DRAFT

WISCONSIN DEPARTMENT OF AGRICULTURE, TRADE, AND CONSUMER PROTECTION

TECHNICAL STANDARD

VERIFICATION OF DEPTH TO BEDROCK

01

INITIAL REVIEW COMMENTS AND RESPONSES

Drafted technical note text (as sent for Initial Review) is in black font.

Comments are in blue, preceded by comment number (**C#**). To find a specific comment number, search for that number using "Ctrl + F" (Windows) or "Command + F" (Mac).

Responses to comments are in green italics.

Changes to standard text are in tracked changes.
Minor editorial suggestions from reviewers are also highlighted.

GENERAL COMMENTS

C12: Which agency determines the "official" map of depth to bedrock?

RESPONSE: *It is indicated in NR 151.075 that "Note: Silurian bedrock map information developed by the department of agriculture, trade and consumer protection and/or department of natural resources, may be used alone or in combination to meet the requirements of this section." DATCP will work in conjunction with DNR to determine the authority to designate an "official map" for depth to bedrock and appropriate next steps for rule revisions.*

C13: Do other agencies have authority to request that the official map be revised based on new information?

RESPONSE: *An entity can request a change to the official map by DNR and DATCP based on new information. A process will be identified by DNR and DATCP.*

C14: Are agencies exempted from performing a verification procedure to revise a map?

RESPONSE: *No, the agencies are not exempt.*

C17: What is the procedure to buffer a known but unmapped outcropping of exposed bedrock? What depth to bedrock do we assume and at what distance around the outcrop?

RESPONSE: *Exposed bedrock is considered a direct conduit to groundwater by definition in NRCS 590, meaning it has the same setbacks (buffer zone) which is within 50 ft from that feature.*

Currently, the procedure is that the exposed bedrock information is submitted to the appropriate county and then submitted to the SnapMaps team to be added into SnapMaps for those counties that currently do that.

C39: In my opinion the intent of NR151 is to protect public interests. Unless it is outside the scope of this document, it is believed that the standard should state that not only the land owner(s) or organization(s) farming the land have a right to challenge currently available bedrock data but any party directly impacted by the nutrient management program implemented at the field in question has the right to challenge currently available data. … People other than the land owner(s) or organization(s) farming the land should be able to challenge the currently available data.

RESPONSE: *NR 151 states that "All crop producers and livestock producers that mechanically apply manure directly or through contract or other agreement to cropland or pasture areas that*

meet the definition of Silurian bedrock under s. NR 151.015 (17) must comply with this section." This standard is also only to refute the existing maps for those who which NR 151.075 applies.

C40: [I suggest] that currently available is data adjusted using a common engineering practice of applying a safety factor. For example, given depths of three and five feet are major concerns one could apply a safety factor of 0.66 for currently available data that states the depth to bedrock is less than or equal to 3 feet and a safety factor of 0.5 for currently available data that states the depth to bedrock is greater than 3 feet and less than or equal to 5 feet. This would provide the public "some" protection for an unknown margin of error in the currently available data. This would also provide land owner(s) or organization(s) farming the land some margin of safety if they are held responsible for currently available data that misclassifies their land.

***RESPONSE:** A margin of error and safety is not included in this standard. This information may be considered in future rulemaking.*

C41: Can a land owner(s) or organization(s) farming the land be penalized for inaccurate currently available data? … None of the methods are 100%. Parties should have some direction about the level of confidence needed to meet the standard. The National Soil Survey Handbook section 614.6 discusses allowing normal errors of observation in Paragraph D.

***RESPONSE:** Issues related to inaccurate data are not included in this standard. This information may be considered in future rulemaking.*

C73: Except for the verification sample spacing, all of the recommendations for field verification are spot on. It's no wonder, they were written by people who have recorded a lot of data, made a lot of maps, and conducted research in the counties in northeastern Wisconsin.

***RESPONSE:** Thank you. The entire team put in a lot of time and effort for this standard creation.*

C87: Suggestion: In the final guidelines, it would be great to have some examples of fields and the sampling density. I am particularly confused about fields with depth boundaries through the field. Here {see image to right] is a field, for example, that has 0.7 acres in the less than 5 ft category and the rest is in the less than 20 ft category. Assuming that the purpose is to show whether or not the less than 5 foot boundary is there, where would be the best sampling locations? How should topography be taken into account? If you do find bedrock within 5 ft within the area indicated on the map, is it ok to assume it's not in the rest of the field?

***RESPONSE:** Thanks for this suggestion. We will provide examples with maps so that the process is clear. In this case, you would only be challenging the < 5ft boundary so you would assume the rest is mapped correctly. Following the site assessment, you would take topography and the many other factors listed in that and the Methodology sections into consideration.*

C89: I think this is putting a lot of liability on whoever is writing the 590. Landowners in these areas may have trouble finding someone to write their plans in the future, and also as this spreads to other parts of the state.

***RESPONSE:** Thank you for the comment. Liability is not addressed in the standard.*

C110: Please clarify what end product will be generated when following this standard. The standard appears to end with the creation of "field maps", not nutrient management plan field restriction maps for manure applications. This is contrary to the Definition and the Conditions Where the Practice Applies, that both reference "fields receiving mechanical applications of manure". A field restriction map that accounts for the verification of depth to bedrock results should be the end product to ensure depth to bedrock is properly reflected on maps for fields receiving mechanical applications of manure.

***RESPONSE:** This standard is intended to provide protocols for depth to bedrock verification to meet the requirements of NR 151.075.*

C115: Data management considerations should be addressed as a complement to this standard – who will keep verification records and how will those records be brought into SnapPlus to update field restriction maps and nutrient management plans?

RESPONSE: *We understand your request and will consider in future rulemaking.*

C116: This document should be a technical note in the 590 Standard for Nutrient Management.

RESPONSE: *The team leaders have reached out to NRCS to see if this is of interest.*

DEFINITION

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

C11: Why only mechanical application? Grazing cattle should be considered as well. For instance, we see in a dry year that the grass growing over cracks in the bedrock is greener and more lush. The grazing cattle will congregate there, not dispersed over the entire field.

RESPONSE: *This technical standard is to support implementation of NR 151.075. Silurian bedrock performance standards in NR 151.075 contain restrictions specific to mechanical manure applications.*

C104: Field has a solid definition, but specifically not used for siting agricultural structures. Pasture Management Plans and pastures are NMP tools, but not defined as a field.

RESPONSE: *The field definition in this standard is derived from the "Field" definition in the NRCS 590 standard. The team made a slight adjustment to this definition to fit this standard.*

PURPOSE

The purpose of this standard is to provide appropriate methods for verification of depth to bedrock to support implementation of s. NR 151.075 in ~~designated~~ areas where the bedrock consists of Silurian dolomite with a depth to bedrock of 20 feet or less.

C67: Based on what data? The 1973 Trotta, Cotter, 1:1,000,000 depth to bedrock contours? The 1979 Sherrill maps of the Silurian Aquifer at 1:250,000? I am very familiar with both, and they are woefully inadequate to be used to enforce any regulations on a field by field basis. Even a 1:24,000 depth to bedrock map isn't going to be adequate resolution to distinguish the difference between 3 and 5-feet to bedrock.

It is unclear what data source would be the determining factor for knowing whether your property falls in the "less than 20 feet" zone. Usually the statement "depth to bedrock of 20 feet or less" is followed by the name of a map, or data set, and the scale of that map or data.

