

HRS DOCUMENTATION RECORD COVER SHEET

Name of Site: Washington County Lead District – Potosi Area

EPA ID No.: MON000705023

Contact Persons

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Pathways, Components, or Threats Not Scored

- 1) Surface Water Pathway: Because inclusion of the surface water pathway would not change the listing decision, the surface water migration pathway was not scored.
- 2) Soil Exposure Pathway: Although soil sampling in the area suggests widespread surficial soil contamination, the soil exposure pathway was not scored because it would not impact the listing decision.
- 3) Air Pathway: Based on the available information, the air migration pathway does not significantly contribute to the site score. In addition, the air migration pathway was not scored because it would not change the listing decision.

HRS DOCUMENTATION RECORD

Name of Site: Washington County Lead District – Potosi Area
 EPA Region: 7
 Date Prepared: September 2007
 Street Address of Site*: Approximately 500 feet east of the intersection of Bell Street and Valley Road, Potosi, Missouri 63664.
 City, County, State: Potosi, Washington, Missouri
 General Location in the State: The site is located in east-central Washington County, Missouri (Ref. 7, pp. 5–6).
 Topographic Map: The location of the site is shown on the Potosi, Missouri, Quadrangle, U.S. Geological Survey, 7.5-Minute Series Topographic Map (Ref. 3, p. 1).
 Latitude: 37.9399° North (Ref. 3, p. 1; Ref. 23, p. 1)
 Longitude: 90.7724° West (Ref. 3, p. 1; Ref. 23, p. 1)

The latitude and longitude listed above specify the approximate location of the Potosi Public Water Supply (PWS) Well No. 4. Reference 23 depicts the exact location of PWS Well No. 4.

Scores	
Ground Water Migration Pathway	100.00
Surface Water Migration Pathway	0
Soil Exposure Pathway	0
Air Migration Pathway	0
HRS SITE SCORE	50.00

Note:

*The street address coordinates, and contaminant locations presented in this HRS documentation record identify the general area of the site’s location. They represent one or more locations EPA consider 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 releases, not precisely delineated boundaries. A site is defined as where a hazardous substance has been “deposited, stored, placed, or 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 CERCLA. Accordingly, EPA recognizes that the preliminary description of facility boundaries at the time of scoring may be refined as more information is obtained concerning location(s) of contamination.

WORKSHEET FOR COMPUTING HRS SITE SCORE

		S	S²
1.	Ground Water Migration Pathway Score (S_{gw}) (from Table 3-1, line 13)	100	10,000
2a.	Surface Water Overland/Flood Migration Component (from Table 4-1, line 30)	0.00	
2b.	Ground Water to Surface Water Migration Component (from Table 4-25, line 28)	0.00	
2c.	Surface Water Migration Pathway Score (S_{sw}) Enter the larger of lines 2a and 2b as the pathway score.	0.00	0.00
3.	Soil Exposure Pathway Score (S_s) (from Table 5-1, line 22)	0.00	0.00
4.	Air Migration Pathway Score (S_a) (from Table 6-1, line 12)	0.00	0.00
5.	Total of $S_{gw}^2 + S_{sw}^2 + S_s^2 + S_a^2$		10,000
6.	HRS Site Score Divide the value on line 5 by 4 and take the square root	50.00	

TABLE 3-1.—GROUND WATER MIGRATION PATHWAY SCORESHEET

Factor Categories and Factors	Maximum Value	Value Assigned
Likelihood of Release to an Aquifer:		
1. Observed Release:	550	550
2. Potential to Release:		
2a. Containment	10	Not Scored
2b. Net Precipitation	10	Not Scored
2c. Depth to Aquifer	5	Not Scored
2d. Travel Time	35	Not Scored
2e. Potential to Release [lines 2a x (2b + 2c + 2d)]	500	Not Scored
3. Likelihood of Release (higher of lines 1 and 2e)	550	550
Waste Characteristics:		
4. Toxicity/Mobility	a	10,000
5. Hazardous Waste Quantity	a	100
6. Waste Characteristics	100	32
Targets:		
7. Nearest Well	50	50
8. Population:		
8a. Level I Concentrations	b	1,580
8b. Level II Concentrations	b	753
8c. Potential Contamination	b	Not Scored
8d. Population (lines 8a + 8b + 8c)	b	2,333
9. Resources	5	Not Scored
10. Wellhead Protection Area	20	Not Scored
11. Targets (lines 7 + 8d + 9 + 10)	b	2,383
GROUND WATER MIGRATION SOURCE FOR AN AQUIFER		
12. Aquifer Source [(lines 3 x 6 x 11)/82,500] ^c	100	100
GROUND WATER MIGRATION PATHWAY SCORE		
13. Pathway Score (S_{gw}), (highest value from line 12 for all aquifers evaluated) ^c	100	100

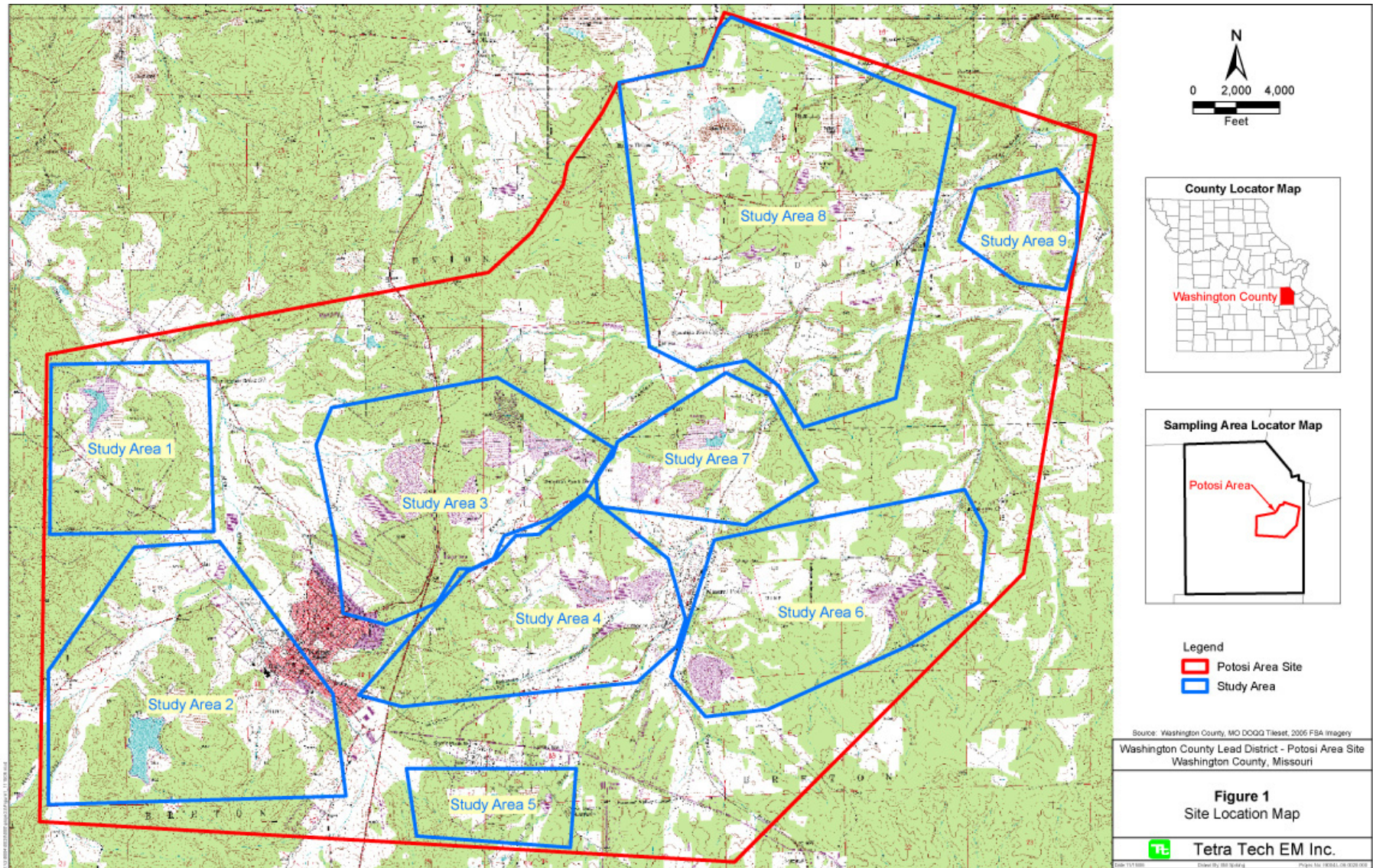
Notes:

- ^a Maximum value applies to waste characteristics category
- ^b Maximum value not applicable
- ^c Do not round to nearest integer

LIST OF ABBREVIATIONS

DGLS	Division of Geology and Land Survey
E	eastern aquifer
EPA	U.S. Environmental Protection Agency
gpm	gallons per minute
HRS	Hazard Ranking System
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MEGA	Missouri Environmental Geologic Atlas
MDNR	Missouri Department of Natural Resources
NA	not applicable
msl	mean sea level
NA	not applicable
ppb	parts per billion
ppm	parts per million
PWS	public water supply
RSE	Removal Site Evaluation
SQL	sample quantitation limit
U	undetected at or below sample quantitation limit
USBM	U.S. Bureau of Mines
USGS	U.S. Geological Survey
W	western aquifer
XRF	x-ray fluorescence
°F	degrees Fahrenheit
µg/L	micrograms per liter

FIGURE 1.-SITE LOCATION MAP



REFERENCES

Reference Number	Description of the Reference
1	U.S. Environmental Protection Agency (EPA). 55 FR 51533. December 14, 1990. 1 page.
2	EPA. Superfund Chemical Data Matrix. January 2004. 10 pages.
3	U.S. Department of Interior Geological Survey (USGS). <u>Potosi Quadrangle, Missouri, 7.5-Minute Series (topographic)</u> . 1958, photorevised 1982. 1 page.
4	Hazardous Materials Control Resources Institute. Elements in North American Soils. 1991. 8 pages.
5	U.S. Department of Agriculture (USDA). Soil Survey of Washington County, Missouri. November 10, 2003. 8 pages.
6	Missouri Department of Natural Resources (MDNR). Site Inspection/Removal Assessment Report for Washington County Lead District – Potosi Area, Washington County, Missouri. CERCLIS ID No. MON000705023. June 16, 2006. 354 pages.
7	Tetra Tech EM Inc. “Removal Site Evaluation Report for Washington County Lead District – Potosi Area Site, Potosi, Missouri.” CERCLIS ID No. MON000705023. Prepared for EPA under Contract No. 68-S7-01-41, Task Order 0267. March 17, 2006. 10 pages.
8	Adamski, J.C., J.C. Peterson, D.A. Freiwald, and J.V. Davis. 1995. Environmental and Hydrologic Setting of the Ozark Plateaus Study Unit, Arkansas, Kansas, Missouri, and Oklahoma. U.S. Geological Survey Water-Resources Investigations Report 94-4022. 52 pages.
9	Miller, D. and J. Vandike. 1997. Groundwater Resources of Missouri. Missouri State Water Plan Series Volume II. 28 pages.
10	Thompson, Thomas L. 1995. “The Stratigraphic Succession in Missouri” Original Preparation (1961) coordinated by Wallace B. Howe. Edited (1961) by John W. Koenig. MDNR Volume 40 (Second Series) Revised. Excerpt. 12 pages.
11	Stohr, C.J., St. Ivany, G., and Williams, J.H. 1981. Geologic Aspects of Hazardous-Waste Isolation in Missouri. Excerpt. 8 pages.
12	EPA. 2006. Safe Drinking Water Information System (SDWIS) for Potosi and Mineral Point, Missouri. SDWIS Violation Reports. http://oaspub.epa.gov/enviro/sdw_form_v2.create_page?state_abbr=MO . October 25. 19 pages.
13	MDNR. 2003. Missouri Environmental Geology Atlas (MEGA). On the world wide web at http://www.dnr.mo.gov/newsrel/nr06_509.htm . Excerpt. 10 pages.
14	MDNR. 2001. Bedrock Geologic Map of the Old Mines, 7.5’Quadrangle, Franklin, Jefferson and Washington Counties, Missouri and Bedrock Geologic Map of the Richwoods 7.5’ Quadrangle, Washington County, Missouri. July. 2 pages.
15	EPA Region 7. HRS Analysis Results Supplement for ASR Numbers 2730, 2801, 2823, 2832, 2863, 2873, 2882, 2901, and 2915 for the Washington County Lead District. January 3, 2007. 100 pages.
16	EPA Region 7. Transmittal of Sample Analysis Results for ASR #2882 for the Washington County Lead District. January 27, 2006. 36 pages.
17	EPA Region 7. Chain of Custody (COC) Records for ASRs 2801, 2823, 2832, 2863, 2882, 2873, 2901, and 2915. June 2005 through August 2006. 34 pages.

REFERENCES (Continued)

Reference Number	Description of the Reference
18	Tetra Tech. 2006. Figure 2: Background Well and Release Well Sample Location Map. September 26, 2006. 1 page.
19	Wharton, H.M., J.A. Martin, A.W. Rueff, C.E. Robertson, J.S. Wells, and E.B. Kisvarsanyi. 1969. "Missouri Minerals – Resources, Production, and Forecasts." Missouri Geological Survey and Water Resources Special Publications Number 1. December. Excerpt. 7 pages
20	Seeger, Cheryl, Missouri Department of Natural Resources to Kumud Pyakuryal, Tetra Tech EM Inc. <u>Memorandum regarding the Old Mines Area sample Area Mining History and Geology.</u> June 30, 2006. 8 pages.
21	MDNR. 2007. Potosi Municipal Well Laboratory Results for Well No. 4. January 19, 2007. 19 pages.
22	MDNR. 2007. Potosi Municipal Well Laboratory Results for Well No. 5. January 24, 2007. 10 pages.
23	MDNR. 2006. Figure 6: Washington County Lead District Potosi Area Site Ground Water Sampling Results & Public Wells Information Map (June – December 2005). May 2006. 1 page.
24	Tetra Tech EM Inc. 2007. Record of Telephone Conversation between Jim McCall, Water Engineer, City of Potosi and Kumud Pyakuryal regarding the Potosi Public Water Supply Information. January 22, 2007. 1 page.
25	MDNR Department of Geology and Land Survey. 2007. Scanned files of historical strip logs for City of Potosi wells # 4 and # 5 – Well Logs Number 19906 and Number 24128 received on computer disk from MDNR Water Resources Center. January. 10 pages.
26	EPA, Larry Marchin, Region 7 CLP Technical Project Officer. 2007. Memorandum to file regarding CLP Metals Data, ASRx# 2690, 2801, 2823, 2832, 2863, 2873, 2882, and 2915 Washington County Lead Site. August 21. 1 page.
27	Wharton, H.M. 1972. "Barite Ore Potential of Four Tailings Ponds in the Washington County Barite District, Missouri." Missouri Geological Survey and Water Resources. Excerpt. 20 pages.
28	Missouri Department of Natural Resources Division of Geology & Land Survey prepared in cooperation with Division of Environmental Quality. <u>Non-Coal Mined Lands (208 strategy).</u> Data Date 1981. Presented on U.S. Geological Survey, Mineral Point, Missouri Quadrangle, 7.5 Minute Series. Topographic Map. 1982. 1 page.
29	MDNR. 2005. Washington County Lead District Site Former Lead and Zinc Mining Inventory Project. May. 1 page.
30	United States Department of Agriculture. 2003. Soil Survey of Washington County, Missouri. November. Excerpt. 20 Pages.
31	MDNR. 2007. Memorandum from Chris Boldt, MDNR Environmental Services Program/Chemical Analysis Section (ESP/CAS), to Kumud Pyakuryal, Tetra Tech Project Manger, regarding the Laboratory Data Packets. March 29. 12 pages.
32	Tetra Tech, Jenna Mead and Jim Vandike, MDNR Telephone Conversation Regarding the Missouri Well Construction Requirements. January 28, 2007. 1 page.
33	EPA Region 7. 2007. Teleconference Form between Michelle Quick, NPL Coordinator and Lawrence Marchin, Project Officer Contract Laboratory Program on January 17. 1 Page.

