HISTORIC PRESERVATION IN THE CERRILLOS MINING DISTRICT

John A. Kretzmann, Design Engineer and Lloyd A. Moiola, Archaeologist,
New Mexico Abandoned Mine Land Bureau,
Mining and Minerals Division,
Energy, Minerals and Natural Resources Department
1220 S. St. Francis Drive, Santa Fe, NM 87505

ABSTRACT

Population growth throughout the West is increasing near historic mining districts that were once only occasionally visited by outdoor enthusiasts. Although Priority 1, 2 and 3 coal-related problems remain in New Mexico, this has prompted the New Mexico Abandoned Mine Land Bureau (AML) to increase its attention toward the state's numerous non-coal problems. However success in both coal and non-coal mine reclamation and closure has contributed to the loss of cultural resources by removing evidence of our Nation's mining heritage. Due to growing interest in preserving historic mining properties by governmental agencies and the public, AML has given consideration to the effects its projects have on abandoned mine sites. This paper focuses on the challenges of preserving the historic mining landscape in the Cerrillos Hills Historic Park, of completing a mine safeguarding project to protect the public from mine hazards, and of incorporating public and agency input into the process. The Cerrillos South Mine Safeguard Project is located about 25 miles south of Santa Fe, in an area formerly behind locked gates. In 1998, with the purchase of a large tract of land in the Cerrillos Hills by the County of Santa Fe for public open space and creation of an historical mining park, AML was called on to assist in safeguarding numerous abandoned mines in the area. This paper will discuss the methods used to safeguard the mine features within the Park, while maximizing the preservation of the historic mining landscape and minimizing impacts to the fragile ecosystem. The project consisted of safeguarding 67 shafts, 17 pits, one adit, two trenches, and two highwalls.

INTRODUCTION

The Cerrillos Mining District is located approximately 25 miles south of Santa Fe, in a small group of conical hills that rise above the surrounding plains (see Plate 1). The District is famed for its turquoise mines as well as other mineral deposits that were important to Native American, Spanish, Mexican, and American miners. The Cerrillos Hills are unique in that they retain mines, artifacts, and features associated with mining activities that endured for over a thousand years. Creation of the Cerrillos Hills Historic Park has fostered greater interest and preservation of this important mining region and provided an open space for recreation and education. During the course of the Cerrillos South Mine Safeguard Project, the New Mexico Abandoned Mine Land Bureau (AML), other government agencies, and interested members of the public were challenged to safeguard abandoned mines in the Cerrillos Mining District, while preserving the integrity of the historic mining landscape for future generations.

BRIEF HISTORY OF THE CERRILLOS HILLS

Los Cerrillos Mining District is the oldest mining district in the United States. Archaeological evidence and archival records reveal a history of mining that spans a period of more than a thousand years. The District encompasses approximately 30 square miles and includes prehistoric Native American turquoise and lead mines, as well as Spanish Colonial (1598-1821), Mexican Period (1821-1846), and American Territorial Period (1846-1912) mines that exploited deposits of lead-silver, copper, turquoise, zinc, and minor amounts of gold.

Prior to the arrival of Europeans, Native Americans from surrounding Pueblos mined the Cerrillos Hills for both turquoise and galena (lead-sulfide). Pueblo peoples first began mining turquoise in the Cerrillos hills between A.D. 700-900 and possibly earlier (Milford 1995:17). Pottery found in association with turquoise mines in the District confirms that the first use of Cerrillos turquoise deposits began before A.D. 1000. Lino Gray (A.D. 650-850) and Red Mesa Black-on-white (A.D. 850-950) pottery sherds are some of the earliest ceramics found in association with the mines. Analysis of potsherds from the Cerrillos turquoise mines by Warren, also indicates two major periods of prehistoric use; A.D. 1000 and 1150/1200, when Chaco Canyon was the major center of cultural development, and from 1350 to 1680 as pueblo culture expanded in areas along the Rio Grande (Warren and Mathien 1985; Deyloff 2001:12).

Mt. Chalchihuitl and Turquoise Hill, which includes the Tiffany and Castilian mines, are the major sources of turquoise in the Cerrillos area. When W. P. Blake (1858), the first geologist to visit the area during the American period, described the large pit on Mt. Chalchihuitl, he measured it at 300 feet across and 200 feet deep (Levine and Goodman 1990:9). Based on their history and past production, Pogue (1915:52) believed that the Cerrillos District contained the most important deposits of turquoise in the United States. The massive excavations, large waste rock dumps, and prehistoric artifacts associated with these mines are just some of several factors that have confirmed that this locality was a major supplier of turquoise in the prehistoric Southwest.

