Point of Beginning

GEOTECHNICAL ENGINEERING REPORT

FOUR ROAD IMPROVEMENTS

KRONENWETTER, WISCONSIN

DECEMBER 22, 2025 | PROJECT NO. 25.2061

ROTH PROFESSIONAL SOLUTIONS
317 DeWitt Street
Portage, WI 53901

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DRILL it.

Point of Beginning

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December 22, 2025

Roth Professional Solutions
Attn: Robert Roth, P.E.
317 DeWitt Street
Portage, WI 53901

RE: Four Road (Autumn Road, Forest Road, Peplin Road, & South Road) Improvements – Kronenwetter, WI

Dear Mr. Roth:

We appreciate the opportunity to perform the subsurface exploration and provide this geotechnical engineering report for the above-referenced project.

This report has been prepared in accordance with our understanding of the project requirements and within the scope of our geotechnical services.

We trust the information and recommendations presented will assist in the design and development of the project. Please contact us if further clarification or additional services are needed.

Sincerely,

Michael Frede, P.E.

Michael Frede, P.E.
Director of Geotechnical Engineering

Enclosure

Contents

EXECUTIVE SUMMARY

This report summarizes the findings of our geotechnical engineering services associated with the proposed reconstruction of four roads for Roth Professional Solutions in the Village of Kronenwetter, Wisconsin.

PROJECT DESCRIPTION

The project consists of repaving the following roads:

- About ½ mile of Autumn Road
- About ¾ mile of Forest Road
- About 1 mile of Peplin Road
- About ½ mile of South Road

STRUCTURAL CONSIDERATIONS

- There are no structures planned for the project.
- There are no retaining walls planned for the project.

CIVIL CONSIDERATIONS

- Minimum asphalt pavement section should consist of the following:
  - Traffic Class II = 5 inches of asphalt over 10 inches of base course
- No stormwater management systems are planned for the project.

CONSTRUCTION CONSIDERATIONS

- Soil improvement should be planned, consisting of removing any unsuitable soils, after the existing pavements are removed.
  - Undocumented fills exist within the project areas that are a concern for pavement support.
  - The soils exhibit variable strengths that can produce inconsistent pavement distress.
  - Organic matter exists within the subgrade soils in sporadic locations, which can be unsuitable for the support of pavements.
- Loose, clean (minimal fines) sands exist near the ground surface that will be sensitive to construction activity and actions to minimize disturbance during construction should be planned.
- Fine-grained (clay and silt) soils exist that are sensitive to construction activity and moisture changes and actions to minimize disturbance during construction should be planned.
- Shallow soils with high moisture content exist that can cause construction challenges.
- Shallow perched water or groundwater existing in localized areas that could cause construction challenges.

PROJECT DESCRIPTION

Point of Beginning is assisting Roth Professional Solutions with the design of new asphalt pavements for four roads in Kronenwetter, Wisconsin. The locations of the project areas are illustrated in Figure 1 in Appendix A.

The proposed project consists of the following:

- New Asphalt Pavement
    - About ½ mile of Autumn Road from Trunk Road to Forest Road.
    - About ¾ mile of Forest Road from Autumn Road to Curve Road.
    - About 1 mile of Peplin Road from South Road to Hwy 153.
    - About ½ mile of South Road from Kane Lane to Oak Road.
- Underground utilities
    - Occasional culverts will be replaced.
- The grading plan for the project has not been provided.
    - Maximum grade changes are estimated to be less than 1 foot.
- No structures are planned for the project.
- No stormwater management systems are planned for the project.

SITE DESCRIPTION

- The project is located in Marathon County.
- The land is currently owned by the Village of Kronenwetter.
- The ground surface elevations vary substantially along the road alignments.
    - From 1227 to 1252 feet along Autumn Road
    - From 1205 to 1278 feet along Forest Road
    - From 1189 to 1219 feet along Peplin Road
    - From 1153 to 1219 feet along South Road

SCOPE OF SERVICES

SUBSURFACE EXPLORATION

- The drilling program consisted of fifteen borings (B-1 through B-15).
    - Autumn Road
        - Three borings (B-1, B-2, and B-3) were drilled to depths of 5 feet.
    - Forest Road
        - Four borings (B-4 through B-7) were drilled to depths of 5 and 10 feet.
    - Peplin Road
        - Four borings (B-8 through B-11) were drilled to depths of 10 feet.
    - South Road
        - Four borings (B-12 through B-15) were drilled to depths of 5 and 10 feet.
- The boring locations are identified in the Boring Location Diagram (Figure 2) in Appendix A.

- The drilling and sampling procedures are described in Appendix D.

ADDITIONAL FIELD TESTING

No additional field testing was conducted.

LABORATORY TESTING

The laboratory testing program consisted of the following:

- All samples were visually examined and classified based on their physical characteristics as defined by the Unified Soil Classification System (USCS).
    - The boring logs are included in Appendix B.
    - The USCS summary is included in Appendix B.
- Water content testing on all samples.
    - The laboratory test results are presented on the boring logs.
- Calibrated hand penetrometer (Q_p) testing on all intact fine-grained (clay and silt) samples.
    - The laboratory test results are presented on the boring logs.
- Typical laboratory procedures are described in Appendix D.

SUBSURFACE CONDITIONS

SOIL CONDITIONS

The subsurface conditions encountered at the borings are summarized below. For detailed descriptions of the geologic conditions encountered at the boring locations, please refer to the attached logs in Appendix B. The size of the project and typical geologic variability between boring locations warrants considering all soil conditions within a project area when designing the various civil elements of the development.

General Soil Conditions

The general profile consisted of the following:

- Asphalt Pavement
    - Autumn Road
        - 4 to 6.5 inches of asphalt
        - 5 to 8 inches of crushed aggregate base course
    - Forest Road
        - 4 to 7 inches of asphalt
        - 4 to 8 inches of crushed aggregate base course
    - Peplin Road
        - Upper Layer
            - 2 to 5 inches of asphalt
            - 4 to 5 inches of crushed aggregate base course
        - Lower Layer
            - 2.5 to 3.5 inches of asphalt

      - 5 to 8 inches of crushed aggregate base course
  - South Road
    - 1.5 to 2 inches of asphalt
    - 10 to 16 inches of crushed aggregate base course
- Soil Profile
  - Autumn Road
    - Undocumented clay and silt fill soil was encountered at B-1 to a depth of about 3 feet.
      - The fill was likely placed when the road was originally constructed.
      - The fill is “undocumented” because no reports were provided to indicate it was placed and compacted sufficiently to support pavements.
    - Native sand was encountered at B-2 and B-3 to depths of about 3 feet.
      - Soil containing organic matter was encountered at B-2.
    - Weathered granite bedrock was encountered at a depth of about 3 feet at all three borings.
      - The samples exhibited characteristics more consistent with sand soil and were therefore defined as soil.
  - Forest Road
    - Undocumented sand fill soil was encountered at B-7 to a depth of about 2 feet.
      - The fill was likely placed when the road was originally constructed.
      - The fill is “undocumented” because no reports were provided to indicate it was placed and compacted sufficiently to support pavements.
    - Stratified layers of native clay, silt, and sand were encountered.
      - The soils varied in their physical composition (clay, silt, sand, and gravel percentages).
    - Weathered granite bedrock was encountered at B-4 and B-6 at depths of about 3 feet.
      - The samples exhibited characteristics more consistent with sand soil and were therefore defined as soil.
  - Peplin Road
    - Undocumented silt and sand fill soil was encountered at B-8, B-10, and B-11 to depths of about 3 feet.
      - The fill was likely placed when the road was originally constructed.
      - The fill is “undocumented” because no reports were provided to indicate it was placed and compacted sufficiently to support pavements.
    - Native clay was encountered at B-9, B-10, and B-11 to depths of about 4.5 to 6 feet.
      - Clay samples containing organic matter were encountered at B-9 and B-10.
    - Stratified layers of native sand were encountered at all four borings.
      - The sand samples varied in their physical composition (clay, silt, and gravel percentages).
    - Weathered granite bedrock was encountered at B-8, B-9, and B-11 at depths of about 3, 8, and 6 feet, respectively.

- The weathered bedrock exhibited characteristics more consistent with sand soil at B-8 from 3 to 8 feet and at B-11 below 6 feet and was therefore defined as soil.
- The bedrock was less weathered at B-8 and B-9 below about 8 feet and was therefore defined as bedrock.
- South Road
  - Undocumented sand fill soil was encountered at all four borings to depths of about 2 to 3 feet.
    - The fill was likely placed when the road was originally constructed.
    - The fill is "undocumented" because no reports were provided to indicate it was placed and compacted sufficiently to support pavements.
  - Native clay was encountered at B-14 at depths of about 3 to 4 feet and below 9 feet.
  - Stratified layers of native sand were encountered at all four borings.
    - The sand samples varied in their physical composition (clay, silt and gravel percentages).
    - One sand sample containing organic matter was encountered at B-14.
- Weathered granite bedrock was encountered at B-14 at a depth of about 8 feet and at B-15 at a depth of about 3 feet.
  - The weathered bedrock exhibited characteristics more consistent with clay and sand soil and was therefore defined as soil.

Physical Soil Conditions

The physical soil characteristics consisted of the following:

Autumn Road

- Fill Soil
  - Fine-Grained (Clay) Fill
    - One clay fill sample was recovered.
      - The sample exhibited very stiff consistency.
        - The Q_p value was 4,000 psf.
      - The moisture content was 26.0%
        - Typically, moisture contents are considered high if they are above 20% in fine-grained soil.
        - The sample was described as wet, suggesting the presence of perched water or groundwater.
- Native Soil (including weathered bedrock samples)
  - Coarse-Grained (Sand) Soil
    - Five native sand samples were recovered.
      - The samples exhibited loose to dense relative density.
        - The N-values ranged from 9 to 30.
          - The average was 15.
          - One sample (20%) was less than 10 (loose).

            - One sample (20%) was 30 (dense).
        - The moisture contents ranged from 4.9% to 17.6%.
            - The average was 12.5%.
            - Typically, moisture contents are considered high if they are above 15% in coarse-grained soil.
                - One sample (20%) exceeded 15%.
            - Three samples (60%) were described as wet, suggesting the presence of perched water or groundwater.

Forest Road

- Native Soil (including weathered bedrock samples)
    - Fine-Grained (Clay and Silt) Soil
        - Four native clay and silt samples were recovered.
            - Three samples were disturbed and could not be tested for their strength.
            - The fourth sample exhibited very stiff consistency.
                - The Q_p value was 4,000 psf.
            - The moisture contents ranged from 5.5% to 25.6%
                - The average was 11.9%.
                - Typically, moisture contents are considered high if they are above 20% in fine-grained soil.
                    - One sample (25%) exceeded 20%.
                - The sample was described as saturated, suggesting the presence of perched water or groundwater.
    - Coarse-Grained (Sand) Soil
        - Six native sand samples were recovered.
            - The samples exhibited loose to medium dense relative density.
                - The N-values ranged from 6 to 19.
                    - The average was 11.
                    - Three samples (50%) were less than 10 (loose).
            - The moisture contents ranged from 5.6% to 18.3%.
                - The average was 11.4%.
                - Typically, moisture contents are considered high if they are above 15% in coarse-grained soil.
                    - One sample (17%) exceeded 15%.
                - Four samples (67%) were described as wet, suggesting the presence of perched water or groundwater.

Peplin Road

- Fill Soil
    - Coarse-Grained (Sand) Fill
        - Three sand fill samples were recovered.

      - The samples exhibited medium dense relative density.
        - The N-values were 13, 17, and 28.
      - The moisture contents were 4.4%, 6.5%, and 15.3%.
        - Typically, moisture contents are considered high if they are above 15% in coarse-grained soil.
- Native Soil (including weathered bedrock samples, but excluding two partially weathered bedrock samples)
  - Fine-Grained (Clay) Soil
    - One clay sample was recovered.
      - The sample exhibited stiff consistency.
        - The Q_p value was 3,500 psf.
      - The moisture content was 36.9%
        - Typically, moisture contents are considered high if they are above 20% in fine-grained soil.
        - The sample contained organic matter, reflected by the high moisture content.
  - Coarse-Grained (Sand) Soil
    - Ten native sand samples were recovered.
      - The samples exhibited loose to dense relative density.
        - The N-values ranged from 8 to 46.
          - The average was 21.
          - One sample (10%) was less than 10 (loose).
          - Two samples (20%) exceeded 30 (dense).
      - The moisture content ranged from 8.1% to 17.5%.
        - The average was 11.5%.
        - Typically, moisture contents are considered high if they are above 15% in coarse-grained soil.
          - One sample (10%) exceeded 15%.
        - Five samples (50%) were described as wet or saturated, suggesting the presence of perched water or groundwater.

<u>South Road</u>

- Fill Soil
  - Coarse-Grained (Sand) Fill
    - Three sand fill samples were recovered.
      - The samples exhibited medium dense relative density.
        - The N-values were 12, 14, and 14.
      - The moisture contents were 11.3%, 13.2%, and 14.9%.
        - Typically, moisture contents are considered high if they are above 15% in coarse-grained soil.
- Native Soil (including weathered bedrock samples)

- Fine-Grained (Clay) Soil
    - One clay sample was recovered.
        - The sample exhibited very stiff consistency.
            - The Q_p value was 5,500 psf.
        - The moisture content was 14.2%
            - Typically, moisture contents are considered high if they are above 20% in fine-grained soil.
- Coarse-Grained (Sand) Soil
    - Six native sand samples were recovered.
        - The samples exhibited loose to dense relative density.
            - The N-values ranged from 9 to 30.
                - The average was 16.
                - One sample (17%) was less than 10 (loose).
                - One sample (17%) was 30 (dense).
        - The moisture contents ranged from 4.1% to 37.7%.
            - The average was 20.8%.
            - Typically, moisture contents are considered high if they are above 15% in coarse-grained soil.
                - Five samples (83%) exceeded 15%.
            - Three samples (50%) were described as saturated, suggesting the presence of perched water or groundwater.
            - The sample with 37.7% moisture contained organic matter, reflected by the high moisture content.

BEDROCK CONDITIONS

- Weathered granite bedrock was encountered at ten of the fifteen boring locations at depths that ranged from 3 to 8 feet.
    - Most of the bedrock samples exhibited characteristics more consistent with soil and therefore were addressed in the *Soil Conditions* section above.
    - Less (partially) weathered granite bedrock was encountered at two boring locations (B-8 and B-9).
        - Two samples were recovered from B-8 and B-9 (Peplin Road) at depths of 8 feet.
        - The samplers experienced refusal (N-values of 50 blows for less than 6 inches of penetration), indicating more competent bedrock.
    - The moisture contents were 5.5% and 16.5%.

