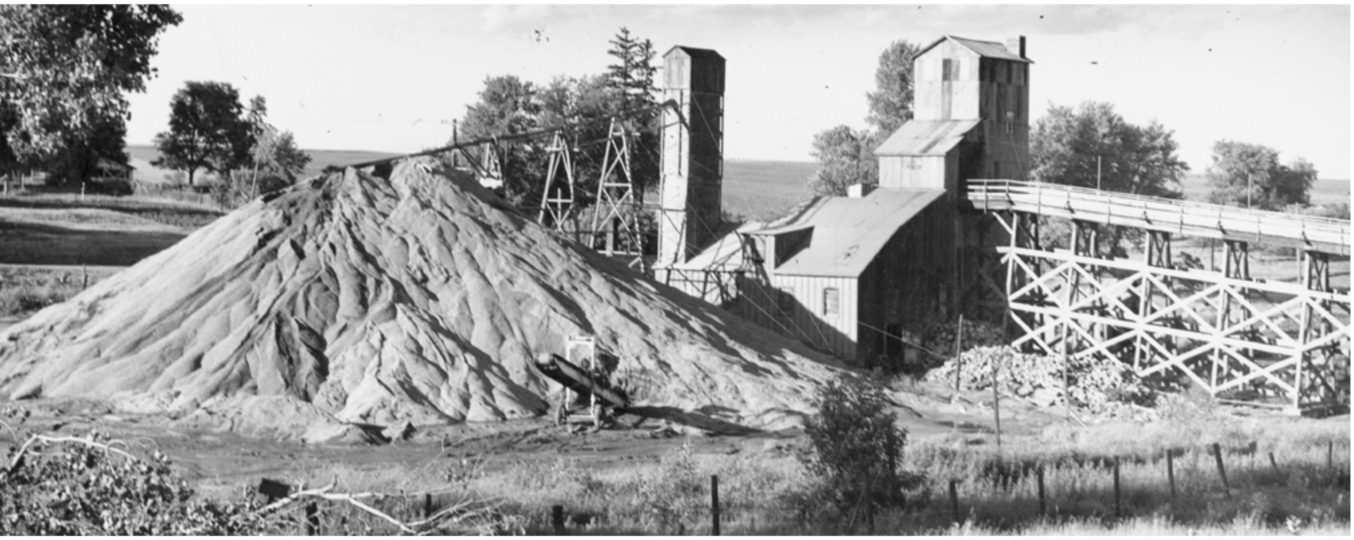
G4177

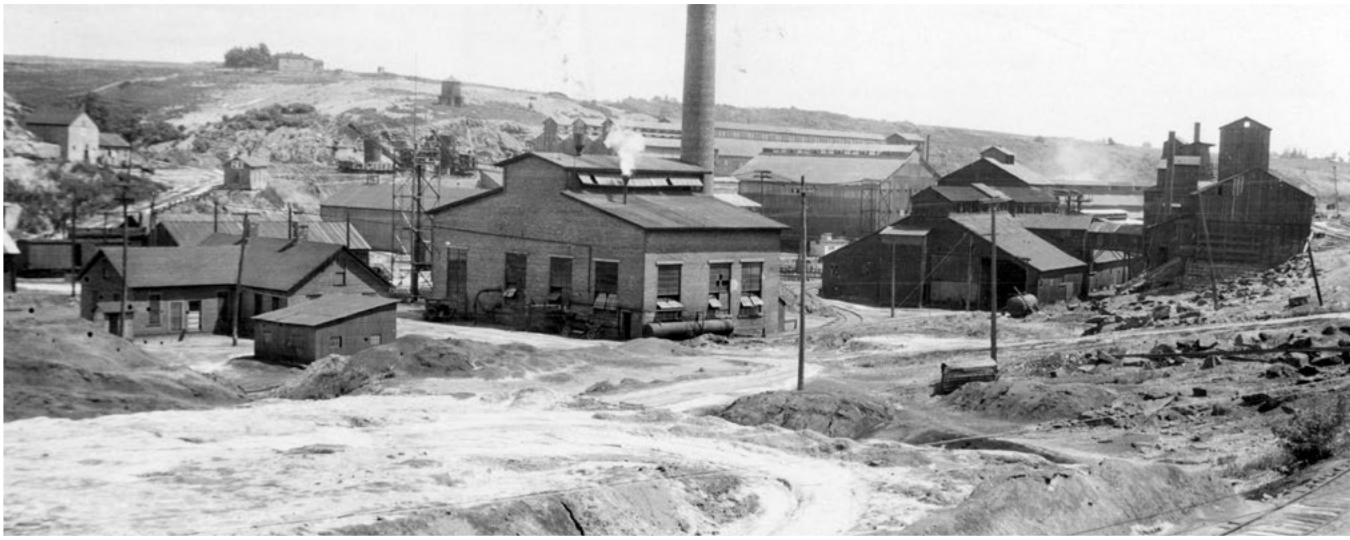


Wisconsin Historical Society, image 37743.

DIGITAL ATLAS

of Historic Mining Activity in Southwestern Wisconsin

Kyle Pepp, Geoffrey Siemering, Steve Ventura



Wisconsin Historical Society, image 38320.

Extension
UNIVERSITY OF WISCONSIN–MADISON

Southwestern Wisconsin is well-known for its rich history in mining. Unfortunately, poor waste rock handling during mine operation, inadequate remediation after mine closure, and recent disturbance of ore or tailings continue to negatively affect human and environmental health throughout the region.

CONTENTS

Historic mine feature and contamination heat maps

On the cover

Wisconsin Historical Society, image 37743 (top): Lead and zinc mine near Dodgeville, WI, 1945.

Wisconsin Historical Society, image 38320 (bottom): Zinc mining operation in Mineral Point, WI, 1915.

This report integrates historic mining information with current land use records to provide tools for regional planning, development, and site remediation. As historic records are used, exact feature locations should be confirmed prior to disturbing soil. Contamination heat maps are provided for each county and their major population centers. These heat maps do not indicate the known presence of soil contaminants, but only indicate an increased likelihood for contamination based on site history.

History

Mining began in the Upper Mississippi River Valley lead and zinc district (figure 1) as early as the 1690s by Native Americans and was continued by French colonists who predominantly mined surface lead deposits (Heyl et al. 1959). Little documentation is available before 1820, but from 1830 to 1871, the mining district was by far the most important lead-producing region in the United States (Heyl et al. 1959). After the 1870s, lead production declined and transitioned to zinc with peak production taking place during times of war. Production ceased in 1979, leaving behind more than 2,000 small mining sites over four counties in southwestern Wisconsin (Grant, Green, Iowa, and Lafayette) and one county in Illinois (Jo Daviess). Figures 2 and 3 show historic lead and zinc production.

Lead ore was primarily mined near the surface while zinc ore was mined deeper underground. Ore was crushed into gravel-sized particles and sorted using gravity and alternating water currents to filter particles over a mesh screen. This produced waste rock (tailings), concentrated ore, and highly concentrated ore. The highly concentrated ore was directly processed via roasting to produce metal. The less concentrated ore required further refinement through

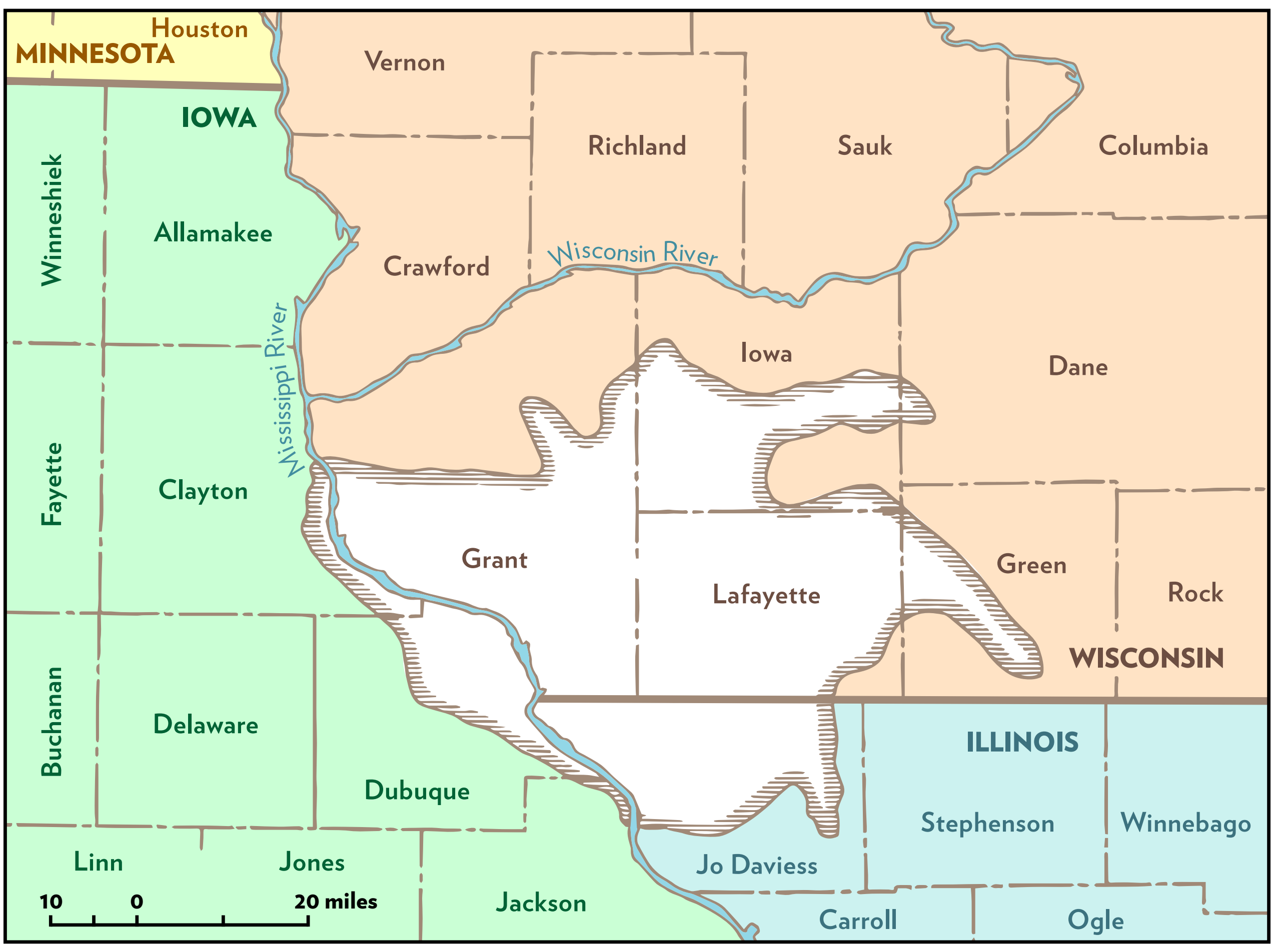


FIGURE 1. **Approximately 4,000 square miles of hilly, unglaciated terrain spanning Illinois, Iowa, and Wisconsin make up the historic lead and zinc mining district of the Upper Mississippi River Valley.**

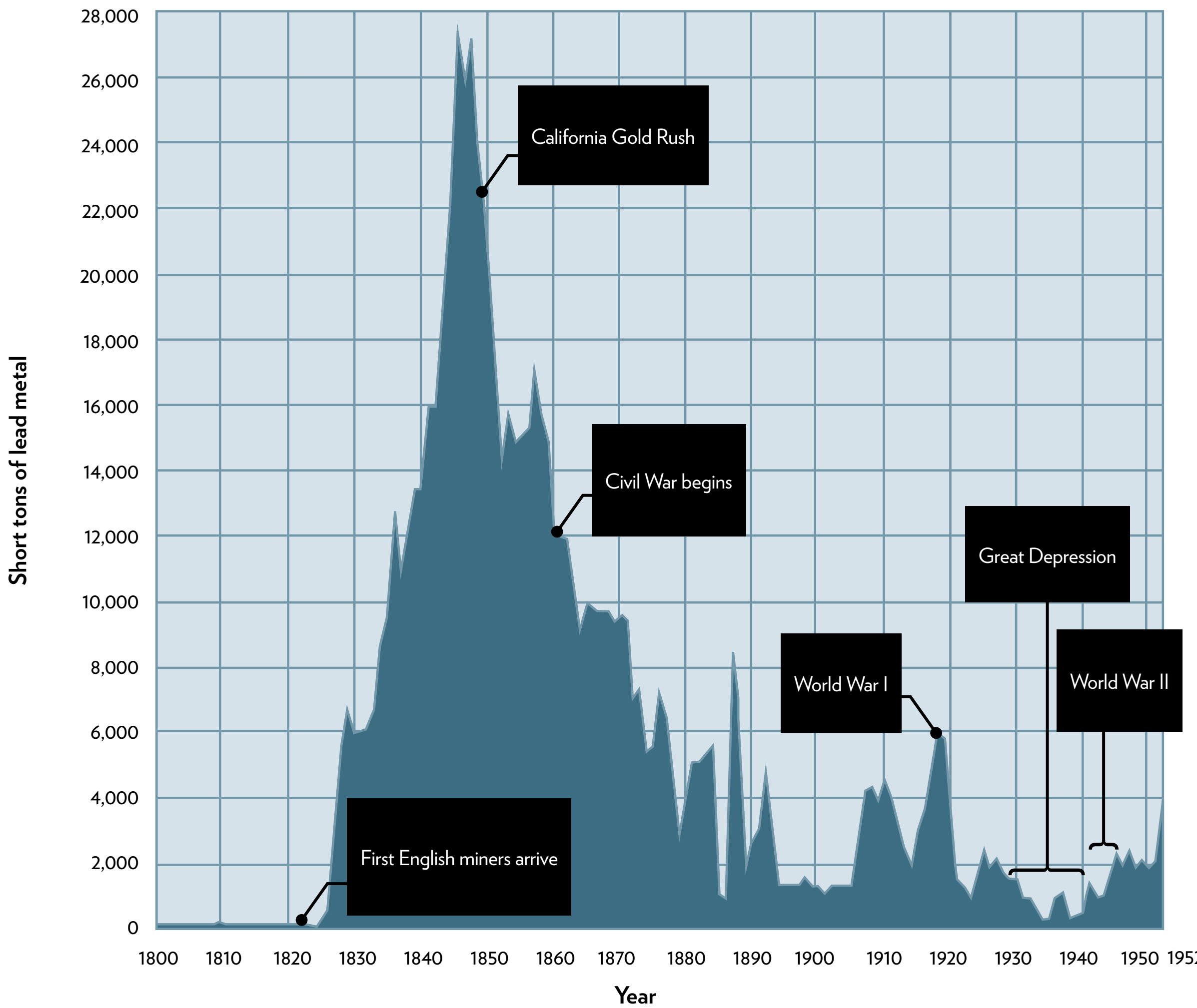


FIGURE 2. **Lead extraction in short tons from 1800 to 1952.**

magnetic separation or froth flotation at centralized processing sites such as those located in Mineral Point and Shullsburg. Roasting took place off-site at a limited number of locations or on railcar-mounted roasters (Tom Hunt, personal communication).

Tailings were piled at the head of a slope near the shafts where the gravity sorting was performed. These tailing piles existed at virtually every mine site and were typically left behind once the mine ceased operation. This material was known to be scavenged for local building projects where crushed rock was needed (e.g., roadbeds and building foundations), although a considerable amount of material was transported downslope by gravity, where it remained unless subsequently excavated (Cashell 1980). Tailings from zinc and lead operations contain high amounts of both metals and are equally hazardous to human health and the environment.

Because mining was the primary economic activity of the region, workers often settled in sites directly adjacent to mines that bore metal-contaminated soil. While zinc occurs naturally in soil and is a trace element essential for human health, high concentrations can negatively impact plants, soil, and water. Zinc can increase water acidity, bioaccumulate in food chains, contaminate groundwater, kill plants, and interrupt soil activity by hindering organisms that breakdown organic matter (Wuana & Okieimen 2011). Unlike zinc, lead is not essential for human health and has numerous negative health implications for the brain, nervous system, red blood cells, and kidneys. Exposure to lead-contaminated soil can happen through direct ingestion of soil, soil deposits on plants, water contamination, and ingestion of plants that have assimilated lead; though plants do not generally uptake lead unless soil is highly contaminated (Wuana & Okieimen 2011).

