Merging Multiple Existing Geotechnical Databases

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Kentucky Transportation Center
College of Engineering, University of Kentucky, Lexington, Kentucky

in cooperation with
Kentucky Transportation Cabinet
Commonwealth of Kentucky

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Kentucky Transportation Center • University of Kentucky
176 Raymond Building • Lexington, KY 40506 • 859.257.6898 • www.ktc.uky.edu

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Merging Multiple Existing Geotechnical Databases

Charlie Sun, Ph.D., P.E.
Research Engineer

Brad Rister, P.E.
Program Manager

and

Eileen Grady
Research Scientist

Kentucky Transportation Center
College of Engineering
University of Kentucky
Lexington, Kentucky

In cooperation with
Kentucky Transportation Cabinet
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16. Abstract
This report discusses a project undertaken by Kentucky Transportation Center (KTC) researchers to create a comprehensive geotechnical database for highway planning, design, maintenance, and repair. The project consolidated multiple geotechnical data sources into a unified database accessible to Kentucky Transportation Cabinet (KYTC) staff, enabling informed decision making and improving project outcomes. Databases were merged with great attention to detail, ensuring data integrity and coherence. A geotechnical data collector app developed as part of the project supports convenient and efficient data collection in the field, even when phones or tablets lack network connectivity. A rockfall rating app and landslide hazard rating system streamline the collection and assessment of rockfall and landslide data. The report highlights tools used to complete the project, including the ArcGIS suite (i.e., ArcMap, ArcGIS Pro, ArcGIS Online, Collector, Field Maps, Survey123), Microsoft Visual Studio, and Microsoft SQL Server. These tools facilitate geodatabase management, field data collection, and data analysis. Detailed instructions and user manuals are provided for each application. Overall, project deliverables strengthen the Cabinet's geotechnical data management as well as its geotechnical investigations, risk assessments, and mitigation strategies. It empowers staff by giving them access to valuable tools for data collection, analysis, and visualization, which in turn positively influence the safety and performance of Kentucky's highways.

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Executive Summary

This report discusses the results of a project Kentucky Transportation Center (KTC) researchers undertook to create a comprehensive geotechnical database and develop geotechnical data collection and assessment tools. Researchers consolidated multiple geotechnical data sources and enhanced data management to achieve better decision making and project outcomes. The report highlights the importance of geotechnical data in highway planning, design, maintenance, and repair, particularly in mountainous areas where soil and rock excavation costs are significant. The stability of embankments and rock cuts, as well as the engineering properties of materials used in subgrades, directly impact highway performance and safety.

The project involved merging existing databases, including the Kentucky Geotechnical Database and the Kentucky Geological Survey (KGS) database. Unique identifiers and meticulous table-by-table merging ensured data integrity and consistency throughout the process. SQL sentences are provided as a guide for the merging process (Appendix B).

Additionally, researchers developed a geotechnical data collector app and rockfall and landslide hazard rating apps. The geotechnical data collector app lets field personnel collect point-based geotechnical information, capture photographs, and synchronize data with GIS platforms for analysis and visualization. The rockfall and landslide hazard rating apps streamline the collection and assessment of rockfall and landslide hazard data, providing a structured workflow for hazard rating and continuous data enhancement.

Merging the Kentucky Geotechnical Database and KGS database, in combination with the apps developed as part of the project, is improving geotechnical investigations, risk assessments, and mitigation strategies. The tools enhance data collection, analysis, and hazard assessment capabilities, empowering KYTC personnel to make informed decisions and recommendations about geotechnical repairs and infrastructure planning.

Overall, the project's successful implementation will improve the safety, performance, and cost-effectiveness of highways in Kentucky, promoting the efficient use of resources and fostering proactive risk management.

Section 1 Introduction

The Kentucky Transportation Cabinet (KYTC) recognizes the importance of geotechnical data for the planning, design, maintenance, and repair of highways. Geotechnical information, including data on rock falls, landslides, soil and rock properties, and engineering characteristics, is crucial for optimizing designs, minimizing costs, and ensuring the safety and performance of highways.

In mountainous areas, the cost of constructing highways is heavily influenced by soil and rock excavation and placement. They account for around 90% of the total cost. In flatter terrain, the cost is approximately 50%. The selection of slope geometry for embankments and cuts in mountainous regions significantly impacts initial construction and future maintenance expenses. The stability of embankments and rock cuts depends on the strength properties and weathering characteristics of geological units. Soil and rock strength determine slope angles which, in turn, affect right-of-way requirements. The engineering properties of materials used in embankment subgrades directly influence pavement performance, settlement, and safety.

Having sound knowledge of geotechnical information during the design phase is invaluable in planning highway facilities. Understanding the past performance of soil and geological units in rock cut slopes and embankments helps identify potential design problems and reduce failures. As traffic volumes increase, conducting geotechnical drilling and retrieving soil and rock specimens for testing during roadway reconstruction becomes challenging, dangerous, and costly. Hence, capturing geotechnical data as they are generated becomes increasingly important.[1]

Maintaining highway rock slopes and correcting landslides present significant engineering challenges and require substantial funds each year. Storing geotechnical engineering data is critical for planning new transportation facilities and repairing rock slopes and landslides. The Federal Highway Administration (FHWA) recommends developing rock slope and landslide inventories to facilitate cost estimates and remedial plans.[2]

With many aging highways in Kentucky, deterioration and collapses of highway cut slopes and embankments are common, posing risks to highway users. Rock slope repairs have been extensive and costly in the state. Gathering geotechnical engineering information requires significant investment, but it is essential for developing economical plans and constitutes the initial step in planning new infrastructure.

Geotechnical data sources are scattered across KYTC District Offices, the KYTC Central Office, the Kentucky Transportation Center (KTC), and Kentucky Geological Survey (KGS). Undocumented geotechnical data may also reside in individual employee computer files, which could become inaccessible as employees retire. To consolidate available geotechnical data, KTC, KYTC, and KGS collaborated to populate a geotechnical database that provides KYTC access to valuable field data for future geotechnical site investigations, which will improve decision making and project outcomes.

Section 2 Project Scope

This project sought to create a comprehensive geotechnical database by merging multiple existing databases and incorporating additional local geotechnical data. Our team began by identifying known geotechnical databases and understanding their organizational structures. We initially focused on an Oracle database developed in the late-1990s by KYTC geotechnical engineering staff and KTC researchers. The database contains information on rock slopes, landslides, and soil and rock properties, including data on:

- Roughly 2,140 potentially hazardous rock slopes (classified using the methodology outlined in FHWA Rockfall Hazard Rating System: Participant's Manual[3]).
- 1,900 identified landslides rated using a simple system devised by KYTC and KTC.
- Geospatial coordinates for each rock slope and landslide recorded with sub-meter accuracy GPS.
- Approximately 7,385 photos describing the sites and a significant number of soil/rock samples dating back to 1962, encompassing various geotechnical properties.

The project also involved collaborating with KGS to integrate another geotechnical database created in 2005. The KGS database enables uploading and cataloging of electronic reports into a relational database, but it lacks historical data on rock slopes, landslides, and soil and rock properties found in the Oracle database.

Additionally, the project sought to capture additional local geotechnical data from KYTC District Offices since valuable institutional knowledge and data exist at these locations. Local information is crucial when evaluating existing landslides or rock falls.

The ultimate objective was to merge all known geotechnical data sources into a unified geotechnical database accessible to KYTC geotechnical staff in the field. Access to this type of database will let engineers and field technicians review historical data during site investigations, enabling them to make more informed decisions and recommendations for future geotechnical repairs. Centralizing and enhancing geotechnical data management facilitates better geotechnical investigations and contributes to more effective risk assessment and mitigation strategies.

In addition to merging databases, the project also included the development of a data collector app for the ArcGIS platform, a rockfall hazard rating application for ArcGIS, and landslide hazard rating applications for both the ArcGIS platform and a Microsoft Internet Information Server web-based system. These applications will enhance data collection, analysis, and hazard assessment capabilities, providing valuable tools for geotechnical staff in their daily operations.

Section 3 Merging the Kentucky Geotechnical Database and KGS Database

Every database has a unique structure, and merging databases requires a thorough understanding of their respective data structures. It is essential to fully grasp the specific data structures to effectively combine and organize the databases. Unique identifier fields play a crucial role in the merging process, especially when dealing with relational databases that utilize distinct foreign keys— identifiers that serve as critical components for establishing relationships and ensuring proper integration between databases. By leveraging these unique identifiers, merging and organizing databases can be done seamlessly.

3.1 Kentucky Geotechnical Database (geo)

The primary objective of the Kentucky Geotechnical Database application is to establish an efficient and effective system for data entry, retrieval, and analysis. To accomplish this, the database is structured into several categories, each with a specific purpose. Categories need to be isolated individually and interconnected within the database to facilitate a logical, flexible, and easily understandable hierarchy. To achieve this, the database is split into multiple levels, adopting a tree-like design and establishing relationships using primary and foreign keys.

In the database, a primary key is assigned to a column or set of columns that uniquely identifies each row in a table. A foreign key is a column or set of columns that holds primary key values from another table. Each entry in the foreign key column(s) must correspond to an entry in the referenced table. This relational approach ensures natural and logical connections among geotechnical data based on their locations. Data are organized into different levels, starting with the highest-level datum, which is the location/site information. Below this level, project categories, detailed information, and lower-level data such as holes, samples, and properties are included. This relational structure minimizes database storage requirements.

Figure 3.1 illustrates the structure of the Kentucky Geotechnical Database, showcasing the tree-like organization and relationships among its components. Data are categorized into major sections, including the Rock Slope Database, Landslide Database, Roadway Database, Structures Database, and Soil and Rock Engineering Database.

The Structures category encompasses different structure types (e.g., bridges, buildings, culverts, dams, drainage systems, pavements, utilities, walls, potential future additions). The Soil and Rock Engineering category contains properties and characteristics of soils and rocks, including classifications, grain sizes, moisture-density relations, California Bearing Ratio (CBR), field and laboratory strengths, consolidation properties, resilient modulus, and visual descriptions. The Classification category includes test results related to specific gravity, liquid limit, plasticity index, natural water content, D50, shrinkage limit, AASHTO soil classification, unified soil classification, soil activity, and soil liquidity index. Similarly, the Rock properties category includes data on lithology, rock quality designation (RQD), slake durability, jar slake test results, visual descriptions, and unconfined compressive strength. The database also incorporates data entry and retrieval schemes, analytical and design applications, statistical analyzers, and electronic photographs and maps. For a detailed representation of the database's entity relationship, see **Appendix A**.

The design and structure of the Kentucky Geotechnical Database aim to streamline data storage, retrieval, and analysis, enabling efficient utilization of geotechnical information for future site investigations and engineering projects.

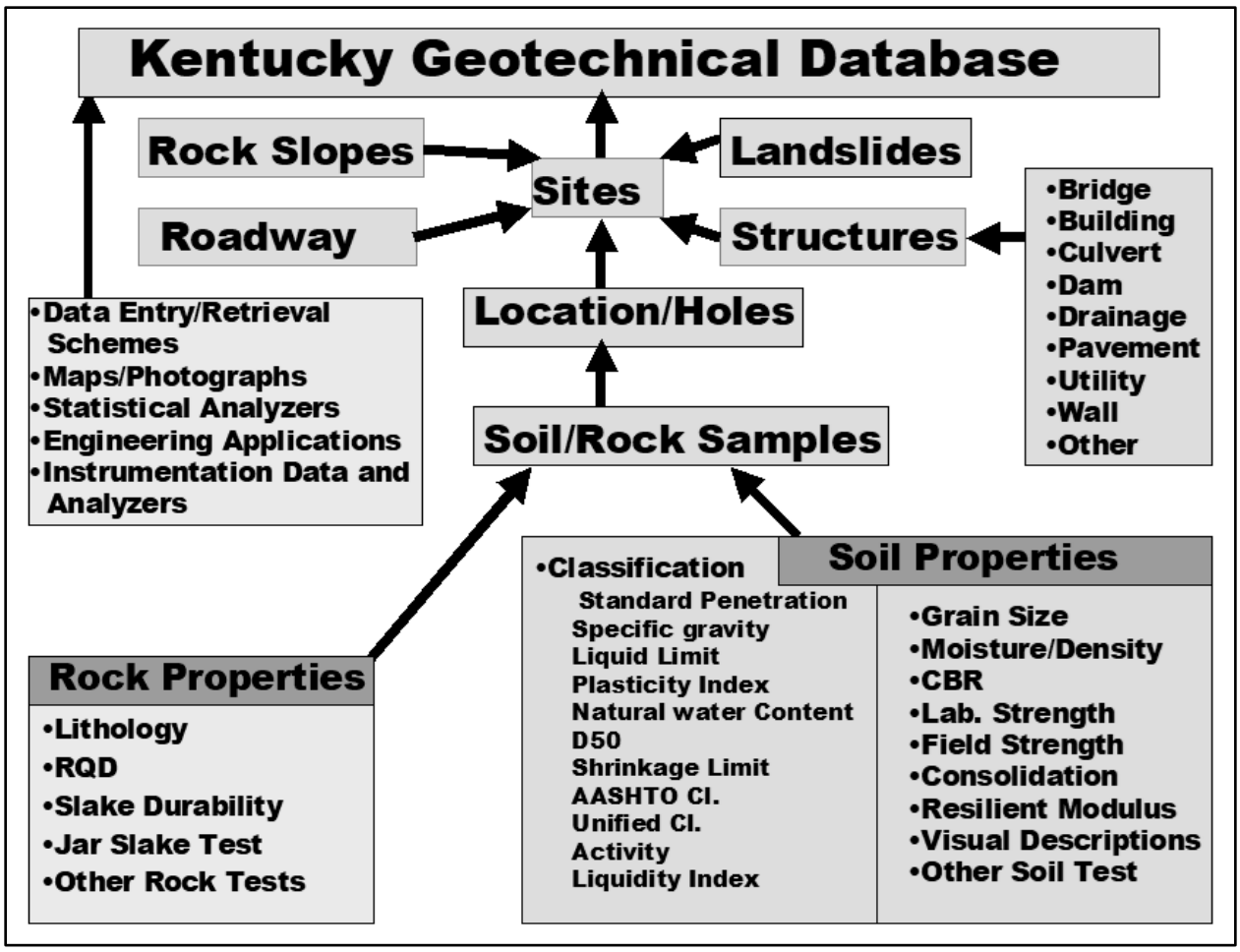

Figure 3.1 Structure of the Kentucky Geotechnical Database

3.2 Database Hosted by Kentucky Geological Survey (KGS)

KGS employs the commercial software gINT to manage its database. gINT is a powerful data management tool designed for geotechnical, geological, and geoenvironmental professionals. This software automates repetitive tasks, eliminates redundant data entry, and significantly enhances productivity. By leveraging gINT, KGS can streamline processes, ensure accessible and interoperable data, and improve reporting and visualization of subsurface information, including soil and rock data, borelogs, laboratory test results, and more. The use of gINT increases productivity and facilitates better decision making by providing a comprehensive and efficient platform for managing geotechnical information.

In the KGS database, the key column used to integrate all the tables is referred to as GintRecID. This column plays a crucial role in establishing the entity relationships within the database.[4] Figure 3.2 partially illustrates the entity relationships in the KGS database, demonstrating the interconnectedness of tables and the use of the GintRecID column.

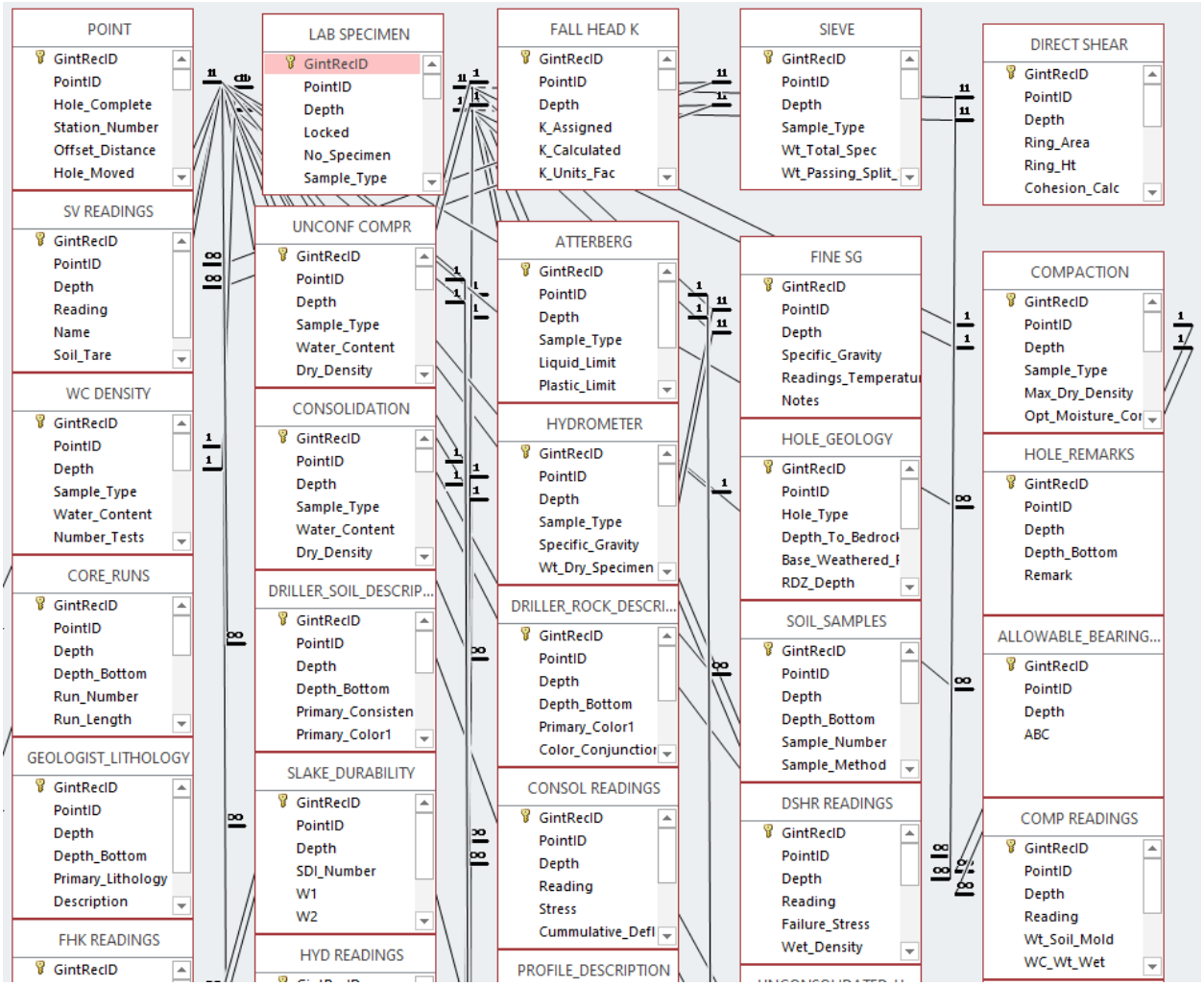

Figure 3.2 Entity Relationships for the KGS Database

3.3 Merging the Kentucky Geotechnical Database and KGS Database

To ensure seamless integration and preserve the structures and data integrity of the Kentucky Geotechnical Database and the KGS database, we followed a meticulous approach. The merging process involved combining the two databases table by table, taking under consideration the unique characteristics of each dataset.

We gave careful consideration to aligning fields, data types, and relationships between corresponding tables in both databases. This table-by-table merging approach ensured that the merged database maintained consistency and coherence, enabling efficient data retrieval and analysis.

To facilitate the merging process, we developed a comprehensive set of SQL sentences. These outline the steps and operations required to transfer data from the Kentucky Geotechnical Database to the corresponding tables in the KGS database. Each SQL sentence is crafted to handle the specific requirements of merging data, including necessary transformations or conversions.

Using SQL sentences provided in **Appendix B**, the merging process can be executed smoothly and accurately. The SQL sentences serve as a guide, offering a clear roadmap for transferring data from the Kentucky Geotechnical Database to the designated tables in the KGS database.

Throughout the merging process, data integrity were prioritized to ensure the accuracy and reliability of the merged database. Quality checks and validation procedures were implemented to verify the consistency and coherence of merged data. Any inconsistencies or discrepancies were resolved promptly to maintain the integrity of the merged dataset.

Section 4 Development of a Geotechnical Data Collector App

The development of a comprehensive geotechnical data collector app was a key project objective. This app gives KYTC users a convenient and efficient means of collecting point-based geotechnical information using tablets, mobile phones, and other devices.

To ensure flexibility and usability, the data collector app operates in an offline mode, allowing users to access and collect data in areas with limited or no internet connectivity. Users have access to pre-planned offline areas, ensuring seamless data collection regardless of location. This eliminates dependency on continuous network availability and enables uninterrupted data collection in the field.

When using the data collector app, users can effortlessly capture point-of-interest data along with relevant photographs. This enables the collection of detailed and accurate information onsite. The app streamlines data collection, reducing manual effort and mitigating the risk of data loss or discrepancies.

Once users return to the office or regain internet connectivity, collected data can be easily synchronized and viewed within a GIS platform such as ArcGIS or ArcGIS Online. This integration with GIS technology enhances data analysis and visualization capabilities, helping users gain valuable insights from the geotechnical information gathered in the field. By leveraging GIS, users can overlay collected data on maps, perform spatial analysis, and make informed decisions based on the geospatial context.

The data collector app supports the addition of follow-up field observations and photographs for sites where data were previously gathered. This feature lets users update and expand upon existing data by providing additional context or documenting changes observed during subsequent field visits. By enabling the continuous enhancement of collected data, the app promotes the iterative refinement of geotechnical datasets, ensuring their accuracy and relevance over time.

4.1 Overview of Tools Used

For implementation, we used several tools and apps from the ArcGIS suite. ArcMap and ArcGIS Pro serve as the primary tools for creating and managing the backend geodatabases that form the foundation of the project. These applications support the creation of geodatabases with layers and tables, which are then uploaded to ArcGIS Online, where they can be accessed and integrated with other applications.

KTC's Pavements, Materials, Geotechnology, & Infrastructure Assessment section has its own organizational account on ArcGIS Online, providing a centralized platform for managing and sharing geospatial data. Once geodatabases are created using ArcMap or ArcGIS Pro, they are uploaded to ArcGIS Online, where they can be accessed and used by mobile applications such as Collector and Survey123.

ArcGIS Collector and ArcGIS Field Maps are mobile applications designed for map-based field data collection. They can be downloaded for free on iOS devices, and users can log in using their ArcGIS Online credentials. By configuring maps in ArcGIS Online, developers and users can define specific data collection workflows and customize the user interface for efficient field data collection. However, Esri is retiring Collector, and Field Maps will be the recommended replacement. The transition from Collector to Field Maps will not result in significant changes for users as the user interface remains largely similar, with the primary difference being the need to download the new app.

Another tool in the ArcGIS suite is Survey123, a form-based mobile app for field data collection. Similar to Collector and Field Maps, Survey123 is available for free download on iOS devices, and users log in using their ArcGIS Online credentials. The Survey123 Connect desktop app is used to create smart forms in Excel format, which are then utilized within the Survey123 field app. This allows for customized data collection forms tailored to specific project requirements.

4.2 Geotechnical Data Collector

The Geotechnical Data Collector app provides a comprehensive solution that combines the display of historical data with the ability to collect information on new geotechnical features and retaining walls as well as record follow-up site visits or inspections. To facilitate data collection, base layers for this collector were initially created using ArcGIS Pro, then published to ArcGIS Online, and are now deployed in the cloud and on user devices for seamless data recording.

Previously, geodatabases stored on the desktop in ArcMap served as the main repository for data. However, with the introduction of field data collection, these geodatabases now function as templates, while active data are stored in the cloud on ArcGIS Online. To access the Geotechnical Data Collection project, users can download the ArcGIS Pro project package file, *Geotechnical Data Collection*, from the shared Dropbox folder. Once downloaded, opening the file in ArcGIS Pro unpacks and saves it on the user's system.

The *Geotechnical Data Collection* contains three primary geodatabases: Historic Geotech Sites, KYTC Geotech Data Collection, and KYTC Retaining Walls. These geodatabases serve as templates published on ArcGIS Online for the purpose of data collection. The core structure of the data collector revolves around a point feature class, which records the locations of geotechnical features, and a related table, which captures follow-up visits or inspections by adding related records to each feature. Both the point feature class and the related table support attachments, allowing users to associate photos with each data entry.

All layers required for data collection have been published and configured in ArcGIS Online. As noted, active data reside in the cloud, while the geodatabases stored on the desktop and viewed in ArcMap function as templates. To collect data in the field, users need to configure a map in ArcGIS Online, which can then be accessed through the mobile Collector or Field Maps apps for data collection. For optimal performance in areas with limited service, the map should be configured for offline data collection.

Two sets of maps are available for the Geotech Data Collection apps. The full version is primarily used by the Geotech Central Office, while an abbreviated and streamlined version is provided for District maintenance offices. Each version consists of a map for use in the mobile app, an online web viewer application, and a map that feeds the online web viewer app. The full version for the Geotech Central Office includes the KYTC Geotech Data Collection layer with all feature types, KYTC Retaining Walls, Historic Geotech Sites (used as a reference layer), and KYTC gINT Layers from KGS. The abbreviated version for Districts contains a layer view called *Geotech for Districts* that references the original KYTC Geotech Data Collection layer but only displays landslides, rockfalls, and sinkholes, along with the Historic Geotech Sites layer for reference.

The Geotech Incident Web Viewer, located in the same folder, serves as a semi-restricted tool displayed on our ArcGIS Online homepage. It also acts as a reference tool for our Pavement Forensic Reports.

For detailed instructions and guidance on using the geotechnical data collector app, please refer to the user's manuals in **Appendices C** and **D**. These manuals provide step-by-step instructions and helpful tips for utilizing the application efficiently.

Section 5 Development of a Rockfall Rating App

The Rockfall Rating App, developed using ArcGIS Field Maps, offers KYTC users a convenient solution for collecting point-based rockfall locations and capturing photos using an iPad. To further assess and classify each rockfall, the collected data are processed and assigned a rating using Survey123.

With the Rockfall Rating App, users can easily identify and record rockfall locations in the field. By leveraging the capabilities of Field Maps, users can accurately pinpoint the exact coordinates of each rockfall occurrence. The application allows for seamless integration with iOS, enabling efficient data collection and geotagging of photos to visually document each rockfall event.

Once rockfall locations and photos have been collected, Survey123 comes into play. This powerful form-based mobile app lets users assign a rating to each rockfall based on specific criteria. By utilizing Survey 123's features functionalities, users can leverage predefined rating scales or custom evaluation criteria to assess the severity and potential risks associated with each rockfall occurrence.

The Rockfall Rating App, in conjunction with Field Maps and Survey123, streamlines data collection for rockfall incidents. It provides KYTC users with a user-friendly interface and efficient workflows, ensuring accurate documentation and assessment of rockfall events.

5.1 Overview of Tools Used

The tools used to develop the Rockfall Rating App are the same as those described in Section 4.1. These tools include Field Maps, Survey123, and ArcGIS Online.

Field Maps serves as the primary application for collecting rockfall locations and capturing photos using an iPad. Its user-friendly interface and intuitive design make it an ideal choice for field data collection. With its offline capabilities, users can seamlessly collect data in areas with limited or no network connectivity.

Following data collection, Survey123 is used to assign ratings to rockfall incidents. Survey 123 is a flexible platform, which lets users define rating scales and criteria. This ensures consistent and standardized evaluations of rockfall severity.

In conjunction with these mobile apps, ArcGIS Online acts as the central hub for data management and collaboration, letting users publish and share geodatabases, maps, and applications across KYTC. ArcGIS Online also provides tools for configuring maps, creating data collection forms, and analyzing collected data.

Using these tools in combination empowers KYTC users to make informed decisions about rockfall mitigation and prioritization, thus enhancing the safety and efficiency of transportation infrastructure.

5.2 Rockfall Hazard Rating System (RHRS)

The Rockfall Hazard Rating System (RHRS) implemented in this app follows guidelines outlined in the FHWA *Rockfall Hazard Rating System: Participant's Manual*.[3] It provides a structured workflow for assessing hazards associated with rockfall incidents. To facilitate this process, the application leverages Field Maps for recording rockfall locations, while Survey123 is utilized to rate the level of hazard posed by each rockfall. Users can also record additional follow-up visits to reevaluate and update a rockfall's hazard rating. Survey123 lets users log in using their ArcGIS Online credentials.

Base layers for this application were created using ArcGIS Pro and Survey123, then published to ArcGIS Online. These layers are deployed in the cloud and on user devices, enabling data collection and recording. As users will add new data directly in the field, the geodatabases stored on the desktop in ArcMap are used as templates, while active data are stored in the cloud on ArcGIS Online. To access files, users download the *Rockfall Hazard Rating System* ArcGIS Pro project package file from the shared Dropbox folder. After downloading, they can open the file in ArcGIS Pro, which unpacks and saves the project to their system. The app contains a geodatabase named *RHRS.gdb*, which serves as the template published to ArcGIS Online for data collection and to create the form in Survey123.

The basic structure for data collection in the RHRS consists of a point feature class used for recording the locations of rockfalls, along with a related table for storing hazard ratings by adding related records to each rockfall feature. Both the point feature class and related table support the attachment of photos, allowing users to associate visual documentation with each recorded rockfall incident.

While the RHRS shares similarities with the Geotech Data Collection app, it utilizes Survey123 to populate the related table with hazard ratings. All necessary ArcGIS Online items for this component can be found on ArcGIS Online, and additional materials associated with the Survey123 can be accessed in the Survey123 Designs folder in the shared Dropbox folder.

For detailed instructions and guidance on using the RHRS app, refer to the user's manual in **Appendix E**.

Section 6 Development of a Landslide Hazard Rating System

Our team successfully developed the Landslide Hazard Rating System, creating two versions of the app to cater to different user needs and to streamline the collection and assessment of landslide hazard information.

The first version was designed on the ArcGIS platform and is tailored to KYTC users. It facilitates the collection of point-based landslide hazard data and accompanying photos using iPads. Leveraging Survey123, the system assigns a hazard rating score to each landslide based on collected information. The hazard data and ratings are seamlessly integrated into the KYTC database, ensuring centralized and up-to-date information for effective decision making.

The second version of the app is a web-based platform and is primarily aimed at KYTC personnel. Its interface enables the submission of landslide hazard information directly to the KYTC database. The system automates the hazard scoring process, utilizing survey data input from users to fill in the hazard scores automatically. The web-based app is equipped with an *Info. & Rating* tab, offering an easy way to submit surveys, photos, and documents related to landslide hazards. It enables efficient communication between submitters (primary users from Districts or counties), the Central Office, and other stakeholders involved in the submission and acceptance process.

The comprehensive Landslide Hazard Rating System greatly improves the efficiency and accuracy of landslide hazard assessment at KYTC. The ArcGIS-based app simplifies data collection, while the web-based platform streamlines the submission process, eliminating manual data entry and reducing the likelihood of errors. Both versions promote standardized data collection, enabling Central Office staff to make informed decisions based on consistent hazard rating scores.

To further enhance the system, ongoing efforts should focus on regular updates and maintenance to ensure compatibility with evolving technologies and address emerging user needs. Continuous improvements to the interface, functionality, and integration of additional geospatial data sources will bolster the accuracy and reliability of the hazard rating system.

Overall, the development of the Landslide Hazard Rating System demonstrates KYTC's commitment to proactive risk assessment and management. By providing efficient tools for data collection, assessment, and communication, it fosters informed decision making and supports efforts to mitigate the impacts of landslides on transportation infrastructure in Kentucky.

6.1 Overview of Tools Used

In addition to the tools mentioned in Section 4.1 for the rating system, development of the web-based app also incorporated the use of Microsoft Visual Studio and Microsoft SQL Server. These tools play crucial roles in creating a robust and functional app hosted on the Microsoft Internet Information Server (IIS).

Microsoft Visual Studio is a powerful integrated development environment (IDE) that lets developers efficiently manage client-side and server-side control mechanisms within a single platform. Its comprehensive set of features and tools facilitate streamlined coding, debugging, and testing processes, enhancing the overall development workflow.

Microsoft SQL Server is a reliable and efficient relational database management system (RDBMS) that offers extensive support for various transaction processing, business intelligence, and analytics applications in corporate

IT environments. With its robust architecture and advanced capabilities, Microsoft SQL Server ensures the secure storage, retrieval, and management of data within the web-based app.

The app developed using these tools is hosted on the Microsoft IIS. This server software provides a reliable and secure environment for delivering web apps to users. It enables efficient processing of incoming requests, seamless integration with other Microsoft technologies, and optimal performance for web-based applications.

By leveraging Microsoft Visual Studio, Microsoft SQL Server, and the Microsoft IIS, the development team created a feature-rich web-based app that incorporates efficient client-side and server-side control mechanisms, utilized a reliable and scalable database management system, and ensured seamless delivery to end users through a robust hosting environment. The use of these tools highlights the commitment to using industry-standard technologies and frameworks to deliver a high-quality, reliable, and user-friendly web-based app.

6.2 Landslide Hazard Rating System (KYLHRS)

The Kentucky Landslide Hazard Rating System (KYLHRS) was adapted from the Colorado Landslide Hazard Rating System (CLHRS) that was originally developed by the Colorado School of Mines and used by the Colorado Department of Transportation (CDOT).[5] The CLHRS has proven to be an effective management system, providing a clear and straightforward approach to identifying key parameters that significantly influence landslide potential hazards in Colorado. However, modifications were necessary to meet the specific requirements of KYTC Central Office Maintenance. To accommodate these needs, we developed an app to collect and rate landslide site data. This user-friendly app serves as a valuable tool for the Central Office, allowing staff to easily add new records and prioritize landslides based on the rating system.

By leveraging knowledge and experience gained from the CLHRS, the KYLHRS affords a systematic approach to landslide hazard assessment that is designed to meet the unique demands of KYTC. The modified system provides a comprehensive framework that considers essential parameters (e.g., slope stability, geological characteristics, historical landslide events) to accurately assess landslide potential and prioritize mitigation efforts.

Continued collaboration and communication between the KYTC and the Colorado School of Mines can further refine the KYLHRS, ensuring the app aligns with the evolving needs and challenges faced by the Central Office Maintenance. Regular updates, incorporating feedback from field observations and advancements in landslide hazard research will contribute to the ongoing improvement and effectiveness of the system.

6.2.1 Hazard Factor Selection

For the KYLHRS, a set of hazard factors were carefully selected based on parameters chosen by CDOT. The primary focus during the selection process was suitability for rapid, effective evaluation. The following hazard factors were identified as crucial components of the KYLHRS:

1. ***Annual Precipitation*** — The intensity and duration of rainfall play a significant role in landslide initiation. Rapid water infiltration and the subsequent increase in pore-water pressures can lead to slope instability and failure.
2. ***Influence of Surface Water*** — The external influence of surface water bodies contributes to landslide hazards.
3. ***Pavement Damage*** — Field observations of existing road damage provide valuable indicators of relative hazard risks. Large cracks, bulges, and pavement displacements are signs of recent or unmitigated ground movements, highlighting areas of heightened risk.
4. ***Failure Frequency*** — Slopes that experience frequent failures are inherently more hazardous. Such occurrences suggest conditions that may be sensitive to site-specific changes, warranting increased attention and mitigation.

5. ***Slope Angle*** — Slope angle is a fundamental factor considered in most soil slope stability analysis methods. It is typically used to calculate stability factors from empirical charts or incorporated into factor of safety (FS) calculations.
6. ***Height of Slope*** — Slope height serves as an essential geometric characteristic in landslide assessment. It provides valuable insights into the potential risks associated with landslides, as taller slopes tend to exhibit greater instability.

By including these hazard factors, the KYLHRS supports comprehensive and rapid evaluations of landslide hazards across Kentucky. Ongoing monitoring, data collection, and collaboration with geotechnical experts will help KYTC progressively refine the KYLHRS. Regular updates and advancements in landslide research should be incorporated to ensure the system remains accurate and relevant to managing landslide risks in Kentucky.

6.2.2 Consequence Factor Selection

While hazard factors in the KYLHRS focus on environmental contributors to landslide failure, consequence factors were carefully selected to comprehensively assess the potential negative impacts of landslide failure on roadways:

1. ***Depth to Slide Plane*** — The depth to the slide plane directly relates to the volume of the mass involved in the landslide. Deeper slide planes generally indicate larger masses and potentially more severe consequences.
2. ***Road Width Affected*** — This factor qualitatively assesses roadway impacts. It considers the extent to which the landslide affects road width.
3. ***Length of Roadway Affected*** — The length of the roadway affected by a landslide is the total length of the road segment that either intersects the landslide mass or is immediately adjacent to it. This measurement is taken perpendicular to the slide axis and parallel to the road.
4. ***Average Annual Daily Traffic (AADT)*** — Disruptions in highway segments inconvenience individual motorists and can also result in significant economic losses due to delays and the need to reroute commercial traffic. Routes that experience higher volumes of daily traffic are assigned higher consequence scores, reflecting the potential economic impact of a landslide.
5. ***Detour Options*** — Disruptions inconvenience individual motorists and can result in significant economic losses due to delays and the need to reroute commercial traffic. Routes with higher volumes of daily traffic garner higher consequence scores, reflecting the potential economic impact of a landslide.
6. ***Annual Maintenance Costs*** — As more funds are allocated to the ongoing repairs of landslide damage, fewer resources are available to address other existing landslide sites or new landslides that occur. This factor accounts for the financial implications of continued maintenance costs associated with landslide mitigation and repair.

By considering these consequence factors, the KYLHRS comprehensive evaluates of the potential negative impacts of landslide failure on roadways. This holistic approach allows for a more accurate prioritization of mitigation measures and resource allocation to effectively manage landslide risks. It is important to regularly review and update the consequence factors based on ongoing monitoring, data collection, and collaboration with experts in geotechnical engineering and transportation. This iterative process will keep the KYLHRS relevant and effective in addressing the potential consequences of landslides on Kentucky's road network.

6.2.3 Factor Evaluation Matrix

To establish a standardized scoring system for the KYLHRS, we adopted a similar approach to the FHWA Rockfall Hazard Rating System. An exponential score set, 3^n (where n = 1, 2, 3, 4), is used to rate each factor for both landslide hazard and consequence assessments. This scoring system is based on historical data related to Kentucky's climate, traffic patterns, and roadway conditions.

Each factor is divided into four categories, corresponding to the exponents 1, 2, 3, and 4. As the category increases from 1 to 4, the associated scores increase exponentially from 3 to 81 points. This exponential progression allows for a rapid escalation in score, effectively differentiating between more hazardous and more serious consequence sites. A comprehensive matrix (Table 6.1) provides scores for the four categories of both hazard factors and consequence factors.

To calculate the hazard score for a particular site, scores from the six hazard factors are summed. Similarly, the consequence score for the same site is computed by summing the scores from the six consequence factors. These scores capture the relative levels of hazard and consequence associated with each site, facilitating a quantitative assessment of landslide risks.

Regular review and refinement of the Factor Evaluation Matrix are essential to ensure it continues to align with current conditions and knowledge of landslide dynamics in Kentucky. Ongoing data collection, analysis, and collaboration with experts in the field will contribute to the continuous improvement and effectiveness of the KYLHRS.

Adoption of this scoring system and the Factor Evaluation Matrix enhances the objectivity and consistency of the KYLHRS, allowing for reliable comparisons and prioritization of landslide risks across different sites. A standardized approach supports informed decision making in landslide mitigation and resource allocation efforts to protect Kentucky's transportation infrastructure.

6.2.4 Total Rating Score

The total rating score for each landslide in the KYLHRS is calculated by multiplying the hazard score and consequence score assigned to the site. Multiplication provides a comprehensive assessment that incorporates both the potential hazard and the potential consequences of a landslide. By multiplying these scores together, the total rating score accounts for the relative severity of the hazard and the potential negative impacts on the affected roadway. Total rating scores can vary widely, allowing for easy prioritization and evaluation of landslide sites based on their overall ratings.

This scoring procedure is employed in both versions of the app developed for the KYLHRS. Whether using the ArcGIS platform-based app or the web-based app, the total rating score calculation remains consistent to ensure a unified and objective evaluation process.

To assist users in understanding and implementing the KYLHRS, **Appendix F** provides a comprehensive user's manual. The manual contains detailed instructions, guidelines, and examples to facilitate the proper use of the rating system and its associated applications.

Regular review and refinement of the total rating score calculation methodology is essential to maintain its effectiveness and alignment with evolving knowledge and understanding of landslide risks. Overall, the total rating score provides a quantitative measure that aids in prioritizing landslide sites and allocating resources effectively for mitigation and risk reduction.