GROUNDWATER CONDITIONS

- Perched water or groundwater was encountered at variable, but generally shallow depths.
    - Autumn Road
        - 1 to 2 feet
    - Forest Road

        - 2 feet to greater than 5 feet
    - Peplin Road
        - 3 feet to greater than 10 feet
    - South Road
        - 3 feet to greater than 5 feet
    - The water conditions are indicated on the cross sections (Figures 3 through 6).
- Fluctuations in the groundwater table elevation occur with variations in precipitation, evapotranspiration, surface runoff, etc.
- Shallow perched groundwater conditions should be expected where relatively permeable coarse-grained soils are underlain by relatively impermeable fine-grained soils, especially following precipitation events.

ANALYSIS AND RECOMMENDATIONS

There are five primary issues that should be considered when planning this project.

- Soil improvement should be planned, consisting of removing any unsuitable soils, after the existing pavements are removed.
    - Undocumented fills exist within the project areas that are a concern for pavement support.
    - The soils exhibit variable strengths that can produce inconsistent pavement distress.
    - Organic matter exists within the subgrade soils in sporadic locations, which can be unsuitable for the support of pavements.
- Loose, clean (minimal fines) sands exist near the ground surface that will be sensitive to construction activity and actions to minimize disturbance during construction should be planned.
- Fine-grained (clay and silt) soils exist that are sensitive to construction activity and moisture changes and actions to minimize disturbance during construction should be planned.
- Shallow soils with high moisture content exist that can cause construction challenges.
- Shallow perched water or groundwater existing in localized areas that could cause construction challenges.

STRUCTURAL CONSIDERATIONS

Foundation Design

- No foundations are planned for the project.

Seismic Design

- Seismic Site Classification is not required for the project.

Floor Slab Design

- No floor slabs are planned for the project.

Retaining Wall Design

- No retaining walls are planned for the project.

CIVIL CONSIDERATIONS

Pavement Design

- The following design values are appropriate for the subgrade soils:
    - Predominant Soil = Sand with Silt (SP-SM)
    - AASHTO Classification = A-3
    - Soil Support Value = 5.1
    - Wisconsin Design Group Index = 6.0
    - CBR Value = 9
    - Subgrade Modulus (k) = 200

  - Soil Resilient Modulus M_R) = 4,700
  - Frost Index = F-2
- Localized areas of undocumented fills and fine-grained soils exist.
  - Therefore, greater than normal distress, faster deterioration, overall reduced service life, and increased maintenance are anticipated.
  - To reduce the potential for localized settlements and provide more consistent subgrade support, a geotextile fabric (e.g., SKAPS W315) could be placed, where encountered, below the base course materials.
- The Wisconsin Asphalt Pavement Association (WAPA) Design Guide should be utilized to design the new asphalt surface pavements.
- The minimum pavement section should consist of the following:

Material	*Traffic Class II*	*WisDOT Specification*
Asphalt Surface Course	2 inches	Section 460
Asphalt Binder Course	3 inches	Section 460
Dense Graded Base Course	10 inches	Section 305

- Hot Mix Asphalt (HMA) and base course materials should be placed and compacted following the project requirements and guidelines of WisDOT Standard Specifications for Highway and Structure Construction, section 460.3.
- The pavement section above is not intended to support on-going construction traffic.
- These recommendations assume the subgrade is prepared as described in this report.
  - Additional corrective action may be warranted at the time of construction, depending on the site conditions.

Stormwater Management Design

- No stormwater management systems are planned for the project.

CONSTRUCTION CONSIDERATIONS

Subgrade Preparation

- All loose, wet, disturbed, or otherwise unsuitable surface soils should be stripped from structural and engineered fill areas prior to any construction activities.
- All pavement areas should be proof-rolled to identify low-strength or disturbed areas that need to be removed or improved.
- Clean sand soils will be sensitive to disturbances from construction activity.
  - Care should be taken during construction to protect exposed soils from disturbance from equipment.

- Fine-grained soils will be sensitive to disturbances from construction activity and increases in moisture content that can cause significant reduction in soil strength and support capabilities.
    - Moisture sensitive soils that become wet will likely impact grading and compaction schedules.
- Placing a working subbase layer of 3-inch crushed stone or utilizing a cement stabilization program could be beneficial in areas subjected to construction traffic and to reduce the potential need to strip disturbed soils.

Engineered Fill and Backfill

- Engineered (compacted and tested) Fill
    - Inorganic Materials
    - Free of Deleterious Debris
    - Non-Frozen
    - Maximum 3 inches in Size
    - Placed in 8 to 10-inch Loose Lifts
    - Minimum Compaction
        - Pavement Areas= 95 percent of the Maximum Dry Density (Modified Proctor)
        - Non-Pavement Areas = 90 percent of the Maximum Dry Density (Modified Proctor)
    - Moisture Content = 3± percent of the Optimum Moisture
    - Placed on Tested and Passing Subgrade Soils
    - Testing Frequency (where not specified by local ordinance)
        - One test per lift for every 5,000 square feet of compacted fill in pavement areas.
        - One test per 100 linear feet of compacted utility trench backfill.
- Imported Fill
    - Fine-Grained Soil (Clay)
        - Suitable for mass grading only.
        - Silt soil should not be used.
    - Coarse-Grained Soil (Sand, Gravel)
        - Suitable for utility, pavement, and mass grading.
    - Processed Aggregate (Crushed and Screened)
        - Suitable for all areas and subgrade undercut areas.
- Bedding of pipes should be performed in accordance with normally accepted procedures for the class of utility being placed.
    - Backfilling of excavations should be done in such a way as to provide relatively uniform lateral support until the backfill extends over the utility, accomplished by alternating fill placement at approximately 1-foot intervals to both sides.
    - Bedding and initial backfill requirements may be specified by the Owner based on planned utility types, bedding conditions, and other factors beyond the scope of this study.
- On-site soil can be reused as engineered fill if they meet the specifications in this report.
    - Due to the moisture sensitive nature of fine-grained soils, their use could pose construction challenges regarding achieving the required compaction requirements. Therefore, their use should be avoided.

Foundation Evaluation

- No foundation construction is planned for the project.

Utility Construction

- No utility construction is planned for the project.

Groundwater Management

- Excavations will likely encounter perched water or groundwater.
- The amount of infiltration will be influenced by predominant soil types at any given location.
- If excavations extend slightly into limited perched water or groundwater conditions, filtered sump pumps or other conventional means should be sufficient.
- For excavations that extend to significant depths into substantial perched water conditions or groundwater, prolonged dewatering with a series of sumps or well points and high-capacity pumps, or other more comprehensive means, may be necessary to facilitate construction.
    - Dewatering is recommended to be performed to a depth of at least 2 feet below the lowest excavation depth.
    - If sump pits are employed, they should be lined with a geotextile and filled with open-graded, free-draining aggregate.
- A qualified dewatering contractor could be engaged to review the soil and groundwater conditions to determine the appropriate means and methods for effective dewatering.

Surface Water Management

- Surface water should not be allowed to collect in excavations or on prepared subgrades during or after construction.
- Areas should be sloped to facilitate removal of collected surface runoff.
- Positive site drainage should be provided to reduce infiltration of surface water around the perimeter of structures and within pavement areas.

Excavation Safety

- Excavation walls may need to be sloped or braced for stability and safety reasons.
- The Owner and Contractor should be aware of, and become familiar with, applicable local, state, and federal safety regulations, including current OSHA Excavation and Trench Safety Standards.
- Construction-site safety generally is the responsibility of the Contractor, who should also be responsible for the means, methods, and sequencing of construction operations.
- The Contractor should be aware that slope height, slope inclination, or excavation depths should in no case exceed those specified in local, state, or federal safety regulations, (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926), or successor regulations.
- The prevalent soils encountered in the borings are Type C when applying the OSHA regulations.

- OSHA regulations are strictly enforced, and if they are not followed, the Owner, Contractor, and/or earthwork Subcontractor(s) could be liable for substantial penalties.

GENERAL QUALIFICATIONS

- Our services for this project are intended for the sole benefit and exclusive use of our client and for the specific application to the project described and are provided in accordance with generally accepted geotechnical engineering practices, with no third-party beneficiaries intended. Any use or reliance of the information by third parties is done solely at their own risk. No warranties, either expressed or implied, are intended or made.
- The findings, analysis, and recommendations presented in this report are based on our understanding of the project, a reasonable geotechnical scope approved by the client, and our engineering judgment.
- Should the details of the project change, Point of Beginning should be notified and provided with the opportunity to review the applicability of the collected information and modify our recommendations, as needed.
- The nature and extent of geologic variations may not become evident during or after construction. If the actual site subsurface conditions differ from the inferred conditions described in this report, the recommendations in this report may need to be revised.
- The recommendations in this report are only valid for the exact and specific locations at which field investigation or laboratory testing was completed. All other areas and regions of the site that are not evaluated will be at the risk of the individual or entity using this Report.
- Site characteristics as provided are for design purposes and not to estimate construction costs. Any party charged with estimating construction costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing.
- Site safety, excavation support, and dewatering requirements/design are the responsibility of others.
- Construction and site development activities have the potential to affect adjacent properties. Such impacts can include damage due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, and noise or air-quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding developments.

APPENDICES

APPENDIX A
Diagrams

APPENDIX B
Geologic Information

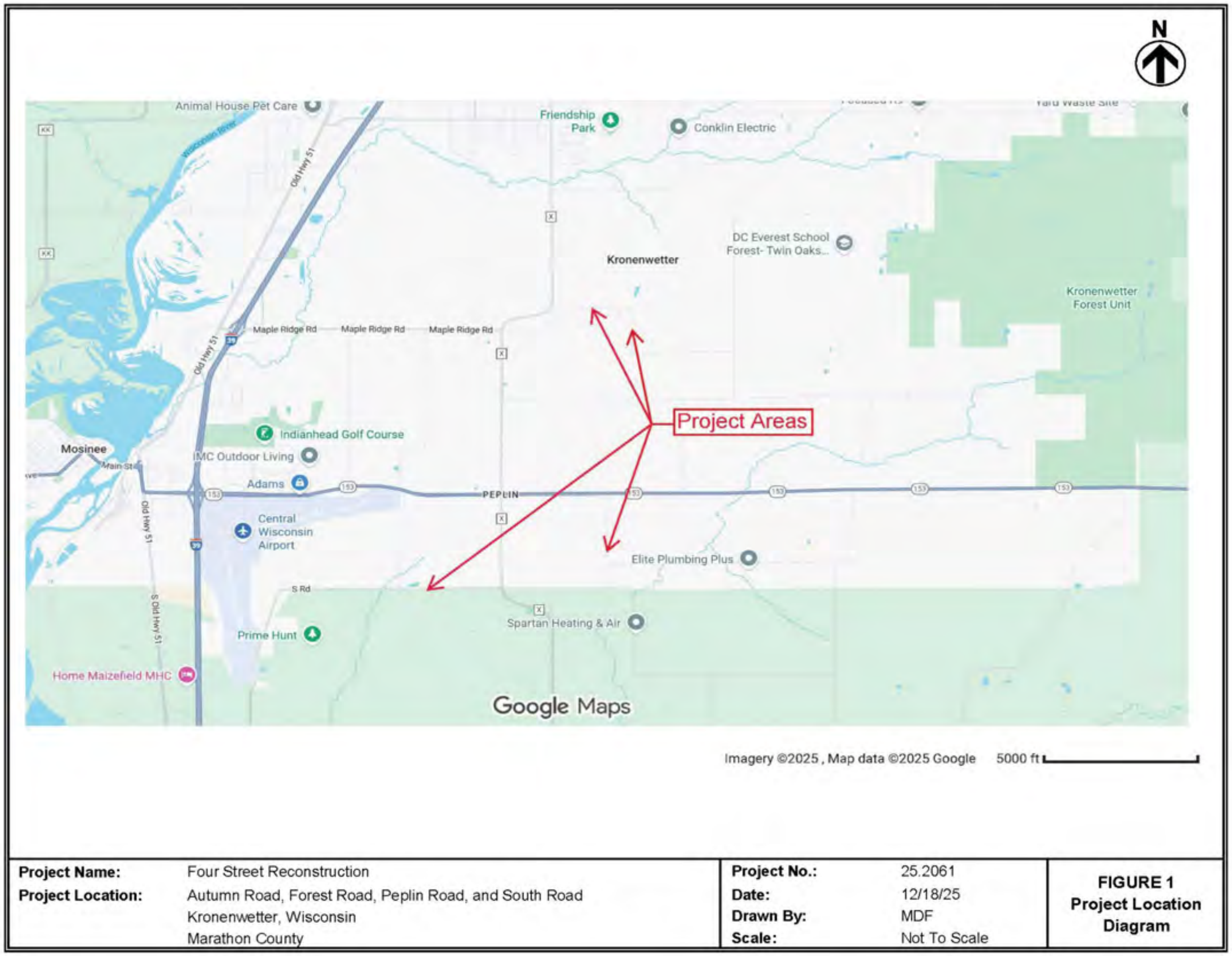
APPENDIX C
Laboratory Reports

APPENDIX D
General Notes & Procedures

APPENDIX E
Additional Documents

APPENDEX A

FIGURE 1 – PROJECT LOCATION DIAGRAM
FIGURE 2 – BORING LOCATION DIAGRAM



Project Name:	Four Street Reconstruction	**Project No.:**	25.2061	**FIGURE 1** **Project Location Diagram**
Project Location:	Autumn Road, Forest Road, Peplin Road, and South Road Kronenwetter, Wisconsin Marathon County	**Date:**	12/18/25	
		Drawn By:	MDF	
		Scale:	Not To Scale	

Project Name:	Four Street Reconstruction	**Project No.:**	25.2061	**FIGURE 2** **Boring Location Diagram**
Project Location:	Autumn Road, Forest Road, Peplin Road, and South Road	**Date:**	12/18/25	
	Kronenwetter, Wisconsin	**Drawn By:**	MDF	
	Marathon County	**Scale:**	Not To Scale	

APPENDIX B

BORING LOGS

All Borings (B-1 through B-15)

LEGEND

USCS

CROSS SECTIONS

Figure 3 – Autumn Road
Figure 4 – Forest Road
Figure 5 – Peplin Road
Figure 6 – South Road

