WISCONSIN DEPARTMENT OF AGRICULTURE, TRADE and CONSUMER PROTECTION

TECHNICAL STANDARD

VERIFICATION OF DEPTH TO BEDROCK

01

DEFINITION

Investigative methods for infield depth to *bedrock*[1] verification for *fields* receiving mechanical applications of manure.

PURPOSE

The purpose of this technical standard is to provide appropriate methods for verification of depth to bedrock to support implementation of Wis. Admin. Code s. NR 151.075 in areas where the bedrock consists of Silurian dolomite with a depth to bedrock of 20 feet or less. This technical standard may be used to perform depth to bedrock verifications. This technical standard has not yet been incorporated into Wisconsin Administrative rule, and as such may be utilized voluntarily at this time.

CONDITIONS WHERE PRACTICE APPLIES

Although this technical standard was created to support implementation of Wis. Admin. Code s. NR 151. 075, this technical standard may be utilized for all fields receiving mechanical applications of manure in areas where the mapped bedrock consists of Silurian dolomite with a depth to bedrock of 20 feet or less and where the existing *Silurian bedrock map information* is being refuted. The person collecting the data is responsible for obtaining landowner permission to access private lands.

This technical standard is not to be used for delineation of closed depressions.

CRITERIA

General Criteria

This section establishes verification protocols, methods and documentation for bedrock depths 20 feet or less from the ground surface.

Laws and Regulations

Users of this technical standard are responsible for compliance with applicable federal, state, tribal and local laws, rules, or regulations including, but not limited to, those governing safety, environmental protection, or nutrient management. This technical standard does not contain the text of federal, state, or local laws. Implementation of this technical standard does not provide an exemption or defense of a violation of law.

Location

This technical standard applies to the area subject to s. NR 151.075 where depth to Silurian dolomite bedrock is 20 feet or less. This technical standard could also be used to verify depth to bedrock in other areas of the state where bedrock is 20 feet or less.

[1] Words in the technical standard that are shown in italics are described in the Glossary section. The words are italicized the first time they are used in the text. Technical standards are reviewed periodically and updated if needed. To obtain the current version of this technical standard, contact your local DATCP office or the Standards Oversight Council office in Madison, WI at (608) 441-2677.

Criteria Applicable to Verification Process

Site Assessment

Prior to initiation of data collection, a site assessment must be performed to determine the depth to bedrock verification needs of the farm. The site assessment must include a review of regional and site-specific information necessary to determine verification priority areas and the data collection method(s) most suitable for the farm as outlined below and in Attachment 1. Findings of the site assessment must be used to identify the fields and/or field areas where bedrock depth verification will be performed, as well as the bedrock depths to be verified and the required sampling density. The following planning resources shall be reviewed, as applicable:

1. Discussions with the landowner and/or operator to identify possible exposed bedrock, shallow soils over bedrock, or karst features;
2. Farm's *nutrient management plan*;
3. Area bedrock and karst maps;
4. Any site-specific subsurface information (e.g., well construction reports, manure storage investigation, windmill drill logs, Wisconsin Department of Natural Resources (DNR) Bureau for Remediation and Redevelopment Tracking System (BRRTS) database information, Wisconsin Department of Transportation (WisDOT) boring logs, prior geophysical investigations, information from the county sanitarian and county land conservation department resources);
5. Air photos, both recent and historic;
6. Maps of land surface elevations [e.g., topographic map, digital elevation model (DEM), Light Detection and Ranging (LiDAR)];
7. Natural Resources Conservation Service (NRCS) Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm);
8. Locations of utilities, tile lines and cultural resources if intrusive investigation methods are to be used;
9. Silurian bedrock map information, available from the University of Wisconsin's Department of Soil Science (https://snapplus.wisc.edu/maps/).

Based on this information, the verification method(s) listed in **Tables 1 and 2** for field investigation can be evaluated.