Although Mount Chalchihuitl and the Turquoise Hill mines remain the most significant prehistoric mines in the District, many smaller prehistoric workings of both turquoise and galena are found throughout the area. Turquoise mines documented by archaeologists in the Cerrillos Hills typically consist of one or more mining related features, including pits, quarries, hearths, campsites, ceramic scatters, and workshop areas (Levine and Goodman 1990:11). Mining tools found in association with these sites include grooved stone axes, mauls, hammer-stones, picks, anvils, lapidary stones, and pottery sherds (Warren 1976:14; Warren and Mathien 1985:98; Mathien 1998:50).

Galena-lead deposits in Cerrillos Hills were an important resource used by the Pueblos for pottery glazes. Lead mining by Rio Grande Pueblos occurred primarily between A.D. 1350 and 1680, but continued into the early 1700s (Warren 1976:13; Deyloff 2001:13). Prehistorically worked lead veins in the Cerrillos area include the Mina del Tiro, Bethsheba mine, the U.S. Grant, the L.C. Cloury, the Ethel shaft, the Helena, the Southwestern, the Chimney Mine, the Bonanza, the J.A. Logan prospects, the Globe veins, and the Stillman vein (Warren 1976:25; Milford 1995:17).

In 1581, inhabitants of San Marcos Pueblo led members of the Rodriguez-Chamuscado Expedition to the galena and other mineral deposits the Pueblos had mined for several centuries prior to Spanish arrival in the region. Philipe de Escalante and other members of the expedition collected several ore samples for assay from the galena veins they examined and in later testimony, claimed discovery of the mines and mineral deposits in the Cerrillos Hills. Assays of the ore samples taken by Escalante and others showed very high silver contents, which prompted further prospecting activities in the 1580s and 1590s by subsequent expeditions (Levine and Goodman 1990:18; Milford 1995:18). During the first few weeks of the Spanish Colonization of New Mexico in1598, the governor, Juan de Onate was given a tour of the Cerrillos Mines. By 1600, archival records indicate a number of mines were active in the District and that silver/lead ores were being refined by both smelting and amalgamation. Although few records exist concerning the extent of Spanish Colonial mining, silver produced in the Cerrillos District may have been a significant component of the 17th century New Mexico economy (Milford 1995:9; 2002:4).

Several mines in the project area were periodically active from the 1600s to the 1900s. However, the Mina del Tiro and Bethsheba are the more notable properties in the Cerrillos South Mine Safeguard Project and were worked both prehistorically by Native Americans and later during the Spanish Colonial through American periods. Spanish miners worked the vein outcrop on the Mina del Tiro during the 1600s and 1700s. Spanish Colonial artifacts and features documented on the mine include three stone and adobe smelters, glaze wares from 1650-1680, olive jar fragments imported from Spain, red wares from Mexico, early Tewa Polychrome sherds dating from 1670-1720, slag and burned adobe, sherds with slag on the bowl interiors, fragments of stone comales, lead ore, bone, and charcoal (Warren 1974:20-30). Similar smelters and artifacts documented on the Mina del Tiro are also found on other Spanish Colonial mines in the District. In the Mexican Period (1821-1846) the Mina del Tiro was worked from 1830 to 1844 and under the United States in both the late 1800s to 1943 (Milford 2002: 4).

Although there is no written reference to mining activities on the Bethsheba before 1879, archaeological evidence in the form of ceramic and other artifacts recovered during a 1971 partial excavation of the mine and subsequent surveys support dates from the 1300s to 1700s for mining activities that occurred during Pueblo and Spanish Colonial use of the mine (Deyloff 2001:13; Bice et. al 2003).

During the American Territorial period, mining activities were intermittent in the Cerrillos District from 1846 to the late 1870s. The Delgado family claimed the Cerrillos Hills as part of a land grant in the 1850s and 1860s and, with the exception of leasing the Mina del Tiro and a few other mining properties, kept most miners away from the area. By 1870, government officials had rejected the Delgado's claim for a land grant and opened the area up to purchase by the public. Between 1870 and 1872, Santa Fe businessmen had purchased properties in the Cerrillos District that contained the known prehistoric turquoise mines and Spanish silver mines (Milford 1995:54-55).

The lack of transportation infrastructure had hindered development of New Mexico's mining industry, however with the approach of the railroad to the New Mexico border in 1879, its impending arrival stimulated substantial activity in anticipation of the economic growth it would bring (Deyloff 2001:29). By 1878, mining activities had increased in Cerrillos and Santa Fe mining

investors hired Robert Hart out of Leadville, Colorado to serve as a manager for their Cerrillos mines. Hart brought several experienced Colorado miners along with him, including Frank Dimmitt, and soon they had discovered rich leads of silver ore. With news of the discovery, many more miners came to Cerrillos and a new mining boom began (Deyloff 2001:31). By April of 1879 papers were running stories designed to promote the fabulous potential of the Cerrillos Mining District (Milford 1995:55). The Cerrillos Mining District was formed shortly afterwards by Dimmitt and Hart, in 1879 and several camps and towns sprang up throughout the area including Purden's Camp, Poverty Hollow, Bonanza City, Carbonateville (a.k.a., Turquoise City, Dimick's Camp), and Cerrillos.

