thoroughbred solar

# Attachment D

# Karst Considerations

## Exhibit 12 – Site Assessment Report

# Karst Considerations

Thoroughbred Solar
Hart County, Kentucky

thoroughbred solar

**October 2022**

# Table of Contents



## Figures



## Tables



## Attachments

# 1. Introduction

Thoroughbred Solar, LLC (Thoroughbred) is proposing a 50-megawatt solar energy facility (the Project) on an approximately 530-acre site in Hart County, Kentucky (the Project Area), as shown on Figure 1 in Attachment A. In addition to the standard geotechnical testing to understand, on a preliminary basis, subsurface conditions to evaluate feasibility and design for the Project, a project in this area of Kentucky warrants particular consideration of karst conditions within the Project Area. This report provides information regarding background review and field investigations completed to date to understand conditions within the Project Area, outlines plans for further investigations to support final design and construction, identifies a menu of actions that could be appropriate for foundation support of various elements of the Project based on ground conditions, and summarizes plans for monitoring and action during Project operation.

## 2. Background Review and Project Components

Kentucky is known as one of the locations within the United States where karst conditions are prevalent. For the Project Area, with Mammoth Cave located approximately 5 miles to the west, and numerous recreational caves in the vicinity (notably Horse Cave to the south of the Project Area), karst is an expected element of site conditions that requires consideration. Karst terrains include regions where the topography is formed and altered by the dissolution of bedrock (commonly limestone or dolomite). Karst landscapes are commonly characterized by features such as surficial depressions, sinkholes, sinking streams, subsurface drainage, springs, and caves.

Based upon review of mapping available from the Kentucky Geological Survey (KGS), as shown on Figure 2 in Attachment A, much of Hart County is considered to be within areas with high potential for karst conditions. In addition, as is also common throughout the county, the Project Area includes a number of areas that are considered to be possible sinkhole locations. As can been seen from the fact that similar mapping areas extend throughout the landscape, including into portions of Interstate 65 (located adjacent to the Project Area to the west), consideration of this type of subsurface is common within this region of Kentucky.

In addition to potential karst areas, numerous additional factors have been involved in determining an appropriate layout for the Project. Proximity to the 69-kilovolt overhead electric transmission line into which the Project will contribute its renewable energy is a key factor for the location of the Project's Substation and switchyard. Other factors include: mapped floodplains; delineated wetlands; larger sinkhole voids; retaining trees where possible; and providing setbacks between the Project and neighbors. Positioning features to allow for ready interconnections between individual panel areas is also important.

Key Project components requiring specific consideration with regard to karst conditions are the following:

- Project Substation and Switchyard – Optimally proximate to the existing transmission line, these features represent the heaviest equipment and require more substation foundation support than other Project elements. Deep piers are often used for the foundations of the transformer and other equipment at the substation.
- Solar Arrays – Solar panels (grouped into arrays) are distributed throughout the Project Area to collect solar energy and transmit it to the existing electrical grid. The panels are mounted to a racking system that is supported on I-beam piles typically driven 6 to 10 feet deep, depending on ground conditions. The racking system that will be selected for this Project will be intended to readily conform to variable topography as well as account for possible differential settlement.
- Inverters/Transformers – A limited number (in this layout, a total of 15) locations will be distributed throughout the Project layout where inverters and integral transformers will be grouped onto pad foundations.
- Collection Lines – Low-voltage electrical lines extend from each solar array to reach an inverter/transformer pad. The transformer steps up the voltage and the medium voltage lines run to the Project Substation. The collection lines may be installed underground or may use racks or supports to remain aboveground but below the solar panels.

- Ancillary features – The Project also includes a small operations and maintenance building, associated parking, gravel access roads throughout the layout, and stormwater management features as appropriate.

As more detailed review of karst conditions within the Project Area have been considered, the individual requirements of each of these features have been incorporated into the Project layout and plans for construction and operation.

# 3. Field Efforts to Date

## 3.1 OBSERVED SINKHOLES

Deep sinkholes have been observed in three locations within the Project Area (shown on Figure 3 in Attachment A). One is a shallower depression and has also been determined to be a delineated wetland feature. The other two were further investigated by an ecological team to confirm whether cave-like features exist that could be used by bat species; neither was determined to have an open area or airflow that would indicate an opportunity for species passage. Their characteristics are as follows:

- Central area – a sinkhole that occurs along the edge of an alfalfa field, on a fencerow adjacent to another agricultural field. The depth of the depression averages approximately 23 feet with maximum depth of approximately 33 feet. The feature was formed by collapse and has some rock outcrops as a result. At the time of the survey, there was no indication that the feature was unstable or that further collapse is likely.
- Southern area – a sinkhole located in a hayfield. The depression is approximately 16 feet deep and 30 feet wide. The bottom of the depression is bare-earth and rounded, without exposed limestone or other features suggestive of a karst opening.

## 3.2 PRELIMINARY GEOTECHNICAL INVESTIGATION

A preliminary geotechnical investigation was completed in early winter 2021. This included:

- Installing six steel test piles at embedment depths ranging between 4.5 and 8 feet below existing ground surface.
- Excavating seven test pits to depths ranging between 3.5 and 8 feet below existing ground surface.
- Drilling one soil boring (near the location of the proposed substation/switchyard) to a depth of 26 feet, and coring of the bedrock to a depth of 8 feet below bedrock contact.
- Conducting in-situ electrical resistivity testing at one test location.
- Performing laboratory thermal resistivity testing on three five-point sets of remolded soil from three of the test pits.
- Conducting other laboratory testing on representative samples.

General findings included observing tilled earth underlain by clay, with faintly weathered limestone present at relatively shallow depths. Groundwater was not encountered, and no sinkholes were observed.

## 3.3 GEOPHYSICAL INVESTIGATIONS

To further understand the accuracy of available mapping for the Project Area, a limited program of geophysical lines and other activity was undertaken (Attachment B). The goal of the selecting the locations was to be within areas anticipated to be used for Project features, and to extend within and outside areas mapped by KGS as having higher sinkhole potential.

To conduct the work, Terracon was retained to support the limited geophysical investigation at the Project site to evaluate the potential for karst features. The survey activities completed by Terracon included the use of electrical resistivity imaging (EI) testing to characterize subsurface soils and bedrock in an area expected to exhibit signs of karst conditions. Terracon utilized an Advanced Geosciences Inc. (AGI) SuperSting R8 control unit. After field collection, the resistivity data was processed using EarthImager2D (engineered by AGI), and an inversion and modeling software package. Changes in the earth resistivity can indicate changes in lithology, voids, saturation, and amount of fracturing. It should be noted that the purpose of the geophysical program was not intended to be an exhaustive evaluation of the entirety of the Project area but rather to gain a general understanding of the subsurface conditions and gauge the prevalence of karst formations.

A total of seven transects, varying in length from approximately 1,000 to 2,600 feet in length, were evaluated, and potential areas of karst/soft soils were identified (Figure 3). The results generally indicated that karst conditions will continue to be a factor in the Project layout, construction, and operations, and were used to inform adjustments to the overall Project layout.

### 3.4 LIDAR REVIEW

In addition to using maps available from the Commonwealth and conducting geophysical transects, publicly available topographical information collected by light detection and ranging (LiDAR) methods was evaluated to identify where depressions exist within the Project Area that could indicate sinkhole activity.

### 3.5 FIELD OBSERVATIONS

To further supplement knowledge of Project Area conditions, field staff attending the geophysical activities performed site reconnaissance to search for sinkholes, topographic depressions, or other features. The focus of this field reconnaissance was outside of the KGS-mapped sinkhole areas in an attempt to correlate mapping with observed conditions in locations where observations were possible. However, a number of features were observed that continued to indicate that karst formation and sinkhole development appears to be inconsistent but prevalent throughout the Project Area, both within and outside the areas mapped by KGS.

## 4. Layout Considerations

Layout considerations vary, as is appropriate, for the various components of the Project, as outlined in Table 1.