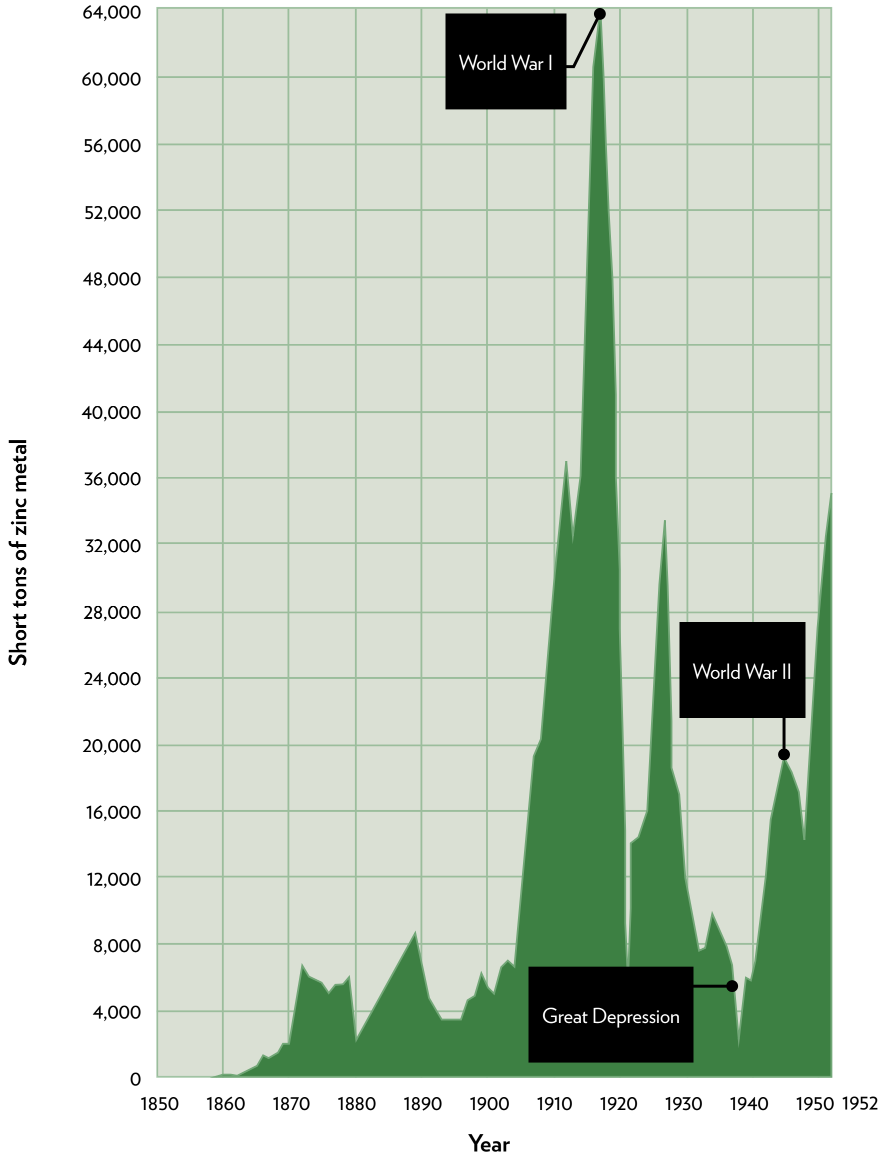


FIGURE 3. **Zinc extraction in short tons from 1800 to 1952.**

Wisconsin Mineral Development Atlas

The Wisconsin Mineral Development Atlas (MDA) of the Upper Mississippi River Valley lead and zinc district was conceived and structured in 1945 through combined efforts of the U.S. Bureau of Mines, the U.S. Geological Survey (USGS), and the State Geological Surveys of Illinois, Iowa, and Wisconsin. The atlas was created by collecting data from mining operations, including exploration, development, planned mines, and detailed logs sufficient to evaluate mineral potential at any site where work had been done. Visual data was organized by county in "MDA sheets" and one square mile Public Land Survey System (PLSS) sections. In Wisconsin, with the exception of five MDA sections in Dane County, virtually all the atlas is within Grant, Green, Iowa, and Lafayette Counties.

MDA sheets were georeferenced using PLSS section corners for use in geographic information systems (GIS). In most cases, boreholes and mine sites have associated drilling information contained in the official copy of the Wisconsin MDA housed at the **Wisconsin Geologic and Natural History Survey (WGNHS)** in Madison, Wisconsin. The atlas is supplemented by the U.S. Geological Survey's Professional Paper 309, *The Geology of the Upper Mississippi Valley Zinc-Lead District*, accessible at **https://pubs.er.usgs.gov/publication/pp309**.

The digitized Atlas

In an effort by the Department of Soil Science at the University of Wisconsin–Madison and Grant, Green, Iowa, and Lafayette Counties, the georeferenced MDA sheets were digitized into shapefiles to improve analysis and visualization. Digitized data are broken into the following layer types: abandoned railroads, boreholes, hazards, lead digs, open activity, shafts, surveyed workings, unsurveyed workings, and no MDA sheet. In addition to MDA sheets, 2011 5-foot resolution light detection and ranging (lidar) hillshade imagery provided by WGNHS, 2015 National Agriculture Imagery Program (NAIP) orthophotos, and USGS's Prospect- and Mine-Related Features (24,000 points) were used to identify features. The Atlas did not provide coherent and detailed definitions for each feature, so some interpretation was necessary. Individual shapefiles are available for Grant, Green, Iowa, and Lafayette Counties as well as combined shapefiles for the entire region. The MDA GIS files are stored at WGNHS. **SnapMaps**, online maps for nutrient management planning in Wisconsin, includes all surface historic mine features from this publication for Grant, Green, Iowa, and Lafayette Counties.

Mine feature definitions

_aban_rail are abandoned railroad lines identified from MDA sheets and substantial visual inspection of 2011 hillshade imagery (including areas with no MDA sheets). 2015 NAIP orthophotos were used for additional confirmation.

_boreholes are all drill holes excluding water wells and mine shafts. Some of the densely mined areas have multiple overlapping layers with minor georeferencing discrepancies; in these cases, the more detailed sheet was used. Original MDA sheets include "degree of mineralization"; this information was not retained. Moreover, most drill holes have an associated core sample with stratigraphy and mineralization details that can be accessed through WGNHS.

_hazards are unique sites with individual labeling in their attribute table.

_lead_digs are sites identified primarily by MDA sheets with additional visual inspection of 2011 hillshade imagery where lead (and other minerals) were obtained on or near the ground surface. 2015 NAIP orthophotos were used for additional confirmation.

_open_activity includes open pit mines, historic quarries, prospecting sites, and some modern quarries. MDA sheets, 2011 hillshade imagery, 2015 NAIP orthophotos, and USGS's Prospect- and Mine-Related Features (24,000 points) were all used to identify these features.

_shafts were identified exclusively by MDA sheets and include all deep mine shafts for underground mines and mine openings associated with surficial lead mining.

_surveyed_workings should be interpreted primarily as detailed, underground zinc mines. The definitions provided by the Atlas for these features are "mine workings" and "surveyed mine workings—outline of excavation."

_unsurveyed_workings should be interpreted as underground zinc mines that lack some or considerable detail, or any other bona fide mine site that lacks detailed information. If a mine site was named but not outlined, this was also captured in the layer. The Atlas's definition for this feature is "unsurveyed workings or workings that are subject to question" and "unsurveyed mine workings—outline of excavation."

_no_mda_sheet are areas that do not have MDA sheets. It should not be assumed that these areas are free from mine activity.

Contamination heat map methodology

To make visualizing contamination simpler, a heat map was created using a GIS weighted overlay analysis. The analysis incorporated proximity to mapped mine features and professional judgement of likely contamination weight and buffer distance to produce a general map where elevated soil contaminant levels may be found. These heat maps do not indicate the known presence of soil contaminants, but only indicate an increased likelihood for contamination based on site history.

The analysis should be considered very coarse as it does not account for any soil movement resulting from natural processes like water or wind erosion, nor reuse of materials for secondary purposes such as roadbeds. The analysis was performed in ArcMap using a 50-foot raster cell, following the procedure shown in figure 4 with the buffer distances and weights displayed in table 1.

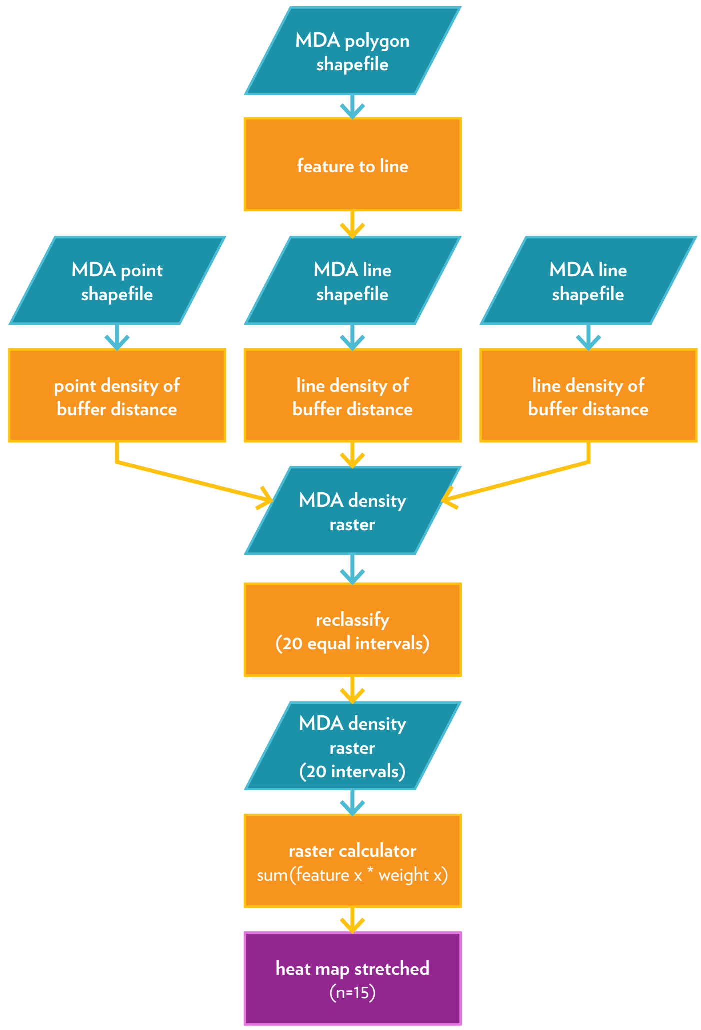


FIGURE 4. Contamination heat map analysis procedure.

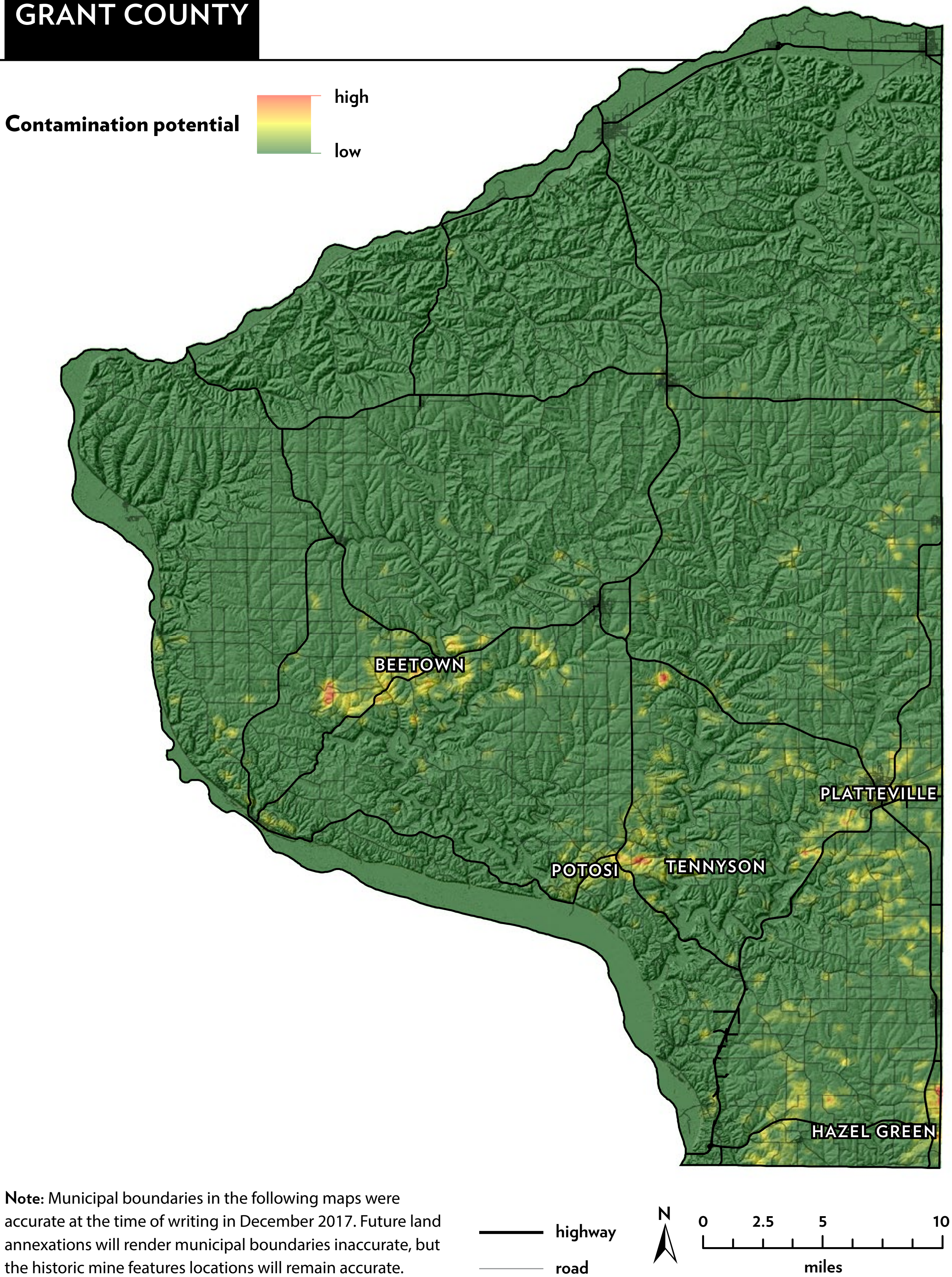
TABLE 1. Buffer distances and weights used to create the contamination heat maps.

Layer	Buffer density distance (ft)	Weight
Abandoned railroad	150	1
Borehole	100	1
Hazard	1,250	4
Lead digging site	1,000	3
Mine shaft	1,000	4
Open mine activity	1,000	2
Surveyed workings	1,000	3
Unsurveyed workings	1,000	2

