrower passages (such as Blacksnake, Sparks, and Little Bat Avenues) will have concrete trails surfaces.

Stairs and handrails are being added in places where trail slopes are particularly steep. Lint curbs are being added to areas with known lint and dust problems such as upper Historic and Spark's Avenue.

The HTR cave trails renovation project started with several demonstration projects in the late 1990s and early 2000s. These included several areas where the trail surface was replaced with pavers and the installation of a wood and composite lumber boardwalk in Broadway. These projects were designed and installed by park staff. Although they were constructed to help address trail issues, their primary purpose was to test two different trail surface approaches that the park would potentially use for a larger trail renovation.

As a result of these demonstration projects, the park staff determined that pavers provided a very good option for building a sustainable cave trail. Although the boardwalk solution is also considered viable for some trail segments, many people feel that it has several drawbacks (such as noise and visual intrusiveness) that rendered it a less desirable. In addition, the State Historic

Preservation staff noted that the boardwalk was not compatible with the cultural landscape of the Historic section.

In 2008 DDS Engineering performed an engineering survey of the cave trails to document their condition at that time (trail surface, slopes, etc.). This engineering survey provides the baseline map/CAD drawings for planning the HTR cave trail renovation.

In preparation for renovations of the park's cave tour trails, the park had the University of Kentucky Program for Archaeological Research (UK-PAR) conduct archaeological and paleontological investigation along selected trail segments in Mammoth and Great Onyx Caves. These investigations included the HTR.

As part of these investigations UK-PAR developed a map rating areas of the HTR as high, medium, or low archaeological and paleontological potential. These designations provided guidance for developing trail construction restrictions to best protect sensitive areas. For example, the area near Giant's Coffin was found to be highly sensitive from an archaeological standpoint. Because of this, the park had UK-PAR perform additional studies in that area to document archaeology that would be covered by the trail. In addition, the park designated that area as a no ground penetration area. This means that infrastructure for supporting the paver trail and lint curbs must be constructed on top of the existing trail surface.

The UK-PAR investigations also recommended having an archaeologist monitor digging activity associated with the construction. This recommendation was implemented during construction, with UK-PAR supplying an archaeologist to monitor activities in the cave.

Project Design

Trail design was developed in 2013-14 by the engineering firm VHB Inc. (Williamsburg, VA). The design process was iterative with the engineers and architects visiting the park, meeting with the NPS national and park review team, taking notes and pictures documenting conditions and potential issues on the trail, developing draft plans, and then repeating the process based on comments from the review team. The NPS review team included park staff representing all divisions, staff from the Denver Service Center, and NPS Southeast Region and Kentucky Historic Preservation staff.

During this process the team made many decisions about the trails. For example, the team chose to try to develop the trails with an organic layout that was similar to the existing trails. For a trail surface the team chose to utilize pavers in Upper Historic and Great Relief Hall. They also decided to utilize concrete walkways in Blacksnake, Spark's, and Little Bat Avenues. Fiberglass grates, for increased traction, were chosen for potentially slick surfaces at Richardson Spring and in River Hall.

Due to slopes with traction issues, several stairs were modified or added. New stairs and handrails are being added in Dante's Gateway and near Richardson Spring. In addition, existing stairs are being extended at the Steps of Time, Scotchman's Trap, and River Hall. The Steps of Time themselves are not being altered (due to their historic nature), but additional stairs are being added at the bottom to alleviate the slick slope on which they ended previously.

Portions of the Scotchman's Steps stairway are being altered and extended, but other portions are remaining intact. Hand rails are being modified or added at several slick areas and stairs. The unusual small steps

near Sidesaddle Pit are being replaced with a ramp with slip resistant concrete.

During review the need for and placement of lint curbs was extensively discussed. The team determined that lint curbs were appropriate for use in areas with demonstrated dust and lint problems. These areas included Upper Historic (including Little Bat Avenue), Great Relief Hall, and from Bandit's Hall through Spark's Avenue.

In addition, lint curbs are being used in the Grecian Bend area (before Fat Man's Misery) to act as retaining walls keeping sediment from migrating onto the trail. The team determined that, because there was no previously identified lint problem and because it would be very visually intrusive, lint curb was not needed in Blacksnake Avenue.

Trail Construction

Timing was (and remains) a crucial element of the construction project. The project was identified as requiring at least 18 months to reasonably construct. However, the park was concerned about having enough tour capacity for summer, if the Historic Tour was not available. So, the construction was divided into two segments.

The first construction season began in early September 2015 and will end just before Memorial Day weekend 2016. The second construction season begins in September 2016 and ends just before Memorial Day weekend 2017. How to best utilize those two seasons was left open to the contractor. The park will run Historic Tours during the summer between the construction periods.

In June 2015 the HTR trail construction project was put out for bid. The winning bidder was The Tradesmen Group, Inc. (Plain City, OH) (TTG). For handrails and

welding they employed a metal fabrication sub-contractor, On Time Fab, Inc. (Owensboro, KY).

The construction phase of the project began with a pre-construction meeting on September 1, 2015. TTG decided to divide the project into halves geographically for the two seasons. For the 2015-16 construction period, they chose to work from Methodist Church to Fat Man's Misery. For the 2016-17 period, they plan to work from Fat Man's Misery to Little Bat Avenue. The park was able to run Mammoth Passage tours into Rafinesque Hall on weekends and busy periods during construction during the 2015-16 period.

As of mid-March 2016, the construction project was on schedule. Concrete walkways and stairs have been largely completed in lower historic. Hand rails are being installed in that area. The paver trail and lint curbs in the Upper Historic Section are almost completed in Methodist Church and from the end of the previously existing paver trail to the area of the Martha Washington

light switch. Work remaining this season is centered on the no ground penetration area near Giant's Coffin and in the Wooden Bowl Room.

As with almost any project in the cave, this project has had its share of challenges. Archaeological materials and voids beneath the existing trail surface have led to modifications of some of the designed plans.

In addition, although the designs by VHB relied on the most complete cave survey available, when the trail was laid out for construction, we inevitably found areas where slight modifications would permit construction with less resource impact. The construction oversight team made decisions on these minor modifications in consultation with the contractor, VHB, the archaeologist, and park staff.

With the construction on schedule, we look forward to using the newly renovated portions of the HTR trails this summer and are already working with TTG in anticipation of next season's construction.