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AN EMPLOYEE OWNED COMPANY

Consulting Engineers • Testing • Inspection Services • Analytical Laboratories

Established 1927

October 16, 2023

Ruetschle Architects
222 Linwood Street
Dayton, Ohio 45405

Attention: Mr. Mike Ruetschle, AIA, Project Manager

Reference: **Geotechnical Exploration Report**
Hilltop Elementary School
Wyoming City School District
425 Oliver Road
Wyoming, Ohio
CTL Project No. 23050027CIN

Dear Mr. Ruetschle:

CTL Engineering, Inc. (CTL) has completed the geotechnical exploration report for the above referenced project. We are providing a digital version (PDF file) of the report via email.

Thank you for the opportunity to be of service to you on this project. If you have any questions, please contact me at our office.

Respectfully Submitted,

CTL ENGINEERING, INC.

Doug R. Batt, P.E.
Project Manager

GEOTECHNICAL EXPLORATION REPORT

HILLTOP ELEMENTARY SCHOOL
WYOMING CITY SCHOOL DISTRICT
425 OLIVER ROAD
WYOMING, OHIO

CTL PROJECT NO. 23050027CIN

PREPARED FOR:

RUETSCHLE ARCHITECTS
222 LINWOOD STREET
DAYTON, OHIO 45405

PREPARED BY:

CTL ENGINEERING, INC.
2105 SCHAPPELLE LANE
CINCINNATI, OHIO 45240

October 16, 2023

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I. PROJECT INFORMATION

The project site is located at the Hilltop Elementary School campus with a street address of 425 Oliver Road in Wyoming, Hamilton County, Ohio. Project information was provided to CTL Engineering, Inc. (CTL) by Mr. Mike Ruetschle via a phone conversation on July 17, 2023. For the purpose of the descriptions stated in this report, the Hilltop Elementary School campus is oriented with its long dimension in an east-west direction, with Building A at the east end, Building B at the south end, Building C at the west end and Building D at the north end. Within the Hilltop Elementary School campus, the area of interest is along southern building line of Buildings A and B and the adjacent ground which supports the buildings.

The existing Hilltop Elementary School campus was reportedly built in the 1970s with some modifications including drainage, playground and surrounding land use during its utilization as a primary educational facility. The Hilltop Elementary School campus consists of four (4) buildings (identified as A through D) with various plan areas and floor elevation that consist of classrooms, administrative offices, a cafeteria, a gymnasium, and maintenance rooms. The campus buildings are connected via overhead steel canopies and concrete sidewalks. The school buildings are constructed of concrete block with a brick veneer.

According to Mr. Mike Anderson (former Facilities and Operations Administrator), school buildings A and B have experienced distress (cracks) and were previously repaired by maintenance personnel or their contractors. However, a documented record of the distresses and their subsequent repairs were not available for CTL's review. This geotechnical exploration report provides observations, findings, preliminary conclusions and recommendations relative to the support of Buildings A and B based on the conditions observed at the boring locations. CTL's services were performed in accordance with its proposal number 23050056CIN-PPL, dated July 19, 2023.

II. EXPLORATION

A total of three (3) soil test borings, identified as B-01-23 through B-03-23, were drilled for this project at the approximate locations shown on the boring location plans in Appendix A. An offset borehole was drilled adjacent to the boring B-03-23 location to install a groundwater monitoring well. A summary of test boring locations, ground surface elevations and coordinates along with their depths are presented below in Table 1.

Table 1. Boring Locations, Depths, Elevations, and Coordinates

Boring No.	Approximate Ground Surface Elevation (feet)	Approximate Latitude	Approximate Longitude	Borehole Depth (feet)
B-01-23	759.0	39.231940	-84.483555	10.0
B-02-23	760.0	39.231731	-84.483679	18.6
B-03-23	760.0	39.231435	-84.484203	25.0

The locations of the test borings were determined in the field by CTL using taped measurements from existing site features. The coordinates of the test boring locations were determined using Google Earth™ computer software and aerial imagery. The ground surface elevations at the test boring location were determined using the Cincinnati Area GIS (CAGIS) website (*https://cagis.hamilton-co.org/cagisonline/#*). Therefore, the boring coordinates and ground surface elevations should be considered approximate.

