OPEN-FILE REPORT 05-11

Mine Site History and Environmental Setting of the Akron Mine, Gunnison National Forest, Gunnison County, Colorado

By

Robert H. Wood II
and
David A. Bird

DOI: https://doi.org/10.58783/cgs.of0511.qlkw1578

Colorado Geological Survey
Department of Natural Resources
Denver, Colorado
2005

FOREWORD

Open-File Report 05-11 describes the history, geology, and environmental setting of the Akron Mine. Part of the site is on U.S. Forest Service-administered land and part is on private. The site was selected for evaluation by the U.S. Forest Service based on the results of an abandoned mine inventory completed in 1996 by the Colorado Geological Survey. This information is useful for State and Federal agencies and private owners for developing realistic and cost-effective reclamation plans.

Funding for this project was provided mostly by the U.S. Forest Service (Agreement No. 1102-0007-98-035). Partial funding came through the Water Resource Data program of the Colorado Geological Survey, and from the Colorado Department of Natural Resources Severance Tax Operational Fund. Severance taxes are derived from the production of gas, oil, coal, and minerals.

Matthew A. Sares
Chief, Engineering and Environmental Geology

Vince Matthews
State Geologist and Division Director

CONTENTS

FIGURES

TABLES

LIST OF ABBREVIATIONS AND SYMBOLS

bk.	book
cm	centimeter(s)
CBM	Colorado Bureau of Mines
CDPHE	Colorado Department of Public Health and Environment
CGS	Colorado Geological Survey
cfs	cubic feet per second
DO	dissolved oxygen
EDR	Environmental Degradation Rating
Ft	feet
gpm	gallons per minute
µg/L	micrograms per liter
µ	microns
µS/cm	microSiemens per centimeter
mg/L	milligrams per liter
NFS	National Forest System
n/a	not applicable
no.	number
oz	troy ounce(s)
p.	page(s)
ppm	parts per million
lb.	pound(s)
PBS	Primary Base Series
quad	quadrangle (7.5-minute)
sq ft	square feet
trec	total recoverable
U.S.	United States
USFS	United States Department of Agriculture - Forest Service
BLM	United States Department of Interior - Bureau of Land Management
v.	volume
vs	versus
>	greater than
<	less than
≤	less than or equal to
%	percent
#	number
$	dollars
~	approximately

INTRODUCTION

Feature #100/200-Akron Mine inventory area 378/4266-1
SE ¼ Sec. 34, T. 50 N., R. 5 E.; Tomichi/Whitepine mining district;
Southeastern Gunnison County; Montrose 2°/ Whitepine Quad.

The Colorado Geological Survey (CGS) inventoried the Akron Mine (Figure 1) and other nearby mining features (adit, shaft, waste-rock dump, tailings, etc.) in 1996 in the Tomichi/Whitepine mining district of the Cebolla Ranger District, Gunnison National Forest. This project was part of an eight-year, statewide inventory of abandoned mines on USFS-administered lands in Colorado. Not all of the mines inventoried were on National Forest System (NFS) lands. Some mines close to NFS lands were inventoried, and other mines that potentially impacted NFS lands were included. The Akron adit portal is located on the eastern side of Tomichi Creek, just south of Whitepine, Colorado (Figure 1). The portal area and some of the waste-rock dump and tailings are on NFS lands. The Akron adit undercuts several patented and unpatented mining claims.

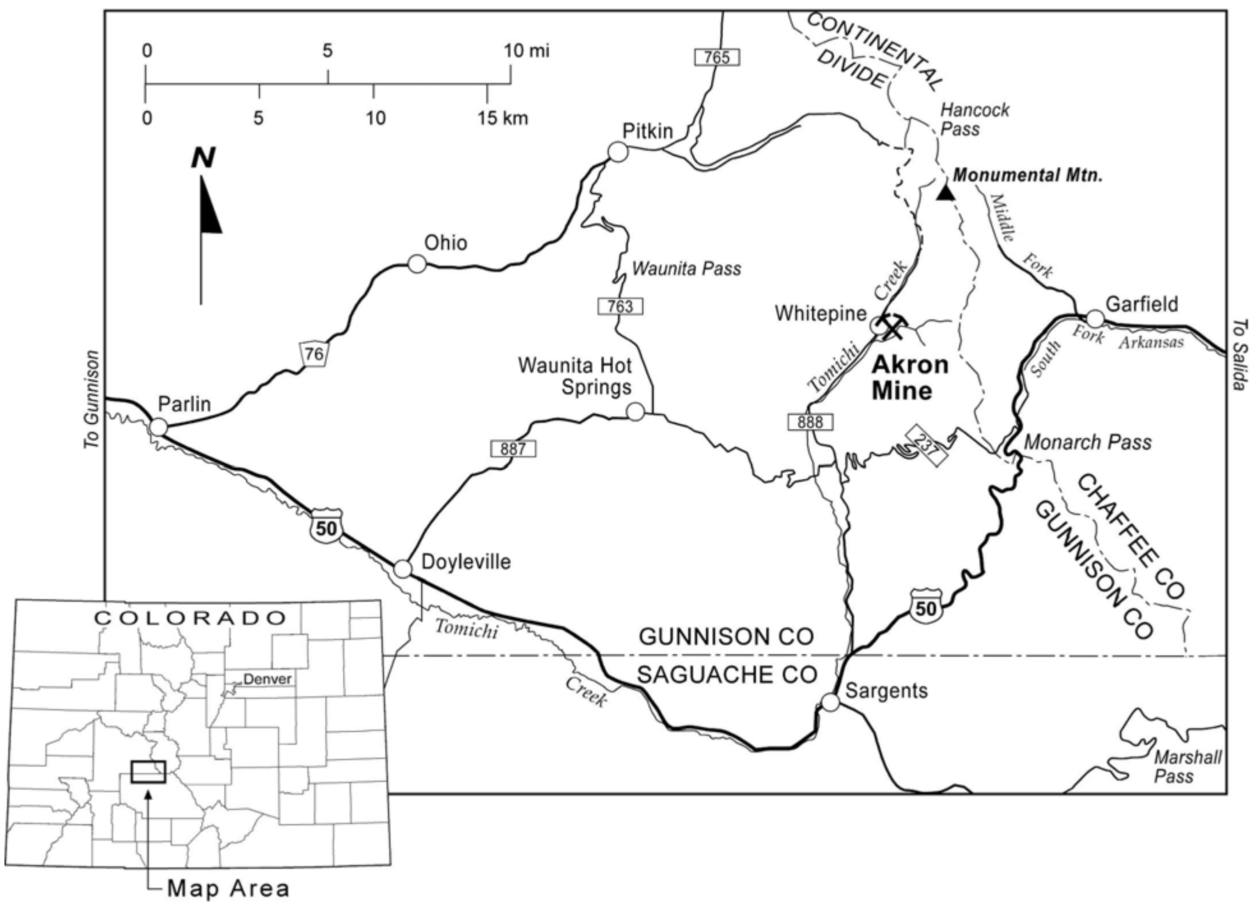


Figure 1. Index map of the Akron Mine area. (Scale is approximate.)

During September 2001, the Forest Service requested a detailed study on the Akron Mine inventory area (#378/4266-1; Figure 2, Appendix A). This report presents the results of the additional work performed on the Akron Mine inventory area. The only mine features in this inventory area are adit #100 (Akron tunnel/adit portal) and the associated waste-rock dump feature #200 (combined dump material and mill tailings). The two concrete foundations noted on the inventory form were probably mill and smelter ruins. CGS assigned an Environmental Degradation Rating (EDR) of 3 (potentially significant) to adit #100 (Akron Mine) and an EDR of 2 (significant) to the associated waste-rock dump (feature #200). According to the Primary Base Series (PBS) map, the portal of the Akron tunnel (adit #100) and some of the waste-rock is on NFS lands. The remainder of the waste rock apparently is on private land. Underground workings are extensive and underlie several patented mining claims.

METHODS OF INVESTIGATION

An explanation of some general methods used in the initial inventory will be helpful in understanding some of the text and figures that follow. During the inventory mines were grouped into inventory areas based primarily on geography and ease of inventory for the field geologist. These take the form of outlined "polygons" on inventory maps. The ID numbers for these inventory areas have the form ###-####-# and are keyed to general UTM coordinates. Mine openings were designated sequentially with 100-series numbers (100, 101, 102, etc.) within each inventory area. These openings are shown as standard mine symbols. Waste rock dumps are designated with 200-series numbers tied to the mine opening and are not symbolized on the maps unless very large. Water test sites (for pH and specific conductance) are indicated as 300-series numbers and shown as dots, unless they are at a mine or dump feature. The inventory forms for the mine features discussed in this report are included in the appendix. These forms contain the initial specific information collected for the mines of concern that prompted this subsequent, more detailed investigation.

Several sources were researched to obtain historical and locational information. Mining claim records (location certificates, assessment records, ownership, and various other transactions) are filed at the Gunnison County Courthouse, Gunnison, Colorado. Location certificates describe and locate the claim, identify all of the locators, and list the discovery and/or location date(s) and the date recorded with the county. Many location notices are not very useful in determining the actual location of the claim. Early mining claim records were filed in a series of numbered books and pages (abbreviated bk. #, p. # in this report). More recent records are filed under serial/reception numbers. In 1976, the Federal Land Policy and Management Act required the filing of unpatented mining claims and evidence of assessment work or notice of intention to hold with the BLM. This requirement was in addition to the required filing with the county.

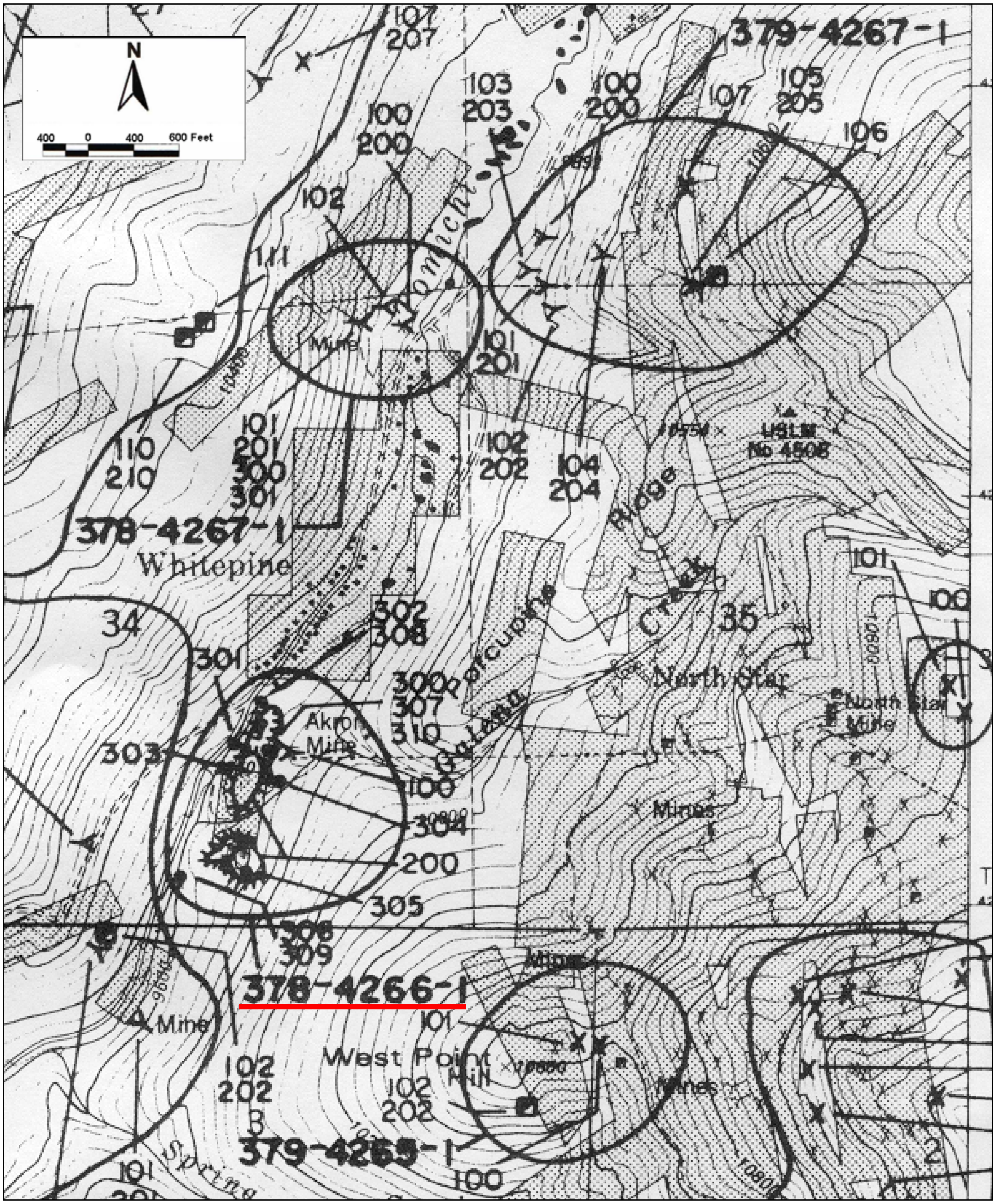


Figure 2. PBS map of the Akron Mine inventory area (378-4266-1). The Akron mine tunnel is feature #100, waste rock #200, and water test sites #300-#310(Scale is approximate.)

Reports by the Director of the Mint, annual mineral-resources reports by the U.S. Geological Survey, and various newspapers and mining journals provided useful production information for some of the mines that were active in the late 1800's and early 1900's, which was the case for most of the mines in this study. Colorado Bureau of Mines (CBM) inspector and mine manager's reports from the early 1900's were also excellent sources for historical information. Annual mineral resources reports by the U.S. Bureau of Mines document activity from about 1924 onward. Most of the later reports primarily focus on larger producing mines and county production.

Frequently, discrepancies occurred among county assessor's records, county recorder's records, BLM master title plats, and Forest Service PBS maps. Surveys and/or title searches are essential for some of the mine sites. Mineral surveys locate and describe mine features associated with the claim at the time of the survey. Usually these features can be located on the ground.

Field work for this study included a visit to each site to see if major changes had occurred since the inventory work in 1996. Although water samples were collected at some locations in 1996, additional samples and water tests were collected in 2002, from the adit and from Tomichi Creek. In addition, the waste-rock dump was sampled on a grid pattern to assess it's potential environmental effects. Waste-rock samples were analyzed for gold, silver, mercury, paste pH, acid neutralization potential, potential acidity, and net acid-base potential. Samples were also analyzed by X-Ray fluorescence to determine a suite of major, minor, and trace elements.

Filtered (0.45 µ) and unfiltered water samples were collected from selected locations for laboratory analyses. Samples were refrigerated until delivery to the lab. Field sampling protocols, laboratory analytical methods, and QA/QC information are in Appendix B.

At locations where a sample of running water was collected, effort was made to measure the streamflow using either a portable Baski cutthroat flume or instream flowmeter. Where the use of either the flume or flowmeter was impractical due to channel conditions or low flow, streamflow was estimated visually or with a catchment such as a 5-gallon bucket.

For consistency in reporting data from different stream segments, analytical results were compared to statewide water quality standards established by the State Water Quality Control Commission (available at http://www.cdphe.state.co.us/op/regs/waterregs/100231.pdf). Stream-segment based regulations were not used. The appropriate standards are shown in the tables alongside the laboratory analytical data. The most stringent of either the domestic-water-supply standard, the aquatic-life standard, or the agricultural standard is shown. Of the metals analyzed during this study, the aquatic life standards for dissolved cadmium (Cd), copper (Cu), lead (Pb), manganese (Mn), nickel (Ni), silver (Ag), uranium (U), and zinc (Zn) are dependent upon the hardness of the water. Thus, each water sample will have a unique set of water quality standards for those metals that are hardness-dependent. To determine hardness, CGS uses method 2340B (Clesceri and others, 1998), which relies on a mathematical calculation rather than a laboratory analysis. Hardness is calculated from the concentrations of calcium (Ca) and magnesium (Mg) by the formula:

$$\text{Hardness (as mg/L CaCO}_3\text{)} = 2.5\text{(mg/L Ca)} + 4.1\text{(mg/L Mg)}$$

The aquatic life standards for aluminum (Al) and iron (Fe), 87 and 1,000 µg/L respectively, are independent of hardness. The aluminum standard is based on dissolved concentration, whereas the iron standard is based on total recoverable concentration. The dissolved iron standard (300 µg/L) used for comparison in this report is the secondary (aesthetic) drinking water standard. Table 1 lists the constituents analyzed, the corresponding statewide water quality standard for each, and the formula for computing the standard from hardness.

Table 1. Constituents analyzed and corresponding statewide water quality standards. Information refers to dissolved concentration unless specified as total recoverable (trec).

Parameter	Water Quality Standard	Basis
pH	6.5 – 9.0	Aquatic Life
Aluminum (trec)	None	None
Antimony (trec)	6 µg/L	Drinking Water - primary
Arsenic (trec)	10 µg/L	Drinking Water - primary
Iron (trec)	1,000 µg/L	Aquatic Life
Thallium (trec)	0.5 µg/L	Drinking Water - primary
Aluminum	87 µg/L	Aquatic Life
Cadmium	$(1.10167 - [\ln(\text{hardness}) \times (0.04184)]) \times e^{(0.7852[\ln(\text{hardness})]-2.715)}$	Aquatic Life
Chloride	250 mg/L	Drinking Water - secondary
Chromium	11 µg/L	Aquatic Life
Copper	$e^{(0.8545[\ln(\text{hardness})]-1.7428)}$	Aquatic Life
Fluoride	2 mg/L	Drinking Water - primary
Iron	300 µg/L	Drinking Water – secondary
Lead	$(1.46203 - [\ln(\text{hardness}) \times (0.145712)]) \times e^{(1.273[\ln(\text{hardness})]-4.705)}$	Aquatic Life
Manganese	$e^{(0.3331[\ln(\text{hardness})]+5.8743)}$	Aquatic Life
Mercury	0.77 µg/L	Aquatic Life
Nickel	$e^{(0.846[\ln(\text{hardness})]+0.0554)}$	Aquatic Life
Silver	$e^{(1.72[\ln(\text{hardness})]-10.51)}$	Aquatic Life
Sulfate	250 mg/L	Drinking Water - secondary
Uranium	$e^{(1.1021[\ln(\text{hardness})]+2.2382)}$	Aquatic Life
Zinc	$e^{(0.8473[\ln(\text{hardness})]+0.8699)}$	Aquatic Life

LOCATION AND GEOGRAPHIC SETTING

The Akron mine is accessed by traveling north on County road 888 for about 10 miles from the town of Sargents, which is at the intersection of U.S. Hwy 50 and CR 888 (Figure 1). Sargents is about 35 miles east of Gunnison, and about 10 miles west of Monarch Pass. The mine is in the

Cebolla Ranger District of the Gunnison National Forest, just south of the town of Whitepine in the southeast corner of section 34, T.50 N., R. 5 E. The adit portal is east of Tomichi Creek and immediately south of Whitepine, Colorado. Several of the mines and claims on Lake Hill, about a mile southeast of the Akron Mine, were either directly connected to, or were undercut by, the Akron adit. The adit was used to drain the workings on Lake Hill, access ore bodies at depth, and was the main haulageway for the May-Mazeppa and North Star groups.

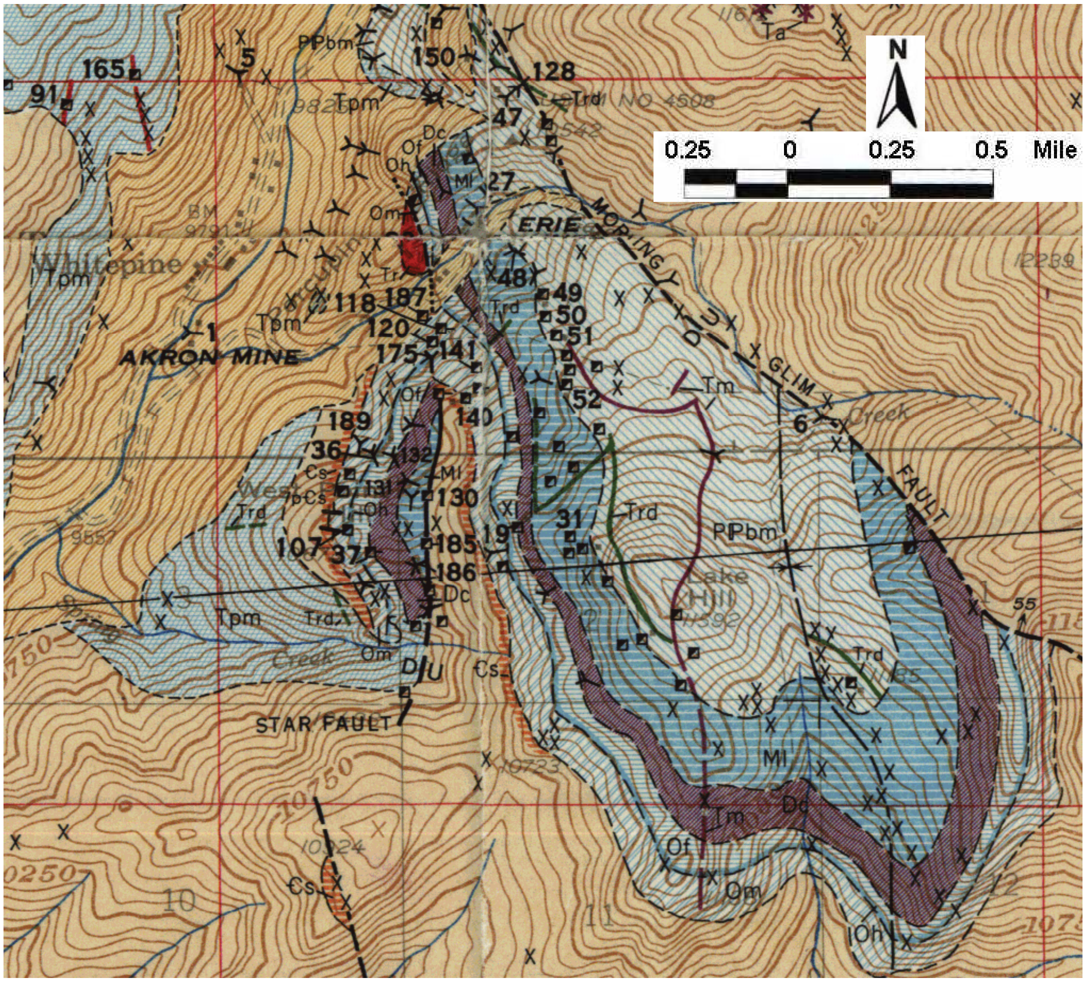
GEOLOGIC SETTING

A geologic map of the Akron mine area is shown on Figure 3. Rocks in the mine area range in age from pre-Cambrian to Quaternary. The pre-Cambrian rocks are metamorphosed sedimentary rocks and intrusive bodies, the Paleozoic and Mesozoic rocks are sedimentary, the Tertiary rocks are intrusive and extrusive igneous rocks with one small area of fossiliferous water-lain tuff, and the Quaternary deposits include glacial moraine, glaciofluvial deposits, landslides, talus and alluvium (Dings and Robinson, 1957). Several episodes of tectonic deformation, during pre-Cambrian, late-Cretaceous/early Paleocene, and early (?) Tertiary times, have created a complex structural setting in the mine area.

Rocks exposed in the Akron mine workings range in age from pre-Cambrian to Tertiary. The Ordovician Manitou dolomite, the host rock for the main orebodies of the Akron mine, is exposed on all levels of the mine. The general strike of stratigraphy is northerly, with eastward dip of 40°-70°. Rhyolite intrusive bodies, many of them hydrothermally altered, are exposed throughout the mine workings.

The chief structure in the mine is the Star Fault, a reverse fault that strikes northerly and dips 40°-80° east, with an average dip of 60° east. Where exposed in the mine, the fault forms a 110-foot-wide breccia and gouge zone containing 90 feet of altered rhyolite porphyry (Dings and Robinson, 1957).

Ore in the Akron mine occurs in a wedge of Manitou dolomite, 20 to 100 feet wide. Ore near the Star Fault is composed of large masses of sphalerite and galena and disseminated pyrite and chalcopyrite. Oxidized ore, though seen at higher levels, was not mined from the Akron mine.



Explanation of geologic map symbols:

Trd=Tertiary rhyolitic dikes
Tm=Tertiary monzonitic and latitic dikes
Tpm=Tertiary Mt. Princeton quartz mozonite
Tr=Tertiary rhyolitie
PlPbm=Pennsylvanian & Permian(?) Belden shale and Minturn formations
Ml=Mississippian Leadville limestone

Dc=Devonian Chaffee formation
Of=Ordovician Fremont dolomite
Oh=Ordovician Harding quartzite
Om=Ordovician Manitou dolomite
Cs=Cambrian Sawatch quartzite
PCs=Pre-Cambrian Silver Plume granite

Numbers refer to named mines.

1-Akron	48=Erie tunnel	130=Morning Star shaft
5-Alwilda tunnel	49=Erie shaft	140=North Star
6-Annie Hudson	51=Eureka-Nest Egg No. 3	150=Parole tunnel
19-Breadwinner	52=Eureka-Nest Egg No. 7	165=Silver Cord
27-Congress tunnel	91=Lilly 141=North Star-Dividend shaft	175=Tenderfoot
31-David H.	107=Maid of Erin-Silver Pick	185=Victor shaft
36-Denver City tunnel	118=May	186=Victor tunnel
37=Denver City shaft	120=Mazeppa	187=W. and A. incline
47=Ensign tunnel	128=Morning Glory	189=West Point

Figure 3. Mine features and Geology of the Akron Mine area (Dings and Robinson, 1947).

AKRON MINE

Workings of the Akron Mine are the most extensive in the Tomichi/Whitepine mining district. Historical information is limited to some of the more important mines or claims associated with the Akron Mine and mill. The North Star and May-Mazeppa were the most important groups worked through the Akron tunnel (adit #100). Work on the Akron tunnel began in 1901, and in 1903 the adit intersected the May-Mazeppa vein at 3,400 feet. The adit was driven to access ore bodies initially worked from surface openings. It was also used as the main haulageway and helped drain the workings on Lake Hill. A mill was built at the mouth of the Akron adit in 1918. Ore processed at the mill not only included the ore associated with the deposits mined through the Akron adit, but also ore from other mines in the area. Interconnected workings of the Akron Mine eventually involved a large number of mining claims. By 1951, the 3,450-foot-long main haulage section of the Akron adit (adit #100) had 5,500 feet of interconnecting drifts and crosscuts. Five main levels above the Akron level had a total of 6,000 feet of drifts and raises. A Defense Minerals contract was awarded in 1951 for exploration and to extend the Akron Tunnel under the Morning Star and Victor Mines. All mining operations apparently ceased during the 1950's.

MINING HISTORY

1879. Ore was first discovered in the Tomichi mining district in the fall, although no significant development work was done until the following year (*Rocky Mountain News*, Aug. 1, 1882, p. 3). Henry F. Lake located the North Star and John G. Evans located the Nest Egg, also known as the Carbonate King (*Rocky Mountain News*, Jan. 21, 1884, p. 6). Work done on the claims was mostly discovery work because Ute Indians arrived during September and the prospectors departed.

1881. Ore in the 34-foot-deep North Star shaft assayed 415 oz silver per ton (*Denver Republican*, Sept. 16, 1881, p. 5). Several hundred tons of ore were shipped from the North Star, Little Carrie, and Lewistown Lodes to Maysville for milling (*Rocky Mountain News*, Nov. 4, 1881, p. 6). The Galena Gulch Mining and Milling Company worked the North Star, Muldoon, Narrow Gauge, and No. 3 Lodes (Burchard, 1882, p. 397). Fifty to 60 tons, worth \$30 to \$70 per ton were shipped during the "season". Ore was exposed in three shafts on the North Star. A 4-foot zone, comprised of mostly galena was exposed in a 20-foot-deep shaft. "Considerable" quantities of galena and carbonate ore were exposed throughout most of the 115-foot-deep shaft. "Very fine" copper carbonate ore occurred in a third shaft. Iron, manganese, and some copper minerals were exposed in the 50-foot-deep Muldoon shaft, sunk in a limestone and granite contact zone. A similar mineralized zone was exposed in the 26-foot-deep Narrow Gauge shaft. A 3½-foot-thick soft carbonate zone exposed in the 18-foot-deep No. 3 shaft contained a 6-inch-thick galena-bearing vein.

Mineral surveys were conducted during October on the North Star Lode and mill site (847 A&B) and the Narrow Gauge (848), Muldoon (849), and No. 3 (850) lodes. Galena Gulch Mining and Smelting Company owned the claim group. Three shafts (19, 25, and 112-feet-deep) were surveyed on the North Star Lode (Figure 4). A building was surveyed on the North Star mill site. Claims adjoining the North Star included the Deadwood (owned by Thomas, Lake and

McPerson), South Star (Lake and McPerson-owners), and the Mazeppa (H.F. Lake, J.A. Staley, and W.L. Cornette-owners). A 26-foot-deep shaft was surveyed on the Narrow Gauge (Figure 5). A 51-foot-deep shaft was surveyed on the Muldoon (Figure 6). Claims adjoining the Muldoon included the Lost Contact (owned by G.B. and H.F. Lake, A.B. Cooper, and R.M. Hinkley) and Morning Star (Owned by Bassler and Swenson). Four shafts (10, 10, 16, and 27 feet deep) were surveyed on the No. 3 (Figure 7). T. Lake and Bessler owned the Helen Lode along the western side of the No. 3 Lode.

1882. A "considerable" quantity of ore had been shipped from the North Star Mine (*Denver Republican* May 28, 1882, p. 10). The North Star was the most famous lead-silver mine in the district (*Denver Republican*, July 7, 1882, p. 2). The 10-foot-wide vein in iron carbonates assayed 52% iron. On the Yellow Jacket Lode north of the North Star, a 30-foot-deep shaft was sunk in hematite. The ore assayed between 50% and 60% iron. The North Star group was considered one of the principal mines in the Tomichi district (Rocky Mountain News, Sept. 4, 1882, p. 8). About 130 tons of ore was shipped from the North Star (*Rocky Mountain News*, Jan. 21, 1884, p. 6). Burchard (1883, p. 464) included the North Star Mine with a list of mines that made ore shipments in the Tomichi district. Galena and "sand carbonates" were discovered on the Nest Egg near the end of the year and 100 tons of ore were shipped.

