# Tri-State Zinc-Lead District: From Bonanza to Superfund

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## Introduction: Early Prospecting Methods in the Tri-State Mining District

The Tri-State mining district of Kansas, Missouri, and Oklahoma extends 160 km from east to west and 48 km from north to south with most production from Cherokee County, Kansas; Jasper and Newton Counties, Missouri, and Ottawa County, Oklahoma (Brockie et al., 1968; Fig. 1, Brichta, 1960). Approximately 4000 mines produced 50% of the zinc and 10% of the lead used by the United States from 1850 to 1950 (Stewart, 1986). Ore production as of 1964 was 22,639,000 tons of zinc concentrates and 3,732,000 tons of lead concentrates from 500,000,000 tons of rock which were valued at $2,051,192,000 after smelting (Brockie et al., 1968). Before companies such as Asarco Inc., American Metals Co., DuPont Chemical Co., Eagle-Picher Co., National Lead Co., St. Joe Lead Co., U.S. Mining, Smelting and Refining, U.S. Steel, and U.S. Zinc conducted profitable commercial mining operations in the area that became known as the Tri-State mining district, the efforts of many prospectors and ventures involving only a few miners, opened the way for lead and zinc mining that continued for 123 years (Stewart, 1986).

The knowledge of how to prospect in a region that contained widespread, low-grade deposits grew with time. Many of the first prospectors were farmers who used converted farm implements as prospecting tools to search for lead ore on their own property (Laas et al., 1986). Some methods, commonly developed in Tri-State by experienced miners and prospectors from other mining regions, laid groundwork for modern mining exploration techniques. By the turn of the century, mechanization and large company ownership took the place of the individual or pair of prospectors with shovels, a converted plow, a windlass, or a horse-drawn hoist (Ritchie, 1988) in the exploration for lead and zinc ores throughout the Tri-State region.

Haworth (1904) attributes miners, William Tingle and Daniel Campbell with the first lead mining operations in the area. William Tingle, who owned a farm two miles east of Joplin, Missouri, brought David Campbell to prospect on his farm in 1848. Campbell, an experienced miner from Washington County, Missouri, examined the topography and located galena close to the surface (Renner, 1985). Tingle recovered 100 pounds of galena from the spot. The new prospect grew into the mining camp of Leadville. A year later Campbell discovered galena within the city limits of Joplin (Haworth, 1904). In view of David Campbell's experience in other Missouri lead fields, John Cox showed Campbell a rock with bright edges from his farm (Shaner, 1948). Campbell smelted lead from the rock to prove the importance of the find. By 1850, approximately 100 persons prospected the surrounding area of the Kansas City Bottoms, which is part of present-day Joplin (Gibson, 1972). Cox searched for additional ore by blasting, and new prospectors merely dug frantically in random places (Shaner, 1948).

The Granby mining field was established concurrently with the Joplin field. In 1850, William Foster sank an exploratory shaft near the Madison Vickery home, after the discovery of lead ore during the digging of a water well (Lasmanis, 1989). Buckley and Buehler (1906) report that prospectors found ore at the surface

