National Park Service
Cultural Landscapes Inventory
2011

Vulcan Mine Historic District
Mojave National Preserve

Vulcan Mine Historic District
Mojave National Preserve

Mojave National Preserve concurs with the findings of the CLI, including the management category and condition assessment as identified below:

MANAGEMENT CATEGORY: **B: Should be preserved and maintained**

CONDITION ASSESSMENT: **Fair**

Lawrence S. Whittaker 4/6/11

Superintendent, Mojave National Preserve Date

Please return to:

Amanda Bennett
Cultural Landscapes Inventory Coordinator
National Park Service
Pacific West Regional Office
909 First Ave., Suite 500
Seattle, WA 98104

OFFICE OF HISTORIC PRESERVATION
DEPARTMENT OF PARKS AND RECREATION
1725 23rd Street, Suite 100
SACRAMENTO, CA 95816-7100
(916) 445-7000 Fax: (916) 445-7053
calshpo@parks.ca.gov
www.ohp.parks.ca.gov

September 28, 2011 Reply In Reference To: NPS110525A

David Louter, PhD
Chief, Cultural Resource Programs
National Park Service - Pacific West Regional
909 First Avenue, Fifth Floor
Seattle, WA 98104-1060

RE: Consensus Determination of Eligibility, Vulcan Mine Historic District Cultural Landscape Inventory, Mojave National Preserve, California

Dear Dr. Louter:

I am writing in response to your letter dated May 24, 2011, that requested my review and concurrence with the findings of Cultural Landscapes Inventory (CLI) documentation of the Vulcan Mine Historic District at the Mojave National Preserve. The CLI serves as a Determination of Eligibility for listing the district on the National Register of Historic Places (NRHP). Consensus agreement on eligibility between the National Park Service (NPS) and my office will result in the district being added to the national database of cultural landscapes managed by the NPS.

After reviewing the CLI and in accordance with 36 CFR 800.4(b) and (c), I concur that the Vulcan Mine Historic District is eligible for listing on the NRHP under Criterion A. As indicated on the attached form, I also concur with the period of significance (1942-1947), the historic district boundary, the landscape characteristics identified in the CLI as contributors to the historic character of the district, and with the remaining resources listed as contributors and non-contributors.

In addition, your letter points out that a portion of the original mine property is located on state-owned land and is included in the proposed historic district boundary but not officially evaluated by NPS in the CLI. I would concur that this "operational area" of the Vulcan Mine, appears to contribute to the historic district's significance and should be included within the historic district boundary.

Thank you for seeking my comments and considering historic properties as part of your project planning. If you require further information, please contact Mark Beason, State Historian II, at phone 916-445-7047 or email mbeason@parks.ca.gov.

Sincerely,

Susan K Stratton for

Milford Wayne Donaldson, FAIA
State Historic Preservation Officer

MOJAVE NATIONAL PRESERVE
Vulcan Mine Historic District

California SHPO Consensus Determination of Eligibility

Actions Requested:

1) SHPO concurrence that the Vulcan Mine Historic District is eligible for the National Register of Historic Places under Criterion A at the national level of significance as the largest source of iron in California during World War II, providing material for the first large-scale steel plant west of the Rockies.

I concur ___✓___, I do not concur _____ that the Vulcan Mine Historic District meets Criterion A at the national level of significance as described in the CLI.

2) SHPO concurrence with the period of significance of 1942 to 1947, covering the duration of active iron mining by Kaiser Corporation Inc., as described in the Vulcan Mine Historic District CLI.

I concur ___✓___, I do not concur _____ with the period of significance as described in the Vulcan Mine Historic District CLI.

3) SHPO concurrence with the historic district boundary of the Vulcan Mine Historic District as identified in the CLI.

I concur ___✓___, I do not concur _____ with the historic district boundary of the Vulcan Mine Historic District as identified in the CLI.

4) SHPO concurrence that the landscape characteristics as identified in the CLI contribute to the historic character of the Vulcan Mine Historic District (see the following landscape characteristic descriptions in the Analysis and Evaluation section of the CLI: Natural Systems and Features, Spatial Organization, Topography, Circulation, Buildings and Structures, and Archeological Sites):

I concur ___✓___, I do not concur _____ with the landscape characteristics that contribute to the historic character of the Vulcan Mine Historic District as described in the CLI.

5) SHPO concurrence with the list of contributing and non-contributing resources to the Vulcan Mine Historic District. (See tables below and the following landscape characteristic descriptions in the Analysis and Evaluation section of the CLI: Circulation; and Buildings and Structures):

Contributing Resource Name	Date Built	Concur	Do not Concur
Vulcan Mine Road	Circa 1942	✓	
Vulcan Mine Mining Complex Circulation Network	1942-1947	✓	
Vulcan Mine Residential Site Foundations and Footings	1942-1947	✓	
Vulcan Mine Crusher Plant Foundations	Circa 1942	✓	

California SHPO Consensus Determination of Eligibility

Vulcan Mine Cap and Fuse House	Pre-1942	✓	
Vulcan Mine Magazine Storage Structure	Pre-1942	✓	
Vulcan Mine Loading Ramps	Circa 1942	✓	

Non-contributing Resource Name	Date Built	Concur	Do not Concur
Kelbaker Road	Pre-1942, altered post-1947	✓	
Loading Ramp Access Road Traces	1942, altered post-1947	✓	
Vulcan Mine Chain Link Fence	2010	✓	

Reasons/comments why any 'Do Not Concur' blocks were checked:

Susan K Stratton for MW Donaldson 28 Sept 2011
California State Historic Preservation Officer Date

Please return form to the attention of:
Vida Germano
Cultural Landscapes Inventory Coordinator
Pacific West Regional Office
1111 Jackson Street, Suite 700
Oakland, CA 94607-4807
510-817-1407, vida_germano@nps.gov

Table of Contents

Inventory Unit Summary & Site Plan

Inventory Unit Description:

The proposed Vulcan Mine Historic District is a 437-acre district near the heart of Mojave National Preserve. The district is significant at the national level under Criterion A for its association with events that have contributed to the broad patterns of American history as the largest source of iron in California during World War II, providing material for the first large-scale steel plant west of the Rockies. The period of significance is 1942 to 1947, covering the duration of active iron mining by Kaiser Corporation.

Mojave National Preserve is located in southeastern California in the Mojave Desert. The Historic District is located in the southwestern quadrant of the preserve, where vegetation is sparse and low-growing. Cacti and thorny shrubs are conspicuous, but many thorn-less shrubs and herbs are also present. Eons of erosion by wind and brief, but powerful seasonal rains have significantly influenced the natural landscape as well as mining development.

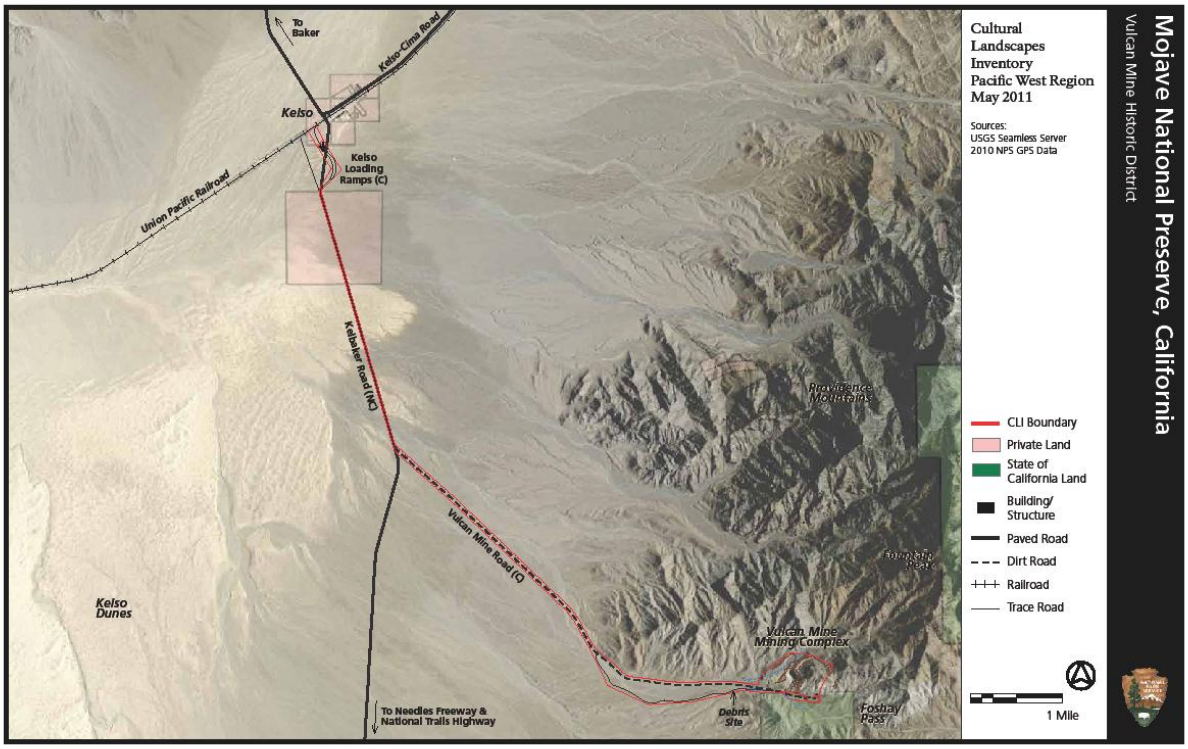
Generally, the Vulcan Mine Historic District is comprised of the main mining complex where ore was extracted from an open pit, a transportation corridor that connects it to Kelso, and the loading ramps at Kelso used to transfer the iron ore to railcars. The mining complex includes the large open pit, waste rock pile, associated operational and residential areas, and a system of roads and terraces. The 9-mile Vulcan Mine-Kelbaker Road originally constructed by Kaiser still follows its original alignment and connects to the historic, earthen loading ramps at Kelso.

Because of the temporary nature of mining in the Vulcan Mine Historic District, mining features were not intended to outlast the brief spurt of mining activity that occurred from 1942 to 1947. All of the buildings were removed in 1949 when mining operations ceased, leaving only foundations and footings to mark their former locations. Some roads and other features located in washes have been disturbed by storm events. However, most features, such as the open pit, waste rock pile, foundations and footings, main roads, and the loading ramps are stable.

Overall, the cultural landscape retains integrity as a Historic District conveying a large-scale mining operation associated with World War II-era mining. The Vulcan Mine appears today much as it did during the period of significance and retains its historical integrity of location, design, setting, materials, workmanship, feeling and association. Contributing resources include the residential area foundations and footings, crusher plant foundations, cap and fuse house, magazine storage structure, Kelso loading ramps, Vulcan Mine Road, and the mining complex circulation network. The historic character of the Vulcan Mine Historic District is still evident in the following landscape characteristics: natural systems and features, spatial organization, topography, circulation, buildings and structures, and archeological sites. Based on the evaluation of these characteristics, the cultural landscape at Vulcan Mine was found to exhibit key patterns, relationships, and features that convey the historical significance of the district.

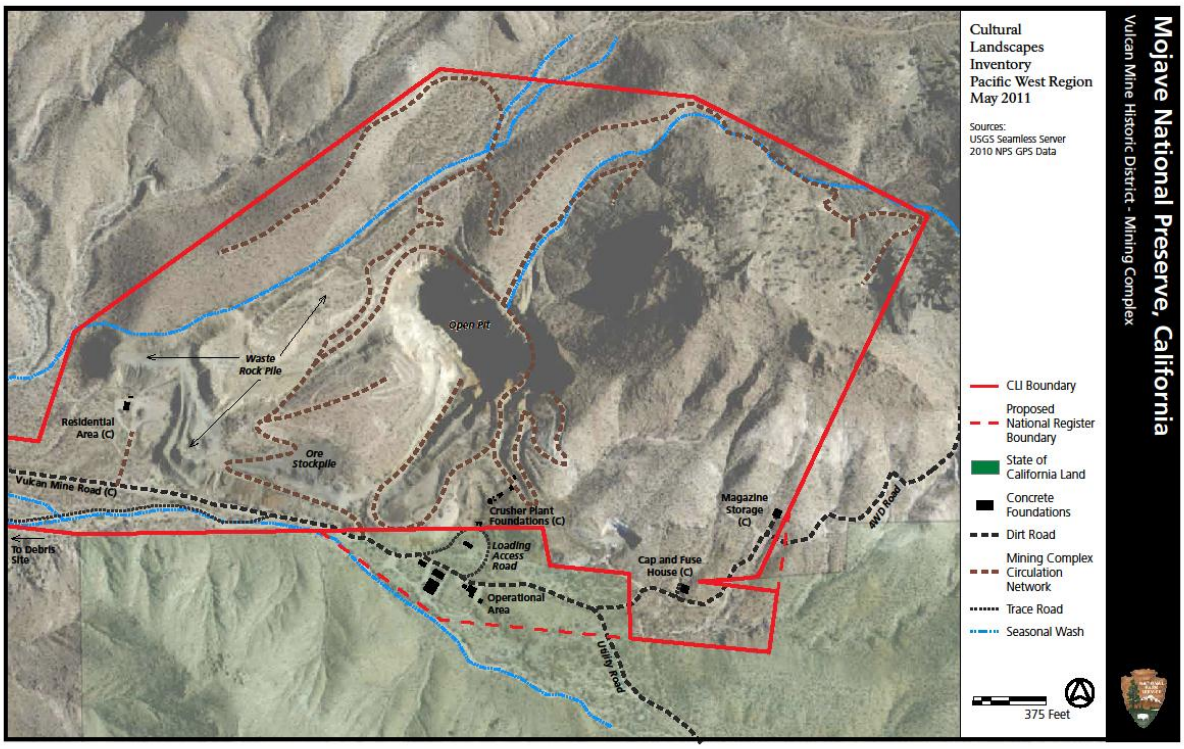
Site Plans

Site Plan: Vulcan Mine Historic District (2010)



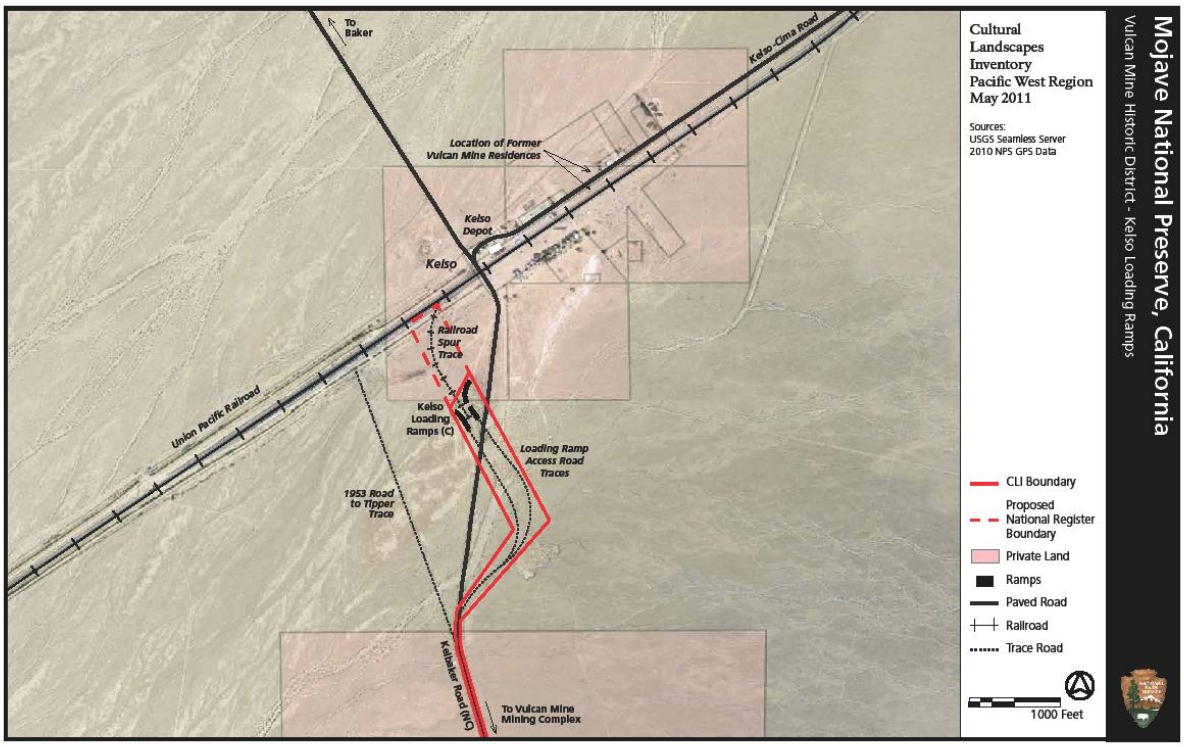
See the Supplemental Information section for a full 11 x 17 inch version of site plan.

Site Plan: Vulcan Mine Mining Complex (2010)



See the Supplemental Information section for a full 11 x 17 inch version of site plan.

Site Plan: Vulcan Mine Kelso Ramps (2010)



See the Supplemental Information section for a full 11 x 17 inch version of site plan.

Property Level and CLI Numbers

Inventory Unit Name:	Vulcan Mine
Property Level:	Landscape
CLI Identification Number:	700015
Parent Landscape:	700015

Park Information

Park Name and Alpha Code:	Mojave National Preserve MOJA
Park Organization Code:	8380
Park Administrative Unit:	Mojave National Preserve

Concurrence Status

Inventory Status: Complete

Completion Status Explanatory Narrative:
Fieldwork was completed in May 2010 by Erica Owens, Amanda Bennett, and Fred Brown of the Pacific West Regional Office in Seattle, Washington, and Bob Hartzler and Catherine Sherraden of the Pacific West Regional Office in Oakland, California. Documentation was finalized in 2011.

Archival research completed in 2010 by Fred Brown, Ted Weasma, Catherine Sherraden and Greg Gress included:

Site visits:
- MOJA records from Ted Weasma, Linda Slater, and Tim Duncan
- Mojave River Valley Museum, Barstow, CA
- San Bernardino County Library branch, Barstow, CA
- University of Washington Libraries, Seattle, WA
- San Bernardino County Archives, San Bernardino, CA
- Kaiser Papers, Bancroft Library, University of California, Berkeley, CA
- NPS Pacific Land Resources Program Center, Oakland, CA

Sites contacted by telephone:
- Bureau of Land Management, California State Office, Sacramento California
- San Bernardino County Museum, Redlands, CA
- Mojave Desert Heritage & Cultural Association, Goffs, CA

The CLI will be considered “Complete” once it has gone through park and SHPO review and has received concurrence.

Concurrence Status:

Park Superintendent Concurrence:	Yes
Park Superintendent Concurrence Date:	04/06/2011
National Register Concurrence:	Eligible—SHPO Consensus Determination
Date of Concurrence Determination:	09/28/2011

Geographic Information & Location Map

Inventory Unit Boundary Description:
The Cultural Landscape Inventory (CLI) boundary starts at the northeastern corner of the ramp, just west of Kelbaker Road. From this point, the boundary extends southeast for 0.3 miles along the eastern side of the ramp access road traces and then turns southwest for 0.3 miles meeting up with Kelbaker Road. The boundary continues southeast along the east side of the Kelbaker Road pavement edge for 2.8 miles and then turns southeast along Vulcan Mine Road. It continues on the eastern side of Vulcan Mine Road, fifty feet from the road centerline, for 5 miles. The boundary then turns northeast, curving around the waste rock pile and along the western side of the ridge road/trail that overlooks the open pit and waste rock pile. From there, the boundary turns east southeast along the northern border of the northern roads/trails of the circulation network. The boundary turns southwest at the northeastern most road/trail, and passes just to the east of the magazine storage and historic end of Vulcan Mine Road. Just southeast of the magazine storage, the boundary meets up with and follows the northern boundary of the State of California property to its northwest corner. The boundary continues west and then northwest for 2.2 miles along the southern side of the historic trace road near the debris site until meeting back up with Vulcan Mine Road. From there the boundary heads northwest for 3 miles along the western side of Vulcan Mine Road, fifty feet from the road centerline until reaching Kelbaker Road. The boundary continues northwest along the west side of the Kelbaker Road pavement edge for 3 miles. From there the boundary turns northeast for 0.15 miles and then northwest for 0.3 miles along the western side of the ramp access roads and the western ramp. At the northwest corner of the western ramp, the boundary turns northeast for 0.1 miles to the point of beginning at the northeast corner of the eastern ramp.

CLI Boundary Justification
The Cultural Landscape Inventory (CLI) boundary of the Vulcan Mine Historic District includes the historic features associated with the mining activity during the period of significance, including the open pit mine and waste rock pile, graded areas, foundations, storage structures, historic road alignments, and the Kelso loading ramps. The boundary of the Vulcan Mine Historic District does not include the northern portion of the Kelso loading ramps and railroad spur traces as well as the southeastern portion of the mining core, including the operational area, because they are on private and State of California property not owned by the National Park Service.

Proposed National Register Boundary Description
The proposed National Register Boundary follows the majority of the CLI Boundary of the Vulcan Mine Historic District and expands into private property at the northwest corner and property owned by the State of California near the Vulcan Mine mining complex south of Vulcan Mine Road. The northwestern expansion begins at the ending point of the CLI Boundary, the northeastern corner of the ramps and continues northwest for 830 feet to the railroad where it turns southwest along the railroad for 550 feet. The boundary then turns southeast for 830 feet, joining up with the starting point of the CLI Boundary at the northwestern corner of the ramps. The southeastern expansion begins at a point approximately 1100 feet east of the northwest corner of the State property line and continues southeast into the State property along a seasonal wash for 725 feet. The boundary then turns east southeast for 950 feet, meeting up with the State property line and southeastern corner of the CLI Boundary.

Proposed National Register Boundary Justification

The proposed National Register Boundary expands upon the CLI Boundary at the northwest corner of the district to include an additional 10 acres of privately owned property that encompasses the northern portion of the Kelso loading ramps and remaining historic railroad spur traces. The expanded boundary in the southeastern corner of the district at the mining complex, south of the open pit, is an additional 12 acres of property that is currently owned by the State of California and contains all remaining historic features in the Operational Area.