1883. In January, ore was shipped from the North Star Mine to the Moffet smelter in Gunnison (*Rocky Mountain News*, Jan. 15, 1883, p. 7). In February, a "large" stockpile of ore on the North Star dump was ready for shipping (*Rocky Mountain News*, Feb. 27, 1883, p. 2). In April, the Galena Gulch Mining and Milling Company was issued a patent for the North Star, Muldoon, Narrow Gauge, and No. 3 Lodes (BLM files). In July, Jerry and John Phillips located the Monitor Lode northeast of the North Star Mine (bk. 64, p. 18). In August, following a two-year idle period, Harris & Blake (lessees and owners of the Cosden sampling works) started working the North Star Mine (Burchard, 1884, p. 309). Previous operators had developed the mine through seven shafts. Harris & Blake operated the property through shaft No. 1 (115-feet-deep, with 60 feet of levels), No. 6 (130-feet-deep, with 100 feet of levels), and No. 7 (110-feet-deep, with 30 feet of levels). Mostly composed of galena, the ore averaged 110 oz per ton silver and 50% lead. Although the mine had operated for less than a year, it had become one of the largest producers in the county. In November, one carload of ore per day from the North Star Mine was under contract to the Moffet smelter (*Rocky Mountain News*, Nov. 3, 1883, p. 8). Frank T. Caley was "pushing work on the North Star". Zellar constructed a shaft house over the 30-foot-deep

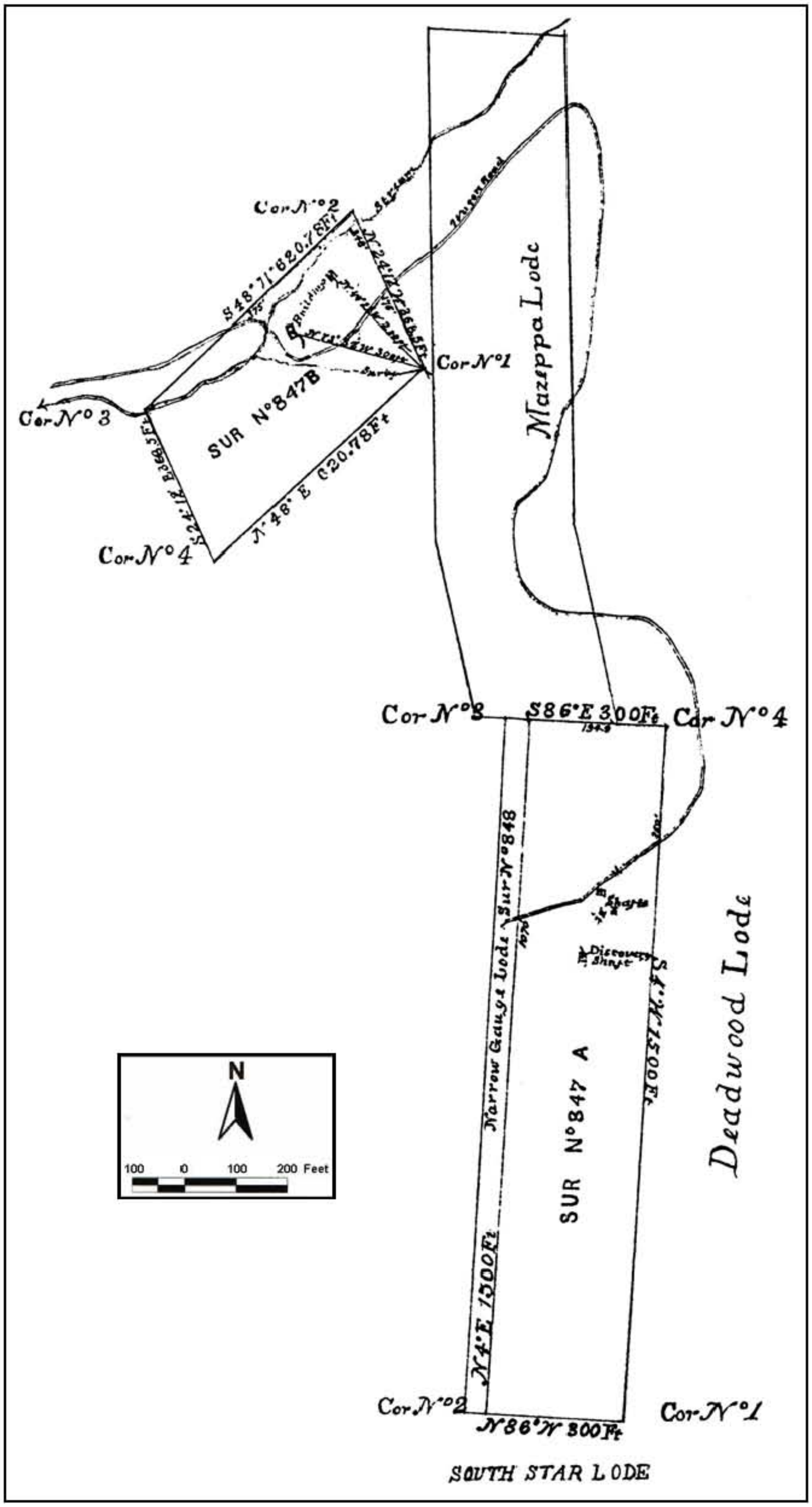


Figure 4. North Star Lode and mill site Mineral Survey (No. 84 A&B). (Modified; Scale is approximate.)

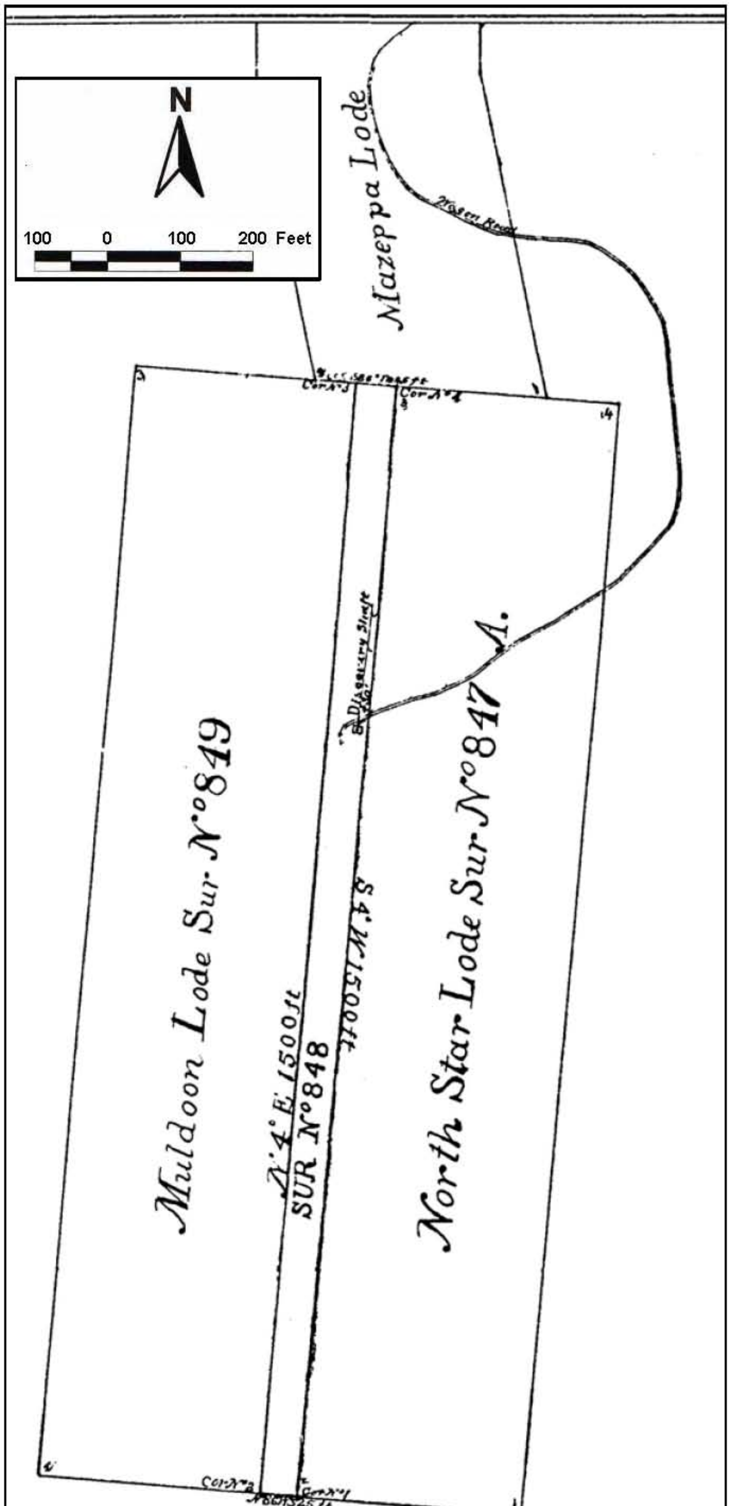


Figure 5. Narrow Gauge Lode Mineral Survey (No. 848). (Modified; Scale is approximate.)

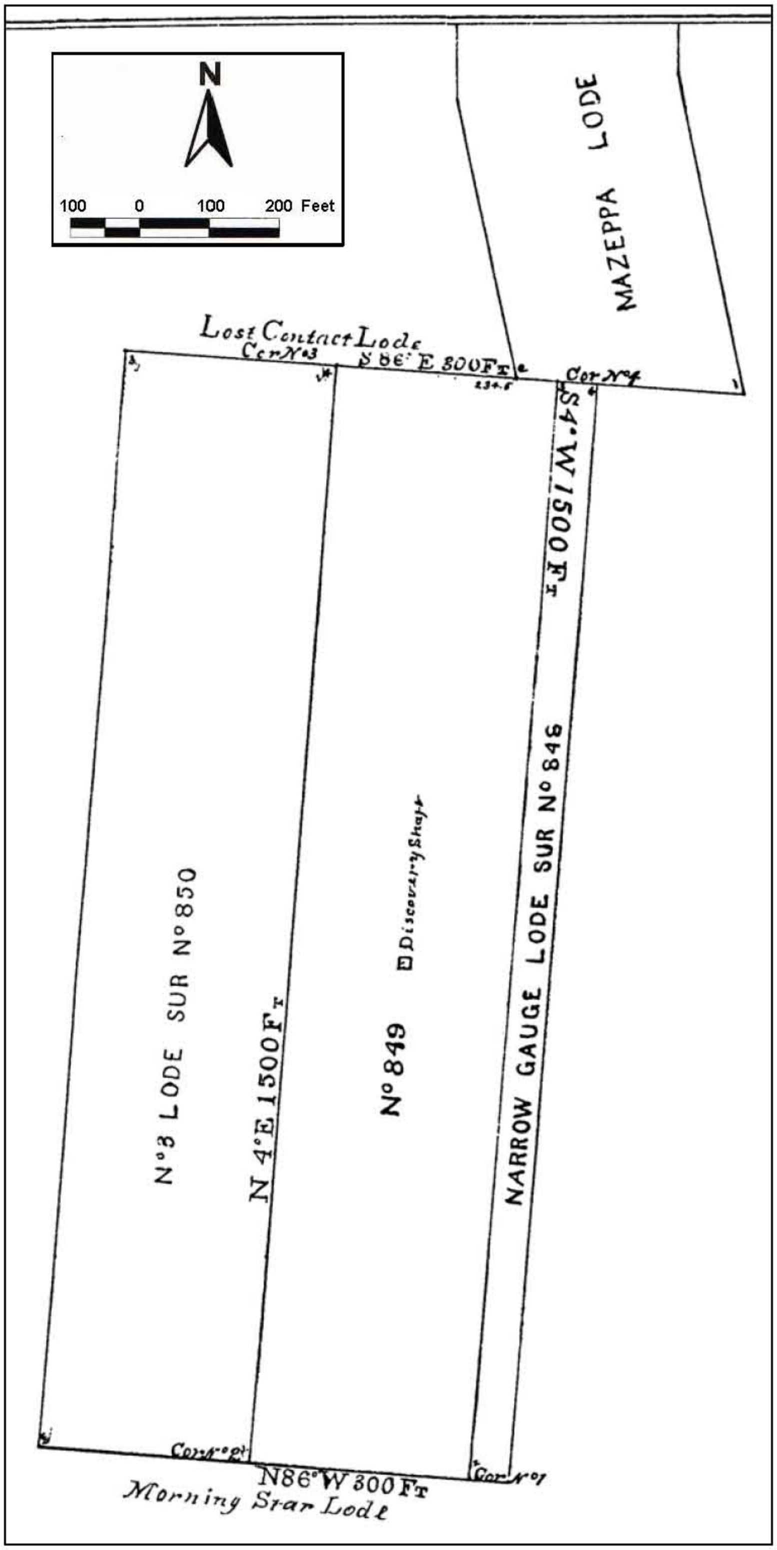


Figure 6. Muldoon Lode Mineral Survey (No. 849). (Modified; Scale is approximate.)

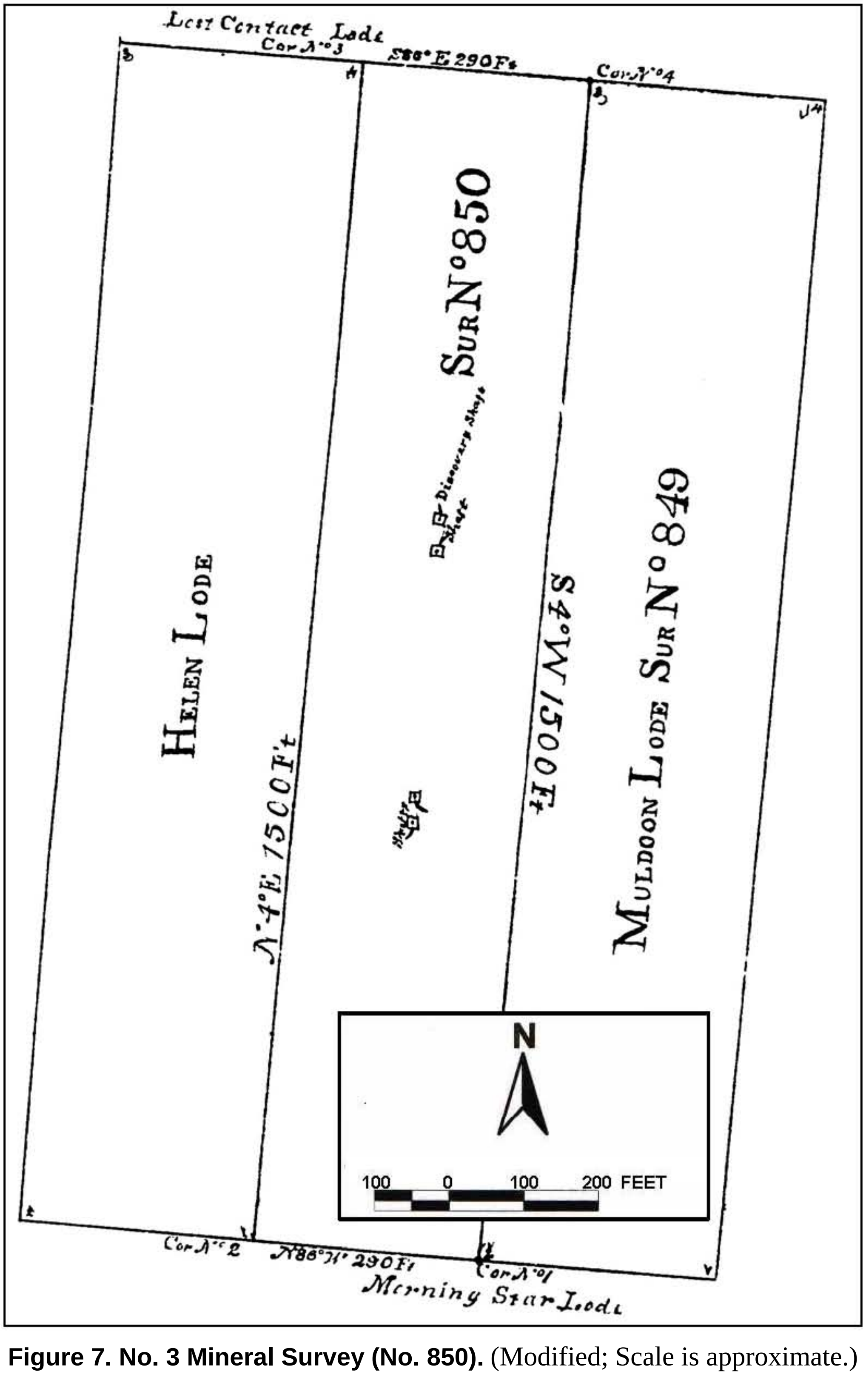


Figure 7. No. 3 Mineral Survey (No. 850). (Modified; Scale is approximate.)

Mazeppa shaft and had plans to extend the shaft 50 to 100 feet during the winter months. Adit #100 (Akron tunnel) intersected the North Star and May-Mazeppa veins in 1903.

Corregan and Lingane (1883, p. 333) described the ore deposits of the North Star group. In all of the workings the ore was deposited with a quartz and carbonate gangue in the contact zone between the granite and carbonate rocks. A 4-foot-wide zone of Galena was exposed in a 20-foot-deep shaft on the North Star. A body of copper carbonates was exposed in the 115-foot-deep North Star shaft. A 4-foot-wide zone containing iron, manganese, and copper minerals was exposed in carbonate rocks in workings on the Muldoon and Narrow Gauge. A 3-foot-wide zone of decomposed carbonate rocks exposed on the No. 3 contained a 6-inch-wide vein of galena. Shipments of sorted ore were worth between $25 and $50 per ton.

During August, Mineral survey No. 1606 was conducted on the Haverford Lode owned by David Scull Jr. and others (Figure 8). The claimants did not meet the required $500 worth of improvements on the claim, but intended to do the work prior to patent. Adjoining claims included the Deadwood, Albany, Bonner, Surprise, Monitor, Bandit, and Iron Crown.

1884. Depressed lead prices caused the North Star Mine to close in January (*Rocky Mountain News*, Jan. 11, 1884, p. 7). The contract between the lessees and the Salt Lake smelter had expired. Mining was expected to resume in the spring with a workforce of 3 or 4 employees. Although no stoping was done, ore removed during development work was shipped at the rate of 10 tons per day from the Harris & Blake concentrator (*Rocky Mountain News*, Jan. 31, 1884, p. 6). The seven North Star Mine shafts were described as follows:

> No. 1--115-feet-deep with drifts at 35 feet and 65 feet. Galena was visible on all sides.
> No. 2--40-feet-deep, ore removed paid the cost of sinking the shaft.
> No. 3--30-feet-deep, no ore was exposed.
> No. 4--15-feet-deep and abundant galena and iron was on the dump.
> No. 5--12-feet-deep and a small vein of galena was exposed.
> No. 6--150-feet-deep with drifts at 60 feet and 120 feet. Galena was exposed in pockets of sand-size material and as immense blocks. Work was concentrated on sinking the shaft to the 180-foot level where a drift would be driven.
> No. 7--96-feet-deep and in mineral the entire depth.

In March the North Star Mine was closed temporarily because of a problem keeping the roads open (*Rocky Mountain News*, March 15, 1884, p. 2). Work continued on other area mines including the Eureka, Sedalia, Lelia Etta, and Silver Trowel. Green and the Terrell Brothers exposed some “fine” mineral in the 60-foot-deep Silver Trowel shaft, in April the (*Rocky Mountain News*, April 9,1884, p. 2). Water problems in the Silver Trowel shaft were resolved by using a larger pump. Although work at the North Star proceeded in June, bad road conditions prevented shipments (*Rocky Mountain News*, June 26, 1884, p. 2). Ore from the Eureka was also stockpiled on the North Star dumps. Galena-bearing ore bodies were exposed in the Paymaster (A. Alsop-owner) and Bandit (A. H. Terrill-owner) shafts. Galena-bearing ore was also exposed in the Nimrod shaft owned by Kenyon, Smith, Paine, and Hopkins (*Rocky Mountain News*, June 10, 1884, p. 6). For the past 2 months, the North Star Company was sinking the No. 6 shaft (*Rocky Mountain News*, July 21, 1884, p. 6). In July, a new orebody was discovered in the shaft. Blake, Harris, and Lake worked the North Star Mine under a bond (*Rocky Mountain News*, Aug. 19, 1884, p. 6). Operations were mostly conducted in the 250-foot-deep shaft.

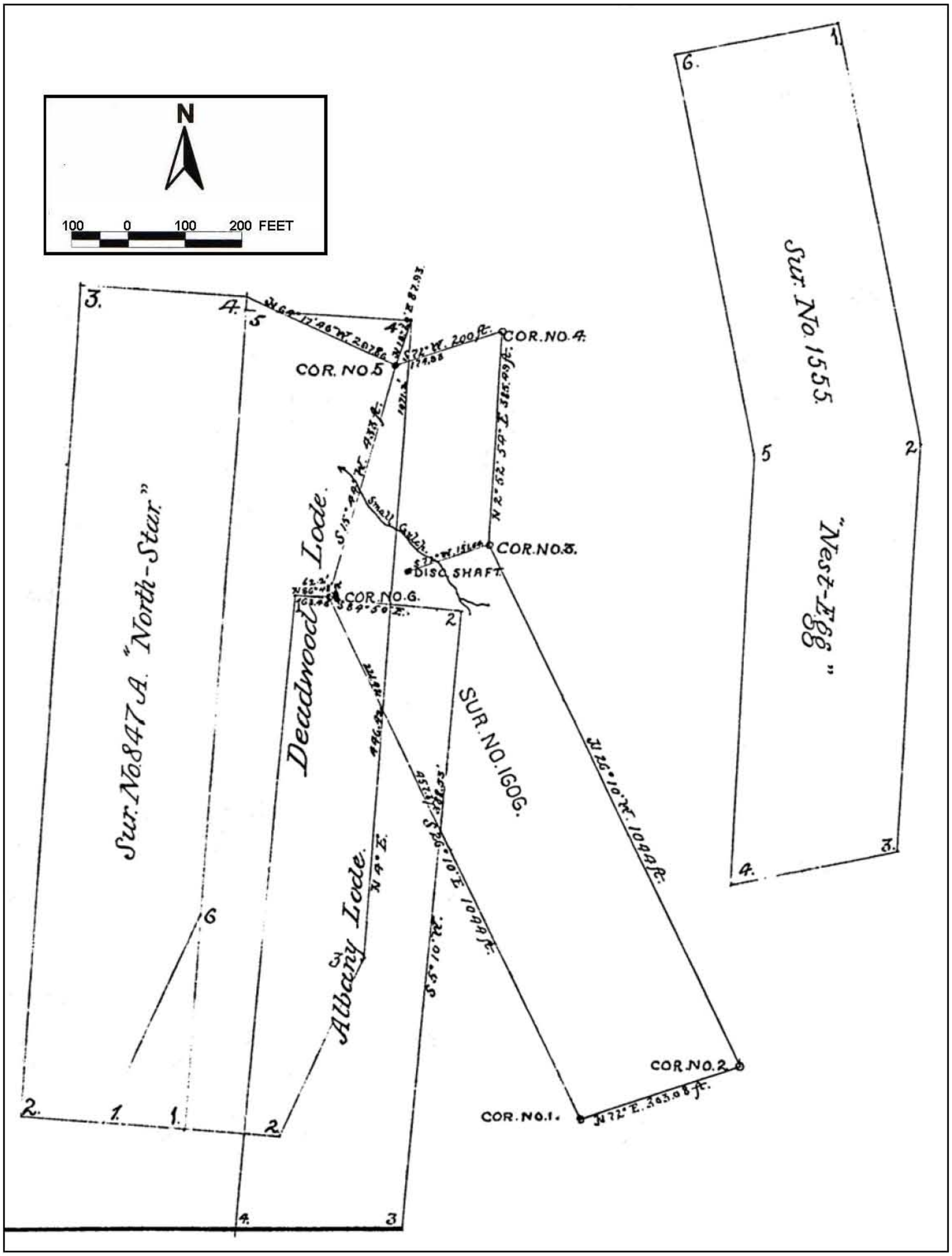


Figure 8. Haverford Mineral Survey (No. 1606). (Modified; Scale is approximate.)

By September, the Harris & Blake concentrator started processing ore from the North Star Mine (*Rocky Mountain News,* Sept. 8, 1884, p. 6). The concentrator recovered over 95% of the mineral values. Another new ore body was discovered at the North Star Mine. The ore averaged 36 oz/ton silver and 60% lead. Henry Lake also discovered galena and carbonate ore on the adjoining Narrow Gauge Lode. Frank Bunnel and the Phillips Brothers exposed an orebody in a shaft on the Erie Lode. Area mines worked during October included the Erie, Eureka, Nest Egg, North Star, and Morning Glim Lodes (*Rocky Mountain News*, Oct. 23, 1884, p. 6). Sand carbonate ore from the Erie assayed 37 oz/ton silver and 45% lead. B.W. Hess managed work on the recently consolidated Eureka and Nest Egg following litigation between the two mines. Several thousand dollars worth of ore was exposed in the North Star Mine and shipments were averaging one carload per day. In another account (Burchard, 1885, p. 216), 4 to 6 carloads of ore were shipped weekly by a large workforce at the North Star Mine. In December, ore from the North Star was high enough in grade that concentration no longer was profitable and the ore was shipped directly to the Moffet smelter in Gunnison (*Rocky Mountain News,* Dec. 19, 1884, p. 6). Ore from the Eureka Mine was also shipped to Gunnison. The lack of ore forced the Cosden concentrator to close.

Mineral surveys were conducted on the following claims: Silver Bayonet Lode (No. 1942) owned by W.T. McConnell and others; Sunset (No. 1981) and Silver Trowel (No. 1982) Lodes owned by J.K. Terrell and others; Erie Lode (No. 2070) owned by J.S. Phillips and others; and the Flirt mill site (No. 2073 B) owned by White Pine Gold and Silver Mining Company. Three shafts (100-, 25-, and undetermined-feet-deep) were surveyed on the Silver Bayonet Lode (Figure 9). Four drifts were driven from the 100-foot deep discovery shaft. Claims adjoining the Silver Bayonet included the Nest Egg, Eureka, Erie, and Lilia Etta. A 10-foot-deep discovery shaft was surveyed on the Sunset Lode (Figure 10) Other workings on the claim were flooded and not surveyed. Claims adjoining the Sunset included the Erie Pueblo, Idaho Bell, Nimrod, Silver Trowel, and Monitor. A discovery shaft was surveyed on the Silver Trowel Lode (Figure 11). Water prevented surveying the other workings on the claim and determining the depth of the discovery shaft. Claims adjoining Silver Trowel included the Pueblo, Ida M. Bell, Nimrod, and Monitor. Two shafts (60 and 40-feet-deep) and a 90-foot-long adit were surveyed on the Erie Lode (Figure 12). Three drifts (20-, 10-, and 10-feet-long) extended from the 60-foot-deep discovery shaft. Only one-half interest in the adit was credited towards the improvements on the Erie Lode. No improvements were surveyed on the Flirt mill site located earlier in the year (Figure 13).

1885. Kinney, Beauchamp, & Hamilton repaired shafts and levels at the Eureka Mine in April in preparation for extensive work (*Rocky Mountain News*, April 22,1885, p. 2). Shipments from the North Star, Eureka, Morning Glim, and other mines in the district were expected to resume in May (*Rocky Mountain News*, April 15,1885, p. 6). A.S. Pettit & Company purchased the Lost Contact and adjoining Little May Lodes (*Rocky Mountain News,* Aug. 15,1885, p. 6). During August, a 3-foot-wide vein was discovered in the 40-foot-deep Lost Contact shaft (*Rocky Mountain News*, Aug. 29,1885, p. 6). The vein assayed between 70- and 5,000-oz/ton silver and contained a “large” percentage of lead. Two carloads of ore were shipped during the month.

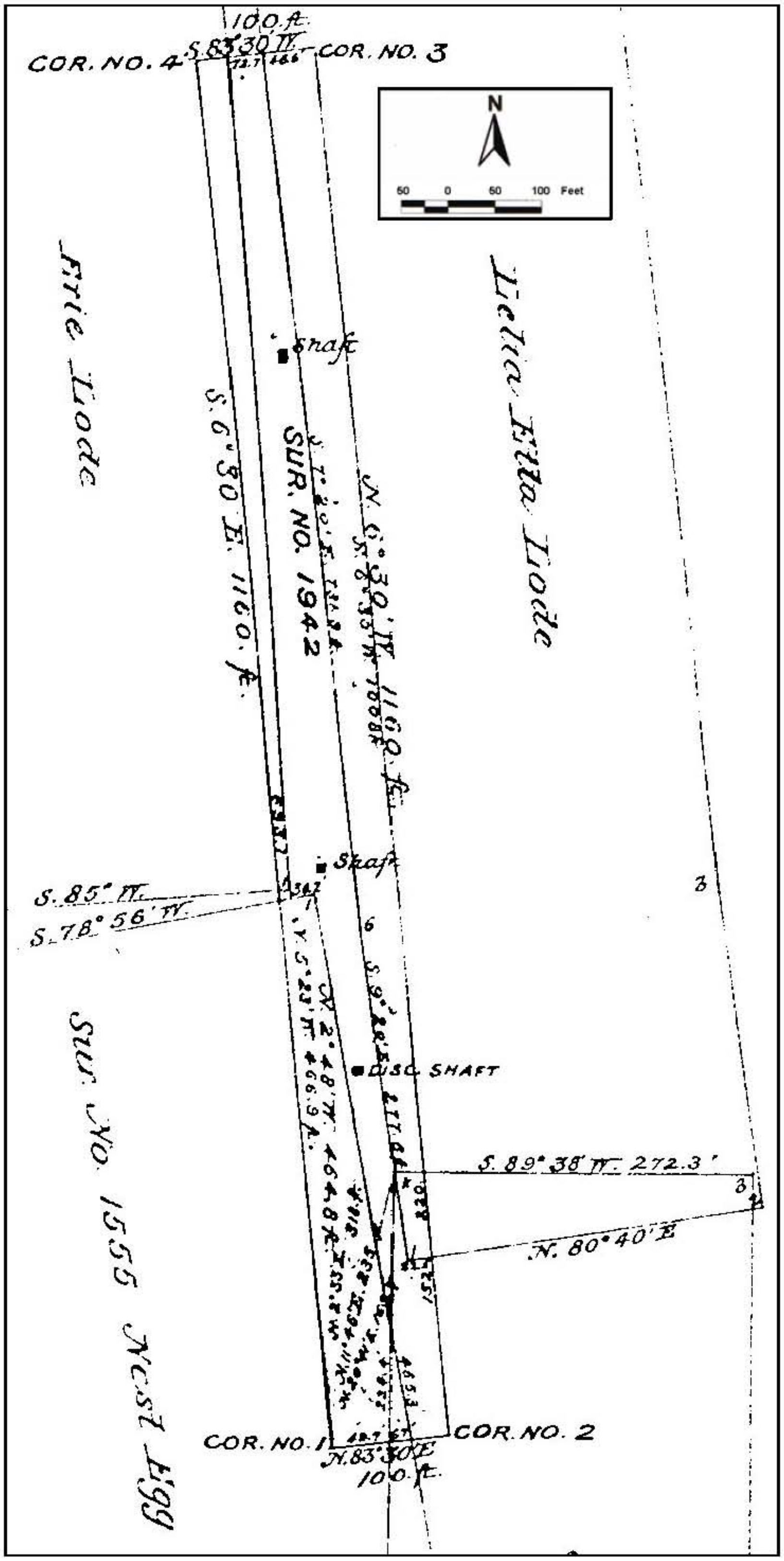


Figure 9. Silver Bayonet Lode Mineral Survey (No. 1942). (Modified; Scale is approximate.)