Point of Beginning

Client:	**Roth Professional Solutions**
Project:	**Autumn Road Improvement, (POB #25.2061)**
Address:	**Autumn Road, Kronenwetter, WI**

BORING LOG

Boring No. **B-1**

Page: **1 of 1**

Drilling Start Date:	**10/27/25**	Boring Depth (ft):	**5**
Drilling End Date:	**10/27/25**	Boring Diameter (in):	**4.0**
Drilling Company:	**POB**	Sampling Method(s):	**Split Spoon**
Drilling Method:	**Solid Stem Auger**	DTW During Drilling (ft):	**2**
Drilling Equipment:	**Mobile B-57**	DTW After Drilling (ft):	**N/A**
Driller:	**Dakota Ciriacks**	Ground Surface Elev. (ft):	**1251.6**
Logged By:	**Neil Henriksen**	Location (Lat, Long):	**44.80796, -89.59276**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	COLLECT Sample Type	Blow Counts	Recovery (ft)	N Value RQD%	SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)	ELEVATION (ft)
0							(0.00') Asphalt: 4 inches of Asphalt Pavement over 8 inches of Crushed Aggregate Base Course									
			SS	6 4 3	1.50	7	(1.00') Fill: SILT with sand (ML); trace fine gravel, little fine-medium sand, mostly silt, moist, dark brown									1250
		▽					(2.00') Fill: Lean CLAY (CL); trace fine gravel, few fine-medium sand, few silt, mostly clay, medium plasticity, very stiff, wet, dark brown	26						2		
			SS	6 9 21	1.10	30	(3.00') Poorly graded SAND with silt and gravel (SP-SM); mostly fine-medium grained sand, little fine-coarse gravel, few silt, dense, moist, gray, (Weathered Granite Bedrock)	4.9								
5							(5.00') Boring terminated									
																1245
10																
																1240
15																

NOTES:

Point of Beginning

Client:	**Roth Professional Solutions**	**BORING LOG**	
Project:	**Autumn Road Improvement, (POB #25.2061)**	**Boring No.**	**B-2**
Address:	**Autumn Road, Kronenwetter, WI**	**Page:**	**1 of 1**

Drilling Start Date:	**10/27/25**	Boring Depth (ft):	**5**
Drilling End Date:	**10/27/25**	Boring Diameter (in):	**4.0**
Drilling Company:	**POB**	Sampling Method(s):	**Split Spoon**
Drilling Method:	**Solid Stem Auger**	DTW During Drilling (ft):	**1**
Drilling Equipment:	**Mobile B-57**	DTW After Drilling (ft):	**N/A**
Driller:	**Dakota Ciriacks**	Ground Surface Elev. (ft):	**1242.1**
Logged By:	**Neil Henriksen**	Location (Lat, Long):	**44.81109, -89.59276**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)	ELEVATION (ft)
			Sample Type	Blow Counts	Recovery (ft)	N Value RQD%										
0							(0.00') Asphalt: 6.5 inches of Asphalt Pavement over 5 inches of Crushed Aggregate Base Course									
		▽	SS	3 3 6	1.50	9	(1.00') Poorly graded SAND with silt (SP-SM); mostly fine grained sand, few fine gravel, few silt, loose, wet, dark brown, (Few Organics)	17.6								1240
			SS	3 4 7	1.40	11	(3.00') Poorly graded SAND with silt and gravel (SP-SM); mostly fine grained sand, little fine-coarse gravel, few silt, medium dense, wet, gray, (Weathered Granite Bedrock)	14.6								
5							(5.00') Boring terminated									
																1235
10																
																1230
15																

NOTES:

Point of Beginning

Client: Roth Professional Solutions
Project: Autumn Road Improvement, (POB #25.2061)
Address: Autumn Road, Kronenwetter, WI

BORING LOG

Boring No. B-3
Page: 1 of 1

Drilling Start Date: **10/27/25**
Drilling End Date: **10/27/25**
Drilling Company: **POB**
Drilling Method: **Solid Stem Auger**
Drilling Equipment: **Mobile B-57**
Driller: **Dakota Ciriacks**
Logged By: **Neil Henriksen**

Boring Depth (ft): **5**
Boring Diameter (in): **4.0**
Sampling Method(s): **Split Spoon**
DTW During Drilling (ft): **1**
DTW After Drilling (ft): **N/A**
Ground Surface Elev. (ft): **1227.2**
Location (Lat, Long): **44.81442, -89.59267**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)	ELEVATION (ft)
			Sample Type	Blow Counts	Recovery (ft)	N Value RQD%										
0	▦						(0.00') Asphalt: 4.5 inches of Asphalt Pavement over 8 inches of Crushed Aggregate Base Course									
	🟨	▽	SS	6 5 5	1.40	10	(1.00') Poorly graded SAND with silt (SP-SM); mostly fine grained sand, few fine gravel, few silt, medium dense, wet, gray	13.8								1225
	🟨		SS	6 7 9	1.40	16	(3.00') Poorly graded SAND with silt and gravel (SP-SM); mostly fine grained sand, little fine-coarse gravel, few silt, medium dense, moist, brown, (Weathered Granite Bedrock)	11.6								
5							(5.00') Boring terminated									
																1220
10																
																1215
15																

NOTES:

Point of Beginning	**Client:** Roth Professional Solutions **Project:** Forest Road Improvement, (POB #25.2061) **Address:** Forest Road, Kronenwetter, WI	**BORING LOG** **Boring No.** B-4 **Page:** 1 of 1

Drilling Start Date: **10/27/25**
Drilling End Date: **10/27/25**
Drilling Company: **POB**
Drilling Method: **Solid Stem Auger**
Drilling Equipment: **Mobile B-57**
Driller: **Dakota Ciriacks**
Logged By: **Neil Henriksen**

Boring Depth (ft): **10**
Boring Diameter (in): **4.0**
Sampling Method(s): **Split Spoon**
DTW During Drilling (ft): **3**
DTW After Drilling (ft): **6**
Ground Surface Elev. (ft): **1205.1**
Location (Lat, Long): **44.81486, -89.59432**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	COLLECT Sample Type	Blow Counts	Recovery (ft)	N Value RQD%	SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)	ELEVATION (ft)
0							(0.00') Asphalt: 7 inches of Asphalt Pavement over 4 inches of Crushed Aggregate Base Course									1205
			SS	5 6 7	1.50	13	(1.00') Poorly graded SAND with silt (SP-SM); mostly fine grained sand, few fine gravel, few silt, medium dense, moist, dark brown	7								
		▽	SS	2 1 6	0.80	7	(3.00') Poorly graded SAND with silt (SP-SM); mostly fine grained sand, few fine gravel, few silt, loose, wet, dark brown	11.8								
5																1200
		▼	SS	3 1 4	1.20	5	(6.00') SILT with sand (ML); few fine gravel, little fine sand, mostly silt, saturated, dark brown	25.6								
			SS	10 8 11	1.40	19	(8.00') Poorly graded SAND with silt and gravel (SP-SM); mostly fine-medium grained sand, little fine-coarse gravel, few silt, medium dense, wet, gray, (Weathered Granite Bedrock)	11.2								
10							(10.00') Boring terminated									1195
15																

NOTES:

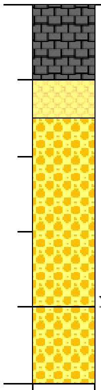
Client:	**Roth Professional Solutions**	
Project:	**Forest Road Improvement, (POB #25.2061)**	
Address:	**Forest Road, Kronenwetter, WI**	

BORING LOG

Boring No. **B-5**

Page: **1 of 1**

Drilling Start Date:	**10/27/25**	Boring Depth (ft):	**5**
Drilling End Date:	**10/27/25**	Boring Diameter (in):	**4.0**
Drilling Company:	**POB**	Sampling Method(s):	**Split Spoon**
Drilling Method:	**Solid Stem Auger**	DTW During Drilling (ft):	**4**
Drilling Equipment:	**Mobile B-57**	DTW After Drilling (ft):	**N/A**
Driller:	**Dakota Ciriacks**	Ground Surface Elev. (ft):	**1228.6**
Logged By:	**Neil Henriksen**	Location (Lat, Long):	**44.81489, -89.60002**



DEPTH (ft)	LITHOLOGY	WATER LEVEL	COLLECT Sample Type	Blow Counts	Recovery (ft)	N Value RQD%	SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)	ELEVATION (ft)
0							(0.00') Asphalt: 4.5 inches of Asphalt Pavement over 7 inches of Crushed Aggregate Base Course									
			SS	5 6 8	1.50	14	(1.00') Poorly graded SAND with silt (SP-SM); mostly fine grained sand, few fine gravel, few silt, medium dense, moist, brown									
							(1.50') Poorly graded SAND (SP); mostly fine-medium grained sand, trace fine gravel, trace silt, medium dense, moist, brown	5.6								
			SS	3 3 3	1.50	6										1225
		▽					(4.00') Poorly graded SAND (SP); mostly fine grained sand, trace fine gravel, trace silt, loose, wet, brown	18.3								
5							(5.00') Boring terminated									
																1220
10																
																1215
15																

NOTES:

Point of Beginning

Client: Roth Professional Solutions

Project: Forest Road Improvement, (POB #25.2061)

Address: Forest Road, Kronenwetter, WI

BORING LOG

Boring No. B-6

Page: 1 of 1

Drilling Start Date: **10/27/25**
Drilling End Date: **10/27/25**
Drilling Company: **POB**
Drilling Method: **Solid Stem Auger**
Drilling Equipment: **Mobile B-57**
Driller: **Dakota Ciriacks**
Logged By: **Neil Henriksen**

Boring Depth (ft): **5**
Boring Diameter (in): **4.0**
Sampling Method(s): **Split Spoon**
DTW During Drilling (ft): **N/A**
DTW After Drilling (ft): **N/A**
Ground Surface Elev. (ft): **1252**
Location (Lat, Long): **44.81491, -89.60261**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)	ELEVATION (ft)
			Sample Type	Blow Counts	Recovery (ft)	N Value RQD%										
0							(0.00') Asphalt: 4 inches of Asphalt Pavement over 8 inches of Crushed Aggregate Base Course									
			SS	4 7 7	0.50	14	(1.00') Lean CLAY (CL); few fine gravel, few fine-medium sand, few silt, mostly clay, medium plasticity, moist, dark brown	6.2								1250
			SS	3 4 6	1.40	10	(3.00') Lean CLAY (CL); few fine-coarse gravel, few fine-medium sand, few silt, mostly clay, medium plasticity, very stiff, moist, brown, (Weathered Granite Bedrock)	5.5						2		
5							(5.00') Boring terminated									
																1245
10																
																1240
15																

NOTES:

Point of Beginning

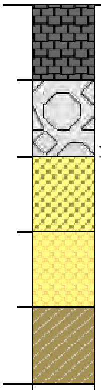
Client:	**Roth Professional Solutions**
Project:	**Forest Road Improvement, (POB #25.2061)**
Address:	**Forest Road, Kronenwetter, WI**

BORING LOG

Boring No. **B-7**

Page: **1 of 1**

Drilling Start Date:	**10/27/25**	Boring Depth (ft):	**5**
Drilling End Date:	**10/27/25**	Boring Diameter (in):	**4.0**
Drilling Company:	**POB**	Sampling Method(s):	**Split Spoon**
Drilling Method:	**Solid Stem Auger**	DTW During Drilling (ft):	**2**
Drilling Equipment:	**Mobile B-57**	DTW After Drilling (ft):	**N/A**
Driller:	**Dakota Ciriacks**	Ground Surface Elev. (ft):	**1277.9**
Logged By:	**Neil Henriksen**	Location (Lat, Long):	**44.81493, -89.60640**



DEPTH (ft)	LITHOLOGY	WATER LEVEL	COLLECT Sample Type	COLLECT Blow Counts	COLLECT Recovery (ft)	COLLECT N Value RQD%	SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)	ELEVATION (ft)
0							(0.00') Asphalt: 4.5 inches of Asphalt Pavement over 8 inches of Crushed Aggregate Base Course									
		▽	SS	7 5 4	1.50	9	(1.00') Fill: Poorly graded SAND with silt (SP-SM); mostly fine grained sand, few fine gravel, few silt, loose, moist, dark brown									
							(2.00') Poorly graded SAND with clay (SP-SC); mostly fine-medium grained sand, few fine gravel, few silt, few clay, loose, wet, brown	14.3								1275
			SS	4 6 7	1.40	13	(3.00') Poorly graded SAND with silt (SP-SM); mostly fine grained sand, trace fine gravel, few silt, trace clay, medium dense, moist, brown									
5							(4.00') Lean CLAY (CL); few fine gravel, few fine-medium sand, few silt, mostly clay, medium plasticity, moist, brown	10.4								
							(5.00') Boring terminated									
10																1270
																1265
15																

NOTES:

Point of Beginning

Client: Roth Professional Solutions
Project: Peplin Road Improvement, (POB #25.2061)
Address: Peplin Road, Kronenwetter, WI

BORING LOG

Boring No. B-8
Page: 1 of 1

Drilling Start Date: **10/30/25**
Drilling End Date: **10/30/25**
Drilling Company: **POB**
Drilling Method: **Solid Stem Auger**
Drilling Equipment: **Mobile B-57**
Driller: **Dakota Ciriacks**
Logged By: **Neil Henriksen**

Boring Depth (ft): **10**
Boring Diameter (in): **4.0**
Sampling Method(s): **Split Spoon**
DTW During Drilling (ft): **N/A**
DTW After Drilling (ft): **N/A**
Ground Surface Elev. (ft): **1198.8**
Location (Lat, Long): **44.77235, -89.59772**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)	ELEVATION (ft)
			Sample Type	Blow Counts	Recovery (ft)	N Value RQD%										
0							(0.00') Asphalt: 2 inches of Asphalt Pavement over 4 inches of Crushed Aggregate Base Course									
							(0.50') Asphalt: 3.5 inches of Asphalt Pavement									
			SS	12 15 13	0.80	28	(1.00') Fill: Poorly graded SAND with silt (SP-SM); mostly fine-medium grained sand, few fine-coarse gravel, few silt, medium dense, moist, brown	6.5								
5			SS	6 9 13	1.20	22	(3.00') Poorly graded SAND with silt (SP-SM); mostly fine-medium grained sand, few fine-coarse gravel, few silt, medium dense, moist, gray, (Weathered Granite Bedrock)	9.9									1195
			SS	13 20 26	0.50	46	(6.00') Poorly graded SAND with silt (SP-SM); mostly fine-medium grained sand, few fine-coarse gravel, few silt, dense, moist, gray, (Weathered Granite Bedrock)	8.1								
10			SS	48 50	0.50	50	(8.00') BEDROCK: Partially Weathered Granite Bedrock	5.5									1190
							(10.00') Boring terminated									
15																	1185

