# **APPENDIX C**:

# GEOTECHNICAL OVERVIEW

**M E M O R A N D U M** **P-006-2023**

**TO:** Stephen DeWitte, P.E.
Transportation Engineer Branch Manager
Division of Planning

**FROM:** Christian Wallover, P.G.
Branch Manager
Engineering Geology and Field Services Branch

**BY:** Taylor Hancock, P.G.
Engineering Geology Section

**DATE:** December 18, 2023

**SUBJECT:** Jefferson County
FD52 056 9999
CS 1001/Plantside Drive Extension
Item No. 05-80003.00
Mars No. 1651901P
Geotechnical Overview for Route Extension

## 1.0 General Overview

This planning study is located in the central eastern portion of Jefferson County, Kentucky, northwest of the I-265/KY 155 (Gene Snyder Freeway/Taylorsville Road) interchange. The proposed extension would begin at the southern end of CS 1001 (Plantside Drive) and run relatively parallel to I-265 before turning west, paralleling KY 155.

The purpose of the study is to identify any geological or geotechnical hazards or concerns that could be problematic for the construction of a new route/route extension within the provided project area.

## 1.1 Scope of Work

The scope of work for this study consists of performing a geotechnical overview for the proposed study area based upon research of available published data and the Geotechnical Branch's experience with highway design and construction within the region. General geotechnical and geologic characteristics of the study area have been identified and are discussed in this report. The following sources were used to perform a literature search:

- Moore, F., Kepferle, R., & Peterson, W. "Geologic Map of the Jeffersontown Quadrangle, Jefferson County, Kentucky." Kentucky Geological Survey: USGS. GQ 999. 1972. <https://kgs.uky.edu/kgsweb/download/24k/gq/JEFFERSONTOWN.pdf>
- "Rehl Road/I-265 Interchange: Interchange Feasibility Study." Qk4. 2009.
- USGS Professional Paper 1151-H: The Geology of Kentucky: Physiography

- Available KYTC ArcMap Datasets and Layers
- KYTC Projects Nearby (see Section 6.0 – Past [Relevant] Geotechnical Reports)

## 2.0 Physiography and Topography

The project area is contained within the Outer Bluegrass physiographic region. This region is characterized as an upland area primarily consisting of interbedded limestones and shales. The limestones are less karstic, thus producing/resulting in fewer sinkholes. The shales are more easily eroded than those of the Inner Bluegrass, which can impede groundwater flow, thus there are fewer wells and springs.

The topography of eastern Jefferson County is variable, ranging from approximately 400' at the Ohio River to 890' elevation in the southwestern portion of the county where the Knobs are encountered. Within the project area, the elevation varies from approximately 740' elevation along the western side to approximately 630' near the eastern/northeastern edge of the project area.

## 2.1 Drainage

In the project area, drainage predominately flows northeast toward Pope Lick Creek, which flows southeast into Floyd's Fork. Floyd's Fork flows south/southwest, eventually flowing into the Salt River. The drainage pattern is dendritic; in this case indicative of homogenous underlying sedimentary bedrock that is unfolded, yet erodes relatively equally in all directions.

Figure 1: Stream beneath (north of) lower Riggs Lake, flowing east/northeast toward Pope Lick Creek.

## 3.0 Geology & Stratigraphy

Available mapping by the Kentucky Geologic Survey (KGS) Geologic Map Service indicates the project area is primarily underlain by bedrock belonging to the Drakes Formation of the Upper

Ordovician and the Osgood and Brassfield Formations of the lower Silurian. The western edge of the expanded project area is underlain by the Laurel Dolomite of the Middle Silurian (see Geologic Maps).

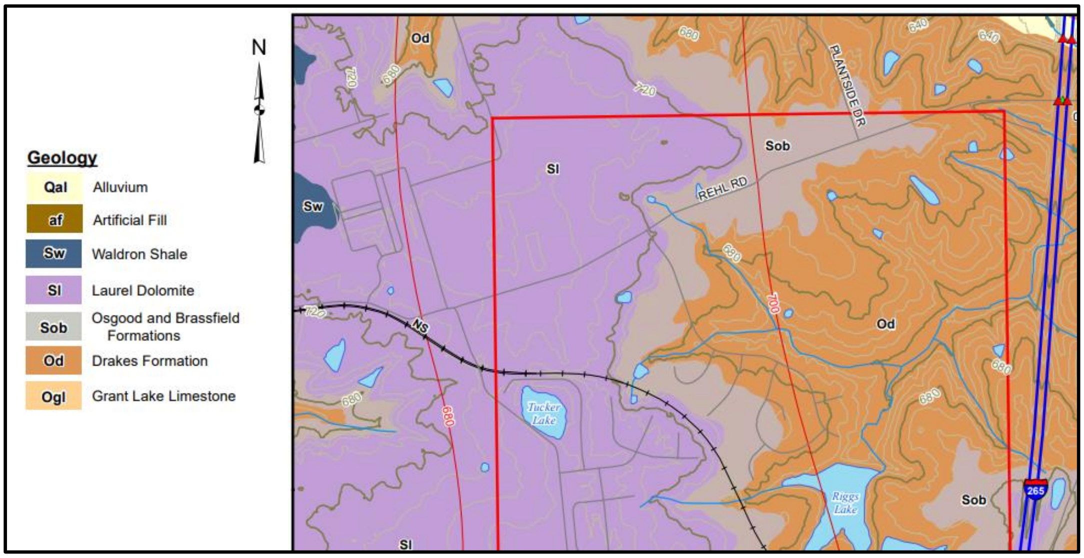



Figure 2: Excerpt from the Geologic Map (attached). Refer to Appendix.

## 3.1 Bedrock

The Drakes Formation – of Ordovician age, typically consists of limestone, dolomite, and shale. In the project area, limestone and shale will be the primary rock type encountered – the Rowland Member of the Drakes Formation being the dominant unit in this area. The limestone is medium gray and greenish-gray to bluish-gray, weathering to pale olive and yellowish-gray. Typical limestone of the Rowland Member is dolomitic and argillaceous, fossiliferous to fossil-fragmental (including colonial corals, brachiopods, ostracods, and bryozoans), and streaked with irregular burrows filled with easily weathered glauconitic material. Dominant shale is shades of olive gray to shades of dark greenish-gray, primarily clayey, and calcareous, weathering to yellowish-gray. This shale is persistent in two beds, each five to seven feet thick, one at the base of the member and one above the intensely fossiliferous zone. Thin interbeds of brown to black, fossiliferous, carbonaceous shale distinguish the Rowland Member from overlying members. In the project area, the Drakes Formation is between 30’ and 105’ thick.

The Osgood and Brassfield Formations of the Lower to Middle Silurian, are comprised of shale and dolomite (Osgood), and Limestone (Brassfield). Shale is greenish-gray, silty, poorly fissile, dolomitic, and weathers to gray flakes or to yellowed-gray clay. Dolomite is yellowish-gray with reddish-orange mottling, fine grained, and occurs at the base of the formation. Brassfield limestone is made up of three distinct types of limestones, each typically two feet or less thick, each potentially missing at any given location. The three types include an orange-yellow, medium grained, fossil fragmental limestone (top), a medium to dark gray, fine grained, non-fossiliferous limestone (middle), and a light olive-gray, coarse grained, highly fossiliferous limestone (base). Exposures of these limestones are predominately limited to stream channels and road cuts.

### 3.2 Soils and Unconsolidated Material

Soil samples obtained during nearby previous geotechnical investigations (see reports listed below in section 6.0), were found to primarily consist of lean clay (CL), with limited fat clay (CH), and sandy clay (SC). The samples were designated as A-6 and A-7-6 in the AASHTO Classification System and as SC, CL, and CH in the Unified Classification System. Depths to rock varied from 4.0 ft. to 20.0 ft, however, depths greater than 20.0 ft may be encountered. Rock fragments and boulder material were encountered in the overburden soil in the core borings.

Figure 3: Typical soils with limestone fragments in the project area south of Riggs Lake.