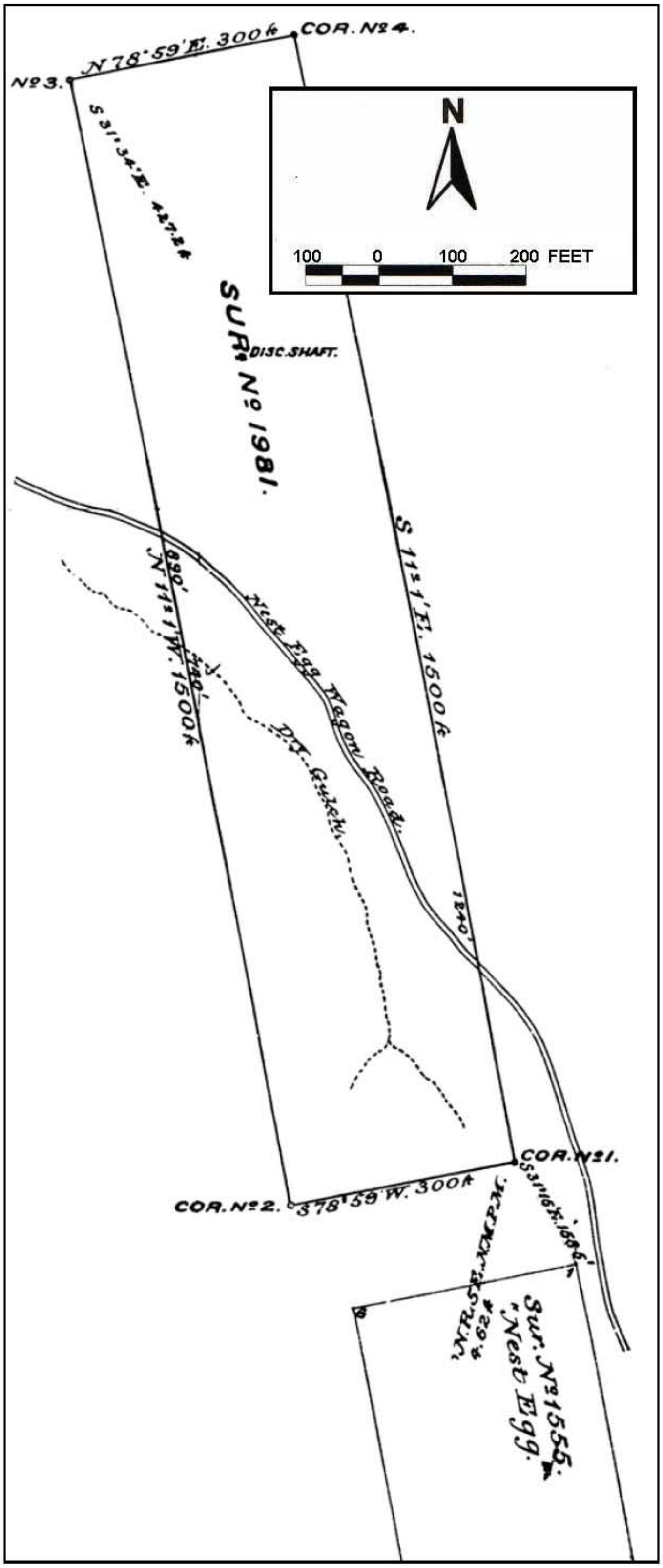


Figure 10. Sunset Lode Mineral Survey (No. 1981). (Modified; Scale is approximate.)

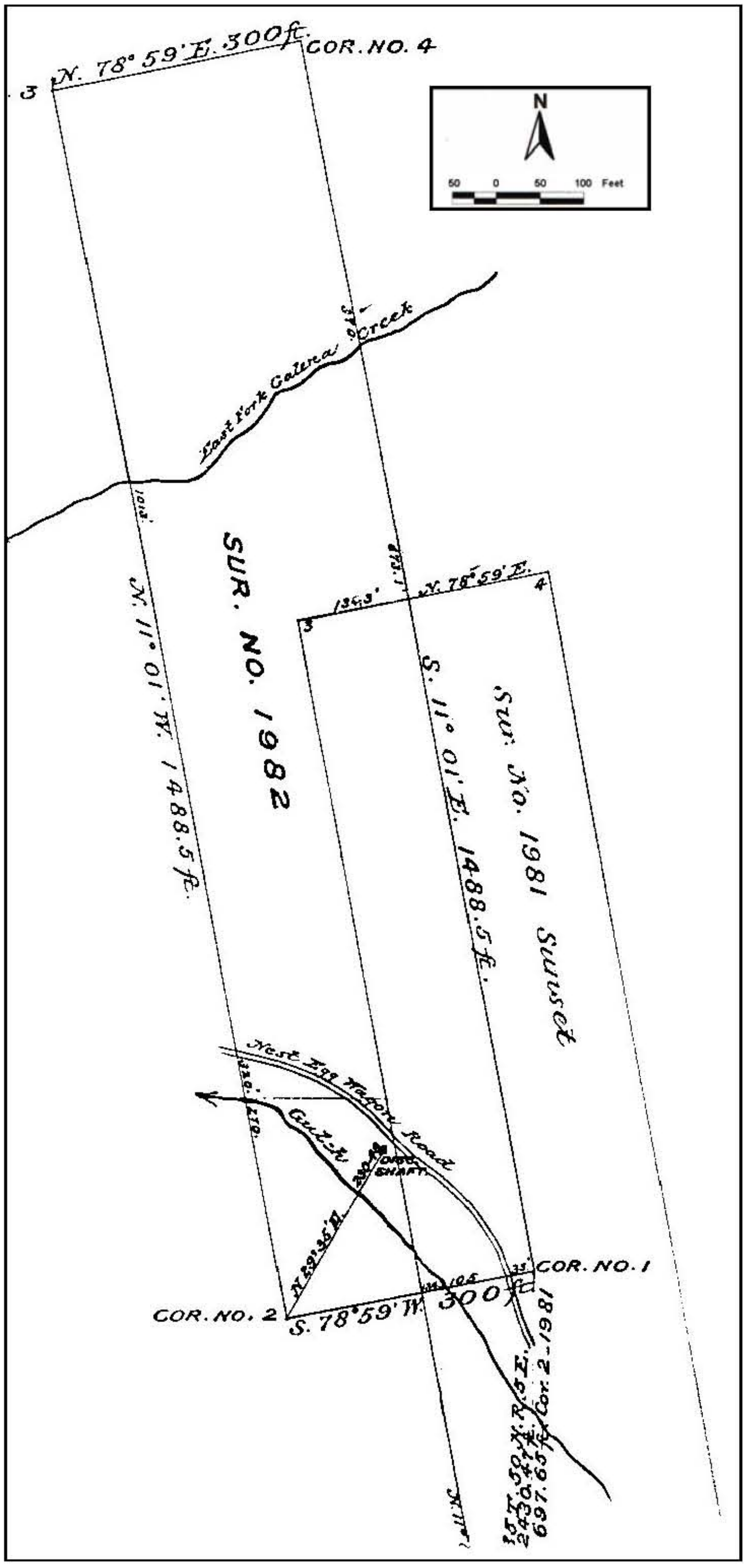


Figure 11. Silver Trowell Lode Mineral Survey (No. 1982). (Modified; Scale is approximate.)

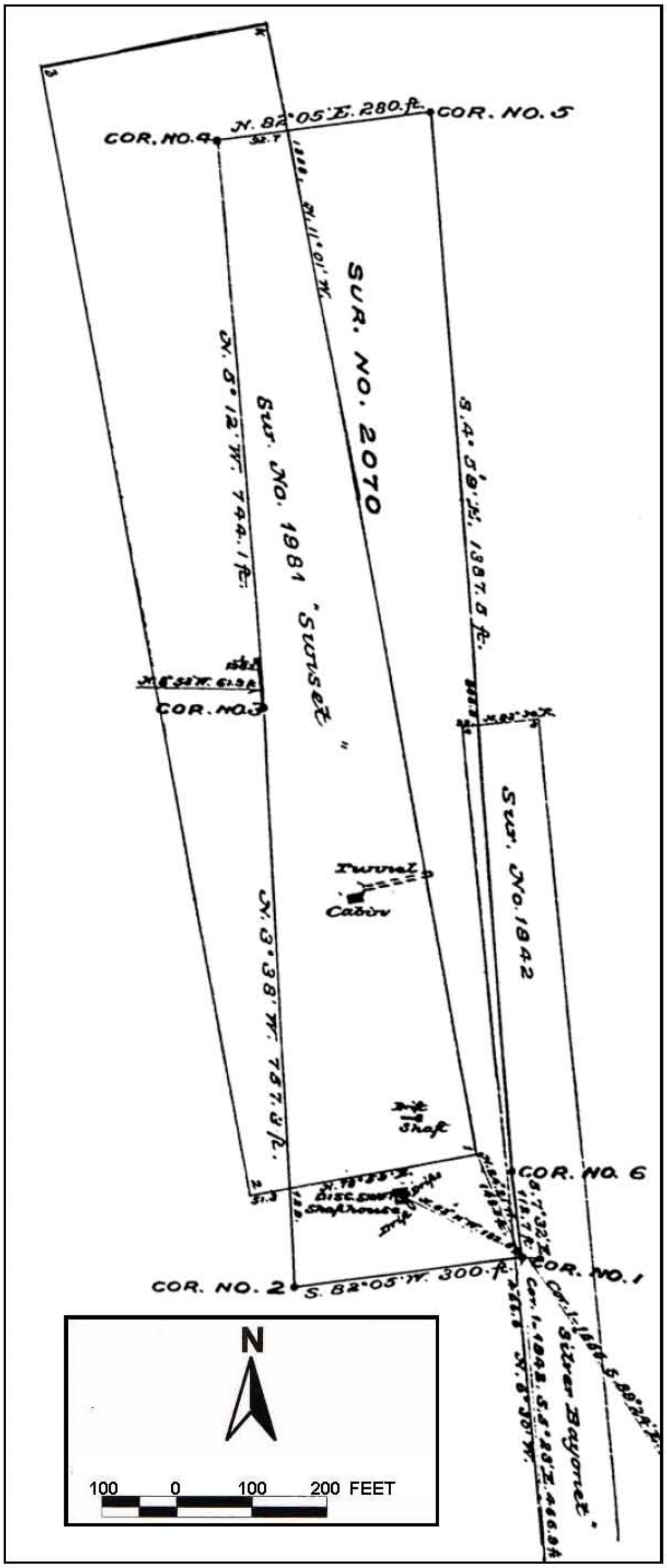


Figure 12. Erie Lode Mineral Survey (No. 2070). (Modified; Scale is approximate.)

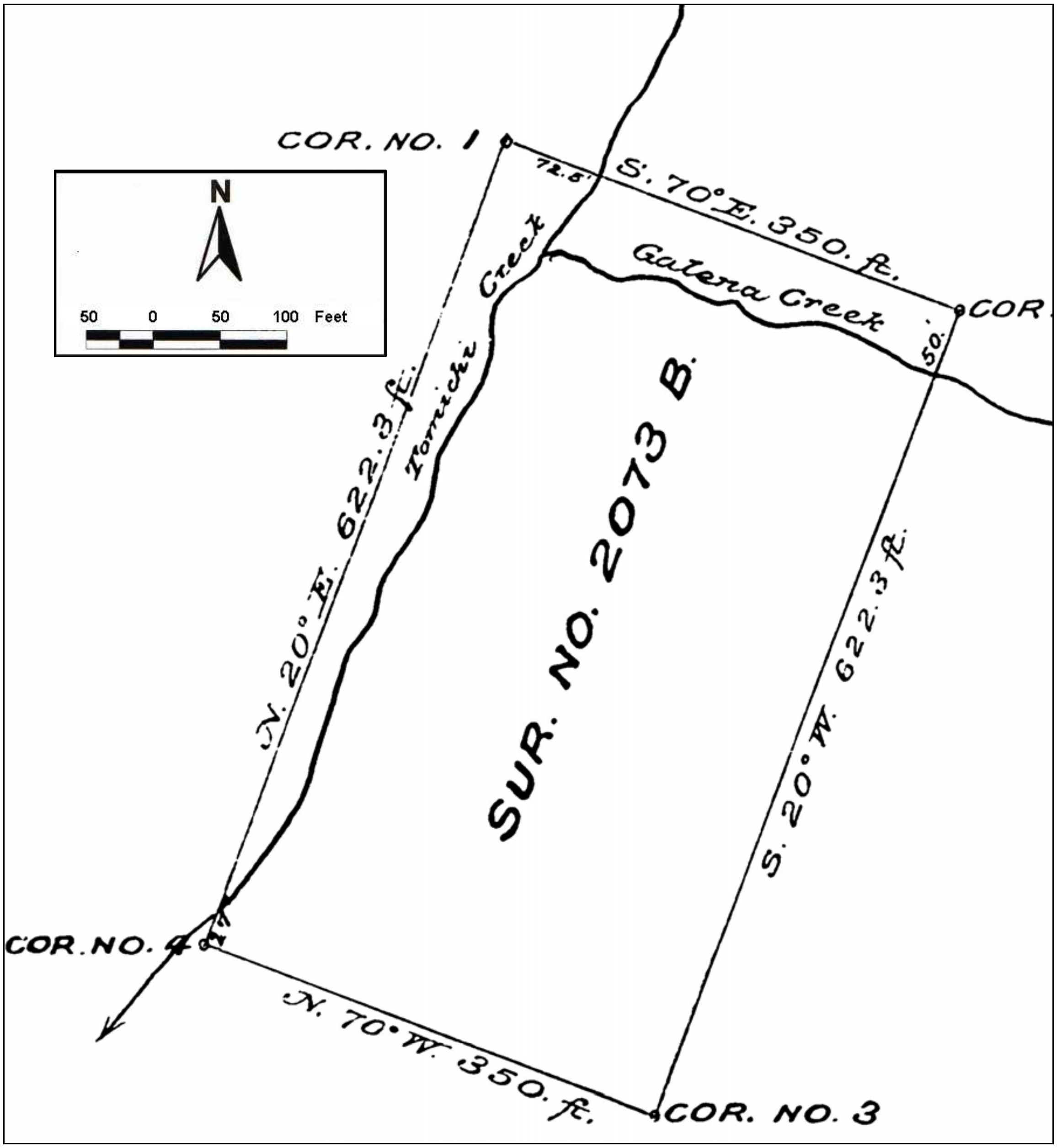


Figure 13. Flirt mill site Mineral Survey (No. 2073 B). (Modified; Scale is approximate.)

Mineral surveys were conducted on the Lost Contact (2332) and Little May (2333) Lodes owned by A.S. Pettit and others. A 50-foot-long open cut and 3 shafts (80, 60, and 45-feet deep) were surveyed on the Lost Contact Lode (Figure 14). Two drifts (201 and 99-feet-long) were driven from the 80-foot-deep shaft. Other parties sunk the 45-foot deep shaft. A 15-foot-long discovery cut, 13-foot-long adit at the face of a 20-foot-long open cut, and 4 shafts (16, 27, 45, and 12-feet-deep) were surveyed on the Little May Lode (Figure 15). Other parties sunk the 12-foot deep shaft. Adjoining claims included the North Star mill site and Lost Contact, Isabel, Dusky Belle, and Mazeppa Lodes.

1886. Patents were issued to Samuel Alsop (Bandit Lode), Ignathius Zeller (Deadwood Lode), David Scull (Haverford Lode), and J.L. Bridge, J. Jones, R.L. McConnell, W.T. McConnell, J.D. Pearce, W.J. Reid, and E. West (Silver Bayonet Lode) (BLM files). Mineral surveys were conducted on the Mazeppa Lode (2498) owned by H. Blossom and others and Lelia Etta Lode (2511) owned by D.A. Barber and others. Three shafts (14, 35, and 30-feet-deep) were surveyed on the Mazeppa Lode (Figure 16). An 8-foot-long drift was driven at the end of a 15-foot-long inclined (33°) drift at the bottom of the 30-foot-deep shaft. Adjoining claims included the North Star mill site and Narrow Gauge, Lost Contact, Little May, Dusky Belle, Yellow Jacket, and Pickwick Lodes. An 18-foot-deep discovery shaft and a 130-foot-deep shaft were surveyed on the Lelia Etta Lode (Figure 17). Adjoining claims included the Eureka, Silver Bayonet, Sedalia, and Eastern Star Lodes.

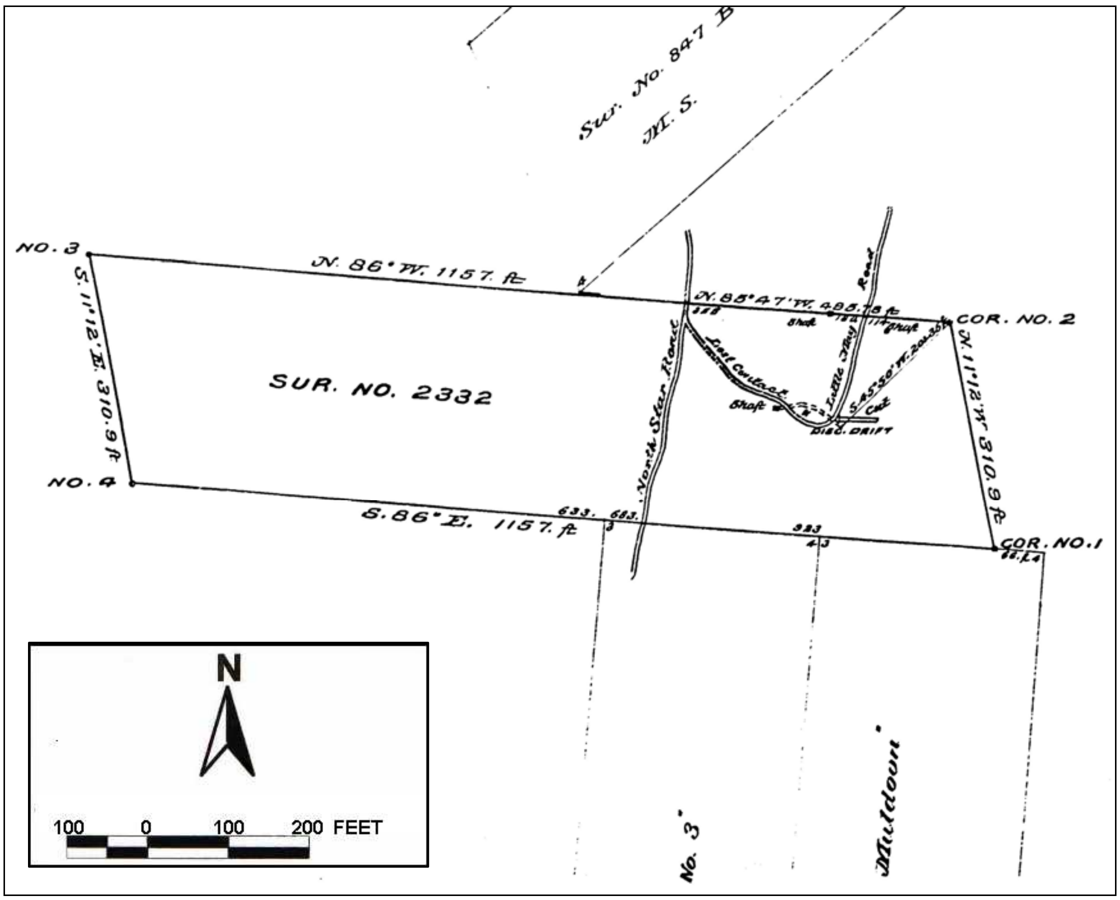


Figure 14. Lost Contact Lode Mineral Survey (No. 2332). (Modified; Scale is approximate.)

1887. In September, mineral surveys on the Sunset (No. 1981) and Silver Trowel (No. 1982) lodes, owned by J.K. Terrell were amended. In November, D. Barber, F. Bunnell, and J. Terrell were issued a patent for the Erie Lode (BLM files). No production was reported from the North Star and Mazeppa Mines (Munson, 1888, p. 170).

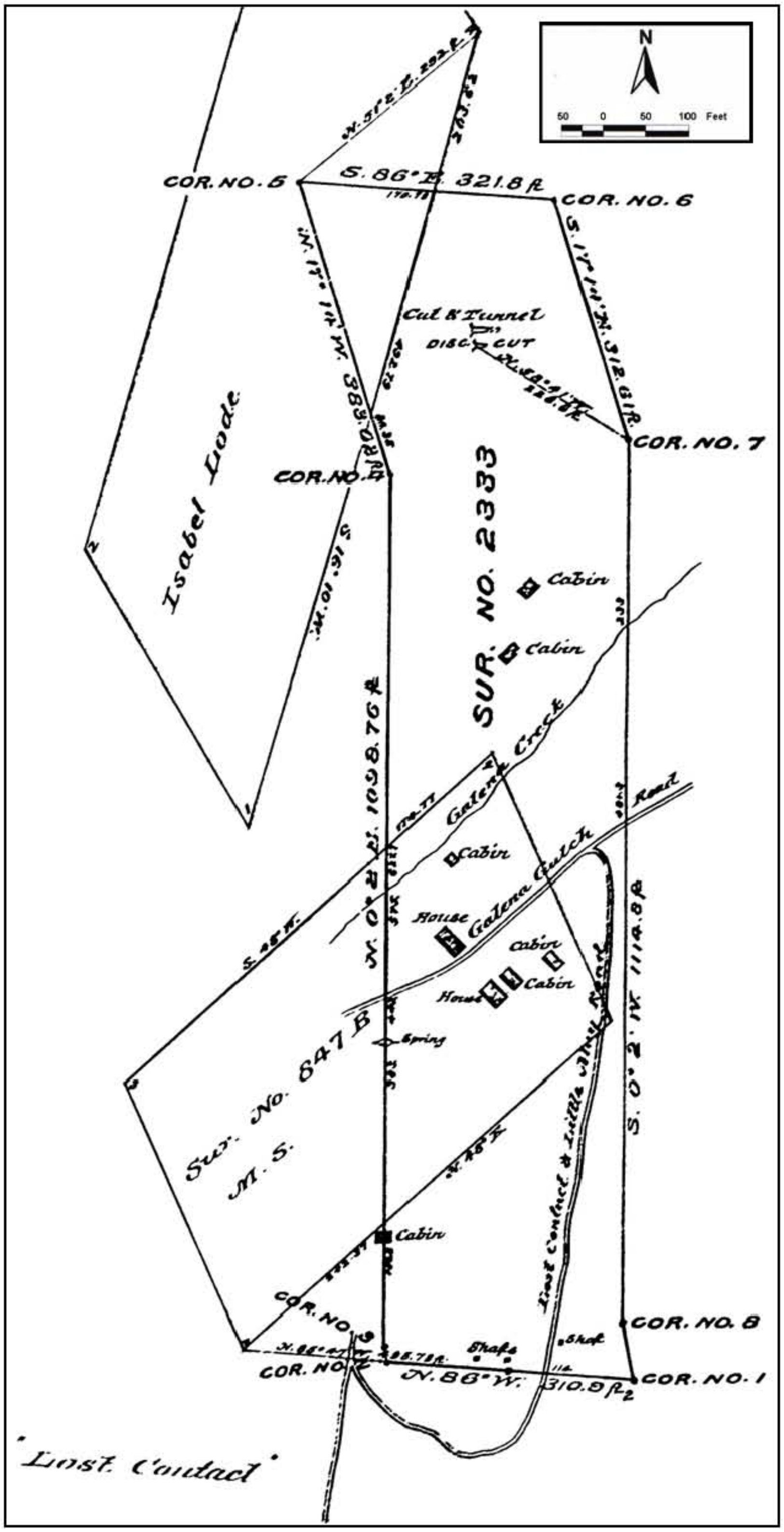


Figure 15. Little May Lode Mineral Survey (No. 2333). (Modified; Scale is approximate.)

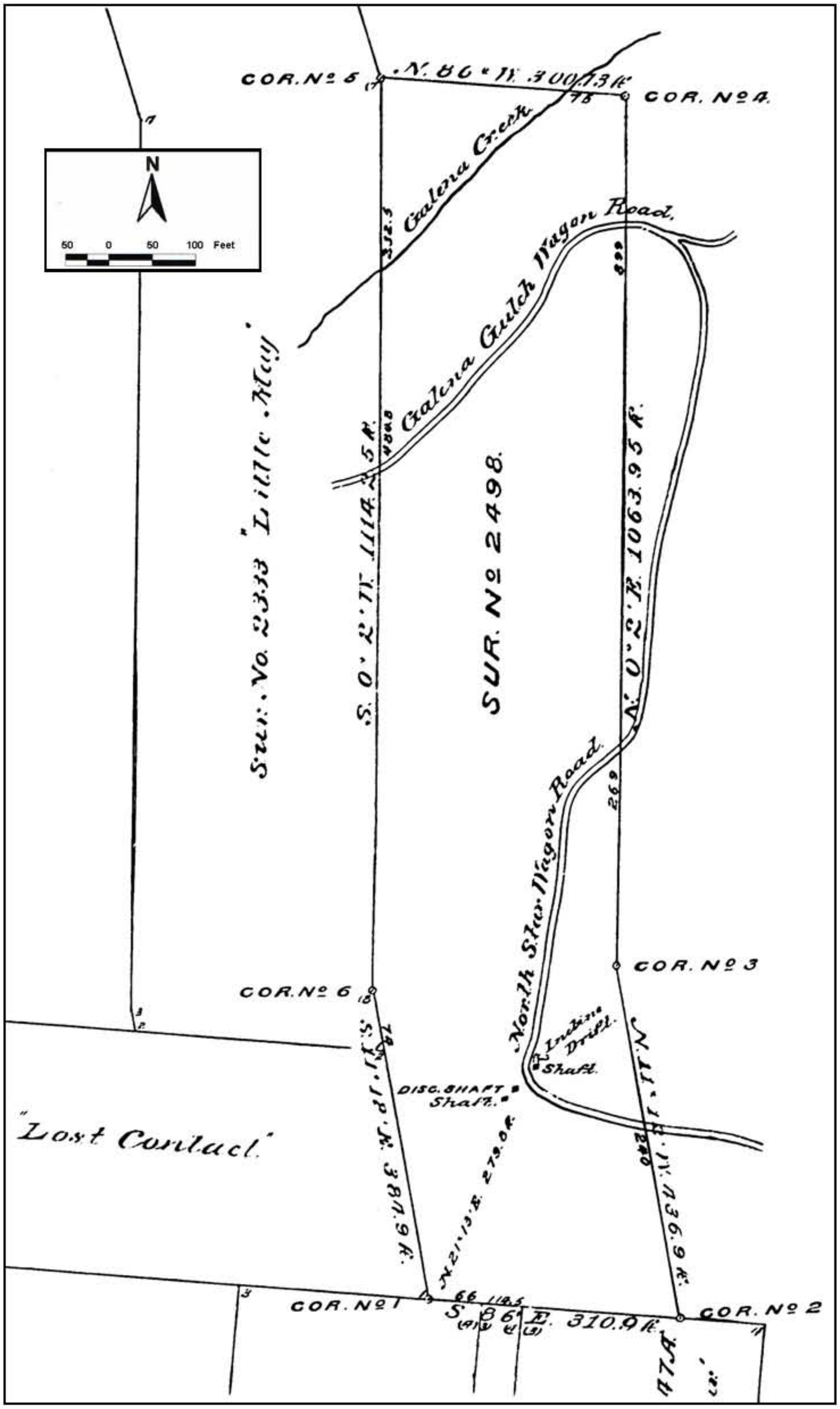


Figure 16. Mazeppa Lode Mineral Survey (No. 2498). (Modified; Scale is approximate.)

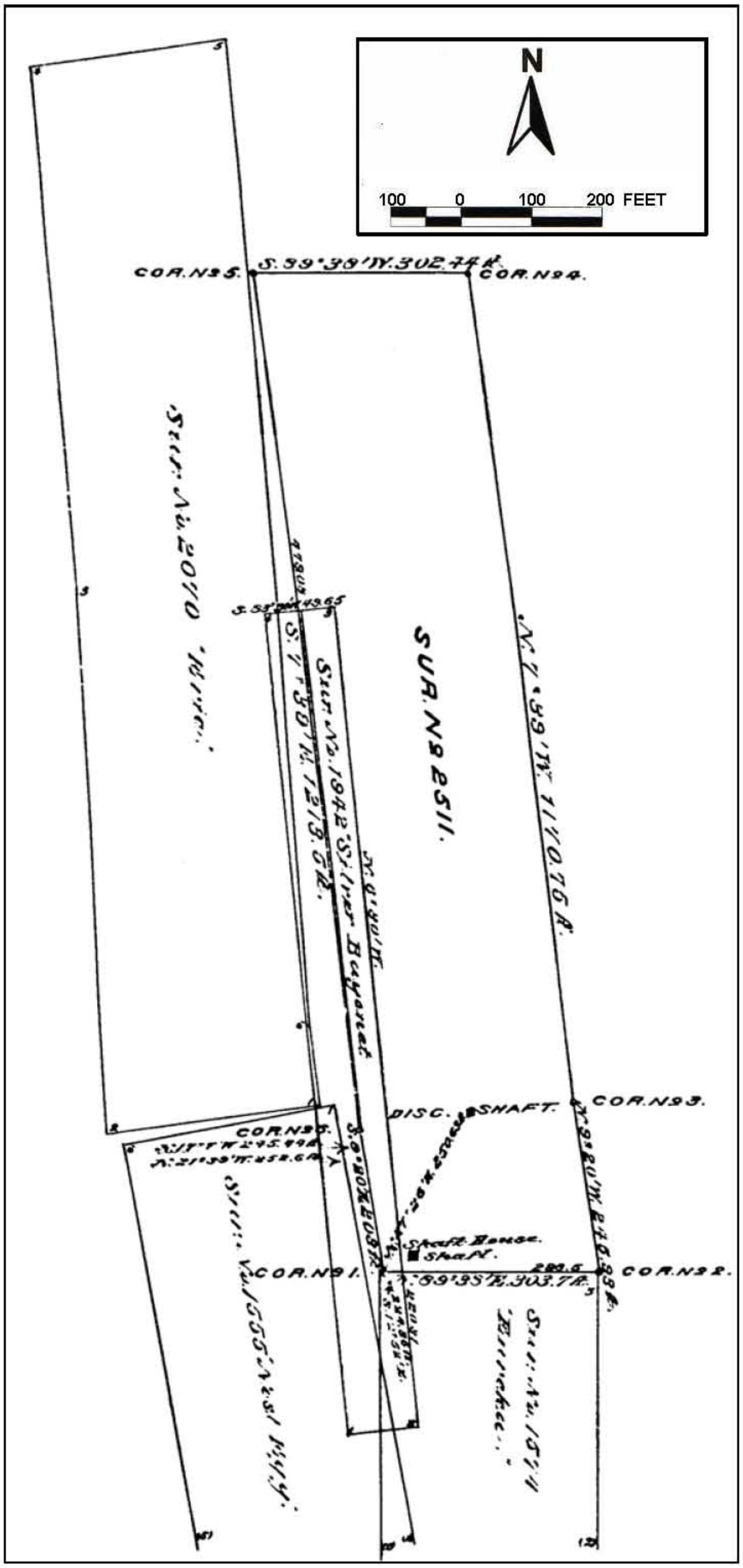


Figure 17. Lelia Etta Lode Mineral Survey (No. 2511). (Modified; Scale is approximate.)