GRANT COUNTY

Historic mine feature and contamination heat maps

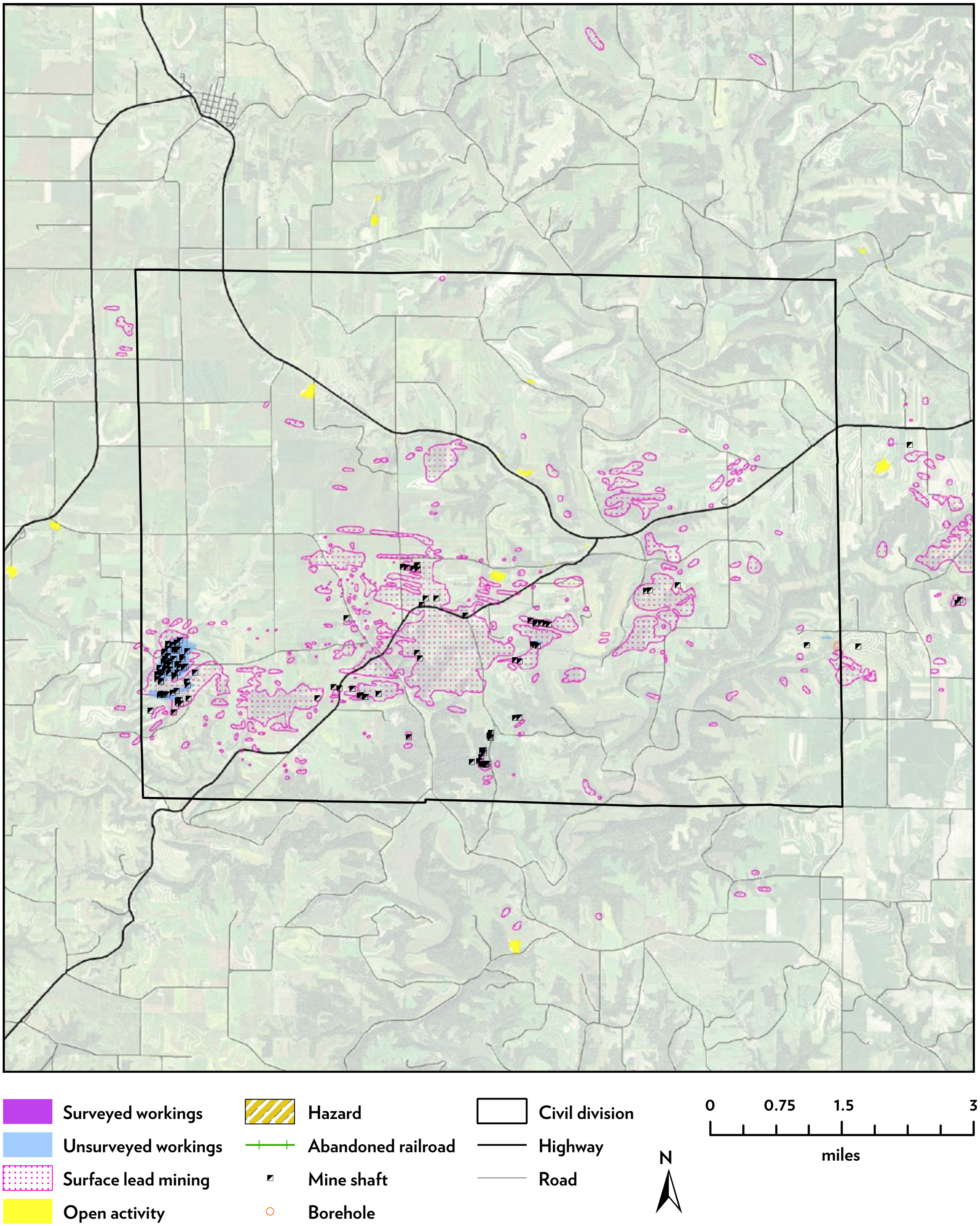
GRANT COUNTY



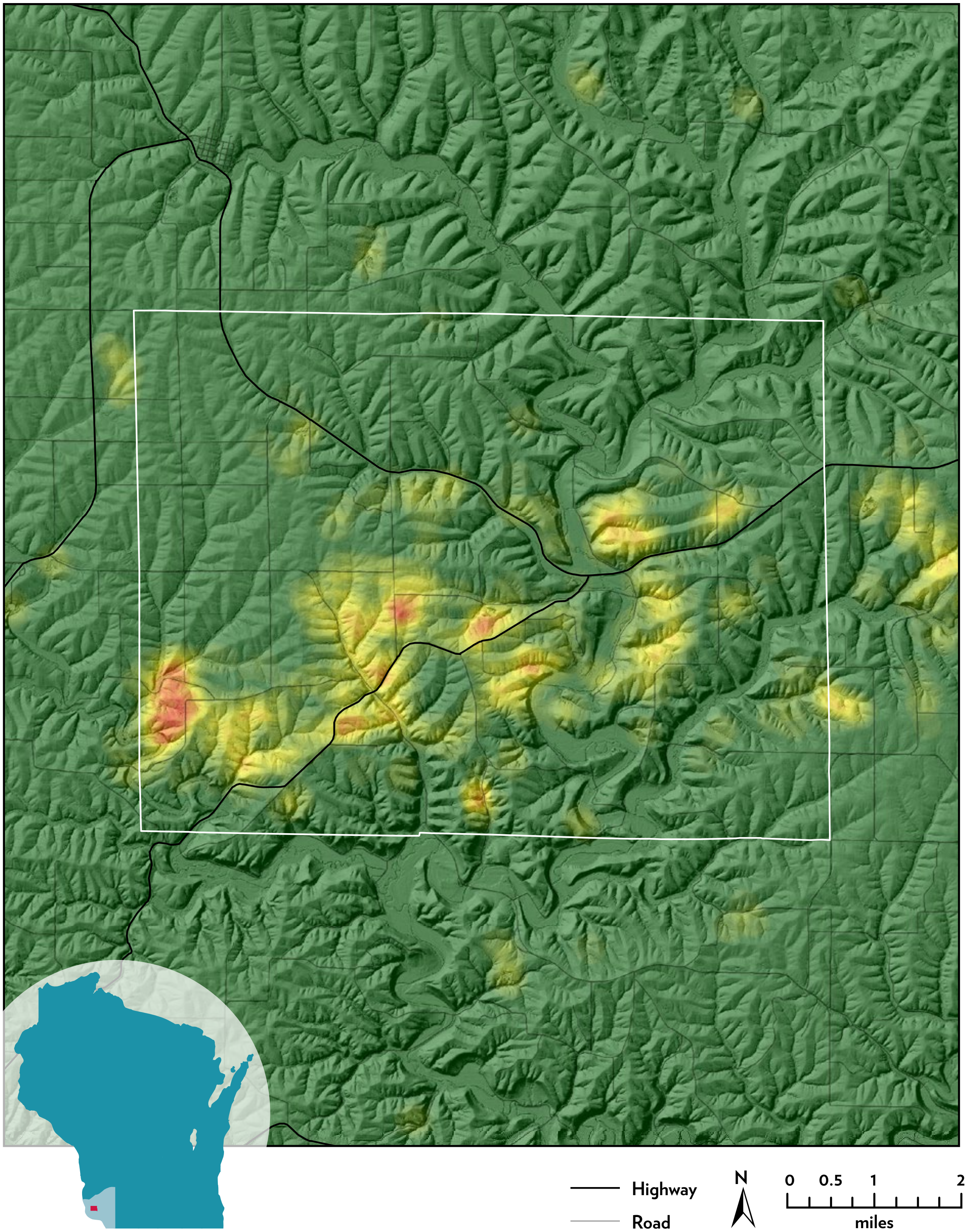
Note: Municipal boundaries in the following maps were accurate at the time of writing in December 2017. Future land annexations will render municipal boundaries inaccurate, but the historic mine features locations will remain accurate.