Table 6.1 Factor Evaluation Metrix Used in KYTC Landslide Hazard Rating System (KYLHRS)

Hazard Factor		**Hazard Category**				
		0 point	**3 points**	**9 points**	**27 points**	**81 points**
Climatic Conditions	**Annual Precipitation (AP)**	0	0 < AP ≤ 50"	50" < AP ≤ 55"	55" < AP ≤ 60"	AP > 60"
Hydrology	**Influence of Surface Water**	Unknown	None or Distant	Seasonal Drainages	Small Stream Erosion or Ponded Water	Contact with River or Reservoir
Existing Movement	**Pavement Damage**	Unknown	Warping only	No Cracking, 1-2" offset	Some Cracking, 2-6" offset	Extensive Cracking, > 6" offset
	Failure Frequency	Unknown	No failure in previous 5 years	1-2 periods of movement in previous 5 years	Movement observed annually	Multiple movement episodes throughout year
Slope	**Slope (Rise : Run)**	Unknown	(Rise : Run) < 1 : 3	1 : 3 ≤ (Rise : Run) < 1 : 2	1 : 2 ≤ (Rise : Run) < 1 : 1	(Rise : Run) ≥ 1 : 1
	Height of Slope (H)	0	0 < H ≤ 5 ft.	5 ft. < H ≤ 10 ft.	10 ft. < H ≤ 15 ft.	H > 15 ft.
Consequence Factor		**Consequence Category**				
		0 point	**3 points**	**9 points**	**27 points**	**81 points**
Slide Size	**Depth to Slide Plane (D_{sp})**	0	0 < D_{sp} ≤ 5 ft.	5 ft. < D_{sp} ≤ 10 ft.	10 ft. < D_{sp} ≤ 15 ft.	D_{sp} > 15 ft.
	Road Width Affected	Unknown	Shoulder Only	<50%	50% - 75%	>75%
	Length of Highway Affected (L_h)	0	0 < L_h ≤ 100 ft.	100 ft. < L_h ≤ 500 ft.	500 ft. < L_h ≤ 1,000 ft.	L_h > 1,000 ft.
Socioeconomic Impacts	**Annual Average Daily Traffic (AADT)**	0	0 < AADT ≤ 2,000	2,000 < AADT ≤ 10,000	10,000 < AADT ≤ 20,000	AADT > 20,000
	Detour Options	Unknown	None required	Onsite, lane shift, reduce Speed	Offsite, < 5 mi.	> 5 mi. or none
	Annual Maintenance Costs	0	0 < Costs ≤ $7K	$7 < Costs ≤ 14K	$14 < Costs ≤ 34K	Costs > $34K

Section 7 Conclusions and Further Work

The integration of the Kentucky Geotechnical Database with the KGS database, along with development of the ArcGIS-based data collector app and the rockfall and landslide hazard rating applications, represents a significant advancement in geotechnical data management and hazard assessment. These initiatives have improved data accessibility, streamlined data collection, and provided valuable tools for assessing and mitigating geotechnical hazards in Kentucky.

Moving forward, several areas warrant further attention and development. It is important to continue expanding the merged geotechnical database by incorporating additional data sources. This ongoing effort will enhance the comprehensiveness and accuracy of the database, allowing for more informed decision making and research.

Furthermore, it is critical to regularly update and maintain the data collector app so it remains compatible with evolving technologies and user requirements. Continuous improvements and refinements to the app's functionality and user interface will enhance data collection efficiency and user experience.

In terms of the hazard rating apps, future work should focus on refining the algorithms and models used for hazard assessment. Incorporating more robust geospatial data, refining analytical techniques, and validating the models through field studies and case analyses will enhance the accuracy and reliability of hazard rating outputs.

Expanding the scope of the hazard rating applications to include other geotechnical hazards such as slope instability, liquefaction, and subsidence would provide a more comprehensive assessment of geotechnical risks. This expansion would require additional data sources and research to develop reliable and effective hazard rating systems for each type of hazard.

The development of a Microsoft IIS web-based app for the landslide hazard rating system opens up opportunities for further enhancements. Continuous updates, improvements to the user interface, and integration with other geotechnical tools and resources will ensure the application remains accessible and valuable to a wide range of stakeholders.

While merging databases and the development of data collector and hazard rating apps have made significant strides in geotechnical data management and hazard assessment, ongoing efforts in data expansion, app maintenance, algorithm refinement, and expansion of the hazard rating systems will continue to advance the field and improve geotechnical risk management in Kentucky.

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[2] Federal Highway Administration, *Geotechnical Technical Guidance Manual*, U.S. Department of Transportation, 2007.

[3] Federal Highway Administration, *Rockfall Hazard Rating System Participant's Manual*, FHWA SA-93-057, U.S. Department of Transportation, 1993.

[4] Weisenfluh, G. A. and Wang, R. *Making KYTC Geotechnical Reports Available on the Web*, Research report KTC-06-28/SPR314-05-1F, Kentucky Transportation Center, 2006.

[5] Pratt, D.R. *A Landslide Hazard Rating System for Colorado Highways*, Master thesis, Colorado School of Mines, 2014.

Appendix A Entity Relationship for Database geo

Table Name: sites

Primary Key: PK_SITES: site_rownum

Index: pk_sites: site_rownum

Foreign Key: none

Table Name: locations

Primary Key: PK_LOCATIONS: site_rownum, hole_id

Index: PK_LOCATIONS: site_rownum, hole_id

Foreign Key: 1. LOCATIONS_TO_SITES: site_rownum;

2. LOCATIONS_TO_PHASES: site_rownum, phase

Table Name: workphase

Primary Key: PK_WORKPHASE: site_rownum, phase

Index: PK_WORKPHASE: site_rownum, phase

Foreign Key: WORKPHASE_TO_SITES: site_rownum

Table Name: samples

Primary Key: PK_SAMPLES: site_rownum, hole_id, sample_id

Index: PK_SAMPLES: site_rownum, hole_id, sample_id

Foreign Key: SAMPLES_TO_LOCATIONS: site_rownum, hole_id

Table Name: bridge_general

Primary Key: PK_BRIDGE_GENERAL: site_rownum, bridge_id

Index: BRIDGE_GENERAL_X: site_rownum, bridge_id

Foreign Key: BRIDGE2SITES: site_rownum

Table Name: culvert

Primary Key: PK_CULVERT: site_rownum

Index: CULVERT_X: site_rownum

Foreign Key: FK_CULVERT2SITES: site_rownum

Table Name: landslide_attri_n_impact

Primary Key: PK_LND_ATTRI_N_IMPACT: site_rownum

Index: LND_ATTRI_N_IMPACT_X: site_rownum

Foreign Key: FK_LND_ATTRI_N_IMPACT: site_rownum (IN SITES TABLE)

Table Name: rockfall

Primary Key: PK_ROCKFALL: site_rownum, inventory_date

Index: PK_ROCKFALL: site_rownum, inventory_date

Foreign Key: ROCKFALL_TO_SITES: site_rownum

Table Name: roadway_general

Primary Key: PK_ROADWAY_GENERAL: site_rownum

Index: PK_ROADWAY_GENERAL: site_rownum

Foreign Key: FK_ROADWAY_GENERAL: site_rownum (IN SITES TABLE)

Table Name: walls_mse

Primary Key: PK_WALLS_MSE: site_rownum

Index: PK_WALLS_MSE: site_rownum

Foreign Key: FK_WALLS_MSE: site_rownum (IN SITES TABLE)

Table Name: brd_appr_stations

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Index: PK_BRD_APPR_STNS: site_rownum

Foreign Key: FK_BRD_APPR_STNS2SITES: site_rownum (IN SITES TABLE)

Table Name: interchange_ramps

Primary Key: PK_INTERCHANGE_RAMP: site_rownum, ramp_id

Index: PK_INTERCHANGE_RAMP: site_rownum, ramp_id

Foreign Key: FK_INTERCHANGE_RAMP2SITES: site_rownum

Table Name: roadway_comments

Primary Key: PK_ROADWAY_COMMENTS: site_rownum, comment_id

Index: PK_ROADWAY_COMMENTS: site_rownum, comment_id

Foreign Key: PK_RDW_CMTS2GENERAL: site_rownum (IN SITES TABLE)

Table Name: roadway_karstic

Primary Key: PK_RDW_KARSTIC: site_rownum, karstic_id

Index: PK_RDW_KARSTIC: site_rownum, karstic_id

Foreign Key: FK_RDW_KARSTIC: site_rownum (IN SITES TABLE)

Table Name: roadway_equations

Primary Key: PK_RDW_EQUATIONS: site_rownum, equation_id

Index: PK_RDW_EQUATIONS: site_rownum, equation_id

Foreign Key: FK_RDW_EQUATION2GENERAL: site_rownum (IN SITES TABLE)

Table Name: roadway_sideroads

Primary Key: PK_RDW_SIDEROAD: site_rownum, sideroad_id

Index: PK_RDW_SIDEROAD: site_rownum, sideroad_id

Foreign Key: FK_RDW_SIDEROAD2GENERAL: site_rownum (IN SITES TABLE)

Table Name: landslide_history

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Index: PK_LND_HISTORY: site_rownum, history_id

Foreign Key: FK_LND_HISTORY: site_rownum (IN SITES TABLE)

Table Name: landslide_maintenance

Primary Key: PK_LND_MAINTENANCE: site_rownum, maintenance_id

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Foreign Key: FK_LND_MAINTENANCE: site_rownum (IN SITES TABLE)

Table Name: landslide_remedial_n_cost

Primary Key: PK_LND_RMD_N_COST: site_rownum

Index: PK_LND_RMD_N_COST: site_rownum

Foreign Key: FK_LND_RMD_N_COST: site_rownum (IN SITES TABLE)

Table Name: cbr

Primary Key: PK_CBR: site_rownum, hole_id, sample_id
Index: PK_CBR: site_rownum, hole_id, sample_id
Foreign Key: CBR_TO_SAMPLES: site_rownum, hole_id, sample_id

Table Name: classification_soil

Primary Key: PK_CLASSIFICATION_SOIL: site_rownum, hole_id, sample_id
Index: PK_CLASSIFICATION_SOIL: site_rownum, hole_id, sample_id
Foreign Key: CLASS_TO_SAMPLES: site_rownum, hole_id, sample_id

Table Name: consolidation

Primary Key: PK_CONSOLIDATION: site_rownum, hole_id, sample_id
Index: PK_CONSOLIDATION: site_rownum, hole_id, sample_id
Foreign Key: CONS_TO_SAMPLES: site_rownum, hole_id, sample_id

Table Name: grainsize

Primary Key: PK_GRAINSIZE: site_rownum, hole_id, sample_id, sieve_id
Index: PK_GRAINSIZE: site_rownum, hole_id, sample_id, sieve_id
Foreign Key: FK_GRAINSZ2SAMPLE: site_rownum, hole_id, sample_id

Table Name: lithology

Primary Key: PK_LITHOLOGY: site_rownum, hole_id, sample_id, primsec
Index: PK_LITHOLOGY: site_rownum, hole_id, sample_id, primsec
Foreign Key: LITH_TO_SAMPLES: site_rownum, hole_id, sample_id

Table Name: moistdensity

Primary Key: PK_MOISTDENSITY: site_rownum, hole_id, sample_id,testnum

Index: PK_MOISTDENSITY: site_rownum, hole_id, sample_id,testnum

Foreign Key: MOIST_TO_SAMPLES: site_rownum, hole_id, sample_id

Table Name: mr

Primary Key: MR: site_rownum, hole_id, sample_id, sample_no

Index: MR: site_rownum, hole_id, sample_id, sample_no

Foreign Key: MR_F: site_rownum, hole_id, sample_id

Table Name: otherrocktests

Primary Key: PK_OTHERROCKTESTS: site_rownum, hole_id, sample_id,otsubsample_id

Index: PK_OTHERROCKTESTS: site_rownum, hole_id, sample_id,otsubsample_id

Foreign Key: OTHER_TO_SAMPLES: site_rownum, hole_id, sample_id

Table Name: sdi_jarslake

Primary Key: PK_SDI_JARSLAKE: site_rownum, hole_id, sample_id sdisubsample_id

Index: PK_SDI_JARSLAKE: site_rownum, hole_id, sample_id sdisubsample_id

Foreign Key: SDI_TO_SAMPLES: site_rownum, hole_id, sample_id

Table Name: ***soilfieldstrengthtest***

Primary Key: ***PK_SOILFIELDSTRENGTHTESTS: site_rownum, hole_id, sample_id***

Index: ***PK_SOILFIELDSTRENGTHTESTS: site_rownum, hole_id, sample_id***

Foreign Key: *FIELD_TO_SAMPLES: site_rownum, hole_id, sample_id*

Table Name: ***soillabstrengthtest***

Primary Key: *PK_SOILLABSTRENGTHTESTS: site_rownum, hole_id, sample_id, strentestnum*

Index: *PK_SOILLABSTRENGTHTESTS: site_rownum, hole_id, sample_id, strentestnum*

Foreign Key: *LAB_TO_SAMPLES: site_rownum, hole_id, sample_id*

Table Name: ***soilvisdesc***

Primary Key: *PK_SOILVISDESC: site_rownum, hole_id, sample_id, primsec*

Index: *PK_SOILVISDESC: site_rownum, hole_id, sample_id, primsec*

Foreign Key: *VISUAL_TO_SAMPLES: site_rownum, hole_id, sample_id*

Table Name: ***rockfall_pictures***

Primary Key: *PK_ROCKFALL_PICTURES: site_rownum, picture_id*

Index: *PK_ROCKFALL_PICTURES: site_rownum, picture_id*

Foreign Key: *RKF_PIC2SITES: site_rownum*

Table Name: pictures

Primary Key: PK_PICTURES: site_rownum, picture_id

Index: PK_PICTURES: site_rownum, picture_id

Foreign Key: FK_PICTURES: site_rownum (IN SITES TABLE)

Table Name: landslide_pictures

Primary Key: PK_LANDSLIDE_PICTURES: site_rownum, picture_id

Index: PK_LANDSLIDE_PICTURES: site_rownum, picture_id

Foreign Key: FK_LANDSLIDE_PICTURES: site_rownum (IN SITES TABLE)

Table Name: users

Primary Key: None

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Foreign Key: None

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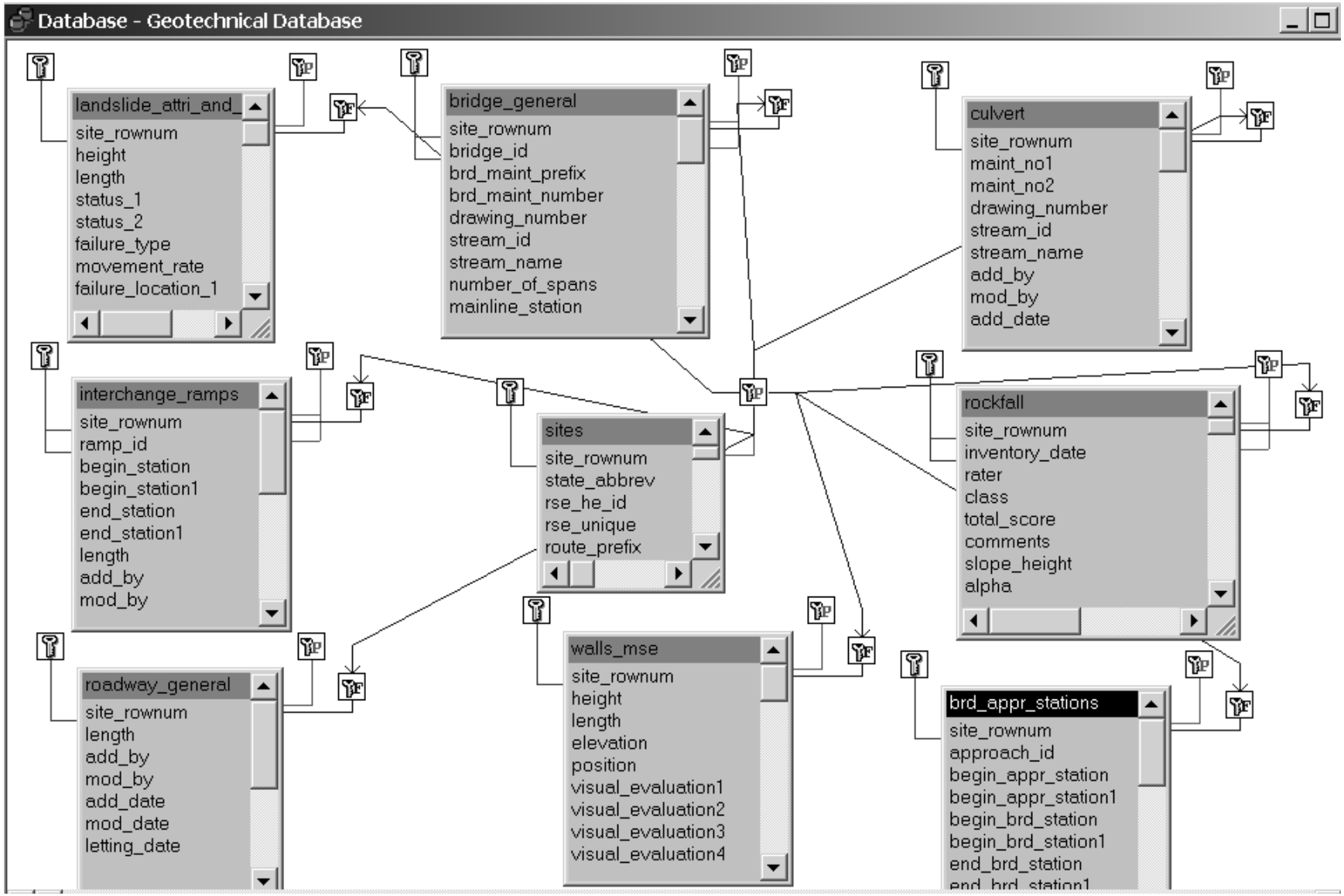
Foreign Key: None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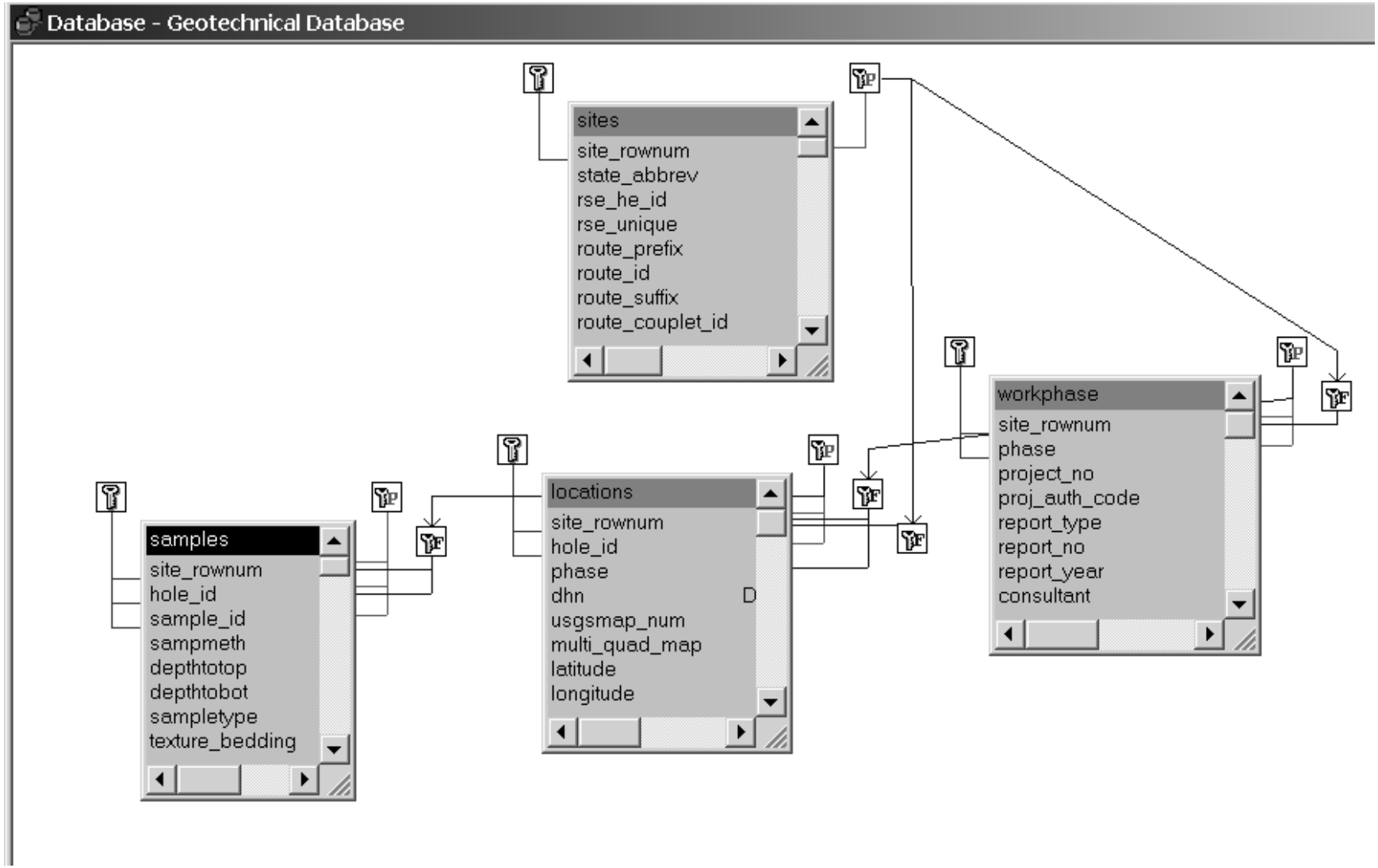
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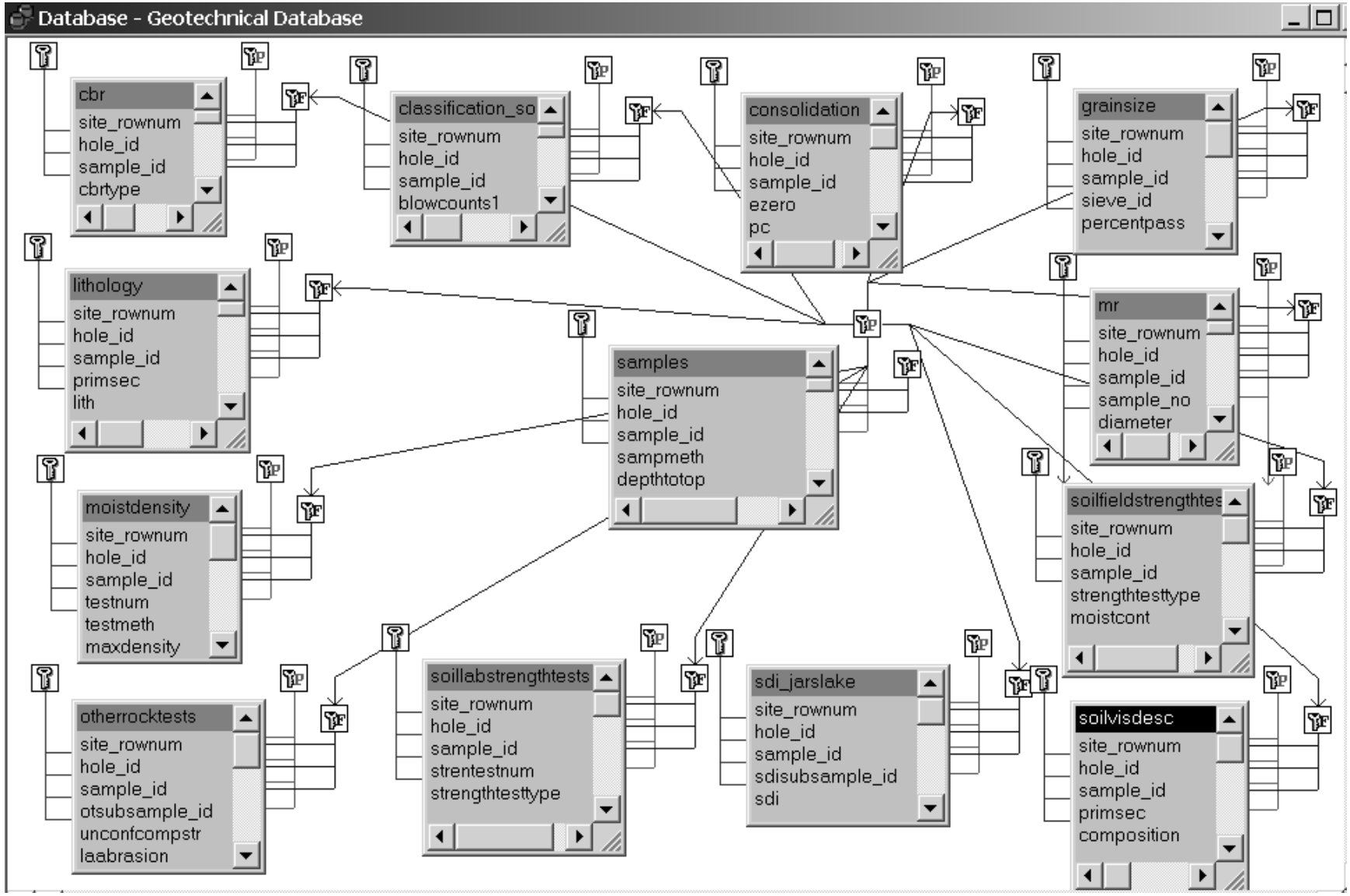
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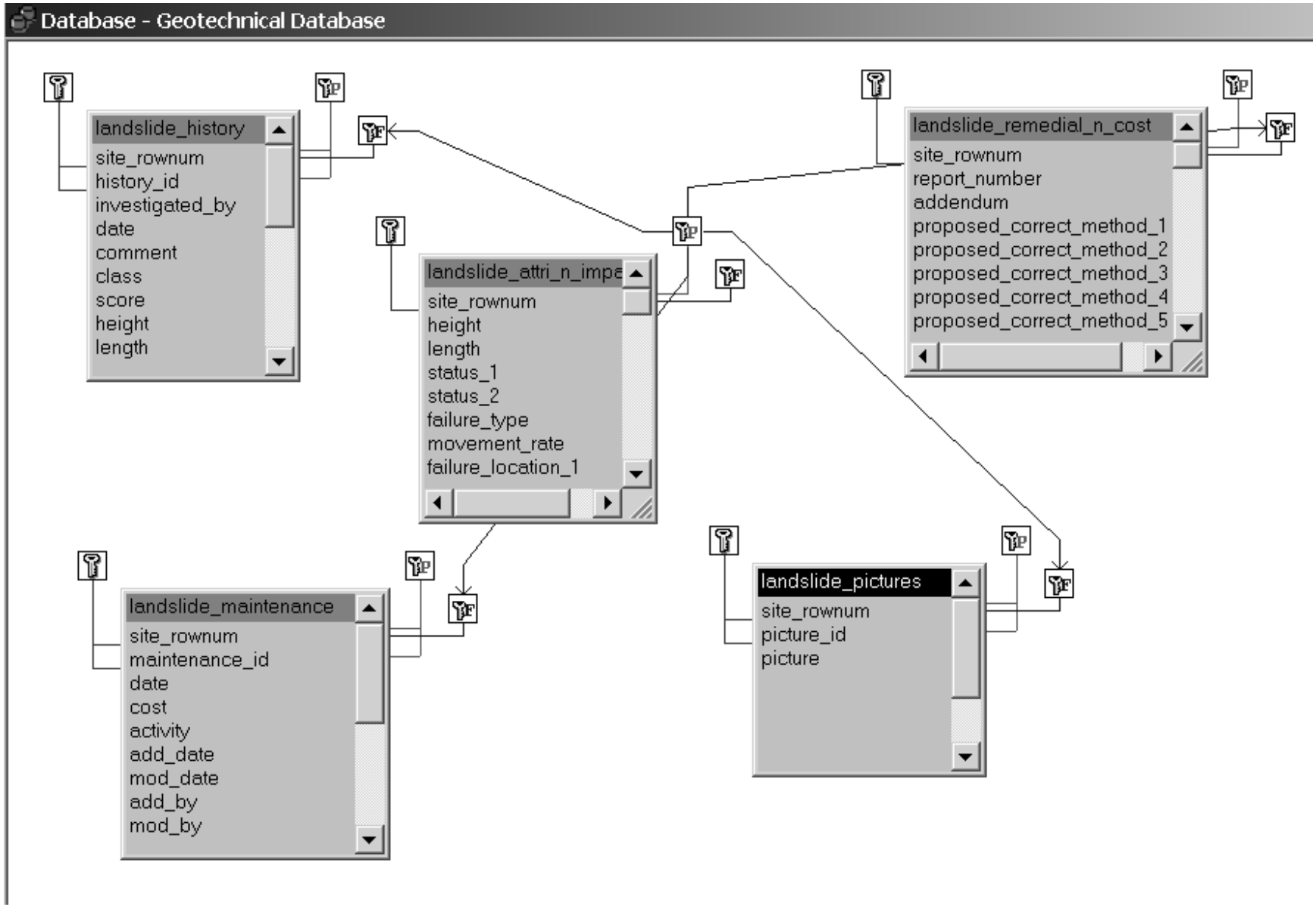
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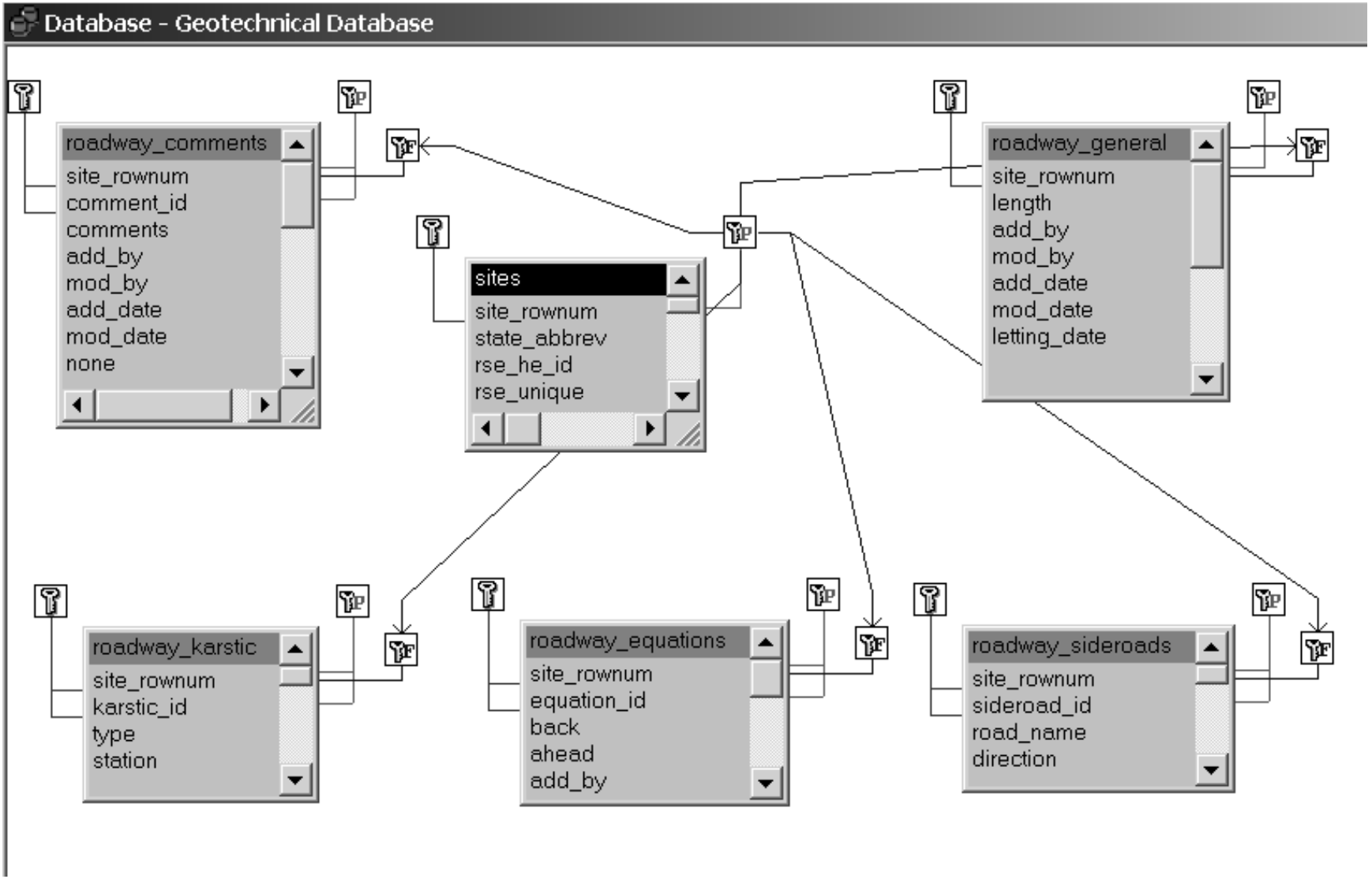
picture_id
picture


Database - Geotechnical Database
roadway_comments
site_rownum
comment_id
comments
add_by
mod_by
add_date
mod_date
none
sites
site_rownum
state_abbrev
rse_he_id
rse_unique
roadway_general
site_rownum
length
add_by
mod_by
add_date
mod_date
letting_date
roadway_karstic
site_rownum
karstic_id
type
station
roadway_equations
site_rownum
equation_id
back
ahead
add_by
roadway_sideroads
site_rownum
sideroad_id
road_name
direction

Appendix B SQL Queries for Merging the KY Geotechnical Database with the KGS Hosted Database

1. **Match to Project Table**

```
INSERT INTO gintEnterprise.dbo.PROJECT(gINTProjectID, Project_Number, Item_Number, Project_Location,
            County_Name, Project_Type, Project_Type_Modifier, Project_Manager, Drilling_Firm,  BM_Latitude,
            BM_Longitude, Horizontal_Datum, Horizontal_Accuracy, Vertical_Accuracy, bmp, emp,
            Geotech_Firm, Drilling_Complete, Geology_Complete, Soils_Complete )
SELECT      Geohazards.dbo.sites.siteRowNum+1000000 as gINTProjectID , workphase.REPORT_TYPE + '-' +
            CAST(workphase.REPORT_NO AS varchar(4)) + '-' + CAST(workphase.REPORT_YEAR AS varchar(5)),
            orkphase.ITEM, sites.siteLocation, county.countyName, projectType.projectTypeDesc, sites.siteDescr,
            workphase.REPORT_WHO, workphase.DRILLER, sites.latitude, sites.longitude, datum.datumName,
            workphase.XY_ACCURACY, workphase.Z_ACCURACY, sites.beginMP, sites.endMP,
            workphase.GEOTECH,  CAST(CASE WHEN sites.holeDataComplete = 'Y' THEN 1 ELSE 0 END AS BIT) as
            Drilling_Complete,  CAST(CASE WHEN sites.kgsStratigraphyComplete = 'Y' THEN 1 ELSE 0 END AS BIT)
            as Geology_Complete,  CAST(CASE WHEN sites.soilSampleDataComplete = 'Y' THEN 1 ELSE 0 END AS
            BIT) AS Soils_Complete
FROM        Geohazards.dbo.sites INNER JOIN Geohazards.dbo.county ON sites.countyID =
            Geohazards.dbo.county.countyID AND sites.stateabbrev =  Geohazards.dbo.county.stateabbrev
            INNER JOIN Geohazards.dbo.workphase ON sites.siteRowNum =
            Geohazards.dbo.workphase.siteRowNum INNER JOIN Geohazards.dbo.datum ON workphase.DATUM
            = Geohazards.dbo.datum.datumCode INNER JOIN Geohazards.dbo.projectType ON
            Geohazards.dbo.sites.projectType = Geohazards.dbo.projectType.projectType
WHERE       (sites.noHole > 0) AND (sites.projectType <> 'LND') AND (workphase.REPORT_TYPE + '-' +
            CAST(workphase.REPORT_NO AS varchar(4)) + '-' + CAST(workphase.REPORT_YEAR AS varchar(5))) is
            not null
ORDER BY    Geohazards.dbo.sites.siteRowNum
```

2. **Match to Point Table**

```
INSERT INTO gintEnterprise.dbo.Point(gINTProjectID, PointID, Station_Number, Offset_Distance, HoleDepth,
            Elevation, Hole_Type, Refusal, Boulders, Original_Latitude, Original_Longitude, Horizontal_Accuracy)
SELECT      Geohazards.dbo.location.siteRowNum+1000000 as gINTProjectID , location.holeID, CONVERT
            (Decimal(10, 2), (location.stationA * 1000 + location.stationB) / 0.3048) AS station_number,
            CONVERT(Decimal(10, 2),location.stationOffset / 0.3028) AS stationOffset, CONVERT(Decimal(10, 1),
            location.holeDepth * 3.2808) AS holeDepth, CONVERT(Decimal(12, 3),location.surfElevDrillingtime *
            3.2808) AS Elevation, location.locationType, CASE WHEN location.refusal = 'Y' THEN 'TRUE' ELSE
            'FALSE' END AS Refusal, CASE WHEN location.BOULDER = 'Y' THEN 'TRUE' ELSE 'FALSE' END AS
            Boulder, location.latitude, location.longitude, CONVERT(Decimal(10, 2),location.locationAccuracy *
            3.2808) AS Horizontal_Accuracy
FROM        Geohazards.dbo.location INNER JOIN Geohazards.dbo.sites ON location.siteRowNum =
            sites.siteRowNum
WHERE       (sites.noHole > 0) AND (sites.projectType <> 'LND') AND (location.holeDepth * 3.2808) IS NOT NULL
ORDER BY    Geohazards.dbo.sites.siteRowNum
```

3. Match to Lab Specimen Table

```
INSERT INTO gintEnterprise.dbo.[LAB SPECIMEN](gINTProjectID, PointID, Depth, Sample_Type, Sample_Number,
            Moisture, Description, Specific_Gravity)
SELECT      sample.siteRowNum + 1000000 AS gINTProjectID, sample.holeID, CONVERT(decimal(10, 2),
            sample.DepthToBot * 3.2808) AS Depth, sample.SampleMethod, CONVERT(varchar(255),
            sample.sampleID) AS Sample_Number, CONVERT(varchar(255), classificationSoil.NATMOISTCONT) AS
            Moisture, sample.Comments, classificationSoil.SPECGRAV
FROM        sample INNER JOIN sites ON sample.siteRowNum = sites.siteRowNum LEFT OUTER JOIN
            classificationSoil ON sample.siteRowNum = classificationSoil.siteRowNum AND
            classificationSoil.holeID = sample.holeID AND classificationSoil.sampleID = sample.sampleID
WHERE       (sites.noHole > 0) AND (sites.projectType <> 'LND') AND (sample.SampleMethod IS NOT NULL) AND
            (CONVERT(decimal(10, 2), sample.DepthToBot * 3.2808) IS NOT NULL)
ORDER BY    sample.siteRowNum
```

4. Match to CBR Table

```
INSERT INTO gintEnterprise.dbo.CBR(gINTProjectID, PointID, Depth, Sample_Type, Plus_No4, Moisture, CBR,
            Water, Rock)
select      cbr.siteRowNum +1000000 as gINTProjectID ,cbr.holeID,
            convert(decimal(10,2),(sample.depthtobot*3.2808)) as Depth, sample.SampleMethod,
            convert(decimal(10,2),cbr.soaked_percent_p_no4) as Plus_No4,
            convert(decimal(10,2),cbr.smoistcont) as Moisture,   convert(decimal(10,2),cbr.soaked_cbr),
            convert(decimal(10,2),location.depthToWater*3.2808) as Water, sample.RockType From
            Geohazards.dbo.cbr  inner join Geohazards.dbo.sites ON CBR.siteRowNum = sites.siteRowNum inner
            join Geohazards.dbo.sample  ON Geohazards.dbo.cbr.siteRowNum =
            Geohazards.dbo.sample.siteRowNum AND Geohazards.dbo.CBR.sampleID =
            Geohazards.dbo.SAMPLE.sampleID AND Geohazards.dbo.CBR.holeID =
            Geohazards.dbo.SAMPLE.holeID INNER JOIN  Geohazards.dbo.location ON
            Geohazards.dbo.sample.siteRowNum  = Geohazards.dbo.location.siteRowNum AND
            Geohazards.dbo.sample.holeID  = Geohazards.dbo.location.holeID
WHERE       (sites.noHole > 0) AND (sites.projectType <> 'LND') AND
            (convert(decimal(10,2),(sample.depthtobot*3.2808))) IS NOT NULL
ORDER BY    Geohazards.dbo.cbr.siteRowNum
```

5. Match to SOIL_CLASSIFICATION Table

```
INSERT INTO gintEnterprise.dbo.SOIL_CLASSIFICATION(gINTProjectID, PointID, Depth, Sample_Type, PF3, PF2, PF1,
            PF3_4, PF3_8, PF4, PF10, PF40, PF200, AASHTO_Symbol, AASHTO_Group_Index, USCS_Symbol,
            Specific_Gravity, Activity, D50)
SELECT      classificationSoil.siteRowNum + 1000000 AS gINTProjectID, classificationSoil.holeID,
            CONVERT(decimal(10, 2), sample.DepthToBot * 3.2808) AS Depth, sample.SampleMethod,
            grainSizeSum.PF3, grainSizeSum.PF2, grainSizeSum.PF1, grainSizeSum.PF3_4, grainSizeSum.PF3_8,
            grainSizeSum.PF4, grainSizeSum.PF10, grainSizeSum.PF40, grainSizeSum.PF200, CASE WHEN
            classificationSoil.AASHTOCLASS IS NOT NULL THEN replace(LEFT(classificationsoil.aashtoclass,
            CHARINDEX('(', classificationsoil.aashtoclass)), '(', '') ELSE NULL END AS AASHTO_Symbol, CASE WHEN
            classificationSoil.AASHTOCLASS IS NOT NULL THEN replace(SUBSTRING(classificationsoil.aashtoclass,
            CHARINDEX('(', classificationsoil.aashtoclass), 10), ' ', '') ELSE NULL END AS AASHTO_Group_Index,
            classificationSoil.UNIFCLASS, classificationSoil.SPECGRAV, CONVERT(decimal(10, 2), (CASE WHEN
            grainSizeSum.PF460 > 0 THEN CAST(classificationsoil.plastind AS float) / CAST(grainSizeSum.PF460 AS
            float) * 100 END)) AS Activity, classificationSoil.D50
FROM        classificationSoil INNER JOIN sites ON classificationSoil.siteRowNum = sites.siteRowNum INNER JOIN
            sample ON classificationSoil.siteRowNum = sample.siteRowNum AND classificationSoil.holeID =
            sample.holeID AND classificationSoil.sampleID = sample.sampleID INNER JOIN grainSizeSum ON
            classificationSoil.siteRowNum = grainSizeSum.siteRowNum AND classificationSoil.holeID =
            grainSizeSum.HOLE_ID AND classificationSoil.sampleID = grainSizeSum.SAMPLE_ID
WHERE       (sites.noHole > 0) AND (sites.projectType <> 'LND') AND (CONVERT(decimal(10, 2),
            sample.DepthToBot * 3.2808) IS NOT NULL)
ORDER BY    sites.siteRowNum, classificationSoil.holeID, classificationSoil.sampleID
```