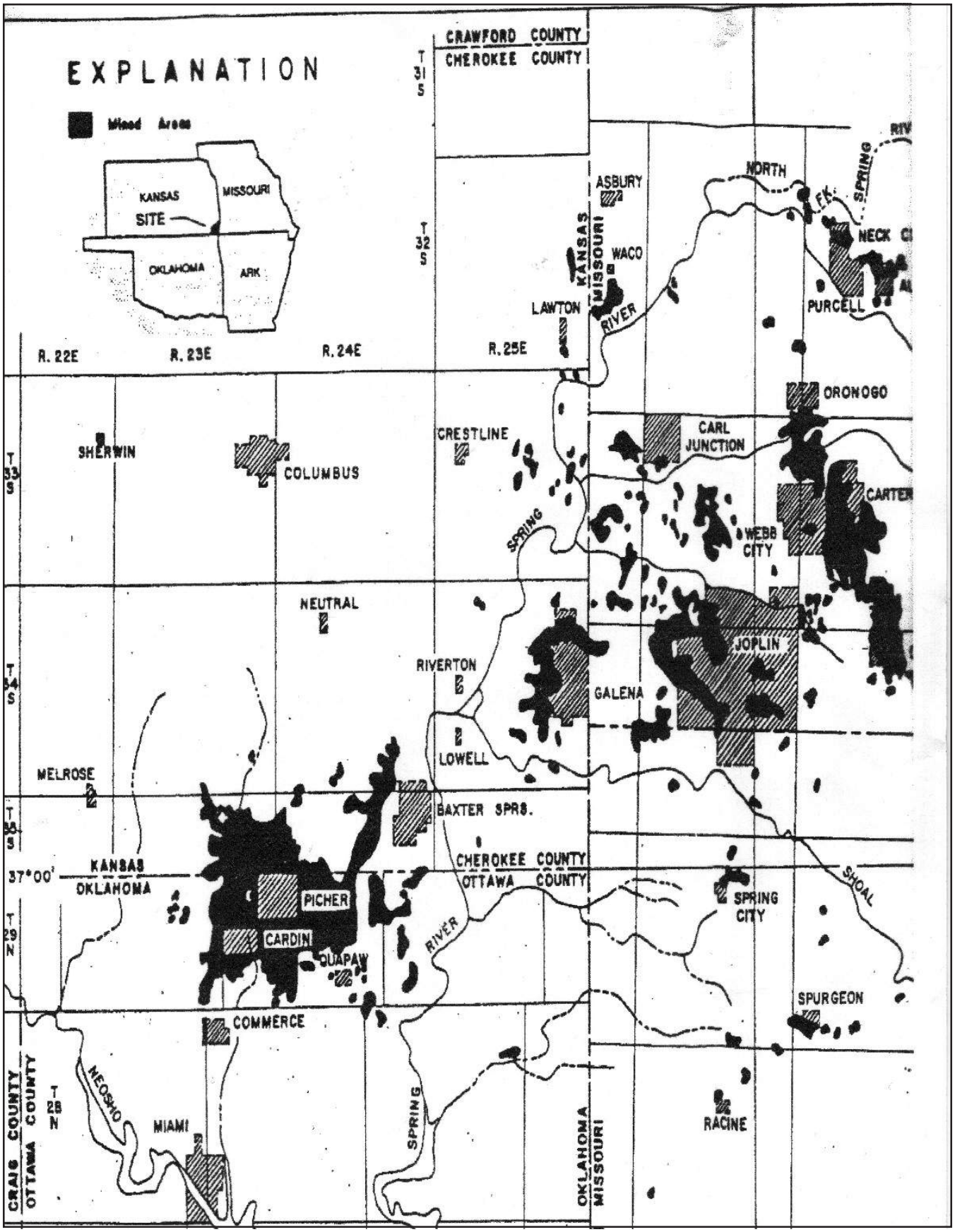


*Figure 1. Western part of the mined areas of the Tri-State Zinc-Lead District (Brichta, 1960).*

and also entangled in grass roots, just below the surface, to a depth of 215 feet in the Granby district. Attention to topography was a prime exploration tool here, because ore followed the sides of pre-Pennsylvanian age valleys with Pennsylvanian strata draped gently over them (Buckley and Buehler, 1906). Andrew McKee and Thomas Livingston prospected the Minersville area north of Joplin, later known as Oronogo, in 1851. Sphalerite and galena occurred at the site, but only the lead ore was valued at this time. Local people collected galena that occurred at the surface at Oronogo as early as 1838 and used it for shot, according to Gibson (1972). Mining companies, such as the Center Valley Mining Company, incorporated in 1897, looked for areas of float or ore picked up at the surface as indication that more could be found below the surface (Ritchie, 1991).

Stream beds and adjacent land in Cherokee County, Kansas, were valuable for exploration, just as in Missouri. Shoal Creek was a focus for prospecting after ore was found at the surface where the stream had cut into Mississippian strata. In the valley it was found in roots of uprooted trees, or plowed up by farmers. Prospectors, convinced that more lead ore could be found near Shoal Creek, sank exploration shafts and found large quantities of ore at 15-20 feet depth and also at Short Creek northwest of Galena (Haworth, 1904).

Exploration shafts were the main tools for evaluating prospects throughout the mining district. An exploration shaft was a vertical passageway for transporting to the subsurface tools, timbers, explosives, and miners, for hauling out dirt, and for supplying air for the prospectors (Ritchie, 1994). The dimensions of the early shafts were approximately 1.6 m by 2 m. A map showing 290 prospecting and mining shafts along Joplin Creek accompanied G.C. Broadhead's 1874 *Report of the Missouri Geological Survey*. In 1877, the Center Creek Mining Company leased 200 acres, purchased from John C. Webb, to prospectors who sank 130 shafts and produced over $5.5 million worth of lead and zinc ore in the Webb City, MO field (Ritchie, 1992). Fowler (1943) states that approximately 30,000 drill holes reaching depths as great as 155 m were used to randomly prospect the region. The chief hindrance to deep prospect shafts was shallow subsurface water that invariably filled the shafts at 10 m depth.

As an understanding of the relationship of country rock to ore deposits grew, prospectors sank shafts along sinkholes, ravines, and valleys formed by subsidence. Jasperoid, which frequently hosted the ores, occurred in the low-lying places, whereas limestone formed the hills. The prospectors expected to find little ore in limestone, but would sink shallow shafts through it at marginal areas to strike jasperoid and ore beneath. In contrast to this line of thinking, prospectors in Kansas east of Galena, sank shafts in the hilltops after a rich ore deposit in the Nevada shaft was established on higher ground (Hornbaker, 1952). In Bureau of Mines Circular 7993, Brichta (1960) described a method known as shale drilling. Because ore deposits were commonly found adjacent to shale basins or slumps, rows of holes were drilled to define the contact between the Cherokee Shale and the Boone Limestone. An isopach map drawn from drill hole data, revealed where shale dipped into a slump and a paying prospect shaft might be sunk in the ore-rich shale within the collapsed strata.

Another indicator was open ground, so-named because ore at the surface occurred either as pebble ore (individual crystals) or finely disseminated grains in secondary flint. Haworth (1904) indicates that adjacent to the open ground, stratified ore was usually present in either dolomite or jasperoid. In addition, if a prospector found voids in the wall rock containing black mud and water, he continued to seek lead ore (Haworth, 1904). Galena crystals often lined the walls of these black mud-filled cavities. If the mud was light-colored, the best ore he could expect was sphalerite, which was usually discarded in the early mining years in Tri-State.

