Preliminary Assessment Prepared for:

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National Park Service
Death Valley National
579 Cow Creek Service Road, Building CC50
Death Valley, California 92328

FINAL

Preliminary Assessment

27 Abandoned Mineral Lands Sites
Death Valley National Park
Inyo and San Bernardino Counties, California and Nye County, Nevada

November 21, 2014

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ACRONYMS AND ABBREVIATIONS

°F	Fahrenheit
AML	Abandoned Mineral Lands
amsl	above mean sea level
ATV	All-Terrain Vehicle
bgs	below ground surface
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
COC	Contaminant of Concern
CSM	Conceptual Site Model
DEVA	Death Valley National Park
ECM	Environmental Cost Management, Inc.
EDR	Environmental Data Resource, Inc.
EPA	(United States) Environmental Protection Agency
FCC	Federal Communication Commission
GPS	Global Positioning System
HR	Hydrologic Region
HRS	Hazard Ranking System
mg/kg	milligrams per kilogram
NEPA	National Environmental Policy Act
NFRAP	No Further Remedial Action Planned
NPS	(United States Department of the Interior) National Park Service
PA	Preliminary Assessment
PVC	polyvinyl chloride
RCRA	Resources Conservation and Recovery Act
SHPO	State Historic Preservation Office
SI	Site Inspection
SOW	Scope of Work
TDS	Total Dissolved Solids
USGS	United States Geological Survey

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EXECUTIVE SUMMARY

Environmental Cost Management, Inc. (ECM) conducted Preliminary Assessments (PAs) at 27 Abandoned Mineral Lands (AML) sites in Death Valley National Park (DEVA). ECM collected information concerning site background, operational history, and current environmental conditions at the sites sufficient to assess potential threats posed to human health and the environment and to determine whether additional characterization is needed. The primary waste generated at these sites is tailings resulting from milling and processing of gold and silver ore. Mill tailings typically contain higher-than-background concentrations of metals. Cyanide and mercury processing activities associated with some mill sites add those compounds to potential contaminants of concern (COCs) for the sites. Preliminary contaminants of concern include elevated metals concentrations, and, at some sites, cyanide.

Each of the 27 AML sites was visited by an ECM geologist to define the project setting and document environmental conditions. Published documents, historical data, and reports contained in files maintained by the National Park Service (NPS) were reviewed to compile and document available information for each site and identify evidence of potential releases to the environment. In addition, site data and information pursuant to the National Environmental Policy Act (NEPA), compiled by Environmental Data Resource Inc. (EDR), were evaluated and are included in this report.

Historical data were collected from NPS files and the published sources and the sites were evaluated using the U.S. Environmental Protection Agency's (EPA's) Hazard Ranking System (HRS) QuickScore software. No sites exceeded a score of 28.50, the score meriting a further action recommendation. Generally, sites that score less than 28.50 receive a no further remedial action planned (NFRAP) recommendation. The HRS scores are very low due partly to the remoteness of most of the DEVA mining sites resulting in fewer receptors. For this reason, AML sites are recommended for further study based upon the Conceptual Site Model (CSM) for each site, rather than the HRS score.

The CSMs integrate information about the site to describe potential source areas, release and transport mechanisms, and complete and incomplete exposure pathways. They also identify potentially exposed receptors under the current and reasonably anticipated future land and water uses. Pathways are the environmental media through which a hazardous substance threatens targets. Potentially exposed media of concern evaluated in the CSMs include groundwater, surface water, surface and subsurface soil, sediment, and air. ECM considered each potential exposure pathway for human and ecological receptors in the CSM for each site. Complete CSM tables are included in the section addressing each AML site. **Table ES-1** summarizes all conclusions for each site and includes recommendations, and **Table 1-1** (groundwater), **Table 1-2** (surface water), and **Table 1-3** (soil, sediment, and air) document in a succinct manner how conclusions are derived for each site.

The CSM result informs NPS resource managers that the pathway from the source, through all potentially impacted media, to human and/or ecological receptors is:

- **Complete and significant**, meaning exposure to population is likely;
- **Complete, but insignificant**, meaning exposure to population may exist, but considered insignificant due to limited potential for exposure; or
- **Incomplete**, meaning exposure to population is unlikely.

Potentially complete and significant exposure pathways for groundwater, surface water, soil, sediment, and/or air exist for 25 of the 27 AML sites within this study. ECM determined that one site has no potentially complete exposure pathways for any medium. The Franklin Mill site has no mill tailings or any other potentially hazardous materials present. The Tucki Mine and Mill site has empty cyanide tanks and coarse gravelly mill tailings, which are less likely to release hazardous concentrations of metals to the environment than typical fine-grained mill tailings. Although cyanide process tanks are present, it is unlikely that cyanide persists in the environment at this site.

In summary:

- **1 site:** Pathway incomplete for all media types – Franklin Mill
- **1 site:** Pathway potentially complete, but considered insignificant for soil only – Tucki Mine and Mill
- **25 sites:** Pathway complete and considered significant for soil, sediment, and air
- **2 sites:** Pathway complete and considered significant for surface water
- **6 sites:** Pathway complete, but considered insignificant for surface water
- **9 sites:** Pathway complete, but considered insignificant for groundwater

At all sites where the exposure pathway is complete and considered significant for soil, sediment, and air, fine-grained tailings exist in various quantities. The nine sites which have a potentially complete pathway for groundwater are considered insignificant due to a lack of potential receptors.

ECM recommends one site, Franklin Mill, for no further action, and 26 sites for further action (additional sampling and analysis of the mill tailings). ECM encourages NPS to prioritize further investigation at sites based on milling processes (i.e., prioritize sites with mercury), popularity of sites for DEVA visitors, and the presence of threatened or endangered plant and animal species or other sensitive environments, such as wetlands (reference **Table 2**). Other criteria to consider, for prioritizing sites to receive further investigation, is the quantity (**Tables 1-1, 1-2,** and **1-3**) and distribution of the tailings present. However, until it is determined what concentrations of potential COCs are present in the source material, it is difficult to discern the threat to potential receptors.

NPS can acquire the recommended data by conducting a Site Inspection (SI) at each of the 26 sites recommended for waste characterization. Typically, an SI involves more thorough investigation, such as determining full extent of waste and impacts to all potentially exposed media. However, SIs can be implemented according to a phased approach. ECM proposes that a single SI be conducted to gather concentration data for waste characterization and background sampling only. This would involve mobilizing to each site and collecting tailings, adjacent soil, and background soil samples. The resulting SI Report would indicate concentrations of COCs compared to appropriate criteria and would provide an update to the CSMs. This would give NPS the data necessary to determine which sites pose the highest risk to human health and the environment.

1.0 INTRODUCTION

At the request of the U.S. Department of the Interior, National Park Service (NPS), Environmental Cost Management, Inc. (ECM) conducted Preliminary Assessments (PAs) to evaluate the potential for release of hazardous constituents related to historical mining and milling operations at 27 Abandoned Mineral Lands (AML) sites in Death Valley National Park (DEVA). **Figure 1** shows the location of all 27 sites. The PAs were conducted in accordance with U.S. Environmental Protection Agency (EPA) guidance[1] and the Preliminary Assessment Work Plan[2].

The PAs were conducted to meet the following objectives:

- Identify, describe, and document past and present practices and processes related to storage, use, and disposal of hazardous substances.
- Identify routine and non-routine activities that may have led to releases of hazardous constituents into the environment.
- Determine operational history including when specific hazardous substance management practices began and ceased; the type and quantity of substances involved; and locations where storage, use, and disposal activities occurred.
- Evaluate the U.S. Environmental Protection Agency (EPA) Hazard Ranking System (HRS) score associated for each site.
- Create a Conceptual Site Model (CSM) considering available information.
- Recommend appropriate further action at the sites.

The scope of the investigation included review of available local, state, and federal agency file information; a preliminary evaluation of potential impacts to site media; identification of potential migration routes, exposure pathways, and receptors; a site inspection/reconnaissance; and interviews with NPS personnel.

The AML sites included in this DEVA PA are divided into four groups, per the NPS Statements of Work (SOW)[3]. **Figure 1-1** shows the location of each of these sites by name and number as listed below.

Group 1

1. Homestake Mill
2. Lost Burro Mine and Mill
3. Crowell Mercury Mill
4. Lane Mill
5. Franklin Mill
6. Big Bell Mine and Mill
7. Cyty's Mill
8. Gold Grotto Mine and Mill
9. Broken Pick Mill

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[1] EPA, Office of Emergency and Remedial Response, EPA/540/G-91/013, Guidance for Performing Preliminary Assessments Under CERCLA, September 1991.

[2] ECM 2014, Preliminary Assessment Work Plan for 24 Abandoned Mine Sites, Death Valley National Park, Inyo County, California, January 29, 2014.

[3] Statement of Work, Modification 0002, Preliminary Assessments for national Park service – Death Valley National Park

10. Morning Glory Mill
11. Queen of Sheba Mine and Mill
12. Ashford Mill

Group 2

13. Starr Mill
14. Journigan's Mill
15. Greene-Denner-Drake Mill
16. Skidoo Mill
17. Tucki Mine and Mill
18. Cashier Mill
19. Lower Wildrose Mill

Group 3

20. Oh Be Joyful
21. Gem Mine
22. Unknown (Sourdough Canyon)

Group 4

23. Panamint City Smelter
24. Happy Hooligan Mine and Mill
25. Gold Hill Mill
26. Indian Mine
27. Telephone Canyon Mill

1.1 GENERAL SITE SETTING

DEVA is located east of the Sierra Nevada Mountains between the Great Basin and Mojave Desert. The park is located primarily in the state of California within Inyo and San Bernardino counties (**Figure 1**). DEVA and surrounding area consists of approximately 3 million acres of badlands, valleys, canyons, and mountains. The area was declared a national monument in 1933 and formally became a national park in 1994. It includes the whole of Death Valley, which runs for approximately 150 miles between the Amargosa and Panamint ranges. DEVA occupies an area of physical extremes from Badwater Basin, located at 282 feet below sea level, to Telescope Peak, located at 11,049 feet above sea level. It is the hottest, lowest, and driest area in North America.

1.2 GEOLOGIC SETTING AND HYDROGEOLOGY

DEVA is located in the Basin and Range Geomorphic Province and is considered the westernmost part of the Great Basin. The province is characterized by subparallel, fault-bounded ranges separated by rotated and down-dropped basins[4] which receive interior drainage resulting in lakes and playas. Death Valley, the lowest area in the United States (282 feet below sea level at Badwater), is one of these basins. **Figure 1** and U.S. Geological Survey (USGS) topographic maps (**Appendix E**) show physiographic features in Death Valley Region[5]. DEVA is comprised of many geologic formations including alluvial fans and lacustrine deposits, salt flats, active volcanism, and mineral-rich rock formations (**Figure 2**). Carbonate rocks of Precambrian and Paleozoic age are extensively

[4] California Geological Survey, California Geomorphic Provinces, Note 36. 2002.

[5] Fridrich, Christopher J. and Ren A. Thompson, Cenozoic Tectonic Reorganizations of the Death Valley Region, Southeast California and Southwest Nevada, U.S. Geological Survey Professional Paper 1783, 2011.

metamorphosed by folding and faulting and are highly fractured and fissured. A salt encrusted playa extends for 200 square miles in the southern portion of the valley[6].

Average annual precipitation over the last 30 years in DEVA has been 2.5 inches, with higher elevations receiving over 15 inches per year. Surface water is scarce at DEVA. Dry washes of all sizes flow only after thunderstorms or heavy winter rains. Surface water drains into enclosed desert basins, where it is lost to evaporation and infiltration.

DEVA is located in the South Lahontan HR (HR) which covers approximately 21 million acres in eastern California. The HR is bounded on the west by the crest of the Sierra Nevada, on the north by the watershed divide between Mono Lake and East Walker River drainages, on the east by Nevada, and the south by the crest of the San Gabriel and San Bernardino mountains and the divide between watersheds draining south toward the Colorado River and those draining northward. This HR includes the Owens, Mojave, and Amargosa river systems, the Mono Lake drainage system, and many other internally drained basins. Runoff is about 1.3 million acre-feet per year[7]. Areas within the South Lahontan HR where groundwater occurs outside alluvial groundwater basins are called groundwater source areas. These areas are associated with the igneous intrusive and extrusive, metamorphic, and sedimentary rocks that underlie the mountainous regions of the HR. Because many of the bedrock regions of the HR consist of mineralized metamorphic rock containing ores of copper, gold, silver, lead, mercury, zinc, and other metals, potential impacts to groundwater are anticipated to predominantly derive from these natural sources. Only a very minor cumulative contribution is expected from the historic mining and milling operations, including those sites evaluated in this PA.

Seventy-six groundwater basins are delineated in the South Lahontan HR, and the Langford Valley Groundwater Basin is divided into two subbasins. The groundwater basins underlie about 11.6 million acres (18,100 square miles) or about 55 percent of the HR. In most of the smaller basins, groundwater is found in unconfined alluvial aquifers; however, in some of the larger basins, or near dry lakes, aquifers may be separated by aquitards that cause confined groundwater conditions. Depths of the basins range from tens or hundreds of feet in smaller basins to thousands of feet in larger basins. The thickness of aquifers varies from tens to hundreds of feet. Well yields vary in this region depending on aquifer characteristics and well location, size, and use.

The chemical character of the groundwater varies throughout the region, but most often is calcium or sodium bicarbonate. Near and beneath dry lakes, sodium chloride and sodium sulfate-chloride water is common. In general, groundwater near the edges of valleys contains lower TDS content than water beneath the central part of the valleys or near dry lakes.

The subsections below present additional information regarding three key basins within DEVA, the Death Valley Basin, the Panamint Basin, and the Amargosa Basin. Specific characteristics for smaller basins associated with individual AML site will be described in environmental sections for each of the 27 sites included in this report.

1.2.1 Death Valley

The Death Valley Groundwater Basin underlies a northwest-trending valley in eastern Inyo and northern San Bernardino counties. The Death Valley groundwater basin encompasses 1,440 square miles and is bordered by consolidated rocks of the Grapevine, Funeral, Black Mountains, and Ibex Hills of the Amargosa Range to the east and southeast; and the Owlshead, Tucki, Panamint, and

[6] Department of Water Resources – California's Groundwater Bulletin 118, South Lahontan Hydrologic Region, Death Valley Groundwater Basin. http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

[7] *Ibid*.

Cottonwood Mountains of the Panamint Range to the west and southwest. Elevation of the valley floor ranges from 282 feet below mean sea level at Badwater to about 4,000 feet above mean sea level at the north end of the valley. There is a 200-square-mile salt incrusted playa in the southern portion of the valley.

The Death Valley-Furnace Creek fault zone is a barrier to the movement of groundwater along the eastern perimeter of the valley. Uplifted beds of the Funeral Formation in the Salt Creek Hills impede the southerly flow of groundwater causing it to rise to the surface at springs along the periphery of the fault zone. Highly fissured and fractured carbonate rocks of Precambrian and Paleozoic age are a source of groundwater originating from outside the basin through faults or solution openings. Several large springs in the area are believed to have their flow derived from outside the basin. The primary water-bearing units in the Death Valley groundwater basin are the unconsolidated, fine- to coarse-grained older and younger Quaternary alluvial deposits found along stream channels and at the base of alluvial fans near the mountains[8].

Groundwater can be found in alluvium of Quaternary age[9]. The primary water-bearing materials used as a source of potable water are the unconsolidated, coarse- to fine-grained older and younger Quaternary alluvial deposits found at the base of the mountains and along stream channels. The fractured and fissured metamorphosed carbonate rocks may permit groundwater originating outside the basin to enter along faults or through solution openings. Furthermore, these formations may form a regional inter-basin flow system allowing groundwater to be transported from outside the basin[10].

Average annual precipitation ranges from about 1 to 4 inches in the central and southern parts of the valley and increases in the northern valley to about 4 to 8 inches. Surface runoff, derived from occasional rainstorms and flash floods in the surrounding mountains, drains towards the central axis of the valley and flows towards Badwater by way of Salt Creek from the north, and the Amargosa River from the south.

Recharge to the basin is predominately through percolation of storm runoff through alluvial fan deposits at the base of the mountains, and from the nearby river drainage system. Within Death Valley, groundwater moves toward the valley floor and ultimately beneath the playa lake at Badwater where discharge occurs through evaporation. At Travertine Point, groundwater was recorded fluctuating from 598 to 601 feet bgs from May 1990 through March 2002[11] .

Springs in the Funeral Mountains have a sodium bicarbonate character. The water is suitable for most beneficial uses at Keane Spring in the northern Funeral Mountains and at the spring near Scotty's Castle. Also, groundwater derived from wells and springs near Emigrant Pass and upper Emigrant Wash are largely low in TDS content and suitable for most domestic and irrigation purposes. Elevated fluoride and boron impair most of the large warm springs and wells in the eastern perimeter of the valley. However, water from Bennett's Well is suitable for domestic and irrigation uses. At Stovepipe wells, groundwater tends to be sodium chloride or sodium bicarbonate-sulfate character. Groundwater

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8 Department of Water Resources. South Lahontan Hydrologic Region – Death Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

9 Ibid.

10 Department of Water Resources – California's Groundwater Bulletin 118, South Lahontan Hydrologic Region, Death Valley Groundwater Basin. http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

11 Department of Water Resources. South Lahontan Hydrologic Region – Death Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf

is marginal to inferior for irrigation and domestic use due to the elevated fluoride, boron, chloride, sulfate, and total dissolved solids concentrations. Water quality in the Quaternary lacustrine deposits are high in total dissolved solids (TDS) and excessively saline[12].

1.2.2 Panamint Valley

The Panamint Valley Groundwater Basin underlies a north-trending valley in southern Inyo County. Annual rainfall is 3 to 4 inches on the valley floor and up to 12 inches in the upper peaks of the Panamint Mountains. Panamint is a closed structural valley; water escapes only through evaporation and only a small quantity of water is being pumped[13]. Recharge to groundwater within Panamint Valley occurs through direct infiltration of rain, subsurface flow from adjoining areas, and percolation of infrequent runoff that occurs during flash floods from the surrounding mountains. The percolation through the alluvial fan deposits at the base of the Panamint Mountains provides the principal recharge to the basin.

Runoff flows to Upper Panamint (dry) Lake in the northern part of the valley to Lower Panamint Lake (dry) in the southern part, but much is lost to evaporation.[14] The younger alluvium, of Holocene age, consists of unconsolidated sand with small quantities of gravel, silt, and clay. This material is still being deposited within the valley during times of stream flow. The unit is permeable and where saturated can yield to wells. The units are thin and lie above the water table, but do transmit precipitation and water from intermittent streams to the groundwater body[15]. The younger fan deposits are, also, of Holocene age. These consist of unconsolidated angular boulders, cobbles, and gravel with small quantities of sand and silt derived from and occurring at the toe of mountain washes. This unit also occurs above the regional water table, and while not an important aquifer, also recharges groundwater within the basin[16].

Groundwater within the Panamint Valley only discharges at South Panamint Lake. Water levels beneath the discharging playas are at or near the land surface, which allow water to evaporate and leave a residue of salt behind. Water beneath dry Panamint Lake is very salty. Water quality problems include high sulfate content and elevated fluoride, chloride, and TDS. As a result, water from most wells on the valley floor is inferior for domestic use and marginal to inferior for irrigation purposes. Fresh water can be obtained from shallow wells near the edge of the dry lake, but most water produced from deep groundwater is not potable. Domestic well depths range from 44 to 48 feet below ground surface[17].

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12 Department of Water Resources – California's Groundwater Bulletin 118, South Lahontan Hydrologic Region, Death Valley Groundwater Basin. http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

13 Department of Water Resources – California's Groundwater Bulletin 118, South Lahontan Hydrologic Region, Panamint Valley Groundwater Basin. http://www.water.ca.gov/pubs/groundwater/bulletin 118/basindescriptions/6-58.pdf

14 Department of Water Resources – California's Groundwater Bulletin 118, South Lahontan Hydrologic Region, Panamint Valley Groundwater Basin. http://www.water.ca.gov/pubs/groundwater/bulletin118/basindescriptions/6-58.pdf

15 Department of Water Resources – Water Wells and Springs in Panamint, Searles, and Knob Valleys. Bulletin No. 91-17. 110 p.

16 Department of Water Resources – Water Wells and Springs in Panamint, Searles, and Knob Valleys. Bulletin No. 91-17. 110 p.

17 Department of Water Resources – California's Groundwater Bulletin 118, South Lahontan Hydrologic Region, Panamint Valley Groundwater Basin. http://www.water.ca.gov/pubs/groundwater/bulletin118/basindescriptions/6-58.pdf

1.2.3 Amargosa River Basin

The Amargosa River Basin covers an area of 3,124 square miles in east-central California and southwestern Nevada. The Amargosa River Basin is divided into three basin areas: Northern Amargosa Groundwater Basin (Nevada), Middle Amargosa Valley Basin (California), and Death Valley Groundwater Basin (California and Nevada)[18]. The main hydrogeologic units consist of unconsolidated basin fill materials, volcanic rocks (mostly in Nevada), and the regionally extensive carbonate rock aquifer.

The Amargosa River Basin watershed is part of the Death Valley regional groundwater flow system. This regional flow system is more extensive than the Amargosa River Basin watershed because it includes an area beyond the watershed that is underlain by a carbonate rock aquifer that drains toward Death Valley. Groundwater recharge in the carbonate aquifer results from precipitation that falls within the mountains of southern and eastern Nevada and is discharged into the Amargosa Valley. The principal surface water body in the region is the Amargosa River, an intermittent river with headwaters issuing from springs northeast of Beatty, Nevada, and extending approximately 180 miles to the terminus of the river in the playa in Death Valley. Except for segments in Amargosa Valley in California and headwaters near Beatty, Nevada, the river is intermittent; water typically flows only following periodic storms. Dry areas of the river flow in the subsurface; perennial segments are supplied by groundwater (springs)[19].

Previous studies indicate that two aquifer systems are present: valley fill deposits and underlying carbonate rock aquifer[20]. In the northern part of the valley, significant groundwater also occurs in the volcanic rocks[21]. The direction of groundwater flow parallels the slope of the ground surface, from recharge points in the higher elevations to spring discharge or discharge to the Amargosa River. Recharge occurs from the 1 to 8 inches of annual precipitation that falls on the ground surface or flows from the highlands, and underflow contributions from Paleozoic carbonate and volcanic Tertiary rocks[22]. The geology of the basin is diverse, with Precambrian, Paleozoic and Mesozoic metamorphic and sedimentary rocks, Mesozoic igneous, Tertiary and Quaternary volcanic rocks, and alluvial/fluvial/playa deposits. The rocks have been deformed by a variety of fault types, including normal faults typical of the Basin and Range, regional strike-slip faults, and thrust faults that displaced units during the Paleozoic and Mesozoic and affect the groundwater flow system today. The valley area is covered by coalescing alluvial fans forming broad slopes between the mountains and valley floor. These basin fill deposits generally overlie Paleozoic rocks. The regional gradient of the groundwater basin is to the south-southeast along the axis of the valley into the playa at Death Valley Junction[23].

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18 Designated Groundwater Basins of Nevada Map. Department of Conservation and Natural Resources, September 2013, http://water.nv.gov/mapping/maps/designated_basinmap.pdf.

19 SGI. 2012. 2012 State of the Basin Report; Amargosa River Basin. Inyo and San Bernardino Counties, California & Nye County, Nevada. March 12, 2012. http://inyo-monowater.org/wp-content/uploads/2013/11/IM_IMP2_Workplan4_20131118.pdf

20 U.S. Geological Survey, Ground-Water resources – Reconnaissance Series, Report 14, Geology and Ground Water of Amargosa Desert, Nevada-California. March 1963

21 SGI. 2012. 2012 State of the Basin Report; Amargosa River Basin. Inyo and San Bernardino Counties, California & Nye County, Nevada. March 12, 2012. http://inyo-monowater.org/wp-content/uploads/2013/11/IM_IMP2_Workplan4_20131118.pdf

22 U.S. Geological Survey, Professional Paper 1703-E. Focused Ground-Water Recharge in the Armagosa Desert Desert Basin. 2007. http://pubs.usgs.gov/pp/pp1703/e/

23 U.S. Geological Survey, Ground-Water resources – Reconnaissance Series, Report 14, Geology and Ground Water of Amargosa Desert, Nevada-California. March 1963.

Beneficial uses of water in the Amargosa basin include agricultural, recreational, wildlife, livestock, and domestic/municipal uses. Domestic water is generally supplied by groundwater from private wells, including users in the town of Beatty, Nevada. The major water use is for agriculture. Water quality varies; in recharge areas concentrations of TDS is low. Dissolved solids become higher in concentration as groundwater moves through the aquifer; much of the groundwater resources are of medium salinity water or poorer[24]. In the northern Amargosa River Basin, where the majority of pumping occurs, groundwater is suitable for irrigation use. Natural springs commonly occur in this area due to deep groundwater under hydraulic pressure. Groundwater in the carbonate rock aquifer generally has a higher head pressure than water in the valley-fill aquifer and discharges into springs and moves upward where permeability of overlying deposits permits.

1.3 CLIMATE AND TOPOGRAPHY

Death Valley National Park covers over 3 million acres of Mojave and Great Basin Desert terrain, with elevations ranging from 282 feet below mean sea level at Badwater Basin to 11,049 feet on the summit of Telescope Peak. Temperatures in the valley range from over 120 degrees Fahrenheit (ºF) in the summer to an average of 40 ºF in the winter but often dip below freezing. Annual precipitation varies from 1.9 inches (2.5 inches is the 30-year average) on the valley floor to over 15 inches in the higher mountains[25].

NPS maintained a climate station at Furnace Creek in Death Valley until 2007. Although exact wind speeds were not archived, daily wind movement, which measures the total distance the wind moves each day, was recorded[26]. According to Roof and Callagan, "Average daily wind movement is lowest during the winter and peaks during the early spring. During March–May, daily wind movement commonly exceeded 250–300 miles per day." Within DEVA, it not uncommon for fine-grained material to become airborne and re-distributed great distances from its source.

Prevalent wind direction is from the south; however, conditions vary greatly in specific locations[27]. The weather station at Park Village indicates wind directions 0 to 360 degrees (*i.e.*, north and south) and scalar wind speeds up to 16 meters per second (2.27 miles per hour)[28]. The Panamint, California, and Hunter Mountain, California, weather stations are located in the south and central areas of Death Valley, respectively. The station wind rose from Panamint indicates prevalent southwesterly wind origins[29]. The station wind rose from Hunter Mountain indicates wind from north-northwest and south-southeast[30]. See the two excerpted wind roses below.

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24 SGI. 2012. 2012 State of the Basin Report; Amargosa River Basin. Inyo and San Bernardino Counties, California & Nye County, Nevada. March 12, 2012. http://inyo-monowater.org/wp-content/uploads/2013/11/IM_IMP2_Workplan4_20131118.pdf

25 National Park Service, Nature and Science website, http://www.nps.gov/deva/naturescience/index.htm

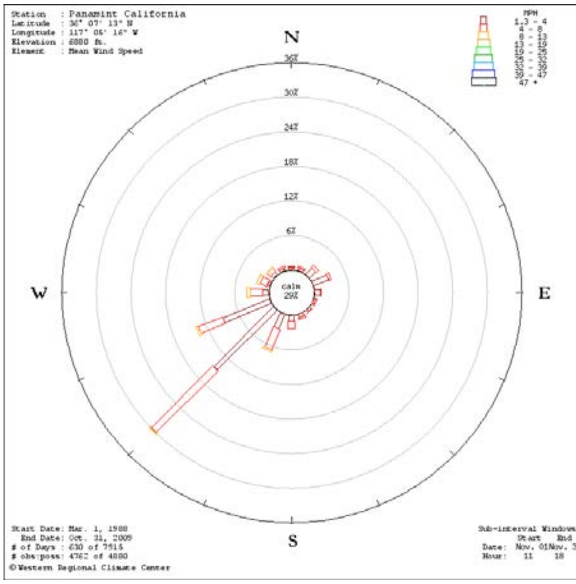
26 Roof, Steven and Charlie Callagan, 2003. The Climate of Death Valley, California. American Meteorological Society Bulletin 84, 1725–1739. doi: http://dx.doi.org/10.1175/BAMS-84-12-1725.

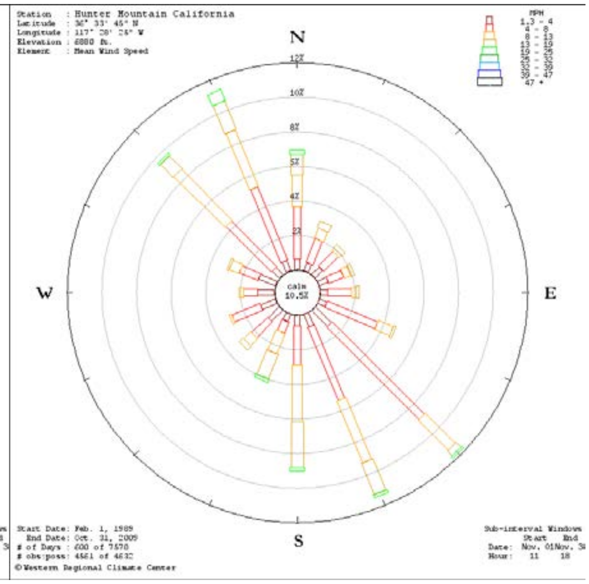
27 National Park Service. Annual Data Summary, Death Valley National Park, 2002, National Park Service, Gaseous Air Pollutant Monitoring Network.

28 Ibid.

29 Western Regional Climate Center. (Updated February 11, 2014). Station Wind Rose Climatology, Panamint California. Retrieved February 11, 2014, from http://www.raws.dri.edu/cgi-bin/rawMAIN.pl?caCPAN

30 Western Regional Climate Center. (Updated February 11, 2014). Station Wind Rose Climatology, Hunter Mountain California. Retrieved February 11, 2014, from http://www.raws.dri.edu/cgi-bin/rawMAIN.pl?caCHNM





1.4 VEGETATION AND WILDLIFE

Death Valley National Park contains a great diversity of plants. Vegetation zones include creosote bush, desert holly, and mesquite at the lower elevations. At the higher elevations, shadscale, blackbrush, Joshua tree, pinyon-juniper, to sub-alpine limber pine and bristlecone pine woodlands can be observed. The saltpan in the middle portion of the valley is devoid of vegetation and slopes along the valley's alluvial fans have sparse cover.

Death Valley's range of elevations and habitats support a variety of wildlife species including 51 species of native mammals, 307 species of birds, 36 species of reptiles, three species of amphibians, and five species and one subspecies of native fishes[31]. Small mammals are more numerous than large mammals such as desert bighorn, coyote, bobcat, mountain lion, and mule deer. Table 2 includes potentially endangered or threatened plant and animal species within DEVA. The table indicates which species may be present at the individual AML sites.

1.5 MILLING AND ORE PROCESSING

The mineral resources of the Death Valley area have been accessed and investigated since the days of the great California gold rush. From the 1850s to 1900 mining in Death Valley was sporadic and many mining endeavors were unsuccessful for a variety of reasons, including lack of finances, inefficient mining techniques, scarcity of water, and insufficient transportation. By the early 1900s new technology enabled large-scale mining operations for gold, silver, and other metals due to renewed interest in mining in the area[32]. Mine holdings are still present in DEVA.

Milled ore was most commonly processed using mercury amalgamation and/or cyanide leaching to extract gold. Amalgamation followed by cyanidation increases the amount of gold recovered from ore. These extraction methods generated piles of pulverized rock or mill tailings which could potentially contain hazardous materials such as cyanide, mercury, and other elevated concentrations of metals. An alternative extraction method used in DEVA silver mine sites was a flotation method.

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31 National Park Service, Nature and Science website, http://www.nps.gov/deva/naturescience/index.htm

32 A History of Mining in Death Valley National Monument California – Nevada. Originally published by the United States Department of the Interior, National Park Service, Denver, Colorado

Historical milling operations and ore processing practices used in Death Valley National Park have the potential to impact the environment. The following is a description of various ore processing methods used at the DEVA mill sites.

1.5.1 Mercury Amalgamation

Amalgamation is one of the oldest gold extraction processes and was commonly used in the early days of mining in Death Valley. The process is based on the fact that mercury forms a chemical bond with gold, called an amalgam. A saturated solution of gold with mercury contains 13.5 percent of gold. The process is inefficient because less than 30 percent of the available gold is recovered and 25 to 30 percent of the mercury used in the process is lost, potentially to the environment[33]. It is not possible to obtain a high percentage gold extraction rate by amalgamation alone because a portion of the fine gold particles fail to settle upon and make contact with the mercury. Also the gold ore may be coated with iron oxide, which inhibits the amalgamation process. For this reason, more modern operations follow amalgamation with cyanidation or flotation.

The amalgamation process comprises several steps[34]. First, ore is crushed, then milled, usually in water, to create fine size particles that will pass through a #14 or #20 size mesh. The fine-grained ore was then entered into the recovery portion of the process. Several recovery processes were used to slowly pass the fine-grained ore over copper plates coated with mercury. The gold-mercury amalgam was then removed at regular intervals and the plates were re-dressed with mercury. Finally the mercury was distilled from the amalgam to produce nearly pure gold. Mercury was an expensive commodity, and as much as possible it was recaptured for later use. Mercury lost during the process potentially ended up in the mill tailings.

In mercury amalgamation the ore is crushed with a jaw crusher, then pulverized using large mechanical devices called stamp mills. The basic design of a stamp mill has been used for thousands of years for a variety of crushing applications, but is most commonly used for the processing of ore for mineral extraction. Typical stamp mill construction consists of a series of heavy metal stamps arranged in a wooden frame called a battery. The stamp mills used in DEVA during the gold rush era were usually powered by water, steam engines, or internal combustion engines. A system of belts, rotating shafts, and cams raise then drop the stamps and crush coarser grain ore into finer grain material capable of further processing[35].

Some of the mills used a second stage, or alternate method of crushing, called ball or rod mills, in which ore was passed through cylinder tumblers partly filled with cast-iron balls or rods. This process further pulverized the ore until it was sand size or smaller.

An alternative milling process was used at some sites. Called an arrastra, a circular trough paved with hard stone was used for fine grinding. In the center an upright post supported projecting arms. Heavy stones were lashed to these arms, and were rotated by mules or other means. Water was added and if free silver or gold was present mercury could be added for amalgamation.

[33] Journal of Cleaner Production 17 (2009) 1373-1381. Mill Leaching: A viable substitute for mercury amalgamation in the artisanal gold mining sector. Accepted 27 March 2009.

[34] A. W. Fahrenwald, The Recovery of Gold From Its Ores. Idaho Bureau of Mines and Geology. Pamphlet No.37, July 1932.

[35] http://www.goldrushnuggets.com/stampmills1.html

1.5.2 Cyanide Leaching (Cyanidation)

Cyanide leaching originated around 1890 and was commonly used in conjunction with amalgamation to extract gold from ore. Cyanide leaching is more economical than amalgamation because approximately 90 percent of the gold that is present can be recovered. Early in its development, the process was used on the waste tailings from amalgamation. Because of the improved recovery, many of the tailings piles from other processes have been reprocessed by cyanide leaching to extract gold. By 1925, cyanidation processing technology was applied to both gold and silver ores without using amalgamation first[36].

Gold is soluble in dilute solutions of potassium or sodium cyanide, and the dissolved gold can be precipitated from the cyanide solution using metallic zinc. The process typically comprises the following steps. The ore is ground or pulverized to a suitable size for use in a cyanide solution, or mixed with water to form a slurry or "pulp." Sodium cyanide and lime are added to the slurry to create and maintain a cyanide solution with an alkaline condition (pH near 11[37]). The pulp is agitated through a series of tanks or stirred to cause dissolution of the gold from the pulverized ore. The gold is precipitated from the cyanide solution by passing it over zinc shavings, or agitating it with zinc dust. The gold-zinc precipitate is refined, producing gold bullion. If silver is present, the gold and silver are separated by dissolving the silver with sulfuric or nitric acid. The bullion could be melted and cast into bars for shipment.

Not all gold ores are suitable for cyanidation processes. Arsenic and antimony-rich ores, such as some ores in the Panamint district, are problematic. Gold ores that contain copper are more soluble in a cyanide solution and increased cyanide consumption makes the process economically impractical. The flotation process is a more economical alternative for extraction of gold from these ores.

Typically cyanide does not persist in arid environments at the surface or in aerobic conditions. Under aerobic conditions, microbial activity can degrade cyanide to ammonia, which then oxidizes to nitrate. This process has been shown effective with cyanide concentrations of up to 200 parts per million. Although biological degradation also occurs under anaerobic conditions, cyanide concentrations greater than 2 parts per million are toxic to these microorganisms. Although cyanide reacts readily in the environment and degrades or forms complexes and salts of varying stabilities, it is toxic to many living organisms at very low concentrations[38].

1.5.3 Flotation Process

Flotation methods came into widespread use because they can recover almost all forms of gold, including fine, free gold, gold associated with any form of sulfides, and gold-oxidized lead and gold-copper ores. When gold or silver is recovered using flotation, the high grade concentrate contains the precious metal. The concentrate may be ground, with or without roasting, treated with cyanide solution, or shipped to a smelter for further processing.

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36 A. W. Fahrenwald, The Recovery of Gold From Its Ores. Idaho Bureau of Mines and Geology. Pamphlet No.37, July 1932.

37 International Cyanide Management Code, For The Gold Mining Industry, http://www.cyanidecode.org/cyanide-facts/use-mininghttp://www.cyanidecode.org/cyanide-facts/use-mining, accessed September 2014

38 International Cyanide Management Code for the Gold Industry, http://www.cyanidecode.org/cyanide-facts/environmental-health-effects#sthash.WJSkUQpM.dpuf, accessed September 2014.

Extraction using the floatation method was completed according to the following general steps[39]. Ore was brought into a mill, and crushed. This milled ore was mixed with water to form a slurry and could then passed through a ball and/or rod mill, which used cast iron balls or long iron rods to further crush the ore into a finer powder.

The different metals in the milled ore were then separated using flotation cells. A mix of reagents and flocculants were introduced to the ore slurry to cause the desired metals to float to the top of the tank solution while at the same time sinking the other metals. In these systems, lead, copper, and other precious metals could be recovered.

[39] W.H. Storms, Engineering and Mining Journal, Vol 60. July 13, Nov 9 and 16, 1895.

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2.0 RECORDS REVIEW

As part of due diligence, ECM reviewed available data resources to document the timing and scope of historical milling practices at each site and to locate mapped national wetlands, monitoring and supply wells, mapped flood zones, sensitive receptors, and nearby environmental cleanup sites. Aerial photography from ESRI World Imagery was referenced for site and vicinity observations. ECM conducted interviews with NPS staff, knowledgeable about the site operations, activities and site visits to obtain relevant information about the sites.

2.1 PREVIOUS INVESTIGATIONS AND REGULATORY ACTIVITY

Between 1975 and 1977, a team of NPS professionals prepared a List of Classified Structures[40] for Western Regional Office. They conducted research and prepared a history of mining in DEVA. As a result of the work, a number of sites were nominated and many have been placed on the National Register of Historic Places.

From March through mid-May of 2002, staff members of the Architectural Conservation Projects Program (IMSF-CAC) of the National Park Service, Intermountain Support Office—Santa Fe performed archeological documentation and condition assessment on nine mining-related sites within Death Valley National Park[41]. The purpose of the site work was to documentation and evaluation of all mining-related resources to make decisions regarding their preservation and use.

