# Identification of Areas Susceptible to Ground Subsidence Due to Mine Drift or Shaft Collapse in Butte, Montana

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- History of mining in Butte
- Explanation of underground mine workings
- Post underground mining challenges/events
- Long term monitoring of subsidence
- Utilization of old mine maps with new technology

# Overview of Butte, Montana Mining

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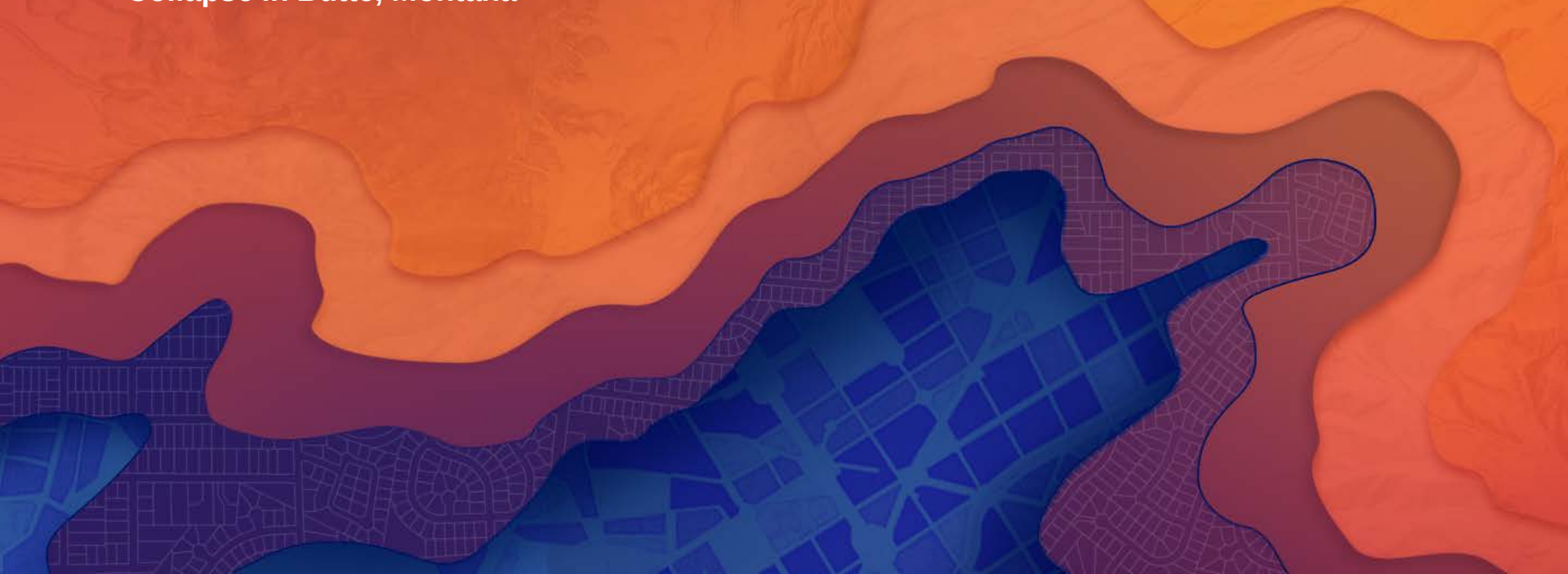