Prospecting was a serious part of developing the Tri-State mining district. Precursors to modern exploration techniques for locating ore deposits included observing and recording surface topography, understanding the relationship of the desirable ores to types of host rocks, and thousands of drill holes and prospect shafts. Events that contributed to the prospecting boom in the Tri-State region were the extension of the St. Louis-San Francisco Railway through southwest Missouri and into eastern Kansas, and establishment of a lead smelter in eastern Kansas (Brichta, 1960). These conveniences made mining more cost effective. In contrast to the early years when farmers became prospectors and used converted farm gear, turn-of-the-century prospecting and mining in the Tri-State mining district became more mechanized, methodical, and effective. Large companies prospected with modern equipment and methods to sink as many shafts in the ground as possible in search of lead ore and the prosperity it brought.

## Tri-State Zinc-Lead District Superfund Site

The Tri-State Mining District spans an enormous area of 2,500 square miles in southeast Kansas, southwest Missouri, and northeast Oklahoma. Over 100 years of world-class, zinc-lead mining (middle 1800s to 1971) yielded substantial volumes of ore at great profit for those involved in the mining, milling, and smelting activities. Present day, post-mining conditions are markedly different from the past in many aspects, especially in terms of socioeconomic conditions and the environment.

Vast areas of land are devoid of vegetation, contain millions of tons of mining wastes, and exhibit elevated concentrations of several heavy metals. The subsurface houses substantial mine workings that are now flooded and contain elevated levels of heavy metals that are pervasive throughout the upper groundwater system rendering this resource unfit for drinking water consumption in many areas. Many streams and drainages contain elevated levels of heavy metals in surface water that are also present in sediments; entire drainage basins are affected and acid mine drainage is prevalent in many locations. Aquatic and terrestrial species have been impacted by the burden of heavy metals resulting from past mining activities. Large areas of ground are unstable and many collapse and subsidence features continue to develop over time. There are thousands of open shafts, wells, and drill holes in the three state area associated with the former mining district. Many unstable ground areas are in proximity to population centers thus causing impacts to roads, homes, utility lines, and businesses. Many former smelters deposited metals-laden airborne fallout over wide areas that now house many people. The general socioeconomic state of the former district is poor. Many areas are characterized by high unemployment, low wages, substandard housing in certain locations, and generally low status. Children under the age of six in former mining district counties within each of the three states have blood lead levels that are elevated above national norms. The Tri-State Mining District has undergone a stark transition from the prosperous times of the past. The U.S. Environmental Protection Agency (EPA) has conducted environmental cleanups under the Superfund program in each of the three states of Kansas, Missouri, and Oklahoma in the former Tri-State Mining District (district) area. There are a total of three EPA sites in the former district that are on the National Priorities List (NPL) of the most hazardous sites in the United States. These NPL sites include the following: the Cherokee County Superfund Site in Kansas; the Oronogo-Duenweg Mining Belt (Jasper County) Site in Missouri; and the Tar Creek Site in Oklahoma. Additional non-NPL Superfund work is being conducted in Newton County, Missouri, immediately south of Jasper County within the district. Several future cleanups are planned and many former companies have participated in the past actions as responsible parties. Environmental response costs to date total several hundred million dollars and much additional work remains. Future natural resource damages for the entire area will likely be immense. The sum of all past and future environmental response actions and natural resource damages may well exceed the benefit derived during more than a century of mining. The environmental work will continue decades into the future. Actions completed to date include the following: the excavation of residential soils impacted by mining/milling wastes and smelter fallout; excavation, regrading, and re-vegetation of surficial mine waste areas; removal of impacted sediments; draining and capping tailing impoundments; filling mine shafts and subsidence features; abandonment of wells; and the provision of new drinking water sources. Environmental cleanups in all three states include the following totals: over 5,000 residential properties excavated and soils replaced; over 1,000 acres of mining wastes restored and re-vegetated; over 1,000 hookups to new sources of drinking water inclusive of drilling and installing new municipal wells; several hundred shafts, wells, and subsidence areas filled; over 30 acres of drained/capped tailing impoundments; sediment removal from several thousand feet of drainages and channels; and the construction of thousands of feet of dikes and erosion control structures.

## Road Log

Leave KCI Hilton Hotel at 7:00 AM.
Some historical and natural points of interest along the road are listed below (Fig. 2).

**Mileage/Points of Interest**

29.5 Cross the Missouri/Kansas border at the Missouri River. The entire broad floodplain was under water during the Great Flood of 1993. The northbound lanes of I-635 were destroyed by floodwaters and a scour hole on the east side of the highway remains.

69.3 LaCygne Generating Plant co-owned by Kansas City Power and Light Company and Kansas Gas and Electric Company to the East of the highway. The Mulberry coal was formerly mined from an 8,000-acre tract of land adjoining the generating plant. Sphalerite occurs in seams and cleats of the coal. Because of the high sulfur content of the coal, it is no longer mined here or used to generate electricity.

74.9 Maris de Cygne Waterfowl Preserve to the west is an important area for birds migrating along the Central Flyway. The lowland along the east of the highway is commonly flooded also and serves as temporary feeding area for birds.

75.8 Trading Post was originally established in 1834 as a French trading post. A Civil War era cemetery and historical buildings are visible from the highway. During the Civil War, galena was found in rock at the Maris de Cygne River by women doing the wash. The hills are outliers from the escarpment to the west capped by the Hertha, Swope, and Dennis Limestones (Buchanan and McCauley, 1987).