RESPONSE: *It is indicated in NR 151.075 that "Note: Silurian bedrock map information developed by the department of agriculture, trade and consumer protection and/or department of natural resources, may be used alone or in combination to meet the requirements of this section." Future rulemaking will determine where this mapping information will be housed.*

C68: New maps are needed.

RESPONSE: *We are very aware of this issue and are actively pursuing options to complete new mapping efforts.*

C74: The existing Silurian bedrock map information is as likely to miss some areas with shallow Silurian bedrock as it is to show it where it doesn't exist. See the Note under separate cover regarding Depth to Silurian Bedrock Maps in SnapMaps.

[1] Words in the 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.

RESPONSE: *In order to implement NR 151.075, we need to use the best mapping we have available, which is currently in SnapMaps.*

C94: Too narrow if we consider the other situations requiring an assessment of bedrock depth. Standards are generally not code specific, rather, codes tend to cite standards.

RESPONSE: *This standard is to specifically implement the in-field verification of depth to bedrock that is required in NR 151.075.*

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to 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 challenged.

C20: Are we sure there are no other types of bedrock?

RESPONSE: *NR 151.075 is specific to Silurian Dolomite but we have added that this standard can be used for other bedrock formations as well.*

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

C21: Define "closed depression determinations".

RESPONSE: *"Closed depressions" is already defined in NR 151.015 (2).*

C117: Explain why this standard is not to be used for closed depressions.

RESPONSE*: The scope of this standard does not include closed depressions.*

C95: Major fault when dealing with groundwater protection. We need comprehensive solutions that address resource protection. Disputes between agencies cannot limit the need to address closed depressions. If closed depression delineation is specified elsewhere, problem solved but I am not aware of this effort being in place or in development.

RESPONSE: *The scope of this standard does not include closed depressions.*

CRITERIA

General Criteria

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

Laws and Regulations

Users of this 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 standard does not contain the text of Federal, State, or local laws. Implementation of this standard may not eliminate pathogen or nutrient losses that could result in a violation of law.

Location

This standard applies to the area subject to s. NR 151.075 ~~comprises portions of the following counties: Brown, Calumet, Dodge, Door, Fond du Lac, Kenosha, Kewaunee, Manitowoc, Milwaukee, Outagamie, Ozaukee, Racine, Sheboygan, Walworth, Washington, and Waukesha~~ where depth to Silurian dolomite bedrock is 20 feet or less. This standard may also be used to verify depth to bedrock (or other bedrock formations) in other locations, if applicable.

C96: If this process will not change in other bedrock formations, remove this language. If for example we have an inclusion area of shale within these counties, we cannot use this standard by the narrow Purpose and Location specs.

RESPONSE: *We have clarified the text for this issue.*

C118: We support the use of the standard in other locations.

RESPONSE: *This standard may also be used to verify depth to bedrock in other locations, if applicable.*

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~~should~~ 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~~2~~. Findings of the site assessment must~~should~~ 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~~may~~ be reviewed, as applicable~~available~~:

1. Discussions with land owner and/or operator to identify possible exposed bedrock, shallow soils over bedrock, or karst features;

C119: Add the words "soils over" so that it reads "…possible shallow soils over bedrock…"

RESPONSE: *Text has been updated, thank you for the suggestion.*

2. Farm's *nutrient management plan* and manure 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);

C15: When well logs indicate that bedrock depth is greater than 20 feet in an area mapped as having a depth of less than 20 feet, does the verification procedure need to be performed to revise the map?

RESPONSE: *Yes. Well log indications do not exclude anyone from performing the verification process. NR 151.075 identifies in-field verification is required for dispute of the maps.*

C22: Suggest adding tile lines to this list.

RESPONSE: *Tile lines are included in Item #8 below.*

C97: No mention of WI Geological and Natural History Survey source documents and data sets?

RESPONSE: *The team developed this list of some applicable resources. WGNHS depth to bedrock maps are incorporated into SnapMaps. Well Construction Report data is accessed from DNR webpage. Any more site-specific data would be in project files and not easily accessible to non-WGNHS personnel.*

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 and depths of utilities/tile lines, 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/).

C75: These depth to bedrock maps are subject to false negatives as well as false positives. Verification will only be undertaken to show false positives.

RESPONSE: *Infield verification is used to dispute a current map. The SnapPlus map should not be the only information considered before a qualified individual performs verification. We realize there are inaccuracies and want individuals to utilize as much available information as they can before performing infield verification. Addressing false negatives are outside of the scope of our work on this standard.*

C76: Please note that there currently are no maps available to distinguish between the 0-3 ft depth. The maps that are in Snap Plus are for 0-2 ft depth and 2-5 ft depth.

RESPONSE: *We are aware of that issue. NR 151.075 uses 0-2ft, 2-3ft and 3-5ft depth increments so we kept the depth ranges the same, for consistency.*

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. ~~T~~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 ~~listed in ATCP 50~~determined by the *Department* **before** any verification work is completed.

C18: Who will determine if the verification plan is adequate?

RESPONSE: *See the Qualifications section.*

C23: Why is pre-approval necessary?

RESPONSE: *It is only necessary if the individual does not meet the requirements in the Qualifications section, #6.*

C77 // C90: Where in ATCP 50? Is this a part of ATCP 50 that isn't written yet? // The appropriate location in ATCP 50 should be used, or at least a more specific description of what qualification section you are referring to (possibly reference the Qualifications section further on in the standard.

RESPONSE: *We have updated the text to identify the Department rather than ATCP 50. This information will be considered in future rulemaking.*

C105: Does this mean said person listed in ATCP 50 may be able to approve a plan that does not meet the Qualifications section of this standard? This is an ATCP Technical Standard and would be my opinion approval should come from DATCP Engineering.

RESPONSE: *No this does not mean that a person qualified to write a plan under ATCP 50.48 could approve a verification plan without also meeting the qualifications in this technical standard.*

C113: County Land Conservation Department involvement should be reflected throughout the standard. LCDs should be listed as the entity to approve the plan for verification.

RESPONSE: *This may be addressed in future rulemaking.*

C120: The entity approving the verification plan should also have appropriate training/certification.

RESPONSE: *This may be addressed in future rulemaking.*

C121: Changes to the verification plan shall be submitted and approved by the appropriate entity.

RESPONSE: *This may be addressed in future rulemaking.*

C122: The verification plan should be submitted sufficiently in advance of planned verification measurements to allow adequate time to review and approve.

RESPONSE: *This may be addressed in future rulemaking.*

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.

C78: Take into account how? Needs more detail to be instructive and helpful.

RESPONSE: *We added more clarification and detail to this section.*

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.

C1: Why are we land leveling? Not all the sampling methods require smooth land and you can survey the area before hand and use that to calibrate your depths.

RESPONSE: *Added "if needed" above. Levelling is to ensure the depth measurements are truly representative of the area. Surveying a field is costly and not necessary.*

C24: How smooth? Is a tillage pass needed?

RESPONSE: *A tillage pass is not needed. We clarified this in the text.*

C123: Clarify the degree to which the land surface must be smoothed. Is verification allowed on rough tilled fields?

RESPONSE: *The land surface must be smooth enough to get a representative sample from the land surface.*

4. Depth verifications must be performed in the field being disputed (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 disputed 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**;

    C124: Add a new letter that refers to collecting a second measurement at a specified % of all samples to assess the precision of field measurements. Such as… "At minimum, duplicate measurements shall be collected at the same location at least once for every X (ten?) measurements. Duplicate measurements shall be located as close as possible to the first sample location. Duplicate measurements shall be compared and if results vary by more than X% additional samples shall be collected beyond the minimum sampling density listed in Tables 1 and 2. Consider this similar to duplicate samples collected for water quality monitoring.

