HAZARD RANKING SYSTEM (HRS) DOCUMENTATION RECORD—REVIEW COVER SHEET

Name of Site: AFTERTHOUGHT MINE

Contact Person: Leslie Ramirez, EPA Region 9 (415) 972-3978

Site Investigation: Leslie Ramirez, EPA Region 9 (415) 972-3978

Documentation Record: Christina Marquis, Weston Solutions, Inc.
christina.marquis@westonsolutions.com

Pathways, Components, or Threats Not Scored

The ground water, soil exposure and subsurface intrusion, and air pathways were not scored. There are no known active drinking water wells within the Target Distance Limit (TDL) (Ref. 4, p. 17). There are no residents on or near the site sources (Ref. 3; Ref. 4, p. 19). Therefore, the listing decision is not significantly affected by those pathways. The site score is sufficient to qualify the site for the NPL on the surface water pathway score.

Table of Contents

Figures

HRS DOCUMENTATION RECORD

Name of Site: AFTERTHOUGHT MINE

EPA ID#: CAN000908808

EPA Region: 9

Date Prepared: March 2024

Street Address of Site: 25 miles northeast of Redding on Highway 299

City, County and State: Bella Vista, Shasta County, California 96008

Topographic Map: Oak Run, CA USGS 7.5-Minute Quadrangle (Ref. 3)

Latitude: 40° 44' 4.3692" North Longitude: 122° 4' 20.6256" West (Ref. 3; Ref. 4, p. 44)

Latitude/Longitude Reference Point: The latitude and longitude correspond to Portal 1 (Source 1) sampling location AC-03 (Ref. 4, p. 44).

SCORES		
Air Pathway	=	Not scored
Ground Water[1] Pathway	=	Not scored
Soil Exposure and Subsurface Intrusion Pathway	=	Not scored
Surface Water Pathway	=	100.00
HRS SITE SCORE	**=**	50.00

*The street address, coordinates, and contaminant locations presented in this HRS documentation record identify the general area where the site is located. They represent one or more locations the United States Environmental Protection Agency (EPA) considers to be part of the site based on the screening information EPA used to evaluate the site for NPL listing. EPA lists national priorities among the known "releases or threatened releases" of hazardous substances; thus, the focus is on the release, not precisely delineated boundaries. A site is defined as where a hazardous substance has been "deposited, stored, disposed, or placed, or has otherwise come to be located." Generally, HRS scoring and the subsequent listing of a release merely represent the initial determination that a certain area may need to be addressed under the Comprehensive Environmental Response, Compensation & Liability Act (CERCLA). Accordingly, EPA contemplates that the preliminary description of facility boundaries at the time of scoring will be refined as more information is developed as to where the contamination has come to be located.

[1] "Ground water" and "groundwater" are synonymous; the spelling is different due to "ground water" being codified as part of the HRS, while "groundwater" is the modern spelling.

HAZARD RANKING SYSTEM SUMMARY SCORESHEETS

SITE NAME: AFTERTHOUGHT MINE

CITY/COUNTY/STATE: Bella Vista, Shasta County, California

EPA ID #: CAN000908808

EVALUATOR: Christina Marquis **DATE:** March 2024

LATITUDE: 40° 44' 4.3692" N **LONGITUDE:** 122° 4' 20.6256" W

	S	S^2
Ground Water Migration Pathway Score (S_{gw})	Not scored	Not scored
Surface Water Migration Pathway Score (S_{sw})	100	10,000
Soil Exposure and Subsurface Intrusion Pathway Score (S_{sessi})	Not scored	Not scored
Air Migration Pathway Score (S_a)	Not scored	Not scored
$S_{gw}^2 + S_{sw}^2 + S_{sessi}^2 + S_a^2$	XXXXXXX	10,000
$(S_{gw}^2 + S_{sw}^2 + S_{sessi}^2 + S_a^2) / 4$	XXXXXXX	2,500
SQRT $((S_{gw}^2 + S_{sw}^2 + S_{sessi}^2 + S_a^2) / 4)$	XXXXXXX	50.00

HRS TABLE 4-1
Surface Water Overland/Flood Migration Component Scoresheet

Factor Categories and Factors	Maximum Value	Value Assigned
Drinking Water Threat		
Likelihood of Release:		
1. Observed Release	550	550
2. Potential to Release by Overland Flow:		
2a. Containment	10	
2b. Runoff	25	
2c. Distance to Surface Water	25	
2d. Potential to Release by Overland Flow (lines 2a x [2b + 2c])	500	
3. Potential to Release by Flood:		
3a. Containment (Flood)	10	
3b. Flood Frequency	50	
3c. Potential to Release by Flood (lines 3a x 3b)	500	
4. Potential to Release (lines 2d + 3c, subject to a maximum of 500)	500	Not scored
5. Likelihood of Release (higher of lines 1 and 4)	550	550
Waste Characteristics:		
6. Toxicity/Persistence	(a)	Not scored
7. Hazardous Waste Quantity	(a)	Not scored
8. Waste Characteristics	100	Not scored
Targets:		
9. Nearest Intake	50	Not scored
10. Population:		
10a. Level I Concentrations	(b)	Not scored
10b. Level II Concentrations	(b)	Not scored
10c. Potential Contamination	(b)	Not scored
10d. Population (lines 10a + 10b + 10c)	(b)	Not scored
11. Resources	5	Not scored
12. Targets (lines 9 + 10d + 11)	(b)	Not scored
Drinking Water Threat Score:		
13. Drinking Water Threat Score ([lines 5 x 8 x 12]/82,500, subject to a maximum of 100)	100	Not scored
Human Food Chain Threat		
Likelihood of Release:		
14. Likelihood of Release (same value as line 5)	550	550
Waste Characteristics:		
15. Toxicity/Persistence/Bioaccumulation	(a)	500,000,000
16. Hazardous Waste Quantity	(a)	10,000
17. Waste Characteristics	1,000	1,000

HRS Table 4-1 – Surface Water Overland/Flood Migration Component Scoresheet (cont'd)

Factor Categories and Factors	Maximum Value	Value Assigned
Targets:		
18. Food Chain Individual	50	20
19. Population:		
19a. Level I Concentrations	(b)	0
19b. Level II Concentrations	(b)	0
19c. Potential Human Food Chain Contamination	(b)	0.00003
19d. Population (lines 19a + 19b + 19c)	(b)	0.00003
20. Targets (lines 18 + 19d)	(b)	20.00003
Human Food Chain Threat Score:		
21. Human Food Chain Threat Score ([lines 14 x 17 x 20]/82,500, subject to a maximum of 100)	100	100.00
Environmental Threat		
Likelihood of Release:		
22. Likelihood of Release (same value as line 5)	550	550
23. Ecosystem Toxicity/Persistence/Bioaccumulation	(a)	500,000,000
24. Hazardous Waste Quantity	(a)	10,000
25. Waste Characteristics	1,000	1,000
Targets:		
26. Sensitive Environments:		
26a. Level I Concentrations	(b)	0
26b. Level II Concentrations	(b)	25
26c. Potential Contamination	(b)	0.175
26d. Sensitive Environments (lines 26a + 26b + 26c)	(b)	25.175
27. Targets (value from 26d)	(b)	25.175
Environmental Threat Score:		
28. Environmental Threat Score ([lines 22 x 25 x 27]/82,500, subject to a maximum of 60)	60	60
Surface Water Overland/Flood Migration Component Score for a Watershed		
29. Watershed Score[c] (lines 13 + 21 + 28, subject to a maximum of 100)	100	100.00
Surface Water Overland/Flood Migration Component Score		
30. Component Score (S_{of}), (highest score from line 29 for all watersheds evaluated, subject to a maximum of 100) (c)	100	100.00

(a) Maximum value applies to waste characteristics category.
(b) Maximum value not applicable.
(c) Do not round to nearest integer.

REFERENCES

Reference Number	Description of the Reference
1	U.S. Environmental Protection Agency (EPA). Hazard Ranking System (HRS), Title 40 Code of Federal Regulations (CFR) Part 300, Appendix A (55 Federal Register [FR] 51583, December 14, 1990, as amended at 82 FR 2779, Jan. 9, 2017; 83 FR 38037, Aug. 3, 2018), as published in the CFR on July 1, 2019, with two attachments—Attachment A: FR Vol. 55, No. 241. December 14, 1990. HRS Preamble. Attachment B: FR Vol. 82, No. 5, January 9, 2017. Addition of a Subsurface Intrusion Component to the Hazard Ranking System Preamble. 197 Pages. Available on-line at: https://semspub.epa.gov/work/HQ/174028.pdf and https://www.regulations.gov/document?D=EPA-HQ-SFUND-2010-1086-0104.
2	EPA, Superfund Chemical Data Matrix (SCDM) Query, Accessed January 24, 2024, 18 pages. Available online at: http://www.epa.gov/superfund/superfund-chemical-data-matrix-scdm.
3	U.S. Geological Survey, 7.5 Minute Topographic Map of Oak Run, California, 2018, 1 sheet.
4	Weston Solutions, Inc., Site Inspection Report Afterthought Mine, prepared for EPA, May 2023, 62 pages.
5	Weston Solutions, Inc., Site Inspection Report Afterthought Smelter, prepared for EPA, May 2023, 52 pages.
6	Ned Black, EPA, contact report with Leslie Ramirez, re: Fishing in Little Cow Creek, with attached California Department of Fish and Wildlife Fishing Guide and Article of 34 Best Fishing Spots Near Redding and Shasta County April 21, 2023, 25 pages.
7	Weston Solutions, Inc., Site Inspection Sampling and Analysis Plan, Afterthought Mine, prepared for EPA, March 2020, 164 pages.
8	Fishbrain.com. Fishing spots, fishing reports and regulations in Little Cow Creek, data extracted January 28, 2024. 22 pages.
9	Eurofins Burlington, Analytical Report, Job Number: 200-64005-1, SDG Number: MY0AA0, July 28, 2022, 546 pages.
10	Eurofins Burlington, Analytical Report, Job Number: 200-64005-2, SDG Number: MY0AC1, July 28, 2022, 876 pages.
11	Eurofins Burlington, Analytical Report, Job Number: 200-64005-3, SDG Number: MY0AF9, July 29, 2022, 483 pages.
12	Eurofins Burlington, Analytical Report, Job Number: 200-63979-1, SDG Number: MY0AJ5, July 26, 2022, 2,420 pages.
13	U.S. Fish and Wildlife Service, National Wetlands Inventory, https://fwsprimary.wim.usgs.gov/wetlands/apps/wetlands-mapper/, data extracted January 25, 2024, 5 pages.
14	Tuggle, J.M., Exploring Shasta County History, Furnaceville & Ingot: The Home of the Afterthought Mine. June 23, 2021, 22 pages.
15	EPA, Afterthought Mine Validation Report, October 5, 2022, 399 pages.
16	EPA, Afterthought Mine Validation Report, October 5, 2022, 180 pages.

Reference Number	Description of the Reference
17	Brown, G.C., California State Mining Bureau, Mines and Mineral Resources of Shasta County, Siskiyou County, Trinity County. 1915. 210 pages.
18	U.S. Fish and Wildlife Service, National Wetlands Inventory, https://fwsprimary.wim.usgs.gov/wetlands/apps/wetlands-mapper/, data extracted October 3, 2023, 1 page.
19	EPA, Afterthought Smelter Validation Report, October 5, 2022, 220 pages.
20	U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 50 CFR Part 226, Endangered and Threatened Species; Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California, (70 FR 52488) September 2, 2005, 140 pages.
21	Albers, J., State of California Division of Mines, Special Report 29, Geology and Ore Deposits of the Afterthought Mine, Shasta County, California, February 1953, 30 pages.
22	State of California Department of Natural Resources, California Journal of Mines and Geology, Volume 50, Number 1, January 1954, 282 pages.
23	State of California Department of Natural Resources, California Journal of Mines and Geology, Volume 53, Nos. 3 & 4, July-October 1957, 395 pages.
24	California State Mining Bureau, Mining in California, January 1923, 50 pages.
25	California State Mining Bureau, Mining in California, April 1926, 112 pages.
26	State of California, The Resources Agency, Department of Water Resources, The Greenhorn and Afterthought Mines – a Plan for the Control and Abatement of Acid and Heavy Metal Pollution, Shasta County, California, July 1985, 97 pages.
27	Ecology & Environment, Inc., Preliminary Assessment, Afterthought Mine, August 24, 1987, 118 pages.
28	Hook & Bullet, Little Cow Creek Fishing near Palo Cedro, California, hookandbullet.com, July 24, 2019, 5 pages.
29	Heiman, Dennis, Associate Land and Water Use Analyst, Memorandum to File, Survey of Afterthought Mine and Little Cow Creek, May 11, 1982, 3 pages.
30	Mining and Scientific Press, Shasta County as a Smelting Centre, October 24, 1908, 2 pages.
31	Lewis, Robert H., Office Memorandum, Afterthought Mine, 205(j) Project, Second Quarterly Sampling Results, September 5, 1984, 4 pages.
32	California Regional Water Quality Control Board, Central Valley Region, Order No. 97-097, NPDES No. CA0084166, Waste Discharge Requirements for Agricultural Management and Production Company, Inc., Afterthought Mine, Shasta County, June 20, 1997, 7 pages.
33	California Regional Water Quality Control Board, Central Valley Region, Order No. Administrative Civil Liability in the Matter of Agricultural Management and Production Company, Inc., Afterthought Mine, Shasta County, September 17, 1999, 8 pages.

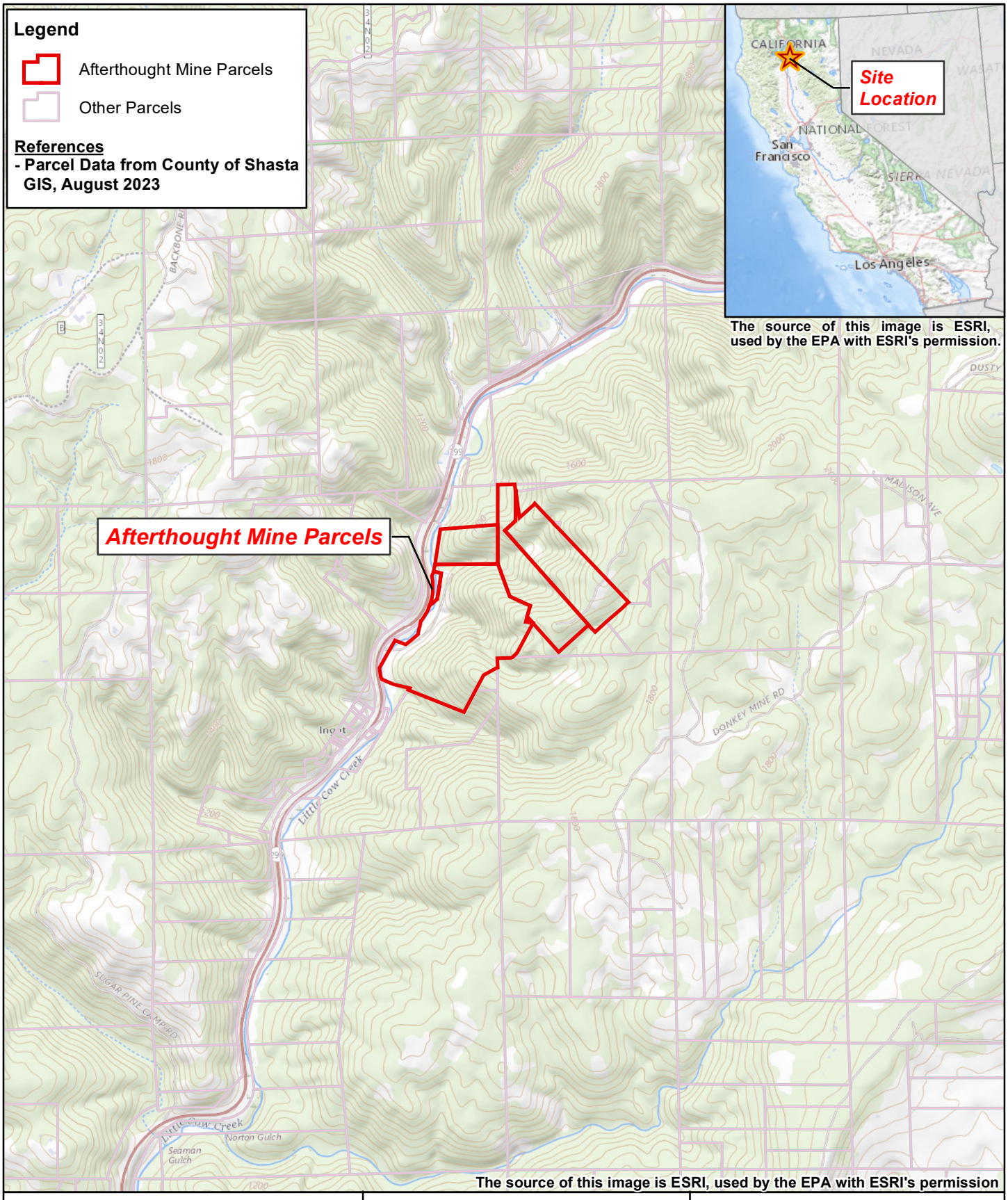
Reference Number	Description of the Reference
34	Rossi, Jeri, ICF, ESAT Region 9, Memorandum, Review of Analytical Data, Tier 3, Afterthought Mine SDG No. MY0AF9, September 30, 2022, 34 pages.
35	Andrews, John, SHN Consulting Engineers & Geologists, Letter with Attachments, Base Maps, Cease and Desist Order 97-098, Afterthought Mine, Shasta County, California, October 24, 1997, 7 pages.
36	SHN Consulting Engineers & Geologists, Remedial Action Plan, Afterthought Mine, Shasta County, California, August 31, 1998, 58 pages.
37	SHN Consulting Engineers & Geologists, Cow Creek Watershed Assessment, November 2001, 370 pages.
38	California State Water Resources Control Board, Final California 2012 Integrated Report (303(d) List/305(b) Report), Little Cow Creek (downstream from Afterthought Mine), https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2012.shtml?wbid=CAR507330101999012611255l, data extracted July 22, 2019, 7 pages.
39	U.S. Geological Survey, Geological Survey Professional Paper 338, Geology and Ore Deposits of East Shasta Copper-Zinc District, Shasta County, California, 1961, 125 pages.
40	U.S. Geological Survey, National Water Information System, USGS 11373300 Little Cow C NR Ingot CA, https://waterdata.usgs.gov/nwis, data extracted June 5, 2019, 2 pages.
41	Weston Solutions, Inc., Preliminary Assessment Report, Afterthought Mine, September 2019, 1,982 pages.
42	Weston Solutions, Inc., Preliminary Assessment Report, Afterthought Smelter, September 2019, 1,842 pages,
43	Rossi, Jeri, ICF, Environmental Services Assistance Team (ESAT) Region 9, Memorandum, Review of Analytical Data, Tier 3, Afterthought Mine SDG No. MY0AA0, September 30, 2022, 49 pages.
44	Rossi, Jeri, ICF, ESAT Region 9, Memorandum, Review of Analytical Data, Tier 3, Afterthought Mine SDG No. MY0AC1, September 30, 2022, 68 pages.
45	EPA, Afterthought Smelter Validation Report, October 5, 2022, 240 pages.
46	Rossi, Jeri, ICF, ESAT Region 9, Memorandum, Review of Analytical Data, Tier 3, Afterthought Mine SDG No. MY0AJ5, October 4, 2022, 53 pages.
47	Weston Solutions, Inc., Attachment 4 Field Logbook. June 2022, 3 pages.
48	EPA. Office of Superfund Remediation and Technology Innovation. Using Qualified Data to Document an Observed Release and Observed Contamination. Directive 9285.7-89FS. November 2022. 20 pages.