Methodology

1. Qualified individuals, as identified in the Qualification section, must develop a plan for verification of depth to bedrock. For those who become qualified by taking a DATCP-approved training course and who prior to that were not previously qualified, the verification plan must be submitted to and approved by the appropriate entity determined by the *Department* **before** any verification work is completed.
2. Choose verification method(s) based on depth suitability and site assessment. Verification method selection should also take into account site topography, variability in soil texture and moisture contents and availability of equipment to choose the best verification method for the specific field conditions.
3. Before conducting verification sampling, the land surface must be smoothed in the immediate vicinity of the sampling point if needed, so depth measurements are collected from a level ground surface representative of the general area. A tillage pass is not required or needed to level out the ground surface.
4. Depth verifications must be performed in the field being refuted (i.e. not in adjacent ditch, road or treeline).

5. **Table 1** and **Table 2** provide the minimum sampling densities based upon verification method and depth to be verified;
    a. At minimum, follow the sampling density appropriate to the depth of bedrock being refuted and the verification method being used. Sampling density can be increased to exceed the minimum density requirement;
    b. When using geophysical methods, complete required verification/ground truthing using protocols outlined in **Table 2**;
    c. The minimum spacing in sample density may cross field boundaries and should match the overall sampling density specific to the verification method chosen for the depth being refuted in that area; and
    d. Use excavation as a verification method only if no other methods are available for use.

Table 1. Intrusive Methods

Method	Description	Minimum Sampling Density Required[1]	Allowable Boundary Depth Verifications
Hand probe	Rod less than 1" diameter is pushed into ground by hand.	At a minimum, one probe per 1/4 acre (~100 ft. spacing) when disputing the 2 ft. and/or 3 ft. boundary.	2 ft. 3 ft.
Hand held or machine auger	Auger is advanced or turned into ground and rotated.	At a minimum, one probe per 1/4 acre (~100 ft. spacing) when disputing the 2 ft. and/or 3 ft. boundary. At a minimum, one probe per 1 acre (~200 ft. spacing) when disputing the 5 ft. boundary.	2 ft. 3 ft. 5 ft.
Direct push probe (e.g. Geoprobe, Giddings, loader/skid steer pushing rod, hammer probe)	Probe is advanced using hydraulic or percussive methods.	One probe per 1/4 acre (~100 ft. spacing) when disputing the 2 ft. and/or 3 ft. boundary. One probe per 1 acre (~200 ft. spacing) when disputing the 5 ft. boundary. One probe per 10 acres (660 ft. spacing) when disputing the 20 ft. boundary.	Suitable for all depths
Excavation[2]	A pit is excavated for evaluation.	One pit per 1/4 acre (~100 ft. spacing) when disputing the 2 ft. and/or 3 ft. boundary. One pit per 1 acre (~200 ft. spacing) when disputing the 5 ft. boundary. One pit per 10 acres (660 ft. spacing) when disputing the 20 ft. boundary.	Excavation equipment suitable to the depth of reach.

Notes:

1. This is only the minimum criteria; additional probing to delineate boundaries may be necessary and will be left up to the qualified individual to make those determinations.
2. Excavation is only to be used if there are no alternative options for verification.
3. All product names and brands are property of their respective owners. All company, product and service names are for identification purposes only. Use of these names and brands does not imply endorsement.