From these previous investigations, NPS has identified the 27 AML sites in this PA as having the potential to contain contaminants of concern; however, no previous environmental investigations or sampling have been completed at these sites.

2.2 ENVIRONMENTAL DATA RESOURCES

Environmental Data Resources (EDR) conducts searches of available environmental records to meet the requirements of EPA's Standards and Practices for All Appropriate Inquiries (40 CFR Part 312), the ASTM Standard Practice for Environmental Site Assessments (E1527-13) or custom requirements developed for the evaluation of environmental risk associated with a parcel of real estate. Additionally, ECM requested a NEPA search which may be used in conjunction with additional research, to determine whether a proposed site action will have significant environmental effect. Prior to site reconnaissance, ECM obtained and reviewed the EDR Radius Map™ Report with GeoCheck® and EDR NEPACheck® for in field confirmation.

EDR provides the following data that was used in conjunction with online research and literature regarding site operations and mining details:

- Natural Areas Map including Federal Lands Data and Threatened or Endangered Species, Fish and Wildlife, Critical Habitat data (where available)
- Historic Sites Map including National Register of Historic Places, State Historic Places, and Indian Reservations.
- Flood Plain Map from the National Flood Plain Data (where available)
- Wetlands Map from the National Wetlands Inventory

40 http://www.hscl.cr.nps.gov/insidenps/summary.asp

41 National Park Service. Death Valley National Park, Historic Preservation Report – Volume I, Abandoned Mine Lands Documentation and Condition Assessment, 2002.

- Federal Communication Commission (FCC) and Federal Aviation Administration (FAA) Map for FCC antenna/tower sites, FAA Markings and obstructions, Airports, and Topographic gradients
- Federal National Priorities List (Listed and Delisted)
- Federal Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) list including CERCLIS-NFRAP
- Various Federal Resource Conservation and Recovery Act (RCRA) Lists
- State and Tribal registered tank lists and voluntary cleanup sites

For a full list of referenced databases and to view the individual reports, refer to **Appendix B**.

2.3 AERIAL PHOTOGRAPHS

Satellite aerial imagery by ESRI World Imagery and Google Earth Pro was used to construct the site figures. The aerial imagery shows the extent of land disturbances at each of the DEVA mill sites and surrounding area, including drainage patterns, depositional areas, and some cultural features. These site features are labeled in **Figures 3-1** to **29-2**.

2.4 INTERVIEWS

ECM interviewed current NPS personnel to obtain information about the sites' current and historical use. NPS personnel interviewed for this report are listed below:

1) Blair Davenport, DEVA Cultural Resources Chief
2) Jeremy Stoltzfus, DEVA Abandoned Mineral Lands Technician
3) Linda Manning, DEVA Wildlife Biologist
4) Greg Cox, DEVA Museum Curator
5) Richard Friese, DEVA Hydrologist

2.5 SITE RECONNAISSANCE

Site reconnaissance was performed by Mr. Chris McCormack, ECM Geologist, with guidance and general assistance from Mr. Jeremy Stoltzfus, DEVA AML Technician. The site visits were performed during the following mobilizations:

- January 8, 2014 – Cyty's Mill
- February 10 through February 21, 2014 – Homestake Mill, Lost Burro Mine and Mill, Big Bell Mine and Mill, Queen of Sheba, Ashford Mill, Starr Mill, Greene-Denner-Drake Mine, Skidoo Mill, Tucki Mine, Cashier Mill, Lower Wildrose, Happy Hooligan Mine and Mill, Gold Hill Mill, Indian Mine, and Telephone Canyon Mill
- March 3 through March 9, 2014 – Crowell Mercury Mill, Lane Mill, Franklin Mill, Gold Grotto Mine and Mill, Broken Pick, Morning Glory, Oh Be Joyful, Gem Mine, Sourdough Canyon Mine, Panamint City Smelter

During the visits, site features were located using a hand-held Global Positioning System (GPS) device. The sites were inspected for evidence of possible hazardous materials; extent of mill tailings; locations of former ore processing areas; site layout, topography, and drainage patterns; presence of springs or other surface water; confirmation of well locations; and indications of material management and storage activities. Photographs showing site features and current environmental conditions are presented in **Appendix C**.

2.6 CONCEPTUAL SITE MODELS

The human health and ecological CSMs are presented within **Sections 3.0** to **29.0**. **Tables 1-1**, **1-2,** and **1-3** summarize the exposure pathways for groundwater, surface water, and soil-sediment-air, respectively. **Table ES-1** exhibits the conclusions of the exposure pathway tables and CSMs and offers recommendations**.** The CSMs integrate information about the site to describe potential source areas, release and transport mechanisms, and complete and incomplete exposure pathways. They also identify potentially exposed receptors under the current and reasonably anticipated future land and water uses.

For the purpose of the PA, “site” refers to the sources, areas between sources, and areas that may have been contaminated as a result of migration from sources. The PA site boundaries are independent of property boundaries. Sources are areas where hazardous substances have been deposited, stored, disposed, or placed. For AML sites, sources include waste rock, mill tailings deposits, and soils that have become contaminated due to chemical or natural processes. Air, surface water, and groundwater contaminated through migration are not considered sources. Pathways are the environmental media through which a hazardous substance threatens targets or receptors. Potentially exposed media of concern evaluated in the CSMs include groundwater, surface and subsurface soil, sediment, and air. Each pathway is evaluated with respect to likelihood of release or exposure, targets, and waste characteristics.

Future data generated can be used to refine the preliminary CSMs.

Based on the operational history, the environmental hazards considered in the evaluation focus on the mill tailings. Potential contain contaminants of concern (COCs) are elevated concentrations of cyanide and metals. Typical release and transport mechanisms include deposition, erosion, runoff, infiltration, leaching, and windborne suspension and deposition of particulates.

2.7 HAZARD RANKING SYSTEM SCORING

The information collected during the PA was compiled and used to develop a preliminary Hazard Ranking Score (HRS) score for each site. Scoring was completed in accordance with Section 3 of EPA’s Guidance for Preparing Preliminary Assessment under CERCLA, suing the EPA’s HRS Quickscore calculator version 3.0.5. HRS scores for the individual sites ranged from 0.21 to 7.52. The worksheets are presented in **Appendix A** and the results for each site are summarized in **Table A-1**.

The HRS was designed to assist decision makers to develop conceptual site models and plan and implement PAs, site inspections (SIs), and other data collection efforts. Typically, under the PA process, sites that score 28.50 or greater receive a further action recommendation, while sites that score less than 28.50 receive an NFRAP recommendation. The low scores reported for the 27 sites at DEVA are due to the remoteness of the sites and limited population exposures. Recommendations for the sites, including the need for additional waste characterization, were therefore developed considering the CSMs including the following factors:

- Potential contaminants of concern and waste characteristics,
- Potentially impacted media (soil/sediment, surface water, groundwater, and air),
- Sensitive receptors, including DEVA workers, contractors, visitors, and ecological receptors, and
- Complete exposure pathways and likelihood or release.

Recommendations and conclusions for the 27 sites at DEVA evaluated during the PA are presented in **Section 30.0**.

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3.0 HOMESTAKE MILL (SITE #1)

The PA inspection of Homestake Mill, also known as the Homestake-King Mill, was conducted on February 13, 2014. Field notes are included in **Appendix D.** Photographs showing site features and current environmental conditions are presented in **Appendix C1.** **Figure 3-1** shows the topographic features in the vicinity of the site, and indicates the location of the mill. Site features are depicted on **Figure 3-2** and include:

- Mill location,
- Mine waste and mill tailings,
- Eroded fine tailings,
- Location of ephemeral stream,
- Map showing local geology, and
- Locations where selected site photographs were taken

3.1 SITE DESCRIPTION

Homestake Mill is located in the Bullfrog Hills, in the Nevada portion of DEVA (Latitude 36.93952°, Longitude -116.88866°) in an area known as the "Nevada Triangle[42]." The site sits at an elevation of approximately 4,950 feet above sea level and is located on a steep south-sloping hillside overlooking broad deposits of alluvium. Site access is via a paved road through the ghost town of Rhyolite, Nevada, which leads to a gravel access road approximately 5 to 7 miles long. The Homestake-King mine was

[42] ECM 2014, Preliminary Assessment Work Plan for 24 Abandon Mine Site, Death Valley National Park, Inyo County, California, January 29, 2014.

one of the only mines (and the largest producer) in the famous Bullfrog Mining District lying within the park. **Photo C1-1** shows the mill as it was in 1908[43].

The mill site contains a series of five, reinforced concrete foundations that are between 66 and 100 feet long, 3 feet thick at the base, and up to 16 feet high. The structures are located on a steep slope (**Photo C1-2**). Floors of the mill rooms remain with many machinery and vat foundations and building debris. The former mill site covers an approximate 100-foot by 150-foot area. A very large abandoned open pit mine, named Gold Bar, is located to the west of Homestake Mill and has cyanide leach mounds to the south, outside the park boundary (**Figure 3-1**). The Gold Bar Mine was a more recent operation that employed a cyanide heap leaching process. Homestake Mill covers approximately 5 acres and is visited by approximately 400 people per year. The mine was determined to be eligible for the National Register of Historic Places in 1981[44].

The mill tailings are visible from the top of the mill and several locations down slope from the mill. Storm runoff from the site will travel south and east into an unpopulated area in Amargosa Valley. The tailings have eroded into an ephemeral stream that flows from the base of the mill down slope. A gravel access road to the site crosses the stream and is currently blocking the tailings from migrating further downstream (**Appendix D**).

3.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

Primarily, milling at the Homestake took place from 1905-08, but the mill was reportedly worked sporadically until 1943. Ore processing was conducted on site using a crusher, a 25-stamp mill, and various ore processing equipment[45]. Processing consisted of crushing the ore using stamps and a rod mill and extraction using mercury amalgamation and cyanide leaching processes (Section 2). Remains of the former Homestake-King Mill are an impressive set of seven tiers formed by remains of large concrete foundation walls (**Photo C1-2**). The mill ruins are highly visible and open to visitors who often walk through the tailings explore the ruins (**Photos C1-2 and C1-4**).

After the tailings were processed through the mill they were discharged down a steep diversion ditch into the alluvial wash below the mill. The tailings are clearly visible from the top of the mill site downslope approximately 0.25 mile (**Photo C1-4**). The estimated volume of tailings remaining on site is approximately 1,000 cubic yards. Preliminary COCs at the site include cyanide and metals.

3.3 ENVIRONMENTAL SETTING

3.3.1 Geology and Hydrogeology

Geological Setting

Homestake Mill is located in the southwestern portion of the Bullfrog Hills, which is northwest of Bare Mountain and northeast of the Grapevine Mountains (**Figure 1**). Sarcobatus Flat is located north of the site and the Amargosa Desert in located south (**Appendix E**). The site is situated on Tertiary-aged

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[43] A History of Mining in Death Valley National Monument California – Nevada. Originally published by the United States Department of the Interior, National Park Service, Denver, Colorado.

[44] National Park Service, List of Classified Structures, Homestake-King Mill Ruins. http://www.hscl.cr.nps.gov/insidenps/report.

[45] A History of Mining in Death Valley National Monument California – Nevada. Originally published by the United States Department of the Interior, National Park Service, Denver, Colorado.

volcanic welded tuff (**Figure 2**). The welded tuff has a base of rhyolitic stone and is gray to reddish-brown, and commonly contains partly broken crystals of sanidine, oligoclase, quartz, and biotite[46].

Groundwater

The site is located in the Amargosa Valley Groundwater Basin in the state of Nevada[47] (**Section 1.2**). The depth to groundwater is not known. Groundwater flow direction in the vicinity of the site generally follows surface water flow, depicted in **Figure 3-2**. The site is located immediately south of the groundwater divide between the Amargosa Valley Groundwater Basin and the Sarcobatus Flat Groundwater Basin, meaning north of the site the flow is generally to the north, and at the site, flow is generally to the south. Based on the topography, groundwater flow from the site is to the south, west, and then southeast into the playa of the Amargosa Desert.

Based upon federal database records research (EDR 3813626.2s, **Appendix B**) and available U.S. topographic maps (**Appendix E**), the closest well to the site is Curre Well, located 2.9 miles northwest and "upgradient." Additionally, two unnamed wells are located immediately west of Curre well. No water quality data were available. The nearest city to the site is Rhyolite, Nevada, which lies 4.2 miles southeast. However, Rhyolite is not directly downgradient of site surface water or groundwater flow. No residences are found within 200 yards, and groundwater is not used as a drinking water source.

Natural springs commonly occur in this area because deep groundwater is under hydraulic pressure from the fractures and fissures transporting groundwater in the Basin and Range Province. The closest down- or cross-gradient springs in the area are Buck Springs, located 2 miles southeast and cross-gradient; Sullivan Springs, located 2.7 miles east-southeast and cross-gradient; and Mud Springs, located 4.3 miles north-northeast and "upgradient" of the site. There are no upgradient springs as the site is situated on the groundwater divide between the Amargosa Valley and Sarcobatus Flat groundwater basins. These springs do not appear hydraulically connected with the site. The southern springs drain south into an adjacent valley and do not intercept potential flow from the site for approximately 9 miles downstream. The northern spring flows into the Sarcobatus Flat to the north and does not appear to influence the site.

3.3.2 Surface Water

Inflow of surface water at the site is generated from infrequent heavy precipitation and begins at the groundwater divide in the Bullfrog Hills located 0.3 miles northeast. Surface water flow during rainfall events is channeled through an unnamed canyon in the wash approximately 830 feet east of the mill ruins (**Figure 3-2**). Surface water in this area is channeled and flows south from the Bullfrog Hills and Sawtooth Mountain Range and southeast into the Amargosa Desert. Drainage into the northwestern portion of the Amargosa Desert coalesces into the Amargosa River, which flows southeast (**Appendix E**). These drainages are ephemeral and experience very little surficial flow.

Homestake Mill is in the same regional drainage basin as Happy Hooligan Mine (Site #26). Any material transported by surface water from the site would not comingle with drainage from the Happy Hooligan Mine for approximately 14.4 miles downgradient. No water quality data were available.

The Amargosa River demonstrates subflow conditions near the city of Beatty, Nevada, located 7.6 miles east-southeast from Homestake Mill. Surface water must travel approximately 13.6 miles

[46] U.S. Department of the interior, Geological Survey. *Geologic Map and Sections of the Bullfrog Quadrangle, Nevada-California.* Geology by H.R. Corwall and F.J. Kleinhampl, 1956-1960.

[47] Designated Groundwater Basins of Nevada Map. Department of Conservation and Natural Resources, September 2013, http://water.nv.gov/mapping/maps/designated_basinmap.pdf.

downstream to reach the Amargosa River. Although there is a perennial river within the target distance of 15 miles downgradient of the site, the arid climate and rapid infiltration rate indicate that the transport of water-borne constituents significant distance off site is unlikely, and most surface water from the site does not reach the river.

3.3.3 Soil, Sediment, and Air

The site is on a southeast-facing hillside that has accumulated alluvial sediments from fine-grained sands to gravels. This indicates that the surface soils are well drained and have moderate infiltration rates. The thickness of the overlying sediments at the site is not known; the EDR specifies that the bedrock is deeper than 60 inches below ground surface (bgs) (EDR 3813626.2s, **Appendix B**). The sediment is classified as the Whirlo soil component.

During Homestake Mill's operation, mine wastes and white medium- to fine-grained tailings were generated and are exposed in the areas surrounding the site (**Figure 3-2**). The site's mill tailings were observed mixed with native fine sediments downslope of the mill foundations. These fine-grained tailings tend to be in low-lying areas along rills in the hillsides and are easily transported by water and wind. Tailing-derived sediments specifically from the site can be traced approximately 0.25 mile from the foundations of the mill. Mill tailings were also observed near the base of the canyon where there are several gravel roads. These tailings may be affected by vehicles disturbing the ground surface and causing tailings to become airborne as dust. Although sparse, vegetation in and around the site did not appear stressed upgradient or downgradient.

The mine wastes are predominantly found in the southern portion of the site. Mine wastes are characterized by reddish-brown to buff-white colored coarse sand and gravel that has been mounded and partially vegetated. Former mill debris such as lumber and concrete footings are also present in and on the mine wastes. These coarse-fraction sediments do not readily become transported by wind or water and have become relatively stable due to the overlying vegetation.

Sparse vegetation currently stabilizes the mill tailings in place, and additional downstream transport of the tailings seems to be temporarily stopped by the dirt access road in a flat area of the wash. The surrounding area and hills downgradient are heavily mined, which indicate a strong likelihood of potential intermixing of transported sediments adjacent to the site. Typical prospects are mining for ore containing mercury, copper, gold, and silver and also have associated mills to extract metals. Upon comingling of ephemeral streams from other areas with mills and mines, extent of the tailings downstream from the site can no longer be confirmed. Generation of windborne particulates is considered likely due to the arid climate and vehicular traffic on exposed mill tailings. Transport of these particulates seems likely due to sparse vegetation cover and high wind speeds at the ground surface.

3.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Homestake Mill is a popular destination and visitors often walk through the ruins to explore. The site is visited by approximately 400 people per year and potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.1s, **Appendix B**). Park staff and contractors may also visit and work at the site. **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B**

Homestake Mill has been assessed using site-specific CSMs. Evaluation of the mill's operational history and site visit observations indicate the environmental hazards are mill tailings derived from mercury amalgamation and cyanide leaching processes to extract gold. Preliminary COCs at the site include cyanide and metals. Additionally, the site was evaluated using the EPA HRS using the information gathered in the PA. Homestake Mill was given an overall score of 0.62 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 3-1** and sensitive ecological receptor pathways are presented in **Table 3-2**. For an explanation of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 3-1: Homestake Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	*P I*	*P I*
		Dermal	*P I*	*P I*
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 3.4: Homestake Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

3.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers who remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. There is no evidence of shallow groundwater at this site; however, parts of the Amargosa River, which is located approximately eight (8) miles downgradient of site, are ephemeral and dry; however, these dry reaches contain subflow (groundwater) when not carrying surface water. A large surface runoff flow could carry sediment to the river system; therefore, human exposure pathway to groundwater is complete but considered insignificant. Surface water was not observed at the site and is only present during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate and vehicular traffic on exposed mill tailings. Windborne transport seems likely due to sparse vegetation and high wind speeds at the ground surface. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for the tailings and adjacent soil from the mercury and cyanide processing areas to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting soil samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places will require consultation with State Historic Preservation Office (SHPO) prior to implementation of additional site inspection activities.

4.0 LOST BURRO MINE AND MILL (SITE #2)

The PA inspection of Lost Burro Mine and Mill was conducted on February 19, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C2**. **Figure 4-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill and mine, cyanide processing area, and extent of tailings. Site features are depicted on **Figure 4-2** and include:

- Mill and mine locations,
- Wash drainage ditches,
- Surface flow direction,
- Mill ruins,
- Extent of tailings,
- Access roads,
- Trails,
- Map showing local surface geology, and
- Locations where selected site photographs were taken.

4.1 SITE DESCRIPTION

Lost Burro Mine and Mill site is located 27 miles southwest of Scotty's Castle, California in the Cottonwood Mountains (east side of the central Panamint Range) (Latitude 36.72713°, Longitude -117.52278°)[48]. The ridge where Lost Burro is located separates Hidden Valley from Racetrack Valley. The site is accessed via 22.5 miles of well graded and maintained gravel road, but the last mile to the site is on a rough four-wheel drive road. Some of the site is located within designated wilderness

[48] ECM 2014, Preliminary Assessment Work Plan for 24 Abandon Mine Site, Death Valley National Park, Inyo County, California, January 29, 2014.

covering approximately 10 acres. The site is an attractive remote location and approximately 1,000 people visit each year to see the mill and cabin ruins. The closest permanent residents to the site live in Stovepipe Wells, CA.

Lost Burro Mine and Mill are situated within a box canyon at an elevation of approximately 5,466 feet above sea level. The ruins are primarily on a bench cut into the southeast canyon wall over an active wash area. **Photo C2-4** shows the view of the wash area from the mill structure floor. Remains of many mine structures are located throughout the site and include an abandoned wooden cabin, wood and metal debris, ruins of a stamp mill, and remains of several water tanks above, at, and below the mill level. The 50-ton five-stamp mill is located on a steep hillside above a wash (**Photo C2-1**). Many ruins are collapsing and are in a deteriorating condition as shown in photographs taken during an assessment in 2002[49]. Two check dams are present in one of the drainages, and a third is present that contains a segment of in-place pipeline. Evidence of strong runoff deposits exist downstream where tailings deposits have been eroded approximately 1.5 to 5 feet into a tailings impoundment created by erosion of an intermittent creek **(Photo C2-6**). A ditch was apparently dug to aid in diverting water and mill tailings across an alluvial finger to the next drainage to the north, away from the housing area. Shafts and adits are present from the mining operations.

There is evidence of visitors using the site for camping and sightseeing[50]. A vehicle road ascends to the site, and a short spur goes up to a saddle at the south end of the site. There are trails leading to the mine openings in the canyon, and between the structural ruins and drainage areas where tailings may collect. A road runs up the canyon that leads to a view overlooking the Racetrack and Sierra Nevada Mountains. Use of these trails and the site area as a campground may expose visitors to the mercury and cyanide processing areas.

A draft National Register Nomination was prepared for the site in 1987. The site was determined to be eligible due to the mine's status of the largest gold producer in the copper, lead, and zinc-producing Ubehebe District, and because of the impressive ruins of the stamp mill and machinery. The site is considered an instructive example of early twentieth-century mining technology[51].

4.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

The history of the Lost Burro Mine and Mill is documented in the 1981 Historic Resource Study[52]. The mine produced exclusively gold in what is known as a copper, lead, and zinc district. After gold was discovered in 1907, the Lost Burro Mine was worked from 1907 until 1917 and then periodically into the 1960s. Mill construction began in 1917, although it is unknown how long the mill was in use or how much ore was processed on site[53]. The presence of the stamp mill and other mining artifacts indicate that the ore was likely processed on site by amalgamation and cyanidation processes. Water was required to run a stamp mill, and an 8-mile-long pipeline was constructed to convey water to the site from Burro Spring.

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49 L.W. Green, 1981. Historic Resource Study, A History of Mining in Death Valley National Monument, California-Nevada, Vol 1 of II, Part 2 of 2. March.

50 National Park Service, 2002. Death Valley National Park, Historic Preservation Report, Volume I. Abandoned Mine Lands Documentation and Condition Assessment.

51 L.W. Green, 1981. Historic Resource Study, A History of Mining in Death Valley National Monument, California-Nevada, Vol 1 of II, Part 2 of 2. March.

52 L.W. Green, 1981. Historic Resource Study, A History of Mining in Death Valley National Monument, California-Nevada, Vol 1 of II, Part 2 of 2. March.

53 ECM 2014, Preliminary Assessment Work Plan for 24 Abandon Mine Site, Death Valley National Park, Inyo County, California, January 29, 2014.

Observation of the mill tailings noted during the PA site visit indicated the tailings are located in five distinct areas throughout the site. The total amount of mill tailings observed on site is approximately 2,450 cubic yards. **Figures 4-1** and **4-2** show the locations of the mill tailings and the erosion and transport paths of the tailings eroding downstream. Photographs of the tailings deposits are also provided (**Photos C2-4, C2-5, and C2-6**). The preliminary COCs at the site include cyanide and metals. A site inspection in 2002 reported that visitors were camping on areas where cyanide waste remained from the ore processing[54]. The report also noted that visitors were parking and camping in the historic housing area.

4.3 ENVIRONMENTAL SETTING

4.3.1 Geology and Hydrogeology

Geological Setting

Lost Burro Mine and Mill are located in the Panamint Range on the western-central portion of the Cottonwood Mountains (**Figure 1**). The Saline Range and Saline Valley are northwest and west, respectively, of the site. The Nelson Range is located southwest (**Appendix E**). The site is situated on Carboniferous Era Mississippian-aged Tin Mountain Limestone (**Figure 2**). The Tin Mountain Limestone is a bluish-gray, fine-grained cherty limestone with calcareous silty shale[55].

Groundwater

The site is located in the South Lahontan HR, Hidden Valley Groundwater Basin in the state of California[56] (**Section 1.2**). The Hidden Valley Groundwater Basin encompasses only 28.1 square miles and is generally cut off from surrounding basins. The depth to groundwater is not recorded but is likely found in alluvium of Quaternary age. Groundwater is only recharged by precipitation and percolation of runoff from the surrounding Cottonwood Mountains. Groundwater flow direction in the vicinity of the site generally follows surface water flow, depicted in **Figure 4-2**. Based upon topographic contours, local groundwater flow is generally to the east and south within the canyon. Once groundwater, if present, reaches the alluvium flat outwash plain to the east, flow trends southward toward the dry lake in the center of Hidden Valley. The site is located immediately east of the groundwater divide between the Hidden Valley Groundwater Basin and the Race Track Valley Groundwater Basin, which is a small region immediately adjacent to the Death Valley Groundwater Basin. Hidden Valley groundwater appears to be self-contained except for Lost Burro Gap on the northern end, which drains a small portion of Hidden Valley (primarily surface water) into Race Track Valley.

Based upon federal database records research (EDR 3813626.4s, **Appendix B**) and available USGS topographic maps (**Appendix E**), there are no wells, natural springs, or wetlands within 4 miles of the site. The nearest springs are Quartz, Rest, and Burro Spring, located at distances of 4.2, 5.2, and 6 miles north to northeast. These springs are up- and cross-gradient of the site. No residences are found within 200 yards and no municipalities are found within a target 15-mile search radius. Groundwater at Lost Burro is not used as a drinking water source.

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[54] National Park Service, Death Valley National Park, Historic Preservation Report, Volume I. Abandoned Mine Lands Documentation and Condition Assessment. 2002

[55] R. Streitz and M. Stinson, California Division of Mines and Geology, *Geologic Map of California, Death Valley Sheet*. 1974, Second Printing 1980.

[56] Department of Water Resources. *South Lahontan Hydrologic Region – Hidden Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-63.pdf.

4.3.2 Surface Water

Inflow of surface water at the site is generated from infrequent heavy precipitation events and begins along the Lost Burro Mountain ridgeline to the pass 0.3 miles northwest (groundwater and surface water divide). Surface water flow from precipitation is channeled through an unnamed canyon approximately 140 feet south of the standing wooden mill structure (**Figure 4-2**). The remnants of stacked rock dams are still present on site, but do not inhibit the movement of water (**Appendix D**). Surface water in this area is channeled and locally runs east, turns north, then east again onto the large alluvial fan from Perdido Canyon and a large, wider unnamed canyon to the east. Surface water becomes trapped in the middle of Hidden Valley in a dry, flat playa or lake bed (**Appendix E**). These drainages are ephemeral and see very little surficial flow with an estimated precipitation rate of 6 to 8 inches of rainfall per year. However, this area receives winter snow perennially, which potentially aids the transport and migration of tailings down the canyon (**Appendix D**). There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site.

4.3.3 Soil, Sediment, and Air

The mill is located on the south-facing hillside near a ridgeline that has accumulated a thin layer of alluvial sediments bound together by clays (likely from the interbedded shale units) with a coarse fraction of sands to gravel. Due to its elevation on a relatively steep hillside, bedrock is at approximately 20 inches bgs, indicating that although the upper surficial soils may be well drained, the overall soil has a very slow infiltration rate. Although thin, the surficial soil is identified as the Theriot soil component with an upper 3 inches considered cemented sandy clay (EDR 3813626.4s, **Appendix B**).

Lost Burro Mill's operation generated reddish-brown fine-grained tailings, which are a stark contrast to the bluish-gray color of the surrounding limestone and tan color of the surrounding alluvium (**Figure 4-2**). The accumulated tailings from deposition are exposed at the surface in cutbanks from water erosion. The fine-grained tailings are eroding downslope along and next to the road that runs from the base of the canyon, through the washout plain. Mill tailings from the site were observed mixed with native fine sediments at the beginning of the washout plain. However, near the tailing's source and continuing downslope for 1 mile, mill tailings continually accumulate and become washed out from heavy rain events or snow melt during winter thaw. Mill tailings were observed in the base of the canyon on and beside the gravel access road. Vegetation was not observed growing directly on tailings. Sparse, but healthy desert vegetation, including creosote and Joshua trees, was observed at the site and in the upstream and downstream directions (**Appendix D**).

Immediately upgradient of the mill is the mine portion of the site, which has many stockpiles of mine waste. The mine waste, characterized by coarse-grained sand to gravel, appear to be stable and not migrating downslope **(Appendix D)**. There are few mines in the vicinity, primarily prospects that may interact with transported sediments. Comingling of mine waste or mill tailings is not anticipated.

Mill tailings were observed crossing the road in several areas and may be affected by vehicles disturbing the ground surface causing tailings to become airborne as dust. Generation of windborne particulates from tailings is considered highly likely due to the arid climate, tailing exposure without adequate cover, high wind speeds, and extended wind movement. Contributing factors include impacts from traffic on the access roads and the overall disbursement of tailings throughout the canyon and washout plain.

No other site in this report is located in this basin within 24.5 miles.

4.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Lost Burro Mine and Mill is a popular backcountry destination for four-wheel drive enthusiasts and visitors may walk through the tailings while they explore. The site is visited by approximately 1,000 people per year, and park staff and contractors may also visit and work at the site. Potentially threatened or endangered species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.3s**, Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B**

The Lost Burro Mine and Mill site has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the February 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from cyanide leaching and mercury recovery to extract gold. Preliminary COCs at the site include cyanide and metals. Additionally, the site was evaluated using the EPA HRS from the information gathered in the PA. Lost Burro Mine and Mill site was given an overall score of 1.21 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in T**able 4-1** and sensitive ecological receptor pathways are presented in **Table 4-2**. For explanations of each exposure category, please refer to the attached **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 4-1: Lost Burro Mine and Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	*P I*
		Dermal	*P I*	*P I*
	Groundwater	Ingestion	I P	I P
		Dermal	I P	I P
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 4-2: Lost Burro Mine and Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	*P I*	*P I*	*P I*	*P I*
		Direct Contact	I P	I P	*P I*	*P I*	*P I*	*P I*
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

4.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, for visitors that camp at this location, and for plants and soil organisms which occupy the subsurface soil. There is no evidence of shallow groundwater at this site; therefore, the pathway is incomplete for human exposure. Surface water was not observed at the site and is only present during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds, and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors to the site (if present), and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the mercury and cyanide processing areas to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting soil samples to evaluate background levels of metals in soil. Sites which are on the National Register of Historic Place or recommended for placement will require consultation with SHPO prior to implementation of additional site inspection activities.

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5.0 CROWELL MERCURY MILL (SITE #3)

The PA inspection of Crowell Mercury Mill was conducted on March 8, 2014. Field notes are included in **Appendix D**. Photographs showing site features, layout, and current environmental conditions are presented in **Appendix C3**. **Figure 5-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill, and extent of tailings. Site features are depicted on **Figure 5-2** and include:

- Mill location,
- Drainage wash,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

5.1 SITE DESCRIPTION

Crowell Mercury Mill (Latitude 36.70588°, Longitude -116.88512°) is located within the Chloride City mining complex, approximately 14 miles southwest of Beatty, Nevada, and 14 miles north of Cow Creek, CA, the nearest locations with permanent residents. The site sits an elevation of approximately 4,721 feet above sea level[57]. The site is west of the old mining town of Chloride City. Access is via 5.5 miles of rough, four-wheel drive road and is located in an open area of steep rolling hills and shallow washes at the top of the Chloride Cliff mine area. The mine area covers approximately 3 acres and

[57] ECM 2014, Preliminary Assessment Work Plan for 24 Abandoned Mine Site, Death Valley National Park, Inyo County, California, January 29, 2014.

remains are scattered around the site, including concrete and brick foundations, metal and work debris, parts of an old furnace, and a large galvanized metal tank (**Photograph C3-1**). The Chloride City Historic District has been nominated for the National Register of Historic Places.

5.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

The mill was operated for a short period of time during the early 1940s and was Chloride City's last commercial mining enterprise, operated by the Crowell Mining and Milling Company. The mine had begun to produce quicksilver (mercury), but burned in 1941, before most of its 500 tons of ore had been processed. The history of the Chloride Cliff Mining District mines and mills is presented in the in the Death Valley Historic Research Study[58] .

Remains of the ore processing equipment include the large galvanized tank and brick foundations. Mill tails have accumulated in and around the mill foundation and in two piles on the southeast side of the site (**Figure 5-1** and **Figure 5-2**). The tailings in and around the brick retort ruins are reddish-grayish (ashen) in color, have coarse-gravel grain size, and an estimated volume of approximately 50 cubic yards (**Photo C3-7**). The mill tailings on the southeast side of the site consist of two separate piles of tailings with an estimated total volume of 200 cubic yards. The larger pile contains an ashen color coarse-grain material and the smaller pile of light pink fine-grain material (**Photo C3-4 and C3-10**). Over the years the tailings have eroded and are migrating downslope in small quantity. The preliminary COCs at this site are metals.

5.3 ENVIRONMENTAL SETTING

5.3.1 Geology and Hydrogeology

Geological Setting

Crowell Mercury Mill is located in the north-central portion of the Funeral Mountains in the Amargosa Range (**Figure 1**). Death Valley and Cotton Ball Basin are located southwest and the Amargosa Desert is located northeast. The southern tip of the Grapevine Mountains is located northwest of the site (**Appendix E**). The site is situated on Later Precambrian sedimentary and metamorphic bedrock of the Pahrump Group: Kingston Peak Formation (**Figure 2**). The Kingston Peak Formation includes conglomerate, quartzite, shale, limestone, and dolomite and is in part equivalent to the Panamint Metamorphic Complex[59]. The mill is located within 20 feet of an identified east-west-trending fault to the south and another east-west trending fault approximately 700 feet to the northeast.

Groundwater

Site groundwater flows into the South Lahontan HR, Death Valley Groundwater Basin in the state of California[60] (**Section 1.2**). The primary water-bearing units are unconsolidated, fine- to coarse-grained older and younger Quaternary alluvial deposits found along stream channels and at the base of alluvial fans near the mountains. Groundwater flow direction in the vicinity of the site generally follows surface water flow, depicted in **Figure 5-2**. Based on the topographic surface, groundwater flows to the east

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[58] L.W. Green, 1981. Historic Resource Study, A History of Mining in Death Valley National Monument, California-Nevada, Vol 1 of II, Part 2 of 2. March.

[59] R. Streitz and M. Stinson, California Division of Mines and Geology, Geologic Map of California, Death Valley Sheet. 1974, Second Printing 1980.

[60] Department of Water Resources. South Lahontan Hydrologic Region – Death Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf

downslope at the site, then south and generally southwest. The narrow, meandering canyon is bound by bedrock indicating continually changing flow direction.

The nearest wells to the Crowell Mercury Mine are near the Keane Wonder Springs, 3 miles to the southwest. However, these wells appear to be open at the surface as cisterns and water seeps from them onto the ground surface. The wells identified on the USGS topographic map are not used for domestic use, but have been tested and are of generally good quality for most uses. At Furnace Creek Ranch (approximately 17.4 miles south of the site), the Pliocene to Pleistocene-aged Funeral Formation is tapped by several wells as a source of water. Stovepipe Wells, 16 miles west, also has wells used for domestic use; however, due to the quality of the water it is treated prior to use. No residences are found within 200 yards, and groundwater is not used as a drinking water source.

Based upon federal database records research (Appendix B) and available USGS topographic maps (Appendix E) there are no nationally recognized wetlands within 4 miles of the site. Water from the closest spring, Keane Wonder Springs, has a sodium-calcium bicarbonate-sulfate character. This spring is located at the base of the mountains, 3 miles southwest and downgradient of the site.

Groundwater does not appear to be a likely transport mechanism for site waste constituents. The surrounding mineralized metamorphic bedrock contains ores of copper, gold, silver, lead, and zinc, and potential impacts to groundwater are anticipated to predominantly derive from these natural sources. Only a very minor cumulative contribution is expected from the historic milling operations, including those sites evaluated in this PA.

5.3.2 Surface Water

In the Chloride City area, surface water is generated from infrequent heavy precipitation; runoff begins in the vicinity of the site and is channeled through a low-lying area to the southeast into an unnamed canyon in the wash approximately 300 feet south of the former water tank footing (Figure 5-2). Surface water in this area locally flows southwest, trends northwest, and then west through a deep unnamed canyon, and finally empties onto the outwash north of Keane Wonder Springs. Surface water then flows approximately 12 miles from the base of the Funeral Mountains to the Cotton Ball Basin, then south through Salt Creek into Middle Basin, before continuing along the Devils Golf Course and into the Badwater Basin (**Appendix E**).

Lane Mill is 0.3 miles cross-slope of the site and hydraulically connected via the same surface drainage. After coursing through 5.3 miles of canyon, surface water drains onto the same alluvial plain that receives flows from Cyty's Mill, located 3 miles southwest; Big Bell Mine and Mill; and Keane Wonder Mine (and several other mines not identified in this report). There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site.

5.3.3 Soil, Sediment, and Air

The mill is located on the northeast-facing side of a small ridgeline that has accumulated a thin surficial layer of alluvial sediments that range in size from sands to gravel. However, this site does not have a classified soil type and is documented to be on unweathered bedrock. This indicates a very slow infiltration rate and no drainage class (EDR 3813626.6s, **Appendix B**).

Crowell Mercury Mill's operation generated pinkish-yellow fine-grained tailings, and coarser reddish-brown tailings (**Figure 5-2**). The site's mill tailings were observed to be separate from native fine sediments, which are a tan color. The tailings can be found on the northeast-facing hillside eroding into the wash below. The accumulated fine-grained tailings are exposed at the surface in low-lying areas due to water erosion (**Figure 5-2**). Tailings were not observed farther downwash but, if present, they are mixed with native material. Vegetation in this area is sparse and drought stressed. Vegetation does not cover the fine-grained tailings but is present in the drainage area and may inhibit erosion downslope or windborne air migration. There are access roads in the area, but they do not appear to impact any of the observed tailings.

The mine waste, characterized by coarse-grained sand to gravel, appears to be stable and not migrating downslope. Mine wastes on site are located upslope by the former water tank near the mill foundations (**Appendix D**). The mine waste is currently exposed with no vegetation cover.

There are many mines and mills in the vicinity, several of which are not identified in this report. Lane Mill is located in a tributary drainage 0.3 miles from the site, and there is potential for mine waste or tailings to become comingled downstream during large rain events. The fine-grained tailings and mine waste are exposed without native sediment or vegetation cover. Over time, erosion will continue and carry sediment and potential mineral land-related materials. Windborne particulates are considered likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, and access roads near tailings.

5.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Cowell Mercury Mill and Chloride City are popular destinations for four-wheel drive enthusiasts and visitors may walk through tailings piles as they explore. The site is visited by approximately 1,000 people per year, and park staff and contractors may also visit and work at the site. Potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.5s, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B**.

Crowell Mercury Mill has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the March 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from mercury bearing ore and recovery processes to extract mercury. Preliminary COCs are metals. Crowell Mercury Mill was given an overall HRS score of 0.66 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in T**able 5-1** and sensitive ecological receptor pathways are presented in **Table 5-2**. For explanations of each exposure category, please refer **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 5-1: Crowell Mercury Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	**P S**	I P
		Dermal	**P S**	I P
	Groundwater	Ingestion	I P	I P
		Dermal	I P	I P
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 5-2: Crowell Mercury Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I **P**	I **P**
		Direct Contact	I P	I P	**P S**	**P S**	I **P**	I **P**
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

5.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Crowell Mercury Mill has approximately 250 cubic yards of mill tailings exposed at the surface, the site is a popular destination for visitors, and potentially endangered or threatened species have been identified in the vicinity of the site. The CSM indicates that human receptors and terrestrial fauna may be the most at risk for ingestion, dermal contact, and inhalation of potential contaminants from surface soil, sediment, and air pathways. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, for plants and soil organisms which occupy the subsurface soil, and for terrestrial fauna due to potential impacts from leaching of mercury. There is no evidence of shallow groundwater at this site. Although a spring is located approximately 3 miles downgradient of the site, the topography suggests that the spring would not receive surface runoff from the Crowell Mercury Mill site; therefore, the groundwater pathway is incomplete for human exposure.