RESPONSE: *We are not requiring duplicate samples in this standard. The requirement of GPS and the level of GPS accuracy required is meant to get at this issue.*

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 disputed in that area; and

C91: [This] is hard to understand. I believe it could be interpreted as you must extend the sampling into an adjacent field OR that you only have to follow the specific field plan. That should possibly be re-worded.

RESPONSE: *Thank you for the feedback. The intention behind this is to make sure that you are using the sampling density for the depth of which you are disputing even if you are crossing field boundaries.*

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 (~104~~0~~ ft spacing) when disputing the 2 ft and/or 3 ft boundary.	2 ft 3 ft
C106: I am struggling with this, but I am not sure I can make a constructive suggestion. Simplest approach, but also feel the precision and accuracy is not very good, however may be the most conservative approach because a stone is going to impact this effort. Feel more than 1 per ¼ acre should be required. I feel machine methods should have more reasons to go that route, as I feel it should be more accurate. ***RESPONSE:*** *The team spent a lot of time discussing appropriate sampling density. After much discussion and reviewing different in-field examples, we decided that the ¼ acre spacing was appropriate to 2 ft and 3ft depths to bedrock and the variation in a field. We added a statement in the Considerations section to help address this further.*			
Hand held or machine auger	Auger is ~~driven~~ advanced or turned into ground and rotated.	At a minimum, one probe per 1/4 acre (~100~~4~~ ft spacing) when disputing the 2 ft and/or 3 ft boundary. At a minimum, one probe per 1 acre (~200~~8~~ ft spacing) when disputing the 5 ft boundary.	2 ft 3 ft 5 ft
Direct push probe (e.g. Geoprobe, loader/skid steer pushing rod, hammer probe)	Probe is advanced using hydraulic or percussive methods.	One probe per 1/4 acre (~100~~4~~ ft spacing) when disputing the 2 ft and/or 3 ft boundary. One probe per 1 acre (~200~~8~~ 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

Method	Description	Minimum Sampling Density Required[1]	Allowable Boundary Depth Verifications
Excavation[2]	A pit is excavated for evaluation.	One pit per 1/4 acre ~~(104~~ (~100 ft spacing) when disputing the 2 ft and/or 3 ft boundary. One pit per 1 acre (~~208~~~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.

C79: No maps are presently available for the 3 ft boundary.

RESPONSE: *We are aware of this issue however the standard uses the depth categories consistent with those in NR 151.075.*

C26: ¼ acre seems aggressive [for 2' and/or 3' boundaries]. ½ acre would be reasonable.

RESPONSE: *The team spent a lot of time discussing whether or not we use ¼ or ½ acre. After much discussion and reviewing different in-field examples, we decided that the ¼ acre spacing would give us the most accurate depiction of the variation of the depth to bedrock in a field.*

C69 // C78 // C124: 104 foot spacing is insufficient to determine the depth differences between 2 feet and 3 feet. One push probe every 30 feet might be an appropriate spacing to capture the difference between 2 feet and 3-feet to bedrock. // Depth to bedrock can vary at points that are just a few inches apart, and one probe per ¼ acre is not likely to be adequate if the field has depths that are hovering close to a particular boundary. One way to get some more assurance without having to poke more holes, is to assign an added safety factor to the depth needed -- 12 inches might be appropriate depending on the depth boundary. For example, if they are disputing the 2 ft boundary and all of the points are greater than 3 ft, that would meet a 12 in safety factor. If some of the points were between 2 and 3 ft, the planner would want to ensure that a concerted effort is made to locate the shallowest depth(s) in the field for verification, using the trends of the measured depths and all other available information. // One probe per ¼ acre is not sufficient.

RESPONSE: *The team spent a lot of time discussing the spacing considering accuracy and cost. We created some test sampling plans using real data to see how verification and boundary lines would change with different densities and also compared actual intrusive and geophysical data to compare the accuracies of different methods and densities. After much team discussion and review of in-field examples, we decided that the ¼ acre spacing would give us a reasonably accurate depiction of the variation of the depth to bedrock in a field while also remaining cost-effective. We added a statement in the consideration section to help address this further.*

C125: Additional probes shall be conducted to ensure crevices are not encountered with first probe. Higher probe density is necessary to identify transition zones and delineate boundaries of soil depths.

RESPONSE: *The team spent a lot of time discussing the spacing considering accuracy and cost. We created some test sampling plans using real data to see how verification and boundary lines would change with different densities and also compared actual intrusive and geophysical data to compare the accuracies of different methods and densities. After much discussion and review of in-field examples, we decided that defining transition zones did not largely change the resulting field maps.*

Furthermore, this is only minimum criteria, additional probing to delineate boundaries may be necessary and will be left up to the qualified individual to make those determinations. We added a statement in the consideration section to help address this further.

C70: 208 feet spacing is insufficient to determine the difference between 3 feet and 5 feet.

RESPONSE: *The team spent a lot of time discussing the spacing considering accuracy, cost, and the quality of data to produce the existing maps. We created some test sampling plans using real data to see how verification and boundary lines would change with different densities and also compared actual intrusive and geophysical data to compare the accuracies of different methods and densities. After much discussion and review of in-field examples, we decided that the ½ acre spacing would give us the most accurate depiction of the variation of the depth to bedrock in a field while also remaining cost-effective.*

C45: While the sample spacings of 104 ft (¼ acre) for a 2 ft boundary depth and 208 ft (1 acre) for a 5 ft boundary depth seem reasonable, a 660 ft spacing for a 20 ft boundary depth seems to be disproportionately large. It is my opinion that the transition from 1 acre for the 5 ft boundary to 4 acres (420 ft line space) for the 20 ft boundary is still potential too large, but more in line with past experiences.

RESPONSE: *The team spent a lot of time discussing the spacing considering accuracy and cost. We created some test sampling plans using real data to see how verification and boundary lines would change with different densities and also compared actual intrusive and geophysical data to compare the accuracies of different methods and densities. After much discussion and review of in-field examples, we decided that the selected spacing would give us the most accurate depiction of the variation of the depth to bedrock in a field while also remaining cost-effective.*

C10: I am very uncomfortable verifying between 5&20 feet with enough accuracy.

RESPONSE: *We understand your concern. In order to implement NR 151.075 we need to recognize the inaccuracies involved with the verification of depth to bedrock but also need to use the available methods to complete the verification required by NR 151.075.*

C16: Are water jet probes an acceptable method of measuring depth to bedrock?

RESPONSE: *No, the team did not determine this to be as an acceptable verification method at this time.*

C25: Clarify depths in Sampling Density and Boundary Depth columns. Suggest using ranges: 0-2 ft, 2-3 ft, 3-5 ft.

RESPONSE: *We chose the boundary depths because a verifier will actually be disputing the boundary of a depth range, not the depth range itself.*

C27: Excavation density too much. Do we really want to disturb the soil? Limit the test holes to a perimeter based on map outline first, especially on 3-5; bedrock.

RESPONSE: *The team chose to stay consistent with other intrusive method sampling densities but we understand that excavation is highly intrusive and have included it with recommendation to use only if there is no other option.*

C28: Instead of “Boundary” use different term like “Mapped Bedrock Boundary”.

RESPONSE: *Thank you for the suggestion.*

Notes:

1. This is only 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. See Attachment 2 for an example depicting the design of an intrusive sampling plan.