76.3 Maris de Cygne River, meaning marsh of swans, is the third largest river in Kansas.

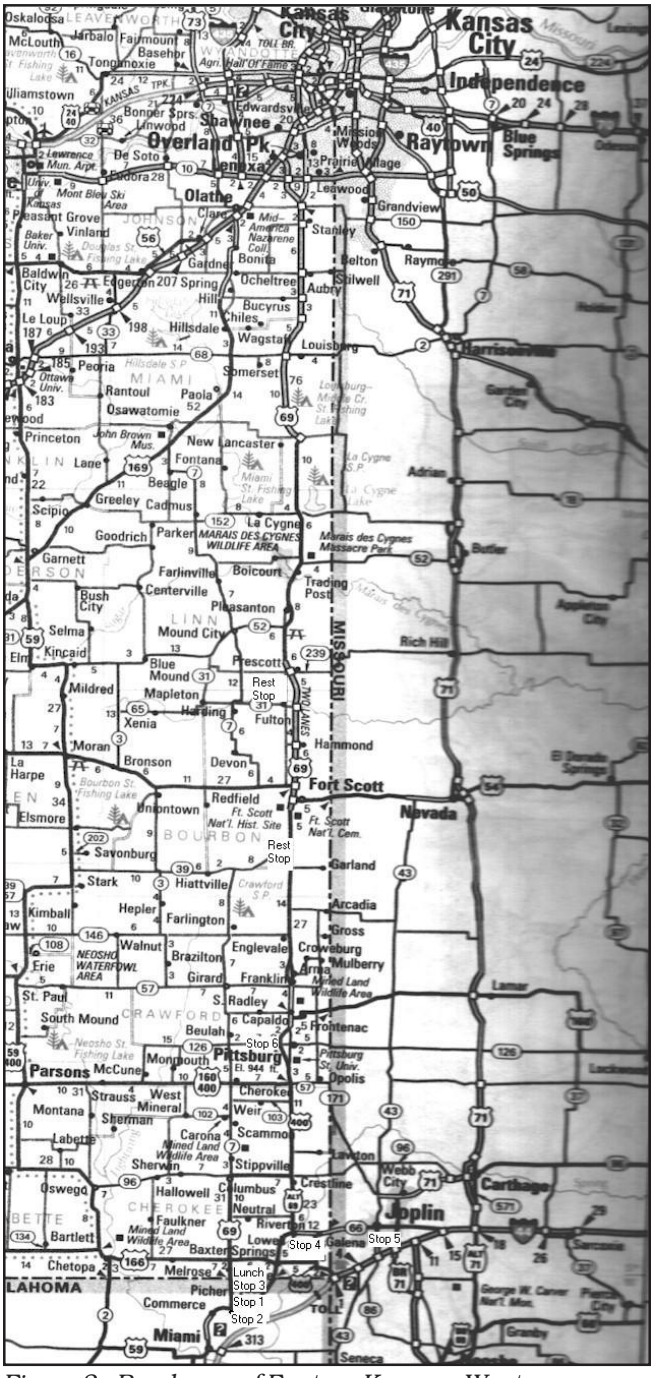


*Figure 2. Road map of Eastern Kansas, Western Missouri, and Northern Oklahoma with field stops.*

77.1 Big Sugar Creek adds to the marshland of the area.

83.4 Mine Creek Battle site commemorating the largest Civil War battle in Kansas is maintained by the Kansas Historical Society. Mine Creek flows near a lead/zinc mine known by Native Americans and French Explorers that was later called the Big Jumbo Mine. The Jumbo near Pleasanton, Kansas, was mined sporadically since the 1840's. It was plagued by seeping gas with at least one major explosion. In 1901, fifteen tons of high grade ore were shipped to Kansas City for refining. Later studies including petrographic examination, x-ray diffraction analysis, and fluid inclusion studies indicated sphalerite, galena, and other mineralization from this mine are identical to those in the Tri-state mining district (Blasch, 1986).

86.3 This roadcut exposes the Ladore Formation, overlain by the Swope Fomation consisting of the Middle Creek Limestone, Hushpuckney Shale, and Bethany Falls Limestone. It is a high point at the northern edge of the Cherokee Lowlands Physiographic Province.

89.1 Prescott, Kansas. East of the town is a zinc-lead deposit discovered in 1945 when a coal stripping operation struck what was described as a solid chimney containing sphalerite and galena. When notified of the find, Eagle-Picher Mining Company dug a 61 m diameter exploration pit 9 m in depth to the Pawnee Limestone. Mining was never pursued and the water-filled pit is now surrounded by strip mine poil banks. Petrographic examination, x-ray diffraction analysis, and fluid inclusion studies indicated sphalerite, galena, and other mineralization in this deposit originated with fluids that mineralized the Tri-state mining district (Ragan, 1994).

91.0 Linn/Bourbon County line

93.0 Osage River

103.9 Marmaton River

104.2 Fort Scott National Historic Site. Military barracks and parade grounds are visible from the highway. The Fort was established as an army post in 1842 along a military road on the frontier that ran along the eastern edge of Kansas. The fort was abandoned in 1855 but reopened as a supply base for Union soldiers during the Civil War.

106.4 **Rest Break at McDonald's in Fort Scott - 9:30 - 10:00AM**

129.6 Pittsburg, Kansas – Extensive coal strip-mined area in the Weir-Pittsburg beds. Chicken restaurants are a remnant from the mining era when a favorite lunch for miners was fried chicken.

131.7 Field office of the Kansas Department of Health and Environment – manages reclamation programs in the coal-mining region and provides technical support for Superfund projects.

132.7 Crawford County Historical Museum, shovel used in strip mining is on display. Pittsburg was founded in 1876 on lands held by the Cherokee Indian Nation.