State and County:
State: California
County: San Bernardino

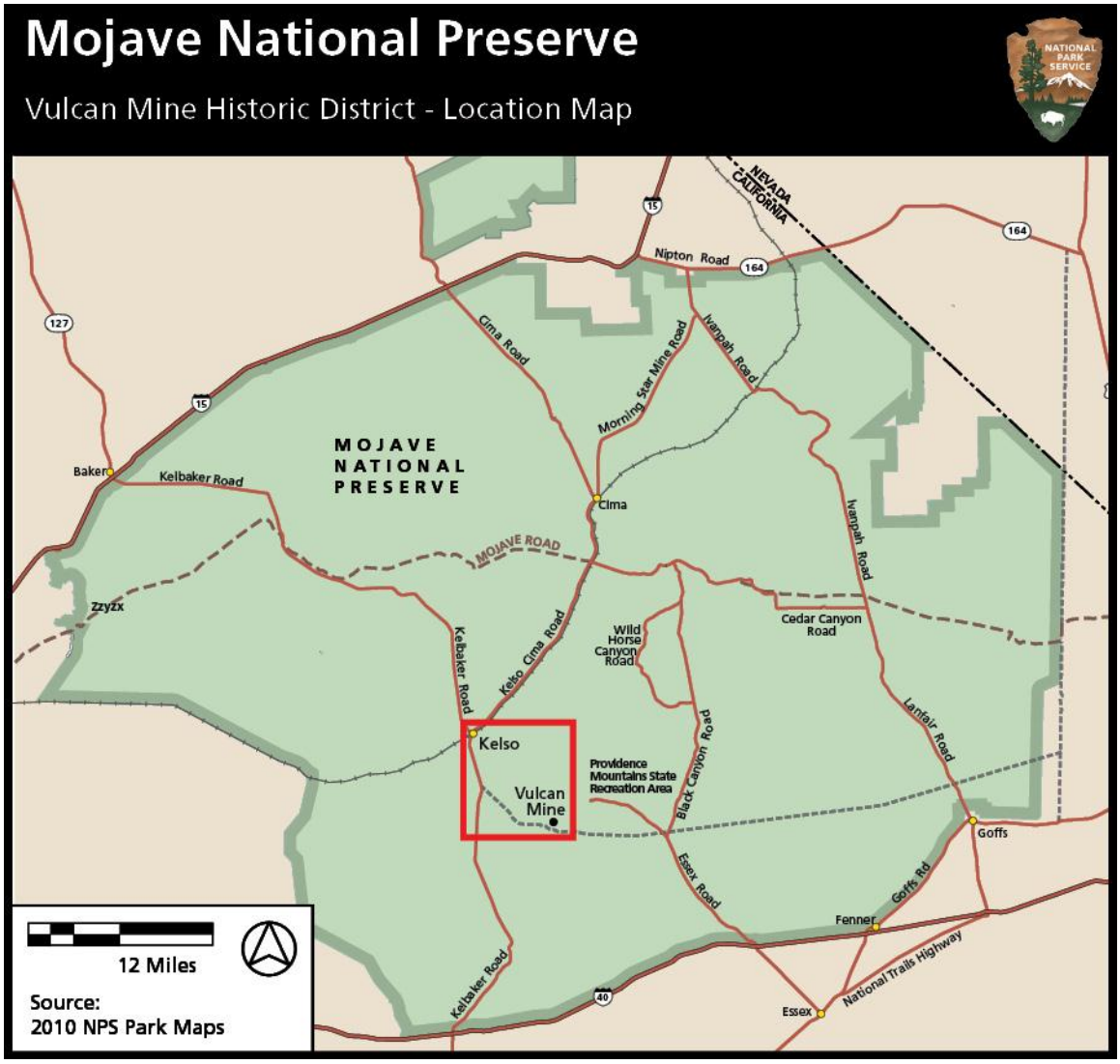
Size (Acres): 437 acres

Boundary UTMS:

Source	Type of Point	Datum	Zone	Easting	Northing
GPS-Differentially Corrected	Area	NAD 1983	11 N	622817	3874787
GPS-Differentially Corrected	Area	NAD 1983	11 N	623048	3874283
GPS-Differentially Corrected	Area	NAD 1983	11 N	622756	3873912
GPS-Differentially Corrected	Area	NAD 1983	11 N	622760	3873836
GPS-Differentially Corrected	Area	NAD 1983	11 N	624014	3869520
GPS-Differentially Corrected	Area	NAD 1983	11 N	627028	3866676
GPS-Differentially Corrected	Area	NAD 1983	11 N	627176	3866483
GPS-Differentially Corrected	Area	NAD 1983	11 N	627461	3866001
GPS-Differentially Corrected	Area	NAD 1983	11 N	628028	3865509
GPS-Differentially Corrected	Area	NAD 1983	11 N	628827	3865403
GPS-Differentially Corrected	Area	NAD 1983	11 N	629762	3865418
GPS-Differentially Corrected	Area	NAD 1983	11 N	630261	3865362
GPS-Differentially Corrected	Area	NAD 1983	11 N	630339	3865539
GPS-Differentially Corrected	Area	NAD 1983	11 N	630868	3865951
GPS-Differentially Corrected	Area	NAD 1983	11 N	631245	3865916
GPS-Differentially Corrected	Area	NAD 1983	11 N	631595	3865712

GPS-Differentially Corrected	Area	NAD 1983	11 N	631353	3865166
GPS-Differentially Corrected	Area	NAD 1983	11 N	631266	3865159
GPS-Differentially Corrected	Area	NAD 1983	11 N	631370	3865139
GPS-Differentially Corrected	Area	NAD 1983	11 N	631367	3865052
GPS-Differentially Corrected	Area	NAD 1983	11 N	631163	3865077
GPS-Differentially Corrected	Area	NAD 1983	11 N	631162	3865172
GPS-Differentially Corrected	Area	NAD 1983	11 N	631035	3865187
GPS-Differentially Corrected	Area	NAD 1983	11 N	631031	3865242
GPS-Differentially Corrected	Area	NAD 1983	11 N	629910	3865242
GPS-Differentially Corrected	Area	NAD 1983	11 N	629165	3865077
GPS-Differentially Corrected	Area	NAD 1983	11 N	628389	3865054
GPS-Differentially Corrected	Area	NAD 1983	11 N	627685	3865348
GPS-Differentially Corrected	Area	NAD 1983	11 N	627400	3866009
GPS-Differentially Corrected	Area	NAD 1983	11 N	627151	3866468
GPS-Differentially Corrected	Area	NAD 1983	11 N	627003	3866659
GPS-Differentially Corrected	Area	NAD 1983	11 N	624029	3869450
GPS-Differentially Corrected	Area	NAD 1983	11 N	622755	3873835
GPS-Differentially Corrected	Area	NAD 1983	11 N	622752	3873890
GPS-Differentially Corrected	Area	NAD 1983	11 N	622769	3874040
GPS-Differentially Corrected	Area	NAD 1983	11 N	622935	3874199
GPS-Differentially Corrected	Area	NAD 1983	11 N	622695	3874696

Location Map:



Vulcan Mine Historic District is located in the southwest quadrant of Mojave National Preserve.

Management Information

General Management Information

Management Category: Should be Preserved and Maintained

Management Category Date: 04/06/2011

Management Category Explanatory Narrative:
The Vulcan Mine Historic District meets all criteria for Management Category B – Should Be Preserved and Maintained. It meets National Register Criteria A, for the district's association with events significant to broad patterns of our history, including the history of mining in the Mojave Desert, and industrial development in the West and during World War II. The historic district is compatible with the park's legislated significance which states "the Mojave Desert area possesses outstanding natural, cultural, historical, and recreational values meriting statutory designation and recognition as a unit of the National Park System." (1994 California Desert Protection Act, Public Law 103-433, Section 501) Finally, the district has a continuing or potential purpose that is appropriate to its traditional use or function, interpretation of industrial mining in the Mojave Desert.

Agreements, Legal Interest, and Access

Management Agreement:

Type of Agreement: **Other**

Management Agreement Explanatory Narrative:
Kelbaker Road is currently part of a litigation case between the NPS and San Bernardino County to determine road ownership. The county currently maintains the asphalt on the road. A 2.8 mile portion of the road between the Kelso loading ramps and Vulcan Mine Road is the historic alignment of the road that once was used to transport ore between the mine and railroad at Kelso. It is directly associated with the cultural landscape of the Vulcan Mine Historic District.

NPS Legal Interest:

Type of Interest: Fee Simple

Public Access

Type of Access: Other Restrictions

Public Access Explanatory Narrative:
The Vulcan Mine area is accessible to the public via public roads and trails. The 40 to 60-foot deep open pit has been fenced around the top bench for safety reasons.

Adjacent Lands Information

Do Adjacent Lands Contribute? Yes

Contributing Adjacent Lands Explanatory Narrative:

Kelso Housing Site
The private property northeast of Kelso Depot, along the railroad track once served the Vulcan Mine as a housing site for married employees. Although all of the structures have been removed, these privately held lands contain potential archeological information that relates to the Vulcan Mine's period of significance.

Northern Portion of Kelso Loading Ramps
The northern portion of the eastern ramp and the traces of former road alignment and railroad spur north of the ramps are located on private property. They are directly associated with the significance the remaining NPS-owned portions of the ramps and the cultural landscape of the Vulcan Mine Historic District as a whole.

State Property
The southeast portion of the mining complex, including the entire operational area of foundations and footings, is located on land owned by the State of California. It is directly associated with the significance the NPS-owned portion of the mining complex and the cultural landscape of the Vulcan Mine Historic District as a whole.

National Register Information

Existing National Register Status

National Register Landscape Documentation:

Undocumented

National Register Explanatory Narrative:

Vulcan Mine is not currently listed on the National Register of Historic Places. The adjacent NPS-owned Kelso Depot is listed on the National Register in 2001 for its significance as a Union Pacific Railroad stop servicing the local ranching and mining communities. The Depot is associated with the rail transport of iron ore from the Vulcan Mine Historic District to the steel plant in Fontana.

National Register Eligibility

National Register Eligibility:	Eligible—SHPO Consensus Determination
Eligibility Concurrence Date:	09/29/2011
National Register Classification:	District
Significance Level:	National
Significance-Contributing/Individual:	Individual
Significance Criteria:	A - Associated with events significant to broad patterns of our history

Period of Significance:

Time Period:	1942-1947
Historic Context Theme:	Developing the American Economy
Subtheme:	The Mining Frontier
Facet:	

Area of Significance:

Area of Significance Category	**Area of Significance Subcategory**
Industry	None

Statement of Significance

The Vulcan Mine Historic District is an open pit iron mine located in Mojave National Preserve. The benches excavated out of the desert landscape form an abrupt contrast to the rolling hills covered with yucca and cacti that surround them. They testify to the ability of events a world away to transform the desert landscape. The site went from an iron prospect of little interest to anyone but its owner and a few workers in the early twentieth century to the largest source of iron in California in World War II. It provided the raw material for the first large-scale integrated steel plant west of the Rockies at Fontana, California (near Los Angeles) and was the source of most of the steel that Kaiser Corporation Inc. used in its west coast shipyards. These shipyards produced an estimated one-third of all U.S. cargo vessels constructed during the war and thus played a crucial role in the Allied victory. Vulcan Mine is eligible for listing on the National Register of Historic Places under Criterion A with a national level of significance for its association with the history of mining in the Mojave Desert, of industrial development in the West, and of World War II. Its period of significance extends from 1942 to 1947.

G. R. Barker and W. S. Williams first located the Vulcan Mine claim in 1905. Charles Colcock Jones purchased the claim from them and had it surveyed in 1907. It was one of many mining properties throughout the West claimed by this prominent mining engineer based in Los Angeles. His work there consisted in exploring and surveying the site to determine the extent of the iron deposit, but apparently not in active mining.

World War II and the efforts of Henry J. Kaiser to establish a steel industry on the West Coast transformed the mine from quiet investment property to a major hub of activity. The proximity to the railroad at Kelso was key to Kaiser's decision to use this mine as the main source of raw material for his new Fontana steel mill. Kaiser bought the mine from Jones in 1942.

Much of the mining infrastructure development occurred within the first two years of Kaiser's ownership from 1942 to 1943. During this time, the residential buildings as well as operational buildings and access roads were constructed within the mine complex. A trailer camp was also established at Kelso, to house additional Kaiser employees. The railroad loading ramps at Kelso were also constructed, and the Vulcan Mine-Kelso Road, leading between the mine and the loading ramps, was realigned and improved during the first two years of Kaiser activity. Initial excavation of the open pit began in 1942, with the pit and adjacent waste rock pile increasing in size over the next five years.

During the years the Kaiser Corporation Inc. (KCI) actively mined the property, from 1942 to 1947, the mine produced 2,643,000 tons of iron ore. It was the principal source of ore for the steel that

went to Kaiser shipyards in Los Angeles, Richmond, and the Portland/Vancouver area that produced 1,490 vessels through the course of the war. The ore also went into munitions during the war and consumer products in the years immediately after World War II. Activity gradually declined at the mine, as Kaiser opened the much larger Eagle Mountain mine to the southeast as a source of iron ore. Vulcan Mine operations ceased at the mine in 1947, however, the buildings were removed sometime after 1949 and KCI continued to ship iron ore from its stockpile at Vulcan until 1950.

The remaining features of the 437-acre Vulcan Mine Historic District include the open pit, waste rock piles, building foundations and footings, loading ramps, and roads, which demonstrate the physical integrity and historic associations of the period of significance. The Vulcan Mine Historic District still retains its ability to convey the scale, character, technology, and operation of the mining and mineral transport processes that took place within the district. The aspects of location, design, setting, materials, workmanship, feeling, and association have not been degraded. The isolated desert setting and lack of modern intrusions that have survived since the historic period help convey the associations of early twentieth-century mining activities at this location. Existing mine features continue to convey the historic feeling established by the presence of a large-scale mining operation in an isolated desert location.

National Historic Landmark Information

National Historic Landmark Status: No

World Heritage Site Information

World Heritage Site Status: No

Chronology & Physical History

Cultural Landscape Type and Use

Cultural Landscape Type: Historic Site

Current and Historic Use/Function

Primary Historic Function-Major Category: Industrial/Processing/Extract

Primary Historic Function-Category: Extractive Facility (Mining)

Primary Historic Function: Mine

Primary Current Function-Major Category: Vacant (Not in Use)

Primary Current Function-Category: Ruin

Primary Current Historic Function:

Other Current and Historic Uses/Functions

Major Category: Domestic (Residential)
Category: Single Family Dwelling
Subcategory: Single Family House
Type: Historic

Major Category: Domestic (Residential)
Category: Multiple Dwelling
Subcategory: Dormitory (Bunkhouse)
Type: Historic

Major Category: General Storage
Category: Equipment/Vehicle Storage
Subcategory: Equipment/Vehicle Storage
Type: Historic

Major Category: General Storage
Category: Warehouse (General Supply Storage)
Subcategory: Warehouse (General Supply Storage)
Type: Historic

Major Category: Transportation
Category: Road-Related
Subcategory: Motorized Equipment
Type: Historic

Current and Historic Names

Current and Historic Name	Type of Name
Vulcan Mine	Both Current and Historic

Ethnographic Study Conducted: No

Chronology

Start Year of Major Event	Start Era AD/BC of Major Event	End Year of Major Event	End Era AD/BC of Major Event	Major Event	Major Event Description
1905	AD	1905	AD	Established	San Pedro, Los Angeles and Salt Lake Railroad began service, including a water station at Kelso.
1905	AD	1905	AD	Established	Vulcan Mine was located by G. R. Barker and Williams.
1905	AD	1909	AD	Built	The road was built from Kelso to Vulcan Mine.
1907	AD	1907	AD	Prospected	The Vulcan Mine was surveyed by Charles Colcock Jones.
1917	AD	1917	AD	Prospected	The Vulcan Mine claims were resurveyed.
1924	AD	1924	AD	Established	Kelso Depot was opened.
1942	AD	1942	AD	Purchased/Sold	Kaiser Company Inc. purchased Vulcan Iron Mine from Charles Colcock Jones.
1942	AD	1942	AD	Mined	Open pit mining of Vulcan Mine began.
1942	AD	1943	AD	Built	Buildings were constructed at Vulcan Mine for housing, offices, and mine work.
1942	AD	1943	AD	Built	A trailer camp was established at Kelso for Kaiser employees.
1942	AD	1943	AD	Built	The Vulcan-Kelso road was realigned and improved and the loading ramps constructed at Kelso.
1947	AD	1947	AD	Abandoned	Active mining at Vulcan Mine ended, while transport of ore from the stockpile continued.
1949	AD	1949	AD	Removed	Most or all buildings were removed from Vulcan Mine complex.
1953	AD	1957	AD	Mined	Mineral Materials Co. began mining at Vulcan Mine for iron ore used in cement making, under a lease from Kaiser.
1980	AD	1980	AD	Established	The East Mojave National Scenic Area was established.
1990	AD	1990	AD	Purchased/Sold	The Vulcan Mine claims were sold from Kaiser to Hugh Davenport and others, with Kaiser retaining the mineral rights.
1994	AD	1994	AD	Established	Mojave National Preserve was established as a result of the California Desert Protection Act.

1997	AD	1997	AD	Purchased/Sold	The Vulcan Mine claims were donated by Hugh Davenport and others to the United States.

Physical History

Early history of the area, prehistory to 1905

Vulcan Mine sits in a high-desert landscape of the Mojave Desert surrounded by rolling hills covered with yucca, cacti, cholla, and creosote. It lies at an elevation of about 4,000 feet, while the nearby Kelso Depot is at 2,130 feet. While little is known of the prehistory of the immediate vicinity of the mine, the site lies within Mojave National Preserve, an area which has a long history of human use. The Ancestral Puebloan people had a presence in what is now the preserve. Around 1000 C.E., Shoshonean and Paiute people replaced them.[1] "[H]istorical, archaeological, and ethnographic information indicates that ancestors of the modern Chemehuevi and Mohave Tribes traveled, camped, hunted, and resided at various places now in the Preserve."[2] John Wesley Powell and G. W. Ingalls described the Providence Mountain band of Desert Chemehuevis that occupied the area that contains Vulcan Mine.[3] Among the first non-Indigenous visitors to the area were the Spanish Franciscan missionary Father Francisco Garcés in 1776 and American fur trapper Jedediah Smith in 1826.

During the era of Spanish rule, this remote desert location was far from the regions of greatest Spanish influence. There were no Spanish missions or outposts nearby. San Diego de Alcalá, 200 miles to the southwest, was established as a mission in 1769. San Juan Capistrano, about 150 miles to the southwest, was established in 1776. The area became part of independent Mexico in 1821 and was part of the conquered territory the United States acquired from Mexico with the Treaty of Guadalupe-Hidalgo in 1848 after the Mexican-American War.

After conquest, the United States moved quickly to survey its new territories in an effort to encourage white settlement. The first record of the lands near the current mine site came with cadastral surveys of the West by the U.S. government. The General Land Office surveyed the area that contained the Vulcan Mine in 1854 and 1855. In doing so, however, surveyors did not survey section lines in the eastern half of township 10 north, range 13 east – the area that contains Vulcan Mine. They simply designated this part of the township as "mountains" on the plat map. The closest that surveyors came to the area of the future mine was the south boundary of the township, about a mile to the south of the future mine – an area they described as "hilly, stony and scattering pines."[4]

The area's geology was essential to its historic role. The area had no ready source of water and only attracted attention because of the iron ore near the surface. Charles Severy, a geologist for Kaiser Corporation, later described the geology of the area as "composed of three main rocks: ancient sedimentary deposits, which have since been more or less metamorphosed; intrusions of acid igneous rocks; and later intrusions and flows of rhyolites. The oldest sedimentary rocks in the region are Cambrian limestones and shales, which have since been metamorphosed to marbles and phyllites. Uncomformably above the Cambrian rocks lie other Paleozoic and Mesozoic marine meta-sediments…. The Vulcan iron deposit is an irregular, mushroom-shaped replacement of limestone by magnetite and hematite along a fault contact with a quartz monzonite."[5] This ore deposit would become the main source of iron ore for the west coast during World War II. (See the Supplemental Information section for the full report.)

The land in the Mojave desert was not suitable for field agriculture. There was, however, cattle grazing in the vicinity of the future mine. Travellers over the Mojave Road, which was established in 1859 about eighteen miles further north of the future mine site, typically had cattle and other livestock with them.[6] Around 1875, George Briggs set up a cattle ranch at Marl Spring, about seventeen miles northwest of the future Vulcan Mine site and LeRoy Blackburn at Government Hole, some twenty miles northeast of the mine.[7] Closer to the Vulcan Mine, John Domingo raised cattle near the Bonanza King in the 1880s, some seven miles northeast. Since ten miles is about the maximum that cattle can range from their water source, some of these cattle may have made it to

the future mine site.[8] However, the landscape near the mine appears to have no traces of the material culture of ranching.

For several reasons, mining took on particular importance in the Mojave Desert. First, the arid climate made other economic activities like farming impractical. Second, the lack of vegetation in the desert made mineral deposits more visible. And third, the area was rich in minerals, as historian Eric Nystrom explains, “the Mojave has been categorized as extremely geologically active, a consequence of its position at the junction of two of earth’s crustal plates. This faulting and other geologic activity left the desert a highly mineralized area, with large varieties of precious metals and industrial minerals scattered in small deposits of rich ore.”[9]

The Mojave desert had a long history of mining before the location of Vulcan Mine in 1905. Puebloan people mined turquoise in the vicinity of the future Preserve. Legends current in the 1860s held that the Spanish later mined the area as well. However, U.S. conquest in 1848 and the gold rush of the 1840s and 1850s soon led to much more intensive prospecting and mining. Within a few years of the first major mineral strike in California – the discovery of gold at John Sutter’s mill in 1848 – miners were exploring the Providence Mountains for minerals. The first documented mineral discovery was the silver strike in Macedonia Canyon in 1863, around 12 miles northeast of Vulcan Mine. “Charles Hamilton and Francis B. Austin on March 12, 1863, discovered some rich silver ore about 10 miles west of Rock Spring.” The Rock Spring mining district was briefly abandoned in 1866 after Indians killed one of the miners, but the army established Camp Rock Spring at the end of 1866 and miners eventually returned to the area and continued mining into the 1870s.[10]

In 1880, George Goreman and P. Dwyer discovered silver ore at a site that would become the Bonanza King Mine Mine, about seven miles northeast of the current Vulcan Iron Mine. The mine employed well over a hundred men in 1882. By 1883, the Southern Pacific Railroad was running from Barstow to Goffs, providing an easy means for the mine owners to ship their bullion. For a time, a small town called Providence existed on the site. After two productive years, the mill burned down and mining operations ceased in 1885. The Trojan Mining Company reopened the mine briefly from 1906 to 1907.[11]

Initial Mining Claim and Charles Colcock Jones, 1905-1942

Charles Colcock Jones, III, first opened the Vulcan Mine. He was born in Georgia on July 28, 1865, shortly after the end of the Civil War, into a prominent family of professionals and former slaveholders. His father Joseph Jones was a doctor; his uncle Charles Colcock Jones, Jr., a lawyer; his grandfather Charles Colcock Jones, a Presbyterian clergyman.[12] According to his obituary, Jones was “educated in Louisiana” and “came west at the turn of the century after a variety of professional experiences with eastern coal, iron and gold mines and steel companies.”[13] By the early twentieth century, he was a prominent mining engineer and entrepreneur in southern California. In 1908, the *Los Angeles Times* described him as "one of the best-known engineers of Los Angeles.”[14] His name appeared regularly in that paper from 1908 until his death, detailing his mining activities, his work in mining organizations, and his opinions on mining policy and other public issues. His wife, Elizabeth King Jones, appeared prominently in the society pages of the paper. The *Times* even profiled two of Mrs. Jones’s cats in an article on “aristocrats in Los Angeles tabbydom.”[15] C. C. Jones died in Los Angeles in 1953.

Jones located the Vulcan Mine during a period some termed the “Great Years” for mining in northeastern San Bernardino County: the first two decades of the twentieth century. Mining intensified, both because of growing demand for a variety of metals—not only gold and silver, but also copper, lead, zinc, chromium, manganese, tungsten, and vanadium—and because of the improved transportation system with new railroads and many graded roads.[16] According to Jones, he first heard about and visited the Vulcan Mine site in the Providence mountains in 1906.[17] Around that time, he purchased Vulcan Lode Claim No. 2 from G. R. Barker and W. S. Williams, who

first located the claim on March 28, 1905.[18] The circumstances of the 1905 location of the mine are not clear. However, the fact that the San Pedro, Los Angeles and Salt Lake Railroad started regular service between Los Angeles and Las Vegas on May 1, 1905, including a stop at Kelso, surely contributed to the economic value of the mine.[19] According to a map included with a published description of the mine, a road between Vulcan Mine and Kelso already existed in 1909. It is not clear when this road was constructed. Presumably, it was built in or around 1905, the year that Kelso Depot was established and Vulcan Mine was located. Mineral Survey no. 4650 presents a plat map of Vulcan Mine No. 2 Claim. From August 19 to August 21, 1907, Albert G. Ruxton surveyed Vulcan No. 2 Lode Mining Claim, which is the current site of the Vulcan Mine pit excavated in the 1940s. As he surveyed, he noted a number of other unsurveyed claims as well: Vulcan Lode Claim, Vulcan No. 4, Vulcan No. 6, and Vulcan Fraction No. 9 Lode Claim. He described an open cut 46 feet long leading to a tunnel 175 feet long valued at $623. Ruxton also noted another shaft nine feet deep and tunnel 68 feet long on the site for which Jones or his grantors was not responsible, indicating that others had explored the area for mining opportunities before Barker and Williams. The survey made no mention of buildings.

Jones obtained another survey of the Vulcan claims in 1917. A. M. Strong conducted the survey on July 18 and July 25, 1917 as part of Mineral Survey 5348 A & B. The claims he investigated were Vulcan, Vulcan Number 4, Vulcan Number 6, Vulcan Number 10, and Vulcan Iron Mine Mill Site. Specifically, the survey described a tunnel in Vulcan Lode running north-northeast 312.5 feet, a shaft 23 feet deep in Vulcan No. 6, and a shaft 32 feet deep in Vulcan No. 10, as well as two drifts, five cuts, and ten trenches, for a total value of $7,400.00. The site also has a galvanized iron building 12 x 30 feet (bearing S. 88° E. 223 feet from Corner Number 3, Vulcan Iron Mine Mill Site), a galvanized iron blacksmith shop eight by twelve feet (bearing S. 75° E 248 feet from Corner number three of Vulcan Iron Mine Mill Site), a well 22 feet deep (bearing N. 22° W 142 feet from Corner No. 1 of Iron Mine Mill Site), and an ore dump (about 230 feet S 70° E from Corner No. 3 Vulcan Iron Mine Mill Site). All of these buildings lay southeast of the pit excavated in the 1940s. Photographs of the mine from roughly the 1920s show at least five different buildings at the site, and dump sites for waste mining material. One photo (22a-01) shows two adits, a headframe, and mill building. These photographs appear to be taken in Vulcan Claim and Vulcan Millsite.