## 4.0 Geologic Hazards and Considerations

### 4.1 Karst

Available mapping indicates the bedrock beneath the project area is predominately prone to karst development (see attached Karst Map). Site specifically, formations underlain by Silurian-aged bedrock are prone to karst. The areas within project limits that are non-karst are the northeastern quadrant – where the Silurian bedrock has eroded – and the southeastern tip of the project area – underlain by Silurian dolomite.

Bedrock conditions in karst-prone areas favor sinkhole development, subsurface drainage, and promote ponding. Extreme or prolonged precipitation events can result in extremely wet soils, ponding, flooding of low-lying areas, and sinkhole formation and/or growth.

### 4.2 Faults

There are no faults mapped in the project area.

### 4.3 Mining/Quarry Activity

There are no reported mines or quarries in the project area.

### 4.4 Landslides

An embankment slide correction (L-014-1994) was completed in the southwest quadrant of the Gene Snyder (I-265)/Taylorsville Rd (KY 155) interchange. Poor bedrock (constructing the roadway atop Osgood and Brassfield Formations) appears to be the primary factor behind the failure. The failed material was excavated, a geotextile fabric type IV placed, and the material replaced with granular fill (Classes 2, 3, and 23).

### 4.5 Wells and Springs

Mapping indicates two plugged monitoring wells inside and two groundwater springs immediately northwest of the project area.

### 4.6 Constructed Lakes

Riggs Lake in the east central portion of the project area is comprised of an upper and lower portion. The lake appears to be owned by Saint Michael Catholic Church. Any alignment seeking to incorporate the existing bridge over the Norfolk Southern line would intersect the eastern edge of the upper lake.

Tucker Lake along the western edge of the project area should not be impacted by nor impact construction or constructability of a Plantside Drive extension.

## 5.0 Design Expectations and Expected Foundation Considerations

### 5.1 Embankments

Generally, embankments built from the native soils and bedrock can be constructed to a height of 20 feet with 2H:1V side-slopes – if the foundation is suitable and proper compaction methods are used. Any embankment built 20 feet or taller will require a stability analysis, which could necessitate a flatter slope be used. If built on alluvium, embankments may require settlement analyses.

### 5.2 Cut Slopes

Cut slope configurations in rock are generally controlled by bedrock lithology, bedrock quality, results of Slake Durability Index (SDI) tests in shales and siltstones, and by the presence of any fractures and/or joints. Slope configurations for rock cuts in durable bedrock can generally be 1H:2V or 1H:4V presplit slopes on approximate 30-foot intervals of vertical height with 18 to 20-feet intermediate benches or 15-foot overburden benches. Slope configurations for non-durable bedrock or soils are generally constructed on a range of 2H:1V to 3H:1V slopes or flatter based on the height of the slopes and content of the material.

Typical slopes in the project area have been constructed on 2H: 1V or flatter due to the presence of non-durable shales and thinly, irregularly to nodular bedded limestones. These conditions promote accelerated weathering, which could undermine any roadway or structure built on/in local bedrock. Should rock cuts be required in the project area, a detailed cut stability analysis will most likely be necessary.

### 5.3 Structures

A previous report (see S-057-2020) – located approximately 1.2 miles east of the project area indicate shallow to moderately deep (0 to 20-feet deep) soils around structure foundations, though soil depths can be greater when sinkholes are encountered. Utilized bridges in (and near) the study area are generally rock bearing (spread footings). Smaller structures such as retaining walls and box culverts may be constructed on soil or bedrock.

An existing bridge over railroad built by Louisville Metro Government is located immediately south of upper Riggs Lake. Construction of this bridge was completed between mid-2017 and early-2018. As the bridge has no approaches, it has been unused since completion and, therefore, is not on the NHI bridge inventory, thus has gone uninspected since being completed.

### 5.4 Saturated, Soft, or Unstable Soils

California Bearing Ratio (CBR) values in the area are generally low (in the range of 1-3). If rock roadbed is not available other methods of improving subgrade can be considered. Chemical stabilization is the preferred method of subgrade improvement. In areas where lanes are being added or chemical stabilization is not feasible (such as cross-overs, tie-ins, etc.) the subgrade can be constructed with Kentucky Coarse Aggregate No. 2, No. 3, or No. 23 sized stone with geotextile fabric.

Low and high plasticity clays can be very moisture sensitive. Working platforms may be necessary for cut and/or fill situations where soft and/or saturated soil is encountered. In these areas a working platform consisting of Kentucky Coarse Aggregate #2's, 3's, or 23's or limestone from roadway excavation wrapped with Geotextile Fabric may be required.

Figure 4: Typical saturated soils with weathered limestone fragments north of Riggs Lake.

## 5.5 Sinkholes

Available mapping indicates several small sinkholes within the project area. Working in areas impacted by karst can prove to be unpredictable. An abundance of karst features can result in greatly varying rockline depths/elevations within a relatively short distance. Karst terrain can likely be a critical factor to any new construction in the project area.

All encountered open sinkholes and/or solution cavities within the limits of construction, whether shown on the plans or not, will require an investigation as outlined under Section 215, Treatment of Open Sinkholes, of the standard specifications for road and bridge construction (see Standard Drawing No. BGX-018).

Any sinkhole to be used for drainage purposes shall incorporate sufficient measures to minimize water infiltration into the subgrade and erosion control measures to minimize siltation of exposed sinkholes – as outlined in section "Drainage to Significant Resources" in the current edition of the Drainage Manual. Such measures may include the use of vegetated channels, grass-lined swales, interceptor ditches, containment basins, etc. as designated in the Manual.

## 5.6 Ponds

Multiple ponds have been identified within the project corridor. Should these ponds be impacted by roadway construction due to alignment, they will require treatment – such as draining and removal of soft and/or unstable material and stabilization of the area by use of Kentucky Corse Aggregate #2's, #3's or 23's and underlain by geotechnical fabric (typical treatment).

## 6.0 Past [Relevant] Geotechnical Reports

| **Planning** | **Roadway** | **Structure** |
|---|---|---|
| P-004-2023 | R-022-2019 | S-057-2020 |

## 7.0 Conclusion

This is a general overview of the geotechnical considerations that need to be taken in to account during alignment selection and construction. This includes the bedrock, soil, and geotechnical hazards that are expected to be encountered in the project corridor. These features may have adverse impacts on the project.

A complete Geotechnical investigation including drilling, sampling, and testing of materials will be needed to anticipate and plan for any special treatment of issues encountered during that phase. This may include the taking of pavement cores where directed by the project team. Analysis of rock core and soil sample testing will be compiled and presented in a Geotechnical Engineering Roadway Report and a Structure Report if needed.

**Attachments:**

- Site Map
- Geologic Map
- Springs and Wells Map
- Karst Potential Map
- Soil Particle Size Map
- Sepia 024 – Treatment of Open Sinkholes