SITE SUMMARY

The Washington County Lead District sites consists of known soil, sediment, and ground water contaminated with metals associated with the historical mining district including barium, cadmium, and lead. The site is part of a larger area known as the Washington County Barite district in southeastern Missouri (Ref. 19, p. 4). The district encompasses most of the central and northeastern part of Washington County, and extends a short distance into Jefferson and St. Francois Counties in the vicinity of Big River (Ref. 19, pp. 4, 5). This district was one of the most productive barite producing areas in the world and produced over 11 million short tons of crude barite ore over an 86 year period from 1885 to 1970 (Ref. 19, p. 5). The barite ores in Washington County consist of fragments and lumps of this mineral irregularly scattered within the residual clays at or near the ground surface (Ref. 19 p. 6; 20, pp. 1, 2). It is theorized that the barite rich clays are accumulated insoluble materials derived from long periods of surface weathering and solution of particular horizons of the dolomite bedrock (Ref. 19, p. 6). The well developed fault and fracture system in the district acted as channel-ways for ascending ore-bearing solutions. The solutions then migrated laterally into porous and permeable horizons in the upper Cambrian Potosi and Eminence Dolomites where barite and associated galena were deposited as runs. The soluble dolomites were eroded over time and replaced with clays leaving the ores in the clay. The ore enriched clay is often capped at the surface by thin layers of barren soil and loess (Ref. 19, p. 6).

The earliest documented mining in Washington County was recorded in the early 18th century and focused on the collection and recovery of near surface lead ores (Ref. 20, p. 1). Early mining operations were conducted by farmers to supplement income and usually consisted of hand dug pits advanced into the residuum over the bedrock (Ref. 20, pp. 1, 2). Mining for barite (the ore from which barium is derived) did not occur until after the civil war when barium became economically valuable as a white pigment in paint (Ref. 20, p. 1). In the early 20th century, several thousand people mined barite in Washington County. In 1926, barite mining boomed in Washington County when the mineral was discovered to be useful as a weighting agent in oil drilling mud. Mechanized strip mining did not occur to a great extent until 1924 (Ref. 20, p. 3; 19, p. 7). By the mid 1980s, production started to decline in Washington County due to competition from Nevada and overseas operations (Ref. 20, p. 1).

EPA Region 7 and the State of Missouri Department of Natural Resources (MDNR) are investigating this district to identify impacted residential yards and wells. Ongoing, time-critical removal actions are being conducted at properties where lead in soils or ground water exceeds defined action levels. To date, the investigation has focused around population centers and areas where the heaviest concentrations of former mine sites are located. To aid in the management of data and available resources, the barite district has been split into three areas named Potosi, Richwoods, and Old Mines. This package presents information pertaining to the area named Washington County Lead District-Potosi, which is located near the eastern Ozark Mountains in southeastern Missouri (see Figure 1 of this document).

While the focus of past environmental assessments at the site has been lead in nine study areas (Study Areas 1 through 9) in and around the town of Potosi, the soil and ground water in the area typically contain other contaminants associated with historical mining districts, including arsenic, barium, and cadmium. Analytical results and XRF screening have confirmed significantly elevated levels of lead in ground water and soil. Lead has been detected above a health-based benchmark in domestic and public drinking water wells (Ref. 6, pp. 27–73; Figure 1 of this document). Lead has also been detected above the EPA's action level of 15 parts per billion (ppb) in the underlying aquifers (see Section 3.1.1 of this document).

Large tailings piles associated with past mining activities are visible in the aerial photograph and are annotated on the U.S. Geological Survey 7.5-minute Quadrangle maps reviewed for the Potosi area (Ref.

7, pp. 5–6). However, within the Potosi portion of the Washington County Mining District are hundreds of prospects and areas that have been subject to anthropogenic disturbance of the ore body. The state of Missouri maintains a database known as the inventory of mines, occurrences and prospects (IMOP) that currently has over 21,000 entries of mining and mining related sites in Missouri. In Washington County alone, 1,426 mines or prospects have been identified (Ref. 20, p. 4). Figure 2 of Reference 20 shows the location of the sites in the northeast part of Washington County (Ref. 20, p. 8). See also Reference 29. IMOP locations in the Potosi area are also included in Figure 2 of Reference 13 (Ref. 13, p. 3). The list of 1,426 mines is not comprehensive, and IMOP points increase as further historical documents are reviewed for entry into the database. At this time, it is impractical to characterize each potential source area. The many smaller source areas, not characterized below, may be contributing to the contamination.

Therefore, for much of the ubiquitous ground water contamination in the Mining District, it is not possible to attribute the contamination to any single mining operation. Because of the extensive mining and large number of individual operations, most wells are downgradient of multiple mines (Refs. 18; 20; 29). Even for those wells that are relatively close to a major mining facility, the karst conditions and faults in the water bearing formations result in a maze of channels that make it impossible to document with certainty that the contamination is a result of releases from the nearby mine (Ref. 9, p. 19 and 21). For this reason, EPA has focused the site investigations and the HRS evaluations on the aquifers associated with the population centers in the mining district and not on individual mines.

Although contaminated soils and ground water plume characterization is ongoing, there are estimated 5,498 individuals served by public and private wells in the Potosi area (Ref. 6, p. 32). Hundreds of additional drinking water wells are present in the area (Ref. 6, p. 27).

The area is primarily rural residential with a number of commercial businesses present along state highways (Ref. 7, p. 6). The climate in Washington County, Missouri, is characterized by cool winters and hot summers. The average daily maximum temperature is 88 degrees Fahrenheit (°F) in the summer and 31°F during the winter. The mean annual precipitation is about 39.33 inches, with 47 percent (18.7 inches) falling between April and September (Ref. 5, pp. 2–3).

2.2 SOURCE CHARACTERIZATION

There are many possible sources such as large tailing piles and ponds visible in the aerial photographs and annotated on the U.S. Geological Survey 7.5-minute Quadrangle maps reviewed for the Potosi area (Ref. 3). As discussed in the site summary of this document, earliest documented mining Washington County dates back to the early 18th century. A list of large facilities and operators associated with study areas within the Potosi area is presented in the description of other possible sources, immediately after Section 2.2.1 Hazardous Waste Quantity. However, the ground water wells that met the observed release criteria were used to define the contaminated plume associated with the Potosi site. The wells that met the criteria are listed below and in the table in Section 3.1.1 (observed release section) of this documentation record; the figure included in Reference 13 of this document depicts the wells (Reference 13, p. 2).

2.2.1 SOURCE IDENTIFICATION

The Potosi study area has been divided into two general areas based on ground water flow away from a topographic high transecting the area from north to south, which may be considered a ground water discontinuity. This topographic high roughly follows the path of Highway 21 (Ref. 13, p. 2). East of the divide, ground water flow is generally towards the northeast, while west of the divide it is generally west or northwest (Ref. 13, p. 2). However, because the area is fractured and karst, ground water flow may not always correspond to the regional flow presented in Reference 13 (Ref. 9, pp. 19 and 22).

Figure 2 in Reference 13 presents the IMOP database and the MDNR map of mined lands relative to sampled wells in the area (Ref. 13, pp. 1-2). Some contaminated wells are within identified mined areas; however, many individual prospects are typically present within the mined areas. Because mining in the Potosi area dates to the 1700s, unidentified mines and prospects are also likely to be present beyond those presented in the IMOP database (Refs. 7, pp. 6-10; 13, pp. 1-2). In general, wells in the western aquifer area are largely within or downgradient of either the Horney Brothers Boar's Head Lodge mined area or the Milchem Settle mine. Wells in the eastern area are downgradient of an increasing number of mines the further northeast they are located (Ref. 13, p. 3).

Pervasive metal contamination was documented by laboratory and XRF analyzer data in overlapping study areas identified during previous assessments. In addition, decades of mining in Washington County in general (and the Potosi area in particular), have caused disturbances of ores and exposed the ore to surficial conditions and nearby human and environmental targets (Ref. 6, pp. 17–18, 23–26; 7, pp. 13–20). Given that the targets are downgradient of multiple mining areas, and the karst nature of the contaminated aquifer and high density of contaminated soil areas, it is not possible to identify any specific source(s) of the contamination at this time (Refs. 6, pp. 29, 41–42; 18; 20; 29). Therefore, the source has been identified as a ground water plume with no identifiable source. Although no particular mining related source has been designated for scoring purposes, possible sources are discussed immediately following Section 2.4.2.1.5 of this documentation record.

EPA conducted soil screening and ground water sampling as part of its Removal Site Evaluation (RSE). Because the most immediate health threat is deemed to be contaminated ground water used for drinking, EPA has provided bottled water to residents with private wells contaminated with lead at concentrations above regulatory action levels. Activities associated with an EPA removal action are ongoing at the site, with specific removals undertaken to address soil contamination at time-critical properties that contained lead concentrations above 1,200 mg/kg in areas outside of the drip zone (Ref. 7, p. 23). Of a total of 399 ground water samples collected in support of the EPA RSE, sixty samples (15 percent) contained lead at a concentration above the MCL of 15 micrograms per liter ($\mu\text{g/L}$). The concentration of lead ranged from 15.1 to 110 $\mu\text{g/L}$ in these samples (Ref 7, pp. 20).

Name of source: - **Potosi Area Ground Water Plume (with no single identified source)**

Number of source: - 1

Source Type: - Other

Description and Location of Source (with reference to a map of the site): Figure 1

The ground water plume source encompasses an area of lead contaminated ground water including a public supply well and numerous private domestic drinking water supply wells in the Potosi area (Refs. 13, p. 2; 18). This source was divided into two aquifers based whether the ground water evidence is located in the eastern sub-aquifer (E) or western sub-aquifer (W) to which the Potosi area has been divided (Ref. 13, p. 2).

The Washington County Lead District - Potosi Area site consists of soil and ground water contamination by lead, which is a contaminant associated with local historical mining. Analytical results and XRF screening have identified elevated levels of lead in ground water and soil; however, the extent of contamination has not been fully characterized. The nine study areas, which the RSE focused on, are centered on and around historical, large-scale mining operations. Areas encompassed by the site include a small town, rural residential sections, and a number of commercial business facilities located generally along the state highways. Large tailings piles associated with past lead and barite mining are visible in aerial photographs and are annotated on the Potosi, Missouri U.S. Geological Survey 7.5-minute quadrangle maps (Ref. 3; 7, p. 6).

Between 2004 and 2006, MDNR completed Pre-Comprehensive Environmental Response and Liability Information System (Pre-CERCLIS) screening assessment, abbreviated Preliminary Assessment, and combined Site Inspection/Removal Assessment at the site. Combination MDNR investigations indicated that an area-wide soil contamination was associated with local mining operations (Ref. 6, pp. 16). Of a total of 427 residential ground water well samples collected by MDNR in support of its investigations, 92 (21.5 percent) contained lead above the MCL of 15 µg/L. Lead in these samples ranged from 15.1 to 92.8 µg/L (Ref. 7, pp. 10–11, 21–22).

EPA and the State of Missouri have performed extensive studies characterizing the extent of the ground water lead contamination but have found no single mining facility to which lead released to any major target well can be individually attributed.

Elevated levels of lead have been detected in the Potosi Public Water Supply (PWS) wells on multiple occasions during the last few years. PWS Well # 4, which serves greater than 700 individuals, has had detections ranging from 4.8 µg/L to 73.5 µg/L (Ref. 24, p. 1; 21, pp. 2–5).

2.2.2 HAZARDOUS SUBSTANCES ASSOCIATED WITH THE SOURCE

The ground water plume source hazardous substances are those hazardous substances for which an observed release has been established within the contaminated ground water plume being evaluated for the scoring purposes underneath the site. The primary contaminant of concern associated with the site used for scoring purposes is lead. The results presented below from historical ground water sampling events suggest elevated levels of lead at the site (Ref. 21, pp. 2–19).

Background Levels:

Public Supply Well

For much of the ubiquitous ground water contamination in the site area, it is not possible to attribute the contamination to any single mining operation. Because of the extensive mining and large number of

individual operations, most wells are downgradient of multiple mines (Refs. 13, p. 3). Even for those wells that are relatively close to a major mining facility, the karst conditions and faults in the water bearing formations result in a maze of channels that make it impossible to document with certainty that the contamination is a result of releases from the nearby mine (Ref. 9, pp. 19 and 22).

The City of Potosi’s Well # 5 is a suitable background well for PWS Well # 4, the release well, based on its similarity in construction, size and location in the aquifer (Ref. 25). Chemical analyses for PWS Well # 5 from 1994 to 2004 indicate that dissolved lead was not detected. In contrast, the City’s Well # 4, located about 1 mile north-northeast has contained dissolved lead concentrations between 4.8 and 12.6 µg/L. A sample from PWS Well # 4, collected in December 2003 contained a total lead concentration of 73.5 µg/L (Refs. 22, pp. 2-10; 21, pp. 2-19; 23).

PWS Well # 4, drilled in 1961, has a surface elevation of 1,017 feet above mean sea level (msl) and reached a total depth of 1,020 feet bgs (-3 feet msl). PWS Well # 5, with a surface elevation of 1056 feet above msl had a total depth of 1,425 feet bgs, or -367 feet msl. Both of these wells were completed in the St. Francois aquifer; however, Well # 5 penetrated approximately 300 feet into the Lamotte sandstone, while Well # 4, terminated at the transition zone between the Bonneterre to the Lamotte (Ref. 25, p. 9–10).