The town of Cerrillos was established in 1879 as a tent camp and was situated between the lead and silver mines of the Cerrillos District immediately to the north and the gold mines of the Ortiz Mountains, and coal mines in Madrid a few miles to the south. In 1880, the railroad arrived in Cerrillos and enabled the establishment of several businesses that included saloons, boarding houses, three hotels, two newspapers, several general stores, and two churches (Mechau 1974:18 Levine and Goodman 1990:42).

Between 1879 and 1881 more than a thousand mine claims covered the Cerrillos Hills, however, most of these claims were only prospects and just a few dozen developed into working mines. The mining boom was short lived; it began in 1879, peaked between 1880 and 1882, and was over by 1885. Sporadic mining activity occurred throughout the remainder of the 19th century, but collapsed after WWI. Many of the town's citizens either relocated or worked the coalmines in Madrid during the first couple of decades of the twentieth century. Between the 1930s and the 1950s, the town's population declined to the point that it could have been considered a ghost town. However, by the 1970s people began to move back into the area and established new businesses. Currently, Cerrillos maintains several small businesses and caters to the tourist industry.

PROJECT DEVELOPMENT

Although several factors went into the creation of the Cerrillos Hills Historic Park, a Santa Fe County Open Space bond proposal that voters approved in November 1998 provided the funds to purchase private lands within Santa Fe County for public use. In early 1999, with a Santa Fe County Open Space park becoming a realizable goal, members of the Los Cerrillos community planning committee and other interested parties organized the Cerrillos Hills Park Coalition, which became the lead group to formally propose acquisition of the private lands within the Cerrillos Hills to form an open space park. Based on public meetings, concerns of the Cerrillos Hills Park Coalition, and advice of the County Open Land and Trails Planning and Advisory Committee (COLPAC), the Santa Fe Board of County Commissioners approved purchase on September 28, 1999 and the County acquired 1,116 acres within the Cerrillos Hills on January 28, 2000.

The Cerrillos South Mine Safeguard Project was formerly located in an area of the Cerrillos Hills that was fairly inaccessible and behind locked gates. With the change in land status beginning in 1998 and the potential opening of a public recreational park and open space, AML was called on for assistance. Santa Fe County, the Cerrillos Hills Park Coalition, and Bureau of Land Management (BLM), which had numerous mines adjacent to the park boundaries, requested that AML close

several mine openings within and adjacent to the Park boundaries because of public safety concerns. Prior to County acquisition of the Park property, AML had fenced many of the shaft features in the Cerrillos Hills as a precursor to a planned abandoned mine lands project. With the purchase of the property by the County, and the likelihood of increased visitation by the public, AML first made the determination that the mine openings in the area could be safeguarded in a manner consistent with the "Stay Out – Stay Alive" initiative. Rock conditions (weathered at the surface, but generally competent within several feet of the surface) and the nature of the mine openings (most shafts and prospect pits being less than 30 feet deep and without possibly unstable, near-surface underground stopes or drifts) made this feasible. AML made the project a priority and proceeded with the first steps of project development in 1999.

In 1999, AML contracted Southwest Archaeological Consultants, Inc. to conduct a cultural resources inventory of 1,200 acres just north of Cerrillos on County, BLM managed lands, and privately owned lands within and adjacent to the boundaries of the Cerrillos Hills Historic Park. The project survey occurred intermittently from December of 1999 through June of 2000 and documented 401 isolated occurrences (single artifacts or dispersed scatters of less than ten artifacts) and 569 mine, mining related, and/or structural features that were grouped into thirty-two archaeological sites (Deyloff 2001:1, 47).

Due to its importance as an archaeological and historical resource the District had been placed on the New Mexico State Register of Cultural Properties on February 20, 1973. The State Historic Preservation Officer (SHPO) initially made a determination that the Cerrillos Mining District was significant under the theme of commerce and eligible to the *National Register of Historic Places* under Criterion (a)-important events. "Los Cerrillos Historic Mining District represents the longest continuously exploited mineral resource area in New Mexico, and probably the United States" (Snow and Warren 1972:section 8).