The test borings were drilled by CTL on September 5 and 6, 2023, utilizing 3-¼ inch I.D. hollow-stem augers powered by a track-mounted drill rig. Split-barrel (spoon) samples and Standard Penetration Tests (SPTs) were performed in the test borings using a 140-pound automatic hammer falling 30 inches to drive a 2-inch O.D. split-barrel (spoon) sampler for 18 inches. The automatic hammer was calibrated at an energy ratio of 76.8 percent. Rock coring was performed in test boring B-03-23 using a wire-line system equipped with a NQ-2 double tube core barrel and a diamond bit.

The soil materials recovered from the split spoon samples obtained during the drilling operations were preserved in glass jars, visually classified in the field, and delivered to CTL's soil laboratory for visual classification, testing and analysis. Samples were also tested for moisture content. Representative soil samples were subjected to laboratory testing including Atterberg Limits, grain size distribution and hand penetrometer. The percent recovery and Rock Quality Designation (RQD) values were determined for the rock core sampling.

Drilling, sampling, field and laboratory testing were performed according to standard geotechnical engineering practices and current AASHTO/ASTM procedures. Results from field and laboratory tests are shown on the enclosed soil profile in Appendix A and the test boring records in Appendix B of this report. The results of the laboratory tests are presented in Appendix C of this report.

An inclinometer casing was installed in boring B-03-23 after completing rock coring, and it extended to a depth of 22.0 feet below existing grade. At the date of this report, the inclinometer has established its initial "baseline" profile. Subsequent measurements will be collected periodically over the next 9 to 12 months to record horizontal displacement relative to inclinometers baseline, if any. A groundwater monitoring well was installed in an offset borehole drilled about 5 feet east of boring B-03-23. The groundwater monitoring well extended down to a depth of 17.3 feet below existing grade. The depth to groundwater in the monitoring well was observed to be 12.3 feet on September 25, 2023 when the baseline inclinometer reading were conducted.

A total of two (2) crack monitor devices, designated as CM-1 and CM-2, were installed on Buildings A and B near boring locations B-01-23 and B-03-23. Photographs of the crack monitor locations are presented in Appendix D. The crack monitors were installed by CTL personnel with a baseline measurement established on October 9, 2023.

III. FINDINGS

A. Observations

The project site is located at the Hilltop Elementary School property with a street address of 425 Oliver Road in Wyoming, Hamilton County, Ohio. The project site is immediately south of the existing Hilltop Elementary School campus. Specifically, the area of interest is along southern line of Buildings A and B and the adjacent ground which supports the buildings.

A site reconnaissance was completed by CTL personnel with Mr. Mike Anderson (former Facilities and Operations Administrator) on July 18, 2023 and August 23, 2023. The project area is bounded to the north by the Hilltop Elementary School Buildings A and B and immediately to the south by a large wooded drainage swale. Beyond the Hilltop Elementary School campus, the site is bordered by Hilltop Park, water storage tank facilities and Oliver Road to the north; Reily Road to the west, and single family residential properties to the south and east.

Adjacent to the existing Buildings A and B, the project area is covered by mowed grass, with small to medium brush and trees beyond the mowed grass. In one location along the southern wall of Building B between boring location B-02-23 and B-03 -23, a cluster of mature trees were observed immediately adjacent to the school building south perimeter wall. Along the east end of the southern portion of the Building B immediately west of boring location B-02-23, a garden was constructed immediately adjacent to the school building's outside perimeter wall. This garden was composed of elevated beds constructed of rectangular boxes made of timber and utilized an automatic sprinkler system for irrigation of the garden. It is not known whether a subsurface drainage system was installed beneath or along the perimeter of the garden. The ground surface immediately south and east of the garden was saturated at the date of our reconnaissance and exploration.