NOTES:

Point of Beginning

Client: Roth Professional Solutions
Project: Peplin Road Improvement, (POB #25.2061)
Address: Peplin Road, Kronenwetter, WI

BORING LOG

Boring No. B-9
Page: 1 of 1

Drilling Start Date:	**10/30/25**	Boring Depth (ft):	**10**
Drilling End Date:	**10/30/25**	Boring Diameter (in):	**4.0**
Drilling Company:	**POB**	Sampling Method(s):	**Split Spoon**
Drilling Method:	**Solid Stem Auger**	DTW During Drilling (ft):	**3**
Drilling Equipment:	**Mobile B-57**	DTW After Drilling (ft):	**N/A**
Driller:	**Dakota Ciriacks**	Ground Surface Elev. (ft):	**1188.7**
Logged By:	**Neil Henriksen**	Location (Lat, Long):	**44.77594, -89.59768**

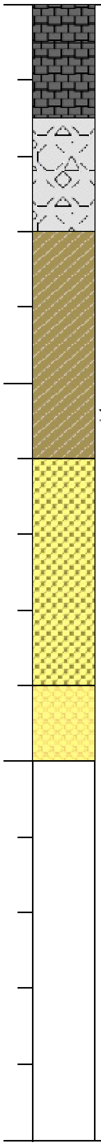
DEPTH (ft)	LITHOLOGY	WATER LEVEL	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)	ELEVATION (ft)
			Sample Type	Blow Counts	Recovery (ft)	N Value RQD%										
0							(0.00') Asphalt: 2.5 inches of Asphalt Pavement over 5 inches of Crushed Aggregate Base Course									
			SS	8 7 5	1.30	12	(0.50') Asphalt: 3 inches of Asphalt Pavement over 8 inches of Crushed Aggregate Base Course									
							(1.50') Poorly graded SAND with clay (SP-SC); mostly fine-medium grained sand, few fine gravel, few silt, few clay, medium dense, moist, brown, (Few Organics)	11.3								
		▽	SS	4 4 4	1.40	8	(3.00') Lean CLAY (CL); trace fine gravel, few fine-medium sand, few silt, mostly clay, medium plasticity, saturated, dark brown, (Organics)									1185
5							(4.50') Poorly graded SAND with silt (SP-SM); mostly fine-medium grained sand, few fine gravel, few silt, loose, saturated, dark gray	14								
			SS	5 6 6	1.20	12	(6.00') Poorly graded SAND with silt (SP-SM); mostly fine-medium grained sand, few fine-coarse gravel, few silt, medium dense, saturated, dark brown	9.4								
			SS	42 50	0.33	50	(8.00') BEDROCK: Partially Weathered Granite Bedrock	16.5								1180
10							(10.00') Boring terminated									
																1175
15																

NOTES:

Point of Beginning

Client:	**Roth Professional Solutions**	**BORING LOG**
Project:	**Peplin Road Improvement, (POB #25.2061)**	**Boring No.** **B-10**
Address:	**Peplin Road, Kronenwetter, WI**	**Page:** **1 of 1**

Drilling Start Date:	**10/30/25**	Boring Depth (ft):	**10**
Drilling End Date:	**10/30/25**	Boring Diameter (in):	**4.0**
Drilling Company:	**POB**	Sampling Method(s):	**Split Spoon**
Drilling Method:	**Solid Stem Auger**	DTW During Drilling (ft):	**N/A**
Drilling Equipment:	**Mobile B-57**	DTW After Drilling (ft):	**5.5**
Driller:	**Dakota Ciriacks**	Ground Surface Elev. (ft):	**1199.5**
Logged By:	**Neil Henriksen**	Location (Lat, Long):	**44.78031, -89.59768**

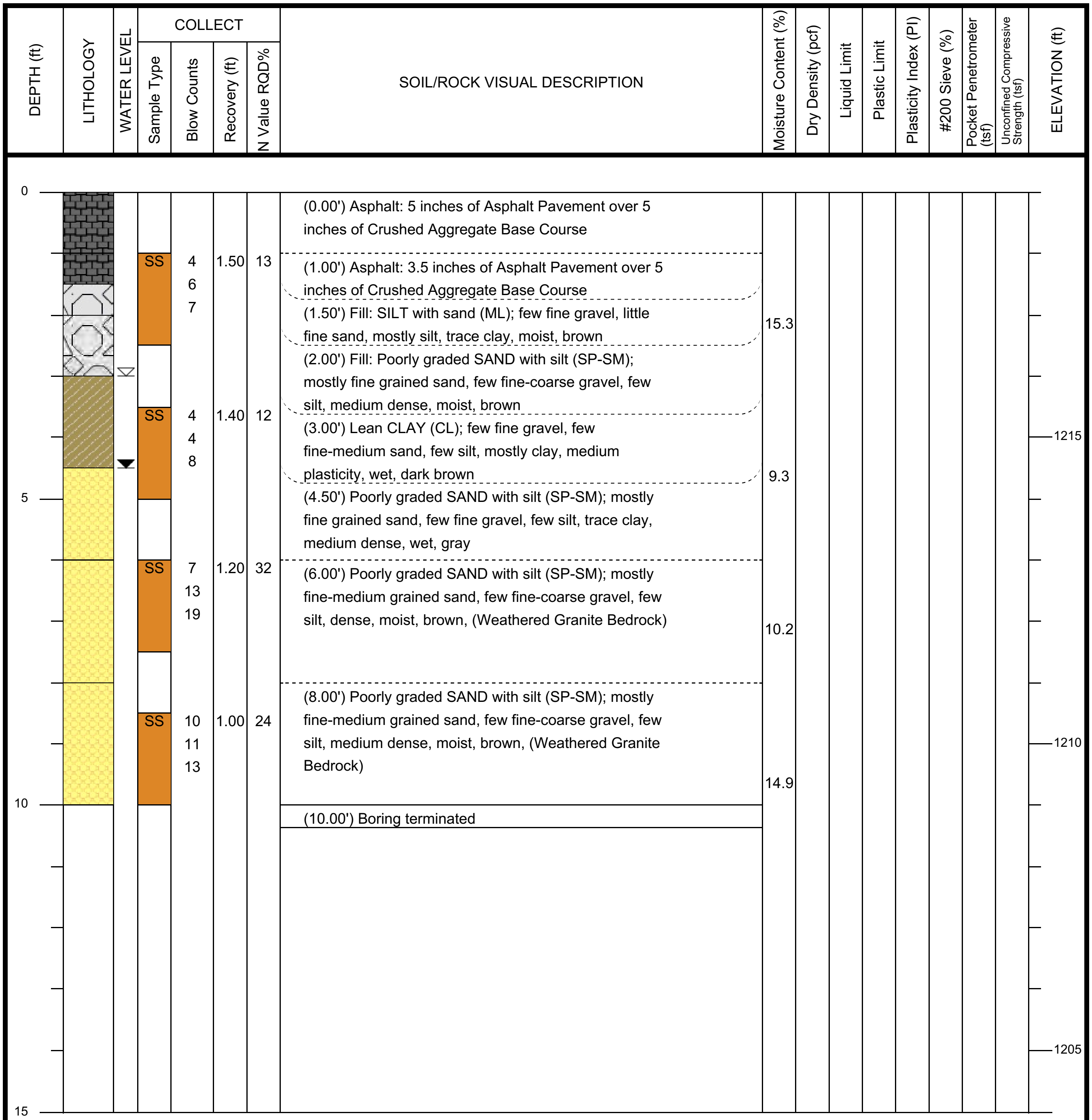


DEPTH (ft)	LITHOLOGY	WATER LEVEL	COLLECT Sample Type	Blow Counts	Recovery (ft)	N Value RQD%	SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)	ELEVATION (ft)
0							(0.00') Asphalt: 5 inches of Asphalt Pavement over 4 inches of Crushed Aggregate Base Course									
			SS	7 9 8	1.10	17	(0.50') Asphalt: 2.5 inches of Asphalt Pavement over 7 inches of Crushed Aggregate Base Course									
							(1.50') Fill: Poorly graded SAND with silt and gravel (SP-SM); mostly fine-medium grained sand, little fine-coarse gravel, few silt, medium dense, moist, dark brown	4.4								
			SS	2 2 3	1.40	5	(3.00') Lean CLAY (CL); trace fine gravel, few fine-medium sand, few silt, mostly clay, medium plasticity, stiff, moist, dark brown, (Few Organics)	36.9						1.75		1195
5		▼														
			SS	6 10 11	1.20	21	(6.00') Poorly graded SAND with clay (SP-SC); mostly fine-medium grained sand, few fine-coarse gravel, few silt, few clay, medium dense, saturated, gray	10								
			SS	8 8 9	1.00	17										
							(9.00') Poorly graded SAND with silt (SP-SM); mostly fine-medium grained sand, few fine-coarse gravel, few silt, medium dense, saturated, gray	17.5								1190
10							(10.00') Boring terminated									
																1185
15																

NOTES:

Client:	**Roth Professional Solutions**	**BORING LOG**	
Project:	**Peplin Road Improvement, (POB #25.2061)**	**Boring No.**	**B-11**
Address:	**Peplin Road, Kronenwetter, WI**	**Page:**	**1 of 1**

Drilling Start Date:	**10/30/25**	Boring Depth (ft):	**10**
Drilling End Date:	**10/30/25**	Boring Diameter (in):	**4.0**
Drilling Company:	**POB**	Sampling Method(s):	**Split Spoon**
Drilling Method:	**Solid Stem Auger**	DTW During Drilling (ft):	**3**
Drilling Equipment:	**Mobile B-57**	DTW After Drilling (ft):	**4.5**
Driller:	**Dakota Ciriacks**	Ground Surface Elev. (ft):	**1219**
Logged By:	**Neil Henriksen**	Location (Lat, Long):	**44.78392, -89.59763**



COLLECT												
Sample Type	Blow Counts	Recovery (ft)	N Value RQD%	SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)
				(0.00') Asphalt: 5 inches of Asphalt Pavement over 5 inches of Crushed Aggregate Base Course								
SS	4 6 7	1.50	13	(1.00') Asphalt: 3.5 inches of Asphalt Pavement over 5 inches of Crushed Aggregate Base Course								
				(1.50') Fill: SILT with sand (ML); few fine gravel, little fine sand, mostly silt, trace clay, moist, brown	15.3							
				(2.00') Fill: Poorly graded SAND with silt (SP-SM); mostly fine grained sand, few fine-coarse gravel, few silt, medium dense, moist, brown								
SS	4 4 8	1.40	12	(3.00') Lean CLAY (CL); few fine gravel, few fine-medium sand, few silt, mostly clay, medium plasticity, wet, dark brown	9.3							
				(4.50') Poorly graded SAND with silt (SP-SM); mostly fine grained sand, few fine gravel, few silt, trace clay, medium dense, wet, gray								
SS	7 13 19	1.20	32	(6.00') Poorly graded SAND with silt (SP-SM); mostly fine-medium grained sand, few fine-coarse gravel, few silt, dense, moist, brown, (Weathered Granite Bedrock)	10.2							
SS	10 11 13	1.00	24	(8.00') Poorly graded SAND with silt (SP-SM); mostly fine-medium grained sand, few fine-coarse gravel, few silt, medium dense, moist, brown, (Weathered Granite Bedrock)	14.9							
				(10.00') Boring terminated								

NOTES:

Point of Beginning

Client: Roth Professional Solutions
Project: South Road Improvement, (POB #25.2061)
Address: South Road, Kronenwetter, WI

BORING LOG

Boring No. B-12
Page: 1 of 1

Drilling Start Date: **10/30/25**
Drilling End Date: **10/30/25**
Drilling Company: **POB**
Drilling Method: **Solid Stem Auger**
Drilling Equipment: **Mobile B-57**
Driller: **Dakota Ciriacks**
Logged By: **Neil Henriksen**

Boring Depth (ft): **5**
Boring Diameter (in): **4.0**
Sampling Method(s): **Split Spoon**
DTW During Drilling (ft): **N/A**
DTW After Drilling (ft): **3**
Ground Surface Elev. (ft): **1219**
Location (Lat, Long): **44.77159, -89.63778**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)	ELEVATION (ft)
			Sample Type	Blow Counts	Recovery (ft)	N Value RQD%										
0	▦						(0.00') Asphalt: 1.5 inches of Asphalt Pavement over 10 inches of Crushed Aggregate Base Course									
	▨		SS	8 8 6	1.40	14	(1.00') Fill: Poorly graded SAND with silt and gravel (SP-SM); mostly fine-medium grained sand, little fine-coarse gravel, few silt, medium dense, moist, dark brown	14.9								
	▨	▼	SS	5 7 9	1.20	16	(3.00') Poorly graded SAND (SP); mostly fine grained sand, trace fine gravel, trace silt, medium dense, saturated, brown	24								1215
5							(5.00') Boring terminated									
																1210
10																
																1205
15																

NOTES:

Point of Beginning

Client: Roth Professional Solutions
Project: South Road Improvement, (POB #25.2061)
Address: South Road, Kronenwetter, WI

BORING LOG

Boring No. B-13
Page: 1 of 1

Drilling Start Date: **10/30/25**
Drilling End Date: **10/30/25**
Drilling Company: **POB**
Drilling Method: **Solid Stem Auger**
Drilling Equipment: **Mobile B-57**
Driller: **Dakota Ciriack**
Logged By: **Neil Henriksen**

Boring Depth (ft): **5**
Boring Diameter (in): **4.0**
Sampling Method(s): **Split Spoon**
DTW During Drilling (ft): **N/A**
DTW After Drilling (ft): **3.5**
Ground Surface Elev. (ft): **1152.5**
Location (Lat, Long): **44.77162, -89.63531**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)	ELEVATION (ft)
			Sample Type	Blow Counts	Recovery (ft)	N Value RQD%										
0							(0.00') Asphalt: 1.5 inches of Asphalt Pavement over 11 inches of Crushed Aggregate Base Course									
			SS	10 6 6	1.40	12	(1.00') Fill: Poorly graded SAND with silt (SP-SM); mostly fine-medium grained sand, few fine-coarse gravel, few silt, medium dense, moist, brown	13.2								1150
		▼	SS	4 6 7	1.10	13	(3.00') Poorly graded SAND (SP); mostly fine grained sand, trace fine gravel, trace silt, medium dense, saturated, brown	22.9								
5							(5.00') Boring terminated									
																1145
10																
																1140
15																