1888. In March, J.K. Terrell was issued a patent for the Sunset Lode (BLM files). In April, J.H. Green, G.J. Terrell, J.K. Terrell, and J.B. Turner were issued a patent for the Silver Trowel Lode. In August, A.S. Pettit was issued a patent for the Lost Contact Lode. In December, R.A. Hopper, T.J. Hurdle, and A.S. Pettit were issued a patent for the Little May Lode. Ore shipped by the May, Contact, Mazeppa Mining Company yielded $300 (15 oz) in gold, $11, 636 (9,000 oz) in silver, and $2,640 (30 tons) in lead (Munson, 1889, p. 110). No production was reported from the North Star Mine. Adit #100 eventually was connected to the workings on the Little May, Mazeppa, and Lost Contact Lodes.

1889. A. Barber, D.A. Barber, J.H. Collins, G.H. Hard, and A.J. Overton were issued a patent for the Lelia Etta Lode (BLM files).

1890. Ore shipped from the May Mazeppa Mining Company yielded $129,792 (100,600 oz) in silver and $218,339 (2,500 tons) in lead (Smith, 1891, p. 134).

1891. In March, D. Barber, H. Lloyd, and A. Wavell were issued a patent for the Ensign Lode (BLM files). Ore shipped from the May Mazeppa Mine yielded $305,200 (236,600 oz) in silver and $274,915 (3,160 tons) in lead (Smith, 1892, p. 180).

1895. In March, H. Blossom, I. Brown, F. Dittmer, N. Hamlin, C.H. Toll, and A. Wheelon were issued a patent for the Mazeppa Lode (BLM files). C.H. Taylor located the Tomichi mill site (bk. 95, p. 470) in August.

1896. A mineral survey was conducted on the Tomichi mill site (Figure 18). Owned by the Tomichi Milling Company. A mill building complete with water powered concentrating machinery (crusher, rollers, jigs, tables, etc.) was surveyed on the claim.

1898. In July, the Turner Mining Company leased the May-Mazeppa mill to treat ore from the Turner and Edgeworth Mines (*Mining Reporter*, July 14, 1898, v. 38, p. 20). In August, the May Mazeppa Mine had a full work force employed at the mine and mill (*Denver Times*, Aug. 9, 1898, p. 6). About 40 tons of lead-silver ore were mined from the 330-foot level and was concentrated in the mill. J.H. Pool was the mill superintendent and J.B. Turner was the mine superintendent. Emil Peterson and R.M. Moseley were shipping 2 carloads of ore per week from the Eureka Mine, under a 2-year lease agreement with the Philadelphia Smelting Company. In September, the workforce at the North Star was mining a “heavy body” of lead-silver ore containing gold values (*Denver Times*, Sept. 14, 1898, p. 8). North Star Mining and Milling Co. owned the May Mazeppa Mine (*Denver Times*, Dec. 31, 1898, p. 20). In December, John Turner (lessee) operated the mine with 15 to 20 employees and milled 30 to 40 tons of crude ore per day. The lead carbonate (cerussite) ore contained 20 to 22 oz/ton silver and 20% to 60% lead. The lead-silver ore, containing minor gold values, was shipped from the North Star Mine (*Denver Times*, Sept. 14, 1898, p. 4).

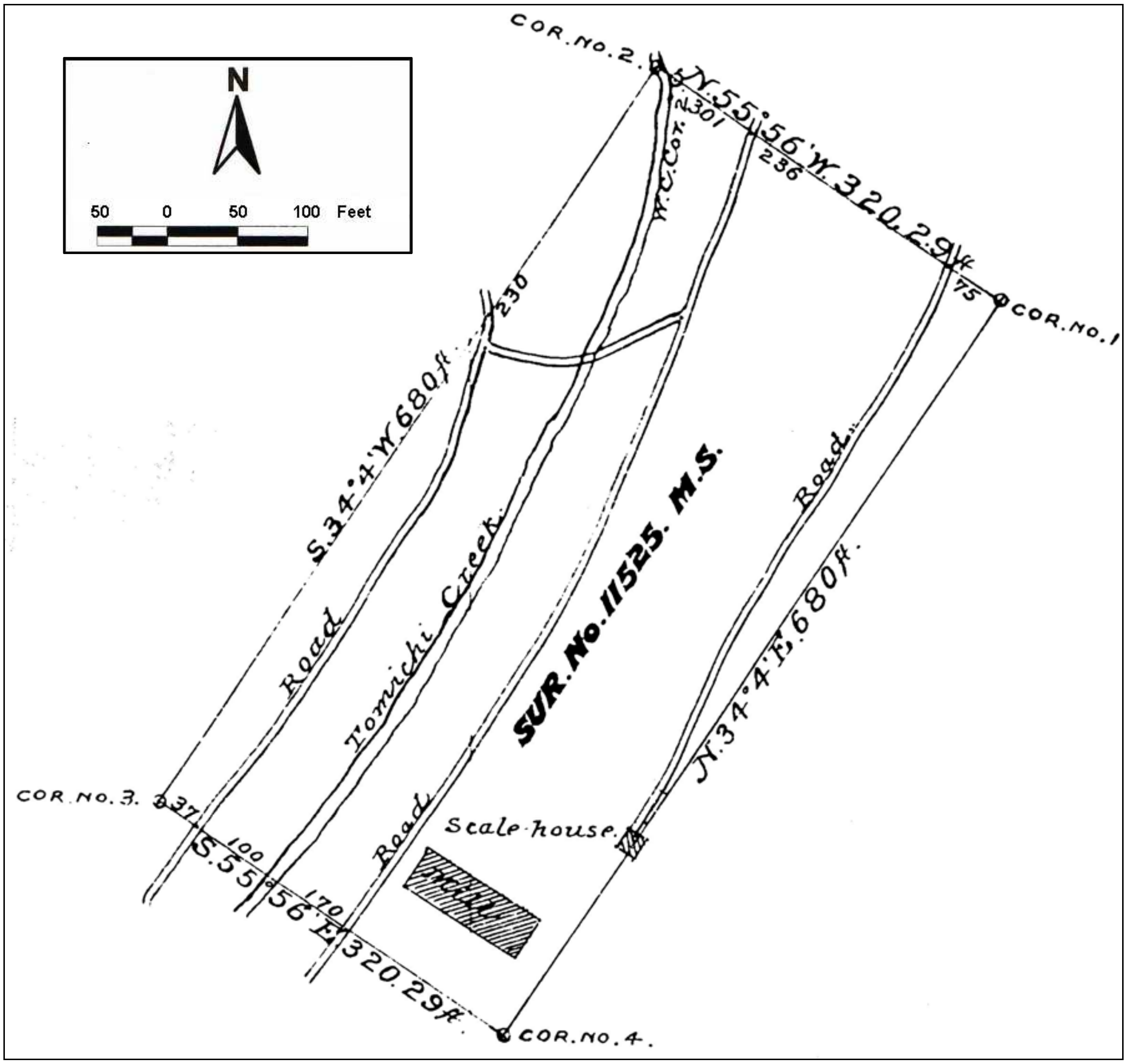


Figure 18. Tomichi mill site Mineral Survey (No. 11525). (Modified; Scale is approximate.)

In November, F.H. Nye (Nov. 3, 1898, v. 3, p. 201, CBM) inspected the workings on the 93-acre May Mazeppa group, which apparently included the North Star Mine. Turner Mining Company (John B. Turner-superintendent/manager) worked the group under a lease agreement. The galena-bearing lead carbonate ore averaged $14/ton and contained low silver values. Ore was mined from irregular pockets in the limestone-quartzite-porphyry contact zone. The mine (North Star?) was described as follows:

> 335-foot-deep double compartment vertical shaft
> Level #1-126-foot-depth had a large amount of drifting and was all stoped out and abandoned.
> Level #2-250-foot-depth had a 525-foot drift east and was stoped to level 1.
> Level #3-335-foot depth had a 320-foot eastern drift and a 125-foot western drift.

Mosley & Peterson operated the Eureka-Nest Egg and David H. Mines under a lease agreement (*Denver Times*, Dec. 31, 1898, p. 20). Between two and three carloads of ore were shipped weekly from the Eureka-Nest Egg. Shipments were irregular from the David H Mine. Lessees also operated the Erie Mine where the ore had a low silver content but assayed between 40% and 60% lead. These mines were eventually worked as part of the Akron group.

1900. In October, the first $10,000 quarterly payment was made toward the $60,000 bond on the North Star Mine (*Denver Times,* Oct. 23, 1900, p. 11). Although the Erie Mine was closed for the winter, the North Star Mine continued making steady shipments to the smelter (*Mining Reporter,* Oct. 25, 1900, v. 42, p. 254). In November, plans were formulated to drive a mile-long drainage and haulage tunnel under Lake Hill to undercut a number of lead-silver producing properties (*Denver Times,* Nov. 30, 1900, p. 11). The tunnel would be started during the next spring and was projected to undercut the Little May, Mazeppa, North Star, Erie, Eureka, and Nest Egg Lodes. In order to treat the large volume of ore possibly encountered in the tunnel, the Tomichi Valley Smelting Company planned to modernize their smelter.

Akron Mining Company (Charles Dick-president; E.R. Hooper-secretary/manager; J.M. Miller-superintendent) owned and operated the North Star group continuously since December 1899 (Manager report-North Star, 1900, p. 288, CBM). Fifteen workers, on average, were employed. The North Star group was comprised of the North Star, Muldoon, No. 3, Narrow Gauge, Deadwood, Little May, and Mazeppa Lodes and the North Star mill site. The lead carbonate ore was worth $12 per ton. Development included 300 feet of shaft, 1,000 feet of tunnels, and 500 feet of drifts. The 1,000-foot-deep North Star shaft was the deepest shaft in the district (Hodges, 1901, p. 115).

1901. In April, driving of the Akron adit began (*Denver Times*, April 2, 1901, p. 11). An ore body discovered in the North Star shaft was the highest-grade encountered to date (*Mining Reporter*, Apri1 18, 1901, v. 43, p. 252). In October, the 300-foot-long Akron adit was worked by 3 shifts (*Denver Times*, Oct. 20,1901, p. 25). In November, the adit had reached a length of 550 feet (*Denver Times*, Nov. 24, 1901, p. 12). In the 1996 USFS-AML Inventory, the Akron adit is identified as mine feature #100 in inventory area #378/4266-1.

The Akron Mining Company was formed from the incorporation of the North Star, Tenderfoot, May, and Mazeppa Mines (Dings and Robinson, 1957, p. 68). The company began driving the Akron tunnel to undercut and drain the orebodies discovered on Lake Hill. Silver and lead ore from the Akron and other area mines would be treated at the Southwestern smelter in Whitepine (Hodges, 1902, p. 117-118). The 65-ton per day smelter was completed near the end of the year.

Other active mines on Lake Hill in the vicinity of North Star Mine include the Nimrod, Paymaster, Yellow Jacket group, Eureka, and Nest Egg (*Denver Times*, Aug. 12,1901, p. 9). Sulfide ore was exposed in the two 75-foot-deep Nimrod and Paymaster shafts (owned by L. W. Baily) sunk on an extension of the Eureka ore body. Ore in an iron-bearing zone was exposed in the Yellow Jacket shaft owned by Carrigan & Baily. By December, 400 tons of carbonate and sulfide ore was shipped per month from the Eureka-Nest Egg Mine operated by D.C. Tobin under lease (*Denver Times*, Dec. 22, 1901, p. 12). About $1½ million in gold, silver, and lead values had been recovered from the Eureka-Nest Egg Mine since it was discovered.

1902. During July, the Akron adit reached a length of 1,800 feet, over half of the 3,000-foot projected length needed to intersect the North Star ore body (*Mining Reporter*, July 10, 1902, v. 46, p. 35). The Akron Mining Company (Charles Dick-president; L.E. Sister-vice president;

Aaron Wagoner-treasurer; E.R. Harper-secretary/manager; S.M. Miller, L.C. Miles, and E.A. Hershey-additional members of the board of directors) owned and operated the Akron adit (*Denver Times*, Aug. 10, 1902, p. 11). Daniel Tobin leased the 50-tons per day Tomichi concentrator from the Akron Mining Company and processed low-grade ore ($10 to $20/ton) from the Erie and Eureka-Nest Egg Mines (*Denver Times*, July 13, 1902, p. 12). In October, the Akron adit had reached a length of 2,300 feet (*Mining Reporter*, Oct. 16, 1902, v. 46, p. 317). It was estimated that another 500 feet would be required to intersect the North Star ore body. Copper sulfide ore was discovered at the Erie Mine. In December 8 to 10 tons of ore was shipped daily from the Eureka and Erie Mines (*Denver Times*, Dec. 16, 1902, p. 10). By the end of the year, the Akron adit was "considerably" over 2,000 feet long (Downer, 1903, p. 115). The Erie Mine group (Erie, Sunset, Monitor, and Silver Trowel Lodes), Lehigh, Nest Egg, and Eureka Lodes, owned by D.H. Campbell and the American Smelting Company (H.Y. Higgins-president) were operated by D.C. Tobin and Charles Eberling under a lease (Manager report-Erie, 1902, p. 180, CBM). Development included 10,000 feet of drifts and levels, 4 shafts, and 7 levels.

1903. Work at the Erie and Eureka Mines was continued through the winter (*Denver Times*, April 16, 1903, p. 10). The lead carbonate ore was direct shipped to smelters in Ohio and the Colorado Smelter Company in Salida. A large quantity of zinc-lead sulfide ore was blocked out. In April, the mill was being equipped to produce iron, lead, and zinc concentrates worth $75/ton. This was to be the first mine in Gunnison County in which the zinc component in the ore was profitable.

In July, the 3,400-foot-long Akron adit intersected the May-Mazeppa "contact" at a depth of about 1,000 feet (*Mining Reporter*, July 2, 1903, v. 48, p. 16). Water was drained from the "whole hill". A large area of new ground, in addition to the North Star and May-Mazeppa veins, was available for prospecting. Hubbard and Hackstaff remolded the Akron Mining Company's mill below Whitepine under a lease agreement (*Mining Reporter*, July 9, 1903, v. 48, p. 37). The mill, expected to be operational by the end of July, was enlarged to a capacity of 100 tons/day and was equipped to handle low-grade concentrating ore from the district. In August, the 3,700-foot-long Akron adit intersected high-grade silver ore believed to be the May-Mazeppa vein (*Mining Reporter*, Aug. 27, 1903, v. 48, p. 190). In November, a 14-foot-thick ore body containing both milling and smelting ore was discovered in a drift on the 330-foot level of the Dividend shaft (North Star Mine). The Akron mill shipped concentrates containing 55% lead. Plans were formulated to construct a mill at the mouth of the Akron adit.

An unpublished map (OSM files), probably prepared around 1903 showed the Akron adit intersecting the Lost Contact vein on the Mazeppa Lode 3,400 feet from the portal (Figure 19). A note near the lower right corner of the map indicates that the Akron adit drains all of the water from the Eureka-Nest Egg workings. The cross section in the lower right corner of the map indicated that the proposed length of the Eureka-Nest Egg Mines tunnel was 4,000 feet.

Workings above the adit included the 100-foot-deep Monitor shaft, Erie shaft with 2,000 feet of workings and apparently connected to the No. 2 and 100-foot-deep Nest Egg shafts, and 300-foot-deep Lehigh shaft. The Great Central Mill & Smelter was near the portal of the Akron adit, a smelter was on the Flirt mill site (MS #2073B), and the Tomichi Mining Company mill and powerhouse was on another claim.

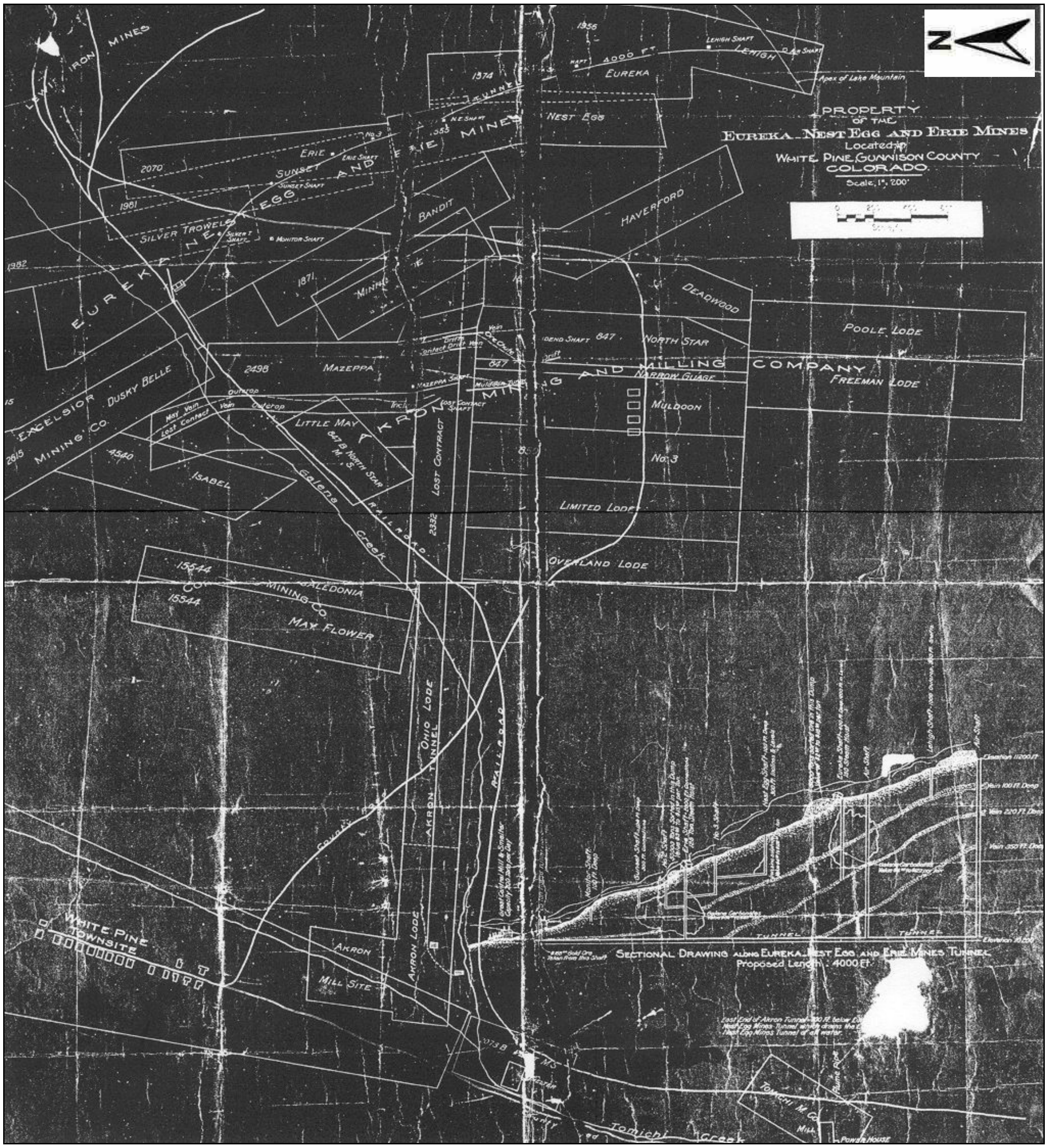


Figure 19. Akron adit and associated claims around 1903 (unpublished property map, Eureka, Nest Egg, and Erie Mines, OSM files).

1904. The Congress Gold Mining Company proposed driving a 2,000-foot-long adit into Lake Hill near the Akron Mining Company property. The Congress Company's ore body was considered an extension of the North Star vein (*Mining Reporter*, Jan. 7, 1904, v. 49, p. 17; Jan. 28, 1904, v. 49, p. 93). D.C. Tobin obtained a co-operating agreement with the North American Prospecting and Mining Company to drive an adit to undercut the Eureka and Erie Mines. Tobin had a lease on the two mines. Chris C. Sierk, John Jones, John R. Chase, and George W. Cutter had an interest in Tobin's venture.

The Akron Mining Company continued advancing the Akron adit and acquired a lease on the Tomichi Valley Smelter (*Mining Reporter*, Jan. 28, 1904, v. 49, p. 93). A raise was started 3,800 feet from the portal to intersect a 320-foot-deep inclined shaft (*Mining Reporter*, June 23, 1904, v. 49, p. 641). Ore was shipped from another 320-foot-deep shaft owned by the company. In July, the Akron Mine was inspected (Edwards, Inspector report-Akron, 1904, v. 6, p. 169, CBM). Akron Mining Company (Charles Dick-president; L.C. Miles-vice president; E.R. Harper-secretary; L.E. Sister-treasurer) operated the mine and owned a large block of claims. The company's claim block (84 acres patented and 86 acres unpatented) included the Little May, Mazeppa, Lost Contact, Lost Contact #3, Muldoon, Narrow Gauge, North Star, Deadwood, Poole, Freeman, Akron, Ohio, Minnie, Aetna, Limited, and Overland Lodes and the Akron and North Star mill sites. The May and Mazeppa claims had been worked nearly continuously from 1879 to 1893 and shipped over $1 million worth of high-grade silver ore. Some of the other claims were worked on an intermittent basis between 1880 and 1893. After the Akron Mining Company began operations in 1902, 1,571 tons of smelting ore and 471 tons of concentrate had been shipped. The three principal veins, May, Mazeppa, and North Star were exposed on the surface. At depth the Mazeppa and North Star veins converged into one larger vein. Two main ore bodies were mined along the May vein and seven were mined along the North Star vein. Carbonate ore assayed between 15% and 35% lead and 6- to 12 oz/ton silver. Sulfate ore averaged 20% lead, 20 oz/ton silver, and $2/ton gold. At the breast of the 4,177-foot-long Akron adit, a 100-foot drift on the May vein was connected through a 387-foot raise to the old workings in the May shaft.

1905. In March, H. Blossom, I. Brown, F. Dittmer, N. Hamlin, C. Toll, and A. Wheelon were issued a patent for the Mazeppa Lode (BLM files). Silver-lead ore was shipped from the Akron Mine (Lindgren, 1906, p.202).

1906. In August, Mineral Survey No. 18026 was conducted on the Monitor Lode owned by J.H. Green and others. Seven shafts (12-, 15-, 25-, 25-, 40-, 40-, and 60-feet-deep) were surveyed on the claim (Figure 20). Akron Mining Company shipped ore (Naramore, 1907, p. 219).

1912. R.S. Alpin and L.W. Bailey were issued a patent for the Yellow Jacket Lode (BLM files). The Akron reduction mill, equipped with jigs and tables, was idle (Henderson, 1913, p. 657).

1913. The Akron property was worked continuously since April (Mine manager report-Little May and North Star, 1914, p. 193 & 201, CBM). Most of the work during the year was concentrated on opening up the mine following a period of seven years when the mine was idle. Development included 200 feet of drifts and 100 feet of crosscuts. Total development included 1,100 feet of shafts, 800 feet of drifts, 200 feet of crosscuts, and 3,800 feet of tunnels. The 40-ton capacity Akron mill remained idle. No ore was shipped.

Based on a reported length of 3,800 feet, Crawford (1913, p. 302, 307) calculated that the vertical depth of the Akron adit at it's face was between 600 and 900 feet. "Some" milling grade ore had been extracted from driving the tunnel. The North Star Mine had been in operation for "only a few years" and worked deposits associated with the Star fault through several shafts. The 365-foot-deep Dividend shaft was the deepest of the North Star shafts. The exact year Crawford's information was gathered is unknown; he began work in the district in 1910.

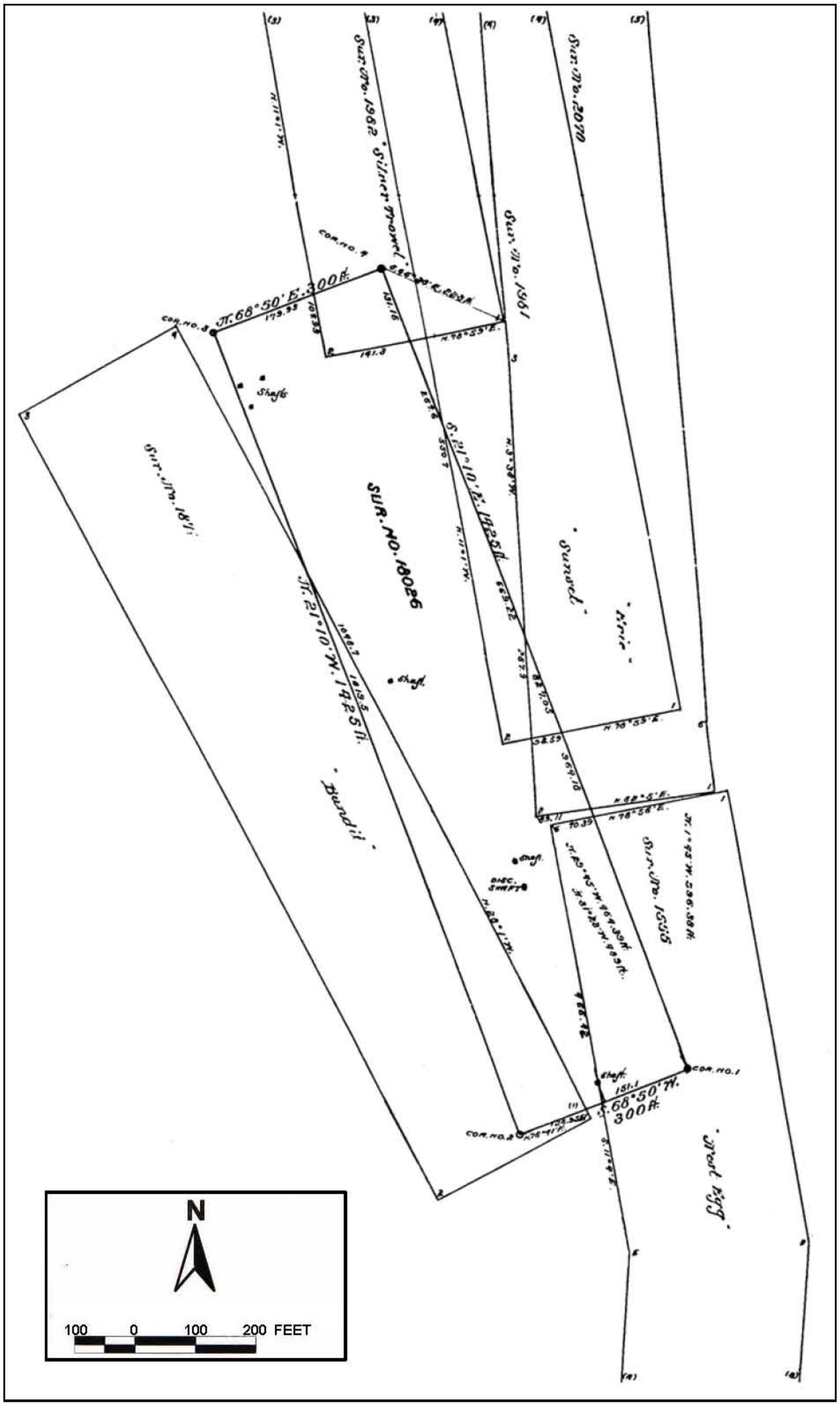


Figure 20. Monitor Lode Mineral Survey (No. 2332). (Modified; Scale is approximate.)

1914. Carrie P. Dick owned the Little May claim block operated under the Akron Mining Company and the North Star claim block operated under the Deadwood Company (Mine manager report-Little May and North Star, 1914, p. 193 & 201, CBM). James E. Dick managed both claim blocks. Patented claims included the Little May, Mazeppa, Lost Contact, North Star, Narrow Gauge, No. 3, Deadwood, and Muldoon Lodes and the Tomichi and North Star mill sites. Seven employees had worked the property since April 1913. Development included 50 feet of shafts, 230 feet of tunnels and drifts, and 200 feet of crosscuts. Total development included 800 feet of shafts, 5,000 feet of tunnels and drifts, and 200 feet of crosscuts. The 40-ton capacity Akron mill, one-half mile south of Whitepine remained idle. No ore was shipped.

1915. J.H. Green and G.J. Terrell were issued a patent for the Monitor Lode (BLM files).

1916. The Akron Mines Company, owned by Carrie P. Dick and managed by James E. Dick continued operation of the Akron Mine (Annual report-Akron, 1916, CBM). Patented claims owned by Carrie Dick included the Haverford, Deadwood, North Star, Narrow Gauge, No. 3, Muldoon, Mazeppa, Little May, Lost Contact, and Bandit Lodes and Tomichi and North Star mill sites. Leased patented claims included the Ensign, Vulcan, Erie, Sunset, and Silver Trowel Lodes. Unpatented claims included the Hillside Lode and Akron tunnel site. Development included 55 feet of shafts, 900 feet of drifts, 400 feet of crosscuts, and 500 feet of raises. Total development included 1,300 feet of shafts, 100 feet of winzes, 3,000 feet of drifts, 800 feet of crosscuts, 925 feet of raises, and 5,300 feet of tunnels. Combined shipments from the Akron, Erie, and Ensign Mines included 34 tons of crude ore and 550 tons of concentrate. Crude ore averaged 0.03 oz/ton gold, 7 oz/ton silver, 10% lead, 10% zinc, and 10% iron. Fourteen employees worked at the Akron Mine, two at the Erie Mine, three at the Ensign Mine, and three at the Akron Mill.

In another account, the Akron Mining Company operated the Akron, Erie, and Ensign groups through a “long tunnel” (Henderson, 1919, p. 360). “A considerable quantity of lead-zinc ore was mined and milled at the 60-ton concentration plant on the property.” A “small” quantity of lead ore from the Alice Mine was also treated at the Akron Mill. Presumably, the “long tunnel” referenced was the Akron adit (inventory feature #100).

1917. In August the Akron Mines Company owned and operated the Akron Mine and operated the Spar Copper, Ensign, and Erie Mines under a lease agreement (Robert Innes, inspector reports-Akron-Spar Copper-Ensign-Erie, 1917, CBM). A 500-foot raise above the Akron adit had three levels 100 feet apart. Level #1 had 70 feet of drifting, level #2 had 25 feet of drifting, and level #3 had 110 feet of drifting. On level #3, a 20-foot-wide ore body was stoped 30 feet over a distance of 70 feet. Ore minerals contained mostly values in lead, zinc, and silver. About 20 tons of ore were hand-sorted and hauled to the railhead at Sargents. Most of the ore was concentrated in the Akron mill located ½ mile from the tunnel.