Surface water was not observed at the site and is only present during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds, and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain metals analytical data for mill tailings and adjacent soil located on site and in the downstream area to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, collecting samples to evaluate background levels of metals in soil will distinguish naturally occurring metals' concentrations in the environment from a release of hazardous materials.

6.0 LANE MILL (SITE #4)

The PA inspection of Lane Mill was conducted on March 8, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C4**. **Figure 6-1** shows the site layout and topographic features in the vicinity of the site, and indicates the locations of the mill and mine, cyanide processing area, and extent of tailings. Site features are depicted on **Figure 6-2** and include:

- Mill location,
- Surface drainage,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

6.1 SITE DESCRIPTION

Lane Mill (Latitude 36.70164°, Longitude -116.88428°) is located in the Chloride City mining complex, 14 miles southwest of Beatty, Nevada, and 13.5 miles north of Cow Creek, CA, the nearest towns with permanent residents. The site sits an elevation of approximately 4,800 feet above sea level[61]. The site is accessed via 6 miles of rough, four-wheel drive road along the same road used to access the Crowell Mercury Mill. Approximately 200 visitors come to the site each year.

[61] ECM 2014, Preliminary Assessment Work Plan for 24 Abandon Mine Site, Death Valley National Park, Inyo County, California, January 29, 2014.

The mill is located in a small canyon and covers an area of approximately 4 to 5 acres. Historical records indicate there is a water well on site that was used for ore processing. Records also indicate the well went dry soon after operations began. An EDR Radius Map report for this site identified no wells within 1.0 mile of the site (EDR, 3813626.8s, **Appendix B**). Remains of mining and mill activity at the site include structure footings, mining equipment, walls/dams made of stones and mill tailings located at various locations around the site (**Appendix C4**). The Chloride City Historic District has been nominated for the National Register of Historic Places[62].

6.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

The mill was constructed in 1916, and operated for only a few days. According to site records, the water supply well on site went dry and the milling operations stopped. Chloride City is a popular destination for four-wheel drive enthusiasts and visitors often walk through tailings piles as they explore the mill site ruins.

Mill tailings are located around two mill foundations, north of the former mill, and in the wash where they have collected behind and around two impoundment dams. The mill tailings are a pinkish/yellowish colored fine-grain material that consists of approximately 150 to 160 cubic yards. There seems to be more mill tailings present on site than would be generated by an operation that only lasted a few days before closing. Mining waste material may have originated from one of the other nearby mine/mill sites. A stockpile of ore waste rock on site is believed to hold as much as 100 cubic yards of buried waste rock. Based on the operational history and information gathered during the PA, the preliminary COCs at this site are cyanide and metals.

6.3 ENVIRONMENTAL SETTING

6.3.1 Geology and Hydrogeology

Geological Setting

Lane Mill is located in the north-central portion of the Funeral Mountains in the Amargosa Range **(Figure 1**). Death Valley and Cotton Ball Basin are located to the southwest, and the Amargosa Desert is located northeast. The southern tip of the Grapevine Mountains is northwest of the site (**Appendix E**). The site is situated on Later Precambrian sedimentary and metamorphic rocks bedrock of the Pahrump Group: Kingston Peak Formation (**Figure 2**). The Kingston Peak Formation includes conglomerate, quartzite, shale, limestone, and dolomite and is in part equivalent to the Panamint Metamorphic Complex[63]. The mill is located within 560 feet of an identified southeast-northwest trending fault to the south and another southeast-northwest trending fault approximately 870 feet to the northeast.

Groundwater

Site groundwater flows into the South Lahontan HR, Death Valley Groundwater Basin in the state of California[64] (**Section 1.2**). The primary water-bearing units are unconsolidated, fine- to coarse-grained older and younger Quaternary alluvial deposits found along stream channels and at the base of alluvial fans near the mountains. If present, groundwater flow direction in the vicinity of the site generally follows

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[62] L.W. Green, 1981. Historic Resource Study, A History of Mining in Death Valley National Monument, California-Nevada, Vol 1 of II, Part 2 of 2. March.

[63] R. Streitz and M. Stinson, California Division of Mines and Geology, Geologic Map of California, Death Valley Sheet. 1974, Second Printing 1980.

[64] Department of Water Resources. *South Lahontan Hydrologic Region – Death Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

surface water flow, depicted in **Figure 6-2**. Based on the topographic surface, groundwater flow would be to the east around the ridgeline at the site, then south and generally southwest. The narrow, meandering canyon is bound by bedrock, indicating continually changing flow direction. Recharge of the groundwater basin is from surface runoff, derived from occasional rainstorms and flash floods in the surrounding mountains.

The nearest wells to the Lane Mill are near the Keane Wonder Springs, 3 miles southwest (EDR 3813626.8s, **Appendix B**). However, these wells appear to be open at the surface as cisterns and water seeps from them onto the ground surface. The wells identified on the USGS topographic map are not used for domestic use, but have been tested and are of generally good quality for most uses. No residences are found within 200 yards, and groundwater is not used as a drinking water source.

Springs in the Funeral Mountains have a sodium bicarbonate character. Keane Wonder Springs (closest spring), located at the base of the mountains, has a sodium-calcium bicarbonate-sulfate character. This spring is located 3 miles southwest and downgradient of the site. Based upon federal database records research (EDR 3813626.8s, **Appendix B**) and available USGS topographic maps (**Appendix E**), there are no nationally recognized wetlands within 4 miles of the site.

6.3.2 Surface Water

The site is situated near a ridgeline and surface water is generated from infrequent heavy precipitation; runoff in the vicinity begins approximately 640 feet to the south. Surface water flow during rainfall events is channeled through the wash to the north in an unnamed canyon (**Figure 6-2**). During the mill's operation, several rock dams were created to halt the flow of water through the site. Though these rock dams are porous, the dams will briefly hold water during the infrequent rain events and resulting in the deposition of fine-grained sediments. Surface water in this area generally flows north and then west through a deep unnamed canyon, before emptying onto the outwash north of Keane Wonder Springs. Surface water then flows approximately 32 miles from the base of the Funeral Mountains to the Cotton Ball Basin, then south through Salt Creek into Middle Basin, continues along the Devils Golf Course, and finally into the Badwater Basin. These drainages are ephemeral.

Crowell Mercury Mine (Site #3), is 0.3 miles north of the site and hydraulically connected via the same surface drainage. After coursing through 5.6 miles of canyon, surface water drains onto the same alluvial plain that receives flow from Cyty's Mill, located 3 miles southwest; Big Bell Mine and Mill; and Keane Wonder Mine (and several other mines not identified in this report). There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site.

6.3.3 Soil, Sediment, and Air

The mill is located on the east-facing side of a wash that has accumulated a thin surficial layer of alluvial sediments that range in size from sands to gravel. However, this site does not have a classified soil type and is documented to be on unweathered bedrock. This indicates a very slow infiltration rate and no drainage class (EDR 3813626.8s, **Appendix B**)

Operations at Lane Mill generated reddish-brown to buff-colored fine-grained tailings, which are distinguishable from the bluish-gray color of the surrounding limestone (**Figure 6-2**). Mounds of tailings and partly consolidated tailing deposits occur along the hillside slopes. Behind the rock dams at the base of the drainage, where ponding occurs during precipitation events, tailings mixed with mine waste have accumulated. The fine-grained tailings are apparent nearly 240 feet from the first large rock dam. The lowest rock dam appears to be silted-in and shows no sign of mill tailings. No tailings were observed farther down wash; however, tailings mixed with native sediments may be present further down the canyon but difficult to identify. Access roads are present in the area but do not appear to traverse any of the observed tailings. Vegetation was not observed on discrete tailings piles. Sparse vegetation was observed growing in the distributed tailings behind the impoundment dams. Site vegetation appeared unstressed both upgradient and downgradient of the site.

The mill is located in an open wash that has several stockpiles of mine waste from prospecting. Mine wastes or unprocessed ore on site are located uphill of the rock dam and immediately below the access road. The mine waste, characterized by coarse-grained sand to gravel, appears to be stable and generally not migrating downslope.

There are many mines and mills in the vicinity, several of which are not identified in this report. There is potential of mine waste or tailings to become comingled farther downstream. The fine-grained tailings and mine waste are exposed without native sediment or significant vegetation cover. Windborne particulates are considered likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, and access roads near tailings.

6.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Lane Mill is visited by approximately 200 people per year and park staff and contractors may also visit and work at the site. Potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.7s, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B**

Lane Mill has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the March 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from cyanide leaching to extract gold. Preliminary COCs include cyanide and metals. Additionally, the site was evaluated using the EPA HRS using the information gathered in the PA. Lane Mill was given an overall score of 1.21 (Table 3). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in T**able 6-1** and sensitive ecological receptor pathways are presented in **Table 6-2**. For explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 6-1: Lane Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	I P	I P
		Dermal	I P	I P
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 6-2: Lane Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

6.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. There is no evidence of shallow groundwater at this site, although historic records indicate a well was once present. Although a spring is located approximately 3 miles downgradient of the site, the topography suggests that the spring would not receive surface runoff from the Lane Mill; therefore, the groundwater pathway is incomplete for human exposure. Surface water was not observed at the site and is only present during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors to the site (if present), and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the cyanide processing areas to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals in soil.

7.0 FRANKLIN MILL (SITE #5)

The PA inspection of Franklin Mill was conducted on March 8, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C5**. **Figure 7-1** shows the topographic features in the vicinity of the site, and indicates the location of the mill. Site features are depicted on **Figure 7-2** and include:

- Mill location,
- Surface flow direction,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

7.1 SITE DESCRIPTION

Franklin Mill is located within the Chloride City mining complex, 15 miles southwest of Beatty, Nevada (Latitude 36.69174°, Longitude -116.87734°) at an elevation of approximately 4,433 feet above sea level. The site is accessed via seven miles of rough, four-wheel drive road, followed by a steep 0.2 mile hike that descends nearly 700 vertical feet.

Franklin mill is the site of the original Chloride Cliff mine and is located within the Chloride Cliff geographic area, which comprised a town, mining district and a group of mines[65]. The Chloride Cliff area is approximately four square miles at an elevation of approximately 5,000 feet above sea level. The site is located in a canyon with a very steep drop to the south and it is situated on a 40 by 40 foot

[65] A History of Mining in Death Valley National Monument, Volume II Part 1 of 2, by John A. Latschar, March 1981.

bench notched out of the canyon wall. Remains of a single-stamp mill and a concrete footing are the only structure present at the site (**Photos C5-1** and **C5-4**).

7.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

Franklin Mill is near one of the oldest mines on the east side of the Death Valley and was discovered on August 14, 1871, by a civil engineer named A.J. Franklin[66]. Mining for silver began in April 1872 and ended approximately two years later due to high overhead costs to run the mine which was a consequence of the remote location and high expense to haul supplies to the site and haul ore out of the mine. The mine stayed closed for nearly 30 years and reopened in 1905 and was operated off and on, under several different owners, until the 1940s. No evidence of mill tailings was observed during the site inspection, however a small stock pile of possible waste rock (less than two cubic yards) was observed near the stamp mill. The mill appears to have never operated.

7.3 ENVIRONMENTAL SETTING

7.3.1 Geology and Hydrogeology

Geological Setting

Franklin Mill is located in the north-central portion of the Funeral Mountains in the Amargosa Range (**Figure 1**). Death Valley and Cotton Ball Basin are located southwest and the Amargosa Desert is located northeast. The southern tip of the Grapevine Mountains is northwest of the site (**Appendix E**). The site is situated on Later Precambrian sedimentary and metamorphic bedrock of the Pahrump Group: Kingston Peak Formation. The Kingston Peak Formation includes conglomerate, quartzite, shale, limestone, and dolomite and is in part equivalent to the Panamint Metamorphic Complex[67]. The site is located within 310 feet of an identified north-south trending fault to the west and another north-south trending fault approximately 740 feet to the east.

Groundwater

Groundwater at the site flows into the South Lahontan HR, Death Valley Groundwater Basin in the state of California[68] (**Section 1.2**). The primary water-bearing units are unconsolidated, fine- to coarse-grained older and younger Quaternary alluvial deposits found along stream channels and at the base of alluvial fans near the mountains. If present, groundwater flow direction likely follows surface flow, depicted on **Figure 7-2**. Based on the topographic surface, groundwater would flow southeast into a narrow, meandering canyon that is bound by bedrock. Recharge of the groundwater basin is from surface runoff, derived from occasional rainstorms and flash floods in the surrounding mountains.

Keane Wonder Springs (closest springs) has a sodium-calcium bicarbonate-sulfate character and is of good quality. This spring is located at the base of the mountains, 2.9 miles southwest and downgradient of the site. The nearest wells to the Franklin Mill are near the Keane Wonder Springs 2.9 miles southwest (EDR 3813626.10s, **Appendix B**). However, these wells appear to be open at the surface as cisterns and water seeps from them on to the ground surface. The wells identified on the USGS topographic map are not used for domestic use, but have been tested and are of generally good quality for most uses. No residences are found within 200 yards, and groundwater is not used as a

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66 A History of Mining in Death Valley National Monument, Volume II Part 1 of 2, by John A. Latschar, March 1981.

67 R. Streitz and M. Stinson, California Division of Mines and Geology, *Geologic Map of California, Death Valley Sheet*. 1974, Second Printing 1980.

68 Department of Water Resources. *South Lahontan Hydrologic Region – Death Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

drinking water source. Based upon federal database records research (**Appendix B**) and available USGS topographic maps (**Appendix E**), there are no nationally recognized wetlands within 4 miles of the site.

7.3.2 Surface Water

The site is located on a broad steep canyon wall below Chloride Cliff. Surface water in this area is generated from infrequent heavy precipitation; runoff begins approximately 0.3 miles to the northwest along the mountain peak and ridgeline (**Figure 7-2**). Surface water drains directly down the hillside into the steep-walled canyon and then flows southwest to the base of the Funeral Mountains (south of the Keane Wonder Mill ruins). Runoff then flows approximately 31.5 miles from the base of the Funeral Mountains to the Cotton Ball Basin, south through Salt Creek into Middle Basin, continues along the Devils Golf Course, and finally empties into Badwater Basin (Appendix D). These drainages are ephemeral[69].

There are no sites in the same drainage area as Franklin Mill. After surface water courses through 2.8 miles of canyon and 3.7 miles onto the Death Valley outwash plain, surface water joins runoff from Cyty's Mill, Big Bell Mine and Mill, Crowell Mercury Mine, Lane Mill, and Keane Wonder Mine. There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site.

7.3.3 Soil, Sediment, and Air

Franklin Mill did not operate; therefore waste or tailings were not generated (**Figure 7-2, Appendix D**). Hiking trails access the area, but there are no roads at this location. The only ground disturbance occurred while installing the mill. Desert vegetation is sparse but appears the same upgradient and downgradient. Since no tailings or waste was generated at Franklin Mill, there can be no transport via wind.

7.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Franklin Mill is a remote site and is visited by fewer than 20 people per year. Park staff and contractors may also visit and work at the site. Potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.9s, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B.**

Franklin Mill has been assessed using site-specific CSM. Based on the operational history and observations during the March 2014 site visit, it is suspected that no operations were conducted and no mill tailings were generated at the site. For this reason, a HRS score was not determined. However, the site was conservatively evaluated assuming cyanide or metals are present based on the potential exposure pathways.

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[69] Department of Water Resources. *South Lahontan Hydrologic Region – Death Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

A summation of the findings for human exposure pathways is shown below in **Table 7-1** and sensitive ecological receptor pathways are presented in **Table 7-2**. For explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 7-1: Franklin Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	I P	I P
		Dermal	I P	I P
Water Erosion	Surface soil	Ingestion	I P	I P
		Dermal	I P	I P
	Subsurface Soil	Ingestion	I P	I P
		Dermal	I P	I P
	Groundwater	Ingestion	I P	I P
		Dermal	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P
		Dermal	I P	I P
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 7-2: Franklin Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Surface soil	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
	Subsurface Soil	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Water Erosion	Sediment	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	I P	I P

P S – Potentially complete pathway and may be significant

P I – Potentially complete pathway but considered insignificant

I P – Incomplete pathway; no evaluation necessary

7.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Mine waste and mill tailings were not observed at the Franklin Mill site. Less than 20 people visit the site annually. Since no source is present, there is no potential for a release of contaminants into the environment. The CSM indicates no complete pathways are present for human or ecological receptors. There is no potential for a release of contaminants into the environment; therefore ECM recommends no further action at this site.

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8.0 BIG BELL MINE AND MILL (SITE #6)

The PA site inspection of the Big Bell Mine and Mill was conducted on February 18, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C6**. **Figure 8-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill and mine, cyanide processing area, and extent of tailings. Site features are depicted on **Figure 8-2** and include:

- Mill and mine location,
- Surface drainages,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

8.1 SITE DESCRIPTION

Big Bell Mine and Mill site is located 12 miles southwest of Beatty, Nevada, in the Funeral Mountains (Latitude 36.69283°, Longitude -116.89609°) at an elevation of approximately 3,600 feet above sea level. **Figures 8-1** and **8-2** show the site layout and site features and **Appendix C6** show photographs taken during the site inspection. The site is accessed via seven miles of rough four-wheel drive road, followed by a steep one mile hike that descends approximately 2,000 feet. This site is located in the Keane Wonder Mine closure area. A sign at the parking area explains the closure, but no physical barriers exist. The site was closed to the public and non-essential employees in 2008; however, it is estimated that the site is visited by approximately 100 people per year.

Big Bell Mine was a large mining operation located in a deep canyon covering and area of approximately 50 acres. Numerous milling and mining artifacts remain on site including a rail track and tram that extends from the mine to the mill process area (**Photos C6-4 and C6-6**).

8.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

The Big Bell Mine was discovered by John Cyty and Mike Sullivan in 1904. The site was not developed until late in 1905, when the Big Bell Mining Company was incorporated by Walter O'Brien[70]. In 1907 several buildings were built on the property to house employees and equipment. The mill was idle from 1912 to 1935 due to financial reasons and was acquired by the Coen Company[71]. In 1936 a ball mill, cyanide tanks, and a pipeline from Keane Spring was installed at the site and ruins of this equipment remain on site (**Appendix C6).** According to historical records, production at the site slowed down due to logistical difficulties and the site closed in 1941. Mill tailings have accumulated at two locations at the site. At the first location mill tailings have accumulated in a fan shape deposit near the base of a cyanide process tank on the east side of the site (**Photo C6-5 and C6-10)**. The tailings extend down slope from a cyanide process tank and form a layer of pink fine grain material approximately 6 to 24 inches thick. The estimated volume of mill tailings at this location is approximately 150 cubic yards (**Figure 8-2**). A second deposit of mill tailings has accumulated in a wash approximately 250 feet down slope from the first location (**Figures 8-1** and 8**-2**). The tailings in the wash are near a metal conical tank and several cyanide process tanks (**Photos C6-20** and **C6-22)**. These tailings are greater than 10 feet thick in some places with an estimated volume of approximately 2,000 to 2,500 cubic yards and appear to be eroding downstream (**Photos C6-20**). **Figure 8-2** shows the location of accumulated mill tailings on site and the extent of erosion. Based on the operational history and information gathered during the PA, COCs include cyanide and metals.

During the PA reconnaissance visit, ECM alerted NPS to the presence of an unknown, white, powdery substance. On a second site visit to the Big Bell site on March 12, 2014, ECM collected a sample to confirm that the substance was not granular cyanide. TestAmerica Laboratories, Inc. analyzed the sample for total cyanide by SM 4500 CN E method. Analytical data indicate no detection of cyanide present in the sample. Additional analyses of the sample (DEVA-BB-01) include:

Analysis Method	Analyte	Result
EPA Method 6010B	Calcium	450,000 mg/kg
EPA Method 6010B	Lead	<9.2 mg/kg
EPA Method 6010B	Magnesium	2,300 mg/kg
EPA Method 6010B	Sodium	280 mg/kg
EPA Method 9045C	pH	9.98

Note: mg/Kg = milligrams per kilogram (parts per million)

70 A History of Mining in Death Valley National Monument, Volume II Part 1 of 2, by John A. Latschar, March 1981.

71 A History of Mining in Death Valley National Monument, Volume II Part 1 of 2, by John A. Latschar, March 1981.

The sample has a high concentration of calcium, pH of 9.98 and no lead. This likely indicates that the substance is most likely lime (calcium hydroxide), used in the cyanide preparation process. Using lime is common practice, because mixing dry cyanide into solution requires a high pH in order to prevent creation of toxic hydrogen cyanide.

8.3 ENVIRONMENTAL SETTING

8.3.1 Geology and Hydrogeology

Geological Setting

Big Bell Mine and Mill site is located in the north-central portion of the Funeral Mountains in the Amargosa Range (Figure 1). Death Valley and Cotton Ball Basin are located to the southwest and the Amargosa Desert is located northeast. The southern tip of the Grapevine Mountains is northwest of the site (**Appendix E**). The site is situated on Later Precambrian sedimentary and metamorphic bedrock of the Pahrump Group: Kingston Peak Formation (**Figure 2**). The Kingston Peak Formation includes conglomerate, quartzite, shale, limestone, and dolomite and is in part equivalent to the Panamint Metamorphic Complex[72]. The mill is located within 0.25 mile of an identified crescent-shaped fault opening to the southwest indicating a transitional rock slide. The mill is located on a ridge that intercepts a relatively steep meandering canyon.

Groundwater

Groundwater from the site flows into the South Lahontan HR, Death Valley Groundwater Basin in the state of California[73] (**Section 1.2**). The primary water-bearing units are unconsolidated, fine- to coarse-grained older and younger Quaternary alluvial deposits found along stream channels and at the base of alluvial fans near the mountains. If present, groundwater flow direction at the site likely follows surface water flows, depicted in **Figure 8-2**. Based on the topographic surface, groundwater flows to the southeast into a narrow, meandering canyon that is bound by bedrock. Recharge of the groundwater basin is from surface runoff, derived from occasional rainstorms and flash floods in the surrounding mountains.

The closest spring is the Keane Wonder Springs, located at the base of the mountains and 2 miles southwest and downgradient of the Site. This spring has a sodium-calcium bicarbonate-sulfate character and is of good quality. Based upon federal database records research (EDR 3813626.12s, **Appendix B**) and available USGS topographic maps (**Appendix E**), there are no nationally recognized wetlands within 4 miles of the site.

The nearest wells to the Big Bell Mine and Mill are near the Keane Wonder Springs, 2 miles southwest (EDR 3813626.12s, **Appendix B**). However, these wells appear to be open at the surface as cisterns and water seeps onto the ground surface. The wells identified on the USGS topographic map are not used for domestic use, but have been tested and are of generally good quality for most uses. At Furnace Creek Ranch (approximately 16.4 miles south of the site), the Pliocene to Pleistocene-aged Funeral Formation is tapped by several wells as a source of water. Stovepipe Wells, 15.5 miles west, also has wells used for domestic use; however, due to the quality of the water it is treated prior to use. No residences are found within 200 yards, and groundwater is not used as a drinking water source.

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[72] R. Streitz and M. Stinson, California Division of Mines and Geology, Geologic Map of California, Death Valley Sheet. 1974, Second Printing 1980.

[73] Department of Water Resources. *South Lahontan Hydrologic Region – Death Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

8.3.2 Surface Water

The site is located in a narrow canyon with headwaters starting at 1.2 miles east-northeast of the site. Surface water in this area is generated from infrequent heavy precipitation and is channeled through the canyon to the southwest (**Figure 8-2**). Surface water in this area generally flows west and then south, and then flows west through a deep unnamed canyon, and past Keane Wonder Mine and mill, before emptying onto the outwash south of Keane Wonder Springs. Surface water then flows approximately 32 miles from the base of the Funeral Mountains to the Cotton Ball Basin, south through Salt Creek into Middle Basin, continues along the Devils Golf Course, and finally flows into Badwater Basin (**Appendix E**). These drainages are ephemeral.

Keane Wonder Mine is 1 mile downslope of the site and is hydraulically connected to the Big Bell Mine and Mill site within the same drainage. After surface water courses through 2.2 miles of canyon and 3.3 miles onto the Death Valley outwash plain, the flow joins runoff from Cyty's Mill, Franklin Mill, Crowell Mercury Mine, and Lane Mill. There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site.

8.3.3 Soil, Sediment, and Air

The site has accumulated a thin surficial layer of alluvial sediments that range from sands to gravels. However, this site does not have a classified soil type and is documented to be on unweathered bedrock. This indicates a very slow infiltration rate and no drainage class (EDR 3813626.12s, **Appendix B**).

During Big Bell Mine and Mill operations, tailings washed down the canyon and accumulated in partly consolidated deposits that have been cut through by water action. The site's operation generated buff to pink light-colored, fine-grained tailings, which are distinguishable from the darker color of the surrounding bedrock (**Figure 8-2**). A 1-foot-thick accumulation of tailings has been deposited below a former holding tank and has the appearance of flowing downslope. More tailings are present on the cut-bank walls and downgradient for approximately 510 feet. The tailings become mixed with native material and are more difficult to identify farther from the site. However, tailings were observed sporadically downgradient as far as 770 feet from the site. Although the site is sparsely vegetated with creosote, the tailings appear to be exposed with little vegetation cover. This site is closed during environmental assessment of Keane Wonder Mine.

Big Bell mine wastes are found across the ridge near a mine adit and cart track. Several mine structures use the mine waste for foundations. Mine wastes or unprocessed ore on site are characterized by coarse-grained sand to gravel and cobbles and appear to be stable and generally not migrating downslope.

The mine is located in narrow canyon with many mines in the vicinity, several of which are not identified in this report. Keane Wonder Mine is located 1.0 mile down wash. There is a potential for mine waste or tailings to become comingled with material from other mines and mills that have been identified in the same drainage. Windborne particulates are considered likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, and the disbursement of tailings throughout the canyon.

8.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

The site is currently closed to the public, but may be visited by approximately 100 people per year. Park staff and contractors may also visit and work at the site. Potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.11s, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B.** Big Bell Mill has been assessed using site-specific CSMs. Based on the operational history of the mill and observations the February 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from cyanide leaching processes to extract gold. Preliminary COCs at the site include cyanide and metals. Additionally, the site was evaluated using the EPA HRS using the information gathered in the PA. Big Bell Mill was given an overall score of 0.69 (Table 3). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 8-1** and sensitive ecological receptor pathways are presented in **Table 8-2**. For explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 8-1: Big Bell Mine and Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	I P	I P
		Dermal	I P	I P
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 8-2: Big Bell Mine and Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant

P I – Potentially complete pathway but considered insignificant

I P – Incomplete pathway; no evaluation necessary

8.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms, which occupy the subsurface soil. There is no evidence of shallow groundwater at this site. Although a spring is located approximately 2 miles downgradient of the site, an inspection of the topography does not suggest the presence of shallow groundwater beneath this site; therefore, the pathway is incomplete for human exposure. Surface water was not observed at the site and is only present during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the cyanide processing areas to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places or have been proposed for consideration will require consultation with SHPO prior to implementation of additional site inspection activities.

9.0 CYTY'S MILL (SITE #7)

The PA inspection of the Cyty's Mill site was conducted on January 8, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C7**. **Figure 9-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill, cyanide processing area, and extent of tailings. Site features are depicted on **Figure 9-2** and include:

- Mill location,
- Surface drainages,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

9.1 SITE DESCRIPTION

Cyty's Mine is located at the western slope of the Funeral Mountains in the Amargosa Range, on the eastern side of Death Valley and located approximately one mile northwest of the Keane Wonder Mine **(Figures 9-1)**. Access to the site is via a two-mile graded gravel road, which is currently closed to the public, followed by a one mile hike. The site covers less than two acres on the western slope of the Funeral Mountains. The remains of a three-stamp mill and a cabin are approximately 100 feet upgradient to mill tailings as shown in **Photos C7-17** and **C7-20**. Mill tailings are located at the base of the mill. Two cisterns and numerous prospect pits are located in southern section of the site**. Photos C7-12 and C7-13** in **Appendix C7** show the small springs and associated cisterns near the mill.

9.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

Cyanide was historically used at the site to extract gold from the milled ore. The study area includes the stamp mill, the possible cyanide processing area, and the tailings deposits (**Figure 9-1**). Mill tailings generated after using cyanide extraction processes remain on site and are located in what is believed to be the cyanide process area and downslope. The tailings pile contains approximately 20 cubic yards of fine-grained, pink tailings. The tailings have migrated approximately 100 feet down slope from the historic cabin (**Photo C7-21**). During the site inspection, tailings did not appear to be migrating downslope in any significant volume. Based on operational history and information gathered during the PA, the preliminary COCs for the site are cyanide and metals.

9.3 ENVIRONMENTAL SETTING

9.3.1 Geology and Hydrogeology

Geological Setting

Cyty's Mill is located on the north side of the Keane Wonder Fault that runs parallel and northeast of the Death Valley-Furnace Creek Fault Zone for 6 miles. The site is located in the northwest portion of the Funeral Mountains in the Amargosa Range (**Figure 1**). Death Valley and Cotton Ball Basin are located southwest and the Amargosa Desert is located northeast. The southern tip of the Grapevine Mountains is northwest of the site (**Appendix E**). The mill is on Later Precambrian sedimentary and metamorphic bedrock of the Pahrump Group: Kingston Peak Formation, near the contact with Pleistocene volcanic rocks (**Figure 2**). The Kingston Peak Formation includes conglomerate, quartzite, shale, limestone, and dolomite and is in part equivalent to the Panamint Metamorphic Complex[74]. Immediately downgradient and southwest of the site is a bicarbonate/evaporite shelf from heavy TDS load deposition from the springs on the eastern side of the fault seeping onto the lower outwash plain.

Groundwater

Groundwater from the site flows into the South Lahontan HR, Death Valley Groundwater Basin in the state of California[75]. Groundwater flow direction generally follows the surface flow direction, depicted on **Figure 9-2**. Based on the topographic surface, groundwater flows to the west or southwest and then south. Recharge of the groundwater basin is from surface runoff, derived from occasional rainstorms and flash floods in the surrounding mountains.

There are two wells noted on the USGS topographic map (**Appendix E**); however, these wells appear to be open at the surface as cisterns and have water seeping out on to the ground surface. The wells identified on the USGS topographic map are not used for domestic use, but have been tested and are of generally good quality for most uses. No residences are found within 200 yards, and groundwater is not used as a drinking water source.

Keane Wonder Springs (ephemerally dry) is located at the site along with two other natural springs and seeps to the southeast along the hiking trail. Based upon federal database records research (EDR 3813626.14s, Appendix B) and available USGS topographic maps (Appendix E), there are no nationally recognized wetlands within 4 miles of the site. However, due to the natural springs in this

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[74] R. Streitz and M. Stinson, California Division of Mines and Geology, *Geologic Map of California, Death Valley Sheet*. 1974, Second Printing 1980.

[75] Department of Water Resources. *South Lahontan Hydrologic Region – Death Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

area there are several locations where water ponds and creates vegetative areas. These are not recognized as wetlands but show some of the same characteristics (**Figure 9-2**).

9.3.2 Surface Water

The site is located in a broad sloping, west facing hillside on the eastern margin of Death Valley. Surface water in this area courses through an intersecting system of drainages. Surface water in this area is generated by seeps and springs that overflow groundwater to the surface and from runoff generated by infrequent heavy precipitation in the upgradient canyons (**Figure 8-2**). Ephemeral and perennial sources of surface water create gullies and rills and also deposit bicarbonate and evaporite material. Surface water in this area generally flows to the southwest on to the Death Valley floor. Surface water then flows approximately 32 miles from the base of the Funeral Mountains to the Cotton Ball Basin, then south through Salt Creek in to Middle Basin, continues along the Devils Golf Course, and finally empties into Badwater Basin (**Appendix E**). These drainages are generally ephemeral due to the infiltration of surface water into the subsurface.

Surface water flows from Cyty's Mill, located 3.5 miles southwest, and comingles with potential runoff from Big Bell Mine and Mill, Lane Mill, and Cromwell Mercury Mine, and Keane Wonder Mine (and several other mines not identified in this report). There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site.

9.3.3 Soil, Sediment, and Air

The site has accumulated a thin surficial layer of alluvial sediments, including bicarbonate/evaporite load and sediment buildup that ranges from silt to gravel. However, this site does not have a classified soil type and is documented to be on unweathered bedrock. This indicates a very slow infiltration rate and no drainage class (EDR 3813626.14s, **Appendix B**).

The mill is located on a broad hillside. Less than 20 cubic yards of tailings are present approximately 150 feet west of the mill structure. The pink fine-grained mill tailings do not appear to be moving a significant distance downslope (**Appendix D**). There is potential for mill tailings to become comingled farther downstream as other mines and mills have been identified in the same drainage (**Figure 8-2**). The tailings do not appear to be impacting surficial flow features and are not migrating downslope. The area is sparsely vegetated with drought stressed desert holly and creosote.

Cyty's Mill is a popular destination for park visitors and is in an area accessed by the public. This area is only accessible by hiking so vehicle traffic is not a concern. Windborne particulates are considered likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, and the area being accessible to the public.

9.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Currently the mill area is closed to the public and access to the site is restricted, due to the closure of nearby Keane Wonder Mine and Mill. Potential pathways of exposure are identified for occasional visitors and park staff and contractors who visit and work at the site. Potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.5s, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B**

Cyty's Mill has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the January 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from cyanide leaching to extract gold. Preliminary COCs include cyanide and metals. Additionally, the site was evaluated using the EPA HRS from the information gathered in the

PA. Cyty's Mill was given an overall score of 0.23 (**Table 3**). The HRS scoring worksheets are provided in Appendix A.

A summation of the findings for human exposure pathways is shown below in **Table 9-1** and sensitive ecological receptor pathways are presented in **Table 9-2**. For explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 9-1: Cyty's Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	*P I*	*P I*
		Dermal	*P I*	*P I*
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	*P I*	*P I*
		Dermal	*P I*	*P I*
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 9-2: Cyty's Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	*P I*	*P I*	I P	I P
		Direct Contact	I P	I P	*P I*	*P I*	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	*P I*	*P I*	*P I*	*P I*
		Direct Contact	I P	I P	*P I*	*P I*	*P I*	*P I*
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant

P I – Potentially complete pathway but considered insignificant

I P – Incomplete pathway; no evaluation necessary

9.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, surface water, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Although subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil, it is not anticipated to be significant, due to limited mobility of the COCs. There is evidence of shallow groundwater at this site; however, the exposure for human receptors is anticipated to be insignificant due to the elevated topography between the mill tailings and the groundwater source. Surface water is present at the site, but is located cross gradient from observed mill tailings; therefore, exposure for human and ecological receptors is likely to be insignificant. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors to the site (if present), and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the cyanide processing areas to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. ECM also recommends collecting samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places or have been proposed for consideration will require consultation with SHPO prior to implementation of additional site inspection activities.

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10.0 GOLD GROTTO MINE AND MILL (SITE #8)

The PA inspection of the Gold Grotto Mine and Mill site was conducted on March 8, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C8**. **Figure 10-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill, processing area, and extent of tailings. Site features are depicted on **Figure 10-2** and include:

- Mill location,
- Surface drainages,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

10.1 SITE DESCRIPTION

Gold Grotto Mine and Mill site is located 23 miles northwest of Death Valley Junction, California, on the east side of the Funeral Mountains (Latitude 36.56899°, Longitude -116.66332°) at an elevation of 3,348 feet above sea level. **Figure 10-1** and **10-2** show the site location and site features. Photographs taken during the site inspection are shown in **Appendix C8.** The site is accessed via six miles of four-wheel drive road. Gold Grotto is part of the larger Echo Lee Mining District and town site. Little is known about the specific mill site, but Lees Camp first became active around 1905-06. It is located in a shallow canyon which drains onto a broad alluvial fan that slopes to the north then east to the community of Amargosa Valley, Nevada (**Figure 10-1**) located approximately 2.9 miles away.

The site is open to the public and visited by less than 300 people per year. There is evidence of visitors using the site for camping and sightseeing. Use of the site area as a campground may expose visitors to tailings from the processing area (**Photo C8-8**).

10.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

The site covers a one-acre area in a north-south-trending canyon. Remains of mining equipment include a cabin ruins and a small mill ruins (**Photos C8-2 and C8-3**). Tailings are scattered around the near the mill and in the former camp area. The tailings consist of pink color fine sand and silt which have migrated less than 20 feet from the mill area. The total volume of tailings is estimated at 30 cubic yards. Based on the mine ruins observed during the site inspection, ore was most likely milled and processed by cyanide. Based on the operational history and results gathered during this PA, the preliminary COCs for the site are cyanide and metals.

10.3 ENVIRONMENTAL SETTING

10.3.1 Geology and Hydrogeology

Geological Setting

Gold Grotto Mine and Mill is located on the eastern-central side of the Funeral Mountains in the Amargosa Range (**Figure 1**). The site is north of the Black Mountains and Greenwater Range. Amargosa Desert, Crater Flat, and Jackass Flat lie northeast of the site and Death Valley and Cotton Ball Basin are located to the west (**Appendix E**). The mill is situated on Cambrian-Precambrian-aged marine sedimentary and metasedimentary bedrock of the Wood Canyon Formation (**Figure 2**). The Wood Canyon Formation contains dark-colored interlayered shale, siltstone and quartzite, with lighter-colored brownish-weathering dolomite or limestone, conglomerate, quartzite and oolitic limestone (lower part below Trilobites is Precambrian)[76].

Groundwater

The site is located in the South Lahontan HR, Middle Amargosa Valley Groundwater Basin in the state of California[77] (**Section 1.2**). This basin encompasses 609 square miles and extends north into Nevada's Amargosa Valley Groundwater Basin[78] in the Death Valley region. The depth to groundwater is not recorded, but groundwater is likely present in alluvium of Quaternary age. Local groundwater flow generally follows surface flow, depicted in **Figure 10-2**. Based upon the topographic surface, groundwater flow is generally north into the playa of Amargosa Desert.

The Middle Amargosa Valley Groundwater Basin is bounded by consolidated rocks of the Resting Springs and Nopah Ranges on the east, The Black Mountains and Greenwater Range on the south, and the Funeral Mountains to the northwest (**Appendix E**). The recharge to this basin is primarily from the subsurface inflow from basins to the north and east in Nevada. Additional recharge is from surface runoff and subsequent percolation through alluvial fan deposits at the base of the bordering mountains.

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[76] R. Streitz and M. Stinson, California Division of Mines and Geology, *Geologic Map of California, Death Valley Sheet*. 1974, Second Printing 1980.

[77] Department of Water Resources. *South Lahontan Hydrologic Region – Middle Amargosa Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-20.pdf.

[78] Designated Groundwater Basins of Nevada Map. Department of Conservation and Natural Resources, September 2013, http://water.nv.gov/mapping/maps/designated_basinmap.pdf

Groundwater levels have remained relatively stable over the last 45 years. Near Death Valley Junction in the north-central part of the basin, the character of the groundwater is sodium bicarbonate, while at the north end of the basin the character is largely sodium bicarbonate-sulfate. In general, the groundwater in the Middle Amargosa Basin is rated inferior to marginal for domestic and irrigation uses primarily because of elevated levels of fluoride and boron[79].