*Table 1:Layout Considerations*

| Project Component | Foundation Type | Karst Considerations |
|---|---|---|
| Project Substation | Deep pile or pier system to support heavier infrastructure | Avoid sinkhole features if possible and/or develop a foundation design that anchors to below sinkhole depths |
| Utility Switchyard | Deep pile or pier system to support heavier infrastructure | Avoid sinkhole features if possible and/or develop a foundation design that anchors to below sinkhole depths |
| Solar Arrays | Shallow piles supporting relatively light structures | Avoid sinkholes with piles; arrays can span sinkhole areas |
| Inverters/Transformers | Slab foundations for moderate loads | Avoid sinkholes |
| Collection Cables | Aboveground cable trays or trenching at depths of approximately 3 feet below ground surface | Adjust installation method based on subsurface conditions |
| Access Roads | Appropriate design and compaction of gravel roads | Plan for two points of access in the event of road settlement |
| O&M Building | Slab foundation of moderate loads | Avoid sinkholes |

Project layout was adjusted based on additional work conducted and adjustments to reflect karst conditions, as shown on Figure 4 in Attachment A. Given the prevalence of karst features throughout the area, as well as other features (such as wetlands, areas of mapped 100-year floodplain, the large wooded area, and proximity to neighbors) that are also important metrics in the design, additional measures will be implemented, as discussed in the following sections, to further manage risks for the Project.

Because karst is frequently a complex system that can be influenced by such factors as groundwater flow direction, infiltration and precipitation, and changes in landform and topography, the Project is also committed to limiting grading to the greatest extent possible and designing a stormwater management approach intended to avoid adverse impacts to Project Area sinkhole development. A preliminary grading plan and stormwater management plan have also been prepared.

## 5. Additional Planned Investigations/Construction Procedures

Further geotechnical investigations will be undertaken within the Project Area as a part of final design and prior to construction. These will include more detailed geotechnical investigations for the Project Substation and Utility Switchyard, as well as specific borings in locations where slab foundations are proposed and sampling along proposed access roads.

While geotechnical borings are not proposed in the location of each pile intended to support the solar arrays, careful observation will be made during pile driving to identify areas of potential concern. In many locations, bedrock is near the surface. In such locations, the piles will be sufficiently anchored without the need to penetrate deeper into the subsurface. Even softer materials are likely to only require pile driving to depths of approximately 10 feet. However, should a “rod drop” or signs of open voids be identified during construction efforts, that location for a given support could be eliminated or other appropriate adjustments (e.g., reverse filter and grouting) would be made. Those adjustments could include relocation of arrays and/or support structures or could reflect more firmly anchoring the remaining supports such that the suspect location is not required.

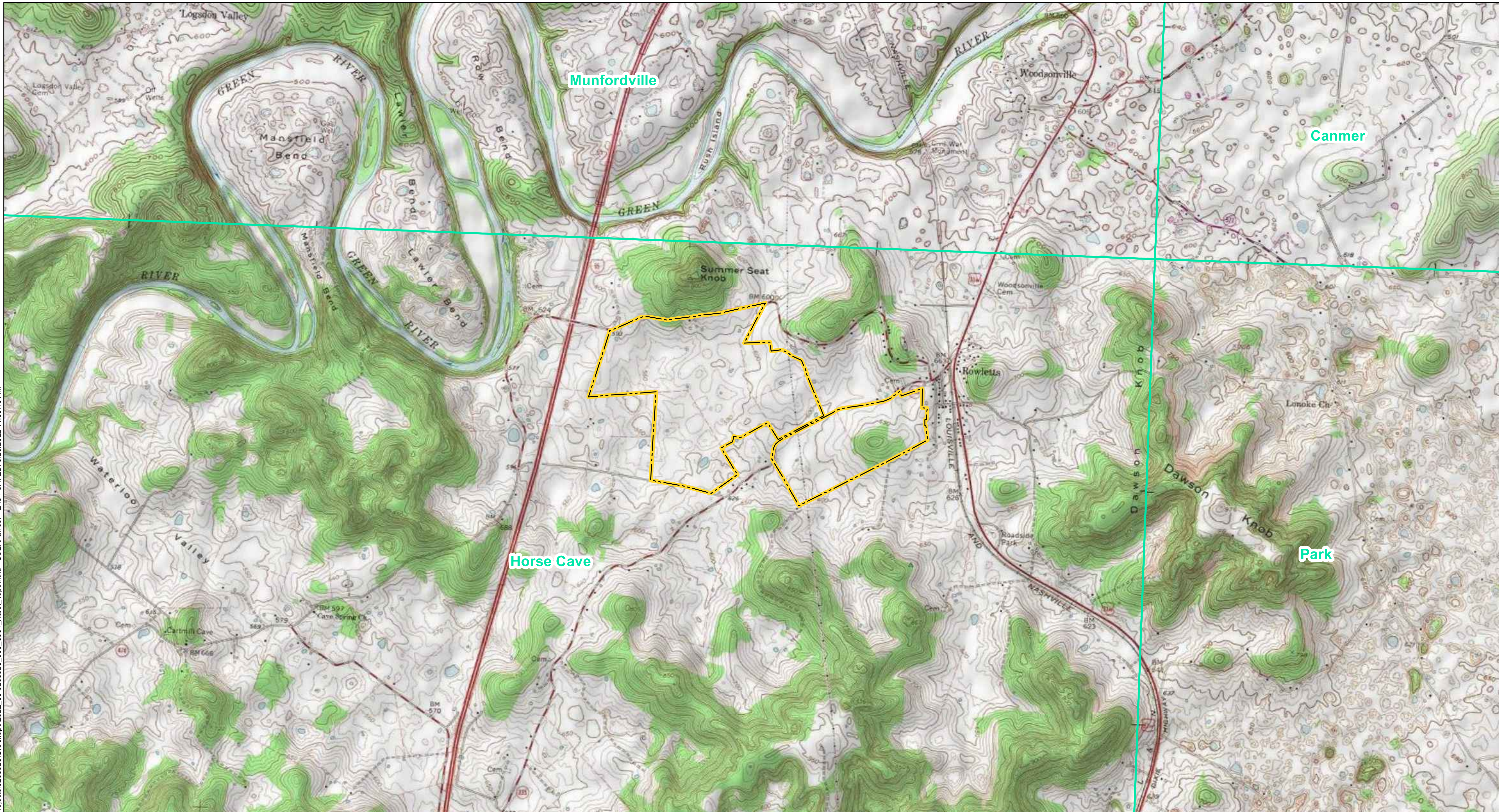
## 6. Plans for Operational Monitoring

Although sudden collapses have the potential to occur, it is considered that longer-duration and gradual ground surface movement is the more likely risk. Therefore, the Project plans to implement a monitoring program throughout its operational life.

The intent of the monitoring program is to evaluate larger-scale, ground-level movement attributable to karst, such as the gradual “bowl-like” movement which gradually occurs as a sinkhole feature develops over time. The monitoring program is intended to determine topographic variations over time, which would result in solar panel bending, tilting, and added stress to racking, modules, and structural components.

This type of monitoring can be accomplished through the use of annual LiDAR or drone surveying to rapidly evaluate potential elevation changes throughout the Project Area. The Project intends to conduct such monitoring annually for the first three years of operation, and then every other year through operating year 35 unless an adequate demonstration can be made that monitoring should cease. If monitoring shows a change in individual elevation, or if differential movement is observed compared to nearby reference points, a more detailed evaluation would be undertaken. This may include engaging a geotechnical engineer to conduct geophysical investigations (electrical resistivity tomography or another recognized method) to evaluate the potential development of detrimental karst activity. In addition, re-setting of panels, racking, or other structural elements may become necessary if movement is shown to prevent flexure of sensitive photovoltaic modules, cracking of glass, or added stress and/or shearing of connection pins, bolts, and other hardware.