ACRONYM LIST

µg/l	micrograms per liter
AMD	acid mine drainage
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CLP	Contract Laboratory Program
CRQL	Contract Required Quantitation Limit
EPA	United States Environmental Protection Agency
gpm	gallons per minute
HRS	Hazard Ranking System
ISM	Inorganic Superfund Method
mg/kg	milligrams per kilogram
ND	not detected at or above the method detection limit
NPL	National Priorities List
NS	Not Scored
PPE	Probable Point of Entry
PRP	Potentially Responsible Party
SAP	Sampling and Analysis Plan
SCDM	Superfund Chemical Data Matrix
SI	Site Inspection
SQL	Sample Quantitation Limit
TDL	Target Distance Limit
USGS	United States Geological Survey
WESTON	Weston Solutions, Inc.

NOTES TO THE READER

Page numbers have been added to the references in the lower right corner. For reference citations, please refer to the page numbers in this location.



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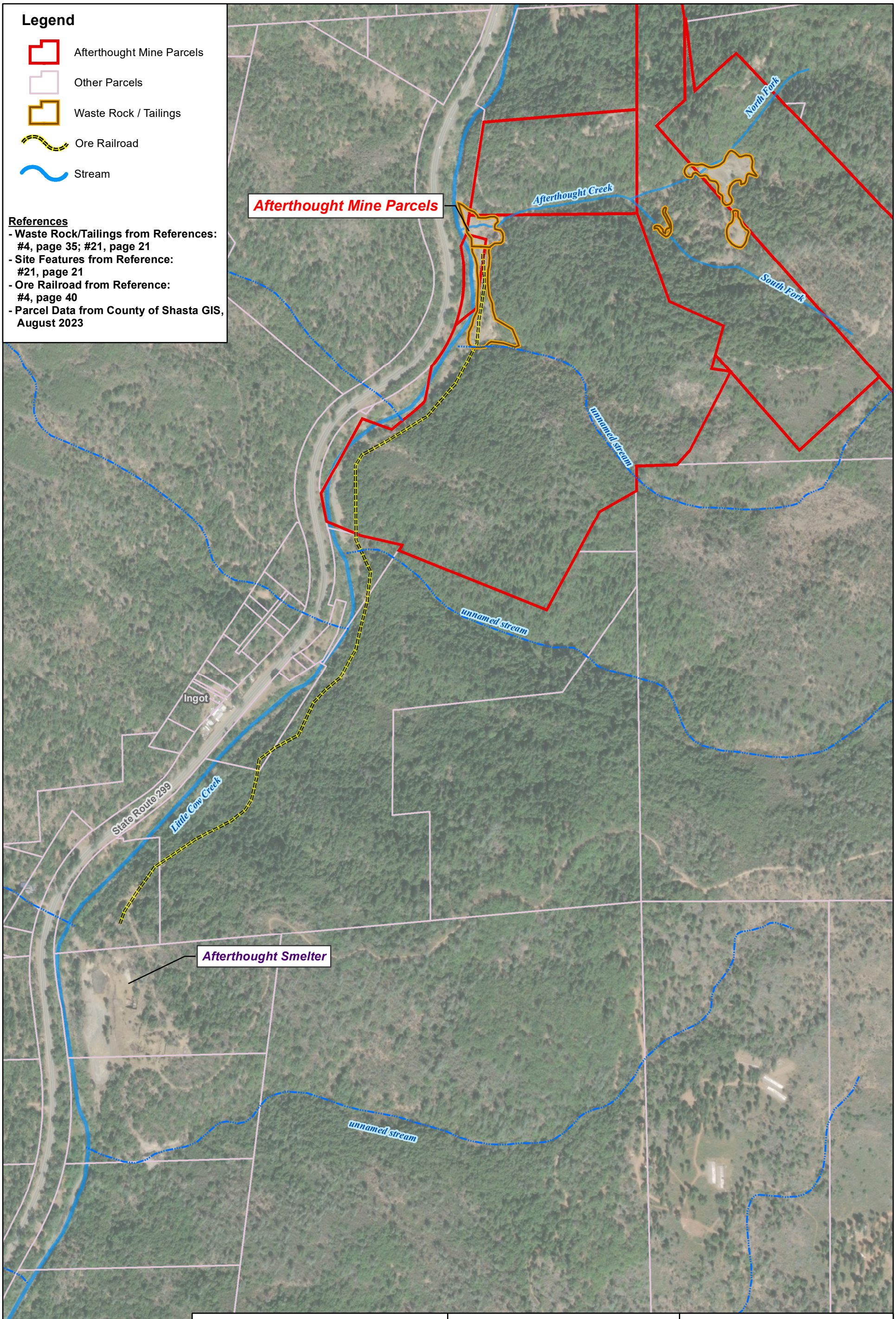
EPA Region 9
Site Assessment Program

Prepared By:
Weston Solutions, Inc.
Concord, CA 94520
February 2024

FIGURE A-1
SITE LOCATION MAP
Afterthought Mine
HRS Documentation Record
Bella Vista, Shasta County, California


Legend
Afterthought Mine Parcels
Other Parcels
Waste Rock / Tailings
Ore Railroad
Stream
References
- Waste Rock/Tailings from References: #4, page 35; #21, page 21
- Site Features from Reference: #21, page 21
- Ore Railroad from Reference: #4, page 40
- Parcel Data from County of Shasta GIS, August 2023
Afterthought Mine Parcels
Afterthought Creek
North Fork
South Fork
unnamed stream
unnamed stream
unnamed stream
Ingot
State Route 299
Little Cow Creek
Afterthought Smelter
The source of this image is ESRI, used by the EPA with ESRI's permission
0
Scale in Feet
800
1:6,000
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Prepared By:
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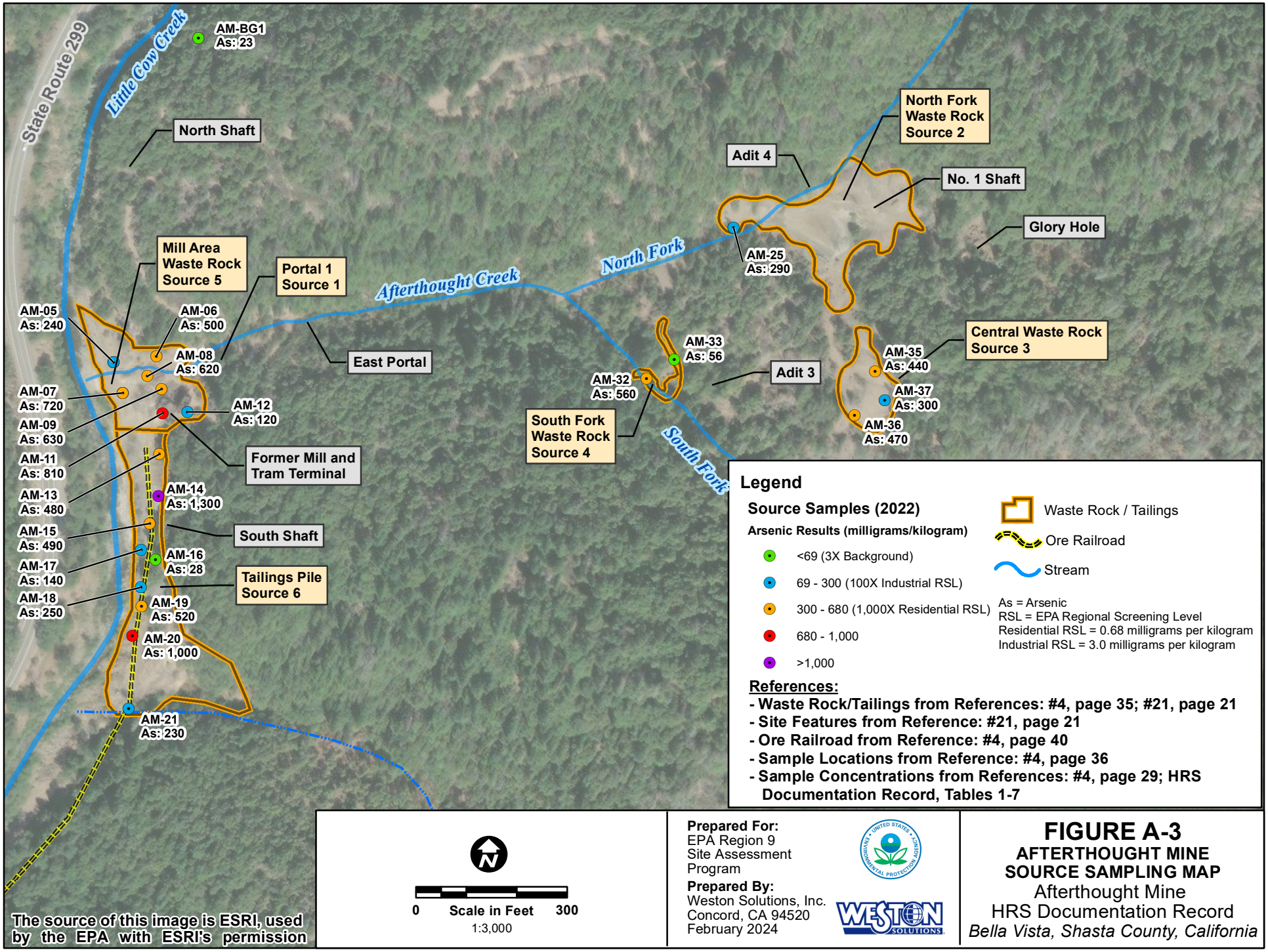
Concord, CA 94520
February 2024
FIGURE A-2
SITE VICINITY MAP
Afterthought Mine
HRS Documentation Record
Bella Vista, Shasta County, California



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February 2024

FIGURE A-3
AFTERTHOUGHT MINE SOURCE SAMPLING MAP
Afterthought Mine
HRS Documentation Record
Bella Vista, Shasta County, California

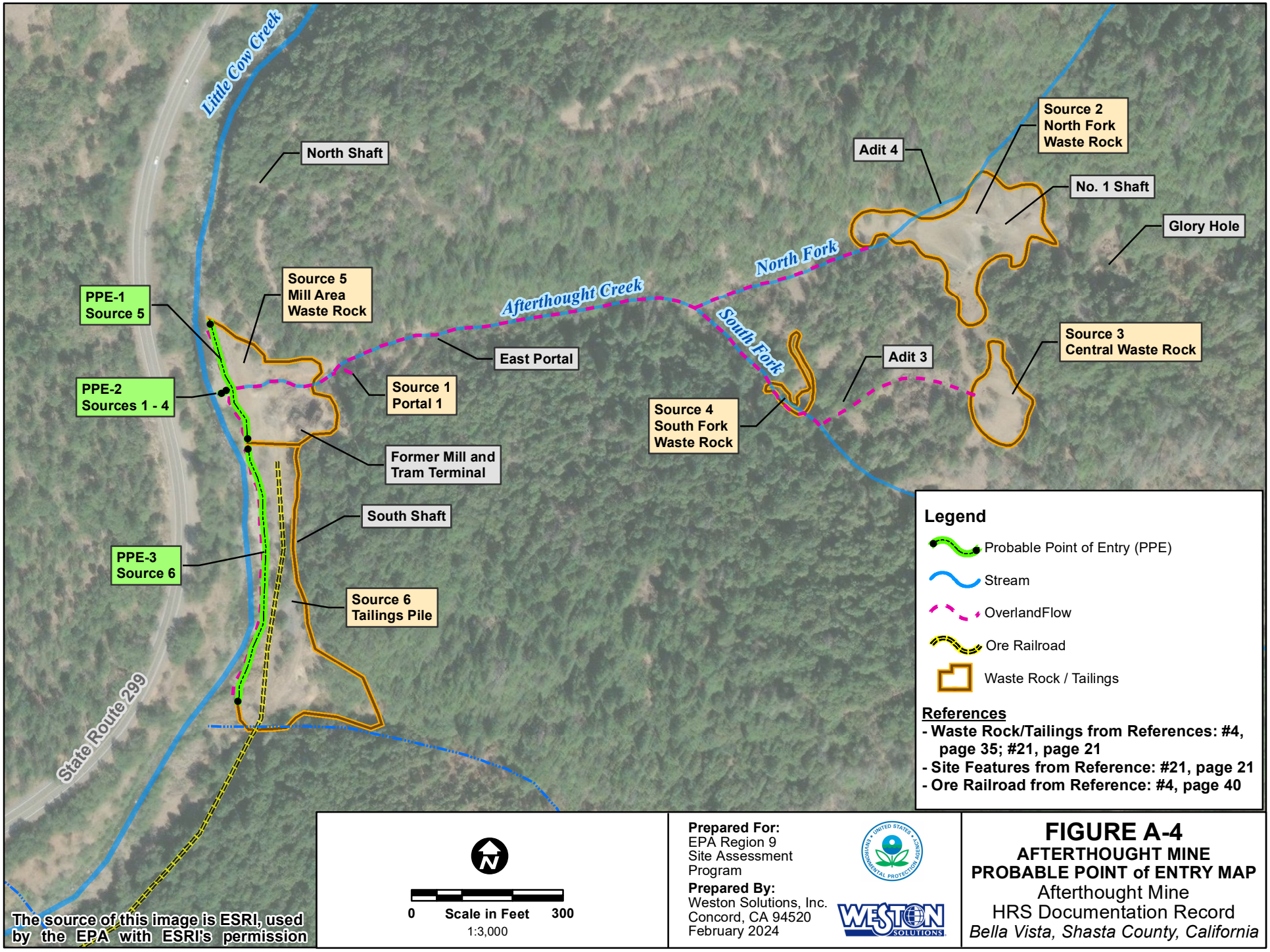

FIGURE A-4
AFTERTHOUGHT MINE
PROBABLE POINT of ENTRY MAP
Afterthought Mine
HRS Documentation Record
Bella Vista, Shasta County, California

Legend

- Afterthought Mine Parcels
- Surface Water Pathway TDL
- Wetland
- Central Valley Steelhead Distinct Population Segment

TDL = Target Distance Limit

References

- **Wetlands from References: #13, pages 1-5; National Wetlands Inventory Map Service**
- **Central Valley Steelhead Population from Reference: #20, pages 117 and 121**
- **Parcel Data from County of Shasta GIS, August 2023**

Afterthought Mine Parcels

PPE-1
PPE-2
PPE-3

TDL Beginning Point

15-mile TDL End Point

Pit River
Little Cow Creek
Shasta National Forest

The source of this image is ESRI, used by the EPA with ESRI's permission

0 — Scale in Miles — 2

1:54,000

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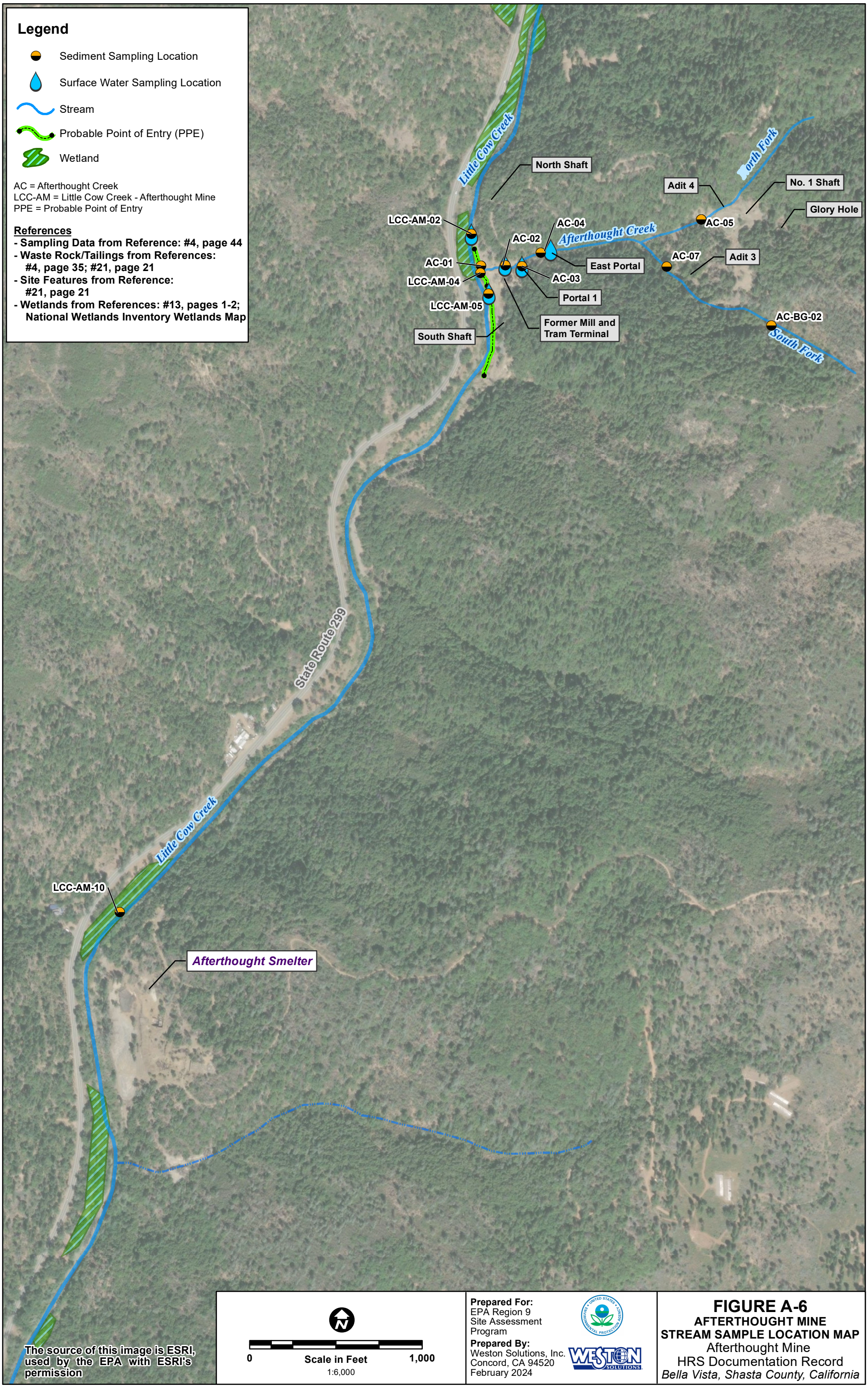
February 2024

FIGURE A-5

15-MILE SURFACE WATER TARGET DISTANCE LIMIT

Afterthought Mine
HRS Documentation Record
Bella Vista, Shasta County, California


Legend
Sediment Sampling Location
Surface Water Sampling Location
Stream
Probable Point of Entry (PPE)
Wetland
AC = Afterthought Creek
LCC-AM = Little Cow Creek - Afterthought Mine
PPE = Probable Point of Entry
References
- Sampling Data from Reference: #4, page 44
- Waste Rock/Tailings from References: #4, page 35; #21, page 21
- Site Features from Reference: #21, page 21
- Wetlands from References: #13, pages 1-2; National Wetlands Inventory Wetlands Map
Little Cow Creek
North Shaft
LCC-AM-02
AC-04
AC-02
Afterthought Creek
AC-01
East Portal
AC-03
LCC-AM-04
Portal 1
LCC-AM-05
South Shaft
Former Mill and Tram Terminal
Adit 4
North Fork
No. 1 Shaft
Glory Hole
AC-05
AC-07
Adit 3
AC-BG-02
South Fork
State Route 299
LCC-AM-10
Afterthought Smelter
The source of this image is ESRI, used by the EPA with ESRI's permission
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Scale in Feet
1,000
1:6,000
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Prepared By:
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February 2024
FIGURE A-6
AFTERTHOUGHT MINE
STREAM SAMPLE LOCATION MAP
Afterthought Mine
HRS Documentation Record
Bella Vista, Shasta County, California

SITE DESCRIPTION

The Afterthought Mine site is located approximately 25 miles northeast of Redding on Highway 299 East, Bella Vista, Shasta County, California (Figure A-1 of this HRS documentation record; Ref. 4, p. 8). For Hazard Ranking System scoring purposes, the site consists of the release of hazardous substances from former operations associated with mining and ore processing. The sources of hazardous substances includes waste rock, tailings, and acid mine drainage (AMD) (Sources 1-6) (Figure A-2 and Figure A-3 of this HRS documentation record; see section 2.2 and subsections of this HRS documentation record).