Based upon federal database records research (EDR 3813626.16s, **Appendix B**), and available USGS topographic maps (**Appendix E**), four wells are present to the east in Nevada. The closest well is approximately 4.4 miles from the site. The wells appear to be used for irrigation in the Amargosa Desert. No natural springs or nationally recognized wetlands are within 4 miles of the site. No residences are found within 200 yards, and groundwater is not used as a drinking water source.

Groundwater does not appear to be a likely transport mechanism for potential waste constituents from the site. The surrounding mineralized metamorphic bedrock contains ores of copper, gold, silver, lead, and zinc, and potential impacts to groundwater are anticipated to predominantly derive from these natural sources. Only a very minor cumulative contribution is expected from the historic mining and milling operations, including those sites evaluated in this PA.

10.3.2 Surface Water

Headwaters at the site are generated approximately 2.4 miles upstream from precipitation. Runoff from precipitation is channeled through an unnamed canyon in the wash approximately adjacent to standing wooden mill structure. Surface waters in this area flow on a broad, flat, wash bottom indicating low intermittent surface flow to the north out onto the alluvial fan plain. Surface water then flows northeast and then trends southeast until flow reaches the ephemeral portion of the Amargosa River 6.4 miles downstream (**Appendix E**). The drainages that feed into the flat wash are ephemeral and experience very little surficial flow with an estimated precipitation rate of 3 to 6 inches of rainfall per year[80].

The nearest community is Amargosa Valley, Nevada, located 3 miles to the east. There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site, and because of the arid climate and rapid infiltration rate, transport of waterborne waste constituents significant distance off site is unlikely.

10.3.3 Soil, Sediment, and Air

Gold Grotto Mine and Mill is located at the base of a northwest-facing hillside on a wide flat drainage outwash. Though the site is beside a Pleistocene alluvial deposit (which is considered bouldery, cobbly, with finer-grained material of assorted lithology), it is located on bedrock. No classified soil type is identified and the site is documented to be on unweathered bedrock. As a result, a very slow infiltration rate is expected and no identified drainage class (EDR 3813626.16s, **Appendix B**). The adjacent Quaternary-aged alluvial deposit may be more conducive to infiltration and groundwater underflow.

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[79] Department of Water Resources. South Lahontan Hydrologic Region – Middle Amargosa Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-20.pdf.

[80] Department of Water Resources. *South Lahontan Hydrologic Region – Middle Amargosa Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-20.pdf.

Gold Grotto Mill's operation generated pinkish coarse- to fine-grained tailings, which are localized and partly consolidated near the former mill. Mill ruins and native material partially overlie the exposed tailings (**Figure 10-2**). No vegetation is covering the tailings; however, sparse vegetation stressed by drought is observed up- and downgradient. The exposed tailings do not appear to be migrating downslope, and are partially held in place by the mill ruins and eroded alluvium. The site is accessed by a gravel road. Due to the small footprint and stability of the tailings, the tailings do not appear to migrate across the road.

Mine waste or unprocessed ore observed on site is limited to the immediate area around the footings of the mill. The mine waste is coarse-grained sand to gravel and does not appear to be migrating downslope. Windborne particulates are considered likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, and access roads near tailings.

10.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Gold Grotto Mine and Mill is a destination for four-wheel drive enthusiasts. The site is visited by approximately 200 people per year and park staff and contractors may visit and work at the site. A recent fire ring was observed on the tailings (**Photo C8-8**). Potentially endangered or threatened species have been identified in the vicinity of the site (EDR 3813626.7s, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B.**

Gold Grotto Mine and Mill has been assessed using site-specific CSMs. Based on the operational history of the mill and March 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from potential cyanide leaching and mercury amalgamation processes to extract gold. Preliminary COCs at the site include cyanide and metals. Additionally, the site was evaluated using the EPA HRS using the information gathered in the PA. Gold Grotto Mine and Mill was given an overall score of 0.69 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 10-1** and sensitive ecological receptor pathways are presented in **Table 10-2**. For explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 10-1: Gold Grotto Mine and Mill: Human Exposure Pathway

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	I P	I P
		Dermal	I P	I P
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 10-2: Gold Grotto Mine and Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

10.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. There is no evidence of shallow groundwater at this site; therefore, the pathway is incomplete for human exposure. Surface water was not observed at the site and is only present during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the mercury and/or cyanide processing areas to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places or have been proposed for consideration will require consultation with SHPO prior to implementation of additional site inspection activities.

11.0 BROKEN PICK MILL (SITE #9)

The PA inspection of the Broken Pick Mill was conducted on March 9, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C9**. **Figure 11-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill, cyanide processing area, and extent of tailings. Site features are depicted on **Figure 11-2** and include:

- Mill location,
- Surface drainages,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

11.1 SITE DESCRIPTION

Broken Pick Mill is located 14 miles southwest of Furnace Creek, California, in Trail Canyon (Latitude 36.31727°, Longitude -117.04495°) at an elevation of approximately 3,600 feet above sea level. This site is accessed at the end of a rough four- wheel drive road approximately 9.5 miles from the junction of West Side Road and Trail Canyon Road. The mines connected with the Broken Pick Mill (also known as the Tarantula Mill) are located approximately one mile west. This is a popular site for visitors who enjoy four-wheel drive roads and the site is visited by approximately 1,000 people per year. The site lies on several low hills and ridges in the trail canyon. The canyon winds through the steep eastern front of the Panamint Mountain Range and water, when present, drains to the east into Death Valley. The closest habited area is in Furnace Creek approximately 14 miles northeast of the site. The site location and site features are shown on **Figures 11-1** and **11-2** and site photographs are shown **in Appendix C9.**

11.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

The structures around the mill camp date from the 1930s to the 1960s, though the dates of mill operation are unknown. There are tailings at the base of the mill. The tailings are located at several locations around the site. The largest accumulation of mill tailings is located northeast of the main cabin at the top of a slope. Mill ruins remain at this location (**Photo C9-9**). The estimated volume of tailings on site is approximately 10 cubic yards. Tailings have also accumulated in a drainage channel than crosses the site in the canyon floor. The tailings in the wash have collected behind impoundment dams at three separate locations in the wash and each dam contains approximately 2 to 10 cubic yards of tailings. Mill tailings have also accumulated in a drainage wash in the northeast area of the site. The mill tailings in the drainage wash are light pink to orange color and consist of fine grain material and approximately 20 to 40 cubic yards of tailings have accumulated at this location. Based on the operational history and results gathered during this PA, the preliminary COCs for the site are cyanide and metals.

11.3 ENVIRONMENTAL SETTING

11.3.1 Geology and Hydrogeology

Geological Setting

The Broken Pick Mill is located near the western boundary of the Panamint Range northeast of Wildrose Peak (**Figure 1**). The Cottonwood Mountains and Harrisburg Flats lay to the northwest. Tucki Mountain is to the north and Death Valley is to the east of the site (**Appendix E**). The mill is situated on Precambrian to Cambrian-aged Johnnie Formation (**Figure 2**), described as purple, red, and green fissile shale; interbedded quartzite; olive-brown shale; yellow silicified dolomite; thin interbedded dolomite with sandstone and quartzite; siltstone; and pebble conglomerate[81].

Groundwater

The site is located in the eastern Panamint Range and groundwater flows into the western side of the Death Valley Groundwater Basin in the South Lahontan HR of California[82] (**Section 1.2**). Groundwater flow direction generally follows surface flow, depicted on **Figure 11-2**. Based on topographic surface, groundwater flows to the northeast towards a wetland and then out through the mouth of Trail Canyon into Death Valley Groundwater Basin. Recharge of the groundwater basin is from surface runoff, derived from occasional rainstorms and flash floods in the surrounding mountains.

Based upon federal database records research (EDR 3813626.18s, **Appendix B**) and available USGS topographic maps (**Appendix E**), there are no wells within 4 miles of the site. At Furnace Creek Ranch (approximately 13.8 miles northeast and upgradient of the site), the Pliocene to Pleistocene-aged Funeral Formation is tapped by several wells as a source of water. No residences are found within 200 yards, and groundwater is not used as a drinking water source.

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[81] R. Streitz and M. Stinson, California Division of Mines and Geology, *Geologic Map of California, Death Valley Sheet*. 1974, Second Printing 1980.

[82]D Capoartment of Water Resources. South Lahontan Hydrologic Region – Death Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

Several natural springs occur in this area indicating shallow groundwater may be present locally. Three upgradient springs are shown on the USGS topographic map approximately 2.25 miles from the mill site up Trail Canyon, and three additional springs are located approximately 1 mile upstream on the South Fork of Trail Canyon (see Morning Glory Mill) (**Appendix E**). The South Fork of Trail Canyon enters the main Trail Canyon channel at the site. These springs do not appear hydraulically connected with the site. However, a nationally recognized wetland extends down trail canyon beginning approximately 0.25 mile from the site at the confluence of Trail Canyon and the South Fork (EDR 3813626.18s**, Appendix B**).

Groundwater does not appear to be a likely transport mechanism for potential waste constituents from the site. The surrounding mineralized metamorphic bedrock contains ores of copper, gold, silver, lead, and zinc. Potential impacts to groundwater are anticipated to predominantly derive from these natural sources. However, the proximity of the downstream wetland (**Figure 11-2**) and the likelihood of shallow groundwater indicate a potential for groundwater transport of site waste materials.

11.3.2 Surface Water

Surface water reaching the site appears to be generated from infrequent heavy precipitation. Runoff is generated along the crests of the canyon walls and upstream elevations approximately 3.25 miles to the surface water divide. The watershed contains several side drainages. Surface water flow during rainfall events would include sheet flow down the canyon walls and channeled flow from the upstream portion of the site drainage west and southwest of the site. Surface flow continues east, downstream approximately 3.75 miles until it empties into the alluvial fan on the east side of Death Valley. If sufficient surface water is present it would empty into Salt Creek or the northern end of the Badwater Basin (**Appendix E**). Drainages are ephemeral with very little surficial flow[83].

Morning Glory Mill (Site #10) is located approximately 1 mile upstream. Sediments from naturally mineralized areas upstream or the mill site could comingle with tailings from the milling operation at Broken Pick. There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site, but a nationally recognized wetland is located down gradient within ¼-mile of the site. There is high potential for surface water to carry waste materials into this area and become deposited in the downgradient wetland.

11.3.3 Soil, Sediment, and Air

Ruins of the milling operation are located on a bench on the northwest fork of Trail Canyon. Bedrock is exposed at the site; however, the floor of the bench has accumulated alluvial sediments from silts to gravel. Bedrock depths vary from surface to greater than 20 inches bgs, indicating that although the upper surficial soils are well drained, the overall soil has a very slow infiltration rate. Though thin in some areas, the surficial soil is named the Theriot soil component with an upper 3 inches classified as silty gravel (EDR 3813626.18s, **Appendix B**).

Operation of the Broken Pick Mill generated silt-sized light pink to orange-pink tailings (**Appendix D**). Tailings were present at least five locations around the site. Tailings are located near the main cabin, several small impoundments along the drainage at the base of the mill ruins for approximately 270 feet, a small mound near a potential processing area, and as scattered deposits in the mill area with small disturbed areas mixed with native sediments (**Figure 11-2**). Access roads in the area also cross tailing paths and dispersed tailings near the mill itself.

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[83] Department of Water Resources. *South Lahontan Hydrologic Region – Death Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

Morning Glory Mill is located 1 mile south and upgradient of Broken Pick Mill along the South Fork tributary. Mine waste and tailings from the Morning Glory Mill could comingle below the confluence of the South Fork and Trail Canyon and in the wetland less than 0.26 mile downgradient. Windborne particulates are considered highly likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, access roads mixed with tailings, and the disbursement of tailings throughout the canyon and washout plain.

11.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Broken Pick is a popular destination for four-wheel drive enthusiasts. The site is visited by approximately 1,000 people per year and park staff and contractors may visit and work at the site. Potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.17s, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B.**

Broken Pick has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the March 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from cyanide leaching to extract gold. Preliminary COCs at the site included cyanide and metals. Additionally, the site was evaluated using the EPA HRS from the information gathered in the PA. Broken Pick Mill was given an overall score of 0.67 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 11-1** and sensitive ecological receptor pathways are presented in **Table 11-2**. For explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 11-1: Broken Pick Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	I P	I P
		Dermal	I P	I P
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	P *I*	P *I*
		Dermal	P *I*	P *I*
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 11-2: Broken Pick Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population: Aquatic – Benthics	Exposed Population: Aquatic – Native Fish	Exposed Population: Terrestrial Receptors – Plants	Exposed Population: Terrestrial Receptors – Soil Organisms	Exposed Population: Birds and Mammals – Upland	Exposed Population: Reptiles
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	*P I*	*P I*	*P I*	*P I*
		Direct Contact	I P	I P	*P I*	*P I*	*P I*	*P I*
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

11.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. There is evidence of shallow groundwater at this site due to the presence of upgradient springs; however, there are no wells or downgradient springs to provide a pathway to groundwater. The groundwater pathway is considered incomplete for human and ecological exposure. Although surface water was not observed at the site and is only present during runoff from infrequent precipitation events, there is a wetlands that is sourced by springs located in the South Fork of Trail Canyon downstream of the site where the tributary enters the Trail Canyon channel. Runoff from the site could result in an insignificant exposure to surface water for human and ecological receptors. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the cyanide processing areas to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places or have been proposed for consideration will require consultation with SHPO prior to implementation of additional site inspection activities.

12.0 MORNING GLORY MILL (SITE #10)

The PA inspection of Morning Glory Mill was conducted on March 9, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C10**. **Figure 12-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill, cyanide processing area, and extent of tailings Site features are depicted on **Figure 12-2** and include:

- Mill location,
- Surface drainages,
- Dissected wash,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

12.1 SITE DESCRIPTION

Morning Glory Mill is located 15 miles southwest of Furnace Creek, California, in the south fork of Trail Canyon Road (Latitude 36.30281°, Longitude -117.04834°) at an elevation of approximately 4286, feet above sea level. This site is accessed at the end of a rough four-wheel drive road approximately 11 miles from the junction of West Side Road and Trail Canyon Road. Morning Glory mine is located one mile southwest of Broken Pick mill. This site is popular for visitors who enjoy four-wheel drive roads and the site is visited by approximately 1,000 people per year. The site covers an area of approximately 3 acres located at the base of a canyon that winds through the steep eastern front of the Panamint Mountain Range. During rain events water drains to the north then east into Death Valley. The closest residents are in Furnace Creek approximately 14 miles northeast of the site. **Figure 12-1** shows the site location and **Figure 12-2** shows site features and drainage direction of runoff water during rain events. Site photographs taken during the site inspection are included in **Appendix C10.**

12.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

Little information exists on the history of this mill, though most of the artifacts and structures at the camp appear to date from the 1930s through the 1960s. Mining equipment and structures found on site include a metal ore bin (**Photograph C10-3**), cyanide tanks, wood and metal debris, a drum with four pipe outlets (**Photograph C10-5)** and cabin ruins. Mill tailings have accumulated around the mill ruins and the cyanide tanks. Tailings are a pinkish color silty material. The estimated total volume of tailings on site is approximately 200 cubic yards and approximately 150 cubic yards of the tailings have been washed approximately 50 feet down slope of the process area. Based on the operational history and results gathered during the PA, the preliminary COCs for the site are cyanide and metals.

12.3 ENVIRONMENTAL SETTING

12.3.1 Geology and Hydrogeology

Geological Setting

The Morning Glory Mill site is located near the western boundary of the Panamint Range northeast of Wildrose Peak **(Figure 1**). The Cottonwood Mountains and Harrisburg Flats lay to the northwest. Tucki Mountain is to the north and Death Valley is to the east of the site (**Appendix E**). The mill is situated on Precambrian to Cambrian-aged marine sedimentary and metasedimentary rocks of the Johnnie Formation (**Figure 2**), described as purple, red, and green fissile shale; interbedded quartzite; olive-brown shale; yellow silicified dolomite; thin interbedded dolomite with sandstone and quartzite; siltstone; and pebble conglomerate[84].

Groundwater

The site is located in the eastern Panamint Range and groundwater flows into the western side of the Death Valley Groundwater Basin in the South Lahontan HR of California[85] (**Section 1.2)**. Ruins of the milling operation are located on a bench on the southeast side of the South Fork of Trail Canyon drainage. Groundwater flow direction generally follows surface water flow, depicted on **Figure 12-2.** Based on the topographic surface, groundwater flows north and down the South Fork of Trail Canyon until reaching the confluence with Trail Canyon. Groundwater proceeds out the mouth of Trail Canyon into the Death Valley Groundwater Basin. Recharge of the groundwater basin is from surface runoff, derived from occasional rainstorms and flash floods in the surrounding mountains.

Based upon federal database records research (EDR 3813626.18s, **Appendix B**) and available USGS topographic maps (**Appendix E**), there are no wells within 4 miles of the site. The nearest residential wells are at Furnace Creek Ranch (approximately 14.3 miles northeast and upgradient of the site) is tapped by several wells as a source of water within the Pliocene to Pleistocene-aged Funeral Formation. No residences are found within 200 yards, and groundwater is not used as a drinking water source.

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[84] U.S. Department of the interior, Geological Survey. *Geologic Map and Sections of the Bullfrog Quadrangle, Nevada-California.* Geology by H.R. Corwall and F.J. Kleinhampl, 1956-1960.

[85] Department of Water Resources. South Lahontan Hydrologic Region – Death Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf

Several natural springs occur in this area within 350 feet on the northwest-facing hillside, indicating shallow groundwater may be present locally (**Figure 12-2**). Two upgradient springs, shown on the USGS topographic map, are classified as nationally recognized wetlands. The wetlands and springs are upgradient of the site along the hillside. These do not appear to be perennial or produce a significant amount of water. Additionally, 1.7 miles west, in Trail Canyon, is another spring, but it does not appear hydraulically connected to the site due to the large ridge between the two areas. Moreover, the springs and wetlands associated with Morning Glory Mill do not appear directly hydraulically connected with any other site (i.e., Broken Pick Mill located downstream). However, a nationally recognized wetland extends down trail canyon beginning approximately 1.25-mile from the site at the confluence of Trail Canyon and the South Fork (EDR 3813626.20s, **Appendix B**).

The surrounding mineralized metamorphic bedrock contains ores of copper, gold, silver, lead, and zinc, and potential impacts to groundwater are anticipated to predominantly derive from these natural sources. However, the proximity of the upstream and downstream wetlands (**Figure 12-2**) and the likelihood of shallow groundwater indicate a potential for groundwater transport of site waste materials.

12.3.2 Surface Water

The springs located above the site do not appear to provide sufficient volume to generate surface flow at the site (**Figure 12-2**). Surface water reaching the site appears to be generated from infrequent heavy precipitation. Runoff generated from precipitation forms along the crests of the canyon walls and upstream approximately 2.6 miles to the surface water divide and the northeast face of Wildrose Peak. The watershed contains numerous smaller drainage channels. Surface water flow during rainfall events would include sheet flow down the canyon walls and channeled flow from the upstream portion of the site drainage primarily southwest of the site. Surface flow continues north 1.25 miles to main channel of Trail Canyon, then east, downstream approximately 3.75 miles until it washes into the alluvial fan on the east side of Death Valley. If sufficient surface water is present it would empty into Salt Creek or the northern end of the Badwater Basin (**Appendix E**). Drainages are ephemeral and see very little surficial flow[86].

Broken Pick Mill (Site #9) is located approximately 1 mile downstream. Sediments from naturally mineralized areas upstream or the Broken Pick Mill site could comingle with tailings from the milling operation at Morning Glory Mill. There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site, but a nationally recognized wetland is located downgradient within 1.25-mile of the site and immediately upgradient and adjacent to the site. There is high potential for surface water to carry waste materials into this area and become deposited in the downgradient wetland.

12.3.3 Soil, Sediment, and Air

Bedrock is exposed in the canyon walls on both sides and at the site. The floor of the bench has accumulated alluvial sediments from silt to gravels. Bedrock depths vary from surface to greater than 20 inches bgs, indicating that although the upper surficial soils are well drained, the overall soil has a very slow infiltration rate. Though thin in some areas, the surficial soil is identified as the Theriot soil component with an upper 3 inches classified as silty gravel (EDR 3813626.20s, **Appendix B**).

Historical operations at the Morning Glory Mill generated silt to clay-sized pink tailings (**Figure 12-2**). Fine-grained tailings are scattered among the mill ruins and within the wash. Tailings extend from the footings of the mill for approximately 300 feet but are bound by a small ridge running parallel to the

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[86] Department of Water Resources. *South Lahontan Hydrologic Region – Death Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

wash (**Appendix D**). Vegetation is apparent and grows within many of the tailings areas, thereby covering the tailings and slowing wind and water transport. Tailings associated with piles may be more susceptible to wind transport than disbursed tailings mixed with native material. Tailing deposits, including disbursed tailings near the mill, impact access roads in the area.

Mine waste is spread throughout the site and is bluish-gray to rusty brown-colored coarse-grained sand to gravel. Mine waste appears to be stable and not migrating downslope. Mine waste is found on the periphery of the small wash.

Broken Pick Mill is located 1 mile north and downgradient of Morning Glory Mill at the confluence of the Trail Canyon and South Fork tributary. Mine waste and/or tailings from the Broken Pick Mill could comingle below the confluence of the South Fork and Trail Canyon and in the wetland less than 0.25 mile downgradient. Windborne particulates are considered highly likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, access roads mixed with tailings, and the disbursement of tailings throughout the canyon and washout plain.

12.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Morning Glory is visited by approximately 1,000, people per year. Park staff and contractors may visit and work at the site, as well. Potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.19s, **Appendix B**). There are two national wetland areas within 0.25 from the site (EDR 3813626.20s, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B**.

Morning Glory Mill has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the March 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from cyanide leaching to extract gold. Preliminary COCs at the site include cyanide and metals. Additionally, the site was evaluated using the EPA HRS using the information gathered during the PA. Morning Glory Mill was given an overall score of 0.67 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 12-1** and sensitive ecological receptor pathways are presented in **Table 12-2**. For explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 12-1: Morning Glory Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	*I* P	*I* P
		Dermal	*I* P	*I* P

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	P *I*	P *I*
		Dermal	P *I*	P *I*
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 12-2: Morning Glory Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	P *I*	P *I*	P *I*	P *I*
		Direct Contact	I P	I P	P *I*	P *I*	P *I*	P *I*
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

12.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, groundwater, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. There is evidence of shallow groundwater at this site due to the presence of upgradient springs; however, there are no wells or downgradient springs to provide a pathway to groundwater. The groundwater pathway is incomplete for human exposure. Although surface water was not observed at the site and is only present during runoff from infrequent precipitation events, there is a wetlands that is sourced by springs located in the South Fork of Trail Canyon located downstream of the site where the tributary enters the Trail Canyon channel. Runoff from the site could result in an insignificant exposure to surface water for human and ecological receptors. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors and potentially endangered species of the Nelson’s Big Horn Sheep within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to cyanide and metals analytical data for tailings and adjacent soil from the cyanide processing area to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals.

13.0 QUEEN OF SHEBA MINE AND MILL (SITE #11)

The PA inspection of the Queen of Sheba site was conducted on February 16, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C11**. **Figure 13-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill and mine, possible cyanide processing area, and extent of tailings. Site features are depicted on **Figure 13-2** and include:

- Mill and mine locations,
- Surface drainage,
- Dissected wash,
- Surface flow direction,
- Location of the salt well,
- Storage tanks,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

13.1 SITE DESCRIPTION

Queen of Sheba Mine and Mill is located 32 miles south of Furnace Creek, California on the east side of Panamint Mountains (Latitude 36.11992°, Longitude -116.88559°) at elevations between 800 to 1,200 feet above sea level. The site is accessed via a 10 mile graded dirt road, followed by a rough four mile four-wheel drive road. The mine and mill area are located at the top of steep alluvial fan and covers an area of approximately 50 acres. The closest residents are in Furnace Creek. There is one downgradient groundwater well ("Salt Well") located near the intersection West Side Road and the access road leading to the site and there are two water storage tanks near the well (**Figure 13-1, Photo C11-1).** The well contains non-potable salt water which was used to operate the mill.

13.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

The Queen of Sheba Historic District has been nominated for the National Register of Historic Places. The Queen of Sheba mine is located approximately 1,500 feet southwest of the Carbonate Mine. The Carbonate Mine was discovered in 1907 when a large out crop of galena was uncovered at the site[87]. The Carbonate Mine was discovered before the Queen of Sheba mine and it was probably named for the type of ore found in the mine which was lead carbonate with silver[88]. Queen of Sheba mine was discovered during exploratory mining of the Carbonate Mine and both mines were in the same ore zone and were actually one extensive mining operation. Queen of Sheba mine operations began in 1924, and a flotation mill was installed in 1948 and possibly also used cyanide processing. Work at the site continued into the 1960s, though the mill ceased operation by then. Remains on site include four concrete foundations pads, an ore bin, wood and metal debris and a crushed steel tank.

Mill tailings are located near the ore loading area and around the mill foundations. The mill tailings have migrated approximately 2,000 feet down slope of the mill foundation. The majority of tailings remain in a small area beneath a collapsed equipment tower and in two impoundments. The mill tailings are pink silty sand material with a total estimated volume of 1,000 cubic yards. Based on the operational history and results gathered during this PA, the preliminary COCs are cyanide and metals, especially lead and copper.

13.3 ENVIRONMENTAL SETTING

13.3.1 Geology and Hydrology

Geology

Queen of Sheba Mine and Mill is located on the southwest portion of the Panamint Range immediately adjacent to Death Valley to the east (**Figure 1**). The site is north of Owlshead Mountains and west of the Black Mountains. Pointer Peak is to the northwest and Panamint Valley is to the west (**Appendix E)**. The site is situated on Cambrian-Precambrian-aged marine sedimentary and metasedimentary bedrock of the Johnnie Formation (**Figure 2**). The Johnnie Formation is characterized by sandy dolomite, quartzite, shale, siltstone, and sandstone[89]. The mill is located at the base of a northeast-facing hillside.

Groundwater

The site groundwater flows into the South Lahontan HR, Death Valley Groundwater Basin[90] (**Section 1.2**). If present, groundwater flow direction generally follows surface flow direction, as depicted on **Figure 13-2**. Based on the topographic surface, groundwater flows through the surrounding alluvial fans directly into the Death Valley Groundwater Basin to the northeast. Recharge of the groundwater

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87 http://www.nps.gov/history/history/online_books/deva/section3a12.htm

88 A History of Mining in Death Valley National Monument, Volume I of II Part 1 of 2, by Linda w. Greene, March 1981.

89 R. Streitz and M. Stinson, California Division of Mines and Geology, Geologic Map of California, Trona Sheet 1962, Second Printing 1978.

90 Department of Water Resources. *South Lahontan Hydrologic Region – Death Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

basin is from surface runoff, derived from occasional rainstorms and flash floods in the surrounding mountains.

The nearest downgradient well to the Queen of Sheba Mine and Mill is Salt Well located 3.8 miles northeast. The wells identified on the USGS topographic map are likely not used for domestic use due to the water quality characteristics. The nearest populated community is Furnace Creek Ranch (approximately 31.4 miles north of the site); the Pliocene to Pleistocene-aged Funeral Formation is tapped by several wells as a source of water. However, Furnace Creek is considered upgradient because the Badwater Depression is -282 feet below sea level and surface and groundwater appear to accumulate in this area. No residences are found within 200 yards, and groundwater is not used as a drinking water source.

Based upon federal database records research (**Appendix B**) and available USGS topographic maps (**Appendix E**), there are no nationally recognized wetlands within 4 miles of the site. Warm Spring and associated seeps are located 3.1 miles southwest of the Site; however, these springs are cross- and upgradient and a mountain exists between the site and springs, and so they are not believed to be hydraulically connected. Salt Well is the nearest well and within 4 miles. However, this well is not presently active and non-potable; therefore, no impacts are anticipated to drinking water. Only a very minor cumulative mineral contribution is expected from the historic mining and milling operations, including those sites evaluated in this PA.

13.3.2 Surface Water

Runoff is formed from infrequent heavy precipitation events with some sheet flow generated in the narrow canyon on the northern side of the hillside. Drainage at the base of the hillside is redirected by a deeper wash that transports surface water to the north (**Figure 13-2**). Surface water flows into the drainage for 710 feet then northeast onto the alluvial out wash plain. Water velocity during infrequent flooding appears to be significant as observed by cut banks and erosion surfaces. Surface water then travels northeast for 5 miles to the Amargosa River which then flows north to Badwater Basin (**Appendix E**). Overland drainage from the site rapidly infiltrates the soil matrix or evaporates into the atmosphere. Drainages are ephemeral and see very little surficial flow[91].

The nearest site is Gold Hill Mill, which is located 3.3 miles southwest and cross-gradient. This site is not hydraulically connected, due to the presence of several canyons and washes. Surface water from each site may coalesce downstream approximately 5.1 miles northeast. There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site; however, the Amargosa River which locally flows ephemerally is located 5 miles northeast and downgradient. Therefore, the potential exists for ephemeral, intermittent surface water to be impacted by mill waste material.

13.3.3 Soil, Sediment, and Air

The site is adjacent to Quaternary alluvium that makes up the ravine and outwash below the site. The site has accumulated a thin surficial layer of alluvial sediments that range from sands to gravel. However, this site does not have a classified soil type and is documented to be on unweathered bedrock. This indicates a very slow infiltration rate and no drainage class (EDR 4038102.2s, **Appendix B**).

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[91] Department of Water Resources. *South Lahontan Hydrologic Region – Death Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

Pinkish fine sand and silt mill tailings were observed near the foundations of the mill structures (e.g., ore loading shoots and bins) and eroding downgradient along the cut banks of the drainage (**Figure 13-2**). Rock dams were constructed at the base of the mill and have approximately 30-foot- diameter dry ponds containing tailings. The rock dams and dry pond tailings have since been eroded through. Within the wash tailings were observed approximately 2,000 feet downstream and then are no longer visible due to mixing with native sediments from other washouts (**Appendix D**).

Vegetation at Queen of Sheba Mill is very sparse and drought stressed. If the tailings continue to erode downslope, they will eventually come into contact with the Amargosa River, which flows ephemerally. The fine-grained tailings are exposed without native sediment or significant vegetation cover. Tailings were observed near the road, therefore, vehicular traffic to this destination may increase airborne particulates of the tailings. Windborne particulates are considered likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, and access roads near tailings.

13.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Queen of Sheba Mine is in a remote area difficult to access. While park staff and contractors may visit and work at the site, fewer than 50 visitors explore the ruins each year. Potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 4038102.5s, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B.**

Queen of Sheba mine has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the February 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from possible cyanide leaching processes. Additionally, the site was evaluated using the EPA HRS using the information provided in this report. Queen of Sheba was given an overall score of 0.38 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 13-1** and sensitive ecological receptor pathways are presented in **Table 13-2**. For site specific explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 13-1: Queen of Sheba Mine and Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	*P I*	*P I*
		Dermal	*P I*	*P I*
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 13-2: Queen of Sheba Mine and Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

13.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, groundwater, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. There is evidence of shallow groundwater at this site; however, the exposure is considered insignificant for human receptors because the groundwater is non-potable saline. Surface water was not observed at the site and is only present during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, potentially endangered or threatened species, and visitors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data, especially lead and copper, for tailings and adjacent soil from the lead and silver processing areas to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places or have been proposed for consideration will require consultation with SHPO prior to implementation of additional site inspection activities.

14.0 ASHFORD MILL (SITE #12)

The PA inspection of the Ashford Mill site was conducted on February 15, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C12**. **Figure 14-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill, processing area, and extent of tailings. Site features are depicted on **Figure 14-2** and include:

- Mill location,
- Surface drainage,
- Dissected wash,
- Surface flow direction,
- Extent of tailings,
- Location of FEMA 100-year flood zone,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

14.1 SITE DESCRIPTION

Ashford mill is located inside the wilderness boundary on the gentle slope of Wingate Wash at an elevation of 119 feet below sea level (EDR, 3813626.24, **Appendix B**). The site is accessed via a 1/8-mile well-graded gravel road with access signage off Highway 178 near the Jubilee Pass Entrance to Death Valley. Ashford Mill and process area are located on an open flat area adjacent to a very small hill.

The site is characterized by very gentle slopes on low rolling 20-foot high hills and flat ground. The mill and extent of the mill tailings cover less than one acre. The site has a set of mill foundations on the edge of the hill and the ruins of a small building approximately 100 feet to the south above the flat, broad junction of Wingate Wash and The Narrows. The site attracts about 7,000 visitors per year. Photographs of the site are show in **Appendix C12** and **Figures 14-1** and **14-2** show the site location and site features.

14.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

Historic records indicate operations at the mill included mostly mechanical type processing. The mill processed gold ore from the Ashford Mine (3.5 miles to the northeast) from 1914-1915. Fine-grained pink tailings have been washed down from the mill operations and are predominantly in a bowl shaped deposit, approximately 50 feet in diameter and 50 to 100 feet from the base of the mill ruins. The deposit is up to 3 feet high and is about 50 cubic yards. The mill tailings are being covered by native vegetation and windblown deposits, which aid in protecting the tailings from wind erosion and human interaction. An additional 20 cubic yards are present in the vicinity of the foundation ruins. These mill tailings are less than 500 feet from parking, access road, restrooms and information signs. The closest resident population is in Furnace Creek, approximately 38 miles away. Based on the operational history and results gathered during this PA, the preliminary COCs at the site are cyanide and metals.

14.3 ENVIRONMENTAL SETTING

14.3.1 Geology and Hydrology

Geological Setting

The Ashford Mill site is located in a portion of Death Valley called The Narrows. This area is between the Black Mountains to the northeast and the Owlshead Mountains to the southwest (**Figure 1, Appendix E**). The site is situated upon Pliocene volcanic basalt flow rocks within the Ricardo Formation and Funeral Fanglomerate (**Figure 2**)[92]. The Black Mountains and Amargosa Thrust Fault lie to the northeast, the Shore line Butte is to the southwest, and Confidence Hills (trending northwest to southeast) is to the south, and the outwash plain from Wingate Wash is to the west. The Death Valley Fault Zone trends northwest to southeast and is expressed less than 1/8-mile southeast (**Appendix E**).

Groundwater

The site groundwater flows north into the South Lahontan HR, Death Valley Groundwater Basin in the state of California[93] (**Section 1.2**). Groundwater flow direction generally follows surface flow, depicted on **Figure 14-2**. Based on the topographic surface, groundwater flow is to the northwest in this area. Recharge of the groundwater basin is from surface runoff, derived from occasional rainstorms and flash floods in the surrounding mountains.

The nearest upgradient well is Ashford Well (dry) is located 2 miles southeast and located in Jubilee Wash. The nearest downgradient well to the Ashford Mill is Salt Well located 11.1 miles northeast. The well identified on the USGS topographic map is likely not used for domestic use due to the water characteristics. No active groundwater wells are present within the 4.0-mile target distance; therefore,

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92 R. Streitz and M. Stinson, California Division of Mines and Geology, *Geologic Map of California, Death Valley Sheet*. 1974, Second Printing 1980.

93 Department of Water Resources. *South Lahontan Hydrologic Region – Death Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

no impacts are anticipated to drinking water. No residences are found within 200 yards, and groundwater is not used as a drinking water source.

Scotty's Spring and Timpapah Spring are located up Scottys Canyon, at distances of 4.2 and 4.6 miles northeast and upgradient. Although the springs are not directly hydraulically connected, if seepage from surface flow is generated, there is a potential for drainage to wash through the site. Based upon federal database records research (EDR 3813626.24s, **Appendix B**) and available USGS topographic maps (**Appendix E),** there are no nationally recognized wetlands within 4 miles of the site. Only a very minor cumulative mineral contribution of excess minerals is expected from the historic milling operations.

14.3.2 Surface Water

Surface water at the site is generated from infrequent heavy precipitation events. Runoff is composed of sheet flow off of the basalt outcrop above the Death Valley basin, flow from the vicinity of the outcrop, and flow from the headwaters, unknown canyon washes, and higher elevations up Ashford Canyon approximately 2.8 miles northeast of Ashton Mine. Surface water flow from precipitation would include sheet flow over the portions of the site at relatively higher elevation and channeled flow around the outcrop for 0.3 miles toward the Amargosa River, 1,300 feet south (**Figure 14-2**). Excess surface water would flow toward the playa lake depression north at Badwater (**Appendix E**).

Due to the proximity of the Amargosa River, a 100-year flood plain was identified 650 feet southwest (**Figure 14-2**). Drainages are ephemeral and see very little surficial flow with an estimated precipitation rate of one to 4 inches of rainfall per year in the central and southern portions of the Death Valley Basin[94]. Overland drainage from the site rapidly infiltrates the soil matrix or evaporates into the atmosphere.

There are no upstream sites within the vicinity; however, downstream surface water will converge with runoff from Gold Hill Mill and Queen of Sheba approximately 15 miles north-northwest downstream of Amargosa River. There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site.

14.3.3 Soil, Sediment, and Air

A portion of the site lies on Quaternary alluvium surrounding the Amargosa River and basalt outcrop. The site is located below sea level and has accumulated Quaternary sediment accumulation greater than 60 inches thick, which appear to be sands and gravels derived from weathering and alluvial migration. The site is considered to have high infiltration rates and soil class is determined to be excessively drained and has been identified as a Carrizo soil component (EDR 3813626.24s, **Appendix B**).

Fine-grained pinkish tailings were observed near the foundation of the mill structure, and a bermed structure, located approximately 50 to 100 feet west on a flat part of The Narrows (**Figure 14-2**). Tailings appear to be well covered by native sediments and desert vegetation and are not migrating (**Appendix D**). If the tailings become loose and begin to erode downslope, they will eventually come into contact with the Amargosa River, which flows ephemerally near the site. Therefore, the potential exists for ephemeral, intermittent surface water to be impacted by metals contamination associated with mercury amalgamation extraction. Releases to air from suspension of contaminated particulates derived from surface soil and exposed sediment can occur. Tailings were not observed near roads;

94 Department of Water Resources. *South Lahontan Hydrologic Region – Death Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

therefore, vehicular traffic to this destination is not a concern for airborne particulates of the tailings. Windborne particulates are considered unlikely due to the native sediments and vegetation covering tailings creating a locking-effect.

If heavy floods or rainfalls occur creating rills at the site, sediments may eventually migrate 650 feet southwest and be captured by the Amargosa River. Tailings moved during storm events that may be potentially deposited on farther downstream and may leach potential contaminants into groundwater in the valley or be deposited along stream beds.

14.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Currently the mill area is open to the public with an estimated 7,000 visitors per year. Park staff and contractors may also visit and work at the site. Potentially endangered or threatened species or sensitive environments have not been identified in the vicinity of the site (EDR, 3813626.23s, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B.**

Ashford Mill has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the February 2014 site visit, assessment of environmental hazards focuses on the mill tailings impacted by mercury amalgamation processes to extract gold. Preliminary COCs at the site include cyanide and metals. Additionally, the site was evaluated using the EPA HRS from information gathered in the PA. The site was given a score of 0.23 (**Table 3**). HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 14-1** and sensitive ecological receptor pathways are presented in **Table 14-2**. For explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 14-1: Ashford Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	I P	I P
		Dermal	I P	I P
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P S***P I*	**P S***P I*

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 14-2: Ashford Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	*P* **S**	*P* **S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

14.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. There is no evidence of shallow groundwater at this site; therefore, the pathway is incomplete for human exposure. Surface water was not observed at the site and is only present during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors to the site (if present), and potentially endangered or threatened ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the mercury amalgamation processing areas for metals to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places or have been proposed for consideration will require consultation with SHPO prior to implementation of additional site inspection activities.