Jones spent substantial sums developing the mine, but appears never to have sold a great deal of ore from it. In 1909, the *Los Angeles Times* reported, “Charles Colcock Jones is developing the Vulcan, a large iron deposit, and has spent, it is claimed, $7000 on it the past two years proving. He has refused several flattering offers for the property; and, it is asserted, has completed arrangements in Pittsburgh to work on a large scale.”[20] There is no evidence, however, that this large-scale work ever occurred. In 1917, Cloudman and others reported, “The work done has been confined to exposing the formation and besides several shallow workings, there is a 100-foot tunnel with numerous crosscuts.”[21] One assessment from 1944 in *Mining Journal*, however, suggests that Jones never worked the mine on a large scale, but merely did the work required to maintain his claim: “At the turn of the century, West Coast iron ore was a beggar, just as the eventual manufacture of western steel was no more than a miner's dream. However, C. Colcock Jones of Los Angeles was a man of foresight and imagination, so yearly he did the prospect work and paid the taxes on a property he had discovered and named the Vulcan, never once failing in his belief that some day--remote as that day might be--the West would come into its own in producing the world's most common and useful metal.”[22] The Mining Law of 1872 provided that a claimant had to do at least a hundred dollars of work on each claim each year in order to maintain that claim.[23] Jones apparently faithfully fulfilled that legal requirement, recognizing the potential value of the claim.

A survey of the area took place between December 15, 1941 and January 21, 1942. It describes conditions near the mine just prior to the intensive mining of the World War II era. The survey of the north boundary of section 25, described “Land, rough mountainous. Soil, rocky, 4th rate.

Undergrowth practically none: desert brush and cacti. Timber, occasional pinyon and catclaw."[24] The 1941 survey described the south boundary of section 25 as "over broken foothills, through light undergrowth" with "Land, rolling and broken foothills of Providence Mtns. Soil, sandy, gravelly and rocky, 3d and 4th rate. Undergrowth, scattering greasewood, desert brush and cacti. Timber, occasional catclaw and willow." The surveyors crossed the markers of the Vulcan Mine mineral claim. They crossed an "unimproved road in channel of wash" leading to Kelso. As they surveyed the west boundary of section 25, they noted the "unimproved road in wash channel." The survey described the terrain in section 25 generally as "Land S1/2 is broken foothills; N1/2 is rough mountainous. Soil, sandy, gravelly and rocky, 3d and 4th rate. Undergrowth, light greasewood, desert brush and cacti. Timber, occasional catclaw, willow and pinyon."

Period of Active Mining, 1942-1947

At Vulcan Mine, as at many other locations in the West, the federal government provided a crucial boost for economic growth. The vastly increased exploitation of Vulcan Mine starting in 1942 stemmed from the U.S. participation in World War II and the increased role of government spending in developing the economy of the West. During its years of operation, the Vulcan Mine was the only large-scale open-pit iron mine in California and the largest producer of iron ore on the Pacific Coast.[25] The steel plant Kaiser Corporation created in Fontana near Los Angeles represented the first large-scale integrated steel plant in the West. By "integrated" plants, steel manufacturers meant plants that included each step of the process "from by-product coke ovens to blast furnace to finishing mills."[26] While other integrated steel plants had operated on the West Coast before, none operated at the scale of the new Fontana plant. The Vulcan Mine was the primary source of iron ore for the mill from 1943 to about 1948.[27] The Kaiser Company estimated that the Fontana mill would produce about half the steel needed for his shipyards. The other half would come from the Columbia Steel Co. mill in Utah.[28] The ore from Vulcan Mine was central to Kaiser's steel manufacturing and shipbuilding operations.

Although Henry J. Kaiser appears never to have visited the Vulcan Mine personally, the mine played an important part in his business strategies to develop the steel industry on the West Coast. Kaiser's success in shipbuilding, steel milling, and iron mining stemmed from massive federal investments in the American West during World War II, a time during which California received more federal dollars than any other state. These investments contributed to an economic boom in the region and altered the allocation of power between regions with the growth of industries in the West and of Western influence in the federal appropriation process.[29] Kaiser was, in the words of historian Richard White, the "prophet, promoter, and prime beneficiary of western industrialization."[30] In the estimation of historian Gerald Nash, "more than any other individual person, industrialist Henry J. Kaiser, was responsible for the wartime manufacturing boom in the West."[31] Vulcan Mine was a crucial part of that manufacturing boom.

Kaiser realized sooner than many industrialists that war with Germany and Japan was virtually inevitable.[32] In the late 1930s and early 1940s, therefore, he sought opportunities to foster the steel production that would be needed for the war effort and to profit from that production. By that time, Kaiser was already a prominent industrialist who saw the potential of government contracts to expand his business empire. Born in the village of Sprout Brook, New York (some thirty miles southeast of Utica) in 1882, he had established a successful road-paving company in Vancouver, British Columbia by 1914. In 1920, he moved his corporate offices to Oakland and helped form the consortium known as the Six Companies that won the government contract to construct the Hoover Dam in 1931. Within the Six Companies, he was given the crucial task of maintaining good relations between the companies and government officials in Washington, D.C. In this capacity, he established contacts and gained skills that would serve him well in his later career. His relationship with Jesse Jones of the Reconstruction Finance Corporation (RFC), for instance, would prove invaluable in his later efforts to create the Fontana steel mill.[33] Crucially, he recognized the huge

profits to be gained from government contracts, and in the words of a *Fortune* magazine article, “backed a truck up to the mint.”[34]

His acquisition and exploitation of Vulcan Mine fit into a strategy of vertical integration that began with his entry into the shipbuilding industry. In 1939, the British government signed a contract with Kaiser to provide cargo ships and to construct shipyards.[35] Motivated by his inability to get a regular supply of steel from Eastern plants and his desire to create a West Coast steel industry, Kaiser presented plans to the U.S. government in 1940 to construct his own steel plant and began searching for a local source of iron ore.[36] With the outbreak of World War II, Kaiser finally received the approval of the U.S. government, which closely controlled the use of key minerals during the war, and received the needed loans from the Reconstruction Finance Corporation (RFC).[37]

The Iron and Steel Division of Kaiser Co., Inc., purchased the Vulcan Mine from C. C. Jones in June 1942. Mining began on December 12, 1942, and the first pig iron was cast at Fontana on December 31.[38] The Fontana steel mill provided steel for Kaiser’s network of shipyards on the West Coast. Reportedly, the first ship to be built with Fontana steel was the S. S. Richard Moczkowski, launched in August 1943 at Kaiser’s Richmond shipyards.[39] Through the course of World War II, California Shipbuilding Corporation at Terminal Island, Los Angeles, managed by Henry Kaiser and his associates, manufactured 306 Liberty Ships, plus 30 Liberty tankers. The Permanente Metals Corporation Yard No. 1 at Richmond, California produced 138 Liberty ships. Yard No. 2 produced 351 Liberty ships. The Vancouver, Washington Kaiser shipyard produced ten Liberty ships. Kaiser's Oregon Ship Building Corporation at Portland produced 322 Liberty ships.[40] In all, Kaiser employed some 250,000 workers in his shipyards during the war, building 1,490 vessels by 1945.[41] Kaiser shipyards produced about one third of the cargo vessels constructed by the United States during World War II.[42]

While the war provided the principal reason for acquiring the Vulcan Mine, the mine continued to be useful after the war had ended. Kaiser foresaw the need for steel in peacetime as well for “household appliances, automobiles, personal airplanes, and a variety of other products.”[43] He was a passionate booster of Western economic expansion. He faced a great deal of opposition from Eastern steel businessmen as he sought the government approvals and contracts he needed to advance these goals.[44] Kaiser tied his own business’s story into a broader narrative of westward migration and manifest destiny. At the 1942 “blowing in” at Fontana, he said, “The westward movement which began so long ago on the Asiatic plains did not come to an end on the Pacific slope of North America. It is poised for the next great thrust. The day of the West is at hand. ‘Westward, the course of empire takes its way.’”[45]

With very little overburden above the iron ore, the Vulcan Mine was an ideal candidate for the open-pit mining techniques that became increasingly prevalent in the mining industry through the twentieth century. Seven benches were constructed using churn drills, wagon drills, and jackhammers to prepare holes for blasting with dynamite. Two-and-a-half cubic yard diesel shovels were used to remove the ore. Euclid ten-cubic-yard dump trucks removed the ore to the electrically driven 42- by 48-inch jaw crusher, where ore was reduced to eight-inch diameter gravel. The truck drivers transporting ore from Vulcan Mine to Kelso worked for a contractor, the Desert Transportation Company. Initially, the company used twenty-five cubic yard Maxi trucks to move the ore to the loading ramp at Kelso in loads of thirty-five tons. Starting in March 1943, it also began using tractor-trailer dump trucks. Although the tractor-trailer rigs were smaller, they were faster and more efficient.[46] As the Kaiser Company newspaper, the *Snorter,* put it, “The haul has been taken over by semi-truck and trailers who are able to make the trips up and down the hill much faster and more economically but not as picturesquely as the big rigs.”[47] The semitrailer trucks used in 1948 were Kenworth fifteen cubic yard rigs that could carry about twenty-five tons.

From 1942 to 1947, the mine produced 2,643,000 tons of ore. It produced 695,233 tons of iron ore in 1944, and 141,823 tons in 1945.[48] By January 1947, 2.1 million tons of ore had been mined, an average of about 500,000 tons a year.[49] The grade of the ore was 52.23% iron, 0.058% phosphorus, 5.22% silica, and 1.62% sulfur.[50] All of the ore for Fontana came from the Vulcan Mine from 1942 until January 1, 1945. In 1945, about 60% of the ore came from Vulcan, while 40% came from the Senter Walker properties near Cedar City, Utah.[51] It is unclear what percentage came from Vulcan after that date. From October 1945 to March 1946, mining was suspended to reduce ore in the operation's stockpile.[52] In 1947, the mine had one shift per day that was producing, on average, 2,500 tons.[53] Active mining apparently ceased on or around July 1, 1947, although Kaiser Corporation continued to ship ore from their stockpiles until 1950.[54]

Throughout its years of operation, dozens of workers were employed at the mine and at Kelso. By October 1942, some 55 men were working preparing the mine for operation.[55] By January 1943, there were about a hundred men living at the mine.[56] An article in July 1943 described the staff at the mine as "some 75 men."[57] In 1948, the workforce were described as "80 to 85 ... at the mine and 12 to 14 men on the contract truck haul."[58] Although Henry Kaiser had adopted an anti-union stance early in his career, he eventually decided it was best to cooperate with unions in order to successfully pursue his business, given the growing power of labor in the 1930s.[59] The workers at the Vulcan Mine were organized with the Metal Trades Council, an affiliate of the American Federation of Labor. In July 1943, the council negotiated a one-year contract on behalf of Vulcan employees.[60] The contract included guaranteed wages and working conditions, a forty-hour workweek, time-and-a-half for overtime, regular pay plus living expenses when travelling on company business, designated holidays on New Year's Day, Memorial Day, Fourth of July, Labor Day, Thanksgiving, and Christmas, and one week of vacation with pay after one year of service.[61]

While the majority of workers were men, women worked as office workers, waitresses in the mess hall, and cleaners in the dorms. The variety of workers needed to keep the mine going can be seen by considering the various jobs mentioned in the *Snorter* newsletter during the war years. Office workers included mine superintendent, mine coordinator, bookkeeper, secretary, accountant, time checker, and paymaster. Mine workers included a wide variety of positions, such as jackhammer operator, shovel operator, conveyor attendant, churn drill helper, welder, foreman of drilling and powder men, engineer, surveyor, ore sampler, electrician, and mechanic. The operation of the mine also required transport workers, warehouse attendants, workers at the Kelso Ramp, dorm custodians, and mess-hall workers. A complete listing of the occupations mentioned in the *Snorter* appears in this report's supplemental information section.

Robert E. "Bob" Talley was the mine superintendent from January 1943 (and perhaps earlier) to April 1943. Talley graduated from Columbia University and worked at a variety of mines in the Western states before joining Kaiser corporation.[62] J. E. Yeomans became the mine superintendent in April 1943. Yeomans died on August 17, 1944 from a cerebral hemorrhage he suffered at the mine.[63] Charles Severy, a graduate of Stanford University, worked as the geologist involved in investigating the site for KCI. He was "the first geologist employed by Kaiser Corporation, iron and steel division" and "played a large part in the geological development of Vulcan."[64] By April 1943, Jack Harris, also a Stanford graduate, worked as geologist at the mine.[65]

Realizing that mining in an isolated desert location was perhaps not the most appealing work, Kaiser Corporation made special efforts to provide the workers the best food possible. Whether the workers agreed it was good or not is not clear, but the company newsletter certainly made a point of emphasizing the quality of the food.[66] The boredom of life in the desert was relieved by occasional trips to Las Vegas.[67] Workers at the Fontana mill also donated old magazines to provide miners at Vulcan with reading material. "The miners work hard under difficult desert conditions and it is the least we can do to help give them some relaxation in the off hours."[68]

Kaiser Company Inc. quickly constructed the buildings it needed at the mine in a few months starting in late 1942. The construction crew was headed by Fred Harden and Loran B. Pipes.[69] The Vulcan site already had "two comfortable dormitories" by January 1943.[70] The cook's dormitory was completed and occupied in February 1943.[71] By about August 1943, the mine had a "new lab for the assaying of the Vulcan ore on the job site."[72] According to the *Snorter* newsletter, construction was "a thing of the past" by March 1943.[73] In December 1949, most of the buildings at Vulcan were put up for sale and were likely removed around that time.

Two descriptions of the buildings at the Vulcan Mine, one from 1943 and one from 1949, give a sense of the mine's infrastructure during its active years.[74] As these descriptions make clear, a number of buildings were larger in 1949 than in 1943, suggesting that the company constructed additions to these buildings as needed to support the mining operation. A 1943 Kaiser company building inventory describes the warehouse and office as a twenty-five-by-seventy-foot, single-story, wood-frame structure (1,750 square feet) on concrete piers with wood floors and composition roof, and a 1949 newspaper ad also describes this building as 1,750 square feet. The 1943 document describes the mess hall as a twenty-one-by-sixty-nine-foot, single-story, wood-frame structure (1,449 square foot) on concrete piers with wood floors and composition roof. In 1949, the building is termed the "cookhouse building" and listed as having 1,600 square feet. In 1943, the dormitories consisted of two twenty-by-seventy-foot structures (1,400 square feet each), with ten-by-nineteen-foot porches. They were wood-frame structures on concrete piers with wood floors and composition roofs. In 1949, these dormitories, or "bunk houses," were listed as 2,200 square feet each. In 1943, the garage was listed as a forty-one-by-fifty-five-foot, single-story, wood-frame structure (1,115 square feet) with a concrete floor under the car pit and a composition roof. The building also contained a chemical laboratory. The garage was not listed in 1949. The power house was described as a single-story, wood-frame structure in 1943 with no size listed. In 1949, it was described as 720 square feet. The central heating building was listed as a fourteen-by-sixteen-foot, single-story, wood-frame structure (224 square feet) with composition roof; in 1949, it was listed as 225 square feet. The first aid room was described in 1943 as a single-story, nine-by-twelve-foot, wood-frame structure (108 square feet) with composition roof. It was listed as 168 square feet in 1949. In addition, several structures were listed for sale in 1949 that did not appear at all in the 1943 list: a 792-square-foot cook's dormitory (possibly the former manager's house), eight plywood trailers without wheels, a 2,250-square-foot repair shop, a 1,160-square-foot machine shop (possibly the former garage), a 1,080-square-foot oil storage building, three store rooms at 150 square feet each, a 225-square-foot store room, and a 10,000 gallon railroad water tank car. KCI also constructed a trailer park for its married employees to the east of the depot.

The road from Vulcan Mine to Kelso was realigned and improved soon after Kaiser acquired the mine. An undated newspaper clipping (ca. June 1942) said "A road is being constructed from Kelso on the Union Pacific Railway, 15 miles [sic] south to the mining claims. Costs of constructing the road are being paid by the Kaiser Co. which is providing its own workers and equipment on the project."[75] The road from Vulcan to Kelso was already described as a "smooth paved road" by January 1943.[76] A comparison of the 1941 plat map and current aerial photographs of the road shows that the alignment was changed in several places. The January 22, 1943, issue of the *Snorter* said that there was "an 8.9 mile paved road owned and maintained by Kaiser Co. to the double railroad spur track at Kelso." In 1948, the road from Vulcan Mine to Kelso was described in the following manner: "The road is 22 feet wide and was built by removing all the large boulders from the road bed, smoothing with a blade, and laying a 3-inch, blacktop, road-mix, macadam surface cover, in which the minus 1½-inch material from the sides of the road be was used."[77]

At Kelso, Kaiser Corporation, Inc. built a spur and a loading ramp south of the tracks and west of the depot to load railcars for the 178 mile journey to Fontana. Ore was dumped into a 100-ton bin. A pan feeder under the bin discharged onto a 42-inch belt conveyor, which in turn discharged into

the rail cars. The pan feeder, loading belt, and a car puller for the rail cars were powered by diesel-powered 60 kilowatt electrical generator.[78]

Period After Active Mining, 1947 to present

Kaiser ceased active mining at Vulcan in 1947. However, the mine continued to ship out stockpiled ore after that date. In the twelve months from July 1948 to June 1949, for instance, the Vulcan Mine shipped 167,970 tons of iron ore.[79] Ore was also shipped in 1950, the final year in which Kaiser shipments from Vulcan Mine are recorded.[80] During the 1950s, the Vulcan Mine was worked periodically to obtain iron ore for use in low-heat portland cement by the Mineral Materials Co., which apparently leased the mine from Kaiser. The addition of iron oxide to cement reduces heat generated during setting and is useful in massive construction projects such as dams in order to reduce cracking from internal thermal stresses. There were two periods when Mineral Materials were extracting materials, 1953 and 1957.[81] Mineral Materials did not make use the loading area that Kaiser had developed in the 1940s. Instead, Mineral Materials built a new road at Kelso to lead directly from the Vulcan-Kelso road to a new tipple close the main railroad track.[82]

After 1957, Vulcan was no longer actively mined, although Kaiser Steel Corporation and later Hugh Morris “Bud” Davenport continued to perform the minimal activities needed to file proof of labor statements with San Bernardino County and to maintain their claim.[83] A search of the San Bernardino County index of recordings shows that Kaiser Corporation filed on the Vulcan Mine every year until it sold the property to Hugh Davenport. Kaiser Steel conducted evaluations of the Vulcan Mine in the period 1985-90, consisting in “the preparation of detailed topographic maps of the property, geologic mapping, ore sampling, and metallurgical assaying and ore concentration test work,” as well as testing existing ore stockpiles for potential processing.[84]

After the period of active mining, the United States gave the area surrounding the Vulcan Mine increasing levels of protection. “The East Mojave National Scenic Area was formed by an order of Secretary of the Interior Cecil Andrus in December 1980, just before President Reagan took office, it was reauthorized by Interior Secretary James Watt in early 1981.”[85]

Kaiser Steel Resources conveyed the Vulcan Mine to Hugh M. Davenport, Agnes E. Davenport, Michael G. Alex and Mary S. Alex, and Jo Anne Knatcher in a corporation grant deed signed November 6, 1989 and recorded January 19, 1990. However, Kaiser retained the mineral rights.[86] A grant deed signed and recorded May 11, 1990, conveyed the land from the Davenports, the Alexes, and Knatcher to White Creek Enterprises, a corporation owned by Hugh Davenport.[87] Davenport hoped to use the site as a dump for 18,000 tons of shredded tires annually. However, on July 13, 1993, the San Bernardino County Board of Supervisors denied, in a 3-1 vote, a request from White Creek Enterprises for a permit to establish the dump.[88] The county vote occurred at a time when Congress was considering the creation of a National Park Service unit in the area and the dump permit was opposed by environmentalists, including Citizens for a Mojave National Park. White Creek Enterprises conveyed the Vulcan Mine back to the Davenports, the Alexes, and Knatcher in a quitclaim deed signed December 15, 1993.[89] Ultimately, President Bill Clinton signed the California Desert Protection Act on October 31, 1994, “eliminating the East Mojave National Scenic Area and giving birth to the Mojave National Preserve.”[90] Hugh M. Davenport, Agnes E. Davenport, Michael G. Alex, and Jo Anne Knatcher conveyed 96.40 acres comprising the Vulcan claims to the United States in a donation grant deed and a quitclaim deed both signed December 30, 1997.[91]

In 2010, the National Park Service constructed a fence around the pit using funds from the American Recovery and Reinvestment Act of 2009 (the “stimulus bill”), using workers from the California Conservation Corps, a program which employs California residents ages 18 to 25.

Endnotes:

[1] Eric Charles Nystrom, "From Neglected Space to Protected Place: An Administrative History of Mojave National Preserve" (California: National Park Service, 2003), 9-11.
[2] Nystrom, "From Neglected Space," 11.
[3] Chester King and Dennis G. Casebier, "Background to Historic and Prehistoric Resources of the East Mojave Desert Region" (Riverside, California: Bureau of Land Management, 1981), 8.
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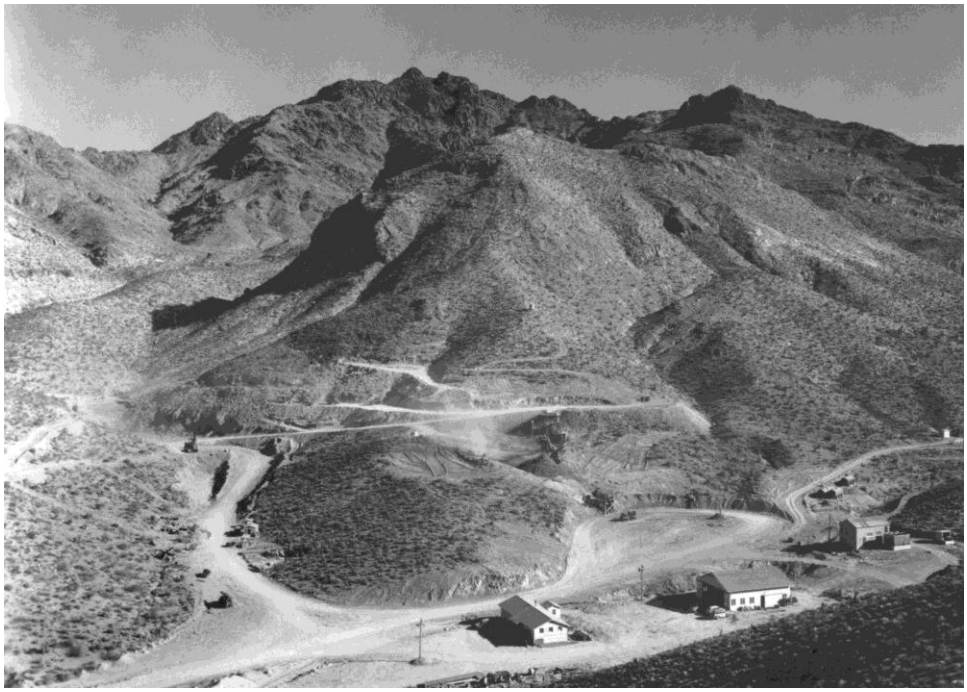
History Figure 1. 1942 photo of residential buildings and Vulcan Mine area before pit, looking northeast. Davenport Photo Collection, held at Mojave National Preserve.