# Jefferson P-006-2023 - Site Map

## Legend

Project Area

**Roads & Rail**

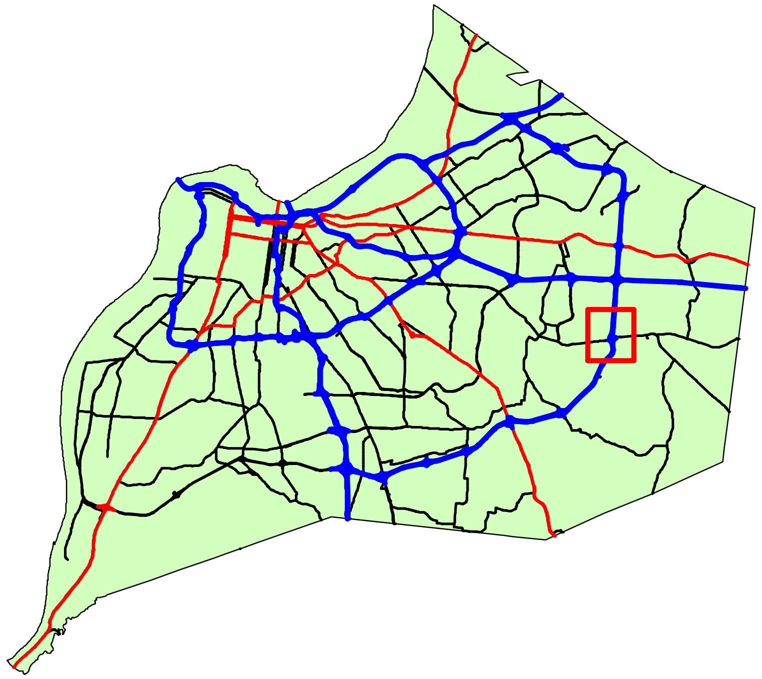
Interstates

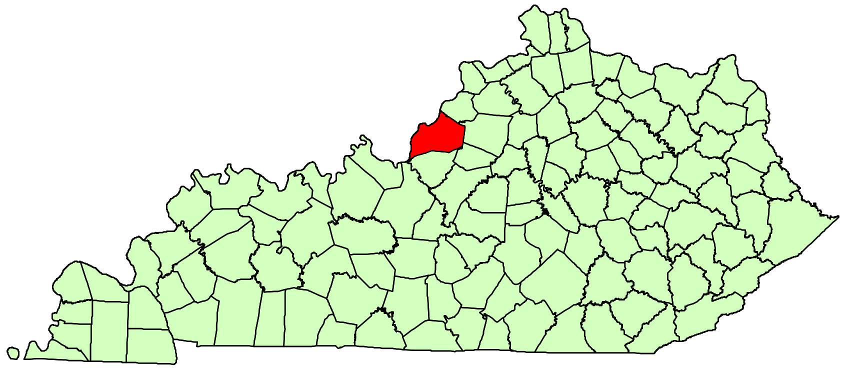
Highways

State Roads

Local Roads

Active Railroad





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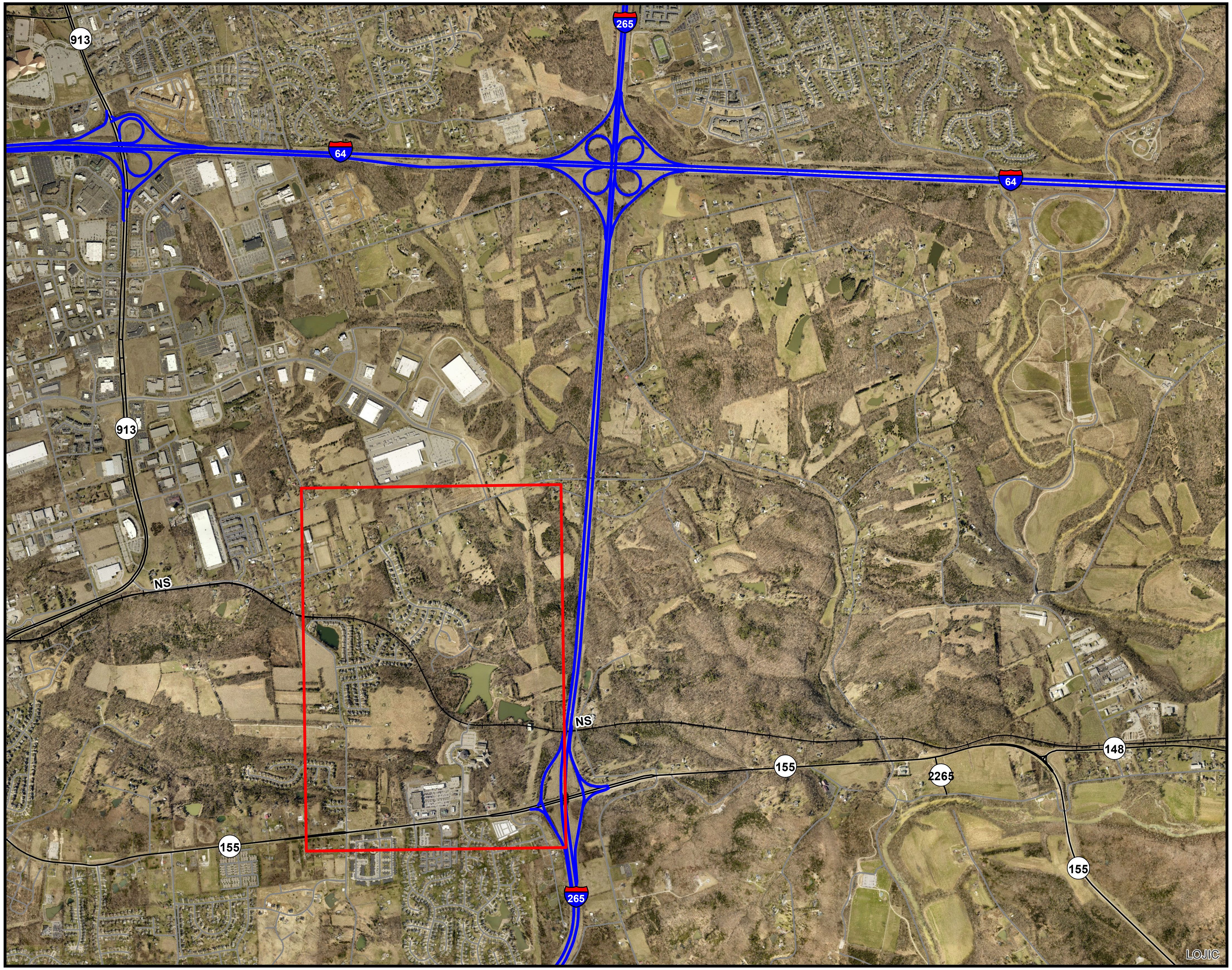