15.0 STARR MILL (SITE #13)

The PA inspection of the Starr Mill was conducted on February 12, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C13**. Site features are depicted on **Figure 15-2** and include:

- Process area location,
- Seeps/springs/wetlands
- Riparian vegetation,
- Location of springs or seeps,
- Dissected wash,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

15.1 SITE DESCRIPTION

Starr Mill is located at 4,009 feet above sea level and bound on the west by steep canyon walls and on the east by Emigrant Canyon Road and the eastern canyon wall. The wash slopes gently to the north and towards the city of Stovepipe Wells, California (13 miles south). The entire site covers an area of less than 0.5 acre. The site is accessed from the west side of Emigrant/Wildrose Road or approximately 4.5 miles south of the junction with Highway 190 (**Figure 15-1**). Access to the site is via a paved road, which is open to the public. The site has a small turnout on a tight curve in the road. Starr Mill is located in a wide, moderately sloped canyon that also contains Emigrant/Wildrose Road.

Less than 50 visitors per year explore the site. Healthy green vegetation is growing on the rock walls of the former process tanks. Though the remnants of the site are not substantial, the site's proximity to the paved road attracts attention from visitors

The site consists of four terraced, in-ground process "pools" and/or tank foundations with stacked rock walls or "dug-in" perimeters, and a concrete grout interior liner, 10 to 20 feet above the wash on the west side of the canyon floor. The foundations are in a descending stacked array for gravity flow. No mill or mill foundations are readily apparent on site. Photographs of the site are shown in **Appendix C13 and Figures 15-1** and **15-2** show the site location and site features.

15.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

This small mill along Wild Rose-Emigrant Canyon Road was operated during the 1930s. The mine's owner, Walter M. Hoover, who owned several pieces of mining property in Death Valley, and a man named Starr ran the small cyanide plant around 1935. The ore was hauled in from Nemo Canyon. The partnership ended and Starr operated the mill until fall 1935, when he left California. Death Valley Monument personnel cleaned the area and removed a small amount of pipes and fittings from the ruins.

The site currently has concrete foundations from a few of the cyanide tanks (**Photo C13-2**) and a mound of tailings on bedrock above the road. Pink fine-grained mill tailings (silt) characterize the site waste. Specifically, a mound of tailings resides on bedrock at the edge of the raised operations area (<50 cubic yards) and is currently eroding down slope. Approximately 5 to 10 cubic yards are visible in the ravine washout below. Based on operational history and results gathered during the PA, the preliminary COCs are cyanide and metals.

15.3 ENVIRONMENTAL SETTING

15.3.1 Geology and Hydrology

Geological Setting

Starr Mill is located between the Cottonwood Mountains of the Panamint Range and the southern portion of Tucki Mountain (**Figure 1**). Harrisburg Flats is to the southeast and Death Valley is to the north (**Appendix E**). Bedrock in the vicinity of Starr Mill is the Cambrian-Precambrian-aged marine Noonday Dolomite beside Quaternary alluvium (**Figure 2**). The Noonday Dolomite is characterized by cream and gray colored dolomite[95]. The mill is situated west of Emigrant Canyon Road, 10 to 20 feet on the west slope of Emigrant Canyon.

The surrounding area and hills in the Emigrant Canyon area are heavily mined, which indicates a strong likelihood of potential intermixing of transported sediments adjacent to the site. Typical prospects are mining for ore containing copper, gold, and silver and also have associated mills to extract metals.

Groundwater

The Site is located in the South Lahontan HR, Death Valley Groundwater Basin in the state of California[96] (**Section 1.2**). Groundwater at the site is located in the alluvial sediments within Emigrant Canyon. Groundwater flow direction generally follows surface water flow, depicted on **Figure 15-2**.

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[95] R. Streitz and M. Stinson, California Division of Mines and Geology, *Geologic Map of California, Death Valley Sheet*. 1974, Second Printing 1980.

[96] Department of Water Resources. South Lahontan Hydrologic Region – Death Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

Based on the topographic surface, groundwater flows down Emigrant Canyon into the Death Valley Groundwater Basin. Local groundwater recharge occurs primarily from infrequent but significant storm events and from spring snowpack melt.

Based upon federal database records research (EDR 3813626.26s, **Appendix B**) and available USGS topographic maps (**Appendix E**), there are 21 USGS California Water Science Center wells present less than 1 mile upgradient of the site. Two of the wells appear to be located in the wash within 0.25 mile of the site. Groundwater in these wells was reported at depths between 2 and 18 feet bgs (EDR 3813626.26s, **Appendix B**). These wells are not used for public or private water supply or for any domestic use.

Two nationally recognized wetlands (**Figure 15-2**) coincide with Upper Emigrant Springs and Lower Emigrant Springs and are located up and downgradient, respectively (EDR 3813626.26s, **Appendix B**). Upper Emigrant Springs is found 560 feet southwest of the site. Emigrant Spring is located 0.6 miles north and downgradient but above the canyon wash. Spring water is piped 4.8 miles northwest to Emigrant Campground from the Emigrant Canyon Spring. Upgradient of the site, Greer, Malapi, Canyon, Burro, Willow and Burns Springs are within 2 miles to the south and would contribute to groundwater or surface water down Emigrant Canyon. Jayhawker Spring is located 1.7 miles west-northwest and cross- and upgradient. This spring in Jayhawker Canyon is not believed to be hydraulically connected to the site due to an intervening mountain ridge.

Groundwater in the Emigrant Canyon/Emigrant Wash system is derived from a highly deformed and mineralized zone containing ores of copper, gold, silver, lead, and zinc. Potential impacts to groundwater are anticipated to predominantly derive from these natural sources. Only a very minor cumulative mineral contribution is expected from the many historic mining and milling operations, including those sites evaluated in this PA.

15.3.2 Surface Water

The headwaters for Emigrant Canyon are a collection of ancillary canyons, but the watershed generally begins at Emigrant Pass, 7 miles south-southeast at the southern end of Harrisburg Flats. These flats collect runoff from the eastern side of Pinto Peak to the western side of Aguereberry Point and funnel it into Emigrant Canyon creating, at times, strong currents. Moreover, streams are occasionally filled seasonally due to spring snow melt on the surrounding mountains generating significant water drainage down the canyon. In the immediate vicinity of the site, surface water is generated from infrequent heavy precipitation events and begins along a short segment of the ridgeline located approximately 900 feet to the west and adjacent to site (**Figure 15-2**). Surface water flow during rainfall events would include sheet flow over this hillside and other portions of the site at relatively higher elevation and some channeled flow from the upstream portion of the drainage up Emigrant Canyon. The channelized runoff flows north until it empties into Emigrant Canyon Wash. Surface water that reaches Emigrant Wash would flow toward Stovepipe Wells and empty into Salt Creek flowing south along the central axis of Death Valley toward the Badwater Basin (**Appendix E**).

Cashier Mill is located upgradient on the southeast side of the Harrisburg Flats approximately 6.4 miles southeast. Greene-Denner-Drake is located up an unnamed canyon 2 miles south-southeast. Journigan Mill is located 1 mile southeast in Emigrant Canyon. These sites are upgradient and sediment transport from these sites passes immediately adjacent to Starr Mill. Skidoo Mill and Telephone Canyon Mill are located cross-gradient to the east and north, respectively, and will join Starr Mill's confluence 6 miles downgradient in Emigrant Wash.

There are no lakes, permanent ponds, or creeks/rivers surface water bodies within 15 miles downgradient from the site. Surface water is not anticipated to be impacted by contaminants related to operations or release from Starr Mill. However, due to the seasonal flow of surface water from spring snow pack melt, and apparent migration downslope of sediment, sediments are likely to be transported long distances by the velocity of water.

15.3.3 Soil, Sediment, and Air

The site has a thin layer of sediment but is wholly on unweathered bedrock. The canyon slopes moderately to the north. Bedrock is present at the site; therefore, the site has no drainage class and has a very slow infiltration rate (EDR 3813626.26s, **Appendix B**).

At Starr Mill, there are less than 50 cubic yards of tailings stockpiles on site, with apparent tailings eroding down the Emigrant Canyon wash (**Figure 15-2**). The surrounding area and hills in the Emigrant Canyon area are heavily mined, which indicate a near certainty of intermixing of transported sediments adjacent to the site and down the wash. Tailings transported from Journigan's Mill are readily apparent in Emigrant Canyon. Due to seasonal surface flows, tailings from other mills may combine with tailings flow from Journigan's Mill all the way to Stovepipe Wells (approximately 15 miles away) and beyond. Downstream, there is no certainty from which mill waste materials came; however, their coalescing through water transport is apparent.

Tailings are spread throughout Emigrant Canyon, some areas have vegetative or native sediment cover and other areas are exposed. Although daily wind movement can exceed 200 miles per day in the spring months at DEVA, the confined nature of the canyon at this location may prevent tailings from becoming airborne as dust. However, the fine-grained nature of the tailings and surface water flow down the canyon causes migration across roads and hiking paths within Emigrant Canyon. Vehicle traffic down this road, which is considered a main thoroughfare, have increased tailings particulates in the air. The site is open to the public and immediately beside the road. Windborne particulates are considered likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, and access roads near tailings.

15.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Starr Mill receives fewer than 50 visitors per year. Potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 4038102.5s, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B**

Starr Mill has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the February 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from cyanide extraction to extract gold. The preliminary COCs are cyanide and metals. Additionally, the site was evaluated using the EPA HRS using the information provided in the PA. Starr Mill was given an overall score of 0.23 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 15-1** and sensitive ecological receptor pathways are presented in **Table 15-2**. **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 15-1: Starr Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population: Worker	Exposed Population: Visitor
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	*P I*	*P I*
		Dermal	*P I*	*P I*
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 15-2: Starr Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population: Aquatic: Benthics	Aquatic: Native Fish	Terrestrial Receptors: Plants	Terrestrial Receptors: Soil Organisms	Birds and Mammals: Upland	Reptiles
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	P *I*	P *I*
		Direct Contact	I P	I P	I P	I P	P *I*	P *I*
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

15.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air and groundwater. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. There is evidence of shallow groundwater at this site; however, the exposure is considered insignificant for human and ecological receptors. Surface water was not observed at the site and is only present during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds, and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors to the site, and ecological receptors including potentially endangered or threatened species within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles and surface water.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the cyanide processing area to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places or have been proposed for consideration will require consultation with SHPO prior to implementation of additional site inspection activities.

16.0 JOURNIGAN'S MILL (SITE #14)

The PA inspection of the Journigan's Mill site was conducted on February 17, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C14**. **Figure 16-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill, cyanide processing area, and extent of tailings. Site features are depicted on **Figure 16-2** and include:

- Mill and process area locations,
- Surface drainages,
- Dissected wash,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

16.1 SITE DESCRIPTION

Journigan's Mill is located in the Panamint Range, one mile south of Emigrant Springs and 13.5 miles south of Stovepipe Wells, California (Latitude 36.4135 N, Longitude 117.1822 West) at an elevation of 4,398 feet above sea level. The site is open to the public and is located on the west side of Emigrant Canyon/Wildrose Canyon Road. Although the ruins at the site are not substantial, the highly visible location on the west side of paved Emigrant Canyon Road attracts visitors, including many who are unfamiliar with mining, milling, and the associated hazards. Approximately 700 people visit the site annually. This site has been nominated for the National Register of Historic Places. It particularly significant due to its association with personalities such as Shorty Belden and Frank Harris, and for the role it played in reviving mines in the Skidoo/Harrisburg areas by reducing production costs. The ruin is the largest ruin of an amalgamation and cyanide plant of the 1930s-1950s period left with the Park.

The 3-acre site lies on the western slope of a wide canyon above a wash sloping moderately to the north. Documentation of site conditions in 2002 is provided in NPS Historic Preservation Report, including physical description of significant cultural features, artifacts, and preservation of site features[97]. The ruins on the hillside cover an area 0 to 60 feet above the wash; the reinforced-concrete mill foundations were divided into three levels: upper, middle, and lower sections (**Photo C14-4**). A small network of road segments leads to various levels of the mill and process areas. Extensive concrete pads and footings cover the central section of the mill area as shown on several photos (**Photos C14-1, C14-4,** and **C14-6**). In addition to the concrete foundations, the mill components include several tanks. The lower section of the mill area is characterized by seven tanks **(Photo C14-7)**. The westernmost group consists of two 12-foot-diameter stone masonry tanks of unshaped local stone and mortar. The central group of tanks consists of four 12-foot-diameter concrete tanks. Two of the middle tanks are marked "Poison" in faded painted lettering (**Photo C14-8**). The lowest tank is a 12-foot-diameter steel tank of which only a small portion remains. This tank is built into the hillside and supported by a retaining wall or local stone with mortar covering gaps. The tanks were used to support the cyanidation operation.

The location of the mercury amalgamation process structures is unknown, but may have been in the area of the middle tank. A steel ore chute and two metal water tanks sit on a leveled part of the slope above the mill and housing areas as shown in the background of **Photo C14-1**. These tanks are both 57 feet in circumference and 8 feet 6 inches tall. The reservoir shown on **Photo C14-11** was formed on site by creating an earthen berm on two sides with a low hillside forming the third side in a shallow drainage and paving the interior with concrete.

The cyanide tank foundations are still in place and there are tailings in and around the tanks. The site of Journigan's Mill has no standing structures, five collapsed/burned/removed structures, one platform, eight archeological features, and no mine openings. As of 2002, the site consisted of the concrete mill foundations and cyanide tanks and the associated housing area, two metal water tanks, a reservoir, a pipeline, and scattered pieces of machinery and vehicles. All of the stranding structures are now gone; a wooden floor platform, two concrete housing foundations, and the foundations to the mill are the only structural remains still present. The concrete footings are in stable condition.

16.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

The site hosted a series of mills that operated intermittently from the 1920s through the early 1970s, the longest continuous use of a site for milling within DEVA. There was a ball mill in 1918 and a stamp mill during the 1920s, and a ball mill with amalgamation and cyanide processing by the 1930s. Roy Journigan acquired the mill property in 1937 and constructed an amalgamation and cyanide plant to process ore and dumped tailings from Skidoo and Cashier Mine. A pipeline diverted water from springs at the mill site that supplied water to the site until World War I. Machinery at the amalgamation and cyanide plant consisted of a 25-ton ore bin, a 3 by 4-foot Straub cone-type ball mill, seven 14 by 5-foot cyanide tanks, 4 by 8-foot amalgamation plates, and four-compartment zinc boxes. The entire operation was powered by a 15-horse-power Fairbank-Morse gasoline engine.

[97] National Park Service. 2002. Death Valley national Park, Historic Preservation Report – Volume 1. Abandoned Mine Lands Documentation and Condition Assessment. FY 2002.

The mill was rebuilt in the 1950s but was dismantled and moved to Columbia Flats, Nevada, in 1959. A detailed history of Journigan's Mill is provided in the Park Service' Historic Resource Study[98].

An estimated 1,500 cubic yards of mine tailings are present at the site (**Figure 16-2**). Scattered mill tailings composed of pink silty sand are found around the mill foundations on all of the levels and in the most of the tanks. A large mound of mining waste and tailings near a foundation is illustrated on **Photo C14-3**. Additional photos of mine tailings observed near the footing and foundation of former buildings are shown in **Photos C14-4** and **C14-12**. Tailings were also observed in three medium and one large stockpile (**Photos C14-13, C14-14, and C14-15**). The visible tailings are eroding downslope, principally into two surface washes trending to the northwest toward Emigrant Canyon. Examples of fine-grained tailings deposits downwash of the plant are shown in Photos **C14-16**, C**14-17**, and **C14-18**. Tailings from mills in the Emigrant Canyon area have been deposited 15 miles downwash to Stovepipe Wells airport, and tailings are present at downgradient Emigrant Springs. Tailings occur on the road at several locations (see **Photo C14-16**). Based on operational history and results gathered during the PA, the preliminary COCs are cyanide and metals.

16.3 ENVIRONMENTAL SETTING

16.3.1 Geology and Hydrogeology

Geological Setting

Journigan's Mill is located between the Cottonwood Mountains of the Panamint Range and the southern portion of Tucki Mountain (**Figure 1-1**). Harrisburg Flats is to the southeast and Death Valley is to the north (**Appendix E**). The mill lies on the western slope of a wide canyon above a wash that slopes moderately to the north. Bedrock in the vicinity of Journigan's Mill is Quaternary alluvium overlying Pliocene to Pleistocene-age non-marine conglomerates of the Funeral Formation. The Funeral Formation contains gravelly mudstone and sandstone with local travertine and well-lithified conglomerate (**Figure 2**).

The surrounding area and hills in the Emigrant Canyon area are heavily mined (**Appendix E**) which indicates a strong likelihood of potential intermixing of transported sediments adjacent to the site. Typical prospects are mining for ore containing copper, gold, and silver and also have associated mills to extract metals.

Groundwater

The site is located in the South Lahontan HR, Death Valley Groundwater Basin in the state of California[99] (**Section 1.2**). Groundwater at the site is located within the alluvial sediment located within Emigrant Canyon. Groundwater flow direction generally follows surface water flow, depicted on **Figure 16-2**. Based on the topographic surface, groundwater flow is to the north down Emigrant canyon into the Death Valley Groundwater Basin. Local groundwater recharge occurs primarily from infrequent but significant storm events and from spring snowpack melt.

Based upon federal database records research (EDR 3813626.28s, **Appendix B**) and available USGS topographic maps (**Appendix E**), there are eight USGS California Water Science Center wells present less than 1 mile upgradient of the site. However, a total of 21 wells are within 4 miles of the site.

[98] L. W. Green. Historic Resource Study, A History of Mining in Death Valley National Monument, vol. I and II, part 1 of 2, March 1981.

[99] Department of Water Resources. South Lahontan Hydrologic Region – Death Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

Groundwater in these wells was reported at depths between 2 and 18 feet bgs (EDR 3813626.28s, **Appendix B**). These wells are not used for public or private water supply or for any domestic use.

One nationally recognized wetland located one mile west-southwest coincides with upgradient Greer Springs (EDR 3813626.28s, **Appendix B**). Upper Emigrant Springs is found 0.9 miles northeast of the site. Emigrant Spring is located 1.5 miles north-northeast and downgradient but above the canyon wash. Spring water is piped 4.8 miles northwest to Emigrant Campground from the Emigrant Canyon Spring. Upgradient of the site, Greer, Malapi, Canyon, Burro, Willow and Burns Springs are within 1.4 miles to the southwest and would contribute to groundwater or surface water down Emigrant Canyon.

Groundwater in the Emigrant Canyon/Emigrant Wash system is derived from a highly deformed and mineralized zone containing ores of copper, gold, silver, lead, and zinc. Potential impacts to groundwater are anticipated to predominantly derive from these natural sources. Only a very minor cumulative mineral contribution is expected from the many historic mining and milling operations, including those sites evaluated in this PA.

16.3.2 Surface Water

The headwaters for Emigrant Canyon are a collection of ancillary canyons, but the watershed generally begins at Emigrant Pass, 6 miles south-southeast at the southern end of Harrisburg Flats. These flats collect runoff from the eastern side of Pinto Peak to the western side of Aguereberry Point and funnel it into Emigrant Canyon creating, at times, strong currents. Moreover, streams are occasionally filled seasonally due to spring snow melt on surrounding mountains, generating significant water drainage down the canyon. In the immediate vicinity of the site, surface water is generated from infrequent heavy precipitation events and begins along a short segment of the ridgeline with multiple springs (none expressed on the surface) located approximately 1.4 miles to the southwest. Surface water flow during rainfall events would include sheet flow over this hillside and other portions of the site at relatively higher elevation and some channeled flow from the upstream portion of the drainage up Emigrant Canyon. The channelized runoff flows north approximately 4.5 miles until it empties into Emigrant Canyon Wash. Surface water that reaches Emigrant Wash would flow toward Stovepipe Wells and empty into Salt Creek flowing south along the central axis of Death Valley toward the Badwater Basin (**Appendix E**).

Cashier Mill is located upgradient on the southeast side of the Harrisburg Flats approximately 5.4 miles southeast. Greene-Denner-Drake Mill is located up an unnamed canyon one mile south. These sites are upgradient and up wash from Journigan's Mill, and runoff from these sites passes immediately adjacent to Journigan Mill. Starr Mill is located 1 mile northwest and downgradient in Emigrant Canyon. Skidoo Mill and Telephone Canyon Mill are located cross-gradient to the northeast and north, respectively, and join Journigan's Mill's confluence 7 miles downgradient in Emigrant Wash.

There are no lakes, permanent ponds, or creeks/rivers surface water bodies within 15 miles downgradient from the site. Surface water is not anticipated to be impacted by contaminants related to operations or release from Journigan's Mill. However, due to the potential seasonal flow of surface water from spring snow pack melt, and apparent migration downslope of sediment, sediments are likely to be transported long distances by the flowing water.

16.3.3 Soil, Sediment, and Air

The site has accumulated a thin layer of alluvial sediments which appear to be sands and gravels. Bedrock is present at the site; therefore, surficial soils are typically less than 3 inches thick and are likely well drained; however the overall infiltration rate is slow (EDR 3813626.28s, **Appendix B**).

An estimated 1,500 cubic yards of mill tailings in the immediate area are associated with the Journigan's Mill site (**Figure 16-2**). Scattered mill tailings composed of pink silty sand occur around the mill foundations, in most tanks, and in separate stockpiles. The visible tailings are eroding downslope, principally into two surface washes on either side of the road trending northwest within Emigrant Canyon. Due to seasonal surface flows, tailings from Journigan's Mill were observed all the way to Stovepipe Wells (approximately 15 miles away) and beyond. Downstream, there is no certainty from which mill waste materials came; however, their coalescing through water transport is apparent.

Tailings are spread throughout Emigrant Canyon; some areas have vegetative or native sediment cover and other areas are exposed. Although daily wind movement can exceed 200 miles per day in the spring months at DEVA, the confined nature of the canyon at this location may prevent tailings from becoming airborne as dust. However, the fine-grained nature of the tailings and surface water flow down the canyon causes migration across roads and hiking paths within Emigrant Canyon. Vehicle traffic down this road, which is considered a main thorough-faire, has increased tailings particulates in the air. Mill tailings are fine-grained and subject to wind transport. Re-deposition of these particulates could impact the surface soils downwind. Windborne particulates are considered likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, and access roads near tailings.

16.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Journigan's Mill is a popular destination for tourists due to accessibly from a paved road. Park staff and contractors may access the site to visit and work as well. Potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.27, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B**.

The Journigan's Mill site has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the February 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from cyanide extraction processes to extract gold. Preliminary COCs include cyanide and metals. Additionally, the site was evaluated using the EPA HRS from the information gathered provided in the PA. Starr Mill was given an overall score of 7.52 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 16-1** and sensitive ecological receptor pathways are presented in **Table 16-2**. For site-specific explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 16-1: Journigan's Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	P *I*	P *I*
		Dermal	P *I*	P *I*

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 16-2: Journigan's Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

16.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. There is evidence of shallow groundwater at this site due to the presence of upgradient springs. Several wells located downgradient are not used for drinking water; therefore, human exposure is considered insignificant. Surface water was not observed at the site and is only present during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, and visitors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the cyanide processing area to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting soil samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places or have been proposed for consideration will require consultation with SHPO prior to implementation of additional site inspection activities.

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17.0 GREENE-DENNER–DRAKE MILL (SITE #15)

The PA inspection of Greene-Denner-Drake Mill was conducted on February 17, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C15**. **Figure 17-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill and mine, cyanide processing area, and extent of tailings. Site features are depicted on **Figure 17-2** and include:

- Mill and mine locations,
- Surface drainage,
- Riparian vegetation,
- Locations of springs and seeps,
- Dissected wash,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

17.1 SITE DESCRIPTION

The Greene-Denner-Drake Mill is located in the Panamint Mountains, 14.5 miles south of Stovepipe Wells, California (Latitude 36.399, Longitude 117.185) at an elevation of 5,020 feet above sea level. The site is open to the public and can be reached via a 0.9 mile hike on an abandoned gravel road within a NPS designated wilderness area. The site is accessed off of Emigrant Canyon/Wildrose Canyon Road. The gravel road is bermed to prevent vehicle access. Fewer than 100 people visit the site each year. The site was probably active for a small amount of time starting in the 1950s. There is a relatively small amount of tailings on site.

Greene-Denner-Drake Mill is located on the north side of a canyon bounded by short steep walls to the north and south, slightly above the gently east-sloping wash floor. The wash enters Emigrant Canyon Wash just up wash from Journigan Mill. The site covers between 3 and 4 acres. The complex contains a mill with some modern reinforcements placed by NPS staff, cabin ruins, and various tanks and debris (**Photo C15-4**). The cabins are well preserved as shown in **Photo C15-1**. The mill structure is built into a small hillside above the wash as shown in **Photos C15-2** and **C15-7**. Two 55-gallon drums are assumed to identify the cyanide processing area (**Photo C15-8**). The age of the abandoned vehicles suggests occupation during the 1950's. Water was piped to the site through a 1-inch steel pipe up wash. Two water tanks constructed of steel are present above the site (**Photo C15-3**).

Less than 50 cubic yards of mill tailings are scattered around the mill. The tailings are migrating downwash toward Emigrant Canyon/Wildrose Canyon Road, and are now found at approximately 0.31 mile, 0.8 mile, and 1.06 mile downwash, where the deposits cross Emigrant Canyon Road. The tailings are medium-coarse, pink to pinkish-orange sand in the vicinity of the mill ruins (**Photos C15-6, C15-8 and C15-9**). Finer grained pink silt tailings are being preferentially transported down wash, where they comingle with tailings sourced at Journigan's Mill and Starr Mill. **Photos C15-5** shows the tailings accumulations in low-lying areas down slope of the mill and cyanide processing area. Tailings of unknown source are present at the parking site upslope of the wash (**Photo C15-10**). These tailings are migrating on and next to Emigrant Canyon Road until they pass under the road via a culvert pipe and are transported down Emigrant Canyon Wash. The tailings in Emigrant Wash migrate past Emigrant Springs to a broad alluvial fan and are observed at Stovepipe Wells airport, more than 15 miles down slope. Emigrant Springs emanates up slope from the wash bottom and in unaffected by the tailings.

17.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

Greene-Denner-Drake Mill was probably only active for a short amount of time during the 1950s. Based on the operational history and results gathered during the PA, the preliminary COCs are cyanide and metals. The mining structure, water tanks and pipe, and drums suggest that a cyanide-leaching batch process was used to recover gold. Not much operational history is available, the site was originally constructed to process tungsten ore in the early 1950's, but low grade ore caused the operation to fail. It was then retrofitted to process gold bearing ore or tailings from the Skidoo area, and was operational till the 1970's.

17.3 ENVIRONMENTAL SETTING

17.3.1 Geology and Hydrogeology

Geological Setting

Greene-Denner-Drake is located between the Cottonwood Mountains of the Panamint Range and the southern portion of Tucki Mountain (**Figure 1**). Harrisburg Flats is to the southeast and Death Valley is to the north (**Appendix E**). Bedrock in the vicinity of the Greene-Denner-Drake Mill is Pliocene to Pleistocene-aged Funeral Formation. The non-marine Funeral Formation includes gravelly mudstone and sandstone with local travertine and well-lithified conglomerate[100] (**Figure 2**). The mill is situated on

[100] R. Streitz and M. Stinson, California Division of Mines and Geology, Geologic Map of California, Death Valley Sheet. 1974, Second Printing 1980.

the north side of an unnamed canyon that opens into Emigrant Canyon. The unnamed sub drainage is bounded by short steep walls rising above the gently east-sloping wash floor.

Groundwater

The site is located in the South Lahontan HR, Death Valley Groundwater Basin in the state of California[101] (**Section 1.2**). Groundwater flow direction generally follows surface water flow, depicted on **Figure 17-2**. Based on the topographic surface, groundwater flow is to the north in the vicinity of the site, although the site is located in a broad, gently sloped wash. Local groundwater recharge occurs primarily from infrequent but significant storm events and from spring snowpack melt.

Based upon federal database records research (EDR 3813626.30s, **Appendix B**) and available USGS topographic maps (**Appendix E**), there are 21 USGS California Water Science Center wells present less than 1 mile upgradient of the site. Two of the wells appear to be located in the wash within 0.25 mile of the site. Groundwater in these wells was reported at depths between 2 and 18 feet bgs (EDR 3813626.30s, **Appendix B**). These wells are not used for public or private water supply or for any domestic use.

There are nine nationally recognized wetlands (EDR 3813626.30s, **Appendix B**) coinciding with Burns Spring, Willow Spring, Malapi Spring, and Greer Spring to the southwest to northwest (**Appendix E**). Burro Spring and Canyon Spring are located cross-gradient and are not hydraulically connected. The other wetlands identified are located upgradient of the site to the southwest and west within the same canyon, and cross- and upgradient 0.8 miles to the west. Except for Burns Springs and the seeps in the same drainage basin as the site, the other springs may be hydraulically connected due to their relative position in elevation and on the same geologic formation, indicating shallow groundwater within those drainage basins.

Groundwater in the Emigrant Canyon/Emigrant Wash system is derived from a highly deformed and mineralized zone containing ores of copper, gold, silver, lead, and zinc. Potential impacts to groundwater are anticipated to predominantly derive from these natural sources. Only a very minor cumulative mineral contribution is expected from the many historic mining and milling operations, including those sites evaluated in this PA.

17.3.2 Surface Water

The headwaters for Emigrant Canyon are a collection of ancillary canyons, but the watershed generally begins at Emigrant Pass, 7 miles south-southeast at the southern end of Harrisburg Flats. These flats collect runoff from the eastern side of Pinto Peak to the western side of Aguereberry Point and funnel it into Emigrant Canyon creating, at times, strong currents. Moreover, streams are occasionally filled seasonally due to spring snow melt from surrounding mountains, generating significant water drainage down the canyon. In the immediate vicinity of the site, surface water is generated from infrequent heavy precipitation events in a narrow but open ravine 2.2 miles to the southwest and is channeled directly down a canyon to the site. Surface water flow during rainfall events would include sheet flow over this hillside and other portions of the site at relatively higher elevation and some channeled flow from the upstream portion of the drainage up Emigrant Canyon. Runoff from the canyon reaches Emigrant Canyon 1 mile northwest and flows northwest 4.6 miles until it empties into Emigrant Canyon Wash.

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[101] Department of Water Resources. South Lahontan Hydrologic Region – Death Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

Surface water that reaches Emigrant Wash would flow toward Stovepipe Wells and empty into Salt Creek flowing south along the central axis of Death Valley toward the Badwater Basin (**Appendix E**).

Cashier Mill is located upgradient on the east side of the Harrisburg Flats approximately 4.9 miles southeast. Starr Mill and Journigan's Mill are located 1 and 2 miles north in Emigrant Canyon. Skidoo Mill and Telephone Canyon Mill are located cross-gradient to the northeast and north, respectively, and will join Greene-Denner-Drake confluence 7.1 miles downgradient in Emigrant Wash.

There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site. Surface water is not anticipated to be impacted by contaminants related to operations or release from Greene-Denner-Drake Mill. However, due to the occasional -seasonal flow of surface water from spring snow pack melt, and apparent migration downslope of sediment, sediments are likely to be transported long distances by the velocity of water.

17.3.3 Soil, Sediment, and Air

The site has accumulated a thin layer of alluvial sediments from sand and gravels derived from weathering. Bedrock is exposed on the surface; therefore the alluvium is likely to be less than 3 inches thick. The surficial material is likely to be well drained, although overall infiltration rates will be very slow because shallow bedrock is present (EDR 3813626.30s, **Appendix B**).

Operations at Greene-Denner-Drake Mill generated medium-coarse sand tailings that are pinkish-orange colored (**Figure 2-2**). The fine-grained fraction of mill tailings (50 cubic yards) were observed migrating all the way down the unnamed canyon, where they eventually comingle with the waste stream from Journigan's Mill, Starr Mill, and Cashier Mill and move onto Emigrant Canyon Wash. Due to seasonal surface flows, tailings from Starr Mill and Journigan's Mill may be combined with tailing flow from other mill sites all the way to Stovepipe Wells (approximately 15 miles away) and beyond (**Appendix E**). Downstream, there is no certainty downstream from which mill waste materials came; however, their coalescing through water transport is apparent.

Tailings have vegetative or native sediment cover in some areas but other deposits are exposed. Although daily wind movement can exceed 200 miles per day in the spring months at DEVA, the confined nature of the canyon at this location may prevent tailings from becoming airborne as dust. However, the fine-grained nature of the tailings and surface water flow down the canyon causes migration across roads and hiking paths within Emigrant Canyon. Vehicle traffic down Emigrant Canyon Road, which is considered a main access, has increased tailings particulates in the air. The site is open to the public and access by foot traffic on a gravel road. Windborne particulates are considered likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, and access roads near tailings.

17.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

The Greene-Denner-Drake Mill is a popular destination for tourists due to accessibly from a paved road. Over 100 people visit the site each year, and park staff and contractors may visit and work at the site as well. Potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.27, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B.**

The Greene-Denner-Drake Mill site has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the February 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from cyanide extraction to extract gold. Preliminary COCs include cyanide and metals. Additionally, the site was evaluated using the EPA

HRS from the information gathered provided in the PA. Greene-Denner-Drake Mill was given an overall score of 0.67 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 17-1** and sensitive ecological receptor pathways are presented in **Table 17-2**. For site-specific explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and for soil/sediment/air.

Table 17.417-1: Greene-Denner-Drake Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	P *I*	P *I*
		Dermal	P *I*	P *I*
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 17.417-2: Greene-Denner-Drake Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant

P I – Potentially complete pathway but considered insignificant

I P – Incomplete pathway; no evaluation necessary

17.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. There is evidence of shallow groundwater at this site due to the presence of upgradient springs. Several wells located downgradient are not used for drinking water; therefore, human exposure is considered insignificant. Surface water was not observed at the site and is only present during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the cyanide processing area to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting soil samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places or have been proposed for consideration will require consultation with SHPO prior to implementation of additional site inspection activities.

18.0 SKIDOO MILL (SITE #16)

The PA inspection of Skidoo Mill was conducted on February 14, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C16**. **Figure 18-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill, cyanide and mercury processing areas, and extent of tailings. Site features are depicted on **Figure 18-2** and include:

- Mill location,
- Surface drainages
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

18.1 SITE DESCRIPTION

The Skidoo Mill is located near the top of a broad ridge in the Panamint Mountains. The site is accessed via a well graded road with signage off Emigrant/Wildrose Road. It is a very popular visitor destination and one of Death Valley's signature mining areas. The site is currently fully open to the public. The mill and process areas are located on a steep canyon wall and covers approximately 5 acres. The mill is well preserved and displays many intact features. All the tanks, mercury tables, and a large portion of the mill operations are well preserved and visible. The Skidoo Mill is currently listed on the National Register of Historic Places.

North, down the canyon, the slope goes over a shear "dry falls." In the area to the south, up the ravine, the grade is very mild and broadens into an alluvial plain. To the east and west are steep to moderately sloped canyon walls. Photographs of the site are shown in **Appendix C16 and Figures 18-1** and **18-2** show the site location and site features.

18.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

In 1906, Skidoo Mill was founded when two prospectors found gold on their way to the Harrisburg strike. The bulk of the milling done at this site took place from 1907-1917, with smaller, sporadic milling continuing periodically until 1942. Skidoo's population grew to 700 people; however, almost nothing remains of the former town. Operations of the mill included four mercury amalgamation tables and at least nine large cyanide-leaching tanks. Skidoo became the Death Valley region's largest mining operation.

Both mercury amalgamation and cyanide-leaching operations took place in large scale. Ore was hauled to the mill by truck to a 50-ton ore bin, crushed by two jaw crushers in series Over 90,000 tons of ore was processed. Once operations had ceased, the mill tailings were removed in large quantities by R. Journigan and reprocessed at Journigan's Mill until a cease order was placed on the operation.

Pink fine-grained tailings are abundant on site and in locations accessible to the public. The tailings are found in many of the operations tanks at the mill and upstream/upslope to an area that is suspected to be an impoundment area. Below the suspected impoundment area, tailings can be traced for approximately 4,000 feet down canyon. The main concentration of tailings covers an area between one and two acres. Based on operational history and information gathered during the PA, the preliminary COCs are cyanide and metals.

18.3 ENVIRONMENTAL SETTING

18.3.1 Geology and Hydrogeology

Geological Setting

Skidoo Mill is located on the southern portion of Tucki Mountain (**Figure 1**). Harrisburg Flats is to the southeast and Death Valley is to the north. The Cottonwood Mountains of the Panamint Range lie to the west (**Appendix E**). The Skidoo Mill is situated on a steep ridge of late Cretaceous-age of the Hunter Mountain Quartz Monzonite (**Figure 2**). The Hunter Mountain Formation is a gneissic and porphyritic quartz monzonite in this area[102]. The mill is located on the north-facing slope approximately 120 feet above the local drainage.

Groundwater

The Site is located in the South Lahontan HR, Death Valley Groundwater Basin in the state of California[103] (**Section 1.2**). Groundwater flow direction at the site generally follows surface water flow, depicted on **Figure 18-2**. Based on the topographic surface, groundwater flows down the steep and narrow drainage canyon to the east. Groundwater then flows through Telephone Canyon and out into the western portion of the Death Valley Groundwater Basin. Recharge of this area and the basin is from surface runoff during strong but infrequent rain and flooding events.

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102 R. Streitz and M. Stinson, California Division of Mines and Geology, *Geologic Map of California, Death Valley Sheet*. 1974, Second Printing 1980.

103 Department of Water Resources. *South Lahontan Hydrologic Region – Hidden Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-63.pdf.

Based upon federal database records research (EDR 4030723.2s, **Appendix B**) and available USGS topographic maps (**Appendix E**), there are no wells within 4 miles of the site. No residences are found within 200 yards, and groundwater is not used as a drinking water source.

Emigrant Springs and Upper Emigrant Springs are located approximately 2.3 miles west of the Skidoo Mill site; however; they are cross-gradient and outside the Skidoo Mill drainage system and not believed to be hydraulically connected. No nationally recognized wetlands are within 1 mile of Skidoo Mill (EDR 4030723.2s, **Appendix B**).

Groundwater in this area, which flows into Emigrant Wash, is derived from a highly deformed and mineralized zone containing ores of copper, gold, silver, lead, and zinc. Potential impacts to groundwater are anticipated to predominantly derive from these natural sources. Only a very minor cumulative mineral contribution is expected from the many historic mining and milling operations, including those sites evaluated in this PA.

18.3.2 Surface Water

Surface water flow at the site is generated from infrequent heavy precipitation. Runoff flows downslope along the top of the watershed divide, 1-mile upstream (east-southeast), and is bound by the northern and southern canyon walls. Surface water flow during rainfall events would include sheet flow down the canyon walls and channeled flow from the upstream portion of the drainage southeast of the site (**Figure 16-2**). Surface flow continues downstream approximately 3.2 miles until it empties into Telephone Canyon. Telephone Canyon continues another 2.3 miles until it outfalls into Emigrant Wash. Surface water that reaches Emigrant Wash would flow toward Stovepipe Wells and then into Salt Creek flowing south along the central axis of Death Valley toward the Badwater Basin (**Appendix E**). Drainages are ephemeral and see very little surficial flow with an estimated precipitation rate of 4 to 8 inches of rainfall per year in the northern portion of the Death Valley Basin[104].