Hazardous substances associated with the site sources include arsenic, cadmium, copper, lead, mercury, and zinc (see Section 2.2, Source Characterization of this HRS documentation record). An observed release of cadmium, copper, lead, and zinc is documented to Little Cow Creek (see Section 4.1.2.1.1, Observed Release of this HRS documentation record). Targets affected by the observed release include the Little Cow Creek fishery (see Section 4.1.3.3 Human Food Chain Threat Targets of this HRS documentation record). Additional targets include potential contamination of Critical Habitat for the Federal-listed threatened Steelhead (*Oncorhynchus mykiss*), and Level II actual contamination of wetlands (see Section 4.1.4.3 Environmental Threat Targets of this HRS documentation record).

The Afterthought Mine site is located in a canyon formed by Little Cow Creek, a perennial stream that flows southwest to Cow Creek. Afterthought Mine is located approximately 3/4 mile upstream from the town of Ingot. The former Afterthought Smelter is located approximately 1 mile downstream of Afterthought Mine. A former rail bed that appears to have been constructed from tailings and/or waste rock connects Afterthought Mine and Afterthought Smelter along the eastern bank of Little Cow Creek (Figure A-2 of this HRS documentation record; Ref. 4, p. 8; Ref. 14, pp. 9, 22; Ref. 17, pp. 28-29).

The Afterthought Mine dates to 1862, when seven claims of the Copper Hill group were staked. During the first few years after the mine's discovery, the oxidized ore near the surface was mined on a small scale for gold and silver. In 1873, M.H. Peck purchased the property, named it the Peck Mine, and mined copper ore that was shipped to Swansea, Wales, for processing. In 1875, Peck built a small reverberatory furnace to reduce the sulfide ore, which failed, as did a water-jacketed furnace built soon afterward. Subsequently, the mine was acquired by Joseph Conland and Associates, who built a 25-ton water-jacketed blast furnace. Two attempts to treat the ore in this furnace were made but both were unsuccessful. In 1896, 200 tons of ore were smelted. This yielded 32 tons of copper matte containing 37 percent copper, 45 ounces of silver, and $7 in gold per ton (Ref. 17, pp. 28-29; Ref. 21, p. 5; Ref. 24, p. 26; Ref. 25, p. 35; Ref. 26, p. 54; Ref. 36, p. 7; Ref. 39, pp. 79, 95-96).

In 1903, the mine was purchased by the Great Western Gold Company. In 1905, the company constructed a 250-ton water-jacketed blast furnace 1 mile downstream of the site at Afterthought Smelter. Operation of this furnace continued successfully until 1908. During this period, the average yearly output was reported to have been $350,000. The copper matte produced in the blast furnace was shipped to a smelter in Salt Lake City where it was converted into blister copper. However, the high zinc content of the ore made it extremely refractory, necessitating a large coke charge and causing the furnace to frequently freeze (Ref. 17, pp. 28-29; Ref. 21, p. 5; Ref. 24, p. 26; Ref. 25, p. 35; Ref. 26, p. 54; Ref. 30; Ref. 36, p. 7; Ref. 39, p. 96).

In 1909, the Afterthought Copper Company acquired Afterthought Mine. A 300-ton oil-flotation mill and a 300-ton reverberatory furnace were completed in 1919 at Afterthought Smelter, with the objective of treating the sulfide ore by the Harwood process. In this process, the ore was first pre-roasted in the reverberatory furnace and then treated by flotation. Operation began in July 1919 and lasted only 8 months, because the zinc and copper sulfides could not be cleanly separated. Late in 1923, the company lost the mine through foreclosure. In February 1925, the Glidden Paint Company, under the name California Zinc Company, began mining zinc ore under lease. The ore was moved by an 8.5-mile aerial tram to the Bully Hill Mill. This tramway was put in operation in November 1925 and delivered about 75 tons a day to the mill. A drop in the price of copper and zinc in 1927 closed the operation (Ref. 21, p. 5; Ref. 23, pp. 14, 340; Ref. 24, pp. 16, 26-27; Ref. 25, pp. 35-36, 108-110; Ref. 26, p. 54; Ref. 36, p. 7; Ref. 39, p. 96).

The Coronado Copper & Zinc Co. purchased the mine in 1946, and after new ore bodies had been located by exploratory drilling, the company constructed a 100-ton selective flotation plant. Mining started in October 1948 and continued until July 1949, when the operation ceased due to a drop in the price of metals. In July 1950, the mine reopened and operated continuously until August 1952. During this time, the crude oxide ore was ground to 94% minus 200 mesh, and the concentrates were made by selective flotation. A copper-lead concentrate was shipped to a smelter in Tooele, Utah, and a zinc concentrate was shipped to a smelter in Great Falls, Montana (Ref. 21, p. 5, Ref. 23, p. 340; Ref. 26, p. 56; Ref. 36, p. 7; Ref. 39, pp. 79, 96).

In 1951, Afterthought Mine was reported to be the highest producer of copper, the second highest producer of zinc, and the third highest producer of lead and silver in California (Ref. 22, pp. 129, 134, 138, 141). From 1900 to 1952, 166,424 tons of ore were mined from Afterthought Mine. Production included 10,730,580 pounds of copper, 23,635,840 pounds of zinc, 1,738,300 pounds of lead, 923,653 ounces of silver, and 4,992 ounces of gold (Ref. 39, pp. 80, 96). Afterthought Mine ceased operations in August 1952 (Ref. 23, p. 340; Ref. 26, p. 56; Ref. 36, pp. 7-8; Ref. 39, p. 79).

During operations, the mine workings totaled about 19,400 linear feet, including 17,200 feet of drifts, crosscuts, and stopes and 2,200 feet of raises and shafts, developed to a depth of 729 feet with 10 levels (Ref. 21, pp. 4, 23; Ref. 24, p. 27; Ref. 26, p. 56; Ref. 39, pp. 95, 97). Remnants of the mine are still present on the mine property, including waste rock piles, adits/portals, and the ruins of the mine plant. AMD discharges from mine portals and mine waste rock piles to Afterthought Creek, which flows into Little Cow Creek adjacent to the mine property (Ref. 4, p. 8).

From the late 1970s to the present, multiple sampling investigations were conducted at the mine property and in downstream surface water by the EPA, California Regional Water Quality Control Board, and California Department of Fish and Wildlife (Ref. 4, pp. 11-12; Ref. 26, p. 60; Ref. 27, pp. 1, 2; Ref. 29; Ref. 31; Ref. 32, p. 1; Ref. 33, p. 4; Ref. 36, p. 7; Ref. 37, pp. 200, 203; Ref. 41, p. 5; Ref. 42, p. 5). A 1.1-mile portion of Little Cow Creek downstream of Afterthought Mine is listed as impaired under Section 303 of the Clean Water Act (Ref. 38, p. 1).

In 2022, EPA conducted a Site Inspection (SI) at Afterthought Mine to determine whether the site was eligible for placement on the National Priorities List (NPL). Based on the June 2022 SI sampling event, on-site hazardous substance sources have been documented at Afterthought Mine, including waste rock, tailings, and AMD (Ref. 4, pp. 5-6; Ref. 5, p. 5). Elevated concentrations of metals, including maximum concentrations of 1,300 milligrams per kilogram (mg/kg) arsenic, 97

mg/kg cadmium, 9,600 mg/kg copper, 11,000 mg/kg lead, 27 mg/kg mercury, and 18,000 mg/kg zinc, were detected in soil and waste rock samples (Ref. 4, p. 5).

SITE SOURCES

A total of six sources were evaluated for scoring the Afterthought Mine site (see Figure A-3 of this HRS documentation record). The sources originated as part of the Afterthought Mine operations. Detailed information about each source, with reference citations, is available in the following sections.

Hazardous substances associated with these sources include arsenic, cadmium, copper, lead, mercury, and zinc.

Afterthought Mine Sources		
Source Number	**Source Name**	**Source Type**
1	Portal 1	Other
2	North Fork Waste Rock	Pile
3	Central Waste Rock	Pile
4	South Fork Waste Rock	Pile
5	Mill Area Waste Rock	Pile
6	Tailings Pile	Pile

2.2 SOURCE 1 SOURCE CHARACTERIZATION

2.2.1 SOURCE IDENTIFICATION

Name of Source: Portal 1 **Number of Source:** 1

Source Type: Other

Description and Location of Source (see Figure A-3 of this HRS documentation record):

Source 1 consists of AMD discharge from Portal 1, located in the lower portion of the mine property adjacent to Afterthought Creek (Ref. 4, p. 36). Portal 1 is also referred to as the main portal in some historical documentation (Ref. 21, p. 4; Ref. 26, p. 16; Ref. 31, pp. 1-2; Ref. 35, p. 7). During mining operations, Portal 1 was the only known portal for the lower levels of the mine and accessed over 3,000 feet of tunnels. Portal 1 has since collapsed (Ref. 26, p. 56).

AMD from Portal 1 flows into Afterthought Creek from the south, depositing a bright orange and green slime on waste rock between the portal and the creek (Ref. 4, pp. 8, 50, 55; Ref. 41, pp. 33, 38-39). Flow from the portal was estimated at 10-20 gallons per minute (gpm) on April 23, 1982 (Ref. 29, p. 2). In 1984, average flow for Portal 1 was estimated at 20 acre-feet per year (Ref. 26, p. 60). When Afterthought Creek is flowing, discharge from Portal 1 has been observed flowing to Afterthought Creek and into Little Cow Creek causing a plume of mine drainage downstream on the south bank (Ref. 26, pp. 60, 62; Ref. 29, p. 2; Ref. 41, pp. 33, 39). Surveys conducted in 1984 estimated that over 90% of the Afterthought Mine-related AMD emanated from Portal 1 (Ref. 26, pp. 60-61; Ref. 31, p. 1).

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE

2022 EPA SI Sampling
From June 21, 2022 through June 24, 2022, Weston Solutions, Inc. collected soil, sediment, and surface water samples as part of the SI for Afterthought Mine (Ref. 4, pp. 50-51). Samples were collected in accordance with Sampling and Analysis Plan (SAP) approved by EPA on May 29, 2020 (Ref. 4, p. 13; Ref. 7, p. 2). Sediment samples were submitted to Eurofins Burlington under the EPA Contract Laboratory Program (CLP) for metals analysis by Inorganic Superfund Method (ISM) 02.4 ICP-AES. Surface water samples were submitted for metals analysis by ISM 0.24 ICP-AES and ICP-MS (Ref. 4, p. 14; Ref. 5, p. 11). Validation of analytical data was contracted by EPA in accordance with ISM 02.4 (Ref. 4, p. 13; Ref. 7, pp. 44-45; Ref. 34, pp. 1-3; Ref. 46, pp. 1, 2, 4).

Water and sediment samples were collected as it flows from the Portal 1 opening (AC-03). The surface water had a pH of 2.77 and conductivity of 2,898 µS/cm (Ref. 4, pp. 50, 55). Sediment samples were collected using a sample-dedicated plastic disposable scoop and transferred to a 4-oz. wide-mouth glass jar. Water was removed from sediment samples by allowing the solids to settle in the sample container and decanting the water after the water clarified sufficiently (Ref. 4, pp. 13, 14; Ref. 7, p. 36). Surface water was collected by submerging the sample container in a location where the bottle could be submerged beneath the surface such that it could be filled and capped without entraining surface scum or bottom sediment. Two sets of surface water samples were collected. The first set was unfiltered and preserved with nitric acid to a pH of less than 2; the second set was filtered with a 0.45-micrometer, disposable filter and preserved with nitric acid

to a pH of less than 2. A peristaltic pump with disposable plastic tubing was used to draw the water through the disposable filter. (Ref. 4, p. 13; Ref. 7, pp. 36-37). Portal sediment samples are compared to a background sample to show the relative increase in hazardous substances over background levels. One background sediment sample was collected from South Fork Afterthought Creek upstream of areas impacted by mining activities. Background surface water samples were not collected as there was no surface water in Afterthought Creek upstream of mine property sources (Ref. 4, pp. 14, 15, 51). Background samples were collected using the same methods as the Source samples (Ref. 4, p. 14). Sampling locations are presented in Figure A-3 of this HRS documentation record.

Table 1: 2022 SI, Source 1 Portal 1 Discharge Concentrations

Station Location	CLP Sample ID	Filtered/ Unfiltered	Sampling Date	Hazardous Substance	Concentration (µg/L)	Sample Adjusted CRQL* (µg/L)	References
ICP-MS Results							
AC-03-W-T	MY0AJ8	Unfiltered	6/23/2022	Arsenic	11	1.0	Ref. 4, pp. 31, 44, 50, 55; Ref. 12, pp. 3, 676; Ref. 15, pp. 64-66, 73, 85-87, 94; Ref. 46, p. 20; Ref. 47, p. 2
				Cadmium	490	1.0	
				Copper	16,000	10	
				Lead	81	1.0	
				Zinc	120,000	150	
AC-03-W-F	MY0AJ7	Filtered	6/23/2022	Arsenic	3.6	1.0	Ref. 4, pp. 31, 44, 50, 55; Ref. 12, pp. 3, 675; Ref. 15, pp. 43-45, 52, 64-66, 73; Ref. 46, p. 17; Ref. 47, p. 2
				Cadmium	470	1.0	
				Copper	16,000	10	
				Lead	78	1.0	
				Zinc	110,000	150	
ICP-AES Results							
AC-03-W-T	MY0AJ8	Unfiltered	6/23/2022	Arsenic	15	10	Ref. 4, pp. 44, 50, 55; Ref. 12, pp. 3, 18; Ref. 15, pp. 64-66, 73, 85-87, 94; Ref. 46, p. 19; Ref. 47, p. 2
				Cadmium	460	5.0	
				Copper	15,000	50	
				Lead	83	10	
				Zinc	110,000	600	
AC-03-W-F	MY0AJ7	Filtered	6/23/2022	Cadmium	460	5.0	Ref. 4, pp. 44, 50, 55; Ref. 12, pp. 3, 17; Ref. 15, pp. 43-45, 52, 64-66, 73; Ref. 46, p. 16; Ref. 47, p. 2
				Copper	15000	50	
				Lead	80	10	
				Zinc	110,000	600	

CLP: Contract Laboratory Program
µg/L: micrograms analyte per liter adit discharge
ng/L nanograms mercury per liter adit discharge
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
*: Since the samples were analyzed through the CLP, the CRQLs presented above are equivalent to the CRQL as defined by the HRS (Ref. 1, Sections 1.1 and 2.3).

Table 2: 2022 SI, Source 1 Portal 1 Sediment Concentrations						
Station Location	**CLP Sample ID**	**Sampling Date**	**Hazardous Substance**	**Concentration (mg/kg)**	**Sample Adjusted CRQL* (mg/kg)**	**References**
Background Sediment Sample						
AC-BG-02-S	MY0AJ0	6/24/2022	Arsenic	26	0.98	Ref. 4, pp. 31, 44, 51; Ref. 11, pp. 4, 27, 413, 435; Ref. 16, pp. 101-103, 110, 121-123, 130; Ref. 34, pp. 33-34; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	1.9	0.49	
			Copper	53	2.5	
			Lead	32 J (46.08)	0.98	
			Mercury	0.11 J- (0.2013)	0.097	
			Zinc	370	5.9	
Source 1 Portal 1 Sample						
AC-03-S	MY0AH2	6/23/2022	Arsenic	800	4.8	Ref. 4, pp. 31, 44, 50, 55; Ref. 11, pp. 3, 21, 413, 429; Ref. 16, pp. 61-63, 70; Ref. 34, pp. 21-22; Ref. 47, p. 2; Ref. 48, pp. 8, 20
			Cadmium	17	2.4	
			Copper	370	2.4	

CLP: Contract Laboratory Program
mg/kg: milligrams analyte per kilogram sediment
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
*: Since the samples were analyzed through the CLP, the CRQLs presented above are equivalent to the CRQL as defined by the HRS (Ref. 1, Sections 1.1 and 2.3).
J-: The sample concentration is an estimated quantity, but the result may be biased low (Ref. 34, pp. 4, 8).
J: The result is an estimated quantity because the laboratory duplicate results were outside the method limit (Ref. 34, pp. 5, 8).

2.2.3 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY

All hazardous substances associated with Source 1 are available to the surface water pathway based on a containment factor value of greater than zero (Ref 1, Section 2.2.3).

Containment Description	Containment Factor Value	References
Release to surface water: When Afterthought Creek is flowing, discharge from Portal 1 has been observed flowing into Afterthought Creek and into Little Cow Creek causing a plume of mine drainage downstream on the south bank. A containment factor of 10 is assigned.	10	Ref. 26, pp. 60, 62; Ref. 29, p. 2; Ref. 41, pp. 33, 39

2.4.2. HAZARDOUS WASTE QUANTITY

2.4.2.1.1 Hazardous Constituent Quantity (Tier A)

The hazardous constituent quantity for Source 1 could not be adequately determined according to the HRS requirements; that is, the total mass of all Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) hazardous substances in the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.1). There are insufficient historical and current data (manifests, potentially responsible party [PRP] records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous constituent quantity for Source 1 with reasonable confidence. Scoring proceeds to the evaluation of Tier B, hazardous wastestream quantity (Ref. 1, Section 2.4.2.1.1).

Hazardous Constituent Quantity Value: NS

2.4.2.1.2 Hazardous Wastestream Quantity (Tier B)

The total Hazardous Wastestream Quantity for Source 1 could not be adequately determined according to the HRS requirements; that is, the total mass, or a partial estimate, of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.2). Insufficient historical and current data (permits, waste concentration data, annual reports, etc.) are available to adequately calculate the total mass, or a partial estimate, of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and the associated releases from the source. Therefore, there is insufficient information to adequately calculate or extrapolate a total or partial Hazardous Wastestream Quantity for Source 1 with reasonable confidence. Scoring proceeds to the evaluation of Tier C, volume (Ref. 1, Section 2.4.2.1.2).

Hazardous Wastestream Quantity Value: NS

2.4.2.1.3 Volume (Tier C)

The exact volume for Source 1 could not be adequately determined with reasonable confidence. Flow from the portal was estimated at 10-20 gpm on April 23, 1982 (Ref. 29, p. 2). In 1984, average flow for Portal 1 was estimated at 20 acre-feet per year (Ref. 26, p. 60). However, as these were not continuous observations and estimates, there is insufficient information to calculate the volume for Source 1 with reasonable confidence. Therefore, based on the presence of hazardous substances in the Portal 1 discharge, the volume of the source is greater than 0 but the total volume is unknown (Ref. 1, Section 2.4.2.1.3).

Volume Assigned Value: >0

2.4.2.1.4 Area (Tier D)

Area is not evaluated for source type "other" (Ref. 1, Section 2.4.2.1.4).

Area Assigned Value: 0

Source Hazardous Waste Quantity Value

According to the HRS, the highest of the values assigned to the source for hazardous constituent quantity (Tier A), hazardous wastestream quantity (Tier B), Volume (Tier C), and Area (Tier D) is assigned as the source hazardous waste quantity value (Ref. 1, Section 2.4.2.1.5).