In their project recommendations chapter, Southwest stated, "As part of the listed historic mining district, all of our project sites are significant under the same criteria used to place the district on the state register initially. The features, clusters and sites combine to tell the story of mining in Los Cerrillos Mining District from A.D. 1000s to the 1900s. The district's identity results from the interrelationship of its resources, which convey a visual sense of the overall historic mining environment" (Deyloff 2001:214-216). Southwest recommended that not only is the Cerrillos Historic Mining District eligible to the *National Register* under Criterion (a), the District should also be considered eligible under Criterions (c)-design/construction elements and (d)-research potential. Both the SHPO and AML agreed that the sites within the Cerrillos Hills were eligible to the National Register under various Criteria and that the project would need to be conducted in a way that would lessen potential negative impacts to the Cerrillos Mining District.

Due to concerns expressed by archaeologists, Historic Preservation Division/SHPO, Santa Fe County, National Park Service, Bureau of Land Management, Tribes, and the Cerrillos Hills Park Coalition, that the AML project would adversely impact the historic landscape of the Cerrillos Mining District, AML understood that it would take extensive consultations with these various parties, before development of a construction plan could proceed.

During the first public meeting in April of 2002, more than forty people showed up to express their concerns about the upcoming AML project. Initially, many people were upset that AML proposed to close the mines in the Cerrillos District. It took several meetings with members of the public and government agencies before AML could convince interested parties that the mines would be safeguarded in a way that addressed their concerns.

Requests by the public and other consulting parties included that AML limit the use of heavy equipment in the Park and the use of waste rock piles during mine closures. Several people requested that AML only build structural closures on the mines. Further, many people expressed an interest in leaving the mines open and that AML build special viewing structures. Key to all concerns was that AML limit the footprint of construction and reclamation activities in the District, limit the use of waste rock piles during mine closures, leave a depression where mines were backfilled or closed with imported materials, and protect artifacts and other archaeological resources in the Park. Because waste rock piles and other mining features make up the historic landscape of the Cerrillos Hills, all parties wanted AML to leave the historic view-shed of the mining district as intact as possible.

Normally the public shows very little interest in AML projects, primarily due to their remote location. However with the proximity to Santa Fe and the backing of a concerned citizens group and additional government agencies, AML spent more than the usual amount of time in the consultation process to complete the Cerrillos South Mine Safeguard Project. During consultations with the Historic Preservation Division/SHPO, the Tribes, and interested members of the public that spanned more than a year's period, AML developed a plan to safeguard the mining features in a way that would protect public safety, produce the least amount of ground disturbance and preserve the historic mining landscape of the Cerrillos Hills. Further AML decided to build special structural closures, not only for bat habitat protection, but also for interpretive purposes within the Park.

PROJECT DESIGN AND CONSTRUCTION

After months of consultation, the final priorities identified that affected the proposed AML project were:

- Preservation of prehistoric and historic artifacts, sites and landscape features, including most of the mine waste piles adjacent to or visible from the planned trail system.
- Continued use of the area by hikers, joggers, bike riders and equestrians and the development over several phases of a formal trail system to support these uses (primarily to be completed by other parties).
- Safeguarding of hazardous mine openings on and nearby the proposed park for public safety.
- Minimization of surface disturbance during construction.
- Installation of structural closures at as many mine openings as feasible along the proposed trail system to allow the public to view an essentially untouched mine opening.
- Preservation of significant bat habitat in several abandoned mine workings.
- Installation of interpretive signage for educational information on the prehistory, history, geology, ecology, flora and fauna of the area.
- Restoration of areas disturbed during construction.

In addition, because of low levels in County funding for on-going maintenance of the Park, all structures built had to have a long life span, be vandal resistant, and require little or no maintenance. Clearly AML would need to develop some innovative approaches to safeguarding mine openings.

Eventually in several meetings, primarily with the Cerrillos Hills Park Coalition, the Bureau of Land Management and private landowners, a specific site-by-site plan for abandoned mine land safeguarding was developed. This plan included the following work items:

- Avoidance of identified cultural artifacts and features during construction.
- Backfilling of 52 shafts, adits, and open stopes.
- Installation of welded wire fencing around a series of closely spaced prehistoric and historic mine features at the Bethsheba Mine, around two other shafts, and along two highwalls. (See Plate 3.)
- Installation of polyurethane foam (PUF) plugs in 16 shafts, primarily to preserve their mine waste piles as integral parts of the mining landscape. (See Plates 4 and 5.)
- Partial backfilling of openings and installation of low metal picket fencing around three shafts along the trail system. (See Plate 6.)
- Installation of high tensile strength steel mesh over eight shaft openings, five of which are along the initially developed trail system, and the rest of which are along planned extensions of the trail system or are at historically significant mines (including the Mina del Tiro). (See Plates 7 through 10.)
- Construction of viewing platforms at five of the shafts with steel mesh covers. (See Plate 8.)
- Installation of a prefabricated steel bridge over one shaft with a steel mesh cover. (See Plate 9.)
- Construction of bat cupolas over three shafts with significant bat habitat. (See Plates 11, 12 and 13.)
- Installation of several weathering steel bases for interpretive signs. (See Plate 14.)
- Installation of erosion and sediment control measures.
- Seeding of areas disturbed during construction