# Attachment A – Figures

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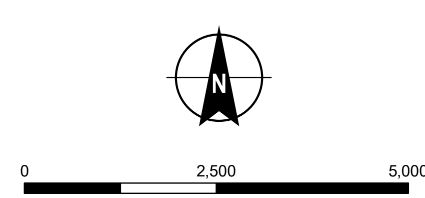
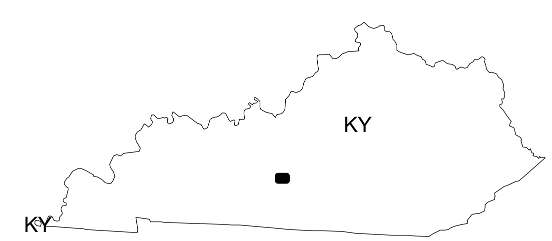
**LEGEND**

- USGS 7.5 Minute Quadrangle
- Project Area

**NOTES**

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. TOPOGRAPHIC MAP SOURCE:USGS

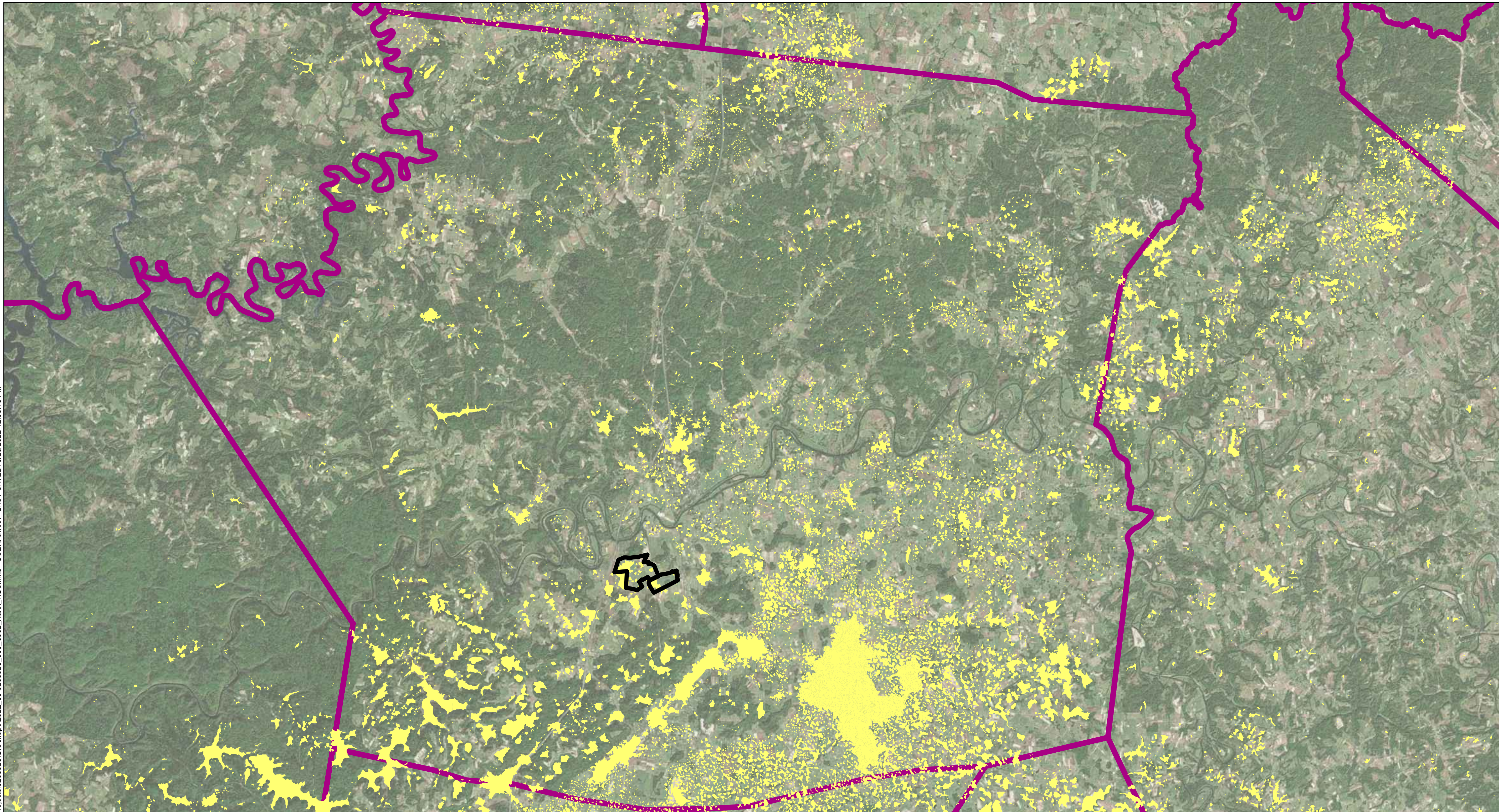



HALEY ALDRICH

**Figure 1**
**Project Location on Topographic Map**

Thoroughbred Solar
Hart County, Kentucky



**LEGEND**

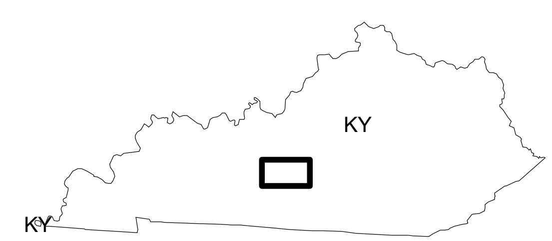
- County Boundary
- KGS-Possible Sinkhole Locations
- Project Area

**NOTES**

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI

N

0 1.5 3 4.5
Miles




HALEY ALDRICH

**Figure 2**
**Mapped KGS Possible Sinkholes within Hart County**

Thoroughbred Solar
Hart County, Kentucky

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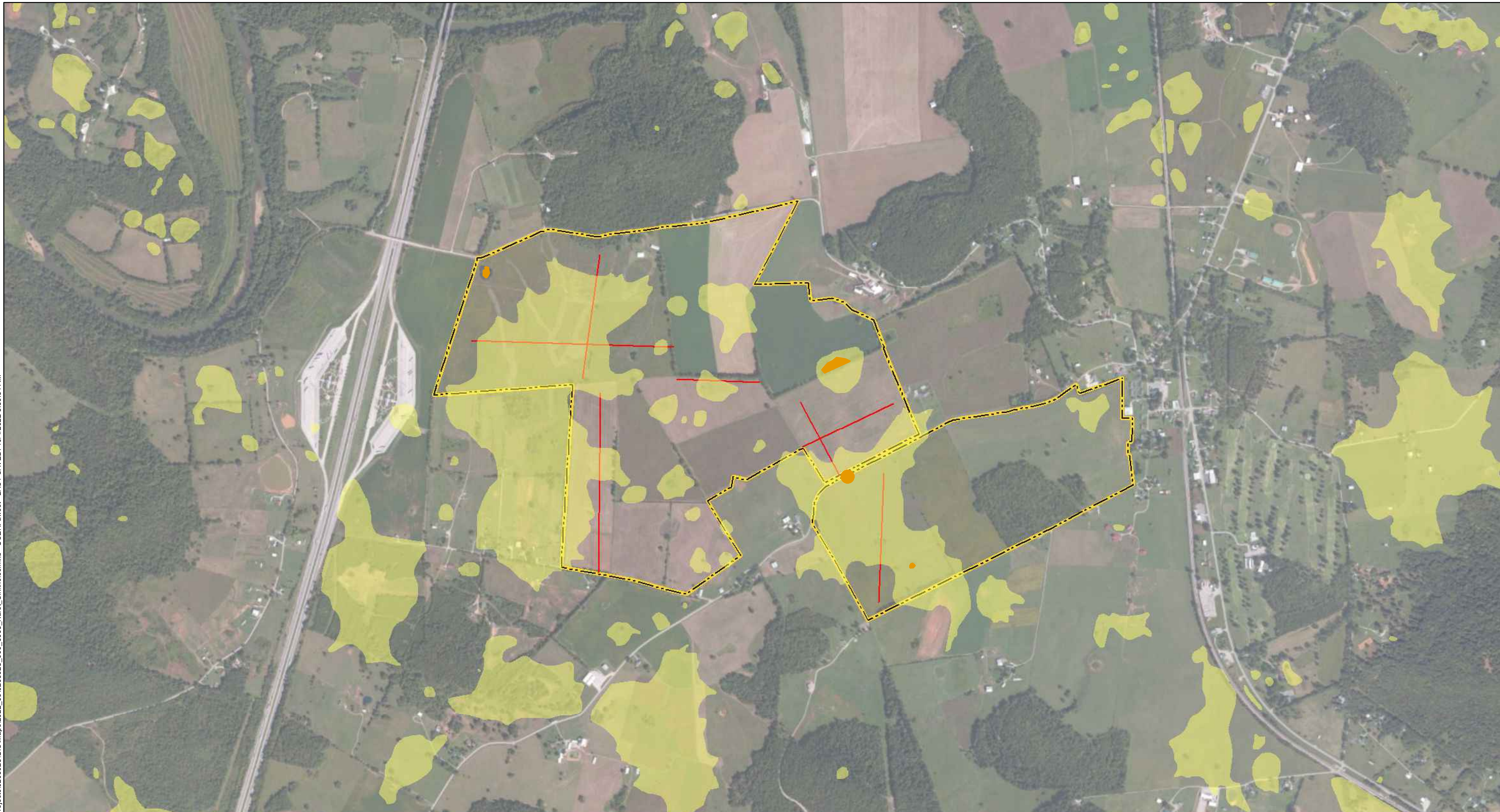