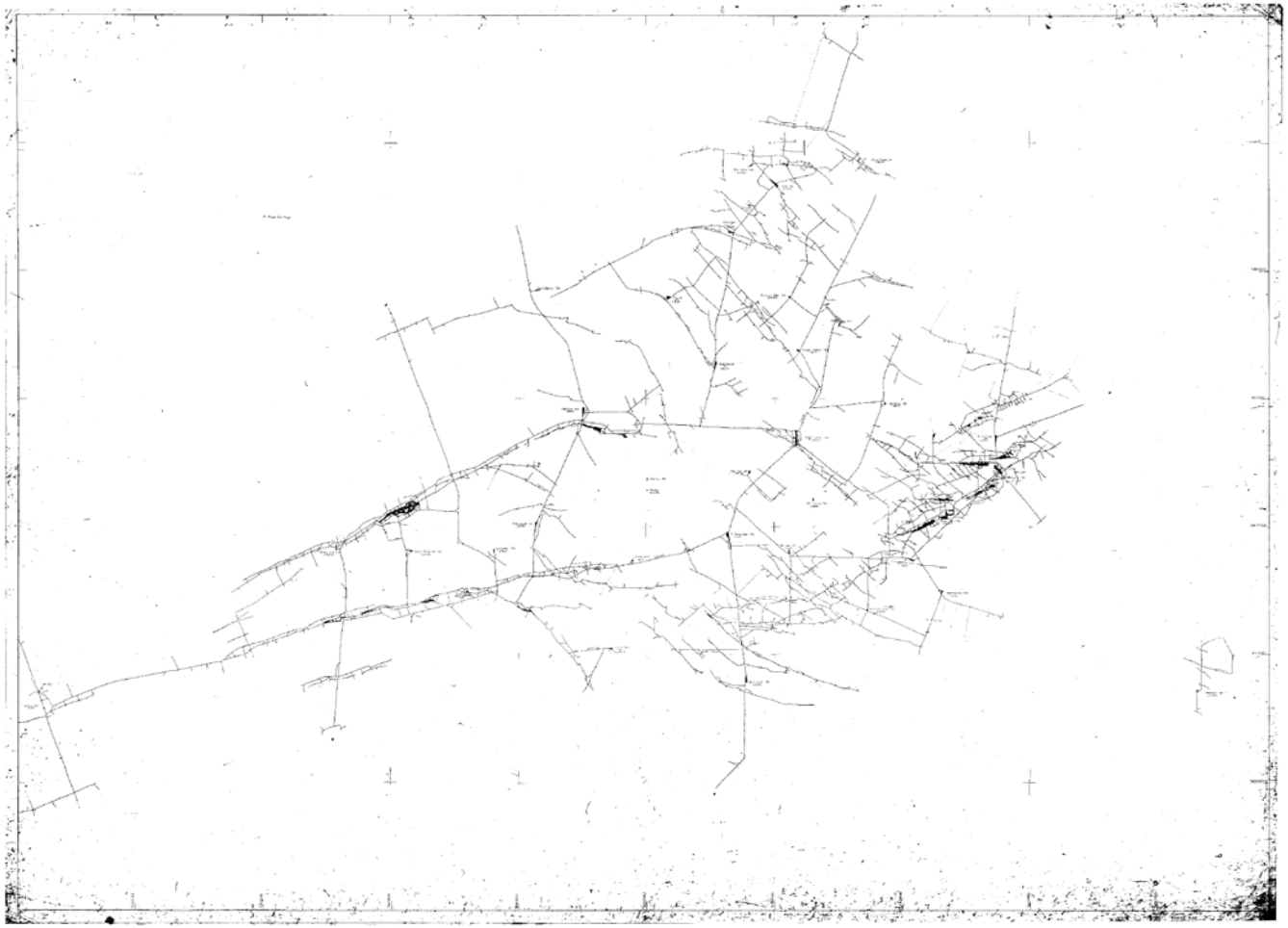
# Overview of Butte, Montana Mining

- Placer mining started in Butte around the 1860s
- Underground hard rock mining resurged in the 1870s
- Historic Anaconda Copper Mining Company (ACMC) maps show approximately 5600 miles of workings (Example on next slide)
- Mine workings extend from just below the surface to about a mile below the surface
- Ground subsidence and sink holes have appeared

**https://www.mininghistoryassociation.org/ButteHistory.htm**

**http://www.co.silverbow.mt.us/481/History-Culture**

# Example: Level 31 Map



Historic Anaconda Copper Mining Company map – Montana Bureau of Mines and Geology – GIS Lab