6. **Match to SOIL_SAMPLES Table**

```
INSERT INTO gintEnterprise.dbo.SOIL_SAMPLES(gINTProjectID, PointID, Depth, Depth_Bottom, Sample_Number,
            Sample_Method, N1, N2, N3, Blowcounts)
SELECT      classificationSoil.siteRowNum +1000000 as gINTProjectID, classificationSoil.holeID,
            convert(decimal(10,2),(sample.DepthToTop*3.2808)) as Depth,
            convert(decimal(10,2),(sample.DepthToBot*3.2808)) as Depth_Bottom,
            convert(varchar(255),sample.sampleID) as Sample_Number, sample.samplemethod,
            convert(decimal(2,0),BLOWCOUNTS1) as N1, convert(decimal(2,0),BLOWCOUNTS2) as N2,
            convert(decimal(2,0),BLOWCOUNTS3) as N3, convert(varchar(255),blowcounts_n) as Blowcount
FROM        Geohazards.dbo.classificationSoil inner join Geohazards.dbo.sites ON classificationSoil.siteRowNum =
            sites.siteRowNum  inner join Geohazards.dbo.sample on
            Geohazards.dbo.classificationSoil.siteRowNum=Geohazards.dbo.sample.siteRowNum AND
            Geohazards.dbo. classificationsoil.HOLEID = Geohazards.dbo.sample.holeID AND Geohazards.dbo.
            classificationsoil.SAMPLEID = Geohazards.dbo.sample.sampleID
WHERE       (sites.noHole > 0) AND (sites.projectType <> 'LND') AND
            (convert(decimal(10,2),(sample.DepthToTop*3.2808))) IS NOT NULL AND
            (convert(decimal(10,2),(sample.DepthToBot*3.2808))) IS NOT NULL
ORDER BY    Geohazards.dbo.sites.siteRowNum
```

7. Match to ATTERBERG Table

```
INSERT INTO gintEnterprise.dbo.ATTERBERG(gINTProjectID, PointID, Depth, Sample_Type, Liquid_Limit,
            Plasticity_Index)
SELECT      classificationSoil.siteRowNum +1000000 as gINTProjectID, classificationSoil.holeID,
            convert(decimal(10,2),(sample.DepthToBot*3.2808)) as Depth, sample.samplemethod,
            cast(classificationSoil.liqlim as real) as Liquid_Limit, cast(classificationSoil.Plastind as real) as
            Plasticity_Index
FROM        Geohazards.dbo.classificationSoil inner join Geohazards.dbo.sites ON classificationSoil.siteRowNum =
            sites.siteRowNum inner join Geohazards.dbo.sample on
            Geohazards.dbo.classificationSoil.siteRowNum=Geohazards.dbo.sample.siteRowNum AND
            Geohazards.dbo. classificationsoil.HOLEID = Geohazards.dbo.sample.holeID AND Geohazards.dbo.
            classificationsoil.SAMPLEID = Geohazards.dbo.sample.sampleID
WHERE       (sites.noHole > 0) AND (sites.projectType <> 'LND') AND
            (convert(decimal(10,2),(sample.DepthToBot*3.2808))) IS NOT NULL
ORDER BY    Geohazards.dbo.sites.siteRowNum
```

8. Match to CONSOLIDATION_KY Table

```
INSERT INTO gintEnterprise.dbo.CONSOLIDATION_KY(gINTProjectID, PointID, Depth, Sample_Type, Pc, Cc, Cr, E0)
select      consolidation.siteRowNum +1000000 as gINTProjectID, consolidation.holeID,
            convert(decimal(10,2),(sample.DepthToBot*3.2808)) as Depth, sample.samplemethod,
            convert(decimal(7,3),(consolidation.PC*0.0104)) as Pc, consolidation.CC, consolidation.CR,
            consolidation.ezero
From        Geohazards.dbo.consolidation inner join Geohazards.dbo.sites ON consolidation.siteRowNum =
            sites.siteRowNum inner join Geohazards.dbo.sample ON
            Geohazards.dbo.consolidation.siteRowNum=Geohazards.dbo.sample.siteRowNum AND
            Geohazards.dbo. consolidation.HOLEID = Geohazards.dbo.sample.holeID AND Geohazards.dbo.
            consolidation.SAMPLEID = Geohazards.dbo.sample.sampleID
WHERE       (sites.noHole > 0) AND (sites.projectType <> 'LND') AND
            (convert(decimal(10,2),(sample.DepthToBot*3.2808))) IS NOT NULL
ORDER BY    Geohazards.dbo.sites.siteRowNum
```

9. Match to GEOLOGIST_LITHOLOGY Table

```
INSERT INTO gintEnterprise.dbo.GEOLOGIST_LITHOLOGY(gINTProjectID, PointID, Depth, Depth_Bottom,
            Primary_Lithology, Description)
select      Geohazards.dbo.lithology.siteRowNum +1000000 as gINTProjectID, Geohazards.dbo.lithology.holeID,
            convert(decimal(10,2),(sample.DepthToTop*3.2808)) as Depth,
            convert(decimal(10,2),(sample.DepthToBot*3.2808)) as Depth_Bottom,
            CONVERT(VARCHAR(255),lithology.LITH) as Primary_Lithology,
            isnull(CONVERT(VARCHAR(255),lithology.MOD1),'')+','+isnull(CONVERT(VARCHAR(255),lithology.MOD
            2),'')+','+isnull(CONVERT(VARCHAR(255),lithology.MOD3),'')+','+isnull(CONVERT(VARCHAR(255),lithol
            ogy.MOD4),'')+','+isnull(CONVERT(VARCHAR(255),lithology.MOD5),'')as Descprition
From        Geohazards.dbo.lithology inner join Geohazards.dbo.sites ON lithology.siteRowNum =
            sites.siteRowNum inner join Geohazards.dbo.sample on
            Geohazards.dbo.lithology.siteRowNum=Geohazards.dbo.sample.siteRowNum AND Geohazards.dbo.
            lithology.HOLEID = Geohazards.dbo.sample.holeID AND Geohazards.dbo.lithology.SAMPLEID =
            Geohazards.dbo.sample.sampleID AND lithology.primsec = 'Primary' AND lithology.LITH is not null
            AND sample.DepthToTop is not null
```

10. Match to COMPACTION Table

```
INSERT INTO gintEnterprise.dbo.COMPACTION(gINTProjectID, PointID, Depth, Sample_Type, Max_Dry_Density,
            Opt_Moisture_Content, Method)
select moistDensity.SITE_ROWNUM +1000000 as gINTProjectID, moistDensity.hole_ID,
            convert(decimal(10,2),(sample.DepthToBot*3.2808)) as Depth,    sample.SampleType,
            convert(decimal(10,2),moistDensity.maxdensity*0.062428) as Strength, moistDensity.optmoist,
            moistDensity.testmeth
FROM        Geohazards.dbo.moistDensity inner join Geohazards.dbo.sites ON moistDensity.SITE_ROWNUM =
            sites.siteRowNum  inner join Geohazards.dbo.sample on
            moistDensity.SITE_ROWNUM=Geohazards.dbo.sample.siteRowNum AND
            Geohazards.dbo.moistdensity.HOLE_ID = Geohazards.dbo.sample.holeID AND
            Geohazards.dbo.moistdensity.SAMPLE_ID = Geohazards.dbo.sample.sampleID
WHERE       (sites.noHole > 0) AND (sites.projectType <> 'LND') AND
            convert(decimal(10,2),(sample.DepthToBot*3.2808))) IS NOT NULL
ORDER BY    Geohazards.dbo.sites.siteRowNum
```

11. Match to TRIAXIAL_STRENGTH Table

```
INSERT INTO gintEnterprise.dbo.TRIAXIAL_STRENGTH(gINTProjectID, ItemKey, phi, cohesion)
SELECT DISTINCT soilLabStrengthTest.siteRowNum + 1000000 AS gINTProjectID, CONVERT(varchar(3),
            soilLabStrengthTest.holeID) + CONVERT(varchar(3), soilLabStrengthTest.sampleID) AS ItemKey,
            soilLabStrengthTest.PHI, CONVERT(decimal(10, 2), soilLabStrengthTest.COHESION * 20.8854) AS
            cohesion
FROM        soilLabStrengthTest INNER JOIN sites ON soilLabStrengthTest.siteRowNum = sites.siteRowNum
WHERE       (sites.noHole > 0) AND (sites.projectType <> 'LND') AND (soilLabStrengthTest.STRENGTHTESTTYPE =
            'consolidated Undrained Triaxial') AND (soilLabStrengthTest.COHESION IS NOT NULL)
```

12. Match to CORE_RUNS Table

```
INSERT INTO gintEnterprise.dbo.CORE_RUNS(gINTProjectID, PointID, Depth, Depth_Bottom, Std_RQD,
            Geologist_Recovery_Percent, KY_RQD)
SELECT      rqdPercrec.siteRowNum + 1000000 AS gINTProjectID, rqdPercrec.holeID, CONVERT(decimal(10, 2),
            rqdPercrec.RQDDEPTH_TOP * 3.2808) AS Depth, CONVERT(decimal(10, 2), rqdPercrec.RQDDEPTH *
            3.2808) AS Depth_Bottom, rqdPercrec.RQD, rqdPercrec.PERCENTREC, rqdPercrec.KYRQD
FROM        rqdPercrec INNER JOIN  sites ON rqdPercrec.siteRowNum = sites.siteRowNum
WHERE       (sites.noHole > 0) AND (sites.projectType <> 'LND') AND (CONVERT(decimal(10, 2),
            rqdPercrec.RQDDEPTH_TOP * 3.2808) IS NOT NULL) AND (rqdPercrec.PERCENTREC IS NOT NULL)
ORDER BY    sites.siteRowNum
```

13. Match to DRILLER_SOIL_DESCRIPTION Table

```
INSERT INTO gintEnterprise.dbo.DRILLER_SOIL_DESCRIPTION(gINTProjectID, PointID, Depth, Depth_Bottom,
            Primary_Consistency, Primary_Color1, Primary_Moisture, Secondary_Major_Constituent,
            Primary_Major_Constituent, Minor_Constituent1)
SELECT      soilvisdesc.siteRowNum + 1000000 AS gINTProjectID, soilvisdesc.holeID, CONVERT(decimal(10, 2),
            sample.DepthToTop * 3.2808) AS Depth, CONVERT(decimal(10, 2), sample.DepthToBot * 3.2808) AS
            Depth_Bottom, (CASE WHEN soilvisdesc.PRIMSEC = 'Primary' THEN consistency END) AS
            Primary_Consistency, soilvisdesc.COLOR, (CASE WHEN soilvisdesc.PRIMSEC = 'Primary' THEN
            NATMOISTCONT END) AS Primary_Moisture, (CASE WHEN soilvisdesc.PRIMSEC = 'Secondary' THEN
            COMPOSITION END) AS Secondary_Major_Constituent, (CASE WHEN soilvisdesc.PRIMSEC = 'Primary'
            THEN COMPOSITION END) AS Primary_Major_Constituent, (CASE WHEN soilvisdesc.PRIMSEC =
            'Tertiary' THEN COMPOSITION END) AS Minor_Constituent1
FROM        soilvisdesc INNER JOIN sites ON soilvisdesc.siteRowNum = sites.siteRowNum INNER JOIN sample ON
            soilvisdesc.siteRowNum = sample.siteRowNum AND soilvisdesc.holeID = sample.holeID AND
            soilvisdesc.sampleID = sample.sampleID
WHERE       (sites.noHole > 0) AND (sites.projectType <> 'LND') AND (CONVERT(decimal(10, 2),
            sample.DepthToTop * 3.2808) IS NOT NULL) AND ((CASE WHEN soilvisdesc.PRIMSEC = 'Secondary'
            THEN COMPOSITION END) IS NOT NULL OR (CASE WHEN soilvisdesc.PRIMSEC = 'Primary' THEN
            COMPOSITION END) IS NOT NULL OR (CASE WHEN soilvisdesc.PRIMSEC = 'Tertiary' THEN
            COMPOSITION END) IS NOT NULL)
ORDER BY    sites.siteRowNum
```

14. Match to ROCK_UNCONFINED_COMPRESSION Table

```
INSERT INTO gintEnterprise.dbo.ROCK_UNCONFINED_COMPRESSION(gINTProjectID, PointID, Depth,
            Depth_Bottom, Sample_Number, Strength_Value)
select      otherRockTest.siteRowNum +1000000 as gINTProjectID, otherRockTest.holeID,
            convert(decimal(10,2),(otherRockTest.OTDEPTH_TOP*3.2808)) as Depth,
            convert(decimal(10,2),(otherRockTest.OTDEPTH_BOT*3.2808)) as Depth_Bottom,
            otherRockTest.sampleID, convert(decimal(10,2),(otherRockTest.unconfcompstr*20.8854)) as
            Strength_Value
From        Geohazards.dbo.otherRockTest inner join Geohazards.dbo.sites ON otherRockTest.siteRowNum =
            sites.siteRowNum inner join Geohazards.dbo.sample ON
            Geohazards.dbo.otherRockTest.siteRowNum = Geohazards.dbo.sample.siteRowNum AND
            Geohazards.dbo.otherRockTest.holeID = Geohazards.dbo.sample.holeID AND
            Geohazards.dbo.otherRockTest.sampleID = Geohazards.dbo.sample.sampleID
WHERE       (sites.noHole > 0) AND (sites.projectType <> 'LND') AND
            (convert(decimal(10,2),(otherRockTest.OTDEPTH_TOP*3.2808))) IS NOT NULL
ORDER BY    Geohazards.dbo.sites.siteRowNum
```

15. **Match to SLAKE_DURABILITY Table**

```
INSERT INTO gintEnterprise.dbo.SLAKE_DURABILITY(gINTProjectID, PointID, Depth, SDI, Jar_Result)
select          sdijarslake.siteRowNum +1000000 as gINTProjectID, sdijarslake.holeID, convert(decimal(10,2),(
                sdijarslake.SDIDEPTH*3.2808)) as Depth,    convert(varchar(255),sdijarslake.SDI) as SDI,
                convert(decimal(4,0),sdijarslake.jarslake) as Jar_Result
From            Geohazards.dbo.sdijarslake inner join Geohazards.dbo.sites ON sdijarslake.siteRowNum =
                sites.siteRowNum Inner join Geohazards.dbo.sample ON Geohazards.dbo.sdijarslake.siteRowNum =
                Geohazards.dbo.sample.siteRowNum AND Geohazards.dbo.sdijarslake.holeID =
                Geohazards.dbo.sample.holeID AND Geohazards.dbo.sdijarslake.sampleID =
                Geohazards.dbo.sample.sampleID
WHERE           (sites.noHole > 0) AND (sites.projectType <> 'LND') AND
                (convert(decimal(10,2),(sdijarslake.SDIDEPTH*3.2808))) IS NOT NULL
ORDER BY        Geohazards.dbo.sites.siteRowNum
```

16. Match to UNCONF COMPR Table

```
INSERT INTO gintEnterprise.dbo.[UNCONF COMPR](gINTProjectID, PointID, Depth, Sample_Type, Dry_Density,
                Wet_Density, Strength)
SELECT          Geohazards.dbo.soilLabStrengthTest.siteRowNum + 1000000 AS gINTProjectID,
                Geohazards.dbo.soilLabStrengthTest.holeID, CONVERT(decimal(10, 2),
                Geohazards.dbo.sample.DepthToBot * 3.2808) AS Depth, Geohazards.dbo.sample.SampleType,
                CONVERT(decimal(10, 2), Geohazards.dbo.soilLabStrengthTest.DRYDENS * 0.062428) AS Dry_Density,
                CONVERT(decimal(10, 2), Geohazards.dbo.soilLabStrengthTest.WETDENS * 0.062428) AS
                Wet_Density, CONVERT(decimal(10, 2), Geohazards.dbo.soilLabStrengthTest.COHESION * 0.062428)
                AS Strength
FROM            Geohazards.dbo.soilLabStrengthTest INNER JOIN Geohazards.dbo.sites ON
                Geohazards.dbo.soilLabStrengthTest.siteRowNum = Geohazards.dbo.sites.siteRowNum INNER JOIN
                Geohazards.dbo.sample ON Geohazards.dbo.soilLabStrengthTest.siteRowNum =
                Geohazards.dbo.sample.siteRowNum AND Geohazards.dbo.soilLabStrengthTest.holeID =
                Geohazards.dbo.sample.holeID AND Geohazards.dbo.soilLabStrengthTest.sampleID =
                Geohazards.dbo.sample.sampleID
WHERE           (Geohazards.dbo.sites.noHole > 0) AND (Geohazards.dbo.sites.projectType <> 'LND') AND
                (Geohazards.dbo.soilLabStrengthTest.STRENGTHTESTTYPE = 'Unconfined Compression') AND
                (CONVERT(decimal(10, 2), Geohazards.dbo.sample.DepthToBot * 3.2808) IS NOT NULL)
ORDER BY        Geohazards.dbo.sites.siteRowNum
```

17. **Match to UNCONSOLIDATED_UNDRAINED_TRIAXIAL Table**

```
INSERT INTO gintEnterprise.dbo.UNCONSOLIDATED_UNDRAINED_TRIAXIAL(gINTProjectID, PointID, Depth,
            Sample_Type, Strength, Moisture, Wet_Density)
select      soilLabStrengthTest.SITEROWNUM +1000000 as gINTProjectID, soilLabStrengthTest.holeID,
            convert(decimal(10,2),(sample.DepthToBot*3.2808)) as Depth, sample.SampleType,
            (soilLabStrengthTest.COHESION*20.8854) as Strength, soilLabStrengthTest.MOISTCONT,
            (soilLabStrengthTest.WETDENS*0.062428) AS Wet_Density
FROM        Geohazards.dbo.soilLabStrengthTest inner join Geohazards.dbo.sites ON
            soilLabStrengthTest.SITEROWNUM = sites.siteRowNum inner join Geohazards.dbo.sample on
            soilLabStrengthTest.SITEROWNUM=Geohazards.dbo.sample.siteRowNum AND
            Geohazards.dbo.soilLabStrengthTest.holeID = Geohazards.dbo.sample.holeID AND
            Geohazards.dbo.soilLabStrengthTest.sampleID = Geohazards.dbo.sample.sampleID
WHERE       (sites.noHole > 0) AND (sites.projectType <> 'LND') AND soilLabStrengthTest.STRENGTHTESTTYPE =
            'Unconsolidated Undrained Triaxial' AND (convert(decimal(10,2),(sample.DepthToBot*3.2808))) IS
            NOT NULL
ORDER BY    Geohazards.dbo.sites.siteRowNum
```

Appendix C KYTC Geotechnical Data Collection: ArcGIS Field Maps, KYTC User Manual, Version for Geotechnical Branch

January 2022

KYTC Geotechnical Data Collection: ArcGIS Field Maps

KYTC User Manual

Version for District Offices, January 2022

KYTC Geotechnical Data Collection: ArcGIS Field Maps – Operator Manual for KYTC users

Overview:

This manual is for users of the KYTC Geotechnical Data Collection: ArcGIS Field Maps application for collecting geotechnical data points, related photos, and follow-up data and photos for collected points. ArcGIS Field Maps is a stand-alone application by ESRI which allows users to use ArcGIS Online hosted layers and maps to collect location-based data. The ArcGIS Field Maps application is available for iOS, Android, and Microsoft devices. This manual is directed at users using iOS (Apple) devices (iPad and iPhone), but can be used by Android or Windows device users (though be aware there may be small differences in how users download and interact with the application).

Application Purpose:

This Field Maps data collection application will provide a means for KYTC users to collect point-based geotechnical information using an electronic device. The application should be used in an "offline" mode to view and collect data. Pre-planned offline areas are provided for users. Users will then be able to collect point-of-interest data and related photos, and then view this data in a GIS (ArcGIS or ArcGIS Online) once they have returned to the office. Users will also be able to add follow-up field observations and photographs to previously collected points.

Contact:

Contact Charlie Sun (charlie.sun@uky.edu or 859-257-7330) at the Kentucky Transportation Center for technical assistance with this application.

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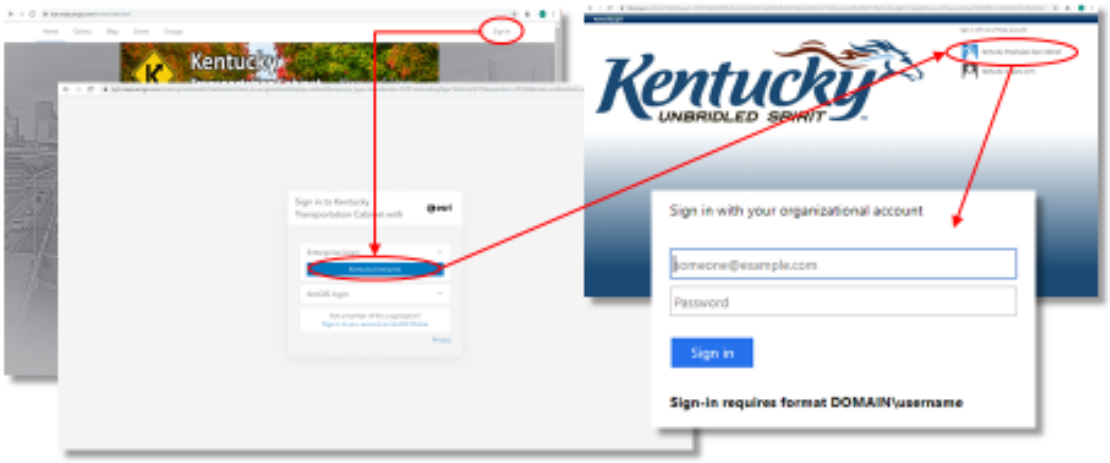
I. First Use

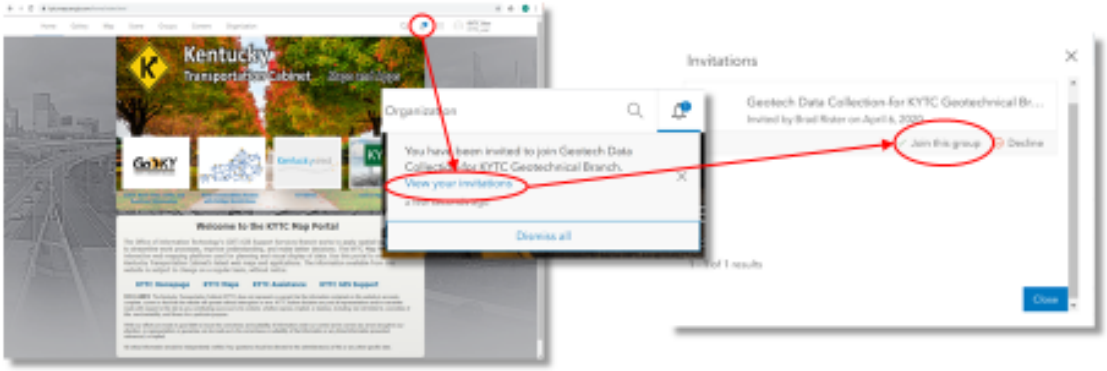
A. Accept invitation to join the Geotech Data Collection Group

Before you begin using the Geotech Collector Map, you must first join the AGOL Group under the KTC Organization. You will receive an invitation to join the group.

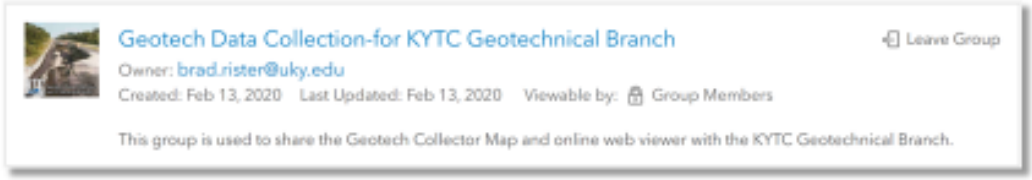
1. Navigate to kytc.maps.arcgis.com and login using your KYTC credentials.



2. Once logged in you should see a notification icon in the top ribbon. Click the icon to expand your notifications, then click "View your invitations", then select "Join this group."



3. You are now a member of KTC's Geotech Collection Group and will be able to access the Geotech Collection map in the Collector app on your mobile device.

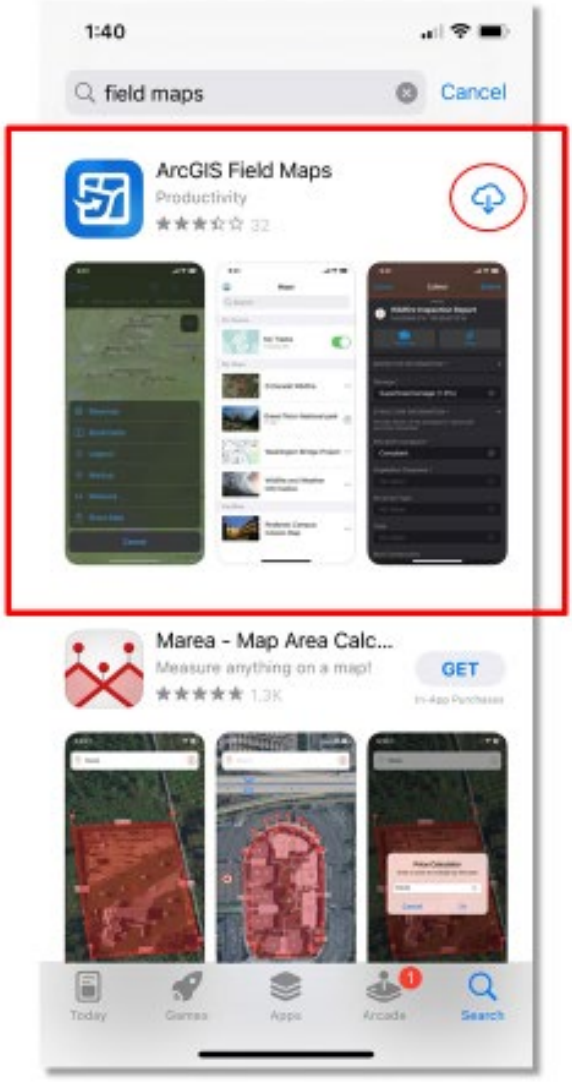


Page 1

I. First Use

B. Download ArcGIS Field Maps

Use device App store (e.g. iOS = "App Store", Android = "Google Play") to find and download the "ArcGIS Field Maps" Application.

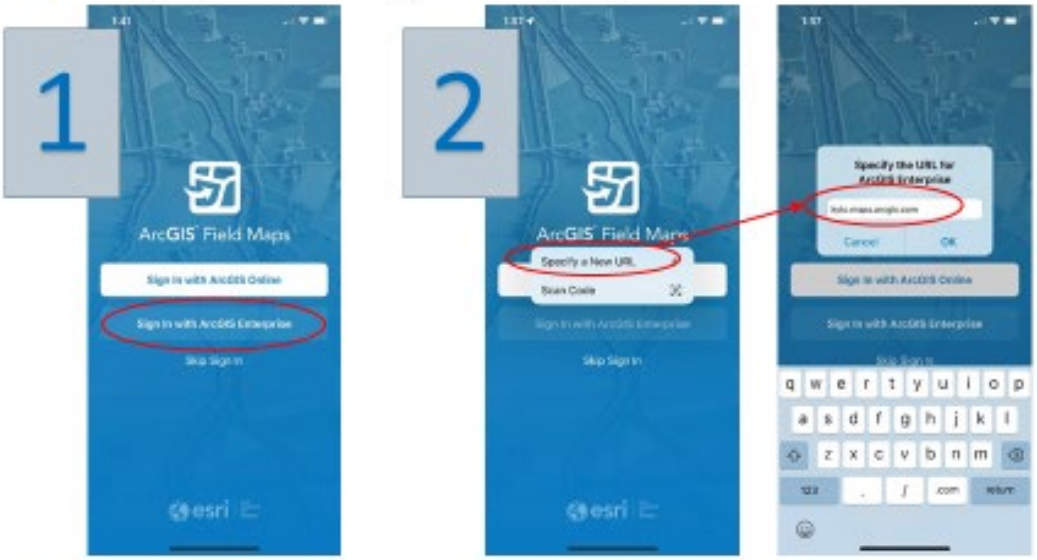


Page 2

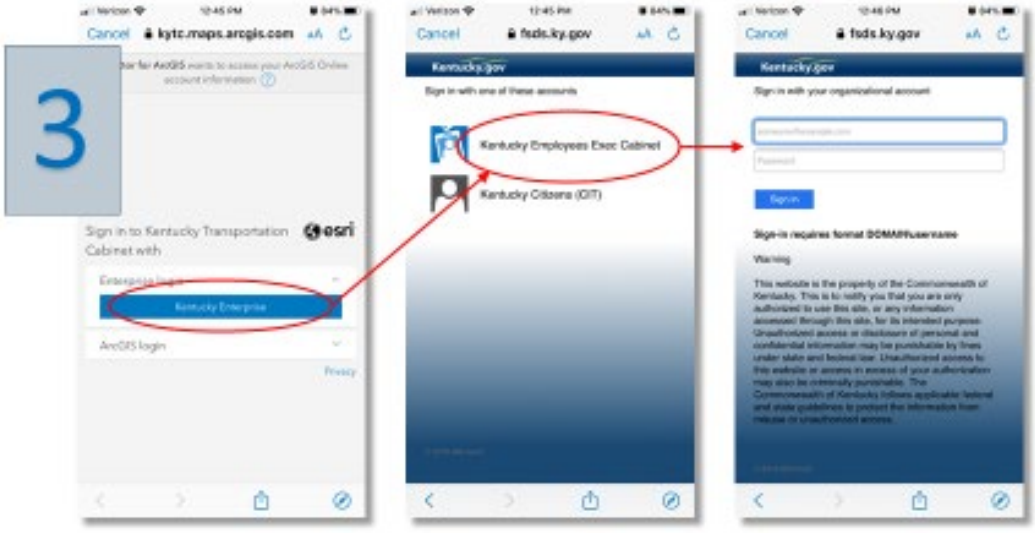
I. First Use

C. Open and login to ArcGIS Field Maps

1. Open Field Maps to see opening screen—select "ArcGIS Enterprise."
2. Select "Specify a New URL" then type in "kytc.maps.arcgis.com" and then click "OK."



3. Login to ArcGIS Field Maps using your KYTC credentials.



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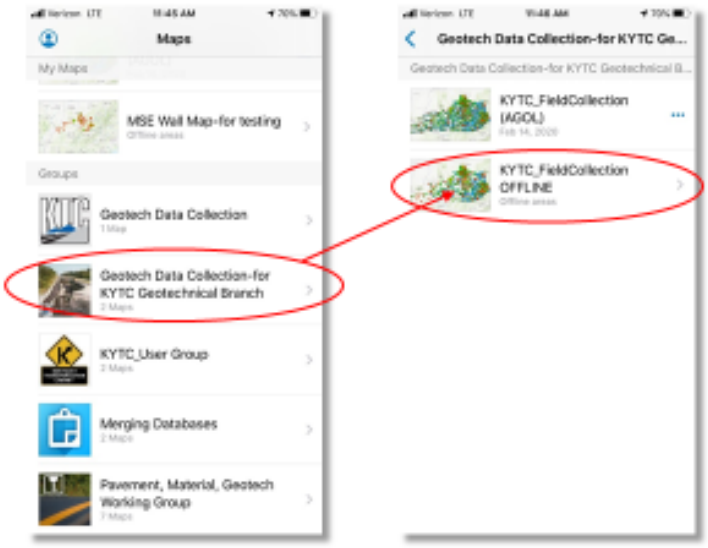
II. Accessing the Map

A. Find group and open map

Select the group "Geotech Data Collection-for KYTC Geotechnical Branch." There are two map options, "KYTC_FieldCollection (AGOL)" and "KYTC_FieldCollection OFFLINE." The offline version is recommended because it is more reliable when operating in areas without cell service.



B. Manage offline area

Offline maps for each district have been prepackaged for download. You may download multiple offline maps to your device. A screen showing offline areas available for download will appear once you choose the "KYTC_FieldCollection OFFLINE" map.

1. Choose a district and download the area to your device.
2. This area will stay on your device, but always be sure to sync the area in the office before going in the field for data collection. This ensures that the offline area contains the most recent data available.

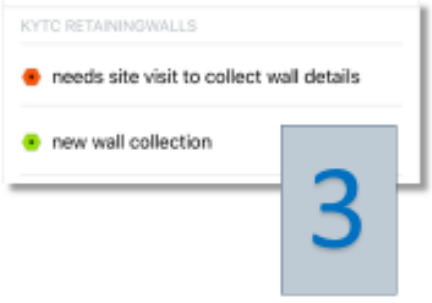
III. Data Collection

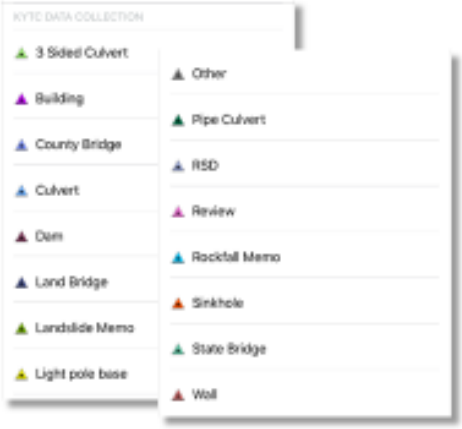
A. Collect a new feature

1. Once the map is opened, click the  icon in the bottom right corner to collect at your current location (the blue dot).

2. A list of feature types appears, this determines the incident type you are collecting. There are two layers to choose a feature from, "KYTC Retaining Walls" and "KYTC Data Collection."

3. Choose a feature type from one of the two layers:
   - The first layer, KYTC Retaining walls has two options to choose from. If collecting a new retaining wall with known attributes, select "new wall collection." The other option, "needs site visit to collect wall details" is used to signify a wall with a known location, but missing attributes.
   - The second layer is the original KYTC Data Collection layer with various geotechnical features, including landslide and rockfalls.

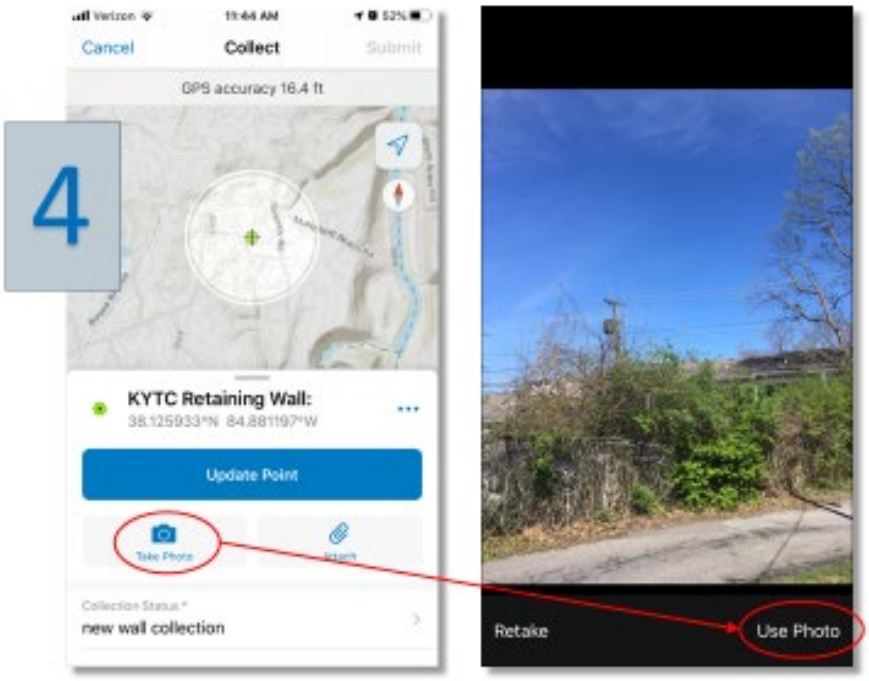




III. Data Collection

A. Collect a new feature

1. Once the map is opened, click the icon in the bottom right corner to collect at your current location (the blue dot).
2. A list of feature types appears, this determines the incident type you are collecting. There are two layers to choose a feature from, "KYTC Retaining Walls" and "KYTC Data Collection."
3. Choose a feature type from one of the two layers:
   - The first layer, KYTC Retaining walls has two options to choose from. If collecting a new retaining wall with known attributes, select "new wall collection." The other option, "needs site visit to collect wall details" is used to signify a wall with a known location, but missing attributes.
   - The second layer is the original KYTC Data Collection layer with various geotechnical features, including landslide and rockfalls.
4. Take a photo of the retaining wall or geotechnical feature or incident. You can take multiple photos.



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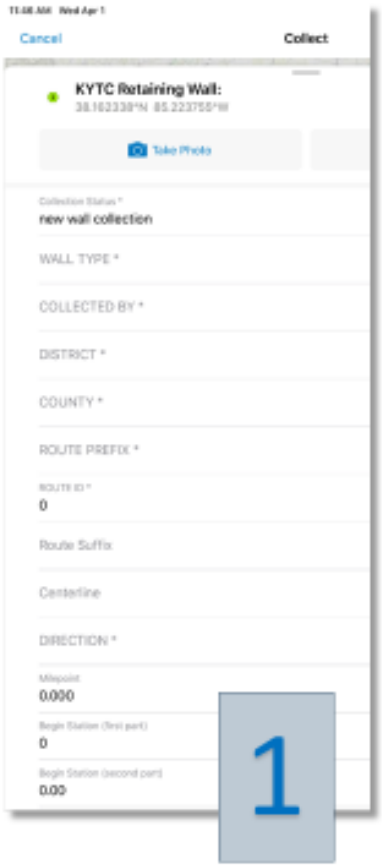
III. Data Collection

B. Enter attributes for new feature

1. If collecting a KYTC Retaining Wall feature type, enter data into the fields as shown below (the attribute window can be pulled up to maximize screen space). Location, collection date and time, and the login user are recorded automatically. Required fields are denoted by CAPITAL FIELD NAMES*



Data Fields:

- Collection Status (text—selection): initial selection for symbology
- WALL TYPE* (text—selection): MSE wall is the only type available
- COLLECTED BY* (text—selection)
- DISTRICT* (text—selection)
- COUNTY* (text—selection)
- ROUTE PREFIX* (text—selection)
- ROUTE ID* (integer—free entry)
- Route Suffix (text—selection)
- Centerline (text—selection)
- DIRECTION* (text—selection)
- Milepoint (decimal number—free entry)
- Begin Station, first part (integer—free entry)
- Begin Station, second part (decimal number—free entry)
- End Station, first part (integer—free entry)
- End Station, second part (decimal number—free entry)
- SITE LOCATION* (text—free entry)
- Site Description (text—free entry)
- 2nd Route Prefix (text—selection)
- 2nd Route ID (integer—free entry)
- 2nd Route Suffix (text—selection)
- KYTC Geotech Report Number (text—free entry)
- RAILROAD CROSSING* (text—selection)
- WET CROSSING* (text—selection)
- Stream Name (text—free entry)
- TOPOGRAPHY* (text—selection)
- 2nd Topography (text—selection)
- HEIGHT* (decimal number—free entry)
- LENGTH* (decimal number—free entry)
- Elevation (decimal number—free entry)
- POSITION* (text—selection)
- MSE Reinforcement Type (text—selection)
- 1st Backfill Material (text—selection)
- 2nd Backfill Material (text—selection)
- 3rd Backfill Material (text—selection)
- Thickness (decimal number—free entry)
- Designer (text—free entry)
- KYTC Drawing Number (text—free entry)
- Manufacturer (text—free entry)
- Manufacturer Drawing Number (text—free entry)
- Year Completed (integer—free entry)
- GENERAL COMMENTS* (text—free entry): enter "No comment" if none
- Bridge ID Number (text—free entry)

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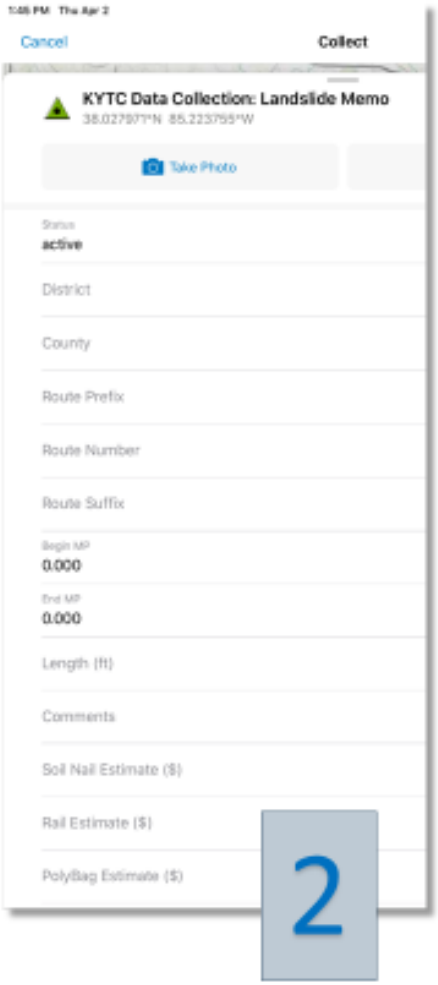
III. Data Collection

B. Enter attributes for new feature

1. If collecting a KYTC Retaining Wall feature type, enter data into the fields as shown below (the attribute window can be pulled up to maximize screen space). Location, collection date and time, and the login user are recorded automatically. Required fields are denoted by CAPITAL FIELD NAMES*

2. If collecting a KYTC Data Collection feature type, enter data into the fields as shown below (the attribute window can be pulled up to maximize screen space). Location, collection date and time, and the login user are recorded automatically.