The Telephone Canyon Mill (Site #27) is in the same subregional drainage basin as the Skidoo Mill site. Potential transported material by surface water from the Skidoo Mill must travel approximately 4.4 miles downgradient before it could comingle with material from the Telephone Canyon Mill. No surface water quality data were discovered during research.

There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site, and because of the arid climate and rapid infiltration rate, transport of waterborne waste constituents significant distance off site is unlikely. However, the relative steepness of the canyon from Skidoo Mill to the west increases the velocity of flow and therefore increases the ability for surface water, when present, to transport sediments a distance until water can slow and infiltrate the ground which is estimated to be approximately 2.5 miles downstream to the northwest (**Appendix E**). Stronger storm events may carry sediments further and potentially into Emigrant wash where they comingle with other mill wastes.

18.3.3 Soil, Sediment, and Air

The site has accumulated a thin layer of alluvial sediments consisting of clay to gravels. Bedrock is visible at the site, and surficial soil thickness ranges from 4 inches to greater than 20 inches. The soils are likely well drained; however, the overall infiltration rate is very slow (EDR 4030723.2s,

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104 Department of Water Resources. *South Lahontan Hydrologic Region – Hidden Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

Appendix B). The surficial soil unit is identified as the Theriot component with the upper 3 inches classified as coarse-grained soils.

Historical operation of the Skidoo Mill generated approximately 90,000 cubic yards of silt-sized pink tailings covering an area of approximately 2 acres. Tailings are present among the processing tanks and downslope into the drainage (**Figure 16-2**). The tailings are found upstream/upslope within a suspected impoundment area. Below this area, tailings are observed for approximately 4,000 feet downslope. Downgradient accumulations occur due to infrequent heavy precipitation events that produce flow in the wash. Vegetation in the area is sparse and drought stressed and does not appear to inhibit the migration of tailings downslope. Tailings mixed with native sediments and dispersion were observed along the margins of the tailings.

The immediate vicinity around Skidoo Mill has been heavily mined and shafts, adits, stopes and prospects are abundant. Comingling of mine waste or mill tailings from other sites downstream are likely in Emigrant Wash. Windborne particulates are considered likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover.

18.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Skidoo Mill is a popular destination for tourists, with 5,000 visitors yearly. Park staff and contractors may access the site to visit and work as well. Potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.27, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B.**

The Skidoo Mill site has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the February 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from cyanide extraction and mercury amalgamation processes to extract gold. Preliminary COCs include cyanide and metals. Additionally, the site was evaluated using the EPA HRS from the information gathered provided in the PA. Skidoo Mill was given an overall score of 2.21 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 18-1** and sensitive ecological receptor pathways are presented in **Table 18-2**. For site-specific explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 18-1: Skidoo Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	I P	I P
		Dermal	I P	I P

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 18-2: Skidoo Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

18.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. There is no evidence of shallow groundwater at this site; therefore, the pathway is incomplete for human exposure. Surface water was not observed at the site and is only present during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors including potentially endangered or threatened species within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the mercury and cyanide processing areas to determine if any releases to the environment have occurred or could occur in the future. Since the site is in a mineralized area, ECM recommends collecting soil samples to evaluate background levels of metals. Special consideration must be given to future investigation activities at the site due to its status on the National Register of Historic Places. Implementation of additional site inspection activities will require consultation with SHPO.

19.0 TUCKI MINE AND MILL (SITE #17)

The PA inspection of Tucki Mine and Mill was conducted on February 12, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C17**. **Figure 19-1** shows the topographic features in the vicinity of the site, and indicates the locations of the cyanide processing area, and extent of tailings. Site features are depicted on **Figure 19-2** and include:

- Process area location,
- Surface drainages,
- Dissected wash,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

19.1 SITE DESCRIPTION

Tucki Mill site is located on the southeast slope of the Tucki Mountains in the Panamint Range, east of the summit. The site is located 4 miles north-northeast of Skidoo and 10 miles by road from Emigrant Canyon via Telephone Canyon. The site is accessed via an unmaintained four wheel drive gravel road off of Emigrant/Wildrose Road. The site is 10 miles from the end of the pavement. Steep peaks surround the Tucki process area, but the site is located on a gently sloping, steep-sided wash. The wash slopes to the east and then drops off a steep mountain edge approximately 0.5 mile from the site. The site operations covered approximately 3 acres.

Operations were conducted on the southern side of the wash. The northern side of the wash has a row of several cabin ruins and trailer foundations. Additionally, one "pool" foundation is at the eastern end of this row. The southern side of the wash is dominated by 2,000 to 3,000 cubic yards of ¾-inch crushed rock that the four former cyanide-leaching tanks reside on. The leach tanks are steel lined rectangular concrete block construction and have an approximate capacity of 100 cubic yards and are ¾-full of ore. Several feet above and to the west of the leach tanks is a second "pool" foundation. At the bottom of the wash, to the west of the cyanide-leaching tanks is a small former pump pad. Photographs of the site are show in **Appendix C17 and Figures 19-1** and **19-2** show the site location and site features.

19.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

The site has been abandoned since 1978. It was a cyanide processing facility, extracting only small amounts of gold associated with quartz fractures in quartzite at a very low profit margin. The ore was reduced using crushing (therefore, no mill was located on site), then the coarse ore was leached by circulating a cyanide solution. Aboveground "pools" were used for the process solution and including pads that may have housed the recovery filters.

The cyanide-leaching operations on site were accomplished by using four concrete, steel-lined rectangular tanks to leach the ore in the form of fine- to coarse-grained crushed rock by circulating a cyanide solution. The cyanide solution was circulated via two portable "pools" and used a charcoal filter to recover gold from the pregnant solution. According to the permit conditions, the cyanide solution was to be neutralized with chlorine or acid before dumping. Due to the coarse nature of the material very little to no waste is eroding. The cyanide-leaching tanks, portable "pool" pads, pump pad, and filter locations have potential to be impacted with cyanide.

19.3 ENVIRONMENTAL SETTING

19.3.1 Geology and Hydrogeology

Geological Setting

The Tucki site is located on the western portion of Tucki Mountain (**Figure 1**). Harrisburg Flats is to the southeast and Death Valley is to the west. The Cottonwood Mountains of the Panamint Range lie to the west (**Appendix E**). The site is situated on Precambrian to Cambrian-aged Deep Spring Formation (**Figure 2**) described as blue-gray limestone, red quartzite, and gray, cross-bedded, fine-grained quartzite, hornfels, and schist[105]. Ruins of the leaching operation are located on both sides of an east-west trending drainage.

Groundwater

The site is located in the Tucki Mountains along the western side of the Death Valley Groundwater Basin in the South Lahontan HR of California[106] (Section 1.2). Groundwater flow direction generally follows surface water flow, depicted on **Figure 19-2**. Based on the topographic surface, local groundwater flow is generally to the southeast. Groundwater, if present, coalesces with flow from Tucki Wash 3.7 miles downgradient. Groundwater eventually flows into the eastern portion of the Death

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[105] U.S. Department of the interior, Geological Survey. *Geologic Map and Sections of the Bullfrog Quadrangle, Nevada-California.* Geology by H.R. Corwall and F.J. Kleinhampl, 1956-1960.

[106] Department of Water Resources. *South Lahontan Hydrologic Region – Hidden Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

Valley Groundwater Basin. The depth to groundwater at the site is not known; EDR estimates the depth to groundwater to be greater than six feet bgs (EDR 3813626.34s, **Appendix B**).

Based upon federal database records research (EDR 3813626.34s, **Appendix B**), and available USGS topographic maps (**Appendix E**), there are no wells, natural springs, or wetlands springs within 4 miles of the site. The residential area closest to the site is Stovepipe Wells, California, which is approximately 10 miles north-northwest and upgradient. Furnace Creek is down and cross-gradient of site groundwater flow. No residences are found within 200 yards, and groundwater is not used as a drinking water source.

Groundwater does not appear to be a likely transport mechanism for waste constituents from the site. The surrounding mineralized metamorphic bedrock contains ores of copper, gold, silver, lead, and zinc. Potential impacts to groundwater are anticipated to predominantly derive from these natural sources. Only a very minor cumulative contribution is expected from the historic cyanide processing operations, including those sites evaluated in this PA.

19.3.2 Surface Water

Surface water reaching the site appears to be generated from infrequent heavy precipitation. Surface water flow during rainfall events is generated along the crests of the canyon walls and from higher elevations. Surface water flow includes sheet flow down the canyon walls and channeled flow from the upstream portion of the site drainage west, north, and south of the site. Surface flow continues downstream approximately 3.7 miles until it outflows onto the alluvial fan on the west side of Death Valley. If sufficient surface water is present it would flow into Salt Flat and then south with Salt Creek along the central axis of Death Valley toward Badwater Basin (**Appendix E**).

There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site, and because of the arid climate and rapid infiltration rate, transport of waterborne waste constituents significant distance off site is unlikely.

19.3.3 Soil, Sediment, and Air

Bedrock is exposed at the site. Sloping canyon walls have accumulated alluvial sediments consisting of silt to gravels. Bedrock depths vary from surface to greater than 20 inches bgs, indicating that although the upper surficial soils are well drained, the overall soil has a very slow infiltration rate, likely due to shallow bedrock. The surficial soil unit is designated as the Theriot soil component with the upper 3 inches classified as coarse-grained soils (EDR 3813626.34s, **Appendix B**).

Operation at the Tucki site generated coarse crushed rock. Foundations for the processing facilities on site were built on ¾" crushed rock. Coarse material from crushing operations was staged for processing in the cyanide leach 'tanks' which circulated recovery solution. Processing yielded some material as fine as silt size, which was confined to the tanks (**Figure 19-2**). Due to the generally coarse nature of the material, mine waste did not appear to be migrating downslope. These coarse-fraction sediments do not readily become transported by wind or water and appear to be relatively stable. Sparse vegetation appeared healthy upstream and downstream.

Ore for the leaching process was believed to have been supplied exclusively from the site, which contains numerous stockpiles of waste rock and ore. Comingling of mine waste with other sites is not anticipated. Windborne particulates are considered unlikely due to the majority of the site being coarse-grained material and fine-grained material is lined with vegetation. This area is in a narrow canyon protecting it from wind erosion.

19.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Tucki Mine receives approximately 100 visitors a year. Park staff and contractors may visit and work at the site, as well, and potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.27, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B.**

The Tucki Mill site has been assessed using site-specific CSMs. Based on the operational history of the processing area and observations during the February 2014 site visit, assessment of environmental hazards focuses on the waste rock associated with cyanide extraction. Preliminary COCs include cyanide and metals. Additionally, the site was evaluated using the EPA HRS from the information gathered provided in the PA. Tucki Mill was given an overall score of 0.1 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 19-1** and sensitive ecological receptor pathways are presented in **Table 19-2**. For site-specific explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 19-1: Tucki Mine and Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P /**	**P /**
		Dermal	**P /**	**P /**
Water Erosion	Surface soil	Ingestion	**P /**	**P /**
		Dermal	**P /**	**P /**
	Subsurface Soil	Ingestion	*P /*	I P
		Dermal	*P /*	I P
	Groundwater	Ingestion	I P	I P
		Dermal	I P	I P
Water Erosion	Sediment	Ingestion	**P /**	**P /**
		Dermal	**P /**	**P /**
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P /**	**P /**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 19-2: Tucki Mine and Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P /**	**P /**	**P /**	**P /**
		Direct Contact	I P	I P	**P /**	**P /**	**P /**	**P /**
Water Erosion	Surface soil	Ingestion	I P	I P	**P /**	**P /**	**P /**	**P /**
		Direct Contact	I P	I P	**P /**	**P /**	**P /**	**P /**
	Subsurface Soil	Ingestion	I P	I P	**P /**	**P /**	I P	I P
		Direct Contact	I P	I P	**P /**	**P /**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P /**	**P /**
		Direct Contact	I P	I P	*P I*	*P I*	**P /**	**P /**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	I P	I P

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

19.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air. Surface soil and sediments represent complete but insignificant exposures to both human and ecological receptors. Higher metals concentrations are typically associated with fine-grained tailings material. Based on the coarse-grained nature of the tailings the exposure is considered insignificant. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. There is no evidence of shallow groundwater at this site; therefore, the pathway is incomplete for human exposure. Surface water was not observed at the site and is only present during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered unlikely due to the majority of the site being coarse-grained material and fine-grained material lined with vegetation. This area is in a tight narrow canyon protecting it from wind erosion. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for soil adjacent to the rock pile to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting soil samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places or have been proposed for consideration will require consultation with SHPO prior to implementation of additional site inspection activities.

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20.0 CASHIER MILL (SITE #18)

The PA inspection of Cashier Mill was conducted on February 17, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C18**. **Figure 20-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill and mine, cyanide processing area, and extent of tailings. Site features are depicted on **Figure 20-2** and include:

- Mill and mine locations,
- Surface drainages,
- Dissected wash,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

20.1 SITE DESCRIPTION

Cashier Mill is located 17 miles south of Stovepipe Wells, California, in the Panamint Mountains (Latitude 36.36151°, Longitude -117.11071°) at an elevation of 5,089 feet above sea level. The site is open to the public and can be reached via a 1.5-mile-long graded dirt road accessed east of Emigrant Canyon/Wildrose Canyon Road. This is one of the more heavily visited mine and mill sites in DEVA. Approximately 3,000 tourists visit the site each year.

The mill site is located on the southeastern side of Providence Ridge, an east-west-trending hill standing approximately 200 feet above a wide valley. The alluvial plain surrounding Providence Ridge extends over 4 miles to the northwest and gently slopes to the north. Gold ore supplying the mill was taken from the Cashier and Eureka Mines, installed in the extreme northeastern extent of the ridge. An entrance to the Eureka Mine is found upslope of the mill ruins. **Photo C18-9** provides a view of the site from the top of Providence Ridge, depicting mine waste and the alluvial valley floor. A substantial amount of deteriorating mining equipment, tanks, and other ruins are present downslope of the mill and mine structures (**Photos C18-3, C18-4**, **C18-11**, and **C18-12**).

The southern hillside contains multiple levels as a result of terraces constructed using a variety of retaining walls, shown on **Photo C18-6**. Each level appears to have supported its own mining activity because the mine entrances, mill structure, and machinery platforms all occur at different elevations as illustrated on **Photo C18-8**. A road supported by stone retaining walls rises to the top of the ridge, and historical and modern foot trails allow visitors to walk between levels and access the mill area and mining ruins, including mine entrances. As shown on **Photo C18-10**, mill tailings are present in these areas and visitors frequently disturb the deposits.

As shown on **Photo C18-6**, Cashier Mill is an impressive three-level, heavy timber structure containing posts up to 12 feet high. The upper section consists of an ore receiving area and is equipped with a large, one-chute ore bin. A large concrete foundation once supported the stamps and comprises the lower part of the mill. The stamps are no longer in place. There are three platform foundations to the south and west that once held cyanide tanks. The remains of a blacksmith's shop and forge, compressor building, series of retaining walls, and abandoned platforms for buildings or machinery are scattered over the site. The entrance to an abandoned mine is observed upslope of the mill ruins. Extensive documentation concerning conditions at Cashier Mill are presented in the NPS Historic Preservation Report[107].

In addition to the mill and mine ruins, the nearby Aguereberry mining camp attracts visitors. Several buildings still stand that date from the site's boom days. **Photo C18-17** shows the old cabins where one of the gold mine's founders, Pete Aguereberry, lived while he worked the mine. Tool remnants, tanks, cans, pieces of deteriorated structures, a collapsed dugout with a corrugated-metal roof over a wooden frame, and other ruins are present, and an outhouse still stands (**Photos C18-14** through **C18-17**). Scattered stone footings that once may have supported tents are found throughout the site. No structures remain from the town of Harrisburg, which was established north of Providence Ridge after gold was discovered. The access road to the mining camp marks the farthest extent that tailings from milling activities have visibly migrated. Aerial views of the site show that tailings have migrated across Harrisburg Flat to the north. Mill tailings deposited in this area are shown on **Photo C18-13**. These tailings deposits could be disturbed by visitors hiking to the site.

20.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

Milling consisted of crushing, amalgamation, and cyanide leeching to recover gold mined from the on-site Cashier and Eureka lodes. The mill was active from 1909 to 1926. Two prominent prospectors, Pete Aguereberry and Shorty Harris, discovered gold on Providence Ridge in July 1905. The Cashier Mine, sited on the southern flank of the ridge, was developed in conjunction with the Eureka Mine, located on the eastern flank. The mining venture was staffed by residents of the new town of Harrisburg, located north of Providence Ridge, and prospectors who lived at Aguereberry Camp. The strikes in the Harrisburg area were considered as part of the Wild Rose Mining District, containing free milling gold in a quartz ledge that stretched north to Skidoo and Emigrant Spring. The ore removed from the Cashier Mine contained gold, silver, copper, and lead in quartz.

In July 1909 the Cashier five-stamp, amalgamation and concentration mill began operation. The first shipment of gold bullion occurred in August. The ore averaged more than $60 a ton, mainly gold, and

[107] National Park Service, U.S. Department of the Interior, 2002. Death Valley National Park, Historic Preservation Report, Volume 1. Abandoned Mine Lands Documentation and Condition Assessment.

the mill worked about 3.5 tons of ore per day, or $6,000 a month. Improvements to the facility's milling capabilities continued through 1915, when a cyanide plant was installed. In 1913 ten carloads of high-grade ore had been produced and by 1916 the Cashier Mine had produced 15,000 tons of ore valued at around $20 per ton. From 1917 to 1938 Eureka Mine was listed as active. However, the Cashier Mill and Mine were listed as idle in 1926 and assumed closed. Aguereberry worked the Eureka Mine until his death in 1945. His heirs inherited the mine, which produced a small amount of ore as recently as 1958. Additional information about mining in the Providence area is provided in the Historic Resource Study[108].

At Cashier Mill a combination of extraction and processing technologies were applied to ensure high gold recovery rates from the ore. A tram was used to haul ore from the Eureka Mine to the mill. The five-stamp mill crushed the ore, and the pulverized material was mixed with water to form a pulp that was passed over mercury-coated copper amalgamation plates. Tailings were further processed using cyanide leaching methods followed by gravity concentration to recover additional gold. The extraction processes are described in Section 1.5. The capacity of the mill was 20 tons per 24 hours with water supplied from the Skidoo pipeline two miles away, and power provided by a distillate engine.

In 1981 the Harrisburg District, which includes the mill site, was nominated to the National Register of Historic Places[109]. The Cashier claim is noteworthy because of the large mill ruin associated with it. It also had a connected power house and blacksmith shop built out of $100 a ton ore. The town site is an important historical resource because a variety of early mining lifestyles and technological processes from the 1900s are displayed there. The history of the site is also linked with Shorty Harris and Pete Aguereberry.

Approximately 100 cubic yards of medium-grained pink sand tailings occur in the vicinity and down slope of the mill foundation where cyanide and mercury processing took place (**Photos C18-7** and **C18-10**). A separate tailing deposit is present up slope of the mill site. Mine waste is present on the hillside to the west and south of the mill ruins. Many foot paths intersect the tailings deposits in the mill and mine areas. Fine-grained pink tailings are migrating down slope in the vicinity of the mill ruins into localized surface drainages as shown on **Figure 18-2** and **Photo C18-7**. Providence Ridge diverts runoff; surface flows transport the tailings washed down slope around the ridge, forming discontinuous deposits in some low areas. Some tailings are carried west and around the ridge, while the majority of the tailings are carried and deposited to the east of the ridge (**Photo C18-5**). The eastern and western drainage segments join 275 feet north of the former mining camp and enter the same surface drainage flowing northwest. The farthest extent of visible tailings have accumulated at the access road to the old camp site 1.5 miles northwest of the ridge, aerial views show the tailings have migrated several miles onto Harrisburg Flats. These tailings may be disturbed by visitors hiking to the site (**Photo C18-13**). Based on the operational history and information gathered during the PA, the preliminary COCs for the site are cyanide and metals.

The surrounding area and hills in the Emigrant Canyon area are heavily mined which indicate a strong likelihood of potential intermixing of transported sediments adjacent to the site. Typical prospects are mining for ore containing copper, gold, and silver and also have associated mills to extract metals.

[108] L.W. Green. Historic Resource Study, A History of Mining in Death Valley National Monument, vol I of II, part 2 of 2. March 1981.

[109] L.W. Green. Historic Resource Study, A History of Mining in Death Valley National Monument, vol I of II, part 2 of 2. March 1981.

20.3 ENVIRONMENTAL SETTING

20.3.1 Geology and Hydrogeology

Geological Setting

Cashier Mill is located in the Harrisburg Flats in the center of the Panamint Range (**Figure 1**). Panamint Valley and Death Valley lie to the west and east, respectively. Tucki Mountain is to the north and the Cottonwood Mountains are to the northwest (**Appendix E**). Bedrock in the vicinity of Cashier Mill consists of later Precambrian-aged sedimentary and metamorphic rocks of the Panamint Metamorphic Complex (**Figure 2**). The Panamint Metamorphic Complex includes granite, gneiss, schist, and metamorphosed sedimentary units[110]. The mill is situated on the southeastern side of Providence Ridge, an east-west-trending hill standing approximately 200 feet above a valley known as the Harrisburg Flats.

The surrounding area and hills in the Emigrant Canyon/Providence area are heavily mined which indicates a strong likelihood of potential intermixing of transported sediments adjacent to the site. Typical prospects are mining for ore containing copper, gold, and silver and also have associated mills to extract metals.

Groundwater

The site is located in the South Lahontan HR, Harrisburg Flats Groundwater Basin in the state of California[111] (**Section 1.2**). The Harrisburg Flats Groundwater Basin underlies a northwest-trending inter-montane valley in the Panamint Range and covers 38.9 square miles. The depth to groundwater is not recorded, but groundwater is likely found in alluvium of Quaternary age. The primary water-bearing materials used as a source of potable water are the unconsolidated younger alluvial deposits and underlying unconsolidated to semi-consolidated older alluvial deposits typically found at the base of the mountains/hills and along stream channels. The basin is bounded by non-water-bearing rocks of the Panamint Range. Based upon topographic contours, groundwater within the basin moves northwestward and discharges as underflow to Emigrant Canyon. Once groundwater, if present, reaches the Emigrant Wash it enters the Death Valley Groundwater Basin. Uplifted beds of the Funeral Formation in the Kit Fox Hills near Salt Creek impede the northeasterly flow of groundwater, causing it to rise to the surface and pond in Mesquite Flat at Stovepipe Wells 13.5 miles to the north.

Based upon federal database records research (EDR 3813626.34s, **Appendix B)** and available USGS topographic maps (**Appendix E**), no wells springs, or wetlands are within 4 miles of the site). Groundwater in the Emigrant Canyon/Emigrant Wash system is derived from a highly deformed and mineralized zone containing ores of copper, gold, silver, lead, and zinc. Potential impacts to groundwater are anticipated to predominantly derive from these natural sources. Only a very minor cumulative mineral contribution is expected from the many historic mining and milling operations, including those sites evaluated in this PA.

20.3.2 Surface Water

The headwaters for the drainage begin at Emigrant Pass 2.3, miles southwest at the southern end of Harrisburg Flats. These flats collect runoff from the eastern side of Pinto Peak to the western side of Aguereberry Point and funnel it into Emigrant Canyon creating, at times, strong currents. Moreover,

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[110] R. Streitz and M. Stinson, California Division of Mines and Geology, Geologic Map of California, Death Valley Sheet. 1974, Second Printing 1980.

[111] Department of Water Resources. South Lahontan Hydrologic Region – Harrisburg Flats Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-74.pdf.

occasionally streams are filled seasonally due to spring snow melt on the surrounding mountains, generating significant water drainage down the canyon. Surface water flow toward the site begins with the downhill flow off of 200-foot-high Providence Ridge and the topographic highs located within 2 miles south and east of the site. Surface water flow during rainfall events would include sheet flow over these hillsides and other portions of the site at relatively higher elevation and some channeled flow from the upstream portion of the site drainage near Aguereberry Point, 3.2 miles to the east (**Appendix E**). The rocks of Providence Ridge act as a barrier to surface flows moving northeastward. Surface flow is diverted to the east and west around the ridge, with a confluence 275 feet north of the ridge (**Figure 20-2**). The channelized runoff flows northwest approximately 4.2 miles until it empties into Emigrant Canyon Wash. Surface water that reaches Emigrant Wash would flow toward Stovepipe Wells and empty into Salt Creek flowing south along the central axis of Death Valley toward the Badwater Basin (**Appendix E**).

Cashier Mill is in the same Emigrant Canyon/Emigrant Wash drainage as Greene-Denner-Drake Mill (Site #15), Journigan's Mill (Site #14), and Starr Mill (#13) and surface flows could possibly carry comingled material from multiple sites. Once runoff enters Emigrant Canyon from Harrisburg Flats, any material transported from Cashier Mill via surface water must travel approximately 1.4 mile to the confluence with runoff from Greene-Denner-Drake Mill, 0.5 mile to Journigan's Mill, and additional 1.1 miles to Starr Mill. Flows reaching Emigrant Wash, 3.5 miles down canyon, could possibly carry comingled material from all of the sites. No surface water quality data were discovered during research.

Several springs are located 4 to 6 miles to the northwest of the site, and Emigrant Spring is located in the Starr Mill area, 7.0 miles northwest from the site. These springs are upgradient in Emigrant Canyon and drain into the wash downgradient. There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site. Surface water is not anticipated to be impacted by contaminants related to operations or release from the Site. However, due to the seasonal flow of surface water, and apparent migration downslope of sediment, sediments are possibly transported long distances by surface water flow.

20.3.3 Soil, Sediment, and Air

The site has accumulated a layer of alluvium identified as the Ulymeyer Series, which is derived from granitic rock and typically occurs on alluvial fans and fan terraces. The surficial material is a clayey-sand with gravel to a depth of 12 inches, overlying a poorly sorted coarser material of clay, sand, and gravel. The soil is well drained with high infiltration rate. Depth to water is greater than 6 feet (EDR 3813626.34s, **Appendix B**).

Operation of Cashier Mill generated silt-sized pink tailings which are typically more fine-grained than the surrounding natural material (**Figure 20-2**). Less than 100 cubic yards of mill tailings were observed downslope of the on-site mine and in the mill and amalgamation/cyanide processing area (**Appendix D**). These tailings have migrated into the surface drainage at the base of Providence Ridge and formed discontinuous deposits circling the ridge as far as 400 feet to the east and 700 feet to the west before infiltrating the subsurface. The farthest extent of field observed tailings from Cashier Mill have accumulated at the access road to the camp site 1.5 miles northwest of the ridge, aerial views show the tailings have migrated several miles onto Harrisburg Flats. Waste rock dumps were observed near the upslope mine workings, which showed evidence of erosion. The site is a popular tourist destination, with over 3,000 visitors each year. This site is accessible by road and tailings are observed crossing the Emigrant Canyon pass road near the site and down the canyon. The fine-grained nature of the tailings and surface water flow down the canyon causes migration across roads and hiking paths within Emigrant Canyon. Visitors easily walk around the ruins using historical and modern trails or explore the site off trail. DEVA staff and contractors also access these areas.

Any metals contamination associated with tailings transported by surface flows from this area will enter Emigrant Canyon, where they will comingle with tailings sourced at Green-Denning-Drake Mill, Journigan's Mill, and Starr Mill. Runoff within the wash flows onto a broad alluvial fan (Emigrant Wash) and eventually to the Stovepipe Wells airport. Visible comingled tailing deposits are visible in the Emigrant Canyon wash all the way the Stovepipe Wells 17.7 miles north (**Appendix E**).

Although sparse, vegetation appeared healthy upstream and downstream of the site. Releases to air from suspension of potentially contaminated particulates derived from surface soil within the basin are possible with the fine-grained tailing materials because the tailings are not buried and the area is subject to wind erosion. Wind transport and re-deposition of these smaller particulates could impact the surface soils downwind. However, strong winds showed no saltation (sediment migration) transport during the site visit (**Appendix D**). The site is open to the public and situated immediately beside the gravel access road. Windborne particulates are considered likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, and access roads near tailings.

20.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Cashier Mill is a popular destination and visitors often walk through tailings piles as they explore the mill ruins. The site is visited by approximately 3,000 people per year and potentially endangered or threatened species have been identified in the vicinity of the site (EDR 3813626.35s, **Appendix B**). DEVA staff and contractors may also visit the site. **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B**

Cashier Mill has been evaluated using site-specific CSMs. Based on the operational history of the mill and observations during the February 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from mercury amalgamation and cyanide leaching processes to extract gold. Preliminary COCs for the site included cyanide and metals. Additionally, the site was evaluated using the EPA HRS using the information provided in this report. Cashier Mill was given an overall score of 0.67 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 20-1** and sensitive ecological receptor pathways are presented in **Table 20-2**. For explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 20-1: Cashier Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	I P	I P
		Dermal	I P	I P
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	*P I*	*P I*

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 20-2: Cashier Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	*P I*	*P I*

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

20.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air. Groundwater and surface water pathways are incomplete for all receptors because there are no groundwater wells or access to impacted surface water within the target distance of 4 miles from the site, and there are no surface water bodies within 15 miles of the site. Exposures related to inhalation of windborne particulates are considered possible due to the arid climate, high wind speeds, and extended wind movement at the site, but are considered insignificant because the fraction of fine-grain material is small and tailings are partially protected by the mine structures. Coarser tailings materials are resistant to wind transport. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors, including potentially endangered or threatened species within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles. The likelihood of exposure is considered insignificant for park staff, contractors, and visitors.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data, including mercury and lead, for tailings and adjacent soil from the mercury and cyanide processing areas to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places or have been proposed for consideration will require consultation with SHPO prior to implementation of additional site inspection activities.

21.0 LOWER WILDROSE MILL (SITE #19)

The PA inspection of Lower Wildrose Mill was conducted on February 17, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C19**. **Figure 21-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill and mine, cyanide processing area, extent of tailings, and perennial stream. Site features are depicted on **Figure 21-2** and include:

- Mill and mine locations,
- Perennial stream,
- Riparian vegetation,
- Spring or seeps,
- Dissected wash,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

21.1 SITE DESCRIPTION

Lower Wildrose is a mill site located in Lower Wildrose Canyon in the western Panamint Range, 16 miles southeast of Panamint Springs, California (Latitude 36.26447°, Longitude -117.19688°) at an elevation of approximately 3,960 feet above sea level. The site is open to the public, and is accessed from Lower Wildrose Road, 0.25 mile from the junction leading to the Wildrose campground (**Figure 21-1** and **21-2**). The mill site is not well known, attracting fewer than 20 visitors each year.

Many springs and seeps are present in the drainage directly below the mill. The route to the Lower Wildrose site traces a narrow, steep-walled canyon that follows the bed of a locally perennial stream. The low-lying area along the stream upslope and downslope of the mill area is filled with areas of lush vegetation, including cottonwood trees. The 0.25-acre site encompasses the area between a sheer canyon wall to the north and a perennial reach of stream to the south.

The stream is fed by a local spring located near the site and discharge from many local springs and seeps. Lush riparian vegetation is confined to a zone within and along the streambed, making it difficult to see the mill ruins from the road. The site is approached by hiking along the north side of the canyon and up a haul road constructed over a 20-foot-high rocky bench above the streambed composed of older, competent alluvial deposits on the north side of the canyon. Upstream of the mill is a campground less than 1.0 mile away. The ruins of the Wildrose Spring Stage Station are found downstream 1.2 miles from the mill, along with a picnic table and a spring. Wildrose Spring is found approximately 0.80 mile down canyon. The water from Wildrose Spring is posted as non-potable.

The remains of a mill structure is found after a short hike above the streambed. Only a small part of the mill structure, some drums, and a small amount of tailings around the base of the mill remain. The ruins consist of a concrete mill foundation and a 55-gallon drum at the base (**Photo C19-2**), and the remains of a 12-foot-diameter corrugated galvanized steel tank at the top (**Photo C19-6**). An overview of the mill ruins from an upslope vantage is shown in **Photo C19-7**. Some mine tails show possible iron or cinnabar mineralization.

21.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

Little is known about this site, including the mine(s) of which it was associated and years of operation. The ruins suggest that small-scale cyanide leaching operations took place at this location. Cyanide solutions may have been mixed and pumped up to a processing tank, and enriched solutions extracted after leaching of the gold was complete.

Approximately 20 cubic yards of tailings are present at what is thought to be the foundation of the mill (**Photo C19-1**). The pink tailings, which range in size from silt to sand, have eroded downslope from the foundation ruins (**Photo C19-4**) and deposited as sediments on the lower bench of older alluvial material and within the channel margins of the streambed (**Photo C19-3**). **Photos C19-9, C19-10**, **C19-11**, and **C19-12** show the accumulated mill tailings in the vicinity of the alluvial bench. The fine grained tailings are being preferentially transported downslope by the stream, which scours the channel during infrequent high stages of stream flow. Sediments comprising the tailings can be traced 0.75 mile downwash to the vicinity of the former Wildrose Spring stage station, where they comingle with eroding pink native sediments and can no longer be distinguished. A thin veneer of mill tailings, approximately 0.5 inch-thick on average, has also been deposited along and downslope of the haul road (**Photo C19-15** and **C19-16**). These tailings deposits have been partially stabilized by vegetation on site. Based on the operational history and information gathered during the PA, the preliminary COCs are cyanide and metals.

A picnic area is found at the Wildrose Spring Stage Station location, which has historical significance as a stop on the stage route between Ballarat and Skidoo, and was a famous meeting place for miners setting up the Wildrose Springs Mining District. Visitors to this site could be exposed to impacted surface water and sediments along the stream bank. The spring at the stage station is marked as non-potable.

21.3 ENVIRONMENTAL SETTING

21.3.1 Geology and Hydrogeology

Geological Setting

Lower Wildrose Mill is located at the southern tip of the Cottonwood Mountains in the Panamint Range (**Figure 1**). Harrisburg Flat is to the northeast and Death Valley is to the west of the site. Panamint Valley is located west and Darwin Hills of the Argus Range are on the west side of Panamint Valley (**Appendix E**). Bedrock in the vicinity of the Lower Wildrose Mill site is later Precambrian sedimentary and metamorphic rocks of the Panamint Metamorphic Complex (**Figure 2**). The Panamint Metamorphic Complex includes granite, gneiss, schist, and metamorphosed sedimentary units.

Groundwater

The site is located in the South Lahontan HR between the Wildrose Canyon Groundwater Basin[112] and the Panamint Valley Groundwater Basin[113] in the state of California (**Section 1.2**). The Wildrose Canyon Groundwater Basin encompasses 8.1 square miles and is bound by non-water-bearing rocks of the southern Panamint Range. Locally groundwater flows west toward the Panamint Valley Groundwater Basin through Wildrose Wash. Replenishment to Wildrose Wash and the Panamint Valley is derived chiefly from the percolation of rainfall and runoff from the surrounding mountains. Percolation through the alluvial fan deposits at the base of the Panamint Mountains provides the principal recharge to the basins. Water quality data for a spring located in the eastern part of the valley indicated water was suitable for all beneficial uses (1954), but samples collected in 1954 and 1956 at Wildrose Spring, downgradient of the site, indicate high levels of sulfate and TDS.

Based upon federal database records research (EDR 3813626.38s, **Appendix B**) and available USGS topographic maps (**Appendix E**), there is one well within 4 miles of the site. This well was identified on the USGS topographic map as upgradient and located near the Ranger Station 1.2 miles east. No residents are found within 200 yards, and groundwater is not used as a drinking water source in the western portion of Wildrose Canyon Groundwater Basin.

Two unnamed springs are located near the site; the upgradient spring is located 1,000 feet east and the downgradient is located immediately adjacent or less than 90 feet from the site (**Figure 21-2**). Wildrose Spring is located 2 mile downgradient. Mud Spring is located 1.2 miles northwest of the site in Nemo Canyon, but is cross-gradient and not hydraulically connected. Three wetlands are noted in the vicinity of the Ranger Station, 0.7miles east and upgradient. The canyon in this area is thick with vegetation indicating a shallow groundwater table.

Groundwater in the Wildrose Groundwater Basin is derived from a highly deformed and mineralized zone containing ores of copper, gold, silver, lead, and zinc. Potential impacts to groundwater are anticipated to predominantly derive from these natural sources. Only a very minor cumulative mineral contribution is expected from the historic mining and milling operations, including Lower Wildrose Canyon Mill site evaluated in this PA.

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[112] Department of Water Resources. South Lahontan Hydrologic Region – Wildrose Canyon Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-75.pdf.

[113] Department of Water Resources. South Lahontan Hydrologic Region – Panamint Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-58.pdf.

21.3.2 Surface Water

A perennial stream fed by springs is present within Wildrose Canyon from 0.5 mile upslope of the Wildrose Spring Campground until infiltration, which is located 0.1 mile downgradient from the site. Riparian vegetation follows the stream and is confined to the stream channel in the wash. The tailings are migrating into the stream and carried down canyon before surface water infiltrates into the wash floor. Surface flows during storm events have deposited sediments onto the alluvial fan at the mouth of Wildrose Canyon in Wildrose Wash, which slopes toward Panamint Valley (**Appendix E**). Surface water impacts are anticipated to occur from contact with potential contaminants in tailing deposits. During most precipitation events, surface water runoff rapidly infiltrates the surficial material down wash or evaporates, limiting the potential release of contaminants to surface water.

Runoff from major precipitation events flows over the alluvial fan deposits at the base of Wildrose Canyon. Although much of the runoff that reaches the valley floor is lost to evaporation, a portion of the surface flow percolates into the subsurface and enters the groundwater system. Tailings moved during storm events may eventually be deposited on the alluvial fan of Wildrose Wash. There are no other lakes, permanent ponds, or creeks/rivers surface water bodies within 15 miles downgradient from the site. However, due to the perennial nature of the stream fed by springs, there is potential for waste material to be deposited in these riparian areas.

21.3.3 Soil, Sediment, and Air

Bedrock is approximately 3 inches below the surface material which has been classified as the Badlands soil component. Due to shallow bedrock, no drainage class is reported and the overall sediment has a very slow infiltration due to the underlying impervious bedrock (EDR 3813626.38s, **Appendix B**).

Mill tailings are migrating downslope from the vicinity of the mill foundation ruin onto an alluvial bench and into the perennial stream that flows down wash through the canyon. Fine-grained silty tailings are being preferentially transported down canyon during heavy precipitation, where they impact sediments at least 0.8 mile downwash at Wildrose Spring Stage Station (**Figure 21-2**). During flash floods, surface runoff eventually moves onto a broad alluvial fan sloping towards the Panamint Valley floor. Surface and subsurface soils and sediment in depositional areas downgradient of the site could be directly impacted by potential releases of cyanide and metals from erosional processes or surface water runoff. Storm runoff from the site will travel down canyon within the wash until infiltration occurs.

Vegetation in the area appears healthy (Appendix D). Releases to air from suspension of potentially contaminated particulates derived from surface soil/sediment within the basin are possible with the fine-grained tailing materials because the tailings are not buried and the area is subject to wind erosion and vehicular traffic on the road downstream of the site. Wind transport and re-deposition of these smaller particulates could impact the surface soils downwind. However, potential transport by wind is limited because the volume of tailings in two piles is less than 20 cubic yards and tailing deposits along the road are thin (0.5 inch thick) and partially stabilized by vegetation (**Appendix D**). Windborne particulates are considered likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, and access roads near tailings.