Comparison of the well logs for PWS Wells # 4 and # 5 indicate that the Ozark Aquifer—made up of the Gasconade (including the Gunther Sandstone), Eminence, and Potosi dolomites—have been cased off, with casing ending near the top of the Bonneterre formation (Ref. 25, pp. 2–8). PWS Well # 4 is cased to a depth of 661 feet bgs (356 feet above msl), while PWS Well # 5 is cased to 792 feet bgs (264 feet above msl). As is typical of the area, the wells are open hole below the cased depth, rather than being screened over the producing interval (Ref. 25, p. 9–10).

Both wells are completed in the St. Francois Aquifer, which is comprised of the Bonneterre formation and Lamotte Sandstone. The top of the Bonneterre was encountered at a depth of 785 feet bgs in PWS Well # 5 (271 feet above msl). In PWS Well # 5, it was encountered at 640 feet bgs (377 feet above msl) or about 100 feet lower in than in PWS Well # 4. The well logs indicate that PWS Well # 5 produces from the Bonneterre and the underlying Lamotte, while PWS Well # 4 reached its total depth in the sandy dolomite transition zone just above the top of the Lamotte Sandstone. No significant differences are apparent in the rock descriptions for the two wells that would suggest a higher concentration of naturally occurring elements (Ref. 25, pp. 9–10). In addition, its upgradient location indicates that PWS Well # 5 is properly located background for comparative purposes.

TABLE 1

SOURCE BACKGROUND SAMPLES FOR MUNICIPAL WELL SAMPLES

Laboratory Sample Number	Well ID	Dates Collected	Dissolved Lead Concentration (µg/L)	SQL (µg/L)	Well Depth	References
94-E273	Potosi PWS Well # 5	07/05/1994	5 U	5	1,425 ft bgs -369 ft msl	13, p. 2; 22, pp. 2–10; 25, pp. 10; 23; 31, pp. 1, 2, 4, 5, 7, 10
97-H553		08/12/1997	< 4	2.5		
0115288		01/16/2001	< 4	2.5		
0340895		12/17/2003	1 U	1		

Notes:

* The SQLs provided in this table are referred to as practical quantitation limits. They are the laboratory's reporting limit (also known as the method detection limit – see the method for more details) for that analyte with any dilution factor, volume adjustment, or percent solids for that sample analysis taken into account and are sometimes called the sample quantitation limit (Ref. 31).

ID Identification
 µg/L micrograms per liter
 U The analyte was not detected at or above the reporting limit
 ft bgs feet below ground surface
 ft msl feet above mean sea level

Private Wells

Based on the obtained analytical results in support of MDNR's environmental services program, historically lead has not been detected in known sampling data at PWS Well # 5. It was not detected in all of the four sampling dates listed in Table 1 above (Ref. 22, pp. 2–10). The samples listed in Table 2 were collected from private wells and serve as background for comparison to other private wells at the site. Background residential wells were selected from an area that is generally upgradient and away from the contaminated wells (Refs. 18). Although well construction information is not available, residential wells that met the observed release criteria are expected to draw drinking water from the same aquifer interval (Ref. 13, p. 2 and 18).

TABLE 2

SOURCE BACKGROUND SAMPLES FOR PRIVATE WELL SAMPLES

Laboratory Sample ID and Property or Well No. (Aquifer) ¹	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	References
2882-131 20905 (E)	01/06/06	Lead (dissolved)	1.00 U	1.0	Unknown	Ref. 7, pp. 823–824; 13, p. 2; 15, p. 79; 16, pp. 4, 6–7, 24; 17, p. 23; 18; 26
2882-135 20854 (E)	01/06/06	Lead (dissolved)	1.00 U	1.0	Unknown	Ref. 7, pp. 811–812; 13, p. 2; 15, p. 79; 16, pp. 4, 6–7, 25; 17, p. 23; 18; 26
2882-136 20760 (E)	01/06/06	Lead (dissolved)	1.00 U	1.0	115	Ref. 7, pp. 703–704; 13, p. 2; 15, p. 79; 16, pp. 4, 6–7, 25; 17, p. 23; 18; 26
2882-138 20842 (E)	01/06/06	Lead (dissolved)	1.00 U	1.0	108	Ref. 7, pp. 799–800; 13, p. 2; 15, p. 79; 16, pp. 4, 6–7, 26; 17, p. 23; 18; 26
2882-142 20843 (E)	01/07/06	Lead (dissolved)	1.00 U	1.0	Unknown	Ref. 7, pp. 801–802; 13; 15, p. 80; 16, pp. 4, 6–7, 27; 17, p. 24; 18; 26
2882-148 20906 (E)	01/06/06	Lead (dissolved)	1.00 U	1.0	Unknown	Ref. 7, pp. 825–826; 13, p. 2; 15, p. 81; 16, pp. 4, 6–7, 28; 17, p. 24; 18; 26, p. 1; 26
2882-150 20853 (E)	01/07/06	Lead (dissolved)	1.00 U	1.0	260	Ref. 7, pp. 809–810; 13, p. 2; 15, p. 81; 16, pp. 4, 6–7, 29; 17, p. 24; 18; 26

Laboratory Sample ID and Property or Well No. (Aquifer) ¹	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	References
2882-159 20821 (E)	01/09/06	Lead (dissolved)	1.00 U	1.0	Unknown	Ref. 7, pp. 787–788; 13, p. 2; 15, p. 82; 16, pp. 4, 6–7, 31; 17, p. 24; 18; 26
2901-106 20789 (E)	01/20/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 737–738, 1293, 1295–1296, 1306; 13, p. 2; 15, p. 91; 17, p. 30; 18; 26
2901-112 20524 (E)	01/20/06	Lead (total)	1.00 U	1.0	90	Ref. 7, pp. 581–582, 1294–1296, 1307; 13, p. 2; 15, p. 92; 17, p. 30; 18; 26
2901-113 20677 (E)	01/20/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 599–600, 1294–1296, 1308; 13, p. 2; 15, p. 92; 17, p. 30; 18; 26
2901-116 20690 (E)	01/20/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 607–608, 1294–1296, 1308; 13, p. 2; 15, p. 92; 17, p. 31; 18; 26
2901-117 20823 (E)	01/21/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 791–792, 1294–1296, 1309; 13, p. 2; 15, p. 92; 17, p. 31; 18; 26
2901-118 20822 (E)	01/21/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 789–790, 1294–1296, 1309; 13, p. 2; 15, p. 92; 17, p. 31; 18; 26
2801-112 20355 (W)	10/12/05	Lead (dissolved)	1.00 U	1.0	Unknown	Ref. 7, pp. 139–140, 1128, 1145; 13, p. 2; 15, p. 8; 17, p. 5; 18; 26
2915-121 20964 (W)	02/06/06	Lead (dissolved)	1.00 U	1.0	120	Ref. 7, pp. 387–388, 1315, 1333; 13, p. 2; 15, p. 100; 17, p. 34; 18; 26
		Lead (total)	1.00 U	1.0		
2915-122 20974 (W)	02/07/06	Lead (dissolved)	1.00 U	1.0	Unknown	Ref. 7, pp. 403–404, 1315–1317, 1333; 13, p. 2; 15, p. 100; 17, p. 34; 18; 26
		Lead (total)	1.00 U	1.0		
2915-112 20973 (W)	02/01/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 401–402, 1315–1317, 1331; 13, p. 2; 15, p. 99; 17, p. 34; 18; 26
2915-113 20960 (W)	02/01/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 379–380, 1315–1317, 1331; 13, p. 2; 15, p. 99; 17, p. 34; 18; 26
2915-117 20963 (W)	02/03/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 385–386, 1315–1317, 1332; 13, p. 2; 15, p. 99; 17, p. 34; 18; 26
2915-119 20957 (W)	02/06/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 373–374, 1315–1317, 1332; 13, p. 2; 15, p. 99; 17, p. 34; 18; 26

Notes:

* The SQLs provided in this table are referred to as reporting limits. They are the laboratory’s reporting limit (also known as the method detection limit – see the method for more details) for that analyte with any dilution factor, volume adjustment, or percent solids for that sample analysis taken into account and are sometimes called the sample quantitation limit.

ID Identification
µg/L micrograms per liter
U The analyte was not detected at or above the reporting limit
1 refers to HRS subaquifer
E eastern aquifer
W western aquifer

ft bgs feet below ground surface

Contaminated Samples

The ground water pathway source hazardous substances are those hazardous substances for which an observed release was established within the evaluated aquifer per current EPA convention for the ground water migration pathway. Lead was detected in PWS Well # 4 on five known occasions since 1997. As noted earlier, of a total of 427 residential ground water well samples collected by MDNR in support of its investigations in the Potosi area, 92 (21.5 percent) contained lead above the MCL of 15 µg/L. Because the most immediate health threat is deemed to be contaminated ground water used for drinking, EPA has provided bottled water to residents with private wells contaminated with lead at concentrations above regulatory action levels. Three-hundred ninety-nine ground water samples were collected in support of the EPA RSE. Sixty samples (15 percent) contained lead at a concentration above the MCL of 15 µg/L. The concentration of lead ranged from 15.1 to 110 µg/L in these samples (Ref 7, pp. 20). EPA RSE analytical data collected from residential wells is presented in Section 3.0 of this document. The samples presented below provide results for wells that roughly delineate Eastern and Western plumes associated with the Potosi area.

Laboratory Sample Number (Aquifer) ¹	Sample Location	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	Reference
0417143 (W)	Potosi PWS Well #4	02/13/2004	Lead (dissolved)	12.6	1.0	1,020 ft bgs -3 ft msl	Ref. 13, p. 2; 21, pp. 1-3; 23; 25, p. 9; 31, pp. 1-3
0340897 (W)	Potosi PWS Well #4	12/17/2003	Lead (total)	73.5	1.0	1,020 ft bgs -3 ft msl	Ref. 13, p. 2; 21, pp. 1, 4-5; 23; 25, p. 9; 31, pp. 1-2, 4
0115287 (W)	Potosi PWS Well #4	01/16/2001	Lead (dissolved)	4.8	2.5	1,020 ft bgs -3 ft msl	Ref. 13, p. 2; 21, pp. 1, 12-13; 23; 25, p. 9; 31, pp. 1-2, 4
0041537 (W)	Potosi PWS Well #4	12/27/2000	Lead (dissolved)	7.7	2.5	1,020 ft bgs -3 ft msl	Ref. 13, p. 2; 21, pp. 1, 14-15; 23; 25, p. 9; 31, pp. 1-3, 5
97-H552 (W)	Potosi PWS Well #4	08/12/1997	Lead (dissolved)	8.0	2.5	1,020 ft bgs -3 ft msl	Ref. 13, p. 2; 21, pp. 1, 18-19; 23; 25, p. 9; 31, pp. 1-2, 6
2801-216 (W)	20291	10/12/05	Lead (total)	14.80 J	1.0	Unknown	Ref. 7 pp. 133-134, 1128, 1131-1133, 1153; 13, p. 2; 15, p. 12; 17, p. 1; 18; 26

Laboratory Sample Number (Aquifer) ¹	Sample Location	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	Reference
2823-137 (W)	20455	10/26/05	Lead (total)	26.8	1.0	Unknown	Ref. 7 pp. 341–342, 1172, 1174–1175, 1193; 13, p. 2; 15, p. 27; 17, p. 8; 18; 26
2832-140 (W)	20494	11/19/05	Lead (total)	19.5 J	1.0	150	Ref. 7 pp. 345–346, 1203, 1205–1206, 1226; 13, p. 2; 15, p. 41; 17, p. 14; 18; 26
2832-119 (W)	20410	11/16/05	Lead (total)	21.8 J	1.0	Unknown	Ref. 7 pp. 179–180, 1203, 1205–1207, 1220; 13, p. 2; 15, p. 38; 17, p. 13; 18; 26
2873-132 (W)	20607	12/19/05	Lead (total)	16.7	1.0	200	Ref. 7 pp. 499–500, 1270–1271, 1284; 13, p. 2; 15, p. 66; 17, p. 28; 18; 26
2801-110 (W)	20272	10/10/05	Lead (dissolved)	8.17J ¹	1.0	500	Ref. 7 pp. 241–242, 1128, 1131–1133, 1144; 13, p. 2; 15, p. 8; 17, p. 5; 18; 26
2832-144 (W)	20386	11/19/05	Lead (total)	2.60 J ¹	1.0	165	Ref. 7 pp. 315–316, 1203, 1205–1207, 1227; 13, p. 2; 15, p. 41; 17, p. 14; 18; 26
2873-127 (W)	20603	12/17/05	Lead (total)	32.4	1.0	172	Ref. 7 pp. 493–494, 1270–1271, 1283; 13, p. 2; 15, p. 65; 17, p. 27; 18; 26
2915-103 (W)	20422	02/01/06	Lead (total)	10.3 J ²	1.0	Unknown	Ref. 7 pp. 417–418, 1314, 1316–1317, 1328; 13, p. 2; 15, p. 98; 17, p. 33; 18; 26
2915-107 (W)	20965	02/01/06	Lead (total)	6.57 J ²	1.0	130	Ref. 7 pp. 389–390, 1315–1317, 1329; 13, p. 2; 15, p. 98; 17, p. 33; 18; 26

Laboratory Sample Number (Aquifer) ¹	Sample Location	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	Reference
2873-103 (E)	20613	12/14/05	Lead (total)	110	1.0	200-300	Ref. 7 pp. 505–506, 1269, 1271, 1277; 13, p. 2; 15, p. 62; 17, p. 26; 18; 26
2863-157 (E)	20594	12/07/05	Lead (total)	83.9	1.0	250	Ref. 7 pp. 1059–1060, 1237, 1239–1240, 1262; 13, p. 2; 15, p. 57; 17, p. 19; 18; 26
2863-155 (E)	20459	12/06/05	Lead (total)	73.7	1.0	100	Ref. 7 pp. 961–962, 1237, 1239–1240, 1262; 13, p. 2; 15, p. 57; 17, p. 19; 18; 26
2873-141 (E)	20396	12/20/05	Lead (total)	25.2 J	1.0	Unknown	Ref. 7 pp. 533–534, 1270–1271, 1286; 13, p. 2; 15, p. 67; 17, p. 28; 18; 26
2801-268 (E)	20432	10/20/05	Lead (total)	16.4	1.0	Unknown	Ref. 7 pp. 437–438, 1128, 1131–1133, 1166; 13, p. 2; 15, p. 18; 17, p. 3; 18; 26
2863-132 (E)	20445	12/05/05	Lead (total)	10.8 J ¹	1.0	90-110	Ref. 7 pp. 957–958, 1237, 1239–1240, 1256; 13, p. 2; 15, p. 54; 17, p. 18; 18; 26
2863-137 (E)	20625	12/03/05	Lead (total)	18.9 J ¹	1.0	Unknown	Ref. 7 pp. 1071–1072, 1237, 1239–1240, 1257; 13, p. 2; 15, p. 55; 17, p. 18; 18; 26
2863-128 (E)	20572	12/05/05	Lead (total)	3.80 J ¹	1.0	140	Ref. 7 pp. 1101–1102, 1237, 1239–1240, 1255; 13, p. 2; 15, p. 53; 17, p. 18; 18; 26

Laboratory Sample Number (Aquifer) ¹	Sample Location	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	Reference
2832-150 (E)	20587	11/21/05	Lead (total)	7.43 J ¹	1.0	120	Ref. 7 pp. 567–568, 1203, 1205–1207, 1228; 13, p. 2; 15, p. 42; 17, p. 14; 18; 26
2901-108 (E)	20701	01/20/06	Lead (total)	25.2 J ¹	1.0	Unknown	Ref. 7 pp. 627–628, 1293, 1295–1269, 1306; 13, p. 2; 15, p. 91; 17, p. 30; 18; 26

Notes:

* The SQLs provided in this table are referred to as practical quantitation limit. They are the laboratory’s reporting limit (also known as the method detection limit – see the method for more details) for that analyte with any dilution factor, volume adjustment, or percent solids for that sample analysis taken into account and are sometimes called the sample quantitation limit.