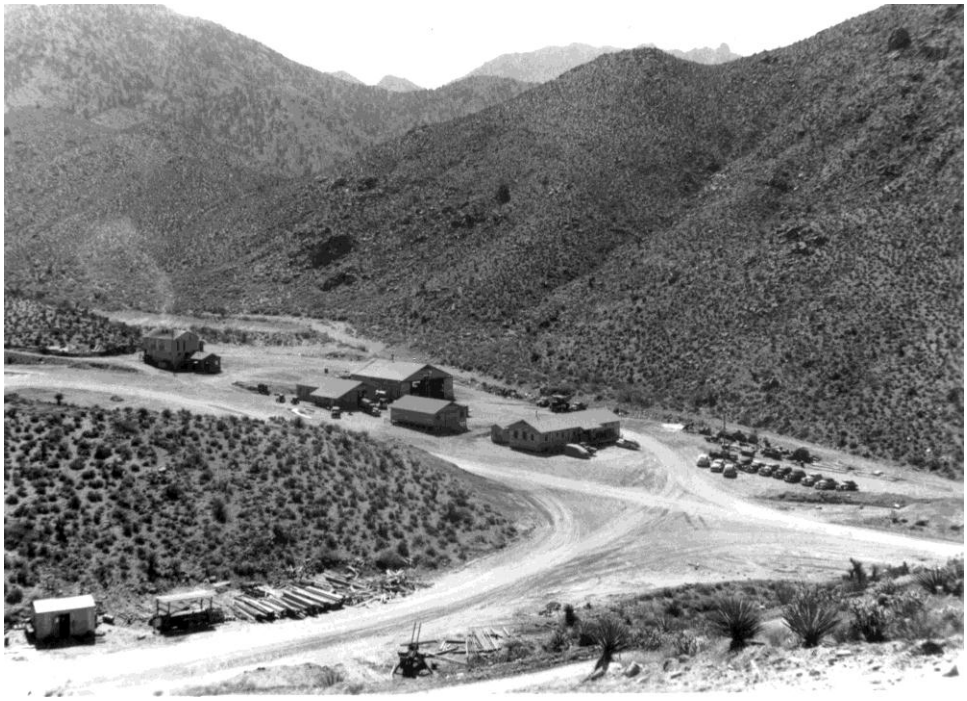


History Figure 2. 1943 photo of operational buildings and early mining activity, looking north. Davenport Photo Collection, held at Mojave National Preserve.

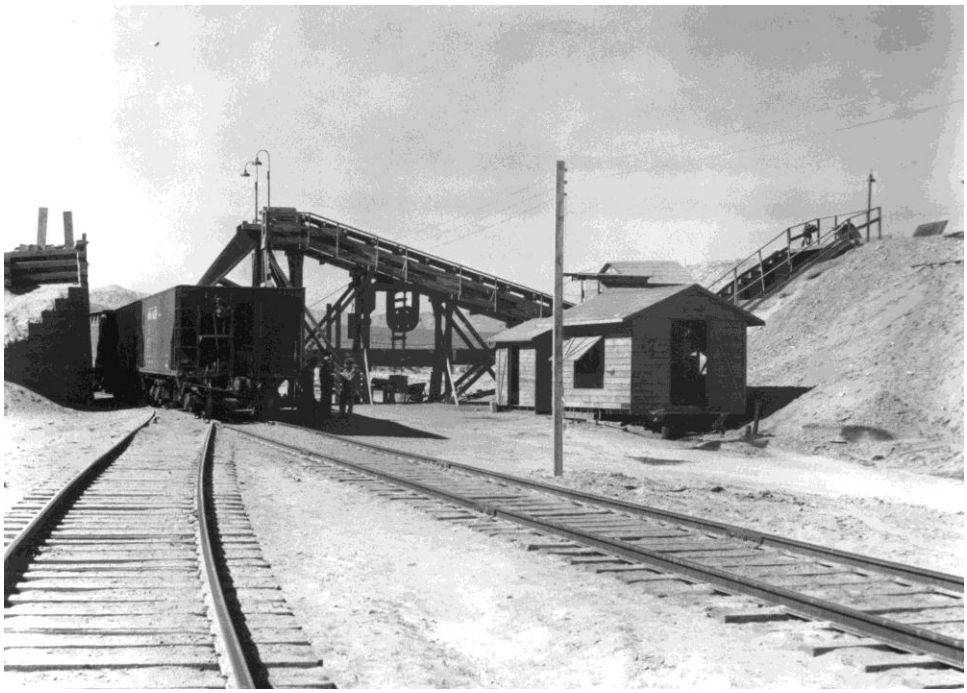
History Figure 3. 1943 photo of Vulcan Mine Road and truck with crushed ore, looking west toward Kelso. Davenport Photo Collection, held at Mojave National Preserve.

History Figure 4. 1943 photo of the crusher plant loading a truck, looking northwest. Davenport Photo Collection, held at Mojave National Preserve.

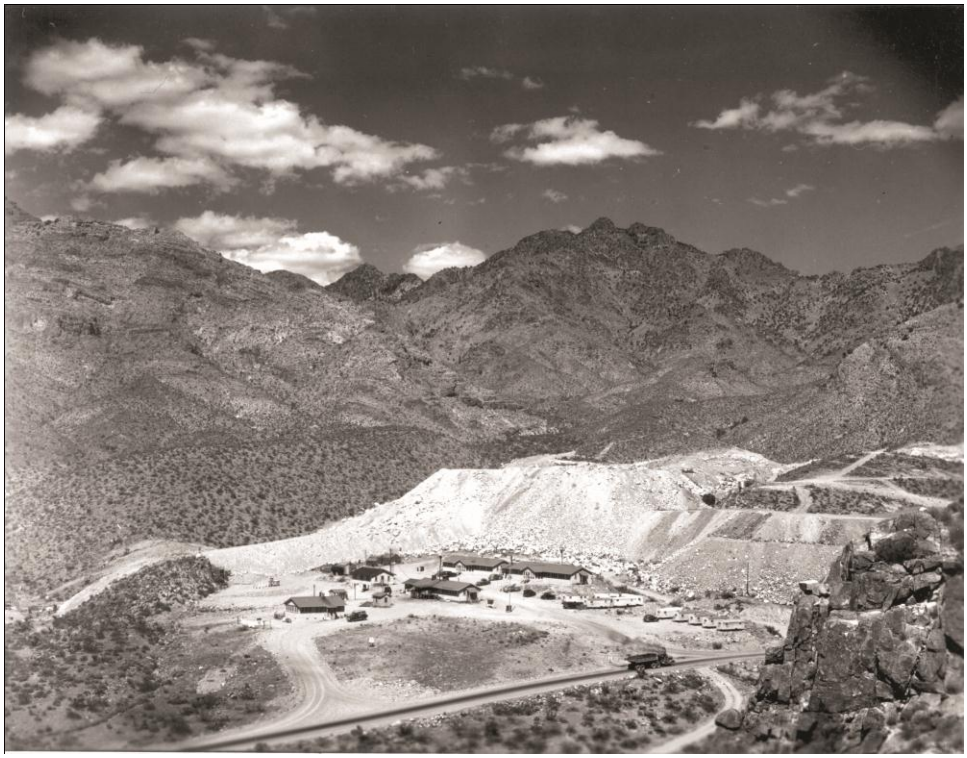
History Figure 5. 1943 photo of the residential building cluster before the waste rock pile, looking west. Davenport Photo Collection, held at Mojave National Preserve.



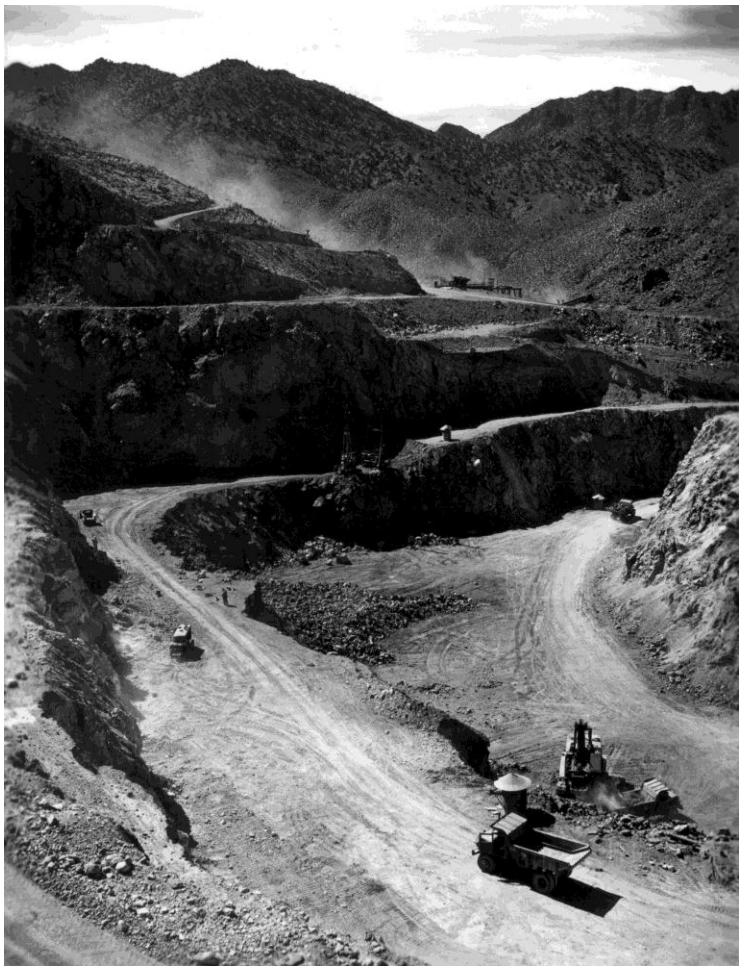
History Figure 6. 1943 photo of the operational building cluster, looking southeast. Davenport Photo Collection, held at Mojave National Preserve.



History Figure 7. 1943 photo of an ore car being loaded by conveyor at the ramps at Kelso, looking southeast. Davenport Photo Collection, held at Mojave National Preserve.



History Figure 8. 1942 photo of the residential building cluster and waste rock pile, looking northeast. Severy Photo Collection, courtesy of Linda Slater.



History Figure 9. Photo of the pit and associated benches, looking southeast. Severy Photo Collection, courtesy of Linda Slater.

Analysis & Evaluation of Integrity

Analysis and Evaluation of Integrity Narrative Summary:

National Register Bulletin 42: Guidelines for Identifying, Evaluating, and Registering Historic Mine Sites states that “when assessing the integrity of a mining property, it is important to remember that the National Register will accept mining properties as eligible for the National Register if the property "exhibit[s] a labyrinth of paths, roads, shaft openings, trash heaps, and fragments of industrial activity like standing headframes and large tailings piles…[where] the combined impact of these separate components may enable the property to convey the collective image of a historically significant mining operation." The National Register guidelines also point out that mining operations that occurred at a specific property "may be judged to have integrity as a system even though individual components of the system have deteriorated over time" due to the fact that most mining properties were intended to last for only a brief period of time.

The historic features of the 437-acre Vulcan Mine Historic District include the open pit, waste rock piles, building foundations and footings, loading ramps, and roads, which convey the historical significance of the property during the period of significance. The remaining buildings and structures illustrate the extent of development that occurred as part of the mining activity. The modified topography of the open pit and waste rock pile reveals the process and effect of open pit mining on the land. The historic road alignments continue to demonstrate how material was transported within the mine complex and how ore was transported from the mine to the railroad at Kelso.

The historic district is comprised of two developed areas: a mining complex, where the open pit, residential area and operational areas were located and the loading ramps near Kelso Depot. These two areas are connected by a paved road. The landscape characteristics that help to convey the historic character of the historic district include natural systems and features, spatial organization, circulation, topography, buildings & structures, and archeological sites. Each of these landscape characteristics are summarized below and are detailed in subsections following the summary.

Natural Systems and Features
The character of the Vulcan Mine Historic District landscape is dominated by the desert ecosystem of the Mojave National Preserve. The mining district is located in a dry alluvial fan that slopes down from the Providence and Kelso Mountain Ranges towards the Kelso Wash. The relatively gentle terrain and the openness of the creosote community vegetation allows for broad views of the surrounding landscape and exposure of the mining features. An iron ore outcrop marks the center of the mining complex and location of the large open pit. Numerous washes pass through the historic district, which influenced the locations chosen for development of roads and buildings at the mine.

Spatial Organization
The assemblage of mining features includes an open pit, waste rock pile, foundations, footings, structures, graded areas, ramps, and roads. The arrangement of these features are best understood through their function as part of the operational or residential development of the site and how the circulation systems connect these two functions.

Circulation
The road system alignments within the Vulcan Mine Historic District have changed little from the period of significance. The interconnections between the open pit, waste rock pile, residential and operational areas, and to the Kelso loading ramps are still evident today. Some of the historic roads are now road traces, no longer maintained, and are gradually losing their distinct character with time. The overall alignments of the roads are an important aspect of the historic character of the Vulcan Mine Historic District. The circulation system helps tie the district together and convey the interconnected nature of the mining operation as well as revealing connections with the regional railroad network.

Topography
The open pit mining technique that was used at Vulcan Mine Historic District left distinctive topographical features on the land including an open pit, waste rock pile, graded areas, and earthen ramps. The orientation of the pit running in the northwest southeast direction reveals the general orientation of the below surface ore body. Near the pit is the waste rock pile, the size of which reveals the nature of the large-scale mining operation at Vulcan Mine. West and south of the pit are two cleared and graded areas defining the residential and operational areas, arranged along the mine complex circulation network. These graded areas aid in understanding where the residential and operational activities where centered during the period of significance.

Buildings and Structures
Several foundations and footings remain, aiding in the interpretation of the historic use at Vulcan Mine during the period of significance. These foundations, in conjunction with the numerous archeological features, circulation features, and topography features demonstrate the mine activities that took place during the period of significance. Some concrete footings and utility poles have been determined to be non-contributing because they are not associated with the mining activity during the period of significance. Additionally, a non-contributing chain-link fence has been added to the historic district since the period of significance.

Archeological Sites
Many of the features of the Vulcan Mine Historic District are archeological in nature. Archeological sites include debris associated with the crusher plant, and a historic road and debris site. The archeological sites mark the location of buildings, structures, roads, and activities associated with mining that took place during the historic period. In conjunction with the buildings and structures, topographic features, circulation features, and small scale features, the archeological features give a good sense of the operations and layout of mine.

Evaluation of Historical Integrity
The Vulcan Mine Historic District still retains its ability to convey the scale, character, technology, and operation of the mining and mineral transport processes that took place within the district. The aspects of location, design, setting, materials, workmanship, feeling, and association have been retained. The isolated desert setting and lack of modern intrusions that have been retained since the historic period helps convey the historic associations of industrial mining activities at this location. Existing mine features continue to convey the historic feeling established by the presence of a large-scale mining operation in an isolated desert location.

The location of the building footings and foundations, open pit, waste rock pile, graded areas, ramps, and circulation system allow modern observers to interpret the historic layout, processes, and interconnected nature associated with the mine during the historic period. The historic design and workmanship of the mine is revealed in the assemblage of mining features

which included the open pit, waste rock pile, foundations, graded areas, ramps and circulation routes. The design and workmanship of the crusher plant is revealed in the foundations and footings, and looped access road. The graded areas within the mining complex along with the presence of a variety foundations and footings reveals the layout of the residential and operational areas utilized by mine employees during the period of significance. The primary remaining material within the historic district is concrete, which reflects the industrial build up at the mine and the need for materials that would hold up to industrial uses. Taken together, the remaining features bear record of the substantial mining activities that took place within the Vulcan Mine Historic District during the period of significance (1942 to 1947).

Natural Systems and Features

Natural systems and features are defined as natural aspects that have influenced the development and physical form of the landscape. Natural systems that have significantly influenced the development of Vulcan Mine include topography, hydrology, vegetation, and climate.

The Vulcan Mine Historic District is located within the southwestern quadrant of Mojave National Preserve, on the eastern slope of the Providence Mountain Range in the exposed, harsh desert environment. The area is bordered by the colder higher altitudes of the Providence Range to the east and the lower altitude and hotter temperatures of the Kelso Dunes to the west. The mining complex of the district is located at the 4000 foot elevation level at the base of a steep canyon extending southwest from 6900 foot Fountain Peak, but begins to level out below the mine with a slight southwest slope. The canyon opens to the west with low growing vegetation allowing for views of the Kelso Dunes in the distance. The large, 40 to 60-foot deep open pit is central to the mine complex within the Vulcan Mine Historic District, bisecting a ridge of Fountain Peak. Two washes pass through the mine complex including one wash on the south side of the operational area and road, flowing west from Foshay Pass.

Topography and Hydrology

The mine is located in a topographically varied landscape comprised of a series of northwest sloping ridges dissected by small to large intermittently flowing washes that empty into the Kelso Wash along the Kelso-Cima Road. The alluvial wash extending west from the mine provided relatively flat terrain for the Vulcan Mine Road that stretches west and northwest from the mine meeting up with Kelbaker Road, leading to the loading ramps at Kelso. The washes that pass through the district are dry most of the time, while active water flow is associated with seasonal storm events. As revealed in the location of the foundations and graded areas, buildings and structures were located at elevations slightly above the washes, to avoid damage resulting from flood events. The same is true of the roads, with most located between washes, although some washes occasionally cross the road. The gentle grade within the washes allowed for easier road construction when compared to the steep hillsides enclosing the mining complex to the north and south. There is existing indication that in at least one case, a wash along the south side of Vulcan Mine Road was relocated by building up earth to form a small dike that diverted water away from the road.

There were no active springs within the vicinity of the mine to provide water during the period of significance. Early on, water was piped to the mine from Goldstone Spring, roughly 1.25 miles away. After the period of significance in 1948, water was purchased from a million-gallon reservoir in Kelso that was piped 5 miles outside of the mining complex and trucked in where it was stored in tanks throughout the complex.

Geology

The geology of the area led to the Vulcan Mine becoming the primary source of iron ore during World War II on the west coast. In 1948, Charles Severy of the U.S. Bureau of Mines described the geology of the area in his report titled Mining Methods at the Vulcan Iron Mine. “Geologically, this region is composed of three main rocks: sedimentary deposits, which have since been more or less metamorphic; intrusions of acid igneous rocks; and later intrusions and flows of rhyolites” (4). He continued to describe the iron deposit at Vulcan Mine as an “irregular, mushroom-shaped replacement of limestone by magnetite and hematite along a fault contact with a quartz monzonite.” (4). The oval-shaped ore body is about 700 feet long by 325 feet wide,

striking east-west, occupying two hillsides that are split by a dry wash. The larger portion of the ore body is on the eastern slope. No other mines in the Providence Mountains were known for iron as abundant as Vulcan Mine. Prior to the patent of the Vulcan claim, the area was known for its major mining operations: Bonanza King and Silver King mines, north of Vulcan Mine.

Vegetation

The Mojave Desert is comprised of predominantly low, sparse vegetation adapted to the harsh desert environment. Due in part to a range in elevation from below sea level (in Death Valley) to 3,500 feet (1,350 meters) native plant communities of the Mojave Desert contain a mixture of species from the lower Colorado and higher Great Basin vegetation communities. The two primary vegetation communities, as identified in the 2006 Mojave National Preserve park brochure, are Creosote Bush Scrub and Cactus-Yucca Scrub.

The Creosote Bush Scrub habitat and vegetation community consists primarily of the strong-scented creosote bush (Larrea tridentate) and bursage (Ambrosia dumosa). As explained in the park brochure, "creosote bushes are said to be the world's oldest living things; some colonies in the Mojave Desert are 11,500 years old." Other species found in this zone include brittlebush (Encilia farinose), desert mallow (Sphaeralcea ambigua), hedgehog cactus (Echinocereus triglochidiatus), and various types of cholla (Cylindropuntia spp.).

The Cactus-Yucca Scrub community includes several species of cacti, including the prominent barrel cactus (Genus ferocactus) and the Mojave yucca (yucca schidigera). Other vegetation, common to the Vulcan Mine site include turpentine broom (Thamnosma montana), desert mistletoe (Phoradendron californicum), Mojave indian paintbrish (Castilleja plagiotoma), Fremonts dalea (psorothamnus fremontii), and Burrobrush (Hymenoclea salsola). Many of these hardy plants bloom with brilliant color in the spring and then fade into the dry silver and sage hues during the summer.

During the period of significance, the lack of trees certainly made road building an easier prospect, but meant a limited local supply of wood for building materials, which had to be brought in from long distances. The species and character of the vegetation provided an open landscape that still remains today. Over time, vegetation has continued to encroach on the historic roads that are no longer maintained or frequently used. Vegetation is also growing out of cracks in the concrete foundations at the residential and operational building areas causing some damage to these features.

Climate

The Mojave Desert experiences extreme variations in temperature and rainfall throughout the year. As summarized in the Mojave park brochure, low elevations, temperatures above 100°F typically begin in May and can last into October. The mountains offer a relatively cooler "retreat," averaging 90°F in July, the hottest month of the year. Extreme temperature fluctuations can be attributed to the clear skies and seasonally strong winds. Intense daytime heat can quickly radiate back toward the sky causing variations that are often more than 30°F in a single day. During winter months, temperatures can drop to freezing, particularly at higher elevations such as the Vulcan Mine.

Deserts are generally understood as dry places, where potential evaporation exceeds precipitation. But rainfall in the Mojave Desert varies by both time of year and elevation. Rainfall ranges from four inches per year at lower elevations to over ten inches at higher elevations, predominantly falling between November and March. During August and September, occasional

thunderstorms are carried in with warm and moist tropical air from the Gulf of California and the Gulf of Mexico.

Summary
The natural systems and features that influenced the way the landscape was developed still remain today and contribute to the historic district's setting. The steep topography near the open pit required areas to be leveled to build residential and operational buildings to support mining activities, but the gentler slope further west allowed for simple road construction to Kelso. Locations of washes helped determine placement of the mining infrastructure, such as buildings and roads.

Landscape Characteristic Graphics:

Natural Systems and Features Figure 1. Washes flowing westward from the Providence Mountains with Kelso Dunes in the background. Source: PWRO, 2010.

Natural Systems and Features Figure 2. Native Vegetation on the hillside above the open pit. Source: PWRO, 2010.

Spatial Organization

Spatial organization is the three-dimensional organization of physical forms and visual associations in the landscape. The Vulcan Mine Historic District retains features that reflect the historic organization of the highly successful mining operation during the historic period from 1942 to 1947. Aspects of its organization reflect the process of open pit mining and how this activity shaped the landscape. The Vulcan Mine-Kelso Road still connects the industrial and residential areas at the mine complex to the Kelso loading ramps where the ore was loaded onto to rail cars to be transported to Fontana, California.

The mine complex, located nine miles southeast of Kelso, contains the largest concentration of features associated with the historic mining activity at the Vulcan Mine Historic District. The complex is centered on the large open pit, waste rock pile and adjacent building areas. The two distinct areas where buildings and structures once stood are the residential area and the operational area, both of which are sited on more level land adjacent to the roads, pit and waste rock pile, responding to the existing topography. Graded roads and walkways connect the building areas with one another and the mining activity.

The residential area is located southwest of the pit, just below the waste rock pile in a level, graded area north of the Vulcan Mine Road. The buildings and structures were associated with habitation activity of those who worked at the mine. Buildings and structures that were constructed in this area during the period of significance were two dormitories, cooks dormitory, mess hall, superintendants cottage, two sheds/equipment structures, thirteen tent frames, and two tanks. Foundations from a water tank, superintendent's cottage, and cooks dormitory, and the large graded area where the two dormitories and mess hall once stood remain today.

South of the open pit is an extensive array of concrete foundations and footings associated with the operational area. In the northern portion of the operational area, closest to the open pit, is the base of the crusher plant that stood on the hillside and traces of a looped access road used for loading trucks. The extracted ore was placed directly onto a conveyor belt at the top of the hillside, which moved the rock into the crusher plant and then down into the trucks. The presence of debris from the crusher plant along with the foundations provides a sense of the activities that took place in the 1940s. In addition to the crusher plant structure are a cluster of foundations on a level terrace south of the slope. Historically, this area had a warehouse, garage, machine shop, administrative building, power house with three buildings, and two storage structures. Today this area retains the foundations of every building or structure except the smallest shed that was located behind the warehouse, reflecting the efficient use of level land below the hills and above the wash. The Vulcan Mine Road, loading access road, and the open pit access roads all intersect in this area.