Data Fields:

- Status (text—selection): defaults to active. Change to repaired only if final repairs have been made.
- District (text—selection)
- County (text—selection)
- Route Prefix (text—selection)
- Route Number (text—free entry)
- Route Suffix (text—selection)
- Begin MP (decimal number—free entry)
- End MP (decimal number—free entry)
- Length (decimal number—free entry)
- Comments (text—free entry)
- Fields to record various types of repair estimates:
  - Soil Nail Estimate (decimal number—free entry)
  - Rail Estimate (decimal number—free entry
  - PolyBag Estimate (decimal number—free entry)
  - Excavate/Replace Estimate (decimal number—free entry)
  - Other Repair Estimate (decimal number—free entry)
- Item Number (text—free entry)
- Project Manager (text—selection)
- District Contact (text—free entry)
- Station Begin (text—free entry)
- Station End (text—free entry)
- KYTC Geotech Report Number (text—free entry)
- Historic URL (text—free entry)
- 2nd County (text—selection)
- 2nd District (text—selection)
- Offset (text—free entry)

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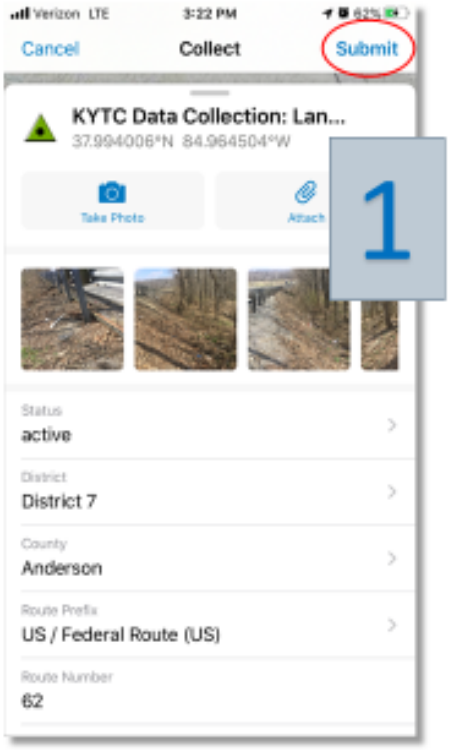
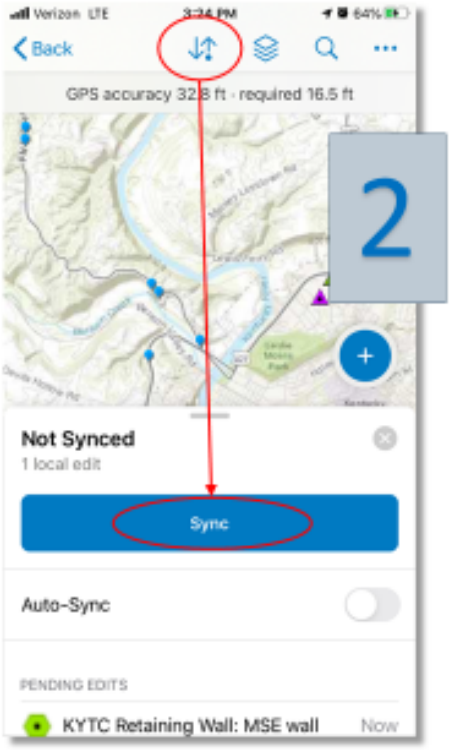
III. Data Collection

C. Submit and sync newly collected feature

1. Click "Submit" when you have added the point, taken at least one photo, and entered attributes for either a KYTC Retaining Wall or KYTC Data Collection feature.

2. The data is stored locally on the device, and you must sync the data when you have a connection. Click the ⇅ icon, and then click "Sync." If you enable "Auto-Sync", your device will attempt to sync the data every 15 minutes as long as the device has a data connection.

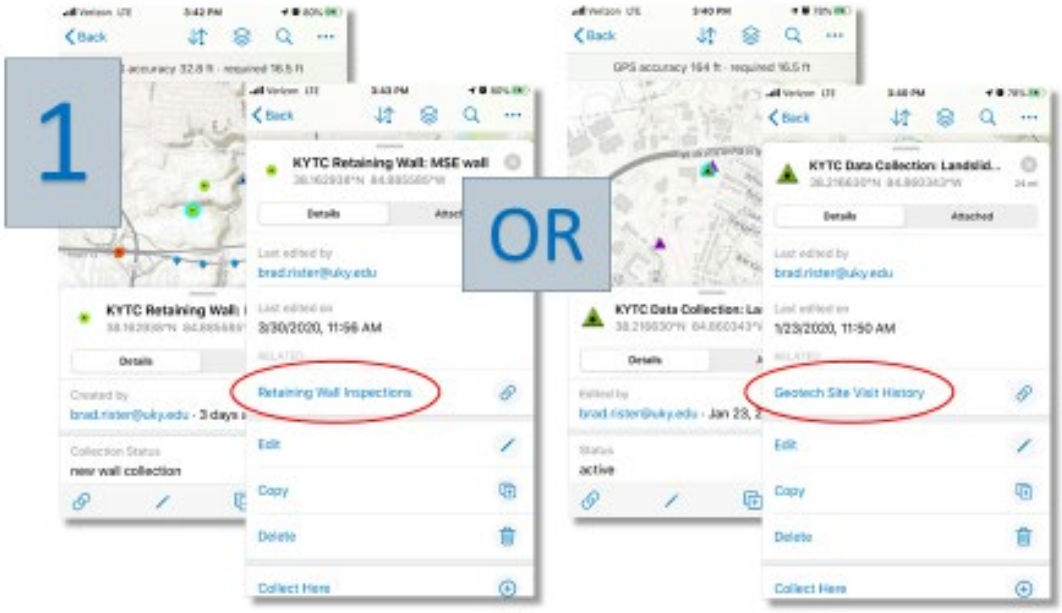




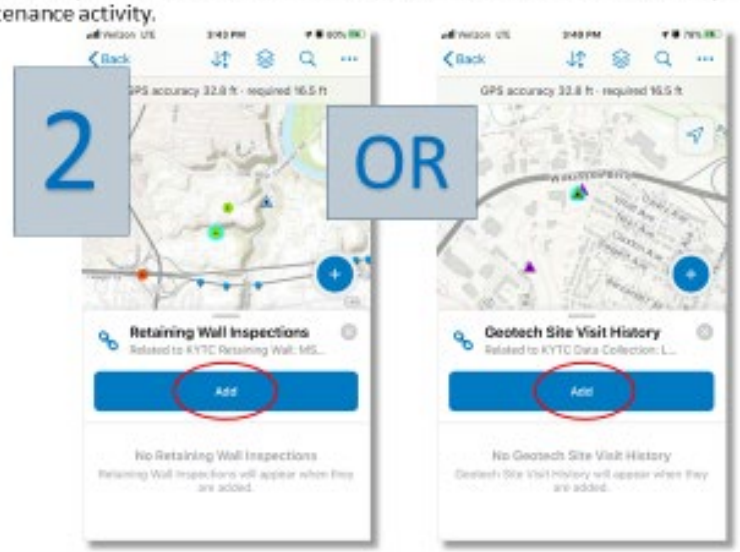
III. Data Collection

D. Add site visit or record maintenance activity

1. On the map interface, click an existing feature, either a KYTC Retaining Wall or KYTC Data Collection feature, to select it, scroll to the bottom of the attribute window, and click "Retaining Wall Inspections" or "Geotech Site Visit History" respectively.



2. You can view previous site visits if available, or click "Add" to record a new inspection, site visit, or maintenance activity.



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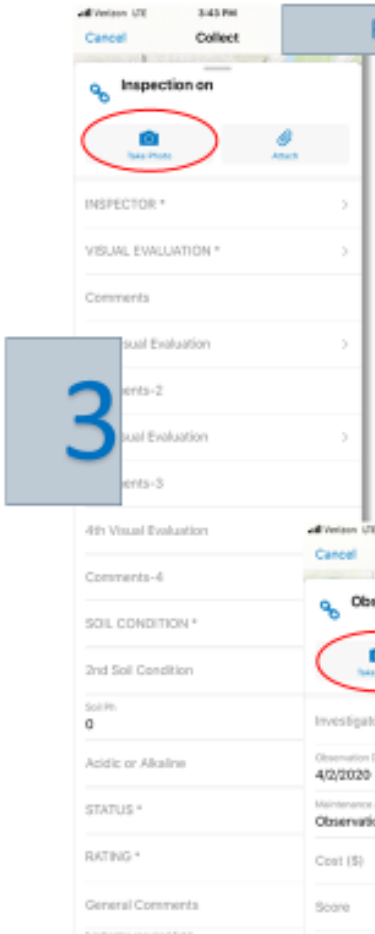
III. Data Collection

D. Add site visit or record maintenance activity

1. On the map interface, click an existing feature, either a KYTC Retaining Wall or KYTC Data Collection feature, to select it, scroll to the bottom of the attribute window, and click "Retaining Wall Inspections" or "Geotech Site Visit History."

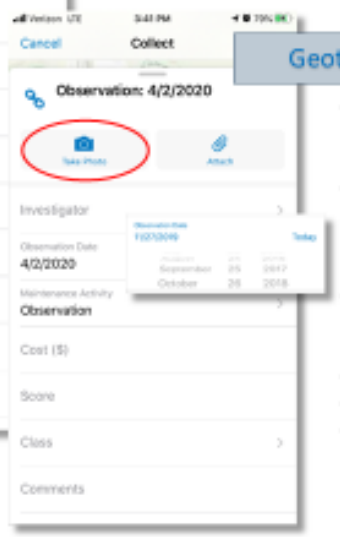
2. You can view previous site visits, or click "Add" to record a new inspection, site visit, or maintenance activity.

3 Add photos, and enter data into the fields for either type of inspection or site visit. Submit when done, and remember to sync if you have not enabled Auto-Sync.



Retaining Wall Inspection

- INSPECTOR* (text—selection): choose your name from the list
- VISUAL EVALUATION* (text—selection): first visual evaluation is required
- Comments (text—free entry): further comment to describe evaluation
- 2nd Visual Evaluation (text—selection)
- Comments-2 (text—free entry)
- 3d Visual Evaluation (text—selection)
- Comments-3(text—free entry)
- 4th Visual Evaluation (text—selection)
- Comments-4 (text—free entry)
- SOIL CONDITION* (text—selection): first soil condition is required
- 2nd Soil Condition (text—selection)
- Soil Ph (decimal number—free entry)
- Acidic or Alkaline (text—selection)
- STATUS* (text—selection)
- RATING* (text—selection)
- General Comments (text—free entry)



Geotech Site Visit

- Observation Date (date field): Select "Today" or choose a date from the date picker if you are recording an activity retroactively
- Maintenance Activity (text—selection): choose a reason for the site visit (observation, patching, final repair, or other—if other explain in comments)
- Cost (decimal number): if a maintenance activity other than observation was performed, record the cost incurred here
- Score (integer—free entry)
- Class (text—selection)
- Comments (text—free entry): describe reason for the site visit and any observations made or work performed

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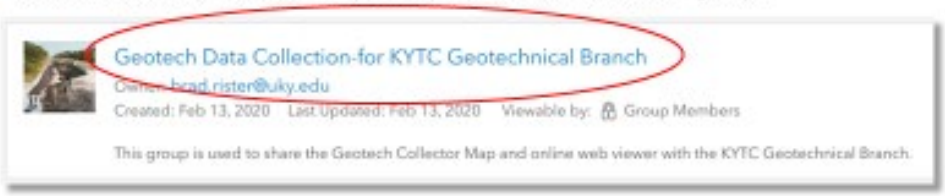
IV. Using the Online Web Viewer

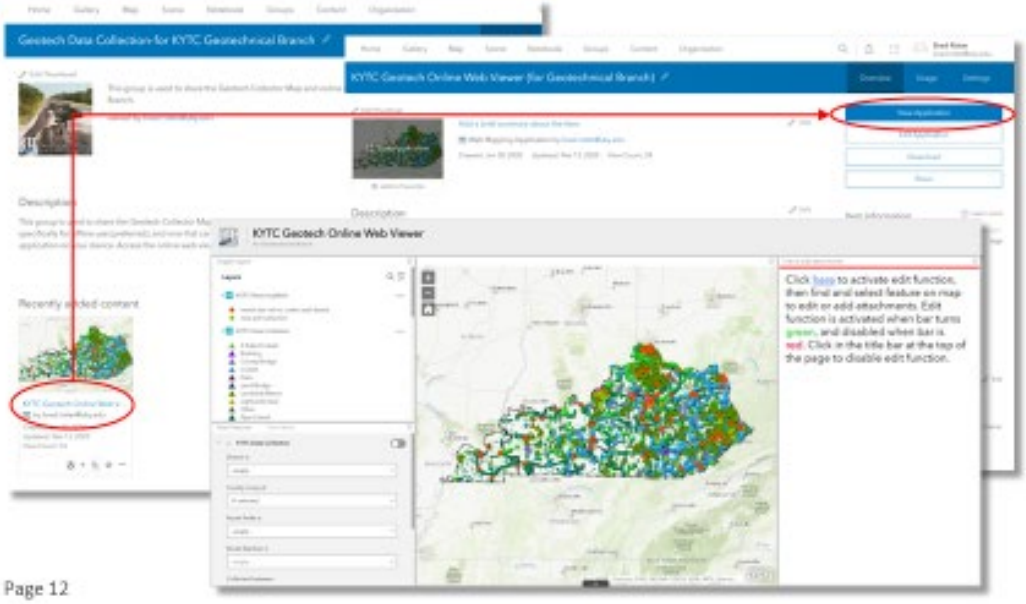
A. How to find the online web viewer

1. Once logged in to AGOL at kytc.maps.arcgis.com using your KYTC enterprise credentials, click on "Groups" in the top ribbon.

2. Select the "Geotech Data Collection-for KYTC Geotechnical Branch" group.



3 Select the "KYTC Geotech Online Web Viewer." It should be the only content visible on the group page. Click "View Application" on the next page, and the web viewer will open.



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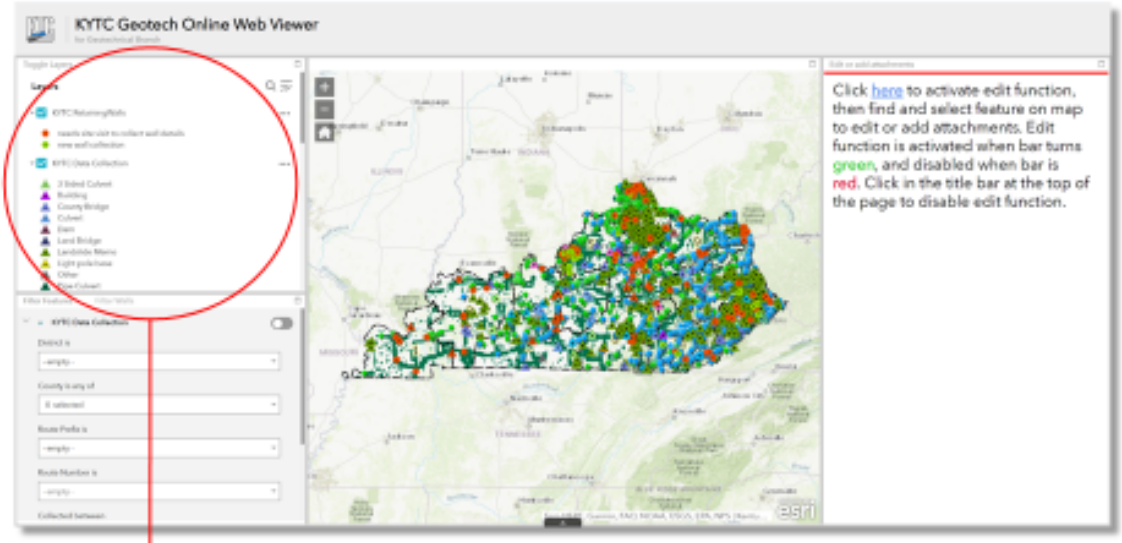
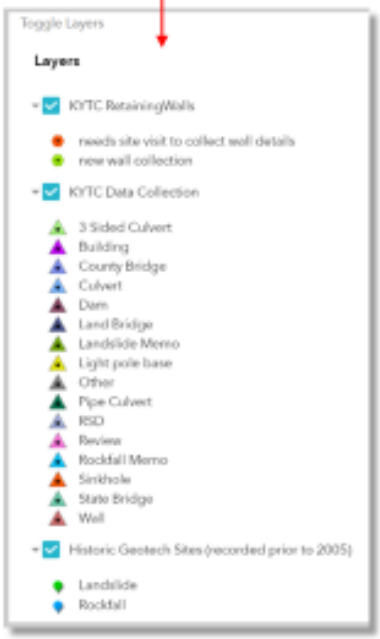
IV. Using the Online Web Viewer

B. Identify features on the map

Layers with existing data have been added to the online map, and these, along with collected features, can be identified in the web viewer, along with any supporting data.





Use the layer list to identify features, and toggle layers on and off.

- KYTC Retaining Walls—features collected in the field using Collector
- KYTC Data Collection—features collected in the field using Collector
- Historic Geotech Sites—landslides and rockfalls collected prior to 2005, used for reference—ID attributes contain link to observation data
- state_milepoints—used to help locate features
- KYTC / gINT layers (hosted by KGS):
  - KYTC Structures – structures entered via the KGS-hosted KYTC point upload map application
  - gINT Boreholes – boreholes in the KGS-hosted gINT database
    - ID attributes contain link to borehole and project data
  - KYTC Holes – boreholes entered via the KGS-hosted KYTC point upload map application (may have some overlap with gINT Boreholes)
    - ID attributes contain links to borehole data (if available) and project report (PDF)
  - KYTC district boundaries
  - KYTC Project Areas – project areas entered via the KGS-hosted KYTC map application
    - ID attributes contain link to project report (PDF)
- World Imagery—optional imagery basemap

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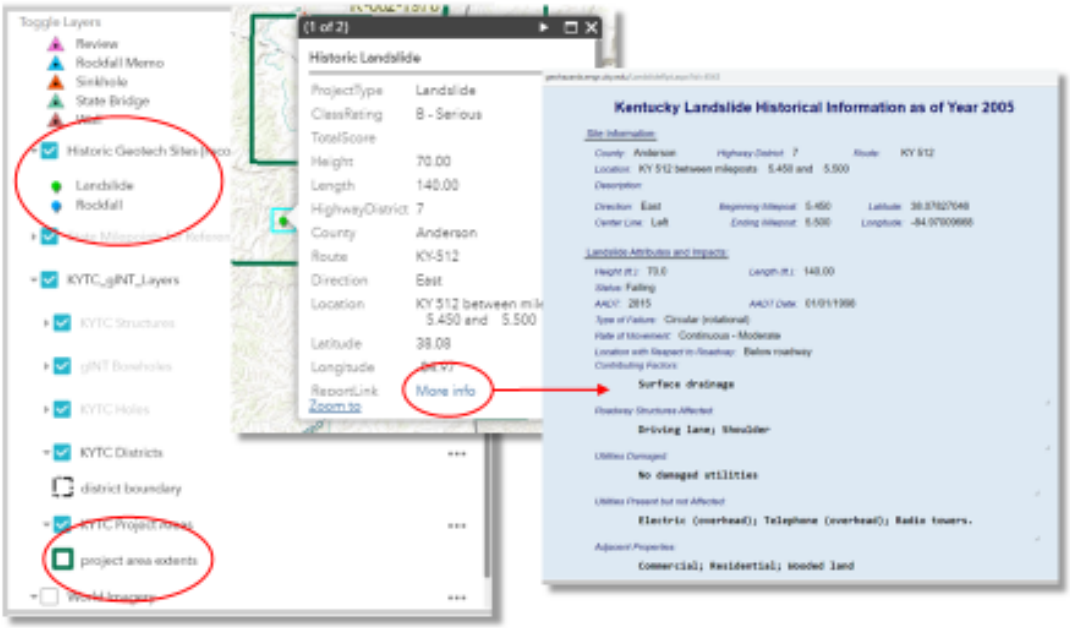
IV. Using the Online Web Viewer

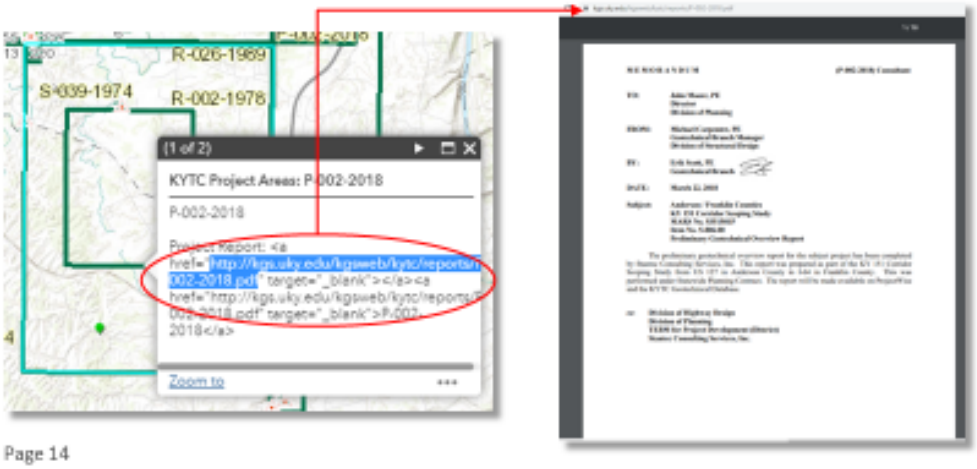
C. Inspect reference layer to view project reports

The layers you will likely use most for reference are the Historic Geotech Sites, and KYTC Project Areas. The online web viewer has an edit function explained in section E where you can add these project report links to your collected features if applicable.

1. Click a Historic Geotech Site to view its attributes, and follow the "More info" link to view the project report (PDF).



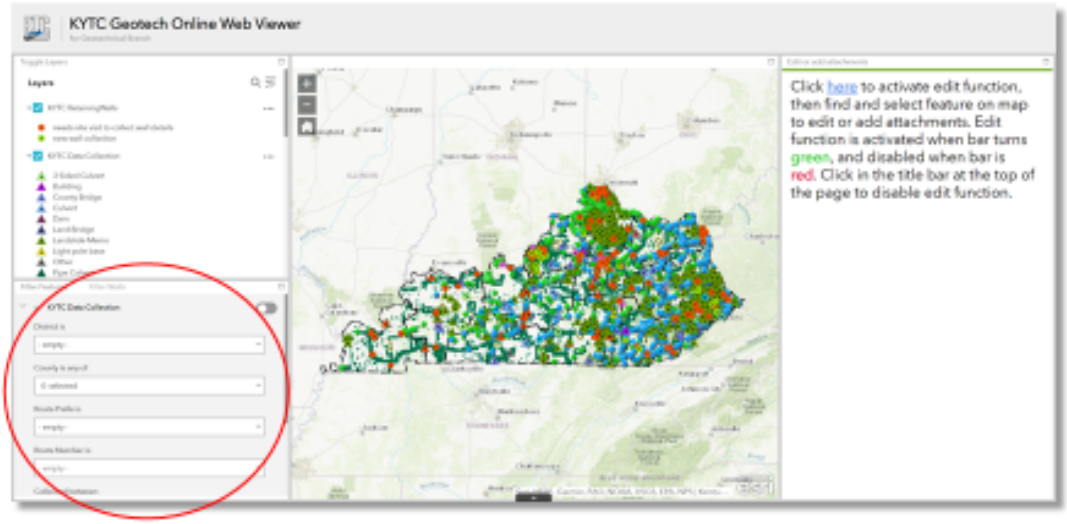
2. Click a KYTC Project Area to access the link for its project report. Copy and paste the link as shown below into your browser to view report.

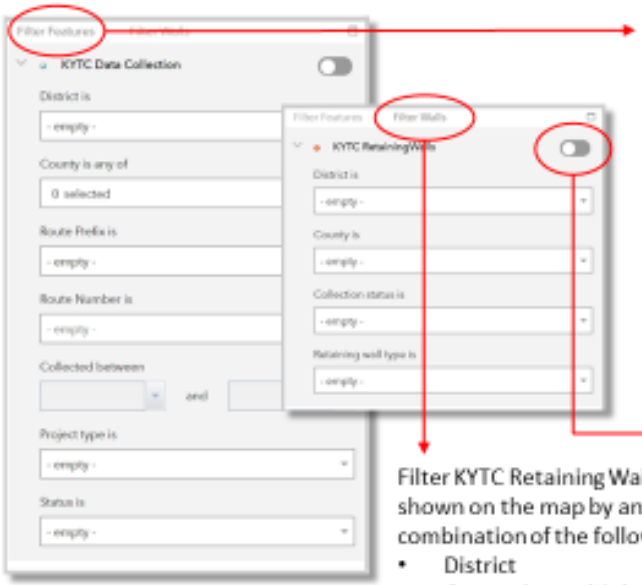


IV. Using the Online Web Viewer

D. Filter features to show on the map

Two filter functions are included in the web viewer to help locate specific geotech features or retaining walls.





Filter KYTC Data Collection features shown on the map by any combination of the following (values in each filter selection are filtered by previous selections):

- District
- County (or multiple counties)
- Route (choose route prefix and route number)
- Date range
- Project type
- Status (active or repaired)

Hit the radio button in the upper right-hand corner to apply either filter. The button turns green when the filter is applied, and the map updates to show only the features that match the filter(s) chosen.

Filter KYTC Retaining Walls shown on the map by any combination of the following:

- District
- County (or multiple counties)
- Collection Status
- Retaining wall type

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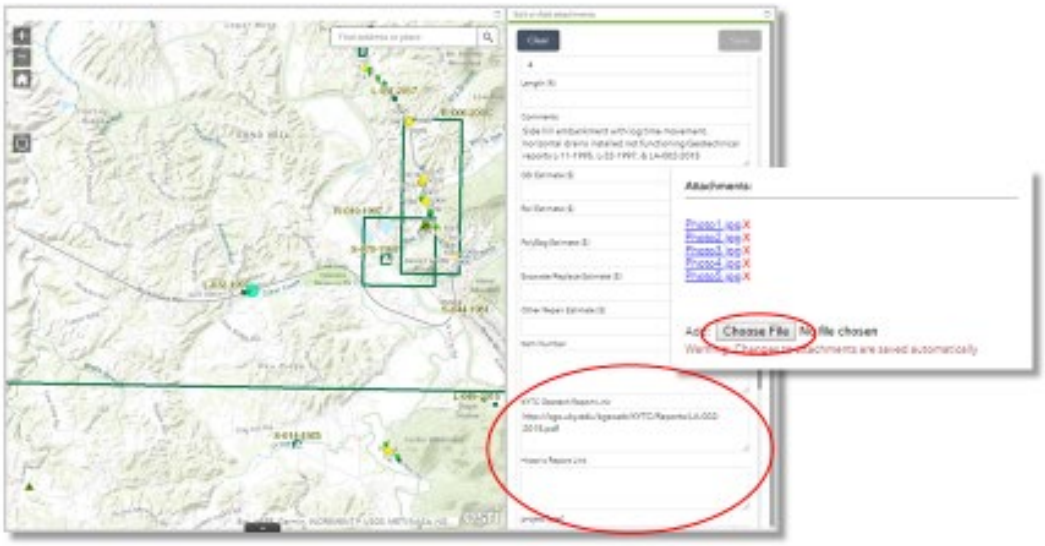
IV. Using the Online Web Viewer

E. Edit features or add attachments

The online web viewer has an edit function to update features or add attachments (repair estimates, KYTC Geotech reports, etc.).

1. First click to activate edit function. Edit function is active when the bar turns green.

2. Select any feature on the map to start editing. You can update attributes, such as inputting any repair estimates, or correcting mistakes made while collecting data in the field. If you find any related historic observations, this is where you can input those report links. You can also add attachments to each feature (e.g. repair quotes or memorandums).



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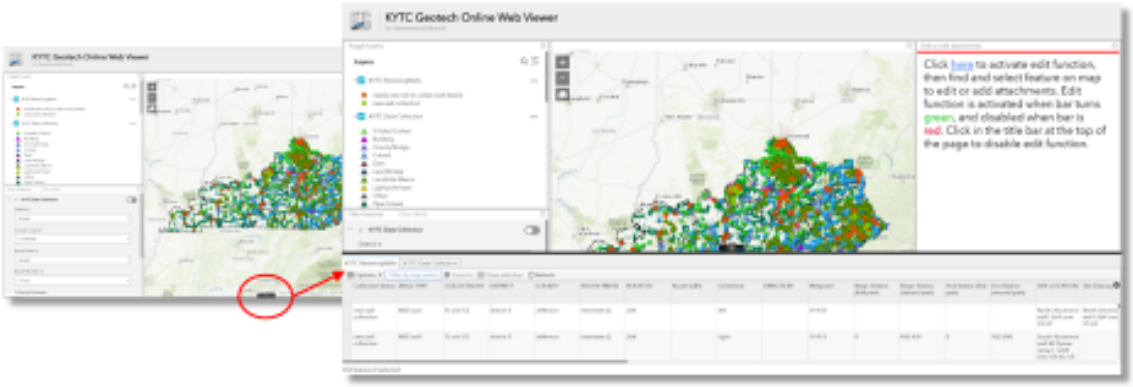
IV. Using the Online Web Viewer

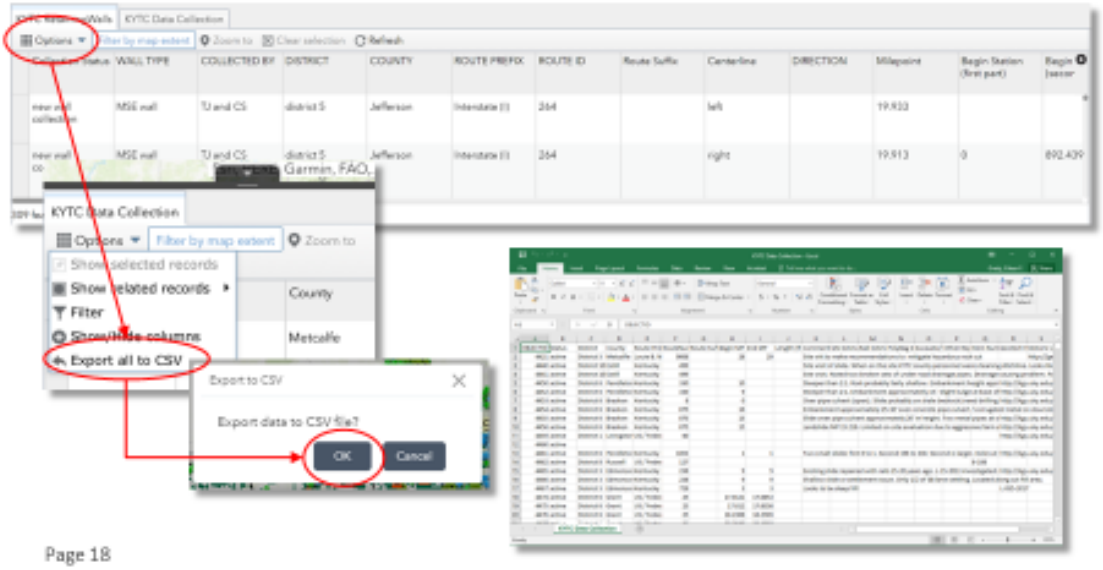
F. Export feature data using the attribute table

The attribute table is filtered by the map extent—only the features visible on the map will appear in the attribute table. Use the filters or zoom the map so that only the features you wish to report are visible in the map window.

1. Click the up arrow tab at the bottom of the map to expand attribute table. There are two tabs, one for KYTC Retaining Walls and one for KYTC Data Collection.



2. Once you have only the features you wish to export visible on the map, select the tab you want to export features from, click "Options", then "Export all to CSV", then "OK." Depending on your computer settings, the exported data will either open in Excel, or save to your downloads folder.

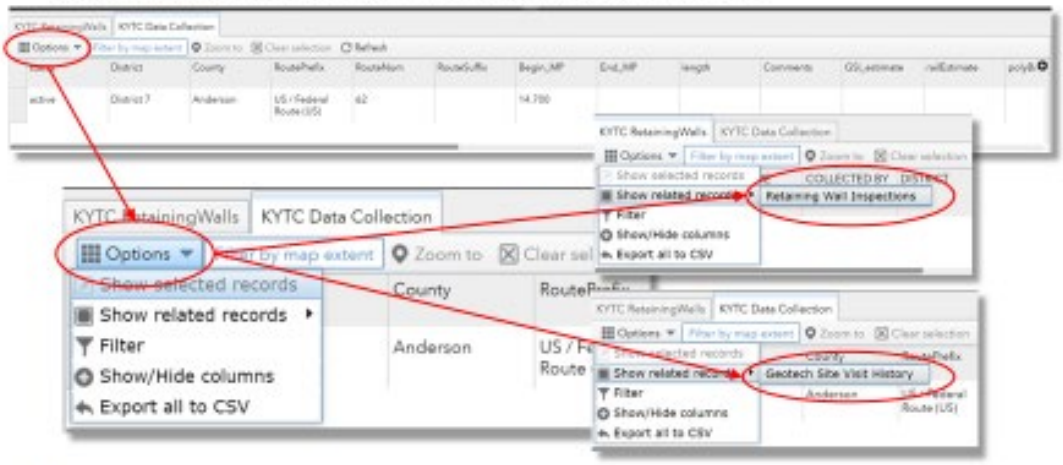


IV. Using the Online Web Viewer

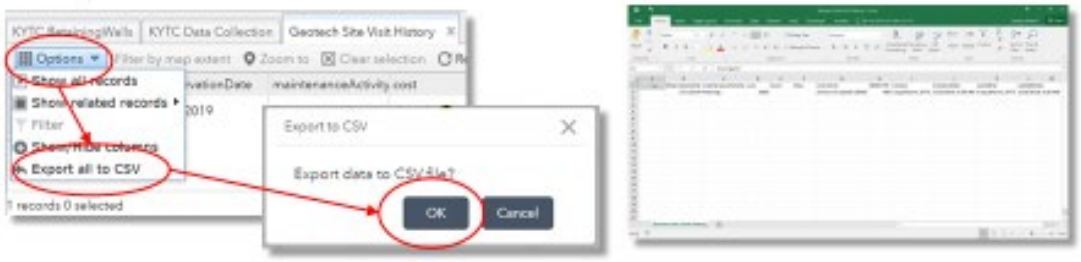
G. Export site visit history using the attribute table

1. To export site visit history for an individual site, either filter or zoom to the site so it is the only visible site on the map. Click the up arrow tab at the bottom of the map to expand attribute table.

2. Once you are sure that only the individual site or retaining wall is visible in the attribute table, click "Options", then "Show related records", then "Geotech Site Visit History," or "Retaining Wall Inspections." The site visit or inspection history will open in a new tab.



3 Once the site visit or inspection history tab opens, click "Options", then "Export all the CSV", then "OK." Depending on your computer settings, the exported data will either open in Excel, or save to your downloads folder.



Appendix D KYTC Geotechnical Data Collection: ArcGIS Field Maps, KYTC User Manual, Version for District Offices

January 2022

KYTC Geotechnical Data Collection: ArcGIS Field Maps

KYTC User Manual

Version for District Offices, January 2022

KYTC Geotechnical Data Collection: ArcGIS Field Maps – Operator Manual for KYTC users

Overview:

This manual is for users of the KYTC Geotechnical Data Collection: ArcGIS Field Maps application for collecting geotechnical data points, related photos, and follow-up data and photos for collected points. ArcGIS Field Maps is a stand-alone application by ESRI which allows users to use ArcGIS Online hosted layers and maps to collect location-based data. The ArcGIS Field Maps application is available for iOS, Android, and Microsoft devices. This manual is directed at users using iOS (Apple) devices (iPad and iPhone), but can be used by Android or Windows device users (though be aware there may be small differences in how users download and interact with the application).

Application Purpose:

This Field Maps data collection application will provide a means for KYTC users to collect point-based geotechnical information using an electronic device. The application should be used in an "offline" mode to view and collect data. Pre-planned offline areas are provided for users. Users will then be able to collect point-of-interest data and related photos, and then view this data in a GIS (ArcGIS or ArcGIS Online) once they have returned to the office. Users will also be able to add follow-up field observations and photographs to previously collected points.

Contact:

Contact Charlie Sun (charlie.sun@uky.edu or 859-257-7330) at the Kentucky Transportation Center for technical assistance with this application.

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- A. Accept invitation to join the Geotech Collection Group—page 1
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- A. How to find the online web viewer—page 9
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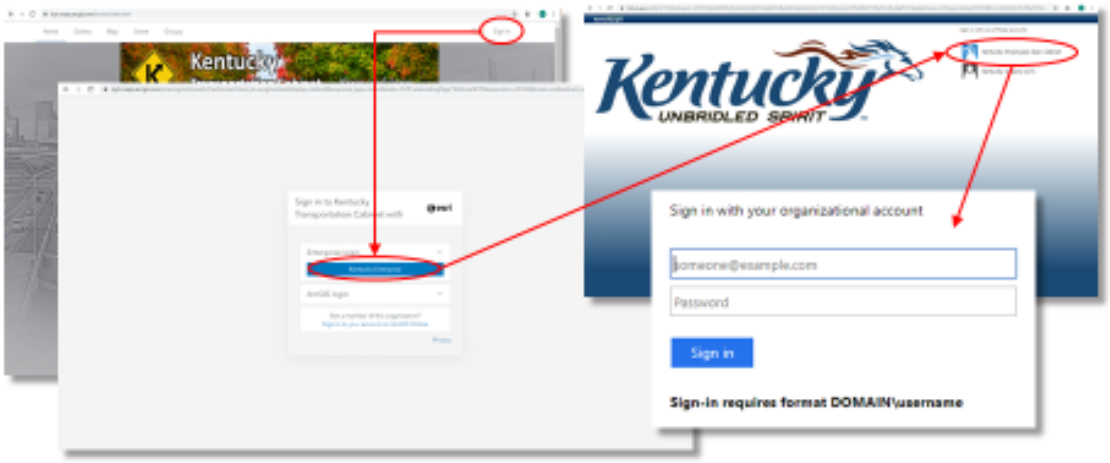
- D. Filter features to show on the map—page 12
- E. Edit features or add attachments—page 13
- F. Export feature data using the attribute table—page 15
- G. Export site visit history using the attribute table—page 16

I. First Use

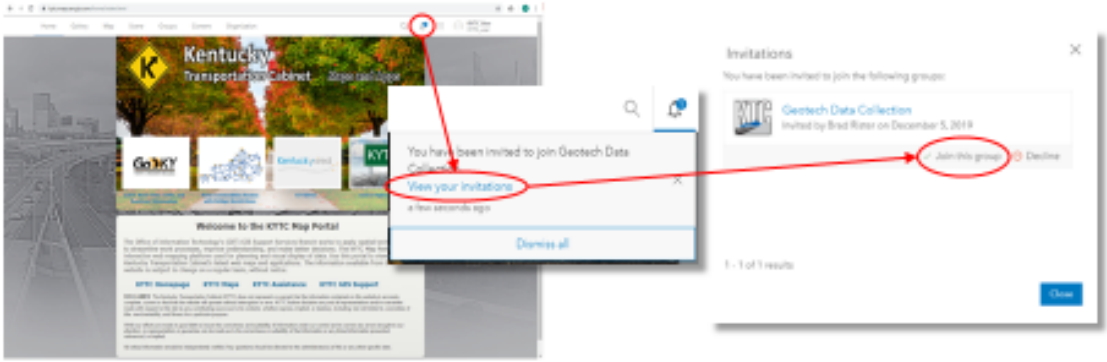
A. Accept invitation to join the Geotech Collection Group

Before you begin using the Geotech Collector Map, you must first join the AGOL Group under the KTC Organization. You will receive an invitation to join the group.

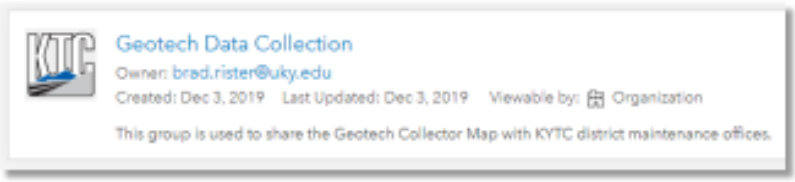
1. Navigate to kytc.maps.arcgis.com and login using your KYTC credentials.



2. Once logged in you should see a notification icon in the top ribbon. Click the icon to expand your notifications, then click "View your invitations", then select "Join this group."



3. You are now a member of KTC's Geotech Collection Group and will be able to access the Geotech Collection map in the Collector app on your mobile device.