* Imagery from 2019

0 0.5 1 Miles

# Jefferson P-006-2023 - Geologic Map

## Legend

Project Area

Building Footprint

**Bridges**

State Maintained

County/City Maintained

**Roads & Rail**

Interstates

Highways

State Roads

Local Roads

Active Railroad

**Hydrology**

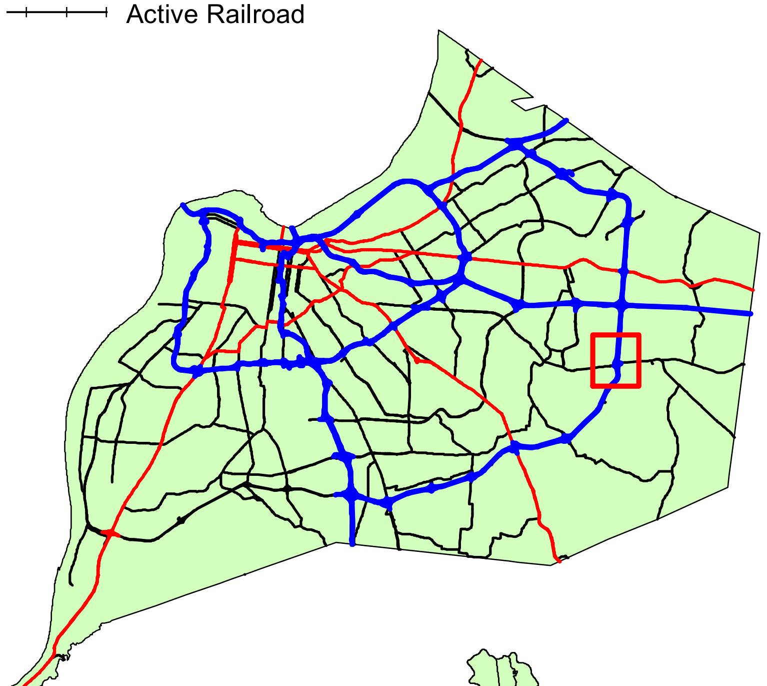
Rivers & Streams

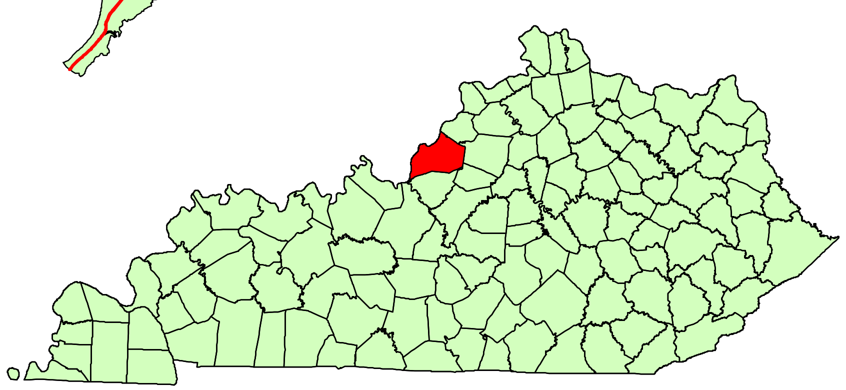
Waterbodies

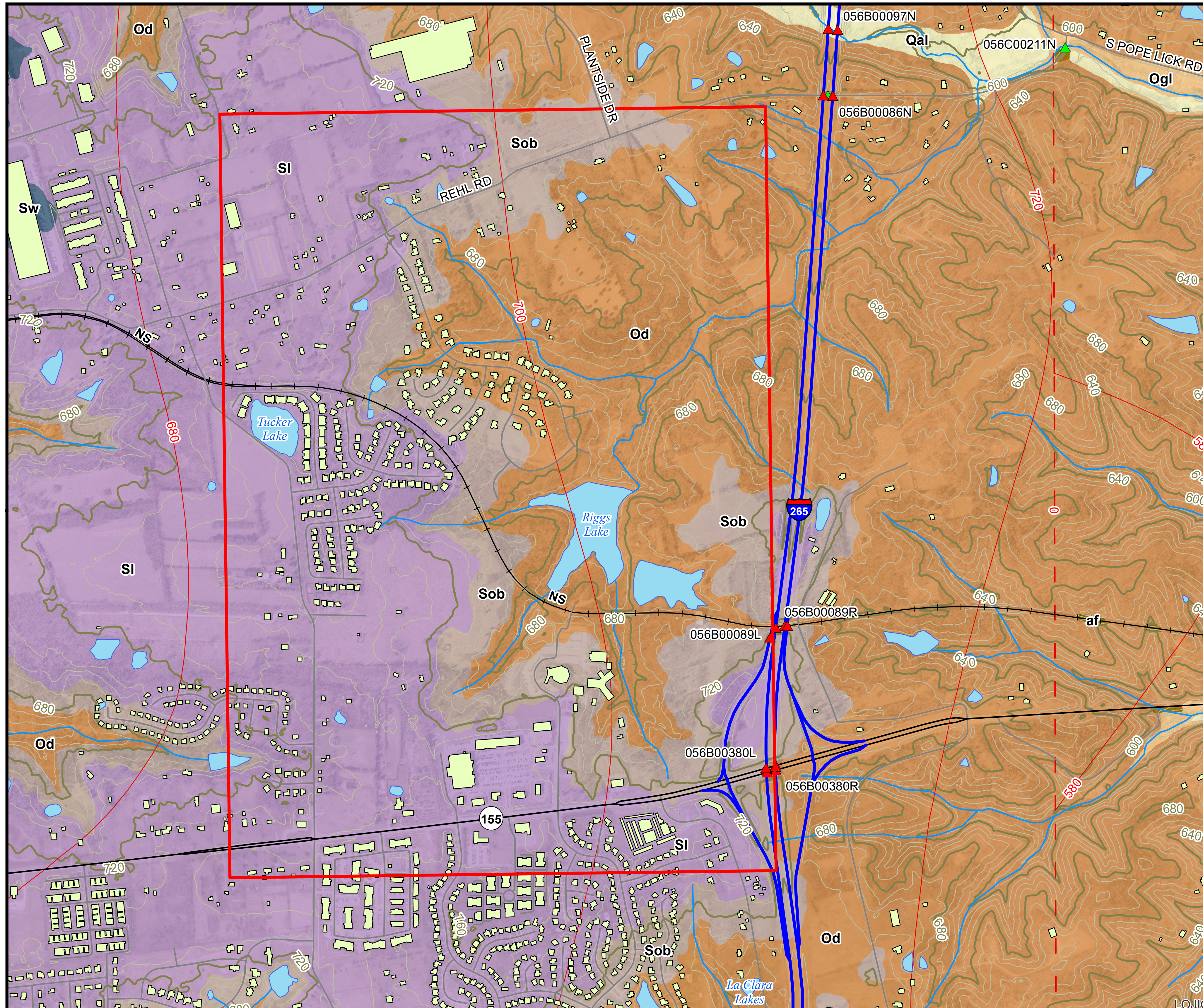
**Geology**

| | |
|---|---|
| Qal | Alluvium |
| af | Artificial Fill |
| Sw | Waldron Shale |
| Sl | Laurel Dolomite |
| Sob | Osgood and Brassfield Formations |
| Od | Drakes Formation |
| Ogl | Grant Lake Limestone |

N








Contour (Index)

Contour (10-ft interval)