**LEGEND**

- KGS-Possible Sinkhole Locations
- Delineated Sinkholes
- Project Area
- Geophysical Transects

**NOTES**

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI

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0 1,200 2,400
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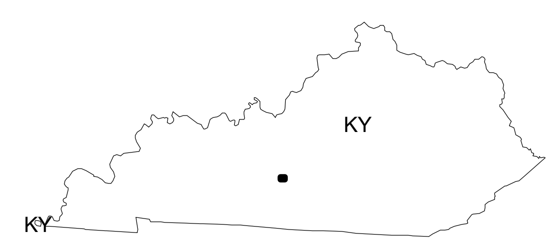
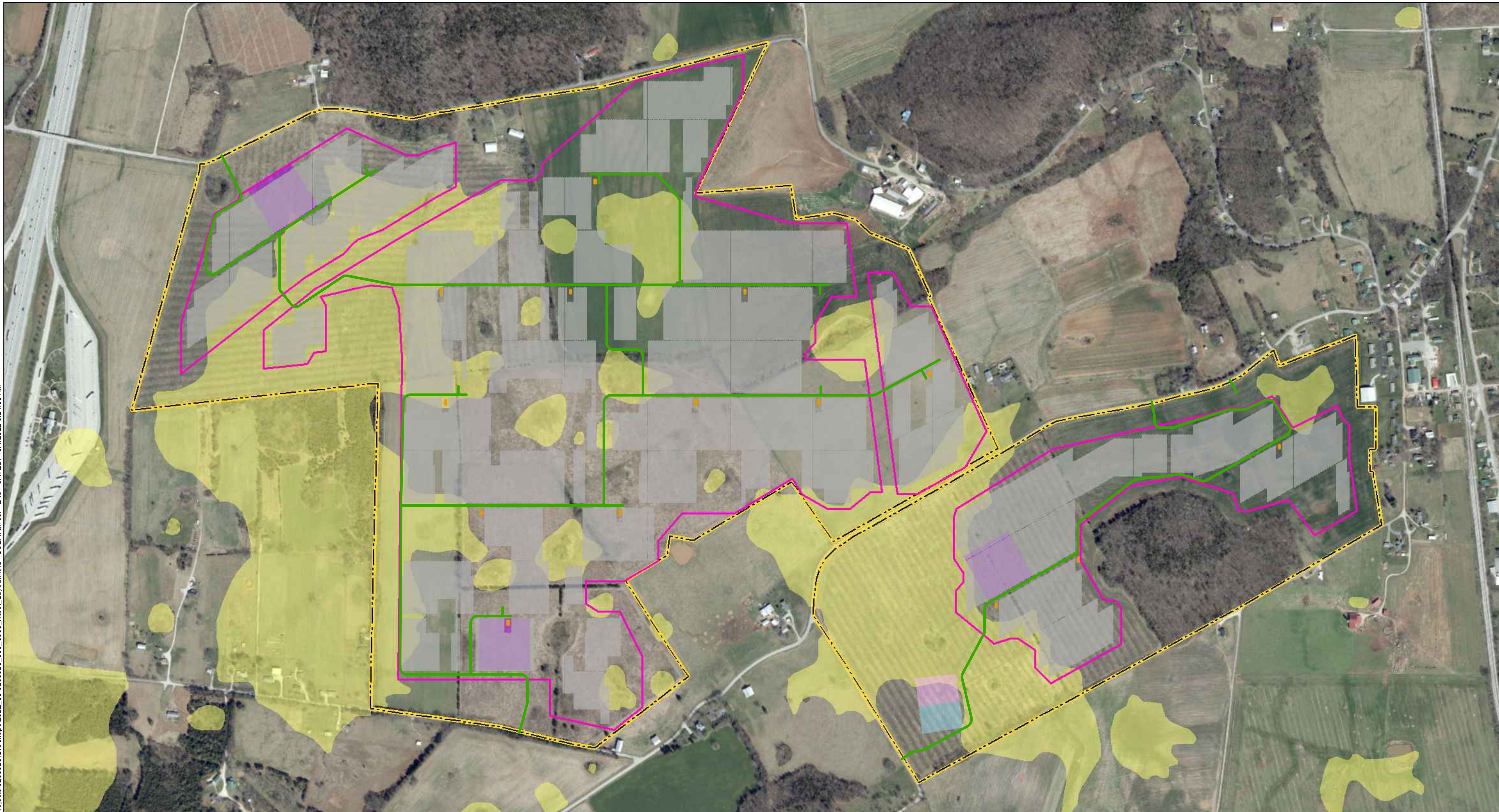



HALEY ALDRICH

**Figure 3**
**Project Location with KGS-Mapped Possible Sinkholes and Geophysical Transects**

Thoroughbred Solar
Hart County, Kentucky

GIS FILE PATH: \\haleyaldrich.com\share\CF\Projects\0203928\GIS\Maps\2022_09\0203928_000_0003_Karst_Sinkholes.mxd - USER: awest - LAST SAVED: 10/4/2022 8:39:34 AM



**LEGEND**

- Access Roads
- Array Trackers
- Proposed Fenceline
- Inverters
- Laydown Areas
- Project Area
- KGS-Possible Sinkhole Locations
- Proposed Substation
- Proposed Switchyard

**NOTES**

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: KENTUCKY GEOGRAPHY NETWORK DATE 2021

N

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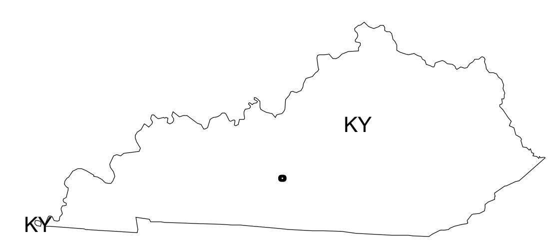
SCALE IN FEET




HALEY ALDRICH

**Figure 4**
**Project Layout**

Thoroughbred Solar
Hart County, Kentucky

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# Attachment B – Preliminary Karst Evaluation

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**REPORT ON**

# PRELIMINARY KARST EVALUATION
# THOROUGHBRED SOLAR
# HART COUNTY, KENTUCKY

by
Haley & Aldrich, Inc.
Midlothian, Virginia

for
Thoroughbred Solar, LLC
c/o Leeward Renewable Energy Development, LLC
Dallas, Texas

File No. 203928-001
October 2022

HALEY & ALDRICH, INC.
1 Park West Circle
Suite 208
Midlothian, VA 23114
804.419.0199

5 October 2022
File No. 203928-001

Thoroughbred Solar, LLC
c/o Leeward Renewable Energy Development, LLC
6688 N. Central Expressway, Suite 500
Dallas, Texas 75206

Attention: Rob Kalbouss

Subject: Preliminary Karst Evaluation
Thoroughbred Solar
Hart County, Kentucky

Dear Mr. Kalbouss:

Haley & Aldrich, Inc. (Haley & Aldrich) was engaged by Thoroughbred Solar, LLC (Thoroughbred) to conduct an on-site review of mapped karst features, engage a geophysical subcontractor to perform electrical resistivity imagery (ERI) testing, and consult with the Thoroughbred team to discuss site conditions. The site is located west of Rowletts in an unincorporated area of Hart County, Kentucky located off L and N Turnpike Road (see Figure 1). This report summarizes the findings of our efforts to date and discusses recommended supplemental subsurface exploration and testing programs.