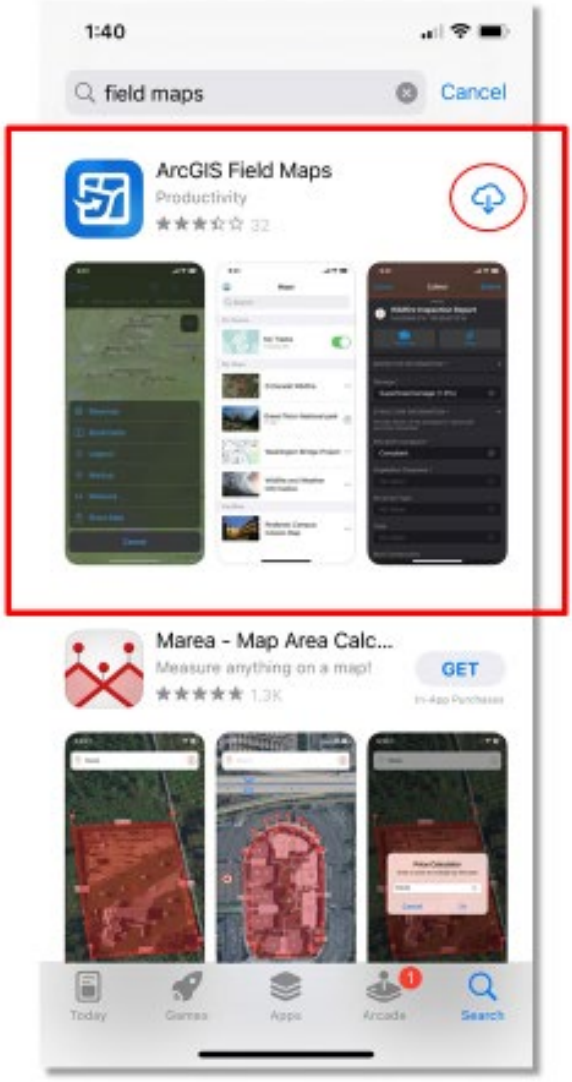


Page 1

I. First Use

B. Download ArcGIS Field Maps

Use device App store (e.g. iOS = "App Store", Android = "Google Play") to find and download the "ArcGIS Field Maps" Application.

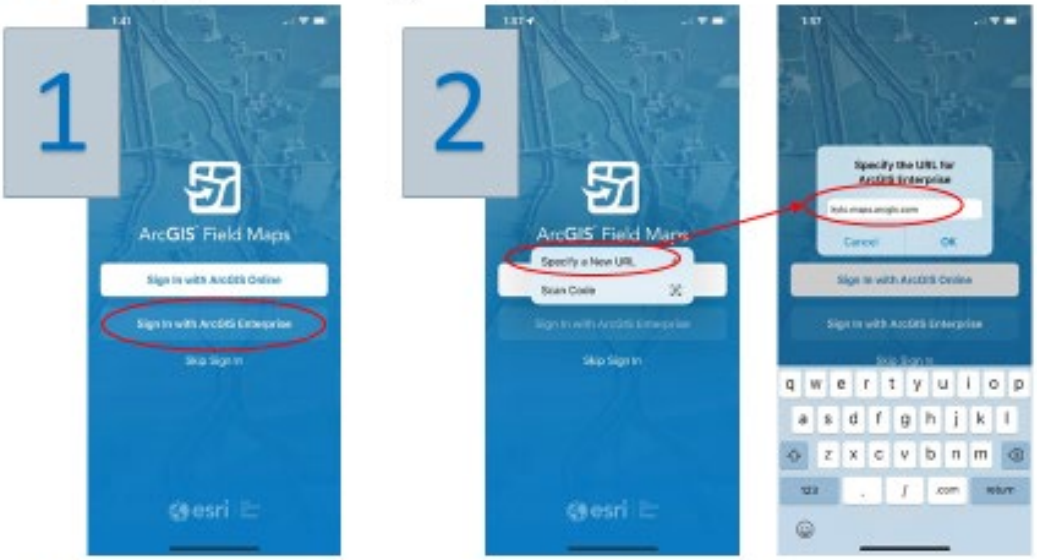


Page 2

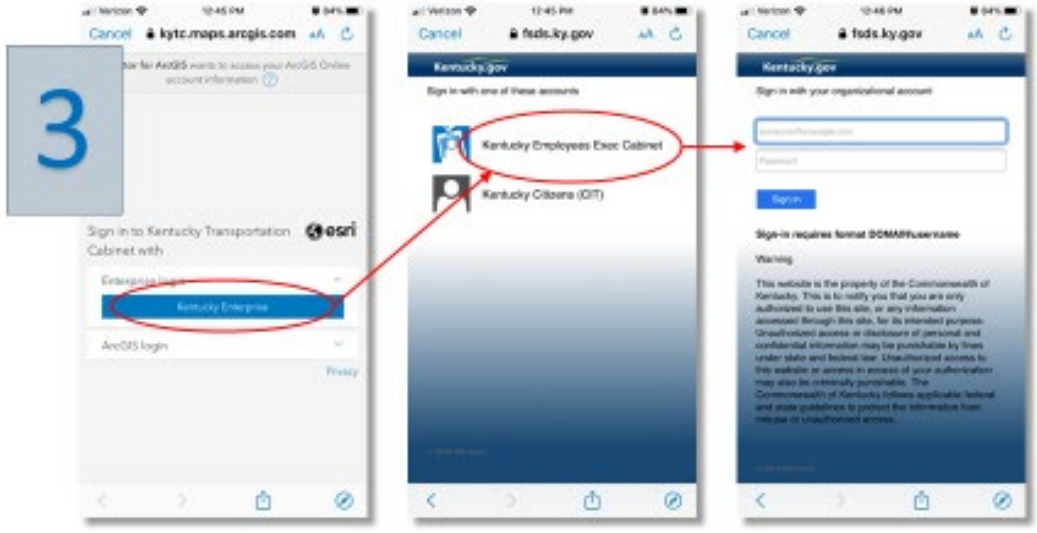
I. First Use

C. Open and login to ArcGIS Field Maps

1. Open Field Maps to see opening screen—select "ArcGIS Enterprise."
2. Select "Specify a New URL" then type in "kytc.maps.arcgis.com" and then click "OK."



3. Login to ArcGIS Field Maps using your KYTC credentials.

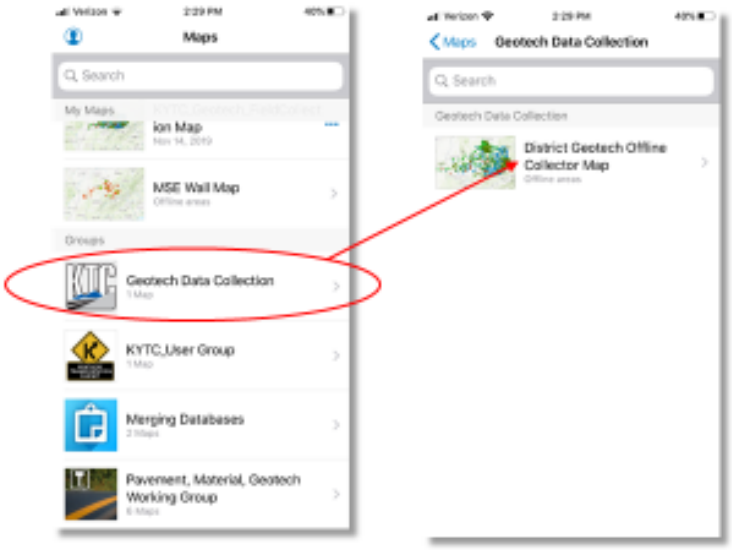


Page 3

II. Accessing the Map

A. Find group and open map

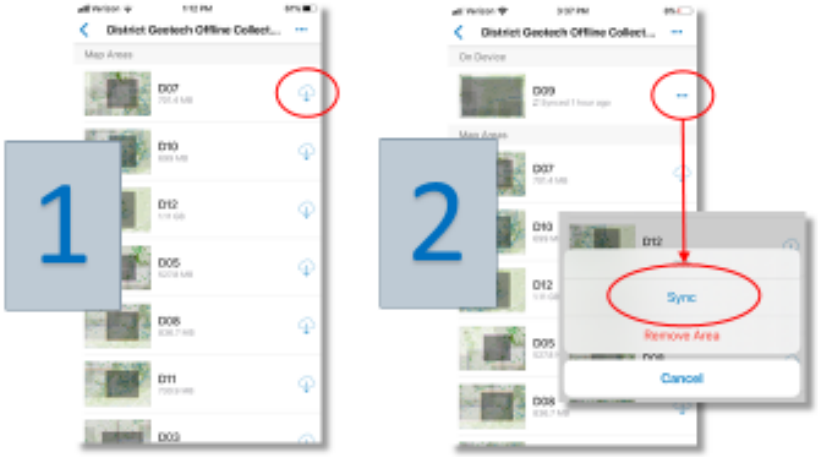
Select the group "Geotech Data Collection," then choose "District Geotech Offline Collector Map."



B. Manage offline area

A screen showing offline areas available for download will appear once you choose the "District Geotech Offline Collector Map."

1. Choose your district and download the area to your device.
2. This area will stay on your device, but always be sure to sync the area in the office before going in the field for data collection. This ensures that the offline area contains the most recent data available.

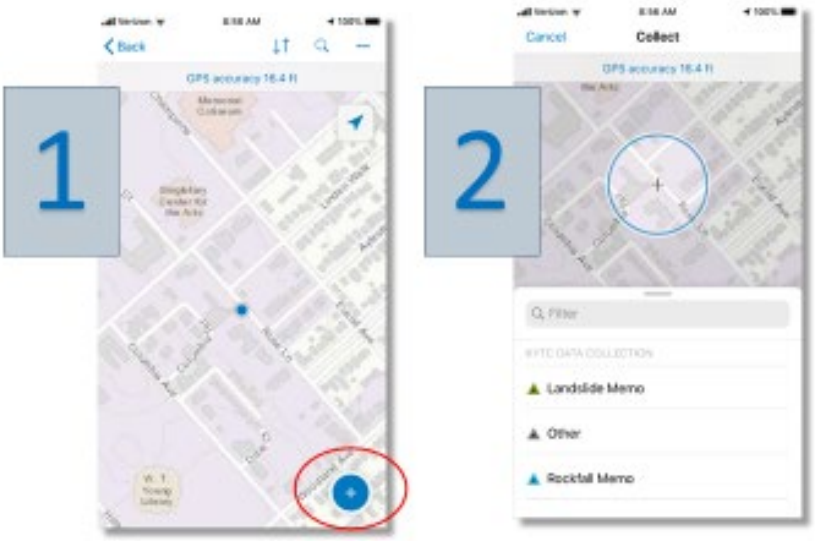


Page 4

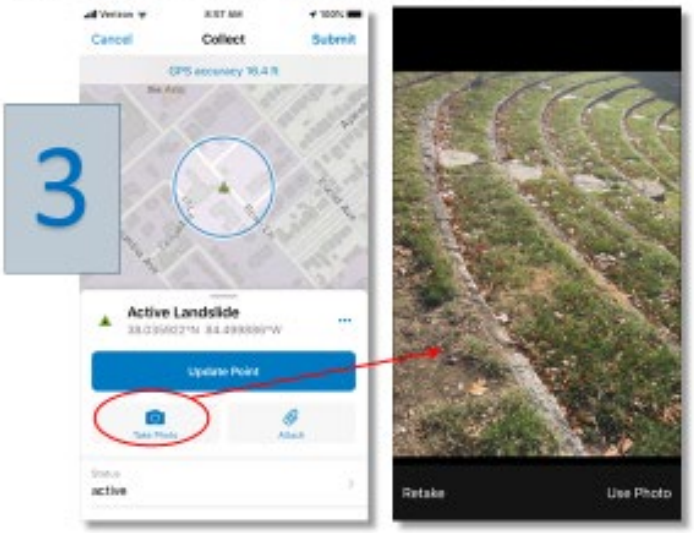
III. Data Collection

A. Collect a new feature

1. To collect at your current location (the blue dot), click the  icon in the bottom right corner.
2. A list of feature types appears—select one—this determines the incident type you are collecting: landslide memo, rockfall memo, sinkhole, or other.



3. Take a photo of the incident. You may take as many photos as you wish.



Page 5

III. Data Collection

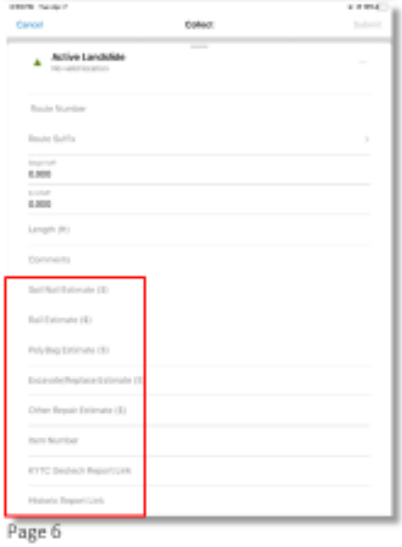
A. Collect a new feature

1. To collect at your current location (the blue dot), click the  icon in the bottom right corner.
2. A list of feature types appears—select one—this determines the incident type you are collecting: landslide memo, rockfall memo, sinkhole, or other.
3. Take a photo of the incident. You may take as many photos as you wish.
4. After selecting feature type and adding photos, enter data into the fields (the attribute window can be pulled up to maximize screen space). Location, collection date and time, and the login user are recorded automatically.

These fields are intended to be recorded at the time of collection:

- Status (text—selection): defaults to active. Change to repaired only if final repairs have been made.
- District (text—selection)
- County (text—selection): use the filter text bar to quickly find your county

- Route Prefix (text—selection)
- Route Number (text—free entry)
- Route Suffix (text—selection)
- Begin MP (decimal number—free entry): a milepoint reference layer is provided on the map to help locate beginning milepoint of the incident
- End MP (decimal number—free entry): a milepoint reference layer is provided on the map to help locate ending milepoint of the incident
- Length (decimal number—free entry): enter approximate length of incident in feet
- Comments (text—free entry): enter any general comments regarding incident



The remaining fields are optional and will likely be added later in the office:

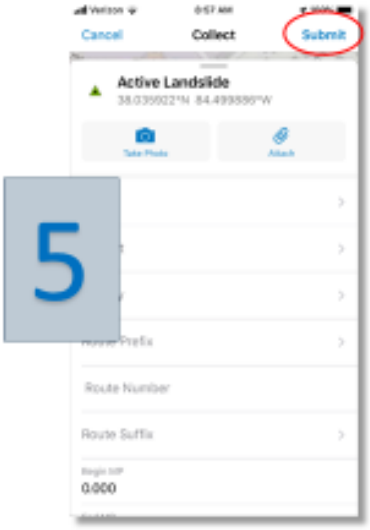
- There are fields to record various types of repair estimates:
  - Soil Nail Estimate (decimal number—free entry)
  - Rail Estimate (decimal number—free entry
  - PolyBag Estimate (decimal number—free entry)
  - Excavate/Replace Estimate (decimal number—free entry)
  - Other Repair Estimate (decimal number—free entry): if you have another repair type estimate that does not fit into one of the categories above
- Item Number (text—free entry): enter the item number if it has been assigned
- Geotech Report Number (text—free entry): enter the KYTC Geotech report number if applicable
- Historic URL (text—free entry): if there is a corresponding historic site, copy its report link here

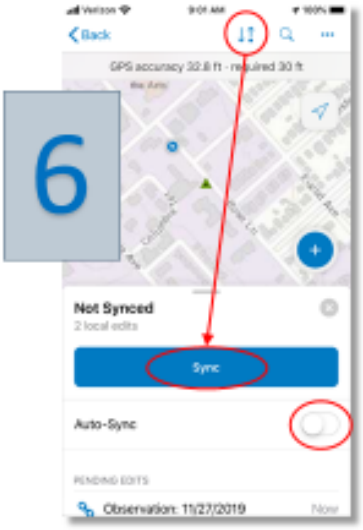
Page 6

III. Data Collection

A. Collect a new feature

1. To collect at your current location (the blue dot), click the  icon in the bottom right corner.
2. A list of feature types appears—select one—this determines the incident type you are collecting: landslide memo, rockfall memo, sinkhole, or other.
3. Take a photo of the incident. You may take as many photos as you wish.
4. After selecting feature type and adding photos, enter data into the fields (the attribute window can be pulled up to maximize screen space). Location, collection data and time, and the login user are recorded automatically.
5. Click "Submit" when you have added the point, taken at least one photo, and entered data into the fields.
6. The data is stored locally on the device, and you must sync the data when you have a connection. Click the ↓↑ icon, and then click "Sync." If you enable "Auto-Sync", your device will attempt to sync the data every 15 minutes as long as the device has a data connection.



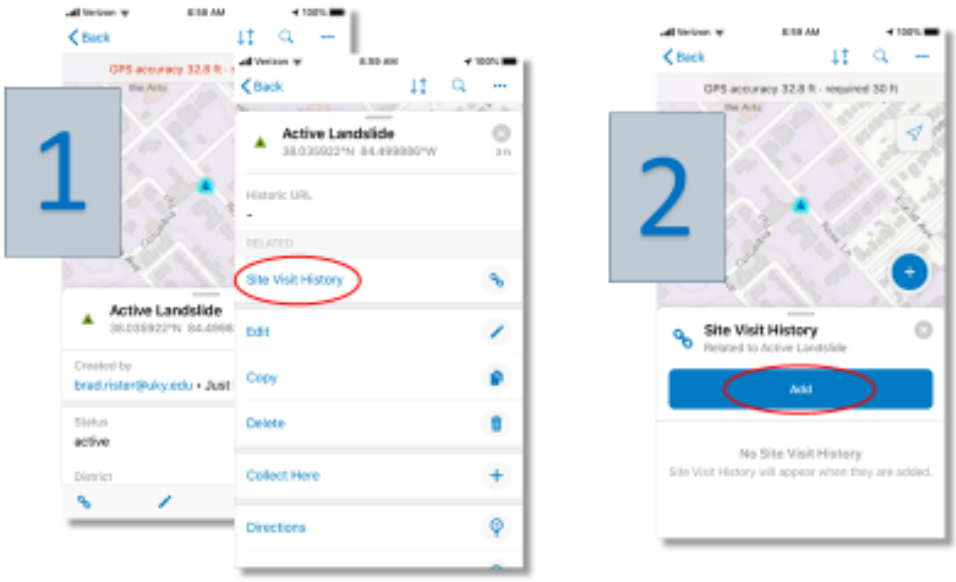


III. Data Collection

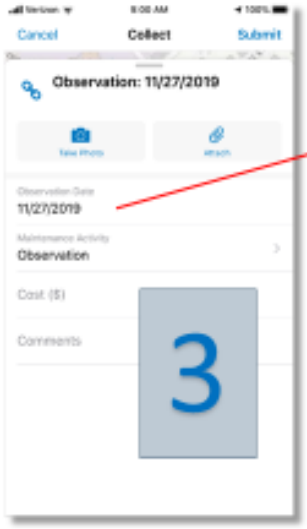
B. Add site visit or record maintenance activity

1. On the map interface, click an existing feature to select it, scroll to the bottom of the attribute window, and click "Site Visit History."

2. You can view previous site visits, or click "Add" to record a new site visit or maintenance activity.



3. Add photos, and enter data into the fields. Submit when done, and remember to sync if you have not enabled Auto-Sync.



- Observation Date (date field): Select "Today" or choose a date from the date picker if you are recording an activity retroactively
- Maintenance Activity (text—selection): choose a reason for the site visit (observation, patching, final repair, or other—if other explain in comments)
- Cost (decimal number): if a maintenance activity other than observation was performed, record the cost incurred here
- Comments (text—free entry): describe reason for the site visit and any observations made or work performed

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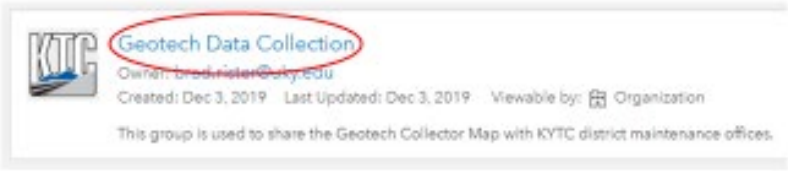
IV. Using the Online Web Viewer

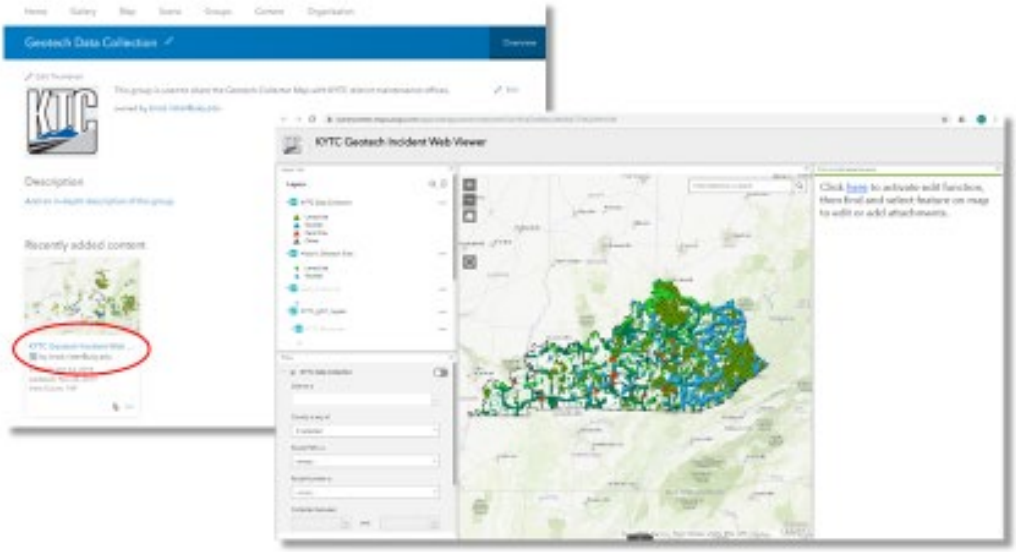
A. How to find the online web viewer

1. Once logged in to AGOL at kytc.maps.arcgis.com using your KYTC enterprise credentials, click on "Groups" in the top ribbon.

2. Select the "Geotech Data Collection" group.



3. Select the "KYTC Geotech Incident Web Viewer." It should be the only content visible on the group page. The web viewer will open.



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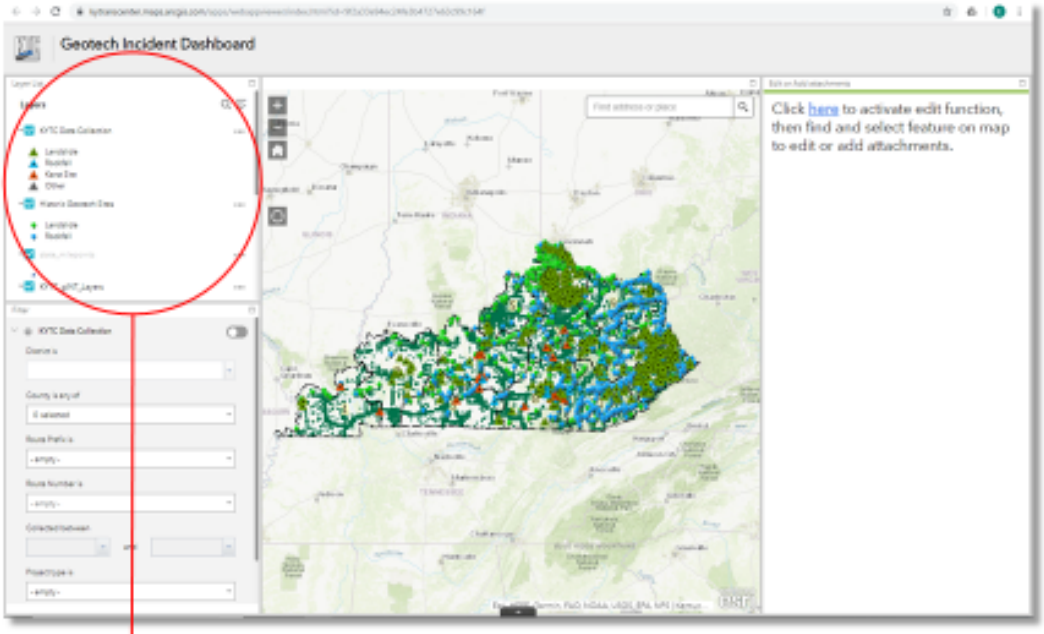
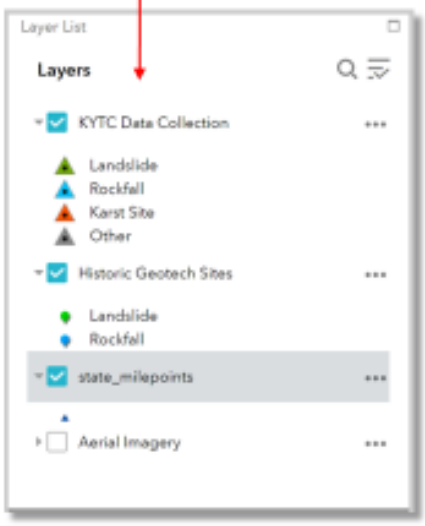
IV. Using the Online Web Viewer

B. Identify features on the map

Layers with existing data have been added to the online map, and these, along with collected features, can be identified in the web viewer, along with any supporting data.





Use the layer list to identify features, and toggle layers on and off.

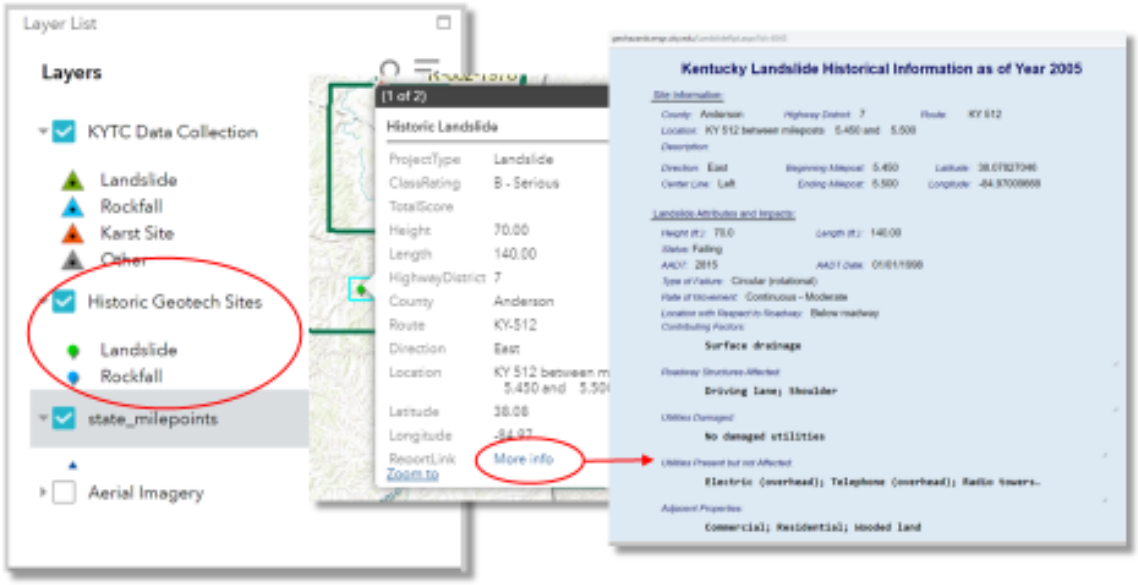
- KYTC Data Collection—features collected in the field using Collector
- Historic Geotech Sites—landslides and rockfalls collected prior to 2005, used for reference—ID attributes contain link to observation data
- state_milepoints—used to help locate features
- Aerial imagery—optional imagery basemap

IV. Using the Online Web Viewer

C. Inspect reference layers to view project reports

The Historic Geotech Sites are included as a reference layer. The online web viewer has an edit function explained in section E where you can add these project report links to your collected features if applicable.

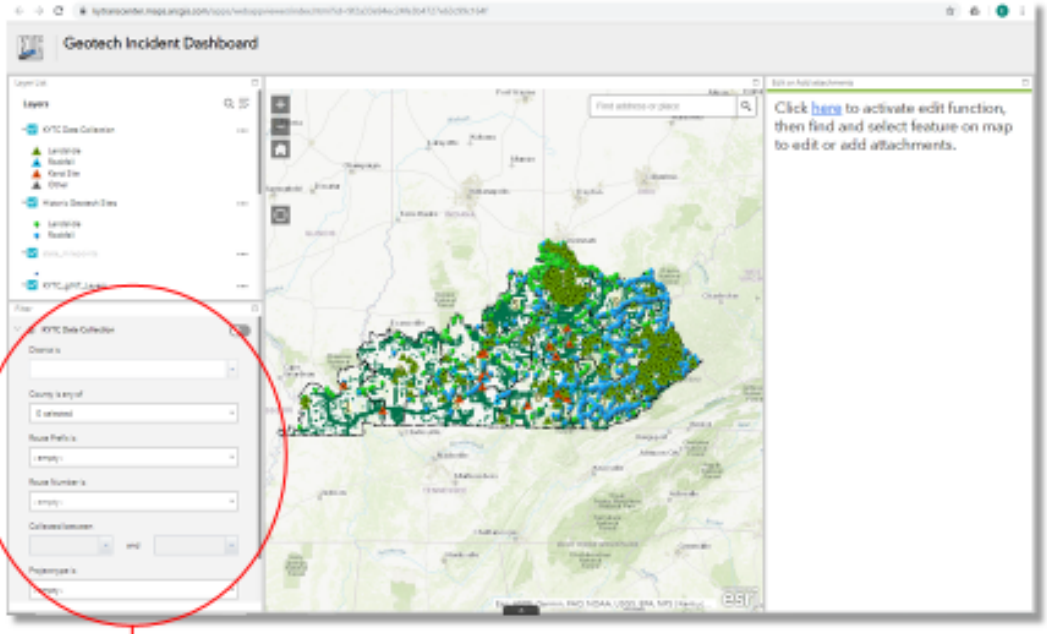
1. Click a Historic Geotech Site to view its attributes, and follow the "More info" link to view the project report (PDF).

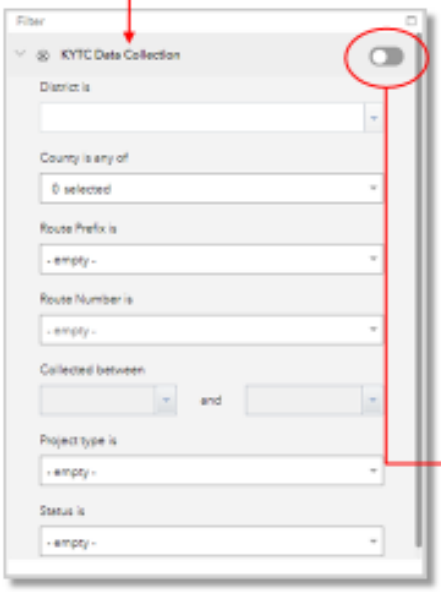


IV. Using the Online Web Viewer

D. Filter features to show on the map

A filter function is included in the web viewer to help locate specific features.





Filter features shown on the map by any combination of the following:

- District
- County (or multiple counties)
- Route (choose route prefix and route number)
- Date range
- Project type (landslide, rockfall, or karst)
- Status (active or repaired)

Hit the radio button in the upper right-hand corner to apply filter. The button turns green when the filter is applied, and the map updates to show only the features that match the filter(s) chosen.

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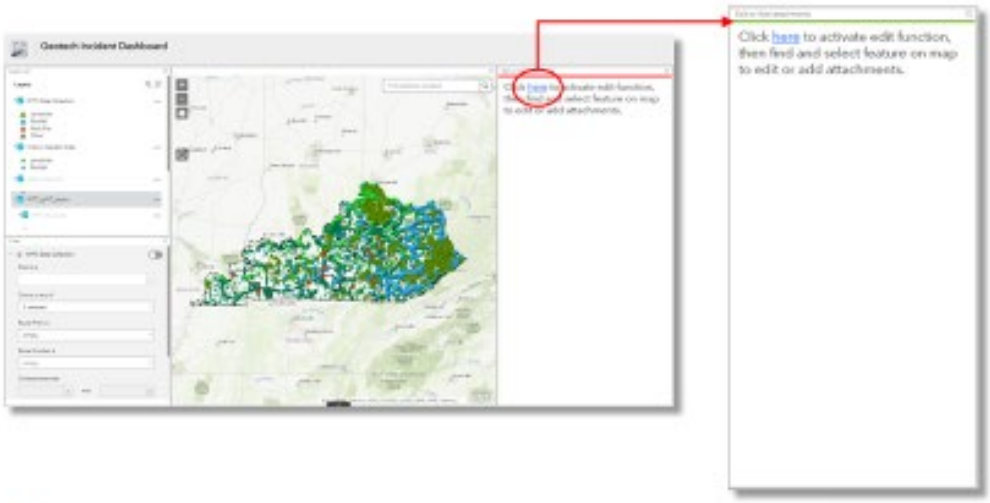
IV. Using the Online Web Viewer

E. Edit features or add attachments

The online web viewer has an edit function to update features or add attachments (repair estimates, KYTC Geotech reports, etc.).

1. First click to activate edit function. Edit function is active when the bar turns green.



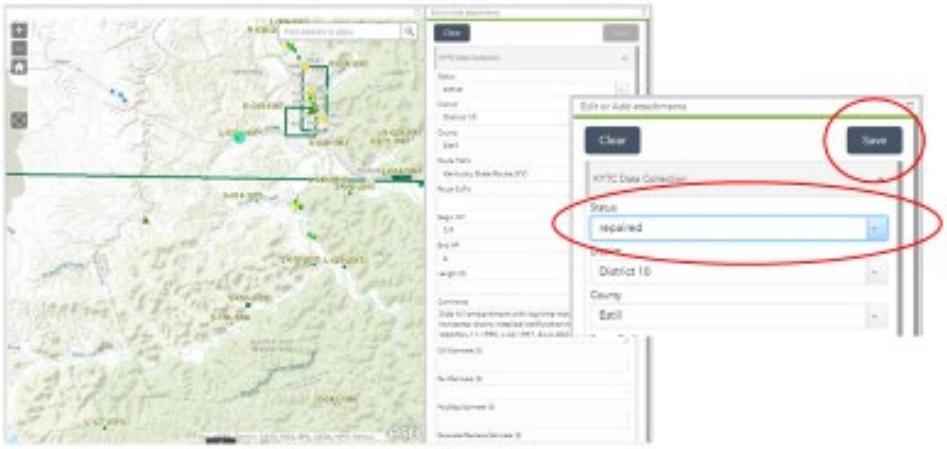
2. Select a feature on the map to start editing. You can update attributes, such as inputting any repair estimates, or correcting mistakes made while collecting data in the field. If you find any related KYTC Geotech project areas or historic observations, this is where you input those report links. You can also add attachments to each feature (e.g. repair quotes or memorandums from the Geotech Branch).

Page 13

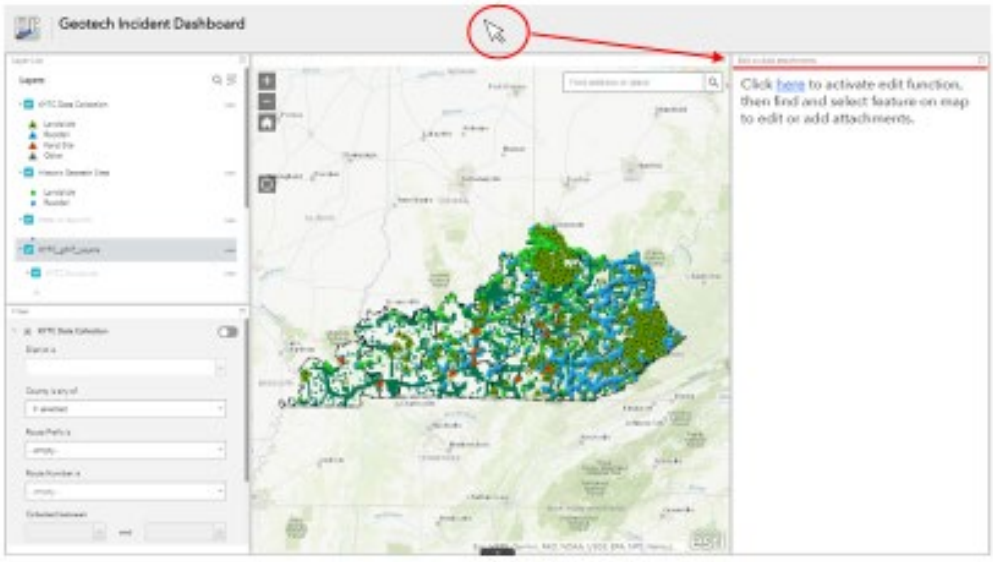
IV. Using the Online Web Viewer

E. Edit feature or add attachments

1. First click to activate edit function. Edit function is active when the bar turns green.
2. Select a feature on the map to start editing. You can update attributes, such as inputting any repair estimates, or correcting mistakes made while collecting data in the field. You can also add attachments to each feature.
3. Be sure to change the status of the site to "repaired" if final repairs have been made, and click "Save" to save your changes.



4. To de-activate edit function, click anywhere in the title bar until the bar in the edit window turns red.



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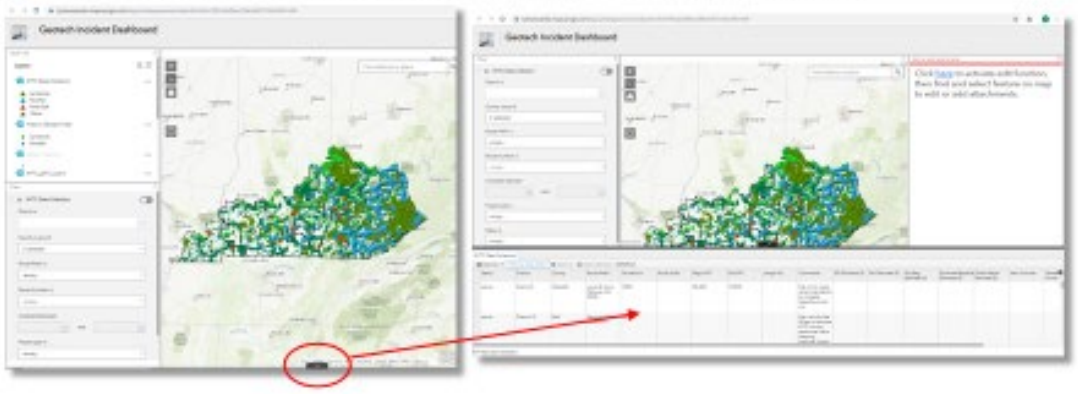
IV. Using the Online Web Viewer

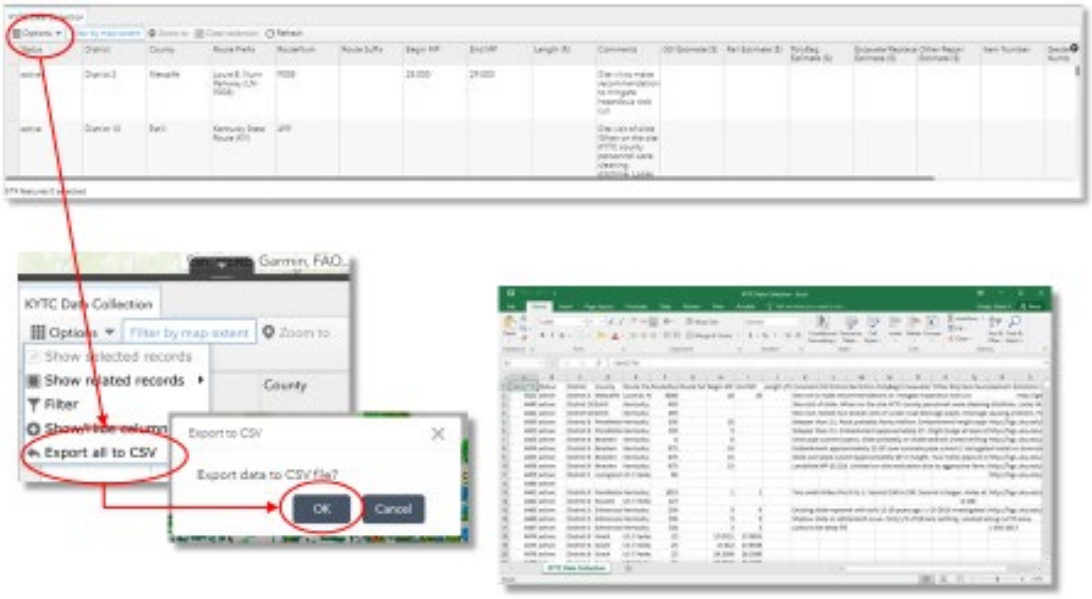
F. Export feature data using the attribute table

The attribute table is filtered by the map extent—only the features visible on the map will appear in the attribute table.

1. Click the up arrow tab at the bottom of the map to expand attribute table.



2. Once you have only the features you wish to export visible on the map, click "Options", then "Export all to CSV", then "OK." The exported data will open in Excel.