NOTES:

Point of Beginning

Client: Roth Professional Solutions
Project: South Road Improvement, (POB #25.2061)
Address: South Road, Kronenwetter, WI

BORING LOG

Boring No. B-14
Page: 1 of 1

Drilling Start Date:	**10/30/25**	Boring Depth (ft):	**10**
Drilling End Date:	**10/30/25**	Boring Diameter (in):	**4.0**
Drilling Company:	**POB**	Sampling Method(s):	**Split Spoon**
Drilling Method:	**Solid Stem Auger**	DTW During Drilling (ft):	**N/A**
Drilling Equipment:	**Mobile B-57**	DTW After Drilling (ft):	**3**
Driller:	**Dakota Ciriacks**	Ground Surface Elev. (ft):	**1153.3**
Logged By:	**Neil Henriksen**	Location (Lat, Long):	**44.77160, -89.63312**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	COLLECT Sample Type	COLLECT Blow Counts	COLLECT Recovery (ft)	COLLECT N Value RQD%	SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)	ELEVATION (ft)
0	▦						(0.00') Asphalt: 1.5 inches of Asphalt Pavement over 10 inches of Crushed Aggregate Base Course									
	▧		SS	7 5 4	1.50	9	(1.00') Fill: Poorly graded SAND with silt (SP-SM); mostly fine grained sand, few fine gravel, few silt, trace clay, loose, moist, gray									
	▩						(2.00') Poorly graded SAND with clay (SP-SC); mostly fine grained sand, trace fine gravel, few silt, few clay, loose, moist, black, (Organics)	37.7								
	▨	▼	SS	3 4 6	1.30	10	(3.00') Lean CLAY (CL); trace fine gravel, few fine-medium sand, few silt, mostly clay, medium plasticity, wet, dark brown									1150
5	▩		SS	6 9 9	1.40	18	(4.00') Poorly graded SAND (SP); mostly fine grained sand, trace fine gravel, trace silt, medium dense, saturated, light brown	18.1 17.7								
10	▨		SS	5 6 7	1.20	13	(8.00') Lean CLAY (CL); few fine gravel, few fine-medium sand, few silt, mostly clay, medium plasticity, very stiff, moist, brown, (Weathered Granite Bedrock)	14.2						2.75		1145
							(10.00') Boring terminated									1140
15																

NOTES:

Point of Beginning

Client:	**Roth Professional Solutions**
Project:	**South Road Improvement, (POB #25.2061)**
Address:	**South Road, Kronenwetter, WI**

BORING LOG

Boring No. **B-15**

Page: **1 of 1**

Drilling Start Date:	**10/30/25**	Boring Depth (ft):	**5**
Drilling End Date:	**10/30/25**	Boring Diameter (in):	**4.0**
Drilling Company:	**POB**	Sampling Method(s):	**Split Spoon**
Drilling Method:	**Solid Stem Auger**	DTW During Drilling (ft):	**N/A**
Drilling Equipment:	**Mobile B-57**	DTW After Drilling (ft):	**N/A**
Driller:	**Dakota Ciriacks**	Ground Surface Elev. (ft):	**1171.3**
Logged By:	**Neil Henriksen**	Location (Lat, Long):	**44.77164, -89.62963**

DEPTH (ft)	LITHOLOGY	WATER LEVEL	COLLECT				SOIL/ROCK VISUAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	Liquid Limit	Plastic Limit	Plasticity Index (PI)	#200 Sieve (%)	Pocket Penetrometer (tsf)	Unconfined Compressive Strength (tsf)	ELEVATION (ft)
			Sample Type	Blow Counts	Recovery (ft)	N Value RQD%										
0							(0.00') Asphalt: 2 inches of Asphalt Pavement over 16 inches of Crushed Aggregate Base Course									1170
			SS	8 8 6	1.40	14	(1.50') Fill: Poorly graded SAND with clay (SP-SC); mostly fine grained sand, trace fine gravel, few silt, few clay, medium dense, moist, gray and brown	11.3								
			SS	9 13 17	1.10	30	(3.00') Poorly graded SAND with clay (SP-SC); mostly fine grained sand, few fine-coarse gravel, few silt, few clay, dense, moist, reddish-brown, (Weathered Granite Bedrock)	4.1								
5							(5.00') Boring terminated									1165
10																1160
15																

NOTES:

POB
Point of Beginning

BORING AND WELL LOG LEGEND

SURFACE

ASPHALT
CONCRETE
FILL
TOPSOIL
AIR
ICE

USCS

Well-graded GRAVEL (GW)
Poorly graded GRAVEL (GP)
Silty GRAVEL (GM)
Clayey GRAVEL (GC)
Silty, Clayey GRAVEL (GC-GM)
Well-graded GRAVEL with silt (GW-GM)
Poorly graded GRAVEL with silt (GP-GM)
Well-graded GRAVEL with clay (GW-GC)
Poorly graded GRAVEL with clay (GP-GC)
Well-graded SAND (SW)
Poorly graded SAND (SP)
Silty SAND (SM)
Clayey SAND (SC)
Silty, Clayey SAND (SC-SM)
Well-graded SAND with silt (SW-SM)
Poorly graded SAND with silt (SP-SM)
Well-graded SAND with clay (SW-SC)
Poorly graded SAND with clay (SP-SC)
SILT (ML)
Lean CLAY (CL)
Silty CLAY (CL-ML)
Organic SOIL (OL)
Elastic SILT (MH)
Fat CLAY (CH)
Organic SOIL (OH)
Organic SOIL (OL/OH)
PEAT (PT)
BEDROCK
WATER

Non-USCS

Gravel
Sand
Silt
Clayey silt
Silt & clay
Clay & silt
Silty clay
Clay
Boulders
Cobbles
Peastone
Glacial till
Iron ore
Wood
Peat
Partially Weathered Rock (PWR)
Saprolite
Ash
Waste
Mud
Alluvium
Colluvium
Residuum

Soil/Rock Contact Lines

Inferred
Abrupt
Gradational

Volume Descriptors

Trace = <5%
Few = 5-10%
Little = 15-25%
Some = 30-45%
Mostly = >=50%

Water Levels

▽ Water Level During Drilling
▼ Water Level at End of Drilling/in Completed Well

Well/Boring Completion

Cap
Riser
Screen
End Plug
Annular Seal
Sanitary Seal (Bentonite Slurry/Chips/Pellets/Powder, Other)
Filter Pack (Sand, Gravel, Other)
Backfill

Sample Type

GR	Grab
EN	Encore
SS	Split Spoon
SH	Shelby Tube
CO	Core Barrel
DP	Direct Push
ID	Lab Sample and ID

Rock

IGNEOUS Rock
METAMORPHIC Rock
SEDIMENTARY Rock
Agglomerate
Andesite
Basalt
Diorite
Gabbro
Granite
Rhyolite
Tuff
Volcanic breccia
Gneiss
Granulite
Hornfels
Marble
Phyllite
Quartzite
Schist
Serpentinite
Skarn
Slate
Amphibolite
Breccia
Chalk
Chert
Claystone
Coal
Conglomerate
Diatomite
Dolomite
Evaporite
Graywacke
Limestone
Mudstone
Sandstone
Shale
Siltstone

Major Component of Sample	Size Range	Description of Components Present in Sample	Percent of Dry Weight
Boulders	Over 8" (200 mm)	Trace	<5
Cobbles	8" to 3" (200 to 75 mm)	Few	5 - 10
Gravel	3" to #4 sieve (75 to 4.76 mm)	Little	15 - 25
Sand	#4 to #200 sieve (4.76 to 0.074 mm)	Some	30 - 45
Silt	Passing #200 sieve (0.074 to 0.005 mm)		
Clay	Smaller than 0.005 mm		

Consistency of Fine-Grained Soils

Unconfined Compressive Strength, Qu, tsf	Consistency
<0.25	Very Soft
0.25 - 0.49	Soft
0.50 - 0.99	Medium Stiff
1.00 - 1.99	Stiff
2.00 - 3.99	Very Stiff
>4.00	Hard

Relative Density of Coarse-Grained Soils

N, Blows per 12 inches	Relative Density
0 - 3	Very Loose
4 - 9	Loose
10 - 29	Medium Dense
30 - 49	Dense
50 - 80	Very Dense
>80	Extremely Dense

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)			
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)		
	▨	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	▨	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)		
	▨	GM	Silty gravels, gravel-sand-silt mixtures
	▨	GC	Clayey gravels, gravel-sand-clay mixtures
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)		
	▨	SW	Well-graded sands, gravelly sands, little or no fines
	▨	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)		
	▨	SM	Silty sands, sand-silt mixtures
	▨	SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)			
SILTS AND CLAYS Liquid limit less than 50%	▨	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
	▨	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	▨	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	▨	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	▨	CH	Inorganic clays of high plasticity, fat clays
	▨	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	▨	PT	Peat and other highly organic soils

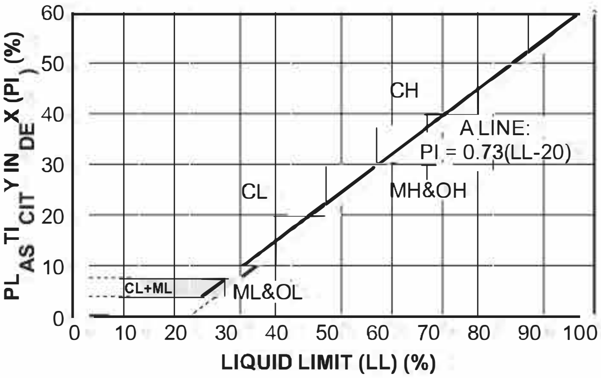
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

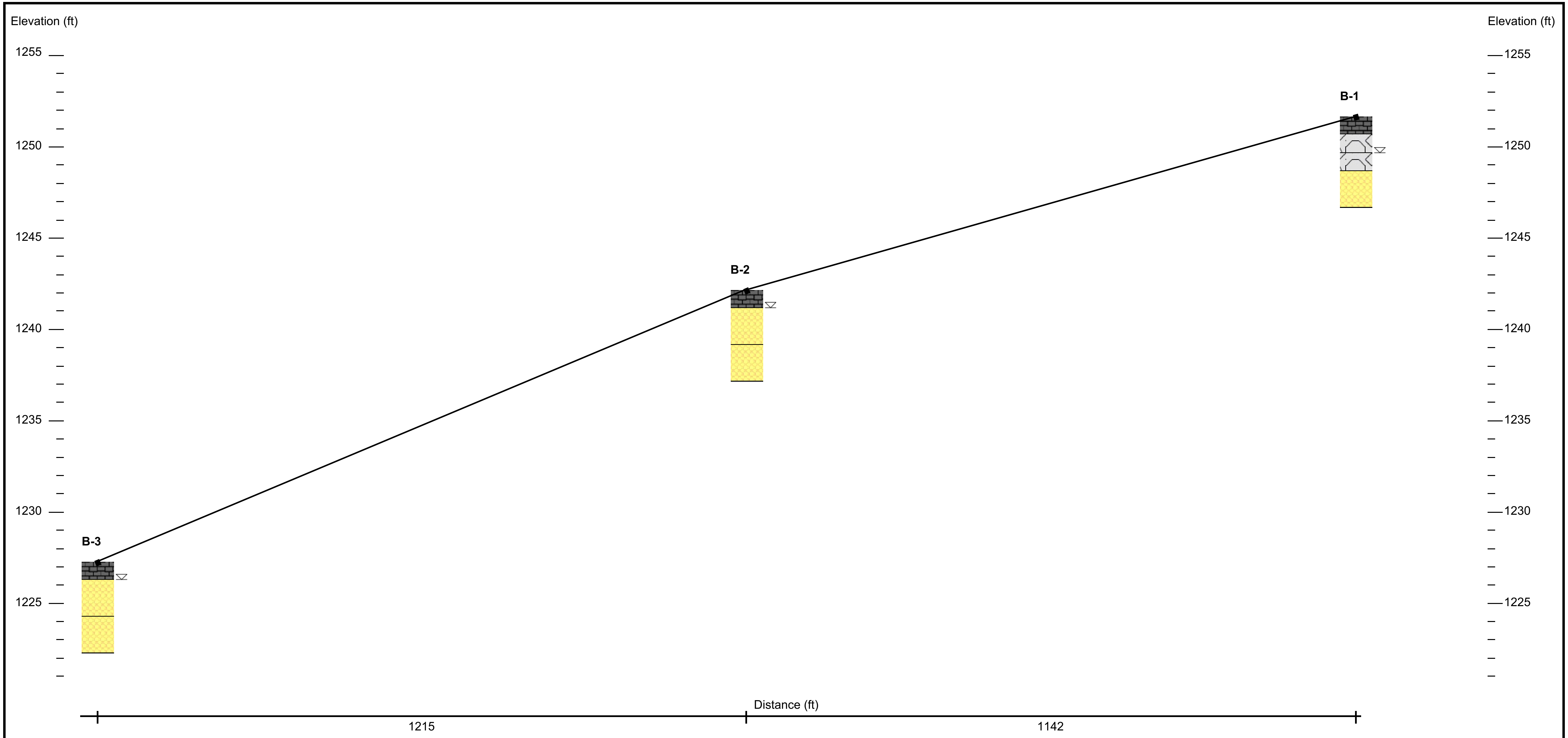
Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent .... GW, GP, SW, SP
More than 12 percent .... GM, GC, SM, SC
5 to 12 percent .... Borderline cases requiring dual symbols

PLASTICITY CHART



UNIFIED SOIL CLASSIFICATION SYSTEM



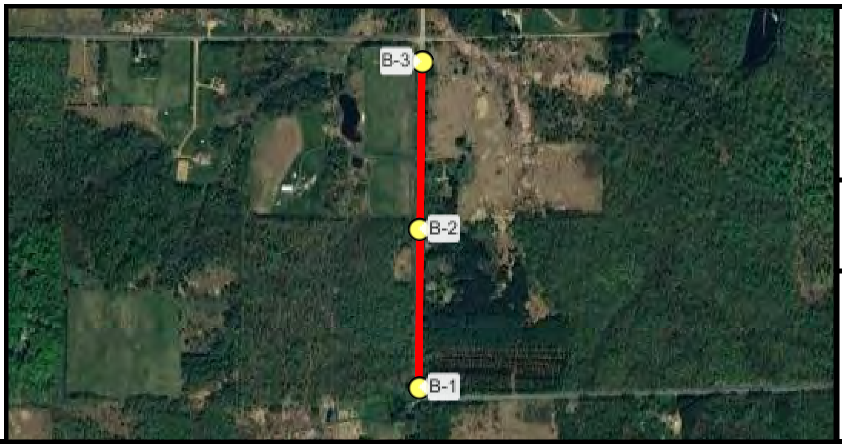
Horizontal scale: 80 feet
Vertical scale: 10 feet