The topography immediately adjacent to the southern side of Buildings A and B is relatively flat to gently sloping with a steep downward slope beyond that forms a large drainage swale with an overall topographic relief of about 18 feet. The drainage swale flows from west to east at Building B and from west to east at Building A where they meet south of boring location B-02-23. The drainage swale then continues in a southeasterly direction. Immediately beyond the southwestern corner of Building B, a segmented block retaining wall supports the adjacent ground to the north and forms the sidewall of the drainage swale at the culvert outlet. Two corrugated high density polyethylene (HDPE) pipes were observed at the bottom of the drainage swale at this location and are assumed to provide an extended outlet from the existing culvert that conveys flow from an unknown source located west of the site.

Surface drainage within the immediate area appears to be conveyed by overland sheet flow to the drainage swale to the south. Within the mowed grass area south of Building A, a catch basin inlet was observed and appears to collect the surface drainage in this area and is then conveyed off site. Along the west side of Building B, a surface drain



consisting of a HDPE corrugated pipe covered with a filter fabric "sock' and a layer of gravel, collects surface drainage along the building and conveys it to the south towards the drainage swale. At the date of our site visits, water was not flowing out of this surface drain. No other downspout or drain outlets were observed, except near the southwest corner of Building B where a vertical white PVC pipe appears to discharge water collected from the roof system.

Areas of observed distress were identified within both the concrete block and brick veneer along the southern, western and eastern walls of Buildings A and B at various location. The observed distresses consisted of cracks, primarily within the masonry joints or expansion joints of both the concrete blocks and brick veneer. Within the brick veneer, some cracks were observed not only along the joints but also through the brick. At some locations, the mortar joint cracks had been previously tuck pointed and or patched while others were still open. The width of the crack openings varied from less than one-sixteenth of an inch to almost one-half inch. It also appears that portions of the brick veneer have been replaced with new brick, due to previous damage to the brick.

B. Geology

According to the Web Soil Survey (*United States Department of Agriculture, Natural Resources Conservation Service*), the majority of surficial soils mapped at the project site are described as Urban land-Udorthents complex, 0 to 12 percent slopes (UrUXC). According to the *Ohio Department of Natural Resources (ODNR) Physiographic Regions of Ohio Map (1998),* the project site is located along the boundary between the Southern Ohio Loamy Till Plain and the Illinoian Till Plain. The Southern Ohio Loamy Till Plain physiographic region is described as Wisconsinan-age glacial till, glacial outwash, and loess over bedrock. The Illinoian Till Plain physiographic region is Illinoian-age glacial till underlain by Ordovician-age bedrock.

Mapping of the bedrock topography (Bedrock Topography of the Cincinnati East, Ohio, Quadrangle, *Digital Map Series BT-3B, ODNR Geological Survey, 1998*) indicates that the bedrock surface elevation is near 750 feet above mean sea level (AMSL). Based on this mapping and existing ground surface elevations ranging from 760 to 762 feet within the project area, the estimated depth to the bedrock surface may range from about 10 feet to down to 15 feet below the existing ground surface.

Geologic mapping (Surficial Geology of the Cincinnati and Falmouth 30 x 60 Minute Quadrangle, Ohio Division of Geological Survey, 2004) indicates that the overburden soils are mapped to consist of Wisconsinan-age glacial till. According to the mapping of bedrock geology in the area, (Ohio Geology Interactive Map, *ODNR GIS & Mapping Services, https://ohiodnr.gov/*), the surficial soil deposits on the site are underlain by Ordovician-age sedimentary bedrock identified as Miamitown Shale-Fairview Formation Undivided. The components of this formation is described below.

> **Miamitown Shale** – Shale (90%) interbedded with limestone (10%), gray to bluish gray, weather to light gray to yellowish gray, planar to nodular, thin to thick bedding.

Fairview – Shale (50%) interbedded with limestone (50%), gray to bluish gray, weathers to light gray to yellowish gray, planar to lenticular, thin to medium bedding

According to the mapping of karst features (Known and Probable Karst in Ohio, *ODNR Geological Survey Map EG-1, 1999; Revised 2002, 2006*), there are two (2) mapped karst features within a mile to the southwest of the project area as well as ten (10) mapped karst features within a mile to the northwest of the project area. Additionally, karst features were not observed at the ground surface during our reconnaissance or field exploration; however, existing development may have covered surface karst features. Any construction in karst topography is accompanied by some degree of risk for future internal soil erosion and ground subsidence that could affect the stability of structures situated above the karst features.