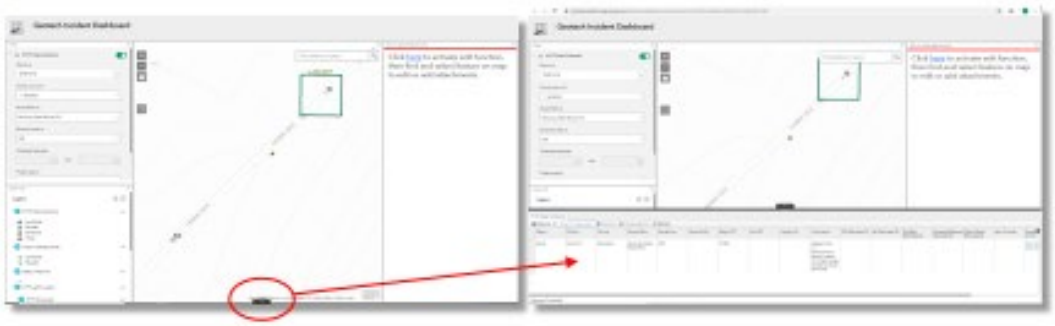


Page 15

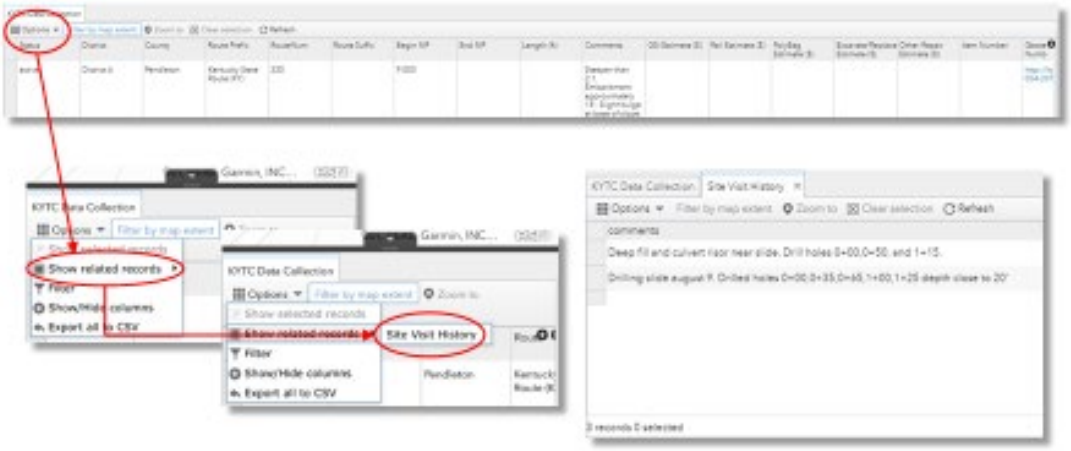
IV. Using the Online Web Viewer

G. Export site visit history using the attribute table

1. To export site visit history for an individual site, either filter or zoom to the site so it is the only visible site on the map. Click the up arrow tab at the bottom of the map to expand attribute table.



2. Once you are sure that only the individual site is visible in the attribute table, click "Options", then "Show related records", then "Site Visit History." The site visit history will open in a new tab.



3. Once the site visit history tab opens, click "Options", then "Export all the CSV", then "OK." The site visit history will open in Excel.

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Appendix E Rockfall Hazard Rating System, ArcGIS Field Maps and Survey123, KYTC User Manual, Version for Geotechnical Branch

January 2022

Rockfall Hazard Rating System

ArcGIS Field Maps and Survey123

KYTC User Manual

Version for Geotechnical Branch, January 2022

KTC KENTUCKY TRANSPORTATION CENTER

Kentucky Geological Survey

Rockfall Hazard Rating System, ArcGIS Field Maps and Survey123 – Operator Manual for KYTC users

Overview:
This manual is for users of the ArcGIS Field Maps and Survey123 applications for collecting rockfall locations and assigning hazard ratings to rockfalls. The ArcGIS Field Maps and Survey123 applications are available for iOS, Android, and Microsoft devices. This manual is directed at users using an iPad iOS (Apple) device. The workflow begins in Field Maps to log rockfall locations, then connects to Survey123 to manage hazard rating inspections for the rockfall location.

Application Purpose:
This ArcGIS Field Maps application will provide a means for KYTC users to collect point-based rockfall locations and photos using an iPad. ArcGIS Survey123 will then be used to assign a rating to each rockfall.

Contact:
Contact Charlie Sun (charlie.sun@uky.edu or 859-257-7330) at the Kentucky Transportation Center for technical assistance with the Rockfall Hazard Rating System.

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I. First Use

A. Accept invitation to join the Geotech Data Collection Group

Before you begin using the Rockfall Hazard Rating System, you must first join the AGOL Group under the KTC Organization. You will receive an invitation to join the group.

1. Navigate to kytc.maps.arcgis.com and login using your KYTC credentials.

2. Once logged in you should see a notification icon in the top ribbon. Click the icon to expand your notifications, then click "View your invitations", then select "Join this group."

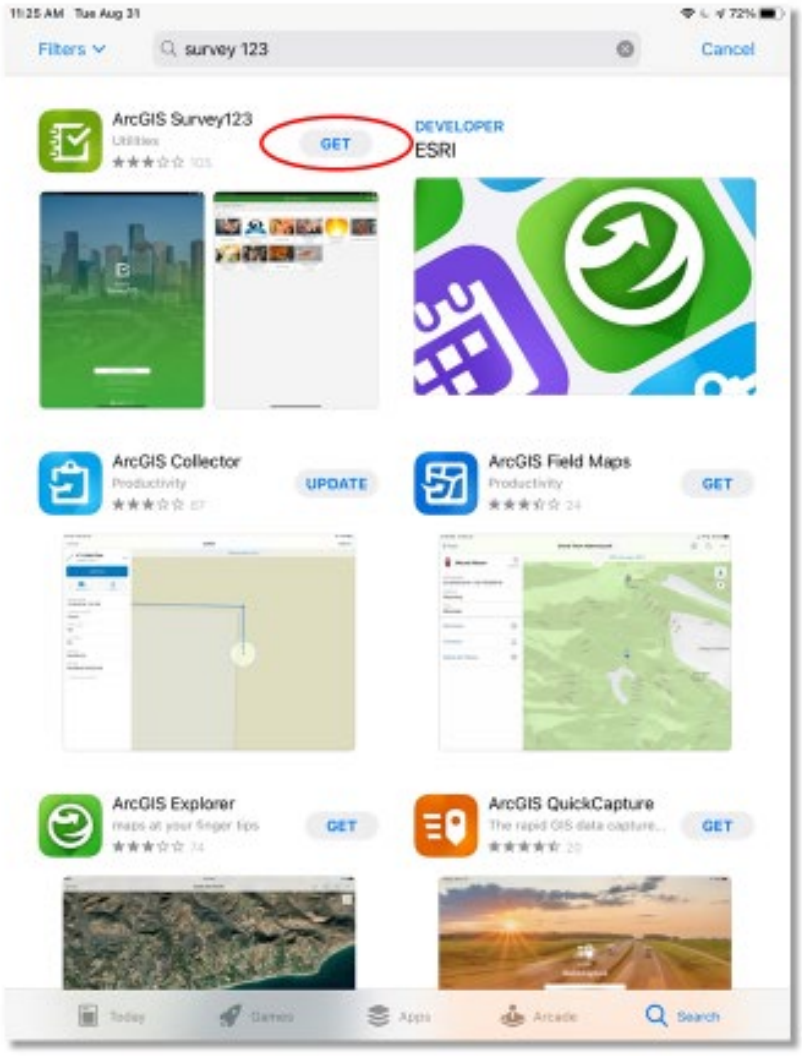
3. You are now a member of KTC's Geotech Collection Group and will be able to access the Geotech Collection map in the Collector app on your mobile device.

Page 1

I. First Use

B. Download ArcGIS Survey123

Use device App store (e.g. iOS = "App Store") to find and download the "ArcGIS Survey123" Application.

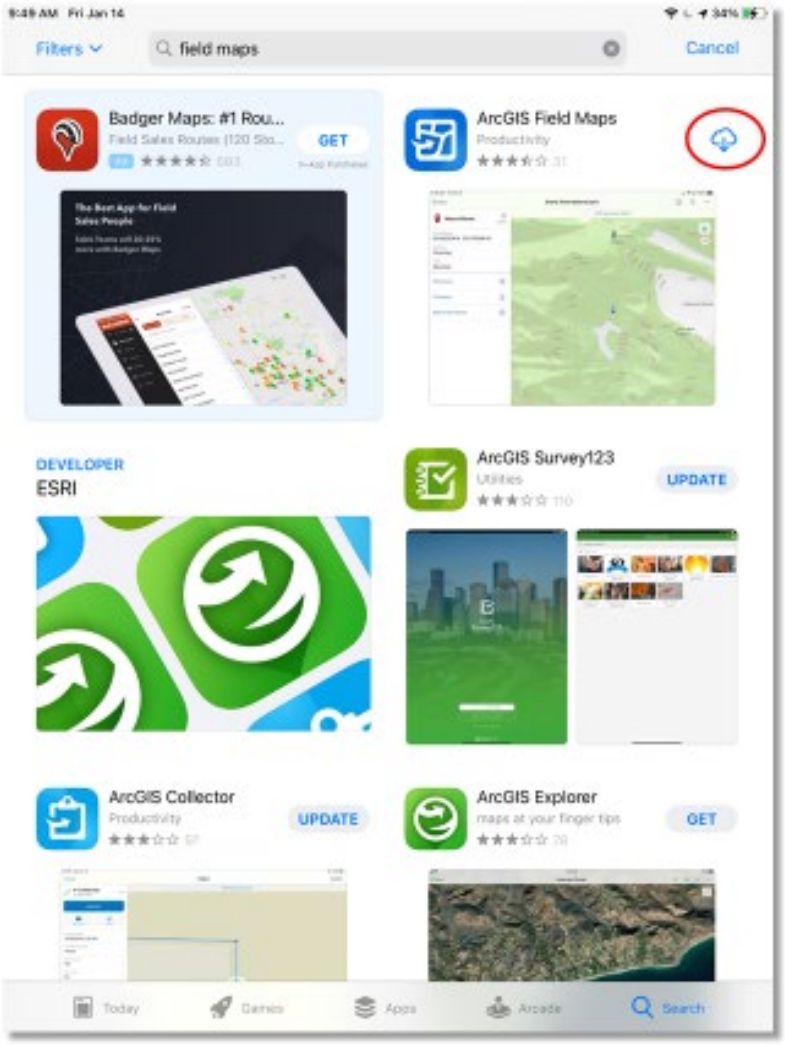


Page 2

I. First Use

C. Download ArcGIS Field Maps

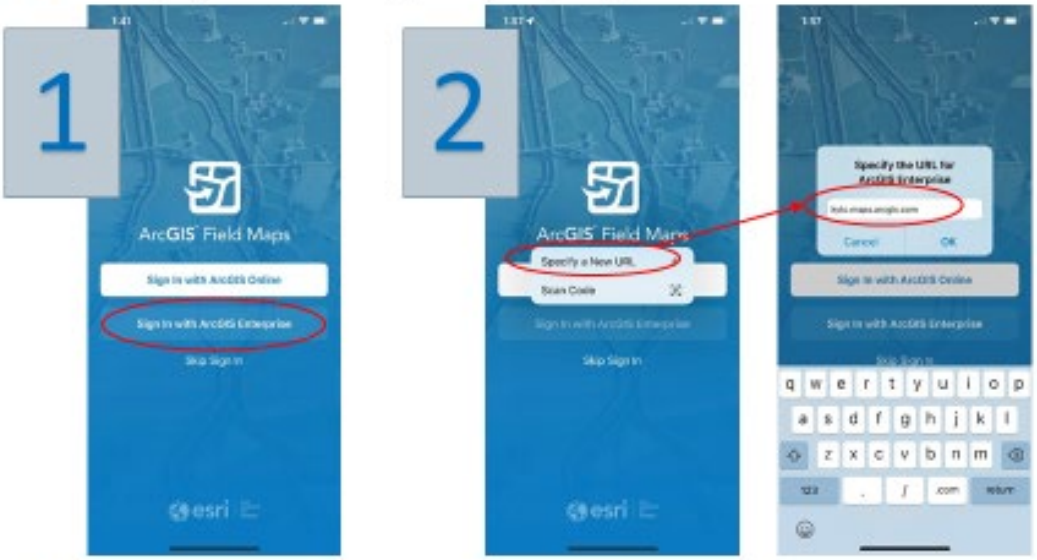
Use device App store (e.g. iOS = "App Store", Android = "Google Play") to find and download the "ArcGIS Field Maps" Application.



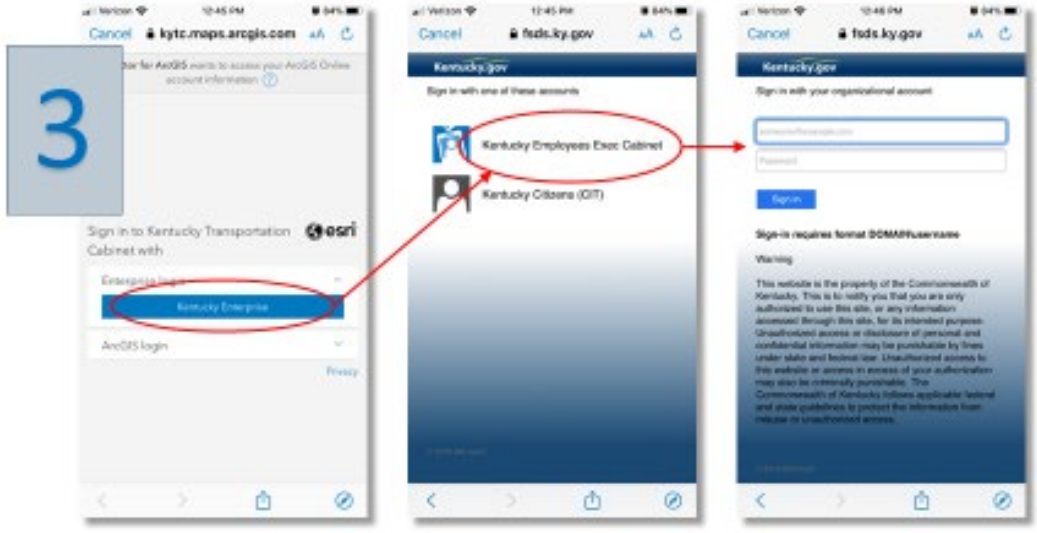
I. First Use

D. Open and login to ArcGIS Field Maps

1. Open Field Maps to see opening screen—select "ArcGIS Enterprise."
2. Select "Specify a New URL" then type in "kytc.maps.arcgis.com" and then click "OK."



3. Login to ArcGIS Field Maps using your KYTC credentials.

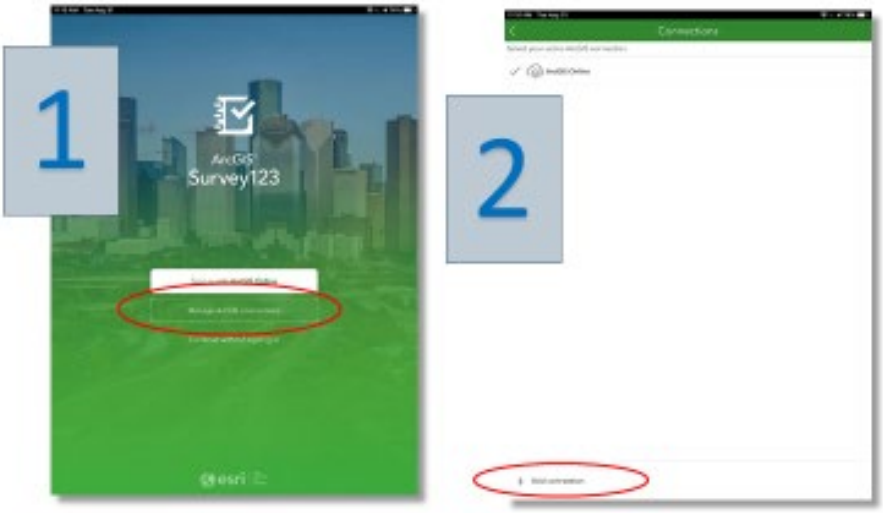


Page 4

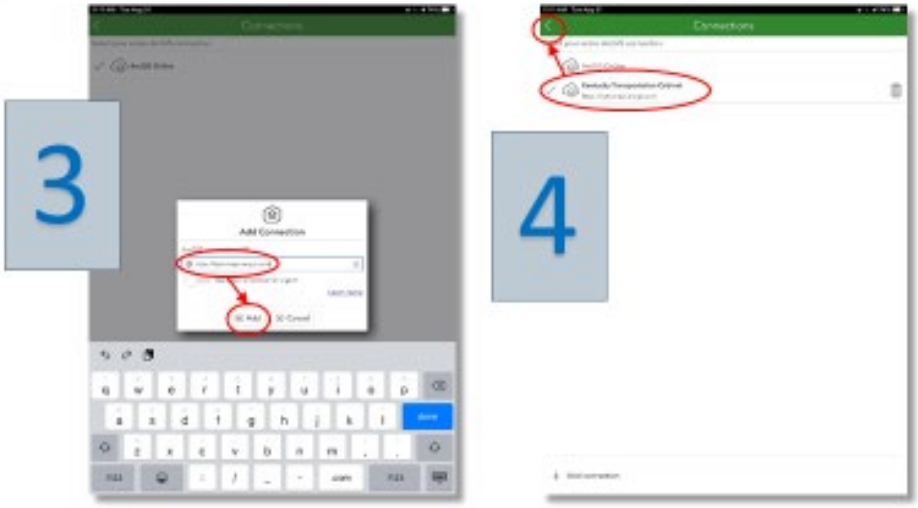
I. First Use

E. Open and login to Survey123

1. Open Survey123 to see opening screen—select "Manage ArcGIS connections."
2. Select "+ Add connection" at bottom of screen.



3. Type "kytc.maps.arcgis.com" into the ArcGIS Connection URL then select "+ Add".
4. Make sure the "Kentucky Transportation Cabinet" is checked, then hit the " < " button.



Page 5

I. First Use

E. Open and login to Survey123

1. Open Survey123 to see opening screen—select "Manage ArcGIS connections."
2. Select "+ Add connection" at bottom of screen.
3. Type "kytc.maps.arcgis.com" into the ArcGIS Connection URL then select "+ Add".
4. Make sure the "Kentucky Transportation Cabinet" is checked, then hit the " < " button.
5. Select "Sign in with Kentucky Transportation Cabinet" and log in with your KYTC credentials.

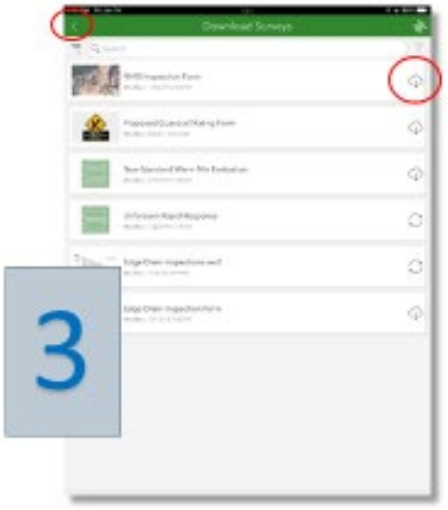
Page 6

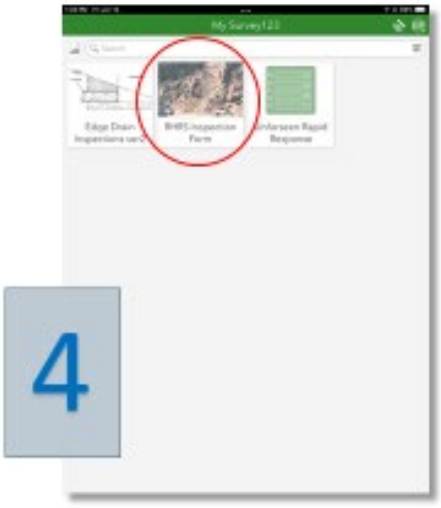
II. Download the RHRS Survey

Survey123 may be used offline but you must download the correct survey to your device before going out into the field.

1. Once you open the app and have logged in, select the icon in the upper right-hand corner with your initials on it.
2. Select "Download Surveys."

3. Select the ☁ icon next to the survey called "RHRS Inspection Form" to download to device. Then select the "<" button to go back to the main menu.
4. Once back on the main menu, you should now see the survey available.





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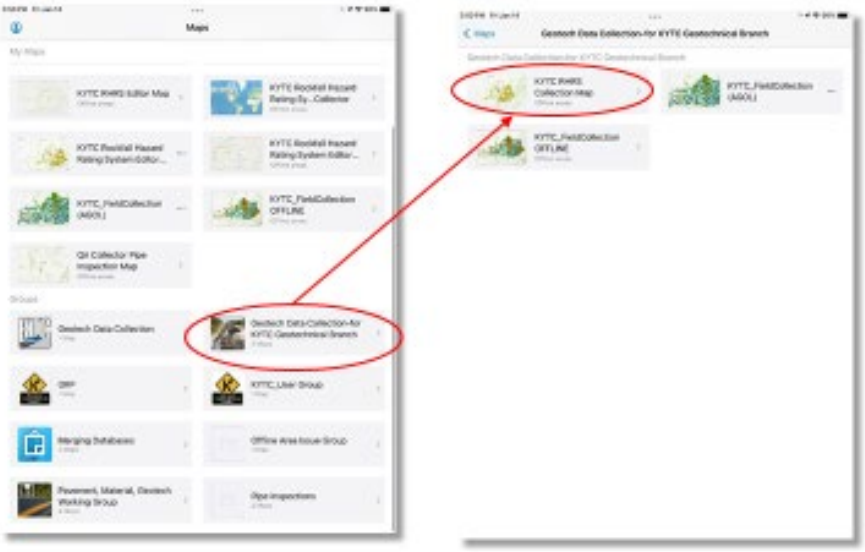
III. Accessing the Map in Field Maps

A. Find group and open map

Select the group "Geotech Data Collection-for KYTC Geotechnical Branch," then select the "KYTC RHRS Collection Map." This map has been designed to only work offline as it is more reliable when operating in areas without cell service. You must download an offline area before collecting data.



B. Manage offline area

1. Offline maps for each district have been prepackaged for download. You may download multiple offline maps to your device. A screen showing offline areas available for download will appear once you select "KYTC RHRS Collection Map." Choose a district and download the area to your device.
2. This area will stay on your device, but always be sure to sync the area in the office before going in the field for data collection. This ensures that the offline area contains the most recent data available.

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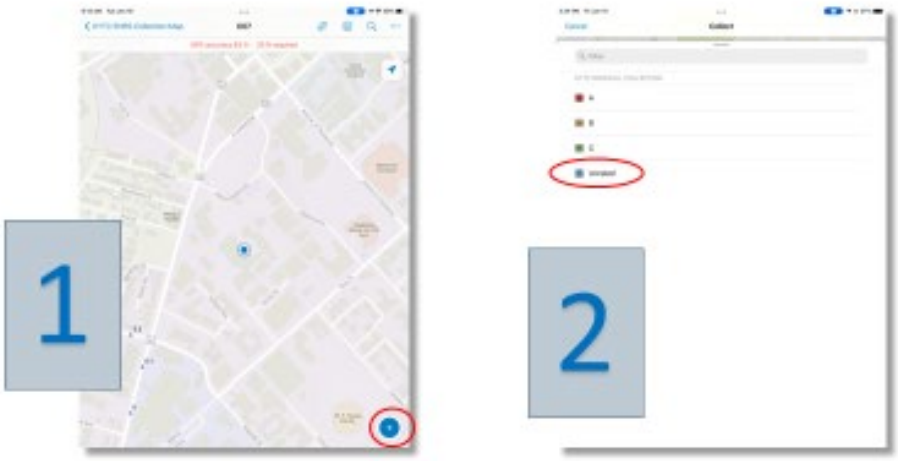
IV. Initial Feature Collection in Field Maps

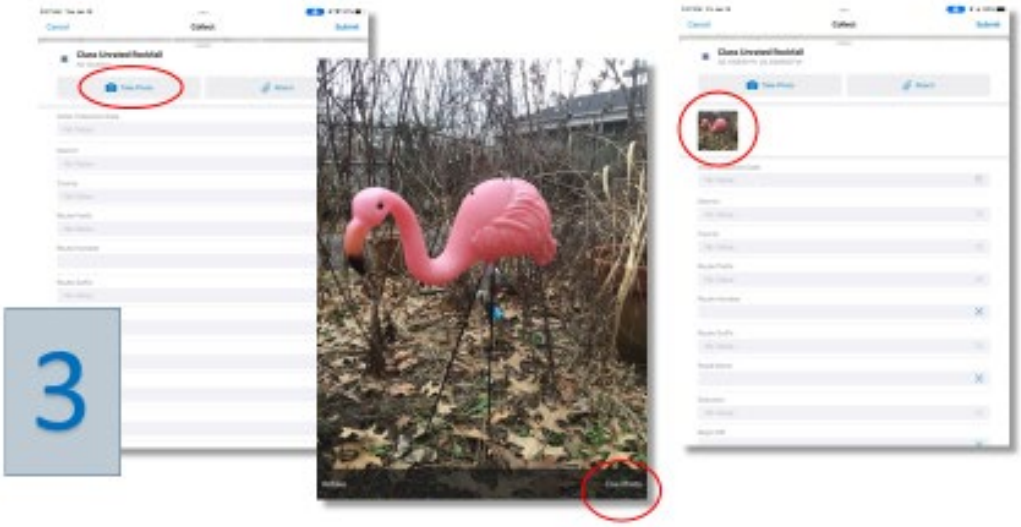
A. Collect a new feature

1. Once the map is opened, click the "+" icon in the bottom right corner to collect at your current location (the blue dot).

2. Rockfalls are symbolized according to their preliminary rating (A, B, or C). Select the blue square—"Unrated" when collecting a new rockfall as it has not been rated yet. (The data collection window can be pulled up to maximize screen space.)



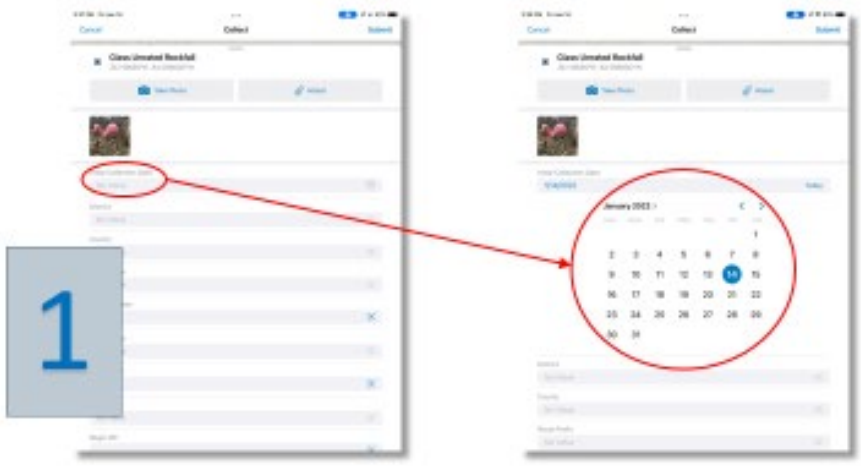
3. Take a photo of the rockfall. Click "Take Photo" to open the camera. You may need to give the app permission to access your camera. Then click "Use Photo" to accept the photo. You may take as many photos as necessary. Photos will appear in the data collection screen as you take them.



IV. Initial Feature Collection in Field Maps

B. Enter attributes for new feature

1. Click in the "Initial Collection Date" field to open the date picker. The picker should automatically choose today's date.



2. Enter data into the fields as shown below. Pull data collection screen down and zoom into map to view milepoints for Begin MP and End MP entry. Begin MP, End MP, Speed Limit, and ADT fields are required fields for calculating the rockfall hazard in next steps.

- Initial Collection Date: today's date
- District: text—selection
- County: text—selection
- Route Prefix: text—selection
- Route Number: integer—free entry
- Route Suffix: text—free entry
- Road Name: text—free entry
- Direction: text—selection
- Begin MP: decimal—free entry
- End MP: decimal—free entry
- Speed Limit: integer—selection
- ADT: integer—free entry
- Current Preliminary Rating: text—selection (leave Unrated for now)
- Current Total Score: integer—free entry (leave blank for now)
- Comments: text—free entry

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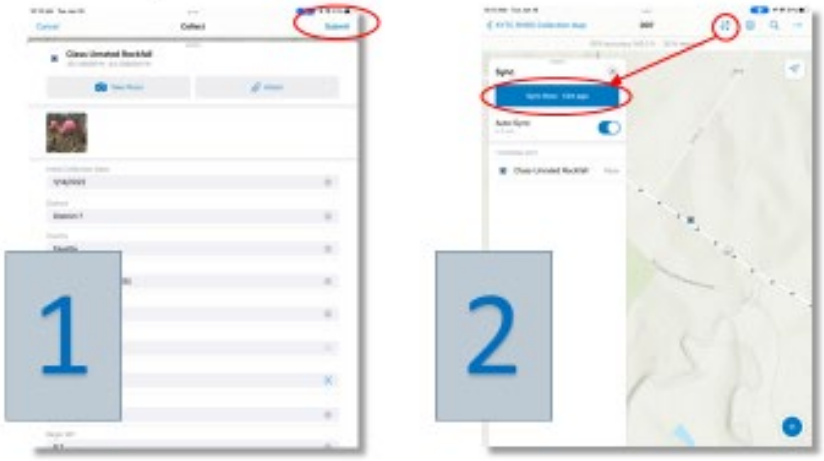
IV. Initial Feature Collection in Field Maps

C. Submit and sync newly collected feature

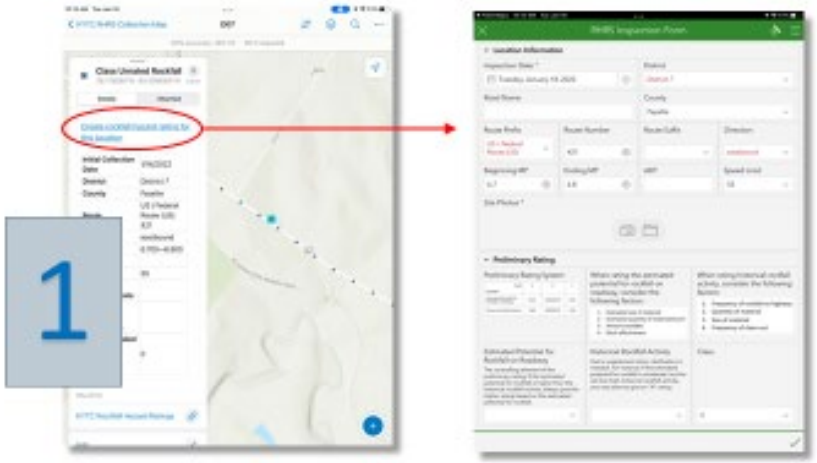
1. Click "Submit" when you have collected the point location of the rockfall, taken at least one picture, and entered attributes.

2. The data is stored locally on the device, and you must sync the data when you have a connection. Click the ↕ icon, and then click "Sync." If you enable "Auto-Sync", your device will attempt to sync the data every 15 minutes as long as the device has a data connection.



D. Follow link to open RHRS Inspection Form in Survey 123 App

1. After submitting and syncing the newly collected rockfall, click on the rockfall to open its popup window. Click on the "Create rockfall hazard rating for this location" link. The RHRS Inspection form will open in the Survey 123 field app (assuming you have already downloaded to your device, see page 7). This creates a new related record for this location and auto-populates some of the fields you entered when collecting the new feature in Field Maps.



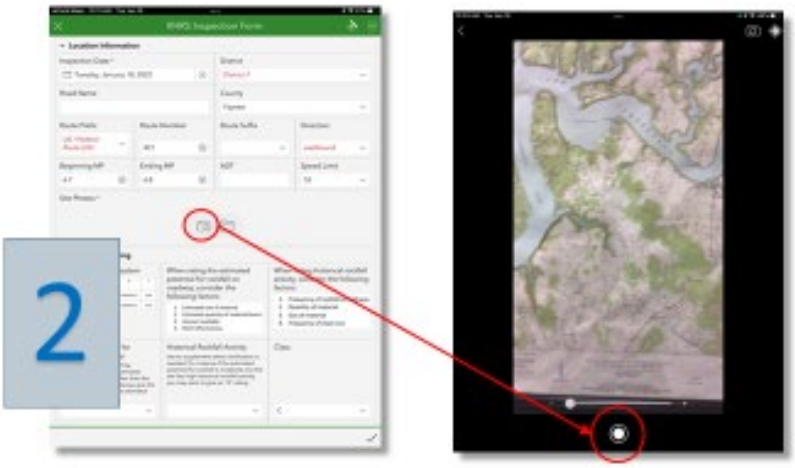
V. Rockfall Hazard Rating in Survey123

A. Group rockfall based on preliminary rating

1. Basic location information will transfer over from the rockfall location collected in Field Maps. You must enter the correct beginning and ending milepoints, ADT, and speed limit for the hazard rating to calculate correctly.

- Inspection Date: auto-populates with today's date
- District: text—selection
- Road Name: text—free entry
- County: text—selection
- Route Prefix: text—selection
- Route Number: integer—free entry
- Route Suffix: text—free entry
- Direction: text—selection
- Beginning MP: decimal—free entry
- Ending MP: decimal—free entry
- ADT: integer—free entry
- Speed Limit: integer—selection

2. Take a photo of the rockfall. Click the camera icon under "Site Photos" to open the camera. You may need to give the app permission to access the camera. Take as many photos as you need.



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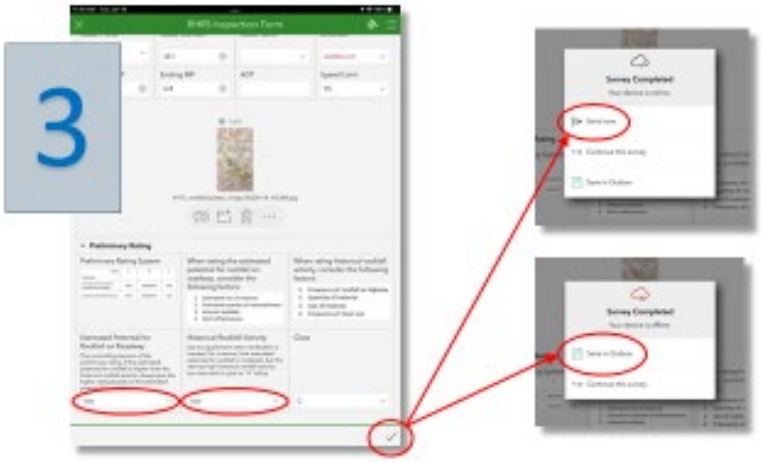
V. Rockfall Hazard Rating in Survey123

A. Group rockfall based on preliminary rating

1. Basic location information will transfer over from the rockfall location collected in Field Maps. You must enter the correct beginning and ending milepoints, ADT, and speed limit for the hazard rating to calculate correctly.

2. Take a photo of the rockfall. Click the camera icon under "Site Photos" to open the camera. You may need to give the app permission to access the camera. Take as many photos as you need.

3. Using the references provided on the form rate both the "Estimated Potential for Rockfall on Roadway" and "Historical Rockfall Activity" as either high, moderate, or low. Based on your answers, the form will calculate the preliminary class rating as either A, B, or C. If the rockfall is rated as a "C", then no further action is required. Click the check at the bottom of the screen, then select, "Send now" if device is online, or "Save in Outbox" if device is offline.



4. If the rockfall is rated as either an "A" or "B", the detailed rating form will appear for you to fill out. Follow instructions on following page for entering the detailed rating.

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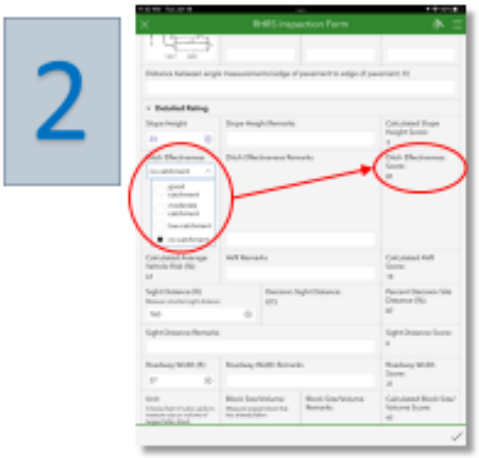
V. Rockfall Hazard Rating in Survey123

B. Complete detailed hazard rating for rockfall site with preliminary class rating of "A" or "B."

1. **Slope Height Category**: Enter slope height measurement values to calculate the slope height, or manually enter the slope height value. The slope height score will automatically calculate after the slope height value field is populated. Enter any comments into the slope height remarks field.

2. **Ditch Effectiveness Category**: The effectiveness of a ditch is measured by its ability to restrict falling rock from reaching the roadway. The rater should consider the following factors: (1) slope height and angle; (2) ditch width, depth, and shape; (3) anticipated volume of rockfall per event; and (4) impact of slope irregularities on falling rocks. The ditch effectiveness score will automatically calculate once the ditch effectiveness category is chosen.



3 points	Good Catchment	All or nearly all falling rocks are retained in the catch ditch.
9 points	Moderate Catchment	Falling rocks occasionally reach the roadway.
27 points	Low Catchment	Falling rocks frequently reach the roadway.
81 points	No Catchment	No ditch, or ditch is totally ineffective. All or nearly all falling rocks reach the road.

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V. Rockfall Hazard Rating in Survey123

B. Complete detailed hazard rating for rockfall site with preliminary class rating of "A" or "B."

3. **Average Vehicle Risk (AVR) Category**: Evaluates the risk associated with the percentage of time a vehicle is present in the rockfall section. The percentage is calculated based on slope length, average daily traffic (ADT) and the posted speed limit which were entered previously in this form. The AVR score also calculates automatically.

4. **Percent of Decision Sight Distance Category**: this category compares the amount of sight distance available through a rockfall section to the low design amount prescribed by AASHTO. Sight distance is the shortest distance that a six-inch object is continuously visible to a driver along a roadway. Decision sight distance (DSD) is the length of roadway, in feet, required by a driver to perceive a problem and bring a vehicle to a stop. Enter the shortest sight distance, and the DSD, Percent DSD, and Sight Distance score will calculate automatically. This field requires the speed limit is entered to calculate correctly.

Method of Measurement: Drive through the site from both directions to determine where the sight distance is most restricted. Decide which direction has the shortest line of sight. Both horizontal and vertical sight distance should be evaluated. Normally an object will be most obscured when it is located just beyond the sharpest part of the curve. Place a six-inch object in that position on the fogline or on edge of pavement if there is no fogline. Then walk along the fogline (edge of pavement) in the opposite direction to traffic flow, measuring the distance it takes for the object to disappear at an eye height of 3.5 ft above the road surface. A roller tape is helpful for making this measurement.

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V. Rockfall Hazard Rating in Survey123

B. Complete detailed hazard rating for rockfall site with preliminary class rating of "A" or "B."

5. **Roadway Width Category**: Roadway width is measure perpendicular to the highway. The minimum width throughout the rockfall section is used when the roadway width is not constant. The unpaved shoulder adjacent to the roadway is not included in the measurement. Enter the roadway width in feet to automatically calculate the roadway width score.

6. **Block Size or Volume of Rockfall per Event Category**: In some rockfall events, the failure is comprised of an individual block. In other cases, the event may include many blocks of differing sizes. This measurement should be representative of the type of rockfall even most likely to occur. If individual blocks are typical of the rockfall, block size should be used for scoring. If a mass of blocks tends to be the dominant type of rockfall, volume per event should be used. A decision on which to use can be determined from the maintenance history, or estimated from observed conditions when no history is available.

First choose feet or cubic yards as the unit, then enter the block size or volume accordingly. The block size/volume score will then calculate automatically.

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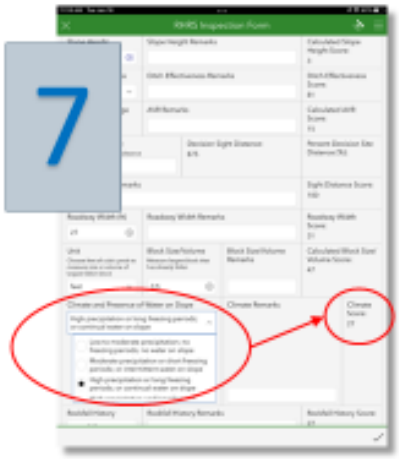
V. Rockfall Hazard Rating in Survey 123

B. Complete detailed hazard rating for rockfall site with preliminary class rating of "A" or "B."

7. **Climate and Presence of Water on Slope Category**: This category evaluated the amount of precipitation and duration of freezing periods, because there are measurable quantities that are directly related to features that cause rockfalls. In addition, water flowing on a slope promotes erosion and thus is also considered in this category. Kentucky climate falls into the 27-point category. Both the category selection and score will automatically populate appropriately.



3 points	Low to moderate precipitation; no freezing periods; no water on slope
9 points	Moderate precipitation or short freezing periods; or intermittent water on slope
27 points	High precipitation *or* long freezing periods; or continual water on slope
81 points	High precipitation *and* long freezing periods; or continual water on slope *and* long freezing periods.

8. **Rockfall History Category**: This category rates the historical rockfall activity at a site as an indicator of future rockfall events. This information is best obtained from the maintenance person responsible for the slope. The rockfall history score will automatically calculate after selecting the appropriate category selection.