# People want answers

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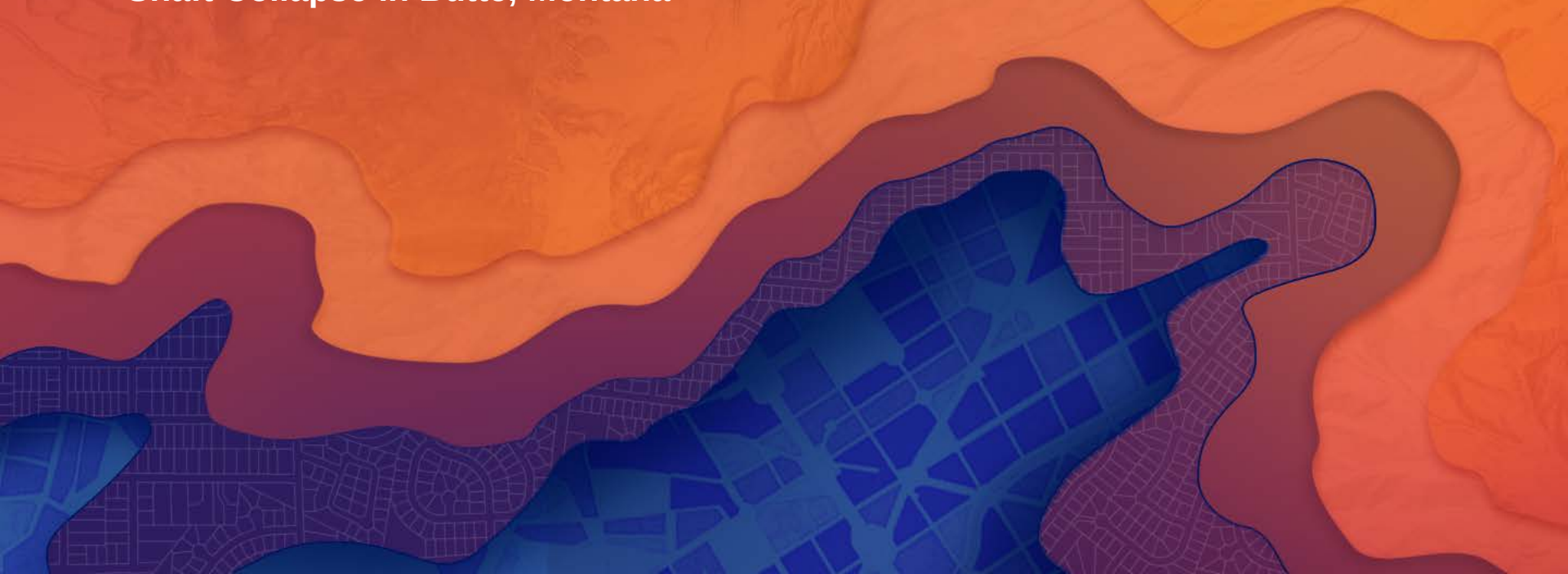

# Individuals Seeking Answers

- “Is there any mine working below my property that would cause X,Y, or Z”
- “I’m interested in purchasing a property. Are there any mine workings below it?”
- My house/building has a big crack in the floor or foundation. Is it from a mine?

# Solution Ideas

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# Solution Ideas

- Development of a georeferenced 3-D model
  - Could be overlaid with property boundaries and ownership information
  - Allow for the input of a GPS location
- Benefits sought
  - Quicker processing time
  - Ability to export an image to provide visual aid to individual