J Although the analytes in question have been positively identified in the samples, the quantitation is an estimate due to the serial dilution percent differences being above the control limits. The reported results may be biased low by as much as 19, 79, 16, and 18% in samples 2801-216, 2832-140, 2832-119, and 2801-141, respectively.

J¹ The analyte has been positively identified in the sample; however the reported value is an estimate due to serial percent dilution being above the control limit. The reported value may be biased low. Therefore, even if the value was adjusted to a higher value to compensate for the bias, it would still meet the observed release criteria.

J² The analyte has been positively identified in the sample; however the reported value is an estimate due to the peak width at 10% peak height exceeding 0.80 amu in the ICP-MS tune. The reported value may be biased low. Therefore, even if the value was adjusted to a higher value to compensate for the bias, it would still meet the observed release criteria.

PWS Public Water Supply

µg/L micrograms per liter

1 refers to HRS subaquifer

E eastern aquifer

W western aquifer

ft bgs feet below ground surface

ft msl feet above mean sea level

2.2.3 HAZARDOUS SUBSTANCES AVAILABLE TO A PATHWAY

Containment Description	Containment Factor Value	Reference
Gas release to air	Not Scored	NA
Particulate release to air	Not Scored	NA
The containment factor value for the ground water migration pathway was evaluated for “All Sources” for evidence of hazardous substance migration from source area (i.e, source area includes source and any associated containment structures). The source is a ground water plume. The plume is defined as an area of contamination released to ground water and detected in ground water samples. Applicable containment factor value was determined based on existing analytical evidence of hazardous substances in ground water samples from private and public wells. Therefore, the highest ground water migration pathway containment factor value of 10 was assigned to Source Number 1 as	10	Ref. 7, pp. 5–31; 21, pp. 9–19

Containment Description	Containment Factor Value	Reference
specified in Table 3-2 of the HRS Rule (Ref. 1, Section 3.1.2.1).		
Release via overland migration and/or flood.	Not Scored	NA

2.2.4 HAZARDOUS WASTE QUANTITY

2.4.2.1.1 Hazardous Constituent Quantity

The information available is not sufficient to adequately determine Tier A, as required in Section 2.4.2.1.1 of the HRS Rule. As a result, the evaluation of Hazardous Waste Quantity proceeds to evaluate Tier B, hazardous wastestream quantity (Ref. 1, Section 2.4.2.1.1).

Hazardous Constituent Quantity Value: NE

2.4.2.1.2 Hazardous Wastestream Quantity

The information available is not sufficient to adequately determine Tier B, as required in Section 2.4.2.1.2 of the HRS Rule. As a result, the evaluation of Hazardous Waste Quantity proceeds to evaluate Tier C, volume (Ref. 1, Section 2.4.2.1.2).

Hazardous Wastestream Quantity Value: NE

2.4.2.1.3 Volume

The information available is not sufficient to evaluate Tier B, the volume will be evaluated under Tier C. For the migration pathways, the source is assigned a value for volume using the appropriate Tier C equation from Table 2-5 (Ref. 1, Section 2.4.2.1.3). Because the extent of the ground water plume is unknown, the volume for the ground water plume will be designated as unknown, but contaminated ground water samples are present, so it is clear the quantity is greater than zero.

Volume: >0

2.4.2.1.4 Area

The area measure (Tier D) is not evaluated for source type “other” (Ref. 1, Table 2-5).

Area: 0

2.4.2.1.5 Source Hazardous Waste Quantity Value

Highest assigned value assigned from Table 2-5: >0

SUMMARY OF SOURCE DESCRIPTIONS

Source No.	Source Hazardous Waste Quantity Value	Source Hazardous Constituent Quantity Complete? (Y/N)	Containment Factor Value by Pathway				
			Ground Water (GW) (Table 3-2)	Surface Water (SW)		Air	
				Overland/flood (Table 4-2)	GW to SW (Table 3-2)	Gas (Table 6-3)	Particulate (Table 6-9)
1	>0	No	10	Not Scored	Not Scored	Not Scored	Not Scored

Other Possible Sources

Lead mining in the Potosi area of Washington County has a long history dating back to the early 1700s. Potosi is located in the region know as the Old Lead Belt, where large-scale mining occurred in Washington, Madison, and St. Francois Counties. The lead mineralization occurs in fractured bedrock and in red clay residuum derived chiefly from the Cambrian Potosi and Eminence dolomites. Miners recovered lead from both residuum and shafts that extended into the bedrock. Continuous mining in the Potosi area began at Mine Renault—just north of Potosi—in 1721 with the use of slave labor. Mine Renault produced as much as 1,500 pounds of ore per day. Many small mines opened and closed during this time, with continuous production for the first 20 years and intermittent production until 1799. Miners, to this point, had recovered galena by hand mining and cleaning from shallow pits less than 10 feet deep. It was not until 1799, when Moses Austin sank a shaft to a depth to 80 feet and erected a reverberatory furnace that lead mining began to develop on a larger scale. This mining process continued until shortly after 1900. Beginning in 1904, the Point Mining and Milling Company used a steam shovel and wet-process mill. Around 1924, the Eagle-Picher Company and National Pigments and Chemical Company began production by stripping residuum and processing the material in a washer and jig plant. Mining operations shifted from hand mining to mechanized during this period and continued until 1942 (Ref. 7, pp. 5–14).

After 1942, lead was mined by removing residuum with mechanized shovels and front-end loaders. The residuum was loaded into trucks and hauled to washers, where clay was removed with high-pressure water in a rotary breaker. This procedure separated the rock by breaking it into smaller pieces. The mined material was then passed through log washers that removed even more clay and separated the mined material. Finally, the material was passed through trammels and onto jigs, where material was separated by weight. Finally, lead and barite were separated from any remaining waste rock. Barite mining did not occur in the Potosi area until post-Civil War time. Before this time, barite was placed in waste piles when lead was recovered. Barite mineralization occurs mostly in red clay residuum, also derived from the Cambrian Potosi and Eminence dolomites. The clay residuum is generally located several inches to 3 or 4 feet below barren soil overburden. The average thickness of the residuum ranges from a few feet to more than 30 feet. Barite mining started because it was found to be a long-lasting white pigment. Later, barite was discovered to be a useful weighting agent in oil drilling. During the 1900s, Washington County was the world leader in barite production. Many of the large mining operations reworked land that experienced hand mining for lead or barite. Considerable ore was usually left behind between pits and shafts (Ref. 7, p. 7).

MDNR has identified mined areas from three sources—U.S. Geological Survey 7.5-minute topographic maps, maps developed by MDNR’s Division of Geology and Land Survey (DGLS), and digital orthophoto quarter quadrangles (DOQQs). MDNR used all three methods to identify potential areas of concern, in conjunction with data points from the IMOP database. Various entities or private citizens

have owned, operated, and managed mines and associated lands in the Potosi area. MDNR used the IMOP database and U.S. Bureau of Mines (USBM) production records housed at DGLS to compile information on mine owners and operators in the Potosi area; the results are summarized in the following list. In addition, IMOP information indicates it is probable that unrecorded early lead mining occurred in all study areas (Ref. 7, pp. 5–14).

The operational background on study areas presented below was obtained from the 2006 Removal Site Evaluation (RSE) report (Ref. 7, pp. 5–14).

- Study Area 1 (Western Sub-Aquifer)** NL Baroid Gun Club Mine operated by Hornsey Brothers — 1955–1960 (IMOP).
IMOP notes that another washer operated in this area pre-1940.
- Study Area 2 (Western Sub-Aquifer)** NL Baroid Boar's Head Lodge Mine, operated by Hornsey Brothers — about 1938–1967 (IMOP).
American Lead and Baryta also operated within this sample area, but information on dates of operation is not available at this time.
IMOP notes that another washer operated in this area pre-1940.
IMOP also notes that several lead operations opened pre-1892, and one opened in 1840. State Mine Inspectors reports for 1899–1902 and 1907–1908 include production information for sites in this area.

- Study Area 3
(Western and Eastern Sub-Aquifer)** Milchem Keyes Branch Mine — 1974–1978, closed by 1979 (USBM production records).
Milchem Settle Mine — 1961–1971, closed late 1971 (USBM production records).
Dresser — 1942–1970 (IMOP).
Magnet Cove also operated within this sample area, but information on dates of operation is not available at this time.
- Study Area 4
(Western and Eastern Sub-Aquifer)** Dresser Potosi — 1942–1978 (IMOP and USBM production records); some production may be as Magcobar.
Milchem — 1957–1980 (USBM production records).
In addition, Magnet Cove, Pfizer, American Lead and Baryta, J.E. Carter Mining Company, Mineral Point Mining Company, C.K. Williams, Ozark Mineral Company, Carter Brothers, and Eversole and McClay operated within this sample area, but information on dates of operation is unavailable at this time.
- Study Area 5
(Eastern Sub-Aquifer)** Ozark Mining Company, Ozark Minerals Company, Fredericktown Lead Company Dempsey mine — 1952–1962, originally opened 1806 (IMOP); may be earlier mining listed in USBM production records.
Lead mining was noted pre-1835 (IMOP).
- Study Area 6
(Eastern Sub-Aquifer)** Pfizer — 1943–1954 (IMOP).
Imco Apex — 1950–1964 (IMOP and USBM production records), 1980–1981 (USBM production records).
In addition, Cordia Mining Company, Carter Mining Company, C.K. Williams, and W.H. Walton operated within this sample area, but information on dates of operation is not available at this time.
- Study Area 7
(Eastern Sub-Aquifer)** Pfizer Mineral Point — 1957–1972 (IMOP and USBM production records).
C.K. Williams operated within this sample area, but information on dates of operation is not available at this time.
- Study Area 8
(Eastern Sub-Aquifer)** NL Baroid Fountain Farm Mine and Plant — 1945–1959 (Mine and Plant) (IMOP), 1968–1980 (Plant) (USBM production records). This plant likely operated between 1959 and 1968; however, reporting in the USBM production records makes this determination difficult without further study of the data.
NL Baroid Bottom Diggings — 1945–1959 (USBM production records).
NL Baroid Cadet — 1957, 1968 to an undetermined date (IMOP).
Terrace Mining Company 1947–1961 (USBM production records).
Superior Wolf — 1950 to an undetermined date (IMOP).
AW Wood AW Wood Mine — 1958–1964 (IMOP).
Dresser Mine #7 (also Wolf) — 1950 to an undetermined date (IMOP).
In addition, Buckman Laboratories, Magcobar, White Brothers, and Degonia operated in this sample area, but information on dates of operation is not available at this time.

The State Mine Inspectors report for 1891–1903 includes production figures for American Lead and Baryta and Shibboleth Lead Mining Company (opened 1811).

**Study Area 9
(Eastern Sub-
Aquifer)**

Hornsey Brothers Cadet Mine — 1966–1979 (IMOP and USBM production records).

Production is noted for another Hornsey operation in 1943 (USBM production records).

MDNR’s search of USBM production data indicated other sites based in the Potosi area, but the information was not specific enough to locate the mines without further investigation. Those sites are listed as follows:

- AW Wood — 1957, 1964–1967, likely the AW Wood mine in SA-8.
- Hornsey Brothers — 1942–1958, 1972.
- Magnet Cove — 1957–1965.
- Dresser Mineral Point — 1975–1981.

MDNR conducted investigative actions, including screening, at the site starting in and around June 2005. During its investigation, MDNR attempted to obtain access to all residential properties on or near the heavily mined areas in each study area to assess the extent of lead contamination in surface soils and ground water. Soil and ground water samples were collected at each property accessed for analysis of lead. Soil screening was conducted in accordance with the guidelines established in the Superfund Lead-Contaminated Residential Sites Handbook (Ref. 7, p. 10). Of the 358 properties screened by MDNR, 170 residences (47 percent) contained lead between 400 mg/kg and 1,200 mg/kg outside the drip zone, and 64 residences (18 percent) contained lead above 1,200 mg/kg outside the drip zone (Ref. 7, pp. 5–14).

These data are based on the highest average XRF reading for lead within the area screened at each residential property. A total of 427 ground water samples were collected during field activities associated with the MDNR investigations. Ninety-two samples (22 percent) contained lead above the regulatory action level and Maximum Contaminant Limit Goals (MCLG) on SCMD of 15 micrograms per liter (µg/L) (Ref. 6, p. 41).

Finally, an additional source type not included above but associated with the site is “contaminated soil.” As described before, a major focus of the work accomplished to date at the site includes screening of soils at residential properties for lead and performing time critical removal actions at residences where lead exceeds action levels (Refs. 6, pp. 70-73; 7, p. 19). The source of the elevated lead in the contaminated soils is not clear and may be a results of previous small hand-worked mines near the residential properties, imported contaminated soil used as fill, houses built on lands previously strip mined by mining operations, airborne dispersion of contaminants from nearby haul roads, or runoff from mine process areas or tailings piles. In some cases, homes were built on or are located near tailings piles. Although these areas of contaminated soil were not included as listed source areas in this section of the documentation record, they are present throughout the Potosi area (Ref. 6, pp. 70-73).

3.0 GROUND WATER MIGRATION PATHWAY

3.0.1 GENERAL CONSIDERATIONS

The site is located in the Salem Plateau Groundwater Province (Ref. 9, p. 6; 3) of the Ozark Plateaus geophysical province (Ref. 11, p. 1). The uppermost bedrock strata at the site are typically the Cambrian-age Eminence and Potosi dolomites; however, small remnants of the overlying Ordovician-age Gasconade and Roubidoux are present at higher elevations (Ref. 14; Figure 1 of this document). Ground water flows away from a topographic high that generally bisects the Potosi study area from north to south. This topographic high may be an aquifer discontinuity; therefore, to be conservative, the Ozark Aquifer will be evaluated both as one aquifer and as two separate sub-aquifers. For the HRS scoring purposes, the area west of the topographic high that bisects the site is referred to as Western Aquifer and the area east of the topographic high is referred to as Eastern Aquifer (Ref. 13, p. 2). The further downgradient a well is located relative to this topographic high, the more likely it is that ground water has been impacted by multiple source areas (Ref. 13, p. 3). The associated targets are also assigned as associated with Eastern or Western aquifer. The scoresheets at the front of this document reflect the single aquifer approach, and the scoresheets in Appendix A reflect the pathway score of each sub-aquifer.