3 points	Few Falls	Rockfalls occur only a few times a year (or less), or only during severe storms. This category is also used if no rockfall history data is available.
9 points	Occasional Falls	Rockfall occurs regularly. Rockfall can be expected several times per year and during most storms.
27 points	Moderate Falls	This category is for sites where frequent rockfalls occur during a certain season (winter or spring wet period or winter freeze/thaw) but are not a significant problem during the rest of the year. This category may also be used where severe rockfall event have occurred.
81 points	Constant Falls	Rockfalls occur frequently throughout the year. This category is also for sites where severe rockfall events are common.

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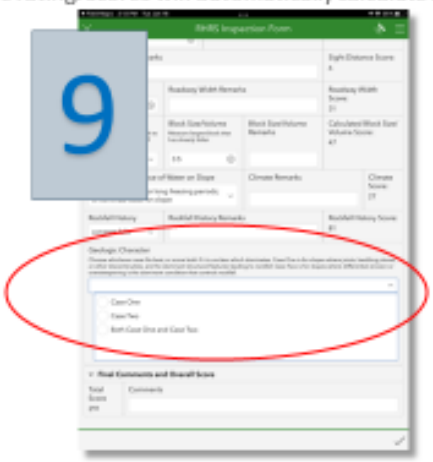
V. Rockfall Hazard Rating in Survey123

B. Complete detailed hazard rating for rockfall site with preliminary class rating of "A" or "B."

9. **Geologic Character**: The geologic conditions of the rockfall sections are evaluated with these categories. Since the conditions that cause rockfall generally fit into 2 categories, Case One and Case Two rating criteria have been developed. Whichever case best fits the slope should be used for the rating. Scores will automatically calculate after selections are chosen.



- Choose "Case One" for slopes where joints, bedding planes, or other discontinuities, are the dominant structural features that lead to rockfall.
- Choose "Case Two" for slopes where differential erosion or oversteepening is the dominant condition that controls rockfall.
- If both situations are present, and it is unclear which dominates, choose "Both Case One and Case Two", and score both sections, and only the highest score will figure into the final total hazard score.

i. **Case One, Structural Condition Category:** Rockfall from Case One slopes occurs as a result of movement along discontinuities. The word "joint" as applied here, represents all possible types of discontinuities, including bedding planes, foliations, fractures, and faults. The term "continuous" refers to joints that are greater than 10 feet in length. The term "adverse" applies not only to the joints spatial relationship to the slope, but also to such things as rock friction angle, joint filling and the effects of water, if present.

3 points	Discontinuous Joints, Favorable Orientation	Slope contains jointed rock with no adversely oriented joints.
9 points	Discontinuous Joints, Random Orientation	Slope contains randomly oriented joints creating a variable pattern. The slope is likely to have some scattered blocks with adversely oriented joints, but no dominant adverse pattern is present.
27 points	Discontinuous Joints, Adverse Orientation	Rock slope exhibits a prominent joint pattern with an adverse orientation. These features have less than 10 feet of continuous length.
81 points	Continuous Joints, Adverse Orientation	Rock slope exhibits a dominant joint pattern with an adverse orientation and a length of greater than 10 feet.

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V. Rockfall Hazard Rating in Survey123

B. Complete detailed hazard rating for rockfall site with preliminary class rating of "A" or "B."

9. **Geologic Character**: The geologic conditions of the rockfall sections are evaluated with these categories. Since the conditions that cause rockfall generally fit into 2 categories, Case One and Case Two rating criteria have been developed. Whichever case best fits the slope should be used for the rating.

   ii. **Case One, Rock Friction Category:** The potential for rockfall by movement along discontinuities is controlled by the condition of the joints. The condition of the joints is described in terms of micro and macro roughness. Rate the roughness based on the criteria below:

3 points	Rough, Irregular	The surface of the joints are rough and the joint planes are irregular enough to cause interlocking.
9 points	Undulating	Macro rough but without the interlocking ability.
27 points	Planar	Macro smooth and micro rough joint surfaces. Friction is derived strictly from the roughness of the rock surface.
81 points	Clay infilling, or slickensided	Low friction materials separate the rock surfaces, negating any micro or macro roughness of the joint surfaces. Slickensided joints also have a lower friction angle, and belong in this category.

   iii. **Case Two, Structural Condition Category:** This case is used for slopes where differential erosion or oversteepening is the dominant condition that leads to rockfall. Erosion features include oversteepened slopes, unsupported rock units (overhangs), or exposed resistant rocks on a slope, which may eventually least to a rockfall event.

3 points	Few Differential Erosion Features	Minor differential erosion features that are not distributed throughout the slope.
9 points	Occasional Erosion Features	Minor differential erosion features that are widely distributed throughout the slope.
27 points	Many Erosion Features	Differential erosion features that are large and numerous throughout the slope.
81 points	Major Erosion Features	Severe cases such as dangerous erosion-created overhangs, or significantly oversteepened soil/rock slopes or talus slopes.

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V. Rockfall Hazard Rating in Survey123

B. Complete detailed hazard rating for rockfall site with preliminary class rating of "A" or "B."

9. **Geologic Character**: The geologic conditions of the rockfall sections are evaluated with these categories. Since the conditions that cause rockfall generally fit into 2 categories, Case One and Case Two rating criteria have been developed. Whichever case best fits the slope should be used for the rating.

   iv. **Case Two, Difference in Erosion Rates Category:** The materials comprised in a slope can have markedly different characteristics that control how rapidly weathering and erosion occur. The rate of erosion on a Case Two slope directly relates to the potential for a future rockfall event. The degree of hazard caused by erosion and thus the score given this category, should reflect the rate at which erosion is occurring; the size of rocks, blocks, or units being exposed; the frequency of rockfall events; and the amount of material released during an event.

3 points	Small Difference	Erosion features take many years to develop. Slopes that are near equilibrium with their environment are covered by this category.
9 points	Moderate Difference	The difference in erosion rates allows erosion features to develop over a period of a few years.
27 points	Large Difference	The difference in erosion rates allows noticeable changes in the slope to develop annually.
81 points	Extreme Difference	The difference in erosion rates allows rapid and continuous development of erosion features.

10. Final Comments and Overall Score: The overall score will automatically calculate based on all criteria entered by user. Enter any final comments.

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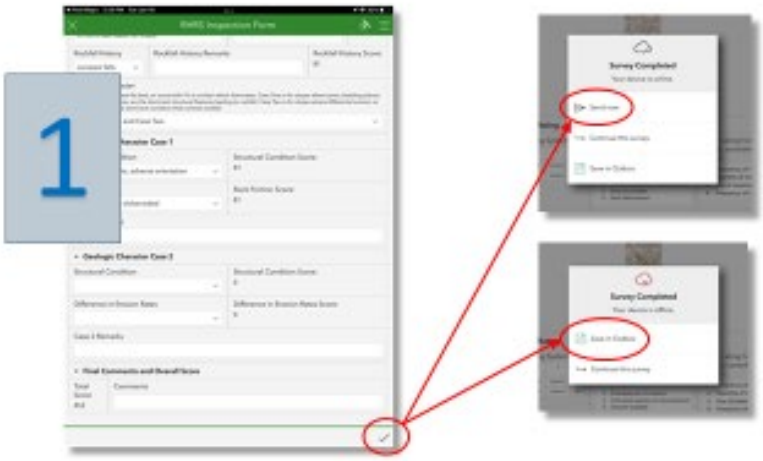
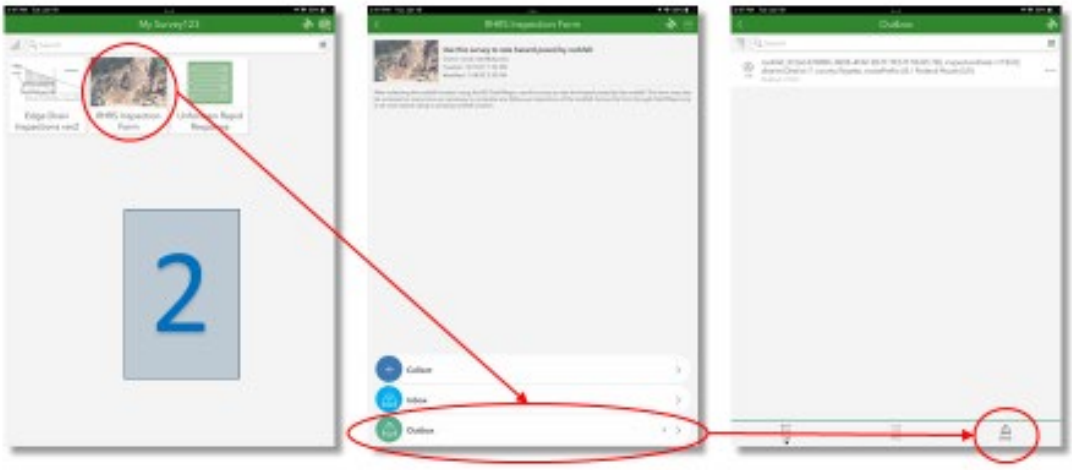
V. Rockfall Hazard Rating in Survey123

C. Submit Survey

1. Once you have completed rating the rockfall hazard, click the checkmark in the bottom right corner of the screen to submit survey response. Select "Send now" if device is online and "Save in Outbox" if device is offline.



2. Send any surveys saved in Outbox when you return to a network connection. From My Survey123 Home Screen, select RHRS Inspection Form. Then select the "Outbox," then click "Send."



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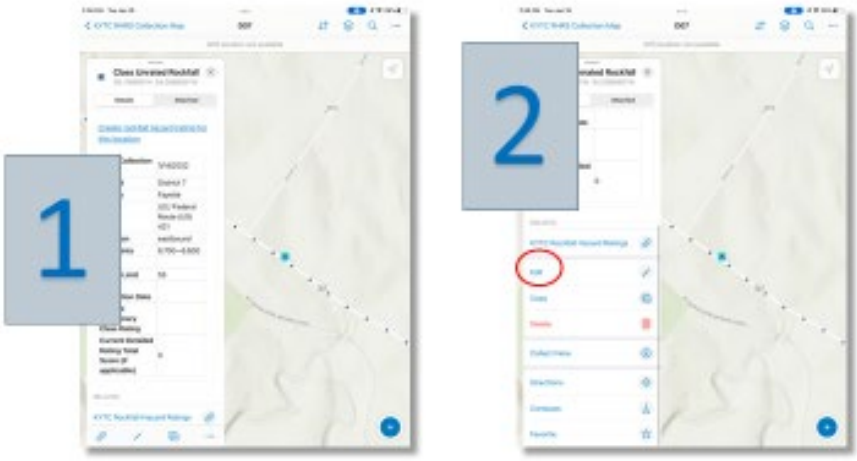
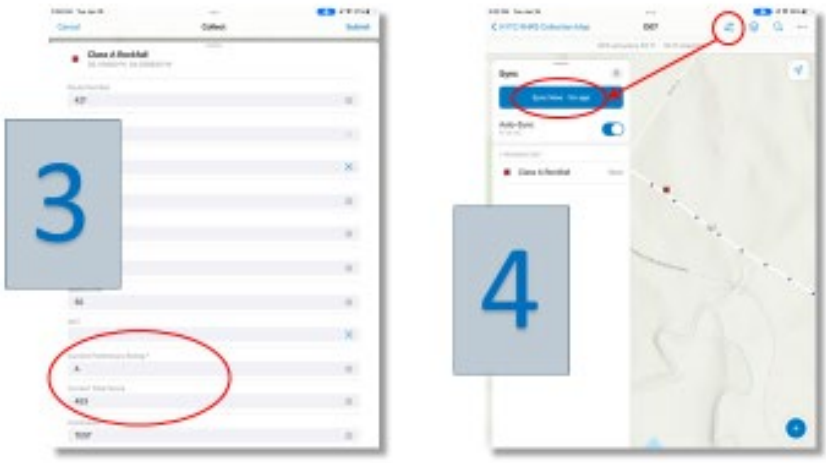
V. Rockfall Hazard Rating in Survey123

D. After rating the rockfall hazard using the RHRS Inspection form, update the current preliminary rating and total hazard score for the rockfall in Field Maps.

1. Open Field Maps, navigate to the rockfall, and click on it to open the feature popup window.
2. Scroll down in the popup window, and click "Edit."



3. Pull up the attribute window to maximize screen space, and update the "Current Preliminary Rating" and "Current Total Score" fields with the values calculated from the RHRS Inspection Form just completed.
4. Then click "Submit," and sync the feature again.



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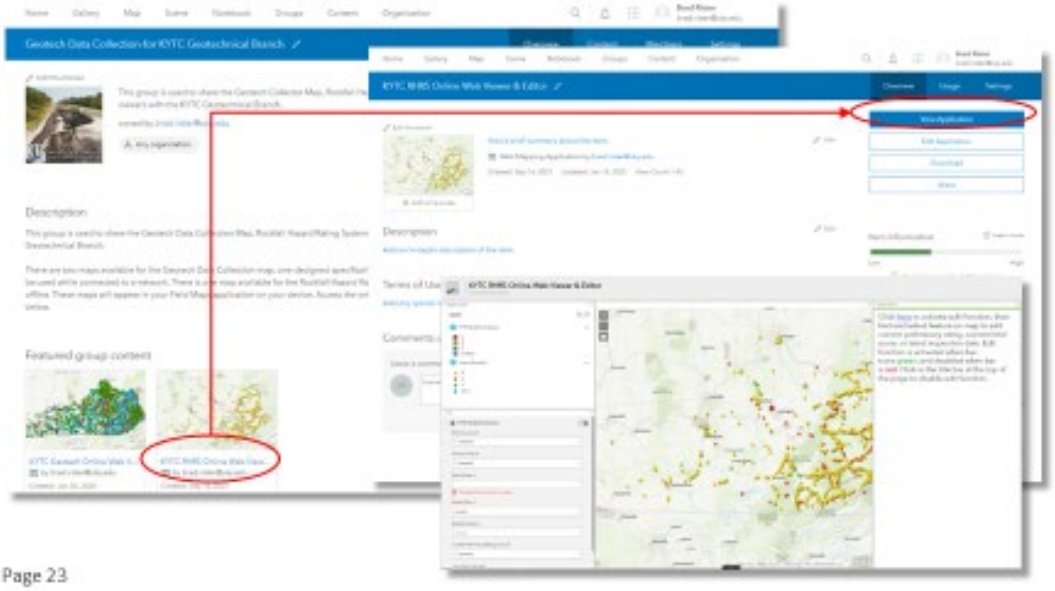
VI. Using the Online Web Viewer

A. How to find the online web viewer

1. Once logged in to AGOL at kytc.maps.arcgis.com using your KYTC enterprise credentials, click on "Groups" in the top ribbon.

2. Select the "Geotech Data Collection-for KYTC Geotechnical Branch" group.

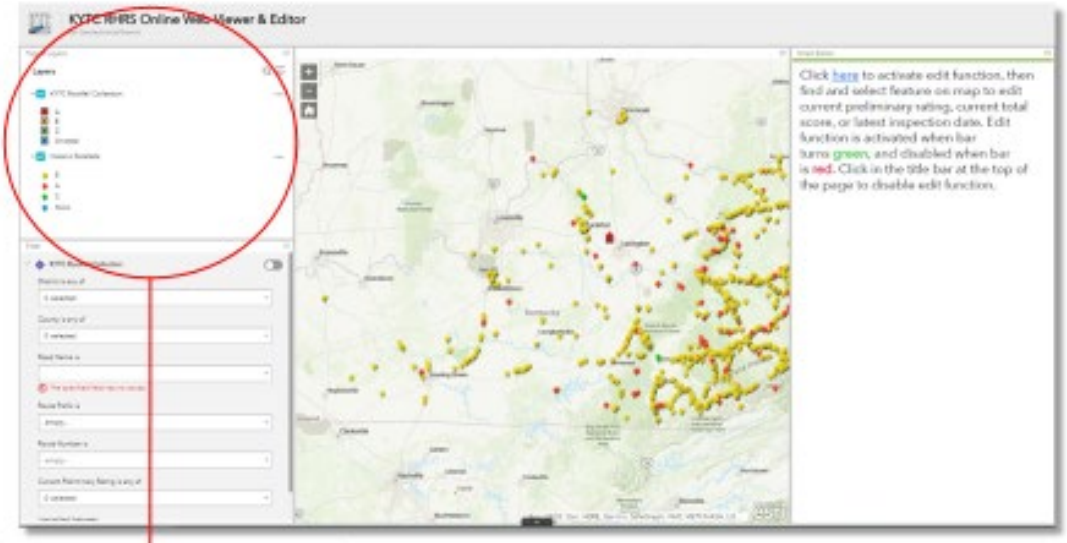
3. Select the "KYTC RHRS Online Web Viewer & Editor" under Featured Group Content. Click "View Application" on the next page, and the web viewer will open.

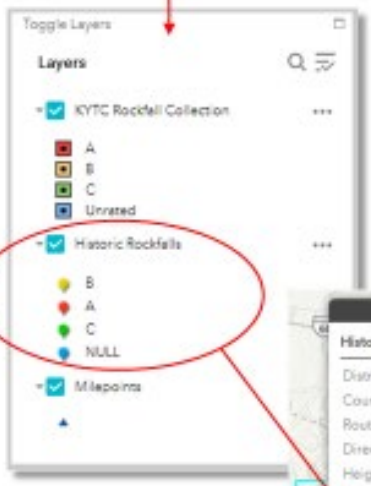


IV. Using the Online Web Viewer

B. Identify features on the map

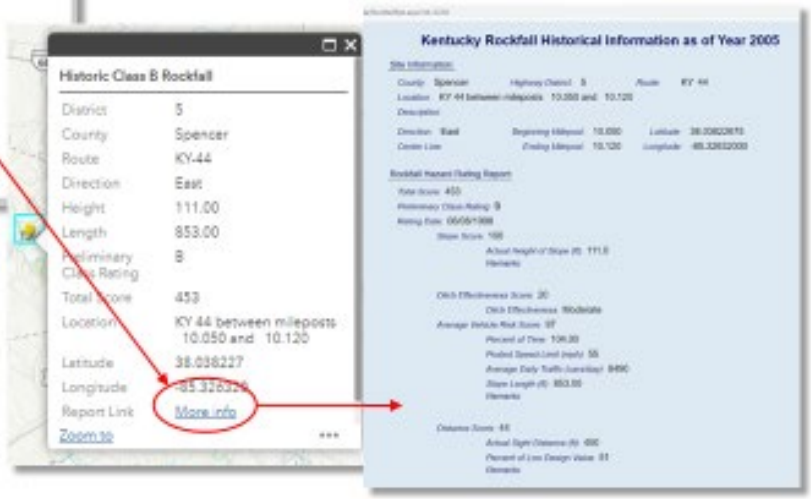
Layers with existing data have been added to the online map, and these, along with collected features, can be identified in the web viewer, along with any supporting data.





Use the layer list to identify features, and toggle layers on and off.

- KYTC Rockfall Collection—rockfalls collected in the field using Field Maps
- Historic Rockfalls—rockfalls collected prior to 2005, used for reference—click any historic rockfall on the map to view attributes, and follow the "More info" link to view the project report (PDF)
- Milepoints—used to help locate features, zoom into map to see visibility and milepoint number



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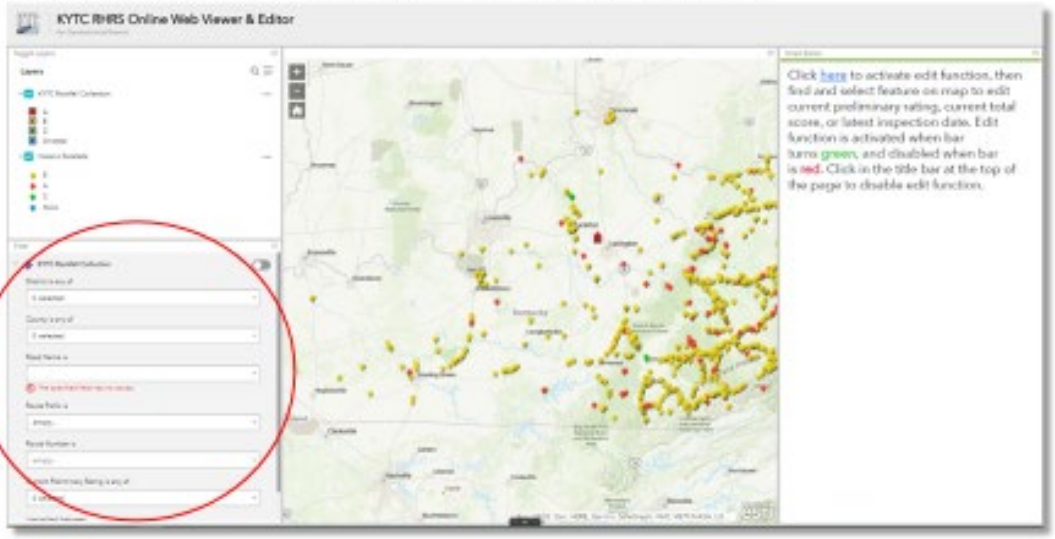
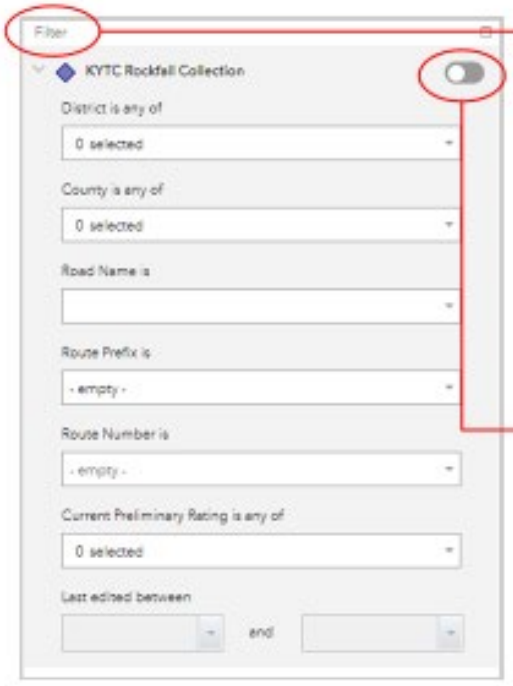
IV. Using the Online Web Viewer

C. Filter features to show on the map

A filter function is available in the web viewer to help locate specific rockfalls.





Filter KYTC Rockfall Collection features shown on the map by any combination of the following (values in each filter selection are filtered by previous selections):

- District (or multiple districts)
- County (or multiple counties)
- Road Name
- Route (choose route prefix and route number)
- Current Preliminary Class Rating (choose multiple)
- Last Edited Date Range

Click the radio button in the upper right-hand corner to apply the filter. The button turns green when the filter is applied, and the map updates to show only the features that match the filter(s) chosen.

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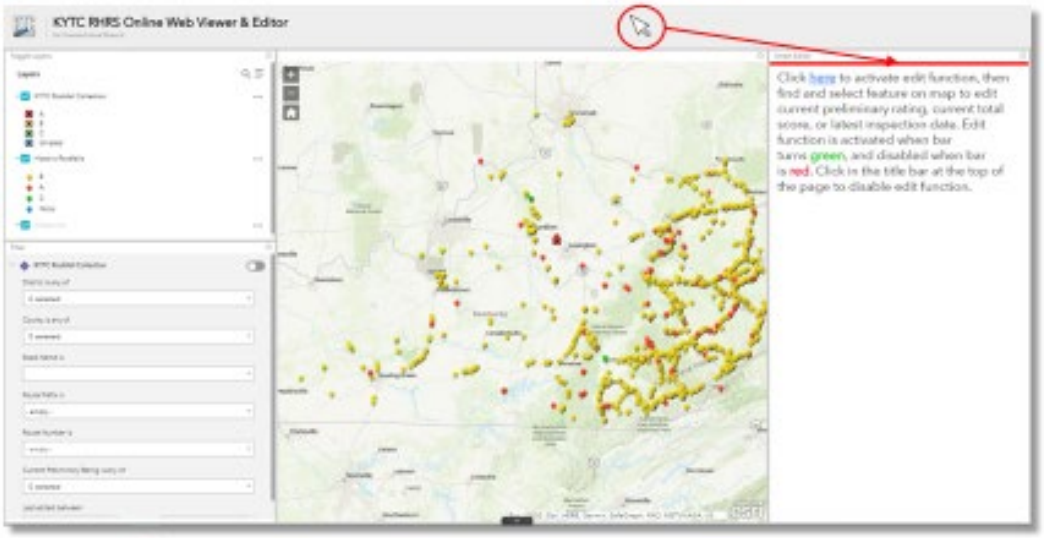
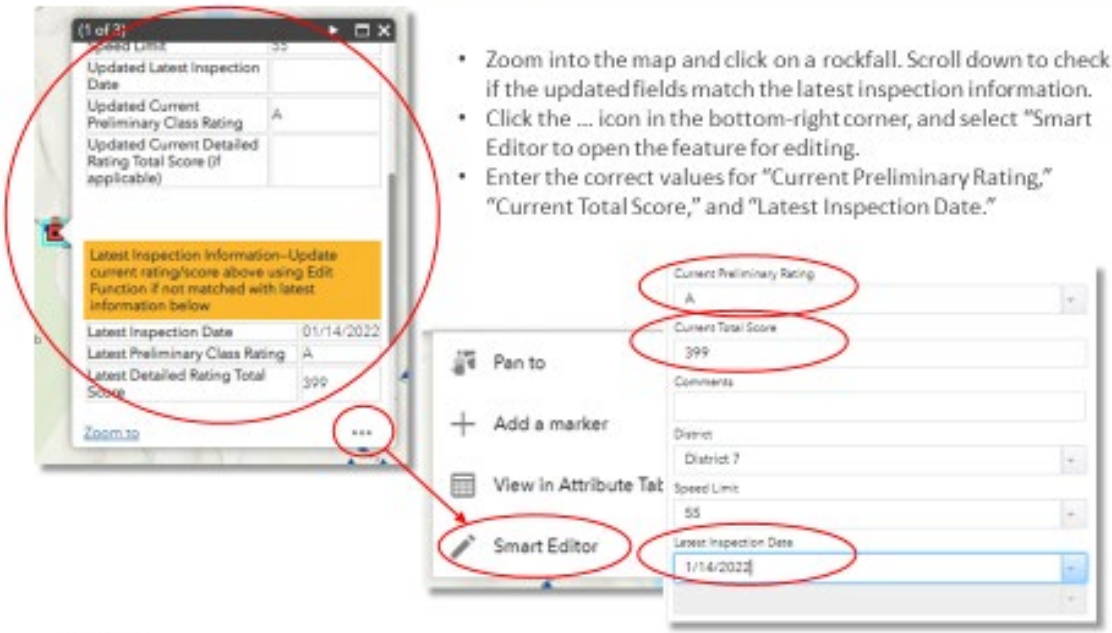
IV. Using the Online Web Viewer

D. Update current preliminary class ratings, current detailed rating total scores, and latest inspection dates for a rockfall

When a rockfall hazard is rating using the RHRS Inspection form in Survey123, a user must update the "Current Preliminary Rating, "Current Total Score," and "Latest Inspection Date" fields in the parent KYTC Rockfall Collection feature. First click anywhere in the title bar to de-activate the "Edit" function.





- Zoom into the map and click on a rockfall. Scroll down to check if the updated fields match the latest inspection information.
- Click the ... icon in the bottom-right corner, and select "Smart Editor to open the feature for editing.
- Enter the correct values for "Current Preliminary Rating," "Current Total Score," and "Latest Inspection Date."

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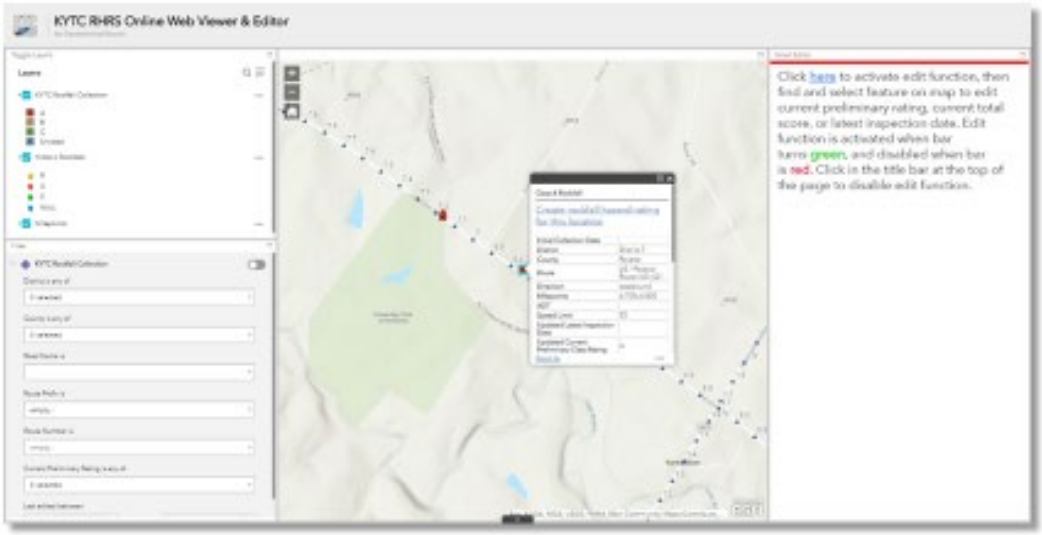
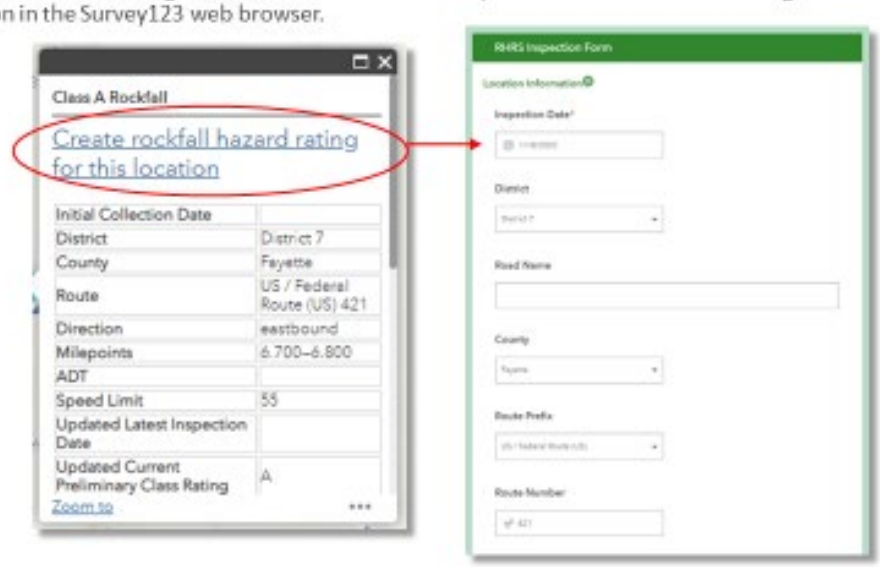
IV. Using the Online Web Viewer

E. Create new or edit existing RHRS Inspection Form using the online web viewer and Survey123 in the web browser

Due to the complicated nature of the RHRS Inspection Form, editing is best done through the Survey123 web browser. Navigate to the rockfall in question and click to open its feature popup window.



1. Create new RHRS Inspection form. Click the "Create rockfall hazard rating for this location" link to create a brand new hazard rating record for that location. This opens a brand new hazard rating record for this location in the Survey123 web browser.

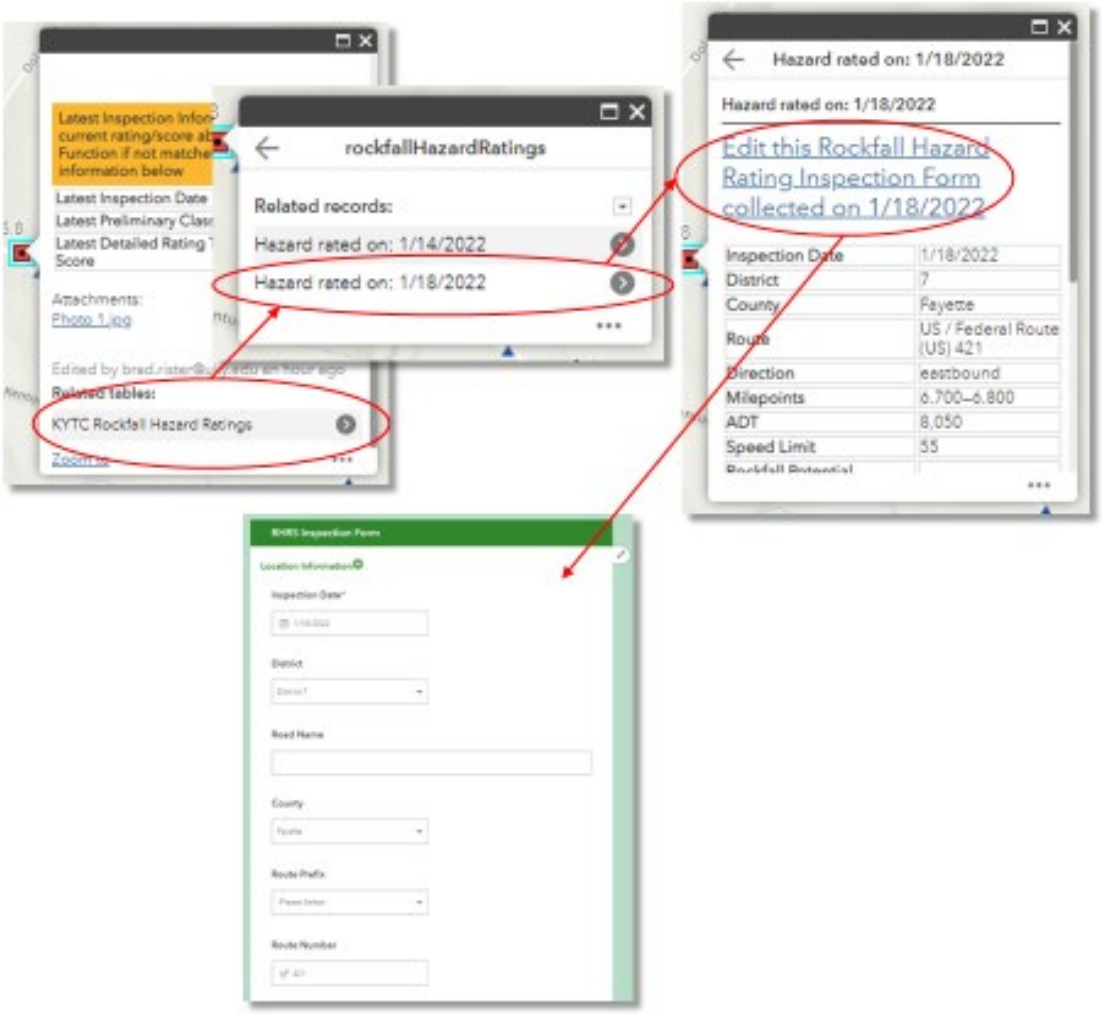


IV. Using the Online Web Viewer

E. Create new or edit existing RHRS Inspection Form using the online web viewer and Survey123 in the web browser

1. Create new RHRS Inspection form. Click the "Create rockfall hazard rating for this location" link to create a brand new hazard rating record for that location. This opens a brand new hazard rating record for this location in the Survey123 web browser.

2. Edit existing RHRS Inspection form. In the feature popup window, scroll down and click on the related table, "KYTC Rockfall Hazard Ratings." Select the record you want to edit (listed by inspection date), then click the "Edit this Rockfall Hazard Rating Inspection Form collected on *date*" link. This opens that existing hazard rating record for editing in the Survey123 web browser.



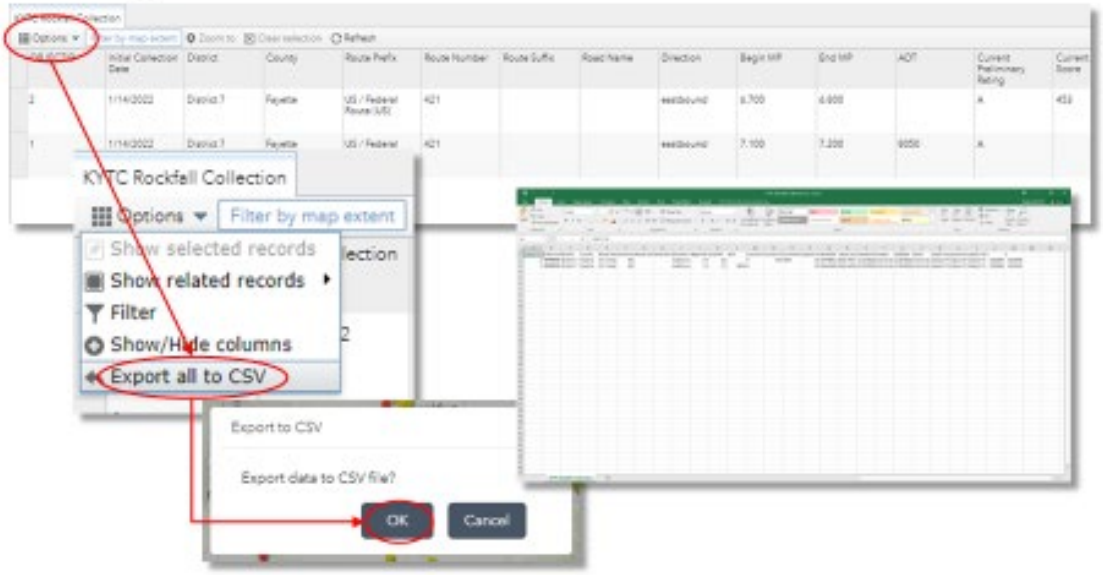
IV. Using the Online Web Viewer

F. Export feature data using the attribute table

The attribute table is filtered by the map extent—only the features visible on the map will appear in the attribute table. Use the filters or zoom the map so that only the features you wish to report are visible in the map window. For example, you could filter by a specific district or county, or only class A rockfalls.

1. Click the up arrow tab at the bottom of the map to expand attribute table.

2. Once you have only the features you wish to export visible on the map, click "Options", then "Export all to CSV", then "OK." Depending on your computer settings, the exported data will either open in Excel, or save to your downloads folder. Once exported to excel, you can perform further analysis, such as sorting by total score to find the rockfalls with the highest hazard scores.



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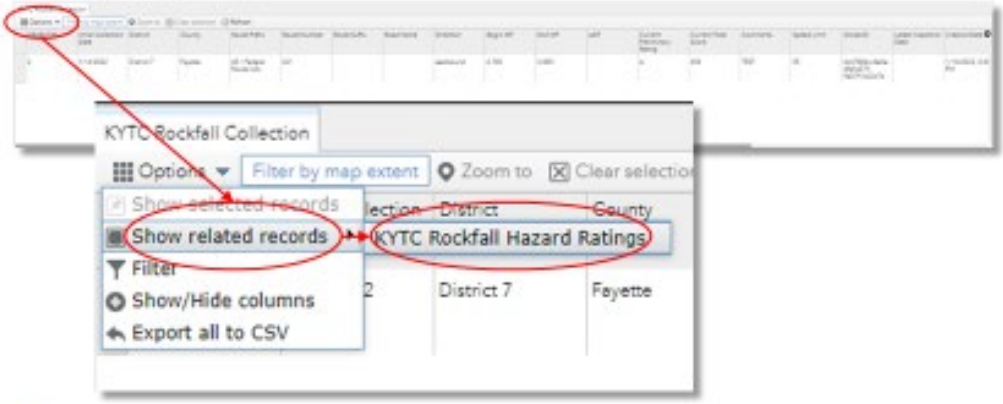
IV. Using the Online Web Viewer

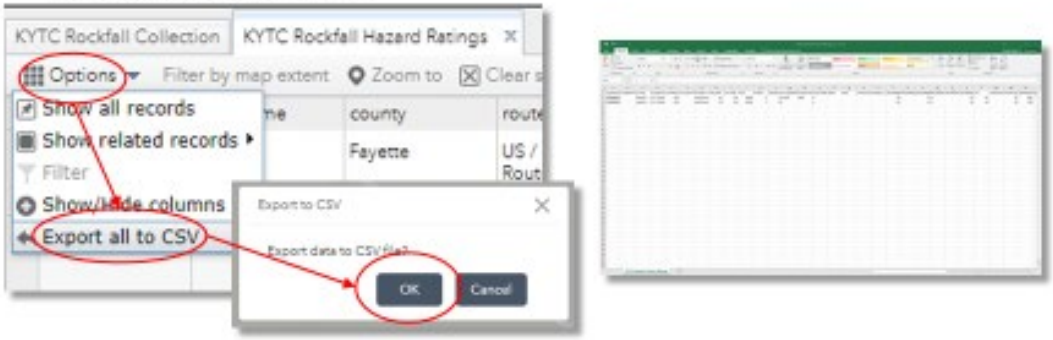
G. Export rockfall hazard rating history using the attribute table

1. To export rockfall hazard rating history for an individual rockfall, either filter or zoom to that rockfall so it is the only visible site on the map. Click the up arrow tab at the bottom of the map to expand attribute table.

2. Once you are sure that only the individual rockfall in question is visible in the attribute table, click "Options", then "Show related records", then "KYTC Rockfall Hazard Ratings." The rockfall hazard rating history will open in a new tab.



3. Once the "KYTC Rockfall Hazard Ratings" tab opens, click "Options", then "Export all the CSV", then "OK." Depending on your computer settings, the exported data will either open in Excel, or save to your downloads folder.



