

Promises and challenges of data collected to aid the St. Louis Area Earthquake Hazards Mapping Project

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The St. Louis Area Earthquake Hazards Mapping Project is a study of the U.S. Geological Survey. The study includes collection of geotechnical data from other sources to assist with subsurface characterization in the project area, which encompasses approximately 1,711 square miles (4,432 square kilometers) of Missouri and Illinois (fig. 1) within the St. Louis Metro area. Data sources include the U.S. Army Corps of Engineers, the Missouri Department of Transportation, and engineering firms. Interpretation of these data will aid the prediction of site response at various localities throughout the project area and the production of seismic hazards maps based on scenario earthquakes affecting the region.

Using data from other sources provides a tremendous cost savings to the project and allows for a greater density of information in the prediction of seismic hazards; however, data from various sources arrive in a variety of formats and standards. Often, data collected for a specific project cover only a limited area. A good example are geotechnical borings from the Missouri Department of Transportation and the U.S. Army Corps of Engineers, which tend to be restricted to the locations of highways or flood protection levees, respectively. Historic data often arrive in analog formats lacking a well-defined spatial reference. Paper maps and photographs must be scanned digitally and georeferenced to existing cospatial imagery and maps. Geotechnical data contains varying levels of detail, which must be accounted for when using them for subsurface characterization.

The objective of this task is to integrate data into a uniform database from various sources so that it is useful for characterization of the subsurface beneath the St. Louis metro area to assist in creating area-wide seismic hazards maps. Using existing data from other sources allows large amounts of data to be collected at a relatively low cost, but creates challenges due because of the different standards and formats in which they are provided. This task involves the interpretation and transformation of differing data sets to a uniform standard.

The project area encompasses a diverse geologic setting. Conditions vary from uplands with Paleozoic bedrock at a shallow depth to the floodplains of the Missouri and Mississippi River, which contain 120 feet (ft) [36.6 meters (m)] or more of unconsolidated Quaternary alluvium overlying bedrock. These floodplains have a shallow water table and are susceptible to liquefaction. The concentration of critical infrastructure including refineries, pipelines, electrical transmission lines, highways, and railroads in these vulnerable areas makes them of particular interest.

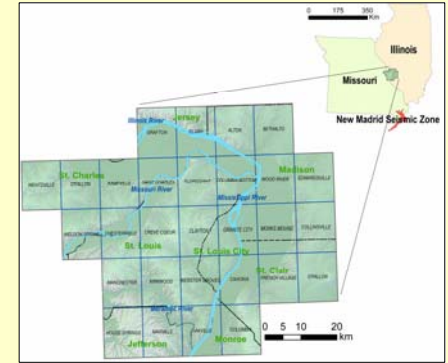


Figure 1. Extent of project study area.



Figure 2. Imagery showing 1956 boring plan and boring locations georeferenced to modern cospatial imagery.

A 1956 boring plan provided by the U.S. Army Corps of Engineers, St. Louis District (fig. 2) has been georeferenced based on modern cospatial imagery. The boring locations were then input as a vector based shapefile, shown as red dots, for use in GIS coverages and databases. This boring plan shows a part of East St. Louis immediately across the Mississippi River from downtown St. Louis.

An example boring log from the Corps of Engineers (fig. 3) illustrates a borehole that was advanced to a depth of around 116 ft (35.4 m) below the ground surface before encountering refusal (symbolized by R). Although these borings do not provide an absolute number as to the depth to bedrock, they do provide useful information and indicate that the bedrock surface lies around 115-120 ft (35.0-36.6 m) beneath unconsolidated Quaternary alluvial floodplain deposits.

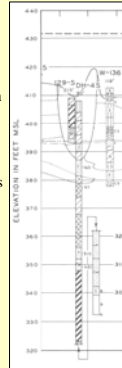


Figure 3. Example boring showing depth to refusal (R).

Data provided by the Howard Bend Levee District, a private entity in Maryland Heights, Missouri has provided boring locations (fig. 6) and four corresponding boring logs conducted according to modern sampling and testing methods as part of an upgrade to 500-year flood protection. The recently opened (2003) Page Ave. (MO Route 364) extension passes through the area with its main bridge over the Missouri River located in the center left and Creve Coeur Lake in the lower right of the boring plan, respectively.



Figure 6. Boring plan illustrating the location of four borings to bedrock as provided by the Howard Bend Levee District.

An example of one log is displayed in fig. 7 (two images) and was conducted using modern methods. Although these logs do not core 5 ft (1.5 m) into the underlying bedrock as is done in modern Corps of Engineers borings, they indicate that the bedrock surface lies approximately 115-125 ft (35.0-38.1 m) beneath a cover of unconsolidated Quaternary alluvium.

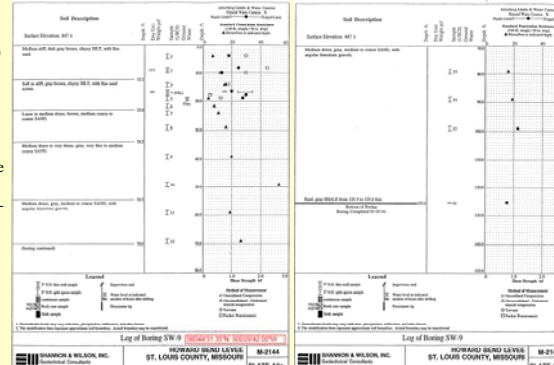


Figure 7. Boring log SW-9 from the Howard Bend Levee District shows depth of bedrock at 125.6 ft (38.3 m) and includes standard penetration test (SPT) blow count data.



Figure 4. Example boring log illustrating more than 65 ft (19.8 m) junk fill beneath St. Louis Floodwall.

A Corps of Engineers boring log from 1963 (fig. 4) taken from a location in St. Louis City north of downtown beneath the St. Louis Floodwall shows greater detail, including a core 5 ft (1.5 m) into bedrock, than the 1956 borings on the east side of the Mississippi River. Notice more than 65 ft (19.8 m) of junk fill including cinders, wood, crushed concrete, steel, and underground piping before native materials are reached. Such materials make the prediction of ground response because of seismic shaking difficult because of the high variability over short distances.

A 1972 Corps of Engineers boring log from the Melvin Price Locks and Dam (LD 26 Replacement) (fig. 5) provides detailed information including depth to bedrock, Atterberg limits (where appropriate), gamma logging, standard penetration test (SPT) blow counts, electrical resistivity, and spontaneous potential. Such details, especially blow counts, aid in the ability to predict how such ground will respond and whether or not liquefaction will occur in an earthquake.

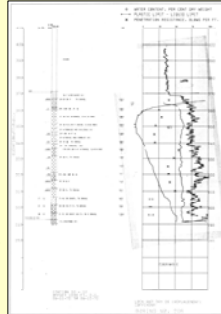


Figure 5. Example of a modern boring log from Melvin Price Locks and Dam showing greater detail than older standards for Corps of Engineers borings.

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