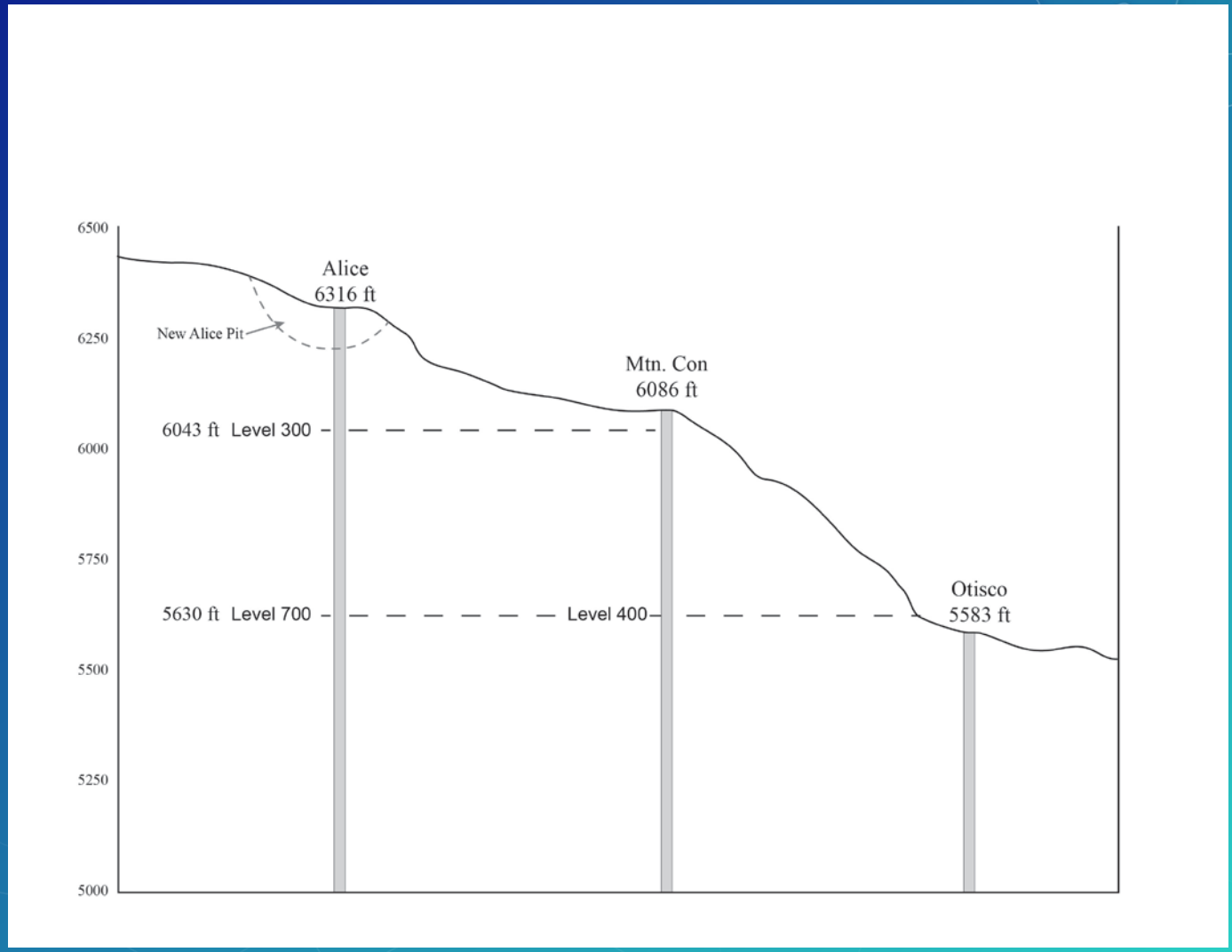
# Development Problems

**Identification of Areas Susceptible to Ground Subsidence Due to Mine Drift or Shaft Collapse in Butte, Montana**

# Development Problems

- Anaconda Copper Mining Company established a local coordinate system for use in their mapping
  - Elevation datum used is unknown since it predates  National Geodetic Vertical Datum of 1929 (NGVD 29)
- Elevations to each mining level were measured from the Alice shaft collar
  - Currently the Alice shaft and headframe are gone.
  - The previous location of the Alice shaft and headframe is now a pit – Alice Pit