Structure contour

0 0.25 0.5 Miles

# Jefferson P-006-2023 - Wells and Springs Map

## Legend

- Project Area
- Building Footprint

**Bridges**

- State Maintained
- County/City Maintained

**Roads & Rail**

- Interstates
- Highways
- State Roads
- Local Roads
- Active Railroad

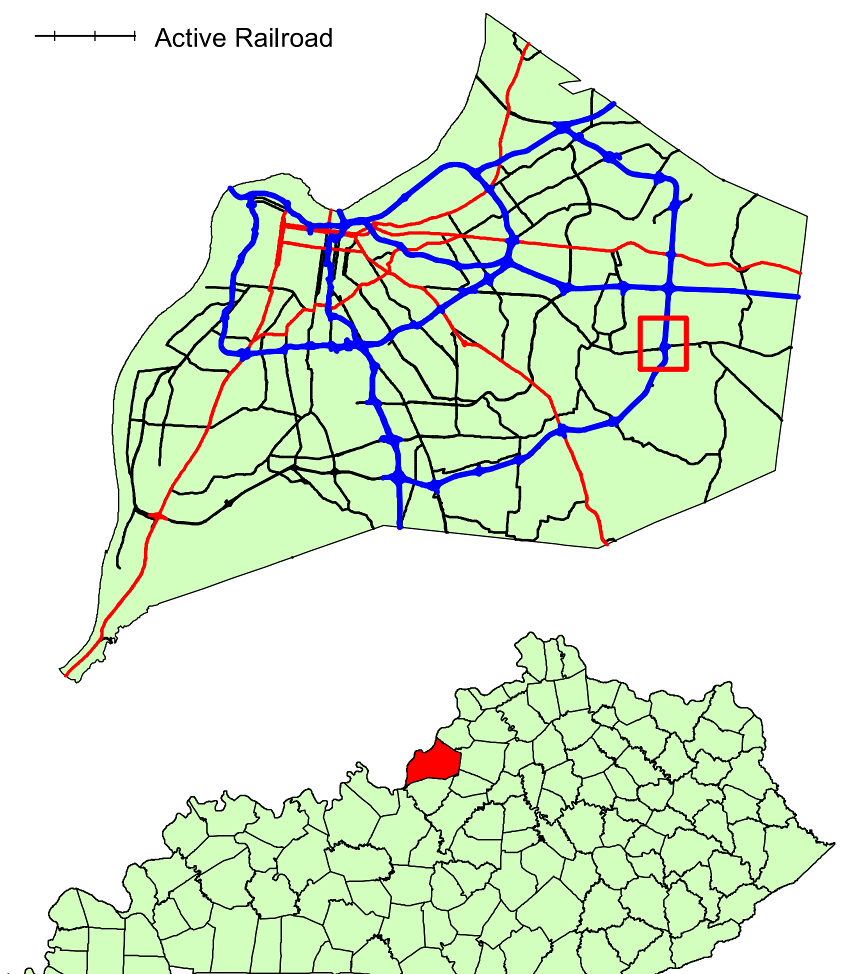
**Hydrology**

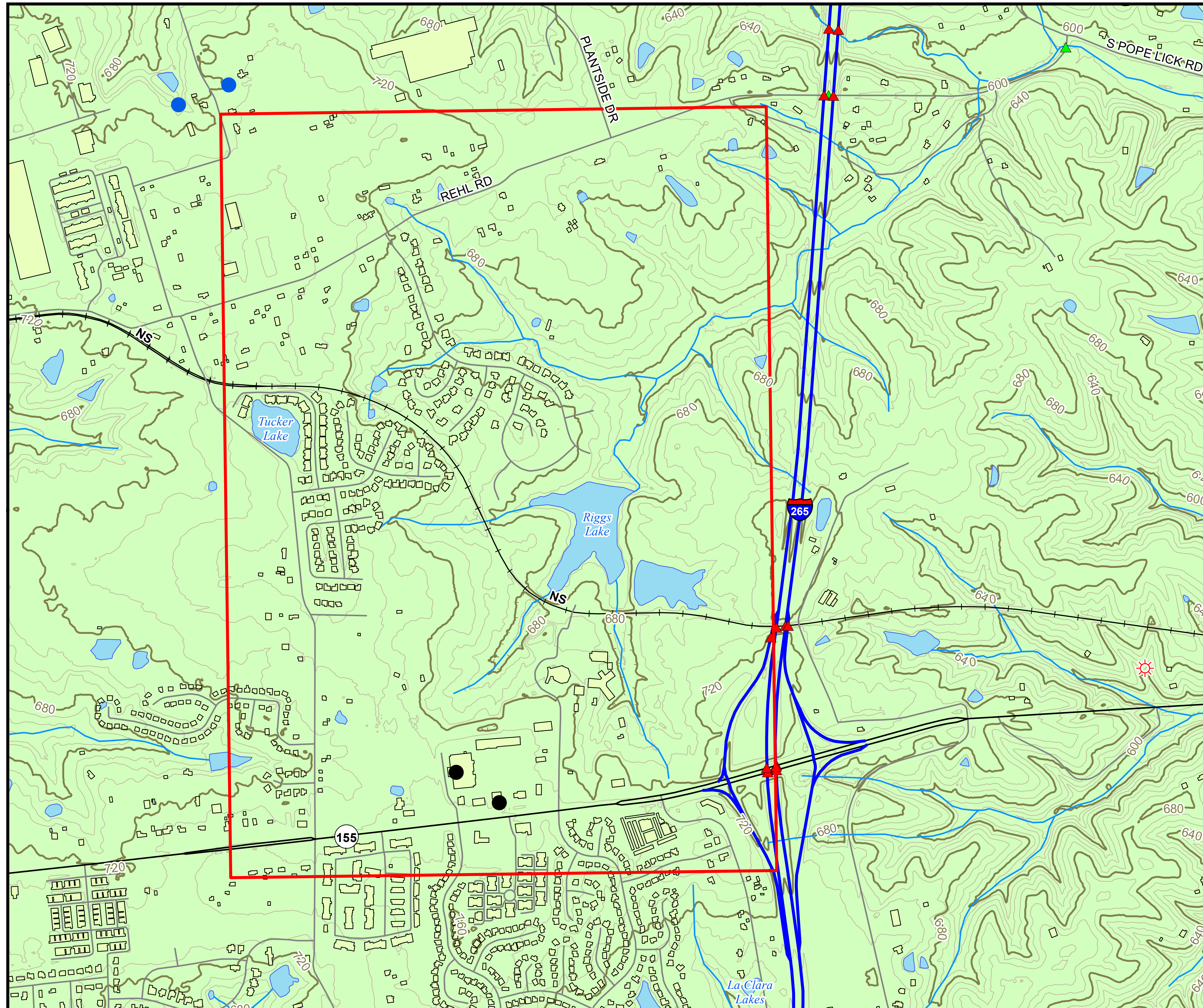
- Rivers & Streams
- Waterbodies

**Wells and Springs**

- Gas Well
- Groundwater Spring
- Plugged Water Well