## Summary

Haley & Aldrich reviewed sinkhole mapping available from the Kentucky Geological Survey (KGS) and worked with the Thoroughbred team to plan and implement geophysical transects that extend within the site both in and out of KGS sinkhole-mapped areas. In addition to implementing the geophysical investigations along the transects, the site areas not mapped as sinkhole areas by KGS were observed (as overgrowth conditions allowed) and descriptive information was collected regarding sinkhole features by review of light detection and ranging (LiDAR) data and visual observations.

Based on our review of the local geology and on-site observations, karst formation and sinkhole development are inconsistent but present throughout the site, both within and outside the areas mapped by KGS. Because karst formations and sinkholes are common throughout the site, additional investigations are recommended once final structure locations have been determined to avoid placing foundations within karst or sinkhole areas, to the extent possible, and/or to plan for appropriate remediation. Foundation mitigation could include, but is not limited to a reverse filter to contain fines

within sinkhole formations, grouting, or increasing pile lengths to eliminate piles otherwise needed within a sinkhole area.

A geotechnical subsurface exploration and testing program consisting of test borings and geophysical testing at planned foundation locations is recommended to aid feasibility planning and installation pricing. Planning is also recommended for long-term maintenance and/or periodic replacement of foundations, solar panels, and associated infrastructure throughout the site, as high-risk karst and sinkhole areas are prevalent and there may be undetected areas of sinkhole activity. Long-term maintenance and/or foundation replacement planning may occur at a later date, as an element of final design. Based on the results of the exploration program, pile load tests (in compression, in tension, and laterally) should be performed at select locations. Haley & Aldrich would be pleased to plan and/or execute the recommended exploration and testing programs.

## Introduction

### EXISTING SITE CONDITIONS

Our understanding of the site is based on the historic geotechnical report entitled *Proposed 50 MWac Hart Solar Power Plant, Rowletts, Hart County, Kentucky*, prepared by G2 Consulting Group LLC, dated 9 June 2022, provided to us by Leeward Renewable Energy Development LLC, and on information derived during our site visits between 7 and 14 July 2022.

The subject site consists of approximately 530 acres of agricultural land in Hart County, Kentucky, just west of Rowletts, as shown on Figure 1. The site is generally bounded by Rowletts Cave Springs Road to the north, the town of Rowletts to the east, L and N Turnpike Road to the south, and Interstate 65 to the west. Existing site grades range from approximate elevation (El.) 557 to 742 feet (ft).

### PROPOSED DEVELOPMENT

Based on our discussions with and information provided by Leeward Renewable Energy Development LLC, Thoroughbred Solar intends to develop a 50-megawatt (MW) solar facility known as Thoroughbred Solar (the Project). The Project will provide energy to the electrical grid via connection to the existing 69-kilovolt overhead transmission line owned by East Kentucky Power Company that extends through the Project site. The Project includes the range of features associated with a solar energy facility, including tracking panels configured in arrays that will be located on pile foundations, discrete locations where inverter/transformers will be located throughout the layout, collection lines that will connect the panels to the inverters and ultimately to a proposed substation and switchyard, and security fencing. Access roadways, an operations and maintenance building, and temporary workspaces for construction will also be included as a part of the Project.

### SCOPE OF WORK

We performed a preliminary karst evaluation to obtain preliminary subsurface information related to potential karst formation and to evaluate potential karst activity and sinkhole formation at the site. The scope of the evaluation included the following:

- performing a desktop review of publicly available geological information, review of the existing geotechnical report for the Project, and review of available aerial photography and topography of the Project site collected from services to which Haley & Aldrich subscribes;
- executing a limited geophysical testing program to obtain subsurface information related to potential karst formation;
- performing a site walkover of accessible areas of the Project site to document conditions observable at the ground surface; and
- preparing this preliminary report.

The scope of this evaluation did not include new subsurface explorations, final design recommendations, or construction contract documents.

## Desktop Review

### HISTORIC SUBSURFACE EXPLORATION PROGRAM AND SOIL CONDITIONS

One soil boring (designated B-1) was drilled by Central Star Drilling of Peebles, Ohio for G2 Consulting Group LLC on 29 January 2022. The test boring was drilled to a depth of 25.7 ft.

Seven test pits (designated (PLT-1 through PLT-3 and TP-4 through TP-7) were performed at the Project site by G2 Consulting Group LLC on 7 and 8 December 2021. The test pits were excavated to depths ranging from 3.5 to 9 ft below existing ground surface.

Subsurface conditions encountered in the historic geotechnical explorations typically consisted of:

- *TILLED EARTH* – An approximately 3- to 16-inch-thick layer of sandy CLAY was encountered at every test pit location and the soil boring location. In general, the surface soils throughout most of the Project area have been tilled for agricultural purposes.
- *NATIVE SOIL* – Below the TILLED EARTH, a layer of soil primarily described as lean to fat CLAY was encountered. This layer was encountered and fully penetrated at a thickness of 18 ft in the test boring. The NATIVE SOIL was not penetrated at any test pit location.
- *WEATHERED ROCK* – At the test boring location below the NATIVE SOIL, faintly weathered limestone was encountered. Limestone fragments were generally present within the cohesive soils at the test pit locations.

### REVIEW OF PUBLICLY AVAILABLE INFORMATION

Haley & Aldrich used mapping available from the KGS and other mapping information that had previously been developed for the Project. This included consideration of mapped 100-year floodplains, delineated wetlands, identified deep sinkholes, and available contour data. In addition, Haley & Aldrich's geophysical contractor evaluated topographical information collected by LiDAR methods in order to identify where depressions exist within the site that could indicate sinkhole activity.

## Field Investigation

### GEOPHYSICAL TESTING

Haley & Aldrich engaged Terracon to conduct geophysical surveys (seven ERI transects). The transects varied in length from approximately 1,050 to 2,600 ft in length. The transect locations were provided by Thoroughbred to extend along potential sinkhole zones and reflect general locations where foundations are likely to be required.

In general, the results of the ERI imaging indicate the presence of multiple suspect karst features along each of transect numbered 1 through 7. These features should be investigated further during Project final design to assess what (if any) impacts they may have on foundation and slab design and construction in these areas. Additionally, coordination with the Project team may allow for adjustment of the proposed construction area to avoid some karst features.

The results of the evaluations and locations of the various suspect karst features are provided on Figure 2. The results of Terracon's geophysical testing are included in Appendix A.

### VISUAL FIELD ASSESSMENT

Representatives from Haley & Aldrich performed a visual field assessment of the Project site to identify karst and sinkhole formations. It should be noted that, due to time constraints and safety concerns, representatives did not physically walk within the sinkhole areas delineated by KGS, or within a cornfield present at the site. In addition, approximately 80 acres of property was added to the site after the field effort was completed. In total, approximately 16 sinkholes, 8 depressions, and 2 ponds were visually identified at the Project site. These observed features were present across the site, and not concentrated in any specific portion of the site.

Haley & Aldrich concluded during its field assessment that the KGS's mapped potential sinkholes and major karst formation areas are consistent with features observed on the site. Additional unmapped sinkholes and other potential karst features were observed during our field reconnaissance.

Areas and point locations of sinkhole activity, depressions, and anomalies detected during our geophysical investigation are shown on Figure 2.

## Recommendations for Supplemental Subsurface Exploration and Testing Programs

Additional subsurface explorations, associated laboratory testing, and geotechnical engineering evaluations are necessary for final Project design, and to provide information for bidding and performing the construction work. The objectives of these explorations would be to provide additional information as it relates to the following:

- Preparing final design recommendations for building foundations, pavements, and site infrastructure/ improvements;
- Selection of inverter foundation locations; and
- Developing final design aspects of sinkhole remediation.

We can prepare a proposal for these services should you elect to move forward additional investigations.

## Limitations

This report provides limited information on site subsurface conditions and comments on preliminary geotechnical aspects of the proposed development in Hart County, Kentucky. The comments provided herein are intended for initial planning purposes only and are not suitable for final design of any structure.

## Closure

Thank you for the opportunity to assist Thoroughbred Solar, LLC c/o Leeward Renewable Energy Development, LLC on this Project. We trust the information provided herein is helpful to your current planning, and we look forward to assisting you with future phases of the Project. Please do not hesitate to contact us if you wish to discuss any aspect of this report.