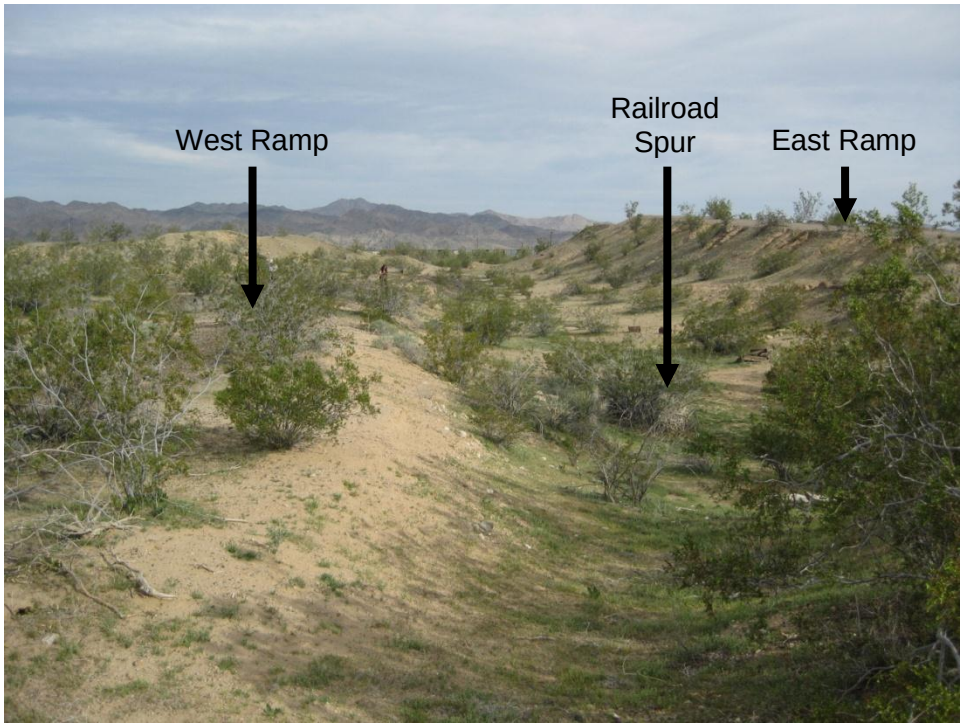
Two additional foundations are located toward the eastern end of the Vulcan Mine Road, east of the pit. These foundations mark the locations of the cap and fuse house and the magazine storage structure. Both were sited to make use of the topography and are built into the hillside with only short access roads off the main road. They were likely located further away from the mining activity to ensure safety of the explosive materials they housed.

The close proximity of the mine complex to the nearby town of Kelso is potentially one of the major factors in the mine's success. With a location just nine miles southeast of Kelso, it was easy to transport iron ore to the railroad line heading west to the steel plant in Fontana, California. In addition to its proximity to Kelso, the historic district was also located in a highly

accessible area of the Providence Mountain Range at the base of the western foothills in a relatively wide alluvial valley. The short distance and gentle grade of the lower canyon allowed for ease in transporting the ore away from the mine complex as well as large machinery, equipment and staff to run the mine.

During the period of significance, a single road used for transporting people, ore and equipment was aligned between Kelso and the mine complex following a portion of the current road now known as Kelbaker Road and the Vulcan Mine Road. Ramps for loading ore into the rail cars were located just south of the railroad track at Kelso, west of the current Kelbaker Road. Two spur tracks ran from the main line south to the ramps. Today the organization of this transport system is still evident through the earthen loading ramps, railroad tracks, and ramp access roads.

Landscape Characteristic Graphics:



Spatial Organization Figure 1. Loading ramps at Kelso, facing northwest. Source: PWRO, 2010.

Spatial Organization Figure 2. Residential Building Area and Waste Rock Pile at left, facing southeast. Source: PWRO, 2010.

Spatial Organization Figure 3. Open pit with terraced slopes that served as stabilization structures as well as roads to access the bottom of the mine, facing northwest. Source: PWRO, 2010.

Topography

Topography is the three dimensional configuration of the landscape surface characterized by features and orientation. Topography, as discussed here, is limited to the manipulation of the landscape by human action.

The activities associated with mining, such as excavation and road system development, significantly altered the topography of the landscape at the Vulcan Mine Historic District. While the greatest human manipulation of the earth took place at the mine complex, the development of the earthen Kelso loading ramps cannot be discounted, but are described in the Buildings and Structures section as structures listed on the LCS. At the mine, material was removed from the hillside to extract the ore, creating a large deep pit, while the waste material was relocated nearby, filling in the adjacent valley. Additional topographic manipulation included tunnels that were created in search of the extent of the iron ore vein during the period of significance. These underground passages are typically not visible above ground except for drill holes and entrances to shafts and adits, and are often difficult to locate. Topography and circulation are very much intertwined at Vulcan Mine when it comes to early development of the pit. The benches surrounding the pit were created as material was excavated and used as slope stabilization structures as well as roads to remove material from the pit. Likewise, roads were created at the waste rock pile as access points for depositing the unwanted material.

Open Pit Iron Mine
The 1948 Severy Report best describes the pit as stadium-shaped with an opening at the top that measures 1000 feet long and 600 feet wide with six benches cut into the steep walls to maintain a pit wall slope of ½:1 (8). The oblong pit runs at a northwest/southeast angle, bisecting a small ridge that runs perpendicular to the lower flanks of the 4600-foot tall peak to the east where the highest ore outcrop reached 4060 feet in elevation. Development of the pit obstructed a wash that once lay between the ridge and peak. It is unclear how the runoff was directed during the period of active mining within the pit, though it now flows from the wash into the pit where water is present year round. It appears as though the northwestern portion of the pit and the waste rock pile are also located where another wash once flowed through. The wash now flows in a narrow valley between the waste rock mound and a taller ridge to the north.

Open pit mining generally uses the bench-mining approach, as found at Vulcan Mine. A series of terraces, called benches, were cut into the hillside in order to extract the ore from the walls of the pit. The benches were also used as roads to transport the ore to the crusher plant or the overburden to the waste rock pile. Some benches were abandoned as the pit was dug deeper and the ore was more abundant elsewhere in the pit. The lowest bench, the bottom of the pit, is at the 3790-foot level. According to the 1948 Severy report, the plan was to open one more bench further down to the 3750-foot level, but it appears as though this final cut was never made since mining within the pit ceased prior to the publication of the report (8). Today, benches are still evident within the pit, although some are inaccessible due to rockfalls. A large bench surrounds the top of the pit at the 4000-foot level on the northeast, northwest and southeast sides, serving historically as an access road to the benches below and presently as a hiking trail with views into the pit. It is difficult to differentiate where this bench ends and the roads accessing the waste rock pile, crusher plant and lower pit begin, as they appear to be a seamless series of interconnected roads that are now used as trails.

Waste Rock Pile

Between the residential area and the open pit is the waste rock pile. The overwhelming mass of dirt and rock removed during mining was of no value to the mine operators and was most easily relocated to an area in close proximity to the pit at a lower elevation to allow for piling. The pile is approximately 800 feet long and 400 feet wide at its widest point, rising 20 to 40 feet above the valley floor near the pit and nearly 70 feet in elevation above the residential building area to the west. The waste rock pile was terraced, similar as the benches in the pit, to provide access routes to and from the pile. The natural slope of the debris material around the waste rock pile perimeter and at the terraces varies with the surrounding terrain. The top layer of the waste rock pile is flat, with portions of the terraces and top used as roads to access the dumping areas. The main leveled portion of the waste pile is around 3945 feet in elevation. The southwest portion of the waste pile includes a series of two terraces between the leveled top and the graded residential area. There is roughly 20-30 feet of elevation gain between each of the levels. It is unclear as to the exact amount of earth that was relocated to the waste pile. The 1948 report indicates that the amount of waste to the amount of ore removed was rather significant, such that the 2,500,000 tons of remaining ore below the bottom of the pit will most likely never be mined due to “the excessive amount of waste to be moved in order to enlarge the pit for deeper mining” (Severy, p. 7).

The historic displacement of material from the open pit to the valley significantly altered the topography, hydrology and character of the area. The slopes created where waste rock is piled leave a very geometric and linear pattern on the landscape that stands out from the organic curving of the natural hillsides and valleys that surround the waste rock pile. When compared to photos from the 1940s, the portions of the site that were filled in are still highly discernable, despite the lines having softened with erosion over the years. Because the waste rock pile was created over half a century ago, vegetation has established and visible erosion similar to that of the native hillsides is evident, but continues to stand out from the natural topography of the area. Indicators of the manipulated topography include the leveled top of the mound, the sorted fine dirt and large rock material, the lighter colored dirt and rock in contrast with surrounding soils, and the distinct terraces.

Southwest of the large pit is a low-grade stockpile. With a similar topographic appearance as the waste rock pile, the stockpile serves as a storage area for lower quality ore and measures around 550-feet by 250-feet at the widest of the wedge-shaped pile. The stockpile sits just above the road that accesses the waste rock pile and western side of the large pit 40 feet in elevation above the main Vulcan Mine Road. The pile is easily identifiable today in aerial photos because the black colored ore stands out from the surrounding lighter colored dirt and gravel.

Adits and Drill Holes

Typically, drill holes, shafts and adits provided knowledge of the location of ore, and reflected the exploitive phase of mining. Drill holes are narrow holes drilled into rock to determine the extent of an ore body. Shafts are vertically or steeply inclined openings, while adits are horizontally inclined openings that provided access to the ore. According to the 1948 Severy report, “exploration consisted of 482 feet of adits and 49 diamond-drill holes having depths 18 to 897 feet and totaling 11,672 feet (2). It appears as though no shafts were drilled during the period of significance, but were used in the area for exploration in the early 1900’s (see Physical History section). No adits, shafts or drill holes were located by CLI staff in 2010, but some adits and drill holes were mapped in the 1948 report, helping to indicate the extent of the ore body. Many of the original adits were located where the current pit is and were subsequently removed during excavation of the pit. It is also likely that some adits been plugged or filled in with debris

over the years. It appears that the Magazine Storage structure at the end of the Vulcan Mine Road, east of the operational building area, is a former adit that was converted to storage. The key indicator of this possibility is in the construction, venting and design, analogous to adit construction. It was likely constructed prior to the period of significance and incorporated in the Kaiser operation for storage.

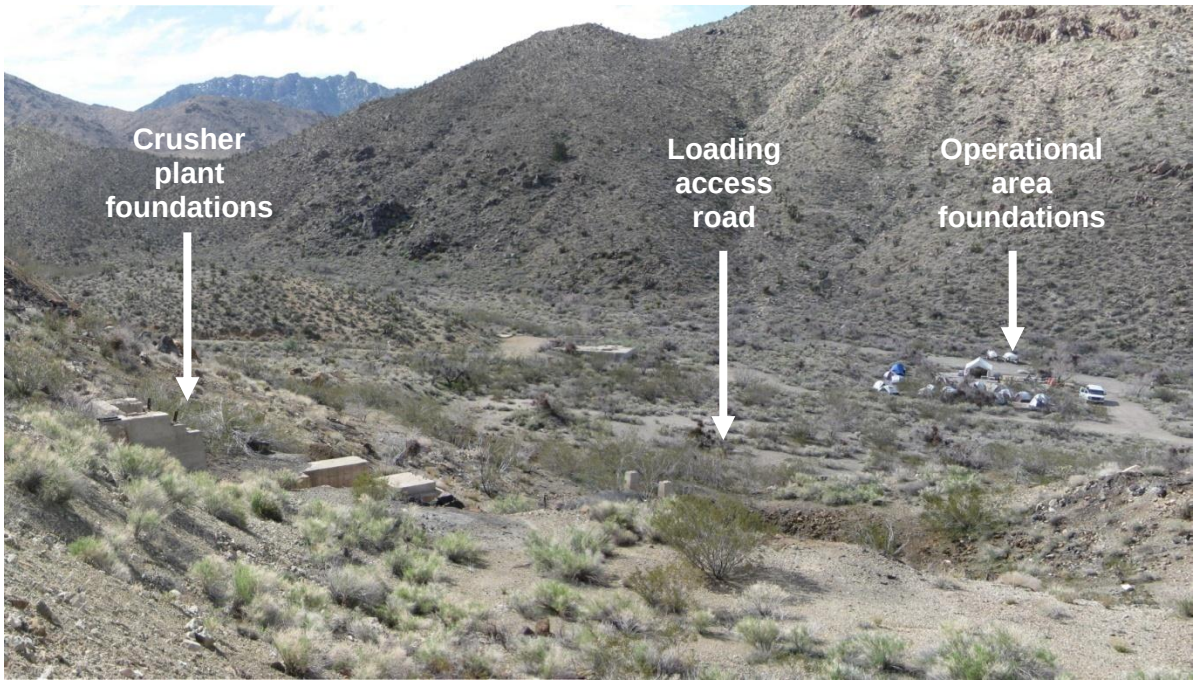
Residential and Operational Areas
Southwest of the waste rock pile and south of the pit are several level graded areas used for residential and operational purposes. The terrain near the open pit tends to be rough, rocky and uneven and as such was unsuitable for working, living and the construction of structures. As a result, rock removal, vegetation removal, and grading were necessary to create flat level areas amenable for the placement of roads, buildings and structures. Many of the miners' residences were clustered near the worksite in the residential area southwest of the waste rock pile. The residential area was located at a higher elevation than the washes that pass through the district and measured roughly 300 feet square. The operational area was separated from the residential area both physically and visually with the waste rock pile and Vulcan Mine Road between the two. It was located around one-third of a mile southeast, near the base of the crusher plant. This area included the building core as well as the looped access road for loading material from the crusher plant and measured around 450 by 480 feet. Despite an increase in vegetation cover and the removal of the buildings, the level graded areas are still evident today, providing a sense of spatial organization and site layout that was present during active mining. Along with the remaining building and structure foundations and footings, the graded areas aid in interpreting where the residential and operational areas once stood during the period of significance.

Landscape Characteristic Graphics:

Topography Figure 1. View of open pit and benches/roads, facing south. Source: PWRO, 2010.

Topography Figure 2. View of waste rock waste rock pile from the residential area, facing northeast. Source: PWRO, 2010.

Topography Figure 3. Residential area, facing west. Source: PWRO, 2010.



Topography Figure 3. Crusher plant foundations located on the hillside (left) above the loading access road and operational area building foundations (background). A construction crew is temporarily using a portion of the foundations as a tent camping site. Source: PWRO, 2010.

Circulation

Circulation comprises the spaces, features, and applied material finishes which constitute systems of movement in a landscape.

The interconnections between the open pit, waste rock pile, mine adits, crushing plant, operational and residential areas, and railroad are still evident today. A number of roads were continuously altered throughout the period of significance as the result of topographic alterations through the mining process of removing and relocating materials. While some of the resulting roads serve as circulation routes, they are best described in context as topographic features in the Topography section. In nearly all situations, roads and walkways were one in the same at Vulcan Mine, during the period of significance. Major roads were generally placed on level land between washes, though there is evidence of roads passing through washes in some locations. The majority of the roads in the district are largely intact, despite occasional washouts out from seasonal flood events. Today, many of the roads and corresponding utility yards of the historic district continue to maintain their alignment, design, and materials, reflecting the character from the period of significance.

Vulcan Mine-Kelso Road

The Vulcan Mine-Kelso Road (see Circulation Figure 1) was the direct access between the railroad depot and the mine. During the period of significance, it was a single nine mile long road. Today, the road is composed of three distinct segments: 1) today's 5.5-mile Vulcan Mine Road that runs from the mine complex to an intersection with Kelbaker Road, 2) a 3-mile segment of the Kelbaker Road, and 3) the .5-mile length of unmaintained access roads to the Kelso loading ramps. Although the historic road alignment of the Vulcan Mine-Kelso Road is intact, each of the three road segments has its own character. Although the overall alignment of the road is an important aspect to understanding the circulation within Vulcan Mine Historic District, only the 5.5-mile Vulcan Mine Road segment still retains enough integrity to be a contributing resource.

1) Vulcan Mine Road
Vulcan Mine Road extends 5.5 miles from the mine complex to the intersection with Kelbaker Road. The single-lane, 22-foot wide, asphalt-paved road was graded and paved in the early 1940s in order to accommodate the heavy trucks that hauled ore from the mine to the railroad. The 1948 Severy report describes the road as "22 feet wide and built by removing all the large boulders from the road bed, smoothing with a blade, and laying a 3-inch, black-top, road-mix, macadam surface cover, in which the minus 1 ½-inch material from the sides of the road bed was used" (10). The asphalt has not been maintained and has degraded significantly such that the bituminous material is barely visible under the gravel. The road extends into the mine complex, past the residential area, meeting up with the utility yard at the operational area and the loading access road below the crusher plant and continues on past the Cap and Fuse Locker and Magazine Storage, the historic end of the road. A segment of this road from just west of the operational area to just east of Cap and Fuse House contributes to the significance of the Vulcan Mine Historic District, but is located on property owned by the State of California.

2) Kelbaker Road
The 3-mile historic segment of Kelbaker Road begins at the intersection with Vulcan Mine Road, and extends northwest toward the Kelso loading ramps, maintaining its historic alignment. The

road is still approximately 22-feet wide, but has been repaved with red tinted asphalt and striped. The development of the longer Kelbaker Road effectively subsumed the historic segment of the original Vulcan Mine-Kelso road, resulting in the division of the three historic segments. It currently extends north of Kelso and south of the intersection with Vulcan Mine Road, as a major road in the preserve, running 70 miles from the city of Baker to the town Amboy, with the town of Kelso located around half-way between. The ownership of Kelbaker Road is currently in question as part of a litigation case between the NPS and San Bernardino County. A roughly one mile segment of the road, just south of the Kelso loading ramps, is currently part of a privately owned tract of property.

3) Loading Ramp Access Road Traces
Just south of Kelso are traces of the two historic ramp access roads. During the period of significance the historic Vulcan Mine-Kelso Road terminated at these ramps. The access roads curved northeast and then northwest to join up with the two loading ramps. They are evidence of the former circulation route that the trucks used to access the railroad ramps to dump ore and then circle back to the mine. The asphalt pavement of these two roads has significantly degraded as a result of no longer being used or maintained, and being degraded by seasonal flooding and creosote plant encroachment. Today, these roads are minimally evident when travelling on Kelbaker Road near Kelso Depot, but are easily identifiable in aerial photos.

Mining Complex Circulation Network

Within the mining complex, a system of roads was established for a number of utilitarian and industrial purposes associated with the mining operation. Land within the operational and residential areas were completely leveled and graded prior to the construction of the buildings. Roads were loosely defined though use, and often not paved, but the areas were generally open allowing for vehicles to drive anywhere. Utility yards served as circulation routes for both vehicles and pedestrians. Likewise, an open, leveled area below the crusher plant was also graded, providing an access road for the dump trucks to be filled and then head out to the railroad at Kelso. Constructing this loading access road required significant cutting of the hillsides northeast of the operational area to allow the trucks to get close enough to the conveyor belt that deposited the ore into the truck bed. Photos from the early 1940s show the loading access road as unpaved, but 2010 fieldwork indicated that it was paved with asphalt at some point.

Today, the utility yard at the residential area continues to exist as a flat, open expanse of land. Vegetation has begun to encroach, but the primary vehicular routes through the utility yard continue to be used by park visitors and staff, maintaining much the original alignments. The utility yard surrounding the operational area has filled in significantly with vegetation. A single road encircles the cluster and two small roads connect within. The roads are heavily defined through current use, with vegetation and foundations defining the borders. The loading access road below the crusher plant has almost completely filled in with creosote plants, but traces of the asphalt alignment and graded area are still visible. This road is no longer used and is barely visible in aerial photography.

A road developed as access to the waste rock pile begins as a spur off of the end of Vulcan Mine Road, just before the operational area. It switchbacks up and over the south-facing hillside of the small ridge southeast of the open pit, travelling northwest up the large valley below Fountain Peak to a fork leading north or south. The northern fork travels up the adjacent hillside,

turning southwest along the top of a small ridge overlooking the open pit and waste rock pile. The southern fork travels up the hillside north of the open pit, turning north along the top of the ridge and then curving southeast around the small peak that towers over the Vulcan Mine site. The road switchbacks up the northern side of the peak, terminating at around 4500 feet, just below a ridge. The purpose of these roads is unknown, but it is possible that this road provides access to trenches or prospects that were developed to determine the extent of the iron vein. Because it was also one of the primary roads accessing the waste rock pile, it most likely changed significantly over time as the waste rock pile grew. These roads are no longer maintained or accessible to vehicles today, but are commonly used as hiking trails.

Contributing Features

Vulcan Mine Road
Feature Identification Number: 152363
LCS Structure Name: Vulcan Mine Road
IDLCS Number: TBD
Type of Feature Contribution: Contributing

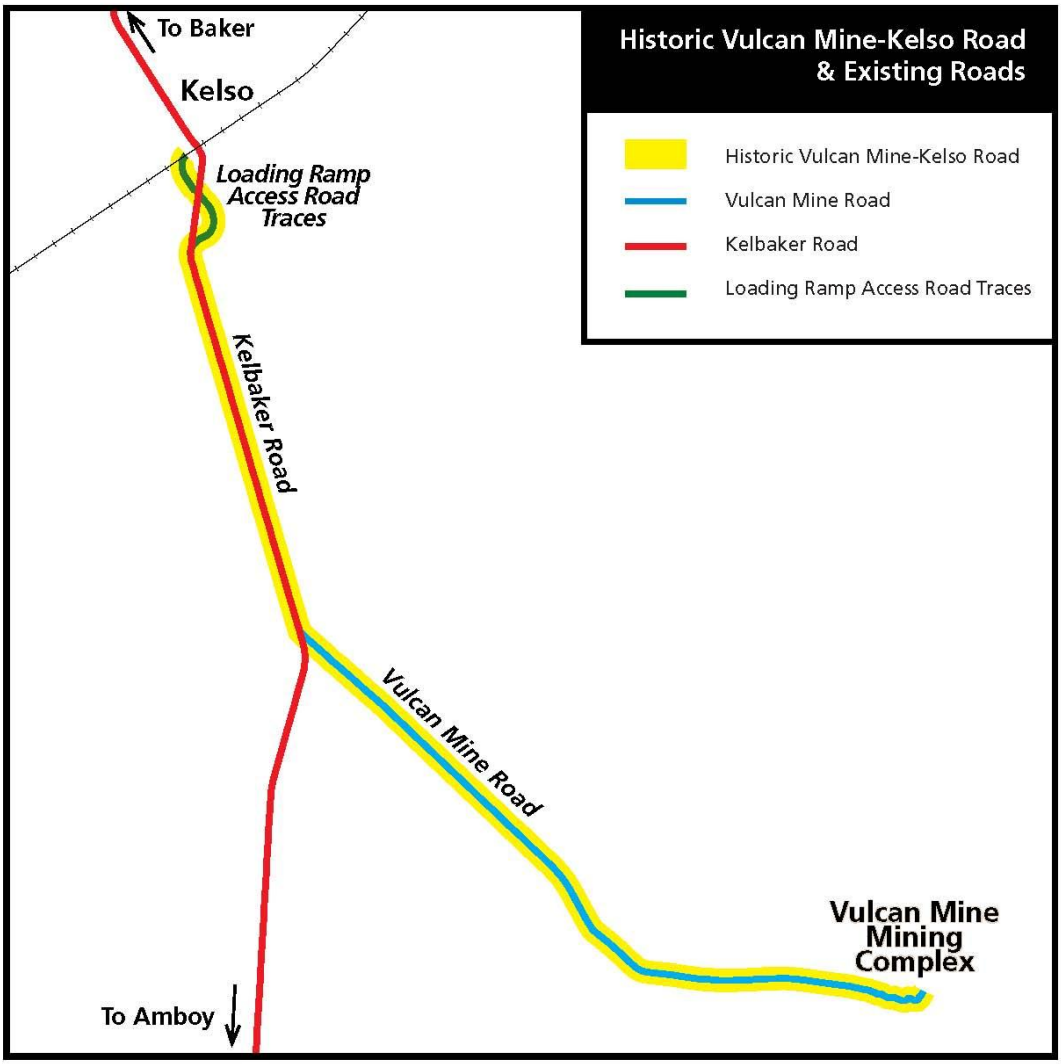
Vulcan Mine Mining Complex Circulation Network
Feature Identification Number: 152365
LCS Structure Name: Vulcan Mine Interior Roads
IDLCS Number: TBD
Type of Feature Contribution: Contributing

Non-Contributing Features

Kelbaker Road
Feature Identification Number: 152375
Type of Feature Contribution: Non Contributing

Loading Ramp Access Road Traces
Feature Identification Number: 152369
Type of Feature Contribution: Non Contributing

Landscape Characteristic Graphics:



Circulation Figure 1. Historic Vulcan Mine-Kelso Road and Existing Roads. Source: PWRO, 2010.

Circulation Figure 2. Vulcan Mine Road, facing northwest. Source: PWRO, 2010.

Circulation Figure 3. Kelbaker Road near the loading ramps, facing southeast. Source: PWRO, 2010.

Circulation Figure 4. Historic ramp access roads east of loading ramps, facing southeast. Source: PWRO, 2010.

Circulation Figure 5. Mining complex circulation network as seen from the steep hillside above the operational area, facing southwest. Source: PWRO, 2010.

Buildings and Structures

Buildings are features constructed for sheltering any form of human activity. Structures are features constructed for purposes other than sheltering human activity, and may include mechanical and structural engineering systems.