About 40 tons of silver-copper-lead ore was shipped daily to Salida from the Spar Copper Mine (Robert Innes, inspector reports-Akron-Spar Copper-Ensign-Erie, 1917, CBM). The property was accessed through the Parole adit. Three miners were drifting and stoping above the Parole level. About 900 tons of silver and copper carbonate ore had been shipped to Salida from the Ensign Mine. Six miners were employed in this mine, also accessed through the Parole adit.

During September, two miners were driving a tunnel at the bottom of the 325-foot-deep Erie shaft. No ore had been shipped from the Erie Mine.

A total of 2,783 tons of crude ore and 281 tons concentrate, reduced from 1,500 tons of low-grade ore, were shipped from the Akron Mine (Annual report-Akron, 1917, CBM files). Copper ore, shipped crude, averaged 0.02 oz/ton gold, 3 oz/ton silver, and 45% copper. Lead-zinc ore, shipped crude, averaged 0.02 oz/ton gold, 7 oz/ton silver, 16% lead, and 17% zinc. Development included 440 feet of raises, 820 feet of drifts, and 150 feet of crosscuts. Patented claims owned by Carrie Dick (Akron Mines Company) included the Bandit, Haverford, Deadwood, North Star, Narrow Gauge, Muldoon, No. 3, Lost Contact, Mazeppa, Little May, Snowden, Jersey, Bob Lee, and Ensign Lodes and Tomichi and North Star mill sites. Unpatented claims included the Hillside Lode, Little May mill site, and Akron tunnel site. Patented claims operated under lease included the Vulcan, Erie, Sunset, Silver Trowel, Spar, Spar #2-#4, Greenbrier #1-#2, and Morning Glim Lodes. The Spar Copper group was leased from C.L. Tutt, Vulcan from J.M. McDougal, and Erie group from J.H. Green and A.C. Terrell. Ore was shipped on a regular basis until October when the mill was closed (Robert Innes, inspector reports-Akron Mines Company, May 29, 1918, CBM).

In another account (Henderson, 1920, p. 824), the Akron Mining Company owned and operated the May, May Mazeppa, Ensign, North Star, and Erie mines and operated the Morning Glim, Parole, and Spar Copper group under lease. Some of the lead-zinc ore was treated at the Akron mill and shipped as lead and lead-zinc concentrate. The Akron Mill also treated a large quantity of silver-bearing and low-grade copper ore. A “considerable” amount of the lead-zinc ore was shipped crude and milled in Denver. Copper ore was shipped to the Salida smelter.

1918. In the early spring, shipments of crude ore resumed (Robert Innes, inspector reports-Akron Mines Company, May 29, 1918, CBM). About 150 tons of ore were hauled monthly from the Akron Mine to the railhead at Sargents. In May, work was conducted on levels run at 100-foot intervals from a 550-foot raise. The raise, driven from the Akron adit, was connected to the Dividend Shaft (North Star Mine). Early production from the Dividend Shaft was worth about $3 million. The old mill was dismantled and a new mill was built near the portal of the Akron adit. A 6-mile-long power line from Monarch was also under construction. About 876 tons of crude ore were shipped (Annual report-Akron Mines Company, 1918, CBM). The ore averaged 0.03 oz/ton gold, 6.5 oz/ton silver, 16% lead, and 21% zinc. Development included 100 feet of raises, 450 feet of drifts, and 100 feet of crosscuts. The Erie and Spar Copper Mines were not operated. No new claims were acquired since 1917.

Henderson (1921, p. 845) reported that the Akron Mining Company continued operating the May, May Mazeppa, Ensign, and North Star mines. Construction began on a new mill utilizing parts of the old mill. High-grade lead-zinc ore was shipped to the River Smelter at Florence. The low-grade lead-zinc ore was shipped to the Western Chemical Co.’s plant at Denver. The Akron crosscut adit was extended to develop the Eureka group acquired under lease and bond.

1919. Carrie Dick continued to own the Akron Mine managed by James Dick (Annual report-Akron Mines Company, 1919, CBM). With the addition of the Yellow Jacket Lode, patented claims owned by Carrie Dick were the same as in 1917. Unpatented claims included the Hillside

Lode and Akron tunnel site. Patented claims leased by the Akron Mines Company included the Erie, Sunset, Silver Trowel, Eureka, Nest Egg, Silver Bayonet, Spar, Spar #2 - #4, Greenbrier #1 and #2, and Morning Glim Lodes. The Spar Copper group was leased from C.L. Tutt, Erie group from J.H. Green and A.C. Terrell, and the Eureka group from the Oteseto Mine Company. No crude ore was shipped. About 26 tons of concentrate, averaging 16.85 oz/ton silver, 37% lead, and 10% zinc were sold. Development included 90 feet of raises, 205 feet of drifts, and 680 feet of crosscuts. Construction was completed on the mill, and operations occurred during September and October (Henderson, 1922a, p. 772).

1920. In July, the Akron Mines company property was owned by the Dick family and operated by the Dorr Company (R. Innes, Inspector report-Akron mine, July 31, 1920, CBM). Operations were conducted in a stope on the 3rd level, accessed through a newly driven 200-foot high North Star raise driven from the Akron adit. A new crosscut was started to intersect the Erie vein. The Nimrod and Paymaster Lodes were the only additional claims added since the 1919 list of claims owned by the Akron Mines Company, managed by James Dick (Annual report-Akron Mines Company, 1920, CBM). Additional clams held under lease included the Lehigh and Lelia Etta. The Spar Copper group was leased from C.L. Tutt, the Erie group from J.H. Green and A.C. Terrell, the Eureka group from the Oteseto Mine Company, and the Collins group from J.H. Collins. About 1,007 tons of crude ore, averaging 23% lead and 26% zinc, were shipped. About 560 tons of lead concentrates and 43 tons of zinc concentrates were sold. Lead concentrates averaged 18.8 oz/ton silver and 43.5% lead. Zinc concentrates averaged 7.4 oz/ton silver, 6.5% lead, and 47% zinc. Development included 350 feet of raises, 300 feet of drifts, and 800 feet of crosscuts. Sixteen workers were employed at the mine and seventeen at the mill.

In another account, a “considerable” quantity of zinc-lead ore was shipped crude to smelters from the Akron Mine (Henderson, 1922b, p. 580-581). Lead concentrate was shipped from the Akron mill, in operation January-March and September-December.

1921. Akron Mines Company continued operating the Akron Mine owned by Carrie Dick (Annual report-Akron Mines Company, 1921, CBM). Patented, unpatented, and leased claim blocks were the same as in 1920. Although the mill was not operated, 47 tons of concentrates were sold. Development included 317 feet of raises and 15 feet of drifts. Only four workers were employed. Henderson (1924, p. 497) reported that two carloads of lead-silver ore, mined during 1920 were shipped from the Akron group.

1922. In June, the Akron Mines company property was owned by Carrie Dick and operated by the Dorr Company, managed by C.A. Chase (R. Innes, Inspector report-Akron mine, June 22, 1922, CBM). For the past two years, five employees were driving a 2-compartment inclined raise at the face of the Akron adit. Inclined at 70°, the raise had attained a length of 350 ft. Although no ore was shipped, development included 52 feet of raises and 530 feet of drifts (Annual report-Akron Mines Company, 1922, CBM). Henderson (1925, p. 539) reported that development work continued on the Akron group; no ore was shipped.

1923. In June, operations at the Akron Mine were concentrated on the North Star ground reached through a 2-compartment raise driven from the Akron adit, 3,800 ft from the portal (R. Innes, Inspector report-Akron mine, June 30, 1923, CBM). The five levels in the raise were spaced at

100-foot intervals. Lessees were stoping above level 2, level 4, and from the Akron level. About 1,000 tons of ore were shipped to Coffeyville, Kansas. “The new mill was a failure and was abandoned.” In October, Eastman discovered an ore body in a 50-foot-deep shaft sunk on an outcrop of the North Star vein (R. Innes, Inspector report-North Star group, Feb. 7, 1924, CBM). The Akron Mines company property, owned by Carrie Dick, was operated by lessees (Eastman & Towne) and by the company (Annual report-Akron Mines Company, 1923, CBM). About 8,191 tons of crude ore and 1,033 tons of middlings were shipped. The product averaged 7.5 oz/ton silver, 17% lead, and 22.6% zinc. Development included 110 feet of raises, 80 feet of drifts, and 135 feet of crosscuts. Fifteen workers were employed. In another account, 7,600 tons of lead-zinc sulfide ore were shipped crude from the Akron group (Henderson, 1927a, p. 630).

1924. In February, 16 employees were operating the Akron Mine, accessed through the 5,000-foot-long Akron adit (R. Innes, Inspector report-Akron Mines Company, Feb. 8, 1924, CBM). Work was conducted on the North Star vein, developed on five levels through a 500-foot-high raise driven from the Akron adit. Older workings connected the raise to the surface. Monthly shipments of lead-zinc sulfide ore averaged 1,000 tons and contained a few ounces of silver per ton and 40% lead and zinc. Carrie Dick continued ownership of the Akron Mines Company property (Annual report-Akron Mines Company, 1924, CBM). Some or all of the work was performed under a lease agreement with Eastman & Towne. A total of 9,005 tons of crude ore and 208 tons of concentrates were shipped. Development included 312 feet of raises and 411 feet of drifts. An average of 20 workers was employed. Henderson (1927b, p. 561) reported that 9,900 tons of lead-zinc sulfide ore, worth $546,800 was shipped crude from the Akron group and Victor Mine.

Eastman & Towne operated the North Star group (North Star, Narrow Gauge, and Muldoon Lodes) under a lease agreement with the Akron Mines Company (Annual report-North Star, 1924, CBM). About 153 tons of crude ore, averaging 0.04 oz/ton gold, 14 oz/ton silver, and 28% lead were shipped to Leadville.

1925. In August, 20 employees were working the Akron Mine owned by Carrie Dick (J. F. Clougher, Inspector report-Akron mine, Aug. 9, 1925, CBM). From the portal, the Akron adit continued on an eastern bearing for a distance of 3,800 feet, then in a northeastern direction for another 1,500 feet (5,300 feet total). At a distance of 3,400 feet from the portal, a 385-foot-high raise was connected to a 50-foot-deep inclined shaft driven from the surface. At a point 4,000 feet from the portal, a 500 foot-high inclined raise was connected to a 365-foot-deep shaft driven from the surface. A 54-foot-deep winze, sunk at a point 4,100 feet from the portal, had two short drifts at the bottom. Ore bodies occurred as replacement deposits along a fault and varied in thickness from 1 foot to 4 feet. Carbonate ore mined near the surface assayed 15 oz/ton silver and 30% lead. One grade of sulfide ore assayed 7 oz/ton silver, 18% lead, and 23% zinc; another grade assayed 14 oz/ton silver, 9.5% lead, and 14% zinc.

Eastman & Towne operated the Akron Mine under a lease agreement and Towne and Nylund leased the Ensign Mine (Annual report-Akron Mines Company, 1925, CBM files). About 5,151 tons of crude ore were shipped, averaging 0.014 oz/ton gold, 5.8 oz/ton silver, 16% lead, 0.098% copper, and 18% zinc. Development included 109 feet of raises, 130 feet of drifts, and 99 feet of winzes. In another account (Henderson, 1928, p. 716), the Akron Mines Company shipped 4,620 tons of lead-zinc sulfide and lead oxide ore (worth $220,187) to various smelters and mills.

1926. In January, ore was shipped from sinking two winzes (M.L. Anderson, Inspector report-Akron mine, Jan. 7, 1926, CBM). The Ensign winze, sunk about a mile from the main workings had reached a depth of 30 feet. A large volume of water was encountered at a depth of 105 feet in the no. 8 level winze sunk below the Akron adit (M.L. Anderson, Inspector report-Akron mine, May 21, 1926, CBM). By March, operations were suspended in the no. 8 level winze until a larger pump could be acquired.

Lessees operated the Akron Mines Company property owned by Carrie Dick (Annual report-Akron Mines Company, 1926, CBM). Eastman and Towne operated the Akron Mine, Towne and Nylund operated the Ensign Mine, and Eastman operated the Tenderfoot adit. The Tenderfoot adit was driven from the Lost Contact Lode toward the North Star Lode. About 2,863 tons of crude were shipped, averaging 0.03 oz/ton gold, 9 oz/ton silver, 15% lead, 0.14% copper, and 22% zinc. Development included 28 feet of winzes, 218 feet of raises, and 616 feet of drifts. In another account (Henderson, 1929, p. 754), lessees operated the Akron Mines Company's property and shipped lead-zinc-copper-silver-gold sulfide ore to Tooele, Utah. Lead-silver smelting ore was shipped to Midvale, Utah.

1927. In June, Eastman and Towne were drifting on a small vein of lead ore in the Tenderfoot adit (R.J. Murray, Inspector report-Tenderfoot tunnel, June 8, 1927, CBM). The work was conducted under a lease agreement with the Akron Mines company (owners). Eastman and Towne also had a lease on the Akron Mine (R.J. Murray, Inspector report-Akron Mine, June 9, 1927, CBM). Work was concentrated on repairing the 125-foot-deep winze (no. 8 level) sunk in the Akron adit. Water was pumped from the winze at a rate of 250 gallons (?) per minute. About 1,055 tons of crude ore were shipped, averaging 0.04 oz/ton gold, 7 oz/ton silver, 18% lead, and 25% zinc (Annual report-Akron Mines Company, 1927, CBM). Development included 180 feet of drifts. In another account (Henderson, 1930, p. 550), "several" hundred tons of lead-zinc-silver sulfide ore from the Akron group was shipped to Tooele and "several" carloads of lead-silver smelting ore to Midvale, Utah.

1928. J.L. Towne continued operating the Akron Mine under a lease agreement with the Akron Mines Company owned by Carrie Dick and managed by James Dick (Annual report-Akron Mines Company, 1928, CBM). About 1,740 tons of crude ore, averaging 0.025 oz/ton gold, 7.5 oz/ton silver, 15% lead, and 21½% zinc and worth $12.93 per ton were shipped. Six employees operated the mine for 183 days. The mill had been idle for several years and most of the machinery was sold. Henderson (1931, p. 843) reported that "over 1,000 tons of zinc-lead-copper-silver-gold milling ore was shipped from the Akron group to the Midvale (Utah) custom selective flotation mill".

1929. In July, the Akron Mines Company was negotiating a deal with the Mourning Star Mine Company and the St. Louis Smelting and Refining Company (J. F. Clougher, Inspector report-Akron Mines Company, July 14, 1929, CBM). J.L. Towne continued operating the Akron Mine under a lease agreement. About 300 tons of crude ore were shipped, worth $25 per ton and averaging 24% lead and 30% zinc of (Annual report-Akron Mines Company, 1929, CBM). Two employees operated the mine for 180 days. In another account “four hundred tons of zinc-lead-copper-silver-gold ore from the North Star group was shipped to the Midvale (Utah) custom selective flotation mill” (Henderson, 1932, p. 942).

1930. The 108 tons of ore from the Akron Mine yielded about 1 oz of gold, 293 oz of silver, 28 pounds of copper, 33,740 pounds of lead, and 51,520 pounds of zinc (Harrer, 1951, p.20).

1931. The 118 tons of ore from the Akron Mine yielded about 1 oz of gold, 1,608 oz of silver, 611 pounds of copper, and 81,155 pounds of lead (Harrer, 1951, p.20).

1937. Operations resumed at the Akron Mine following a 7-year idle period (D.C. McNaughton, Inspector report-Akron Mine, Dec. 1, 1937; Annual report-Akron Mine, 1937, CBM). Work, managed by J.L. Towne and J.H. Warner, involved cleaning out and retimbering 700 feet of the Akron adit and one of the shafts. The company had planned to build a 150-ton mill and extract ore from 4 levels. No ore was shipped. In another account, Callahan Zinc-Lead Co. acquired control of the Akron Mine (Dings and Robinson, 1957, p. 68). The acquisitions included the Akron tunnel and the May, Mazeppa, and W. & A Mines.

1938. Five employees of the Callahan Zinc-Lead Company (H.B. Van Sinderen-president; F. Eichelberger-vice president, J.H. Hall-secretary/treasurer) concentrated efforts on cleaning out and retimbering the Akron adit owned by Carrie Dick (D.C. McNaughton, Inspector report-Akron Mine, Dec. 18, 1938; Annual report-Akron Mine, 1938, CBM). No ore was shipped. Callahan Zinc-Lead Company acquired the Akron Mine (Harrer, 1951, p.4).

1939. In June, the Callahan Zinc-Lead Company had three workers employed in cleaning out and retimbering the Akron adit between the portal and the Lost Contact vein (D.C. McNaughton, Inspector report-Akron Mine, June 16, 1939, CBM). No ore was shipped.

1941. Callahan Zinc-Lead Co., Inc. had a lease agreement on the Akron Mine (Henderson and Martin, 1943, p. 305). A sub-lessee shipped two cars of zinc-lead-copper-silver-gold ore to the custom mill in Midvale, Utah. The Mine was operated from July through December (D.C. McNaughton, Inspector report-Akron Mine, September 24, 1942, CBM).

1942. In September ore was mined mostly from a 600-foot-long stope above the 300 level (D.C. McNaughton, Inspector report-Akron Mine, September 24, 1942, CBM). Since July 1941, 400 tons of 48% lead-zinc ore (worth $16/ton) and 50 tons of tailings from the old mill, averaging 20% lead-zinc and 6 oz/ton silver, were shipped. Carrie continued ownership of the Akron claim group operated during half of the year by the Callahan Zinc-Lead Company (Annual report-Akron Mine, 1942, CBM). Patented claims included Bandit, Yellow Jacket, Nimrod, Paymaster, Mazeppa, Little May, Lost Contact, North Star, No. 3, Muldoon, Narrow Gauge, Deadwood, Haverford, 5/8 Erie, 17/56 Sunset, 17/56 Silver Trowell, Bob Lee, Ensign, Leonora, Wolverine, Jersey, and Snowden Lodes and the Flirt, Tomichi and North Star mill sites. Unpatented claims included the Little Don, Aviator, Hillside Akron, and Ohio Lodes and the Akron tunnel site. About 240 tons of ore were shipped, worth $13.68 per ton and averaging 0.13 oz/ton gold, 6.8 oz/ton silver, 15.8% lead, and 21½% zinc. In another account, Callahan Zinc-Lead Company operated the Akron Mine and shipped 286 tons of zinc-lead-silver ore to Midvale, Utah

(Henderson, 1943, p. 334). Henderson apparently reported ore from the Erie Mine with the shipments from the Akron Mine (Dings and Robinson, 1957, p. 68).

1943. Callahan Zinc-Lead Company (H.B. Van Sinderen-president; J.B. Beaty-vice president) owned and operated the Akron Mine (Annual report-Akron Mine, 1943, CBM). About 4,170 tons of ore were shipped, worth $3.74 per ton and averaging 5.7 oz/ton silver, 8% lead, 12% zinc, and 0.3 % copper. The Silver Trowel/Erie adit was extended 400 feet. In another account, 3,941 tons of zinc-lead-silver ore from the Akron Mine was shipped to the Midvale mill and the Leadville smelter (Henderson, Mote, and Cushmam, 1945, p. 330). A raise in the Silver Trowel/Erie adit was extended to the 4th level of the Erie shaft (Dings and Robinson, 1957, p. 68).

1944. Callahan Zinc-Lead Company operated the Akron (Dyrenforth & associates-owner) and Erie (Burleson & associates-owner) Mines throughout the year (D.C. McNaughton, Inspector report-Akron and Erie Mines, September 7-8, 1944; Annual report-Akron Mine, 1944, CBM). About 5,825 tons of ore were shipped, worth $3.63 per ton and averaged 4 oz/ton silver, 7½% lead, 11% zinc, and 0.45% copper. In September, ore mined from the 250-foot level was reached through the Akron adit. Additional ore shipped from the Erie Mine was from a drift off of a 40-foot-high raise driven from the 855-foot-long No. 5 main haulage adit. Development included 350 feet of drifts and 250 feet of tunnels (Mote, 1946, p. 317). Total development included a 3,000-foot-long crosscut adit, 250 feet of raises, and 400 feet of drifts. Ore was shipped from the Erie-Sunset and Lost Contact claims. Presumably, the 3,000-foot-long crosscut adit referred to the Akron adit. Earlier reports indicated that the Akron adit was over a mile long. A possible explanation for this discrepancy is that Callahan had not reopened the Akron adit completely to the face.

1945. Callahan Zinc-Lead Company (J. Hall-president; J.B. Beaty and H.J. Hill-vice president) continued operating the Akron and Erie Mines (Annual report-Akron Mine, 1945, CBM). About 6,032 tons of ore were shipped, worth $5.48 per ton and averaging 4.6 oz/ton silver, 8% lead, 11% zinc, and 0.33 % copper. Callahan drove 850 feet of drifts (Woodard and Gustavson, 1947, p. 328). Total development included a 3,000-foot-long adit with 250 feet of raises, and 1,000 feet of drifts and another 800-foot-long adit with 750 feet of drifts. All the shipments (6,176 tons of ore yielding 68 oz of gold, 27,800 oz of silver, 19 tons of copper, 480 tons of lead, and 650 tons of zinc) were mined from the Sunset and Lost Contact Lodes. Milling facilities were no longer on the property.

1946. Callahan Zinc-Lead Company continued operation of the Akron and Erie Mines (D.C. McNaughton, Inspector report-Akron and Erie Mines, September April 25, 1946). In April, ore shipments were averaging 200 tons per month from the Akron Mine and 400 tons per month from the Erie Mine. Callahan operated the Akron unit and shipped 4,220 tons of ore yielding 50 oz of gold, 20,044 oz of silver, 31 tons of copper, 444 tons of lead, and 695 tons of zinc from the Lost Contact, Erie, and Sunset Lodes (Gustavson, 1948, p. 1403). Development consisted of 19 feet of shaft, 500 feet of drifts, and 800 feet of diamond drilling. Shenon and Full (1946) prepared a claim map of the Akron, Tenderfoot, and Erie (No. 4) adits (Figure 21), a surface map of the geology and workings of the Akron Mine area (Figure 3), and a geologic map of the lower workings in the North Star-Dividend shaft (Figure 22).

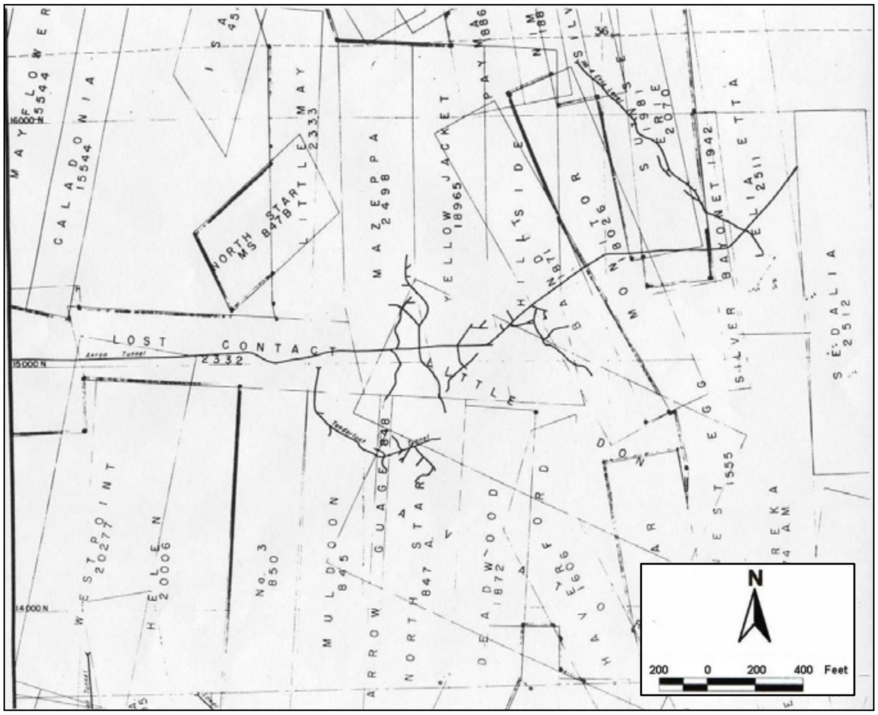


Figure 21. Map of Akron Mine and associated claims (Shenon and Full, 1946; Scale is approximate).

1942-1946. Callahan Zinc-Lead Company's production from the Akron Mine was considered "small scale" (Dunn and Flynn, 1953, p. 68).

1947. Callahan Zinc-Lead Company (J. Hall-president, R.F. Mahoney-vice president) owned and operated the Akron and Erie Mines (Annual report-Akron and Erie Mines, 1947, CBM). No new claims had been added to the Akron group. Patented claims associated with the Erie Mine included Erie, Sunset, and Silver Trowel. About 2,550 tons of crude ore were shipped from the Erie Mine, worth $23 per ton and averaging 0.02 oz/ton gold, 4 oz/ton silver, 5% lead, 15% zinc and 0.5% copper. About 8,620 tons of crude ore were shipped from the Akron Mine, worth $50 per ton and averaging 0.01 oz/ton gold, 6 oz/ton silver, 19% lead, 0.5% copper, and 21% zinc. Test runs using 69 tons of the Akron ore and 169 tons of Erie ore were treated at the company's 100-ton capacity flotation mill. Completed in December, the new mill concentrated about 5 tons of ore into 1 ton of concentrate. About 20 tons of lead concentrate and 30 tons of zinc concentrate were recovered at the mill. Lead concentrate averaged 0.02 oz/ton gold, 18 oz/ton silver, 65% lead, 11% zinc and 0.15% copper. Zinc concentrate averaged 0.02 oz/ton gold, 6 oz/ton silver, 10% lead, 50% zinc and 0.1% copper. Ten workers were employed in the milling operation and 50 were at the mine. In another account, Callahan shipped 10,235 tons of ore averaging 0.01 oz/ton gold, 7.4 oz/ton silver, 22% zinc, 17% lead, and 0.4% copper from the Akron and Erie Mines (Martin, 1949, p. 1366-1367). Development at the Akron Mine included 2,310 feet of drifts, 498 feet of raises, and 349 feet of diamond drilling. At the Erie Mine, development consisted of 100 feet of shaft, 1,200 feet of drifts, and 95 feet of raises.

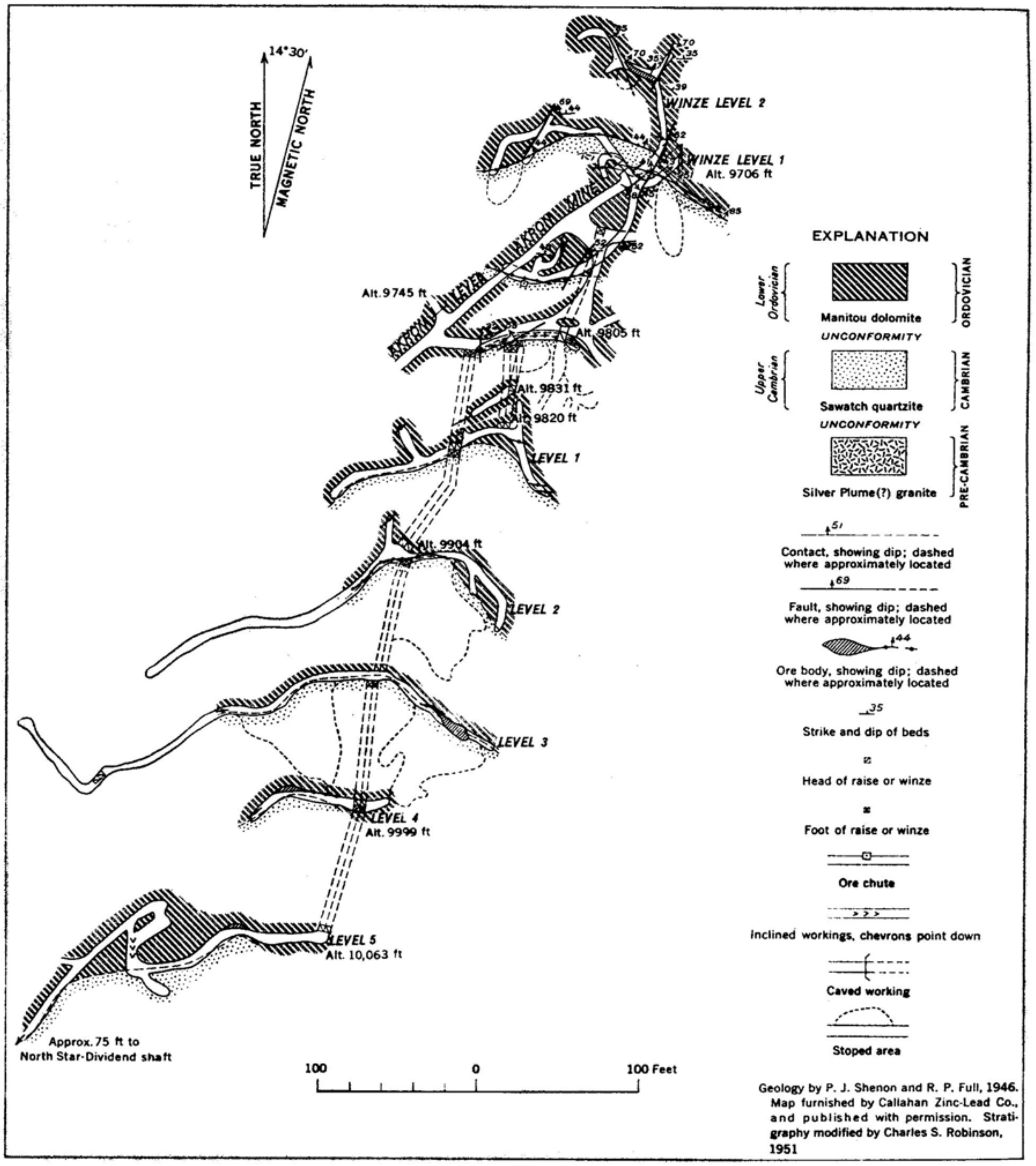


Figure 22. Geologic map of the lower levels in the north Star-Dividend shaft. (From Shenon and Full as cited in Dings and Robinson, 1957, Figure 4)

In another account, 2,496 tons of ore were shipped from the Erie Mine and 9,061 tons were shipped from the Akron Mine (D.C. McNaughton, Inspector reports-Akron and Erie Mines, May 11, 1948, CBM). Ore from the Akron Mine was recovered from drifting on and stoping above the Akron or No. 1 level (245 feet north and 310 feet south), 75-foot-level (125 feet north), 150-foot-level (95 feet south and 70 feet north), 250-foot-level (150 feet south), and 350-foot-level (40 feet north and 40 feet south). The main heading of the Akron adit was extended 200 feet (5,480-foot total length) and was expected to intersect the Erie vein in another 500 feet. A 70-

foot-high, 3-compartment raise was also driven from the Akron level. Ore from the Erie Mine was stoped above the No. 4 (main working level), No. 6, and No. 650 levels. Ore minerals included petzite, a gold-silver telluride mineral, and silver, lead, copper, and zinc-bearing sulfide minerals. Although the Erie Mine was not connected to the Akron adit (adit #100), Callahan operated both mines and processed ore from both mines in the company's mill.