4. See Attachment 2 for an example depicting the design of an intrusive sampling plan.

Table 2. Geophysical Methods

Method	Description	Protocols	Output	Allowable Boundary Depth Verification
Contact Electrical Conductivity (e.g. Veris)	Electrodes in direct contact with the ground to measure the apparent electrical conductivity of the subsurface.	At least one survey line (covering the length of the field) per 100 ft. spacing when disputing the 2 ft. and/or 3 ft. boundary.	Continuous profile of apparent bulk electrical conductivity along a survey line. Multiple profiles may be combined to produce a plan view map.	2 ft. 3 ft.
Electromagnetic (EM) surveys - Frequency domain conductivity (e.g., Dual EM, EM-31, EM-34, EM-38)	Using the induction principle, measures the apparent electrical conductivity of the subsurface.	At least one survey line (covering the length of the field) per 100 ft. spacing when disputing the 2 ft. and/or 3 ft. boundary. At least one survey line per 200 ft. spacing when disputing the 5 ft. boundary. At least one survey line per 660 ft. spacing when disputing the 20 ft. boundary.	Continuous profile of electromagnetic apparent conductivity along a survey line. Multiple profiles may be combined to produce a plan view map.	2 ft. 3 ft. 5 ft. 20 ft. (depending on instrument model)
Electrical Resistivity Imaging	Electrodes in direct contact with the ground at specified spacings to measure the electrical conductivity of the subsurface.	At least one survey line (covering the length of the field) per 200 ft. spacing when disputing the 5 ft. boundary. At least one survey line per 660 ft. spacing when disputing the 20 ft. boundary.	Continuous profile of electrical resistivity along a survey line. Multiple profiles may be combined to produce a plan view map.	5 ft. 20 ft.
Horizontal-to-Vertical Spectral Ratio (HVSR)	A seismometer, records ambient seismic noise to estimate sediment thickness and depth to bedrock.	At a minimum, one measurement per 1 acre (200 ft. spacing) when disputing the 5 ft. boundary. One measurement per 10 acres (660 ft. spacing) when disputing the 20 ft. boundary.	Provides info about natural frequency at a point. Natural frequency can be converted to depth of sediments if the S-wave velocity is known.	5 ft. 20 ft.

Method	Description	Protocols	Output	Allowable Boundary Depth Verification
Low Frequency Ground Penetrating Radar (GPR)	Radar waves are reflected at boundaries of geologic units.	At least one survey line (covering the length of the field) per 100 ft. spacing when disputing the 2 ft. and/or 3 ft. boundary. At least one survey line per 200 ft. spacing when disputing the 5 ft. boundary. At least one survey line per 660 ft. spacing when disputing the 20 ft. boundary.	Continuous profiles of two-way travel times of radar waves along a survey line resulting in a cross section of the subsurface along a survey line.	2 ft. 3 ft. 5 ft. 20 ft.
Multi-channel analysis of surface waves (MASW)	Seismograph and an array of geophones to record the surface wave energy created from a source.	At least one survey line (covering the length of the field) per 200 ft. spacing when disputing the 5 ft. boundary. At least one survey line per 660 ft. spacing when disputing the 20 ft. boundary.	Cross-sections of shear wave velocity as a function of depth.	5 ft. 20 ft.
Resistivity Mapping with a Towed Array (e.g. OhmMapper)	Capacitance coupled discharge with a towed array in direct contact with the ground, to measure the bulk electrical properties of the subsurface.	At least one survey line (covering the length of the field) per 200 ft. spacing when disputing the 5 ft. boundary. At least one survey line per 660 ft. spacing when disputing the 20 ft. boundary.	Continuous profile of electrical resistivity along a survey line.	5 ft. 20 ft.
Seismic refraction	Seismograph and an array of geophones to record the seismic energy created from a source.	At least one survey line (covering the length of the field) per 200 ft. spacing when disputing the 5 ft. boundary. At least one survey line per 660 ft. spacing when disputing the 20 ft. boundary.	Layered profile of seismic velocities along survey lines.	5 ft. 20 ft.

Notes:

1. New technologies not listed in this table are acceptable based on a qualified individual's experience with that equipment.
2. Anticipated depth and boundary refer to the depth to bedrock indicated on the map being refuted.
3. Geophysical instruments must be properly calibrated and operated using manufacturer recommendations for specific environment being evaluated.