Tier Evaluated	Source 1 Values
A	NS
B	NS
C	>0
D	0

Source 1 Hazardous Waste Quantity Value: >0

2.2 SOURCE 2 SOURCE CHARACTERIZATION

2.2.1 SOURCE IDENTIFICATION

Name of Source: North Fork Waste Rock **Number of Source:** 2

Source Type: Pile

Description and Location of Source (see Figure A-3 of this HRS documentation record):

Source 2 consists of the waste rock pile along North Fork Afterthought Creek (Ref. 4, p. 35; Ref. 21, p. 21; Ref. 36, pp. 16-18). This waste rock pile is located in the upper portion of the mine property and consists of waste rock from the No. 1 Shaft and Adit 4. Intermittent surface water in the North Fork Afterthought Creek flows through the waste rock pile (Ref. 4, p. 8; Ref. 36, pp. 16-18; Ref. 41, pp. 33, 36-37). A mine dump was mapped at this location in 1921 (Ref. 21, p. 21). The area of the Source 2 waste rock pile is approximately 42,672.58 square feet. The area was measured based on the aerial photo presented in Figure A-3 of this HRS documentation record and on field observations during the 2019 PA and the 2022 SI correlating the unvegetated area with the boundaries of the waste rock pile (Ref. 4, pp. 35, 51, 53-54; Ref. 41, pp. 33, 36-37).

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE

2022 EPA SI Sampling

From June 21, 2022 through June 24, 2022, Weston Solutions, Inc. collected soil, sediment, and surface water samples as part of the SI for Afterthought Mine (Ref. 4, pp. 50-51). Samples were collected in accordance with the SAP approved by EPA on May 29, 2020 (Ref. 4, p. 13; Ref. 7, p. 2). Soil samples were submitted to Eurofins Burlington under the EPA CLP for metals analysis by ISM 02.4 ICP-AES (Ref. 4, p. 14). Validation of analytical data was contracted by EPA in accordance with ISM 02.4 (Ref. 7, pp. 44-45; Ref. 43, pp. 1, 2, 4; Ref. 44, pp. 1, 2, 4).

Waste rock samples were collected from one location within Source 2 (AM-25) (Ref. 4, p. 36). Waste rock samples were collected using a sample-dedicated plastic disposable scoop and transferred to a 4-oz. wide-mouth glass jar (Ref. 4, p. 13; Ref. 7, p. 36). Pile source samples were compared to a background sample to show the relative increase in hazardous substances over background soil levels. A background soil sample was collected from native soils north of the mine property in an area that was not observed to be impacted by mining activities (Ref. 4, pp. 13-14, 50). Background samples were collected using the same methods as the Source samples (Ref. 4, pp. 13, 14). Source sampling locations are presented in Figure A-3 of this HRS documentation record.

Table 3: 2022 SI, Source 2 North Fork Waste Rock						
Station Location	**CLP Sample ID**	**Sampling Date**	**Hazardous Substance**	**Concentration (mg/kg)**	**Sample Adjusted CRQL* (mg/kg)**	**References**
Background Soil Samples						
AM-BG-1	MY0AA0	6/22/2022	Arsenic	23	1.0	Ref. 4, pp. 29, 50; Ref. 9, pp. 2-3, 12, 14, 470; Ref. 19, pp. 1-3, 10; Ref. 43, pp. 10-11; Ref. 47, p. 2; Ref. 48, pp. 8, 20
			Cadmium	1.7	0.51	
			Copper	77	2.5	
			Lead	100	1.0	
			Mercury	0.20 J- (0.366)	0.10	
			Zinc	310	6.1	
Source 2 North Fork Waste Rock Sample						
AM-25	MY0AC6	6/24/2022	Arsenic	290	1.7	Ref. 4, pp. 29, 51; Ref. 10, pp. 3, 13, 18, 764, 786; Ref. 44, pp. 18-19; Ref. 45, pp. 41-43, 50; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	9.5	0.86	
			Copper	780	2.2	
			Lead	1,800	1.7	
			Mercury	2.9 J-	0.20	
			Zinc	1,400	10	

CLP: Contract Laboratory Program
mg/kg: milligrams analyte per kilogram tailings
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
*: Since the samples were analyzed through the CLP, the CRQLs presented above are equivalent to the CRQL as defined by the HRS (Ref. 1, Sections 1.1 and 2.3).
J-: The result is an estimated quantity, but the result may be biased low (Ref. 43, pp. 5, 9; Ref. 44, pp. 5, 10).

2.2.3 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY

All hazardous substances associated with Source 2 are available to the surface water pathway based on a containment factor value of greater than zero (Ref 1, Section 2.2.3).

Containment Description	Containment Factor Value	References
Release to surface water: There is no known maintained engineered cover or functioning and maintained run-on control system and runoff management system. Surface water in the intermittent North Fork Afterthought Creek flows through the waste rock pile.	10	Ref. 4, p. 8; Ref. 41, pp. 33, 36-37

2.4.2. HAZARDOUS WASTE QUANTITY

2.4.2.1.1 Hazardous Constituent Quantity (Tier A)

The hazardous constituent quantity for Source 2 could not be adequately determined according to the HRS requirements; that is, the total mass of all CERCLA hazardous substances in the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.1). There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous constituent quantity for Source 2 with reasonable confidence. Scoring proceeds to the evaluation of Tier B, hazardous wastestream quantity (Ref. 1, Section 2.4.2.1.1).

Hazardous Constituent Quantity Value: Not Scored (NS)

2.4.2.1.2 Hazardous Wastestream Quantity (Tier B)

The total Hazardous Wastestream Quantity for Source 2 could not be adequately determined according to the HRS requirements; that is, the total mass, or a partial estimate, of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.2). Insufficient historical and current data (permits, waste concentration data, annual reports, etc.) are available to adequately calculate the total mass, or a partial estimate, of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and the associated releases from the source. Therefore, there is insufficient information to adequately calculate or extrapolate a total or partial Hazardous Wastestream Quantity for Source 2 with reasonable confidence. Scoring proceeds to the evaluation of Tier C, volume (Ref. 1, Section 2.4.2.1.2).

Hazardous Wastestream Quantity Value: NS

2.4.2.1.3 Volume (Tier C)

The volume for Source 2 could not be adequately determined with reasonable confidence The depth of Source 2 is unknown. Scoring proceeds to the evaluation of Tier D, area (Ref. 1, Section 2.4.2.1.3).

Volume Assigned Value: 0

2.4.2.1.4 Area (Tier D)

The area of the Source 2 waste rock pile is approximately 42,672.58 square feet. The area was measured based on the aerial photo presented in Figure A-3 of this documentation record and on field observations during the 2019 PA and the 2022 SI correlating the unvegetated area with the boundaries of the waste rock pile (Figure A-3 of this documentation record; Ref. 4, pp. 51, 53-54; Ref. 41, pp. 33, 36-37). In accordance with Ref. 1, Table 2-5, the equation for assigning a value for a pile is the area in square feet divided by 13:

$$42{,}672.58 / 13 = 3{,}282.51$$

Area Assigned Value: 3,282.51

Source Hazardous Waste Quantity Value

According to the HRS, the highest of the values assigned to the source for hazardous constituent quantity (Tier A), hazardous wastestream quantity (Tier B), Volume (Tier C), and Area (Tier D) is assigned as the source hazardous waste quantity value (Ref. 1, Section 2.4.2.1.5).

Tier Evaluated	Source 2 Values
A	NS
B	NS
C	0
D	3,282.51

Source Hazardous Waste Quantity Value: 3,282.51

2.2 SOURCE 3 SOURCE CHARACTERIZATION

2.2.1 SOURCE IDENTIFICATION

Name of Source: Central Waste Rock Pile **Number of Source:** 3

Source Type: Pile

Description and Location of Source (see Figure A-3 of this HRS documentation record):

Source 3 consists of the waste rock pile between North Fork and South Fork Afterthought Creek in the upper portion of the mine property (Figure A-3 of this HRS documentation record; Ref. 4, pp. 35, 51, 53; Ref. 36, pp. 17-18). A mine dump was mapped at this location in 1921 (Ref. 21, p. 21). The area of the Source 3 waste rock pile is approximately 14,809.81 square feet. The area was measured based on the aerial photo presented in Figure A-3 of this documentation record and on field observations during the 2022 SI correlating the unvegetated area with the boundaries of the waste rock pile (Figure A-3 of this documentation record; Ref. 4, pp. 35, 51, 53).

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE

2022 EPA SI Sampling

From June 21, 2022 through June 24, 2022, Weston Solutions, Inc. collected soil, sediment, and surface water samples as part of the SI for Afterthought Mine (Ref. 4, pp. 50-51). Samples were collected in accordance with the SAP approved by EPA on May 29, 2020 (Ref. 4, p. 13; Ref. 7, p. 2). Soil samples were submitted to Eurofins Burlington under the EPA CLP for metals analysis by ISM 02.4 ICP-AES (Ref. 4, p. 14). Validation of analytical data was contracted by EPA in accordance with ISM 02.4 (Ref. 7, pp. 44-45; Ref. 43, pp. 1, 2, 4; Ref. 44, p. 1, 2, 4).

Waste rock samples were collected from three locations within Source 3 (AM-35 through AM-37) (Ref. 4, pp. 36, 51, 53). Waste rock samples were collected using a sample-dedicated plastic disposable scoop and transferred to a 4-oz. wide-mouth glass jar (Ref. 4, p. 13; Ref. 7, p. 36). Pile source samples were compared to a background soil sample to show the relative increase in hazardous substances over background soil levels. A background soil sample was collected from native soils north of the mine property in an area that was not observed to be impacted by mining activities (Ref. 4, pp. 13-14, 50). Background samples were collected using the same methods as the Source samples (Ref. 4, pp. 13, 14). Source sampling locations are presented in Figure A-3 of this HRS documentation record.

Table 4: 2022 SI, Source 3 Central Waste Rock Pile						
Station Location	**CLP Sample ID**	**Sampling Date**	**Hazardous Substance**	**Concentration (mg/kg)**	**Sample Adjusted CRQL* (mg/kg)**	**References**
Background Soil Samples						
AM-BG-1	MY0AA0	6/22/2022	Arsenic	23	1.0	Ref. 4, pp. 29, 50; Ref. 9, pp. 2-3, 12, 14, 470; Ref. 19, pp. 1-3, 10; Ref. 43, pp. 10-11; Ref. 47, p. 2; Ref. 48, pp. 8, 20
			Cadmium	1.7	0.51	
			Copper	77	2.5	
			Lead	100	1.0	
			Mercury	0.20 J- (0.366)	0.10	
			Zinc	310	6.1	
Source 3 Central Waste Rock Pile Samples						
AM-35	MY0AD8	6/24/2022	Arsenic	440	2.4	Ref. 4, pp. 29, 51, 53; Ref. 10, pp. 3, 13, 21, 764, 789; Ref. 44, pp. 30-31; Ref. 45, pp. 61-63, 70; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	21	1.6	
			Copper	2,400	6.1	
			Lead	8,700	12	
			Mercury	16 J-	0.87	
			Zinc	3,200	19	
AM-36	MY0AD9	6/24/2022	Arsenic	470	3.7	Ref. 4, pp. 29, 51, 53; Ref. 10, pp. 3, 13, 22, 764, 790; Ref. 44, pp. 32-33; Ref. 45, pp. 61-63, 70, 81-83, 90; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	34	1.9	
			Copper	3,000	9.4	
			Lead	8,500	9.4	
			Mercury	12 J-	0.95	
			Zinc	4,200	22	
AM-37	MY0AE0	6/24/2022	Arsenic	300	2.0	Ref. 4, pp. 29, 51, 53; Ref. 10, pp. 3, 13, 23, 764, 791; Ref. 44, pp. 34-35; Ref. 45, pp. 81-83, 90; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	6.5	0.98	
			Copper	1,200	2.5	
			Lead	3,100	3.9	
			Mercury	5.0 J-	0.37	

CLP: Contract Laboratory Program
mg/kg: milligrams analyte per kilogram tailings
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
*: Since the samples were analyzed through the CLP, the CRQLs presented above are equivalent to the CRQL as defined by the HRS (Ref. 1, Sections 1.1 and 2.3).
J-: The result is an estimated quantity, but the result may be biased low (Ref. 43, pp. 5, 9; Ref. 44, pp. 5, 10).

2.2.3 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY

All hazardous substances associated with Source 3 are available to the surface water pathway based on a containment factor value of greater than zero (Ref 1, Section 2.2.3).

Containment Description	Containment Factor Value	References
Release to surface water: There is no evidence of a maintained engineered cover or functioning and maintained run-on control system and runoff management system.	10	Ref. 4, pp. 35, 51, 53; Ref. 21, p. 21

2.4.2. HAZARDOUS WASTE QUANTITY

2.4.2.1.1 Hazardous Constituent Quantity (Tier A)

The hazardous constituent quantity for Source 3 could not be adequately determined according to the HRS requirements; that is, the total mass of all CERCLA hazardous substances in the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.1). There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous constituent quantity for Source 3 with reasonable confidence. Scoring proceeds to the evaluation of Tier B, hazardous wastestream quantity (Ref. 1, Section 2.4.2.1.1).

Hazardous Constituent Quantity Value: NS

2.4.2.1.2 Hazardous Wastestream Quantity (Tier B)

The total Hazardous Wastestream Quantity for Source 3 could not be adequately determined according to the HRS requirements; that is, the total mass, or a partial estimate, of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.2). Insufficient historical and current data (permits, waste concentration data, annual reports, etc.) are available to adequately calculate the total mass, or a partial estimate, of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and the associated releases from the source. Therefore, there is insufficient information to adequately calculate or extrapolate a total or partial Hazardous Wastestream Quantity for Source 3 with reasonable confidence. Scoring proceeds to the evaluation of Tier C, volume (Ref. 1, Section 2.4.2.1.2).

Hazardous Wastestream Quantity Value: NS

2.4.2.1.3 Volume (Tier C)

The volume for Source 3 could not be adequately determined in accordance with HRS requirements. The depth of Source 3 is unknown. Scoring proceeds to the evaluation of Tier D, area (Ref. 1, Section 2.4.2.1.3).

Volume Assigned Value: 0

2.4.2.1.4 Area (Tier D)

The area of the Source 3 waste rock pile is approximately 14,809.81 square feet. The area was measured based on the aerial photo presented in Figure A-3 of this documentation record and on field observations during the 2022 SI correlating the unvegetated area with the boundaries of the waste rock pile (Figure A-3 of this documentation record; Ref. 4, pp. 35, 51, 53). In accordance with Ref. 1, Table 2-5, the equation for assigning a value for a pile is the area in square feet divided by 13:

$$14{,}809.81 / 13 = 1{,}139.22$$

Area Assigned Value: 1,139.22

Source Hazardous Waste Quantity Value

According to the HRS, the highest of the values assigned to the source for hazardous constituent quantity (Tier A), hazardous wastestream quantity (Tier B), Volume (Tier C), and Area (Tier D) is assigned as the source hazardous waste quantity value (Ref. 1, Section 2.4.2.1.5).

Tier Evaluated	Source 3 Values
A	NS
B	NS
C	0
D	1,139.22

Source Hazardous Waste Quantity Value: 1,139.22

2.2 SOURCE 4 SOURCE CHARACTERIZATION

2.2.1 SOURCE IDENTIFICATION

Name of Source: South Fork Waste Rock **Number of Source:** 4

Source Type: Pile

Description and Location of Source (see Figure A-3 of this HRS documentation record):

Source 4 consists of the waste rock pile along South Fork Afterthought Creek (Figure A-3 of this HRS documentation record; Ref. 4, p. 35; Ref. 21, p. 21; Ref. 36, pp. 16-18). This waste rock pile is located in the upper portion of the mine property and is associated with Adit 3, also known as Portal 3 (Ref. 4, pp. 8, 35, Ref. 36, pp. 16-18; Ref. 41, pp. 22, 33) A mine dump was mapped at this location in 1921 (Ref. 21, p. 21). Water in the South Fork Afterthought Creek flows through the waste rock pile (Figure A-3 of this HRS documentation record; Ref. 4, p. 8; Ref. 36, p. 17; Ref. 41, pp. 33, 36-37). The area of the Source 4 waste rock pile is approximately 10,136 square feet, based on the historical boundaries of the mine dump (Figure A-3 of this HRS documentation record; Ref. 4, p. 35; Ref. 21, p. 21; Ref. 36, pp. 17-18; Ref. 41, p. 22).

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE

2022 EPA SI Sampling

From June 21, 2022 through June 24, 2022, Weston Solutions, Inc. collected soil, sediment, and surface water samples as part of the SI for Afterthought Mine (Ref. 4, pp. 50-51). Samples were collected in accordance with the SAP approved by EPA on May 29, 2020 (Ref. 4, p. 13; Ref. 7, p. 2). Soil samples were submitted to Eurofins Burlington under the EPA CLP for metals analysis by ISM 02.4 ICP-AES (Ref. 4, p. 14). Validation of analytical data was contracted by EPA in accordance with ISM 02.4 (Ref. 7, pp. 44-45; Ref. 43, pp. 1, 2, 4; Ref. 44, pp. 1, 2, 4).

Waste rock samples were collected from two locations within Source 4 (AM-32 and AM-33) (Ref. 4, pp. 36, 51). Waste rock samples were collected using a sample-dedicated plastic disposable scoop and transferred to a 4-oz. wide-mouth glass jar (Ref. 4, p. 13; Ref. 7, p. 36). Pile source samples were compared to a background soil sample to show the relative increase in hazardous substances over background soil levels. A background soil sample was collected from native soils north of the mine property in an area that was not observed to be impacted by mining activities (Ref. 4, pp. 13-14, 50). Background samples were collected using the same methods as the Source samples (Ref. 4, pp. 13, 14). Source sampling locations are presented in Figure A-3 of this HRS documentation record.

Table 5: 2022 SI, Source 4 South Fork Waste Rock						
Station Location	**CLP Sample ID**	**Sampling Date**	**Hazardous Substance**	**Concentration (mg/kg)**	**Sample Adjusted CRQL* (mg/kg)**	**References**
Background Soil Samples						
AM-BG-1	MY0AA0	6/22/2022	Arsenic	23	1.0	Ref. 4, pp. 29, 50; Ref. 9, pp. 2-3, 12, 14, 470; Ref. 19, pp. 1-3, 10; Ref. 43, pp. 10-11; Ref. 47, p. 2; Ref. 48, pp. 8, 20
			Cadmium	1.7	0.51	
			Copper	77	2.5	
			Lead	100	1.0	
			Mercury	0.20 J- (0.366)	0.10	
			Zinc	310	6.1	
Source 4 South Fork Waste Rock Pile Samples						
AM-32	MY0AD5	6/24/2022	Arsenic	560	4.0	Ref. 4, pp. 29, 51; Ref. 10, pp. 3, 13, 19, 764, 787; Ref. 44, pp. 20-21; Ref. 45, pp. 41-43, 50; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	13 J+ (9.219)	2.0	
			Copper	790	2.5	
			Lead	1,300	2.0	
			Mercury	4.2 J-	0.41	
AM-33	MY0AD6	6/24/2022	Copper	260	2.2	Ref. 4, pp. 29, 51; Ref. 10, pp. 3, 13, 20, 764, 788; Ref. 44, pp. 28-29; Ref. 45, pp. 41-43, 50, 61-63, 70; Ref. 47, p. 3; Ref. 48, pp. 8, 20

CLP: Contract Laboratory Program
mg/kg: milligrams analyte per kilogram tailings
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
*: Since the samples were analyzed through the CLP, the CRQLs presented above are equivalent to the CRQL as defined by the HRS (Ref. 1, Sections 1.1 and 2.3).
J-: The result is an estimated quantity, but the result may be biased low (Ref. 43, pp. 5, 9; Ref. 44, pp. 5, 10).
J+: The result is an estimated quantity, but the result may be biased high (Ref. 44, pp. 6, 10)
J: Result is considered qualitatively uncertain because serial dilution analysis does not meet analysis criteria (Ref. 44, pp. 6-7).