Sincerely yours,
**HALEY & ALDRICH, INC.**

Elizabeth Sullivan
Technical Specialist

Brett R. Grunert
Senior Project Manager

Lynn Gresock
Principal Consultant

Enclosures:

Figure 1 – Project Locus
Figure 2 – Preliminary Karst Evaluation
Appendix A – Terracon Geophysical Exploration Report

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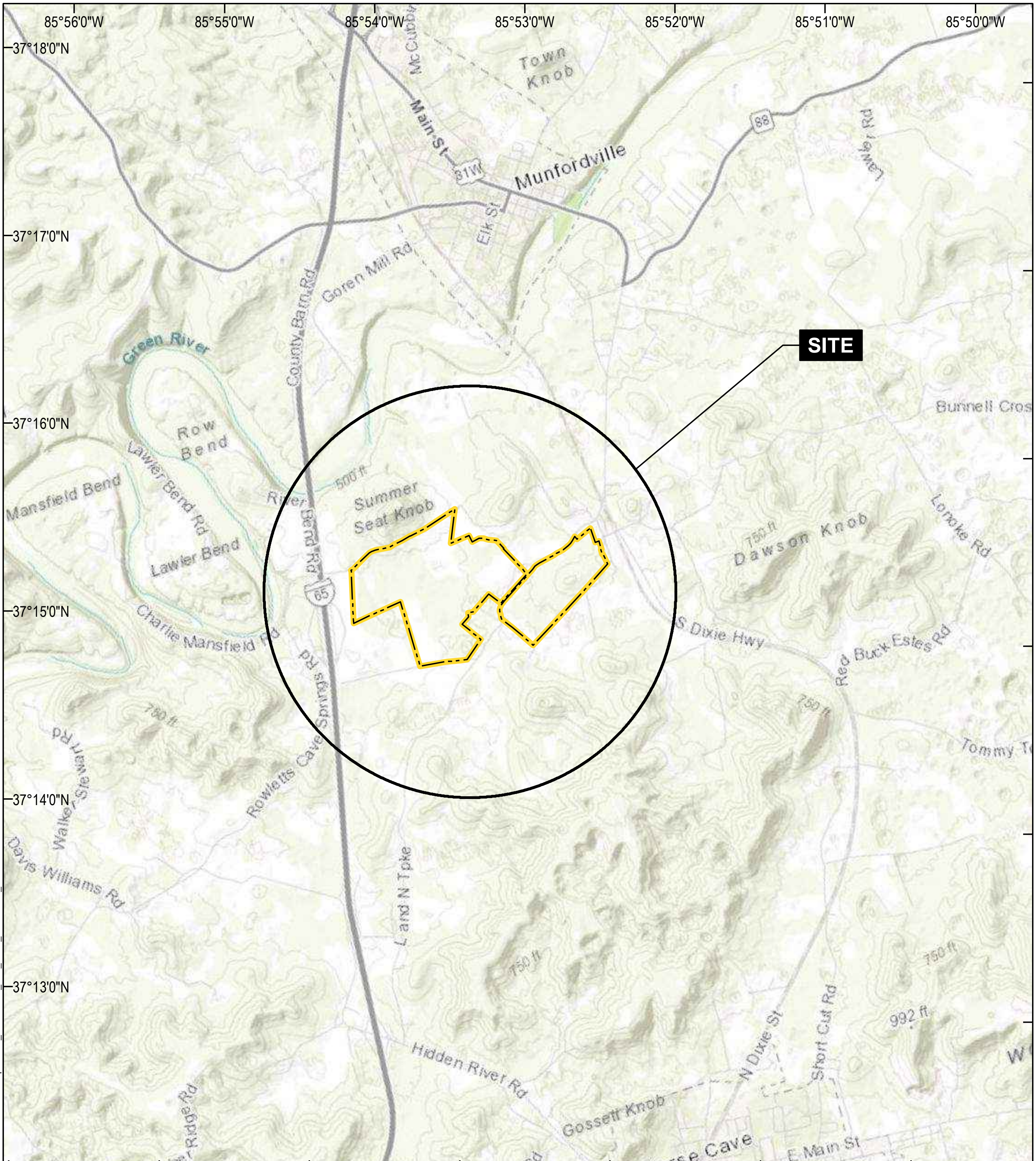
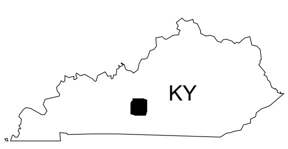
# FIGURES




N

MAP SOURCE: ESRI
SITE COORDINATES: 37°14'20.6" N, 85°54'48.4" W

HALEY ALDRICH

THOROUGHBRED SOLAR
HART COUNTY, KENTUCKY

PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
OCTOBER 2022

FIGURE 1

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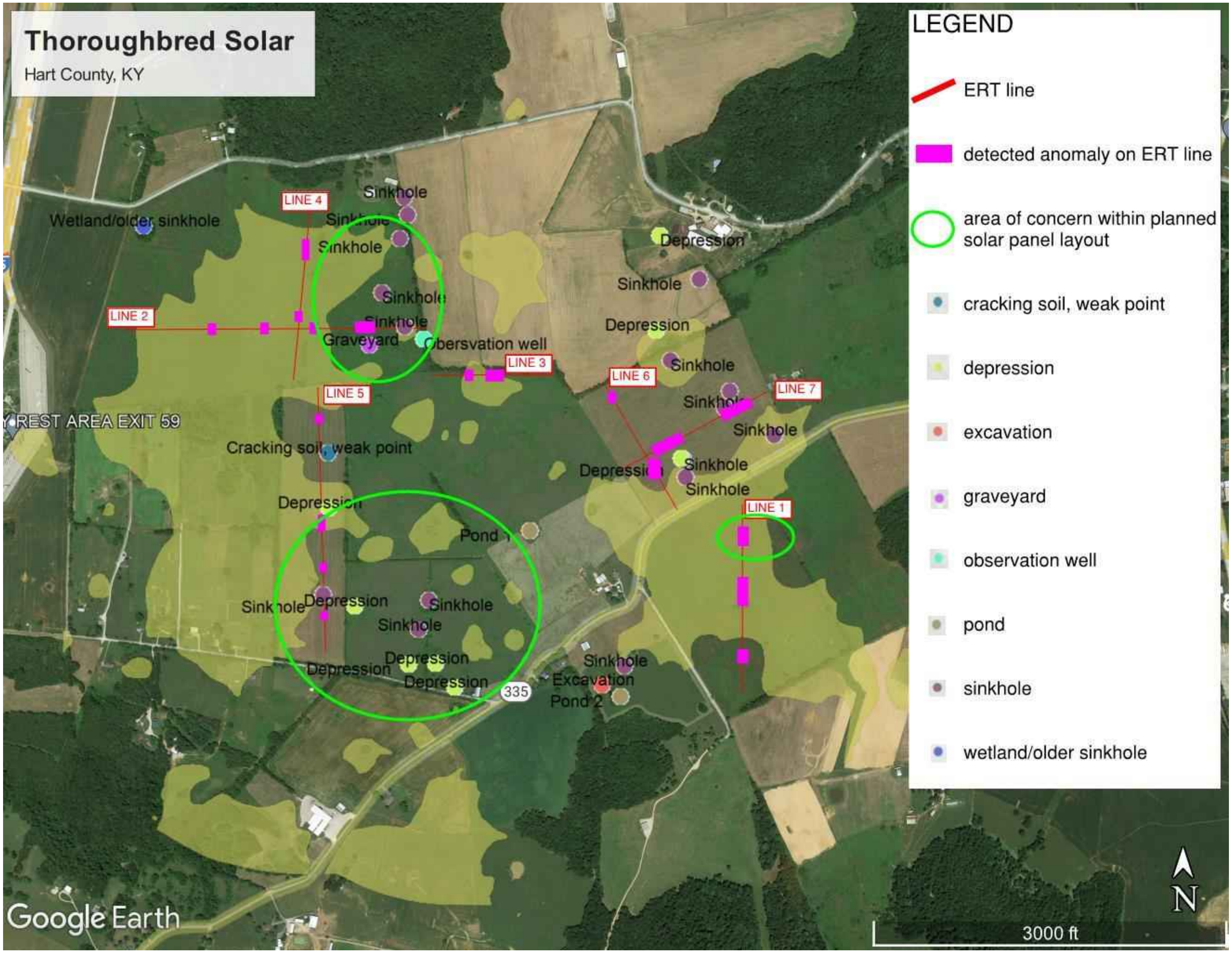


Note: The areas of concern noted are based on our observations in the field and subsurface data obtained from our investigations. There may be other, undetected areas with increased sinkhole activity.