The Eminence and Potosi form the Ozark Aquifer, which also includes younger Ordovician rocks such as the Gasconade and Roubidoux, which have largely been eroded in this area. Underlying the Ozark aquifer are the Derby-Doe Run Dolomite and Davis Formation these units have lower permeability and are referred to as the St. Francois confining unit. The St. Francois aquifer underlies these less permeable units and consists of the Bonneterre Dolomite and Lamotte Sandstones (Ref. 9, pp. 8, 14, 19; 14).

Bedrock in the area has been faulted upward and the overlying Ordovician-age strata have largely been removed through erosion. The Washington County soil survey indicates that solution weathering along structural features has created numerous springs, fens, caves, and related karst features in Washington County, with over 75 caves and 100 springs documented in the county (Ref. 30, p. 5). Surface and subsurface weathering of the carbonate rocks of the Ozark aquifer in the Salem Plateau has created numerous karst ground water recharge features such as sinkholes and losing streams that allow very rapid movement of water into the subsurface (Ref. 9, p. 19).

Ground Water Migration Pathway Description

Aquifer/Stratum Name #1: Ozark Aquifer—Eminence Dolomite

The Eminence dolomite varies from about 150 to 200 feet thick in Washington County and has a gradational contact with the underlying Potosi dolomite (Ref. 9, pp. 9–10). The Eminence Dolomite consists of medium- to coarsely-crystalline dolomite with mostly nodular chert (Ref. 9, p. 9–10). The Eminence is karst dolomite, and based on the HRS Section 3.1.2.4 (Table 3-6), it is assigned a hydraulic conductivity of 1×10^{-2} centimeters per second (cm/sec).

Aquifer/Stratum Name #2: Ozark Aquifer—Potosi Dolomite

The Potosi Dolomite consists of medium- to finely-crystalline dolomite with frequent quartz druse “mineral blossoms” (Ref. 10, pp. 6–7). The Potosi dolomite is approximately 250 feet thick in the area and is the major host rock for the barite and lead ores in Washington County (Ref. 14, p. 1). Dissolution, mineralization, and secondary alteration are common along structural features and associated fractures (Ref. 14, sheet 1). Based on Section 3.1.2.4 of the HRS (Table 3-6), the karst Potosi dolomite is assigned a hydraulic conductivity of 1×10^{-2} cm/sec.

The Eminence and Potosi dolomites are the lowermost units of the Ozark Aquifer system. Because the same hydraulic conductivity is assigned to these karst dolomites, it is reasonable to combine the units as a single aquifer.

Missouri Environmental Geologic Atlas (MEGA) documents the presence of karst topography in the Potosi area, revealing cave features, losing streams, sinkholes, and springs in the site area (Ref. 13, p. 2). Because dissolution and fracturing have created abundant secondary porosity in the Ozark aquifer, hydraulic properties are heterogeneous and anisotropic. Horizontal hydraulic conductivities typically range from 0.001 to 86 feet per day (ft/day), and yields range from 50 to 100 gallons per minute (gpm) (Ref. 8, p. 49). Permeable residuum coupled with karst features produce complex ground water conditions, with rapid percolation of waters to the bedrock aquifers (Ref. 8, pp. 5, 49). In south-central Missouri, municipal wells completed at depths of 950 to 1,500 feet below ground surface in the Ozark Aquifer have shown increased turbidity following rainstorms, illustrating the rapidity of the recharge from the surface (Ref. 8, p. 49). In addition, mine shafts or tunnels and deep exploratory borings could also act as conduits for ground water flow both vertically and laterally. Because of these features, ground water flow may not always follow topography or, for deeper ground water, the generally northwestern regional flow towards the Meramec River (Ref. 8, p. 45).

The Ozark aquifer is unconfined in the area, and the potentiometric surface generally mimics topography (Ref. 8, pp. 44, 45, 49). The Ozark aquifer is recharged nearly everywhere by meteoric waters, and ground water generally flows laterally from higher elevations to discharge points along springs and seeps. Ground water divides in the Ozark aquifer generally correspond to topographic divides. A major topographic ridge extends across southern Missouri, forming a regional ground water discontinuity, with water in the deep part of the aquifer flowing away from the ridge and discharging into major rivers. In Washington County, this deep ground water flow would be northwest towards the Meramec River (Ref. 8, p. 45).

Ground water is the principal source of public and private water supplies in the site area. The Ozark Aquifer is the most important aquifer in the Salem Plateau (Ref. 9, p. 19). Of the Ozark aquifer formations, the Potosi dolomite is the most prolific and reliable aquifer. In its outcrop area or where it is near surface, such as in the site area, the Potosi dolomite generally produces water at about 20 to 30 gallons per minute (Ref. 9, p. 19). The upper part of the Eminence yields 50 to 75 gpm, principally due to secondary porosity developed along fractures (Ref. 9, p. 20).

MDNR well logs for 11 private wells in the area indicate that the Eminence is the uppermost bedrock, and the rest indicate the uppermost bedrock is the Potosi. All 11 reached their total depth in the Potosi (Ref. 13, pp.8–9). Review of the well logs for the deep City of Potosi and Mineral Point public wells, indicates the base of the Ozark aquifer occurs at depths ranging from 190 to 555 feet bgs (445 to 720 feet above msl). These public wells are producing from the lower St. Francois aquifer and have cased-off the Ozark aquifer.

MDNR records for 204 certified wells (wells drilled after about 1986) in the Potosi site indicate that—with one exception—the domestic wells range in depth from 100 to 425 feet. Based on the depth to the base of the Ozark aquifer in the public wells, it is likely that all but the one certified private wells are producing from the Ozark Aquifer. Static water levels for the certified wells range from 10 feet below ground surface (bgs) to 60 feet bgs, but are typically between 20 and 40 feet bgs (Ref. 13, p. 4–8). Certified well records indicated test yields ranged from 10 to 60 gpm, with most yields of about 20 or 30 gpm. The wells identified in the MDNR well records are shown on Figures 1 and 2 in Reference 13 (Ref. 13, p. 2-3).

St. Francois Confining Unit—Elvin Group

Underlying the Ozark Aquifer is the St. Francois confining unit. This consists of the Derby-Doerun Dolomite and the Davis Formation, which together form the Elvins Group (Ref. 10, p. 3, p. 5–6). The St. Francois confining unit is saturated, but its hydraulic conductivity is generally too low to yield appreciable water (Ref. 9, p. 19). These confining units separate the Ozark aquifer from the St. Francois aquifer; however, they restrict rather prevent water interchange between the two aquifers (Ref. 9, p. 15). Penetration of the St. Francois confining unit could increase the ability of contaminants to enter the underlying St. Francois aquifer. Where both the Ozark aquifer and the St. Francois aquifer are open to a well, it is possible that water from the shallow Ozark aquifer formations infiltrates the deeper Lamotte. Because the potentiometric surface of the Ozark aquifer is generally above that of the Lamotte, the potential exists for down-hole water movement in the well during non-pumping periods (Ref. 9, p. 16).

Aquifer/Stratum Name #3: St. Francois Aquifer—Bonneterre Dolomite

The Bonneterre is a fine- to medium-crystalline dolomite, which may locally be a limestone. It generally has a low clastic content, but may contain thin shale layers or partings. Sand content increases towards the base of the Bonneterre forming a gradational contact with the underlying Lamotte sandstone. In the Salem Plateau area, the Bonneterre has an average thickness of 350 feet (Ref. 9, p. 8). The Bonneterre typically has a low hydraulic conductivity and yields only modest quantities of water (Ref. 9, p. 14).

Aquifer/Stratum Name #4: St. Francois Aquifer—Lamotte Sandstone

The Lamotte Sandstone is the oldest sedimentary rock formation in the Potosi area. It is predominantly a quartzose sand, but grades laterally to an arkosic sandstone or conglomerate. It varies in color from light gray to dark brown or red. The Lamotte unconformably overlies Precambrian basement rocks. The Lamotte ranges in thickness from about 100 feet, along the margins of the St. Francois Mountains, to over 300 feet in the western and southern parts of the Salem Plateau. It averages about 200 feet in thickness (Ref. 9, p. 8). The Lamotte Sandstone is responsible for most of the water produced from the St. Francois aquifer (Ref. 9, p. 14).

Before the hydrogeologic characteristics of Ordovician dolomites had been evaluated, it was commonly believed that only sandstones would yield sufficient water quantities for municipal supplies (Ref. 9, p. 16). Consequently, some municipal wells—such as those in Potosi and Mineral Point—were completed in the Cambrian Lamotte Sandstone (Ref. 25, pp. 9–10). This aquifer is penetrated by relatively few deep municipal wells (Ref. 9, p. 15). It is considered a moderately-yielding aquifer, with the Lamotte Sandstone responsible for most of the production (Ref. 9, p. 14).

The St. Francois aquifer is mainly used in the unconfined outcrop area around the St. Francois Mountains, where it is the only local source of ground water. This aquifer is rarely used where it is confined, because the thicker overlying Ozark Aquifer is more readily available (Ref. 8, p. 50). Horizontal hydraulic conductivities in the St. Francois aquifer range from 0.1 to 8.6 ft/day and yields range from 100 to 500 gpm (Ref. 8, p. 50). The Lamotte Sandstone is responsible for most of the water produced from the St. Francois aquifer. The overlying Bonneterre typically has low hydraulic conductivity and yields only modest quantities of water (Ref. 9, p. 14). Because the Potosi and Mineral Point municipal wells are completed as open hole below the casing depth—set into the top of the Bonneterre—the wells are likely producing water from both formations.

The St. Francois aquifer receives recharge from two general sources: down-dip movement from the outcrop region in the St. Francois Mountains, and downward movement from the overlying Ozark aquifer

(Ref. 9, p. 15). Hydraulic conductivity information for the St. Francois is scarce because wells are generally open-hole completions and produce from all formations below the required casing length—typically 80 feet (Ref 9, p. 15, 24–28; 13, pp 4–8). A lateral hydraulic conductivity of 8×10^{-5} feet per second was used for the St. Francois aquifer by researchers developing a region flow model (Ref. 9, p. 15). Well yields for St. Francois aquifer wells generally range from 70 to 125 gallons per minute (Ref. 9, p. 15). Where both the Ozark and St. Francois aquifer are open to a well, it is possible for water from the upper aquifer to migrate down the well (when it is not pumping) and enter the lower aquifer. This is because the potentiometric surface of the shallower Ozark aquifer is generally above that for the Lamotte (Ref. 9, p. 16).

SUMMARY OF AQUIFER(S) BEING EVALUATED

Aquifer No.	Aquifer Name	Is Aquifer Interconnected with Upper Aquifer within 2 miles? (Y/N/NA)	Is Aquifer Continuous within 4-mile TDL? (Y/N)	Is Aquifer Karst? (Y/N)
1	Surficial Aquifer Ozark (Eminence Dolomite)	NA	Y	Y
2	Surficial Aquifer Ozark (Potosi Dolomite)	Y	Y	Y
3	St. Francois Aquifer (Bonneterre Dolomite)	Y	Y	N
4	St. Francois Aquifer (Lamotte Sandstone)	Y	Y	N

3.1 LIKELIHOOD OF RELEASE

3.1.1 OBSERVED RELEASE

Aquifer Being Evaluated: Ozark and St. Francois

Chemical Analysis

As part of the EPA and MDNR investigations in 2005 and 2006, hundreds of ground water samples were collected from private drinking water wells in all aquifer layers at similar concentration ranges. EPA samples were submitted to the EPA Region 7 laboratory for analyses of total lead. The rationale for choosing these private well sampling locations was to document any metal contamination in the Ozark aquifer. Private wells were selected throughout the Potosi area (Ref. 7, pp. 21, 22, 31). In addition, MDNR collected private well samples that showed significantly elevated level of lead, above 15 µg/L (Ref. 6, pp. 30–36). The presence of karst topography is documented in the Potosi areas including cave features, sinkholes, and springs (Ref. 6, pp. 27–31). Penetration of the St. Francois confining unit by mine shafts, vents, and exploratory borings could increase the ability of contaminants to enter the underlying St. Francois aquifer. Where both the Ozark aquifer and the St. Francois aquifer are open to a well, it is possible that water from the shallow Ozark aquifer formations infiltrates the deeper Lamotte. Because the potentiometric surface of the Ozark aquifer is generally above that of the Lamotte, the potential exists for down-hole water movement in the well during non-pumping periods (Ref. 9, p. 16). The presence of lead contamination in Potosi municipal well #4, completed in the St. Francois aquifer, supports the interconnectivity of the Ozark and St. Francois aquifers (see Section 3.1.1 of this document). Thus, the surficial aquifer is interconnected, and the following municipal and private well samples were identified to be representative background samples.

Background Concentrations and Sample Similarity: Background wells contained no concentrations of lead. Locations of the background samples are shown on Figure 2 and 3 in Reference 17 and Reference 18, respectively. Samples were collected from the same environmental media (ground water), collected and analyzed using the same procedure and laboratory as the release samples for their respective comparisons. Therefore, the release samples compared with similar background samples. Missouri well construction regulations currently require that private wells be cased a minimum of 80 feet, with the casing set a minimum of 30 feet into unweathered bedrock (Ref. 9, pp. 24–28). Below the cased depth, the wells are open hole; consequently, water produced from the well is a composite of all water bearing units between the depth of casing and total well depth. Prior to these regulations being enacted in 1987, casing requirements were set by the Department of Health but were not enforced (Ref. 32, p. 1).

The following table presents the concentrations of metals detected in the background wells and the sample quantitation limits provided by the EPA Region 7 laboratory. All laboratory reports indicate which laboratory performed the analysis, which was either conducted in house at the EPA Region 7 laboratory or out sourced to a laboratory under the contract laboratory program (CLP) (Ref. 33, p. 1). In addition, MDNR provided reference documents indicating its analysis procedure and respective methods (Ref. 31, 1–12).