BEETOWN

Historic mine features

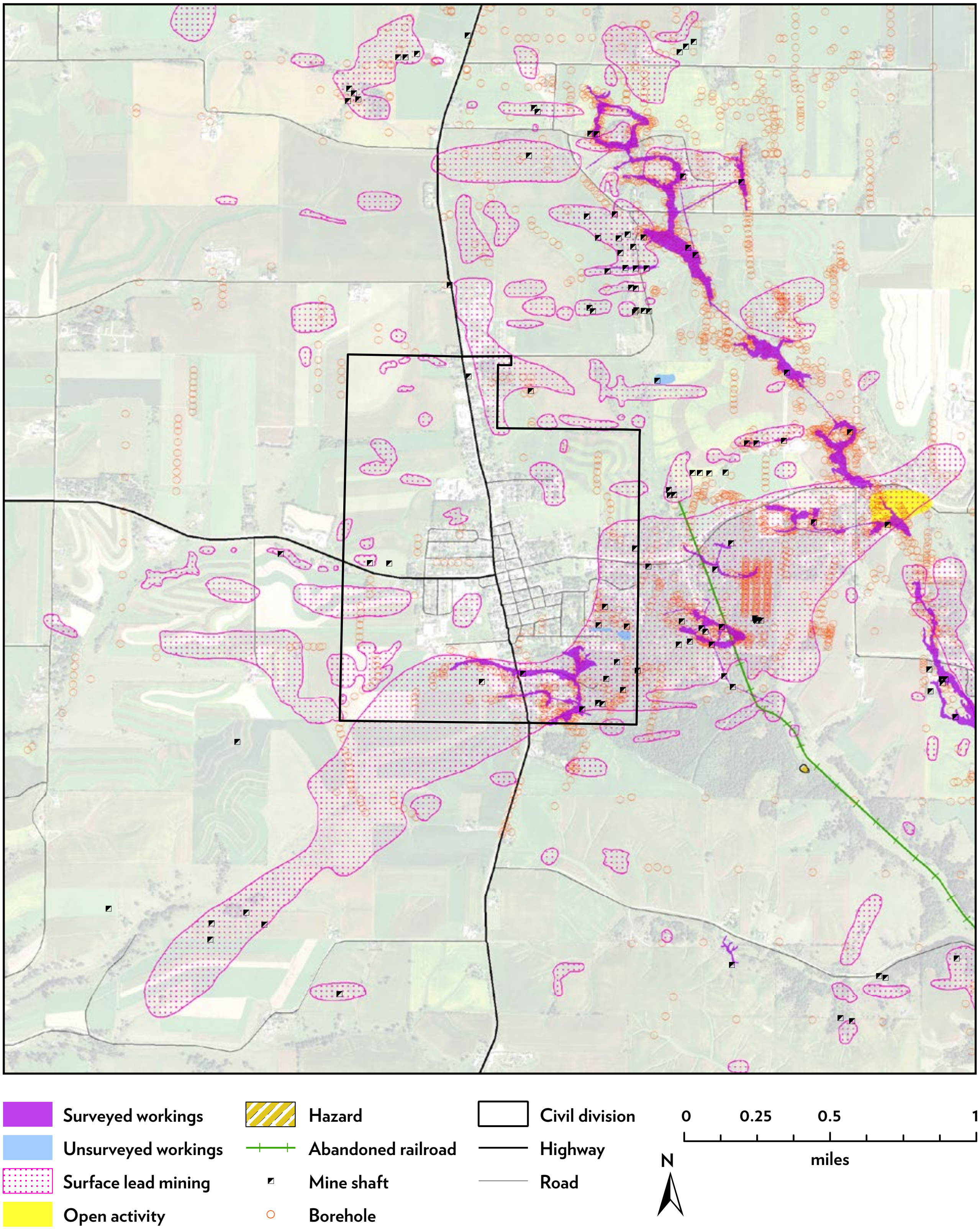


BEETOWN

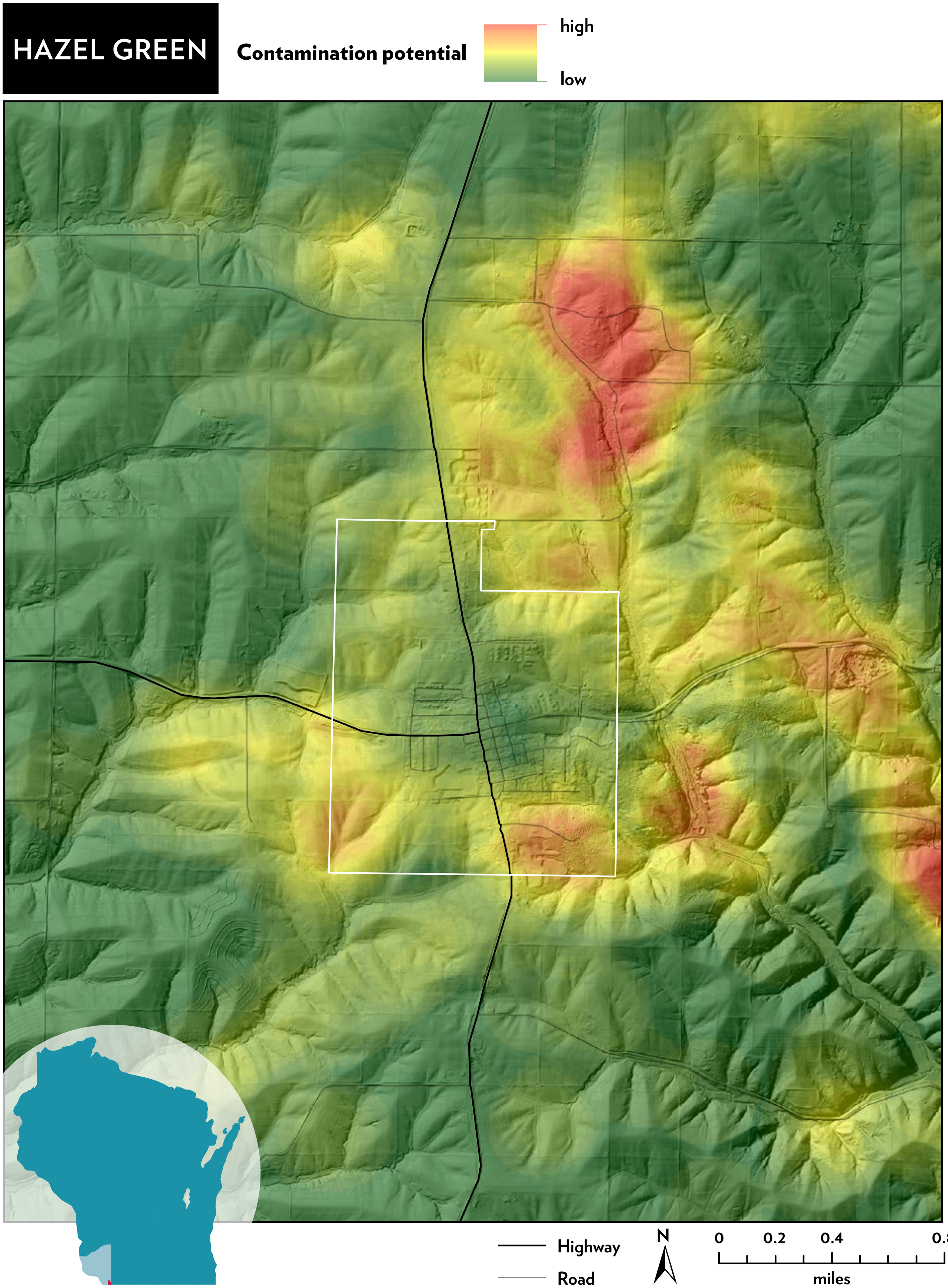

Contamination potential
high
low
Highway
Road
N
0 0.5 1 2
miles

HAZEL GREEN

Historic mine features

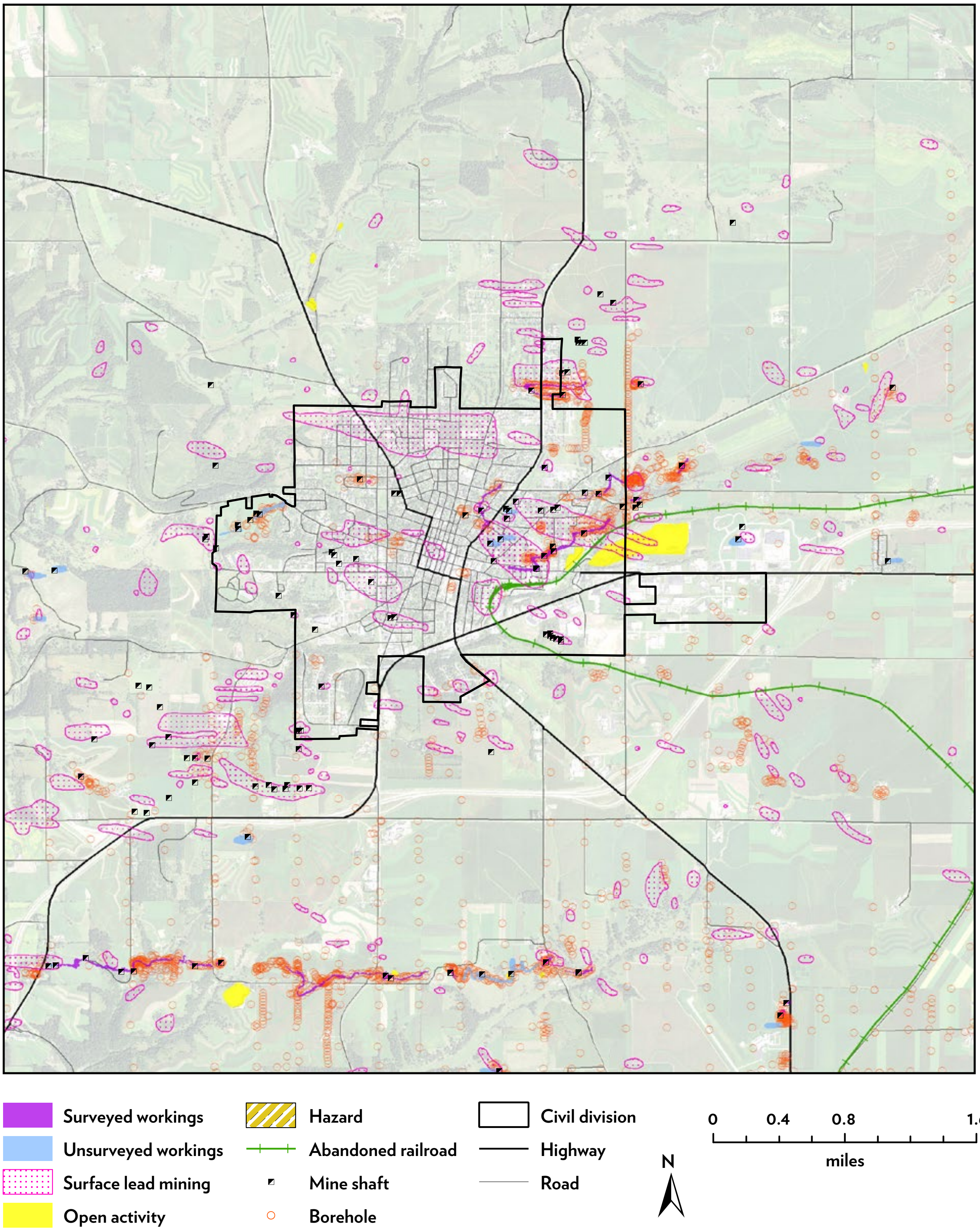


HAZEL GREEN

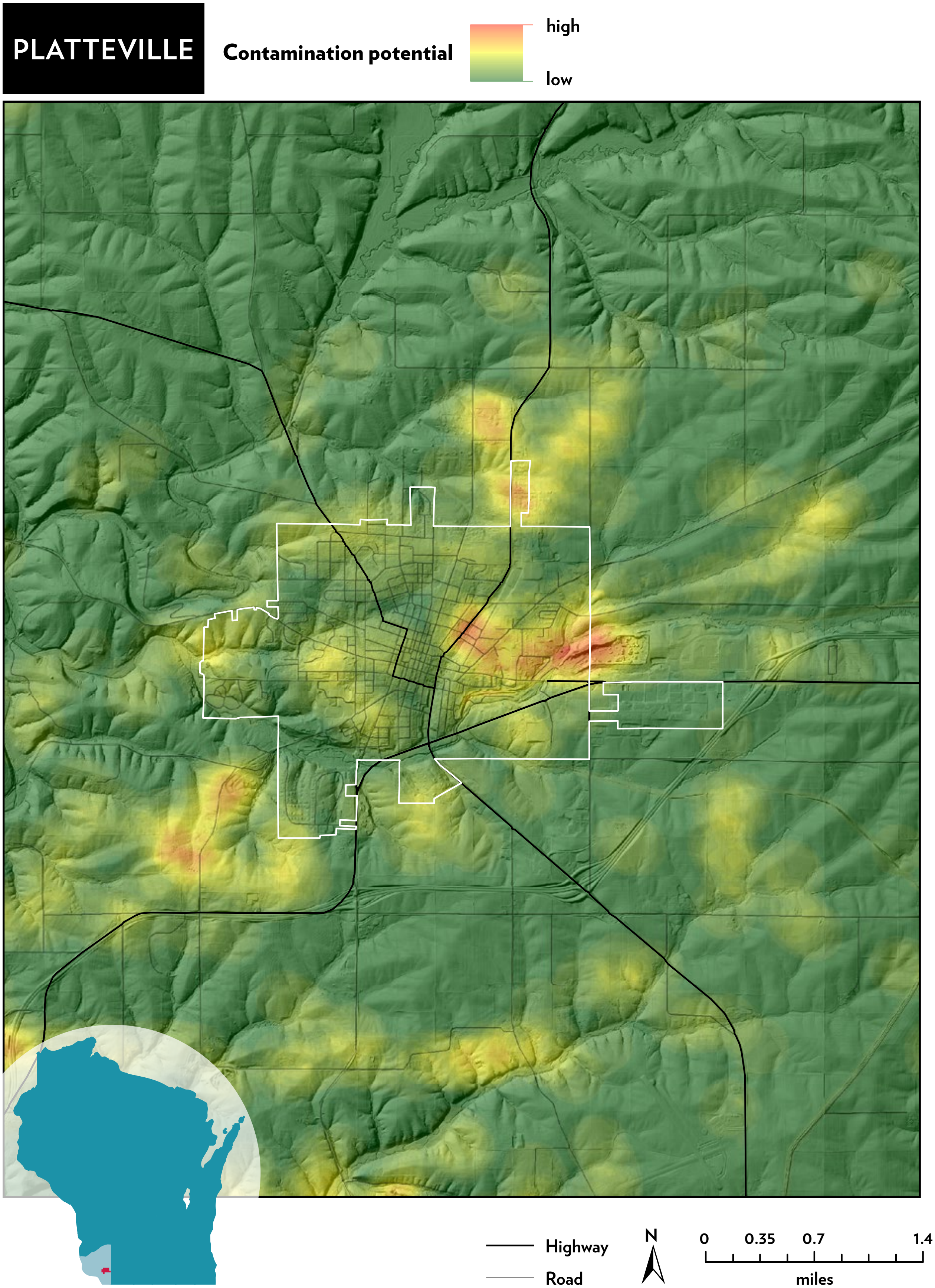

Contamination potential
high
low
Highway
Road
N
0
0.2
0.4
0.8
miles

PLATTEVILLE

Historic mine features

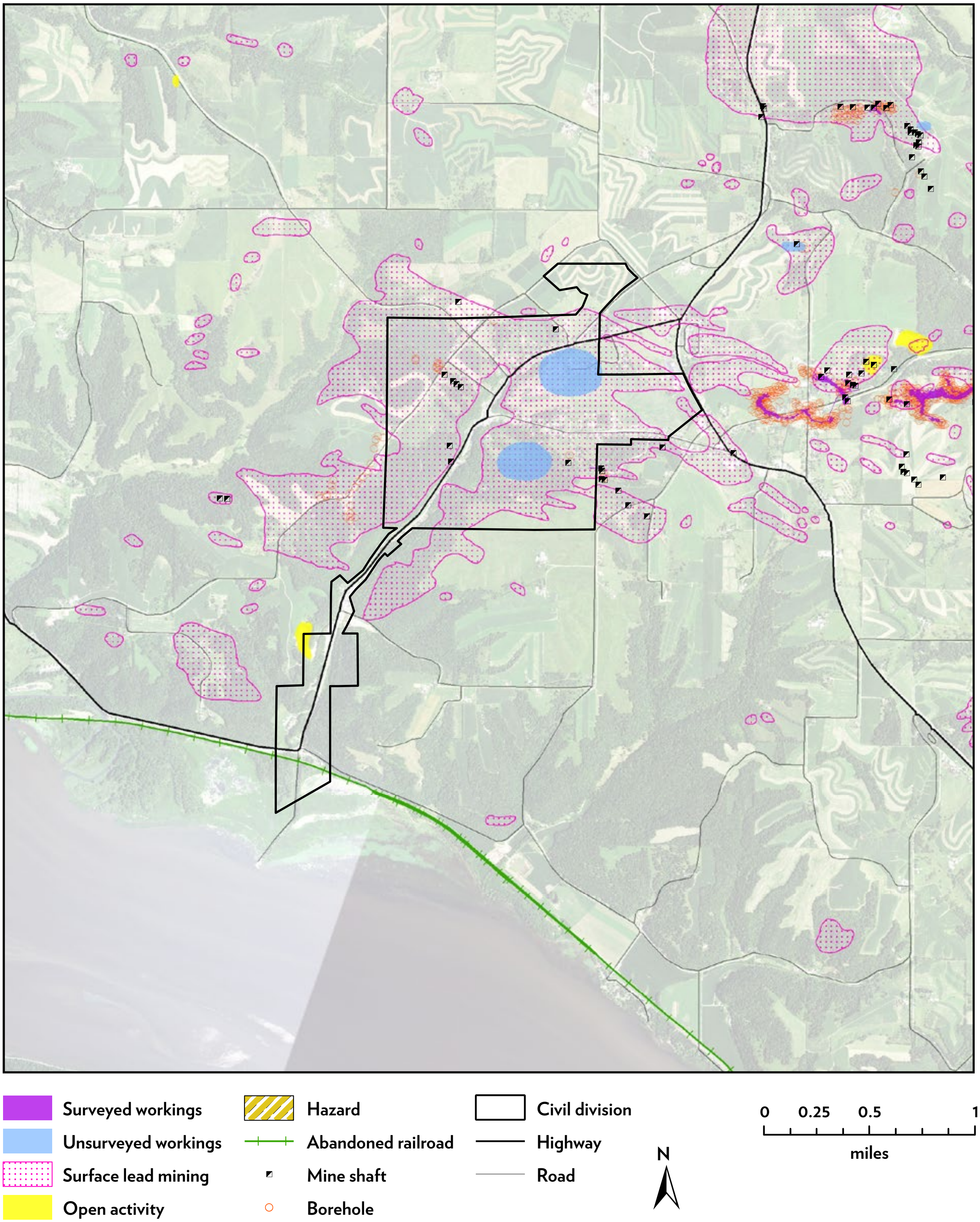


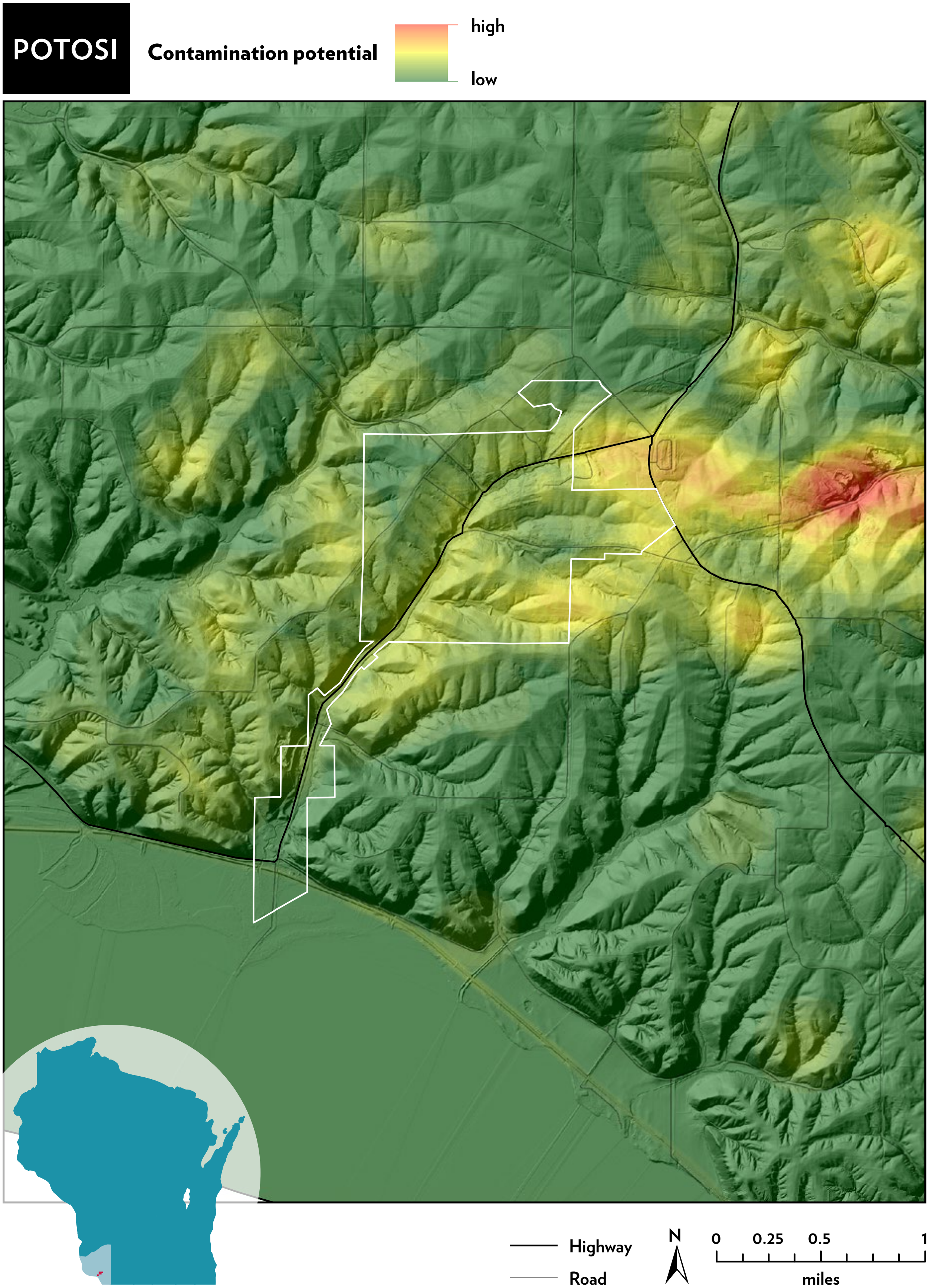
PLATTEVILLE



POTOSI

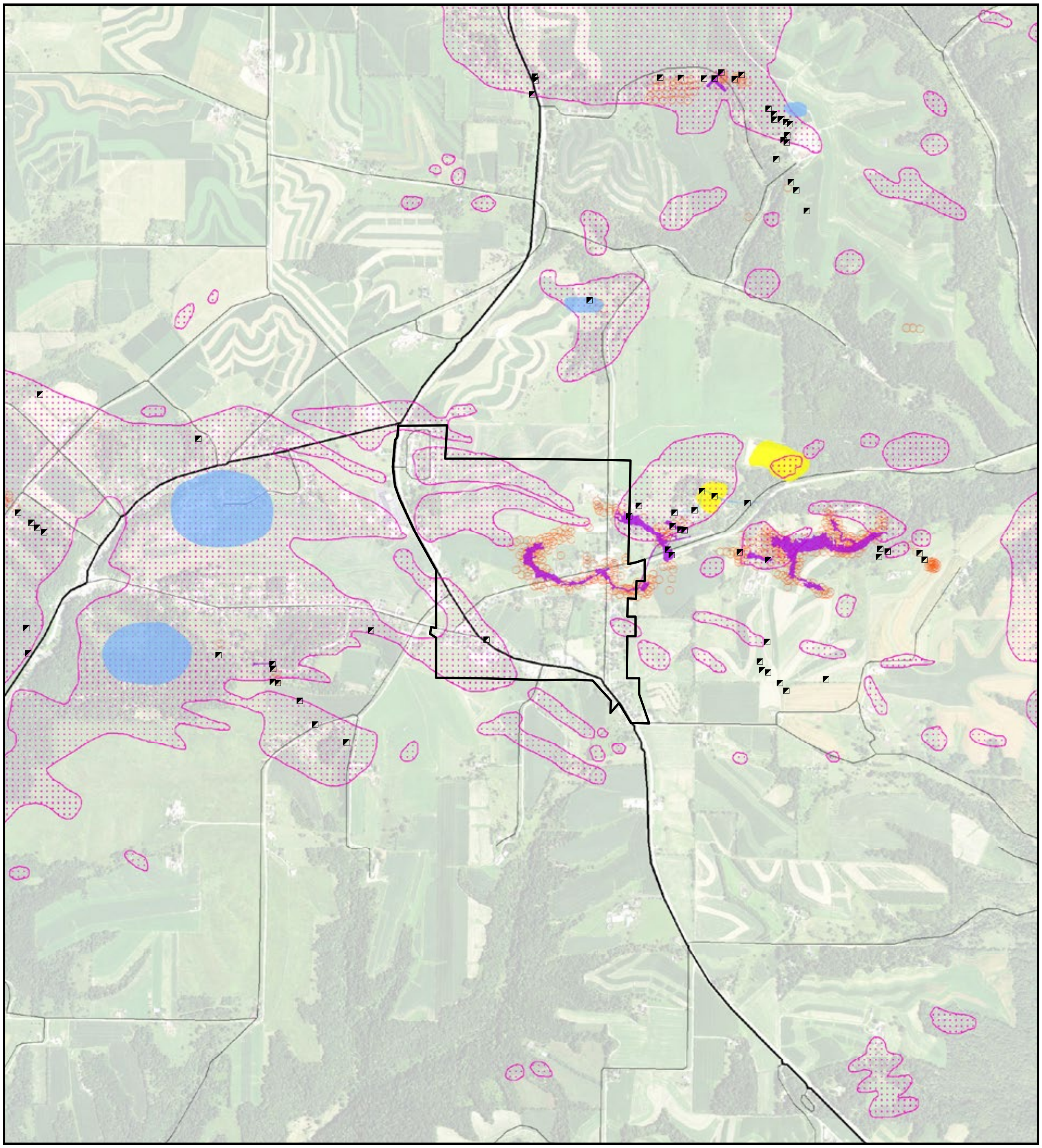
Historic mine features

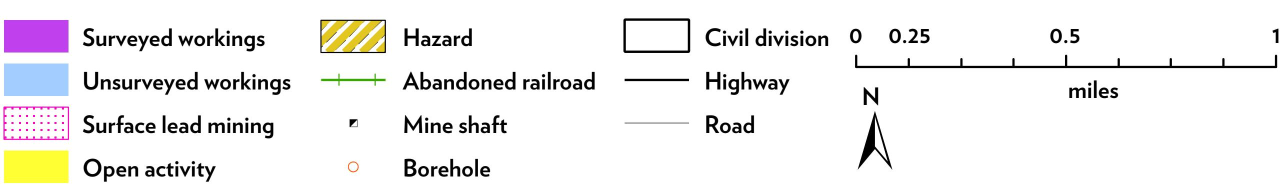


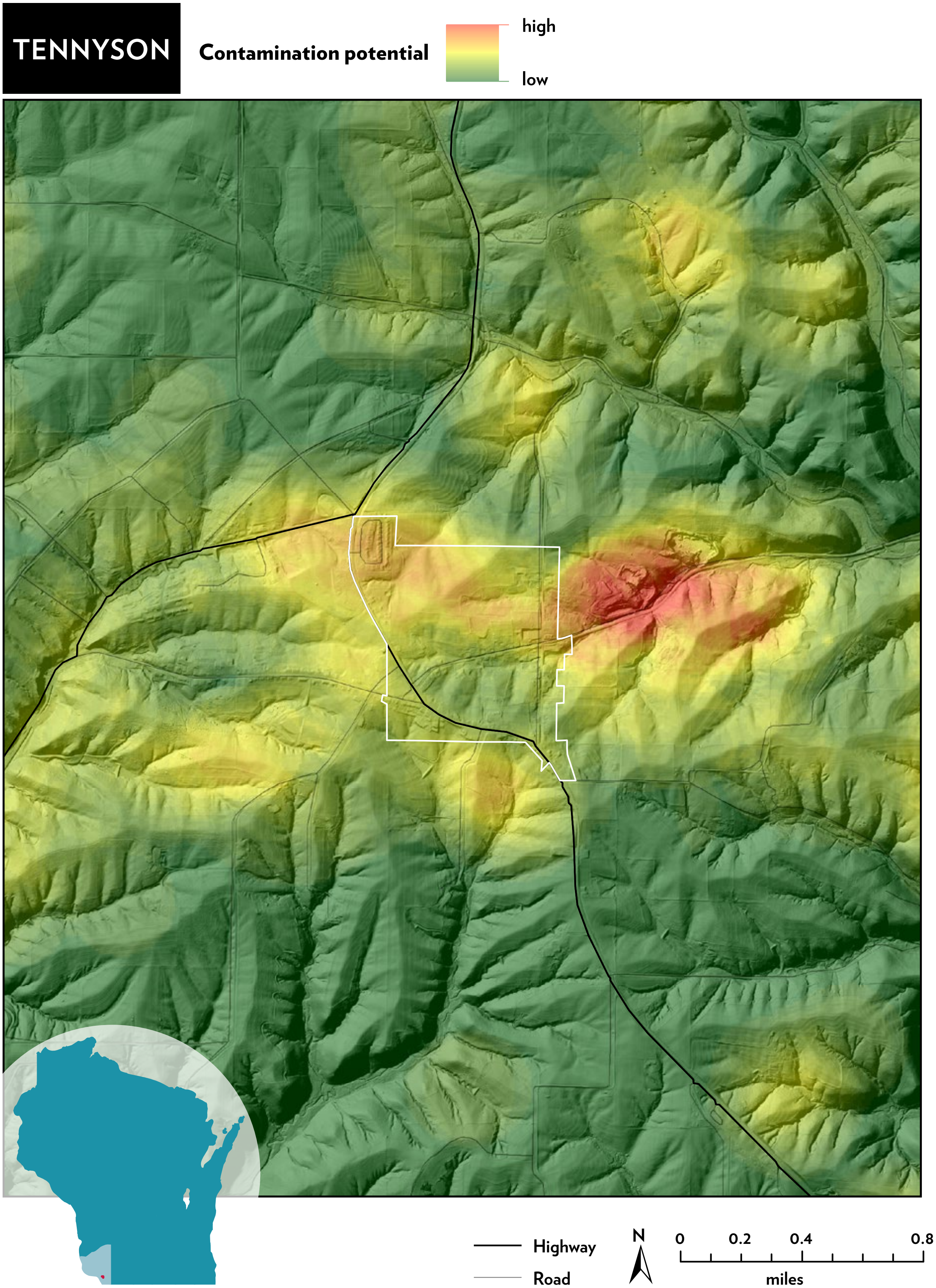

POTOSI
Contamination potential
high
low
Highway
Road
N
0
0.25
0.5
1
miles

TENNYSON