Legend

- ▩ ASPHALT
- 🟨 Poorly graded SAND with silt (SP-SM)
- ▨ FILL

- ▽ Water Level During Drilling
- ▼ Water Level at End of Drilling
- ▒ Cap
- ☰ Screen
- ▥ Annular Seal
- ▤ Sanitary Seal
- ⠿ Filter Pack
- ▦ Backfill

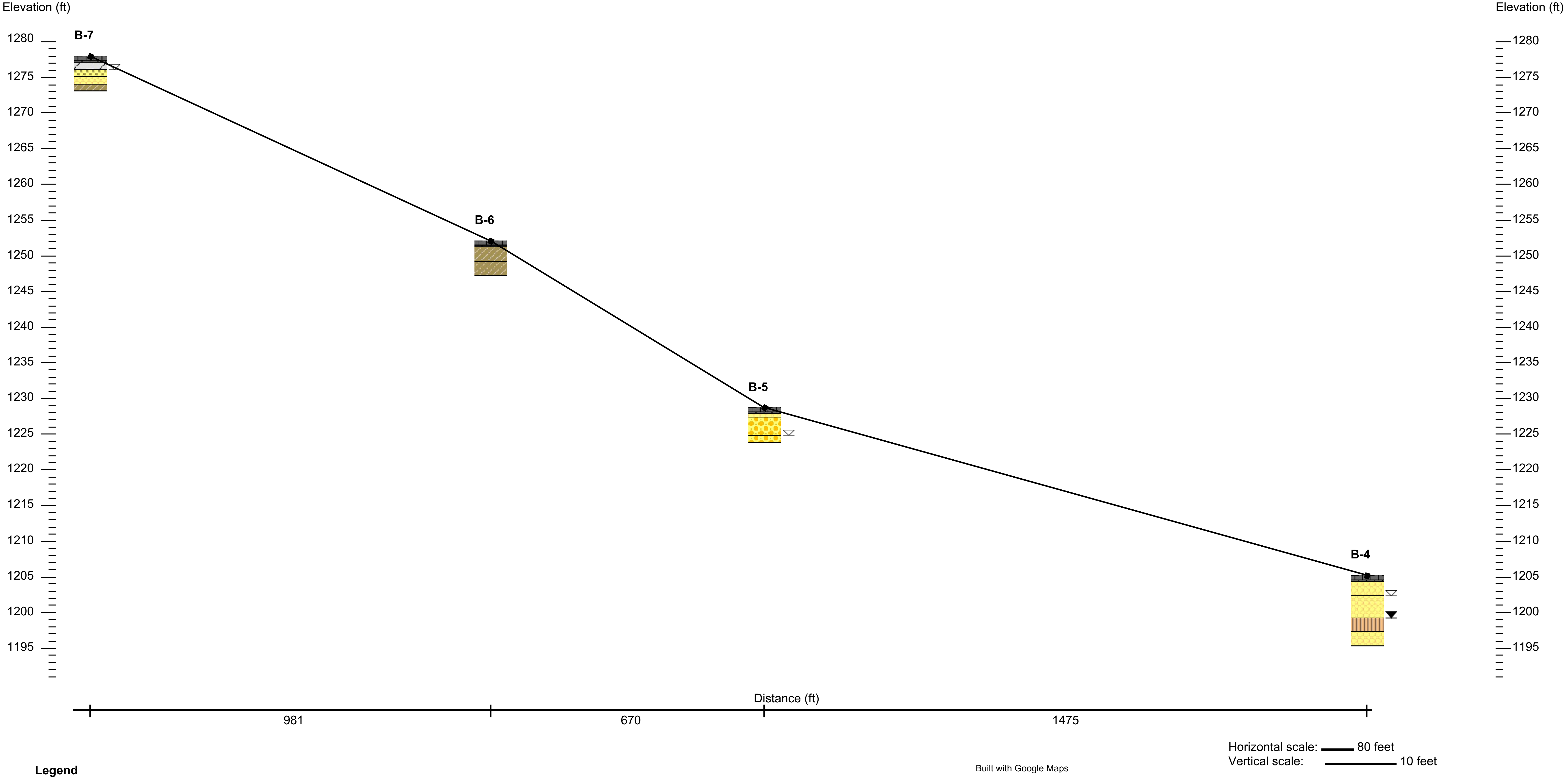
Built with Google Maps



Point of Beginning

FIGURE 3
GEOLOGIC CROSS SECTION

Roth Professional Solutions
Autumn Road Reconstruction
(POB #25.2061)
Autumn Road
Kronenwetter, Wisconsin



Legend

▦ ASPHALT
▨ FILL
▩ Poorly graded SAND with clay (SP-SC)
▩ Poorly graded SAND with silt (SP-SM)
▨ Lean CLAY (CL)
▥ SILT (ML)
▩ Poorly graded SAND (SP)

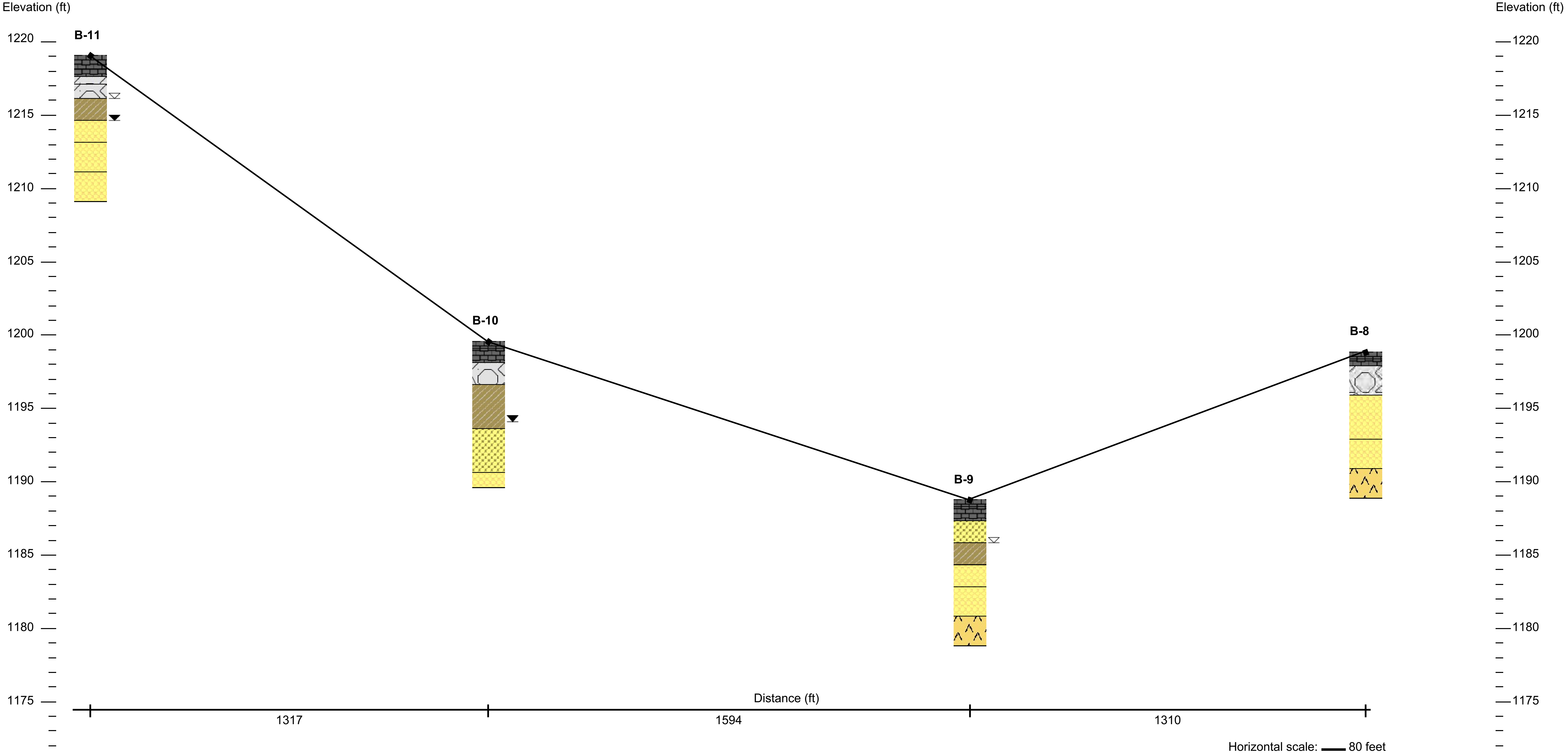
▽ Water Level During Drilling
▼ Water Level at End of Drilling
▩ Cap
▤ Screen
▥ Annular Seal
▤ Sanitary Seal
▩ Filter Pack
▦ Backfill

Built with Google Maps

Point of Beginning

FIGURE 4
GEOLOGIC CROSS SECTION

Roth Professional Solutions
Forest Road Reconstruction
(POB #25.2061)
Forest Road
Kronenwetter, Wisconsin



Horizontal scale: 80 feet

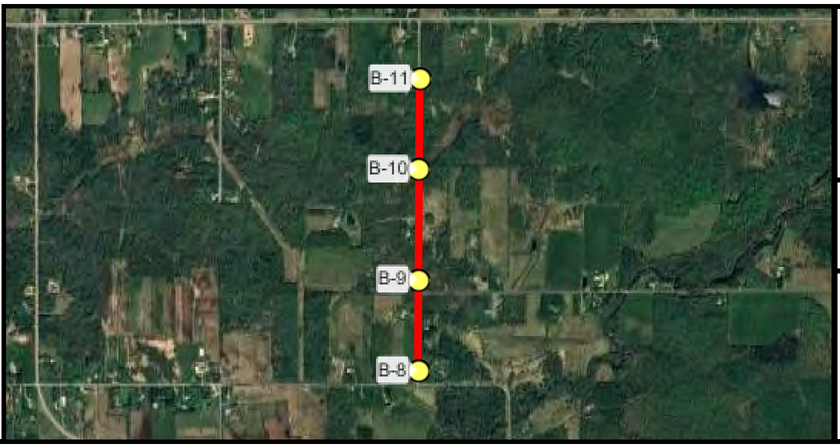
Vertical scale: 10 feet

Legend

▦	ASPHALT
⬡	FILL
▨	Lean CLAY (CL)
▤	Poorly graded SAND with silt (SP-SM)
^	BEDROCK
▩	Poorly graded SAND with clay (SP-SC)

▽	Water Level During Drilling
▼	Water Level at End of Drilling
▒	Cap
☰	Screen
▮	Annular Seal
▤	Sanitary Seal
⁘	Filter Pack
▦	Backfill

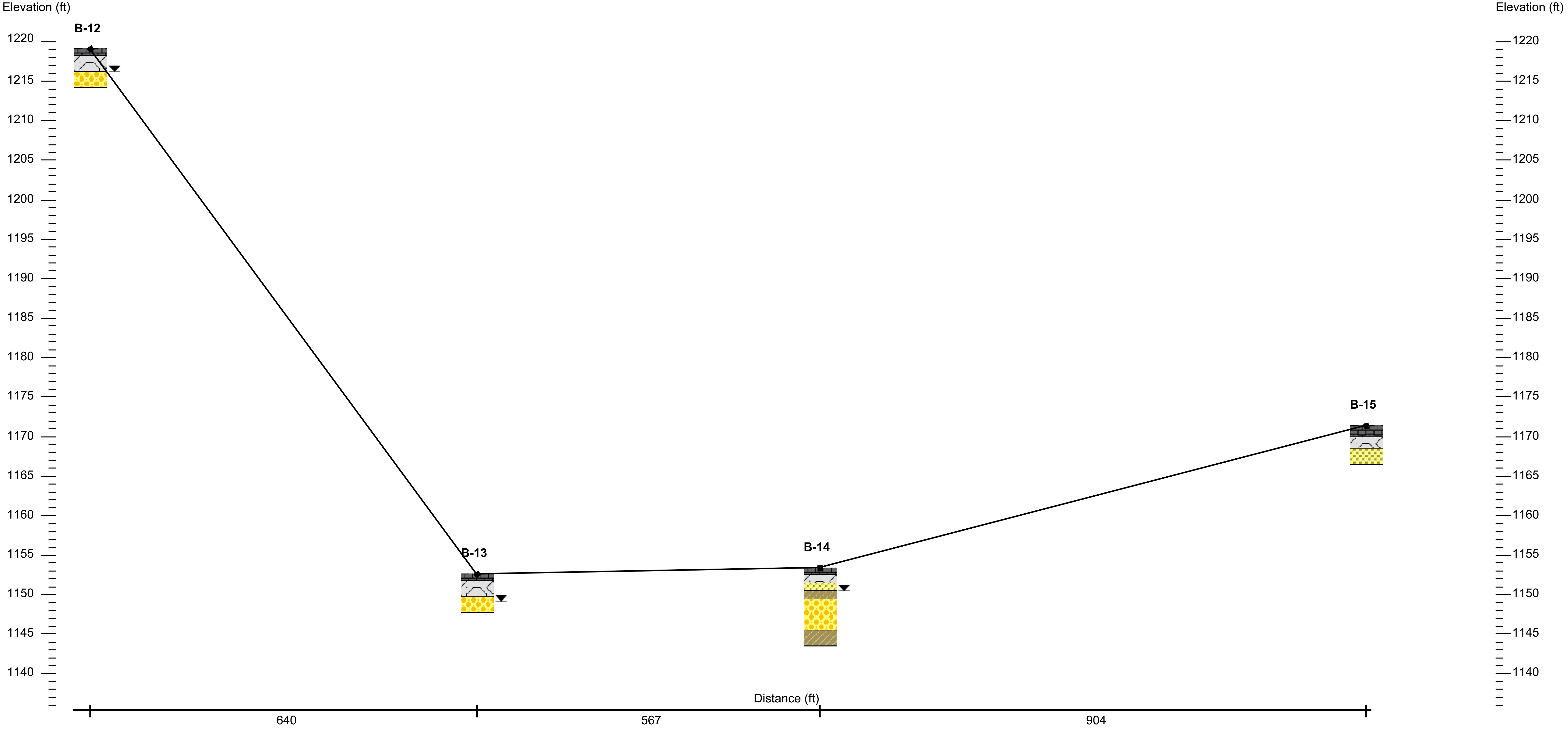
Built with Google Maps



Point of Beginning

FIGURE 5
GEOLOGIC CROSS SECTION

Roth Professional Solutions
Peplin Road Reconstruction
(POB #25.2061)
Peplin Road
Kronenwetter, Wisconsin



Horizontal scale: 60 feet
Vertical scale: 10 feet

Legend

- ASPHALT
- FILL
- Poorly graded SAND (SP)
- Poorly graded SAND with clay (SP-SC)
- Lean CLAY (CL)

- ▽ Water Level During Drilling
- ▼ Water Level at End of Drilling
- Cap
- Screen
- Annular Seal
- Sanitary Seal
- Filter Pack
- Backfill

Built with Google Maps

Point of Beginning

FIGURE 6
GEOLOGIC CROSS SECTION

Roth Professional Solutions
South Road Reconstruction
(POB #25.2061)
South Road
Kronenwetter, Wisconsin

APPENDIX C

LABORATORY REPORTS

None

APPENDIX D

GENERAL NOTES & PROCEDURES

Drilling Procedures

Borings are drilled with a track- or truck-mounted rotary drill rig using one of a variety of drilling methods, depending on the soil conditions.