**GROUND WATER MIGRATION PATHWAY – BACKGROUND SAMPLES
FOR RESIDENTIAL AND PUBLIC WATER SUPPLY SAMPLES**

Laboratory Sample ID and Property or Well No. (Aquifer)¹	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	References
2882-131 20905 (E)	01/06/06	Lead (dissolved)	1.00 U	1.0	Unknown	Ref. 7, pp. 823–824; 13, p. 2; 15, p. 79; 16, pp. 4, 6–7, 24; 17, p. 23; 18; 26
2882-135 20854 (E)	01/06/06	Lead (dissolved)	1.00 U	1.0	Unknown	Ref. 7, pp. 811–812; 13, p. 2; 15, p. 79; 16, pp. 4, 6–7, 25; 17, p. 23; 18; 26
2882-136 20760 (E)	01/06/06	Lead (dissolved)	1.00 U	1.0	115	Ref. 7, pp. 703–704; 13, p. 2; 15, p. 79; 16, pp. 4, 6–7, 25; 17, p. 23; 18; 26
2882-138 20842 (E)	01/06/06	Lead (dissolved)	1.00 U	1.0	108	Ref. 7, pp. 799–800; 13, p. 2; 15, p. 79; 16, pp. 4, 6–7, 26; 17, p. 23; 18; 26
2882-142 20843 (E)	01/07/06	Lead (dissolved)	1.00 U	1.0	Unknown	Ref. 7, pp. 801–802; 13, p. 2; 15, p. 80; 16, pp. 4, 6–7, 27; 17, p. 24; 18; 26
2882-148 20906 (E)	01/06/06	Lead (dissolved)	1.00 U	1.0	Unknown	Ref. 7, pp. 825–826; 13, p. 2; 15, p. 81; 16, pp. 4, 6–7, 28; 17, p. 24; 18; 26
2882-150 20853 (E)	01/07/06	Lead (dissolved)	1.00 U	1.0	260	Ref. 7, pp. 809–810; 13, p. 2; 15, p. 81; 16, pp. 4, 6–7, 29; 17, p. 24; 18; 26
2882-159 20821 (E)	01/09/06	Lead (dissolved)	1.00 U	1.0	Unknown	Ref. 7, pp. 787–788; 13, p. 2; 15, p. 82; 16, pp. 4, 6–7, 31; 17, p. 24; 18; 26
2901-106 20789 (E)	01/20/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 737–738, 1293, 1295–1296, 1306; 13, p. 2; 15, p. 91; 17, p. 30; 18; 26
2901-112 20524 (E)	01/20/06	Lead (total)	1.00 U	1.0	90	Ref. 7, pp. 581–582, 1294–1296, 1307; 13, p. 2; 15, p. 92; 17, p. 30; 18; 26
2901-113 20677 (E)	01/20/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 599–600, 1294–1296, 1308; 13, p. 2; 15, p. 92; 17, p. 30; 18; 26

Laboratory Sample ID and Property or Well No. (Aquifer) ¹	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	References
2901-116 20690 (E)	01/20/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 607–608, 1294–1296, 1308; 13, p. 2; 15, p. 92; 17, p. 31; 18; 26
2901-117 20823 (E)	01/21/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 791–792, 1294–1296, 1309; 13, p. 2; 15, p. 92; 17, p. 31; 18; 26
2901-118 20822 (E)	01/21/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 789–790, 1294–1296, 1309; 13, p. 2; 15, p. 92; 17, p. 31; 18; 26
2801-112 20355 (W)	10/12/05	Lead (dissolved)	1.00 U	1.0	Unknown	Ref. 7, pp. 139–140, 1128, 1145; 13, p. 2; 15, p. 8; 17, p. 5; 18
2915-112 20973 (W)	02/01/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 401–402, 1315–1317, 1331; 13, p. 2; 15, p. 99; 17, p. 34; 18; 26
2915-113 20960 (W)	02/01/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 379–380, 1315–1317, 1331; 13, p. 2; 15, p. 99; 17, p. 34; 18; 26
2915-117 20963 (W)	02/03/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 385–386, 1315–1317, 1332; 13, p. 2; 15, p. 99; 17, p. 34; 18; 26
2915-119 20957 (W)	02/06/06	Lead (total)	1.00 U	1.0	Unknown	Ref. 7, pp. 373–374, 1315–1317, 1332; 13, p. 2; 15, p. 99; 17, p. 34; 18; 26
2915-121 20964 (W)	02/06/06	Lead (dissolved)	1.00 U	1.0	120	Ref. 7, pp. 387–388, 1315, 1333; 13, p. 2; 15, p. 100; 17, p. 34; 18; 26
		Lead (total)	1.00 U	1.0		
2915-122 20974 (W)	02/07/06	Lead (dissolved)	1.00 U	1.0	Unknown	Ref. 7, pp. 403–404, 1315, 1333; 13, p. 2; 15, p. 100; 17, p. 34; 18; 26
		Lead (total)	1.00 U	1.0		
94.E273 Potosi PWS Well # 5 (W)	07/05/1994	Lead (dissolved)	5 U	5	1,425 ft bgs -369 ft msl	13, p. 2; 22, pp. 2–10; 23; 25, pp. 10; 31, pp. 1, 4, 5, 7, 10

Laboratory Sample ID and Property or Well No. (Aquifer) ¹	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	References
97.H553 Potosi PWS Well # 5 (W)	08/12/1997	Lead (dissolved)	< 4	2.5	1,425 ft bgs -369 ft msl	
0115288 Potosi PWS Well # 5 (W)	01/16/2001	Lead (dissolved)	< 4	2.5	1,425 ft bgs -369 ft msl	
0340895 Potosi PWS Well # 5 (W)	12/17/2003	Lead (dissolved)	1 U	1	1,425 ft bgs -369 ft msl	

Notes:

* The SQLs provided in this table are referred to as reporting limits. They are the laboratory's reporting limit (also known as the method detection limit – see the method for more details) for that analyte with any dilution factor, volume adjustment, or percent solids for that sample analysis taken into account and are sometimes called the sample quantitation limit.

ID Identification
µg/L micrograms per liter
U The analyte was not detected at or above the reporting limit
1 refers to HRS subaquifer
E eastern aquifer
W western aquifer
ft bgs feet below ground surface
ft msl feet above mean sea level

Contaminated Samples

Although arsenic, barium, cadmium, and lead were found in the samples collected at the site, only lead has been used to document actual contamination for scoring purposes. Figure 2 in Reference 18 and the figure included with Reference 13 depict background and release ground water samples associated with the EPA investigations.

TABLE 3
OBSERVED RELEASE SAMPLES**

Sample ID Property or Well No. (Aquifer) ¹	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	Population Served	References
2801-103 20328 (W)	10/12/05	Lead (dissolved)	47.2 J ¹	1.0	Unknown	3	Ref. 7, pp. 283–284, 1127, 1131–1133, 1142; 13, p. 2; 15, p. 7; 17, p. 5; 18; 26
2801-108 20397 (W)	10/11/05	Lead (dissolved)	21.50 J ¹	1.0	300	4	Ref. 7, pp. 323–324, 1127, 1131–1133, 1144; 13, p. 2; 15, p. 8; 17, p. 5; 18; 26
2801-111 20321 (W)	10/11/05	Lead (dissolved)	22.1	1.0	180	2	Ref. 7 pp. 275–276, 1128, 1131–1133, 1145; 13, p. 2; 15, p. 8; 17, p. 5; 18; 26
2801-117 20344 (W)	10/11/05	Lead (dissolved)	17.3	1.0	Unknown	2	Ref. 7 pp. 295–296, 1128, 1131–1133, 1146; 13, p. 2; 15, p. 9; 17, p. 5; 18; 26
2801-121 20380 (E)	10/20/05	Lead (dissolved)	20.9	1.0	Unknown	3	Ref. 7 pp. 407–408, 1128, 1131–1133, 1147; 13, p. 2; 15, p. 9; 17, p. 5; 18; 26
2801-202 20328 (W)	10/12/05	Lead (total)	48.3 J ¹	1.0	Unknown	3	Ref. 7 pp. 283–284, 1128, 1131–1133, 1148; 13, p. 2; 15, p. 10; 17, p. 1; 18; 26
2801-209 20332 (W)	10/12/05	Lead (total)	17.2 J ¹	1.0	250	3	Ref. 7 pp. 289–290, 1128, 1131–1133, 1151; 13, p. 2; 15, p. 11; 17, p. 1; 18; 26
2801-210 20329 (W)	10/12/05	Lead (total)	58.8 J ¹	1.0	200	4	Ref. 7 pp. 285–286, 1128, 1131–1133, 1151; 13, p. 2; 15, p. 11; 17, p. 1; 18; 26

Sample ID Property or Well No. (Aquifer) ¹	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	Population Served	References
2801-211 20390 (W)	10/11/05	Lead (total)	24.1 J ¹	1.0	280	3	Ref. 7 pp. 321–322, 1128, 1131–1133, 1151; 13, p. 2; 15, p. 11; 17, p. 1; 18; 26
2801-212 20325 (W)	10/12/05	Lead (total)	47.2 J ¹	1.0	Unknown	5	Ref. 7 pp. 277–278, 1128, 1131–1133, 1152; 13, p. 2; 15, p. 11; 17, p. 1; 18; 26
2801-213 20321 (W)	10/11/05	Lead (total)	19.0 J ¹	1.0	180	2	Ref. 7 pp. 275–276, 1128, 1131–1133, 1152; 13, p. 2; 15, p. 11; 17, p. 1; 18; 26
2801-220 20344 (W)	10/11/05	Lead (total)	17.5	1.0	Unknown	2	Ref. 7 pp. 295–296, 1128, 1131–1133, 1154; 13, p. 2; 15, p. 12; 17, p. 1; 18; 26
2801-226 20327 (W)	10/12/05	Lead (total)	36.8	1.0	400	1	Ref. 7 pp. 281–282, 1129, 1131–1133, 1155; 13, p. 2; 15, p. 13; 17, p. 2; 18; 26
2801-267 20326 (W)	10/22/05	Lead (total)	28.0	1.0	Unknown	2	Ref. 7 pp. 279–280, 1129, 1131–1133, 1165; 13, p. 2; 15, p. 18; 17, p. 2; 18; 26
2801-268 20432 (E)	10/20/05	Lead (total)	16.4	1.0	Unknown	4	Ref. 7 pp. 437–438, 1128, 1131–1133, 1166; 13, p. 2; 15, p. 18; 17, p. 3; 18; 26
2801-270 20424 (W)	10/20/05	Lead (total)	43.0	1.0	300	2	Ref. 7 pp. 421–422, 1128, 1131–1133, 1166; 13, p. 2; 15, p. 18; 17, p. 3; 18; 26
2801-271 20425 (W)	10/20/05	Lead (total)	16.9	1.0	270	3	Ref. 7 pp. 423–424, 1128, 1131–1133, 1166; 13, p. 2; 15, p. 18; 17, p. 3; 18; 26
2823-101 20495 (W)	10/24/05	Lead (total)	21.5	1.0	200	11	Ref. 7 pp. 465–466, 1171, 1174–1175, 1184; 13, p. 2; 15, p. 36; 17, p. 7; 18; 26
2823-104 20427 (W)	10/24/05	Lead (total)	30.9	1.0	180	4	Ref. 7 pp. 427–428, 1171, 1174–1175, 1185; 13, p. 2; 15, p. 37; 17, p. 7; 18; 26
2823-109 20380 (E)	10/20/05	Lead (total)	15.9	1.0	Unknown	3	Ref. 7 pp. 407–408, 1171, 1174–1175, 1186; 13, p. 2; 15, p. 37; 17, p. 7; 18; 26

Sample ID Property or Well No. (Aquifer) ¹	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	Population Served	References
2823-113 20397 (W)	10/11/05	Lead (total)	23.0	1.0	300	4	Ref. 7 pp. 323–324, 1172, 1174–1175, 1187; 13, p. 2; 15, p. 38; 17, p. 7; 18; 26
2823-116 20435 (E)	10/20/05	Lead (total)	38.2	1.0	Unknown	3	Ref. 7 pp. 439–440, 1172, 1174–1175, 1188; 13, p. 2; 15, p. 38; 17, p. 7; 18; 26
2823-133 20335 (W)	10/25/05	Lead (total)	21.2	1.0	340	2	Ref. 7 pp. 291–292, 1172, 1174–1175, 1192; 13, p. 215, p. 40; 17, p. 8; 18; 26
2823-137 20455 (W)	10/26/05	Lead (total)	26.8	1.0	Unknown	1	Ref. 7 pp. 341–342, 1172, 1174–1175, 1193; 13, p. 2; 15, p. 41; 17, p. 8; 18; 26
2823-140 20508 (E)	10/26/05	Lead (total)	21.7	1.0	Unknown	9	Ref. 7 pp. 545–546, 1172, 1174–1175, 1194; 13, p. 2; 15, p. 41; 17, p. 8; 18; 26
2823-144 20503 (E)	10/26/05	Lead (total)	34.6	1.0	Unknown	3	Ref. 7 pp. 543–544, 1172, 1174–1175, 1195; 13, p. 2; 15, p. 41; 17, p. 8; 18; 26
2832-119 20410 (W)	11/16/05	Lead (total)	21.8 J ¹	1.0	Unknown	5	Ref. 7 pp. 179–180, 1203, 1205–1207, 1220; 13, p. 2; 15, p. 38; 17, p. 13; 18; 26
2832-120 20373 (W)	11/16/05	Lead (total)	21.5 J ¹	1.0	Unknown	6	Ref. 7 pp. 159–160, 1203, 1205–1207, 1221; 13, p. 2; 15, p. 39; 17, p. 13; 18; 26
2832-140 20494 (W)	11/19/05	Lead (total)	19.5 J ¹	1.0	150	4	Ref. 7 pp. 345–346, 1203, 1205–1207, 1226; 13, p. 2; 15, p. 41; 17, p. 14; 18; 26
2832-166 20465 (E)	11/22/05	Lead (total)	18.3	1.0	100	5	Ref. 7 pp. 909–910, 1204–1207, 1232; 13, p. 2; 15, p. 44; 17, p. 15; 18; 26
2863-111 20576 (E)	12/01/05	Lead (total)	39.0	1.0	Unknown	2	Ref. 7 pp. 1045–1046, 1236, 1239–1240, 1251; 13, p. 2; 15, p. 51; 17, p. 17; 18; 26
2863-116 20519 (E)	12/01/05	Lead (total)	50.2	1.0	Unknown	4	Ref. 7 pp. 979–980, 1237, 1239–1240, 1252; 13, p. 2; 15, p. 52; 17, p. 17; 18; 26