The concentration of remaining features in the operational and residential building areas, the presence of the onsite crusher plant foundations, and the remaining mining features reflect the size and success of the Vulcan Mine operations during the period of significance. Most of the structures that remain in the Vulcan Mine Historic District are building and structure foundations, foundation slabs, walls, and earthen loading ramps that aid in the interpretation of the historic mining district. Also remaining are the cap and fuse house and magazine storage.

CONTRIBUTING FEATURES

Residential Area Foundations
Historically, the residential area contained approximately seven buildings, 10 tent frames, and 2 tanks during the period of significance. The buildings were typically constructed of wood and set on either a concrete slab or on a concrete pier block foundation. Today, one concrete slab foundation and two distinct clusters of concrete piers remain. The dormitories and mess hall, which were intended for temporary use, had pier block foundations. No remnants of these buildings remain. The two dormitories once stood at the western base of the waste rock pile with the mess hall west of them. The majority of the wood buildings were removed and sold in the late 40s or early 50s, as indicated by a 1949 advertisement in the Los Angeles Times.

One large concrete slab foundation remains for what appears to be the cook's dormitory (Los Angeles Times) located west of the two dormitories. Constructed into a small hillside, it was once a two-story structure with the top level accessed from the dormitory elevation on the east side and the lower level accessed from the west side. As a result, it has three poured concrete retaining walls. The concrete floor measures approximately 38 feet long by 20 feet wide, while the east and south walls are 6 feet high and the north wall is 3 feet high. There are no written references to the building, other than the 1949 Los Angeles Times ad to sell the main structure, and it is not shown in the 1948 report Site Plan. There are, however, a number of historic photos from 1943 displaying the construction and completed building north of the mess hall. Today, the foundation slab and walls are still in good condition with the exception of a 4-foot by 1-foot section that has crumbled away from the top of the east wall and large crack extending from the break. This damage appears to be the direct result of root damage from a large desert willow that is in close proximity to the building with roots contacting the wall.

Southwest of the cook's dormitory is a cluster of concrete piers that once supported the superintendent's cottage (Severy, Fig. 2), also called the manager's house (Kaiser Papers, Vol. 84). The former wood frame structure once measured 24 feet by 28 feet. The square piers are strewn about the ground and vary in size from roughly 1x1x1 feet to 1x1x2 feet. Some of the pier blocks have protruding rebar and some are attached to unformed concrete footings.

Just north of the cook's dormitory, located at the base of the waste rock pile is a poured concrete U-shaped support for a large metal fuel tank. This support is roughly 6 inches thick, 6 feet long, and 3 feet high with a U-shaped depression to support the cylindrical tank. There were likely three of these supports during the period of significance, but only one remains on site.

Crusher Plant Foundations
Several poured concrete foundation components for the crusher plant are located on a steep hillside above the loading access road south of the open pit. Trucks would off-load bulk ore at the top of the plant, and crushed ore would emerge at the bottom, 65 feet below the unloading area. Five foundation clusters and other structure components make up the remnants of the crusher plant. The uppermost portion of the structure sits at the 4000-foot elevation level. The top cluster includes a large wood support beam with two concrete pilings below it. Further downhill at the 3980-foot level are two massive concrete foundations, one above the other, that likely supported the crusher equipment. Intact, rusted steel doors on the lower foundation were likely used to regulate the passage of excavated material being processed. Further down are two concrete obelisk-shaped pillars, located just above a large conical depression in the ground. Below the depression is a collapsed tunnel leading to a series of wood timbers that support an opening in the hillside where the crushed ore once came out on a conveyor belt and into waiting trucks. Remnants of the rubber conveyor belt still lay on the hillside next to the opening. The crusher plant foundations along the hillside are in varying states of deterioration, but continue to help illustrate the process that was used to prepare the ore for transport.

Above the top of the crusher plant, on the uphill side of the switchback road, is a series of three poured concrete U-shaped supports that once held a metal tank. The supports are roughly 6 inches thick, approximately 6 feet long and 3 feet high with a U-shaped depression in the top to accommodate a cylindrical tank, similar to the tank foundation in the residential area.

Below the crusher plant within the center of the looped loading access road is a poured concrete slab foundation with a tall metal pole sticking out. The foundation marks the location of a former refueling station for the trucks that transported the ore. The size of the slab is undetermined due to the heavy vegetation growth around it.

Cap and Fuse House
Southeast of the loading access road, along the Vulcan Mine Road, is the cap and fuse house (Severy, Fig. 2), also called the blasting cap locker. It is a small storage structure built into the hillside with a roughly 12-foot long and 5-foot tall poured concrete wall that faces west. A roughly 40-inch square steel frame and door are located in the center of the wall with exposed metal flashing above the frame. The interior space is only as wide as the door opening, with concrete walls and ceiling and a dirt floor. The door is jammed open to the inside of the structure. The structure was once used to store the caps and fuses for the explosives that were used in the blasting of the open pit. The historic character of the cap and fuse house remains intact today and continues to aid in the story of the development of the large open pit.

Magazine Storage Structure
Further east of the cap and fuse house is the magazine storage (Severy, Fig. 2) or explosives locker, another storage structure built into the hillside at the end of a short road/walkway. A narrow poured concrete wall surrounds a steel frame door, built into what appears to be a former adit opening. The door is around 4.5 feet tall and opens into a large cavernous room that was dug out of the hillside. At the back of the room is a small opening, likely used as a prospecting tunnel prior to the 1940s Kaiser operations. Rock piled on the floor has crumbled from the ceiling. A rusted metal vent pipe projects from the ground on the hillside above the storage structure and appears to be a vent for the structure. The magazine storage remains intact and continues to aid in the story of the development of the Vulcan Mine through the use of explosives, as well as early prospecting activities.

Kelso Loading Ramps

Immediately southwest of Kelso and west of Kelbaker Road are two earthen landforms that once served as ramps for loading ore from the trucks onto railroad cars of the Los Angeles and Salt Lake Railroad. The ramps were constructed of earth built up in two curvilinear forms side by side. The railroad tracks were once located between the two ramps as a spur off the main line that parallels Kelso-Cima Road. The ramps allowed trucks to travel up from the south side, dump material into the railroad cars and then down the ramp to the north and back to Vulcan Mine. The east ramp measures around 20 feet high at the highest point and 600 feet in length. This ramp has an approximately 40-foot gap, where soil was mistakenly removed by a park contractor in 2001. The smaller west ramp is intact and measures around 20 feet high by 500 feet long. It has a widened area on the north end that appears to have been used as a turnaround instead of a down ramp. The former access roads serving the ramps on the east side of Kelbaker Road are discussed in the Circulation section.

The northern portion of the eastern ramp and railroad spur north of the ramps are associated with the significance of the Vulcan Mine Historic District, but because they are located on private property they cannot be counted as contributing to this Cultural Landscapes Inventory because it is outside the NPS management boundary.

NON-CONTRIBUTING FEATURES

Chain Link Fence

One non-contributing structure has been constructed within the historic district since the period of significance. For safety reasons, a chain-link fence was installed around the top bench of the large open pit in 2010. The fence is open at the dirt road on the southwest side of the pit allowing for general access of the lower benches. The fence color varies between black, brown and silver. The fence does have a negative visual impact to the historic character of the site, particularly the dark colored segments that don’t fade into the light-colored setting.

UNDETERMINED FEATURES

Unknown Structure Footings

The footings for a structure of unknown use and construction date are located along Vulcan Mine Road approximately one-quarter mile south of Kelbaker Road. At this location, nine concrete piers, with buried footings remain in place as three rows of three. It has been hypothesized that this may have once been part of a guard or weigh station for the mine, but is unclear as to what exactly the piers once supported and whether or not it was directly associated with the Vulcan Mine Historic District during the period of significance. A short dirt road extends from the Vulcan Mine Road near the footings, possibly associated with activities associated with the unknown structure.

Communication Poles

North of the Vulcan Mine Road, just 1.75 miles west of the residential area are a series of wood poles clustered on top of a low ridge. There are seven 25-foot tall telephone poles standing and one down. A variety of other wood poles, metal pipes, and cairns are also found in the general area, some standing and others down. It is unclear whether these poles were directly associated with the mining activity at Vulcan Mine, providing telephone, power, or other communication during the period of significance. They are no longer in use.

STATE-OWNED PROPERTY

Some historic features that contribute to the significance of the Vulcan Mine Historic District are located on private property and as a result they cannot be counted as contributing to this Cultural Landscapes Inventory because it is outside the NPS management boundary.

Operational Area Foundations

Except for the crusher plant, the entire operational area is located on State of California owned property. Historically, this area contained approximately nine of buildings during the period of significance. They were typically constructed of wood on either a poured concrete slab or on a concrete pier block foundation. Today, seven concrete slab foundations and one set of concrete pier blocks remain within this area. Many of the slabs also include short walls or curbs that provided a base for the buildings and structures. The buildings and structures were removed and sold in the late 40s or early 50s, as indicated by a 1949 ad in the Los Angeles Times. The exact name and function of some buildings is unknown or may have multiple names according to various sources.

At the far northwest corner of the operational area is a cluster of poured concrete piers in the location of the former warehouse, one of the first structures built onsite around 1942. Some piers remain in-situ from the period of significance, and are mostly buried with only the upper portions extending above grade, while other piers have been dug up and are strewn about the area. Most are poured blocks of concrete, some with rebar sticking out of them and/or attached concrete footings.

Starting just east of the warehouse is a concrete slab foundation for what is believed to have been the administrative or operational building. The poured slab is approximately 15 feet by 45 feet with a few remaining segments of 2-foot high walls around the perimeter along with downed wall segments. Historic photos indicate that this building was raised up on piers on top of the slab. The underneath may have been used for storage of some sort.

Directly southwest of the administrative building is the poured concrete foundation for what may have been a machine or service shop. This slab measures around 65 feet by 25 feet with 1-foot high walls around the perimeter. The slab is significantly covered with dirt, rocks and vegetation.

Southwest and directly next to the machine shop is the large poured concrete slab used for the garage. The slab measures around 60 feet by 65 feet and has no perimeter wall, but rather a short 4-inch tall curb separating approximately one-third of the southwest side. This portion appears to have been poured after the main building was constructed as it does not appear in the historic photos. It is unclear as to whether this portion was ever covered, but may have been an outdoor work space. The edges of the slab are not well-defined and covered by dirt. Vegetation is encroaching around the edges.

Approximately 140 feet east of the Garage are concrete foundations for three structures associated with power generation at the site. The largest and smallest building foundations were constructed on a leveled area that was approximately 2-3 feet higher in elevation than the third medium building which was located northwest of the largest foundation. The large building foundation is the remains of the main power house building, and is rectangular with two smaller rectangular slabs adjoining it on the north and south sides. The main slab measures 40 feet by 24 feet with a 6-inch high curb wall around the perimeter. Portions of the slab are raised, and have exposed iron mounting fixtures, probably to accommodate the power generation

machinery. This main power house building appears tall in historic photos, either 2 stories high or 1 tall story to house large machinery. Because this foundation was built at a higher elevation than the medium building, it had retaining walls that extended down around the sloping northwest side. Northwest of the largest building is the medium concrete slab, 18 feet by 20 feet, with a 2-inch tall curb around the perimeter. It also has raised portions on the slab with exposed rebar. Directly south of the largest foundation is the small poured concrete slab, approximately 15 feet by 20 feet with 3 foot tall concrete wall on three sides. The southeast side wall is broken, and it is not clear how tall it may have been during the period of significance. Inside the structure are two standing trapezoidal-shaped pillars and two additional overturned pillars lying on the slab. These pillars are approximately as tall as the concrete walls, and likely held up some kind of machinery or tank. The walls are cracked and some are leaning with exposed rebar. It is unclear what the medium and small structures were used for, but they likely provided support for the main power house in some way.

About 45 feet southwest of the power house building foundations is a poured concrete slab that measures approximately 15 feet by 12 feet, and is 1 foot thick. The small hill to the east is eroding and rock and soil covers the corner of the slab. The name and use of this structure is unknown, but it appears in historic photos from the period of significance and may have been used for some sort of storage.

About 250 feet east of the power house building foundations on the south side of Vulcan Mine Road are two sets of three poured concrete U-shaped supports that once held two metal tanks side by side. The supports are each roughly 1 foot thick, approximately 6 feet long and 2.5 feet high with a U-shaped depression in the top to accommodate a cylindrical tank, similar to the tank foundations in the residential area and above the crusher plant. They are each built into concrete bases that are approximately 2.5 feet wide and 7 feet long. All six supports are still standing with minimal wear and are in good condition.

Contributing Features

Vulcan Mine Residential Site Foundations and Footings
Feature Identification Number: 152411
LCS Structure Name: TBD
IDLCS Number: TBD
Type of Feature Contribution: Contributing

Vulcan Mine Crusher Plant Foundations
Feature Identification Number: 152437
LCS Structure Name: TBD
IDLCS Number: TBD
Type of Feature Contribution: Contributing

Vulcan Mine Cap and Fuse House
Feature Identification Number: 152435
LCS Structure Name: TBD
IDLCS Number: TBD
Type of Feature Contribution: Contributing

Vulcan Mine Magazine Storage Structure
Feature Identification Number: 152431
LCS Structure Name: TBD
IDLCS Number: TBD
Type of Feature Contribution: Contributing

Vulcan Mine Loading Ramps
Feature Identification Number: 152457
LCS Structure Name: TBD
IDLCS Number: TBD
Type of Feature Contribution: Contributing

Non-Contributing Features

Vulcan Mine Chain Link Fence
Feature Identification Number: 152455
Type of Feature Contribution: Non Contributing

Landscape Characteristic Graphics:

Buildings and Structures Figure 1. Concrete foundation for cook's dormitory in residential area, facing east. Source: PWRO, 2010.

Buildings and Structures Figure 2. Upper half of crusher plant foundations, facing northeast. Source: PWRO, 2010.

Buildings and Structures Figure 3. Cap and fuse house, facing northeast. Source: PWRO, 2010.

Buildings and Structures Figure 4. Magazine storage, facing north. Source: PWRO, 2010.

Buildings and Structures Figure 5. View of the eastern loading ramp with gap, facing south. Source: PWRO, 2010.

Buildings and Structures Figure 6. View of the western loading ramp and graded railroad spur trace in front, facing northwest. Source: PWRO, 2010.

Archeological Sites

Archeological sites are the location of ruins, traces, or deposited artifacts in the landscape, and are evidenced by the presence of either surface or subsurface features. Evaluation of these sites and features under Criterion D is outside of the scope of this study. However, these archeological sites are important to understanding the significance and extent of the mining activities within the historic district. The archeological features provide a sense of the scale of the mining operation as well as the historic layout and interrelationships. In conjunction with the remaining buildings & structures, topographic features, and circulation, archeological features mark the operations and layout of sites within the historic district.

Those archeological sites that are included consist of sites whose remains are associated with the period of significance of the historic district. Within the Vulcan Mine Historic District there may be archeological sites that predate the period of significance. While these locations may be archeologically significant in their own right, they are not directly linked to the significance of Vulcan Mine for their contribution to the history of the mining activity between 1942 and 1947. As a result, they do not contribute to the significance of the Vulcan Mine Historic District and are not described in this Cultural Landscapes Inventory. Below is a list of archeological sites associated with the mining operations during the period of significance that are located within the historic district boundary. See the Site Plans located in the Supplemental Information section for the feature locations.

Crusher Plant Debris
Adjacent to the Crusher Plant foundations on the hillside above the loading access road are a few artifacts associated with the plant itself. A large rusted metal bin can be seen half-buried that may have been used to transport or store the ore, or may have attached to a machine to pick up and deposit the ore. About half way down the hill is a large piece of conveyor belt that once moved the ore through portions of the plant. The frayed remnant includes one side of rubber backed with thick fabric, and metal clips along the side that possibly helped hold the belt in place.

Historic Road Trace
Just west of the mining core, south of Vulcan Mine Road, is a segment of road that dates to the period of significance. The historic road veers off from Vulcan Mine Road near the residential area in the mining complex and stretches northwest atop a small ridge that is 30 to 50 feet higher than the Vulcan Mine Road. It joins back up with Vulcan Mine Road after two miles. It is unclear as to what the road was used for in the period of significance, but may have provided a higher transportation route during flooding, or was used prior to the construction and paving of Vulcan Mine Road. The road is currently used as a hiking trail.

Debris Site
Along the historic road, closer to the mine complex, is a lengthy and dense area used to dispose of trash. The debris site consists primarily of metal can, glass, pottery and other household types of debris. Bottle and cans date to the period of significance. It is unclear as to when the debris was dumped in this location, but likely relates to the residential building area.

Landscape Characteristic Graphics:

Archeological Sites Figure 1. Conveyor belt remnant near crusher plant foundation. Source: PWRO, 2010.

Archeological Sites Figure 2. Historic road trace near debris site and mine complex, facing east. Source: PWRO, 2010.

Archeological Sites Figure 3. Debris site along historic road trace, facing west. Source: PWRO, 2010.

Condition

Condition Assessment and Impacts

Condition Assessment: Fair

Assessment Date: February 28, 2011

Condition Assessment Explanatory Narrative:
As a whole, the Vulcan Mine Historic District has been assessed as being in fair condition. The temporary nature of mining in the Vulcan Mine Historic District resulted in the removal of all buildings and structures after mining activity ceased. However, the historic property continues to exhibit the building and structure foundations, labyrinth of roads, and other fragments of mining activity, including the large open pit and waste rock piles that were developed during the period of significance. Many of these features show evidence of negative impacts and deterioration resulting from erosion and vegetation overgrowth that require corrective action and maintenance to prevent further loss of historic resources.

Stabilization Measures:

The following stabilization measures have been identified for the Vulcan Mine Historic District:

1. Prevent water in the washes from flowing over Vulcan Mine Road and roads within the mine complex during major storm events.
2. Remove vegetation overgrowth from the concrete foundations, including growth within cracks and under the structures to prevent further cracking and damage.
3. Prevent erosion from further deteriorating the Kelso Loading Ramps.

Impacts

Type of Impact: Erosion

External or Internal: Internal

Impact Description: The intermittent and seasonal flow of water in drainages and washes had led to the erosion of a variety of mining features including roads, ramps, open pit, waste rock pile, and in some cases buildup of earthen material on foundations. Other than roads which must pass through washes, most mining features are located outside washes.

Type of Impact: Neglect

External or Internal: Internal

Impact Description: Neglect is probably the greatest threat to the remaining mining structures in Mojave National Preserve. The abandoned Historic District mine features have been abandoned and minimally maintained since the historic period. The Preserve does not have adequate resources to maintain the hundreds of abandoned mining structures, and must carefully allocate preservation resources to maintain the most threatened and most significant examples of historic mining, in both desert and mountain environments. Without maintenance, small failures can aggregate, causing larger failures and the collapse of mine openings, buildings and other structures.

Type of Impact: Structural Deterioration

External or Internal: Internal

Impact Description: The concrete foundations, footings, and walls will gradually deteriorate given exposure to the elements and a lack of maintenance.

Type of Impact: Exposure to Elements

External or Internal: Internal

Impact Description: Ultraviolet exposure deteriorates exposed wood surfaces like those remaining at the Crusher Plant. Rare but heavy rains can displace foundations. As structures become unstable, they become increasingly threatened by exposure to erosion, winds and other environmental impacts.

Type of Impact: Vandalism/Theft/Arson

External or Internal: Internal

Impact Description: Theft and vandalism of abandoned equipment and at mine sites may be a problem given the easy access from public roads.

Treatment

Approved Treatment: Preservation

Approved Treatment Document Explanatory Narrative:
The General Management Plan (April 2002) does not specify an approved treatment for cultural landscapes potentially eligible for listing on the National Register. However, the GMP does specifically mention preservation as the approved treatment for listed properties, which is reflected in the following management goal statement for cultural resources:
"Identify, inventory, monitor, and evaluate archeological sites, historic properties, cultural landscapes, and ethnographic resources; nominating significant resources to the National Register of Historic Places and manage, protect, and preserve such listed properties in a way that will preserve their documented archeological, architectural, ethnographic, historic, or research values" (GMP 2002, 51).

The GMP states, "At least sixteen potential historic landscapes have been identified in Mojave National Preserve that are potentially eligible for listing on the National Register of Historic Places, but cultural landscape studies have not been undertaken to identify their character-defining elements…. The Preserve will inventory the cultural landscapes and prepare nomination for those determined to be eligible for the National Register of Historic Places" (58).

Bibliography and Supplemental Information

Bibliography

Citation Title: See Supplement Information for Bibliography

Supplemental Information

Title: Bibliography

Description:

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Title: Vulcan Mine Historic District Site Plan

Description: A larger version of the Vulcan Mine Historic District Site Plan is available from the park's resource management division or the Pacific West Region's CLI program.

Title: Vulcan Mine Historic District Mining Complex Site Plan

Description: A larger version of the Vulcan Mine Historic District Mining Complex Site Plan is available from the resource management division or the Pacific West Region's CLI program.

Title: Vulcan Mine Historic District Kelso Ramps Site Plan

Description: A larger version of the Vulcan Mine Historic District Kelso Ramps Site Plan is available from the resource management division or the Pacific West Region's CLI program.

Title: Mining Methods at the Vulcan Iron Mine, San Bernardino County, Calif.

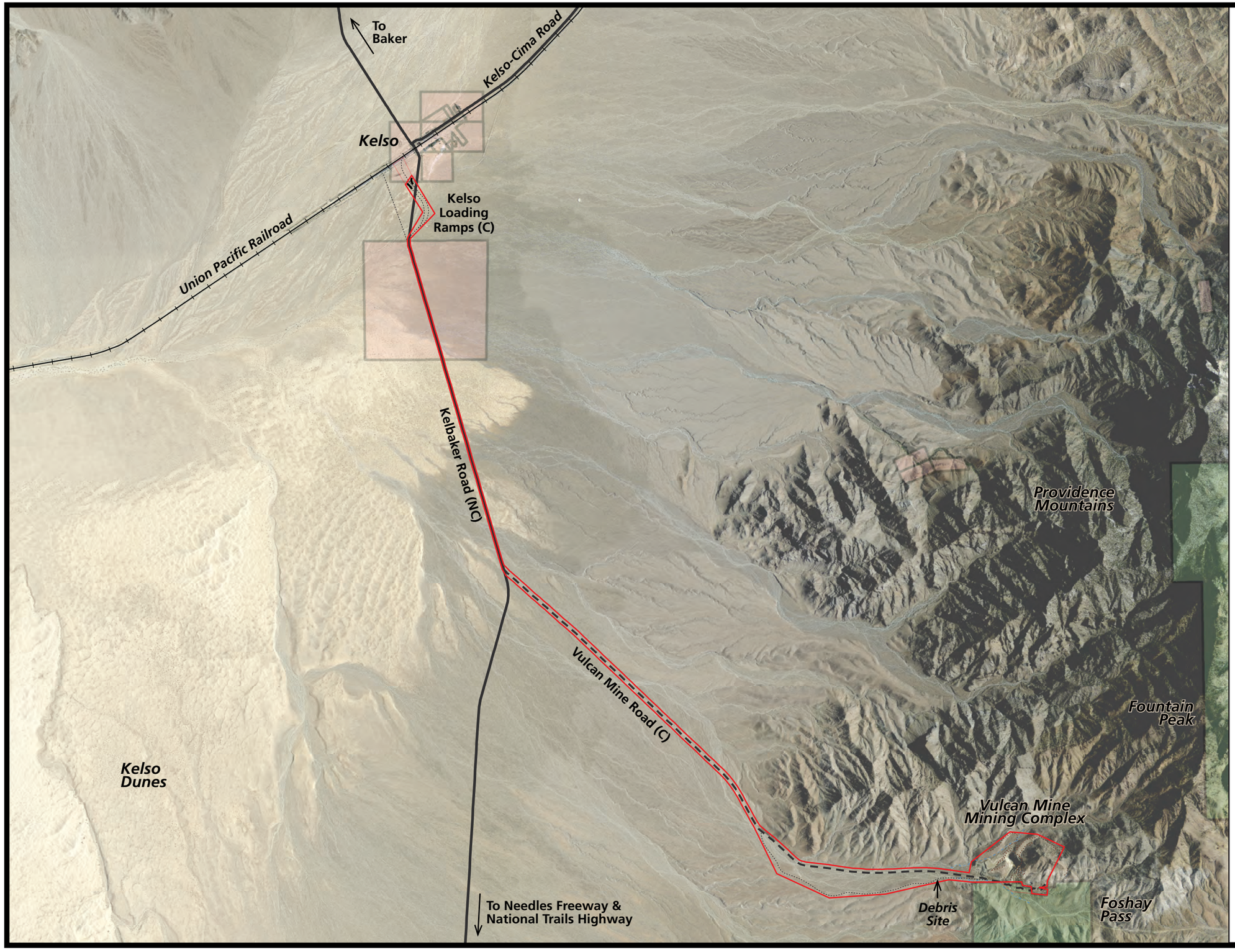
Description: The 1948 report by Charles Severy for the U.S. Bureau of Mines is available in a separate pdf file. This file is available from the Pacific West Regional CLI Coordinator or from the cultural resources staff at Mojave National Preserve.