Because many of the mine openings were not accessible on existing roads and trails, the contract specifications required the restricting of most off-road access to small equipment and at the most remote sites to foot access. The specifications defined small equipment as either all-terrain vehicles or tracked construction equipment with operating weights no greater than 13,000 pounds and no wider than seven feet. The contractor, Pioneer Industries of Albuquerque, NM elected to use a six-wheeled ATV for personnel access and for carrying of small loads of construction material. Pioneer also used a small tracked excavator and front-end loader to access off-road sites for backfilling of mine openings. This approach proved to be successful in minimizing damage to soils and in most places no traces of equipment passage were visible a few months after project completion.

Pioneer placed polyurethane foam plugs at 16 shafts, primarily to preserve the mine waste piles. So that the shafts looked undisturbed from a distance, the fill placed over the plugs (for vandal

resistance and protection from ultraviolet radiation and fire) was left depressed 18 inches below the top of the mine waste collar. To drain surface and subsurface water, AML specified that a slotted HDPE pipe be placed through the plug with a small cast iron beehive grate and concrete collar at the surface. (See Plates 4 and 5.)

At three shallow shafts along the trail system, the openings were partially filled to ten feet below the surface. AML required that the fill be covered with about twelve inches of wood fiber surfacing engineered for use in playgrounds. The wood fiber surfacing is designed to help absorb the impact of a person falling into the shaft, reducing possible injury. These shafts are surrounded with a weathering steel picket fence 3'-6" high with posts set into colored concrete footings. (See Plate 6.)

For many years AML has used cable netting as a means to safeguard abandoned shaft and stope openings. However, in an area of expected high visitation, this material has several distinct disadvantages: it is easily cut with hand tools, the life expectancy in many environments is probably no more than twenty years, the usual six inch square openings are too large to be safe for children to walk on, and construction of nets with smaller openings exponentially increases the cost of the netting.

AML found an alternative to cable netting in very high tensile strength steel mesh, specifically a product called TECCO by Geobrugg. TECCO mesh looks somewhat like chain link fencing with diamond shaped openings about three inches wide by 5½ inches long. It is a product designed primarily for steep slope stabilization with a wire tensile strength in excess of 250,000 pounds per square inch. A zinc/aluminum coating rated for a minimum 100-year life protects the mesh from corrosion – an important property since sulfate levels were elevated at some of mine waste piles in the Cerrillos Hills. Although only about 1/8 inch in diameter, the wire is very difficult to cut with ordinary hand tools (but can be repaired with clamps if cut) and multiple cuts would be required to make an opening large enough for a person to enter. Weighing only 0.34 pounds per square foot in roll widths of 11½ feet, the material is easy to place over shaft openings. All but one shaft in this project required two roll widths, field spliced together in place, to cover the opening. The largest shaft opening required three roll widths. (See Plates 7 through 10.)

To anchor the perimeter of the mesh and to snug the mesh closely to the ground surface, Pioneer drilled grout-bonded rock anchors at least five feet into bedrock around the shaft openings. The specifications required the rock anchors to be epoxy coated and the sleeves grout filled for corrosion protection. After installation of the mesh and anchors, Pioneer covered the heads of the rock anchors and the mesh in contact with the ground with adjacent mine waste rock for concealment. This leaves only that portion of the mesh over the mine opening visible (see Plates 8 and 9).

To allow visitors to safely view the shaft openings through the mesh covers, AML designed a viewing platform on one edge of the opening using precast segmental concrete wall units, serrated steel floor grating and fabricated weathering steel handrails (see Plate 8). At the largest and deepest shaft protected by a mesh cover, Pioneer installed a prefabricated weathering steel bridge that allows visitors to look directly down the shaft (see Plate 9). Although the anchored mesh can easily handle the weight of as many people as can stand over the opening, AML specified low barriers constructed

of PVC-coating piping around the shaft openings. These barriers discourage walking, jumping or bike riding on the mesh for liability reasons.