1948. Callahan Zinc-Lead Company continued ownership and operation of the Akron and Erie Mines (Annual report-Akron and Erie Mines, 1948, CBM). Patented claims associated with the Erie Mine included Erie, Sunset, Silver Trowel, Silver Bayonet, Lelia Etta, and Sedalia. Patented claims associated with the Akron Mine included Bandit, Nimrod, Mazeppa, Lost Contact, North Star, Muldoon, Ensign, Bob Lee, Leonora, Wolverine, Iron Duke Jersey, Snowden, Little May, Yellow Jacket, Paymaster, No. 3, Narrow Gauge, Deadwood, and Haverford Lodes and the Flirt, Tomichi and North Star mill sites. Unpatented claims included the Protractor #1-6, Hematite, Jumbo, Sunburst, Cloudburst, Midget, Hillside #1-4, Little Don, Aviator, Akron, and Ohio Lodes and the Akron #1-9 mill sites. Included with the 18,158 tons of ore (worth $51.10 per ton) processed at the mill were 2,348 tons of ore from the Erie Mine. The 2,511 tons of lead concentrate produced at the mill averaged 0.0135 oz/ton gold, 24.03 oz/ton silver, 64% lead, 13% zinc, and 0.2% copper. The 4,378 tons of zinc concentrate produced at the mill averaged 0.0125 oz/ton gold, 5.73 oz/ton silver, 7% lead, 51% zinc, and 0.25% copper. In combined metal values the concentrates were worth about $1.5 million and contained about 90 oz of gold, 85,000 oz of silver, 16 tons of copper, 2,000 tons of lead, and 2,600 tons of zinc (Martin, 1950, p. 1461). Development included 1,966 feet of drifts, 610 feet of crosscuts, 1,198 feet of raises, and 2,724 feet of diamond drilling.

1949. Callahan Zinc-Lead Company continued operating the Akron Mine and mill (Annual report-Akron Mine and mill, 1949, CBM). No additional claims had been acquired since 1948. The 100-ton-per-day flotation mill recovered 1,746 tons of lead-silver concentrate and 3,181 tons of zinc concentrate from 14,676 tons of ore. The ore averaged 0.0049 oz/ton gold, 4.61 oz/ton silver, 10.6% lead, 14.16% zinc, and 0.15% copper. Lead-silver concentrate averaged 0.0178 oz/ton gold, 25.55 oz/ton silver, 63.4% lead, 12.8% zinc, and 0.5% copper. Zinc concentrate averaged 0.0113 oz/ton gold, 5.01 oz/ton silver, 52% zinc, 8.2% lead, and 0.34% copper. Development included 1,667 feet of drifts, 329 feet of crosscuts, 623 feet of raises, and 1,090 feet of diamond drilling (Martin, 1951, p. 1435).

In June, the raise driven 4,300 feet from the portal of the Akron adit was connected with the 250 and 350-foot levels (Murray, Inspector reports-Akron Mine, June 1, 1949, CBM). Basket lagging installed outside the 10-inch timbers was apparently successful in absorbing the constant pressure exerted on the timbers. Ore was mined from the 150, 170, 250, and 350-foot levels. Vein thickness varied from 1 to12 feet and the combined lead-zinc content ranged between 10% and 60%. Constant drilling was required to locate new ore bodies. Ore bodies occurred in nearly flat to vertical deposits.

1950. Callahan Zinc-Lead Company continued operating the Akron Mine and mill (Annual report-Akron Mine and mill, 1950, CBM). The 12,342 tons of ore processed in the company's mill yielded 869.87 tons of lead-silver concentrate and 2,293.46 tons of zinc concentrate. Lead-silver concentrate averaged 0.025 oz/ton gold, 62.46 oz/ton silver, 66.29% lead, 9.16% zinc, and

1.19% copper. Zinc concentrate averaged 0.014 oz/ton gold, 9.25 oz/ton silver, 51.22% zinc, 7.12% lead, and 0.61% copper. Six workers were employed in the mill and 34 worked at the mine. Active mining operations were on the 150, 250, and 350-foot levels (Murray, Inspector reports-Akron Mine, December 1, 1950, CBM). The sulfide-oxide-telluride ore carried silver-lead-zinc values and occurred in veins, pipes, and as flat-lying deposits. Each level was composed of a maze of sublevels, stopes and finger raises. Development included 1,176 feet of drifts, 168 feet of crosscuts, and 813 feet of raises (Martin, 1953, p. 1455). About 675 feet of old drifts were also rehabilitated.

1901-1950. The Bureau of Mines (Harrer, 1951, p.20) estimated that nearly 90,000 tons of ore were shipped from the Akron Mine (Table 2).

1925-1950. Callahan Zinc-Lead Company (Harrer, 1951, p.20) estimated that nearly 60,000 tons of ore were shipped from the Akron Mine (Table 3).

TABLE 1. - Production of the Akron mine, 1901-1950.[1/]

Year	Crude Ore dry tons	Ounces Gold	Ounces Silver	Pounds Copper	Pounds Lead	Pounds Zinc
*1901	1,500	75	12,000	- -	- -	- -
1903	163	9	1,102	- -	229	- -
1905	700	52	7,000	- -	210,000	- -
1906	85	-	1,354	- -	22,632	- -
1916	3,301	14	7,490	4,931	216,926	143,205
1919	1,500	1	444	- -	17,455	- -
1920	5,523	-	11,713	- -	997,448	521,800
1927	1,167	19	9,206	3,263	494,183	353,934
1928	1,427	20	10,207	2,641	514,031	725,983
1929	389	7	2,943	526	125,986	159,804
1930	108	1	293	28	33,740	51,520
1931	118	1	1,608	611	81,155	- -
1941	92	2	805	- -	34,386	45,791
**1942	380	3	1,865	1,379	105,521	144,981
1943	3,941	40	21,597	20,681	597,870	910,479
**1944	5,768	68	21,545	43,794	794,269	1,151,837
**1945	6,176	63	22,896	24,035	782,659	1,083,396
**1946	4,220	28	14,266	47,746	730,251	1,071,976
1947	8,001	58	48,554	12,607	2,853,740	3,315,862
**1948	18,158	89	85,312	31,468	4,016,293	5,153,685
1949	14,676	67	60,578	39,073	2,737,872	3,755,978
1950	12,342	-	72,836	- -	1,578,650	2,426,660
Totals	89,735	617	415,614	232,783	16,945,296	21,016,891

*Mint report.
**Akron, Erie, and other ore combined.

Based on the above table totals of recovered metals, crude ore assayed an average of 0.007 ounce gold and 4.6 ounces silver per ton, 0.13 percent copper, 9.4 percent lead, and 11.7 percent zinc.

1/ Compiled by Economics Division, U. S. Bureau of Mines, Region IV, Denver, Colo., on metal content of concentrates and smelter settlements.

Table 2. Akron Mine production from 1901 to 1950. (From Harrer, 1951, p.20.)

TABLE 2. - Production of the Akron mine, 1925-1950. 2/

Year	Crude Ore dry tons	Oz./T. Silver	Percent Copper	Percent Lead	Percent Zinc	Remarks
1925	485.10	11.71	-	9.02	8.54	
1926	178.10	18.93	-	12.27	12.10	
1943-45	5,777.00	7.93	0.20	8.75	12.49	Custom mill assays at Leadville, Colo.
1946	1,397.00	7.45	0.20	14.83	18.09	"
1947	8,138.00	7.18	0.20	19.49	22.00	"
1948	15,810.00	5.07	-	12.41	15.30	80-ton flotation mill in operation. Concentrates shipped to Leadville, Colo., and Amarillo, Texas.
1949	14,676.00	4.61	-	10.60	14.16	Low-grade footwall ore bodies mined.
1950	12,342.00	6.75	-	6.80	11.27	"
Total and Averages	58,803.20	6.04	0.2	11.43	14.96	

Year	Crude Ore dry tons	Ounces Silver	Pounds Copper	Pounds Lead	Pounds Zinc
1925	485.10	5,683	-	87,531	82,862
1926	178.10	3,372	-	43,722	43,084
1943-45	5,777.00	45,820	6,234	1,011,212	1,443,719
1946	1,397.00	10,403	5,546	414,459	505,667
1947	8,138.00	58,462	32,975	3,172,950	3,582,148
1948	15,810.00	80,157	27,399	3,924,042	4,995,960
1949	14,676.00	67,752	42,414	3,110,300	4,153,890
1950	12,342.00	83,366	-	1,680,380	2,783,791
Totals	58,803.20	355,015	114,568	13,444,596	17,591,121

From the above table totals, crude ore is estimated to average 6.04 ounces silver per ton, 0.2 percent copper, 11.43 percent lead, and 14.96 percent zinc. These analyses are the basis of ore reserve grade and all estimates.

2/ Compiled by Callahan Zinc-Lead Company, White Pine, Colo., and based on gross metal content at mill (mill heads - dry).

Table 3. Akron Mine production from 1925 to 1950. (From Harrer, 1951, p.21.)

1951. Callahan Zinc-Lead Company (J. Hall-president; R.F. Mahoney-vice president) continued operating the Akron-Erie Mine and shipped concentrates from the company's mill (Annual report-Akron-Erie Mine and mill, 1951, CBM). About 1,023 tons of lead concentrate worth $271,567 and 2,256 tons of zinc concentrate worth $390,242 were shipped. The concentrates yielded 58 ounces of gold, 116,716 ounces of silver, 1,694,450 pounds of lead, 2,431,209 pounds of zinc, and 53,333 pounds of copper. In April, a 1,700-foot-long crosscut (project A), which would undercut the Morning Star property at depth, was started from a point within the Akron adit (Murray, Inspector reports-Akron Mine, February 28, 1951, CBM). Squeezing and expanding ground, encountered in the first 370-foot portion of the crosscut, required constant maintenance to keep the working open. In March, operations in the Erie Mine were concentrated on removing pillars and general cleanup around the 400-foot-deep inclined shaft, connected to the No. 4 level, 400 feet from the adit portal (Murray, Inspector reports-Erie Mine, March 4, 1951, CBM). The Erie Mine had been stoped out and operations were nearly completed. Callahan Zinc-Lead Company was awarded a Defense Minerals contract that provided matching funds for exploration (Martin, 1954, p. 1467). At the time the Defense Minerals contract was awarded, claims owned or controlled by Callahan Zinc-Lead Company included:

Patented claims (Owned by Callahan-1951)	**Mineral Survey**
Bandit	1871
Bob Lee	2494
Deadwood	1872
Ensign	4508
Erie	2070
Haverford	1606
Little May	2333
Lost Contact	2332
Mazeppa	2497
Muldoon	849
Narrow Gauge	848
Nimrod	18861
No 3	850
North Star	847A
Sunset	1981
Yellow Jacket	18965
Paymaster	18861
North Star Millsite	847B
Trowell	1982
Flirt Millsite	2073A
Tomichi Millsite	11525
Leonora	5872
Wolverine	5872
Jersey	2305
Snowden	2415

Unpatented claims
(Owned by Callahan)
Little Don
Aviator
Hillside
Akron
Akron Tunnel site
Ohio

Patented claims (leased by Callahan)	**Mineral Survey**
Comstock JR	17383
Dusky Belle	2615
Evening Star	20007
Hartford	18876
Helen	20006
Hutchinson	1906
Iron Mask	8312
Isabel	4540
Little Giant	6692
Magnolia No. 1	20008
Mary Campbell	1986
Mattie E.	13295
Vulcan	8312
Belvidere	17383
Gopher	17384
David H.	1941
Denver City	1940
John G.	1966
Little Iron	1967
W. A.	13295
Little Alice	15553
Black Diamond	15554
Inspiration	19137
Last Chance	1937
Good Hope	20008
John C.	20008
Lucky Boy	20008
Washington	20008
Columbus	20008
Bryan	20008
Morning Star	6575
Victor	17173
Excelsior	2615
Sam T.	1985
Annie Hudson	1695

Unpatented claims
(leased by Callahan)
Starlight
Lonestar
Estrellita
Dog Star
Polar Star
Bright Star
Lucky Star
Little Star
Double Star
Twin Star
Nova

The USGS examined the Akron Mine (Dings and Robinson, 1957, p. 68). The Akron adit, Mazeppa Shaft, and a raise from the 350 level to the Tenderfoot adit provided access to the mine. The 3,450-foot-long main haulage section of the Akron adit (adit #100) had 5,500 feet of interconnecting drifts and crosscuts. Five main levels above the Akron level had a total of 6,000 feet of drifts and raises. A large portion of the mine had been stoped before 1940 and between 1940 and September 1951 (Figure 23).

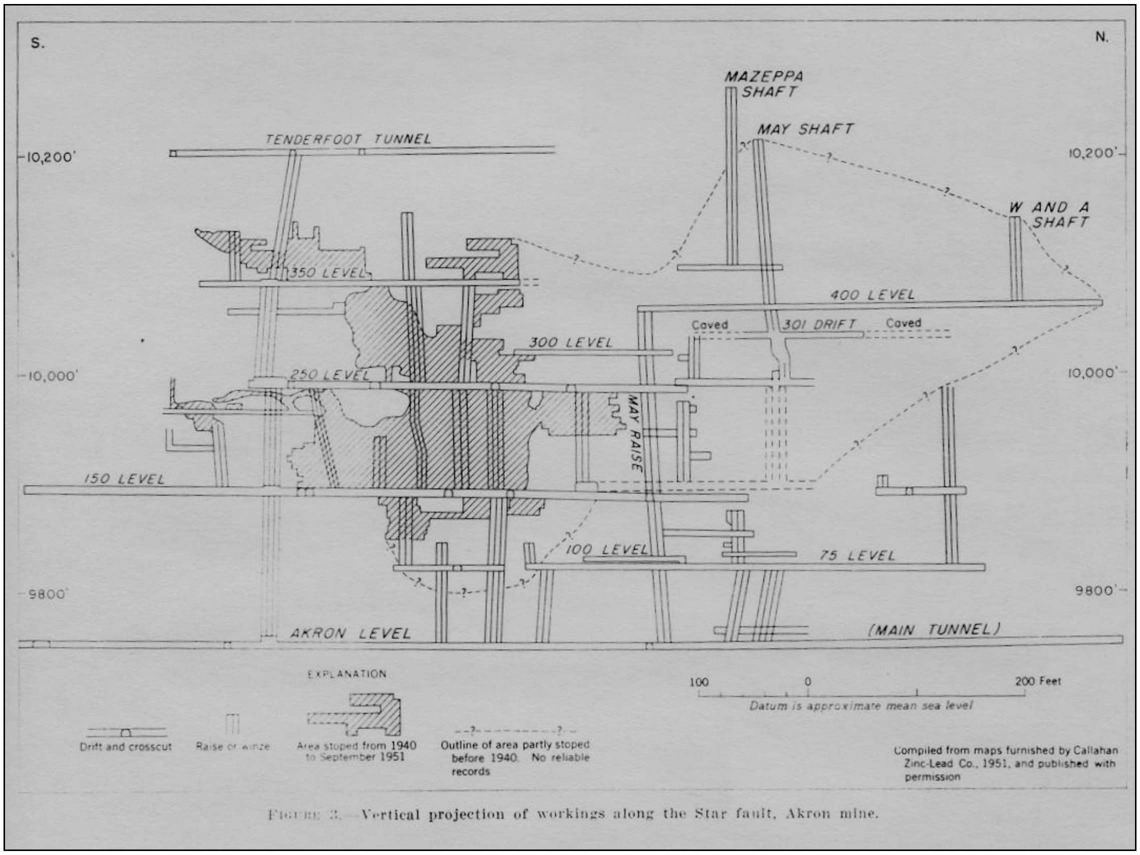


Figure 23. Map of 1951 Akron Mine workings along the North Star fault. (From Dings and Robinson, 1957, Figure 3.)

1952. Callahan Zinc-Lead Company continued operating the Akron-Erie Mine and shipped concentrates from the company's mill (Annual report-Akron-Erie Mine and mill, 1952, CBM). No new claims were located or patented. About 1,020 tons of lead concentrates (worth $244,859) and 1,920 tons of zinc concentrates (worth $308,332) were shipped. The concentrates yielded 51 ounces of gold, 100,592 ounces of silver, 1,625,428 pounds of lead, 2,122,470 pounds of zinc, and 37,518 pounds of copper. In December, a raise was started at the face of the 1,880-foot-long crosscut driven from a point within the Akron adit (Information report-Akron Mine, December 6, 1952, CBM). The crosscut was probably the one intended to intersect the Morning Star Mine workings. Ore in the Erie Mine was extracted from a winze below and a pillar above the main level (Information report-Erie Mine, December 12, 1952, CBM).

Dunn (general superintendent) and Flynn (assistant superintendent) substantiated reports that Callahan Zinc-Lead Company's mining operation was confined to the Akron and Erie Mines with exploration work in the Morning Star and Victor mine, all accessed through the Akron Tunnel (1953, p. 68-69). Work conducted in the areas was limited to exploration. Most of the ore was mined along the north south striking, 60° east dipping Star Fault generally situated along a granite limestone contact. Callahan estimated that the Star Fault had a 4,000-foot vertical displacement and it was traceable for 6,000 feet across company property. All of the ore was processed in the company's 100-ton selective flotation plant (Figure 24) and the tailings were placed behind a tailings dam (Figure 25) south of the mine.

Figure 24. 1952 photograph of Callahan Zinc-Lead Company's mill on the North lobe of Akron Mine dump #200, looking north.

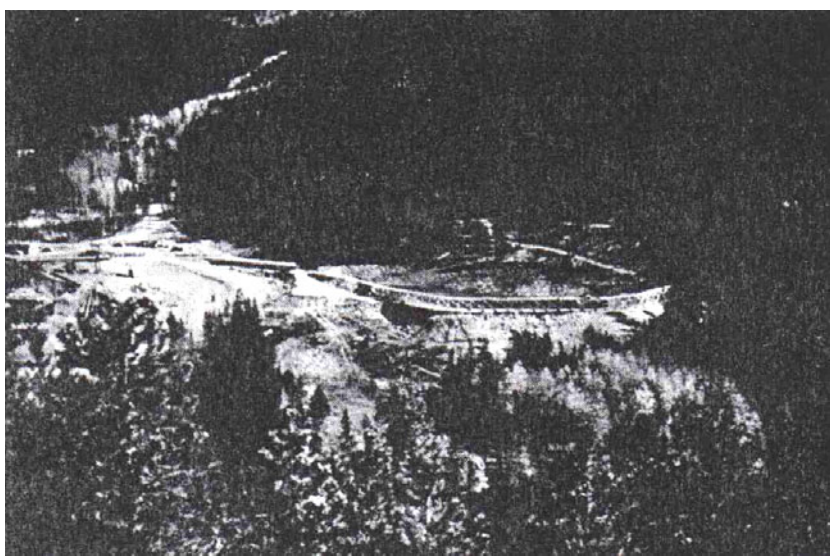


Figure 25. 1952 photograph of Callahan Zinc-Lead Company's tailings and retention dam on the South lobe of Akron Mine dump #200, looking north.

In another account, depressed lead and zinc prices forced the Callahan Zinc-Lead Company to suspend operations at the Akron-Erie Mine and mill in November (Martin, 1955, p. 231; Martin and Kelly, 1956, p. 263). From 1943 through 1952, the Akron group of mines was the principal metal producer in the county. Development included 1,253 feet of drifts, 821 feet of raises, and 114 feet of shafts. Mines owned by Callahan included the Akron, Erie, May, Mazeppa, W & A, Tenderfoot, North Star, Morning Star, Victor, West Point, and some of the claims associated with the Spar Copper Mine (Dings and Robinson, 1957, p. 68-78).

1947-1952. Callahan Zinc-Lead Company mined 95,000 tons of ore from the Akron Mine averaging 20% combined lead and zinc (Dunn and Flynn, 1953, p. 68).

1953. Callahan Zinc-Lead Company continued ownership of the Akron-Erie Mine and mill (Annual report-Akron Mine, 1953, CBM). No ore was shipped, although the company had spent $27,446 on exploration and improvements. In December, the pumps and equipment were removed (Information report-Akron Mine, December 18, 1953, CBM). In another account, Callahan Zinc-Lead Company's Akron-Erie Mine and mill remained idle (Martin and Kelly, 1956, p. 263).

1954. Callahan Zinc-Lead Company continued ownership of the Akron-Erie Mine and mill (Annual report-Akron Mine, 1954, CBM). No ore was shipped. In April, most of the underground equipment was removed (Information report-Akron Mine, April 15, 1954, CBM). In August, a small crew was driving a raise toward an old shaft (Information report-Akron Mine August 11, 1954, CBM).

1955. Callahan Zinc-Lead Company's Akron-Erie Mine and mill remained idle (Kelly and others, 1958, p. 274). "Some" material was shipped to the smelter from mill cleanup operations. In another account, the Akron Mine remained closed, with only a watchman remaining on the property (Annual report-Akron Mine, 1955, CBM).

1956. Callahan Zinc-Lead Company's Akron Mine and mill remained closed (Annual report-Akron Mine, 1956, CBM). A watchman guarded the property. Four employees worked for two months repairing the tunnel and some of the buildings (Information report-Akron Mine, September 6, 1956, CBM).

1959. Callahan Zinc-Lead Company's Akron Mine and mill remained closed (Information report-Akron Mine, December 1, 1959, CBM). Worked was concentrated on dismantling all of the surface buildings around the portal.

UNPATENTED MINING CLAIMS FILED WITH BLM

The Federal Land Policy and Management Act requires the filing of unpatented mining claims with the BLM. Claims located prior to the act had to be filed by October 22, 1979. Claims located afterward need filing within 90 days of location. The BLM lists claims geographically with a quarter section as the smallest subdivision. The Akron Mine (Akron Mine inventory area #328/4266-1, feature # 100/200) is just south of the town of Whitepine in the southeast corner of section 34, T.50 N., R. 5 E. Only mining claims recorded with the BLM in the southeast quarter of section 34 are included in this discussion. Mining claims records closed before 1980 are usually no longer available at the BLM. More recent claim owners may not have performed any noticeable work on their claims. Annual performance of assessment work is no longer required. BLM requires an annual filing fee and evidence of assessment work or a notice of intention to hold the claim.

1969-1979. Robert Hall located and held the Scott #4 Lode.

1978-1982. Joe Hersey located and held the JHC #25-27 Lodes.

1978-2000. Wyoming Fuel Co. located and held the WFC #28-29 Lodes.

1980-2002. John and Ralph Stitzer located and continue to hold the Strawberry Lode.

1987-1988. Joe Hersey and Cook Boyce located and held the Franklin #15 and Franklin #25-27 Lodes.

SITE DESCRIPTION

The mine is 0.2 miles south of the town of Whitepine, on the east side of CR 888 (Figure 1 and 26). The large waste rock dump sits just across Tomichi Creek (Figure 26), bordering the creek for about 500 meters (Figure 27), and is easily visible from the road (Figure 26 and 28). Access to the mine and dump is unrestricted, and the area appears heavily used by recreational vehicles. The portal of the Akron Mine (adit #100) is caved, but discharges a significant quantity of water nonetheless (Figure 29). The discharge was measured at 120 gpm during this investigation in June of 2002, and at 100 gpm during the inventory in September of 1996. The adit discharge flows westerly across the dump partly in a channel (Figure 30), cascades over the crest of the dump (Figure 31) and enters Tomichi Creek (Figure 32), about 200 feet from the portal. Mosses, algae and other plant life were observed in the channel, and insect life was seen in the water. The channel contained no significant precipitate. The flow in Tomichi Creek, just downstream from the mine, was measured at 2,443 gpm (5.4 cfs) (Figure 33).

The volume of the Akron Mine dump (#200) was estimated at 120,000 yards in the 1996 inventory. The dump consists of a north lobe (Figures 26, 27, 28, 34, 35, and 38) and a south lobe (Figures 36, 37, and 38), separated by a dirt road, and each has a separate tailings pile deposited upon it (Figures 39 and 40). The toe of the northern waste rock dump is in contact with Tomichi Creek for about 500 meters alongside the stream (Figure 27). Mill ruins abut the southwest edge of the north lobe of the waste rock dump (Figure 41), and some concrete foundations and remains of old wood structures are evident (Figures 26 and 39); one intact wooden structure remains (Figure 42). Rare rills cut the face of the sparsely vegetated dump, and minor sheet wash erosion has occurred. Vegetation, consisting of evergreen trees and shrubs, is dense adjacent to the site but sparse atop the dump and nonexistent on the tailings pile.

Hydrologic conditions were considerably different in 2002 than in 1996. Galena Creek was flowing at an estimated 100 gpm during the inventory in 1996, but was dry in 2002. During the 1996 inventory, a small pond filled a depression on the southern end of the south tailings pile, but was dry in 2002 (Figure 40).

The dump appears to consist primarily of unmineralized shale and quartzite with some porphyry material mixed in. The 1996 inventory stated that the dump consisted of marble and granite with abundant chalcopyrite, minor bornite, and bright gray metallic sulfides believed to be arsenopyrite.

Figure 26. North lobe of Akron Mine dump #200 and town of Whitepine in distance, looking north.

Figure 27. North lobe of Akron Mine dump #200 alongside Tomichi Creek, looking northeast.

Figure 28. North lobe of Akron Mine dump #200, looking east across Tomichi Creek from County Road 888.

Figure 29. Akron Mine adit #100 (water sample site AKRMH-02-7), showing caved portal and adit discharge.

Figure 30. Discharge from Akron Mine adit #100 flowing over dump.

Figure 31. Akron Mine discharge flowing over crest of dump.

Figure 32. Confluence of Akron Mine discharge with Tomichi Creek (site of water sample AKRMH-02-5).

Figure 33. Sample site AKRMH-02-4 in Tomichi Creek below confluence with adit discharge.

Figure 34. North lobe of Akron Mine dump #200, looking southwest across Tomichi Creek.

Figure 35. North lobe of Akron Mine dump #200, looking east across Tomichi Creek.

Figure 36. South lobe of Akron Mine dump #200, looking southeast.

Figure 37. South lobe of Akron Mine dump #200, looking north.

Figure 38. Akron Mine dump #200, looking south, showing north lobe in foreground and south lobe in background.

Figure 39. Tailings pile on north lobe of Akron Mine dump #200, looking south.

Figure 40. Tailings pile on south lobe of Akron Mine dump #200, looking northwest (tailings on north lobe can be seen in background)**.**

Figure 41. Mill ruins alongside north lobe of Akron Mine waste rock dump #200.

Figure 42. Wooden shack adjacent to north lobe of Akron Mine waste rock dump #200.

WASTE AND HAZARD CHARACTERISTICS

The main Akron mine adit (#100) and its associated waste rock dump (#200) were the only features included in the 1996 inventory for the Akron Mine area. The tailings were apparently included together with the waste rock during the 1996 inventory, and were not evaluated separately or assigned separate Environmental Degradation ratings.

Eight water samples were collected from the mine area in June of 2002 (Table 4), one of which was a duplicate. Five samples were taken from Tomichi Creek, and two plus the duplicate were from the adit discharge. Water sample locations are shown on Figure 43. The adit was discharging 100 gpm during the inventory, and 120 gpm during this investigation in June of 2002. Galena Creek was dry at the time of sampling, but was reported flowing in wetter years.

Numerous trace elements were detected in the waters of the Akron Mine area (Table 4), but due to the water's relatively high hardness only one constituent, zinc, exceeds State regulatory standards, and only in the adit discharge. Calcium and magnesium in the water apparently originate from the abundant carbonate rocks in the area. Tomichi Creek has sufficiently good quality that trout are able to live along the entire reach adjacent to the mine site.

Two water samples and one duplicate were collected from the adit effluent – one close to the portal (AKRMH-02-7 and its duplicate AKRMH-02-8; Figure 29), and another just before the discharge enters Tomichi Creek (AKRMH-02-5; Figure 32). The water emerging at the portal was relatively clear, had pH of 7.42 and EC of 332 μS/cm. Only zinc exceeded State water quality standards, with a concentration of 229 μg/L versus its hardness-dependent aquatic life standard of 198 μg/L. At the toe of the dump (AKRMH-02-5; Figure 32), the portal discharge had pH of 8.11 with EC of 352 μS/cm. Again dissolved zinc was the only constituent to exceed standard, with a concentration of 223 μg/L against a standard of 199 μg/L. Sample AKRMH-02-5 left a small amount of yellow precipitate on the filter during sampling.

The Akron mine adit (#100) was assigned an EDR of 3, indicating "potentially significant" environmental degradation. Water samples collected for this investigation indicate that the impact from the adit effluent to Tomichi Creek is not severe at present. The adit effluent has neutral pH with abundant alkalinity, and only zinc exceeds standard. However, if weathering exposes zones within the mine or on the dump containing higher contents of sulfide minerals, then the adit discharge could have a more adverse impact on the watershed.

A water sample from Tomichi Creek (AKRMH-02-1), downstream from all mine influence, is within standard for all constituents analyzed. The pH of Tomichi Creek decreases slightly from 8.05 upstream of the mine to 7.78 downstream of the mine. EC increases slightly from 133 μS/cm upstream of the mine to 147 μS/cm downstream of the mine. The water has relatively good quality and supports trout and other aquatic life. Filamentous algae were present. Evidence of minor leaching of waste rock material into Tomichi Creek can be seen locally where the dump is in contact with the stream, but no adverse effects to water quality are evident in the laboratory analyses. Although no precipitate or suspended material is apparent in the water, four filters were required to collect the water sample, indicating the presence of suspended matter in the water.

A water sample collected from a seep beneath apparent tailings (sample AKRMH-02-2; Figure 44), as well as a sample from Tomichi Creek itselft (AKRMH-02-3; Figure 45), were also within standard for all constituents analyzed. Minor amounts of orange-yellow precipitate were observed in the streambed, and filamentous algae were seen. Trout were also present in Tomichi Creek at that location.

Three composite grab rock samples were collected (Table 5), one of waste dump material (AK-02-1) and two of tailings (AK-02-2 and AK-02-3). Rock sample locations are shown on Figure 43.

The Akron waste rock dump was assigned an EDR of 2, indicating "significant" environmental degradation. However, significant degradation was not evident during the 2002 investigation. Leaching from the dump to the creek was apparent, due to a small orange-colored plume emanating from the dump and dispersing into the creek. But as stated earlier, the chemical analyses revealed no constituents in violation of State water quality standards in Tomichi Creek. The three rock samples from the mine facilities showed strongly positive net acid neutralizing potential and neutral paste pH (Table 5), suggesting that the waste rock and tailings are not going to release acid to the watershed in the foreseeable future. The rocks were relatively enriched in silver (up to 0.86 oz/ton), lead (up to 9,459 ppm, or 0.94%), and zinc (up to 14,974 ppm, or

1.5%), and exceeded Bureau of Land Management risk management criteria for the following constituents: Arsenic in all three samples for “resident” (1 mg/kg), camper (20 mg/kg), and “worker” (12 mg/kg); copper in AK-02-2 and AK-02-3 for “resident” (250 mg/kg); lead in all three samples for all categories (“resident” at 400 mg/kg, “camper” and “ATV driver” at 1,000 mg/kg, “worker” and “surveyor” at 2,000 mg/kg); manganese in all three samples for “resident” (960 mg/kg); zinc in all three samples for “resident” (2,000 mg/kg).