4. GPS location must be recorded at 30-foot intervals along the geophysical survey line. Automated GPS and data collection recommended, where available. See GPS Requirements section.
5. Geophysical methods must be used in conjunction with intrusive methods to verify correlation of geophysical data with depth to bedrock (see Geophysical Method Ground Truthing section). When ground truthing geophysical measurements, intrusive sampling density is reduced to 10% of the densities in Table 1. This is only minimum criteria, additional survey or probing to delineate boundaries may be necessary and will be left up to the qualified individual to make those determinations.
6. All product names and brands are property of their respective owners. All company, product and service names are for identification purposes only. Use of these names and brands does not imply endorsement.
7. See Attachment 2 for an example depicting the design of a geophysical survey and ground truthing plan.

Geophysical Method Ground Truthing

Prior knowledge of expected depth to bedrock and variation in soil types and/or textures in a *mapped area* is required to design an accurate geophysical survey.

When geophysical surveys are used to assess depth to bedrock, depth-to-bedrock data must also be collected by direct measurement using an intrusive method (see Table 1) in several locations so as to "ground truth" the interpretation of the geophysical data.

Note: Geophysical derived depths to bedrock are dependent on known conditions and are often interpreted after integrating intrusive results. Thus, geophysical data may require additional analysis after ground truthing or an intrusive sampling program.

Once the geophysical survey has been completed, the results must be presented in a map format that includes a legend showing the full range of measured geophysical values. The range of measured values must be divided into categories that can be related to the depths of interest and those categories presented on the map (and shown in the legend).

Ground truthing data must be collected such that mapped areas with both similar geophysical values and similar depths are sampled. First geophysical data are collected and areas of similar geophysical values are identified. For areas with similar geophysical values, the investigator needs to assess visible variation in soil moisture and/or texture. Measured geophysical values can vary based on depth to rock, soil type and moisture content. If the field appears to be uniform with respect to soil moisture and texture, then the investigator defines mapped areas in terms of similar geophysical values. Each mapped area must be ground-truthed in at least two locations and the sampling locations should be distributed throughout the field. If variations in soil moisture and/or texture are observed, the number of ground truth locations should be increased such that mapped areas covering the full range of geophysical values, moisture and texture are sampled.

The number of ground truth points must be at least 10% of the total required by intrusive methods (in Table 1) alone. Additional ground truth points must be collected if the number of points collected in the mapped areas does not meet the 10% number. Therefore, 10% of the total required by intrusive methods (in Table 1) with a minimum of 2 locations per mapped area is required.

Global Positioning System (GPS) Requirements

Intrusive and geophysical survey locations shall be identified using a GNSS/GPS device (which could include a cellular phone equipped with a GPS application) that maintains a minimum horizontal accuracy of 16 feet.

Qualifications

Persons qualified to conduct the bedrock depth verification process must be knowledgeable and competent in designing, performing and evaluating bedrock depth verification work. Knowledge and

competency can be acquired through field work, education and training. Qualified persons are recognized as:

1. Certified professional crop consultant (CPCC) by the National Alliance of Independent Crop Consultants; or
2. Certified crop adviser (CCA) or certified professional agronomist (CPAg) by the American Society of Agronomy, Wisconsin certified crop advisers board; or
3. Certified professional soil scientist (CPSS) by the Soil Science Society of America; or
4. Licensed professional geologist, professional hydrologist, professional soil scientist, or professional engineer by the Wisconsin Department of Safety and Professional Services (DSPS); or
5. Persons with DATCP conservation engineering practitioner certification for DATCP Technical Standard 01 – Verification of Depth to Bedrock; or
6. Landowners, operators, or others not meeting the above criteria may complete a DATCP-approved training course appropriate for the individual verification method to become qualified if they also have related field experience and/or education. The individual must work with the qualified entity identified by DATCP to get their verification plan approved **before** starting any work and may only perform verification on their owned land, or on other land with permission of the landowner.