# Development Problems



# 633 West Broadway Street, Lincoln Elementary School

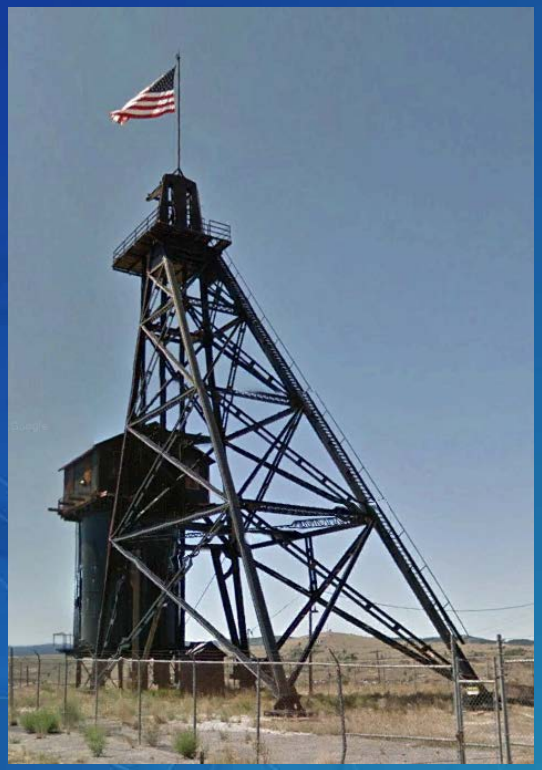
# Old Glory Incline Shaft

# Silver King Shaft

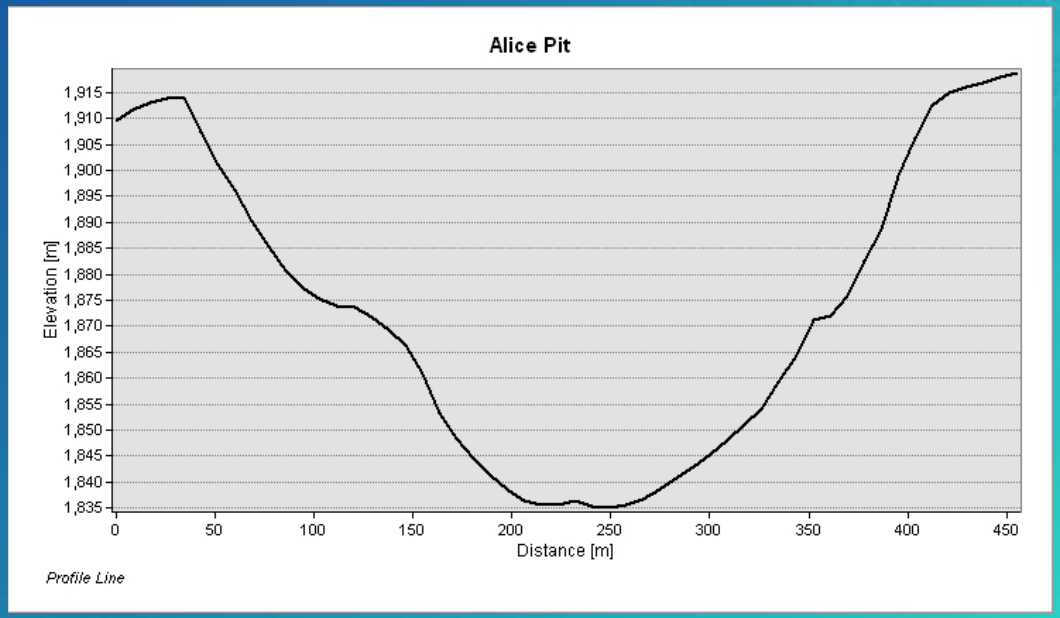

# Development Problems

- Unable to directly calculate correction needed to convert local elevation to North American Vertical Datum of 1988 (NAVD 88) due to the Alice shaft headframe being removed and a pit being developed.

**Ideal – Collar present**



**Not Ideal – No collar and area is a pit**



# Development Solutions

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# Development Solutions

- Interpolation of ground points to determine an approximate Alice Shaft ground elevation
- All levels of drifts were intersected with the Digital Elevation Model (DEM) cell boundaries to allow for individual calculations of depth below surface
- Determination of average vertical correction based on still standing headframes and DEM
  - Approximate error:
    - ~ +/- 5 m from average correction to still standing headframes
    - error from DEM is dynamic. A steeper ground area may incur a larger error