Sample ID Property or Well No. (Aquifer) ¹	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	Population Served	References
2863-134 20464 (E)	12/05/05	Lead (total)	41.3 J ¹	1.0	85	2	Ref. 7 pp. 969–970, 1237, 1239–1240, 1257; 13, p. 2; 15, p. 54; 17, p. 18; 18; 26
2863-137 20625 (E)	12/03/05	Lead (total)	18.9 J ¹	1.0	Unknown	2	Ref. 7 pp. 1071–1072, 1237, 1239–1240, 1257; 13, p. 2; 15, p. 55; 17, p. 18; 18; 26
2863-150 20471 (E)	12/06/05	Lead (total)	45.9	1.0	205	2	Ref. 7 pp. 917–918, 1237, 1239–1240, 1261; 13, p. 2; 15, p. 56; 17, p. 19; 18; 26
2863-155 20459 (E)	12/06/05	Lead (total)	73.7	1.0	100	5	Ref. 7 pp. 961–962, 1237, 1239–1240, 1262; 13, p. 2; 15, p. 57; 17, p. 19; 18; 26
2863-157 20594 (E)	12/07/05	Lead (total)	83.9	1.0	250	3	Ref. 7 pp. 1059–1060, 1237, 1239–1240, 1262; 13, p. 2; 15, p. 57; 17, p. 19; 18; 26
2863-158 20600 (E)	12/07/05	Lead (total)	41.3	1.0	Unknown	5	Ref. 7 pp. 1061–1062, 1238–1240, 1263; 13, p. 2; 15, p. 57; 17, p. 19; 18; 26
2873-103 20613 (E)	12/14/05	Lead (total)	110	1.0	200-300	2	Ref. 7 pp. 505–506, 1269, 1271, 1277; 13, p. 2; 15, p. 62; 17, p. 26; 18; 26
2873-107 20592 (E)	12/16/05	Lead (total)	34.5	1.0	Unknown	2	Ref. 7 pp. 1055–1056, 1269, 1271, 1278; 13, p. 2; 15, p. 63; 17, p. 27; 18; 26
2873-111 20637 (E)	12/08/05	Lead (total)	15.3	1.0	240	1	Ref. 7 pp. 525–526, 1269, 1271, 1279; 13, p. 2; 15, p. 63; 17, p. 27; 18; 26
2873-126 20604 (W)	12/17/05	Lead (total)	15.0	1.0	200	2	Ref. 7 pp. 495–496, 1269, 1271, 1282; 13, p. 2; 15, p. 65; 17, p. 27; 18; 26
2873-127 20603 (W)	12/17/05	Lead (total)	32.4	1.0	172	1	Ref. 7 pp. 493–494, 1270–1271, 1283; 13, p. 2; 15, p. 65; 17, p. 27; 18; 26
2873-132 20607 (E)	12/19/05	Lead (total)	16.7	1.0	200	6	Ref. 7 pp. 499–500, 1270–1271, 1284; 13, p. 2; 15, p. 66; 17, p. 28; 18; 26

Sample ID Property or Well No. (Aquifer) ¹	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	Population Served	References
2873-134 20618 (E)	12/19/05	Lead (total)	18.4	1.0	125	2	Ref. 7 pp. 513–514, 1270–1271, 1284; 13, p. 2; 15, p. 66; 17, p. 28; 18; 26
2873-138 20481 (E)	12/20/05	Lead (total)	31.9	1.0	Unknown	1	Ref. 7 pp. 541–542, 1270–1271, 1285; 13, p. 2; 15, p. 66; 17, p. 28; 18; 26
2873-140 20638 (W)	12/20/05	Lead (total)	22.3	1.0	Unknown	2	Ref. 7 pp. 351–352, 1270–1271, 1286; 13, p. 2; 15, p. 67; 17, p. 28; 18; 26
2873-141 20396 (E)	12/20/05	Lead (total)	25.2 J ¹	1.0	Unknown	4	Ref. 7 pp. 533–534, 1270–1271, 1286; 13, p. 2; 15, p. 67; 17, p. 28; 18; 26
2901-108 20701 (E)	01/20/06	Lead (total)	19.9	1.0	Unknown	4	Ref. 7 pp. 627–628, 1293, 1295–1269, 1306; 13, p. 2; 15, p. 91; 17, p. 30; 18; 26
2801-106 20291 (W)	10/12/05	Lead (dissolved)	2.53 J ¹	1.0	Unknown	1	Ref. 7 pp. 133–134, 1127, 1131–1133, 1143; 13, p. 2; 15, p. 7; 17, p. 5; 18; 26
2801-110 20272 (W)	10/10/05	Lead (dissolved)	8.17 J ¹	1.0	500	2	Ref. 7 pp. 241–242, 1128, 1131–1133, 1144; 13, p. 2; 15, p. 8; 17, p. 5; 18; 26
2801-216 20291 (W)	10/12/05	Lead (total)	14.80 J ¹	1.0	Unknown	1	Ref. 7 pp. 133–134, 1128, 1131–1133, 1153; 13, p. 2; 15, p. 12; 17, p. 1; 18; 26
2801-238 20273 (W)	10/11/05	Lead (total)	9.51 J ² (7.26)	1.0	130	2	Ref. 7 pp. 113–114, 1129, 1131–1133, 1158; 13, p. 2; 15, p. 14; 17, p. 2; 18; 26
2801-255 20272 (W)	10/10/05	Lead (total)	8.89 J ² (6.79)	1.0	500	2	Ref. 7 pp. 241–242, 1129, 1131–1133, 1162; 13, p. 2; 15, p. 16; 17, p. 2; 18; 26
2832-122 20398 (W)	11/18/05	Lead (total)	5.52 J ¹	1.0	Unknown	2	Ref. 7 pp. 325–326, 1203, 1205–1207, 1221; 13, p. 2; 15, p. 39; 17, p. 13; 18; 26

Sample ID Property or Well No. (Aquifer) ¹	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	Population Served	References
2832-129 20315 (W)	11/18/05	Lead (total)	2.76 J ¹	1.0	110	2	Ref. 7 pp. 263–264, 1203, 1205–1207, 1223; 13, p. 2; 15, p. 40; 17, p. 13; 18; 26
2832-141 20468 (W)	11/19/05	Lead (total)	3.50 J ¹	1.0	Unknown	4	Ref. 7 pp. 343–344, 1203, 1205–1207, 1226; 13, p. 2; 15, p. 41; 17, p. 14; 18; 26
2832-142 20402 (W)	11/19/05	Lead (total)	6.40 J ¹	1.0	175	5	Ref. 7 pp. 327–328, 1203, 1205–1207, 1226; 13, p. 2; 15, p. 41; 17, p. 14; 18; 26
2832-144 20386 (W)	11/19/05	Lead (total)	2.60 J ¹	1.0	165	3	Ref. 7 pp. 315–316, 1203, 1205–1207, 1227; 13, p. 2; 15, p. 41; 17, p. 14; 18; 26
2832-150 20587 (E)	11/21/05	Lead (total)	7.43 J ¹	1.0	120	1	Ref. 7 pp. 567–568, 1203, 1205–1207, 1228; 13, p. 2; 15, p. 42; 17, p. 14; 18; 26
2863-126 20513 (E)	12/05/05	Lead (total)	6.69 J ¹	1.0	Unknown	4	Ref. 7 pp. 975–976, 1237, 1239–1240, 1255; 13, p. 2; 15, p. 53; 17, p. 18; 18; 26
2863-127 20574 (E)	12/05/05	Lead (total)	10.3 J ¹	1.0	150	4	Ref. 7 pp. 1043–1044, 1237, 1239–1240, 1255; 13, p. 2; 15, p. 53; 17, p. 18; 18; 26
2863-128 20572 (E)	12/05/05	Lead (total)	3.80 J ¹	1.0	140	1	Ref. 7 pp. 1101–1102, 1237, 1239–1240, 1255; 13, p. 2; 15, p. 53; 17, p. 18; 18; 26
2863-129 20444 (E)	12/05/05	Lead (total)	2.99 J ¹	1.0	Unknown	1	Ref. 7 pp. 955–956, 1237, 1239–1240, 1255; 13; 15, p. 54; 17, p. 18; 18; 26
2863-132 20445 (E)	12/05/05	Lead (total)	10.8 J ¹	1.0	90-110	4	Ref. 7 pp. 957–958, 1237, 1239–1240, 1256; 13, p. 2; 15, p. 54; 17, p. 18; 18; 26
2915-103 20422 (W)	02/01/06	Lead (total)	10.3 J ³	1.0	Unknown	3	Ref. 7 pp. 417–418, 1314, 1316–1317, 1328; 13, p. 2; 15, p. 98; 17, p. 33; 18; 26

Sample ID Property or Well No. (Aquifer) ¹	Sampling Date or Analyzed Date	Hazardous Substance	Hazardous Substance Concentration (µg/L)	Sample Quantitation Limit* (µg/L)	Well Depth (ft bgs)	Population Served	References
2915-104 20930 (W)	02/02/06	Lead (total)	8.66 J ³	1.0	125	2	Ref. 7 pp. 367–368, 1315–1317, 1329; 13, p. 2; 15, p. 98; 17, p. 33; 18; 26
2915-106 20912 (W)	02/02/06	Lead (total)	2.95 J ³	1.0	Unknown	2	Ref. 7 pp. 359–360, 1315–1317, 1329; 13, p. 2; 15, p. 98; 17, p. 33; 18; 26
2915-107 20965 (W)	02/01/06	Lead (total)	6.57 J ³	1.0	130	4	Ref. 7 pp. 389–390, 1315–1317, 1329; 13, p. 2; 15, p. 98; 17, p. 33; 18; 26
2915-110 20959 (W)	02/02/06	Lead (total)	5.47 J ³	1.0	100	2	Ref. 7 pp. 377–378, 1315–1317, 1330; 13, p. 2; 15, p. 99; 17, p. 34; 18; 26
2915-114 20913 (W)	02/03/06	Lead (total)	3.42 J ³	1.0	47	2	Ref. 7 pp. 361–362, 1315–1317, 1331; 13, p. 2; 15, p. 99; 17, p. 34; 18; 26
0417143 Potosi PWS Well #4 (W)	02/13/04	Lead (dissolved)	12.6	1.0	1,020 ft bgs -3 ft msl	700	Ref. 13, p. 2; 21, pp. 2–5; 23; 24, p. 1; 25, p. 9; 31, pp. 1–2, 4

Notes:

* The SQLs provided in this table are referred to as reporting limits in Reference 43. They are the laboratory’s reporting limit (also known as the method detection limit – see the method for more details) for that analyte with any dilution factor, volume adjustment, or percent solids for that sample analysis taken into account and are sometimes called the sample quantitation limit.

** Please see Reference 13 Geology Map figure 1 for sub-aquifer specific sample locations considered for scoring purposes (Ref. 13, p. 2)

J¹ The analyte has been positively identified in the sample; however the reported value is an estimate due to serial percent dilution being above the control limit. The reported value may be biased low. Therefore, even if the value was adjusted to a higher value to compensate for the bias, it would still meet the observed release criteria.

J² The analyte has been positively identified in the sample; however the reported value is an estimate due to poor precision obtained with this analyte in the laboratory duplicate sample. The reported value is biased unknown. Values adjusted in accordance with EPA factsheet “Using Qualified Data to Document an Observed Release and Observed Contamination are presented in parentheses.

J³ The analyte has been positively identified in the sample; however the reported value is an estimate due to the peak width at 10% peak height exceeding 0.80 amu in the ICP-MS tune. The reported value may be biased low. Therefore, even if the value was adjusted to a higher value to compensate for the bias, it would still meet the observed release criteria.

µg/L micrograms per liter

1 refers to HRS subaquifer

E eastern aquifer
W western aquifer
ft bgs feet below ground surface
ft msl feet above mean sea level

Attribution

Lead mining in the Potosi area of Washington County has a long history dating back to the early 1700s. Potosi is located in the region known as the Old Lead Belt, where large-scale mining occurred in Washington, Madison, and St. Francois Counties. The lead mineralization occurs in fractured bedrock and in red clay residuum derived chiefly from the Cambrian Potosi and Eminence dolomites. Miners recovered lead from both residuum and shafts that extended into the bedrock. Continuous mining in the Potosi area began at Mine Renault—just north of Potosi—in 1721 with the use of slave labor. Mine Renault produced as much as 1,500 pounds of ore per day. Many small mines opened and closed during this time, with continuous production for the first 20 years and intermittent production until 1799. Figure 2 in Reference 13 shows the abundance of mined lands and IMOP database entries in the Potosi area.

Prior to 1799, miners, to this point, had recovered galena by hand mining and cleaning from shallow pits less than 10 feet deep. It was not until 1799, when Moses Austin sank a shaft to a depth of 80 feet and erected a reverberatory furnace that lead mining began to develop on a larger scale. This mining process continued until shortly after 1900. Beginning in 1904, the Point Mining and Milling Company used a steam shovel and wet-process mill. Around 1924, the Eagle-Picher Company and National Pigments and Chemical Company began production by stripping residuum and processing the material in a washer and jig plant. Mining operations shifted from hand mining to mechanized mining during this period and continued until 1942. After 1942, lead was mined by removing residuum with mechanized shovels and front-end loaders. The residuum was loaded into trucks and hauled to washers, where clay was removed with high-pressure water in a rotary breaker. This procedure separated the rock by breaking it into smaller pieces. The mined material was then passed through log washers that removed even more clay and separated the mined material. Subsequently, it passed through trammels and onto jigs, where material was separated by weight. Finally, lead and barite were separated from any remaining waste rock (Ref. 7, pp. 5–23).

Barite mining did not occur in the Potosi area until post-Civil War time. Before this time, barite was placed in waste piles when lead was recovered. Barite mineralization occurs mostly in red clay residuum, also derived from the Cambrian Potosi and Eminence dolomites. The clay residuum is generally located several inches to 3 or 4 feet below barren soil overburden. The average thickness of the residuum ranges from a few feet to more than 30 feet. Barite mining started because it was found to be a long-lasting white pigment. Later, barite was discovered to be a useful weighting agent in oil drilling. During the 1900s, Washington County was the world leader in barite production. Many of the large mining operations reworked land that experienced hand mining for lead or barite. Considerable ore was usually left behind between pits and shafts (Ref. 7, pp. 5–23).

MDNR conducted investigations at the site in June 2005. During this investigation, MDNR attempted to obtain access to all residential properties on or near the heavily mined areas in each study area to assess the extent of lead contamination in surface soils and ground water. Soil and ground water samples were collected at each property accessed for analysis of lead. MDNR data suggested area-wide ground water contaminated with lead at the site (Ref. 6, pp. 5–93).

A total of 174 ground water samples were collected during field activities for the PA/SI. Thirty-seven samples (21 percent) contained lead above the regulatory action level of 15 µg/L. Lead concentrations in these samples ranged from 15.1 to 92.8 µg/L. Barium was detected in three samples at levels that exceed the maximum contaminant level (MCL) of 2,000 µg/L. These barium results ranged from 2,090 to 2,230 µg/L. Cadmium was detected above its MCL of 5 µg/L in one sample, at a concentration of 5.73 µg/L (Ref. 7, pp. 5–4).