According to the mapping of historic and active mines (ODNR Mines of Ohio), there are no documented mines in the general vicinity of the project area.

C. Subsurface Conditions

A general description of the soils encountered during our subsurface exploration is presented below. Further details of the subsurface conditions encountered during CTL's geotechnical exploration are presented in the Test Boring Records in Appendix B. Results of the soil laboratory tests are presented in Appendix C.

1. Surficial Materials

The ground surface was covered by either topsoil (B-02-23 and B-03-23) underlain by gravel, or only gravel (B-01-23). The thickness of these materials ranged from 2 to 6 inches with a total thickness of these material of about 6 inches.

2. Fill Materials

Beneath the surficial materials, fill or possible fill materials were encountered in two (2) of the three (3) test borings. In general, the fill material consisted of highly plastic soils classified as fat clay (CH) according to the USCS. These fill materials ranged in depth from about 3.0 feet to about 5.5 feet below ground surface (bgs).

The fine-grained cohesive fill soils were visually described as stiff to very stiff brown and gray fat clay (CH) with varying amount of silt, sand and gravel. SPT N_{60}-values determined within the fine-grained fill soils ranged from 13 blows per foot (bpf) to 17 bpf. The moisture content values ranging from 20 to 21 percent.

The N_{60}-value is the SPT blow count corrected for the hammer efficiency delivered by the hammer system utilized, normalized to 60 percent efficiency in bpf.

3. Native Soils

Below the surficial and fill materials, the test borings encountered fine-grained cohesive soils to the boring termination depths or weathered bedrock. The fine-grained cohesive soils were visually described as stiff to hard, brown, brown with dark brown and gray specks, grayish brown, and gray lean clay (CL), silty clay (CL-ML), and fat clay (CH). SPT N_{60}-values determined within the fine-grained soils ranged from 12 bpf to 24 bpf with moisture content values ranging from 10 to 31 percent.

4. Bedrock

Beneath the overburden soil materials, the test borings encountered weathered bedrock at approximate depths ranging from 10 to 19.0 feet bgs. The determination of the weathered bedrock surface from the overlying soil stratums can be estimated from the split-spoon sampling, the increased resistance to the advancement of the drilling equipment and a review of the recovered materials. The drilling equipment and sampling were able to penetrate into the weathered rock to depths ranging from less than 1 foot to 20 feet (B-03-23) before achieving auger refusal.

Upon achieving auger refusal in test boring B-03-23, the rock was cored to an additional depth of five (5) feet. The bedrock consisted of interbedded shale (68%) and limestone (32%). The shale was described as gray, highly weathered, very weak to weak, and thin bedded. The limestone was described as gray, slightly weathered, strong, very thin to thin bedding, and fossiliferous. The RQD value was 48 percent with a 100 percent recovery.

5. Results of Laboratory Tests

Selected soil samples were tested in the laboratory for Atterberg Limits and grain size distribution. The results of the soil laboratory tests and consolidation tests are presented in Appendix C and are summarized below in Table 2.

Table 2. Soil Laboratory Test Results

Boring No.	Sample No.	Depth (feet)	USCS	LL	PI	Silt (%)	Clay (%)
B-01-23	SS-2	3.5 – 5.0	CH	70	37	22	54
B-02-23	SS-1	1.0 – 2.5	CH	52	27	33	47
B-02-23	SS-5	11.0 – 12.5	CH	53	27	34	50
B-03-23	SS-2	3.5 – 5.0	CH	62	33	29	57
B-03-23	SS-4	8.5 – 10.0	CH	65	35	31	61

SS-# = Split Spoon Sample Number
LL = Liquid Limit
PI = Plasticity Index
Silt Fraction (particle size < 0.075 mm
Clay Fraction (particle size < 0.005 mm)

6. Depths to Groundwater and Borehole Cave-in

Groundwater was encountered in one (1) of the three (3) test borings during drilling operations. Table 3 summarizes the depth groundwater was encountered, either during drilling activities, at completion, or when obtaining monitoring well readings, along with the borehole cave-in depth.