Historic mine features





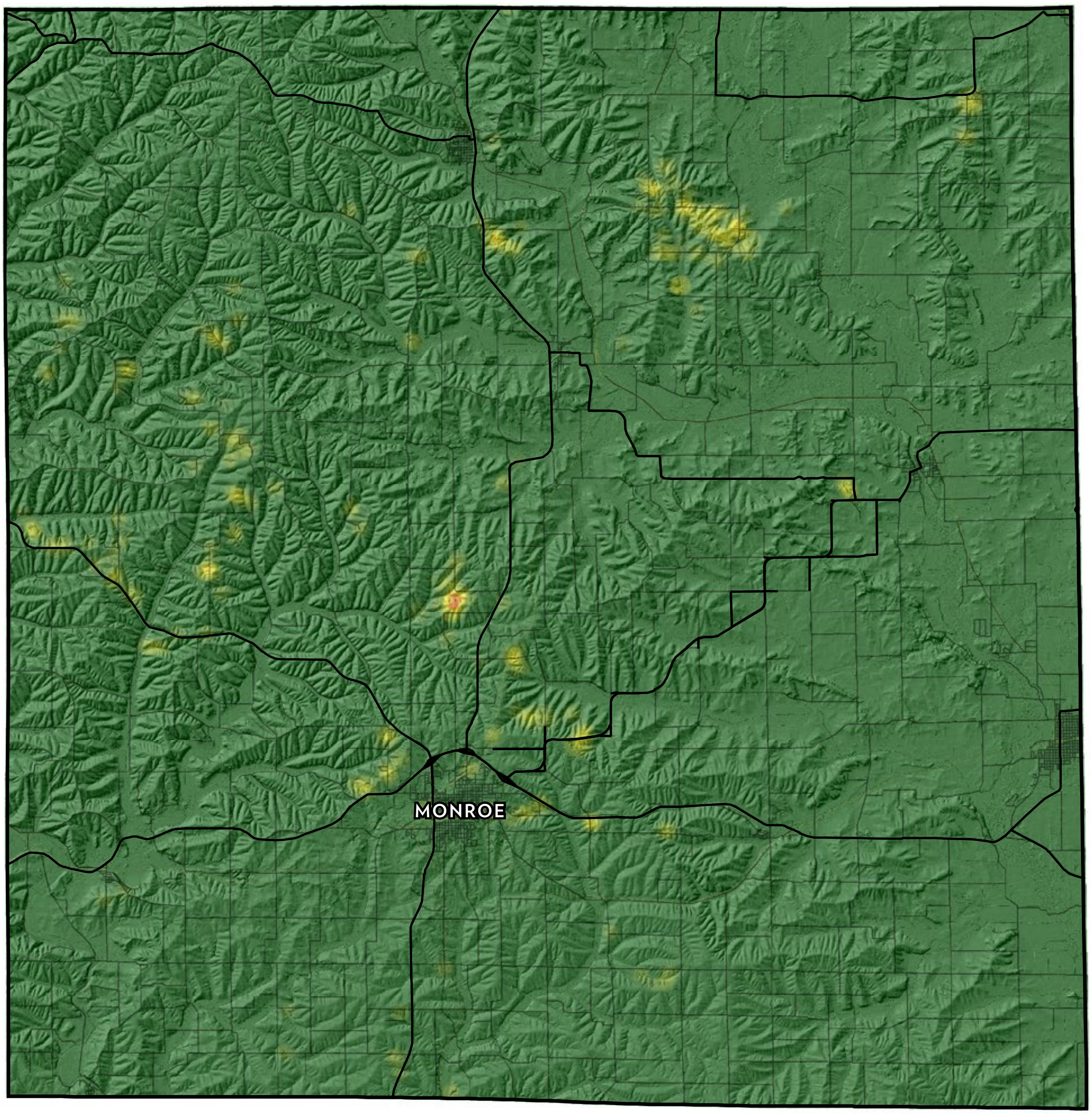

TENNYSON
Contamination potential
high
low
Highway
Road
N
0
0.2
0.4
0.8
miles

GREEN COUNTY

Historic mine feature and heat maps

GREEN COUNTY

Contamination potential high / low

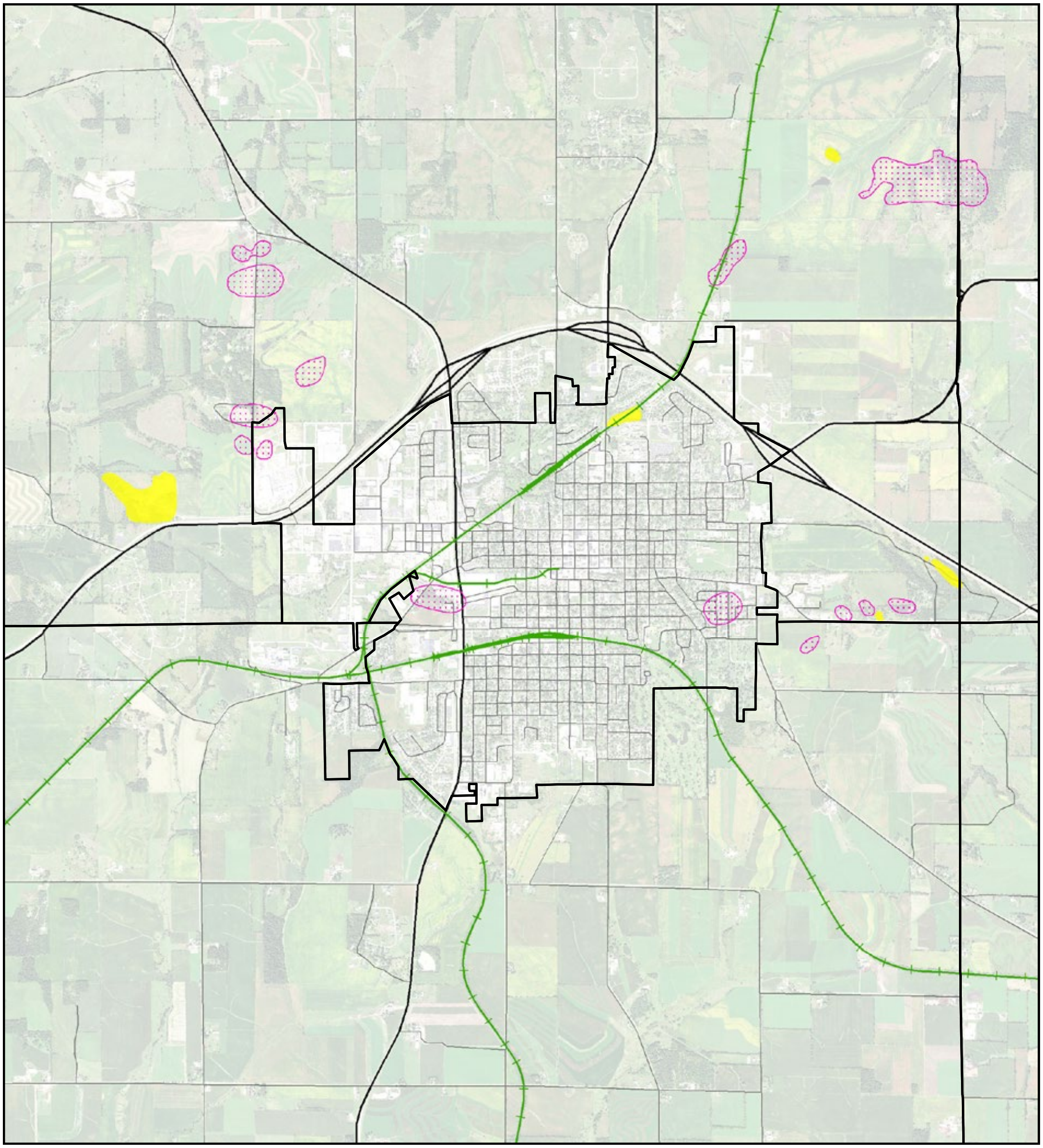


Note: Municipal boundaries in the following maps were accurate at the time of writing in December 2017. Future land annexations will render municipal boundaries inaccurate, but the historic mine features locations will remain accurate.

highway
road
N
0 1.5 3 6
miles

MONROE

Historic mine features

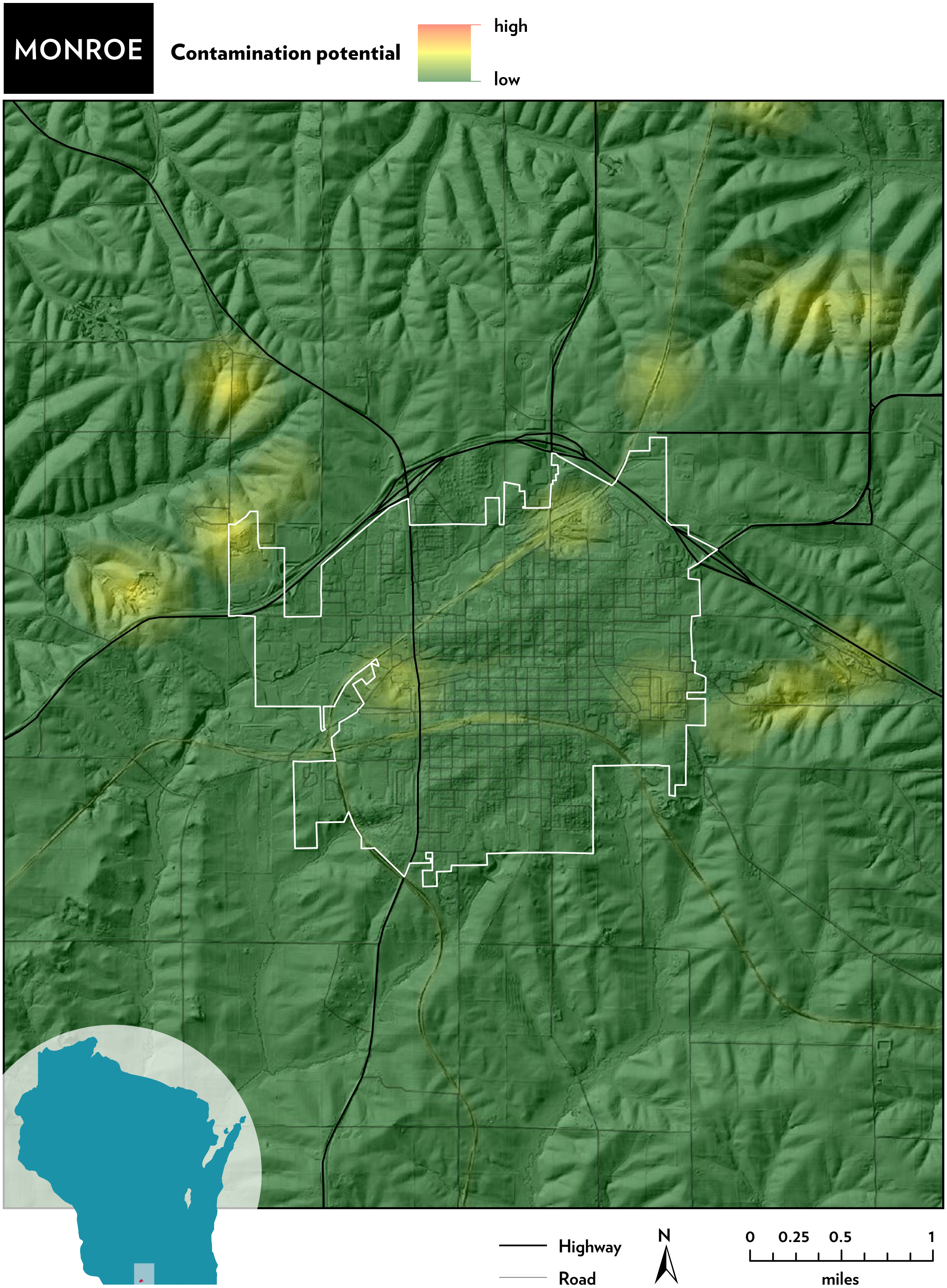


Surveyed workings
Unsurveyed workings
Surface lead mining
Open activity
Hazard
Abandoned railroad
Mine shaft
Borehole
Civil division
Highway
Road