# Results

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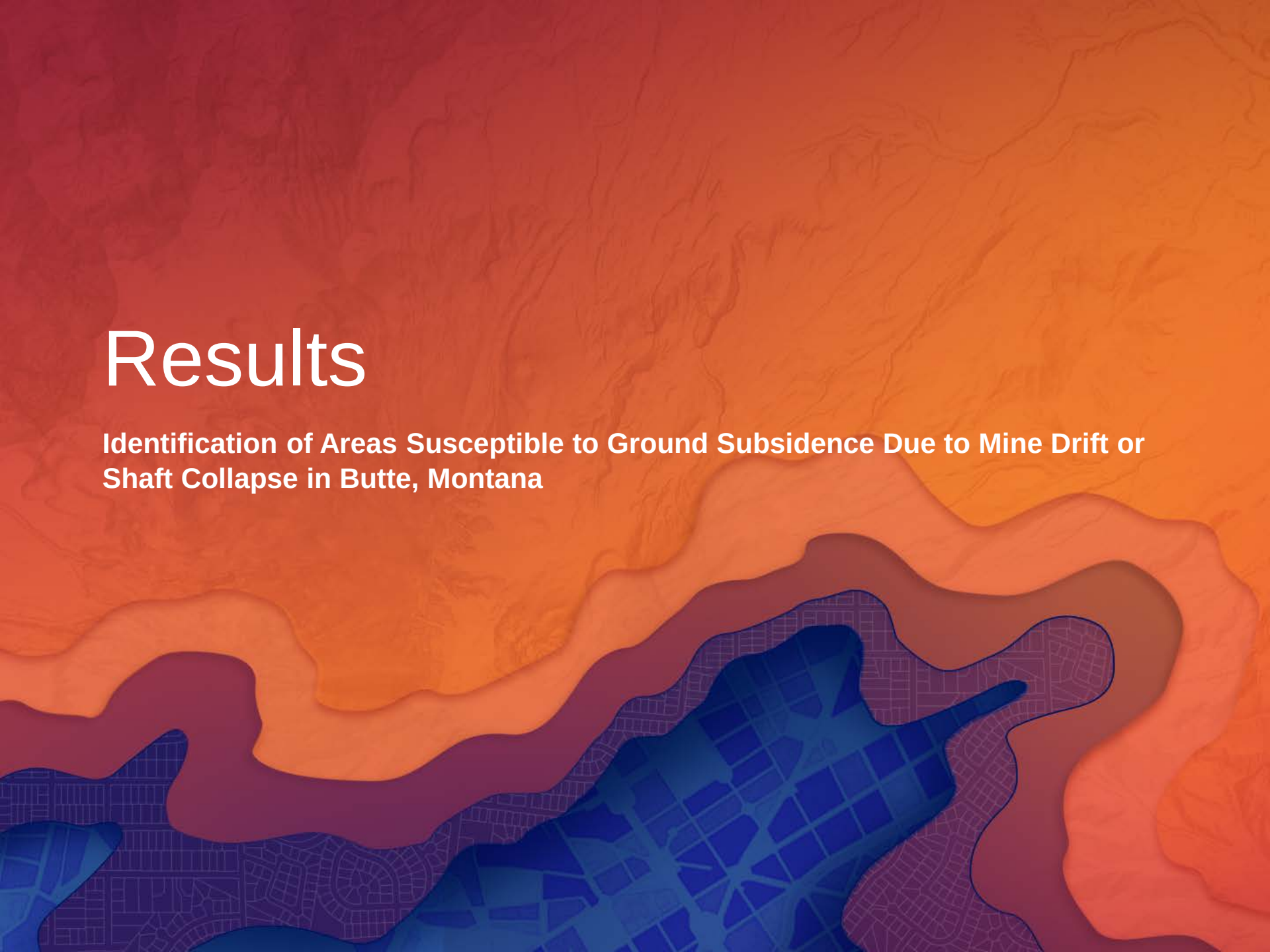
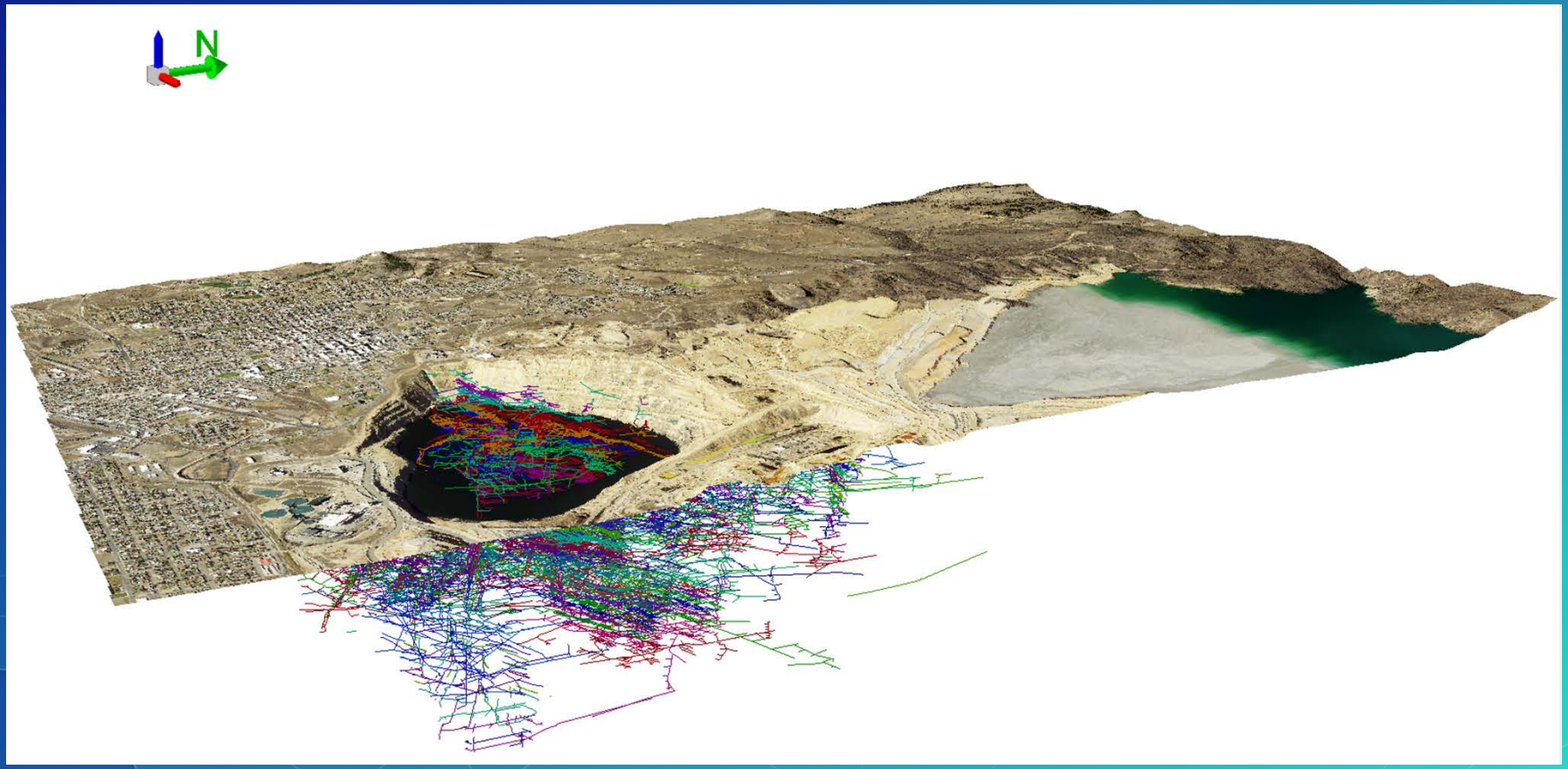