136.7 The Robb Prairie - one of the parcels of land being reclaimed with prairie grass.

139.5 Crawford/Cherokee County line.

147.4 North boundary of the Cherokee County Superfund Site (Fig 3). This Tri-State Mining District remediation site represents the Kansas portion of the district and spans 115 square miles. The site is subdivided into sub-sites and operable units.

150.6 Community of Crestline. Crestline is a sub-site of the Cherokee County Superfund site and is combined with the Badger, Lawton, and Waco sub-sites to comprise Operable Unit #06 (OU-

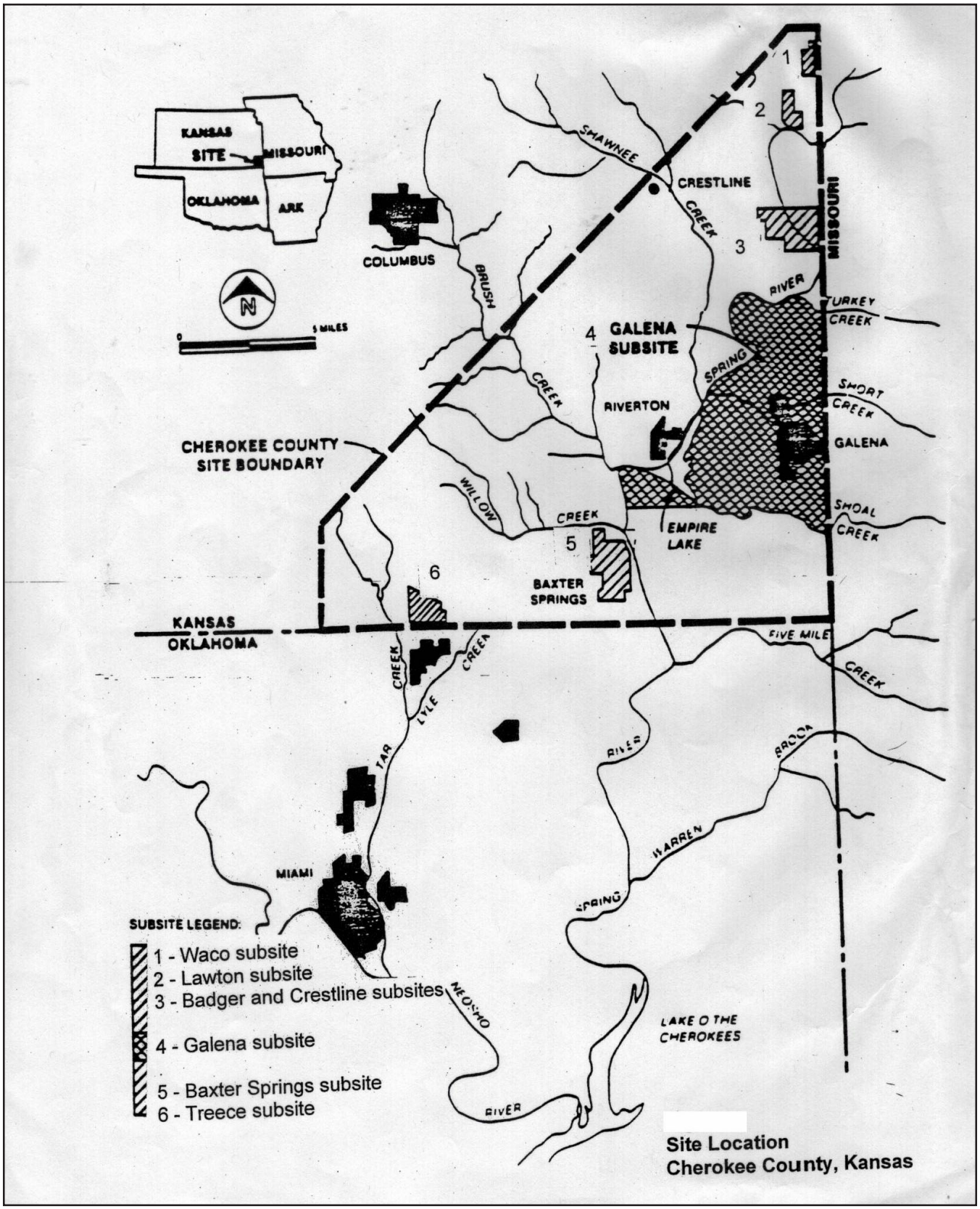


*Figure 3. Environmental Protection Agency Superfund remediation area in Cherokee County, Kansas. The nearly triangular Superfund site location is outlined with a dashed line.*

6) of the site. A feasibility study report outlining potential remedial alternatives for OU-6 is in draft format.

161.2 Baxter Springs (11:15 AM). Baxter Springs is Operable Unit #03 (OU-3) of the Cherokee County Superfund Site and will be the subject of a field stop after lunch. Baxter Springs has a colorful history as a cattle drive town and as the target of an attack in 1863 by the infamous Quantrill's raiders on the army barracks resulting in 63 deaths. Lead and zinc mining and production began in 1906 and ended in 1961. More recently it enjoys the resurgent popularity of location on Route 66 that connects Los Angeles and Chicago.