0 0.375 0.75 1.5 miles

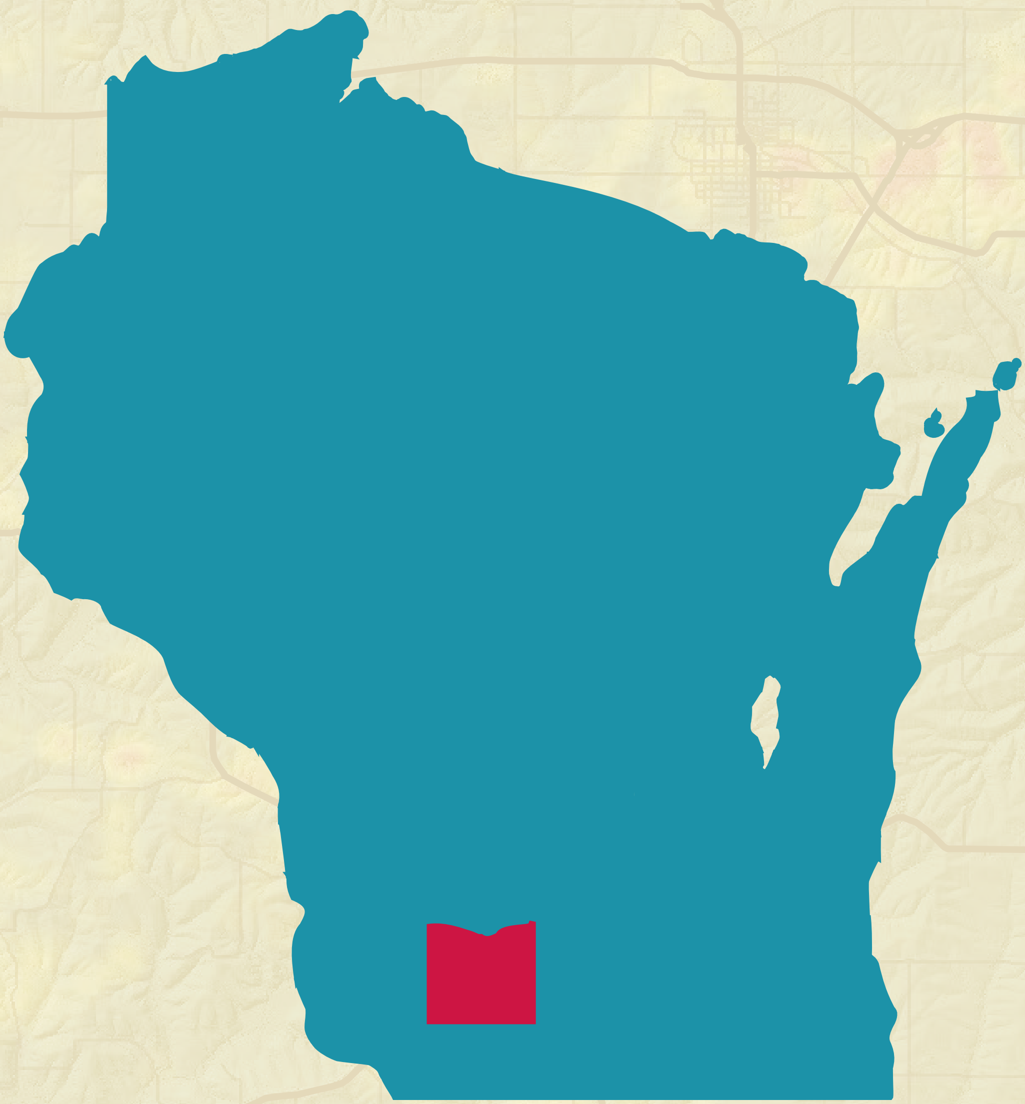
N

MONROE

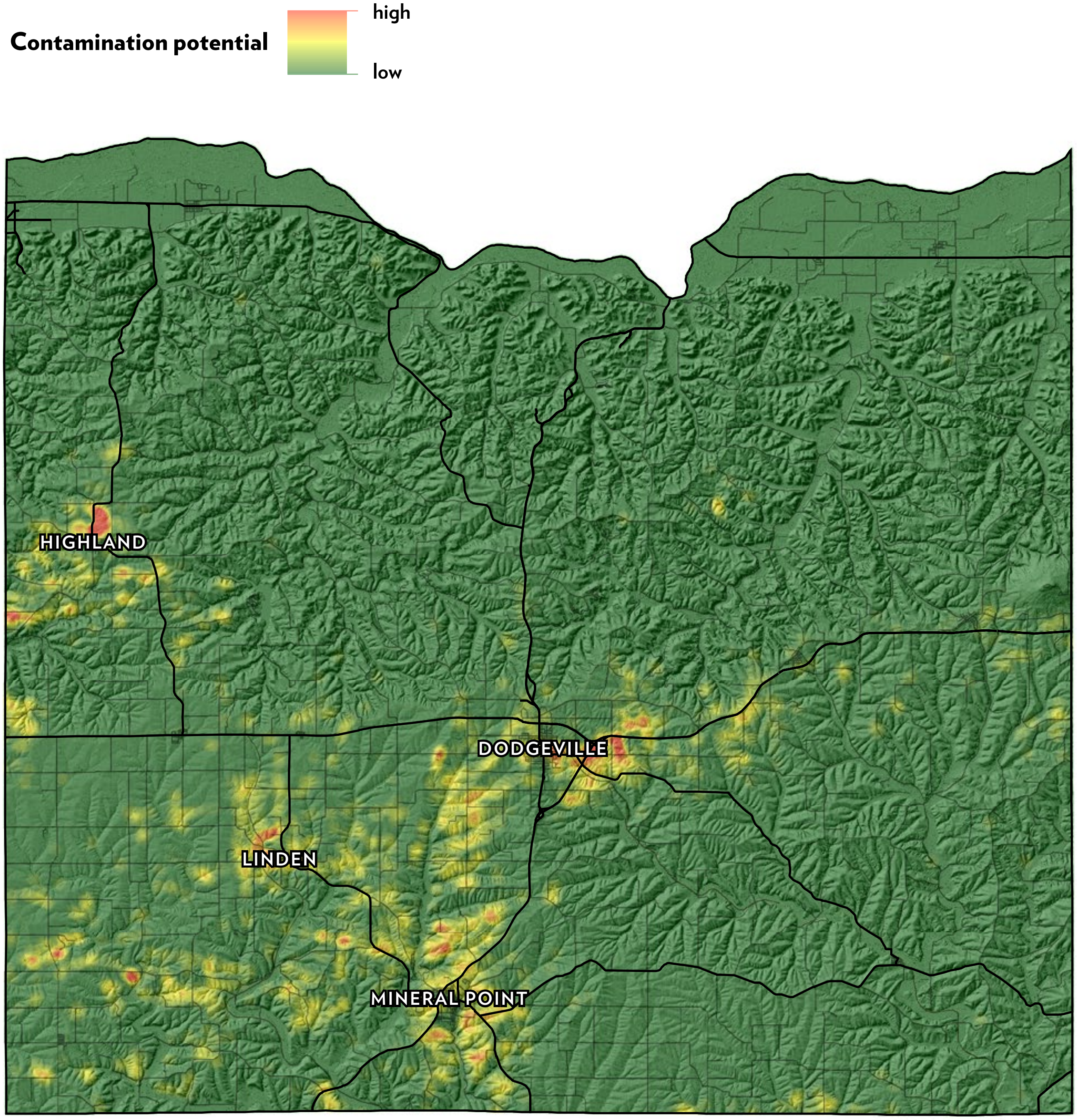

Contamination potential
high
low
Highway
Road
N
0 0.25 0.5 1
miles

IOWA COUNTY

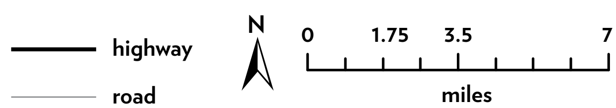
Historic mine feature and heat maps



IOWA COUNTY

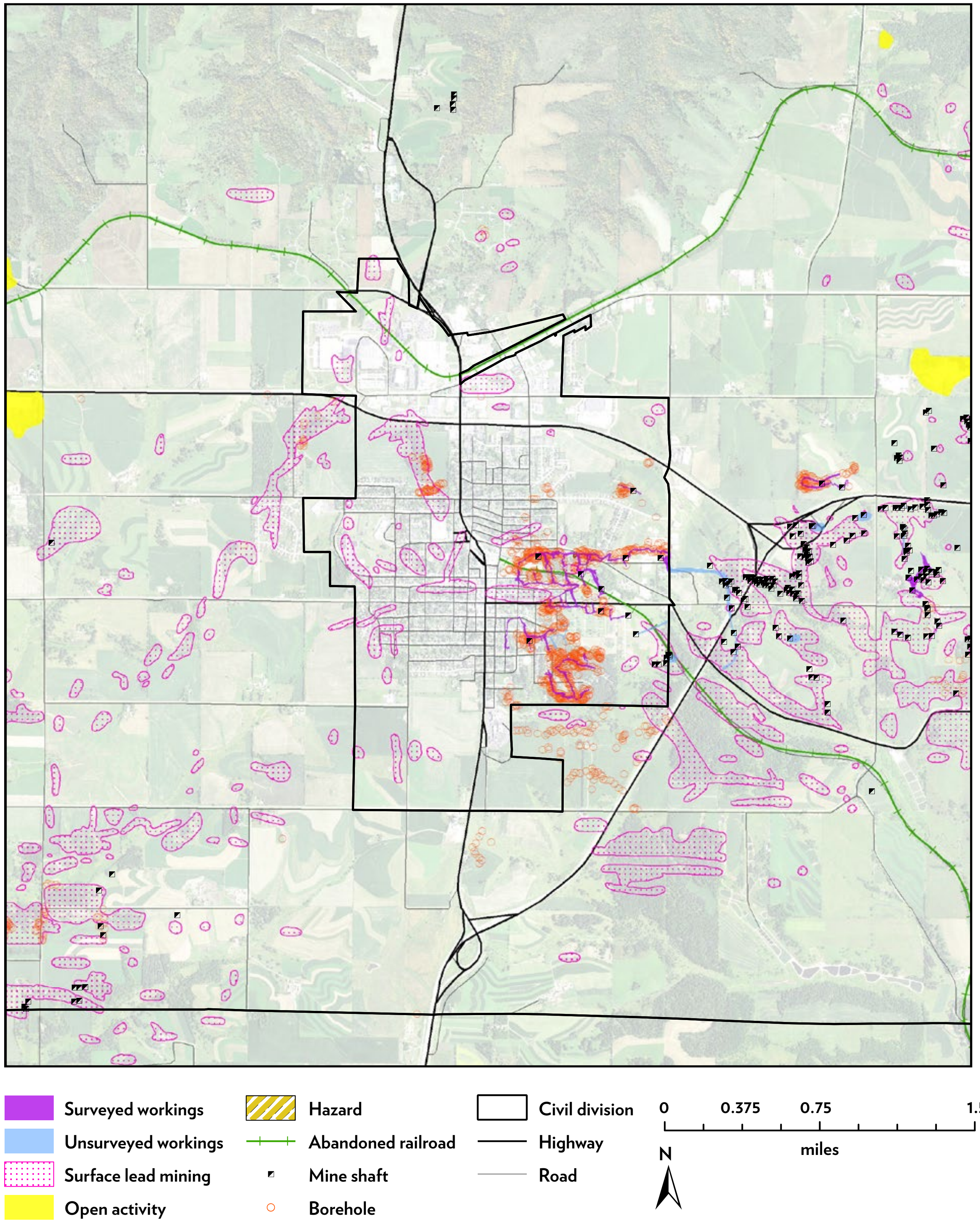


Note: Municipal boundaries in the following maps were accurate at the time of writing in December 2017. Future land annexations will render municipal boundaries inaccurate, but the historic mine features locations will remain accurate.