Abandonment Procedures

1. If infield depth to bedrock verification uses *boreholes* or other subsurface investigations, they must be backfilled with soil within 72 hours of being created (NR 151.075 (5)) or before applications of nutrients, whichever is first. When abandoning, qualified persons must follow the *filling and sealing* requirements as defined.
    a. Boreholes greater than 1” wide and less than 5 feet deep must be abandoned with either soil cuttings or bentonite granules or chips (3/8” in diameter or less) to grade.
    b. All boreholes greater than 1” wide and between 5 feet and 10 feet deep must be abandoned with bentonite granules or chips (3/8” in diameter or less) to grade.
    c. For boreholes, regardless of width, that are greater than 10 feet deep or where water table (as defined in NR 141) is encountered, follow abandonment procedures in NR 141.
2. If infield bedrock verification incorporates test pits:
    a. For test pits less than or equal to 10 feet depth, the excavation must be backfilled and lightly compacted in no more than 2-foot lifts to approximate the pre-excavated profile. The excavated materials should be replaced in layers and density similar to the surrounding undisturbed soils.
    b. For test pits greater than 10 feet depth, the excavation must be abandoned according to NR 812.26 which defines excavation as drillhole and requires different criteria.

CONSIDERATIONS

The following statements are optional considerations and not required practices:

- Accuracy of geophysical methods typically decreases as depth increases. Other factors such as soil type, subsurface moisture, field conditions and depth to bedrock impact geophysical readings and their accuracy.
- Due consideration must be given to local environmental concerns, economics, the farm’s manure and nutrient management plan and personal safety and health factors when choosing verification method(s).

- The quality of bedrock depth information generated is greatly influenced by the knowledge and expertise of the individuals collecting and interpreting the data.
- When locating intrusive sampling locations, consider spacing locations evenly across representative mapped areas within field to be verified.
- When using an intrusive method, if bedrock encountered is outside of expected range, consider additional probing to verify that what was encountered was not another hard surface (i.e. small boulder, gravel, etc.).
- When choosing verification equipment, consider the operators' expertise and physical ability, as well as weather and field conditions.

PLANS AND SPECIFICATIONS

Field investigation data shall be compiled, georeferenced and interpreted to create a depth to bedrock *field map* for areas where verification activities were completed. Submittals shall be made to the appropriate regulatory agency identified by the Department prior to the application of manure when generated depth to bedrock field maps differ from current publicly available Silurian bedrock maps.

Results of depth to bedrock investigations shall include the following information:

- Field data reporting forms, to include the information listed in Attachment 3;
- Geophysical data map, if applicable, with legend, unit and ground truthing locations;
- Borehole abandonment forms, if applicable;
- Name and qualifications of individual(s) analyzing the field data;
- A computer file with tabulated data in spreadsheet format (or use automatic download functions, if available) identifying latitude/longitude coordinates as recorded during the field effort; and
- Field maps depicting intrusive method data points and depth to bedrock, including information below.
    - Borings and/or geophysical survey locations by recording latitude/longitude coordinates of verification borings and geophysical survey locations using the WGS84 coordinate system; and
    - Field location, field boundary, acres, field identification number, scale, all borings/and or geophysical survey locations using the above requirements and a North directional arrow.

The verification information shall then be used to update the NRCS 590 Nutrient Management plan prior to manure application.

REFERENCES

Chapter NR 141, Wis. Adm. Code, Groundwater Monitoring Well Requirements, https://docs.legis.wisconsin.gov/code/admin_code/nr/100/141/

Chapter NR 151.075, Wis. Adm. Code, Runoff Management, Silurian bedrock performance standards, https://docs.legis.wisconsin.gov/code/admin_code/nr/100/151/II/075

University of Wisconsin, SnapMaps, https://snapplus.wisc.edu/maps/.

USDA, NRCS WI, December 2015, Conservation Practice Standard, Nutrient Management, Code 590.