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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 ~~M~~measures~~s~~ the ~~bulk~~apparent electrical ~~current~~ conductivity~~e~~ of~~d~~ ~~by~~ the subsurface.	At least one survey line (covering the length of the field) per 100 ft field 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
C53: Unless the manufacturer can provide specific details to the contrary, the distance between the outside electrodes (maximum width of the array) should be on the order of 5.5 times the average depth of investigation. In other words, for this system to reach an average depth of 2 feet to 3 feet, the width of the system should be about 11 to 16.5 feet wide, respectfully. While this estimate can be somewhat dependent on soil conditions, the math and physics behind this estimated depth is based on extensive research discussed in "2-D and 3-D Electrical Imaging Surveys" By Dr. M.H.Loke Copyright (1996-2018). ***RESPONSE:*** *The Allowable Boundary Depth Verification targets are within the manufacturer's stated depths for functionality of the Veris instrument. In addition, some committee members have experience with the equipment in field situations where depth to rock is within 2 to 3 ft of ground surface (as verified by push probe). While Loke may state the 5.5 times average depth rule, others feel that this is conservative and that 3 times is more realistic.* **C57:** Suggest adding to output column: "Multiple 1-D profiles may be combined to produce a 2-D plan view map." ***RESPONSE:*** *We agree and inserted this statement.*				
Electromagnetic (EM) surveys - Frequency domain conductivity (e.g., Dual EM, EM-31, EM-34, EM-38)	Using the induction principle, measures the apparent~~bulk~~ electrical conductivity of the subsurface.	At least one survey line (covering the length of the field) per 100 ft field spacing when disputing the 2 ft and/or 3 ft boundary. At least one survey line per 200 ft field spacing when disputing the 5 ft boundary.	Continuous profile of apparent electromagnetic 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)
C58: Suggest adding to Output column: "Multiple 1-D profiles may be combined to produce a 2-D plan view map." ***RESPONSE:*** *We inserted a similar statement.* **C59:** Add 20 ft boundary for EM boundary depth verification. ***RESPONSE:*** *We did not originally include the 20 ft depth because there are limited models that are appropriate. But we agree that some can; and adjusted the listed Allowable Boundary Depths accordingly.*				

Method	Description	Protocols	Output	Allowable Boundary Depth Verification
Electrical Resistivity Imaging	Electrodes in contact with the ground at specified~~various~~ spacings~~, path differences between electrodes~~ to measure the ~~bulk~~produce a ~~dataset that creates an~~ electrical resistivity~~profile~~ of the subsurface.	At least one survey line (covering the length of the field) per 200 ft field spacing when disputing the 5 ft or 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
This reviewer is distinguishing between Electrical Resistivity Profiles and Electrical Resistivity Imaging. These are essentially the same method. We do not recommend simple1-D profiles. But do recommend Electrical resistivity imaging or tomography. Our Method Title was not clear and by adding the word "imaging" we hope to correct that. **C60:** Suggest adding to Output column: "Multiple 1-D profiles may be combined to produce a 2-D plan view map." ***RESPONSE:*** *We agree and inserted this statement.* **C61:** Add 2 ft and 3 ft boundary depth verification (dependent on array configuration). ***RESPONSE:*** *We are not comfortable adding these shallow depths. The array configuration (stakes very close together) limit the applicability of this method especially considering that the contact electrical conductivity method is designed for these shallow depths.*				
Horizontal-to-Vertical Spectral Ratio (HVSR)	~~Using a~~A seismometer, records ambient seismic noise to estimate sediment thickness and depth to bedrock.	At a minimum, one measurement per 1 acre (20~~0~~8 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
C54: Reached out to colleges and could not find supporting documentation to suggest that HVSR methods are viable for depths less than 30m. Assumed there is some confusion between MASW seismic methods and HVSR methods. MASW is a viable seismic method for this technical standard. [See Comment C63 to add MASW] ***RESPONSE:*** *Experience of the team members is that this method has successfully been used in this geologic setting to image depths <20 ft (as verified by both electrical resistivity imaging and backhoe pits). We do agree that the 5 ft depth may not be appropriate. In addition, Minnesota geophysicists (Chandler and Lively, 2016) have used this for depths significantly <30m.*				

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 field spacing when disputing the 2 ft and/or 3 ft boundary. At least one survey line per 200 ft field spacing when disputing the 5 ft boundary.	Continuous 2-D 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 field spacing when disputing the 5 ft or 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 mMeasures the bulk electrical properties of the subsurface.	At least one survey line (covering the length of the field) per 200 ft field spacing when disputing the 5 ft or 20 ft boundary.	Continuous profile of electrical resistivity along a survey line.	5 ft 20 ft

C64: Suggest changing Output column to:

"Continuous 1-D profile of apparent electrical resistivity along a survey line or produces an electrical resistivity image (cross section) of the subsurface along a survey line. Multiple 1-D profiles may be combined to produce a 2-D plan view map. Multiple 2-D cross-sections may be combined to produce 3-D plan view maps as a function of depth."

RESPONSE: *This description of Output is lengthy and could be used to describe many of these geophysical methods. It is not unique to resistivity mapping. It has to do with the design of the investigation. Given our specifications of minimal spacing for data collection, these comments may not be appropriate.*

C65: Add 2 ft and 3 ft boundary depth verification (dependent on array configuration).

RESPONSE: *We chose not to include the 2 and 3 ft depths because of the method has more difficulty producing a sharp boundary between differing materials as compared to electrical resistivity imaging.*

Method	Description	Protocols	Output	Allowable Boundary Depth Verification
Seismic refraction	~~Using a~~ ~~s~~Seismograph and an array of geophones ~~(planted or land streamer)~~ to record the seismic energy created from a source ~~(e.g. sledgehammer and plate), and create time/ distance graphs to identify depths~~.	At least one survey line (covering the length of the field) per 200 ft field spacing when disputing the 5 ft or 20 ft boundary.	Layered profile of seismic velocities along survey lines.	5 ft 20 ft

This method description is too long for a table summarizing methods for professionals familiar with geophysics.

C66: Suggest changing Output column to:

"Continuous 1-D profile of apparent electrical resistivity along a survey line or produces an electrical resistivity image (cross section) of the subsurface along a survey line. Multiple 1-D profiles may be combined to produce a 2-D plan view map. Multiple 2-D cross-sections may be combined to produce 3-D plan view maps as a function of depth."

RESPONSE: *This description of Output is lengthy and could be used to describe many of these geophysical methods. It is not unique to seismic refraction. It has to do with the design of the investigation. Given our specifications of minimal spacing for data collection, these comments may not be appropriate.*

C9: I think the evaluation methods in Table 1&2 will be proven over time. I don't think, in my experience, that we are ready to declare final approval as some may be added and some may prove impractical.

RESPONSE: *DATCP anticipates the standard will be reviewed routinely and updated as appropriate.*

C2: In the description [column] I would clarify how the unit is taking measurements - individual measurements/spot measurements, or profiles.

RESPONSE: *How the instrument collects measurements should be understood by a qualified operator.*

C3 // C46: [In the Protocols column], all the other spacing for the 2-3 ft is 104 ft. Be consistent. // Suggest field line spacings adjusted to 104 ft, 208 ft, and 420 ft to be consistent with the spacings provided in Table 1 for intrusive methods. [Note, comment C45 suggests change to 420 ft spacing.]

RESPONSE: *Thank you for your suggestion, we updated tables and spacings to be consistent.*

C98: Can [the Protocol requirements] be modified to reflect a distance from the line being disputed? It should be relative to the accuracy of the line being disputed rather than the length of the field. This is true for all Protocols listed.