Biologists under contract with AML found significant bat habitat in three shafts, two of which are within Park boundaries. Because the rock near the surface at these shafts is weathered and eroded, AML designed each bat cupola to rest on a steel tube, placed through a polyurethane foam plug. The foam plug transfers structural loads to both bedrock in the shaft and the sides of the erosion cone at the shaft collar. The foam coating, several inches thick, also acts as a corrosion barrier for the steel tube. The prefabricated weathering steel tube is shaped like a rectangular funnel with the bottom closely fitting the dimensions of the shaft (see Plates 11, 12 and 13).

To blend the structures into the landscape and to reduce maintenance costs, several measures were taken. All visible concrete is integrally colored a shade of brown close to that of the surrounding rock and soil. The bat cupolas, pedestrian bridge, hand railing and metal picket fences are all constructed using weathering steel. Weathering steel forms a tightly adhering reddish brown rust coating that does not require painting and is unobtrusive in the landscape. The welded wire fencing materials, including barbed wire, and the low barrier piping and accessories are black PVC-coated to reduce visibility and to increase their life span.

Pioneer began construction work began in early May 2003 and substantially completed the project the following October at a cost of $671,000.

CONCLUSIONS

The cultural and mining heritage of the Cerrillos Hills is long, rich, and unique in American history. These facts have led to efforts over the last few decades to preserve as much of that heritage as possible, eventually resulting in the establishment of the first public park in New Mexico dedicated to mining history. (Information on the Cerrillos Hills Historic Park can be found at www.cerrilloshills.org.)

Many of the mine features preserved in the Cerrillos South Mine Safeguard project are in and of themselves not historically important; others are. The presence of these mine openings in an historic mining park however mandated that a representative sample be set aside for historic preservation and educational purposes. With their partners in development of the Park, AML developed several approaches to achieve these goals, primarily by selecting materials and methods than minimized the physical disturbance, ecological disruption and visual impacts of the mine safeguard project. At the same time, the mine closures are safe for public visitation, are designed to be long lasting and vandal resistant, and provide places for people to become acquainted with New Mexico's mining heritage.

Cooperative partnering between the town of Cerrillos, the Cerrillos Hills Park Coalition, the Bureau of Land Management, the National Parks Service, the County of Santa Fe, the New Mexico Abandoned Mine Land Bureau, and numerous individuals and local businesses have created a safe, educational and recreational environment for park visitors, while respecting and preserving a significant prehistoric and historic mining landscape and its features.

REFERENCES

Bice, Richard A., Phyllis S. Davis, and William M. Sundt
2003 *Indian Mining of Lead for use in Rio Grande Glaze Paint*. Report of the AS-5 Bethsheba Project Near Cerrillos, New Mexico. Published by the Albuquerque Archaeological Society.

Blake, W. P.
1858 The Chalchihuitl of the Ancient Mexicans, its Locality and Association, and Its Identity with Turquoise. *American Journal of Science* 25: 227-232.

Deyloff, Glenda
2001 *A Cultural Resources Survey In A Portion of Los Cerrillos Mining District, Santa Fe, County, New Mexico*. Southwest Archaeological Consultants, Inc. Report SW 450, Santa Fe, New Mexico. NMCRIS #74362

Levine, Daisy F., and Linda J. Goodman
1990 *An Archaeological and Ethnographic Survey within the Cerrillos Mining District, Santa Fe County, New Mexico*, Vol. 1. Laboratory of Anthropology Note No. 508. Museum of New Mexico, Santa Fe.

Mathien, Francis Joan
1998 Tri-Cultural Use of the Cerrillos Mines. In *America's Mining Heritage*, edited by Ronald M. Greenberg, pp.49-52. CRM 21(7): 49-52. U. S. Department of Interior, Washington, D.C.

Mechau, Michael
1974 Historical, Social, and Economic Description of the Cerrillos Region, New Mexico. (Report 6). In Romcoe Environmental Study, Oxymin Cerrillos Project. Rock Mountain Center on Environment (1976).

Milford, Homer E.
1995 Historic Survey of the Los Cerrillos Area and its Mining History, vol. 1. *Cultural Resource Survey for Real De Los Cerrillos Project, Santa Fe County, New Mexico*. New Mexico Abandoned Mine Land Bureau Report No. 1994-2. Mining and Minerals Division, Energy, Minerals and Natural Resources Department, Santa Fe.

2000 Environmental Assessment. Cerrillos South Mine Reclamation Project, Abandoned Mine Lands Project, Project Number 35141, Santa Fe County, New Mexico, BLM, County and Private Land. Abandoned Mine Land Bureau, New Mexico Mining and Minerals Division.

Pogue, Joseph E.
1915 The Turquoise: A Study of its History, Mineralogy, Geology, Ethnology, Archaeology, Mythology, Folklore, and Technology. Memoir 3. Vol. 12, Part 2. *National Academy of Sciences*, Washington, D.C.