With few exceptions, the chemical loadings to the watershed attributable to the mine are negligible, based on comparisons of water samples from Tomichi Creek upstream of the mine (sample AKRMH-02-6; Figure 46), and downstream of the mine (sample AKRMH-02-1; Figure 47). The exceptions are lead, which nearly triples from 5.4 to 15.7 grams per day; sulfate, which increases about 8% from 266 to 287 kilograms per day; and zinc, which exhibits more than a ten-fold increase from 44 to 573 grams per day.

Both the adit and the dump were assigned physical hazard ratings of 5, indicating no significant hazard. Due to its collapse, the adit is inaccessible. Although the dump abuts the stream, mature shrubs are developed along the toe of the dump and serve to stabilize the dump.

[intentionally blank]

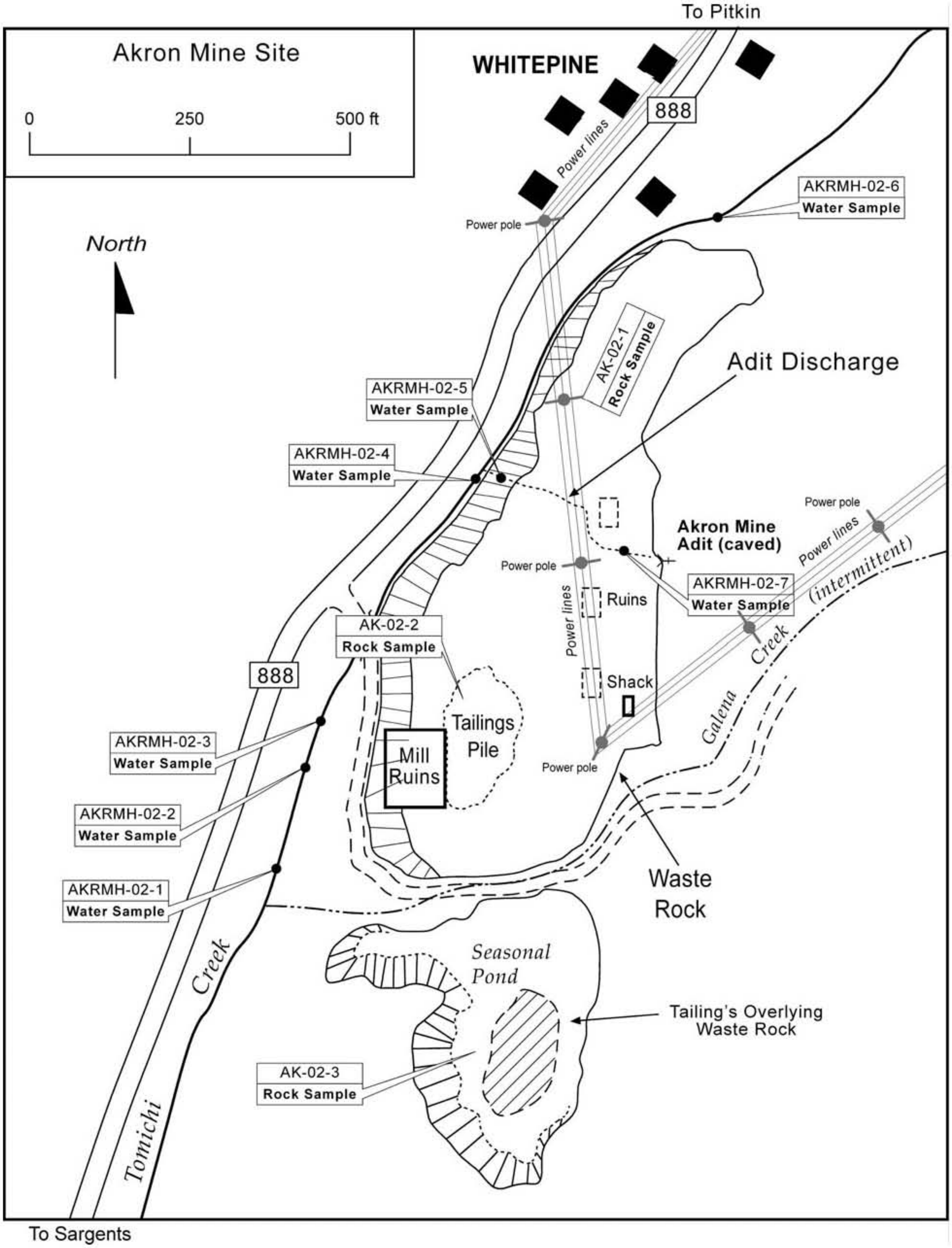


Figure 43. Map of Akron Mine area showing locations of water and rock samples and other notable features (Scale is approximate).

Table 4. Results of chemical analyses and measurement of field parameters for water samples from the Akron Mine.

Sample	AKRMH-02-1, Tomichi Creek downstream from mine (27 June 2002)			AKRMH-02-2, Side channel from beneath tailings (27 June 2002)		
Parameter	Concentration/ measurement	Standard	Load (grams/day)	Concentration/ measurement	Standard	Load (grams/day)
Flow (gpm)	2,200	None		247	None	
pH (standard units)	7.78	5.0 - 9.0		8.09	5.0 - 9.0	
Conductivity (µS/cm)	147	None		144	None	
Alkalinity (mg/L CaCO3)	50	None		55	None	
Hardness (mg/L CaCO3)	67	None		66	None	
Aluminum (trec) (µg/L)	20.0	None	240	22.5	None	30.3
Antimony (trec) (µg/L)	<1.5	6	N/A	<1.5	6	N/A
Arsenic (trec) (µg/L)	<5.0	10	N/A	<5.0	10	N/A
Iron (trec) (µg/L)	158	1000	1,895	<500	1000	N/A
Thallium (trec) (µg/L)	<1.5	0.5	N/A	<1.5	0.5	N/A
Aluminum (µg/L)	6.67	87	80	7.05	87	9.5
Cadmium (µg/L)	<0.20	1.67	N/A	<0.20	1.64	N/A
Calcium (mg/L)	20.9	None	250,637	20.3	None	27,332
Chloride (mg/L)	0.25	250	2,998	0.18	250	242
Chromium (µg/L)	0.248	11	3.0	0.277	11	0.4
Copper (µg/L)	2.35	6.39	28.2	2.41	6.25	3.2
Fluoride (mg/L)	0.24	2	2,878	0.12	2	162
Iron (µg/L)	90.5	300	1,085	98.4	300	133
Lead (µg/L)	1.31	1.63	15.7	1.28	1.59	1.7
Magnesium (mg/L)	3.7	None	44,371	3.63	None	4,887
Manganese (µg/L)	20.2	1,447	242	19.8	1,434	26.7
Mercury (µg/L)	<0.20	0.77	N/A	<0.20	0.77	N/A
Nickel (µg/L)	1.25	37.3	15	1.19	36.4	1.6
Potassium (mg/L)	0.514	None	6,164	0.514	None	692
Silicon (mg/L)	3.76	None	45,091	3.66	None	4,928
Silver (µg/L)	<0.10	0.04	N/A	<0.10	0.04	N/A
Sodium (mg/L)	1.85	None	22,186	1.86	None	2,504
Sulfate (mg/L)	24	250	287,813	23	250	30,967
Uranium (µg/L)	1.93	972	23.1	1.86	944	2.5
Zinc (µg/L)	47.8	85	573	43.8	83	59

Number in ***bold italics*** indicate a concentration/measurement exceeding water quality standard.

Table 4 (continued). Results of chemical analyses and measurement of field parameters for water samples from the Akron Mine.

Sample	AKRMH-02-3, Tomichi Creek adjacent to tailings (27 June 2002)			AKRMH-02-4, Tomichi Creek downstream from adit effluent (27 June 2002)		
Parameter	Concentration/ measurement	Standard	Load (grams/day)	Concentration/ measurement	Standard	Load (grams/day)
Flow (gpm)	1,900	None		1,900	None	
pH (standard units)	8.05	5.0 - 9.0		8.02	5.0 - 9.0	
Conductivity (µS/cm)	138	None		133	None	
Alkalinity (mg/L CaCO3)	35	None		42	None	
Hardness (mg/L CaCO3)	66	None		62	None	
Aluminum (trec) (µg/L)	28.5	None	300	14.8	None	156
Antimony (trec) (µg/L)	<1.5	6	N/A	0.623	6	6.6
Arsenic (trec) (µg/L)	<5.0	10	N/A	<5.0	10	N/A
Iron (trec) (µg/L)	160	1000	1,684	<500	1000	N/A
Thallium (trec) (µg/L)	<1.5	0.5	N/A	<1.5	0.5	N/A
Aluminum (µg/L)	7.03	87	74	7.62	87	80
Cadmium (µg/L)	<0.20	1.64	N/A	<0.20	1.58	N/A
Calcium (mg/L)	20.3	None	213,700	19.4	None	204,200
Chloride (mg/L)	0.19	250	2,000	0.16	250	1,684
Chromium (µg/L)	0.269	11	2.8	0.209	11	2.2
Copper (µg/L)	2.48	6.25	26.1	2.55	5.98	26.8
Fluoride (mg/L)	0.11	2	1,158	0.12	2	1,263
Iron (µg/L)	102	300	1,074	105	300	1,105
Lead (µg/L)	1.24	1.59	13.1	0.825	1.50	8.7
Magnesium (mg/L)	3.63	None	38,209	3.37	None	35,472
Manganese (µg/L)	18.7	1,434	197	20.8	1,409	219
Mercury (µg/L)	<0.20	0.77	N/A	<0.20	0.77	N/A
Nickel (µg/L)	1.17	36.4	12.3	1.14	34.9	12
Potassium (mg/L)	0.510	None	5,368	0.508	None	5,347
Silicon (mg/L)	3.68	None	38,735	3.65	None	38,420
Silver (µg/L)	<0.10	0.04	N/A	<0.10	0.03	N/A
Sodium (mg/L)	1.81	None	19,052	1.78	None	18,736
Sulfate (mg/L)	23	250	242,095	22	250	231,569
Uranium (µg/L)	1.88	943	19.8	1.75	891	18.4
Zinc (µg/L)	45.0	83	474	28.8	79	303

Number in ***bold italics*** indicate a concentration/measurement exceeding water quality standard.

Table 4 (continued). Results of chemical analyses and measurement of field parameters for water samples from the Akron Mine.

Sample	AKRMH-02-5, Adit discharge at toe of dump (27 June 2002)			AKRMH-02-6, Tomichi Ck upstream of mine (27 June 2002)		
Parameter	Concentration/ measurement	Standard	Load (grams/day)	Concentration/ measurement	Standard	Load (grams/day)
Flow (gpm)	120	None		2,327	None	
pH (standard units)	8.11	5.0 - 9.0		8.05	5.0 - 9.0	
Conductivity (µS/cm)	352	None		133	None	
Alkalinity (mg/L CaCO3)	135	None		45	None	
Hardness (mg/L CaCO3)	185	None		62	None	
Aluminum (trec) (µg/L)	18.1	None	11.8	20.4	None	259
Antimony (trec) (µg/L)	<1.5	6	N/A	<1.5	6	N/A
Arsenic (trec) (µg/L)	<5.0	10	N/A	<5.0	10	N/A
Iron (trec) (µg/L)	<500	1000	N/A	165	1000	2,093
Thallium (trec) (µg/L)	<1.5	0.5	N/A	<1.5	0.5	N/A
Aluminum (µg/L)	<1.0	87	N/A	7.94	87	100.7
Cadmium (µg/L)	<0.20	3.5	N/A	<0.20	1.57	N/A
Calcium (mg/L)	46.7	None	30,547	19.4	None	246,079
Chloride (mg/L)	0.46	250	301	0.16	250	2,030
Chromium (µg/L)	0.490	11	0.3	0.246	11	3.1
Copper (µg/L)	0.244	15.2	0.2	2.44	5.93	31
Fluoride (mg/L)	0.12	2	78.5	0.12	2	1,522
Iron (µg/L)	<50	300	N/A	98.2	300	1,246
Lead (µg/L)	0.716	4.9	0.5	0.422	1.48	5.4
Magnesium (mg/L)	16.7	None	10,924	3.23	None	40,971
Manganese (µg/L)	20.9	2,026	13.7	20.3	1,405	258
Mercury (µg/L)	<0.20	0.77	N/A	<0.20	0.77	N/A
Nickel (µg/L)	2.80	87.6	1.8	1.32	34.6	16.7
Potassium (mg/L)	0.975	None	638	<0.500	None	N/A
Silicon (mg/L)	5.18	None	3,388	3.71	None	47,059
Silver (µg/L)	<0.10	0.22	N/A	<0.10	0.03	N/A
Sodium (mg/L)	2.19	None	1,433	1.77	None	22,452
Sulfate (mg/L)	70	250	45,788	21	250	266,374
Uranium (µg/L)	10.5	2960	6.9	1.79	882	22.7
Zinc (µg/L)	***223***	199	146	3.49	79	44.3

Number in ***bold italics*** indicate a concentration/measurement exceeding water quality standard

Table 4 (continued). Results of chemical analyses and measurement of field parameters for water samples from the Akron Mine.

Sample	AKRMH-02-7, Adit discharge ~100 ft from portal (27 June 2002)			AKRMH-02-8, Duplicate of AKRMH-02-7 (27 June 2002)		
Parameter	Concentration/ measurement	Standard	Load (grams/day)	Concentration/ measurement	Standard	Load (grams/day)
Flow (gpm)	120	None		120	None	
pH (standard units)	7.42	5.0 - 9.0		7.42	5.0 - 9.0	
Conductivity (µS/cm)	332	None		332	None	
Alkalinity (mg/L CaCO3)	110	None		110	None	
Hardness (mg/L CaCO3)	184	None		187	None	
Aluminum (trec) (µg/L)	5.32	None	3.5	12.3	None	8.0
Antimony (trec) (µg/L)	<1.5	6	N/A	<1.5	6	N/A
Arsenic (trec) (µg/L)	<5.0	10	N/A	<5.0	10	N/A
Iron (trec) (µg/L)	<500	1000	N/A	<500	1000	N/A
Thallium (trec) (µg/L)	<1.5	0.5	N/A	<1.5	0.5	N/A
Aluminum (µg/L)	<1.0	87	N/A	<1.0	87	N/A
Cadmium (µg/L)	<0.20	3.5	N/A	<0.20	3.55	N/A
Calcium (mg/L)	46.2	None	30,220	47.3	None	30,940
Chloride (mg/L)	0.47	250	307	0.46	250	301
Chromium (µg/L)	0.656	11	0.4	0.845	11	0.6
Copper (µg/L)	0.179	15.05	0.1	0.152	15.3	0.1
Fluoride (mg/L)	0.11	2	72	0.10	2	65.4
Iron (µg/L)	<50	300	N/A	<50	300	N/A
Lead (µg/L)	<0.10	4.8	N/A	<0.10	4.9	N/A
Magnesium (mg/L)	16.6	None	10,858	16.8	None	10,989
Manganese (µg/L)	71.7	2,019	46.9	72.0	2,032	47.1
Mercury (µg/L)	<0.20	0.77	N/A	<0.20	0.77	N/A
Nickel (µg/L)	3.16	87	2.1	2.49	88.4	1.6
Potassium (mg/L)	1.03	None	674	1.05	None	687
Silicon (mg/L)	5.16	None	3,375	5.22	None	3,415
Silver (µg/L)	<0.10	0.21	N/A	<0.10	0.22	N/A
Sodium (mg/L)	2.19	None	1,433	2.22	None	1,452
Sulfate (mg/L)	71	250	46,443	70	250	45,788
Uranium (µg/L)	10.5	2931	6.9	10.2	2993	6.7
Zinc (µg/L)	***229***	198	150	***218***	201	143

Number in ***bold italics*** indicate a concentration/measurement exceeding water quality standard.

Figure 44. Sample site AKRMH-02-2 from seep discharging from beneath apparent tailings deposit and discharging to Tomichi Creek.

Figure 45. Sample site AKRMH-02-3 from Tomichi Creek directly upstream from site of seep emerging from beneath apparent tailings deposit.


Figure 46. Sample site AKRMH-02-6 in Tomichi Creek upstream from mine.

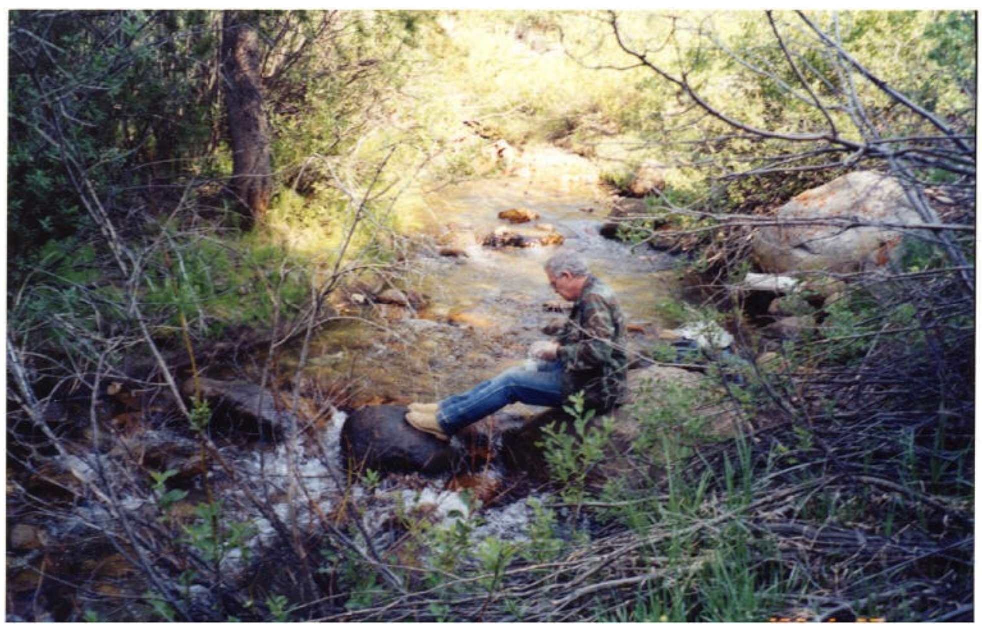


Figure 47. Sample site AKRMH-02-1 in Tomichi Creek upstream from mine.

Table 5. Rock Geochemistry Data from Akron Mine Waste Dump and Tailings

		Sample Number		
Constituent	**Units**	**AK-02-1**	**AK-02-2**	**AK-02-3**
Gold	oz/ton	<0.005	<0.005	<0.005
Mercury	ppm	0.3	0.2	0.3
Silver	oz/ton	0.47	0.86	0.83
Neutralization Potential	Tons $CaCO_3$/ 1000 tons	258	294	394
Potential Acidity	Tons $CaCO_3$/ 1000 tons	22.7	258	235
Net Acid Base Potential	Tons $CaCO_3$/ 1000 tons	235	42	178
Paste pH	Standard Units	8.03	8.1	7.77
Na_2O	wt %	0.18	0.1	0.11
MgO	wt %	6.65	7.26	9.68
Al_2O_3	wt %	11.5	6.7	5.65
SiO_2	wt %	50.5	36.8	36.1
P_2O_5	wt %	0.07	0.06	0.06
S	wt %	1.02	6.57	6.37
Cl	wt %	<0.02	<0.02	<0.02
K_2O	wt %	2.85	1.17	1.01
CaO	wt %	13.8	16.2	16.8
TiO_2	wt %	0.18	0.11	0.09
MnO	wt %	0.53	1.81	2.25
Fe_2O_3	wt %	3.76	13.4	15.4
BaO	wt %	0.03	<0.01	<0.01
V	ppm	21	13	11
Cr	ppm	21	<10	35
Co	ppm	<10	22	12
Ni	ppm	<10	<10	<10
W	ppm	<10	<10	<10
Cu	ppm	150	384	353
Zn	ppm	11,069	13,922	14,974
As	ppm	38	98	139
Sn	ppm	75	<50	<50
Pb	ppm	6,851	9,459	8,884
Mo	ppm	<10	10	<10
Sr	ppm	146	75	66
U	ppm	11	24	44
Th	ppm	17	28	42
Nb	ppm	18	18	17
Zr	ppm	83	67	45
Rb	ppm	117	46	36
Y	ppm	44	39	37

MIGRATION PATHWAYS

SURFACE WATER PATHWAY

Based on two measurements taken several years apart, it might be reasonable to conclude that the discharge from the Akron mine adit to Tomichi Creek remains somewhat consistent at around 100 gpm, at least in the summer months. During normal precipitation years, Galena Creek might flow over the waste rock dump and enter Tomichi Creek.

Tomichi Creek exhibits a drop in pH from 8.05 to 7.78 due to the inflow of the adit effluent. The EC increases slightly from 133 μS/cm upstream of the mine to 147 μS/cm downstream of the mine.

The inventory states that the adit discharge causes “potentially significant” environmental degradation (EDR of 3) to the Tomichi Creek watershed, and that the waste rock dump causes “significant” environmental degradation (EDR of 2) to Tomichi Creek due to the toe of the dump being in contact with surface water. However, the water chemistry data from this investigation do not support the contention that impacts from the waste rock dump and adit discharge cause a significant adverse impact.

GROUND WATER PATHWAY

The underground workings of the Akron Mine were not accessed during this investigation, so the underground geology was not observed. However, the mine is developed in a variety of rock types, from Tertiary to Precambrian, and the geology of the system is reported to be structurally complex (see earlier section entitled **GEOLOGIC SETTING**). A structurally complex aquifer could potentially allow for more enhanced ground-water transport of contaminants from the mine workings to the stream than would occur in such a geologic environment setting without the structural enhancement. However, the adit is near creek level, which is the topographic low point in the mine area, and likely a ground-water discharge zone. So it might be reasonable to assume that ground-water discharge from the mine is focused in the adit area, and the relative quantity of mine-influence ground-water discharge elsewhere is negligible, an assumption supported by the relatively negligible impact to Tomichi Creek seen in the water chemistry.

A quantitative assessment of ground-water flow is impossible at this time because no recent aquifer test data are known for the mine site. State records revealed 26 household wells in the town of Whitepine. However, these are upstream or across the creek from the mine site, and depths to water are relatively shallow. Thus, it is reasonable to assume that hydraulic gradients are not oriented from the mine toward town, and impact to the town from mine-influenced water is unlikely.

A less obvious source of contamination could originate from the waste rock dump and tailings. The dimensions of the waste rock and tailings were reported in the 1996 inventory at 1,500 ft by 250 ft, which totals 375,000 sq ft in surficial area. Assuming annual precipitation of 36 inches (CSU, 2002), and neglecting evaporation, up to 16 gpm of precipitation could be infiltrating into the waste rock and tailings, picking up contaminants, and discharging to the ground water system. The actual loading from these sources is unknown until further testing is done, but these piles are a potential source of contaminants that should not be ignored in the assessment of remediation alternatives.

SOIL EXPOSURE PATHWAY

The possibility of ingesting toxic levels of metals is the primary concern regarding this pathway. The mine lies on the edge of the community of Whitepine, and residences exist just across Tomichi Creek from the mine site. The area is used for four-wheeling and possibly other recreational activities. Metal concentrations up to 0.9% lead and 1.5% zinc were measured in the waste rock dump (Table 5). A detailed assessment of soil exposure pathways is beyond the scope of this investigation.

AIR EXPOSURE PATHWAY

There are residences just across Tomichi Creek from the mine site, so exposure to airborne mine-derived contaminants might be a concern. There appears to be unrestricted use of recreational vehicles on the tailings deposits, and this activity could potentially mobilize tailings dust into the air and increase exposure via this pathway. However, a detailed assessment of air exposure pathways is beyond the scope of this investigation.

SUMMARY AND CONCLUSIONS

Two features at the Akron mine, the adit and the waste rock dump, have the potential for environmental degradation. These were the only features included in the 1996 inventory. The adit was assigned an Environmental Degradation Rating (EDR) of 3, indicating "potentially significant" environmental degradation, and the waste dump was assigned an EDR of 2, indicating "significant" environmental degradation. At present, neither the adit nor the waste dump appears to be causing significant environmental degradation. The adit discharge exceeds State of Colorado water quality standards in zinc, but none of the constituents analyzed in Tomichi Creek downstream of the mine exceeded the statewide, concentration-based aquatic life standard.

The discernible impacts to the watershed are the following:

- The pH of Tomichi Creek drops from 8.05 upstream of the mine to 7.78 downstream,
- Electrical conductivity in Tomichi Creek increases from 133 μS/cm upstream of the mine to 147 μS/cm downstream,
- Dissolved zinc increases from 3.49 μg/L upstream of the mine to 47.8 μg/L downstream, but is still within the statewide standard,
- Dissolved lead increases from 0.422 μg/L upstream of the mine to 1.31 μg/L downstream, but is still within the statewide standard,
- Dissolved uranium increases from to 1.79 μg/L upstream of the mine to 1.93 μg/L downstream, but is still within the statewide standard,

- The zinc loading increases more than ten-fold from 44 grams/day upstream of the mine to 573 grams per day downstream.
- The lead loading nearly triples from 5.4 grams/day upstream of the mine to 15.7 grams/day downstream.
- The sulfate loading increases about 8% from 266 kg/day upstream of the mine to 287 kg/day downstream.

The adit discharge does not appear to acquire any additional significant contaminants as a result of flowing over the waste dump (Table 4; compare sample AKRMH-02-7 from adit portal with AKRMH-02-5, from discharge at toe of dump). In fact, analyses from this investigation indicate that some attenuation of various constituents occurs. Concentrations of aluminum (5.32 μg/L vs 18.1 μg/L) and lead (undetectable vs 0.716 μg/L) increase, but manganese (71.7 μg/L vs 20.9 μg/L) and nickel (3.16 μg/L vs 2.8 μg/L) concentrations decrease slightly.

The waste dump consists of two lobes, each of which has a pile of tailings deposited directly upon it. The tailings were not assigned separate Environmental Degradation ratings in the 1996 inventory, rather they were apparently included within the overall rating for the waste rock dump. The EDR of 2 assigned to the waste dump is apparently attributed to the potential for leaching of contaminants to Tomichi Creek, which sits in direct contact with the waste rock dump for an estimated 500 meters. However, water chemistry data indicate that Tomichi Creek water is within standard for all analyzed constituents, and visual observations indicate that the creek supports a trout fishery. Rock geochemistry data for the waste rock and tailings indicate positive net acid-neutralizing potential and neutral paste pH at all three sample locations. However, the data only indicate present conditions, and the site should be periodically monitored to detect future contamination to the watershed.

REFERENCES

Burchard, H.C., 1882, Colorado *in* Report of the Director of the Mint upon the statistics of production of precious metals in the United States - 1881: Director of the Mint Report, p. 354-445.

Burchard, H.C., 1883, Colorado *in* Report of the Director of the Mint upon the statistics of production of precious metals in the United States - 1882: Director of the Mint Report, p. 390-593.

Burchard, H.C., 1884, Colorado *in* Report of the Director of the Mint upon the production of precious metals in the United States during calendar year 1883: Director of the Mint Report, p. 235-433.

Burchard, H.C., 1885, Colorado *in* Report of the Director of the Mint upon the production of precious metals in the United States during calendar year 1884: Director of the Mint Report, p. 176-249.

Clesceri, L.S., Greenberg, A.E., and Eaton, A.D. (eds.), 1998, Standard methods for the examination of water and wastewater, 20th edition. Prepared and published jointly by the American Public Health Association, the American Water Works Association, and the Water Environment Federation, Published by the American Public Health Association, Washington D.C., 1325 p.

Corregan, R.A. and Lingane, D.F., 1883, The Colorado mining directory and buyers guide: The Colorado Mining Directory Company, Denver, CO, 908 p.

Crawford, R.D., 1913, Geology and ore deposits of the Monarch and Tomichi Districts, Colorado: Colorado Geological Survey Bulletin 4, 317 p.

Dings, M.G., and Robinson, C.S., 1957, Geology and ore deposits of the Garfield quadrangle, Colorado: U.S. Geological Survey Professional Paper 289, 110 p.

Dunn, J.E. and Flynn, R.J. 1953, *in* 1953 Mining Yearbook, Colorado Mining Association publication, p. 68-69.

Downer, F.M., 1903, Colorado *in* Report of the Director of the Mint upon the production of precious metals in the United States – 1902: Director of the Mint Report, p. 88-133.

Gustavson, S.A., 1948, Gold, silver, copper, lead, and zinc-Colorado *in* Mineral Yearbook-1946: U.S. Bureau of Mines publication, p. 1387-1412.

Harrer, C.M., 1951, Callahan Lead-Zinc Company, Akron unit, Victor, Morning Star, Akron Mines, Gunnison County, Colorado *in* Defense Administration report DMA Docket No. 110.

Henderson, C.W., 1913, Gold, silver, copper, lead, and zinc - Colorado *in* Mineral Resources of the United States (part I)-1912: U.S. Geological Survey publication, p. 635-705.

Henderson, C.W., 1919, Gold, silver, copper, lead, and zinc-Colorado *in* Mineral resources of the United States (part I)-1916: U.S. Geological Survey publication, p. 331-388.

Henderson, C.W., 1920, Gold, silver, copper, lead, and zinc - Colorado *in* Mineral Resources of the United States (part I)-1917: U.S. Geological Survey publication, p. 797-853.

Henderson, C.W., 1921, Gold, silver, copper, lead, and zinc - Colorado *in* Mineral Resources of the United States (part I)-1918: U.S. Geological Survey publication, p. 819-875.

Henderson, C.W., 1922a, Gold, silver, copper, lead, and zinc - Colorado *in* Mineral Resources of the United States (part I)-1919: U.S. Geological Survey publication, p. 751-792.

Henderson, C.W., 1922b, Gold, silver, copper, lead, and zinc-Colorado *in* Mineral resources of the United States (part I)-1920: U.S. Geological Survey publication, p. 565-595.

Henderson, C.W., 1924, Gold, silver, copper, lead, and zinc-Colorado *in* Mineral resources of the United States (part I)-1921: U.S. Geological Survey publication, p. 479-511.

Henderson, C.W., 1925, Gold, silver, copper, lead, and zinc - Colorado *in* Mineral Resources of the United States (part I)-1922: U.S. Geological Survey publication, p. 519-556.

Henderson, C.W., 1927a, Gold, silver, copper, lead, and zinc-Colorado *in* Mineral resources of the United States (part I)-1923: U.S. Geological Survey publication, p. 611-648.

Henderson, C.W., 1927b, Gold, silver, copper, lead, and zinc-Colorado *in* Mineral resources of the United States (part I)-1924: Bureau of Mines publication, p. 547-576.

Henderson, C.W., 1928, Gold, silver, copper, lead, and zinc in Colorado *in* Mineral Resources of the United States - 1925: Bureau of Mines publication, p. 701-730.