RESPONSE: *This comment gets at the large question of whether we are disputing boundaries or mapping depth to rock within a field. For all of our methods, not just geophysics, we have chosen a "field-mapping" approach. If a depth-boundary, based on current maps is being challenged, the*

field-mapping approach is the more conservative method since the location of the "new" boundary essentially unknown. By mapping the entire field, it can be determined if the boundary belongs there.

C29: Clarify depths in Protocols and Boundary Depth columns. Suggest using ranges: 0-2 ft, 2-3 ft, 3-5 ft.

RESPONSE: *As a team, we felt there was some confusion using the ranges since you are actually trying to dispute the 2ft, 3ft, 5ft or 20ft boundary. We feel that using the boundaries rather than the ranges is the clearest approach.*

C126: The relative accuracy of the different methods should be included. Were all geophysical methods commonly used in Wisconsin listed in this table or were some removed due to lack of accuracy for the intended end use?

RESPONSE: *The team prepared this table of geophysical technologies that are readily available and represent appropriate accuracy and cost-effectiveness for verification of depth to bedrock. The relative accuracy of the various methods was originally included in the table, but ultimately removed. For the very shallow depths (2 and 3 ft) the accuracy will vary as field conditions (such as moisture content) vary. Given that, we did not feel that we could assign realistic accuracies for the various methods. We chose to address this by specifying the appropriate target depths for each method.*

C55: Consider adding Low Frequency GPR as a viable geophysical method that was not included in Table 2. If in doubt, the usefulness of the method would be validated through the quality control process. Suggest additional row to Table 2:

Low Frequency Ground Penetrating Radar (GPR) With Advance Stacking and Post Processing Capabilities	Uses electromagnetic (EM) signal to reflect energy off of geologic units at depth. Only units with low frequency antennas (less than 250 MHz), units capable of stacking 1000's of traces, and systems with post processing capabilities will likely yield desirable results.	At least one survey line (covering the length of the field) per 104 ft field spacing when disputing the 2 ft and/or 3 ft boundary. At least one survey line per 208 ft field spacing when disputing the 5 ft boundary. At least one survey line per 420 ft field spacing when disputing the 20 ft boundary. Distance between traces should be less than or equal to the manufacturer's recommendations for the selected antenna. Continuous lines or short representative GPR sections at locations along a line. The distance between GPR sections along a line should average less than or equal to 1/4 the line spacing.	Continuous profiles of reflected EM energy along a survey line. Produces an image or cross section of the subsurface along a survey line. More advanced methods can combine multiple 2-D cross-sections to produce 3-D plan view maps as a function of time/depth.	2 ft 3 ft 5 ft 20 ft (dependent on instrument configuration)

RESPONSE: *GPR was not included in this list as the majority of the soils in the area covered by the Silurian bedrock standard are quite conductive. However, we can add the method since some recent advancements in the technology might make it more appropriate for areas with conductive soils. The row was added with edits to remove the detailed specificity of the protocols such that it*

is similar in detail to the other methods. We are assuming that the table is being used by qualified professionals.

C62: Consider adding row for Direct Current Electrical Resistivity Imaging to Table 2:

Direct Current Electrical Resistivity Imaging	Uses direct current with electrodes in contact with the ground and variable electrode spacings to measure the bulk electrical resistivity as a function of depth.	Though often used for characterizing large fields, this method is likely location specific within a site and intended for fields with more complex geology or karst conditions.	2-D electrical resistivity image or cross-section of the subsurface along a survey line. Multiple 2-D cross-sections may be combined to produce 3-D plan view maps as a function of depth.	5 ft 20 ft

RESPONSE: *See above response for electrical resistivity. This row would be duplicative and is not being added.*

C63: Consider adding row for MASW to Table 2:

Multi-channel analysis of surface waves or MASW	Uses a seismograph and an array of geophones (planted or land streamer) to record the seismic energy created from a source (e.g. sledgehammer and plate). The method measures soil thickness or depth to bedrock.	At least one survey line (covering the length of the field) per 208 ft field spacing when disputing the 5 ft boundary. At least one survey line per 420 ft field spacing when disputing the 20 ft boundary. Distance between measurements along a line should average less than or equal to 1/4 the line spacing. See notes (b) and (d).	Maps bedrock using 2-D images or cross-sections of shear wave velocity as a function of depth. Advance methods can combine multiple 2-D cross-sections to produce 3-D plan view maps as a function of depth.	5 ft 20 ft

RESPONSE: *Agreed. MASW is a viable alternative. It was not included in the original table because of the limited use in Wisconsin. The added row will be edited to remove the detailed specificity of the protocols such that it is similar in detail to the other methods. We are assuming that the table is being used by qualified professionals.*

C56a: Suggest adding detail on measurement spacing to Protocols column:

Electrical Conductivity and EM, and Resistivity Mapping rows: "Distance between measurements along a line should average 20 ft or less (often less than 10 ft for higher levels of confidence)."

RESPONSE: *The data are collected continuously. Based on realistic travel speed across a farm field, the resulting sampling densities will be greater than those listed above. We agree that the proposed densities are reasonable. But the detailed design of data collection is beyond the scope of the standard and we are leaving those details to a qualified professional.*

C56b: Suggest adding detail on measurement spacing to Protocols column:

Electrical Resistivity Profiling, HVSR and Seismic refraction "Distance between measurements along a line should average less than or equal to 1/4 the field line spacing."

RESPONSE: *HVSR is a point measurement, rather than data collection along a profile. The data collection densities in this table are the same as those specified for the intrusive methods. For*

electrical resistivity and seismic refraction profiles, this would result in a distance of 50 ft between measurements (200/4). This density is less than what some professionals would do when targeting a 5 or 20 ft depth. The detailed design of a geophysical investigation needs to consider site-specific conditions and not be too prescriptive.

Notes:

1. New technologies not listed in this table are acceptable based on a qualified individual's experience with that equipment.

~~1.~~2. Anticipated depth and boundary refer to the depth to bedrock indicated on the map being disputed.

~~2.~~3. Geophysical instruments must be properly calibrated and operated using manufacturer recommendations for specific environment being evaluated.

~~3.~~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.

C47: Suggest changing to use of a DGPS with sub-meter accuracy to record the starting point of a line, the end point of a line, and locations along a continuous line using an average spacing of 50 feet or less or at intervals stated under protocols for non-continuous lines.

RESPONSE: *The team gave serious consideration to this question. We decided that if farm personnel were to be able to do own their investigations for the intrusive methods, we could not specify a DGPS accuracy any greater than that that is available on a smartphone. In addition, the locational accuracy of manure application (how this the resulting maps will be used) is of a similar accuracy to the GPS accuracy of a smartphone.*

~~4.~~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.

~~5.~~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 rock and variation in soil types and/or textures in an area is required in order to design an accurate geophysical survey.

When geophysical surveys are used to assess depth to rock, depth-to-rock 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 result. Thus, geophysical data may require additional analysis after ground truthing or an intrusive sampling program.

C4 // C127: Does direct measurement mean intrusive methods? // Clarify what is meant by "direct measurement."

RESPONSE: *Yes. Corresponding edit made to text above.*

C43: Suggest adding:

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

RESPONSE: *Corresponding edit made to text above.*

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).

C80: This map legend should also include an indication of error or uncertainty in the measurements, to allow the reviewer to understand whether or not the disputed boundary falls within this area of uncertainty.

RESPONSE: *An allowable error of uncertainty may be considered in future rulemaking.*

C5: Picturing what this means is not easy. An example of a map with the requested legend would help in ensuring you are getting what you ask for.

RESPONSE: *We have provided an example map with an example sampling scenario.*

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.