EPA conducted a RSE from September 2005 through February 2006. The RSE objective was to further define the extent of lead contamination in surface soils and ground water at the site. During these investigations, a total of 1,280 residential properties were screened. Of this total, 675 properties (53 percent) contained lead in surface soils at concentrations below the EPA Region 9 preliminary remediation goal (PRG) of 400 parts per million (ppm), 24 properties (2 percent) contained lead above 400 ppm only in the drip zone, 446 residences (35 percent) contained lead between 400 ppm and 1,200 ppm outside the drip zone, and 135 residences (10 percent) contained lead above 1,200 ppm outside the drip zone. The highest concentration of lead detected in residential surface soils at the site was 10,633 ppm. These data are based on the highest average XRF reading for lead within the area screened at each residential property (Ref. 7, pp. 5–23).

As discussed earlier in multiple sections, lead and mineral mining in the Potosi area of Washington County has a long history dating back hundreds of years. Early miners tossed the barite aside into waste piles, as it originally had few uses. It became valuable after the Civil War, when it was used as a long-lasting white pigment. Barite mining boomed in 1926, when the mineral was discovered to be a useful weighting agent in oil drilling mud (Ref. 20, pp. 1–2). The production of barite in Washington County started to decline in 1985 because of competition in Nevada and overseas (Ref. 20, p. 1). Commercial mining operations created large piles of mining wastes (Ref., p. 2). The release wells presented above are located down-gradient of the possible sources and contain elevated concentrations of lead (see Section 3.1.1 of this document; Refs. 18 and 29). The occurrence of these metals in the ground water samples is at least partially attributed to the tailings piles. Some of the metals in the ground water may be naturally occurring; however, there are a significant number of wells located up-gradient of the evaluated sources that contain low levels, or no levels of lead, which indicates the naturally occurring levels of barium and lead are significant less than what is found in the vicinity of the source areas. Ground water in the Potosi area has been divided into two areas based on flow away from a topographic high that generally bisects the area north to south. The further downgradient a well is located relative to this topographic high, the more likely it is that ground water has been impacted by multiple source areas (Refs. 13, p. 3). Because there are multiple sources upgradient of contaminated target wells, it is unfeasible to associate release to any one source. The ground water plumes currently are uncontained, and thus present a threat to nearby human health and the environment.

Hazardous Substances Released: Lead

Ground Water Observed Release Factor Value: 550

3.1.2 POTENTIAL TO RELEASE

Not Evaluated.

3.2 WASTE CHARACTERISTICS

3.2.1 TOXICITY/MOBILITY

Hazardous Substance	Source No.	Toxicity Factor Value	Mobility Factor Value	Does Haz. Substance Meet Observed Release? (Y/N)	Toxicity/Mobility (Table 3-9)	Reference
Lead	1	10,000	1	Yes	10,000	2, p. BI-8

Toxicity/Mobility Factor Value: 10,000
(Ref. 1, Table 3-9)

3.2.2 HAZARDOUS WASTE QUANTITY

Source No.	Source Type	Source Hazardous Waste Quantity
1	Ground Water Plume with no single identified Source	> 0, but unknown

The HRS states that if the hazardous constituent quantity is not adequately determined for one or more sources then assign a factor value of 100 if any target for that migration pathway is subject to Level I or Level II (Ref. 1, Section 2.4.2.2). As there are Level I and Level II targets for this pathway (see Section 3.3 of this document), 100 will be assigned as the hazardous waste quantity factor value.

Sum of Values: > 0
Hazardous Waste Quantity Factor Value: 100
(Ref. 1, Table 2-6)

3.2.3 WASTE CHARACTERISTICS FACTOR CATEGORY VALUE

As specified in the HRS (Ref. 1, Section 3.2.3), the Hazardous Waste Quantity Factor Value of 100 is multiplied by the highest toxicity/mobility value of 10,000 for lead, resulting in a product of 1,000,000 (1.0E+06). Based on this product, a waste characteristics factor value (WCFV) of 32 is assigned from Table 2-7 of the HRS Rule (Ref., Section 2.4.3.1).

Toxicity/Mobility Factor Value: 10,000
Hazardous Waste Quantity Factor Value: 100

Toxicity/Mobility Factor Value X Hazardous Waste Quantity Factor Value: 1,000,000
Waste Characteristics Factor Category Value: 32
(Table 2-7)

3.3 TARGETS

3.3.1 NEAREST WELL

The following nearest well contains contamination that meets the observed release criteria, and the lead concentration is above the HRS health-based benchmark of 15 µg/L (MCL/MCLG) (See Section 3.1.1 of this document; Refs. 1, Table 2-3, 3-10; 2, p. 9).

Well ID: **2873-103**

Level of Contamination (I, II, or potential): I

Nearest Well Factor Value: 50
(Ref. 1, Table 3-11; Section 3.1.1 of this document)

3.3.2 POPULATION

3.3.2.1 Level of Contamination

3.3.2.2 Level I Targets (concentrations associated with Level I targets are presented in Section 3.1.1 of this document)

The following targets obtain drinking water from wells that contained one or more analytes at concentrations that meet the observed release criteria and are above an HRS health-based benchmark; specifically, lead above its MCL/MCLG of 15 (µg/L) (Ref. 1, Table 2-3, Table 3-10, and Section 3.1.1).

Sample ID Number	Aquifer No.	Population Served	Reference
2801-103 W	1	3	Ref. 7, pp. 283–284
2801-108 W	1	4	Ref. 7, pp. 323–324
2801-111 W	1	2	Ref. 7 pp. 275–276
2801-117 W	1	2	Ref. 7 pp. 295–296
2801-121 E	1	3	Ref. 7 pp. 407–408
2801-202 W	1	3	Ref. 7 pp. 283–284
2801-209 W	1	3	Ref. 7 pp. 289–290
2801-210 W	1	4	Ref. 7 pp. 285–286
2801-211 W	1	3	Ref. 7 pp. 321–322
2801-212 W	1	5	Ref. 7 pp. 277–278
2801-213 W	1	2	Ref. 7 pp. 275–276
2801-220 W	1	2	Ref. 7 pp. 295–296
2801-226 W	1	1	Ref. 7 pp. 281–282
2801-267 W	1	2	Ref. 7 pp. 279–280
2801-268 E	1	4	Ref. 7 pp. 437–438
2801-270 W	1	2	Ref. 7 pp. 421–422
2801-271 W	1	3	Ref. 7 pp. 423–424
2823-101 W	1	11	Ref. 7 pp. 465–466
2823-104 W	1	4	Ref. 7 pp. 427–428
2823-109 E	1	3	Ref. 7 pp. 407–408
2823-113 W	1	4	Ref. 7 pp. 323–324
2823-116 E	1	3	Ref. 7 pp. 439–440
2823-133 W	1	2	Ref. 7 pp. 291–292
2823-137 W	1	1	Ref. 7 pp. 341–342
2823-140 E	1	9	Ref. 7 pp. 545–546
2823-144 E	1	3	Ref. 7 pp. 543–544

Sample ID Number	Aquifer No.	Population Served	Reference
2832-119 W	1	5	Ref. 7 pp. 179–180
2832-120 W	1	6	Ref. 7 pp. 159–160
2832-140 W	1	4	Ref. 7 pp. 345–346
2832-166 E	1	5	Ref. 7 pp. 909–910
2863-111 E	1	2	Ref. 7 pp. 1045–1046
2863-116 E	1	4	Ref. 7 pp. 979–980
2863-134 E	1	2	Ref. 7 pp. 969–970
2863-137 E	1	2	Ref. 7 pp. 1071–1072
2863-150 E	1	2	Ref. 7 pp. 917–918
2863-155 E	1	5	Ref. 7 pp. 961–962
2863-157 E	1	3	Ref. 7 pp. 1059–1060
2863-158 E	1	5	Ref. 7 pp. 1061–1062
2873-103 E	1	2	Ref. 7 pp. 505–506
2873-107 E	1	2	Ref. 7 pp. 1055–1056
2873-111 E	1	1	Ref. 7 pp. 525–526
2873-126 W	1	2	Ref. 7 pp. 495–496
2873-127 W	1	1	Ref. 7 pp. 493–494
2873-132 W	1	6	Ref. 7 pp. 499–500
2873-134 E	1	2	Ref. 7 pp. 513–514
2873-138 E	1	1	Ref. 7 pp. 541–542
2873-140 W	1	2	Ref. 7 pp. 351–352
2873-141 E	1	4	Ref. 7 pp. 533–534
2901-108 E	1	2	Ref. 7, pp. 627–628

Sum of Population Served by Level I Wells: 158
Western sub-aquifer: 89
Eastern sub-aquifer: 69

Sum of Population Served by Level I Wells x 10: 1,580
Western sub-aquifer: 890
Eastern sub-aquifer: 670

Level I Concentrations Factor Value: 1,580
Level I Concentrations Factor Value (western sub-aquifer): 890
Level I Concentrations Factor Value (eastern sub-aquifer): 670

3.3.2.3 Level II Targets (concentrations associated with Level II targets are presented in Section 3.1.1)

The following targets obtain drinking water from wells that contained one or more analytes at concentrations that meet the observed release criteria and are not above an HRS health-based benchmark (Ref. 1, Table 2-3, Table 3-10, and Section 3.1.1).

Sample ID No.	Aquifer	Population Served	References
0417143 (Potosi PWS Well #4) W	1	700	Ref. 24, p. 1

Sample ID No.	Aquifer	Population Served	References
2801-106 W	1	1	Ref. 7 pp. 133–134
2801-110 W	1	2	Ref. 7 pp. 241–242
2801-216 W	1	1	Ref. 7 pp. 133–134
2801-238 W	1	2	Ref. 7 pp. 113–114
2801-255 W	1	2	Ref. 7 pp. 241–242
2832-122 W	1	2	Ref. 7 pp. 325–326
2832-129 W	1	2	Ref. 7 pp. 263–264
2832-141 W	1	4	Ref. 7 pp. 343–344
2832-142 W	1	5	Ref. 7 pp. 327–328
2832-144 W	1	3	Ref. 7 pp. 315–316
2832-150 E	1	1	Ref. 7 pp. 567–568
2863-126 E	1	4	Ref. 7 pp. 975–976
2863-127 E	1	4	Ref. 7 pp. 1043–1044
2863-128 E	1	1	Ref. 7 pp. 1101–1102
2863-129 E	1	1	Ref. 7 pp. 955–956
2863-132 E	1	3	Ref. 7, pp. 957–958
2915-103 W	1	3	Ref. 7 pp. 957–958
2915-104 W	1	2	Ref. 7 pp. 417–418
2915-106 W	1	2	Ref. 7 pp. 367–368
2915-107 W	1	4	Ref. 7 pp. 359–360
2915-110 W	1	2	Ref. 7 pp. 389–390
2915-114 W	1	2	Ref. 7 pp. 377–378

Sum of Population Served by Level II Wells: 753

Western sub-aquifer: 739

Eastern sub-aquifer: 14

Sum of Population Served by Level II Wells x 1: 753

Western sub-aquifer: 739

Eastern sub-aquifer: 14

Level II Concentrations Factor Value: 753

Level II Concentrations Factor Value (Sub-Aquifer 1): 739

Level II Concentrations Factor Value (Sub-Aquifer 2): 14

3.3.2.4 Potential Contamination

Not Scored.

3.3.3 RESOURCES

Not Scored.

Resources Factor Value:

3.3.4 WELLHEAD PROTECTION AREA

Not Scored.

Wellhead Protection Area Factor Value:

4.0 SURFACE WATER MIGRATION PATHWAY

Not Scored.

5.0 SOIL EXPOSURE PATHWAY

Not Scored.

6.0 AIR MIGRATION PATHWAY

Not Scored.

APPENDIX A
SUB-AQUIFER SCORESHEETS

TABLE 3-1.—GROUND WATER MIGRATION PATHWAY SCORESHEET

EASTERN SUB-AQUIFER

Factor Categories and Factors		Maximum Value	Value Assigned
Likelihood of Release to an Aquifer:			
1.	Observed Release:	550	550
2.	Potential to Release:		
2a.	Containment	10	Not Scored
2b.	Net Precipitation	10	Not Scored
2c.	Depth to Aquifer	5	Not Scored
2d.	Travel Time	35	Not Scored
2e.	Potential to Release [lines 2a x (2b + 2c + 2d)]	500	Not Scored
3.	Likelihood of Release (higher of lines 1 and 2e)	550	550
Waste Characteristics:			
4.	Toxicity/Mobility	a	10,000
5.	Hazardous Waste Quantity	a	100
6.	Waste Characteristics	100	32
Targets:			
7.	Nearest Well	50	50
8.	Population:		
8a.	Level I Concentrations	b	670
8b.	Level II Concentrations	b	11
8c.	Potential Contamination	b	Not Scored
8d.	Population (lines 8a + 8b + 8c)	b	681
9.	Resources	5	Not Scored
10.	Wellhead Protection Area	20	Not Scored
11.	Targets (lines 7 + 8d + 9 + 10)	b	731
GROUND WATER MIGRATION SOURCE FOR AN AQUIFER			
12.	Aquifer Source [(lines 3 x 6 x 11)/82,500] ^c	100	100
GROUND WATER MIGRATION PATHWAY SCORE			
13.	Pathway Score (S_{gw}), (highest value from line 12 for all aquifers evaluated) ^c	100	100

Notes:

- ^a Maximum value applies to waste characteristics category
- ^b Maximum value not applicable
- ^c Do not round to nearest integer

TABLE 3-1.—GROUND WATER MIGRATION PATHWAY SCORESHEET

WESTERN SUB-AQUIFER

Factor Categories and Factors	Maximum Value	Value Assigned
Likelihood of Release to an Aquifer:		
1. Observed Release:	550	550
2. Potential to Release:		
2a. Containment	10	Not Scored
2b. Net Precipitation	10	Not Scored
2c. Depth to Aquifer	5	Not Scored
2d. Travel Time	35	Not Scored
2e. Potential to Release [(lines 2a x (2b + 2c + 2d))]	500	Not Scored
3. Likelihood of Release (higher of lines 1 and 2e)	550	550
Waste Characteristics:		
4. Toxicity/Mobility	a	10,000
5. Hazardous Waste Quantity	a	100
6. Waste Characteristics	100	32
Targets:		
7. Nearest Well	50	50
8. Population:		
8a. Level I Concentrations	b	890
8b. Level II Concentrations	b	739
8c. Potential Contamination	b	Not Scored
8d. Population (lines 8a + 8b + 8c)	b	1,629
9. Resources	5	Not Scored
10. Wellhead Protection Area	20	Not Scored
11. Targets (lines 7 + 8d + 9 + 10)	b	1,679
GROUND WATER MIGRATION SOURCE FOR AN AQUIFER		
12. Aquifer Source [(lines 3 x 6 x 11)/82,500] ^c	100	100
GROUND WATER MIGRATION PATHWAY SCORE		
13. Pathway Score (S_{gw}), (highest value from line 12 for all aquifers evaluated) ^c	100	100

Notes:

- ^a Maximum value applies to waste characteristics category
- ^b Maximum value not applicable
- ^c Do not round to nearest integer