HALEY ALDRICH

THOROUGHBRED SOLAR
HART COUNTY, KENTUCKY

PRELIMINARY KARST EVALUATION

SCALE : AS SHOWN
OCTOBER 2022

FIGURE 2

203928-001-FIG 2.PPT

# APPENDIX A
## Terracon Geophysical Exploration Report

October 4, 2022

Haley & Aldrich, Inc.
3 Bedford Farms Drive
Bedford, NH 03110

Attn: Mr. Anant Panwalkar, P.E.
P: (603) 391-3333
E: APanwalkar@haleyaldrich.com

**Re: Geophysical Exploration Report**
Thoroughbred Solar
Horse Cave, Hart County, Kentucky
Terracon Project Number N1225225

Dear Mr. Panwalkar:

Terracon Consultants, Inc. (Terracon) performed geophysical exploration services consisting of Electrical Resistivity Imaging (ERI) on July 7th – 8th and July 11th – 13th, 2022. The purpose of the geophysical exploration was to interpret the approximate top of bedrock and locate potential karst features to generally characterize the subsurface at the project site. The following sections outline the exploration methodology and findings.

## 1.0 GEOPHYSICAL EXPLORATION

The ERI method uses an array of electrodes inserted into the ground to measure the subsurface resistivity profile. The survey uses potential and current electrodes that function independently of one another to measure the potential field. A transmitting current dipole is followed by a series of potential dipoles which measure the resulting voltage gradient at each station. As the transmitting dipole is advanced along the electrodes, the resulting gradient measurements were collected as a 2D section below the survey array.

Terracon used an Electrical Resistivity Imaging (ERI) system consisting of an Advanced Geosciences Inc. (AGI) SuperSting R8 control unit. After field collection, the resistivity data was processed using EarthImager 2D (engineered by AGI), an inversion and modeling software package. Changes in the earth resistivity can indicate changes in lithology, voids, saturation, and amount of fracturing.

The client requested surveys along 7 lines spread across the site that appear to intercept closed depressions and potential sink holes. Exhibit 1 displays the line locations on a site map. The map highlights closed depression features based on publicly available LiDAR data.

## 2.0 GEOPHYSICAL FINDINGS

The cross-sectional images generated from the ERI testing are displayed on Exhibits 2 and 3. The images are representations of the electrical resistivity of the subsurface. Resistivity is sensitive to clay content, water, and bedrock quality (clay seams and fractures). Water and clay (including poor bedrock) produce low resistivity values (purple, blue, and dark green). Massive limestone units with minimal fracturing produce high resistivity values (red, orange, yellow, and light green). Significant air voids are characterized by isolated very high resistivity zones. The top of rock interpretation should be considered approximate due to the minimal direct exploration that has been completed on the site. The following is a summary of our findings:

- The interpreted depth to the top of bedrock ranging appears to range from surficial to approximately 20 feet below existing grade. Bedrock depths are primarily within 5 to 10 feet of existing grade.
- The ERI data indicates varying amounts of potential weathering and fracturing of the bedrock, with potential limestone caprock zones underlain by clay filled voids.
- Potential karst anomalies were interpreted on all 7 lines. The features are characterized by low elevation dips in the top of bedrock underlain by low resistivity zones.
    - Low resistivity zones within the bedrock may indicate weathered/fractured rock or a solutioning channel into the bedrock
    - Very low resistivity anomalies (purple to blue) may indicate a water or clay filled void in the bedrock.
- Karst anomalies below at least 10 feet of bedrock pose a reduced risk at the surface especially when the feature doesn't have a direct infiltration pathway to the surface.
- The anomalies interpreted on the profiles were overlayed on Exhibit 1.

## 3.0 CONCLUSIONS

The complex nature of karst makes it difficult to assess. We recommend direct exploration at the geophysical anomaly locations to better characterize the risk. The areas of highest risk are where the data indicates a karst throat that connects the soil overburden with karst features within the bedrock. These features allow water infiltration that can move soils, creating sinkholes. Our survey did not indicate large air-filled voids. Close monitoring of these areas during construction is recommended as voids and sinkhole throats may be uncovered.

## 4.0 LIMITATIONS

All geophysical testing methods rely on instrument signals to indicate physical conditions in the field. Signal information can be affected by on-site conditions beyond the control of the operator, such as, but not limited to, cultural features, standing water, high subsurface moisture content, and other buried objects. Interpretation of those signals is based on a combination of known factors combined with the experience of the operator and geophysical scientist evaluating the results. The provided depth measurements are estimated based on the electrical properties of the subsurface material.

This report has been prepared for the application discussed and in accordance with generally accepted geophysical practices. No warranties, expressed or implied, are intended or made. The findings presented in this report are based upon the data obtained from the geophysical surveys and from other information discussed in this report. This report does not reflect variations that may occur in areas not tested or inaccessible to the geophysical equipment, across the site, or due to the modifying effects of construction or weather.

We appreciate the opportunity to be of service to you on this project. Please do not hesitate to contact should you have any questions.