DODGEVILLE

Historic mine features

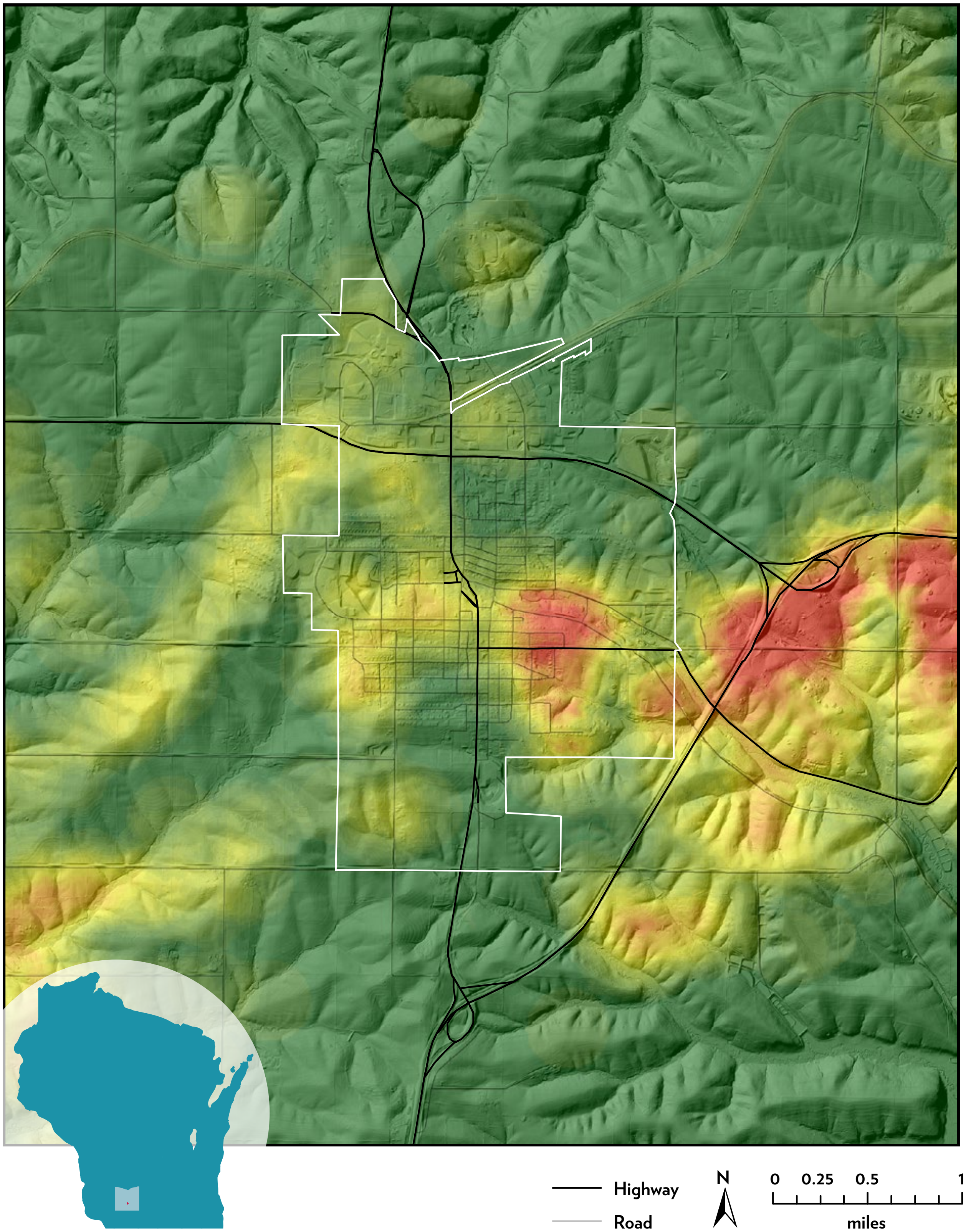


DODGEVILLE

Contamination potential

high

low



Highway

Road

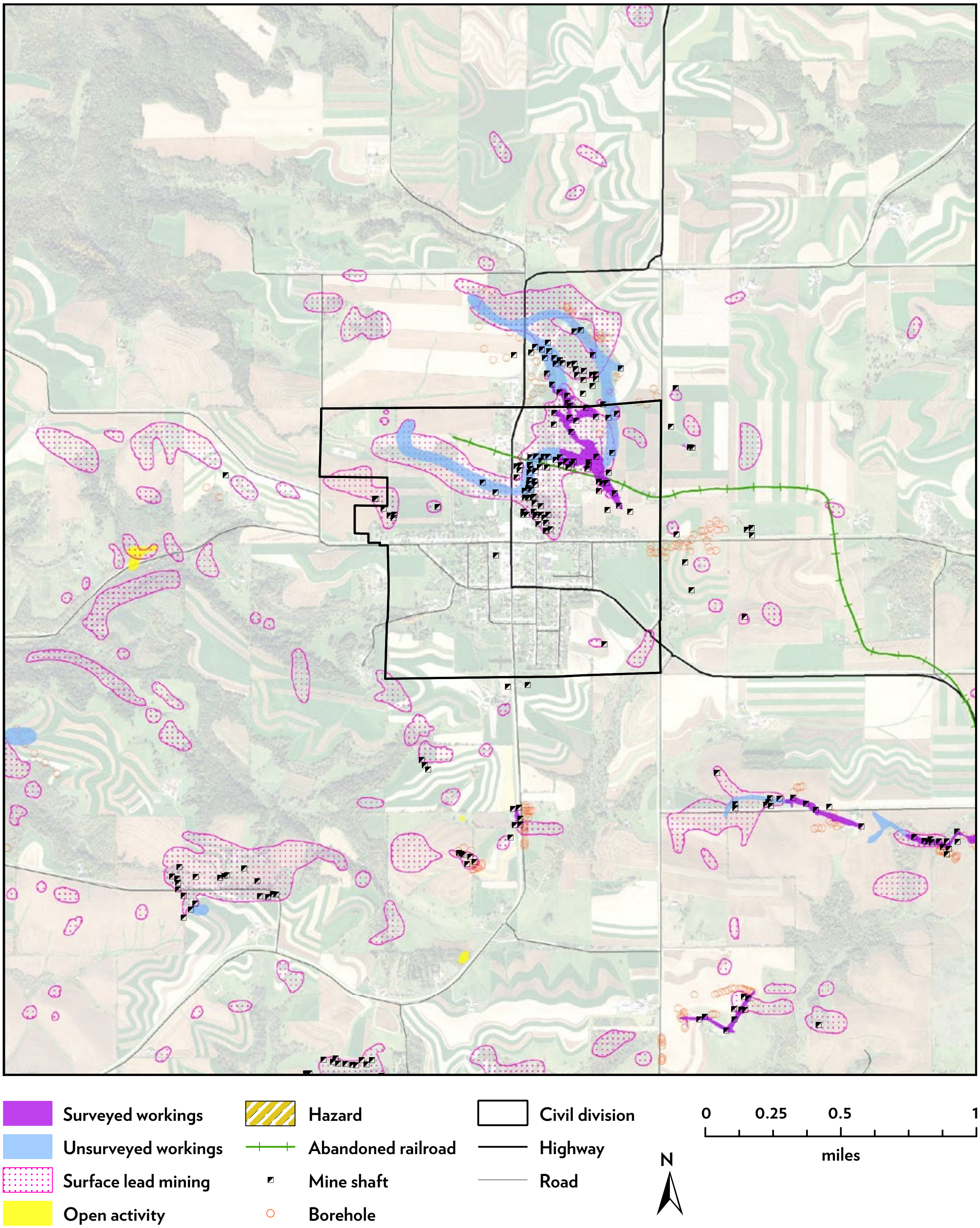
N

0 0.25 0.5 1

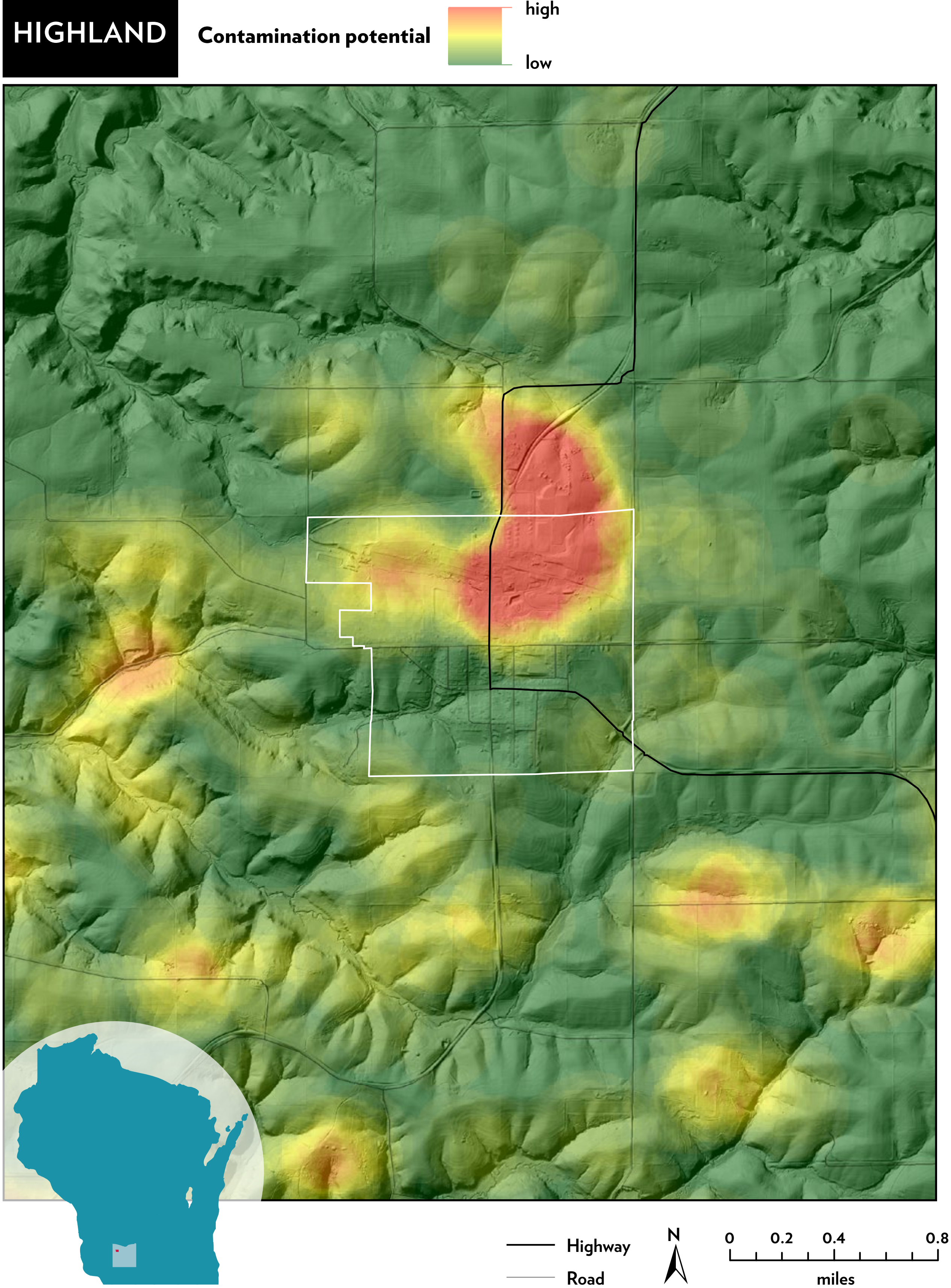
miles

HIGHLAND

Historic mine features

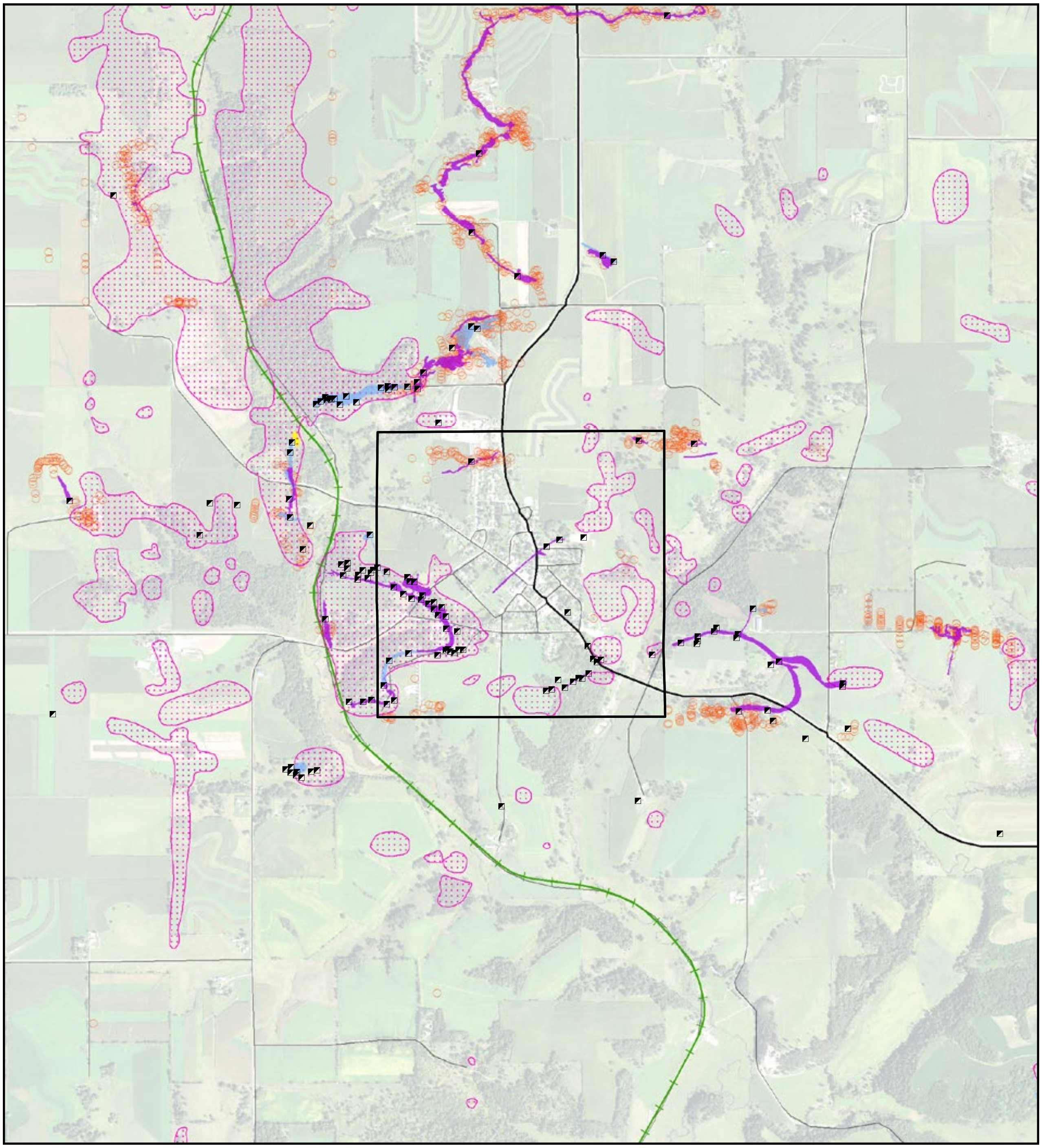


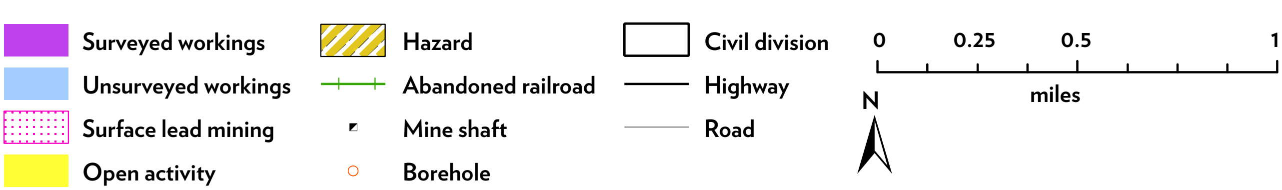
HIGHLAND

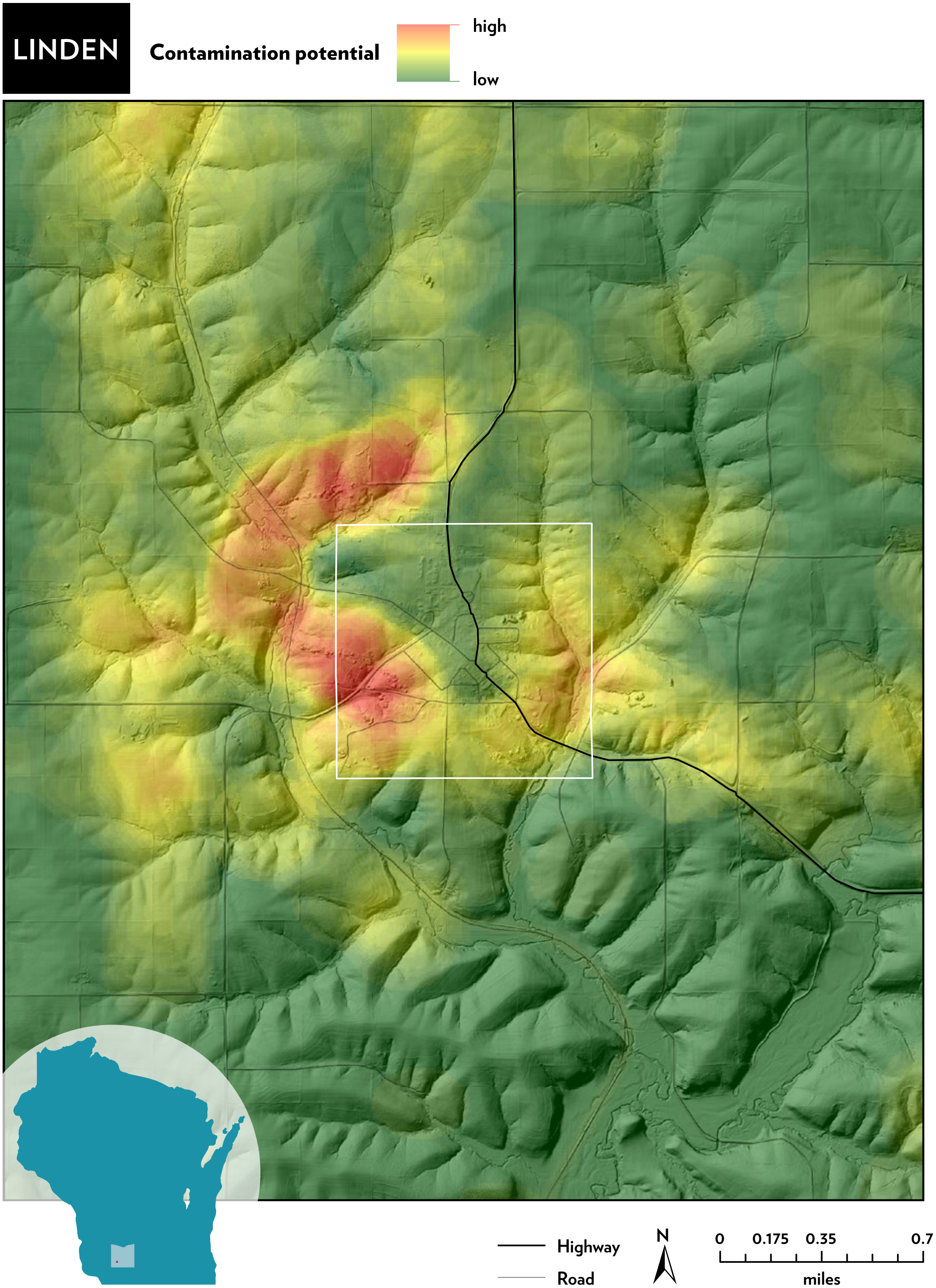

Contamination potential
high
low
Highway
Road
N
0 0.2 0.4 0.8
miles

LINDEN

Historic mine features

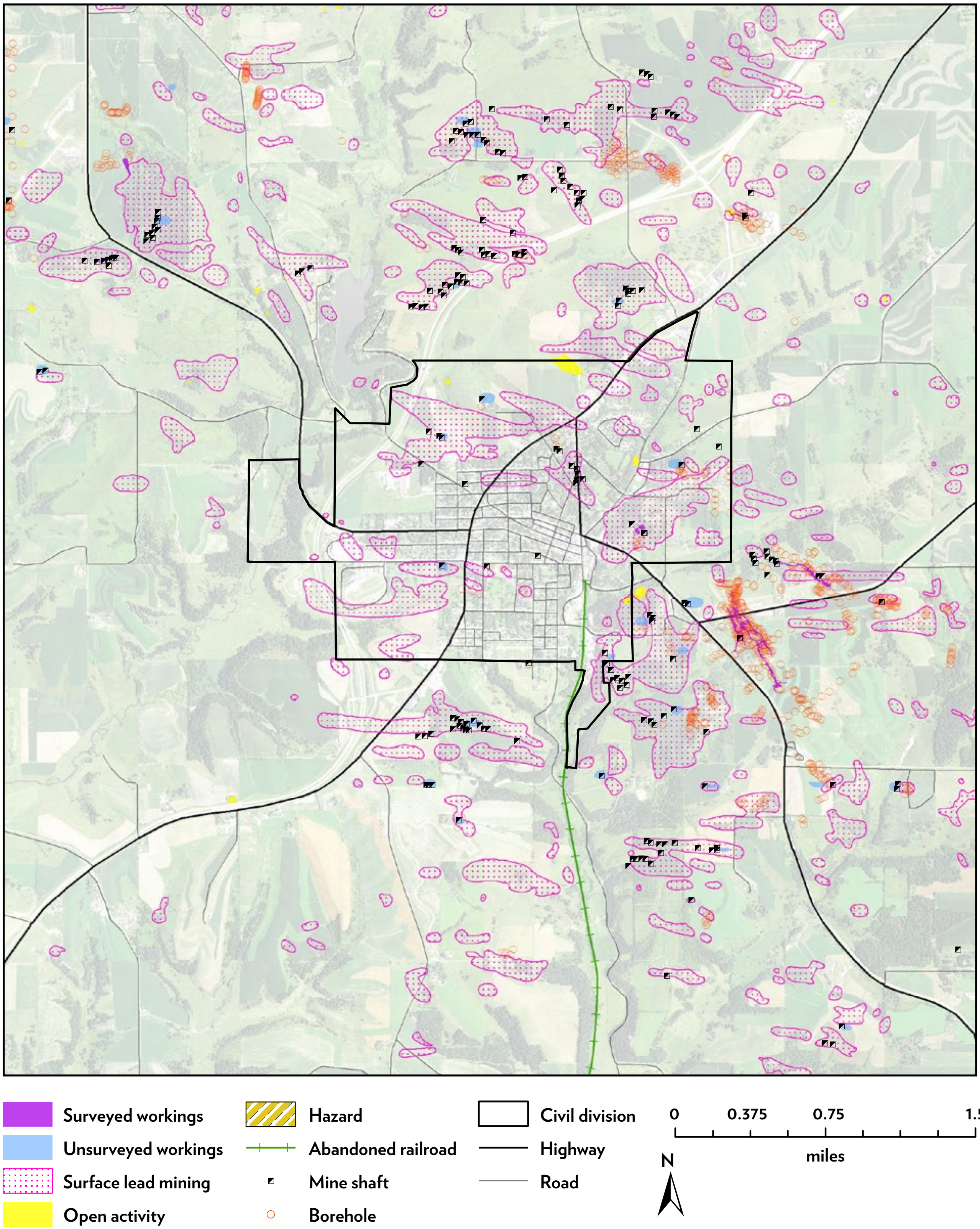





LINDEN
Contamination potential
high
low
Highway
Road
N
0
0.175
0.35
0.7
miles

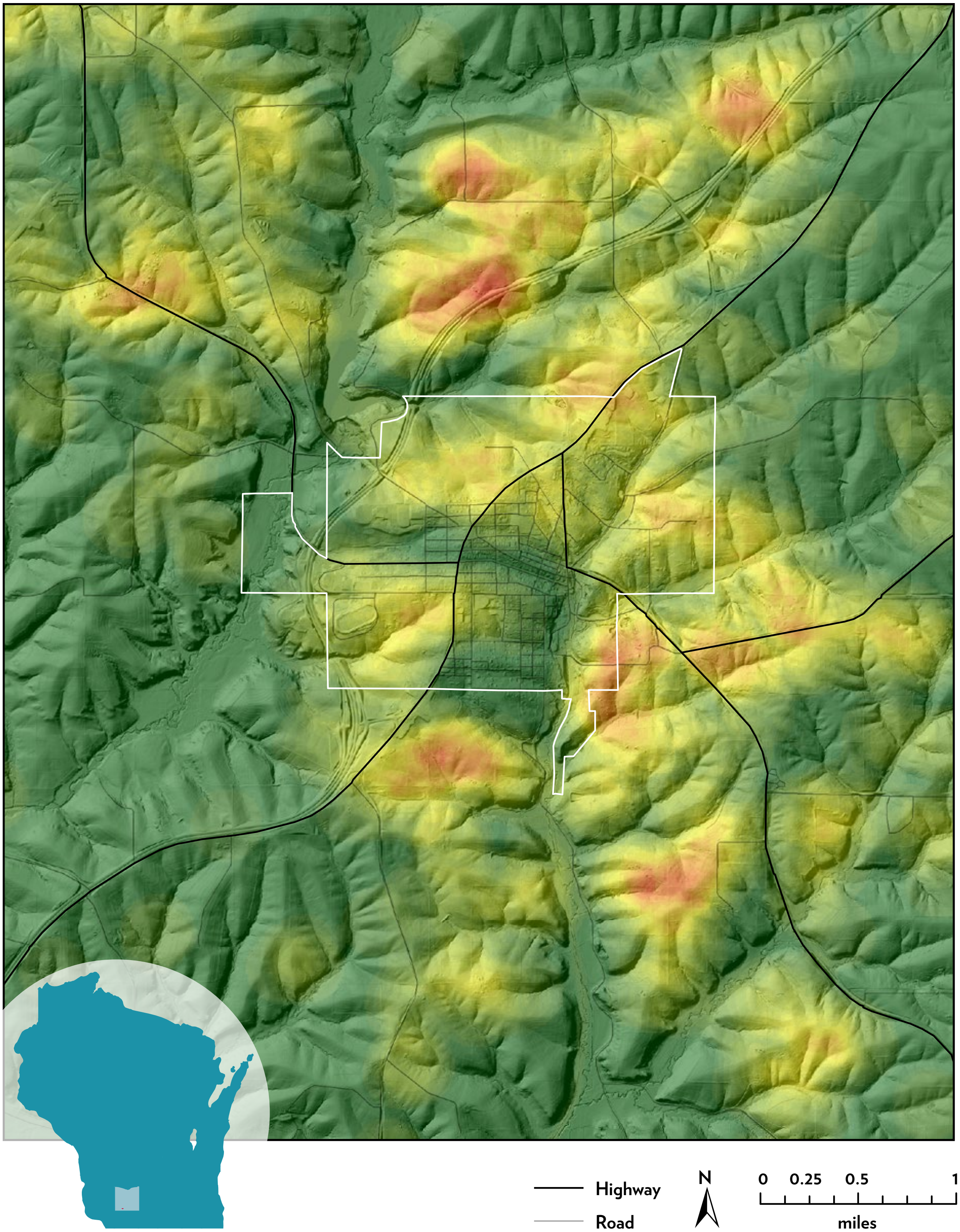
MINERAL POINT

Historic mine features



MINERAL POINT

Contamination potential high low

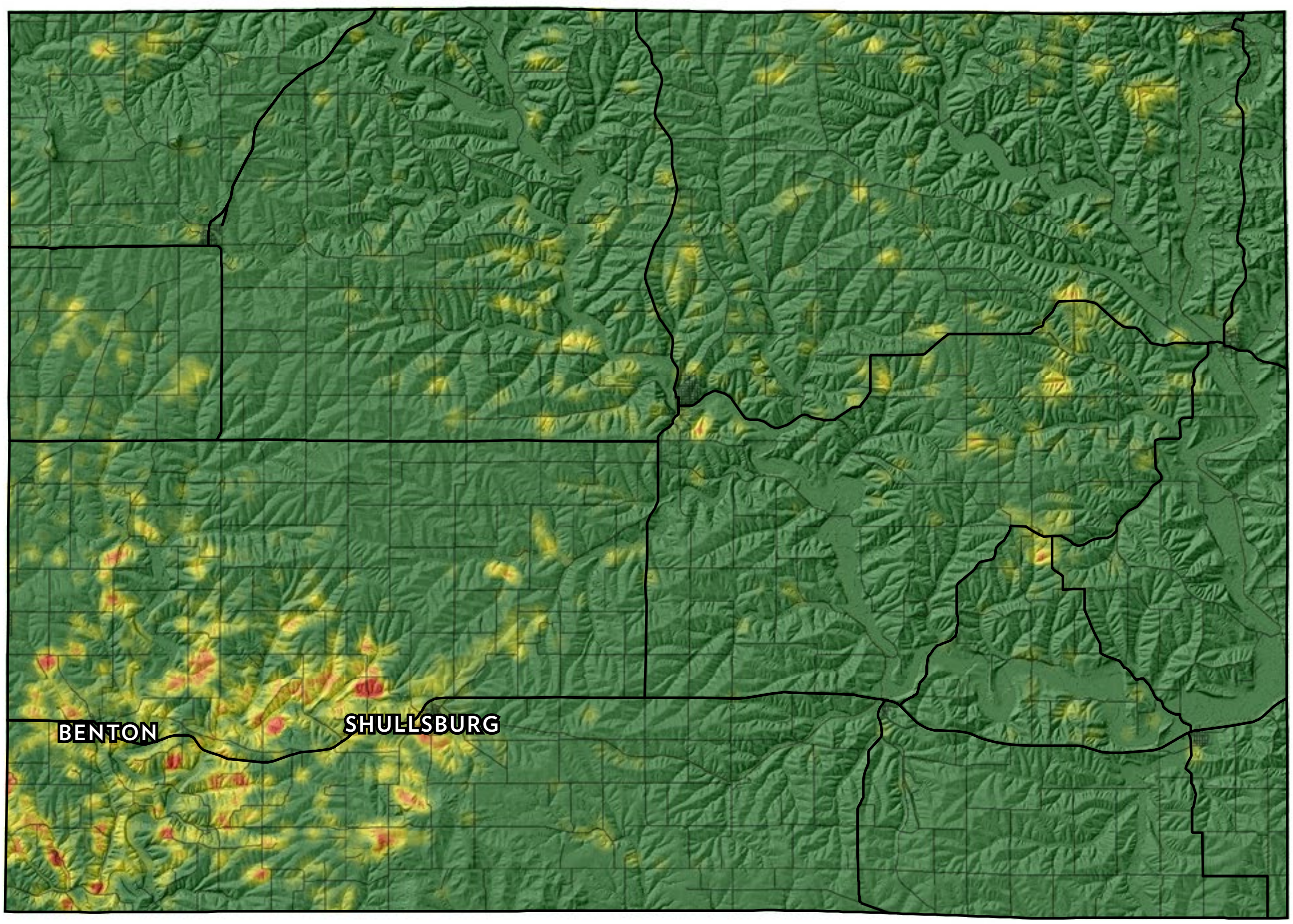


LAFAYETTE COUNTY

Historic mine feature and heat maps

LAFAYETTE COUNTY

Contamination potential high low



Note: Municipal boundaries in the following maps were accurate at the time of writing in December 2017. Future land annexations will render municipal boundaries inaccurate, but the historic mine features locations will remain accurate.