2.2.3 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY

All hazardous substances associated with Source 4 are available to the surface water pathway based on a containment factor value of greater than zero (Ref 1, Section 2.2.3).

Containment Description	Containment Factor Value	References
Release to surface water: There is no evidence of a maintained engineered cover or functioning and maintained run-on control system and runoff management system. Surface water in the South Fork Afterthought Creek flows intermittently through the waste rock pile.	10	Ref. 4, pp. 8, 35, Ref. 21, p. 21; Ref. 41, pp. 22, 33, 36-37

2.4.2. HAZARDOUS WASTE QUANTITY

2.4.2.1.1 Hazardous Constituent Quantity (Tier A)

The hazardous constituent quantity for Source 4 could not be adequately determined according to the HRS requirements; that is, the total mass of all CERCLA hazardous substances in the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.1). There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous constituent quantity for Source 4 with reasonable confidence. Scoring proceeds to the evaluation of Tier B, hazardous wastestream quantity (Ref. 1, Section 2.4.2.1.1).

Hazardous Constituent Quantity Value: NS

2.4.2.1.2 Hazardous Wastestream Quantity (Tier B)

The total Hazardous Wastestream Quantity for Source 4 could not be adequately determined according to the HRS requirements; that is, the total mass, or a partial estimate, of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.2). Insufficient historical and current data (permits, waste concentration data, annual reports, etc.) are available to adequately calculate the total mass, or a partial estimate, of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and the associated releases from the source. Therefore, there is insufficient information to adequately calculate or extrapolate a total or partial Hazardous Wastestream Quantity for Source 4 with reasonable confidence. Scoring proceeds to the evaluation of Tier C, volume (Ref. 1, Section 2.4.2.1.2).

Hazardous Wastestream Quantity Value: NS

2.4.2.1.3 Volume (Tier C)

The volume for Source 4 could not be adequately determined with reasonable confidence. The depth of Source 3 is unknown. Scoring proceeds to the evaluation of Tier D, area (Ref. 1, Section 2.4.2.1.3).

Volume Assigned Value: NS

2.4.2.1.4 Area (Tier D)

The area of the Source 4 waste rock pile is approximately 10,136 square feet, based on the historical boundaries of the mine dump (Figure A-3 of this HRS documentation record; Ref. 4, p. 35; Ref. 21, p. 21; Ref. 36, pp. 17-18; Ref. 41, p. 22). In accordance with Ref. 1, Table 2-5, the equation for assigning a value for a pile is the area in square feet divided by 13:

$$10{,}136 / 13 = 779.69$$

Area Assigned Value: 779.69

Source Hazardous Waste Quantity Value

According to the HRS, the highest of the values assigned to the source for hazardous constituent quantity (Tier A), hazardous wastestream quantity (Tier B), Volume (Tier C), and Area (Tier D) is assigned as the source hazardous waste quantity value (Ref. 1, Section 2.4.2.1.5).

Tier Evaluated	Source 4 Values
A	NS
B	NS
C	0
D	779.69

Source Hazardous Waste Quantity Value: 779.69

2.2 SOURCE 5 SOURCE CHARACTERIZATION

2.2.1 SOURCE IDENTIFICATION

Name of Source: Mill Area Waste Rock **Number of Source:** 5

Source Type: Pile

Description and Location of Source (see Figure A-3 of this HRS documentation record):

Source 5 consists of the waste rock pile along Afterthought Creek and Little Cow Creek in the lower portion of the mine in the vicinity of the former mill (Figure A-3 of this HRS documentation record; Ref. 4, pp. 35, 51; Ref. 21, p. 21; Ref. 36, pp. 18-19; Ref. 41, pp. 33, 40). Afterthought Creek flows through this waste rock pile to Little Cow Creek (Ref. 4, p. 52; Ref. 36, pp. 17-18; Ref. 41, p. 40). A mine dump was mapped at this location in 1921, forming the flat surface beneath the former mill building (Ref. 21, p. 21).

Source 5 is located along the eastern bank of Little Cow Creek and has been observed to be in contact with Little Cow Creek surface water (Figure A-3 of this HRS documentation record; Ref. 4, pp. 8, 50-52, 58; Ref. 41, pp. 7, 33, 39-40). The area of the Source 5 waste rock pile is approximately 32,726 square feet. The area was measured based on the aerial photo presented in Figure A-3 of this documentation record and on field observations during the 2019 PA and the 2022 SI correlating the unvegetated area with the boundaries of the waste rock pile (Figure A-3 of this HRS documentation record; Ref. 4, pp. 51-52, 58; Ref. 41, pp. 33, 40).

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE

2022 EPA SI Sampling

From June 21, 2022 through June 24, 2022, Weston Solutions, Inc. collected soil, sediment, and surface water samples as part of the SI for Afterthought Mine (Ref. 4, pp. 50-51). Samples were collected in accordance with the SAP approved by EPA on May 29, 2020 (Ref. 4, p. 13; Ref. 7, p. 2). Soil samples were submitted to Eurofins Burlington under the EPA CLP for metals analysis by ISM 02.4 ICP-AES (Ref. 4, p. 14). Validation of analytical data was contracted by EPA in accordance with ISM 02.4 (Ref. 7, pp. 44-45; Ref. 43, pp. 1, 2, 4).

Waste rock samples were collected from seven locations within Source 5 (AM-05 through AM-09 and AM-11 through AM-12) (Figure A-3 of this documentation record; Ref. 4, pp. 36, 51, 58). Waste rock samples were collected using a sample-dedicated plastic disposable scoop and transferred to a 4-oz. wide-mouth glass jar (Ref. 4, p. 13; Ref. 7, p. 36). Pile source samples were compared to a background soil sample to show the relative increase in hazardous substances over background soil levels. A background soil sample was collected from native soils north of the mine property in an area that was not observed to be impacted by mining activities (Ref. 4, pp. 13-14, 50). Background samples were collected using the same methods as the Source samples (Ref. 4, p. 14). Source sampling locations are presented in Figure A-3 of this HRS documentation record.

Table 6: 2022 SI, Source 5 Mill Area Waste Rock						
Station Location	**CLP Sample ID**	**Sampling Date**	**Hazardous Substance**	**Concentration (mg/kg)**	**Sample Adjusted CRQL* (mg/kg)**	**References**
Background Soil Samples						
AM-BG-1	MY0AA0	6/22/2022	Arsenic	23	1.0	Ref. 4, pp. 29, 50; Ref. 9, pp. 2-3, 12, 14, 470; Ref. 19, pp. 1-3, 10; Ref. 43, pp. 10-11; Ref. 47, p. 2; Ref. 48, pp. 8, 20
			Cadmium	1.7	0.51	
			Copper	77	2.5	
			Lead	100	1.0	
			Mercury	0.20 J- (0.366)	0.10	
			Zinc	310	6.1	
Source 5 Mill Area Waste Rock Samples						
AM-05	MY0AA6	6/23/2022	Arsenic	240	1.7	Ref. 4, pp. 29, 51; Ref 9, pp. 2-3, 5, 12, 19, 460, 475; Ref. 19, pp. 41-43, 50, 61-63, 70; Ref. 43, pp. 20-21; Ref. 47, p. 2; Ref. 48, pp. 8, 20
			Cadmium	39	0.84	
			Copper	1,300	4.2	
			Lead	2,500	2.5	
			Mercury	1.7 J-	0.10	
			Zinc	8,700	50	
AM-06	MY0AA7	6/23/2022	Arsenic	500	3.8	Ref. 4, pp. 29, 51; Ref 9, pp. 2-3, 5, 12, 20, 460, 476; Ref. 19, pp. 61-63, 70; Ref. 43, pp. 22-23; Ref. 47, p. 2; Ref. 48, pp. 8, 20
			Cadmium	20	1.9	
			Copper	640	1.9	
			Lead	2,100	2.3	
			Mercury	2.9 J-	0.20	
			Zinc	3,100	23	
AM-07	MY0AA8	6/23/2022	Arsenic	720	3.9	Ref. 4, pp. 29, 51; Ref 9, pp. 2-3, 5, 12, 21, 460, 477; Ref. 19, pp. 61-63, 70; Ref. 43, pp. 24-25; Ref. 47, p. 2; Ref. 48, pp. 8, 20
			Cadmium	16	3.9	
			Copper	1,400	3.9	
			Lead	5,700	7.9	
			Mercury	6.5 J-	0.58	
			Zinc	1,500	9.4	
AM-08	MY0AA9	6/23/2022	Arsenic	620	4.1	Ref. 4, pp. 29, 51; Ref 9, pp. 2-3, 5, 12, 22, 460, 478; Ref. 19, pp. 61-63, 70, 81-83, 90; Ref. 43, pp. 26-27; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	28	2.0	
			Copper	790	2.0	
			Lead	1,900	1.6	
			Mercury	5.2 J-	0.48	
			Zinc	4,200	24	
AM-09	MY0AB0	6/23/2022	Arsenic	630	4.0	Ref. 4, pp. 29, 51; Ref 9, pp. 2-3, 5, 12, 23, 460, 479; Ref. 19, pp. 81-83, 90; Ref. 43, pp. 28-29; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	19	2.0	
			Copper	600	2.0	
			Lead	1,700	1.6	
			Mercury	3.3 J-	0.21	
			Zinc	2,200	14	
AM-11	MY0AB2	6/23/2022	Arsenic	810	5.4	Ref. 4, pp. 29, 51; Ref 9, pp. 2, 4, 5, 12, 25, 460, 481; Ref. 19,
			Cadmium	63	2.7	
			Copper	2,100	5.4	

Table 6: 2022 SI, Source 5 Mill Area Waste Rock						
Station Location	**CLP Sample ID**	**Sampling Date**	**Hazardous Substance**	**Concentration (mg/kg)**	**Sample Adjusted CRQL* (mg/kg)**	**References**
			Lead	4,800	5.4	pp. 121-123, 130; Ref. 43, pp. 32-33; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Mercury	11 J-	1.0	
			Zinc	11,000	64	
AM-12	MY0AB3	6/23/2022	Arsenic	120	0.87	Ref. 4, pp. 29, 51; Ref 9, pp. 2, 4, 5, 12, 26, 460, 482; Ref. 19, pp. 121-123, 130; Ref. 43, pp. 34-35; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	26	0.44	
			Copper	2,000	6.5	
			Lead	2,300	2.6	
			Mercury	3.5 J-	0.19	
			Zinc	7,700	78	

CLP: Contract Laboratory Program
mg/kg: milligrams analyte per kilogram tailings
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
*: Since the samples were analyzed through the CLP, the CRQLs presented above are equivalent to the CRQL as defined by the HRS (Ref. 1, Sections 1.1 and 2.3).
J-: The result is an estimated quantity, but the result may be biased low (Ref. 43, pp. 5, 9).

2.2.3 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY

All hazardous substances associated with Source 5 are available to the surface water pathway based on a containment factor value of greater than zero (Ref 1, Section 2.2.3).

Containment Description	Containment Factor Value	References
Release to surface water: There is no known maintained engineered cover or functioning and maintained run-on control system and runoff management system. Afterthought Creek runs through this waste rock pile to Little Cow Creek. Source 5 is located along the eastern bank of Little Cow Creek and has been observed to be in contact with Little Cow Creek surface water.	10	Figure A-3 of this HRS documentation record; Ref. 4, pp. 35, 50-52, 58; Ref. 21, p. 21; Ref. 41, pp. 7, 33, 39-40

2.4.2. HAZARDOUS WASTE QUANTITY

2.4.2.1.1 Hazardous Constituent Quantity (Tier A)

The hazardous constituent quantity for Source 5 could not be adequately determined according to the HRS requirements; that is, the total mass of all CERCLA hazardous substances in the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.1). There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous constituent quantity for Source 5 with reasonable confidence. Scoring proceeds to the evaluation of Tier B, hazardous wastestream quantity (Ref. 1, Section 2.4.2.1.1).

Hazardous Constituent Quantity Value: NS

2.4.2.1.2 Hazardous Wastestream Quantity (Tier B)

The total Hazardous Wastestream Quantity for Source 5 could not be adequately determined according to the HRS requirements; that is, the total mass, or a partial estimate, of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.2). Insufficient historical and current data (permits, waste concentration data, annual reports, etc.) are available to adequately calculate the total mass, or a partial estimate, of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and the associated releases from the source. Therefore, there is insufficient information to adequately calculate or extrapolate a total or partial Hazardous Wastestream Quantity for Source 4 with reasonable confidence. Scoring proceeds to the evaluation of Tier C, volume (Ref. 1, Section 2.4.2.1.2).

Hazardous Wastestream Quantity Value: NS

2.4.2.1.3 Volume (Tier C)

The volume for Source 5 could not be adequately determined with reasonable confidence. The depth of Source 5 is unknown. Scoring proceeds to the evaluation of Tier D, area (Ref. 1, Section 2.4.2.1.3).

Volume Assigned Value: 0

2.4.2.1.4 Area (Tier D)

The area of the Source 5 waste rock pile is approximately 32,726 square feet. The area was measured based on the aerial photo presented in Figure A-3 of this documentation record and on field observations during the 2019 PA and the 2022 SI correlating the unvegetated area with the boundaries of the waste rock pile (Figure A-3 of this HRS documentation record; Ref. 4, pp. 51-52, 58; Ref. 41, pp. 33, 40). In accordance with Ref. 1, Table 2-5, the equation for assigning a value for a pile is the area in square feet divided by 13:

$$32{,}726 / 13 = 2{,}517.38$$

Area Assigned Value: 2,517.38

Source Hazardous Waste Quantity Value

According to the HRS, the highest of the values assigned to the source for hazardous constituent quantity (Tier A), hazardous wastestream quantity (Tier B), Volume (Tier C), and Area (Tier D) is assigned as the source hazardous waste quantity value (Ref. 1, Section 2.4.2.1.5).

Tier Evaluated	Source 5 Values
A	NS
B	NS
C	0
D	2,517.38

Source Hazardous Waste Quantity Value: 2,517.38

2.2 SOURCE 6 SOURCE CHARACTERIZATION

2.2.1 SOURCE IDENTIFICATION

Name of Source: Tailings Pile **Number of Source:** 6

Source Type: Pile

Description and Location of Source (see Figure A-2 and A-3):

Source 6 consists of the tailings pile along Little Cow Creek in the lower portion of the mine property (Figure A-3 of this HRS documentation record; Ref. 4, pp. 35, 51; Ref. 21, p. 21; Ref. 36, pp. 17-18; Ref. 41, pp. 33, 40). A mine dump was mapped at this location in 1921, forming the flat surface and road base along the eastern bank of Little Cow Creek (Ref. 21, p. 21). Tailings and waste rock appear to have been used to construct a rail bed between Afterthought Mine and Afterthought Smelter located approximately 1 mile downstream of the mine. The tailings pile was observed to be in direct contact with surface water in Little Cow Creek (Ref. 4, pp. 50-52, 59-60; Ref. 14, pp. 9, 22; Ref. 17, pp. 28-29; Ref. 41, pp. 33, 41). During the SI sampling event, acidic water was observed emerging from the tailings on Little Cow Creek bank and flowing into Little Cow Creek (Ref. 4, pp. 57-58).

The area of the Source 6 tailings pile is approximately 63,883 square feet. The area was measured based on the aerial photo presented in Figure A-3 of this documentation record and on field observations during the 2019 PA and the 2022 SI correlating the unvegetated area with the boundaries of the tailings pile (Figure A-3 of this HRS documentation record; Ref. 4, pp. 35, 50-52, 59; Ref. 41, p. 33).

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE

2022 EPA SI Sampling

From June 21, 2022 through June 24, 2022, Weston Solutions, Inc. collected soil, sediment, and surface water samples as part of the SI for Afterthought Mine (Ref. 4, pp. 50-51). Samples were collected in accordance with the SAP approved by EPA on May 29, 2020 (Ref. 4, p. 13; Ref. 7, p. 2). Soil samples were submitted to Eurofins Burlington under the EPA CLP for metals analysis by ISM 02.4 ICP-AES (Ref. 4, p. 14). Validation of analytical data was contracted by EPA in accordance with ISM 02.4 (Ref. 7, pp. 44-45; Ref. 43, pp. 1, 2, 4; Ref. 44, pp. 1, 2, 4).

Tailings samples were collected from eight locations within Source 6 (AM-13 through AM-15 and AM-17 through AM-21) (Figure A-3 of this documentation record; Ref. 4, p. 36). Tailings samples were collected using a sample-dedicated plastic disposable scoop and transferred to a 4-oz. wide-mouth glass jar (Ref. 4, p. 13; Ref. 7, p. 36). Pile source samples were compared to a background soil sample to show the relative increase in hazardous substances over background soil levels. A background soil sample was collected from native soils north of the mine property in an area that was not observed to be impacted by mining activities (Ref. 4, pp. 13-14, 50). Background samples were collected using the same methods as the Source samples (Ref. 4, p. 14). Source sampling locations are presented in Figure A-3 of this HRS documentation record.