Sincerely,
**Terracon Consultants, Inc.**

Kyle J. Shalek, Ph.D.
Senior Geophysicist

Benjamin W. Taylor, P.E., P.G.
Principal, Regional Manager

Attachments: Exhibits 1 - 3

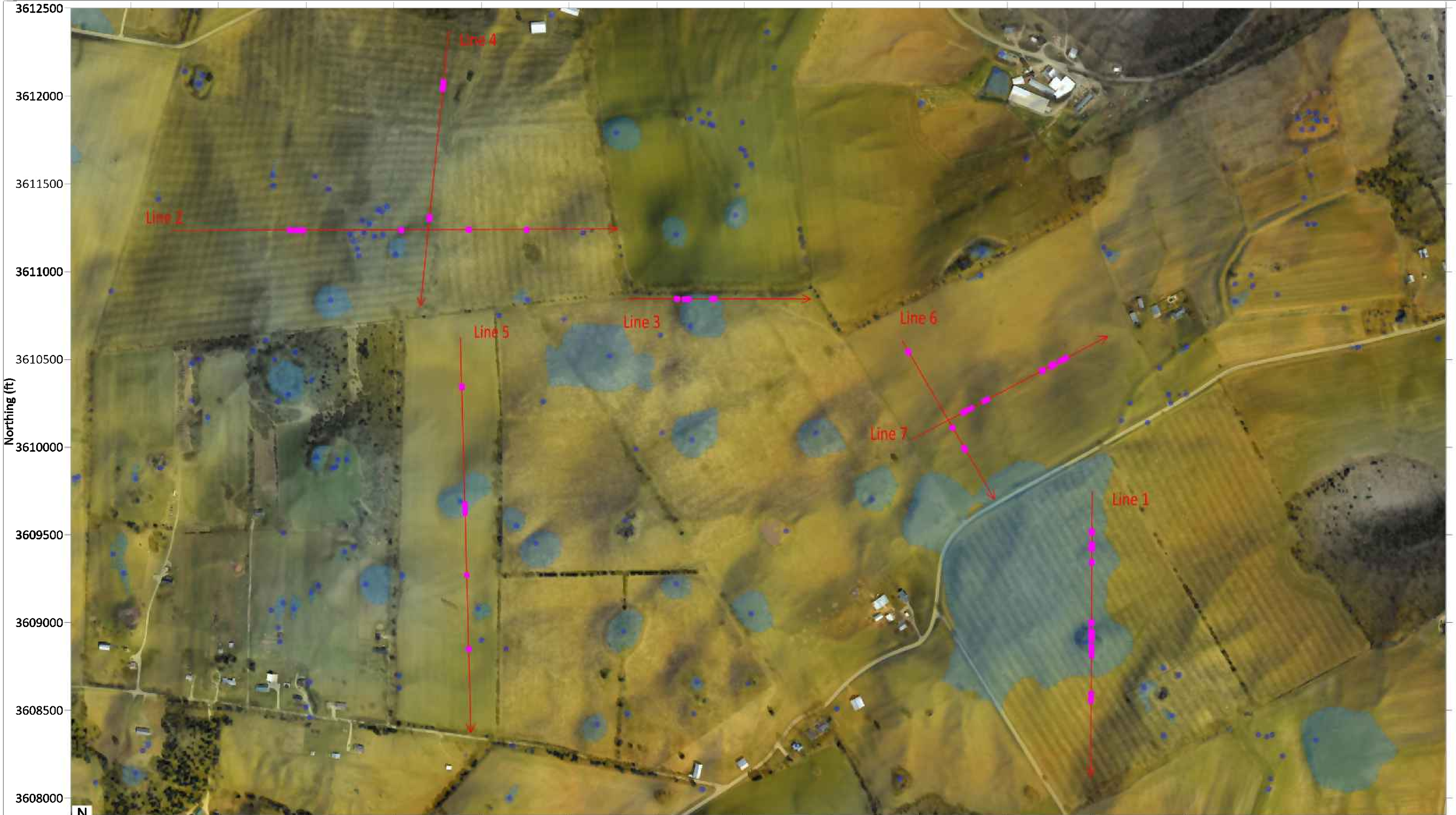


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

State Plane: Kentucky Single Zone (ft)

ERI Lines

Public LiDAR Closed Depressions

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| Project Manager: KJS | Project No. N1225225 | Terracon Consulting Engineers & Scientists | Geophysical Survey Plan | EXHIBIT | |
| Drawn by: KJS | Scale: 1" = 500' | 611 Lunken Park Drive Cincinnati, Ohio 45226 | Thoroughbred Solar | 1 | |
| Checked by: SEB | File Name: Thoroughbred | | Horse Cave, Hart County, Kentucky | | |
| Approved by: BWT | Date: 07/15/2022 | | | | |


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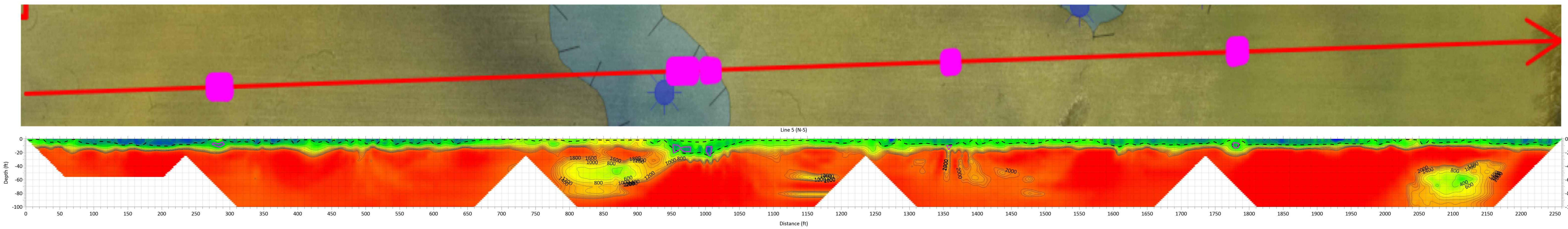
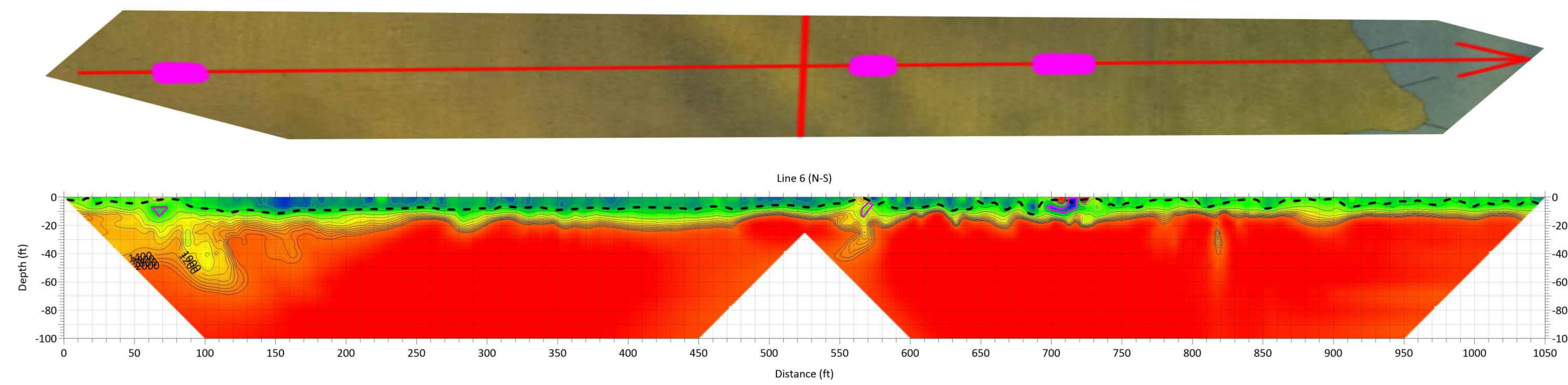
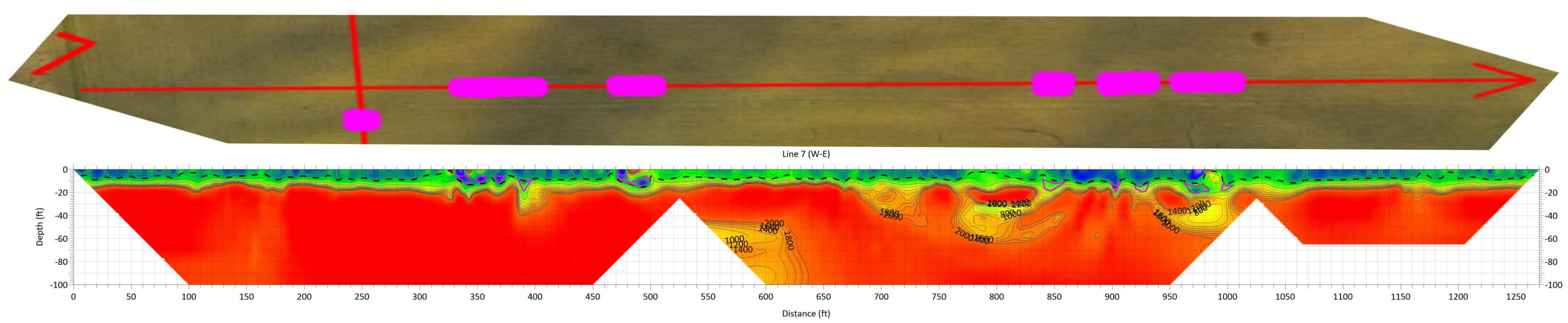
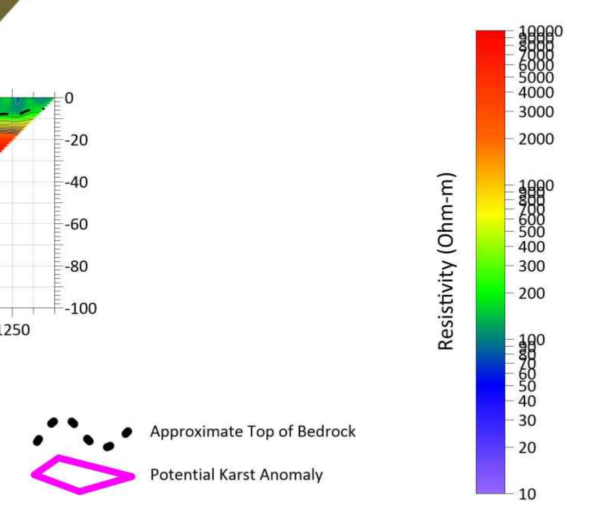
| Project Manager: KJS | Project No. N1225225 | Terracon Consulting Engineers & Scientists | ERI Cross-Sections | EXHIBIT |
| Drawn by: KJS | Scale: 1" = 55' | 611 Lunken Park Drive | Thoroughbred Solar | 2 |
| Checked by: SEB | File Name: Thoroughbred | Cincinnati, Ohio 45226 | Horse Cave, Hart County, Kentucky | |
| Approved by: BWT | Date: 07/15/2022 | | | |

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