# Results

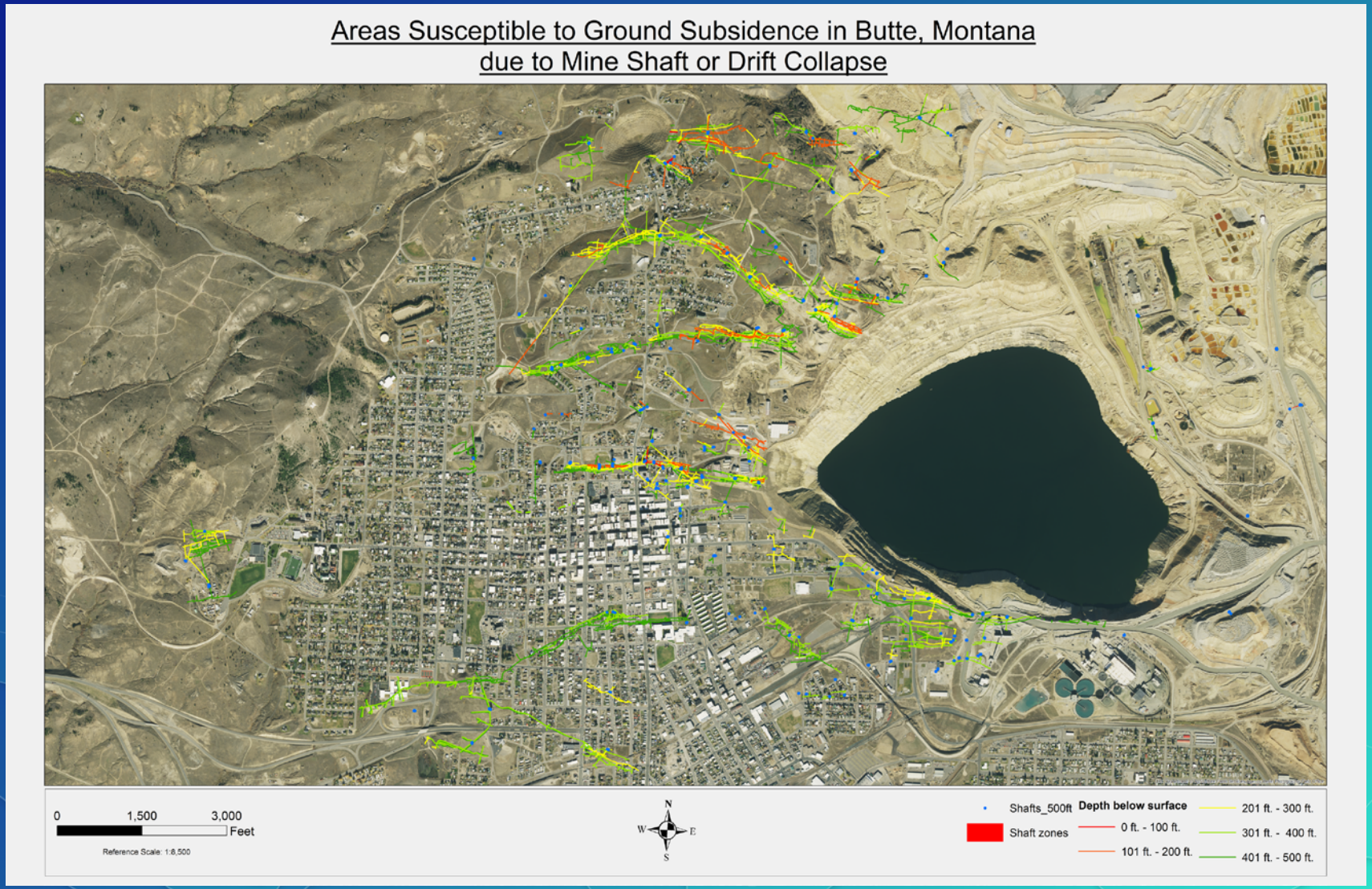
- Developed a 3D model of all 51 levels of mining drift and shaft locations
- Developed a general map showing areas that may be susceptible to ground subsidence due to mine drift or shaft collapse

# 3D Model




NAIP Imagery: USDA-FSA-APFO Aerial Photography Field Office

# General Map: Drifts <= 500 ft.




ESRI World Imagery: https://services.arcgisonline.com/ArcGIS/rest/services/World_Imagery/MapServer


ABANDONED MINE SHAFT
I JUST HATE IT WHEN BUTTE PEOPLE DROP IN UNANNOUNCED!
Butte Weekly
FREE
BUTTE RESIDENTS SUING MINING COMPANIES
THE BUTTE WEEKLY
09-20-06

# Questions?

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