Table 7: 2022 SI, Source 6 Tailings Pile						
Station Location	**CLP Sample ID**	**Sampling Date**	**Hazardous Substance**	**Concentration (mg/kg)**	**Sample Adjusted CRQL* (mg/kg)**	**References**
Background Soil Samples						
AM-BG-1	MY0AA0	6/22/2022	Arsenic	23	1.0	Ref. 4, pp. 29, 50; Ref. 9, pp. 2-3, 12, 14, 470; Ref. 19, pp. 1-3, 10; Ref. 43, pp. 10-11; Ref. 47, p. 2; Ref. 48, pp. 8, 20
			Cadmium	1.7	0.51	
			Copper	77	2.5	
			Lead	100	1.0	
			Mercury	0.20 J- (0.366)	0.10	
			Zinc	310	6.1	
Source 6 Tailings Pile Samples						
AM-13	MY0AB4	6/23/2022	Arsenic	480	2.5	Ref. 4, pp. 29, 51; Ref. 9, pp. 2, 4, 12, 27, 460, 483; Ref. 19, pp. 121-123, 130, 141-143, 150; Ref. 43, pp. 36-37; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	59	1.7	
			Copper	2,100	6.2	
			Lead	3,000	2.5	
			Mercury	8.6 J-	0.46	
			Zinc	13,000	75	
AM-14	MY0AB5	6/23/2022	Arsenic	1,300	9.6	Ref. 4, pp. 29, 51; Ref. 9, pp. 2, 4, 12, 28, 460, 484; Ref. 19, pp. 141-143, 150; Ref. 43, pp. 38-39; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	38	4.8	
			Copper	590	2.4	
			Lead	2,200	2.9	
			Mercury	6.9 J-	0.49	
			Zinc	3,600	17	
AM-15	MY0AB6	6/23/2022	Arsenic	490	3.0	Ref. 4, pp. 29, 51; Ref. 9, pp. 2, 4, 12, 29, 460, 485; Ref. 19 pp. 141-143, 150, 161-163, 170; Ref. 43, pp. 40-41; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	25	1.5	
			Copper	480	2.5	
			Lead	2,900	3.0	
			Mercury	7.1 J-	0.46	
			Zinc	4,100	24	
AM-17	MY0AB8	6/23/2022	Arsenic	140	0.98	Ref. 4, pp. 29, 51; Ref. 9, pp. 2, 4, 12, 31, 461, 487; Ref. 19, pp. 161-163, 170, 181-183, 190; Ref. 43, pp. 44-45; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	31	0.49	
			Copper	2,400	4.9	
			Lead	2,000	2.0	
			Mercury	3.5 J-	0.19	
			Zinc	7,500	59	
AM-18	MY0AB9	6/23/2022	Arsenic	250	1.6	Ref. 4, pp. 29, 51; Ref. 9, pp. 2, 4, 12, 32, 461, 488; Ref. 19, pp. 181-183, 190; Ref. 43, pp. 46-47; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	24	0.79	
			Copper	3,800	9.8	
			Lead	6,900	7.9	
			Mercury	3.8 J-	0.20	
			Zinc	4,300	24	
AM-19	MY0AC0	6/23/2022	Arsenic	520	3.1	

Table 7: 2022 SI, Source 6 Tailings Pile						
Station Location	**CLP Sample ID**	**Sampling Date**	**Hazardous Substance**	**Concentration (mg/kg)**	**Sample Adjusted CRQL* (mg/kg)**	**References**
			Cadmium	43	1.5	Ref. 4, pp. 29, 51; Ref. 9, pp. 2, 4, 12, 33, 461, 489; Ref. 19, pp. 181-183, 190, 201-203, 210; Ref. 43, pp. 48-49; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Copper	6,100	26	
			Lead	6,200	10	
			Mercury	18 J-	0.94	
			Zinc	10,000	62	
AM-20	MY0AC1	6/23/2022	Arsenic	1,000	9.7	Ref. 4, pp. 29, 51; Ref. 10, pp. 3, 13, 15, 764, 783; Ref. 44, pp. 12-13; Ref. 45, pp. 1-3, 10, 21-23, 30; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	97	4.8	
			Copper	9,200	24	
			Lead	11,000	9.7	
			Mercury	27 J-	1.8	
			Zinc	18,000	87	
AM-21	MY0AC2	6/23/2022	Arsenic	230	1.4	Ref. 4, pp. 29, 51; Ref. 10, pp. 3, 13, 16, 764, 784; Ref. 44, pp. 14-15; Ref. 45, pp. 21-23, 30; Ref. 47, p. 3; Ref. 48, pp. 8, 20
			Cadmium	34	0.72	
			Copper	4,200	9.0	
			Lead	4,300	3.6	
			Mercury	19 J-	0.99	
			Zinc	8,300	43	

CLP: Contract Laboratory Program
mg/kg: milligrams analyte per kilogram tailings
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
*: Since the samples were analyzed through the CLP, the CRQLs presented above are equivalent to the CRQL as defined by the HRS (Ref. 1, Sections 1.1 and 2.3).
J-: The result is an estimated quantity, but the result may be biased low (Ref. 43, pp. 5, 9; Ref. 44, pp. 4-5, 10).

2.2.3 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY

All hazardous substances associated with Source 6 are available to the surface water pathway based on a containment factor value of greater than zero (Ref 1, Section 2.2.3).

Containment Description	Containment Factor Value	References
Release to surface water: There is no maintained engineered cover or functioning and maintained run-on control system and runoff management system. The tailings pile was observed to be in direct contact with surface water in Little Cow Creek. During the SI sampling event, acidic water was observed emerging from the tailings on Little Cow Creek bank and flowing into Little Cow Creek.	10	Figure A-3 of this HRS documentation record; Ref. 4, pp. 35, 50-52, 57-59; Ref. 14, pp. 9, 22; Ref. 17, pp. 28-29; Ref. 21, p. 21; Ref. 41, pp. 33, 40

2.4.2. HAZARDOUS WASTE QUANTITY

2.4.2.1.1 Hazardous Constituent Quantity (Tier A)

The hazardous constituent quantity for Source 6 could not be adequately determined according to the HRS requirements; that is, the total mass of all CERCLA hazardous substances in the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.1). There are insufficient historical and current data (manifests, PRP records, State records, permits, waste concentration data, etc.) available to adequately calculate the total or partial mass of all CERCLA hazardous substances in the source and the associated releases from the source. Therefore, there is insufficient information to evaluate the associated releases from the source to calculate the hazardous constituent quantity for Source 6 with reasonable confidence. Scoring proceeds to the evaluation of Tier B, hazardous wastestream quantity (Ref. 1, Section 2.4.2.1.1).

Hazardous Constituent Quantity Value: NS

2.4.2.1.2 Hazardous Wastestream Quantity (Tier B)

The total Hazardous Wastestream Quantity for Source 6 could not be adequately determined according to the HRS requirements; that is, the total mass, or a partial estimate, of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and releases from the source is not known and cannot be estimated with reasonable confidence (Ref. 1, Section 2.4.2.1.2). Insufficient historical and current data (permits, waste concentration data, annual reports, etc.) are available to adequately calculate the total mass, or a partial estimate, of all hazardous wastestreams and CERCLA pollutants and contaminants for the source and the associated releases from the source. Therefore, there is insufficient information to adequately calculate or extrapolate a total or partial Hazardous Wastestream Quantity for Source 6 with reasonable confidence. Scoring proceeds to the evaluation of Tier C, volume (Ref. 1, Section 2.4.2.1.2).

Hazardous Wastestream Quantity Value: NS

2.4.2.1.3 Volume (Tier C)

The volume for Source 6 could not be adequately determined with reasonable confidence. The depth of Source 6 is unknown. Scoring proceeds to the evaluation of Tier D, area (Ref. 1, Section 2.4.2.1.3).

Volume Assigned Value: NS

2.4.2.1.4 Area (Tier D)

The area of the Source 6 tailings pile is approximately 63,883 square feet. The area was measured based on the aerial photo presented in Figure A-3 of this documentation record and on field observations during the 2019 PA and the 2022 SI correlating the unvegetated area with the boundaries of the tailings pile (Figure A-3 of this HRS documentation record; Ref. 4, pp. 35, 50-52, 59-60; Ref. 41, pp. 33, 40). In accordance with Ref. 1, Table 2-5, the equation for assigning a value for a pile is the area in square feet divided by 13:

$$63{,}883 / 13 = 4{,}914.08$$

Area Assigned Value: 4,914.08

Source Hazardous Waste Quantity Value

According to the HRS, the highest of the values assigned to the source for hazardous constituent quantity (Tier A), hazardous wastestream quantity (Tier B), Volume (Tier C), and Area (Tier D) is assigned as the source hazardous waste quantity value (Ref. 1, Section 2.4.2.1.5).

Tier Evaluated	Source 6 Values
A	NS
B	NS
C	0
D	4,914.08

Source Hazardous Waste Quantity Value: 4,914.08

SITE SUMMARY OF SOURCE DESCRIPTIONS

Source No.	Source Hazardous Waste Quantity Value (see Section 2.4.2)	Containment			
		Ground Water	Surface Water	Gas	Air Particulate
1	>0	NE	10	NE	NE
2	3,282.51	NE	10	NE	NE
3	1,139.22	NE	10	NE	NE
4	779.69	NE	10	NE	NE
5	2,517.38	NE	10	NE	NE
6	4,914.08	NE	10	NE	NE
TOTAL	>12,632.88				

Notes:
NE = Not Evaluated.

Other Possible Sources Not Scored

Afterthought Smelter
Afterthought Smelter is located approximately 1 mile downstream of Afterthought Mine on the east bank of Little Cow Creek. In 1905, a 250-ton water-jacketed blast furnace was constructed at Afterthought Smelter to process ore from Afterthought Mine. Operation of this furnace continued successfully until 1908. A 300-ton oil-flotation mill and a 300-ton reverberatory furnace were completed in 1919 at Afterthought Smelter. Operation began in July 1919 and lasted only 8 months, because the zinc and copper sulfides could not be cleanly separated. (Ref. 21, p. 5; Ref. 23, p. 340; Ref. 24, pp. 16, 26-27; Ref. 25, pp. 35-36, 108-110; Ref. 26, p. 54; Ref. 36, p. 7; Ref. 39, p. 96).

Afterthought Smelter was terraced with waste rock and included tailings ponds and a tailings impoundment, which are still present on the smelter property (Ref. 5, p. 8). During the 2022 SI sampling event, the soil berm at the south end of the tailings ponds was observed to be breached, with a drainage channel to Little Cow Creek (Ref. 5, pp. 39-40, 47-50). A tailings impoundment located at the southern end of the smelter property in a ravine was observed to have failed, and tailings were deeply eroded from seasonal surface water drainage (Ref. 5, pp. 39, 46). Waste rock and tailings on the smelter property contained elevated concentrations of metals, including up to 2,600 mg/kg arsenic, 650 mg/kg cadmium, 54,000 mg/kg copper, 41,000 mg/kg lead, 73J mg/kg mercury, and 160,000 mg/kg zinc (Ref. 5, p. 5). Sources at Afterthought Smelter were not scored as part of this HRS documentation record due to the distance from the sources at Afterthought Mine.

Rail Bed
A rail bed that appears to have been constructed from tailings and/or waste rock connects Afterthought Mine and Afterthought Smelter along the eastern bank of Little Cow Creek (Figures A-2 and Figure A-4 of this HRS documentation record; Ref. 4, p. 8; Ref. 14, pp. 9, 22; Ref. 17, pp. 28-29). Based on the SI sampling results presented in Section 4.1.2.1.1 Observed Release, Attribution of this HRS documentation record, elevated concentrations of arsenic, cadmium,

copper, lead, mercury, and zinc are present in the rail bed materials. The rail bed was not scored as a source due to lack of information regarding the history and construction.

Other Areas of Concern

Afterthought Mine

Additional adits, portals, and waste rock piles are located on the mining property (Figure A-3 of this HRS documentation record; Ref. 21, pp. 21-23; Ref. 26, p. 56; Ref. 35, p. 5; Ref. 36, pp. 17-18). These possible sources are not scored as they were not sampled during the SI. Sampling was not conducted due to lack of field access, or lack of available surface water to sample (Ref. 4, p. 15).

4.0 SURFACE WATER MIGRATION PATHWAY

Little Cow Creek is a perennial stream that flows south adjacent to the Afterthought Mine site. The six site sources drain to Little Cow Creek. Little Cow Creek discharges into Cow Creek, which is a tributary to the Sacramento River. The Little Cow Creek confluence with Cow Creek is beyond the 15-mile target distance limit (TDL) from the site (Figure A-5 of this HRS documentation record; Ref. 3; Ref. 37, p. 149).

Little Cow Creek within the TDL is a fishery (Ref. 4, p. 18; Ref. 6, p. 1; Ref. 8, pp. 11-20; Ref. 28; Ref. 37, pp. 300, 305, 315-316, 320-321). Little Cow Creek within the TDL is designated critical habitat for steelhead trout (*Oncorhynchus mykiss*) (Ref. 20, pp. 117, 121). Approximately 2.31 miles of wetlands are located within the TDL (Figure A-6 of this HRS documentation record; Ref. 13, pp. 1-5; Ref. 18).

4.1 OVERLAND/FLOOD MIGRATION COMPONENT (Figures A-4 and A-5)

The overland/flood migration component evaluates surface water threats that result from overland migration of hazardous substances from a source at the site to surface water. Three types of threats are evaluated for this component: drinking water threat, human food chain threat, and environmental threat (Ref. 1, Section 4.1).

4.1.1 GENERAL CONSIDERATIONS

4.1.1.1 Definition of Hazardous Substance Migration Path for Overland/flood Component

The hazardous substance migration path includes both the overland segment and the in-water segment that hazardous substances would take as they migrate away from sources at the site. The overland segment begins at a source and proceeds downgradient to the probable point of entry (PPE) to the surface water. The in-water segment begins at this PPE. For rivers, the in-water segment continues in the direction of flow for the distance established by the TDL (Ref. 1, Section 4.1.1.1).

As shown in Figure A-4 of this HRS documentation record, most of Afterthought Mine, including Sources 1 through 5, is drained by the intermittent Afterthought Creek and its tributaries to Little Cow Creek. Sources 5 and 6 also drain directly into the perennial Little Cow Creek. Multiple mine adits/portals and waste rock piles are located throughout Afterthought Mine. In the upper portion of the mine, intermittent surface water in the North Fork Afterthought Creek flows through waste rock (Source 2) associated with the No. 1 Shaft and Adit 4. The overland drainage path from Source 2 waste rock to its PPE in Little Cow Creek is approximately 1,320 feet and consists of the North Fork Afterthought Creek and Afterthought Creek (Figure A-4 of this HRS documentation record). Intermittent surface water in the South Fork Afterthought Creek is fed in part by drainage emitting from Adit 3. The intermittent South Fork Afterthought Creek drains the South Fork Waste Rock pile (Source 4), and overland drainage flows from the Central Waste Rock pile (Source 3) to the South Fork Afterthought Creek before reaching the intermittent Afterthought Creek, which then drains into Little Cow Creek. The overland drainage paths from Sources 3 and 4 to their PPE in Little Cow Creek are approximately 1,690 feet and 1,162 feet, respectively (Figure A-4 of this HRS documentation record). The North Fork and South Fork Afterthought Creek join to flow downhill through the lower portion of the mine property. In the lower portion of the mine, near Little Cow Creek, AMD from Portal 1 (Source 1) flows into the intermittent Afterthought Creek

from the south, depositing a bright orange and green slime on waste rock between the portal and the creek. The overland drainage path from Source 1 to Little Cow Creek is approximately 528 feet (Figure A-4 of this HRS documentation record). In April 2019, Afterthought Creek was observed to flow into Little Cow Creek, causing the water in Little Cow Creek to be cloudy for some distance downstream. During the June 2022 SI sampling, surface water in Afterthought Creek infiltrated into the ground downstream of the confluence with the Portal 1 AMD before reaching Little Cow Creek. The point where Afterthought Creek flows into Little Cow Creek is designated as PPE 2 (Figure A-4 of this HRS documentation record; Ref. 4, pp. 8, 50-55; Ref. 36, pp. 17-18; Ref. 41, pp. 15, 33, 35-36, 39).

In addition to the flow from Afterthought Creek, Source 5 and Source 6 are located along the eastern bank of Little Cow Creek and have been observed to be in contact with Little Cow Creek surface water. PPE 1 is the length of approximately 250 feet where Source 5 is in contact with Little Cow Creek. PPE 3 is the length of approximately 500 feet where Source 6 in contact with Little Cow Creek (Figure A-4 of this HRS documentation record; Ref. 4, pp. 8, 50-55; Ref. 41, pp. 15, 33, 39).

Distance from Sources to Surface Water		
Source	**Approximate Distance from Source to PPE** (Figure A-4 of this HRS documentation record)	**PPE**
Source 1 – Portal 1	528 ft	2
Source 2 – North Fork Waste Rock	1,320 ft	2
Source 3 – Central Waste Rock Pile	1,690 ft	2
Source 4 – South Fork Waste Rock	1,162 ft	2
Source 5 – Mill Area Waste Rock	0 ft	1
Source 6 – Tailings Pile	0 ft	3

4.1.1.2 Target Distance Limit

The TDL defines the maximum distance over which targets are considered in evaluating the site. The TDL begins at the farthest upstream PPE (PPE 1). The TDL ending is measured from the furthest downstream PPE (PPE 3) and extends for 15 miles along the surface water from that point (Ref. 1, Section 4.1.1.2). The TDL is shown on Figure A-5 of this HRS documentation record.

Little Cow Creek is a perennial stream that flows south adjacent to the Afterthought Mine site. The six site sources drain to Little Cow Creek. Little Cow Creek discharges into Cow Creek, which is tributary to the Sacramento River. The Little Cow Creek confluence with Cow Creek is beyond the 15-mile TDL from the site (Figure A-1 and Figure A-5 of this HRS documentation record; Ref. 3; Ref. 37, p. 149).

The drainage basin of Little Cow Creek above Afterthought Mine comprises about 60 square miles. Mean flow in Little Cow Creek was measured at upstream USGS stream gage 11373300 from 1957-1965 at 51.1 to 252.0 cubic feet per second (cfs), or 62,657 gpm. Flows in Little Cow Creek were measured approximately 200 feet upstream from Afterthought Creek from August 1997 to May 1998 at an average flow rate of 211,509 gpm, or 565.9 cfs (Ref. 26, pp. 10, 61; Ref. 36, pp. 20, 22; Ref. 40).

4.1.2.1 Likelihood of Release

4.1.2.1.1 Observed Release

Observed Release by Direct Observation
An observed release to surface water may be established when a material that contains one or more hazardous substances has been seen entering surface water through migration or is known to have entered surface water through direct deposition (Ref. 1, Section 4.1.2.1.1).

Basis for Direct Observation:
Source 5 and Source 6 at the Afterthought Mine property are located along the bank of Little Cow Creek and have been observed to be in contact with surface water (PPE 1 and PPE 3) (Figure A-4 of this HRS documentation record; Ref. 3; Ref. 4, p. 8; Ref. 41, pp. 33, 41). Source 5 and Source 6 border Little Cow Creek for approximately 750 feet (Figure A-4 of this HRS documentation record).

Analytical data documenting the presence of hazardous substances in Source 5 and Source 6 is presented in Section 2.2.2 Hazardous Substances Associated with the Source of this HRS documentation record.

Hazardous Substances in Release:
Hazardous substances documented in Source 5 and Source 6 include arsenic, cadmium, copper, lead, mercury, and zinc (see Section 2.2.2, Hazardous Substances Associated with the Source of this HRS documentation record).

Observed Release by Chemical Analysis
The minimum standard to establish an observed release by chemical analysis is analytical evidence of a hazardous substance significantly above the background level and some portion of the significant increase above the background level is attributable to the site. In accordance with HRS Table 2-3, if the background concentration is not detected, a significant increase is established when the sample measurement equals or exceeds the sample quantitation limit (SQL). If the background concentration equals or exceeds the detection limit, a significant increase is established when the sample measurement is three times or more above the background concentration. If the sample analysis was performed under the EPA CLP, the EPA Contract Required Quantitation Limit (CRQL) can be used in place of the SQL if the SQL is not available (Ref. 1, Section 2.3). Attribution will be discussed later in this Section.

2022 EPA SI Sampling
EPA tasked Weston Solutions, Inc. to conduct an SI at the Afterthought Mine site (Ref. 4, p. 13). From June 21, 2022 through June 24, 2022, Weston Solutions, Inc. collected soil, sediment, and surface water samples as part of the SI for Afterthought Mine (Ref. 4, pp. 50-51). Samples were collected in accordance with the SAP approved by EPA on May 29, 2020 (Ref. 4, p. 13; Ref. 7, p. 2). Sediment samples were submitted to Eurofins Burlington under the EPA CLP for metals analysis by ISM 02.4 ICP-AES. Surface water samples were submitted for metals analysis by ISM 0.24 ICP-AES and ICP-MS (Ref. 4, p. 14; Ref. 5, p. 11). Validation of analytical data was contracted by EPA in accordance with ISM 02.4 (Ref. 4, p. 13; Ref. 7, pp. 44-45; Ref. 46, p. 1).

To document an observed release, surface water and sediment samples were collected from Little Cow Creek upstream and downstream of site sources. Background sample LCC-AM-02 was collected upstream of all sources at Afterthought Mine (Ref. 4, pp. 44, 50, 57). Sample LCC-AM-04 was collected immediately downstream of the confluence with Afterthought Creek (PPE 2) (Ref. 4, pp. 44, 50, 56). Sample LCC-AM-05 was collected approximately 140 feet downstream of the confluence with Afterthought Creek (Ref. 4, pp. 44, 50-51, 57). Sample LCC-AM-10 was collected approximately 0.9 mile downstream of Afterthought Creek and upstream of Afterthought Smelter (Figure A-6 of this HRS documentation record; Ref. 5, pp. 33, 39, 49-50).