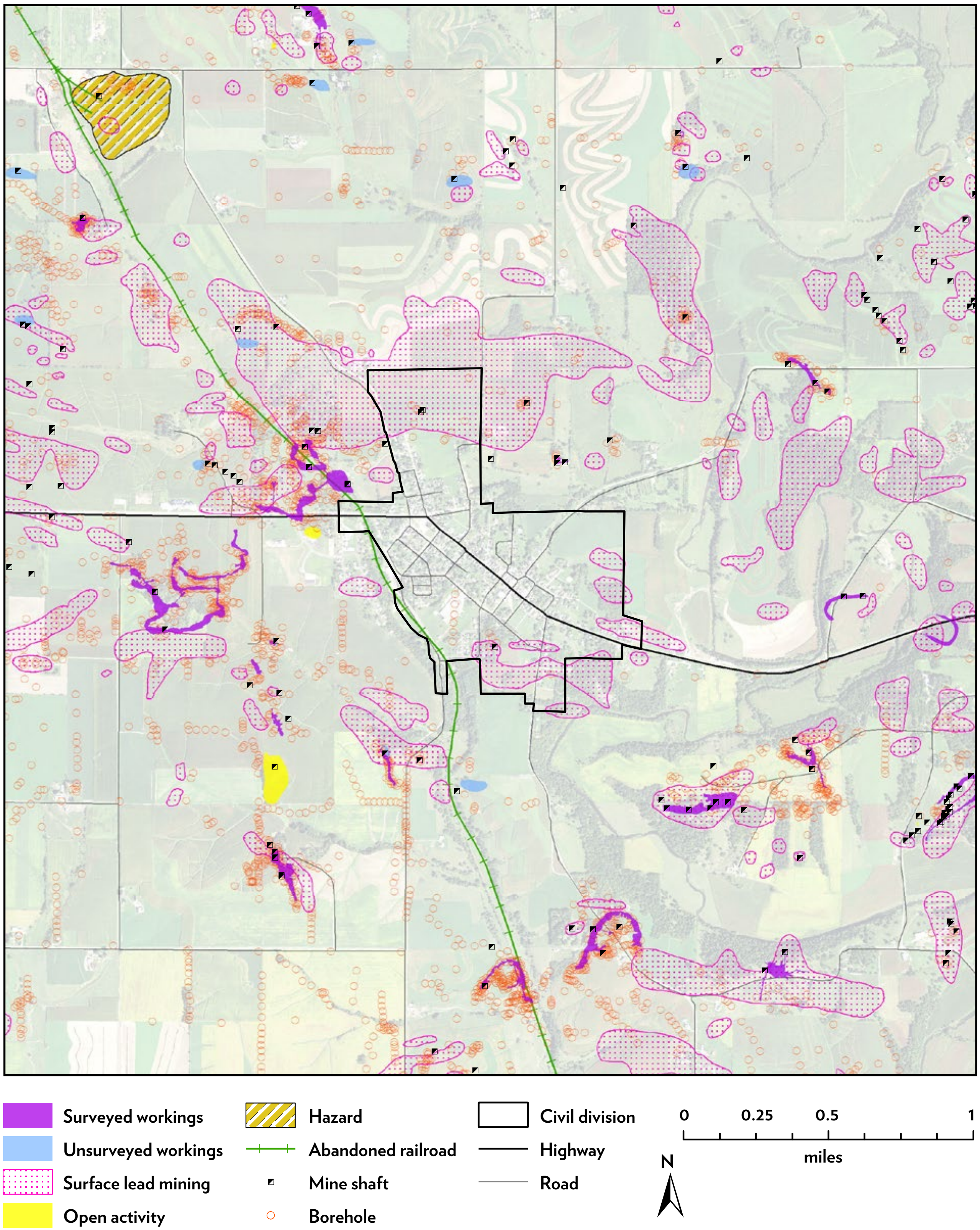
highway
road

N

0 1.75 3.5 7
miles

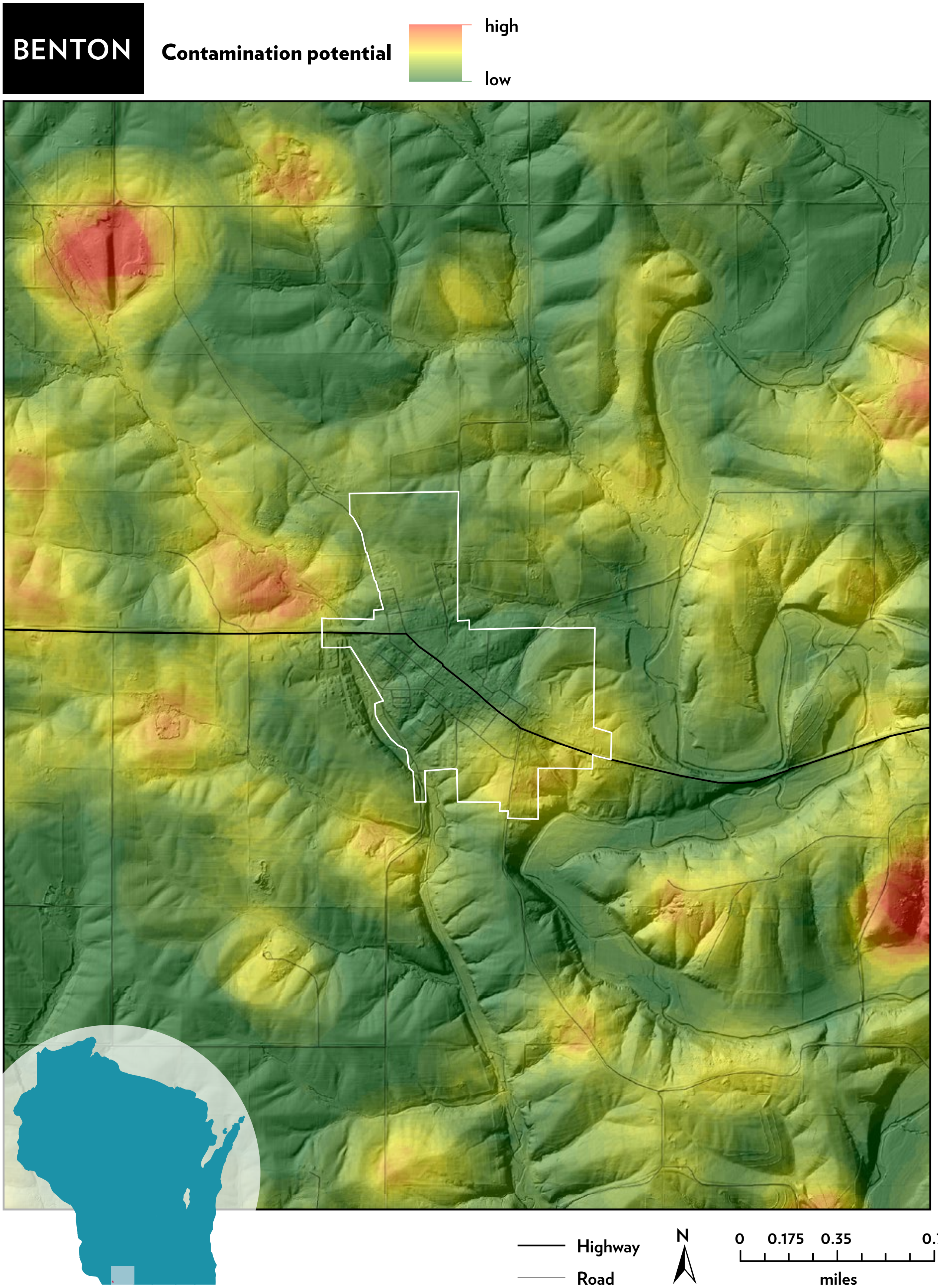
BENTON

Historic mine features



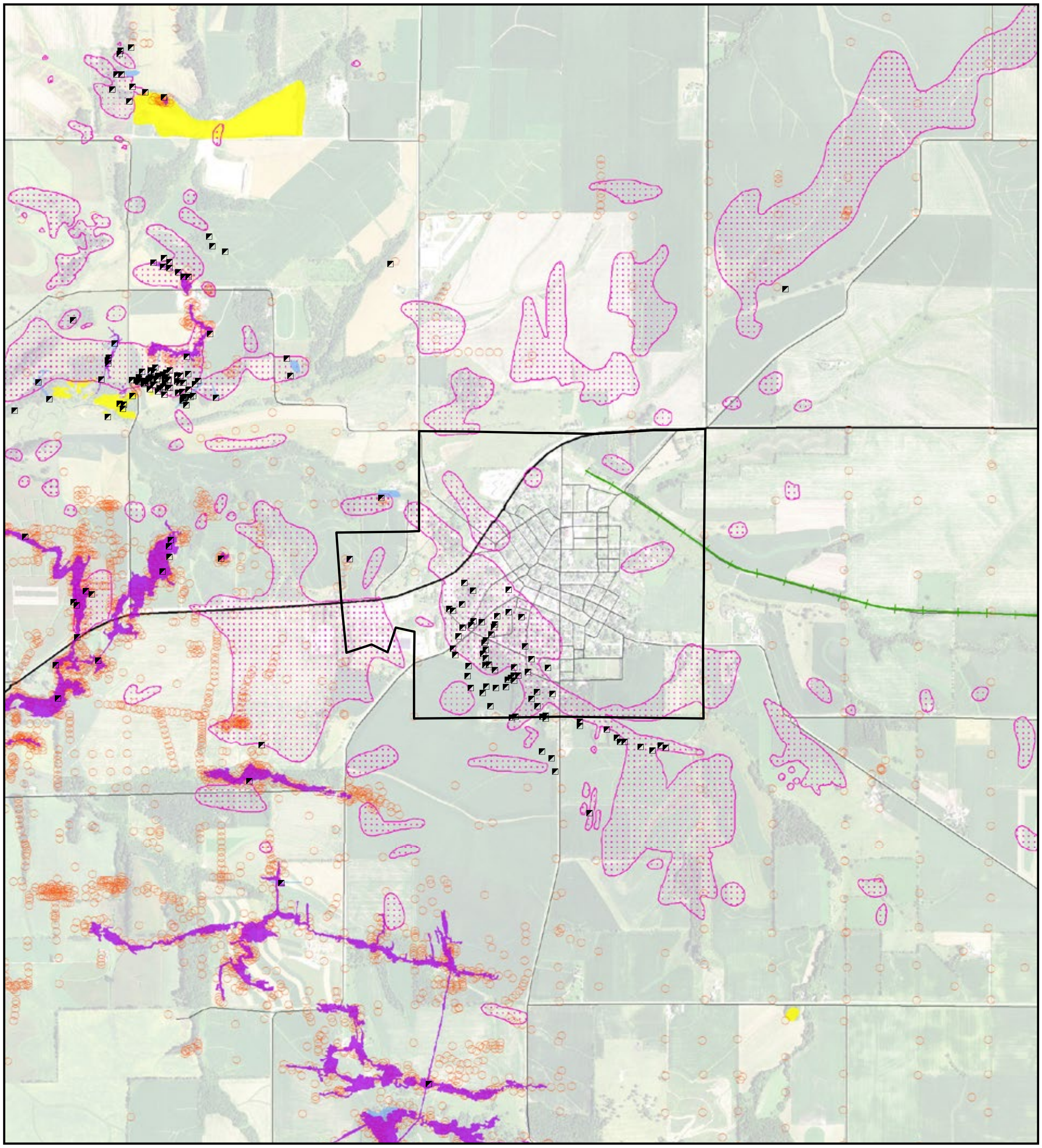
BENTON

Contamination potential



SHULLSBURG

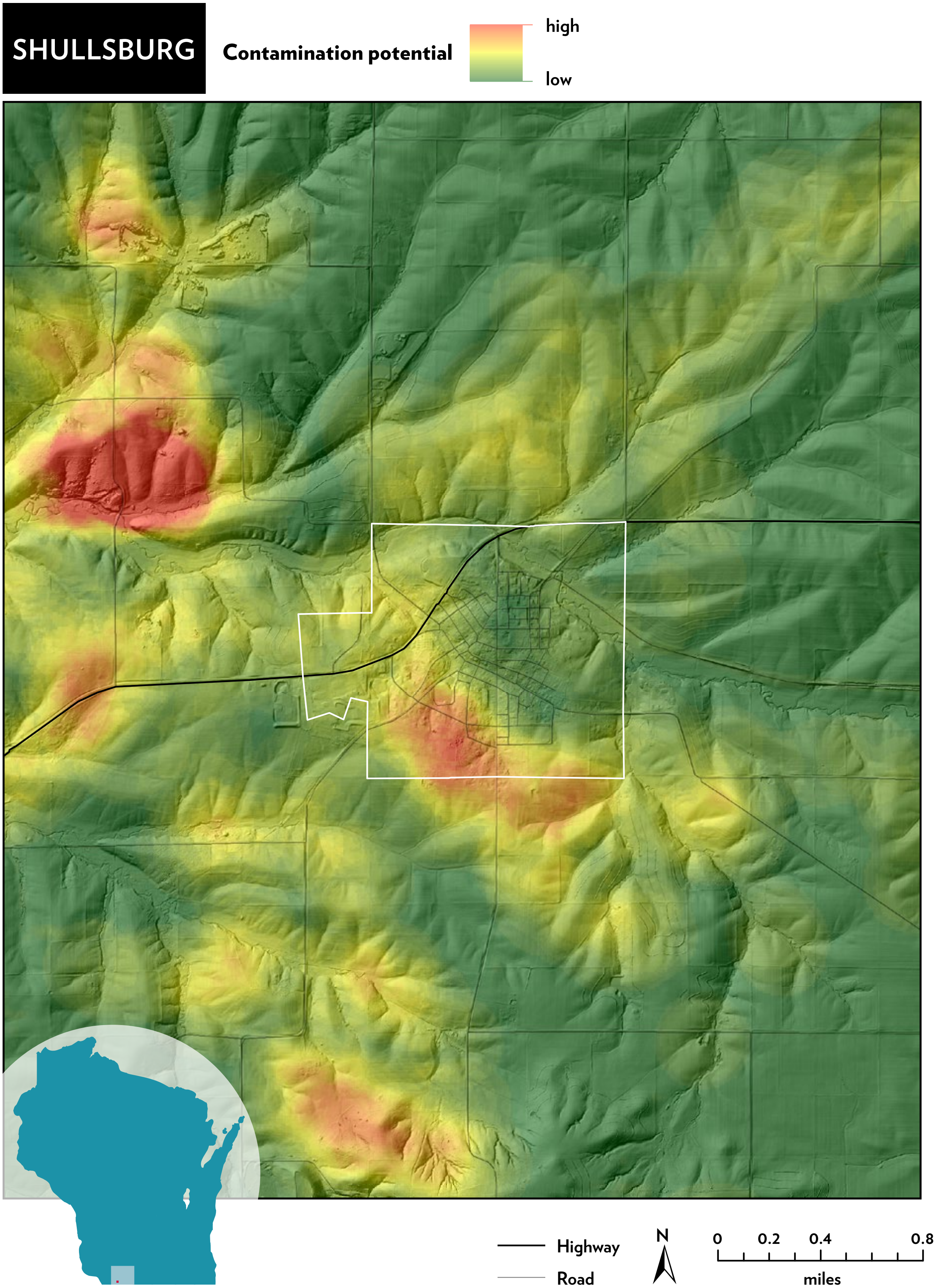
Historic mine features



Surveyed workings
Unsurveyed workings
Surface lead mining
Open activity
Hazard
Abandoned railroad
Mine shaft
Borehole
Civil division
Highway
Road

0 0.25 0.5 1
miles

N


SHULLSBURG
Contamination potential
high
low
Highway
Road
N
0
0.2
0.4
0.8
miles

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Heyl Jr, Allen V., Allen F. Agnew, Erwin J. Lyons, Charles H. Behre Jr, and Arthur E. Flint. *The geology of the Upper Mississippi Valley zinc-lead district*. No. 309. US Government Printing Office, 1959. https://pubs.er.usgs.gov/publication/pp309.

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UW–Madison Division of Extension publications

- **G4173, *Managing Mine-scarred Lands in Southwestern Wisconsin***
- **A2100, *Sampling Soils for Testing***
- **A2166, *Sampling Lawn and Garden Soils for Analysis****
- **A3905-03, *Soil Contaminants in Community Gardens****
- **A4088, *Reducing Exposure to Lead in Your Garden Soil****
- **A4089, *Lead in Home Garden Soil****

*Available in Spanish

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Figures 1–3 adapted from Heyl et al. 1959 (**https://pubs.er.usgs.gov/publication/pp309**).

Cover photos: Top: Wisconsin Historical Society, Clayton Lurvey, Dodgeville Mine, image 37743. **https://www.wisconsinhistory.org/Records/Image/IM37743**. Bottom: Wisconsin Historical Society, Zinc Works, image 38320. **https://www.wisconsinhistory.org/Records/Image/IM38320**.