Snow, David H., and A. H. Warren

1972 Los Cerrillos Mining District (SR-273). Application for Registration, New Mexico State Register of Cultural Properties. On file, New Mexico State Planning Office, Santa Fe.

Warren, A. H.
1976 An Archaeological Survey of the Occidental Minerals Corporation Proposed Mining Project Area in the Cerrillos District, Santa Fe County, New Mexico. Romcoe Environmental Study-Oxymin Cerrillos Project. Rocky Mountain Center on Environment Report 7, Denver. Ms. On file, Southwest Archaeological Consultants, Santa Fe.

Warren, A. H., and Frances J. Mathien
1985 Prehistoric and Historic Turquoise Mining in the Cerrillos District: Time and Place. In *Southwestern culture History: Collected Papers in Honor of Albert H. Schroeder*, edited by Charles A. Lange, pp. 93-128. Archaeological Society of New Mexico 10. Albuquerque.

John A. Kretzmann worked for many years as a design and project engineer in water resources before beginning work in abandoned mine reclamation and safeguarding in 1991 for the New Mexico Abandoned Mine Land Bureau. This work has included design of steep slope abandoned coal mine waste pile reclamation, structures for bat habitat preservation, and other structures for abandoned mine closure. He has a bachelor's degree in Civil Engineering from Valparaiso University.

Lloyd A. Moiola worked as an archaeologist for private consultants and the Museum of New Mexico before joining the New Mexico Abandoned Mine Land Bureau in 1997. His work with AML includes management of archaeological and environmental survey contracts for Section 106 and NEPA compliance, mine reconnaissance, and oversight of photogrammetry and mapping projects. He has a bachelor's degree in Anthropology from the University of Texas at Dallas.

APPENDIX I – PROJECT PHOTOS

Plate 1. View of the Cerrillos Hills above the Galisteo River and town of Cerrillos.

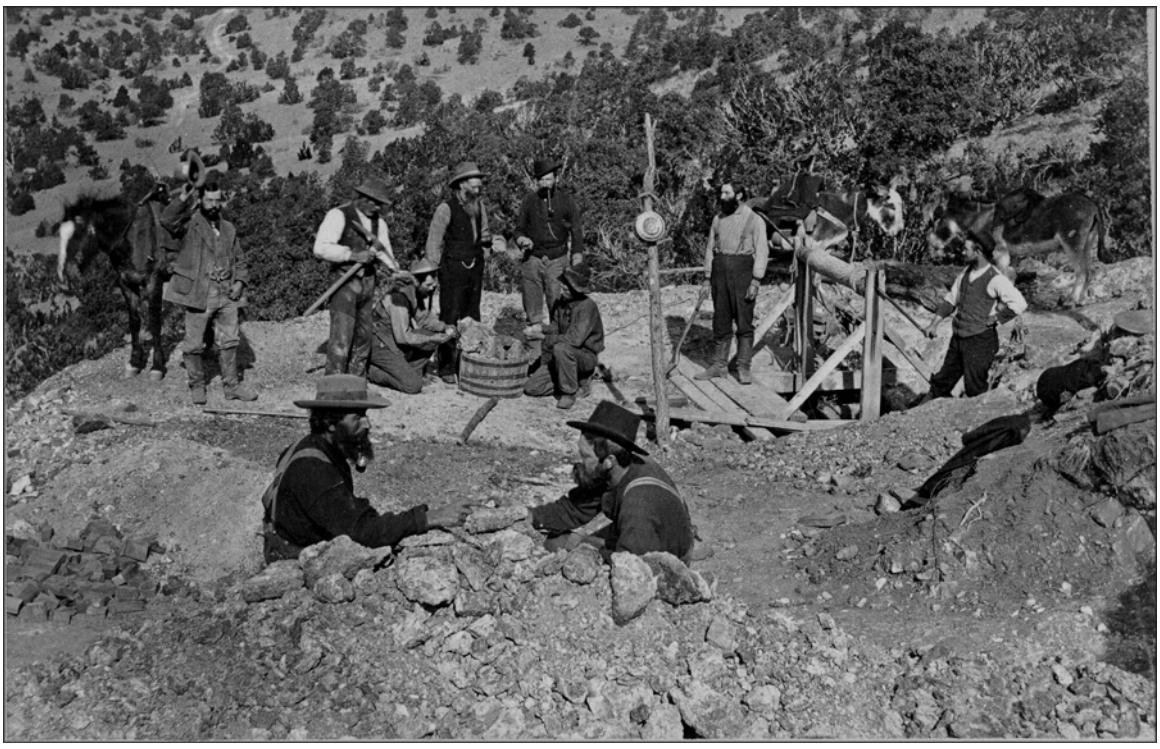

Plate 2. Our Georgie Silver Mine, Cerrillos Hills, 1880.