N






0 0.25 0.5 Miles

# Jefferson P-006-2023 - Karst Potential Map

## Legend

Project Area

Building Footprint

**Bridges**

State Maintained

County/City Maintained

**Hydrology**

Rivers & Streams

Waterbodies

**Roads & Rail**

Interstates

Highways

State Roads

Local Roads

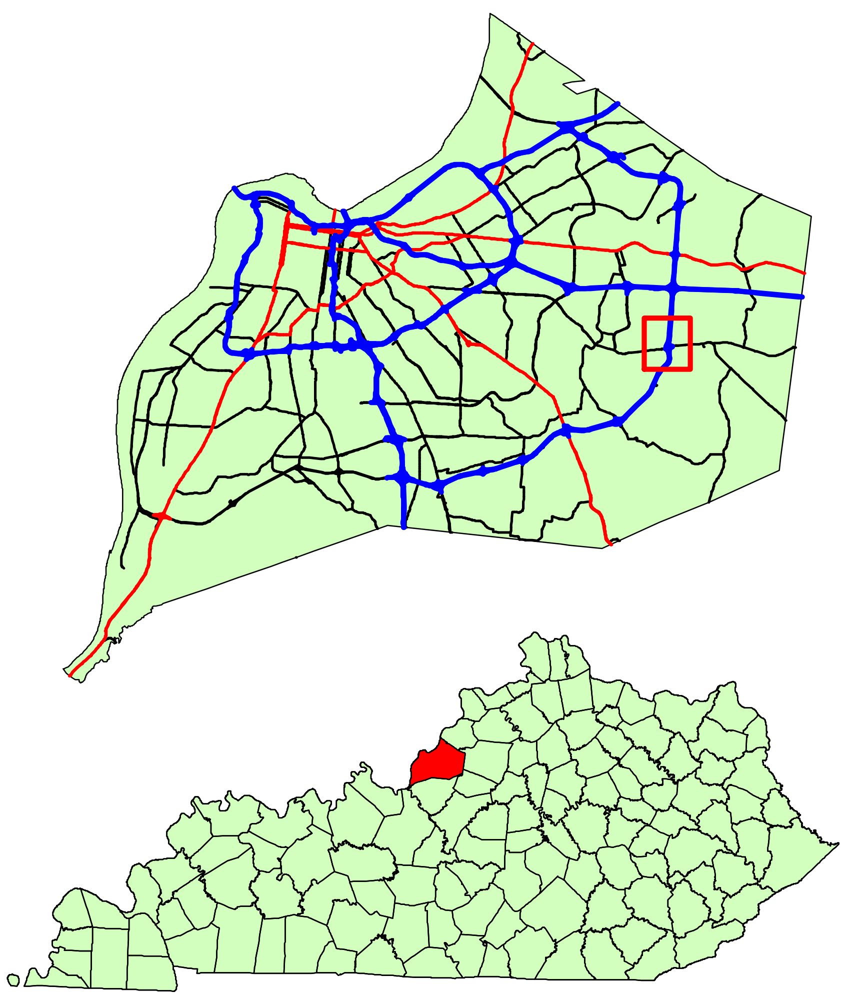
Active Railroad

**Karst Potential**

INTENSE

PRONE

NONE



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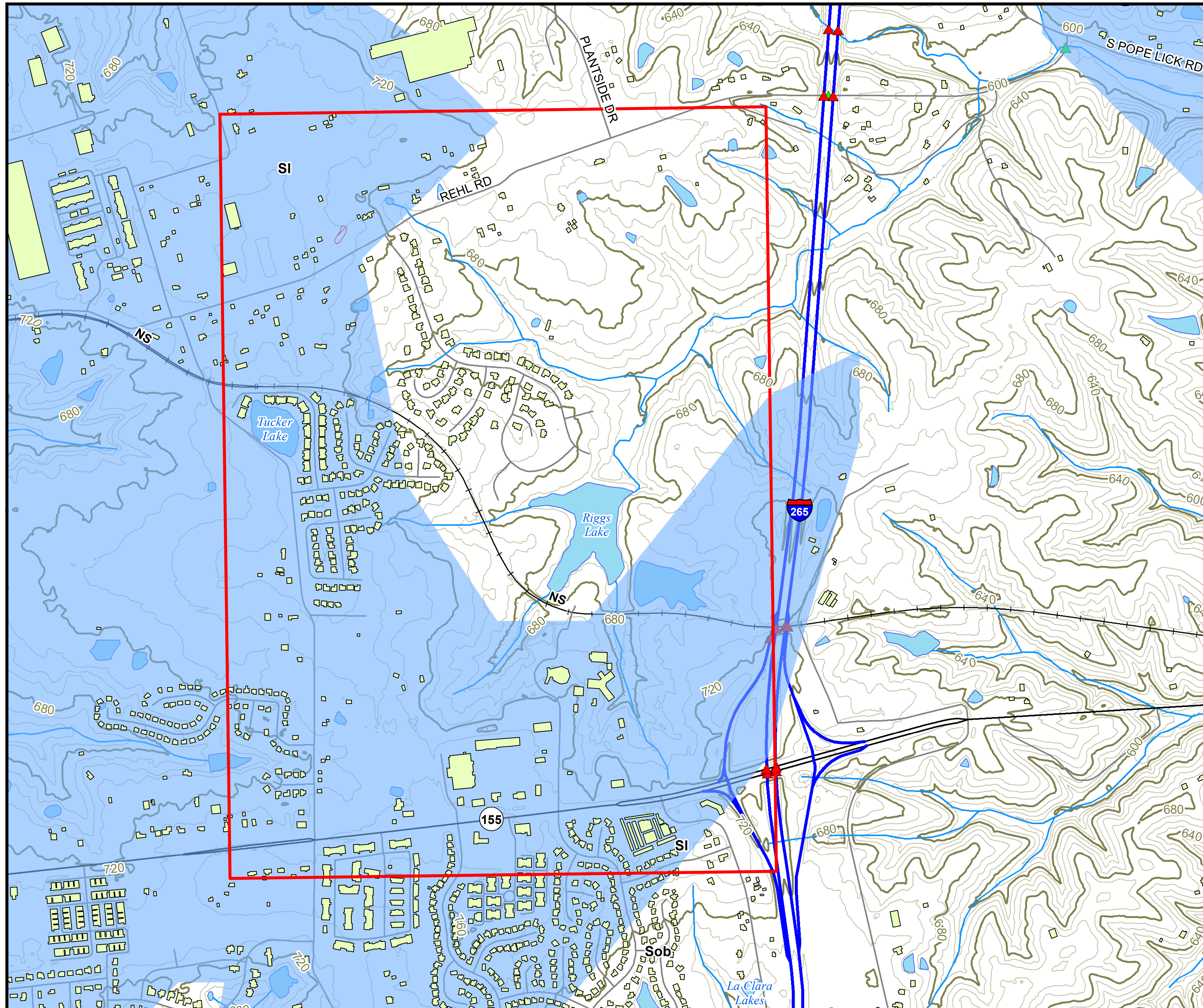