After each boring is completed, the open boreholes are either backfilled with the auger cuttings or bentonite chips, depending on government regulations or project specifications. The boreholes at the ground surface may also be capped with asphalt or concrete.

Hand-Auger Drilling (HA) - A fluted sampling device on the end of a T-Probe is advanced into the soil to the desired sample depth and then manually extracted to recover a disturbed sample. Sampling to depths greater than 3 to 5 feet can be difficult, depending on the soils encountered.

Solid-Stem Auger Drilling (AD) - Continuous flight augers are advanced to create a borehole. With solid-stem auger drilling, casing and drilling fluids are not used to maintain an open borehole. Therefore, this method is suitable in soils that will maintain an open borehole when the augers are removed. Typically, soil-stem drilling is not appropriate below the groundwater table. Soil samples can be collected at any interval.

Hollow-Stem Auger Drilling (HS) - Continuous flight augers are advanced by a truck- or track-mounted drill rig to create a borehole. Hollow-stem augers have open stems that allow a soil sampling tool to be used without removing the augers from the borehole. This drilling method is not appropriate below the groundwater table when sand soils are encountered.

Rotary Drilling (RD) - Various auger bits attached to drill rod, in conjunction with circulating drilling fluid, are used to advance the borehole. Surface casing is used to maintain borehole stability and to facilitate the circulation of the drilling fluid. The borehole will remain open due to the presence of dense drilling fluid (mud) when the auger bit and drill rod are removed. This drilling method is appropriate in soils that do not maintain an open borehole during drilling.

Diamond Core Drilling (DD) - A double-tube or triple-tube core barrel with a diamond bit is advanced through bedrock or cemented material to create an in-situ cylinder material that can be extracted. When the core barrel has proceeded to the desired core run length, the core sample is retained by a core catcher and retrieved.

Soil Sampling Procedures

Representative soil samples are collected during the drilling process using one of a variety of sampling methods. Typically, soil samples are obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter.

Field logs for each boring, which describe the method of borehole advancement, sampling methods, sample depths, and other observations regarding soil and groundwater conditions, are prepared at the time of drilling. The field logs are utilized by geotechnical staff as an aid in preparing the final boring logs.

Auger Sampling (AS) - Soil samples are obtained as cuttings from the auger flights as they are lifted from the borehole. Auger samples provide a general indication of subsurface conditions; however, they do not provide undisturbed samples, nor do they provide samples from specific depths. Due to the possible loss of soil components, or the mixing of soil components from various elevations, auger samples may not be representative of in-situ soil conditions.

Split-Barrel Sampling (SS) - ASTM Standard D-1586 - A 2-inch-O.D. split-barrel sampler is driven into the soil 18 inches by a 140-pound weight free-falling 30 inches. The first 6 inches of penetration is usually considered a seating drive. The Standard Penetration Resistance (SPT) value (N-Value) is the number of blows over the final 12 inches of driving. This value provides an indication of the in-place relative density of coarse-grained (sand and gravel) soils. The N-Value should be considered qualitative, since many variables can affect the results. A representative portion of the soil sample is recovered from the split-barrel sampler, placed in a sample jar, and delivered to a laboratory for further examination and possible testing. The ASTM standard is attached.

Shelby Tube Sampling Procedure (ST) - ASTM Standard D-1587 - A 2- or 3-inch-diameter thin-walled seamless steel tube having a sharp cutting edge is hydraulically pushed into the soil to obtain a relatively undisturbed sample. This procedure is generally used for fine-grained (clay and silt) soils. The Shelby tubes are carefully handled to minimize sample disturbance and delivered to a laboratory where the soil is extruded from the tube for further examination and possible testing. The ASTM standard is attached.

Miscellaneous Procedures

Soil Classification - The samples collected were evaluated in accordance with the Unified Soil Classification System (USCS). A summary of the USCS is included in Appendix B.

The descriptions presented on the boring logs are a representation of the subsurface conditions, based on visual soil classifications of soil samples and laboratory test results. The stratigraphic lines on the logs are approximate and the transition between the layers may be gradual rather than distinct.

Boring Location Layout - If the boring locations are not staked by the project civil engineer ahead of drilling, geotechnical staff will lay out the borings either by visibly referencing site features or utilizing handheld GPS equipment. The boring location accuracy, if not pre-staked, will be 10 feet.

Boring Surface Elevations - If the surface elevations at the boring locations are not provided by the project civil engineer, they will be obtained using a variety of methods, including topographic survey interpolation, the USGS website database, government GIS websites, or handheld GPS equipment. The accuracy of the surface elevations will be ½ foot if surveyed and 1 foot if interpolated from website/plan resources.

Subsurface Water Observation - Subsurface water (groundwater and perched water) observations will be recorded during drilling and at the completion of drilling. Any recorded observations will be approximate and accurate to 2 feet. Water level measurements refer only to those observed at the times and locations indicated and may vary with time.

Designation: D 1586 – 99

AMERICAN SOCIETY FOR TESTING AND MATERIALS
100 Barr Harbor Dr., West Conshohocken, PA 19428
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Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This test method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For a specific precautionary statement, see 5.4.1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

NOTE 1—Practice D 6066 can be used when testing loose sands below the water table for liquefaction studies or when a higher level of care is required when drilling these soils. This practice provides information on drilling methods, equipment variables, energy corrections, and blow-count normalization.

2. Referenced Documents

2.1 *ASTM Standards:*

D 2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

D 4633 Test Method for Stress Wave Energy Measurement for Dynamic Penetrometer Testing Systems[2]

D 6066 Practice for Determining the Normalized Penetration Resistance Testing of Sands for Evaluation of Liquefaction Potential[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *anvil*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.1.2 *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.1.3 *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.1.4 *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.1.5 *hammer*—that portion of the drive-weight assembly consisting of the 140 ± 2 lb (63.5 ± 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.1.6 *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.1.7 *hammer fall guide*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.1.8 *N-value*—the blowcount representation of the penetration resistance of the soil. The N-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.1.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.1.10 *number of rope turns*—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.1.11 *sampling rods*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.1.12 *SPT*—abbreviation for standard penetration test, a term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This test method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This test method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and

*A Summary of Changes section appears at the end of this standard.

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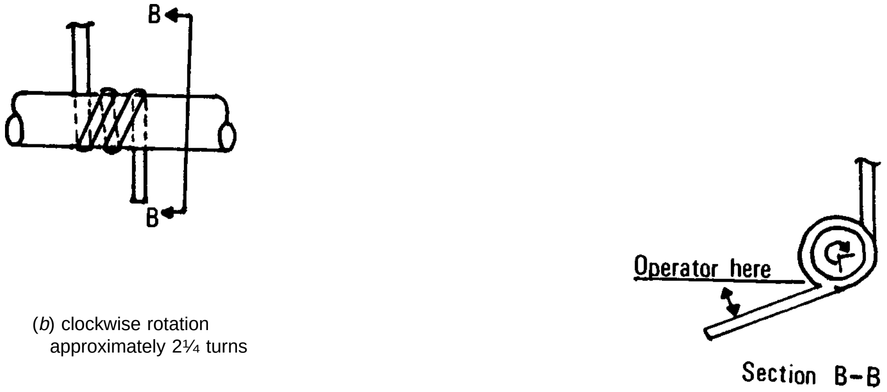
[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Jan. 10, 1999. Published March 1999. Originally published as D 1586 – 58 T. Last previous edition D 1586 – 98.

[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

(*a*) counterclockwise rotation
approximately 1¾turns



(*b*) clockwise rotation
approximately 2¼ turns

FIG. 1 Definitions of the Number of Rope Turns and the Angle for (*a*) Counterclockwise Rotation and (*b*) Clockwise Rotation of the Cathead

widely published correlations which relate SPT blowcount, or *N*-value, and the engineering behavior of earthworks and foundations are available.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions.

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjuction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2 *Roller-Cone Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 *Solid, Continuous Flight, Bucket and Hand Augers*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅛ in. (28.5 mm).

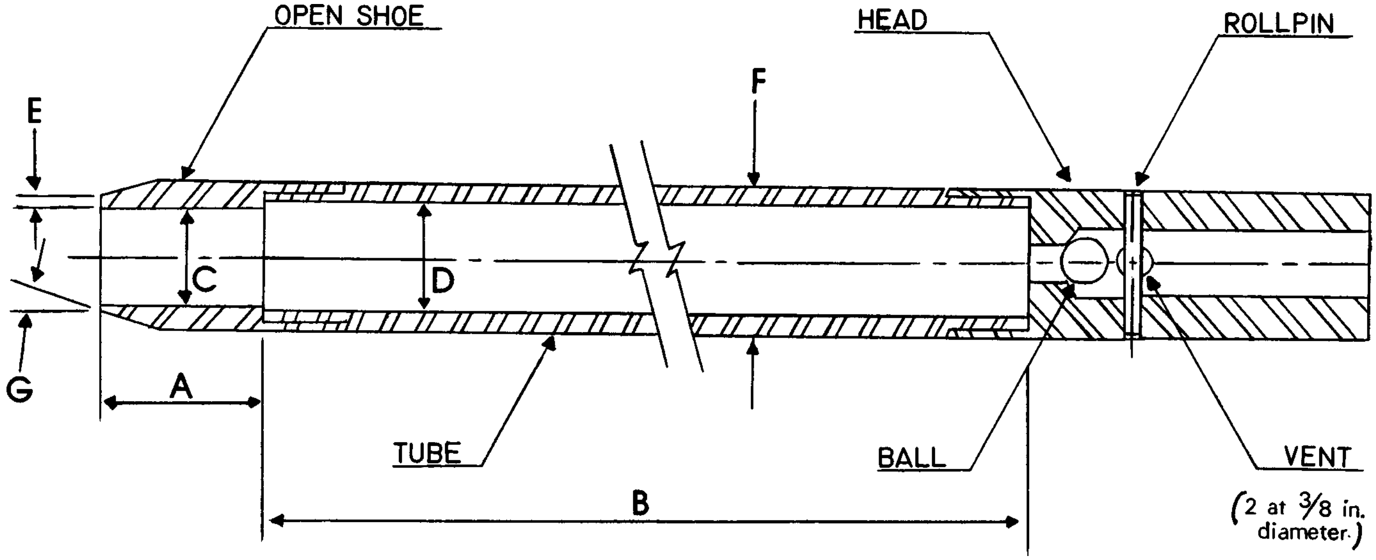
NOTE 2—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the *N*-values to depths of at least 100 ft (30 m).

5.3 *Split-Barrel Sampler*—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.

NOTE 3—Both theory and available test data suggest that *N*-values may increase between 10 to 30 % when liners are used.

5.4 *Drive-Weight Assembly*:

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 − 0.00 in. (38.1 ± 1.3 − 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 − 0.00 in. (50.8 ± 1.3 − 0.0 mm)
G = 16.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

NOTE 4—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 mm) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-kg) hammer and count the number of blows applied in each 6-in. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance," or the "*N*-value." If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lb (63.5-kg) hammer shall be accomplished using either of the following two methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) unimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may be used during the performance of the penetration test, as shown in Fig. 1.

NOTE 5—The operator should generally use either 1¾ or 2¼ rope turns, depending upon whether or not the rope comes off the top (1¾ turns) or the bottom (2¼ turns) of the cathead. It is generally known and accepted that 2¾or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the percent recovery or the length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job,

8.1.2 Names of crew,

8.1.3 Type and make of drilling machine,

8.1.4 Weather conditions,

8.1.5 Date and time of start and finish of boring,

8.1.6 Boring number and location (station and coordinates, if available and applicable),

8.1.7 Surface elevation, if available,

8.1.8 Method of advancing and cleaning the boring,

8.1.9 Method of keeping boring open,

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.1.11 Location of strata changes,

8.1.12 Size of casing, depth of cased portion of boring,

8.1.13 Equipment and method of driving sampler,

8.1.14 Type sampler and length and inside diameter of barrel (note use of liners),

8.1.15 Size, type, and section length of the sampling rods, and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number,

8.2.2 Description of soil,

8.2.3 Strata changes within sample,

8.2.4 Sampler penetration and recovery lengths, and

8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

9. Precision and Bias

9.1 *Precision*—A valid estimate of test precision has not been determined because it is too costly to conduct the necessary inter-laboratory (field) tests. Subcommittee D18.02 welcomes proposals to allow development of a valid precision statement.

9.2 *Bias*—Because there is no reference material for this test method, there can be no bias statement.

9.3 Variations in *N*-values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, *N*-values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.4 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in *N*-values obtained between operator-drill rig systems.

9.5 The variability in *N*-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting *N* on the basis of comparative energies. A method for energy measurement and *N*-value adjustment is given in Test Method D 4633.

10. Keywords

10.1 blow count; in-situ test; penetration resistance; split-barrel sampling; standard penetration test

SUMMARY OF CHANGES

(1) Added note to Section 1, Scope. The note refers to a related standard, Practice D 6066.