USDA, NRCS WI, October 2017R, Conservation Practice Standard, Waste Storage Facility, Code 313.

USDA NRCS, Web Soil Survey, https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm.

Wisconsin Department of Natural Resources Bureau for Remediation and Redevelopment Tracking System (BRRTS) database, https://dnr.wi.gov/topic/Brownfields/botw.html.

GLOSSARY

Bedrock – The solid or consolidated rock formation typically underlying loose surficial material such as soil, alluvium or glacial drift. Bedrock includes but is not limited to limestone, dolomite, sandstone, shale and igneous and metamorphic rock.

> *Note: Although solid or consolidated bedrock can sometimes be removed with typical excavation equipment, these materials are included in the above definition.*

Borehole – A circular hole deeper than it is wide, constructed in earth material for the purpose of either installing a well or obtaining geologic or groundwater related data. Boreholes are also referred to as drillholes.

Department – The Wisconsin Department of Agriculture, Trade and Consumer Protection.

Field – A group or single nutrient management unit with the following conditions: similar soil type, similar cropping history, same place in rotation (i.e., second year corn fields, established alfalfa), similar nutrient requirements and directly adjacent. Examples include: alternate strips in a contour strip system, pasture, variable rate nutrient application management units and other management units where grouping facilitates implementation of the nutrient management plan.

Field map – The map of a field that includes the completed verification depths and sampling locations required by this technical standard.

Filling and Sealing – To fill a well, drillhole, pit or reservoir with a material or materials so the well, drillhole, pit or reservoir will not act as a vertical conduit to contaminate another well, groundwater or an aquifer.

Mapped area – A continuous area or coverage with similar bedrock depths and soil properties such as electrical conductivity, used to develop a sampling/verification plan.

Nutrient Management Plan (NMP) – A planning document that outlines the requirements for managing the amount, form, placement and timing of applications of plant nutrients to cropland.

Silurian bedrock map information – Areas where Silurian dolomite bedrock occurs in Wisconsin can be identified by the most current NRCS, Wisconsin Geological and Natural History Survey, DATCP, DNR, or county maps. Silurian bedrock map information, available from the University of Wisconsin Department of Soil Science, can be found at https://snapplus.wisc.edu/maps/.

Attachment 1

Management and Site Assessment

WI Department of Agriculture, Trade and Consumer Protection
Technical Standard 01 – Verification of Depth to Bedrock

Farm: _____ Owner/Operator: _____

Assessment By: _____ Date: _____

Qualifications of assessor/verifier: _____

Location: _____ ¼ of _____ ¼, Sec. _____, T. _____, R. _____

Township: _____ County: _____ Field ID(s) _____

MANAGEMENT ASSESSMENT

Intent/Purpose:

- Items to consider before investigation
    - Mechanical application of solid (greater than 12%) or liquid manure?
    - What are the farm's nutrient management and manure management objectives?
    - Discuss with landowner and/or operator to identify possible shallow bedrock or karst features to determine verification priority areas.
    - What are the priority fields and current identified restrictions?
    - Contacting Digger's Hotline
    - What depth(s) to bedrock is desired to be verified (>2 ft., >3 ft., >5 ft., >20 ft.)?

SITE ASSESSMENT

Describe the site and attach information as available, information that may be included could consist of:

- Current nutrient management restriction maps
- Area bedrock and karst maps
    - SnapMaps or others as available
- Site specific information which may consist of:
    - Well construction reports
    - Manure storage soils investigation information
    - Windmill drill logs
    - DNR BRRTS database information
    - WisDOT boring logs
    - Wisconsin Geological and Natural History Survey data
    - Prior geophysical investigations

- County Land & Water Conservation Department and Sanitarian resources
- Recent and historic air photos
  - Is there evidence of exposed bedrock, fracture traces, sinkholes?
- Topographic maps – DEMs, LiDAR information
- NRCS Web Soil Survey information
- Digger's Hotline and other utility/tile line locations, if intrusive methods are used
- Photos of the site
- Cultural resources

Notes:

1. These items are only a recommended list and should not be interpreted as being required.
2. Based on information gathered in this Management and Site Assessment Form, the verification method(s) listed in Tables 1 and 2 of Technical Standard 01 – Verification of Depth to Bedrock for field investigation can be evaluated.