C99: Needs clarification… is a map area an individual polygon within a field showing (for example a 2 foot bedrock depth) or is the area multiple polygons of similar depth within a field? I am guessing it is the latter, but it needs to be one or the other.

RESPONSE: *The map area is multiple polygons of similar depth and similar geophysical values within a field. Definition of map area has been added and clarification added above.*

C128: Moisture content should be added to this section in a way that identifies how moisture should be considered (e.g. it is not appropriate to complete verification when X conditions exist).

RESPONSE: *We are trusting that the qualified persons performing the verification will be using their professional judgement regarding appropriate moisture content and other related factors.*

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 map area is required.

C6: This feels contradictory. I am reading it to mean that you only need 2 locations to be ground truthed but the next paragraph looks like it needs to be 10% of the total required in Table 1.

To be less confusing I recommend combining the sentences to read 10% of the total required by intrusive methods with a minimum of 2 locations.

RESPONSE: *We have combined those to clarify the wording. Thank you.*

C30: 10% of what? Initial bedrock map or geophysical finding? Then do you revert back to Table 1 for further testing?

RESPONSE: *10% of the total required by intrusive methods (in Table 1) alone.*

C42: Without probes, auger holes, or excavations that are spaced the same distance apart as in a geophysical survey, intrusive methods can be less accurate at characterizing variations in depth to bedrock horizontally across a field. … The logic and reasoning applied to ground truthing geophysical methods is equally applicable for confirming intrusive methods. While there is a clear benefit in implementing intrusive methods on a limited basis to ground truth geophysical results for quality control and correlating or "calibrating" the geophysical response to known conditions, it is equally important to apply geophysical methods on a limited basis to verify intrusive methods. [Note: the reviewer prepared an Intrusive Method section parallel to this Geophysical Method Ground Truthing Section and consistency edits throughout the text to shift approach so that when intrusive sampling is the primary method of investigation, limited geophysical methods are used for quality control.]

RESPONSE: *While this reviewer makes a good point that a combination of methods will likely produce the most accurate maps, it should also be noted that not all farms are in a financial position to pay for a geophysical investigation. We need some methods that can be completed with little to no cost to a farmer. The hand probing or augering intrusive methods are such options.*

C44: Suggest adding:

"If site conditions allow, the intrusively sampled lines should parallel the long axis of the survey area. The location of the intrusive sampling lines are required to coincide with the geophysical results and should, more or less, be equally distribute over the field. The presentation should demonstrate a) there is an agreement between the depths derived from the intrusive sampling program and the interpreted geophysical results and b) that the soil and bedrock conditions remain fairly consistent over the bedrock verification survey area.

"Note: For intrusive sampling, it is important to confirm that there are not erratic bedrock conditions. If there are erratic conditions the intrusive sampling method may not correlate well with the geophysical results, giving the impression there is a poor correlation."

RESPONSE: *Thank you for the suggestion. This inclusion would be inconsistent with the text created by the SOC team.*

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.

C31: Give examples of programs for mapping points and coordinates. Example "Sirus."

RESPONSE: *According to technical standard requirements, we cannot include name or company brands in our standard.*

C48: Suggest reconsidering the use of cell phone based GPS. Reason: Non-subscription sub-meter DGPS is readily available and has a typical accuracy of less than 1 meter most of the time. I have personally seen the adverse results of others using a cell phone for GPS measurements. The outcome of an intrusive sampling program or a geophysical survey can easily be compromised by poor GPS data.

RESPONSE: *When we considered the use of cell phones for GPS measurements, the team reached out to several GPS experts and determined that when considering availability and accuracy, cell phones would be an acceptable option.*

C100: Most GNSS receivers report specifications in meters, I assume you are referring to 5 meters in this case. Also, GPS refers to the US Global Positioning System, proper reference would be GNSS. The standard's language would exclude other navigation constellations.
https://www.semiconductorstore.com/blog/2015/What-is-the-Difference-Between-GNSS-and-GPS/1550/

RESPONSE: *Thank you for providing that information, we clarified the text.*

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. A certified professional crop consultant (CPCC) by the National Alliance of Independent Crop Consultants; or
2. A certified crop adviser (CCA) or certified professional agronomist (CPAg) by the American Society of Agronomy, Wisconsin certified crop advisers board; or

C81: While many CCAs and CPCCs are sufficiently capable and knowledgeable to do some of these verifications, there is nothing in the requirements for their certifications to guarantee that they know anything about bedrock depth verification by most, if not all, of these methods. They should all have the DATCP training required for #6.

RESPONSE: *We have included the following text to clarify: "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."*

3. A 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 WI 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 NRCS Engineering Job Approval Authority~~; or

C128: Certification and/or job approval for which conservation practices? Or is it certification specific to this standard?

RESPONSE: *We are in the process of discussing internally and with NRCS on which certifications may/will be included. Thank you for the comment.*

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 in ATCP 50 to get their verification plan approved **before** starting any work, and may only perform verification on their own land.

C7: I suggest having these training courses available to everyone else listed above as well. That is a chance to ensure that the everyone is on the same page and you get the product that you need the first time.

RESPONSE: *Training will be available to any interested parties, but is only required if one doesn't already have credentials from above list.*

C51: Providing a path for landowners, operators or others not meeting the qualifications in paragraphs 1. through 5. should be extended to the general public. This would provide parties directly impacted by a neighboring nutrient management program the same ways and means (as a land owner(s) or organization(s) farming the land and means) to challenge currently available data. There may be legal issues with others than landowners getting access; however, this venue provides the same opportunity for bedrock verification that those allowed to "police" themselves

RESPONSE: *Training will be available to any interested parties, but is only required if one doesn't already have credentials from above list.*

C50: The general intent of paragraph 6. is commendable. However, should the land owner(s) or organization(s) farming the land be allowed to "police" themselves?

RESPONSE: *The team's decision was to put a process in place for farmers to do the verification themselves. This is the same concept as allowing a farmer or landowner write and implement their own nutrient management plan (ATCP 50) if they take a DATCP qualified training course.*

C71: Self-reporting / self-verification is problematic.

RESPONSE: *The team's decision was to put a process in place for farmers to do the verification themselves. This is the same concept as allowing a farmer or landowner write and implement their own nutrient management plan (ATCP 50) if they take a DATCP qualified training course.*

C92: If the landowner/operator/others get the DATCP certification, can they verify bedrock depths for others or only land that they own/manage? For Nutrient Management a farmer/landowner who takes a DATCP training course can only plan for his/her own farm.

RESPONSE: *Only their own land. We clarified this in the text. Thank you for the comment.*

C112: A uniform training and certification program should be developed for all persons using this standard. Training should not only be required of those who are listed in category #6 in the list of qualified persons.

RESPONSE: *Training will be available to any interested parties, but is only required if one doesn't already have credentials from above list.*

C32: Are there other ways to be qualified? There may be issue of no time to get through a class, cost, and have enough in-field experience as a farmer on our own land to know enough to determine what bedrock is.

RESPONSE: *Thank you for the comment. We will consider cost and time when we create the course/training.*

C107: Qualifications for contractor? I think it would be good to have contractors able to show that they know how to accurately use the equipment above the augers. Some sort of certification should be necessary from my perspective.

RESPONSE: *The person completing the verification work needs to be qualified under the Qualifications.*

C82: All of the geophysical methods require some specialized training, even for the professionals in items 3, 4 or 5.

RESPONSE: *We recognize that specialized training would be needed for geophysical methods and have clarified this in the wording.*

C49: Geophysical methods are not always taken seriously. Because geophysical methods are instrument based many believe you simply turn the instrument on and start taking measurements. Over the years, I and other professionals I work with are clearly aware of inexperienced operators abusing geophysical methods. These abuses reach well-known engineering firms.