Henderson, C.W., 1929, Gold, silver, copper, lead, and zinc in Colorado *in* Mineral Resources of the United States - 1926: Bureau of Mines publication, p. 733-774.

Henderson, C.W., 1930, Gold, silver, copper, lead, and zinc in Colorado *in* Mineral Resources of the United States - 1927: Bureau of Mines publication, p. 527-572.

Henderson, C.W., 1931, Gold, silver, copper, lead, and zinc in Colorado *in* Mineral Resources of the United States - 1928: Bureau of Mines publication, p. 817-872.

Henderson, C.W., 1932, Gold, silver, copper, lead, and zinc in Colorado *in* Mineral Resources of the United States - 1929: Bureau of Mines publication, p. 921-968.

Henderson, C.W., 1943, Gold, silver, copper, lead, and zinc-Colorado *in* Minerals Yearbook-1942: Bureau of Mines publication, p. 317-348.

Henderson, C.W. and Martin, A.J., 1943, Gold, silver, copper, lead, and zinc-Colorado *in* Minerals Yearbook-1941: Bureau of Mines publication, p. 285-319.

Henderson, C.W., Mote, R.H., and Cushman, R.V., 1945, Gold, silver, copper, lead, and zinc in Colorado *in* Mineral Resources of the United States - 1943: Bureau of Mines publication, p. 314-342.

Hodges, J.L., 1901, Colorado *in* Report of the Director of the Mint upon the production of precious metals in the United States - 1900: Director of the Mint Report, p. 100-136.

Hodges, J.L., 1902, Colorado *in* Report of the Director of the Mint upon the production of precious metals in the United States - 1901: Director of the Mint Report, p. 104-148.

Kelly, F.J., Kerns, W.H., Parker, B., and Ransome, A.L., 1958, The mineral industry of Colorado *in* Minerals Yearbook (volume III)-1955: U.S. Bureau of Mines publication, p. 239-286.

Lindgren, W., 1906, Gold and silver - Colorado *in* Mineral Resources of the United States - 1905: U.S. Geological Survey publication, p. 185-214.

Martin, A.J., 1949, Gold, silver, copper, lead, and zinc-Colorado *in* Mineral Yearbook-1947: U.S. Bureau of Mines publication, p. 1351-1376.

Martin, A.J., 1950, Gold, silver, copper, lead, and zinc-Colorado *in* Mineral Yearbook-1948: U.S. Bureau of Mines publication, p. 1446-1469.

Martin, A.J., 1951, Gold, silver, copper, lead, and zinc-Colorado *in* Mineral Yearbook-1949: U.S. Bureau of Mines publication, p. 1421-1442.

Martin, A.J., 1953, Gold, silver, copper, lead, and zinc-Colorado *in* Mineral Yearbook-1950: U.S. Bureau of Mines publication, p. 1440-1462.

Martin, A.J., 1954, Gold, silver, copper, lead, and zinc-Colorado *in* Mineral Yearbook-1951: U.S. Bureau of Mines publication, p. 1453-1470.

Martin, A.J., 1955, The mineral industry of Colorado *in* Minerals Yearbook (volume III)-1952: U.S. Bureau of Mines publication, p. 206-240.

Martin, A.J. and Kelly, F.J., 1956, The mineral industry of Colorado *in* Minerals Yearbook (volume III)-1953: U.S. Bureau of Mines publication, p. 235-273.

Mote, R.H., 1946, Gold, silver, copper, lead, and zinc-Colorado *in* Minerals Yearbook-1944: Bureau of Mines publication, p. 301-326.

Munson, G.C., 1888, Colorado *in* Report of the Director of the Mint upon the production of precious metals in the United States during calendar year 1887: Director of the Mint Report, p. 148-194.

Munson, G.C., 1889, Colorado *in* Report of the Director of the Mint upon the production of precious metals in the United States during calendar year 1888: Director of the Mint Report, p. 94-133.

Naramore, C., 1907, Gold and silver - Colorado *in* Mineral Resources of the United States (part I)-1906: U.S. Geological Survey publication, p. 199-240.

Shenon, P.J. and Full, R.P., 1946, Akron Mine, Callahan Zinc-Lead Company, Tomichi mining district, Gunnison County, Colorado: unpublished report, OSM files.

Smith, M.E., 1891, Colorado *in* Report of the Director of the Mint upon the production of precious metals in the United States - 1890: Director of the Mint Report, p. 126-143.

Smith, M.E., 1892, Colorado *in* Report of the Director of the Mint upon the production of precious metals in the United States - 1891: Director of the Mint Report, p. 172-187.

Woodward, G.E. and Gustavson, S.A., 1947, Gold, silver, copper, lead, and zinc-Colorado *in* Mineral Yearbook-1945: U.S. Bureau of Mines publication, p. 310-341.

APPENDIX A
ABANDONED MINE INVENTORY FORM FOR THE AKRON MINE

USFS-AMLI FIELD DATA FORM WS

LOCATION AND IDENTIFICATION

(1) **ID#:** 02- 08- 04 - 07 - 378 / 4266 - 1
rgn st fst rd xutm yutm area#

(2) **Site name:** Akron Mine

(3) **Other name/reference:**

2 (4) **Highest priority Environmental Degradation occurring in this area:**
1=extreme; **2**=significant; **3**=potentially significant; **4**=slight; **5**=none

5 (5) **Highest priority Mine Hazard noted in this area:**
E=emergency; **1**=extreme danger; **2**=dangerous; **3**=potentially dangerous; **5**=no significant hazard

M (6) **Commodity: C**=coal; **U**=uranium; **M**=metals; **I**=industrial material.
(Metal or Indust. material type:)

(7) **Quad name and date:** Whitepine 1984

(8) **County:** GUNNISON

(9) **2° map:** MONTROSE

(10) **Water Cataloguing Unit #:** 14020003

(11) **Mining district/coal field:** WHITEPINE

(12) **Land survey location:** - - SE sec 34 ,T 50N ,R 5E

(13) **Receiving stream:** GALENA flowing into TOMICHI
nearest named stream next named

(14) **Elevation** (ft): 9700

1 (15) **General Slope: 1**=0-10°; **2**=11-35°; **3**=greater than 35°

M (16) **Regional terrain: R**=rolling or flat; **F**=foothills; **T**=mesa; **H**=hogback; **M**=mountains; **S**=steep/narrow canyon

G (17) **Type of access: N**=no trail; **T**=trail; **J**=jeep road; **G**=gravel road; **M**=paved road; **P**=private/restricted road

G (18) **Quality of access for construction vehicles: G**=good; **M**=moderate; **P**=poor; **X**=very poor

(19) **Nearest town on map:** Whitepine

0.2 (20) **Road distance from nearest town** (#.# miles)

(21) **Nearest road** (name and/or #): CR 888
FR=forest rd; **CR**=county rd; **SH**=state highway; **I**=interstate

Distance to following types of public uses (#.# miles):

0 (22) Road

\- (23) Dwelling (year-round)

\- (24) Campground/picnic area

(25) Marked trail

0.2 (26) Other public use (explain) TOWN OF WHITEPINE

ENVIRONMENTAL INFORMATION

D (27) **Vegetation density adjacent to site: D**=dense; **M**=moderate; **S**=sparse; **B**=barren

PA (28) **Vegetation type adjacent to site: B**=barren; **W**=weeds; **G**=grass; **R**=riparian **S**=sagebrush/oakbrush/brush; **J**=juniper/piñon; **A**=aspen; **P**=pine/spruce/fir; **T**=tundra

N (29) **Evidence of intentional reclamation: Y**=yes; **N**=no (if yes, use comments)

5 (30) **Size of disturbed area in acres**

Y (31) **Potential historical structures in area: Y**=yes; **N**=no (if yes, use comments)

N (32) **Positive evidence of BATS: G**=guano; **I**=insect remains; **B**=bat sighting; **O**=other(use comments); **N**=no (use comments to expand on any positive evidence;"No" only indicates absence of positive evidence, **not** absence of bats)

9/6/96 (33) **Recorded by/date:** JOHN NEUBERT

ADITS, SHAFTS, AND OPENINGS

Feature Nos.		100	101	102	103	104	105	106	107	108	109	110	111
Type of Feature		A											
Opening Size (ft)	H	-											
	W	-											
Depth (ft)		-											
Condition		F											
Drainage		W											
Access Deterents		N											
Deterent Condition		=											
Ratings	Env. Deg.	3											
	Hazard	5											
Photo	Roll No.	JN9											
	Frame No.	21											
Comments?		Y											

DUMPS, TAILINGS, AND SPOIL BANKS

Feature No.		200	201	202	203	204	205	206	207	208
Type of Feature		D								
Plan view Dimension (ft.)	L	1500								
	W	250								
Volume (yds)		120000								
Steepest Slope Angle (dgr)		38								
Steepest Slope Length (ft)		70								
Size of Materials		FSGL								
Cementation		U								
Vegetation Type		P, A								
Vegetation Density		S								
Drainage		W								
Stability		S								
Water Erosion	of Feature	G								
	Storm Runoff	C								
Wind Erosion		N								
Radiation Count		-								
Access Deterents		N								
Deterent Condition		-								
Ratings	Env. Deg.	2								
	Hazard	5								
Photo	Roll No.	JN9								
	Frame No.	23,24								
Comments?		Y								
Soil Sample No.										

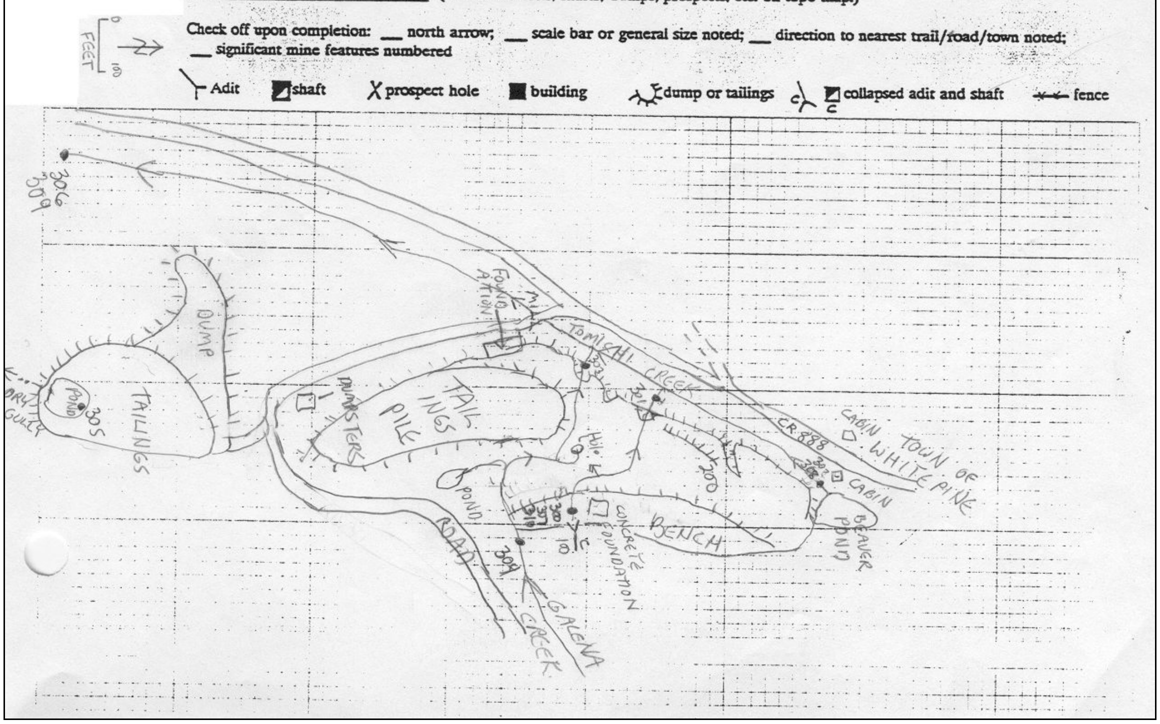
DRAINAGE/WATER SAMPLES							
Item Nos.	300	301	302	303	304	305	306
Adit/Shaft/Dump No./Other=0 (If other location, describe in comments)	100	200	200	200	200	200	200
pH (standard units)	7.19	7.76	7.80	8.21	7.92	7.92	7.82
Conductivity (uS)	340	339	134	261	260	1534	164
Flow (gpm)	100	100	800	15	100	—	800
Method of Flow Measure	E	E	E	E	E	—	E
Date Flow/Sample (m/d/y)	9/6/96	9/6/96	9/6/96	9/6/96	9/6/96	9/6/96	9/6/96
Location of Sample/Flow	A	C	RU	RD	RU	A	RD
Evidence of Toxicity in Site Drainage	N	N	N	N	N	N	N
Evidence of Toxicity in Receiving Stream	N	N	N	N	N	N	N
Distance from Stream (ft)	350	10	—	10	0	500	—
Comments?	Y	Y	Y	Y	Y	Y	Y
Lab Water Sample No.		SEE OTHER SIDE					

GPS READINGS		
Ftr. No.		Location
100	Lat.	38 32 19.8
	Long.	106 23 45.0
	Lat.	
	Long.	
	Lat.	
	Long.	
	Lat.	
	Long.	
	Lat.	
	Long.	
	Lat.	
	Long.	
	Lat.	
	Long.	
	Lat.	
	Long.	
	Lat.	
	Long.	
	Lat.	
	Long.	
	Lat.	
	Long.	

DIAGRAM OF PROBLEM AREA (Locate all adits, shafts, dumps, prospects, etc. on topo map.)

Check off upon completion: ___ north arrow; ___ scale bar or general size noted; ___ direction to nearest trail/road/town noted; ___ significant mine features numbered

Adit   shaft   X prospect hole   building   dump or tailings   collapsed adit and shaft   fence



No.	307	308	309	310
Adit/ other	100	100	100	100
pH	7.28	7.51	7.75	7.28
Conductivity	342	133	163	342
Flow	115	800	800	115
Method of Flow meas.	D	E	E	D
Date	9/9/96	9/9/96	9/9/96	9/9/96
Location	A	RU	RD	A
Toxicity in site	N	N	N	N
Toxicity in stream	N	N	N	N
Distance from stream	350	—	—	350
Comment	Y	Y	Y	Y
Wster sample no.	378/ 4266/ 1.307	378/ 4266/ 1.308	378/ 4266/ 1.309	378/ 4266/ 1.310

•81. Local person interviewed ______________________________
Name Address

•82. Name and address of person desiring a copy of this form: ______________________________

•83. Describe the minimum work needed to mitigate any public health, safety, welfare, or environmental problems observed at the site. Note specific reclamation activities along with an estimated cost and time period to implement each activity described. Code costs as: 1= less $10,000; 2= $10,000 to $100,000; 3= $100,000 to $500,000; 4= more than $500,000. Code estimated time to complete the activity as: 1= less than 1 month; 2= 1 to 12 months; 3= 1 to 3 years; 4= over 3 years

Cost	Time	Recommended reclamation activity
		DIVERT GALENA CREEK & CONTROL MINE DRAINAGE
		TO PREVENT ADDITIONAL EROSION.

•84. Comments relating to geology, health, safety, welfare, environmental, or restoration problems of a certain feature. All comments must be keyed to mine feature # or drainage/water sample item #.

Ftr.# 100 - COMPLETELY CAVED
300 - CLEAR WATER 301 - PHOTO 22 - PART OF MINE DISCHARGE MIXES WITH GALENA CK AND FLOWS DOWN HOLE IN DUMP SURFACE (SEE SKETCH MAP) MOST OF GALENA CK GOES DOWN HOLE, PART FLOWS ACROSS DUMP. 302 - FROM TOMICHI CK ABOVE WORKINGS. 303 - FROM FRACTION OF GALENA CK WHICH FLOWS ACROSS DUMP, TAKEN JUST ABOVE CONFLUENCE WITH TOMICHI CK. 304 - FROM GALENA CREEK ABOVE WORKINGS. 305 - FROM POND ON SOUTH END OF TAILINGS PILE. NO DISCHARGE, BUT DEEP EROSIONAL SCAR ON SOUTH SIDE OF POND INDICATIVE OF INTERMITTENT DISCHARGE. 306 - FROM TOMICHI CREEK BELOW WORKINGS,
200 - MARBLE AND GRANITE - ABUNDANT CHALCOPYRITE, MINOR BORNITE, AND BRIGHT GRAY METALLIC (ARSENOPYRITE?) NOT GALENA! AS SHOWN ON SKETCH, ABOUT 1/3 TO 1/4 OF DUMP IS TAILINGS WITH STRONG SULFUR SMELL. NORTHERN TAILINGS ARE PILED ABOVE DUMP LEVEL. DUMP, & ESPECIALLY TAILINGS ARE USED BY MOTORCYCLES.

307 - WATER SAMPLE AT 300, PORTAL OF AKRON MINE
308 - WATER SAMPLE AT 302, TOMICHI CK UPSTREAM FROM DUMP
309 - WATER SAMPLE AT 306, TOMICHI CK DOWNSTREAM FROM DUMP
310 - DUPLICATE OF 307, UNFORTUNATELY - DIFFERENT FILTER TYPE

-if more comments use back of page →

General Comment (on whole inventory area or group of mine features): ______________________________

-if more comments use back of page →

OFFICE/LITERATURE INFORMATION

•41. Owner of surface ______________________________
•42. Last known operator ______________________________
•43. Estimated production ______________________________
•44. Dates of production ______________________________
•45. Literature not cited in comments ______________________________
•46. Citation of any historical register listing ______________________________

CODES FOR TABULAR INFORMATION

ALL TABLES: If appropriate code is not listed, use: **N** = none or no; **N/A** = not applicable; **UNK** = unknown; **O** = other, explain in #84

ADITS, SHAFTS, & OPENINGS

- Type of feature: **A** = adit; **S** = vertical shaft; **I** = incline shaft; **P** = prospect hole; **ST** = stope; **G** = glory hole; **SU** = subsidence feature; **PT** = open pit; **O** = other, explain in #84.
- Condition: **I** = intact; **P** = partially collapsed or filled; **F** = filled or collapsed; **N** = feature searched for but not found (mine symbol on map)
- Drainage: **N** = no water draining; **W** = water draining; **S** = standing water only (note at what depth below grade)
- Access deterents: **N** = none; **S** = sign; **F** = fence; **C** = sealed or capped; **D** = open door or hatch; **L** = locked door or hatch; **G** = open grill; **O** = other, explain in #84.
- Deterent condition: **P** = prevents access; **D** = discourages access; **I** = ineffective
- Ratings: Hazard: **E** = emergency; **1** = extreme danger; **2** = dangerous; **3** = potential danger; **5** = no significant hazard
  Env. Deg.: **1** = extreme; **2** = significant; **3** = potentially significant; **4** = slight; **5** = none
- Comments?: **Y** = yes; **N** = no

DUMPS, TAILINGS, AND SPOIL AREAS

- Type of feature: **D** = mine dump; **T** = mill tailings; **W** = coal waste bank; **S** = overburden or development spoil pile; **DS** = dredge spoil; **HD** = placer or hydraulic deposit; **H** = highwall; **P** = processing site
- Size of materials: **F** = fine; **S** = sand; **G** = gravel; **L** = cobbles; **B** = boulders
- Cementation: **W** = well cemented; **M** = moderately cemented; **U** = uncemented
- Vegetation Type: **G** = mixed grass; **S** = sagebrush/oakbrush/brush; **J** = juniper/piñon; **A** = aspen; **P** = pine/spruce/fir; **T** = tundra; **R** = riparian; **F** = tilled crops; **B** = barren/no vegetation; **W** = weeds
- Vegetation Density: **D** = dense; **M** = moderate; **S** = sparse; **B** = barren
- Drainage: **N** = no water draining; **W** = water draining across surface; **S** = standing water only; **SP** = water seeping from side of feature
- Stability: **U** = unstable; **P** = potentially unstable; **S** = stable
- Water erosion: of Feature: **N** = none; **R** = rills; **G** = gullies; **S** = sheet wash
  Storm Runoff: **C** = in contact with normal stream; **S** = near stream or gully, but only eroded during storm or flood; **N** = no storm/flood runoff erosion
- Wind erosion: **N** = none; **D** = dunes; **B** = blowouts; **A** = airborne dust
- Radiation Count: **N** = none taken; record value of reading if taken
- Access deterents: **N** = none; **S** = sign; **F** = fence; **O** = other, explain in #84
- Ratings: Hazard: **E** = emergency; **1** = extreme danger; **2** = dangerous; **3** = potential danger; **5** = no significant hazard
  Env. Deg.: **1** = extreme; **2** = significant; **3** = potentially significant; **4** = slight; **5** = none
- Comments?: **Y** = yes; **N** = no

DRAINAGE/WATER SAMPLES

- Adit/Shaft/Dump No./Other: Indicate Feature No. associated with water information; **0** = other, explain in comments
- Flow (cfs): record seeps as 0.01 cfs (Rule of Thumb: a cfs= one full-blast garden hose)
- Method of flow measure: **E** = estimate; **T** = bobber/stopwatch/x-section; **W** = weir; **D** = catchment; **F** = flow meter
- Location of sample and flow: **A** = immediately adjacent to adit/shaft; **B** = below dump/tailings; **C** = immediately above confluence with receiving stream; **SW** = standing water in/on feature; **RU** = receiving stream upstream of feature; **RD** = receiving stream dowmstream of feature;
- Evidence of toxicity: **N** = none; **A** = absence of benthic organisms; **W** = opaque water; **P** = yellow or red precipitate; **S** = suspended solids; **D** = salt deposits
- Comments?: **Y** = yes; **N** = no

APPENDIX B

WATER SAMPLING PROTOCOLS AND QA/QC RESULTS

AT SAMPLE SITE:

1. **Calibration**

Check pH and conductivity meter calibration. Re-calibrate if necessary. Log date, time, and calibration results into field notebook.

2. **Data Sheet**

Begin completing a Water Sample Data Sheet. Perform requisite measurements of GPS location, pH, conductivity, temperature, physical description, etc.

3. **Water Sample**

1) Put on gloves.

2) If sub-sampling at a location other than the sample site, rinse a clean, unused 1000-mL sample bottle with the sample water *3 times*. Then fill it with sample water. If flow at the site is too low to allow using the sample bottle without stirring up the bottom sediment, use a syringe **--rinsed with sample water 3 times** to transfer the water into the sample bottle. *Do not touch the inside of the bottle, the lid, or the sample water.*

3) Label the 1000-mL bottle with the sample number. If a syringe is used to transfer sample water into the sample bottle, the same syringe can be used for the subsequent sub-sampling of this sample. Therefore, return the syringe to its packaging and label the packaging with the sample number as well. Place the labeled syringe into a ziplock bag.

4) Place sample bottle(s) and any syringes to be re-used for sub-sampling into separate ziplock bags.

4. **Flow measurement or estimation**

After sampling and/or on-site subsampling is complete, use a flume to measure the volume of flow. In many cases, use of a flume is not practical. A flowmeter may be a viable option in larger streams. In small streams or streams with a steep gradient, using a liter bottle or 5-gallon bucket as a catchment may be effective. Depending on site conditions, these methods should be accurate to within about 20%. Estimation of flow is the last alternative, if the other options are not practical.

<u>AT THE SUBSAMPLING LOCATION:</u>

1) Label each sub-sample bottle <u>before</u> beginning the subsampling procedure.

Record the following:

1) Name of sample site
2) Sample number
3) Subsample type
   The subsamples will be one of the following:
   a) Filtered metals, acidified (FMA)
   b) Unfiltered metals, acidified (MA)
   c) Unfiltered unacidified (NEUT)
4) Time
5) Date

2) Put on gloves and safety goggles.

3) Begin subsampling:

A) **<u>Unfiltered metals acidified (MA) sample</u>**
This sample **<u>is not</u>** filtered, and has acid added. It is for analysis of total metals (**Note:** If the samples are to be sent to the State Inorganic Laboratory or to Analytica Laboratory, acid will not be added in the field. It will already be in the FMA and MA bottles).

1. **(Perform this step only if the laboratory has not added acid to the bottle)**
   Rinse the new acid-cleaned, 250-mL, MA plastic bottle with 10-20 mL of raw sample water three times.

2. After shaking the 1000-mL sample bottle to adequately mix any sediment or suspended material, pour the water into the 250-mL "MA" subsample bottle to just below the neck of the bottle.

3. **(Perform this step only if the laboratory has not added acid to the bottle)**
   Add 20 drops of concentrated (16 molar) nitric acid to this sample if the pH is greater than 4.5. If pH is less than 4.5 only ten drops are needed. (must be preserved to a pH=2 or lower, so if sample is very basic, more nitric acid may be required) **<u>Use care when working with nitric acid.</u>**

4. After tightly securing the lid, lightly shake the bottle to mix the acid with the subsample.

B) **<u>Filtered metals acidified (FMA)</u>**

This sample is filtered and has acid added. It is used for analysis of dissolved metals (**Note:** If the samples are to be sent to the State Inorganic Laboratory or to Analytica Laboratory, acid will not be added in the field. It will already be in the MA and FMA bottles).

1. Put on new gloves (only if necessary)

2. Rinse a new 60-cubic centimeter (cc) syringe (or, if a syringe was used on site, rinse and re-use this syringe) by drawing in 10 mL of raw sample water. Then pull up on the syringe so that the entire syringe barrel can be exposed to the 10 ml of sample. Shake, discard and repeat twice. Then fill the syringe with sample water from the 1,000-mL bottle. Purge the syringe of any air bubbles to prevent an "air-lock" in the filter.

3. Rinse a new 0.45 μm disposable filter, by attaching the filter to the rinsed syringe and forcing 20 cc of sample water through the filter. Point the syringe away from the subsampling area.

4. **(Perform this step only if the laboratory has not added acid to the bottle)**
   Rinse the new, acid-cleaned, 250-mL FMA plastic bottle with 10 mL of filtered sample water three times.

5. Filter sample water into a new, acid-cleaned, 250-mL FMA plastic bottle. Fill the bottle to just below the neck of the bottle. If pushing water through the filter becomes difficult, place the syringe with the filter into a caulking gun (covered with plastic tape). The filter should be outside the end of the gun with the syringe barrel inside the gun. If filtering in the caulking gun becomes difficult, attach a new filter. Rinse this filter with 20 mL of sample, and then resume filtering into bottle.

6. **(Perform this step only if the laboratory has not added acid to the bottle)**
   Add 20 drops of concentrated (16 molar) nitric acid to this sample if the pH is greater than 4.5. If pH is less than 4.5 only ten drops are needed. (must be preserved to a pH = 2 or lower, so if sample is very basic, more nitric acid may be required) **<u>Use care when working with nitric acid.</u>**

7. After tightly securing the lid, lightly shake the bottle to mix the acid with the subsample.

C) **Unfiltered unacidified sample (NEUT)**
This sample is **not** filtered and does **not** have acid added. It is used for analysis of anions.

1. Put on new gloves (only if necessary)

2. Rinse a new, **non**-acid cleaned, 250 mL "NEUT" plastic bottle three times with about 10 mL of sample water and discard.

4. Pour sample water into the "NEUT" bottle to just below the neck of the bottle. Preserve by refrigeration (at 4º C) in a cooler.

D) **Alkalinity Determination**-(Only performed on samples with a pH of 4.5 or greater.)

1. Use a CHEMetrics, Inc. K-9810 (10 to 100 ppm) or K-9815 (50-500 ppm) total alkalinity titration kit.

2. Fill a syringe from the 1,000 mL bottle and inject 20 mL of sample water through a 0.45 μm filter into the small cylinder supplied with the kit.

3. Add six drops of actuator solution to the filtered water sample. The actuator solution will cause the sample water to become green.

   Note: The water is turned green, titrated to pink/red, and then to green again, at which time the meniscus is read. See below.

4. Attach the soft, pliable end of the short tubing piece to the ampule.

5. Break the scored tip of the ampule by hand and insert it into the device supplied in the titration kit. This device allows the user to admit small volumes of sample water into the evacuated ampule.

6. Immerse the stiff end of the tubing in the sample water.

7. Carefully add sample water to the ampule until a pink/red color appears. This is done by pressing the control bar on the device supplied with the titration kit, which squeezes the plastic ball in the pliable tubing. Mix the solution thoroughly in the ampule between additions. Add sample water until the solution just turns green.

8. After the solution turns green, invert the ampule and read the number at the meniscus. This number is the alkalinity as calcium carbonate expressed as milligrams per liter (mg/L) or ppm of $CaCO_3$. Multiplying by 1.2 will

convert this to mg/L bicarbonate alkalinity. Multiplying the bicarbonate alkalinity by 1.2 gives the bicarbonate ion (HCO_3^-) component in mg/L.

QA/QC Samples

Field duplicate sample - A field duplicate is an independent sample of the original media (water, solids), collected at the same time and same location as the original sample. Preferably, the sample is a blind duplicate, which is submitted with a surrogate sample number, with the actual sample number known only by CGS. This sample is used to confirm the reproducibility of the analytical results.

Laboratory duplicate sample - A laboratory duplicate is an internal QA/QC sample, selected by the laboratory, and consists of a split from a sample received by the laboratory. The laboratory uses the duplicate to confirm the reproducibility of the analyses.

Equipment Blanks - Are created by reproducing the entire sampling process with de-ionized water (reagent grade). Equipment blanks are also submitted blind with a surrogate sample number, to test for contamination by sampling equipment such as syringes and filters. Clean, unused sampling equipment should be used.

Trip Blanks - Are identical to equipment blanks, except they are collected at the very start of the sampling program, and the blank accompanies the samples from start to finish of the sampling program. Trip blanks are also submitted blind with a surrogate sample number, to test for cross-contamination between samples during storage and transport.

QA/QC RESULTS

Samples were analyzed by Analytica Laboratory in Thornton, Colorado. This is a USEPA certified laboratory and follows QA/QC procedures required by the USEPA. The report of analytical results includes Quality Assurance/Quality Control (QA/QC) data. The QA/QC data, at a minimum, includes: instrument check standards [CCV] (% recovery), reference samples (% recovery), spikes (% recovery), and duplicates (relative % difference). These QA/QC tests will be done at a minimum of 10% frequency or once per batch. Original laboratory QA/QC documentation may be viewed, upon request, at the CGS offices.

One duplicate sample was collected (AKRMH-02-8, a duplicate of AKRMH-02-7). Comparisons of the two samples are within acceptable tolerances.

An internal method blank run by the laboratory detected total recoverable aluminum at a concentration of 0.713 μg/L. However, the concentrations of aluminum at the site are all well below Colorado water quality standards, so this is not regarded as a concern.

ANALYTICAL METHODS

USEPA Method 200.8 (ICP/MS – Inductively Coupled Plasma/Mass Spectrometry) was used to analyze most parameters (dissolved aluminum, cadmium, calcium, chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, silicon, silver, sodium, uranium, and zinc, and total recoverable aluminum, antimony, arsenic, iron, and thallium). Dissolved mercury was analyzed by USEPA Method 245.1 (Cold Vapor Atomic Absorption). USEPA Method 300.0 (Ion Chromatography) was used for chloride, fluoride, and sulfate.