0 0.25 0.5 Miles

# Jefferson P-006-2023 - Soils Map

## Legend

Project Area

Building Footprint

**Bridges**

State Maintained

County/City Maintained

**Roads & Rail**

Interstates

Highways

State Roads

Local Roads

Active Railroad

**Hydrology**

Rivers & Streams

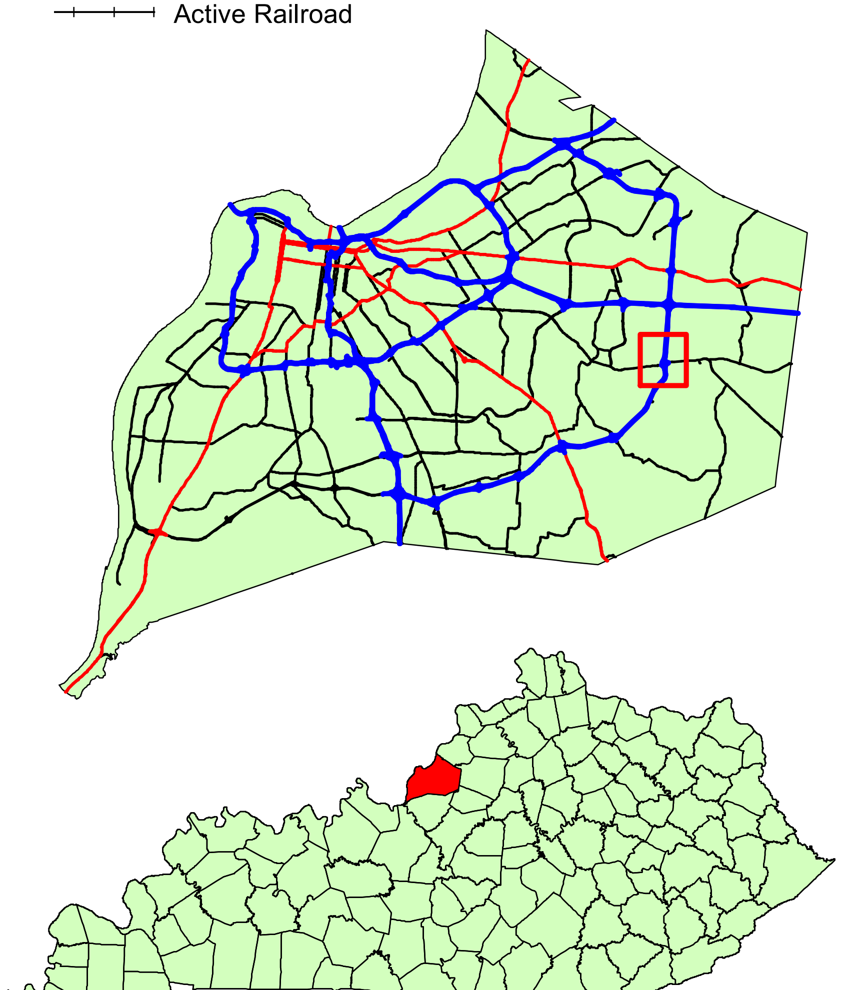
Waterbodies

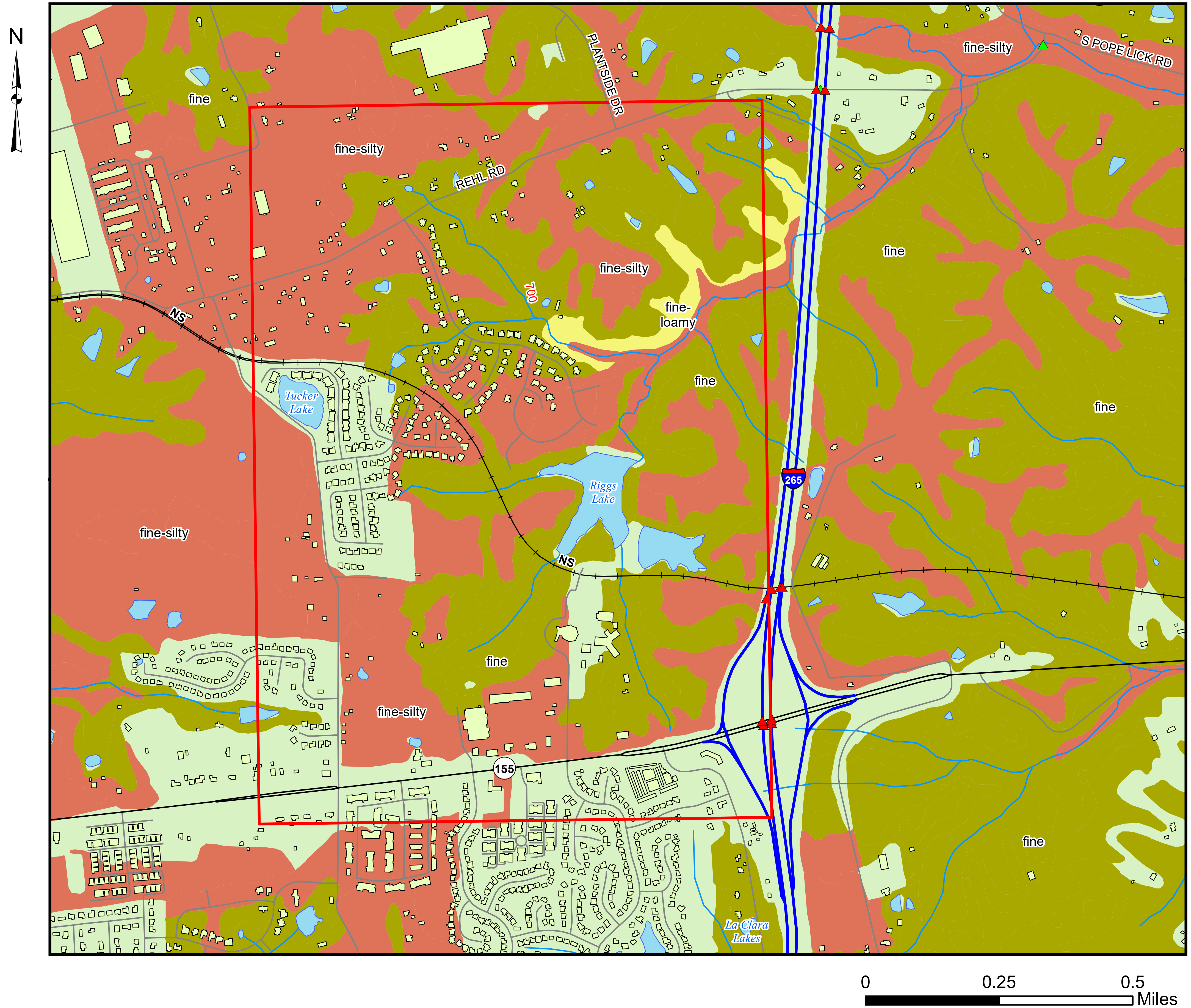
**Soil Particle Size**

fine

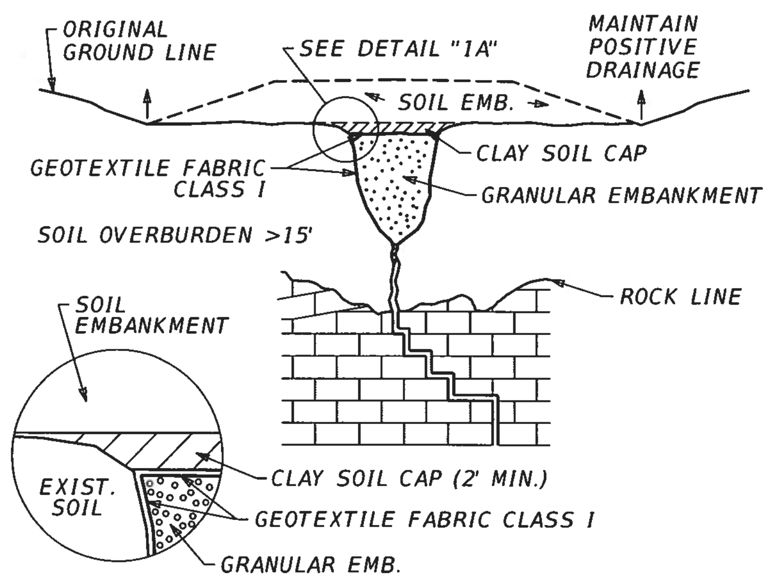
fine-loamy

fine-silty





## CONDITION NO. 1: SOIL EMBANKMENT OVER DEEP OVERBURDEN WITH OPEN SINKHOLES

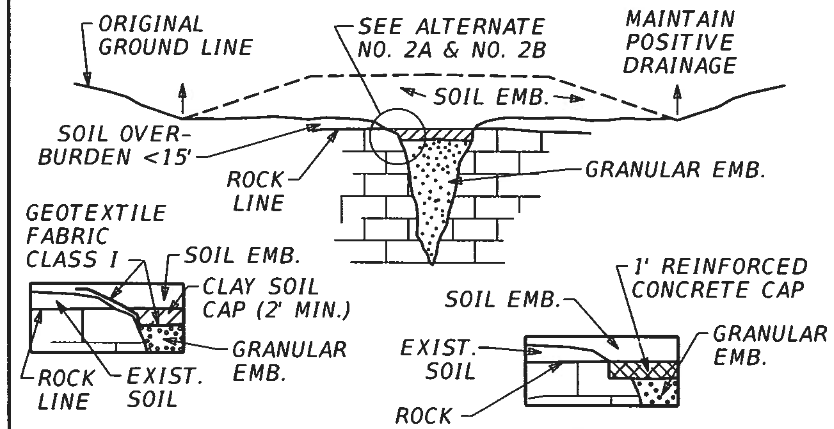



DETAIL "1A"

PROCEDURE:

a. REMOVE DEBRIS. DO NOT EXCAVATE SOIL OVERBURDEN.
b. LINE OPENING WITH GEOTEXTILE FABRIC CLASS I.
c. REFILL WITH GRANULAR EMBANKMENT.
d. PLACE GEOTEXTILE FABRIC CLASS I ON TOP OF GRANULAR EMBANKMENT.
e. REFILL WITH (2' MINIMUM) CLAY SOIL CAP.

## CONDITION NO. 2: SOIL EMBANKMENT OVER SHALLOW OVERBURDEN WITH SINKHOLE OPENING IN ROCK




( CLAY SOIL CAP ) ALTERNATE NO. 2A

( CONC. CAP ) ALTERNATE NO. 2B

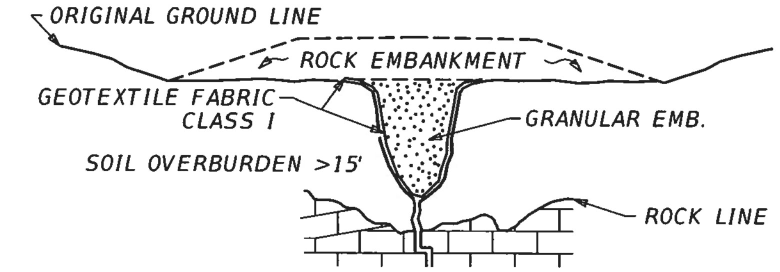
PROCEDURE FOR ALTERNATE NO. 2A

a. REMOVE DEBRIS AND SOIL OVERBURDEN.
b. REFILL OPENING WITH GRANULAR EMBANKMENT TO 2' MIN. BELOW ROCK LINE.
c. PLACE GEOTEXTILE FABRIC CLASS I ON TOP OF GRANULAR EMB. OVERLAPPING ORIGINAL GROUND LINE.
d. REFILL WITH (2' MIN.) CLAY SOIL CAP.

PROCEDURE FOR ALTERNATE NO. 2B

a. REMOVE DEBRIS AND SOIL OVERBURDEN.
b. REFILL OPENING WITH GRANULAR EMBANKMENT TO 1' MIN. BELOW ROCK LINE.
c. CONSTRUCT 1' REINFORCED CONCRETE CAP. CAP SHOULD BE INTERLOCKED WITH ROCK FOR SUPPORT.