Each surface water sample included one filtered sample for dissolved metals and one unfiltered sample for total metals analyses. Sediment samples were analyzed for metals via EPA CLP ISM 02.4 ICP-AES. Filtered and unfiltered surface water samples were analyzed for metals via both EPA CLP ISM 02.4 ICP-AES and EPA CLP ISM 02.4 ICPMS. Water samples were also screened for pH in the field, using a YSI 650 Water Quality Meter (Ref. 4, p. 14; Ref. 5, p. 11). No other mining or smelting operations are known to be present downstream of Site sources and upstream of surface water and sediment samples documenting an observed release (Figure A-6 of this HRS documentation record; Ref. 3; Ref. 26, p. 11; Ref. 36, p. 6; Ref. 37, p. 198).

-Background Little Cow Creek

Background location LCC-AM-02 was sampled for surface water and sediments during the same sampling event using the same sampling methods and laboratories as the downstream contaminated Little Cow Creek surface water and sediment samples (Ref. 4, p. 14). An observed release is established based on Little Cow Creek surface water and sediment sampling.

Table 8: 2022 SI, Little Cow Creek Background Surface Water Concentrations

Station Location	CLP Sample ID	Filtered/ Unfiltered	Sampling Date	Hazardous Substance	Concentration (µg/L)	Sample Adjusted CRQL* (µg/L)	References
ICP-MS Results							
LCC-AM-02-W-T	MY0AM6	Unfiltered	6/23/22	Cadmium	1.0U	1.0	Ref. 4, pp. 32, 50, 57; Ref. 12, pp. 4, 24, 682; Ref. 15, pp. 190-192, 199, 211-213, 220; Ref. 46, p. 38; Ref. 47, p. 2
				Copper	2.0U	2.0	
				Lead	1.0U	1.0	
				Zinc	5.0U	5.0	
LCC-AM-02-W-F	MY0AM5	Filtered	6/23/22	Cadmium	1.0U	1.0	Ref. 4, pp. 32, 50, 57; Ref. 12, pp. 4, 23, 681; Ref. 15, pp. 169-171, 178, 190-192, 199; Ref. 46, p. 35; Ref. 47, p. 2
				Copper	2.0U	2.0	
				Lead	1.0U	1.0	
				Zinc	5.0U	5.0	
ICP-AES Results							
LCC-AM-02-W-T	MY0AM6	Unfiltered	6/23/22	Cadmium	5.0U	5.0	Ref. 4, pp. 32, 50, 57; Ref. 12, pp. 4, 24; Ref. 15, pp. 190-192, 199, 211-213, 220; Ref. 46, p. 37; Ref. 47, p. 2
				Copper	25U	25	
				Lead	10U	10	
				Zinc	60U	60	
LCC-AM-02-W-F	MY0AM5	Filtered	6/23/22	Cadmium	5.0U	5.0	Ref. 4, pp. 32, 50, 57; Ref. 12, pp. 4, 23; Ref. 15, pp. 169-171, 178, 190-192, 199; Ref. 46, p. 34; Ref. 47, p. 2
				Copper	25U	25	
				Lead	10U	10	
				Zinc	60U	60	

CLP: Contract Laboratory Program
µg/L: micrograms analyte per liter surface water
U: Not detected above the level of the reported CRQL (Ref. 46, p. 8)
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
*: Since the samples were analyzed through the CLP, the CRQLs presented above are equivalent to the CRQL as defined by the HRS (Ref. 1, Sections 1.1 and 2.3).

Table 9: 2022 SI, Little Cow Creek Background Sediment Concentrations						
Station Location	**CLP Sample ID**	**Sampling Date**	**Hazardous Substance**	**Concentration (mg/kg)**	**Sample Adjusted CRQL* (mg/kg)**	**References**
LCC-AM-02-S	MY0AF9	6/23/22	Cadmium	0.35 J	0.65	Ref. 4, pp. 32, 50, 57; Ref. 11, pp. 3, 13, 15; Ref. 16, pp. 1-3, 10, 21-23, 30; Ref. 34, p. 10; Ref. 47, p. 2; Ref. 48, pp. 8, 20
			Copper	21	3.3	
			Zinc	51	7.8	

CLP: Contract Laboratory Program
mg/kg milligrams analyte per kilogram sediment
ND: Not Detected above the method detection limit
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
*: Since the samples were analyzed through the CLP, the CRQLs presented above are equivalent to the CRQL as defined by the HRS (Ref. 1, Sections 1.1 and 2.3).
J: Result is above the MDL but below the CRQL (Ref. 16, p. 1; Ref. 34, p. 4).

Table 10: Background Levels to Establish an Observed Release to Little Cow Creek			
Sample Type	**Hazardous Substance**	**Maximum Background Concentration 2022 SI Sampling Results (µg/L)**	**HRS Table 2-3 Minimum Concentration to Document an Observed Release by Chemical Analysis (µg/L)**
Unfiltered Surface Water (µg/L) ICP-MS and ICP-AES Results	Cadmium	ND	sample CRQL
	Copper	ND	sample CRQL
	Lead	ND	sample CRQL
	Zinc	ND	sample CRQL
Filtered Surface Water (µg/L) ICP-MS and ICP-AES Results	Cadmium	ND	sample CRQL
	Copper	ND	sample CRQL
	Lead	ND	sample CRQL
	Zinc	ND	sample CRQL
Sediment (mg/kg)	Cadmium	0.35 J, CRQL = 0.65*	1.95
	Copper	21	63

µg/L: micrograms analyte per liter surface water
ng/L: nanograms mercury per liter surface water
J: Result is above the MDL but below the CRQL (Ref. 11, p. 15; Ref. 16, p. 1).
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
ND: Not detected above the method detection limit
*: Detection below the CRQL is treated as non-quantifiable for HRS purposes, and adjustment factors are not applied. For a conservative background level, the sample adjusted CRQL of cadmium in sample LCC-AM-02-S is used here as a maximum background concentration (Ref. 12, p. 6; Ref. 16, p. 1; Ref. 34, p. 4).

- Little Cow Creek Samples Establishing an Observed Release

Surface water and sediment samples establishing an observed release are shown on Figure A-6 of this HRS documentation record. These samples contained cadmium, copper, lead, and/or zinc at concentrations exceeding the background levels specified above.

Table 11: 2022 SI, Little Cow Creek Contaminated Surface Water Concentrations							
Station Location	**CLP Sample ID**	**Filtered/ Unfiltered**	**Sampling Date**	**Hazardous Substance**	**Concentration (µg/L)**	**Sample Adjusted CRQL* (µg/L)**	**References**
ICP-MS Results							
LCC-AM-05-W-T	MY0AN2	Unfiltered	6/23/22	Cadmium	410	1.0	Ref. 4, p. 32; Ref. 12, pp. 4, 684; Ref. 15, pp. 253-255, 262, 274-276, 283; Ref. 46, p. 44; Ref. 47, p. 2
				Copper	13,000	8.0	
				Zinc	98,000	130	
LCC-AM-05-W-F	MY0AN1	Filtered	6/23/22	Cadmium	410	1.0	Ref. 4, p. 32; Ref. 12, pp. 4, 683; Ref. 15, pp. 211-213, 220; Ref. 46, p. 41; Ref. 47, p. 2
				Copper	13,000	8.0	
				Zinc	98,000	130	
LCC-AM-10-W-T	MY0AP2	Unfiltered	6/23/22	Copper	15	2.0	Ref. 4, p. 32; Ref. 12, pp. 4, 686; Ref. 15, pp. 337-339, 346; Ref. 46, p. 50; Ref. 47, p. 3
LCC-AM-10-W-F	MY0AP1	Filtered	6/23/22	Copper	12	2.0	Ref. 4, p. 32; Ref. 12, pp. 4, 685; Ref. 15, pp. 316-318, 325; Ref. 46, p. 47; Ref. 47, p. 3
ICP-AES Results							
LCC-AM-05-W-T	MY0AN2	Unfiltered	6/23/22	Cadmium	380	5.0	Ref. 4, p. 32; Ref. 12, pp. 4, 26; Ref. 15, pp. 253-255, 262, 274-276, 283; Ref. 46, p. 43; Ref. 47, p. 2
				Copper	12,000	25	
				Lead	92	10	
LCC-AM-05-W-F	MY0AN1	Filtered	6/23/22	Cadmium	380	5.0	Ref. 4, p. 32; Ref. 12, pp. 4, 25; Ref. 15, pp. 211-213, 220; Ref. 46, p. 40; Ref. 47, p. 2
				Copper	12,000	25	
				Lead	92	10	
				Zinc	89,000	600	

CLP: Contract Laboratory Program
µg/L: micrograms analyte per liter surface water
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
*: Since the samples were analyzed through the CLP, the CRQLs presented above are equivalent to the CRQL as defined by the HRS (Ref. 1, Sections 1.1 and 2.3).

Table 12: 2022 SI, Little Cow Creek Contaminated Sediment Concentrations						
Station Location	**CLP Sample ID**	**Sampling Date**	**Hazardous Substance**	**Concentration (mg/kg)**	**Sample Adjusted CRQL* (mg/kg)**	**References**
LCC-AM-04-S	MY0AG1	6/23/22	Cadmium	4.6	0.47	Ref. 11, pp. 3, 13. 16; Ref. 16, pp. 21-23, 30; Ref. 34, p. 12; Ref. 47, p. 2
			Copper	200	2.4	
LCC-AM-05-S	MY0AG2	6/23/22	Cadmium	4.7	0.52	Ref. 11, pp. 3, 13, 17; Ref. 16, pp. 21-23, 30; Ref. 34, p. 14; Ref. 47, p. 2
			Copper	130	2.6	

CLP: Contract Laboratory Program
mg/kg: milligrams analyte per kilogram sediment
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
*: Since the samples were analyzed through the CLP, the CRQLs presented above are equivalent to the CRQL as defined by the HRS (Ref. 1, Sections 1.1 and 2.3).

Attribution

Operations at the Afterthought Mine began in 1862. The mine operated over a span of 90 years under various owners until activities ceased in August 1952 (Ref. 23, p. 340; Ref. 26, p. 56; Ref. 36, pp. 7-8; Ref. 39, p. 79). During operations, Afterthought Mine was mined for gold, silver, copper, and/or zinc (see the Site Description section of this HRS documentation record).

Remnants of the mine, including waste rock piles, adits/portals, and the ruins of the mine plant, are still present on the property. AMD still discharges from mine portals, including Portal 1 (Source 1), to the intermittent Afterthought Creek, and runoff from mine waste rock piles, including Sources 2 through 5, drains into the creek. Afterthought Creek then flows into Little Cow Creek adjacent to the mine property (Figure A-4 of this HRS documentation record; Ref. 4, p. 8).

Where AMD from Portal 1 (Source 1) flows into Afterthought Creek, it has deposited a bright orange and green slime on waste rock. In April 2019, Afterthought Creek was observed to flow into Little Cow Creek, causing the water in Little Cow Creek to be cloudy for some distance downstream (Ref. 4, pp. 8, 50-55; Ref. 41, pp. 15, 33, 35-36, 39). Water collected from Portal 1 had a pH of 2.77 during the 2022 SI (Ref. 4, pp. 50). The waste rock and tailings piles scored as sources in this HRS documentation record (Sources 2 through 6) and that drain to Little Cow Creek cover a combined area of about 164,227.39 square feet (Section 2.4.2 in this HRS documentation record for each source scored).

Little Cow Creek is a perennial stream that flows south adjacent to the Afterthought Mine site. The six site sources scored in this HRS documentation record all drain into Little Cow Creek at PPEs 1 through 3. Little Cow Creek discharges into Cow Creek beyond the site TDL (Figure A-5 of this HRS documentation record; Ref. 3; Ref. 37, p. 149).

Source 5 and Source 6 at the site are located along the bank of Little Cow Creek and have been observed to be in contact with surface water (PPE 1 and PPE 3) (Figure A-4 and Section 4.1.1.1 of this HRS documentation record; Ref. 3; Ref. 4, p. 8; Ref. 41, pp. 33, 41). Sources 1 through 4, as well as additional possible sources not scored at the mine property, drain to the intermittent

Afterthought Creek, which flows into Little Cow Creek (PPE 2) (Figure A-4 of this HRS documentation record; Ref. 4, pp. 8, 50-55; Ref. 41, pp. 15, 33, 35-36, 39).

Surface water and sediment samples were collected from the intermittent Afterthought Creek downstream of Sources 1 through 5 during the 2022 SI to show migration of hazardous substances from the sources to Little Cow Creek (Ref. 4, p. 13). A background sediment sample was collected from the intermittent South Fork Afterthought Creek upstream of site sources. Background surface water samples were not collected as surface water was not present in Afterthought Creek upstream of the site sources. (Ref. 4, pp. 14, 15, 50-51). Arsenic, cadmium, copper, lead, and zinc were present at detectable levels in surface water samples downstream of the Afterthought Mine sources. Arsenic, cadmium, copper, lead, mercury, and zinc were present at elevated concentrations in sediment samples (as compared to background levels) in Afterthought Creek downstream of Afterthought Mine sources, and they show the impact of the sources on Afterthought Creek sediments to its confluence with Little Cow Creek at PPE 2. Afterthought Creek water and sediment sample data are shown below in Table 13 and Table 14 of this HRS documentation record. Also shown below in Table 15 are the results of surface soil samples collected from the former rail bed during the SI, as it appeared to be constructed of waste rock from the Afterthought Mine operations (Ref. 4, pp. 29-30, 40, 50). This former rail bed runs south along Little Cow Creek through Source 6 and towards the Afterthought Smelter property (Figure A-2 and Figure A-4 of this HRS documentation record).

Surface water and sediment samples were collected from Little Cow Creek during the 2022 SI to determine if a release to the creek has occurred (Ref. 4, pp. 44, 50, 57). Cadmium, copper, lead, and zinc were detected at concentrations significantly above background levels in surface water samples collected from Little Cow Creek downstream of one or more PPEs from Sources 1 through 6. Cadmium and copper were detected at concentrations significantly above background levels in sediment samples collected from Little Cow Creek at or downstream of one or more PPEs from Sources 1 through 6 (Table 8 through Table 12 of this HRS documentation record).

As explained above, the hazardous substances in the observed release by chemical analysis to Little Cow Creek (cadmium, copper, lead, and zinc) at and downstream of the site PPEs were also detected in the reach of Afterthought Creek that drains Sources 1 through 4 and a portion of Source 5, in Sources 5 and 6 that border Little Cow Creek, and in each of the other four sources scored. No other non-site-related sources of the hazardous substances in the observed release have been identified in the immediate vicinity of the site or in between the site PPEs and the upgradient background samples. (See Figures A-1 and A-6 of this HRS documentation record).

Table 13: 2022 SI, Afterthought Creek Sediment Attribution Sampling						
Station Location	**CLP Sample ID**	**Sampling Date**	**Hazardous Substance**	**Concentration (mg/kg)**	**Sample Adjusted CRQL* (mg/kg)**	**References**
Background Sediment Sample						
AC-BG-02-S (South Fork Afterthought Creek upstream of site sources)	MY0AJ0	6/24/2022	Arsenic	26	0.98	Ref. 4, pp. 31, 44, 51; Ref. 11, pp. 4, 13, 27, 413, 435; Ref. 16, pp. 101-103, 110-113, 121-123, 130; Ref. 34, pp. 33-34; Ref. 47, p. 3
			Cadmium	1.9	0.49	
			Copper	53	2.5	
			Lead	32 J[1]	0.98	
			Mercury	0.11 J-	0.097	
			Zinc	370	5.9	
Afterthought Creek Attribution Samples						
AC-07-S (South Fork Afterthought Creek downstream of Adit 3)	MY0AH6	6/24/2022	Arsenic	920	5.3	Ref. 4, pp. 31, 44, 51; Ref. 11, pp. 3, 13, 24, 413, 432; Ref. 16, pp. 81-83, 90, 101-103, 110; Ref. 34, pp. 27-28; Ref. 47, p. 3
			Cadmium	21	2.6	
			Copper	850	2.6	
			Lead	1,600J	2.1	
			Mercury	3.5 J-	0.18	
			Zinc	1,200	13	
AC-05-S (North Fork Afterthought Creek downstream of Adit 4)	MY0AH4	6/24/2022	Arsenic	140	0.98	Ref. 4, pp. 31, 44, 51; Ref. 11, pp. 3, 13, 23, 413, 431; Ref. 16, pp. 81-83, 90; Ref. 34, pp. 25-26; Ref. 47, p. 3
			Cadmium	11	0.49	
			Copper	1,200	2.5	
			Lead	1,200 J	0.98	
			Mercury	2.1 J-	0.18	
			Zinc	2,000	12	
AC-04-S (Afterthought Creek downstream of East Portal)	MY0AH3	6/24/2022	Arsenic	260	1.9	Ref. 4, pp. 31, 44, 51; Ref. 11, pp. 3, 13, 22, 413, 430; Ref. 16, pp. 61-63, 70, 81-83, 90; Ref. 34, pp. 23-24; Ref. 47, p. 3
			Cadmium	11	0.96	
			Copper	950	2.4	
			Lead	1,800 J	1.9	
			Mercury	4.0 J-	0.40	
			Zinc	1,500	12	
AC-02-S (Afterthought Creek downstream of Portal 1)	MY0AH1	6/24/2022	Arsenic	490	3.5	Ref. 4, pp. 31, 44, 50, 51; Ref. 11, pp. 3, 13, 20, 413, 428; Ref. 16, pp. 61-63, 70; Ref. 34, pp. 19-20; Ref. 47, p. 3
			Cadmium	14	1.8	
			Copper	480	2.9	
			Lead	1,000 J	1.2	
			Mercury	5.7 J-	0.46	
			Zinc	1,200	7.0	
AC-01-S (Afterthought Creek immediately upstream of confluence with Little Cow Creek)	MY0AH0	6/24/2022	Arsenic	220	2.0	Ref. 4, pp. 31, 44, 50, 51; Ref. 11, pp. 3, 13, 19, 413, 427; Ref. 16, pp. 41-43, 50; Ref. 34, pp. 17-18; Ref. 47, p. 3
			Cadmium	9.2	1.0	
			Copper	420	2.5	
			Lead	670 J	1.0	
			Mercury	3.6 J	0.19	
			Zinc	1,300 J[1]	12	

CLP: Contract Laboratory Program
mg/kg: milligrams analyte per kilogram tailings
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
*: Since the samples were analyzed through the CLP, the CRQLs presented above are equivalent to the CRQL as defined by the HRS (Ref. 1, Sections 1.1 and 2.3).
J-: The result is an estimated quantity, but the result may be biased low (Ref. 34, pp. 4, 8).
J: Result is an estimated quantity because laboratory duplicate results are outside method limit (Ref. 34, pp. 5, 8)

Table 14: 2022 SI, Afterthought Creek Surface Water Attribution Sampling

Station Location	CLP Sample ID	Filtered/ Unfiltered	Sampling Date	Hazardous Substance	Concentration (µg/L)	Sample Adjusted CRQL* (µg/L)	References
ICP-MS Results							
AC-04-W-T (downstream of East Portal)	MY0AK0	Unfiltered	6/24/2022	Arsenic	2.2	1.0	Ref. 4, pp. 31, 44, 50-51, 55; Ref. 12, pp. 3, 678; Ref. 15, pp. 106-108, 115, 127-129, 136; Ref. 46, p. 26; Ref. 47, p. 3
				Cadmium	13	1.0	
				Copper	2,700	2.0	
				Lead	29	1.0	
				Zinc	2,800	5.0	
AC-04-W-F (downstream of East Portal)	MY0AJ9	Filtered	6/24/2022	Cadmium	3.7	1.0	Ref. 4, pp. 31, 44, 50-51, 55; Ref. 12, pp. 3, 677; Ref. 15, pp. 85-87, 94, 106-108, 115; Ref. 46, p. 23; Ref. 47, p. 3
				Copper	18	2.0	
				Zinc	340	5.0	
ICP-AES Results							
AC-04-W-T (downstream of East Portal)	MY0AK0	Unfiltered	6/24/2022	Cadmium	13	5.0	Ref. 4, pp. 31, 44, 50-51, 55; Ref. 12, pp. 3, 20; Ref. 15, pp. 106-108, 115, 127-129, 136; Ref. 46, p. 25; Ref. 47, p. 3
				Copper	2,400	25	
				Lead	29	10	
				Zinc	2,800	60	
AC-04-W-F (downstream of East Portal)	MY0AJ9	Filtered	6/24/2022	Cadmium	3.6 J	5.0	Ref. 4, pp. 31, 44, 50-51, 55; Ref. 12, pp. 3 19, Ref. 15, pp. 85-87, 94, 106-108, 115; Ref. 46, p. 22; Ref. 47, p. 3
				Copper	19 J	25	
				Zinc	360	60	

CLP: Contract Laboratory Program
µg/L: micrograms analyte per liter adit discharge
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
*: Since the samples were analyzed through the CLP, the CRQLs presented above are equivalent to the CRQL as defined by the HRS (Ref. 1, Sections 1.1 and 2.3).
J: Result is an estimated quantity. Result is above the MDL but below the CRQL (Ref. 15, p. 85; Ref. 46, pp. 5, 8).