Mojave National Preserve, California

Vulcan Mine Historic District

Cultural
Landscapes
Inventory
Pacific West Region
May 2011

Sources:
USGS Seamless Server
2010 NPS GPS Data



CLI Boundary
Private Land
State of California Land
Building/ Structure
Paved Road
Dirt Road
Railroad
Trace Road

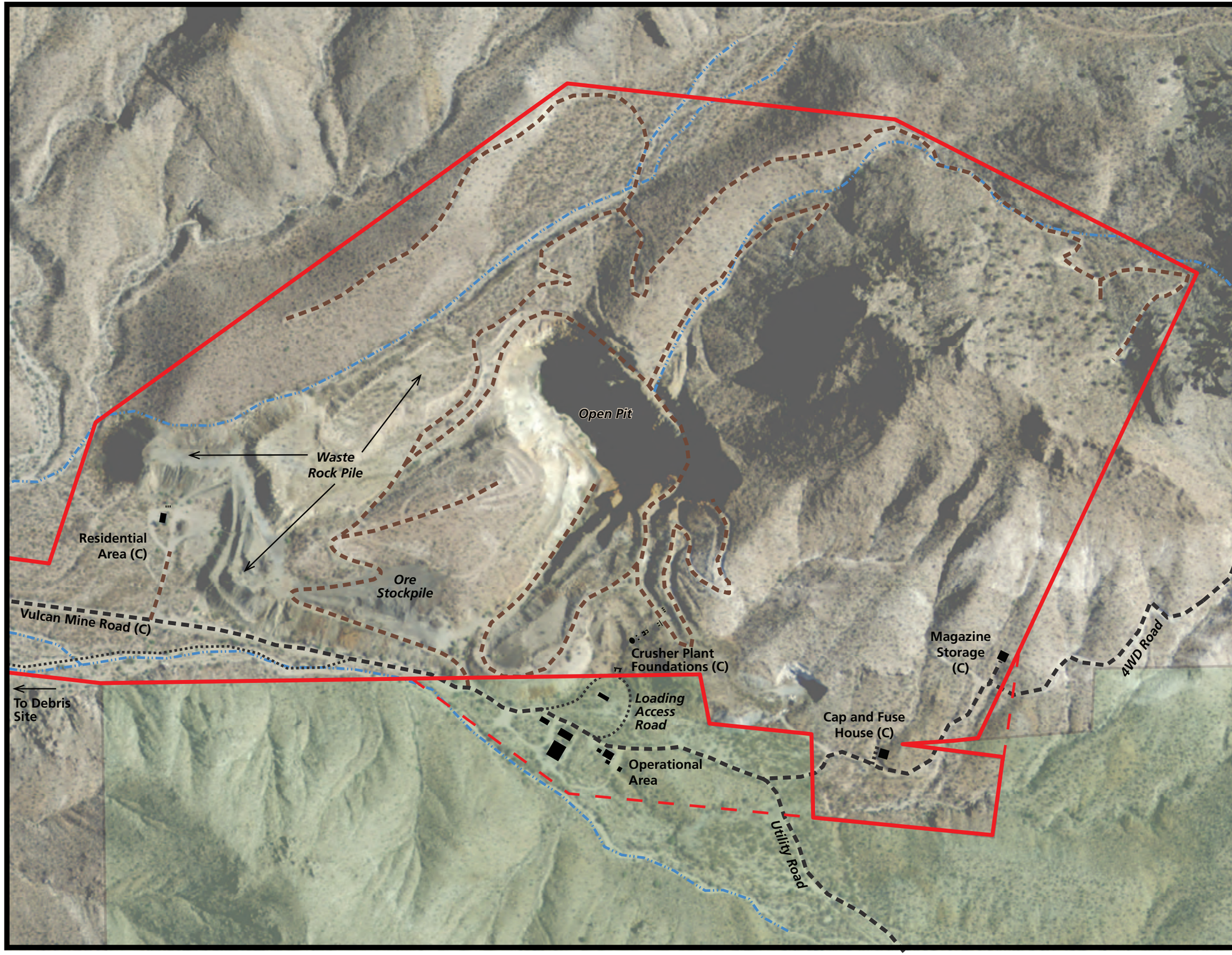
1 Mile

Mojave National Preserve, California

Vulcan Mine Historic District - Mining Complex

Cultural
Landscapes
Inventory
Pacific West Region
May 2011

Sources:
USGS Seamless Server
2010 NPS GPS Data



CLI Boundary

Proposed National Register Boundary

State of California Land

Concrete Foundations

Dirt Road

Mining Complex Circulation Network

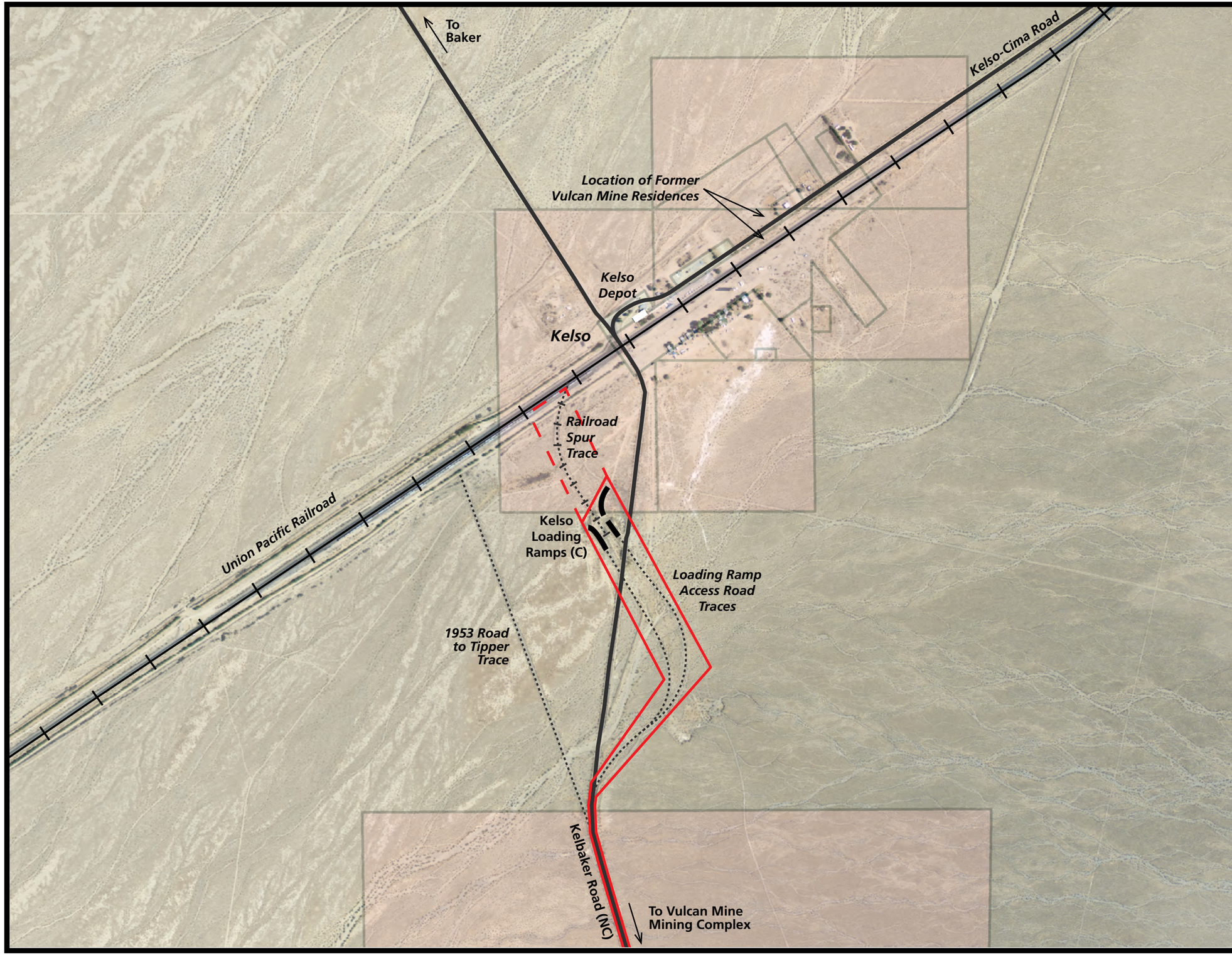
Trace Road

Seasonal Wash

375 Feet

Mojave National Preserve, California

Vulcan Mine Historic District - Kelso Loading Ramps



Cultural Landscapes Inventory
Pacific West Region
May 2011

Sources:
USGS Seamless Server
2010 NPS GPS Data

CLI Boundary
Proposed National Register Boundary
Private Land
Ramps
Paved Road
Railroad
Trace Road

1000 Feet

I. C. 7437 MARCH 1948

UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY

BUREAU OF MINES
JAMES BOYD, DIRECTOR

INFORMATION CIRCULAR

MINING METHODS AT THE VULCAN IRON MINE
SAN BERNARDINO COUNTY, CALIF.

BY

C. L. SEVERY

I.C. 7437,
March 1948.

INFORMATION CIRCULAR

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

MINING METHODS AT THE VULCAN IRON MINE, SAN BERNARDINO COUNTY, CALIF.[1]

By C. L. Severy[2]

CONTENTS

ILLUSTRATIONS

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7437."

2/ Mining engineer, Reno Branch, Mining Division, Bureau of Mines, U. S. Department of the Interior.

SUMMARY

The Vulcan mine, which is the only large-scale open-pit iron mine in California, furnishes the blast-furnace feed for the Kaiser Co., Inc., steel plant at Fontana, Calif. It lies in the Mojave Desert, San Bernardino County, Calif., at an altitude of 4,000 feet and 9 miles from Kelso, a station on the Union Pacific Railroad 178 miles by rail from Fontana.

The deposit is an irregular, mushroom shaped replacement of limestone by magnetite and hematite along a fault contact with quartz monzonite. On the surface, the ore body was 700 feet long by 325 feet wide, ovular in shape, and striking roughly east and west. The ore extends to a maximum depth of 900 feet as determined by diamond drilling.

Exploration consisted of 482 feet of adits and 49 diamond-drill holes having depths 18 to 897 feet and totaling 11,672 feet.

As laid out, the open pit has seven benches, the top one 60 feet, one 50 feet, and five 40 feet in height. Six of these have been opened to the present 3,790-foot bench. Mining is confined to one shift per day, and production averages 2,500 tons. Churn drills, wagon drills, and jackhammers are used for drilling various depths of blast holes.

Open-pit mining with 2½-cubic-yard Diesel-powered shovels started December 12, 1942, and to January 1, 1947, 2,100,000 tons3/ of ore had been mined, leaving a developed reserve of 400,000 tons to the 3,750-foot bench, which will be the bottom of the pit as planned. All stripping for mining to this depth has been completed. There remain 2,500,000 tons of proven but not developed high-sulfur ore below the proposed pit bottom. The calculated grade for the indicated 5,000,000 ton ore reserves was 52.23 percent iron, 0.058 percent phosphorus, 5.22 percent silica, and 1.62 percent sulfur.

From the pit the ore is trucked in Euclid 10 cubic yard dump trucks to the crushing plant, where the ore is reduced by an electrically driven 42 by 48-inch jaw crusher to minus 8-inch size and stocked by conveyor belt on a 6,000-ton storage pile. Fifteen cubic yards Kenworth, semitrailer, Diesel-powered, end-dump trucks haul the ore from the storage pile 9 miles to Kelso, where it is either loaded into cars for shipment to Fontana or stock-piled. This hauling is contracted.

At Fontana the ore is crushed to 1-3/4 inches and sized through screens, the minus 1/2-inch going to the sintering plant and the oversize to the bedding pile, from whence the ore is drawn off, sampled, and weighed for blast-furnace feed. From 50 to 70 percent of the Vulcan ore is sintered.

Besides the crushing unit, the surface plant at the mine consists of an office, warehouse, garage, machine shop, power plant, dormitories, dining room, cook house, and superintendent's house. From 80 to 85 men are employed

3/ All tonnages are short tons unless otherwise stated.

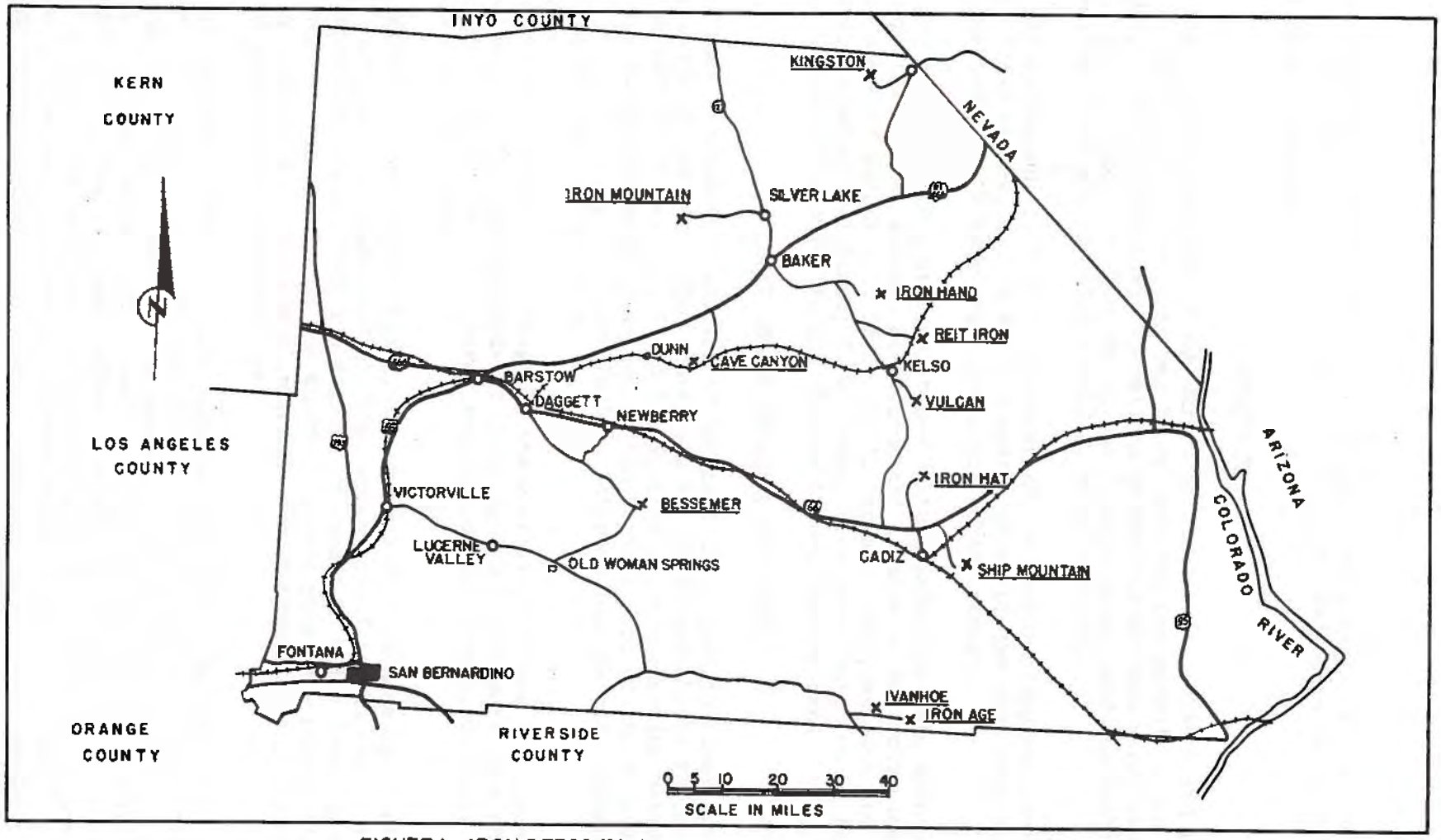


FIGURE I. IRON DEPOSITS OF SAN BERNARDINO COUNTY, CALIFORNIA

at the mine and 12 to 14 men on the contract truck haul. A company-owned trailer court at Kelso accommodates 20 families, and space is provided for 10 private trailers.

INTRODUCTION

One of the functions of the Bureau of Mines is to collect and publish data on mining operations that may be of interest and useful to the mining industry. This paper covers operations at the Vulcan iron mine, which is the largest producer of iron ore on the Pacific coast, and was compiled by the Mining Division, of which Lowell B. Moon is chief.

Acknowledgment is made to Spangler Ricker, supervising engineer, California Field Office, and to A. C. Johnson, chief of the Reno Branch, Mining Division for their constructive criticism of the report.

For their courtesy and assistance in furnishing the data upon which the report is based, special acknowledgment is made to the following members of the staff of Kaiser Co., Inc.: A. B. Ordway, vice president and general manager, Fontana Steel Plant; T. M. Price, vice president; Ken B. Powell, mining engineer; John Tillia and Charles Severy, geologists.

LOCATION AND PHYSICAL FEATURES

Figure 1 shows the location of the mine in respect to other known iron occurrences of San Bernardino County and to the Fontana blast furnace. It lies in the SW$\frac{1}{4}$ of sec. 25, T. 10 N., R. 13 E., San Bernardino Meridian, and is 9 miles southeast of Kelso, in the central part of the Mojave Desert. Kelso is a station on the Union Pacific Railroad and the rail distance from there to Fontana is 178 miles.

The deposit occupies a ridge on the west slope of the Providence Mountains, which rise to an altitude of 5,000 to 6,000 feet northeast of the mine. Altitude at the ore outcrop ranges from 3,900 to 4,100 feet, and at Kelso it is 2,150 feet.

Typical of the Mojave Desert, the general area is made up of steep mountains surrounded by long alluvial fans, which extend to the valley floors. The temperature ranges from 105 degrees in summer to below freezing during the winter months. Owing to the altitude at the mine, the summer nights are usually comfortable. The annual rainfall ranges from 1 to 6 inches and is derived largely from thunderstorms.

Two sources of water are available to the mine: The Goldstone spring and the Cornfield or Union Pacific spring. The Goldstone spring furnished 1 gallon per minute by gravity through 1$\frac{1}{4}$ miles of 1-inch pipeline, but this line is no longer in use. The normal flow of 150 gallons per minute from the Cornfield spring is being stored in a million-gallon reservoir 1 mile south of Kelso, for emergency use by the Union Pacific Railroad, from whom the Vulcan mine now purchases its entire water supply. The water is piped 3.4 miles from the reservoir to the ore-haulage road, from whence it is trucked about 5 miles to the mines.

HISTORY

The Vulcan iron deposit was located by Charles Colcock Jones in and the first application for patent survey was made on July 5, 1907. mining claims and a millsite were patented subsequently, and in 1912 holes were diamond drilled into the deposit, and 80 feet of adit was

During the war, when the shortage of ship's plates became acute, Kaiser Co., Inc., Iron and Steel Division, was organized to build a 1 ton daily capacity blast furnace and steel mill on the Pacific coast. the many iron deposits examined, the Vulcan was chosen as a quick and quate source of iron-ore supply for the first few years of operations Consequently, it was purchased in June 1942, and additional claims we located for water rights and surface installations.

Further diamond drilling was done from May to September 1942. A top road was constructed from Kelso to the mine. A camp to accommodat men was erected; crushing equipment was installed; and mining began o December 12, 1942. The first pig iron was cast at Fontana on Decembe 1942. Since that time the mine has been in continuous operation with exception of one 6-month period, October 1945 to March 1946, inclusive mining was suspended to reduce inventories of stock-piled ore.

GEOLOGY

The following paragraphs on geology are quoted from the report of Severy, geologist for Kaiser Co., Inc.:

> Geologically, this region is composed of three main rocks: sedimentary deposits, which have since been more or less metamorp intrusions of acid igneous rocks; and later intrusions and flows rhyolites.
>
> The oldest sedimentary rocks in the region are Cambrian lime and shales, which have since been metamorphosed to marbles and ph lites. Uncomformably above the Cambrian rocks lie other Paleozoi and Mesozoic marine meta-sediments. Faulted against these sedime taries is a large mass of quartz monzonite, undoubtedly intruded depth and later brought to its present position by faulting. This igneous mass, probably of Jurassic age, lies to the west and south west of the deposit. Tertiary intrusive rhyolites have intruded the sedimentary series on the north and northeast, whereas small rhyolitic flows are present immediately to the north of the deposi
>
> The Vulcan iron deposit is an irregular, mushroom-shaped replacement of limestone by magnetite and hematite along a fault con tact with a quartz monzonite. On the surface the body is 700 feet long by 325 feet wide, maximum dimensions, and it is ovular in sha striking roughly east-west. It occupies two hillsides, being tran sected by a dry wash. The larger part of the ore body lies on the eastern slope, the smaller portion on the west, where it is termin

by a fault. There is no overburden on the deposit. In three dimensions, the deposit has a mushroom shape, with the north, east, and south ore contacts with limestone dipping inward toward the middle of the deposit at angles of 50 to 85 degrees. In the center of the deposit, as explored by diamond-drill holes "A" and "B", the ore extends to a depth of around 900 feet, simulating a stem or pipe. On the west, the ore is terminated by a high-angle reverse fault striking N. 60° W. and dipping 70 degrees to the west, which brings the iron and limestone against the quartz monzonite. No ore is found in the monzonite or in commercial quantities at any other point in the limestone along the fault.

The relation of mineralization of the faulting is somewhat obscure, but it is certain that movement has occurred above the fault subsequent to the mineralization. Proof is found in slickensided iron ore along the fault zone and that no iron is found in the monzonite, which would be expected even if conditions for replacement were favorable. There are two possibilities as to the sequence of faulting and mineralization. One is that the replacement by the ore occurred in the limestone on both sides of the fault. Later movement and erosion removed all traces of the ore on the west and brought the monzonite against the terminated ore body. The other is that the replacement occurred, with the monzonite on the one side being relatively unreplaced, with some later movement along the fault plane.

CHARACTER OF ORE

Three main types of ore are found in this deposit:

1. A highly oxidized mixture of hematite and limonite.
2. A dark-gray magnetite with a small amount of hematite.
3. A blue-black magnetite-hematite ore with a high lime content.

The first type of ore is encountered in the east drift from the portal to approximately 150 feet, and in the diamond-drill holes to an average depth of 50 feet. In general, it is a soft, fractured ore composed largely of hematite and limonite stain, with some black magnetite. Calcite, often iron-stained, in the form of seams, encrustations, and disseminations is abundant and forms the bulk of the gangue material. Greenish serpentine occurs as small inclusions and disseminations. Only occasional pyrite is found.

The second type of ore is found with depth in the drill holes and in the east drift beyond 150 feet and extending almost to the contact. It is a hard, fine to medium-grained, gray-black magnetite with small amounts of hematite, which decreases with depth. Occasionally, subhedral to euhedral crystals of magnetite are found associated with serpentine. Pyrite occurs as disseminations, scattered grains, and seams through the ore and in general increases with depth. Often the pyrite is associated with calcite as subhedral

crystals. Calcite, up to 5 percent, occurs as stringers, inclusions, and small veinlets cutting the ore at random. Serpentine is the most abundant waste material, occurring as inclusions, wide bands up to 3 feet in width, and as disseminations through most of the ore body. It varies in color from a white or buff through green to a dark blue, and is often mottled. It is commonly soft, although some sections are porcelaneous in character.

The third type of ore is a blue-black magnetite-hematite that has a high lime content. The lime occurs as calcite thoroughly disseminated through the ore. Pyrite occurs as small grains throughout this type of ore, which is found on the western side of the deposit adjacent to the fault and close to the contact in the east drift.

The average specific gravity of the Vulcan ores, including waste sections, as determined from a systematic examination of the drill cores and drift samples is 3,85.

