

Partnership in Preservation

By Cecilia E. Young

As the Department of Defense budget continues to shrink, installations must cut the cost of doing business by reducing staffs, funds, and mission-support programs. So how can installations continue to maintain these programs when money is scarce? One way is to form partnerships. The Army Partnership Program has been around for many years but is receiving a resurgence of attention as a way for installations to capitalize on existing assets. And Fort Leonard Wood is doing just that!

The installation capitalized on the benefits of partnerships on a recently completed environmental project. The challenge was to complete geotechnical stabilization and preservation of an archaeologically significant site, known as the Miller Cave Complex, at minimal expense.

Fort Leonard Woods' primary mission is to train soldiers—mainly engineer soldiers. The U.S. Army Engineer Center develops training manuals, products, and equipment required by the engineer force, and among these are materials on environmental awareness, training, and protection. Along with the rest of the Department of Defense, Army engineers are concerned with environmental preservation and conservation. Installation commanders are charged with the moral and legal obligations to preserve and protect our nation's environment and its natural and cultural resources. Special emphasis is placed on resources impacted by projects on military installations.

This article highlights how the many players worked in a partnership to benefit their organizations, the installation, and the environment.

The Players

Fort Leonard Wood's resident archaeologist, working with University of Illinois staff, determined that the Miller Cave Complex is a significant archaeological and historical site that should be preserved. The complex includes both Miller and Sadie's Caves and a group of

Characteristic	Classification
Soil classification (Unified)	ML (sandy silt)
Soil classification (AASHTO)	A-4 (sandy loam)
Characteristic	**Percentage**
Natural water content (sample)	35
Liquid limit	39
Plastic limit	33
Shrinkage limit	28
Plasticity index	6
Liquidity index	37
Optimum water content	27
Swell potential	18

Figure 1. Geotechnical Test Results, Miller Cave Soils

prehistoric and historic rock carvings (petroglyphs). As both a geological wonder and an archaeological site with cultural remains dating from 6500 B.C. to A.D. 1300, Miller Cave was extensively excavated in the 1920s by the Smithsonian Institution. Subsequent digging by vandals and curious amateurs greatly reduced the site's archaeological integrity. In spite of the disturbances, recent archaeological investigations substantiated the presence of intact cultural deposits in both caves. Because of this, they are eligible for the National Register of Historic Places.

A grant was obtained from the Legacy Resource Management Program (LRMP), which was created "to promote, manage, research, conserve, and restore the priceless biological, geophysical, and historical resources which exist on public lands, facilities, or property held by the Department of Defense. The Legacy challenge is to create a program of management, conservation, and restoration that encourages proactive stewardship of resources at the installation level. At the same time, these efforts will be coordinated across the military services, scientific disciplines, and geographic regions."[1] LRMP granted money to perform the analysis and purchase materials, but it did not cover manpower costs to perform the work.

The scientific analysis, investigation, and design to determine the best way to preserve and protect the site were accomplished through a cooperative effort between Fort Leonard Wood, the U.S. Army Corps of Engineers' Waterways Experiment Station, and Texas A&M University. A geological engineering professor and an engineering cadet from Texas A&M collected soil samples from three areas in Miller Cave to determine the basic geotechnical properties of the soil for the soil-cement mixture design. An undergraduate class of geotechnical engineering students at the university tested and analyzed the soil. Figure 1 shows the laboratory results.[2]

In addition to the standard classification tests, two soil-cement mixtures were prepared and tested. Samples containing 5 and 10 percent Portland cement by total weight (water content = 35 percent) were mixed and compacted in a Harvard miniature compaction mold. Samples were extruded and allowed to cure in a room with 100 percent humidity for 3 months before performing unconfined compression tests to mirror conditions in the field. Test results and recommendations by the Portland Cement Association (1992 and 1995) suggested the soil-cement design shown in Figure 2 for the floor of Miller Cave.[2]

The soil analyses indicated that in-situ (in-place) site preservation was the best

Characteristic	Recommendation
Minimum hardened thickness	4 inches
Cement percentage (weight of soil)	10 percent
Cement per square foot of cave floor	3.7 pounds
Floor coverage per bag of cement	25 square feet

Figure 2. Soil-Cement Design of Miller Cave Floor



A BNCOC student uses a rototiller to prepare the floor of Miller Cave for soil-cementing.

option for Miller Cave. The irregular cave floor, brought about by years of digging and excavation, would be preserved and hardened with the soil-cement mixture. The floor would look natural and would not interfere with educational exploration but would prevent further vandalism. Interpretive plaques would be installed to explain the historical and archaeological significance of the cave.[3] In Sadie's Cave, which has been disturbed less by digging, they decided to close the entrance with an iron bar fence that allows egress to an endangered species of bats but prevents human intrusion.