168.1 Blue Mound, a sandstone capped hill is the topographic high for Cherokee County.

168.7 First view of large chat piles. According to x-ray diffraction analysis (Drake, 1999) mineral content of chat is approximately as follows:

| **Mineral** | **Percent** |
|---|---|
| Quartz | 65-73 |
| Dolomite | 11-18 |
| Calcite | 7-15 |
| Hemimorphite | 1-10 |

169.0 Kansas/Oklahoma state line. Picher, Oklahoma (Fig. 4). The boyhood home of Mickey Mantle. Extensive chat piles and mining wastes are in close proximity to houses; recreation vehicle trails crisscross the chat piles.

169.8 West on E. 20 Road. Boulder-sized mine waste and overburden piles (locally called bullrock) and chat piles are near the roads.

170.2 Remnant mining structures line the road and adjacent properties.

170.6 **Field Stop 1** - **Approximately 11:45AM - 12:15PM -** Picher-Cardin sub-district chat piles, waste rock, tailings impoundments. Opportunity to collect Tri-State Mining District specimens.

172.2 Lytle Creek – Note the stream is clear at this location.

174.1 **Field Stop 2 – Approximately 12:30-12:45 PM -** Confluence of Lytle Creek and Tar Creek. Note the red-orange stained, overbank sediments and surface water. A recent pH test of the water at this location indicates a value of 6.3.

186.7 **Lunch - 1:00 - 2:00 PM -** Café on the Route: A unique dining and lodging experience on Historic Route 66. The restaurant was the former Baxter Bank that was robbed by the notorious Jesse James in 1876. **Slide presentation:** Overview of the EPA Environmental Remediation at the Baxter Springs Sub-site of the Cherokee County Superfund Site - Dave Drake.

188.9 **Field Stop 3 - 2:15 - 3:00PM -** Observe EPA cleanup work at the Baxter Springs remediation site (Fig. 5). Remedial activities include the following: Nearly 100 acres of chat have been re-graded, re-contoured, capped, and re-vegetated; nearly 30 acres of tailings impoundments have been drained and capped, over 50 acres of sediments have been removed from impacted drainages/streams; and over 40 residential properties have been excavated and restored.

191.1 Leaving Baxter Springs, KS to Galena, KS on scenic Route 66.

195.9 Empire Electric Company at Riverton prior to crossing the Spring River. Ecologically this is the main drainage basin of concern addressed by various environmental cleanups in the three states of Kansas, Missouri, and Oklahoma.

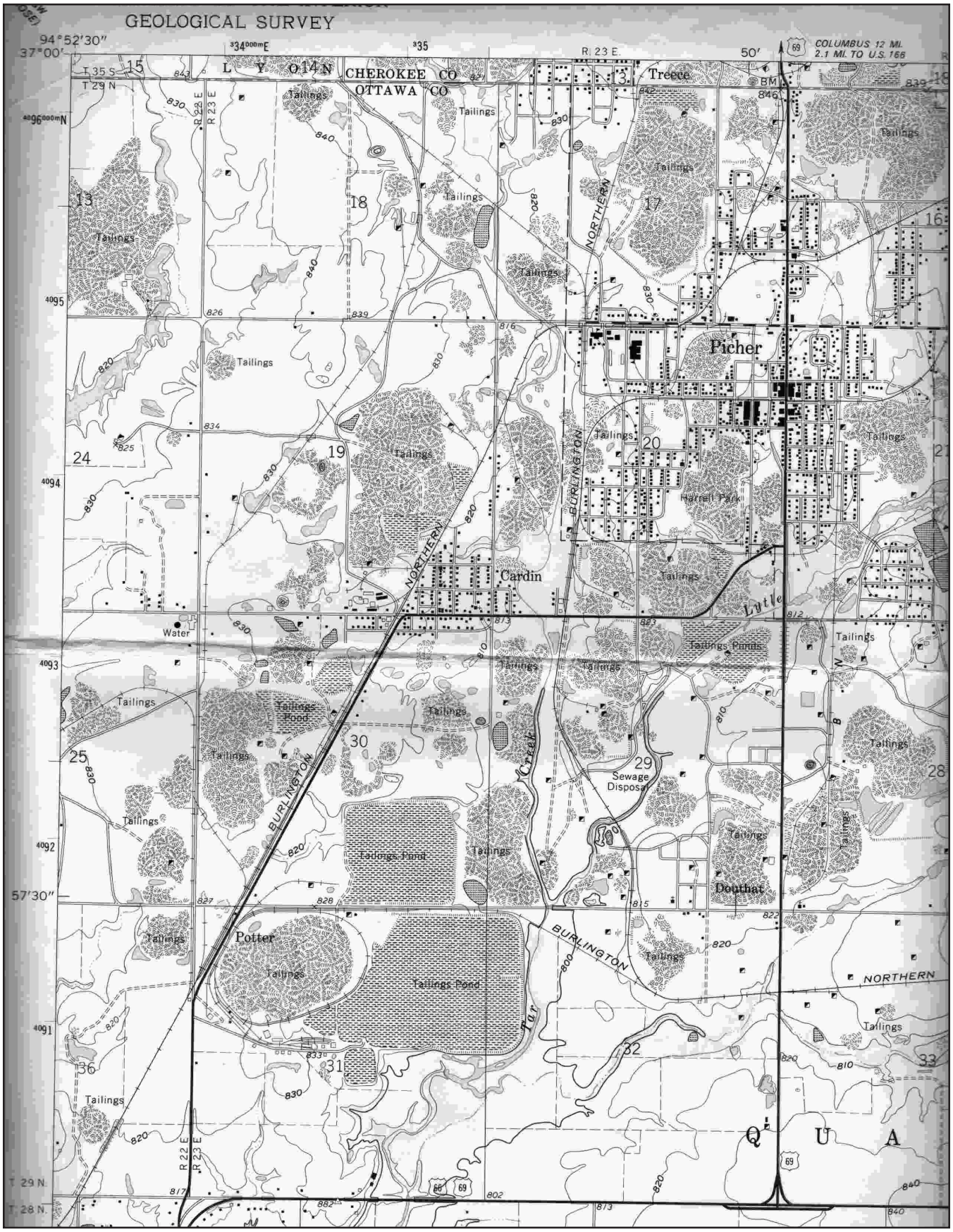


*Figure 4. Topographic map of the Picher-Cardin Oklahoma area showing waste piles and chat piles in mined areas.*