The chemical composition of the ore was determined from assays of the cores and sludes from diamond-drill holes, cut samples from the drifts, and surface samples taken at 50-foot intervals over the entire outcrop. Values were calculated by dividing the proposed pit into 13 mining blocks, and the combined results were as follows:

Entire ore body

	Percent								
	Fe	P	Mn	SiO_2	Al_2O_3	CaO	MgO	S	TiO_2
Waste included...	52.23	0.058	0.08	5.22	1.86	4.70	5.17	1.62	0.20
Waste excluded...	54.99	0.052	0.09	4.69	1.69	4.40	4.30	1.66	

Minable ore body

	Percent								
	Fe	P	Mn	SiO_2	Al_2O_3	CaO	MgO	S	TiO_2
Waste included...	50.69	0.063	0.11	3.89	1.45	6.30	5.18	1.19	0.20
Waste excluded...	55.16	0.06	0.10	3.40	1.56	5.33	4.10	0.96	

Minable ore is that which can be mined by open-pit methods. Owing to its high phosphorus content, it is of the non-Bessemer or basic type. The most detrimental element is the sulfur in the pyrite, which has not set pattern of distribution but in general increases with depth. The silica content is consistently low.

EXPLORATION

Exploration was done principally by the driamond drilling of 49 holes ranging in depth from 18 to 897 feet and totaling 11,672 feet. In addition, 482 feet of adit was driven.

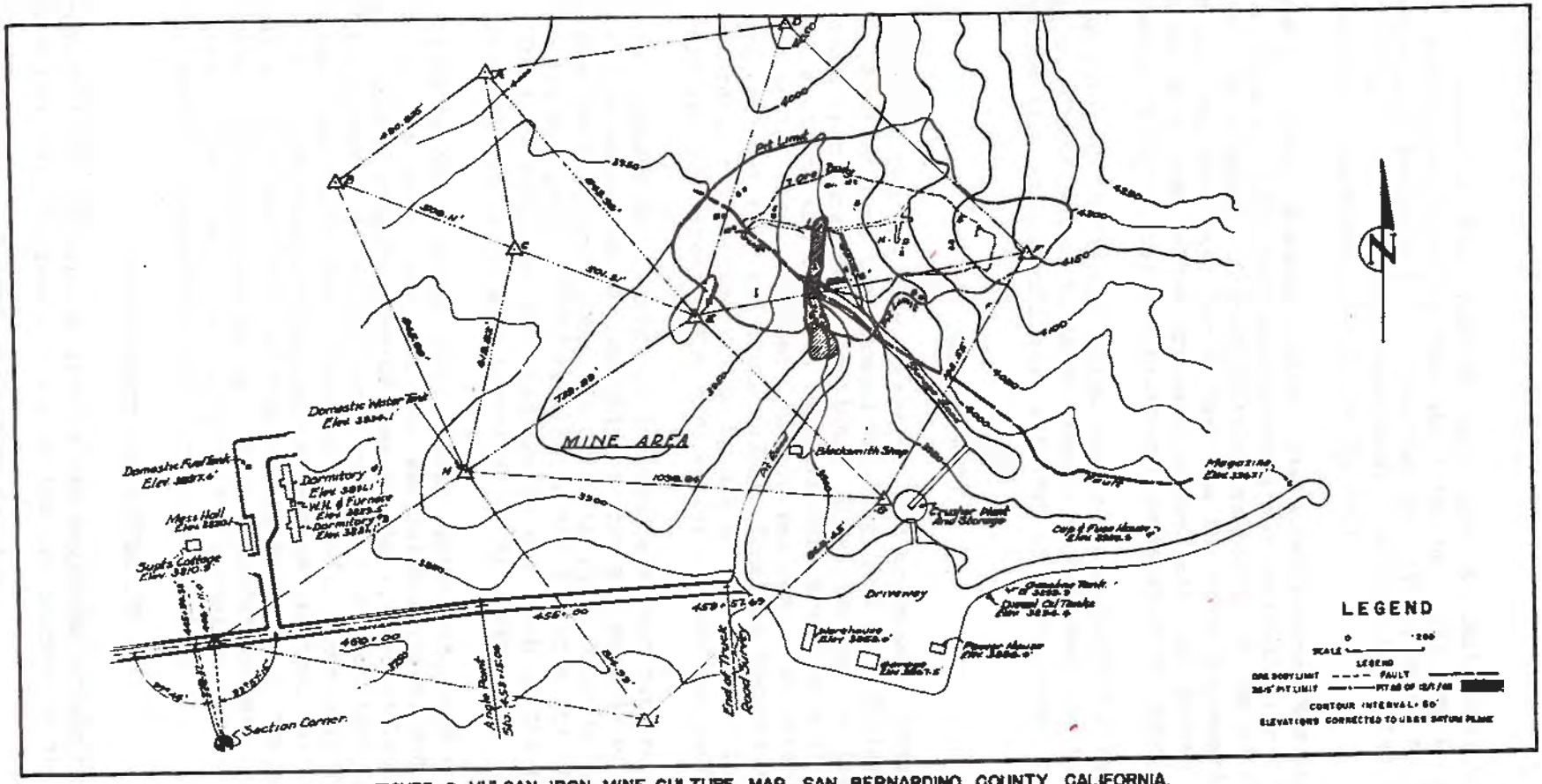


FIGURE 2. VULCAN IRON MINE CULTURE MAP, SAN BERNARDINO COUNTY, CALIFORNIA.

The first work was done some 30 years ago. At that time, 10 holes ranging in depth from 18 to 350 feet and totaling 1,793 feet were drilled by the Continental Drilling Co. of Los Angeles. Also, prior to the acquisition of the property by the present owners, an adit was driven from the dry wash westward under the outcrop for 80 feet.

Kaiser Co., Inc., diamond drilled nine holes between May and September 1942 for a total of 3,111 feet and extended the east adit for a total length of 252 feet. At a point 210 feet in from the portal of the adit, two crosscuts were run, one northeast for 45 feet and the other southward for 50 feet. On the west side of the dry wash another adit was driven 135 feet westerly until it cut across the fault and penetrated the country rock.

During 1944, 30 additional holes were diamond-drilled with company-owned drills. These ranged in depth from 71 to 445 feet and totaled 6,768 feet. Records show an over-all core recovery of 76.4 percent on this drilling.

ORE RESERVES

The extent of the ore body, tonnages, and grade were determined from the results obtained from the diamond drilling, and the pit-layout mining plan was based upon these determinations. In estimating the tonnage, six longitudinal sections and 15 cross sections were drawn on a 50-foot grid, and a factor of 9.3 cubic feet per long ton was used. In establishing the grade of the ore, the core and sludge assays from the diamond drill were adjusted according to relative volume by use of the Longyear factors. Where core recovery was 100 percent, the core analysis alone was used.

Reserves classed as minable ore include only that portion of the ore body that can be extracted economically by open-pit methods of mining. The total ore developed piror to the 1944 drilling was 5,050,000 tons. It extended to a maximum depth of 825 feet below the lowest point of the surface outcrop. The 1944 drilling indicated ore to the north of the pit but did not determine the limits in that direction or in depth.

According to the original plan, mining operations would terminate on the 3,675-foot pit level, but this plan was later revised, and mining by the open-pit method will be carried down to the 3,750-foot level. The estimate of the ore above the 3,750-foot level was 2,500,000 tons, of which 2,100,000 tons had been mined to January 1, 1947. There will remain, therefore, over 2,500,000 tons of high-sulfur-content ore that has been diamond drilled but not yet developed and that cannot be mined in the present pit set-up without additional stripping. It is doubtful whether these reserves will be mined in the near future owing to the excessive amount of waste to be moved in order to enlarge the pit for deeper mining.

DEVELOPMENT AND OPERATIONS

Figure 2 shows the surface area at the beginning of mining operations.[4] A pit was started at the lowest level of the ore outcrop in the dry wash.

4/ Map from Geological Report by Charles Severy.

There was no overburden on the ore, but large quantities of waste have been stripped, so that a pit slope of 1:1 could be maintained in the wall rock around the edges. The pit slope in the ore is 1/2:1. Waste is dumped on the southwest and west sides, where there is unlimited dump room. This is shown in figure 4.

The pit eventually will have seven benches, the top one 60 feet, one 50 feet, and five 40 feet in height. Faces of the top bench, which is at an altitude of 4,000 feet, extended to the upper limits of the outcrop, which on the east side reached an altitude of 4,060 feet. The lowest pit bench is now on the 3,790-foot level, and one more will be opened. The width of the benches varies with their location in the pit. When abandoned, a remnant of each bench is left to catch any falling rocks and to leave the over-all slope 1/2:1.

Figure 3 shows the pit plan.5/ The pit is stadium-shaped, and the axis is N. 44° W. At the top it is 1,000 feet long and 600 feet wide.

Normal rate of production is 2,200 to 2,800 tons per day of one 8-hour shift, but 3,500 tons has been produced in one day. Mining started December 10, 1942, and proceeded at varying rates as follows: Ore was mined continuously on a single-shift daily basis to December 31, 1944, at which time mining was discontinued and stripping was done on a two-shift daily basis until May 31, 1945. During stripping, ore requirements were met from the stock pile at Kelso, where 250,000 tons had accumulated during the 2-year mining period. Ore was again mined from June 1, 1945, to September 30, 1945, when mining operations were suspended until April 1, 1946 in order to reduce inventories of stock pile ore.

The Vulcan mine furnished all of the iron ore used at Fontana from December 1942 to January 1, 1945, after which time and until January 31, 1946, about 40 percent of the blast-furnace feed was ore low in sulfur purchased in Utah. Since that period, the Fontana plant has been operating entirely on Vulcan ore. For several months the plant has been operating on a curtailed basis, but production is being stepped up to 1,200 tons of hot metal, and this will require 2,400 tons of ore per day.

From the beginning of operations to January 1, 1947, a total of 2,100,000 tons has been mined, and 1,855,400 tons of this has been shipped to Fontana. This ore contained 52 to 55 percent iron, and the sulfur content ranged from 0.2 to 1.6 percent. In addition, 3,001,775 tons, or 1,204,710 cubic yards of waste has been moved and dumped. The ratio of cubic yards of waste moved to tons of ore moved is 0.71 to 1.

DRILLING AND BLASTING

Drilling equipment consists of two 29-T Bucyrus-Erie gasoline-driven churn drills, 2 Gardner-Denver wagon drills, one Ingersol-Rand wagon drill, 8 jack hammers, and 3 portable, Diesel-powered, Ingersol-Rand air compressors, two of which are rated at 500 cubic feet and one at 315 cubic feet per minute.

5/ Copy of Kaiser Co., Inc., monthly development map for January 1947, furnished by Ken B. Powell, mining engineer.

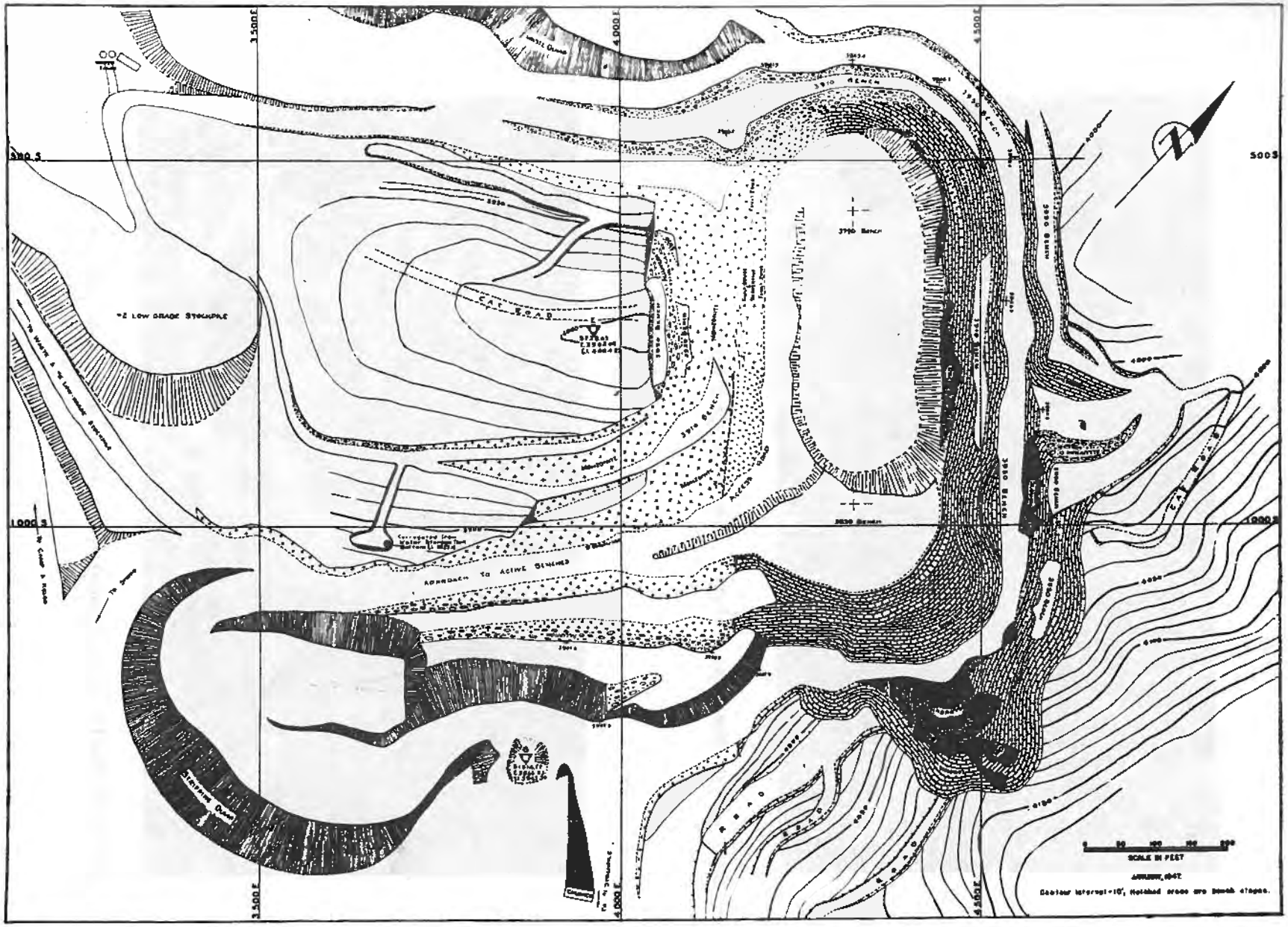


FIGURE 3. PIT PLAN, VULCAN IRON MINE, SAN BERNARDINO COUNTY, CALIFORNIA.

Figure 4. - Vulcan iron mine, west end, showing camp and waste dump.

Figure 5. - Vulcan iron mine, east end, showing pit, crushing plant, office, etc.

Figure 6. - View of pit, looking northwest from 4,000-foot bench.

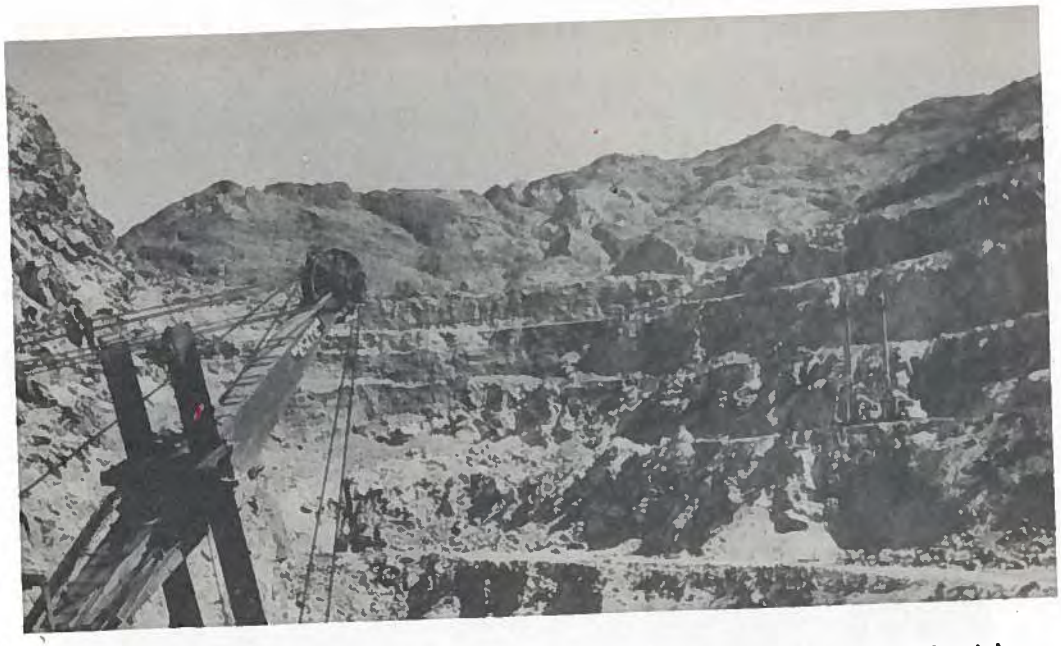


Figure 7. - View from bottom of pit, 3,830-foot level, looking N. 30° W.

Figure 8. - Crushing plant.

Figure 9. - Shovel in operation.

Each of the three types of drills has its special use. The jack hammers are used in drilling for secondary blasting to depths of 12 feet or less, and holes are spaced 3 to 3½ feet apart. Wagon drills are used for drilling high bottom and drop cuts with holes 12 to 24 feet deep. Holes are spaced 6 feet apart, and a 3½ inch starter bit is used. Churn drills are used for drilling blast holes on the benches, and holes are 24 to 55 feet deep, have a 13-foot burden and 13-foot spacing, and are 9 inches in diameter. (Figs. 6 and 7.) Churn-drilling holes less than 24 feet in depth is not economical. All holes on the benches are drilled 5 feet below ground level of the lower benches.

Jack-hammer holes are loaded and tamped in the regular manner. Wagon-drill holes are sprung two or three times to make room for a large charge, but churn-drill holes are not sprung. Holes are charged with 40-percent gelatin and then fired electrically with primacord, 2 or 3 sticks of 60 to 80 percent dynamite being used as primers. All calculations for the blasting charges are made by the powder foreman, and the charges, depending on the ground, vary as much as 300 pounds per hole. In some blasts as much as 10 tons of powder is used and 30 to 40 thousand tons of ore is broken. Powder consumption per ton of waste broken is 0.251 pound, and per ton of ore it is 0.335 pound.

ORE HANDLING

After the ore or waste is broken, it is handled by two 54-B, Bucyrus-Erie, 2½ cubic yard, Diesel-powered shovels, and one shovel of the same type is held in reserve. (See figs. 6 and 7.) The shovels load into 10 cubic yard-capacity Euclid dump trucks, 11 of which are required. One shovel will load 18.6 trucks per hour. (See fig. 9.) The distance from the pit to the crushing plant has varied from 350 feet to 2,400 feet. The crushing plant, as shown in figures 5 and 6, is near the southeast end of the pit.

The trucks dump into a bin, from which the ore is fed to a 6-inch bar grizzly by a 5-foot Stephens-Adamson pan feeder. A 42-inch, 10-ply, stacker conveyor belt receives the undersize, and the oversize is reduced to 8 inches by an electrically driven, 42- by 48-inch, Taylor jaw crusher having a capacity of 3,000 tons per 8 hours. The product from the crusher goes to the stacker belt, which feeds the storage pile, where 6,000 tons of ore can be stocked. The stock pile is above an inverted con-shaped cavity cut from the rock and connected with an adit where a 5-inch Stephens-Adamson pan feeder discharges to a 42-inch conveyor belt equipped with a Merrick weightometer. Trucks loaded direct from the belt haul the ore to Kelso.

Kelso is 9 miles by road from the mine, and the grade, with a maximum of 6.9 percent, favors the load. Kenworth semitrailer trucks of 15 cubic yards capacity are used for haulage, all of which is done by contract. The average load is 25 tons of ore. Trailers are end-dump type with hoist attachment, and the trucks are powered with Cummings Diesel engines and equipped with hydrotarders. A hydrotarder is a braking mechanism attached to the drive shaft of the truck. It has a closed water circuit, the circulation of which can be regulated from the driver's seat to hold the truck at any

desired speed on downgrade. With the mechanism, speeds commensurate with the condition of the road surface can be maintained on steep downgrades with no danger of the truck gaining speed or going out of control, and with no undue strain to the clutch or engine. Braking is attained without the use of brakes. These make for fast runs with loads to Kelso.

The road is 22 feet wide and was built by removing all the large boulders from the road bed, smoothing with a blade, and laying a 3-inch, blacktop, road-mix, macadam surface cover, in which the minus 1½-inch material from the sides of the road bed was used. More than 1,900,000 tons of ore has been transported, and the road maintenance has been negligible despite the great variation in temperature.

At Kelso the ore is dumped from a ramp into a 100-ton bin, from under which a pan feeder discharges onto a 42-inch belt conveyor equipped with a Merrick weightometer. This belt discharges into the railroad cars. The grade of the railroad siding is 0.6 percent, and the cars are placed under the discharge belt by gravity. A Buda Diesel engine connected to a 60-kilowatt generator furnishes power to a pan feeder, loading belt, and an electric, vertical, capstan-type car puller, which is used to start the loaded cars down the spur. When more ore is trucked than is required for shipment, the excess is stock-piled at the railroad loading ramp. The ore is transported to Fontana by the Union Pacific and Santa Fe Railroads. The freight rate is $1.25 per ton for a minimum shipment of 1,500 long tons.

ORE TREATMENT

At Fontana the ore is dumped from the railroad cars by a Link-Belt car roll against baffle plates to a long-pan feeder. The feeder discharges to a 42-inch conveyor belt, which carries the ore to a jaw crusher, which reduces it to minus 4-inch size. The crusher discharges onto a 1-3/4-inch mesh screen. The oversize is fed to a cone crusher that works in closed circuit with the screen. The undersize product goes to another screen, usually of 3/4-inch mesh but occasionally of 3/8- or 1/2-inch mesh. The undersize goes directly to the sintering plant, and the oversize to the bedding system. Portions of the oversize can be diverted, when required, to regrinding cones and sent to the sintering plant. About 50 to 70 percent of the Vulcan ore is sintered because of its high sulfur content.

The ore is bedded longitudinally in piles from a traveling belt stacker. Four of these piles are laid parallel. The cross section of each is triangular. The ore is removed from the piles by recovery rakes and plows, which cut the pile crossways and dump onto a conveyor belt equipped with an automatic sampler and an automatic weigher. The belt discharges into one of the storage bins that supply the blast furnace. The furnace operators have complete analysis of ore, which is generally charged into the furnace within 2 days after the filling of the storage bins and can balance the charge accordingly.

The sintered ore, when cooled, is stocked in a storage pile by an elevated conveyor belt with movable tripper. It is drawn off through chutes

to a recovery belt in a tunnel beneath the pile and transported to the blast-furnace bins, sampled, and weighed out for charge, the same as the ore.

SAMPLING

Only rough sampling of the ore is done at the mine. The approximate grade is known from the diamond-drill analysis, and the sludges from the churn-drill holes for blasting are sampled and analysed as a further check on the grade of ore in the benches being worked. A limited amount of selecting is done by the shovel operators, and any considerable amounts of serpentine or limestone are sent to the waste dumps. The conclusive sampling is done at Fontana by an automatic sampler on the conveyor belt to the blast-furnace storage bins.

MINE SURFACE PLANT

In addition to the crushing plant, the installations at the mine consist of an office and warehouse, garage, gasoline pumps, machine shop, power plant, 2 dormitories, cook house and mess hall, cook's dormitory, and the superintendent's house. At Kelso, a trailer court was built to accommodate 20 families in company-owned trailers, and space was provided for 10 private trailers. The normal complement of men, including the kitchen staff, is 80 to 85 and 12 to 14 on the contract truck haul.

The power plant consists of a Fairbanks-Morse 280-horsepower, 4-cycle, marine-type, Diesel engine, direct-connected to a Fairbanks-Morse generator. This plant furnishes power for crushing, conveyor belts, shop equipment, lighting, and refrigeration.

PRODUCTION DATA

Churn drills average 6.22 feet of hole per hour, and the wagon drills average 16.42 feet per hour.

Shovels average 342 short tons of ore or waste per hour.

Average man hours per ton ore and waste is 0.157.

Tons of ore and waste per man shift, including all personnel at the mine, averages 50.96.

An average of 18.6 trucks are loaded per shovel hour.

Powder consumption per ton averages 0.335 pound for ore and 0.251 pound for waste.

Gasoline consumption averages 0.055 gallon per ton of ore and waste hauled.

Diesel oil averages 0.3 gallon per ton of ore and waste hauled.