Table 15: 2022 SI, Rail Bed Attribution Sampling						
Station Location	**CLP Sample ID**	**Sampling Date**	**Hazardous Substance**	**Concentration (mg/kg)**	**Sample Adjusted CRQL* (mg/kg)**	**References**
AR-01	MY0AE9	6/22/2022	Arsenic	38	0.98	Ref. 4, pp. 29-30, 40, 50; Ref. 10, pp. 4, 13, 26, 764, 794; Ref. 44, pp. 40-41; Ref. 45, pp. 101-103, 110; Ref. 47, p. 2
			Cadmium	2.8	0.49	
			Copper	410	2.5	
			Lead	190	2.0	
			Mercury	0.40 J-	0.11	
			Zinc	500	12	
AR-02	MY0AF0	6/22/2022	Arsenic	14	0.96	Ref. 4, pp. 29-30, 40, 50, 60; Ref. 10, pp. 4, 13, 27, 764, 795; Ref. 44, pp. 48-49; Ref. 45, pp. 101-103, 110, 121-123, 130; Ref. 47, p. 2
			Cadmium	2.1	0.48	
			Copper	30	2.4	
			Lead	540	0.96	
			Mercury	4.0 J-	0.38	
			Zinc	450	5.7	
AR-03	MY0AF1	6/22/2022	Arsenic	210	1.8	Ref. 4, pp. 29-30, 40, 50; Ref. 10, pp. 4, 13, 28, 764, 796; Ref. 44, pp. 50-51; Ref. 45, pp. 121-123, 130; Ref. 47, p. 2
			Cadmium	3.9	0.89	
			Copper	620	2.2	
			Lead	250	1.8	
			Mercury	1.2 J-	0.096	
			Zinc	170	11	
AR-04	MY0AF2	6/22/2022	Arsenic	300	2.1	Ref. 4, pp. 29-30, 40, 50; Ref. 10, pp. 4, 13, 29, 764, 797; Ref. 44, pp. 52-53; Ref. 45, pp. 121-123, 130, 141-143, 150; Ref. 47, p. 2
			Cadmium	14	1.0	
			Copper	2,000	5.2	
			Lead	2,100	2.1	
			Mercury	6.0 J-	0.48	
			Zinc	2,200	13	
AR-05	MY0AF3	6/22/2022	Arsenic	770	4.8	Ref. 4, pp. 29-30, 40, 50; Ref. 10, pp. 4, 13, 30, 765, 798; Ref. 44, pp. 54-55; Ref. 45, pp. 141-143, 150; Ref. 47, p. 2
			Cadmium	33	2.4	
			Copper	780	2.4	
			Lead	320	0.96	
			Mercury	2.3 J-	0.19	
			Zinc	5,200	29	
AR-06	MY0AF4	6/22/2022	Arsenic	370	2.9	Ref. 4, pp. 29-30, 40, 50; Ref. 10, pp. 4, 13, 31, 765, 799; Ref. 44, pp. 56-57; Ref. 45, pp. 141-143, 150, 161-163, 170; Ref. 47, p. 2
			Cadmium	7.6	1.5	
			Copper	370	2.4	
			Lead	570	0.98	
			Mercury	10 J-	0.97	
			Zinc	340	5.9	
AR-07	MY0AF5	6/22/2022	Arsenic	430	2.9	Ref. 4, pp. 29-30, 40, 50; Ref. 10, pp. 4, 13, 32, 765, 800; Ref. 44, pp. 58-59; Ref. 45, pp. 161-163, 170; Ref. 47, p. 2
			Cadmium	18	1.5	
			Copper	250	2.4	
			Lead	650	0.97	
			Mercury	3.2 J-	0.19	

Table 15: 2022 SI, Rail Bed Attribution Sampling						
Station Location	**CLP Sample ID**	**Sampling Date**	**Hazardous Substance**	**Concentration (mg/kg)**	**Sample Adjusted CRQL* (mg/kg)**	**References**
			Zinc	2,200	12	
AR-08	MY0AF6	6/22/2022	Arsenic	220	1.7	Ref. 4, pp. 29-30, 40, 50, 60; Ref. 10, pp. 4, 13, 33, 765, 801; Ref. 44, pp. 60-61; Ref. 45, pp. 161-163, 170; Ref. 47, p. 2
			Cadmium	34	0.87	
			Copper	2,400	6.5	
			Lead	2,500	2.6	
			Mercury	3.2 J-	0.17	
			Zinc	8,700	78	
AR-08	MY0AF7	6/22/2022	Arsenic	230	1.9	Ref. 4, pp. 29-30, 40, 50; Ref. 10, pp. 4, 13, 34, 765, 802; Ref. 44, pp. 62-63; Ref. 45, pp. 161-163, 170, 181-183, 190; Ref. 47, p. 2
			Cadmium	34	0.96	
			Copper	2,300	4.8	
			Lead	2,100	1.9	
			Mercury	4.9 J-	0.35	
			Zinc	9,000	58	

CLP: Contract Laboratory Program
mg/kg: milligrams analyte per kilogram tailings
CRQL: EPA Contract Laboratory Program Contract Required Quantitation Limit
*: Since the samples were analyzed through the CLP, the CRQLs presented above are equivalent to the CRQL as defined by the HRS (Ref. 1, Sections 1.1 and 2.3).
J-: The result is an estimated quantity, but the result may be biased low (Ref. 44, pp. 4, 10).

Hazardous Substances Released

An observed release of cadmium, copper, lead, and zinc to surface water is documented by chemical analysis.

Surface Water Observed Release Factor Value: 550

4.1.2.1.2 Potential to Release

Potential to Release was not scored, because an Observed Release was established.

4.1.2 Drinking Water Threat

No drinking water intakes are located within 15 miles downstream of the PPEs. Therefore, the listing decision is not significantly affected by the drinking water threat to the surface water pathway.

4.1.3.2 Human Food Chain Threat Waste Characteristics

The human food chain threat waste characteristics factor category value is based on hazardous waste quantity, toxicity, surface water persistence, and bioaccumulation potential for the hazardous substances documented in the site source in the release to surface water.

4.1.3.2.1 Toxicity/Persistence/Bioaccumulation

HRS Toxicity, Persistence, and Bioaccumulation Potential Factor Values are presented below for the hazardous substances documented in Sources 1 through 6. Factor Values are provided in the Superfund Chemical Data Matrix (Ref. 2).

Table 16: Toxicity/Persistence/Bioaccumulation

Hazardous Substance	Source No.	Toxicity Factor Value	Persistence Factor Value*	Bioaccumulation Potential Factor Value**	Toxicity/ Persistence/ Bioaccumulation Factor Value (Ref. 1, Table 4-16)	Reference
Arsenic	1-6, OR	10,000	1	5	50,000	Ref. 2, p. 2
Cadmium	1-6, OR	10,000	1	50,000	500,000,000	Ref. 2, p. 5
Copper	1-6, OR	100	1	50,000	5,000,000	Ref. 2, p. 8
Lead	1-6, OR	10,000	1	5,000	50,000,000	Ref. 2, p. 11
Mercury	2-6, OR	10,000	1	50,000	500,000,000	Ref. 2, p. 14
Zinc	1-3, 5, 6, OR	10	1	500	5,000	Ref. 2, p. 17

Notes:
* Persistence factor value for Rivers
** Bioaccumulation factor value for Freshwater
OR = Observed Release

Toxicity/Persistence/Bioaccumulation Factor Value: 500,000,000
(Ref. 1, Table 4-16)

4.1.3.2.2 Hazardous Waste Quantity

The calculations for hazardous waste quantities for Sources 1 through 6 are presented in Section 2.4.2.

Table 17: Hazardous Waste Quantity		
Source No.	**Source Type**	**Source Hazardous Waste Quantity**
1	Other	>0
2	Pile	3,282.51
3	Pile	1,139.22
4	Pile	779.69
5	Pile	2,517.38
6	Pile	4,914.08
	sum:	>12,632.88

Hazardous Waste Quantity Factor Value: 10,000
(Ref. 1, Table 2-6, Section 2.4.2.2)

4.1.3.2.3 Waste Characteristics Factor Category Value

Toxicity/Persistence/Bioaccumulation Factor Value: 500,000,000
Hazardous Waste Quantity Factor Value: 10,000

Toxicity/Persistence/Bioaccumulation Factor Value X
Hazardous Waste Quantity Factor Value: 5,000,000,000,000

Waste Characteristics Factor Category Value: 1,000
(Ref. 1, Table 2-7)

4.1.3.3 Human Food Chain Threat Targets

Fall-run chinook salmon migrate upstream into Cow Creek, including Little Cow Creek, during the fall (late September through December) after the first autumn rains have increased stream flow. Little Cow Creek provides habitat for fish, including rainbow trout, steelhead trout, Sacramento sucker, and California roach. Fish reported caught in Little Cow Creek downstream of the site include largemouth bass, smallmouth bass, spotted bass, steelhead trout, carp, Chinook salmon, brown trout, bream/bluegill, brook trout, and rainbow trout (Ref. 4, p. 18; Ref. 8, pp. 11-22; Ref. 28; Ref. 37, pp. 300, 305, 315-316, 320-321).

Rainbow trout, Sacramento sucker, and California roach have been observed in Little Cow Creek downstream from the mine property, as well as upstream and in the vicinity of the smelter property (Ref. 26, pp. 62-63). Multiple documented fish catches on Little Cow Creek (Ref. 8, pp. 12-20). While most fish catches on Little Cow Creek did not log exact locations, at least one was logged within the TDL in 2019 (Ref. 8, p. 16).

The California Department of Fish and Wildlife refers to Little Cow Creek as North Cow Creek in some documents (Ref. 6, p. 1; Ref. 37, p. 154). North Cow Creek is identified as a fishery and has been stocked with trout in the past. Discarded fishing tackle has been observed all along Little Cow Creek, including within the zone of actual contamination and the TDL (Ref. 6, p. 1).

4.1.3.3.1 Food Chain Individual

Little Cow Creek within the TDL is a fishery and fish are caught for human consumption (see Section 4.1.3.3 of this HRS documentation record). An observed release of cadmium, copper, lead, and zinc from the site to surface water is documented by chemical analysis and by direct observation (see Section 4.1.2.1.1 of this HRS documentation record).

Food Chain Individual Factor Value: 20

4.1.3.3.2 Population

4.1.3.3.2.1 Level I Concentrations

Level I actual contamination is not documented.

Level I Concentrations Factor Value: 0

4.1.3.3.2.2 Level II Concentrations

Level II actual contamination is not documented

Level II Concentrations Factor Value: 0

4.1.3.3.2.3 Potential Human Food Chain Contamination

Potential Population Targets

Table 18: Potential Population Targets							
Identity of Fishery	**Annual Production (pounds)**	**Type of Surface Water Body**	**Average Annual Flow (cfs)**	**Reference**	**Population Value (P_i) (Ref. 1, Table 4-18)**	**Dilution Weight (D_i) (Ref. 1, Table 4-13)**	**P_i x D_i**
Little Cow Creek within the TDL	>0	moderate to large stream	51.1 to 252.1	Ref. 8, p. 16; Ref. 40, p.1	0.03	0.01	0.0003

Sum of P_i x D_i: 0.0003
(Sum of P_i x D_i)/10: 0.00003

Potential Human Food Chain Contamination Factor Value: 0.00003

4.1.4.2 Environmental Threat Waste Characteristics

The environmental threat waste characteristics factor category value is based on hazardous waste quantity, ecosystem toxicity, surface water persistence, and ecosystem bioaccumulation potential for the hazardous substances documented in the site source in the release to surface water.

4.1.4.2.1 Ecosystem Toxicity/Persistence/Bioaccumulation

HRS Ecosystem toxicity, Persistence, and Environmental Bioaccumulation Factor Values are presented below for the hazardous substances documented in Sources 1 through 6. Factor Values are provided in the Superfund Chemical Data Matrix (Ref. 2).

Table 19: Ecosystem Toxicity/Persistence/Environmental Bioaccumulation

Hazardous Substance	Source No.	Ecosystem Toxicity Factor Value	Persistence Factor Value*	Environmental Bioaccumulation Factor Value**	Ecosystem Toxicity/ Persistence/ Environmental Bioaccumulation Factor Value (Ref. 1, Table 4-21)	Reference
Arsenic	1-6, OR	10	1	50,000	500,000	Ref. 2, p. 2
Cadmium	1-6, OR	10,000	1	50,000	500,000,000	Ref. 2, p. 5
Copper	1-6, OR	1,000	1	50,000	50,000,000	Ref. 2, p. 8
Lead	1-6, OR	1,000	1	50,000	50,000,000	Ref. 2, p. 11
Mercury	2-6, OR	10,000	1	50,000	500,000,000	Ref. 2, p. 14
Zinc	1-3, 5, 6, OR	10	1	50,000	500,000	Ref. 2, p. 17

Notes:
* Persistence factor value for Rivers
** Bioaccumulation factor value for Freshwater
OR = Observed Release

Toxicity/Persistence/Bioaccumulation Factor Value: 500,000,000
(Ref. 1, Table 4-21)

4.1.2.2.2 Hazardous Waste Quantity

The calculations for hazardous waste quantities for Sources 1 through 6 are presented in Section 2.4.2.

Table 20: Hazardous Waste Quantity		
Source No.	**Source Type**	**Source Hazardous Waste Quantity**
1	Other	>0
2	Pile	3,282.51
3	Pile	1,139.22
4	Pile	779.69
5	Pile	2,517.38
6	Pile	4,914.08
	sum:	>12,632.88

Hazardous Waste Quantity Factor Value: 10,000
(Ref. 1, Table 2-6, Section 2.4.2.2)

4.1.2.2.3 Waste Characteristics Factor Category Value

Toxicity/Persistence/Bioaccumulation Factor Value: 500,000,000
Hazardous Waste Quantity Factor Value: 10,000

Toxicity/Persistence/Bioaccumulation Factor Value X
Hazardous Waste Quantity Factor Value: 50,000,000,000

Waste Characteristics Factor Category Value: 1,000
(Ref. 1, Table 2-7)

4.1.4.3 Environmental Threat Targets

Most Distant Level II Sample
Sample ID: LCC-AM-10-W-F and LCC-AM-10-W-T
Distance from the probable point of entry: Approximately 4,075 feet downstream of the downstream end of PPE 3
Reference: Figure A-6 of this HRS documentation record; Ref. 4, p. 32; Ref. 12, pp. 4, 27-28; Ref. 15, pp. 316-318, 325, 337-339, 346; Ref. 46, pp. 47, 50

4.1.4.3.1 Sensitive Environments

Little Cow Creek within the TDL provides Critical Habitat for the Federal-listed threatened Steelhead (*Oncorhynchus mykiss*) (Figure A-5 of this HRS documentation record; Ref. 20, pp. 117, 121).

Approximately 0.15 mile of wetlands frontage are located along Little Cow Creek between the most upstream point of PPE 1 and sample location LCC-AM-10. Approximately 2.15 miles of wetlands are located along Little Cow Creek downstream of sample location LCC-AM-10 within the TDL (Figure A-6 of this HRS documentation record; Ref. 13, pp. 1-5; Ref. 18).

4.1.4.3.1.1 Level I Concentrations

Level I actual contamination is not documented.

Level I Concentrations Factor Value: 0

4.1.4.3.1.2. Level II Concentrations

Level II Sensitive Environment Targets

Table 21: Level II Sensitive Environment Targets

Total Length of Wetlands Frontage	Surface Water Body	Distance from PPE 1 to Nearest Sensitive Environment	References	Sensitive Environment Value (Ref. 1, Table 4-24)
0.15 mile	Little Cow Creek	0 miles	Figure A-6 of this HRS documentation record; Ref. 13, p. 1	25

Sum of Level II Sensitive Environments Value: 25

Level II Concentrations Factor Value: 25

4.1.4.3.1.3 Potential Contamination

Little Cow Creek within the TDL provides Critical Habitat for the Federal-listed threatened Steelhead (*Oncorhynchus mykiss*) (Figure A-5 of this HRS documentation record; Ref. 20, pp. 117, 121). Approximately 2.34 miles of wetlands are located along Little Cow Creek downstream of sample location LCC-AM-10 within the TDL (Figure A-6 of this HRS documentation record; Ref. 13, pp. 1-5; Ref. 18). Mean flow in Little Cow Creek was measured at upstream USGS stream gage 11373300 from 1957-1965 at 51.1 to 252.0 cubic feet per second (cfs). Flows in Little Cow Creek were measured approximately 200 feet upstream from Afterthought Creek from August 1997 to May 1998 at an average flow rate of 211,509 gpm (Ref. 26, pp. 10, 61; Ref. 36, pp. 18, 20, 22; Ref. 40). In accordance with Ref. 1, Table 4-13, Little Cow Creek within the TDL is described as a moderate to large stream.

Table 22: Potential Sensitive Environment Targets

Type of Surface Water Body (Ref. 1, Table 4-13)	Sensitive Environment	References	Sensitive Environment Value (Ref. 1, Table 4-23)
Moderate to large stream	Designated critical habitat for steelhead trout (*Oncorhynchus mykiss*)	Ref. 20, pp. 1, 117, 121	100

Table 23: Potential Wetland Frontages

Type of Surface Water Body (Ref. 1, Table 4-13)	Total Length of Wetlands	References	Sensitive Environment Value (Ref. 1, Table 4-23)
Moderate to large stream	2.15 miles	Figure A-6 of this HRS documentation record; Ref. 13, pp. 2-5; Ref. 18	75

Table 24: Potential Contamination

Type of Surface Water Body	Sum of Sensitive Environments Values (S_j)	Wetland Frontage Value (W_j)	Dilution Weight (D_j) (Ref. 1, Table 4-13)	$D_j(W_j + S_j)$
Moderate to large stream	100	75	0.01	1.75

Sum of Dj(Wj + Sj): 1.75
(Sum of Dj(Wj + Sj))/10: 0.175

Potential Contamination Factor Value: 0.175