RESPONSE: *We recognize that specialized training would be needed for geophysical methods and will make sure that is clarified in the wording. Thank you for the comment.*

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.

C93: It may want to be noted that applications of nutrients are prohibited before those holes are filled. Something like within 72 hours or before applications of nutrients, whichever is first. That way manure/fertilizer will not be applied over those holes before they are filled.

RESPONSE: *Thank you for the thoughtful comment. Clarification added above.*

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.

C33: Bentonite is expensive. Suggest only use when bedrock is 0-3' or water table. In cases where no bedrock or greater than 3', then backfill with original soil.

RESPONSE: *This doesn't require bentonite use. They can also use soil cuttings if the boreholes are greater than 1" wide and less than 5 feet deep.*

C129: Clarify that soil cuttings should be compacted back in hole.

RESPONSE: *Compaction of soil cuttings is not required for boreholes greater than 1 in wide and less than 5 ft deep. NR 812 uses the term "filling and sealing" instead of the term abandonment regarding this issue, which we will update for clarification.*

NR 812.07(41m)(41m) "Filling and sealing" means 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.

Note: The term "filling and sealing" replaces the term "abandonment," previously used in this chapter.

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 greater than 10 feet deep or where water table 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~~, they~~ 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.

~~2.~~b. For test pits greater than 10 feet ~~deep~~ depth, the excavation~~n the test pits~~ must be abandoned according to NR 812.26 which defines excavation as drillhole and requires different criteria.

C34: Is compaction needed in those 2' lifts?

RESPONSE: *Yes, the 2-foot lift would insinuate some type of compaction (likely briefly tamping with the bucket of the backhoe to match density of the surrounding soil), but this should be clarified. Thanks for the comment.*

C35: Explain more. Do we need to revert to a boring if >10' depth?

RESPONSE: *No, if a test pit is greater than 10 feet deep, NR 812.26 abandonment (i.e., "filling and sealing" – see Glossary) procedures must be followed.*

C108: I am ok with the first sentence [in Item #2] because there needs to be acknowledgement these are fields intended to grow something in and compaction is going to be problematic. I do feel this could be controversial because sealing properties vs. density similar to the surrounding undisturbed soils has two different intentions.

RESPONSE: *The intent is to replace excavated material in layers and density similar to the surrounding undisturbed soil, and not necessarily to seal the excavation.*

C109: The reference to NR 812.26 appears to be very vague and too broad. I feel the intention here is to directly reference NR 812.26 (7) (a) 4 because of the dug condition however this Admin. Code is directly for the purpose or wells or extraction of groundwater and feel the standard is a not applicable.

RESPONSE: *DATCP and DNR have determined greater than 10 feet deep test pits fall under NR 812.26 requirements, hence the citation. Thanks for the comment.*

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.

C130: Remove. A uniform training and certification program with minimum expectations for qualifications is necessary to avoid this and ensure quality depth to bedrock determinations are made.

RESPONSE: *The team included this statement so that those reading the standard who may not meet the qualifications can understand why we are requiring training and qualifications criteria.*

- When locating intrusive sampling locations, consider spacing locations evenly across representative map areas within field to be verified.

C101: Unclear… should it read "When using intrusive sampling methods,"?

RESPONSE: *No, this sentence means when you are identifying where you will sample, sample evenly across your representative map areas.*

C83: Would be better to locate them in the place judged to be most likely to have the shallowest bedrock depth, based on topography and soils and other map information. It would be particularly important to avoid placing them in the area of a fracture void. This should also be part of a required practice.

RESPONSE: *The standard requires that these factors also be considered when performing verification.*

- 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 ~~in ATCP 50~~ prior to the application of manure when generated depth to bedrock field maps differ from current publicly available Silurian bedrock maps.

C131: "field map" appears to be italicized, however no definition is included in the glossary.

RESPONSE: *Definition was added to Glossary section.*

C36: Who is the appropriate agency?

RESPONSE: *It will be determined by DATCP.*

C37: Do we need to submit more paperwork for approval if we are following these standards? Manure spreading maps would only need to be updated via NMP.

RESPONSE: *The documentation required will be identified by DATCP.*

C114: County Land Conservation Department involvement should be reflected throughout the standard. LCDs should be listed as the entity to … receive a copy of verification.

RESPONSE: *This will be considered in future rulemaking.*

C132: Identify a minimum time frame for submittal in advance of planned manure application (such as one week) to allow the entity sufficient time to review prior to manure application.

RESPONSE: *This will be considered in future rulemaking.*

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

- Field data reporting forms, to include the information listed in Attachment ~~2~~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

C102: Why? Please establish reasons for this requirement and intended use. Need more detail.

RESPONSE: *This is required so that we can have the proper information to update the maps being disputed. It also allows for regulatory authorities to perform their own verification for quality control if they so choose.*

- 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

C133: Clarify that all data points collected should be reported.

RESPONSE: *Clarified in text.*

C52: Suggest adding that plan view maps may be depicted using a local coordinate system that can be tied to latitude/longitude coordinates using the WGS84 coordinate system. Reason: Plan view maps presented in latitude/longitude are not always user friendly.

RESPONSE: *This is allowed under the standard.*

    - 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.

C8: There are other map requirements spelled out above that should be repeated here.

RESPONSE: *We have added the additional requirements.*

C103: No mention of scale such as 1:660, etc. We assume the existing maps will provide a scale at which they are drawn to, we need to deliver maps to a specific scale. 1 point per quarter acre is not a scale, it is a sample density.

RESPONSE: *We will not be requiring a specific scale as these will be submitted as field maps or longitude/latitude points but the verifiers are required to identify what scale they used.*

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

C19: Who is responsible for revising the public copy of the official map?

RESPONSE: *We will consider this in future rulemaking.*

C84: This verification data should also be used to update the DNRs depth to Silurian Dolomite layers.

RESPONSE: *The verification data will very likely be used to update this existing map layer but the responsibility of what entity will house and maintain the data will be identified in future rulemaking.*

C111: Interpretation of the infield verification measurements should be outlined within the standard so that verification measurements are properly translated into field maps. For example: guidance should be given on where to draw boundaries to connect known data points, such as "for hand probe data boundaries should be drawn based on known data points and not interpolations between data points". And/or "all data collected shall be recorded and used to inform boundary determinations" to remove the potential to selectively choose measurements to meet a desired end goal.

RESPONSE: *We have discussed this issue as a team extensively and have decided that the qualified persons performing the verification will use their professional judgment when translating verification data since there are many variables that would go into guidance on this topic. This includes interpolation between data points.*

C134: Reworded to be "The verification information shall then be used to update the 590 Nutrient Management plan prior to manure application." This will ensure that field restriction maps and planned manure applications accurately reflect spreadable acres of the field before manure is applied. Interaction between SnapPlus and field verification maps is necessary to ensure field acres are updated within the nutrient management plan.

RESPONSE: *Thank you for your comment. We have updated the text to reflect this change.*

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://~~snapmaps17.~~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 standard.

Filling and Sealing – "Filling and sealing" means 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, ~~department of agriculture, trade and consumer protection~~DATCP, DNR~~department of natural resources~~, or county maps. Silurian bedrock map information, available from the University of Wisconsin D~~d~~epartment of S~~s~~oil S~~s~~cience, 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) _____

C38: Does each field need a site assessment, or one per farm with multiple field IDs?

RESPONSE: *One site assessment per farm with multiple field IDs would be acceptable.*

C135: Qualifications of person conducting assessment should be included.