Attachment 2

Examples of Verification Process

The following examples were created to help qualified professionals review how to conduct a credible verification of bedrock depth according to the procedures outlined in this technical standard.

Example 1 – Intrusive example for disputing a 2 ft. depth to bedrock boundary. In this example, an intrusive method will be used to sample locations along the 0-2 ft. and 2-5 ft. depth to bedrock boundaries, since this is the area of the field the landowner is refuting. Follow steps 1-3 below.

1) Identify the map and which depths will be refuted in the field (see Figure 1). This example is disputing the 2 ft. depth to bedrock boundary to verify if bedrock is deeper than 2 ft. The soils map in SnapMaps was used as the starting point for developing the verification plan.

2) Develop a verification plan by determining the appropriate verification method and sampling density as indicated in Table 1.
   a) This example is disputing the 2 ft. boundary using a hand probe. Table 1 calls for the following density at a minimum for the area being refuted.
      i) "At a minimum, one probe per 1/4 acre (~100 ft. spacing) when disputing the 2 ft. and/or 3 ft. boundary."
      ii) In this example, eight hand probe locations would be performed, as shown as green points labeled 1 to 8 in Figure 1.
      iii) Remember, this is **minimum** spacing and more probing may be required depending on encountered depth – the qualified individual will make this determination.

3) Perform the verification using the approved plan from step 2.

Figure 1 – Example 1, Using an Intrusive Method

Example 2 – Geophysical survey example for disputing a 2 ft. depth to bedrock boundary. This example is disputing the 2 ft. depth to bedrock boundary in order to verify if bedrock is actually deeper than 2 ft. The soils map in SnapMaps was used as the starting point for developing the verification plan. Follow steps 1-3 below.

1) Identify the map and which depths will be refuted in the field.
2) Develop a verification plan by determining the appropriate verification method and sampling density as indicated in Table 2, with corresponding ground truthing. In this example, an EM geophysical method (e.g. EM-38, EM-31, or DualEM) and ground truthing with a hand probe will be used across the 0-2 ft. depth to bedrock boundary since this is the area of the field the landowner is disputing.
    a) This example (see Figure 2) is disputing the 2 ft. boundary using an EM geophysical method (e.g. EM-38, EM-31, or DualEM) and ground truthing with a hand probe.
        i) Table 2 calls for the following density at a minimum for the area being refuted: “At least one survey line (covering the length of the field) per 100 ft. spacing when disputing the 2 ft. and/or 3 ft. boundary.” The two survey lines shown in Figure 2 meet these criteria.
        ii) From the Geophysical Method Ground Truthing section, “10% of the total required by intrusive methods (in Table 1) with a minimum of two locations per map area is required.” Therefore, two hand probes would be performed. 10% of eight hand probes performed in Example 1 is less than one hand probe so the minimum of two hand probes is required. Preferred probe locations would be 1 and 5 to maximize distance and sample different bedrock depth areas. The ground truth hand probes are shown as green points in Figure 2.
        iii) Remember, this is **minimum** spacing and more probing or survey lines may be required depending on encountered depth – the qualified individual will make this determination.