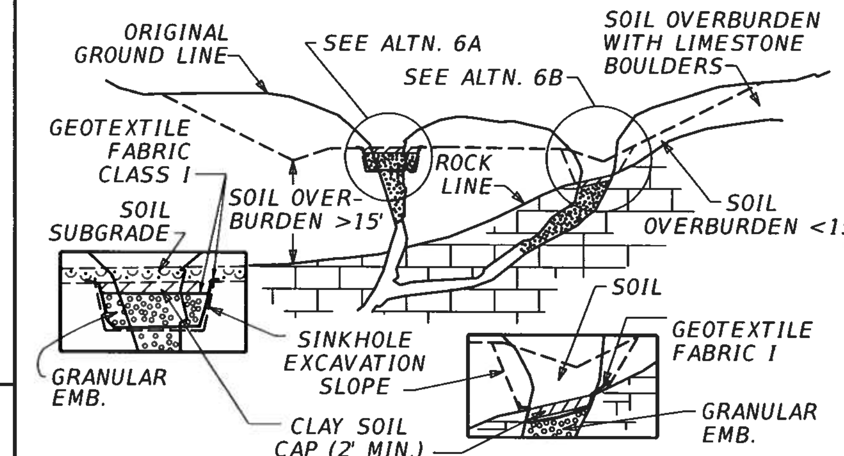
## CONDITION NO.3: ROCK EMBANKMENT OVER DEEP OVERBURDEN WITH OPEN SINKHOLES




PROCEDURE:

a. REMOVE DEBRIS. DO NOT EXCAVATE SOIL OVERBURDEN.
b. LINE OPENING WITH GEOTEXTILE FABRIC CLASS I.
c. REFILL OPENING WITH GRANULAR EMBANKMENT TO TOP OF DEPRESSION.

## CONDITION NO. 6: CUT SECTIONS WITH SINKHOLE OPENINGS IN SOIL




ALTN. 6A

ALTN. 6B

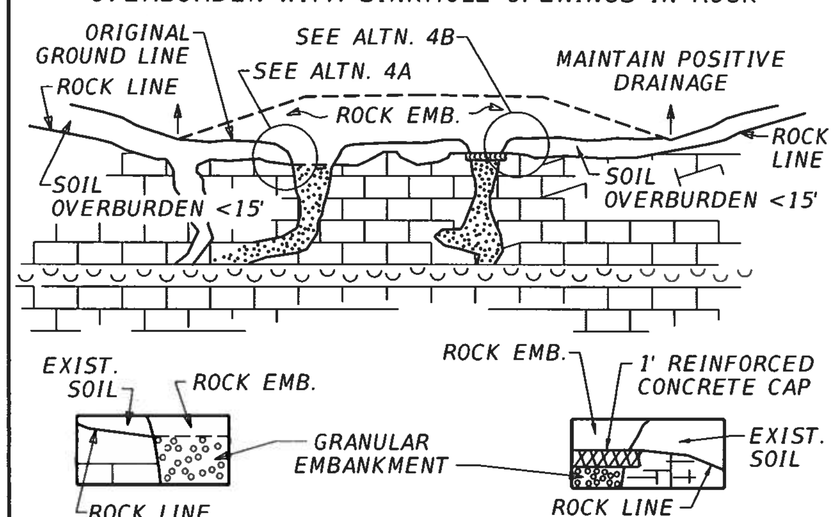
ALTERNATE NO. 6A SOIL OVERBURDEN GREATER THAN 15'

a. REMOVE DEBRIS. DO NOT EXCAVATE SOIL OVERBURDEN.
b. LINE OPENING WITH GEOTEXTILE FABRIC CLASS I.
c. REFILL WITH GRANULAR EMBANKMENT.
d. PLACE GEOTEXTILE FABRIC CLASS I OVER GRANULAR EMBANKMENT OVERLAPPING ORIG. GROUND LINE.
e. REFILL WITH (2' MIN.) CLAY SOIL CAP. IF ROCK SUBGRADE IS USED OMIT SOIL CAP AND FABRIC UNDER-LYING SOIL CAP.

ALTERNATE NO. 6B SOIL OVERBURDEN LESS THAN 15'

a. REMOVE DEBRIS AND SOIL OVERBURDEN.
b. REFILL OPENING WITH GRANULAR EMBANKMENT TO 2' MIN. BELOW ROCK LINE.
c. PLACE GEOTEXTILE FABRIC CLASS I OVER GRANULAR EMBANKMENT OVERLAPPING ORIG. GROUND LINE.
d. REFILL WITH (2' MIN.) CLAY SOIL CAP. IF CONCRETE CAP IS USED THE FABRIC SHALL BE OMITTED AND CAP SHALL BE INTERLOCKED WITH THE BEDROCK FOR SUPPORT AS DETAILED IN COND. NO. 2 ALTERNATE NO. 2B.

## CONDITION NO. 4: ROCK EMBANKMENT OVER SHALLOW OVERBURDEN WITH SINKHOLE OPENINGS IN ROCK




ALTERNATE NO. 4A

( CONC. CAP ) ALTERNATE NO. 4B

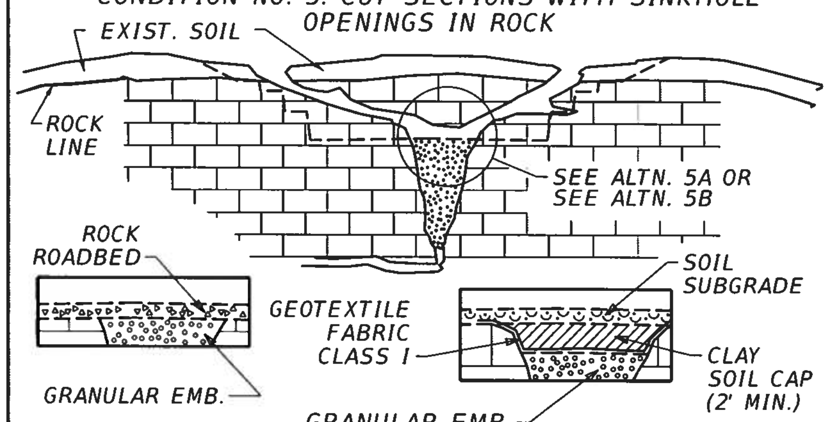
PROCEDURE FOR ALTERNATE NO. 4A

a. REMOVE DEBRIS AND SOIL OVERBURDEN.
b. REFILL OPENING TO ROCK LINE WITH GRANULAR EMBANKMENT.

PROCEDURE FOR ALTERNATE NO. 4B

a. REMOVE DEBRIS AND SOIL OVERBURDEN.
b. REFILL OPENING WITH GRANULAR EMBANKMENT TO 1' MIN. BELOW ROCK LINE.
c. CONST. 1' REINFORCED CONC. CAP. CAP SHOULD BE INTERLOCKED WITH ROCK FOR SUPPORT.

## CONDITION NO. 5: CUT SECTIONS WITH SINKHOLE OPENINGS IN ROCK




( ROCK ROADBED ) ALTERNATE NO. 5A

( SOIL SUBGRADE ) ALTERNATE NO. 5B

PROCEDURE FOR ALTERNATE NO. 5A

a. REFILL OPENING WITH GRANULAR EMBANKMENT. IF CONCRETE CAP IS USED IT SHALL BE INTERLOCKED WITH THE BEDROCK FOR SUPPORT AS DETAILED IN CONDITION NO. 2 ALTERNATE NO. 2B.

PROCEDURE FOR ALTERNATE NO. 5B

a. REFILL OPENING WITH GRANULAR EMBANKMENT. TO 2' MINIMUM BELOW SOIL SUBGRADE.
b. PLACE GEOTEXTILE FABRIC CLASS I OVER GRANULAR EMBANKMENT.
c. REFILL WITH (2' MIN.) CLAY SOIL CAP. IF CONCRETE CAP IS USED THE FABRIC SHALL BE OMITTED AND CAP SHALL BE INTERLOCKED WITH THE BEDROCK FOR SUPPORT AS DETAILED IN COND. NO. 2 ALTERNATE NO. 2B.

THE CONCRETE CAP SHALL BE CLASS "B" CONC. AND CONTAIN NO. 8 REINFORCING BARS PLACED AT 12" CTRS. IN BOTH DIRECTIONS AND LOCATED 3" FROM THE BOTTOM SURFACE OF THE CAP.

SUBMITTED [signature] DIVISION DIRECTOR 02-08-2023 DATE

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

DRAWING TITLE: SEPIA 024 - TREATMENT OF OPEN SINKHOLES

ITEM NO. | COUNTY OF | SHEET NO.