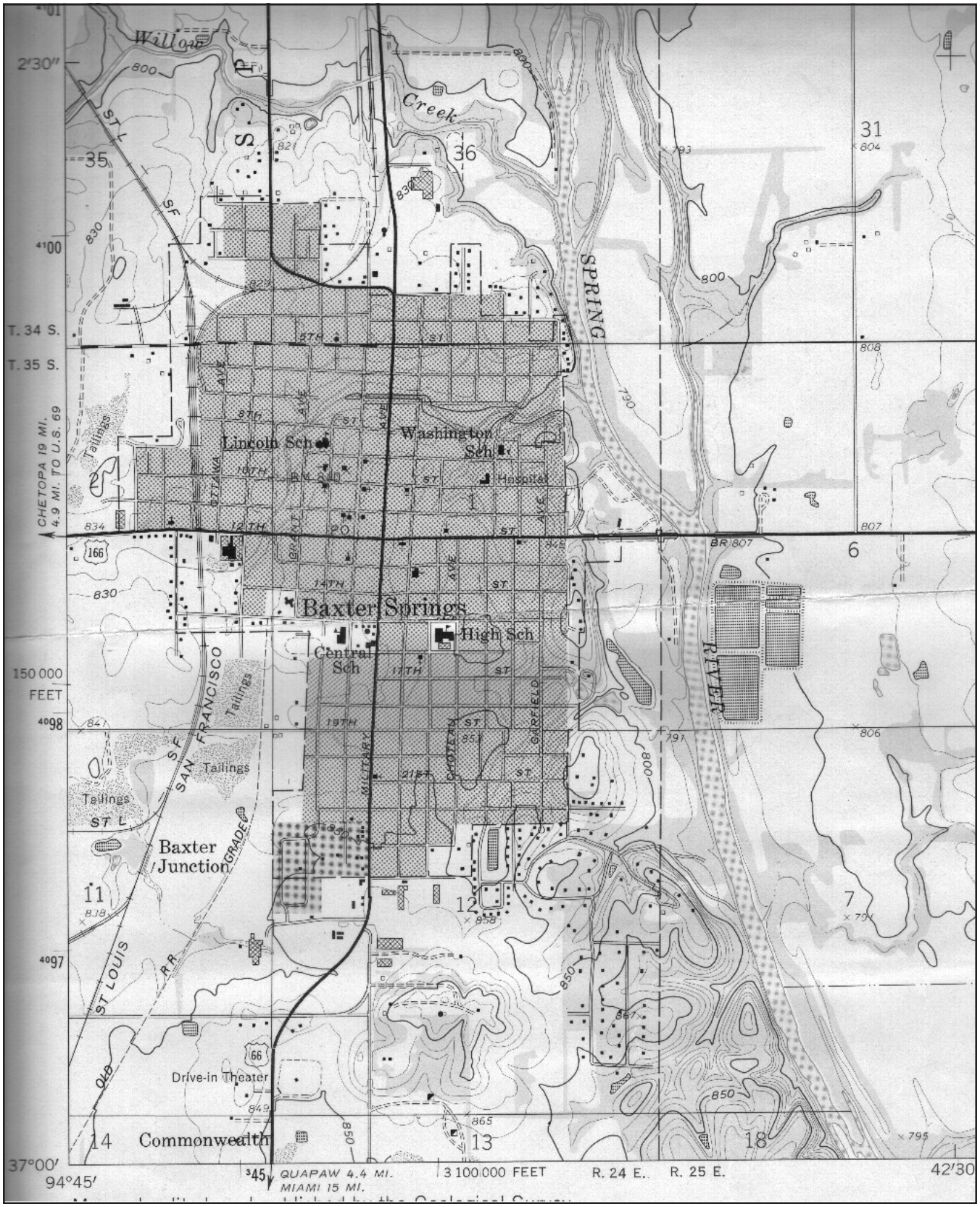


*Figure 5. Topographic map of Baxter Springs area showing pre-remediation waste and chat piles that have now been removed.*

198.2 South on 90th Street - Rural Water District serving over 500 hookups. This was an EPA Superfund remedial action conducted to address the problem of rural residents consuming metals-laden groundwater. This cleanup is designated as Operable Unit #01 (OU-1) of the Cherokee County Superfund Site and was completed in the early 1990s.

198.5 East on 21st Street - Operable Unit #05 (OU-5) of the Cherokee County Superfund Site is part of a 900 acre EPA Superfund remedial action that addressed surficial mining wastes and was completed in the mid 1990s. The area was regarded, wastes segregated, shafts and subsidences filled, and the surface re-vegetated with native prairie grasses. The Kansas Department of Health and Environment is still performing long-term operation and maintenance activities at this cleanup site.