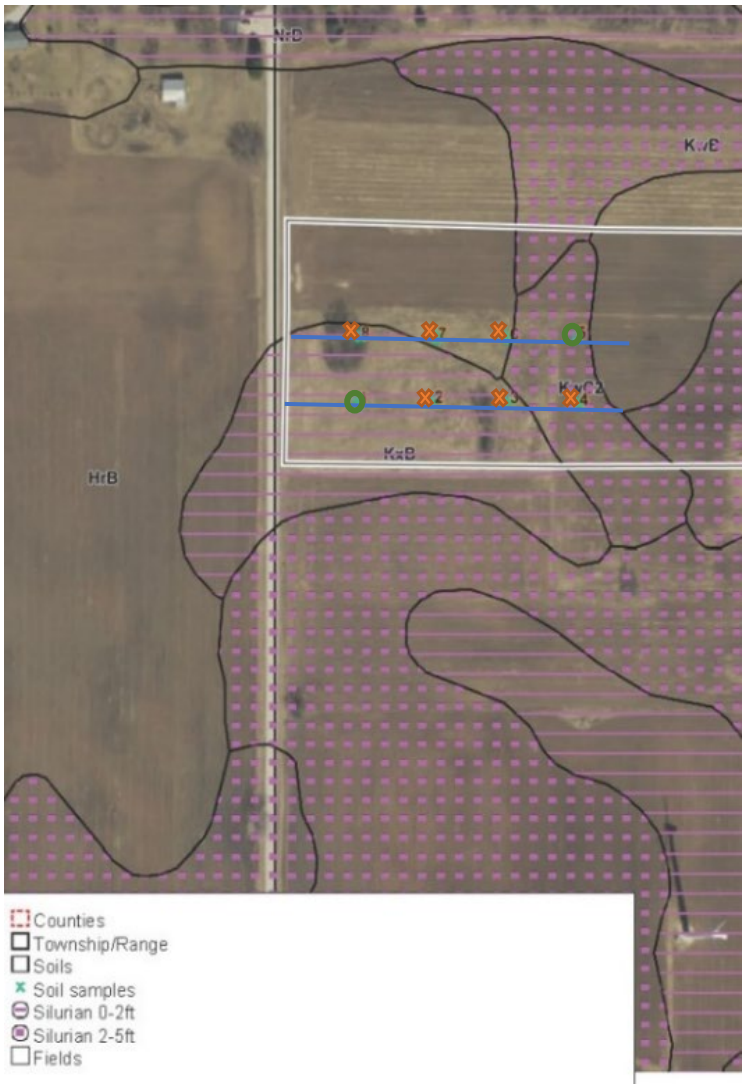

Figure 2 – Example 2, Using Geophysical Method

3) Perform the verification using the approved plan from step 2.

Attachment 3

Field Data Collection Requirements

This attachment describes information to be collected for infield depth to bedrock verification.

1. Owner/Facility Name, Address, Phone Number
2. Property Location Information
    a. County
    b. Civil Town/City/Village
    c. Parcel ID#
3. Probe/Boring/Test Pit Information
    a. Equipment operator name and agency/firm
    b. Data recorder name and agency/firm
    c. Test hole ID #
    d. Field ID
    e. Tillage Conditions
    f. Date(s) of each test hole
    g. Equipment/Method used (e.g. tile probe, hand auger, hydraulic push, excavator). Include probe/auger diameter and/or equipment make and model, as appropriate.
    h. GPS latitude/longitude location
    i. Total depth of boring/pit, measured to the nearest 1 inch
    j. Depth to bedrock, if encountered, measured to the nearest 1 inch
    k. Borehole abandonment method
    l. Notes
4. Geophysical Survey Information
    a. Equipment operator name and agency/firm
    b. Data recorder name and agency/firm
    c. Date(s) of data collection
    d. Field moisture condition (e.g., saturated, unsaturated, droughty)
    e. Equipment/method used. Include equipment manufacturer and model
    f. Data collection sample spacing
    g. GPS latitude/longitude location
    h. Anticipated total depth measured by geophysical instrument and the instrument configuration used to achieve depth
    i. Depth at which bedrock was encountered, measured from ground surface and the accuracy of depth interpretation. If bedrock was not encountered, indicate that bedrock was not encountered