21.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

The Lower Wildrose site only receives approximately 20 visitors per year. Park staff and contractors may visit and work at the site, and potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.37s, **Appendix B**). Three seep/wetlands are located within 1.0 mile of the site (EDR 3813626.37s, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B**

Lower Wildrose mine has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the February 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from cyanide extraction processes to extract gold. Preliminary COCs include cyanide and metals. Additionally, the site was evaluated using the EPA HRS from the information gathered provided in the PA. Lower Wildrose was given an overall score of 0.4 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 21-1** and sensitive ecological receptor pathways are presented in **Table 21-2.** For explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 21-1: Lower Wildrose Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	*P I*	*P I*
		Dermal	*P I*	*P I*
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Wind	Air (Particulates)	Inhalation	*P I*	*P I*

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 21-2: Lower Wildrose Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	P *I*	P *I*
		Direct Contact	I P	I P	I P	I P	P *I*	P *I*
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	*P I*	*P I*	**P S**	I P	**P S**	**P S**
		Direct Contact	*P I*	*P I*	**P S**	I P	**P S**	**P S**
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	*P I*	*P I*

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

21.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, groundwater, and surface water for workers and visitors. The groundwater exposure is considered insignificant for human receptors because access to groundwater via the well is unlikely. A complete pathway is present for surface water for all receptors except soil organisms. Exposures related to inhalation of windborne particulates are considered possible due to the arid climate, high wind speeds, and extended wind movement at the site, but are considered insignificant because the fraction of fine-grain material is small and tailings are partially protected by vegetation and surface structures. Coarser tailings materials are resistant to wind transport. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors including potentially endangered or threatened species within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles. The likelihood of exposure is considered insignificant for Park staff, contractors and visitors.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data, including mercury and lead, for tailings and adjacent soil from the cyanide processing areas to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals.

22.0 OH BE JOYFUL (SITE #20)

The PA inspection of the Oh Be Joyful site was conducted on March 6, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C20**. **Figure 22-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill and mine, cyanide processing area, and extent of tailings. Site features are depicted on **Figure 22-2** and include:

- Mill location,
- Surface drainage,
- Dissected wash,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

22.1 SITE DESCRIPTION

The Oh Be Joyful site is located 17 miles southeast of Panamint Springs, California, on the west side of the Panamint Mountains (Latitude: 36.209801 N, Longitude 117.214996 W), at an elevation of 3,256 feet above sea level. The site is partially located in designated wilderness (EDR 4058976.1s, **Appendix B**). The site is open to the public and is a four-wheel drive and hiking destination. Up to 200 visitors explore the site each year. Access is provided via Tuber Canyon Road, a 3.7-mile semi-rough, unimproved gravel road that connects paved Wildrose Road to Tuber Canyon in the east. The road often washes out 3.1 miles up the canyon from Wildrose Road. The closest permanent residences to the site live in the Panamint Springs area approximately 16 miles northwest of the site.

The site is located within a small side canyon between low, steep-sided hills that open into Tuber Canyon. The Oh Be Joyful Mill site is bounded on the east by the Panamint Range and on the west by Panamint Valley. The mill and cyanide processing area covers approximately 3 acres. Vegetation at the site is sparse and appears stressed by the drought conditions. A representative view of the mountain slopes above the mining structures is shown in **Photo C20-6**. At the mouth of Tuber Canyon, coalescing alluvial fan deposits spread across the floor of Panamint Valley. **Photos C20-4** and **C20-7** provide a view from the mine and mill site downslope toward the valley.

Three springs are located cross gradient and upslope of the mine site, and two wetlands have been mapped approximately 0.75 mile upslope (EDR 4058976.1s, **Appendix B**). Spring discharge infiltrates or evaporates before contacting mine discharge or tailings. The wash bed in the vicinity of the site is dry but carries water during rain events before infiltrating into the wash bed. Evidence of erosion from storm events is present throughout Tuber Canyon. **Photos C20-19** and **C20-20** (**Appendix C20**) show washout areas with tailings deposits downslope of the site. Accumulated tailings near an intermittent stream washout are shown on **Photo C20-15** (**Appendix C20**).

22.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

Gold has been produced from two mines within the Tuber Canyon area, including the Oh Be Joyful. Based on known occurrence, the highest potential for gold was near the granitic Hall Canyon Pluton in Tuber and adjacent canyons of the Panamint Range. The mines enter the hillside above the mill, where a small tram system was used to transport the ore to the mill for processing. The milling consisted of crushing, amalgamation, and cyanide processing. Milling took place from 1899-1902 and periodically afterwards. Today there are still several of the corrugated steel cyanide tanks in place. The tanks reside on eroding, unconsolidated material as shown on **Photos C20-1 and C20-2**. Remnants of a former mill structure sits downslope of the upper set of steel cyanide tanks (**Photo C20-3**). Various abandoned mining debris and deteriorated structures lie on the ground and cabin ruins are found just below the milling facilities (**Appendix C20**).

The tailings have eroded downslope over time and now cover an area of several thousand square feet. **Figure 22-2** shows the locations where rock waste and mill tailings are eroding downslope. The mill tailings originate from two distinct sources. The older processing area is found lower on the hillside and includes the foundations of at least five deteriorated cyanide tanks. Tailings in this area are partially contained by a breached impoundment. Between 200 and 300 cubic yards of fine silt tailings are present around the tank foundations and impoundment (**Photo C20-13**). Approximately 50 cubic yards of tailings are found around the mill foundation and the four newer, relatively intact cyanide tanks located higher on the hillside. The fine pink silt tailings from both sources have been transported downslope and deposited a distance of at least 200 to 200 yards from the upper mill/cyanide processing site. Several photos in **Appendix C20** show the tailings deposits in low-lying areas of the wash. Further downslope the tailings comingle with sediments transported into Tuber Wash and become impossible to distinguish. Based on operational history and information gathered during the PA, the preliminary COCs are cyanide and metals.

22.3 ENVIRONMENTAL SETTING

22.3.1 Geology and Hydrogeology

Geological Setting

Oh Be Joyful Mill is located on the western side of the Panamint Range south of the Cottonwood Mountains (**Figure 1**). Harrisburg Flat is to the north-northeast and Death Valley is to the east of the site. Panamint Valley is located to the west of the site (**Appendix E**). Bedrock in the vicinity of the Oh Be Joyful site is later Precambrian sedimentary and metamorphic rocks of the Panamint Metamorphic Complex (**Figure 2**). The Panamint Metamorphic Complex includes granite, gneiss, schist, and metamorphosed sedimentary units[114]. The site is located within a small unnamed side canyon with dissected, steep-sided hills that opens into Tuber Canyon.

Groundwater

The site is located upgradient of the South Lahontan HR, Panamint Valley Groundwater Basin in the state of California[115] (**Section 1.2**). Groundwater flow direction generally follows surface flow, depicted on **Figure 21-2**. Based upon the topographic surface, local groundwater flow is generally to the northwest into Tuber Canyon, and through Wildrose Wash toward the Panamint Valley. Replenishment to the groundwater basin is derived chiefly from the percolation of rainfall and runoff from the surrounding mountains. Percolation through the alluvial fan deposits at the base of the Panamint Mountains provides the principal recharge to the basin. Water quality data for a spring located in the eastern part of the valley indicated water was suitable for all beneficial uses (1954), but samples collected in 1954 and 1956 at Wildrose Spring, downgradient of the site, indicate high levels of sulfate and TDS.

Based upon federal database records research (EDR 4014387.2s, **Appendix B**) and available USGS topographic maps (**Appendix E**), there are no wells within 4 miles of the site. No residents are found within 200 yards, and groundwater is not used as a drinking water source in the eastern portion of the Panamint Valley Groundwater Basin. Two unnamed springs are located up and cross-gradient 0.9 miles and 2 mile east of Oh Be Joyful Mill.

Groundwater within Panamint Valley Groundwater Basin is derived from a highly deformed and mineralized zone containing ores of copper, gold, silver, lead, and zinc. Potential impacts to groundwater are anticipated to predominantly derive from these natural sources. Only a very minor cumulative mineral contribution is expected from the historic mining and milling operations, including those sites evaluated in this PA.

22.3.2 Surface Water

Surface water flow at the site is generated from infrequent heavy precipitation and is sourced along the short side canyon that opens into Tuber Canyon. Sheet flow within the 0.4-mile portion of canyon upslope of the site will collect in the local wash and flow 0.2 miles before entering Tuber Canyon. From its confluence with flow in Tuber Canyon, runoff will flow 0.6 miles until it empties into the Panamint Valley. The site is near the mouth of Tuber Canyon, and so runoff from the side canyon will comingle with storm flow beginning 7 miles east up canyon at the headwaters. This canyon appears to have primarily self-contained surface flow. Surface water that reaches Wildrose Wash flows into the Panamint Valley and toward Alkali Lake (dry) (**Appendix E**).

Two wetlands are associated with identified spring upgradient and upslope approximately 0.9 miles northeast of the mill site (EDR 4058976.2s, **Appendix B**). The discharge infiltrates or evaporates before reaching the site or contacting mine discharge or tailings. The wash bed in the vicinity of the site is dry but carries water during rain events. Stormwater flow within Tuber Canyon will not impact the upgradient springs. Runoff within the wash flows onto a broad alluvial fan sloping toward Panamint Valley. During most precipitation events, surface water runoff rapidly infiltrates the wash bed or evaporates, limiting the potential release of contaminants to surface water. There are no lakes, permanent ponds, or creeks/rivers within the target distance of 15 miles downgradient of the site, and

114 R. Streitz and M. Stinson, California Division of Mines and Geology, Geologic Map of California, Death Valley Sheet. 1974, Second Printing 1980.

115 Department of Water Resources. South Lahontan Hydrologic Region – Panamint Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-58.pdf.

because of the arid climate and rapid infiltration rate, transport of waterborne waste constituents significant distance off site is unlikely.

22.3.3 Soil, Sediment, and Air

The site has accumulated a thin layer of alluvial sediments which appear to be sands and gravels. Bedrock is present at the site; therefore, surficial soils are typically less than 3 inches thick and are likely well drained; however the overall infiltration rate is slow (EDR 40143873.2s, **Appendix B**).

Approximately 250 cubic yards of mill tailings originate from the mill foundation, upper cyanide tanks, and lower cyanide tank foundations (**Figure 22-2**). Mill tailings are also present in a partially blocked, breached impoundment, and waste rock detritus is washing downslope from above the site. Storm runoff from the site will travel down canyon within the wash until infiltration or evaporation occurs. The fine pink silt tailings from all sources are being preferentially transported down canyon and deposited a distance of at least 200 to 300 yards from the upper mill/cyanide processing site (**Appendix D**). Surface and subsurface soils and sediment in depositional areas downgradient of the site could be directly impacted by potential releases of cyanide, mercury, and metals associated with erosional processes or surface water runoff. Transported contaminants could be deposited as sediments and infiltration of waters into the soil could result in leaching of contaminants and transport through the soil column to subsurface soil at depth. During intense flash floods, sediments could move onto a broad alluvial fan sloping toward the Panamint Valley floor.

The site is open to the public and is a four-wheel drive and hiking destination. Up to 200 visitors come to the site each year. Visitors can easily walk among the ruins to explore the site. DEVA staff and contractors also access these areas. These activities may disturb the mill tailings. Soil, sediment, and air present potentially complete exposure pathways to human and ecological receptors.

Releases to air from suspension of potentially contaminated particulates derived from surface soil within the basin are likely because the tailings are exposed at the surface and the area is subject to wind erosion. Mill tailings are fine-grained and subject to wind transport. Re-deposition of these particulates could impact the surface soils downwind.

22.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

The Oh Be Joyful Mill is a backcountry destination for four-wheel drive enthusiasts and hikers, and visitors may contact the mill tailings as they examine the mill and mine workings. The site is visited by approximately 200 people per year. Workers such as park staff and contractors may also visit the site. No potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site. **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B**

Oh Be Joyful Mill has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the March 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from cyanide leaching to extract gold. Preliminary COCs include cyanide and metals. Additionally, the site was evaluated using the EPA HRS from the information gathered provided in the PA. Oh Be Joyful was s given an overall score of 1.37 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 22-1** and sensitive ecological receptor pathways are presented in **Table 22-2**. For site-specific explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 22-1: Oh Be Joyful: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	I P	I P
		Dermal	I P	I P
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 22-2: Oh Be Joyful: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant

P I – Potentially complete pathway but considered insignificant

I P – Incomplete pathway; no evaluation necessary

22.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. Shallow groundwater may be present at this site; however, there are no wells to complete exposure pathway. Surface water was not observed at the site and is only present seasonally upstream of the mill site and during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the cyanide processing area to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places or have been proposed for consideration will require consultation with SHPO prior to implementation of additional site inspection activities.

23.0 GEM MINE (SITE #21)

The PA inspection of Gem Mine was conducted on March 7, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C21**. **Figure 23-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill, cyanide processing area, and extent of tailings. Site features are depicted on **Figure 23-2** and include:

- Mill and process area locations,
- Surface drainages,
- Riparian vegetation,
- Dissected wash,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

23.1 SITE DESCRIPTION

Gem Mine is located in Jail Canyon in the western Panamint Range approximately 9 miles north of Ballarat and 26 miles southwest of Furnace Creek (Latitude 36.192600°, Longitude -117.178101°) at an elevation of approximately 3,820 feet above sea level. The site is open to the public and is accessed via a rough four-wheel drive road, located approximately 3.8 miles from the intersection of Indian Ranch Road and Trona Wildrose Road. The 4-mile drive follows the main wash on the north side of the canyon that has been deeply eroded by flash floods. The hike from the road's end to the mine and mill site is approximately 1 mile. Fewer than 200 visitors hike to the site each year.

The route to Jail Canyon crosses the alluvial fan created by drainage from the canyon. The 15-acre site begins where the eastern tributary of Jail Canyon extends up a narrow, steep-walled canyon section to include the mines and spring emanating from the canyon wall. The existing mill structure from a later phase of mining activity is found up canyon approximately 700 feet from a cabin located at the mouth of an eastern tributary. The 1-mile hike from the road to the mill ruins partially follows a perennial stream (**Photos C21-3** and **C21-20**) fed by a year-round spring that supports an assemblage of riparian vegetation (EDR 4058976.2s, **Appendix B**). The spring in this canyon historically produced enough water to run a waterwheel, which powered a three-stamp mill.

The ruins are a mix of older and more modern structures. Processing equipment sits at the end of the road that was powered by a gasoline engine sometime after 1950. In the same location are the remains of a concrete slab that is possibly the site of the three-stamp mill run by the waterwheel when operations began in 1899. Several tanks and a portable soft-sided tank occur in the area with possible flotation mill debris (**Photo C21-9**). Mining debris and ruins are common on site (**Photos C21-2** and **C21-17**). The trail leads up-canyon to a cabin and densely vegetated area, then follows the streambed (**Photos C21-11** and **C21-12**). The more modern, largely intact mill sits 0.125 mile from the cabin and is largely hidden from view. An ore crusher, ball mill, agitator/classifier, conveyer belt, flotation tank, and concentration table are evident (**Photos C21-15**, **C21-18**, and **C21-19**). Above the mill are various openings to the mine. Equipment ruins and a spring that contributes to the stream are further up the canyon.

A tailings area is present at the suspected location of the original three-stamp mill (**Figure 23-2)**. Less than 10 cubic yards of tailings and mine waste is found in the vicinity of the larger, more modern mill structure (**Photo C21-15**). Approximately 50 cubic yards of pinkish-orange tailings, ranging in size from silt to coarse sand, cover the tank, tank pad, and original mill foundation area (**Figure 21-2**; **Photos C21-13** and **C21-14**). Down canyon, a dammed tailings pond and two level benches partially contain approximately 200 cubic yards of tailings. The tailings are eroding into the perennial stream that flows down canyon in the wash (**Photo C21-21**). Discharge from Jail Canyon during storm events has formed a broad alluvial plain at the mouth of the canyon. No evidence of tailings deposits was observed on the alluvial fan surface (**Appendix D**).

23.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

Jack Curran found the mine in 1899, when it was known as the Gem Mine. He gave half interest to Ballarat storekeeper Charles Weaver in exchange for a three-stamp mill. They rigged up the little mill to run from a waterwheel, the first in Death Valley, and started shipping several thousand dollars in bullion monthly in the winter of 1899-1900. Mining at the Gem Mine, Ratcliff, World beater, and Oh Be Joyful mines and others supported the town of Ballarat, CA. In 1901 a cloudburst in the Panamint Mountains caused flash floods which destroyed the original three-stamp Gem mill in Jail Canyon. The mining and milling facility was repaired/rebuilt after this and other flood events.

The mill has undergone several phases of activity, operating as the New Discovery Mine, and later as the Corona Mine. The ore is contained in quartz veins near a contact of Paleozoic schist with a granitic mass. The mass intruded Paleozoic schist, limestone, and quartzite. Ore minerals are galena, chalcopyrite, pyrite, pyrrhotite, bornite, and sphalerite, and the mine produced gold, silver, zinc, and lead. The gold is associated with sulfide minerals.[116] As described in the 1950s, the mine contained several adits, tunnels, and shafts. Mine equipment consisted of a compressor and hoist powered by a gasoline engine. A 25-ton mill included a 12 by 16-inch Pilgrim crusher, a 4- by 6-foot ball mill, a rake

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classifier, a 4-cell Groch flotation unit, and a concentrating table[117]. The last mining efforts took place in the 1980s.

During the early period of operations, a three-stamp mill was used to crush the ore before cyanide leaching and flotation methods were used to extract the precious metals. Mercury amalgamation processes may also have been used during the mill's early history. Cyanide leaching and flotation processing followed by gravity concentration before smelting were likely used to extract the precious metals contained in the ore mined during later operations. These extraction processes are described in Section 1.5. Based on the operational history and information gathered during the PA, the preliminary COCs are cyanide and metals.

A storage shed on site contained one or two bags of borax (50 pounds), one bag of fertilizer (Grangetto's 15-15-15 Triple Nutrient Booster (30 pounds), one bag of concrete (30 pounds), four or five bags of polyethylene (200 pounds), one to two bags of soda (50 pounds), five to seven bags of petrothene (300 pounds), one bag of Three Elephant borax powder (50 pounds), and two large boxes of a fine white powder (300 pounds in boxes and loose) (**Appendix D**). **Photos C21-4** through **C21-8** document the contents of the storage shed.

23.3 ENVIRONMENTAL SETTING

23.3.1 Geology and Hydrogeology

Geological Setting

Gem Mine is located on the western side of the Panamint Range south of the Cottonwood Mountains (**Figure 1**). Harrisburg Flat is to the north-northeast and Death Valley is to the west of the site. Panamint Valley is located west and Darwin Hills of the Argus Range are on the other side of the valley (**Appendix E**). The Gem Mill site is located on later Precambrian sedimentary and metamorphic rocks and Mesozoic granitic rocks (**Figure 2**). Bedrock is the Panamint Metamorphic Complex, which contains granite, gneiss, schist, and metamorphosed sedimentary units, and Hunter Mountain Quartz Monzonite, which in the central Panamint Range consists of gneissic and porphyritic quart monzonite[118] (**Figure 23-2**). The site is located approximately 1.75 miles from the mouth of Jail Canyon and extends up the southern steep-walled canyon branch to include the mine and mill location.

Groundwater

The site is located upgradient of the South Lahontan HR, Panamint Valley Groundwater Basin in the state of California[119] (**Section 1.2**). Groundwater flow direction generally follows surface water flow, depicted in **Figure 23-1**. Based on the topographic surface, groundwater flow is generally to the west in Jail Canyon and then through Wildrose Wash toward the Panamint Valley. Replenishment to the groundwater basin is derived chiefly from the percolation of rainfall and runoff from the surrounding mountains. Percolation through the alluvial fan deposits at the base of the Panamint Mountains provides the principal recharge to the basin.

Based upon federal database records research (EDR 4014387.1s, **Appendix B**) and available USGS topographic maps (**Appendix E**), there are no wells within 4 miles of the site. No residents are found

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117 Mines of Inyo County, California Journal of Mines and Geology, vol.47, no. 1 January 1951

118 R. Streitz and M. Stinson, California Division of Mines and Geology, Geologic Map of California, Death Valley Sheet. 1974, Second Printing 1980.

119 Department of Water Resources. South Lahontan Hydrologic Region – Panamint Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-58.pdf.

within 200 yards, and groundwater is not used as a drinking water source at the site. One unnamed springs is located upgradient of the site 2 miles east. The canyon in this area is thick with riparian vegetation indicating a shallow groundwater table.

23.3.2 Surface Water

Surface water at the site is generated from infrequent heavy precipitation and begins at the headwaters of Jail Canyon 5.3 miles east. This canyon is primarily self-contained. In the vicinity of the site, surface water is generated along a two-mile ridgeline on the north and south headwall marking the surface water divide at the top of Jail Canyon. Surface water flow during rainfall events would include sheet flow over the portions of the site at relatively higher elevation and channeled flow for approximately 6.4 miles from the canyon headwaters to the site. The channelized runoff within Jail Canyon flows west and south approximately 1.7 miles until it empties into Wildrose Wash and then the Panamint Valley (**Appendix E**). Surface water that reaches the Panamint Valley would flow toward Lower Panamint Lake (dry).

Two miles of streambed are present within Jail Canyon from 3,600 to 5,200 feet above sea level. A perennial stream with vegetation dominated by *Salix spp*, *Baccharis sp*, *Foresteria neomexicana*, and some *Populous fremontii, Vitis girdiana*, and C*lematis ligusticifolia* cover some areas. The riparian vegetation is confined to the streambed at the base of the canyon (**Figure 23-2**). The tailings are migrating into the stream and carried down canyon before the stream infiltrates into the wash floor. Surface flows during storm events may have deposited sediments onto the alluvial fan at the mouth of Jail Canyon that slopes toward Panamint Valley. During most precipitation events, surface water runoff rapidly infiltrates the surficial material down wash or evaporates, limiting the potential release of contaminants to surface water. There are no other lakes, permanent ponds, or creeks/rivers surface water bodies within 15 miles downgradient from the site. However, due to the perennial nature of the stream fed by the upgradient spring, there is potential for waste material to be deposited in these riparian areas.

23.3.3 Soil, Sediment, and Air

A thin layer of alluvial sediments has accumulated from clays to gravel. Due to its location a relatively steep hill side, bedrock is approximately 20 inches bgs. This indicates that although the upper surficial soils may be well drained, the overall soil has a very slow infiltration rate. The surficial soil type is identified as the Theriot soil component with the upper 3 inches considered cemented sandy clay. Depth to the water table is more than 6 feet (EDR 4014387.1s, **Appendix B**).

Mill tailings are migrating down slope into the perennial stream that flows down wash through the canyon. Tailings form moderately thick accretions in the area near the tailings pond and benches (**Figure 23-2**); fine-grained silty tailings are being preferentially transported down canyon where they eventually move onto a broad alluvial fan sloping towards the Panamint Valley floor. Surface and subsurface soils and sediment in depositional areas downgradient of the site could be directly impacted by potential releases of cyanide, mercury, and metals from erosional processes or surface water runoff. Storm runoff from the site will travel down canyon within the wash to Panamint Lake or until infiltration occurs.

Riparian vegetation is prevalent at the site until the location where a north confluence enters the canyon and the ravine widens and has filled with sediment. The low-lying area that has accumulated tailings is not adequately covered by vegetation or native sediments. Vehicles can access this area; however, the observed tailings are not directly in contact with the road. Releases to air from suspension of potentially contaminated particulates derived from surface soil within the basin are likely because the tailings are not covered and the area is subject to wind erosion. Mill tailings are fine-grained and subject to wind transport. Re-deposition of these particulates could impact the surface soils downwind.

23.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Gem Mill is visited by approximately 200 people per year who may walk through tailings deposits as they explore the mill site ruins. No potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 4058976.2s, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B.**

The Gem Mine site has been assessed using site-specific CSMs. Based on the operational history and information gathered during the March 2014 site visit, the environmental hazards considered in the evaluation focus on the mine waste/mill tailings from mercury amalgam, cyanide leaching, and flotation processes to extract gold and silver extraction. Preliminary COCs include cyanide and metals. Additionally, the site was evaluated with the EPA HRS using the information provided in this report. The Gem site was given an overall score of 1.41 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 23-1** and sensitive ecological receptor pathways are presented in **Table 23-2**. For site-specific explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 23-1: Gem Mine: Human Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	I P	I P
		Dermal	I P	I P
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 23-2: Gem Mine: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	**P S**	I P	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	I P	**P S**	**P S**
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

23.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and surface water. The groundwater pathway is incomplete for human receptors because there are no groundwater wells. A complete pathway is present for surface water for all receptors except soil organisms. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors including potentially endangered or threatened species within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles. The likelihood of exposure is considered insignificant for Park staff, contractors and visitors.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the mercury and cyanide processing areas to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals.

24.0 UNKNOWN (SOURDOUGH CANYON) (SITE #22)

The PA inspection of Sourdough Canyon was conducted on March 5, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C22**. **Figure 24-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill, cyanide processing area, extent of tailings, and perennial stream. Site features are depicted on **Figure 24-2** and include:

- Mill and process area locations,
- Perennial stream,
- Riparian vegetation,
- Springs or seeps,
- Dissected wash,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

24.1 SITE DESCRIPTION

The mill in Sourdough Canyon is located 25 miles southeast of Panamint Springs, California, in Sourdough Canyon, at an elevation of approximately 6,302 above sea level (latitude 36.117 North, longitude 117.097 West). The site is located deep in the Panamint Range and is accessed via 14 miles of dirt road (graded and four-wheel drive), followed by a strenuous 6-mile hike with 4,000 feet of elevation gain. Inyo County maintained the road to Panamint City/Sourdough Canyon until 983, when a series of cloudbursts completely washed the canyon out to bedrock. The ruins are open to the public. Despite the remoteness of the site, it is well known and very popular with backpackers.

Sourdough Canyon is a secluded steep and narrow tributary canyon of Surprise Canyon located north of Panamint City, between Telescope Peak and the Panamint Valley. The 3-acre mill site is bounded to the north, west, and east by steep mountains. A representative overview of the site is shown on **Photo C22-1**. Two springs, Limekiln Spring and Brewery Spring, are found 3 to 5 miles downgradient of the site. These springs discharge to a perennial stream.

Several structures were observed during the site visit, including an ore bin, ball mill, classifier, and cyanide process tanks (**Photos C22-6, C22-12 and C22-15**). The mining structure and equipment are in a deteriorated condition as shown on **Photos C22-7** and **C22-8**, but still relatively intact. Abandoned vehicles, campers, trailers, and construction equipment litter the hillside (**Photos C22-4**, **C22-5**, and **C22-10**), along with rusted drums on the edge of the settling basin (**Photos C22-13** and **C22-14**) and general refuse, including batteries (**Photo C22-9**). Deteriorating mill structures are present on the hilltop overlooking the cyanide process tank and impoundment that holds the majority of tailings (**Photos C22-11** and **C22-15**).

24.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

The area around Panamint City has been a silver producing region since the 1870's. The mineral belt in this region of the Panamint Range is 2.5 miles wide and 5 miles long. Silver veins, some highly fractured, run parallel to Surprise Canyon for a significant distance. The silver bearing ore is characterized by a rich, high yield ore near the surface that transitioned with depth to ore containing copper, lead, iron, and zinc. The change in ore character meant that original expectations for production were not met as the mines were developed in depth. This ultimately leads to mine failure and abandonment.

Information available for the site is limited, though it is fairly modern and was probably used in the 1970s. The site sits just above the former town of Panamint City and contains abandoned structures typical of a small-scale cyanide operation. The mill, classifier, and cyanide tanks appear to date to the 1960s or 1970s. Tailings were piped to cyanide tanks and then emptied to an impoundment following processing (**Photo C22-12**). Near the end of Surprise Canyon Road is a well preserved cabin (**Photo C22-3**), and approximately 1 mile along the north canyon face are the remnants of historic mining activity (**Photo C22-16**).

The mill tailings are found mainly within the impoundment located south of the mill. The basin is 20 feet by 40 feet and contains approximately 50 cubic yards of fine white sand tailings and minor mine debris (**Photo C22-11**). The basin appears structurally sound, with a stable dam. Fewer than 10 cubic yards of coarser tailings are present in the vicinity of the mill and shaker table (**Appendix D**). One cyanide process tank contains approximately 10 cubic yards of tailings. Based on the operational history and information gathered during the PA, the preliminary COCs are cyanide and metals.

The mill site at Sourdough Canyon is part of the Panamint Historic Mining District located within the boundaries of the lands added to Death Valley National Monument (now DEVA) in 1994. The Park Service has determined to nominate the Panamint Historic Mining District, including the Sourdough Canyon site, for listing on the National Register of Historic Places because of its historical significance, integrity of the archaeological remains, and research potential.

24.3 ENVIRONMENTAL SETTING

24.3.1 Geology and Hydrogeology

Geological Setting

Sourdough Canyon Mill is located on the western side of the central portion of Panamint Range, between Telescope Peak and Sentinel Peak (**Figure 1**). Panamint Valley lies to the west and Death Valley lies to the east over the crest of the Panamint Range (**Appendix E)**. Bedrock in the vicinity of the Sourdough Mill site is later Precambrian sedimentary and metamorphic rocks of the Panamint Metamorphic Complex[120] (**Figure 2**). The Panamint Metamorphic Complex includes granite, gneiss, schist, and metamorphosed sedimentary units. The site lies in Sourdough Canyon, a tributary at the top of Surprise Canyon and is bounded to the north, west, and east by steep mountains.

The surrounding area and hills in the Surprise Canyon area are heavily mined which indicates a strong likelihood of potential intermixing of transported sediments adjacent to the site. Typical prospects are mining for ore containing copper, gold, and silver and also have associated mills to extract metals.

Groundwater

The site is located upgradient of the South Lahontan HR, Panamint Valley Groundwater Basin in the state of California[121] (Section 1.2). Groundwater flow direction is generally follows surface water flow, depicted on **Figure 23-2**. Based on the topographic surface, local groundwater flow is generally to the south for 0.2 miles down Sourdough Canyon, then west approximately 6.3 mile in Surprise Canyon before emptying into the Panamint Valley Groundwater Basin. Depth to the water table is more than 6 feet (EDR 3813626.40s, **Appendix B**). Replenishment to the groundwater basin is derived chiefly from the percolation of precipitation and runoff from the surrounding mountains. Percolation through the alluvial fan deposits at the base of the Panamint Mountains provides the principal recharge to the basin.

Based upon federal database records research **(**EDR 3813626.40s, Appendix B) and available USGS topographic maps (**Appendix E**) there are no wells within 4 miles of the site. No permanent residents are found within 200 yards; however, a cabin is located on site that is a destination for backpackers. One unnamed spring is located upgradient of the site immediately to the north and may be a source of drinking water. However, because the spring is upgradient any waste materials from the site will not impact this source of potential drinking water. Two springs are located down gradient of the site, Brewery Spring is located 1.8 miles west and Limekiln Spring is located 2.9 miles east. Each downgradient spring has an associated 0.5-1 mile-long riparian area downgradient.

24.3.2 Surface Water

Surface water at the site is generated from infrequent heavy precipitation and is sourced along the 5-mile-long ridgeline marking the surface water divide at the top of Sourdough/Surprise Canyon. Surface water flow during rainfall events includes sheet flow over the portions of the site at relatively higher elevation over the 1.5-mile wash, and flow from directly upslope or north of the site. Flow from Sourdough Canyon joins the channelized runoff in Surprise Canyon 0.2 miles south or downslope from the site, and flows west, then southwest approximately 6 miles until it empties into the Panamint Valley. (**Appendix E**).

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[120] R. Streitz and M. Stinson, California Division of Mines and Geology, Geologic Map of California, Death Valley Sheet. 1974, Second Printing 1980.

[121] Department of Water Resources. South Lahontan Hydrologic Region – Panamint Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-58.pdf.

A spring is identified 600 feet up the surface drainage north of the site and is also recognized as national wetland. The spring supporting the wetland appears to discharge from the hill slope and will not be impacted by the site. A segment of stream fed by two perennial springs is located 2 to 3 miles downgradient of the site within Surprise Canyon. Sediment and surface water flow during storm events could potentially carry mill waste materials into the stream and riparian vegetation areas (**Figure 24-2**). The diked impoundment/settling basin contains silt mill tailings, but no water. The Sourdough site is in the same subregional drainage basin as the Panamint City Smelter (Site #23). Potential transported material by surface water from the Panamint City Smelter must travel approximately 1/4 miles downgradient before it could comingle with material from Sourdough Mill (Figure 24-4). No surface water quality data were discovered during research.

Any precipitation or surface flow potentially entering the settling basin will likely evaporate to the atmosphere or infiltrate to the subsurface. During most precipitation events, surface water runoff rapidly infiltrates the surficial material or evaporates, limiting the potential release of contaminants to surface water. The downgradient riparian areas may be affected by surface flow from the site during periods of heavy rainfall. However, the tailings on site are contained are do not appear to migrate downslope. Area vegetation did not appear to be stressed (Appendix D). There are no lakes or permanent ponds within 15 miles downgradient from the site; however, the spring-fed perennial creek that flows through the site may provide a pathway for sediment to be deposited or carried.

24.3.3 Soil, Sediment, and Air

A thin layer of alluvial sediments has accumulated from clay to gravel. Due to its location on a relatively steep hill side, bedrock is approximately 20 inches bgs. This indicates that although the upper surficial soils may be well drained, the overall soil has a very slow infiltration rate (EDR 3813626.40s**, Appendix B**). The surficial soil type is identified as the Theriot soil component with an upper 3 inches considered cemented sandy clay.

Except for material present in an abandoned cyanide tank and within the mill and shaker table area, the tailings from the cyanide extraction process are contained within a diked impoundment/settling basin (**Figure 24-2**). The impoundment and dam structures are in good condition with sufficient freeboard to contain precipitation from rain events (**Appendix C**). No deterioration of the dam or berm surrounding the basin was noted (**Appendix D**). All tailings areas appear stable, and media downgradient of the site do not appear impacted by the release and transport of contaminants from erosional processes or surface water runoff. No vegetation grows within the impoundment area and no native sediments appear to be covering this area. Signs of animals in the tailings of the impoundment indicate that this area is accessible to wildlife as well. The ECM geologist observed no evidence that erosion and downslope deposition of sediments are occurring. If elevated metals concentrations are present in the surface soil as a result of past operations, then infiltration of waters into the soil could result in leaching of contaminants and transport through the soil column to subsurface soil at depth.

Releases to air from suspension of potentially contaminated particulates derived from surface soil within the basin are likely because the tailings are not buried and the area is subject to wind erosion. Mill tailings are fine-grained and subject to wind transport. Re-deposition of these particulates could impact the surface soils downwind. Windborne particulates are considered highly likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, and the loose nature of tailings within the impoundment area.

24.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

The Sourdough Canyon Mill is a popular destination for backpackers despite its remoteness. Visitors may come in contact with tailings as they explore. The site is visited by approximately 200 people per year and potentially endangered or threatened species and sensitive environments have been identified in the vicinity of the site (EDR 3813626.39s, **Appendix B**). Park staff and contractors may visit or work at the site. **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B.**

The Sourdough Canyon site has been assessed using site-specific CSMs. Based on operational history of the mill and observations during the March 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from cyanide leaching processes to extract silver and gold. Preliminary COCs for the site include cyanide and metals. Additionally, the site was evaluated using the EPA HRS using the information gathered in the PA. Sourdough Canyon was given an overall score of 0.67 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 24-1** and sensitive ecological receptor pathways are presented in **Table 24-2**. For site-specific explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 24-1: Sourdough Canyon Mine: Human Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	P *I*	P *I*
		Dermal	P *I*	P *I*
Water Erosion	Sediment	Ingestion	I P	I P
		Dermal	I P	I P
Leaching/Runoff	Surface Water	Ingestion	P *I*	P *I*
		Dermal	P *I*	P *I*
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 24-2: Sourdough Canyon Mine: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	*P I*	*P I*	I P	I P
		Direct Contact	I P	I P	*P I*	*P I*	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	P *I*	P *I*
		Direct Contact	I P	I P	I P	I P	P *I*	P *I*
Water Erosion	Sediment	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Leaching/Runoff	Surface Water	Ingestion	I P	I P	P *I*	P *I*	P *I*	P *I*
		Direct Contact	I P	I P	P *I*	P *I*	P *I*	P *I*
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

24.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil and air. Surface soil represents complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil but exposure is believed to be insignificant due to the limited amount of dispersed tailings at the site. There is evidence of shallow groundwater at this site due to the presence of upgradient springs. Several wells located downgradient are not used for drinking water; therefore, human exposure is considered insignificant. Although surface water was not observed at the site and is only present during runoff from infrequent precipitation events, there are wetlands located approximately 2 miles downstream of the site in Surprise Canyon. Runoff from the site could result in an insignificant exposure to surface water for human and ecological receptors. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the cyanide processing area to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals.

25.0 PANAMINT CITY SMELTER (SITE #23)

A site visit to Panamint City Smelter was conducted on March 4 and 5, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C23**. **Figure 25-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill and processing areas, extent of tailings, and perennial stream. Site features are depicted on **Figure 25-2** and include:

- The location of perennial stream,
- Riparian vegetation,
- Dissected wash,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

25.1 SITE DESCRIPTION

Panamint City Smelter is located 25 miles southeast of Panamint Springs, California, in Surprise Canyon (Latitude 36.11702°, Longitude -117.09705°) at an elevation of 6,926 feet above sea level. This site is located deep in the Panamint Range and is accessed via 14 miles of dirt road (graded and four-wheel drive), followed by a strenuous 6-mile hike with 4,000 feet of elevation gain. Two springs, Limekiln Spring and Brewery Spring, flow 3 to 5 miles downgradient of the site. These springs discharge to a perennial stream. The remains of the mill and smelter structures are open to the public. Despite the remoteness of the site, it is well known and very popular with backpackers.

The site lies at the top of Surprise Canyon and bounded to the north, south, and east by steep mountains. Surprise Canyon is a secluded steep canyon and contains the ruins of Panamint City. Inyo County maintained the road to Panamint City/Sourdough Canyon until 1983, when a series of cloudbursts completely washed the canyon out to bedrock. The investigation area at Panamint City covers approximately 15 acres and consists of a 1870's smelter area and a 1970's mill and floatation processing area with a tailings pond. A broad view of the canyon and process structures is shown on Photo C23-21 (**Appendix C23**).

Figures 25-1 and **25-2** show key site features of the Panamint City site. Several structures remain following abandonment of the mill and smelter (**Photos C23-1** and **C23-6**). The smelter area includes brick smelter ruins (**Photo C24-5**), several tall rock walls and footings (**Photo C23-8**), and a 70-foot brick smokestack (**Photo C23-1**). Mill ruins are present on the hillside overlooking the tailing impoundment holding the majority of tailings (**Photos C23-6**, **C23-7**, and **C23-19**). Overviews of the site are presented as **Photos C23-16** and **C23-19**. The ruins of Panamint City were added to Death Valley National Park in October of 1994.

25.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

Panamint City was a rough place during its heyday. Its founders were outlaws who, while hiding from the law in the Panamint Mountains, found silver in Surprise Canyon. Concentration of the silver ore on the site consisted of crushing and smelting. In 1874 the town was at the peak of its boom with a population of 2,000 citizens. The silver ore was reduced in Panamint City by the Surprise Valley Mill and Water Company's massive 20-stamp mill which was constructed in 1874-75. By the fall of 1875 the boom was over, and in 1876 a flash flood reportedly destroyed most of the town. Periodic small-scale attempts have been made to revive the area, the latest in 1982, but none have been successful.