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Appendix F User's Manual, KYTC Landslide Hazard Rating System Web Application

2022

2022

User's Manual

KYTC Landslide Hazard Rating System Web Application

Charlie Sun and Christopher Van Dyke

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1. INTRODUCTION

The Kentucky Transportation Cabinet's (KYTC) Landslide Hazard Rating System web application[1] -- http://kylhrs.uky.edu/ is intended to be a platform for submitting landslide hazard information to KYTC centered database by KYTC personnel. The system is set up to automatically fill in hazard scores based on survey data input from the users and is intended to be used from **Info. & Rating** tab at the page settings. The user can submit their pictures and documents from **Attachments** tab as well.

It is anticipated that there will be two (2) primary users of the web application — KYTC Engineers and Officers engaged in repairing and administrating landslide hazards along the Kentucky highway. Primary users (Submitters) from districts or counties can submit landslide hazard surveys online, central office can accept surveys online, and communications circulate among submitters and central office when they submit or accept landslide hazard surveys.

To assist users of the web application, the following sections highlight many of its features and provide guidance on their use. The web application's various graphical user interfaces are illustrated and described.

[1] Referred to hereafter in this guide as *web application*.

2. OVERALL WEB PAGE SETTING

All functioning web pages on the web application are divided into three sections — **Header**, **Main Content**, and **Footer** (Figures 1).

Figure 1. Overall web page setting: Links to other pages and LOGIN page are in Header Portion

2.1 Header

The **Header** is fixed at the top of each page and has two different settings for before and after login. The content present before *and* after login include web title, date and time, and links to **HOME** and **INSTRUCTIONS**. Before login, there are also links to **LOGIN** (upper right corner of the page), **REGISTER**, **FAQ**, and **CONTACT US**. After login, the user's first name appears on the top line and the **LOGIN** link is replaced with **LOGOUT** in the top right corner. Links for **EXISTING SITE**, **NEW SITE** and **MY ACCOUNT** appear for users who are registered as Submitters and Central Office Landslide Hazard Rating System manager. Additional link, **USER ADMIN** appears for Central Office Landslide Hazard Rating System manager.

2.2 Main Content

The **Main Content** section of each page hosts the different functioning pages, which are illustrated in detail later.

2.3 Footer

The **Footer** contains links to related web sites such as **KYTC Division of Maintenance**, **Kentucky Transportation Cabinet**, and **Kentucky Transportation Center**.

3. USER AS A NON-REGISTERED USER

Non-registered user can register as **Submitter** and receive instant approval from the web application's management system. The functions described below are available to non-registered users in the **Header** section.

3.1 HOME – Default Page of Web Application

The **HOME** link is the first link in the **Header**'s last line (Figure 1). Clicking this link loads the web application's home page (Figure 1). This is the web application's default page and briefly introduces the application.

3.2 REGISTER – Get Approval Instantly from Web Application Management System

The **REGISTER** link is the second link in the **Header**'s last line (Figure 1). After clicking this link, users are asked to supply personal information to create their account (Figure 2). If a red asterisk appears next to a field, the user must provide the required information to complete their registration. Required information includes **First Name**, **Last Name**, **Email** (which is used as the **Login ID** by the user and for all correspondence email sent by administrators), **Password** (created by the user), **Phone Number**, **Street Address**, **City**, **State**, **Zip Code**, **Country**, and **Organization**. ***Submitter*** is the only option for user **Designation** for now. If registrant's email domain contains "gmail" or "yahoo", or does not exist in current user database, they will be assigned as a **UserTBA** temporarily and wait further verification by administrator from web application. The **UserTBA** can view all the existing sites in different stages, such as **Surveyed**, **Submitted**, **Accepted**, and **All Existing Sites**. Some information (e.g., **Fax Number**, **Web Site**, and **Description**) is optional. Information supplied by the user is confidential and maintained in the web application management system. Passwords are encrypted and stored in the web application management system as well.

After the user enters all the required information and clicks the **Register** button, the page shown in Figure 3 appears. This page informs the user: *"An activation link has been sent to your email address. Please follow the instructions in the email to activate your account."*

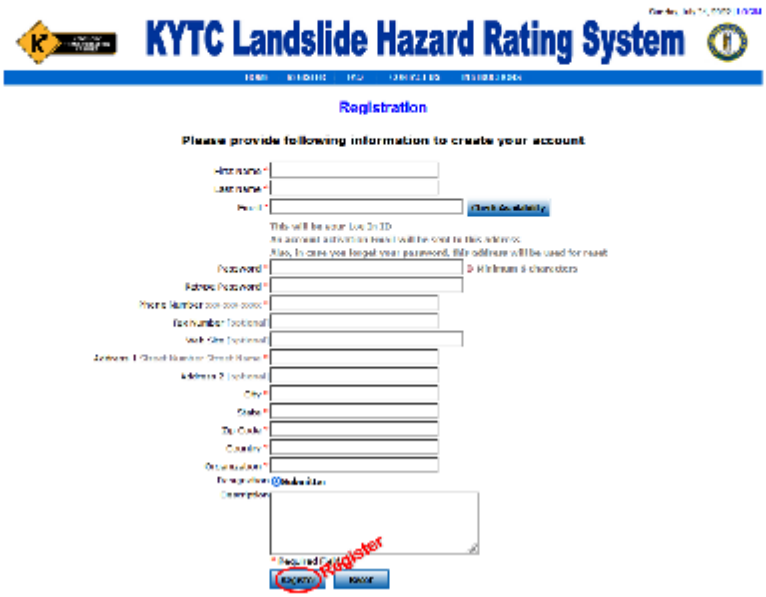

Figure 2. REGISTRATION screen

Figure 3. Information after Register button is clicked

Figure 4 is an image of the email sent to the user.

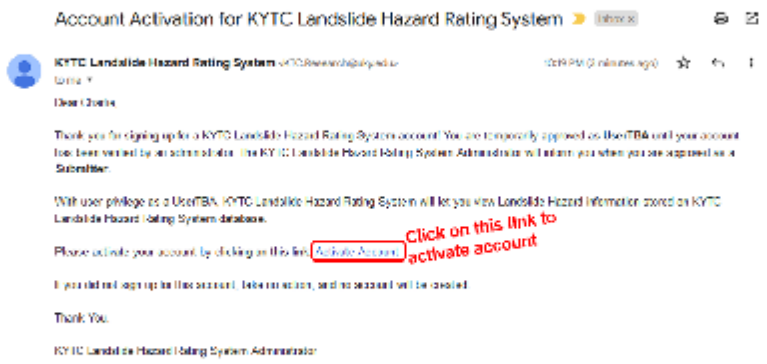

Figure 4. Email provides a link to activate user's account

A user can automatically activate their account by clicking on the link provided in the email. The **Activation** page (Figure 5) informs the new user of their account activation status. If activation is successful, the registered user may click on the LOGIN link, which is located on the upper right corner of the page, to log into the system by using LOGIN page (Figure 10).

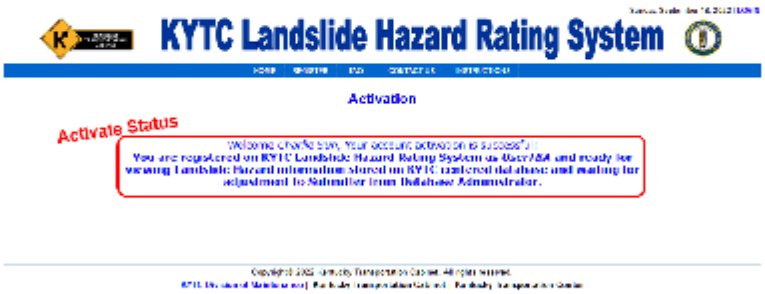

Figure 5. Screen after activating user's account

3.3 FAQ – Frequently Asked Questions

FAQ link is the third link in the Header's last line (Figure 1). This link provides straightforward answers to frequently asked questions about the web application (Figure 6).

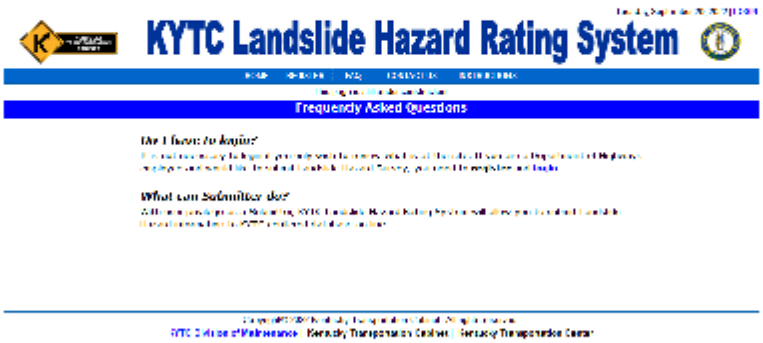

Figure 6. FAQ page provides straightforward answers to frequently asked questions about the web application

3.4 CONTACT US – Communicating with Web Application Administrator

The CONTACT US link is the fourth link in the Header's last line (Figure 1). The CONTACT US page offers a portal for users to communicate with a system administrator (Figure 7). The users may either use physics address to send regular mail; or they may supply the required information and click the Send button. Clicking the Send button generates an email that is sent by the system to both the sender and the web application administrator.

Figure 7. CONTACT US screen

3.5 INSTRCTIONS

The **INSTRUCTIONS** link is the Header's final link (Figure 1). Under this link, users find a ***Quick Start Guide*** and a ***User's Manual*** (Figure 8). The ***Quick Start Guide*** presents a brief instruction for using this web application; the ***Manual*** provides more detailed instructions. Users can view it online or download a copy for printing.

Figure 8. **INSTRUCTIONS** screen

4. USER AS A SUBMITTER

Submitter is a registered user and belongs to a major group on the web application. They can instantly activate their account after registering and following directions shown on the screen. If the **Submitter** does not activate their account, the administrator can send them a notification email with the activating link or activate the account on their behalf. Personal information can be modified by clicking on the **MY ACCOUNT** link. Unlike non-registered users, a **Submitter** can access accepted landslide hazard sites as well as the landslide hazard surveys **Initiated, Submitted,** and **All Existing Sites** (Figure 9). A **Submitter** also can submit their landslide hazard surveys or share surveys with other submitters who are in the same group, submit their surveys online, and upload attachments.

Figure 9. Submitters can view all the surveys at different stages

4.1 LOGIN

Figure 10 displays the LOGIN page. This page is the gateway for registered users to access the web application. A **Submitter** may **Log In** by entering their email address, password into the appropriate fields in the **Login** area, and clicking on **Sign In** button.

Figure 10. LOGIN page

4.2 FORGOTTEN PASSWORD

If user forgets their login password, they can click Forgotten Password link shown in Figure 10. Clicking this link takes the user to a page where they can reset their password (Figure 11). On the Forgotten Password page, a user enters their registered email address and clicks the Reset Password button. This creates a temporary, randomly generated password and emails it to the user. An instance instruction is shown on screen (Figure 12) and the email is like one in Figure 13. Once the user logs in with their temporary password, the user is prompted to immediately proceed to the MY ACCOUNT page and update their password.

Figure 11. Reset Password screen

Figure 12. Brief instruction is shown on screen

Figure 13. Temporary password created and included in email

4.3 Starting Page after LOGIN

The **INSTRUCTIONS** page (Figure 9) appears following login. The **Submitter** has access to new links like **EXISTING SITE**, **NEW SITE**, and **MY ACCOUNT**. A submitter can edit their own and their group's existing surveys which have not been submitted from the site list; they can enter the new survey by clicking on **NEW SITE** link; and they can modify their personal information by clicking on **MY ACCOUNT** link.

4.4 EXISTING SITE

Sub-links for **Surveyed, Submitted, Accepted** and **All Existing Sites** will show up when a user mouse over the link **EXISTING SITE** (Figure 9). Each sub-link will open a corresponding list per site status. Figure 14 shows a list including all existing sites currently housed in the web application when the sub-link **All Existing Sites** is clicked. All titles of columns function like "**sort by**" key when any title is clicked. The list in Figure 14 is sorted by column of **County**, which is default sort order. The first clicking on any title will bring list sorted ascending by this column; the second clicking on same title will bring list sorted descending by this column. Keeping clinking on same title will bring the list sorted back and forth between ascending and descending by this column.

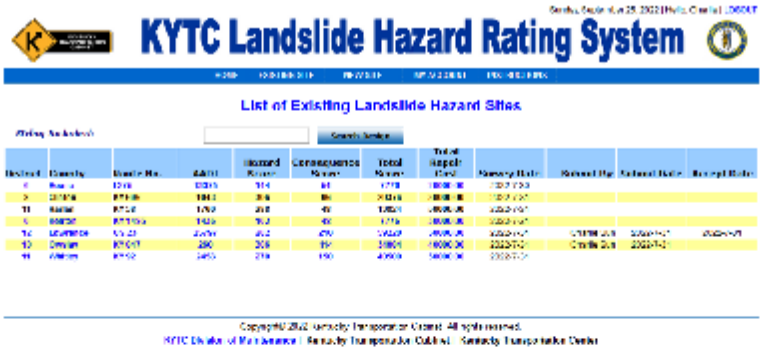

Figure 14. List of all existing sites sorted by County when the sub-link **All Existing Sites** is clicked

Users can view site detail information by clicking on an item in any column, such as **District, County, Route No., AADT, Hazard Score, Consequence Score, Total Score, or Total Repair**

Cost from the list in Figure 14. Two (2) tabs are visible to users on the view site page — **Info. & Rating** and **Attachments**.

4.4.1 Info. & Rating – Shows site information and rating

Figure 15 displays contents under the first tab, **Info. & Rating**. This tab contains detailed information, including Site Information, Hazard Factor Rating, Consequence Factor Rating, and Overall Score and Comments. The button, Print Survey Form can print survey information on screen in PDF format.

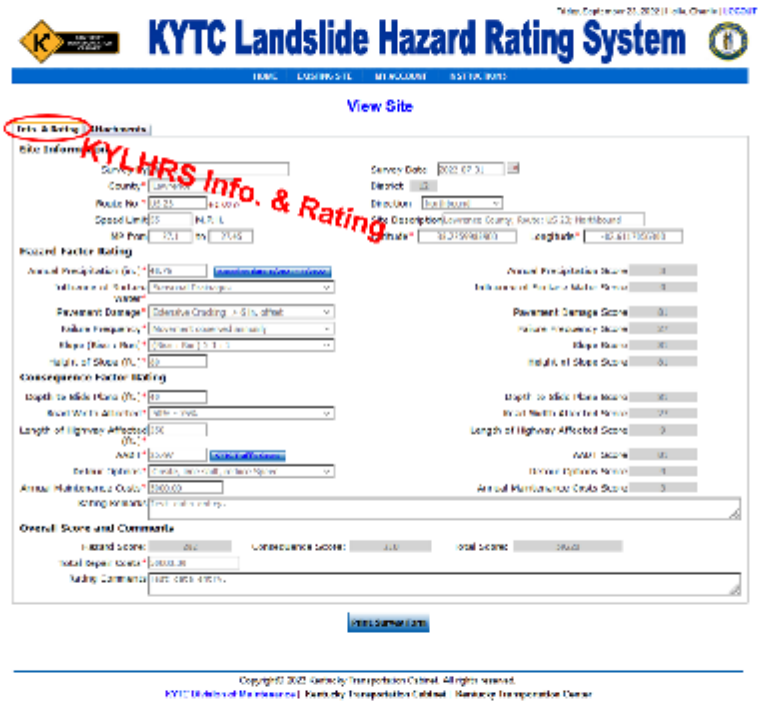

Figure 15. Landslide hazard site detail information and rating

4.4.2 Attachments – Shows uploaded attachments by submitter

On the Attachments tab, the user may view or download attachments about this site uploaded by the submitter (Figure 16). Clicking on a file name will view this attachment.

Figure 16. Layout under Attachments Tab

4.5 NEW SITE – Create and Submit a New Landslide Hazard Survey

The Submitter can enter a new landslide hazard site information by clicking the NEW SITE link. The page displayed in Figure 17 appears once a user clicks this link. The tab, Info. & Rating is visible once the link is opened.

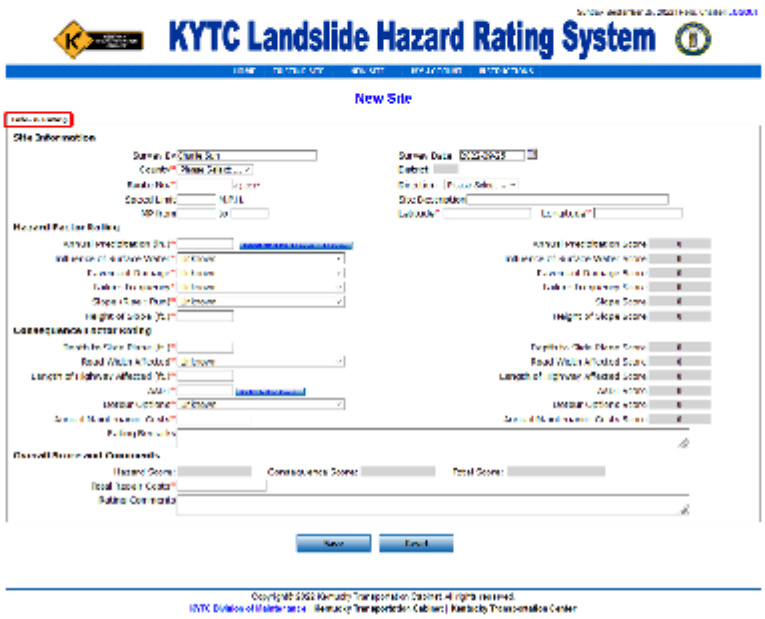

Figure 17. Screen for inputting a new site information

The tabs contain three kinds of entry fields:

1. Required Fields are denoted with *
   - Required fields must be completed to view scores or save their site.
2. Field with gray background
   - Ignorable fields will be automatically filled by program when user inputs corresponding information.
3. Fields without any mark:
   - Optional fields — information can be entered in them, or they can be left blank.

4.5.1 Info. & Rating – Entering Site Information, Hazard and Consequence Factors

When the **NEW SITE** is clicked, some fields are pre-selected or have default values. The default values for "Survey By" is user's name; "Survey Date" is today's date; hazard and consequence factors in dropdown lists are pre-selected as "Unknown". Clicking on the Based on data 6/2021 - 5/2022 hot link aside "Annual Precipitation" opens NOAA National Centers for Environmental Information web page, where users can find most updated annual precipitation data. Clicking on the KYTC Traffic Count hot link opens KYTC's Traffic Count Reporting System web page, where users can gather AADT data.

The **District** and **Annual Precipitation** fields are automatically populated after making a **County** selection. Annual precipitation amount is based on the data June 2021 – May 2022 from NOAA web page. All the hazard and consequence factor scores are automatically filled after entering the corresponding factors. "Hazard Score", "Consequence Score" and "Total Score" are automatically posted when corresponding factors are entered.

Figure 18 shows an example of data entered for a new site.

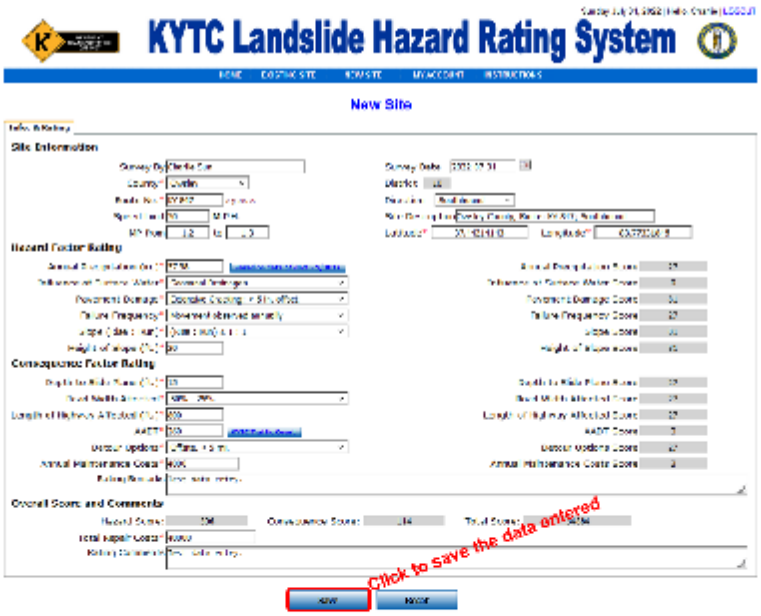

Figure 18. Example of data entered for a new site

4.5.2 Save Button

Clicking the Save button saves a landslide hazard survey after all required data have been entered. One more tab, one dropdown list, and three more buttons are brought up after the Save button is clicked (Figure 19). Users can upload attachments to the server by using functions on the **Attachments** tab. They can save the design ***as Update*** or ***as New Site*** by choosing the appropriate option in the dropdown list. Users can delete the current design by clicking **Delete**, submit surveys by clicking **Submit**, and print out the Landslide Hazard Survey Form by clicking **Print Survey Form**.

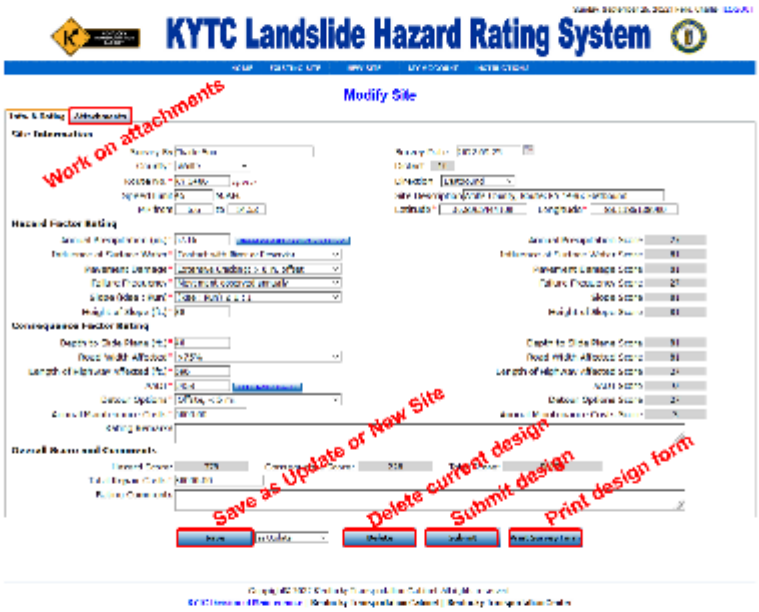

Figure 19. More functions show up after Save Button is clicked

4.5.3 Attachments – Uploading and managing Attachments

After saving a landslide hazard site information, Submitters can upload attachments (e.g., pictures; .PDF, .doc, or .zip files) using the page shown in Figure 20 and following these steps:

1. Click **Browse** to identify a file to upload.
2. Click **Upload** to send the selected file to the web application server.

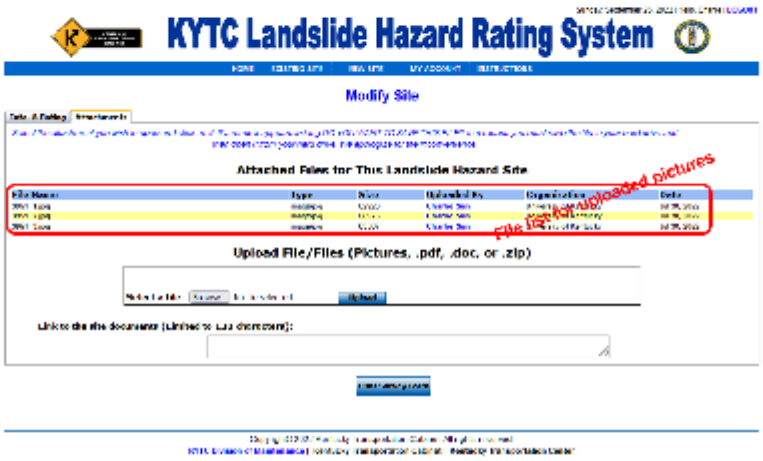

Figure 20. Upload and manage attachments under **Attachment** Tab

4.5.4 Save Option Dropdown List

The **Save Option Dropdown List** contains two save options — ***as Update*** and ***as New Site***. Save ***as New Site*** creates a new site when a user begins it with some common data as the current site.

4.5.5 Delete Button

Clicking the **Delete** button deletes the current site information. It begins a new landslide hazard survey after deleting.

4.5.6 Submit Button

Users will send landslide hazard site information to Central Office Landslide Hazard Rating System (LHRS) Manager after they click the **Submit** button. When users successfully submit their survey form, emails with the **Survey Form** attached as a PDF file are sent to the **Central Office LHRS Manager** and **Submitter**. The message *"Your pavement design has been successfully submitted. Thank you."* appears onscreen. All the information for the current site is locked. No one can make changes.

4.5.7 Print Survey Form Button

Clicking the **Print Survey Form** button creates a PDF version of the **Landslide Hazard Survey Form** (Figure 21). Users can save this file on their local hard drive or open it onscreen using software for viewing PDFs (e.g., Adobe Reader or Acrobat) and save it later. The printed form is identical to the form sent to **Central Office LHRS Manager**.

KYTC Landslide Hazard Rating System

KENTUCKY TRANSPORTATION CABINET
DIVISION OF MAINTENANCE

Site Information:

Surveyed By: Charlie Sun — Survey Date: 2022-09-29
County: Wolfe — District: 10
Route No.: KY 1486 — Direction: Eastbound
Speed Limit: 45 MPH — Site Description: Wolfe County; Route: KY 1486; Eastbound
MP from: 6.6 to: 14.33 — Latitude: 36.8965444 Longitude: -83.119613

Hazard Factor Rating:

Annual Precipitation (in.):	57.16	Annual Precipitation Score:	27
Influence of Surface Water:	Contact with River or Reservior	Influence of Surface Water Score:	81
Pavement Damage:	Extensive Cracking, > 6 in. offset	Pavement Damage Score:	81
Failure Frequency:	Movement observed annually	Failure Frequency Score:	27
Slope (Rise : Run):	(Rise : Run) 1 : 1	Slope Score:	81
Height of Slope (ft.):	58	Height of Slope Score:	81

Consequence Factor Rating:

Depth to Slide Plane (ft.):	40	Depth to Slide Plane Score:	81
Road Width Affected:	>75%	Road Width Affected Score:	81
Length of Highway Affected (ft.):	596	Length of Highway Affected Score:	27
AADT:	2459	AADT Score:	9
Detour Option:	Offsite, > 5 mi.	Detour Option Score:	27
Annual Maintenance Costs:	$5000.00	Annual Maintenance Costs Score:	5

Overall Score and Comments:

Hazard Score: 378 Consequence Score: 228 Total Score: 86184

Total Repair Costs $50000.00

This survey has not been submitted yet.

Figure 21. **Landslide Hazard Survey Form** in PDF format

4.6 MY ACCOUNT -- Modify Personal Information

Clicking **MY ACCOUNT** brings up the page depicted in Figure 22. A registered user can update their profile and change their password or contact information on this page (except for their email address, which serves as the user ID).

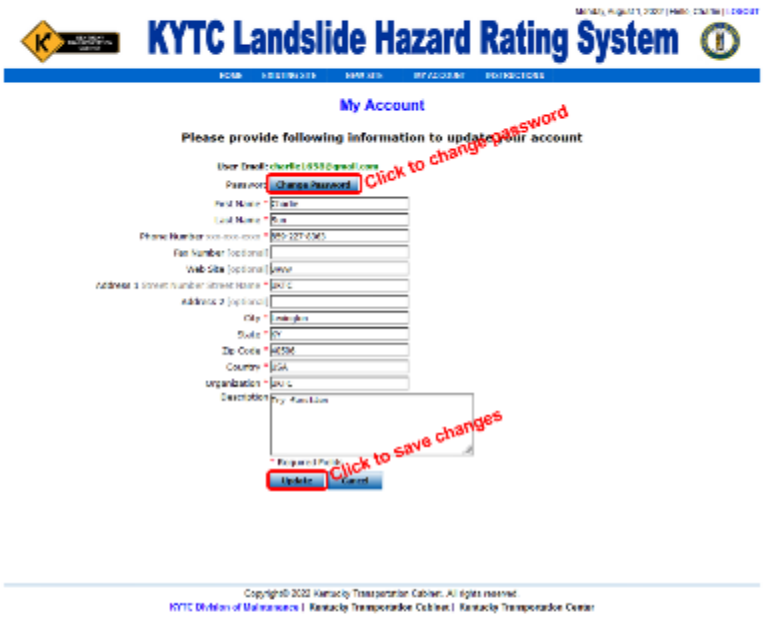

Figure 22. Update user's account from **MY ACCOUNT** link

5. USER AS A CENTRAL OFFICE LHRS MANAGER

The Central Office LHRS Manager has the most user privileges in the web application. In addition to the links Submitters can access, the Central Office LHRS Manager sees the following links on the Header after logging in: USER ADMIN → (User Admin, User List and Groups) – see Figure 23. The Central Office LHRS Manager has final authority to accept or request changes for survey. USER ADMIN → (User Admin, User List and Groups) links to pages for maintaining all the information of registered users and groups. On these pages, new users can be added and information for existing users can be modified. On all pages listing existing sites, the Central Office Manager can activate or archive sites. Attachments can be managed on the Attachments tab. To learn how to navigate privileges available to Submitters, refer to the following sections:

4.3 Starting Page after LOGIN
4.5 NEW SITE – Create and Submit a New Landslide Hazard Survey

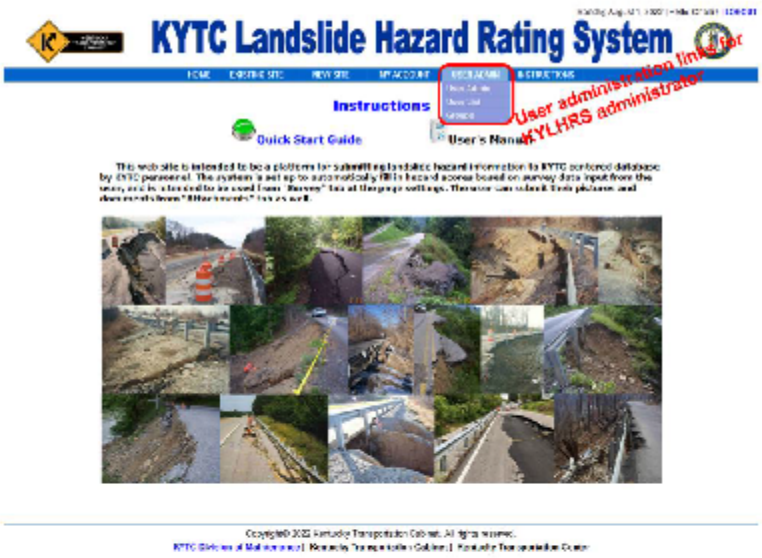

Figure 23. Header – after a Central Office LHRS Manager logs in

5.1 Screen for Managing Existing Project List

On the page listing existing sites, the Central Office LHRS Manager can archive or activate a landslide hazard survey site by checking or unchecking the archive checkbox and clicking the Update Button (Figure 24). The Central Office LHRS Manager can click on Retrieve Archive or Retrieve All to view different groups of landslide hazard survey sites.

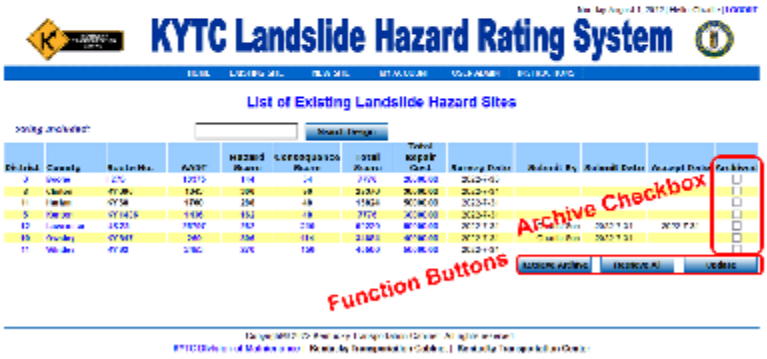

Figure 24. Archive/active sites by a Central Office LHRS Manager

5.2 Screen for Managing Attachments

The Central Office LHRS Manager can review or download attachments that have been uploaded by the Submitter on the survey site page's Attachment tab. Following review, they can decide whether to delete the attachment by checking the appropriate box. Once a Central Office LHRS Manager has made their selection(s), they should click the Update Attachments button (Figure 25).

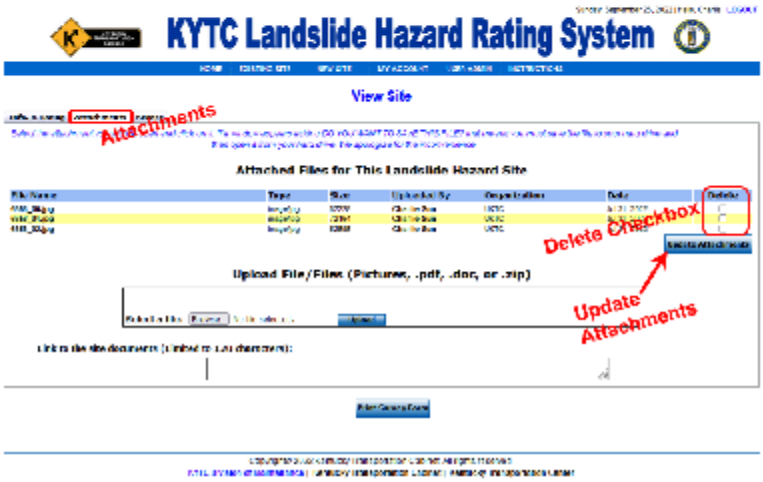

Figure 25. Manage attachments by Central Office LHRS Manager

5.3 Accept or Request Changes – Central Office LHRS Manager's Decision

After the Central Office LHRS Manager logs in, if a landslide hazard survey site is awaiting their acceptance, the portion of Central Office LHRS Manager's Decision under Accept tab will be active (Figure 26). After deciding to Accept or Request Changes, the Central Office LHRS Manager fills out the corresponding information and clicks the Submit button. Once submitted, individual emails containing the Landslide Hazard Survey Form in PDF format are sent to the Submitter who submitted the survey site. A copy of this email is sent to the Central Office LHRS Manager for recordkeeping purposes.

If the Central Office LHRS Manager requests changes, emails which include the suggestions or modifications for further consideration are sent to the Submitter.

Figure 26. Central Office LHRS Manager submits their decision

5.4 USER ADMIN – User Administration

In the Header section, the Central Office LHRS Manager has access to USER ADMIN → User Admin. Clicking on this link brings up the User Administration page. This page contains three tabs — Pending Submitter, All Existing Users, and Add New User. Figure 27 displays the Pending Submitter tab, which lets the Central Office LHRS Manager approve or delete pending requests for Submitter by clicking the corresponding buttons.

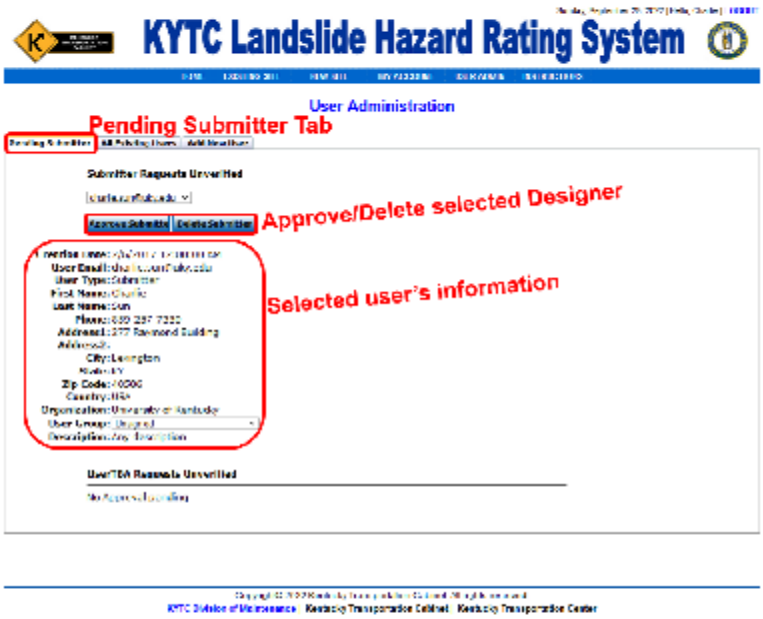

Figure 27. User Administration page with Submitter in pending

5.4.1 Pending Submitter -- Approve/Reject Pending Submitter

The area on this tab depends on whether Submitter requests are pending. These situations arise only when a user has registered on web application management system but not activated their account yet. If there are users who have not activated their accounts, dropdown lists appear. When the dropdown list under Submitter Requests Unverified is clicked and a user is selected, the user information appears as seen in Figure 27.

The Central Office LHRS Manager may approve a Submitter's request by clicking the Approve Submitter button. They can reject or delete a request by clicking the Delete Submitter button. If a Submitter is approved, the web application management system

sends an email to the **Submitter** notifying them of the approval. If there are no requests pending, "No Approval pending" appears under **Submitter Requests Unverified**.

5.4.2 All Existing Users -- Maintain All Registered User's Information

A second tab — **All Existing Users** — provides the **Central Office Manager** with a dropdown list of all existing registered users. When a user is selected from the dropdown list, their personal information appears beneath the dropdown list, which the **Central Office LHRS Manager** can modify (Figure 28). The **Central Office LHRS Manager** can save changes to a user's profile by clicking the **Update** button; change their status by clicking the **Change Status** button; or reset their password by clicking the **Reset Password** button. Clicking the **Reset Password** sends the selected user an email with a new password automatically generated by the system.

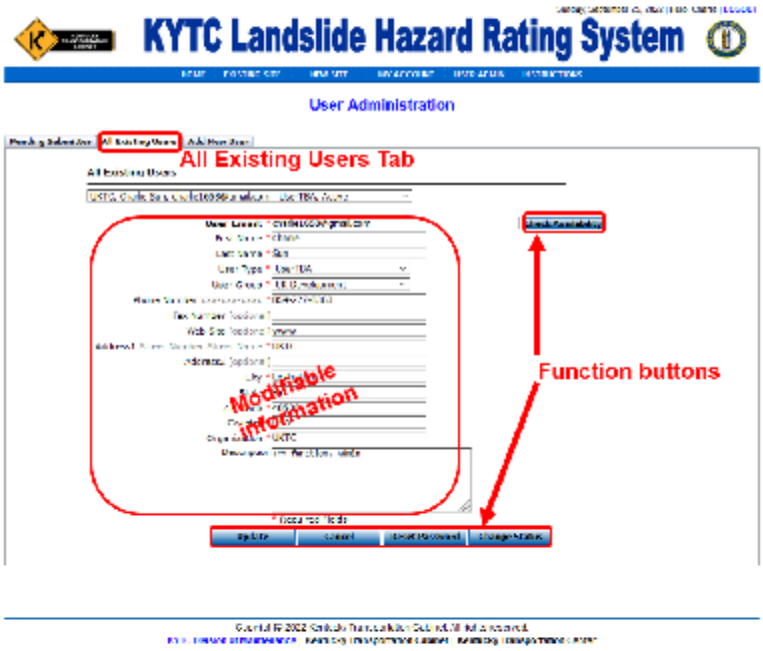

Figure 28. User info appears when user is selected on **All Existing Users** tab

5.4.3 Add New User -- Add/Invite New User

Clicking the **Add New User** button lets the **Central Office LHRS Manager** registering and activating a new user on their behalf (Figure 29). This user does not need to activate their account and can directly login to the web application management system via the **LOGIN** link. This page looks nearly identical to the **Registration** page seen in Figure 2 except the **Central Office LHRS Manager** can select **User Type** and **Group** for the invited user directly. No activation from user's side is needed. After clicking **Register**, the web application management system instantly sends an email to the invited user that includes the **LOGIN** link.

Figure 29. Add New User tab lets Central Office LHRS Manager to add/invite new users

5.5 USER List

The Central Office LHRS Manager has access to the USER ADMIN → User List link in the Header. Clicking this link takes the Central Office LHRS Manager to the User List page (Figure 30). On this page, the Central Office LHRS Manager can search users by using any string included in any fields. All titles of columns function like "sort by" key when any title is clicked. The Central Office LHRS Manager can copy users' email addresses by selecting the checkboxes in the front of users and clicking the button of Copy Selected Email Addresses. They can go to user detail page and modify their data by clicking on a user.

Figure 30. USER ADMIN → User List page provides Central Office Manager an interface maintaining user information and copy user email addresses

5.6 GROUP ADMIN – Group Administration

The Central Office LHRS Manager has access to the USER ADMIN → Groups link in the Header. Clicking this link takes the Central Office LHRS Manager to the User Group List page (Figure 31). On this page, the Central Office LHRS Manager can modify existing groups' information and add new groups.

Figure 31. USER ADMIN → Groups page provides Central Office LHRS Manager an interface maintaining group information

6. USER AS AN ADMINISTRATOR

An **Administrator** is an assistant to the **Central Office LHRS Manager** in the web application. The **Administrator** can perform all functions available to the **Central Office LHRS Manager** except receiving email when the submitter submits a landslide hazard site survey. Only the Central office LHRS Manager will get this email.

7. LOGOUT

The **LOGOUT** link appears in the upper right corner of every page of the web application. When a user clicks a **LOGOUT** link, the system deletes all session variables, and a fresh session begins. The user is then redirected to the original **HOME** page. To reenter the site, the user must click the **LOGIN** link in the upper right corner of the page and enter their **Email Address** and **Password**.

If you have questions or need assistance with the KYTC Landslide Hazard Rating System web application, please contact:

Brian Schroeder, Email: brian.schroeder@ky.gov; Phone: (502) 564-4556

Charlie Sun, Email: charlie.sun@uky.edu; Phone: 859-257-7330