Table 3. Groundwater and Borehole Cave-in Depths

Boring No.	Approximate Boring Elevation (feet)	Groundwater (feet)			Borehole Cave-in Depth (feet)
		During Drilling	At Completion	Monitoring Well	
B-01-23	759.0	N/A	"Dry"	N/A	4.0
B-02-23	760.0	13.0	N/A	N/A	15.0
B-03-23	760.0	N/A(1)	N/A (1)	12.3(2)	N/A (3)

(1) Water was introduced during the rock coring procedure.
(2) A groundwater reading was conducted on September 25, 2023 in the monitoring well that was installed 5 feet east of B-03-23.
(3) Inclinometer casing set in borehole

It should be noted that the groundwater depths encountered during subsurface explorations are generally not a reliable indication of long-term groundwater levels. Fluctuations in the level of the groundwater table (or saturated soils/perched water levels) will occur due to seasonal variances in rainfall, drainage, types of soils present and other factors. Groundwater can be perched at various elevations above the general static groundwater level after periods of rainfall, especially in the lower elevations and natural drainage paths of the site.

IV. CONCLUSIONS AND RECOMMENDATIONS

Based on our observations of the building exterior walls, site features and surrounding ground surface; the results of the test borings and laboratory testing; and our previous experience with similar conditions and development, it is CTL's opinion that the existing buildings are not currently being impacted by an active landslide towards the drainage swale to the south of school Buildings A and B.

There is a possibility that some portions of school Buildings A and B may be impacted by a very slow gradual downward movement (e.g. creep) of the adjacent ground surface towards the drainage swale due to erosion or other factors. In order to observe the potential for this movement, instrumentation (an inclinometer and a groundwater monitoring well) was installed during the exploration. This instrumentation will allow the collection of data indicating lateral movement of the subsurface soils away from the building and towards the drainage swale at the B-03-23 boring location (southwest corner of Building B), if any. In addition, CTL installed crack monitoring devices on the exterior walls of Buildings A and B near the southeast corner of Building A (CM-1) and near the southwest corner of Building B (CM-2).

A. Continued Monitoring of Installed Instrumentation

CTL understands that the Hilltop Elementary School has been in operation for approximately 50+ years, and distresses (cracks within the masonry walls) and deformations have occurred over the life of the structure. Some distresses and deformations have been aesthetically repaired using caulk, paint, or mortar, but the concern of active horizontal and/or vertical movement is still present.

CTL has implemented a monitoring program consisting of instrumentation devices such as crack monitors (walls and corners), an inclinometer, and a groundwater monitoring well. CTL recommends that the monitoring of these instruments be performed over a period of 9 to 12 months, at a minimum, to determine whether there is any active ongoing movement of the adjacent ground and/or building. In addition, trends in displacement of the underlying soil or building movement, if any, may also be identified during the monitoring period which may aid in determining remediation efforts. Once the monitoring data has been collected and reviewed, CTL can provide an opinion on a course of action that may range from underpinning the buildings' foundations to making mortar joint repairs to the brick veneer and block walls.

In addition, CTL observed site features and identified site conditions that pose a concern from a geotechnical engineering standpoint. The following items can be addressed at the discretion of the Wyoming City School District based on their future planning for the school buildings.

B. Highly Plastic Clays

The test borings encountered highly plastic clays, classified as CH according to the USCS, were encountered at various depths across the site. Based on the depth of these materials were encountered along with the results of the laboratory tests, CTL anticipates that portions of the spread foundations supporting Building A and Building B are supported by the highly plastic soils encountered at this site.

These highly plastic soils are susceptible to volume change with variations in moisture content. Should these volume changes occur within beneath building foundation and/or floor slab, the resulting deformations can cause undesirable vertical movements of the foundations, walls and floor slabs, forming cracks in masonry walls and concrete floor slabs. The details of the potential movement is a function of the swell pressure as a result of the expanding highly plastic clay offset by the pressure applied by the building's foundation and or floor load. The degree of vertical movement due to the expansion (swell) or shrinkage of the site's soils, can be determined by performing additional laboratory testing. These tests will aid in determining the magnitude of the swell potential and whether it would be considered excessive relative to the pressure applied by the proposed building foundations.