199.2 **Field Stop 4 - 3:15 - 3:30PM** - Viewing a portion of the re-vegetated area. Native vegetation was utilized to withstand local climatic conditions/poor soil, and does not require mowing, fertilization, or excessive maintenance. Pre-remedial aerial photographs show the contrast between historic and current conditions.

Proceed to Joplin via Route 66 through Galena (Fig. 6). Note re-vegetated Short Creek Valley and other areas that comprise the 900-acre cleanup. Due to smelter fallout over 700 residential properties in Galena were remediated.

206.4 **Field Stop 5 - 3:45 - 4:30PM -** Joplin Museum Complex: Everett J. Ritchie Tri-State Mineral Wing and Dorothea B. Hoover Historical Wing. Exceptional collection of Tri-state mineral specimens and mining photos.

240.3 Coal strip mine area en route to Big Brutus, the second largest electric shovel in the world in 1962.

243.3 **Field Stop 6 - 5:15 - 5:30** – Big Brutus facts: Bucyrus Erie model 1850B, 16 stories tall, weight-11 million pounds, bucket capacity 90 $yd^3$ (150 tons or three rail cars), cost was $6.5 million in 1962, used for stripping overburden to expose the coal. Electricity for Big Brutus's last month of operation was $27,000.

311.2 **Rest stop and convenience store at Prescott, KS – 6:45-7:00PM**

400.3 Return to Hilton **8:45PM**

**Note: All times are approximate and distances may vary somewhat due to the nature of the field stops.*

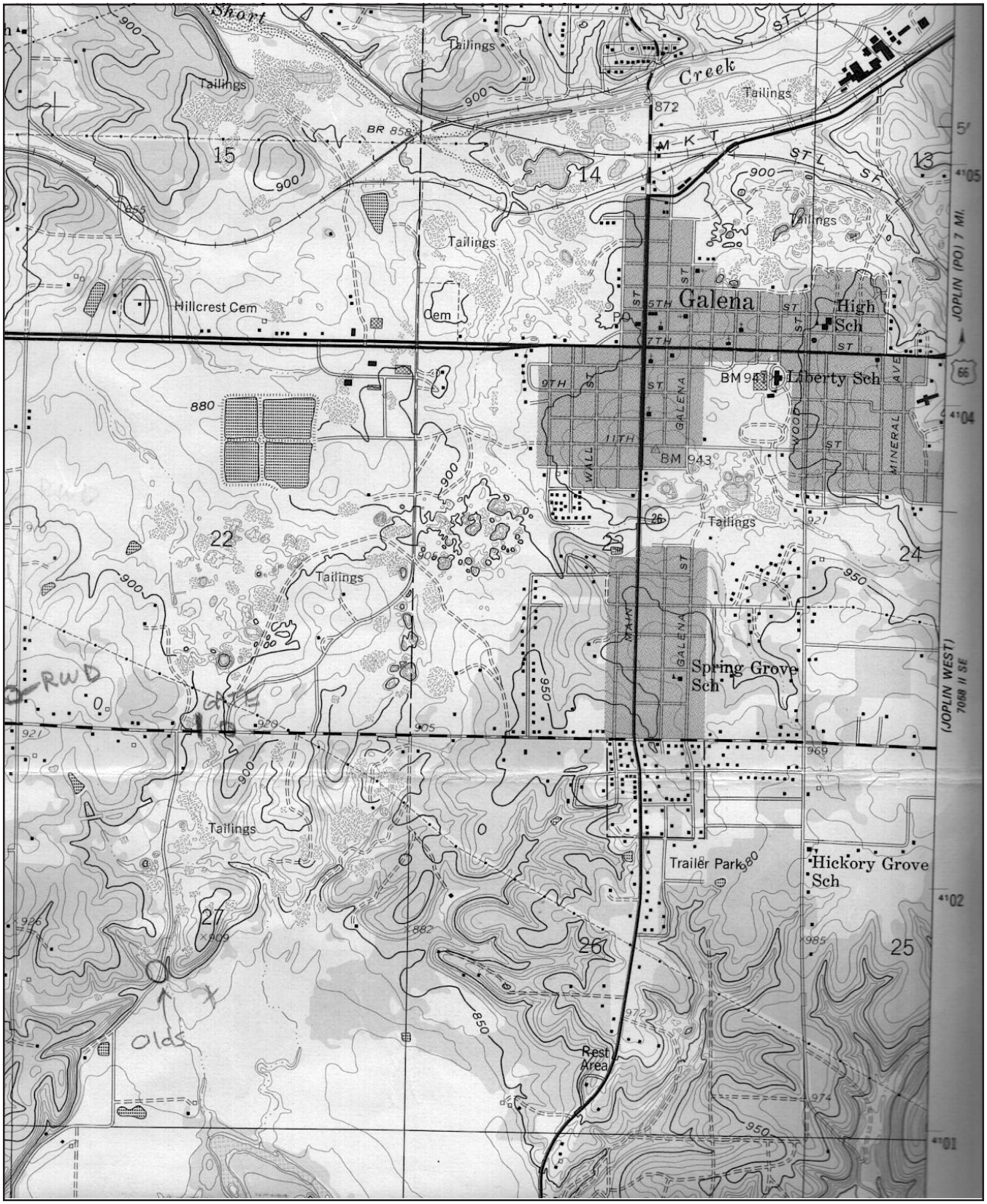


*Figure 6. Topographic map of Galena, Kansas area showing pre-remediation waste and chat piles in areas that are now covered with prairie grass.*

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