The area around Panamint City has been a silver producing region since the 1870's. The mineral belt in this region of the Panamint Range is 2.5 miles wide and 5 miles long. Silver veins, some highly fractured, run parallel to Surprise Canyon for a significant distance. The silver bearing ore is characterized by a rich, high yield ore near the surface that transitioned with depth to ore containing copper, lead, iron, and zinc. The change in ore character meant that original expectations for production were not met as the mines were developed in depth. This ultimately led to mine failure and abandonment. The silver ore that was processed at the smelter originated from several mines in the area and in some cases was delivered to the mill via a 2,600-foot aerial tramway. Ore averaged $80 to $100 a ton from the Wyoming and Hemlock mines. The more recent phase of extraction during the 1970's included milling of ore then used a flotation process to extract metals. Ore was brought into the mill, placed on a conveyer, and crushed. It was screened for size, and returned to the crusher if too large. Ore was then passed through a rod mill. This type of mill used long iron rods that rolled around to further crush the ore into a fine powder. The resulting powder was passed through a ball mill, which rolled 2- to 3-inch-diameter iron balls over the powder to crush the ore in an even finer material capable of flotation separation.

The different metals in the powdered ore material were then separated using flotation cells. A mix of reagents and flocculants were introduced to the ore slurry to cause the desired metals to float to the top of the tank solution while at the same time sinking the other metals. In these systems, lead is typically removed first, followed by copper, and finally silver. The solutions were pumped through filters that left a damp cake-like material that was passed through a squeeze press. No amalgamation with mercury was performed as the ore was processed to recover silver. The waste material (tailings) made of water, reagent/flocculants, and ground rock were gravity fed through a 4-inch polyvinyl chloride pipe downslope to a settling pond, where the solid tailings settled out. The settling pond is now dry and contains only solid tailings. The borax found in drums on site (**Photo C23-18**) could have been used as a flocculent in the separation process.

The mill tailings are found mainly within the impoundment located north of the mill. The basin is 75 feet by 100 feet and contains approximately 200 cubic yards of pink silty tailings and minor mine debris (**Photo C23-7**). The basin appears structurally sound, with a stable dam. Fewer than five cubic yards of tailings are present at the mill and no tailings were observed near the smelter (**Appendix D**).

Panamint City is unique as it is the only ghost town that is located within the boundaries of the lands added to Death Valley National Monument (now DEVA) in 1994. The Park Service has determined to nominate the Panamint Historic Mining District, including Panamint City, for listing on the National Register of Historic Places because of its historical significance, integrity of the archaeological remains, and research potential.

25.3 ENVIRONMENTAL SETTING

25.3.1 Geology and Hydrogeology

Geological Setting

Panamint City Smelter is located in the center of the Panamint Range, on the western side, between Telescope Peak and Sentinel Peak (**Figure 1**). Panamint Valley lies to the west and Death Valley lies to the east over the crest of the Panamint Range (**Appendix E**). Bedrock in the vicinity of the Panamint City Smelter site is later Precambrian sedimentary and metamorphic rocks of the Panamint Metamorphic Complex[122] (**Figure 2**). The Panamint Metamorphic Complex includes granite, gneiss, schist, and metamorphosed sedimentary units. The site lies at the top of Surprise Canyon and is bounded to the north, south, and east by steep mountains.

Groundwater

The site is located upgradient of the South Lahontan HR, Panamint Valley Groundwater Basin in the state of California[123] (**Section 1.2**). The groundwater flow direction generally follows surface water flow, depicted on **Figure 25-2**). Based upon the topographic surface, local groundwater flow is generally west approximately 6.3 mile through Surprise Canyon, and into the Panamint Valley Groundwater Basin. Replenishment to the groundwater basin is derived chiefly from the percolation of rainfall and runoff from the surrounding mountains. Percolation through the alluvial fan deposits at the base of the Panamint Mountains provides the principal recharge to the basin. Water quality in the Panamint Valley Groundwater Basin in this area is inferior for domestic use and inferior to marginal for irrigation.

Based upon federal database records research (EDR 3813626.40s, **Appendix B**) and available USGS topographic maps (**Appendix E**), there are no wells within 4 miles of the site. No permanent residents are found within 200 yards and groundwater is not a source of drinking water. Two springs are located downgradient of the site, Brewery Spring is located 1.9 miles west and Limekiln Spring is located 3 miles east. Each downgradient spring has an associated 0.5-1 mile-long riparian area downgradient.

Four wetlands are located within target distance (EDR 3813626.40s, **Appendix B**). Three of the wetlands are located upgradient of the site, and the fourth coincides with the settling basin constructed to hold tailings downgradient of the mill. Except for a small volume of tailings present at the mill, the tailings from the 1970s separation process are contained within the diked impoundment/settling basin. Although shown as a wetland in the EDR, the settling basin contains no water. Any precipitation or

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122 R. Streitz and M. Stinson, California Division of Mines and Geology, Geologic Map of California, Death Valley Sheet. 1974, Second Printing 1980.

123 Department of Water Resources. South Lahontan Hydrologic Region – Panamint Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-58.pdf.

surface flow potentially entering the settling basin will likely evaporate to the atmosphere or infiltrate to the subsurface.

Groundwater in the Surprise Canyon system is derived from a highly deformed and mineralized zone containing ores of copper, gold, silver, lead, and zinc. Potential impacts to groundwater are anticipated to predominantly derive from these natural sources. Only a very minor cumulative mineral contribution is expected from the historic mining and milling operations, including those sites evaluated in this PA.

25.3.2 Surface Water

Surface water at the site is generated from infrequent heavy precipitation and is sourced along a 5.0-mile ridgeline marking the surface water divide at the top of Surprise Canyon. Surface water flow during rainfall events includes sheet flow over the portions of the site at relatively higher elevation along the 0.5-mile wash, up canyon, and some channeled flow directly uphill of the site. The channelized runoff within Surprise Canyon flows west then southwest approximately 6 miles until it empties into the Panamint Valley. (**Appendix E**).

Spring-fed ephemeral and perennial streams course from the north through Sourdough Canyon and from farther upgradient in Surprise Canyon. This stream courses down the canyon for an undetermined length but is fed by additional springs further down gradient. Two perennial springs located 2 to 3 miles downgradient feed a 1.5-mile segment of riparian area within Surprise Canyon. Sediment and surface water flow during storm events could potentially carry chemicals of concern into the stream. The diked impoundment contains silt-sized mill tailings, but no water. The springs and stream are attractive to both visitors and wildlife. The impact is expected to be insignificant, however, because mill tailings at the site are confined and likely contain only low concentrations of metals native to the ores. Mercury was not used for silver extraction. During most precipitation events, surface water runoff rapidly infiltrates the surficial material or evaporates, limiting the potential release of contaminants to surface water (**Figure 25-2**). Area vegetation did not appear to be stressed.

The Panamint City Smelter site is in the same subregional drainage basin as the Sourdough Mill site (Site #22). Potential transported material by surface water from the Panamint City Smelter must travel approximately 400 feet downgradient before it could comingle with material from Sourdough Mill. No surface water quality data were discovered during research.

Any precipitation or surface flow potentially entering the settling basin will likely evaporate to the atmosphere or infiltrate to the subsurface. During most precipitation events, surface water runoff rapidly infiltrates the surficial material or evaporates, limiting the potential release of contaminants to surface water. Area vegetation did not appear to be stressed. There are no lakes or permanent ponds within the target distance of 15 miles downgradient of the site, and because of the arid climate and rapid infiltration rate, transport of waterborne waste constituents a significant distance off site is unlikely.

25.3.3 Soil, Sediment, and Air

A thin layer of alluvial sediments has accumulated from clay to gravel. Due to its location on a relatively steep hill side, bedrock is approximately 20 inches bgs. This indicates that although the upper surficial soils may be well drained, the overall soil has a very slow infiltration rate. The surficial soil type is identified as the Theriot soil component with an upper 3 inches considered cemented sandy clay (EDR 3813626.40s**, Appendix B**).

The volume of mill tailings contained within the settling basin is estimated at approximately 200 cubic yards; less than 5 cubic yards are present in the vicinity of the mill (**Figure 25-2**). The impoundment and dam structures are in good condition with sufficient freeboard to contain precipitation from rain events. The ECM Geologist observed no deterioration of the dam or berm surrounding the basin (**Appendix D**). All tailings areas appear stable, and media downgradient of the site do not appear impacted by the release and transport of contaminants from erosional processes or surface water runoff. Burro sign was present in the settling basin and the area is accessible to local wildlife. Based on the extraction process used, the tailings originating from the ore processing facility are not anticipated to contain elevated concentrations of metals. However, this material has not been characterized. If elevated metals concentrations are present in the surface soil as a result of past operations, then infiltration of waters into the soil could result in leaching of contaminants and transport through the soil column to subsurface soil at depth.

Tailings within the settling basin are confined and not subject to erosion from surface water flows, but are subject to wind erosion. No vegetation grows within the impoundment area and no native sediments appear to be covering this area. Releases to air from suspension of potentially contaminated particulates derived from surface soil within the basin are likely because the tailings are not buried and the area is subject to wind erosion. Mill tailings are fine-grained and subject to wind transport. Re-deposition of these particulates could impact the surface soils downwind. It is also possible that air emissions during historical smelting operations could have impacted surface soil at the site. If elevated metals concentrations are present in the surface soil as a result of past operations, then infiltration of waters into the soil could result in leaching of contaminants and transport through the soil column to subsurface soil at depth. Windborne particulates are considered highly likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, and the loose nature of tailings within the impoundment.

25.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

The Panamint City site is a popular destination for backpackers despite its remoteness. Visitors may come in contact with tailings as they explore. The site is visited by approximately 200 people per year and potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.39s, **Appendix B**). Park staff and contractors may visit or work at the site. **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B.**

The Panamint City site has been assessed using site-specific CSMs. Based on operational history of the mill and observations during the March 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from floatation processes to extract silver. Cyanidation is a possibility. Preliminary COCs for the site include cyanide and metals. Additionally, the site was evaluated using the EPA HRS using the information gathered in the PA. Panamint City was given an overall score of 0.66 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 25-1** and sensitive ecological receptor pathways are presented in **Table 25-2.** For site-specific explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air. For a listing of potentially endangered or threatened species and identified wetlands, flood.

Table 25-1: Panamint City Smelter: Human Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	P *I*	P *I*
		Dermal	P *I*	P *I*
Water Erosion	Sediment	Ingestion	P **S**	P **S**
		Dermal	P **S**	P **S**
Leaching/Runoff	Surface Water	Ingestion	P *I*	P *I*
		Dermal	P *I*	P *I*
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 25-2: Panamint City Smelter: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	*P I*	*P I*	I P	I P
		Direct Contact	I P	I P	*P I*	*P I*	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	P *I*	P *I*
		Direct Contact	I P	I P	I P	I P	P *I*	P *I*
Water Erosion	Sediment	Ingestion	I P	I P	I P	I P	P **S**	P **S**
		Direct Contact	I P	I P	I P	I P	P **S**	P **S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	P *I*	P *I*
		Direct Contact	I P	I P	I P	I P	P *I*	P *I*
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

25.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil and air. Surface soil represents complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil but exposure is believed to be insignificant due to the limited amount of dispersed tailings at the site. Although there is no evidence of shallow groundwater at this site; several springs are located approximately 2 miles downgradient in Surprise Canyon. These springs could contact surface runoff from the site; therefore, the pathway is complete but insignificant for human and ecological exposures. Although surface water was not observed at the site and is only present during runoff from infrequent precipitation events; a 1.5-mile stretch of Surprise Canyon located approximately 2 miles downstream contains surface water that could receive runoff from the site. Exposure for human and ecological receptors is considered insignificant. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain metals analytical data for tailings and adjacent soil from the processing areas to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places or have been proposed for consideration will require consultation with SHPO prior to implementation of additional site inspection activities.

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26.0 HAPPY HOOLIGAN MINE AND MILL (SITE #24)

The PA inspection of the Happy Hooligan Mine site was conducted on February 13, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C24**. **Figure 26-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill, cyanide processing area, and extent of tailings. Site features are depicted on **Figure 26-2** and include:

- Mill and process area locations,
- Riparian vegetation,
- Dissected wash,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

26.1 SITE DESCRIPTION

The Happy Hooligan Mine and Mill is located in the Nevada portion of the Park, within the so-called Nevada Triangle. This region was added to Death Valley National Monument by a proclamation by President Roosevelt in 1937. It includes most of the higher elevations of the Grapevine Mountains and much of the Bullfrog Mining District. The mine is situated approximately 12 miles southwest of Beatty, Nevada (-116.99611, 36.87426) at an elevation of 4,906 feet above sea level. The site is accessible via a rough, 10-mile long, unmarked, and unmaintained road. The 4-wheel drive vehicle road is accessed from the paved road to the ghost town of Rhyolite, Nevada. This little known and remote site is visited by fewer than 10 off-road adventurers a year.

The site is located on the gentle east-sloping edge of a hillside within the Grapevine Mountains, overlooking a broad alluvial fan. Mines and prospects are located upslope and to the west. The cyanide-leaching processing area covers less than 0.5 acre. Mine waste at the Happy Hooligan site consists mostly of small dumps around shallow adits, prospects and shafts (**Figures 26-1** and **26-2**). Car parts litter the site, as well as assorted tin and wood debris, that seem to have come from the failed processing attempt in the 1930s. A series of steel process tanks with a small amount of tailings remain at the processing facility (**Photo C24-5**). Views looking down from the site into the Amargosa Valley are shown in **Photos C24-6** and **C24-7**.

The site was constructed as a cyanide-leaching operation. Very little is known about the activities on site, but it is believed to have operated during the 1930s. Mill tailings and waste rock generated using cyanide extraction processes remain on site and are located in the 50-foot by 75-foot cyanide process area. Mining debris, waste rock, and the pink tailings deposits are located in the vicinity of the three 75- to 100-gallon rusting steel cyanide process tanks (**Photos C24-3**, **C24-4**, and **C24-5**). The remains of several metal tanks and other debris are also present on the hillside (**Photos C24-1**, **C24-2**, and **C24-5**). A horizontal trough appears to be in line with the cyanide tanks. In addition, an open horizontal trough-type tank and an additional undetermined (wash?) tank are to the west and upslope. **Figures 24-1** and **24-2** show the approximate location of the cyanide processing area and steel cyanide tanks.

26.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

Very little is known about the activities on site, but it is believed to have operated during the 1930s. The mine was one of the earlier discoveries made within the Bullfrog District and was part of the Rhyolite Boom. The deposits were discovered in May 1905 and by early 1906 the mine supported its own camp, with a boardinghouse, blacksmith shop, and store-saloon. A road was built to lure investors. Workings consisted of a 300-foot shaft, a 200-foot adit, and a 300-foot adit located upslope of the cyanide processing area. Production was largely a hoax; the ore was a high-grade surface enrichment that was quickly worked out. The Hooligan Mine was abandoned before the end of 1907, although brief attempts were made to revive the mine in the 1930s and the 1950s.

Less than 2 cubic yards of pink and multi-colored silt to coarse-grained mill tailings are present in what is believed to be the cyanide processing area (**Appendix D).** This material has not migrated from the site farther than 5 feet downslope to the east (**Photos C24-3 and C24-8**). The majority of the tailings are contained within the steel cyanide process tanks. A series of small metal tanks and a small amount of tailings remain. Based on operational history and information gathered during the PA, the preliminary COCs are cyanide and metals.

26.3 ENVIRONMENTAL SETTING

26.3.1 Geology and Hydrogeology

Geological Setting

The Happy Hooligan site is located on the southeastern side of the Grapevine Mountains and southwest of the Bullfrog Hills (**Figure 1**). Sarbatocus Flat is located north of the site and the Amargosa Desert in located southeast (**Appendix E**). The site is located on Tertiary-aged basalt (**Figure 2**) characterized by dark-gray to black fine-grained porphyritic basalt flows and dikes[124].

[124] U.S. Department of the interior, Geological Survey. *Geologic Map and Sections of the Bullfrog Quadrangle, Nevada-California.* Geology by H.R. Corwall and F.J. Kleinhampl, 1956-1960.

Groundwater

The Site is located in the Amargosa Valley Groundwater Basin in the state of Nevada[125]. Previous studies indicate that two aquifer systems are present: valley fill deposits and underlying carbonate rock aquifer. Therefore, groundwater in the Amargosa Desert derives from recharge to the valley fill from the precipitation that falls on the ground surface or flows from the highlands during storm events, and contributions from outside the basin's boundaries by movement through underlying Paleozoic carbonate and volcanic tertiary rocks (in the northern part of the valley). Recharge to valley fill derives from the precipitation that falls on the ground surface or flows from the highlands during storm events. A large quantity of water is stored in the area; the principal use of groundwater is for irrigated agriculture. Many of the groundwater resources are documented having medium salinity water or poorer[126]. The depth to groundwater is not known, but based upon geographic contours groundwater flow is generally to the southeast along the axis of the valley into the playa at Death Valley Junction. Potential sources of chemicals to groundwater related to mining operations include historic releases, infiltration and leaching of chemicals in soil and sediments, and flow of groundwater through mineralized bedrock and alluvial materials. Local groundwater recharge occurs from precipitation; periodic major storms produce regional surface water flow.

Based upon federal database records research (EDR 3813626.42, **Appendix B**) and available USGS topographic maps (**Appendix E**), no wells or nationally recognized wetlands are located within 4 miles of the site that could be used for potable drinking water or for municipalities. The nearest city to the site is the ghost town of Rhyolite, Nevada, which is 9.5 miles east, and the towns of Beatty and Gold Center, located 13 miles further to the east. However, the city/towns are not directly downgradient of site surface water or groundwater flow.

Natural springs commonly occur in this area due to deep groundwater under hydraulic pressures from fractures and fissures transporting groundwater in the basin and range province. The closest springs are Cave Rock Spring (dry during site visit), located 1 mile upgradient, and McDonald Spring, which is 2.5 miles northwest and upgradient of the site. Two additional springs are located 4.0 and 5.0 miles upgradient of the site. None of these springs appear to be directly hydraulically connected with the Hooligan Mine site. Groundwater flows southeast toward the Amargosa River, located approximately 13 miles southeast of the site. The Amargosa River is considered ephemeral in this area. Infiltration losses during ephemeral flow of the river is a major source of groundwater recharge on the Amargosa Desert floor.

26.3.2 Surface Water

Inflow of surface water at the site is generated from infrequent heavy precipitation. Surface flow begins 0.20 mile to the northwest and directly upslope from the site. Surface water flow during precipitation events includes sheet flow over this hillside and the highlands of the Amargosa Range south of the divide (**Appendix E**). Runoff flows across the alluvial fan deposits to the southeast until evaporation or infiltration occurs. During major events, surface runoff may flow approximately 13 miles to the Amargosa River, which flows southeast (**Figure 26-2**). The drainages shown on the topographic map are ephemeral and experience very little surficial flow.

Infrequent but significant flash floods occur at the site during rainstorms, but the mill tailings do not appear to have been transported downgradient beyond 5 feet from the cyanide processing area

[125] Designated Groundwater Basins of Nevada Map. Department of Conservation and Natural Resources, September 2013, http://water.nv.gov/mapping/maps/designated_basinmap.pdf.

[126] U.S. Geological Survey, Ground-Water resources – Reconnaissance Series, Report 14, Geology and Ground Water of Amargosa Desert, Nevada-California. March 1963.

(**Appendix D**). During rain events, suspended sediments are carried downslope to the south and east and deposited in an alluvial fan that spreads across the Amargosa Valley floor.

Happy Hooligan Mine is in the same regional drainage basin as Homestake Mine. Material transported by the site by surface water would not comingle with material from the Homestake Mine (Site #1) for approximately 14.4 miles downgradient. The Armargosa River is within the target distance of 15 miles downgradient of the site but considered ephemeral.

26.3.3 Soil, Sediment, and Air

The site is located on the gentle east-sloping edge of a hillside within the Grapevine Mountains that has accumulated alluvial sediments from fine-grain sand to gravel. This indicates that the surface soils are well drained and have moderate infiltration rates. The precise thickness of the overlying sediments at the site is not known, but may be thicker than 60 inches (EDR 3813626.42s, **Appendix B**). The sediment is classified as the Whirlo soil component.

During operation of the Happy Hooligan site, small quantities of mine wastes and pink fine-grained tailings were generated and released to the immediate vicinity of the site (**Figure 26-2**). Less than 2 cubic yards of mill tailings were observed in the former cyanide processing area (**Appendix D**). These tailings have migrated 5 feet from the source. Waste rock dumps were observed near the upslope mine workings. This coarser material does not readily become transported by wind or water and has become relatively stable due to overlying vegetation. Vegetation at the site is sparse, but appears the same upgradient as downgradient. All of the cyanide tanks appear to have rusted through and may have potentially leaked into the subsurface. Surface and subsurface soils and sediment in depositional areas downgradient of the site could be directly impacted by potential releases associated with erosional processes, surface water runoff, or leaching.

Releases to air from suspension of contaminated particulates derived from surface soil and exposed sediment are likely because the tailings are at the surface and the area is subject to wind erosion. Mill tailings are fine-grained and subject to wind transport. Storm runoff from the site will travel south and east into an unpopulated area of Armargosa Valley. Tailings in the area of the ruins can be accessed by visitors.. Windborne particulates are considered likely due to the arid climate, high wind speeds, extended wind movement, and the exposure of tailings without adequate cover.

26.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

The site is little known and visited by less than 10 off-road visitors per year. However, visitors may come in contact with tailings as they explore the mill site, and park staff and contractors may access the site to perform maintenance and inspections. No potential threatened or endangered species or sensitive environments have been identified in the vicinity of the site (EDR 3813626_42, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B.**

Happy Hooligan Mine has been assessed using site-specific CSMs. Based on the operational history of the mill and observations during the February 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from cyanide leaching processes to extract gold. Additionally, the site was evaluated using the EPA HRS using the information gathered in the PA. The Happy Hooligan Mine was given an overall score of 0.22 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 26-1** and sensitive ecological receptor pathways are presented in **Table 26-2**. For an explanation of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 26-1: Happy Hooligan Mine and Mill: Human Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	I P	I P
		Dermal	I P	I P
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P
		Dermal	I P	I P
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 26-2: Happy Hooligan Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	**P S**	**P S**
		Direct Contact	I P	I P	*P I*	*P I*	**P S**	**P S**
Leaching/Runoff	Surface Water	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant

P I – Potentially complete pathway but considered insignificant

I P – Incomplete pathway; no evaluation necessary

26.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. There is no evidence of shallow groundwater at this site; therefore, the pathway is incomplete for human exposure. Surface water was not observed at the site and is only present during runoff from infrequent precipitation events; therefore, human and ecological receptors are not likely to encounter surface water at the site. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and adjacent soil from the cyanide processing area to determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting samples to evaluate background levels of metals.

27.0 GOLD HILL MILL (SITE #25)

The PA inspection of the Gold Hill Mill site was conducted on February 15, 2014. Field notes are included in **Appendix D**. Photographs showing site features and current environmental conditions are presented in **Appendix C25**. **Figure 27-1** shows the topographic features in the vicinity of the site, and indicates the locations of the mill and mine, processing area, extent of tailings, and perennial stream. Site features are depicted on **Figure 27-2** and include:

- Mill location,
- Perennial stream,
- Riparian vegetation,
- Spring or seeps,
- Dissected wash,
- Surface flow direction,
- Extent of tailings,
- List of threatened or endangered species,
- Map showing local surface geology, and
- Locations where select site photographs were taken.

27.1 SITE DESCRIPTION

Gold Hill Mill is located 35 miles south of Furnace Creek, California, in Warm Spring Canyon (Latitude 35.96871°, Longitude -116.93167°) at an elevation of 2,360 feet above sea level. The Gold Hill Mining District is one of the oldest mining areas within DEVA, with prospecting and work dating from the 1870s. The Gold Hill region is located within DEVA in the southwest corner, in the Panamint Mountain Range, at the northeastern end of Butte Valley and north of Warm Spring. Gold Hill Mill is heavily visited due to its location next to the Warm Spring Mining Camp and along the road to Butte Valley.

This site is accessed via 14 miles of infrequently graded dirt roads requiring high clearance four-wheel drive vehicles. The site is open to the public and is accessed via the West Side Road and Warm Springs Canyon – Butte Valley Roads. The West Side Road parallels the base of the Panamint Mountains along the western side of Death Valley. From the Warm Springs Canyon – Butte Valley Road turnoff the mill site is reached via 11 miles of infrequently graded dirt roads requiring high clearance and four-wheel drive vehicles. At approximately seven miles from the turnoff the road leads to the Panamint Mine, the easternmost of many talc mines in the vicinity of Warm Spring Canyon; large mine dumps on the south side of the road at 8.6 miles are from the Grantham Mine (shut down in 1988 and owned by the Park Service), which consists of a series of pits and underground tunnels between this point and Warm Spring. The Gold Hill Mill is located just south of the road approximately 11 miles from the turnoff. The mill site can also be reached from the west via Goler Wash to Butte Valley, an extreme high-clearance jeep trail.

The site covers less than one acre and consists of a complete and well-preserved mill with evidence of mercury amalgamation. The mill ruins rest in the bottom of an east-west trending, narrow mountain canyon wash that slopes eastward at a moderate rate toward Death Valley. The workings of a former talc mining operation occur approximately 700 feet downgradient, along the south side of the wash. The entrance to a talc mine adit is protected by a gate (**Photo C25-1**).Talc tailings from the mine area are above the adit entrance (**Photo C25-2**).

A spring and an abandoned mining camp are located south of the mill ruins. The Warm Spring Camp is located approximately 200 feet south of the mill and includes several buildings abandoned since the 1980s. These buildings appear structurally sound with new roofs (**Photo C25-6**). Immediately west of the mill are the concrete foundations of a mill house. Warm Spring is located behind and south of the cabins, cross-gradient and upslope of the mill ruins. The spring actively discharges water at a rate of about 50 gallons per minute to the wash, providing a stream. The stream infiltrates into the ground approximately 500 feet downwash. (**Photo C25-5**). Camping is not allowed at the spring, and various warning signs are posted in the camp, mill, and talc mine area.

The mill structures are considered to be of regional significance and warrants nomination to the National Register of Historic Places. The area is important because of the combination of old and newer technological processes displayed, and is a prime example of an early ore-processing plant. As such it possesses both historical and technological significance.

27.2 OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

The Gold Hill Mill Site was located on February 5, 1933, immediately prior to establishment of Death Valley National Monument and reportedly crushed gold-bearing ore from several nearby mines into the 1950s, including the Panamint Treasure Mine (Taylor, Treasure, and Gold Hill). The deposit was contained in a quartz vein in limestone[127]. The mill processed ore from the Gold Hill mines, located to the northwest. Part of the Gold Hill Mill itself was evidently built in the late 1930s, although no information has been located on the structure or the machinery that was put to work processing the gold ore brought down from nearby Gold Hill. Some of the milling structures were likely installed earlier. The milling structure consist of several different types of milling operations. (**Photos C25-8**). The mill contains a power-driven arrastra which was used to grind the ore (**Photo C25-9**); an oil-burning hot-shot engine that drove an elaborate arrangement of flywheels, a belt and pulley system, and drive shafts that operated the mill machinery; a Blake jaw crusher; a cone crusher; concentrating tables; a cylindrical ball mill; an ore bin and chute; an unloading platform; a conveyor system; and other related milling operation ruins (**Photos C25-7**). Immediately west of the mill are the concrete foundations of a

[127] Mines and Mineral Resources of Inyo County, California Journal of Mines and Geology, vol. 47, No 1 January 1951

mill house. An erosion-control berm is located upslope of the mill to assist in channeling surface flow away from the mill site.

The arrangement of the milling equipment was considered innovative for the times. Instead of using a linear processing flow, with the ore moving in one direction, the ore at Gold Hill Mill was processed in a complete circle. The ore travelled east from the primary crusher to the secondary ore bin, north and west through finer crushing and classification, and then west and south through the recovery circuit. The arrangement was not ideal for repair or maintenance, due to the compact design and restricted access to internal machines.

Minor mill tailings from the amalgamated mercury process used to extract the gold have accumulated in and around the mill workings, primarily on the east side (**Photo C25-11**), scattered in and around the equipment, and comingling with native rock (**Photo C25-13**). Vegetation is stabilizing the tailings in some areas (**Photo C25-12**), and the erosion-control berm acts to minimize erosion. Most of the fine pinkish-orange mill tailings are downslope from the arrastra outlet, extending upslope past the mill about 20 feet and downslope about 45 feet. No visible tails are present around the large adjacent concrete slab. The tails cross the entry road, and a three- to four-inch layer of tailings are visible on both sides of the wash at several locations along the road. Less than 50 cubic yards of tailings are currently visible at the site. If the mill tails continue to erode downslope along the access road, they will enter the flow of spring discharge. Based on operational history and information gathered during the PA, the preliminary COCs for the site are cyanide and metals.

27.3 ENVIRONMENTAL SETTING

27.3.1 Geology and Hydrogeology

Geological Setting

Gold Hill Mill is located on the southwest portion of the Panamint Range immediately adjacent to Death Valley to the east (**Figure 1**). The site is north of Owlshead Mountains and west of the Black Mountains. Panamint Valley is to the west (**Appendix E**). Bedrock in the vicinity of the Gold Hill Mill site is pre-Cenozoic granitic and metamorphic rocks of the Cronese Mountains area (**Figure 2**). This undifferentiated unit includes assemblages of quartzite, marble, talc, schist and meta-igneous rocks. The mill ruins rest in the bottom of an east-west trending, narrow mountain canyon wash that slopes eastward at a moderate rate toward Death Valley. The site resides on a flat-bottomed ledge of recent Quaternary sediments.

Groundwater

This site is situated between the upgradient Butte Valley Groundwater Basin and the downgradient Death Valley Groundwater Basin[128] in the state of California. The Butte Valley Groundwater Basin underlies Butte Valley in the Panamint Range and encompasses 13.8 square miles[129]. The depth to groundwater is not recorded but water in this basin is likely be found in alluvium of Quaternary age. The primary water-bearing materials used as a source of potable water likely consist of unconsolidated, fine- to coarse-grained sand, pebbles, and boulders with variable amounts of silt and clay. Groundwater flow direction generally follows surface water flow, depicted on **Figure 27-2**. Based upon topographic surface, local groundwater flow is generally to the east, toward Death Valley. Recharge of the

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[128] Department of Water Resources. *South Lahontan Hydrologic Region – Death Valley Groundwater Basin*, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-18.pdf.

[129] Department of Water Resources. South Lahontan Hydrologic Region – Butte Valley Groundwater Basin, California's Groundwater Bulletin 118, February 27, 2004, http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/6-81.pdf.

groundwater basin is from surface runoff, derived from occasional rainstorms and flash floods in the surrounding mountains. Springs are present in the vicinity of Gold Hill Mill and likely serve to recharge local groundwater.

Three nationally recognized wetlands are upgradient on the southern hillside from the Site. One wetland is supplied by Warm Spring and the other two are supplied by two unnamed seeps (**EDR 3813626.44s, Appendix B**). No groundwater wells are present within the 4.0-mile target distance: therefore, no impacts are anticipated to drinking water. No residences are found within 200 yards, and groundwater is not used as a drinking water source.

Groundwater discharge into the Death Valley Groundwater basin, if present, would likely interact with groundwater from Queen of Sheba and Ashford Mill down gradient. Groundwater in the Warm Spring Canyon system is derived from a highly deformed and mineralized zone containing ores of copper, gold, silver, lead, and zinc. Potential impacts to groundwater are anticipated to predominantly derive from these natural sources. Only a very minor cumulative mineral contribution is expected from the historic mining and milling operations, including those sites evaluated in this PA.

Surface Water

Surface water at the site is generated from infrequent heavy precipitation sourced in the headwaters of the northern portion of Butte Valley approximately 4.5 miles west. The Butte Valley Fault Zone bisects the basin and forces surface water from the northern portion to discharge into Warm Springs Canyon, while the southern portion empties into the Panamint Valley Basin. Surface water flow during rainfall events would include sheet flow over the portions of the Site at relatively higher elevation and channeled flow for 4.4 miles from west to east toward the Site (**Figure 27-2**). The channelized runoff within Warm Springs Canyon flows east and northeast approximately 4 miles until it empties into Death Valley (A**ppendix E**). Potential surface water that may enter Death Valley would flow toward the playa lake depression at Badwater.

Warm Spring and an unnamed spring approximately 600 feet to the east emanate from the north-facing wall of the canyon, upslope from the mill, and discharge into the wash forming a small riparian area downgradient of the mill. The springs provide a stream of water flowing east that typically infiltrates into the subsurface within 500 feet of their discharge point (**Figure 27-2**). Overland drainage from the site rapidly infiltrates the soil matrix or evaporates into the atmosphere.

There are no lakes or permanent ponds within the target distance of 15 miles downgradient of the site, and because of the arid climate and rapid infiltration rate, transport of waterborne waste constituents a significant distance off site is unlikely. Three wetlands are mapped within the target distance, but are upgradient of the mill site. However, the springs consistently discharge into the wash for a limited distance. The mill site is a popular tourist attraction, and the spring waters attract both humans and wildlife in this desert climate. Surface water in riparian areas may be affected by migrating sediments downgradient.

27.3.2 Soil, Sediment, and Air

The site has accumulated a layer of alluvial sediments which appear to be sands and gravels derived from weathering. Bedrock is near the surface at the site but increases into the center of the wash. The site is considered to be atop unweathered bedrock indicating very slow infiltration rates and no drainage class reported (EDR 3813626.44s, **Appendix B**); however, quaternary sediments in the central portion of the valley typically have high infiltration rates and are well to moderately-drained.

Tailings were observed near the foundation of the mill structure and for approximately 350 feet downgradient along the gravel road (**Figure 27-2**). Eroding tailings may impact surface water due to the proximity of the discharge from of Warm Springs. If the tailings continue to erode downslope on their current course, they will eventually come into contact with the water discharge associated with one or both springs. Therefore, the potential exists for ephemeral, intermittent surface water to be impacted by metals contamination associated with mercury amalgamation extraction. Releases to air from suspension of contaminated particulates derived from surface soil and exposed sediment could occur, but the fine-grained tailings are mixed with courser material and vegetation binds some of the material, making the tailings less susceptible to wind erosion. However, tailings were observed near and crossing the road; therefore, vehicular traffic to this popular destination will increase airborne particulates of the tailings.

During infrequent heavy precipitation events, suspended fine-grained tailings material from the mill are carried downslope to the east. Sediments may eventually be deposited within the alluvial fan that opens at the mouth of the canyon and spreads across the valley floor. Tailings moved during storm events that may be potentially deposited on the alluvial fan at the mouth of Warm Spring Canyon may leach potential contaminants into groundwater in the valley. Windborne particulates are considered highly likely due to the arid climate, high wind speeds, extended wind movement, exposure of tailings without adequate cover, access roads crossing tailings, and the disbursement of tailings in the canyon.

27.4 PATHWAY AND ENVIRONMENTAL HAZARD ASSESSMENT

Gold Hill Mill is a favorite destination of tourists wishing to study the well-preserved mill and camp ruins. Visitors often walk through tailings as they explore the mill site ruins. DEVA staff and contractors may also access the site. Potentially endangered or threatened species or sensitive environments have been identified in the vicinity of the site (EDR 3813626.43s, **Appendix B**). **Table 2** lists potentially endangered or threatened species and identified wetlands, flood zones, surface water bodies, and wells within the vicinity of each site confirmed by DEVA staff, and complete EDR reports are in **Appendix B**

The Gold Hill Mill site has been assessed using site-specific CSMs. Based on the operational history of the mill and February 2014 site visit, assessment of environmental hazards focuses on the mill tailings derived from mercury amalgamation and possible cyanide leaching to extract gold. Additionally, the site was evaluated using the EPA HRS using the information gathered during the PA. Gold Hill Mill was given an overall score of 0.33 (**Table 3**). The HRS scoring worksheets are provided in **Appendix A**.

A summation of the findings for human exposure pathways is shown below in **Table 27-1** and sensitive ecological receptor pathways are presented in **Table 27-2**. For explanations of each exposure category, please refer to **Table 1-1** for groundwater, **Table 1-2** for surface water, and **Table 1-3** for soil/sediment/air.

Table 27-1: Gold Hill Mill: Human Exposure Pathways

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
Direct Contact	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
	Subsurface Soil	Ingestion	*P I*	I P
		Dermal	*P I*	I P
	Groundwater	Ingestion	I P	I P

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population	
			Worker	Visitor
		Dermal	I P	I P
Water Erosion	Sediment	Ingestion	**P S**	**P S**
		Dermal	**P S**	**P S**
Leaching/Runoff	Surface Water (Future)	Ingestion	*P I*	*P I*
		Dermal	*P I*	*P I*
Wind	Air (Particulates)	Inhalation	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

Table 27-2: Gold Hill Mill: Ecological Receptors

Transport Pathways	Contaminated Media	Exposure Route	Exposed Population					
			Aquatic		Terrestrial Receptors		Birds and Mammals	Reptiles
			Benthics	Native Fish	Plants	Soil Organisms	Upland	
Direct Contact	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
Water Erosion	Surface soil	Ingestion	I P	I P	**P S**	**P S**	**P S**	**P S**
		Direct Contact	I P	I P	**P S**	**P S**	**P S**	**P S**
	Subsurface Soil	Ingestion	I P	I P	**P S**	**P S**	I P	I P
		Direct Contact	I P	I P	**P S**	**P S**	I P	I P
	Groundwater	Ingestion	I P	I P	I P	I P	I P	I P
		Direct Contact	I P	I P	I P	I P	I P	I P
Water Erosion	Sediment	Ingestion	I P	I P	*P I*	*P I*	*P I*	*P I*
		Direct Contact	I P	I P	*P I*	*P I*	*P I*	*P I*
Leaching/Runoff	Surface Water (Future)	Ingestion	I P	I P	*P I*	*P I*	*P I*	*P I*
		Direct Contact	I P	I P	*P I*	*P I*	*P I*	*P I*
Wind	Air (Particulates)	Inhalation	I P	I P	I P	I P	**P S**	**P S**

P S – Potentially complete pathway and may be significant
P I – Potentially complete pathway but considered insignificant
I P – Incomplete pathway; no evaluation necessary

27.5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Potentially complete exposure pathways include soil, sediment, surface water, and air. Surface soil and sediments represent complete and potentially significant exposures to both human and ecological receptors due to the potential for tailings to have caused a release to those media. Subsurface soil may represent a complete pathway for workers that remove the surface soil or disturb subsurface soil, and for plants and soil organisms which occupy the subsurface soil. There is evidence of shallow groundwater at this site; however, there are no wells or downgradient springs to provide a pathway to groundwater. The groundwater pathway is considered incomplete for human and ecological exposure. Surface water was observed at the site; however, the springs discharge upgradient of the mill site and the surface water typically infiltrates within several hundred feet of discharge. Surface water exposure is currently believed to be insignificant. Exposures related to inhalation of windborne particulates are considered likely due to the arid climate, high wind speeds and extended wind movement at the site. Targets of concern are DEVA employees, contractors, visitors, and ecological receptors within the 200-foot-radius limit for soil exposure, and potentially several miles for windborne particles.

ECM recommends additional waste characterization to obtain cyanide and metals analytical data for tailings and soil from the mercury amalgamation and cyanide leaching processing areas determine whether these contaminants exist at concentrations that could have resulted in a release into the environment. Since the site is in a mineralized area, ECM recommends collecting soil samples to evaluate background levels of metals. Sites which are on the National Register of Historic Places or have been proposed for consideration will require consultation with SHPO prior to implementation of additional site inspection activities.