With all of the historical, archaeological, and scientific research done and the plan chosen, free labor was needed to complete the project. Fort Leonard Wood's Office of Excellence, which establishes mutually beneficial partnerships for the installation, coordinated with Libby NCO Academy to make the project a field training exercise for the Basic Noncommissioned Officer Course (BNCOC). It offered students a practical hands-on experience with environmental training. Two classes from the Academy (the 62N Heavy Equipment Construction Supervisor and the 51H Construction Foreman) also participated. Both classes were given a description of the problem and the work to be performed; they were to determine how best to accomplish the missions and develop the bill of materials.

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62N Mission

The 62N students' mission at Miller Cave was to stabilize the cave floor by soil-cementing it and camouflaging the trail leading to Sadie's Cave. First, they developed plans to get all the necessary equipment and cement into the cave. The most accessible entrance is a three-foot opening located about two feet above the ground. The BNCOC students transported 75 bags of Portland cement, weighing 95 pounds each, over a rugged trail

to the cave site and into the cave. They also moved two 200-pound plate tampers, two 100-pound rototillers, and twenty-five 5-gallon containers of water to the cave. Because of the awkward size and shape of the rototillers, they were disassembled to fit through the narrow entrance into the cave and reassembled inside.

Safety was an important element of this exercise. To protect themselves from noise and dangerous exhaust fumes generated by the tampers and rototillers, the students wore hearing protection and masks while working in the cave.

Deep trenches left in the cave floor by amateur diggers required excavation with hand tools before rototillers could be used. The students applied basic information on soil-cement preparation and application described in FM 5-410, *Military Soils Engineering*. This technology is used to give dirt roads the bearing capacity needed for convoys, an engineering task in wartime. The students usually train on level surfaces like roads and runways. But the hilly, rocky terrain around Miller Cave gave them training that will be useful in mountainous areas such as Bosnia.

51H Mission

The 51H students' mission was to make the trail leading to Miller Cave safe and accessible to the public. They installed a rope handrail to guide visitors to Miller Cave and away from the trail leading to Sadie's Cave. The students also erected steps at treacherous drop-off points.

The 51H mission was not free from problems and challenges. Obstacles they overcame included setting up power generators and selecting the correct drills and bits to drill through rocks to construct the stairs.

The Winners

The Miller Cave Geotechnical Stabilization Project was a cooperative effort and a "win-win" situation for all involved.

- Fort Leonard Wood helped protect a culturally and archaeologically significant site at virtually no cost to the installation.
- BNCOC students received practical and unique hands-on training that brought U.S. history alive and allowed them to leave a legacy for future generations.
- Texas A&M students analyzed and examined soil samples from a significant historic and archaeological site.

These benefits would have been impossible without the cooperation and encouragement of installation commanders and employees. One goal of the LRMP is to form partnerships, and the Miller Cave project was a partnership in its truest sense. The LRMP is also about stewardship, and this project combined military missions with environmental stewardship. This cooperative effort sets the standards for the Army and the entire Department of Defense.

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Project Participants:

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Libby NCO Academy: CSM Robert Robinson, Commandant; MSG John McCalmon, BNCOC Chief; SSG Douglas Brandt, 62N Instructor; SSG David McBride, 51H Instructor.

Endnotes:

[1] *Legacy: Our Path to Enhanced Stewardship*, United States Department of Defense, Office of the Deputy Assistant Secretary of Defense for the Environment.

[2] "Investigation and Design of Site Protection for Miller Cave (23PU2), Sadie's Cave (23PU235), and the Miller Petroglyphs (23PU255)," Fort Leonard Wood, Missouri, prepared by Christopher C. Mathewson, PhD, PE, REG, page 18.

[3] Ibid, pages 15 and 16.