Plate 3. Wire mesh fence with barbed wire at a highwall.
AML placed a similar fence around the Bethsheba Mine.

Plate 4. Polyurethane foam plug with a drain pipe.

Plate 5. A complete polyurethane foam closure with beehive grate and concrete collar.

Plate 6. Metal picket fence around a partially filled shallow shaft.

Plate 7. Installation of high-strength steel mesh with rock anchors. Note the partially completed bridge abutments on two sides of the shaft opening.

Plate 8. A completed mesh and viewing platform installation at a shaft.
Note the preservation of the timber cribbing remnants at the shaft collar.

Plate 9. The completed mesh and bridge installation over a shaft.

Plate 10. The concrete collar and mesh installation
at the Mina del Tiro Shaft (on private property).

Plate 11. Placement of a structural tube for a bat cupola into a shaft opening. The space between the tube and shaft opening will be filled with polyurethane foam for structural support of the installation and as a corrosion barrier for the weathering steel tube.

Plate 12. Installation of a shop-fabricated bat cupola onto a structural tube.

Plate 13. A completed bat cupola installation with a concrete collar.

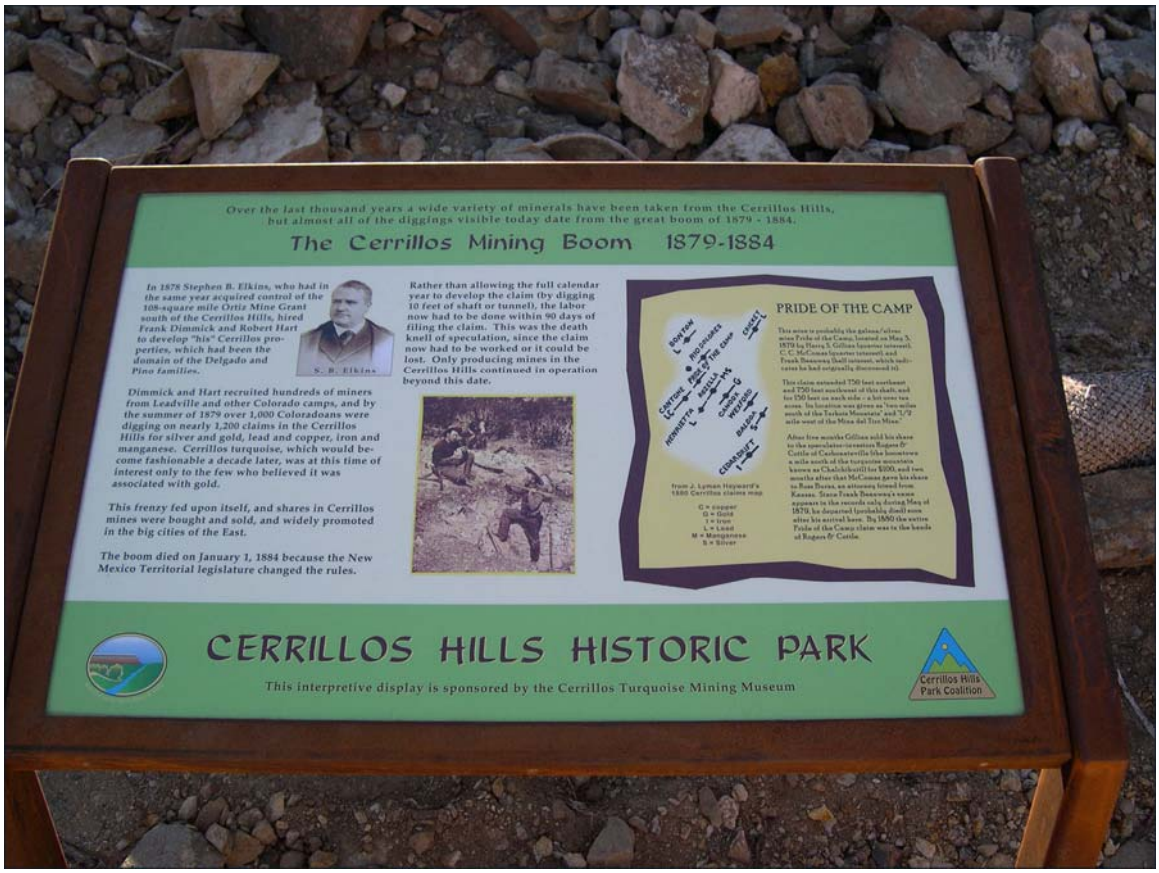

Plate 14. An interpretive sign mounted on a weathering steel base.