(2) Added Practice D 6066 to Section 2 on Referenced Documents.

Designation: D 1587 – 00

Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes[1]

This standard is issued under the fixed designation D 1587; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This practice covers a procedure for using a thin-walled metal tube to recover relatively undisturbed soil samples suitable for laboratory tests of engineering properties, such as strength, compressibility, permeability, and density. Thin-walled tubes used in piston, plug, or rotary-type samplers should comply with Section 6.3 of this practice which describes the thin-walled tubes.

NOTE 1—This practice does not apply to liners used within the samplers.

1.2 This Practice is limited to soils that can be penetrated by the thin-walled tube. This sampling method is not recommended for sampling soils containing gravel or larger size soil particles cemented or very hard soils. Other soil samplers may be used for sampling these soil types. Such samplers include driven split barrel samplers and soil coring devices (D 1586, D 3550, and D 6151). For information on appropriate use of other soil samplers refer to D 6169.

1.3 This practice is often used in conjunction with fluid rotary drilling (D 1452D 5783) or hollow-stem augers (D 6151). Subsurface geotechnical explorations should be reported in accordance with practice (D 5434). This practice discusses some aspects of sample preservation after the sampling event. For information on preservation and transportation process of soil samples, consult Practice D 4220. This practice does not address environmental sampling; consult D 6169 and D 6232for information on sampling for environmental investigations.

1.4 The values stated in inch-pound units are to be regarded as the standard. The SI values given in parentheses are provided for information purposes only. The tubing tolerances presented in Table 2 are from sources available in North America. Use of metric equivalent is acceptable as long as thickness and proportions are similar to those required in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.6 This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Standard Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Penetration Resistance and Split Barrel Sampling of Soils[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 3550 Practice for Ring-Lined Barrel Sampling of Soils[2]

D 3740 Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock[3]

D 5783 Guide for Use of Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices[3]

D 6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling[3]

D 6169 Guide for Selection of Soil and Rock Sampling

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[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved August 10, 2000. Published December 2000. Originally published as D 1587–58T. Last previous edition D 1587–83.

[2] *Annual Book of ASTM Standards,* Vol 04.08.

[3] *Annual Book of ASTM Standards,* Vol 04.09.

***A Summary of Changes section appears at the end of this standard.**

TABLE 1 Suitable Thin-Walled Steel Sample Tubes[A]

Outside diameter (D_o):			
in.	2	3	5
mm	50.8	76.2	127
Wall thickness:			
Bwg	18	16	11
in.	0.049	0.065	0.120
mm	1.24	1.65	3.05
Tube length:			
in.	36	36	54
m	0.91	0.91	1.45
Inside clearance ratio, %	<1	<1	<1

[A] The three diameters recommended in Table 1 are indicated for purposes of standardization, and are not intended to indicate that sampling tubes of intermediate or larger diameters are not acceptable. Lengths of tubes shown are illustrative. Proper lengths to be determined as suited to field conditions.

TABLE 2 Dimensional Tolerances for Thin-Walled Tubes

	Nominal Tube Diameters from Table 1[A] Tolerances					
Size Outside Diameter	2 in.	50.8 mm	3 in.	76.2 mm	5 in.	127 mm
Outside diameter, D_o	+0.007 -0.000	+0.179 -0.000	+0.010 -0.000	+0.254 -0.000	+0.015 -0.000	0.381 -0.000
Inside diameter, D_i	+0.000 -0.007	+0.000 -0.179	+0.000 -0.010	+0.000 -0.254	+0.000 -0.015	+0.000 -0.381
Wall thickness	±0.007	±0.179	±0.010	±0.254	±0.015	±0.381
Ovality	0.015	0.381	0.020	0.508	0.030	0.762
Straightness	0.030/ft	2.50/m	0.030/ft	2.50/m	0.030/ft	2.50/m

[A] Intermediate or larger diameters should be proportional. Specify only two of the first three tolerances; that is, D_o and D_i, or D_o and Wall thickness, or D_i and Wall thickness.

Devices Used With Drill Rigs for Environmental Investigations[3]

D 6232 Guide for Selection of Sampling Equipment for Waste and Contaminated Media Data Collection Activities[4]

3. Terminology

3.1 *Definitions:*

3.1.1 For common definitions of terms in this standard, refer to Terminology D 653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *inside clearance ratio, %*—the ratio of the difference in the inside diameter of the tube, D_i, minus the inside diameter of the cutting edge, D_e, to the inside diameter of the tube, D_i expressed as a percentage (see Fig. 1).

3.2.2 *ovality*—the cross section of the tube that deviates from a perfect circle.

4. Summary of Practice

4.1 A relatively undisturbed sample is obtained by pressing a thin-walled metal tube into the in-situ soil at the bottom of a boring, removing the soil-filled tube, and applying seals to the soil surfaces to prevent soil movement and moisture gain or loss.

5. Significance and Use

5.1 This practice, or Practice D 3550 with thin wall shoe, is used when it is necessary to obtain a relatively undisturbed specimen suitable for laboratory tests of engineering properties or other tests that might be influenced by soil disturbance.

NOTE 2—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective sampling. Users of this practice. are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 5740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Drilling Equipment*—When sampling in a boring, any drilling equipment may be used that provides a reasonably clean hole; that minimizes disturbance of the soil to be sampled; and that does not hinder the penetration of the thin-walled sampler. Open borehole diameter and the inside diameter of driven casing or hollow stem auger shall not exceed 3.5 times the outside diameter of the thin-walled tube.

6.2 *Sampler Insertion Equipment*, shall be adequate to provide a relatively rapid continuous penetration force. For hard formations it may be necessary, although not recommended, to drive the thin-walled tube sampler.

6.3 *Thin-Walled Tubes*, should be manufactured to the dimensions as shown in Fig. 1. They should have an outside diameter of 2 to 5 in. (50 to 130 mm) and be made of metal having adequate strength for the type of soil to be sampled. Tubes shall be clean and free of all surface irregularities including projecting weld seams. Other diameters may be used but the tube dimensions should be proportional to the tube designs presented here.

6.3.1 *Length of Tubes*—See Table 1 and 7.4.1.

6.3.2 *Tolerances*, shall be within the limits shown in Table 2.

6.3.3 *Inside Clearance Ratio*, should be not greater than 1 % unless specified otherwise for the type of soil to be sampled. Generally, the inside clearance ratio used should increase with the increase in plasticity of the soil being sampled, except for sensitive soils or where local experience indicates otherwise. See 3.2.1 and Fig. 1 for definition of inside clearance ratio.

6.3.4 *Corrosion Protection*—Corrosion, whether from galvanic or chemical reaction, can damage or destroy both the thin-walled tube and the sample. Severity of damage is a function of time as well as interaction between the sample and the tube. Thin-walled tubes should have some form of protective coating, unless the soil is to be extruded less than 3 days. The type of coating to be used may vary depending upon the material to be sampled. Plating of the tubes or alternate base metals may be specified. Galvanized tubes are often used when long term storage is required. Coatings may include a light coat of lubricating oil, lacquer, epoxy, Teflon, zinc oxide, and others.

NOTE 3—Most coating materials are not resistant to scratching by soils that contain sands. Consideration should be given for prompt testing of the sample because chemical reactions between the metal and the soil sample con occur with time.

6.4 *Sampler Head*, serves to couple the thin-walled tube to the insertion equipment and, together with the thin-walled tube,

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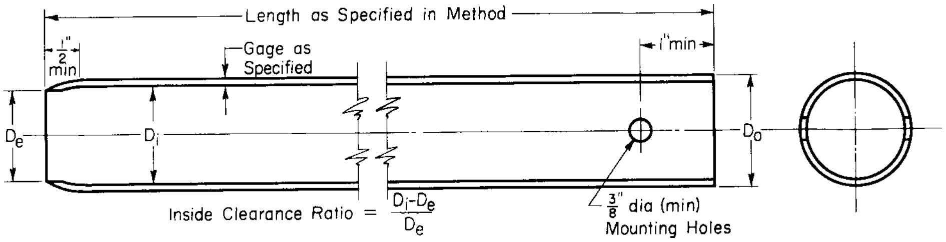
[4] *Annual Book of ASTM Standards,* Vol 11.04.



NOTE 1—Minimum of two mounting holes on opposite sides for D_o smaller than 4 in. (101.6 mm).

NOTE 2—Minimum of four mounting holes equally spaced for D_o 4 in. (101.6 mm) and larger.

NOTE 3—Tube held with hardened screws or other suitable means.

NOTE 4—2-in (50.8 mm) outside-diameter tubes are specified with an 18-gage wall thickness to comply with area ratio criteria accepted for "undisturbed samples." Users are advised that such tubing is difficult to locate and can be extremely expensive in small quantities. Sixteen-gage tubes are generally readily available.

Metric Equivalent Conversions

in.	mm
3⁄8	9.53
1⁄2	12.7
1	25.4
2	50.8
3	76.2
4	101.6
5	127

FIG. 1 Thin-Walled Tube for Sampling

comprises the thin-walled tube sampler. The sampler head shall contain a venting area and suitable check valve with the venting area to the outside equal to or greater than the area through the check valve. In some special cases, a check valve may not be required but venting is required to avoid sample compression. Attachment of the head to the tube shall be concentric and coaxial to assure uniform application of force to the tube by the sampler insertion equipment.

7. Procedure

7.1 Remove loose material from the center of a casing or hollow stem auger as carefully as possible to avoid disturbance of the material to be sampled. If groundwater is encountered, maintain the liquid level in the borehole at or above ground water level during the drilling and sampling operation.

7.2 Bottom discharge bits are not permitted. Side discharge bits may be used, with caution. Jetting through an open-tube sampler to clean out the borehole to sampling elevation is not permitted.

NOTE 4—Roller bits are available in downward-jetting and diffused-jet configurations. Downward-jetting configuration rock bits are not acceptable. Diffuse-jet configurations are generally acceptable.

7.3 Lower the sampling apparatus so that the sample tube's bottom rests on the bottom of the hole and record depth to the bottom of the sample tube to the nearest 0.1-ft (.03 m)

7.3.1 Keep the sampling apparatus plumb during lowering, thereby preventing the cutting edge of the tube from scraping the wall of the borehole.

7.4 Advance the sampler without rotation by a continuous relatively rapid downward motion and record length of advancement to the nearest 1 in. (25 mm).

7.4.1 Determine the length of advance by the resistance and condition of the soil formation, but the length shall never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clays. In no case shall a length of advance be greater than the sample-tube length minus an allowance for the sampler head and a minimum of 3-in. (75 mm) for sludge and end cuttings.

NOTE 5—The mass of sample, laboratory handling capabilities, transportation problems, and commercial availability of tubes will generally limit maximum practical lengths to those shown in Table 1.

7.5 When the soil formation is too hard for push-type insertion, the tube may be driven or Practice D 3550 may be used. If driving methods are used, the data regarding weight and fall of the hammer and penetration achieved must be shown in the report. Additionally, that tube must be prominently labeled a "driven sample."

7.6 Withdraw the sampler from the soil formation as carefully as possible in order to minimize disturbance of the sample. The tube can be slowly rotated to shear the material at the end of the tube, and to relieve water and/or suction pressures and improve recovery. Where the soil formation is soft, a delay before withdraw of the sampler (typically 5 to 30 minutes) may improve sample recovery.

8. Sample Measurement, Sealing and Labeling

8.1 Upon removal of the tube, remove the drill cuttings in the upper end of the tube and measure the length of the soil sample recovered to the nearest 0.25 in. (5 mm) in the tube. Seal the upper end of the tube. Remove at least 1 in. (25 mm) of material from the lower end of the tube. Use this material for soil description in accordance with Practice D 2488. Measure the overall sample length. Seal the lower end of the tube. Alternatively, after measurement, the tube may be sealed without removal of soil from the ends of the tube.

8.1.1 Tubes sealed over the ends, as opposed to those sealed with expanding packers, should be provided with spacers or appropriate packing materials, or both prior to sealing the tube ends to provide proper confinement. Packing materials must be nonabsorbent and must maintain their properties to provide the same degree of sample support with time.

8.1.2 Depending on the requirements of the investigation, field extrusion and packaging of extruded soil samples can be performed. This allows for physical examination and classification of the sample. Samples are extruded in special hydraulic jacks equipped with properly sized platens to extrude the core in a continuous smooth speed. In some cases, further extrusion may cause sample disturbance reducing suitability for testing of engineering properties. In other cases, if damage is not significant, cores can be extruded and preserved for testing (D 4220). Bent or damaged tubes should be cut off before extruding.

8.2 Prepare and immediately affix labels or apply markings as necessary to identify the sample (see Section 9). Assure that the markings or labels are adequate to survive transportation and storage.

NOTE 6—Top end of the tube should be labeled "top".

9. Field Log

9.1 Record the information that may be required for preparing field logs in general accordance to ASTM D 5434 "Guide for Field Logging of Subsurface Explorations of Soil and Rock". This guide is used for logging explorations by drilling and sampling. Some examples of the information required include;

9.1.1 Name and location of the project,

9.1.2 Boring number,

9.1.3 Log of the soil conditions,

9.1.4 Surface elevation or reference to a datum to the nearest foot (0.5 m) or better,

9.1.5 Location of the boring,

9.1.6 Method of making the borehole,

9.1.7 Name of the drilling foreman and company, and

9.1.8 Name of the drilling inspector(s).

9.1.9 Date and time of boring-start and finish,

9.1.10 Depth to groundwater level: date and time measured,

9.2 Recording the appropriate sampling information is required as follows:

9.2.1 Depth to top of sample to the nearest 0.1 ft. (.03 m) and number of sample,

9.2.2 Description of thin-walled tube sampler: size, type of metal, type of coating,

9.2.3 Method of sampler insertion: push or drive,

9.2.4 Method of drilling, size of hole, casing, and drilling fluid used,

9.2.5 Soil description in accordance with Practice D 2488,

9.2.6 Length of sampler advance (push), and

9.2.7 Recovery: length of sample obtained.

10. Keywords

10.1 geologic investigations; sampling; soil exploration; soil investigations; subsurface investigations; undisturbed

SUMMARY OF CHANGES

In accordance with committee D18 policy, this section identifies the location of changes to this standard since the last edition, 1994, which may impact the use of this standard.

(1) Editorial corrections to various sections based on comments received from Committee Balloting

(2) Added D 6232 to Section 2.

(3) Changed Note 7 to Section 8.1.2.

(4) Renumbered Note 8.

APPENDIX E

ADDITIONAL DOCUMENTS

None