RESPONSE: *We agree and have added this criteria.*

MANAGEMENT ASSESSMENT

Intent/Purpose:

- Items to consider before investigation
  - Mechanical application of solid (greater than 12%) or liquid manure?

    C136: Definition of solid manure does not match 590 standard (<11% & 16% dry matter).

    RESPONSE: *Solid manure is defined in NR 151.015 and NR243.03 as being manure with a solids content of 12% or more. We are required to use this definition for the technical standard.*
  - 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?
  - What depth 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

C85: Note that there is not a >3 ft map.

RESPONSE: *We are aware of this limitation. NR 151.075 uses 0-2ft, 2-3ft and 3-5ft depth increments so we kept the depth ranges the same, for consistency.*

- Site specific subsurface info 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
  - Utility/tile line locations if intrusive methods are used

C72: These are the components one would use to make new depth to bedrock maps. The verification instructions are very similar to the approach taken to map the depth to bedrock in the Town of Lincoln in Kewaunee county.

RESPONSE: *Thank you for this feedback.*

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.

C86: These items [in Note 2] should be used to identify where the shallowest depth bedrock is likely to be and verification points should be there.

RESPONSE: *The location of the verification points will follow the methods listed in this standard whenever a farmer/landowner is looking to refute the depth indicated on a current depth to bedrock map.*

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 the procedures outlined in this 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 disputing. Follow steps 1-3 below.

1) Identify the map and which depths will be disputed in the field (see Figure 1). This example is disputing the 2 ft depth to bedrock boundary in order to verify if bedrock is actually deeper than 2 feet. 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 disputed.

      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, 8 hand probe locations would be performed, as shown as green points 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.

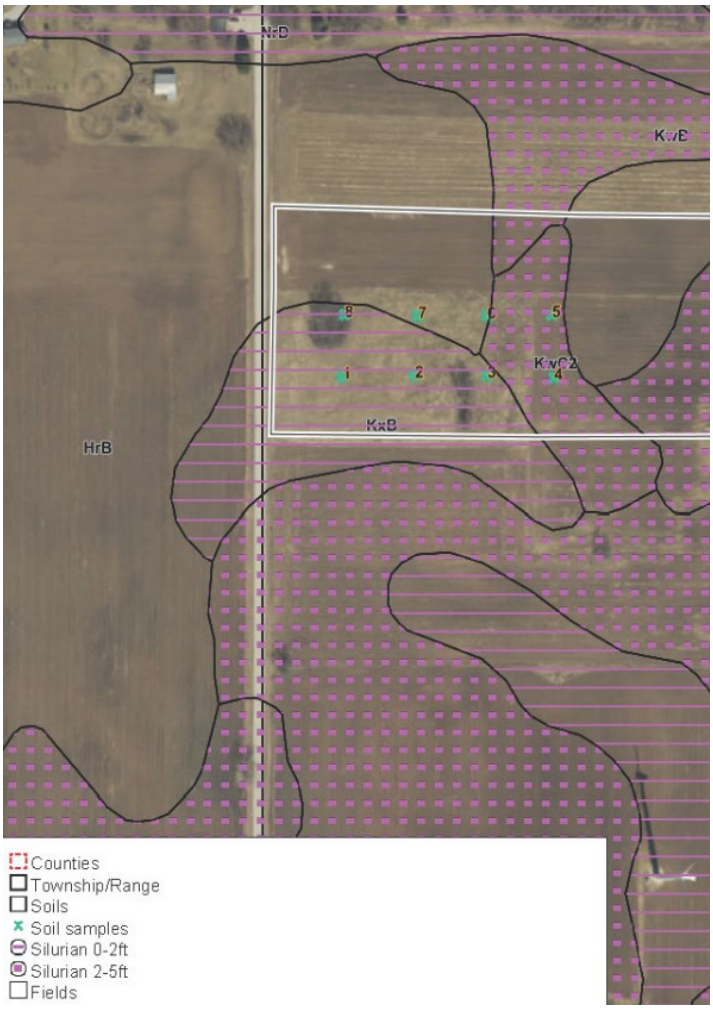

Figure 1 – Example 1, Using an Intrusive Method

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 feet. 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 disputed 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 disputed: "At least one survey line (covering the length of the field) per 100 ft field 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 2 locations per map area is required." Therefore, two hand probes would be performed. 10% of 8 hand probes performed in Example 1 is less than 1 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.

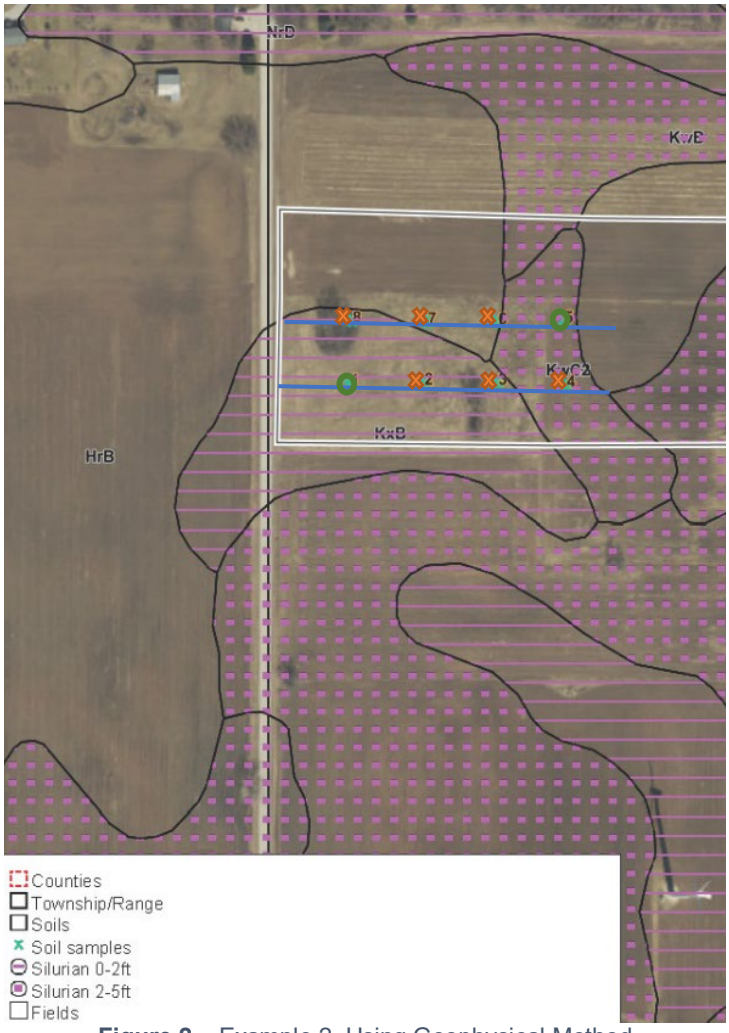

Figure 2 – Example 2, Using Geophysical Method

      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.

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.

C137: Photos should be required field data to be collected and submitted.

RESPONSE: *The submittal of photos is not required but we include them as a consideration.*

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~~frequency~~
    g. GPS latitude/longitude location
    h. Anticipated ~~T~~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.

C88: Including the accuracy of depth reporting is very important. This guidance should also indicate how to use the accuracy to determine whether the measured depth is acceptable. If

the measured depth is 55 inches and the accuracy of measurement is within 6 inches, is it ok to consider this within 5 ft?

RESPONSE: *We agree with the importance of accurately reporting measured depth to bedrock. We will consider this for future rulemaking.*