C. Building B - Garden Area

The garden area located immediately south and at the east end of Building B is subject to and irrigation system that increases not only the moisture content of the surficial soils but also possibly the underlying soils beneath the building foundations. The repeated cycle of irrigating the garden adds undesirable moisture to the highly plastic clay soils that were previously described above, possibly causing excessive swell of the highly plastic soils and resulting in vertical movement. CTL recommends the garden and irrigation system be moved a distance of at least 10 feet from the building or any other structure with sufficient downward gradient of the ground surface away from the building such that positive drainage continues towards the drainage swale or other similar drainage features/structures.

D. Building B - Mature Trees

A cluster of trees are located along the south building line of Building B. The root system of the trees are more than likely impacting not only the building's wall, but also the foundation supporting the wall as well. In addition, the tree's root system will also draw moisture from the underlying soil, and as a result, possibly reduce the soil's moisture content such that "drying" of the highly plastic clay soil may cause shrinkage and vertical movement. CTL recommends that trees, brush and similar vegetation be removed along with their root ball. The resulting void should be backfilled with properly placed and compacted engineered fill consisting of low plasticity soil material. Depending on the horizontal and vertical extent of the root ball system it may be preferable to place controlled density fill-controlled low strength material (CDF-CLSM) in lieu of compacted soil fill. Prior to the removal of the trees, an experienced arborist and registered structural engineer, licensed in the state of Ohio, should be consulted as to the phasing of the tree removal and backfill of the tree's root ball so that the removal doesn't negatively impact the support of the building foundation and wall.

V. CHANGED CONDITIONS

The evaluations, conclusions, and recommendations in this report are based on our interpretation of the field and laboratory data obtained during the exploration, our understanding of the project and our experience with similar sites and subsurface conditions using generally accepted geotechnical engineering practices. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates drilled, they are not necessarily representative of the subsurface conditions between boring locations or subsurface conditions during other seasons of the year.

In the event that changes in the project are proposed, additional information becomes available, or if it is apparent that subsurface conditions are different from those provided in this report, CTL should be notified so that our recommendations can be modified, if required.

VI. TESTING AND OBSERVATION

During the design process, it is recommended that CTL work with the project designers to confirm that the geotechnical recommendations are properly incorporated into the final plans and specifications, and to assist with establishing criteria for the construction observation and testing.

CTL is not responsible for independent conclusions, opinions and recommendations made by others based on the data and recommendations provided in this report. It is recommended that CTL be retained to provide construction quality control services on this project. If CTL is not retained for these services, CTL shall assume no responsibility for compliance with the design concepts or recommendations provided.

VII. CLOSING

The report was prepared by CTL Engineering, Inc. (Consultant) solely for the use of Client in accordance with an executed contract. The Client's use of or reliance on this report is limited by the terms and conditions of the contract and by the qualifications and limitations stated in the report. It is also acknowledged that the Client's use of and reliance of this report is limited for reasons which include: actual site conditions that may change with time; hidden conditions, not discoverable within the scope of the assessment, may exist at the site; and the scope of the investigation may have been limited by time, budget and other constraints imposed by the Client.

Neither the report, nor its contents, conclusions or recommendations, are intended for the use of any party other than the Client. Consultant and the Client assume no liability for any reliance placed on this report by such party. The rights of the Client under contract may not be assigned to any person or entity, without the consent of the Consultant which consent shall not be unreasonably withheld. This geotechnical report does not address the environmental conditions of the site. The Consultant is not responsible for consequences or conditions arising from facts that were concealed, withheld, or not fully disclosed at the time the assessment was conducted.

To the fullest extent permitted by law, the Consultant and Client agree to indemnify and hold each other, and their officers and employees harmless from and against claims, damages, losses and expenses arising out of unknown or concealed conditions. Furthermore, neither the Consultant nor its employees shall be liable to the Owner in an amount in excess of the available professional liability insurance coverage of the Consultant. In addition, Client and Consultant agree neither shall be liable for any special, indirect or consequential damages of any kind or nature.

The Consultant's services have been provided consistent with its professional standard of care. No other warranties are made, either expressed or implied.

Respectfully Submitted,

CTL ENGINEERING, INC.

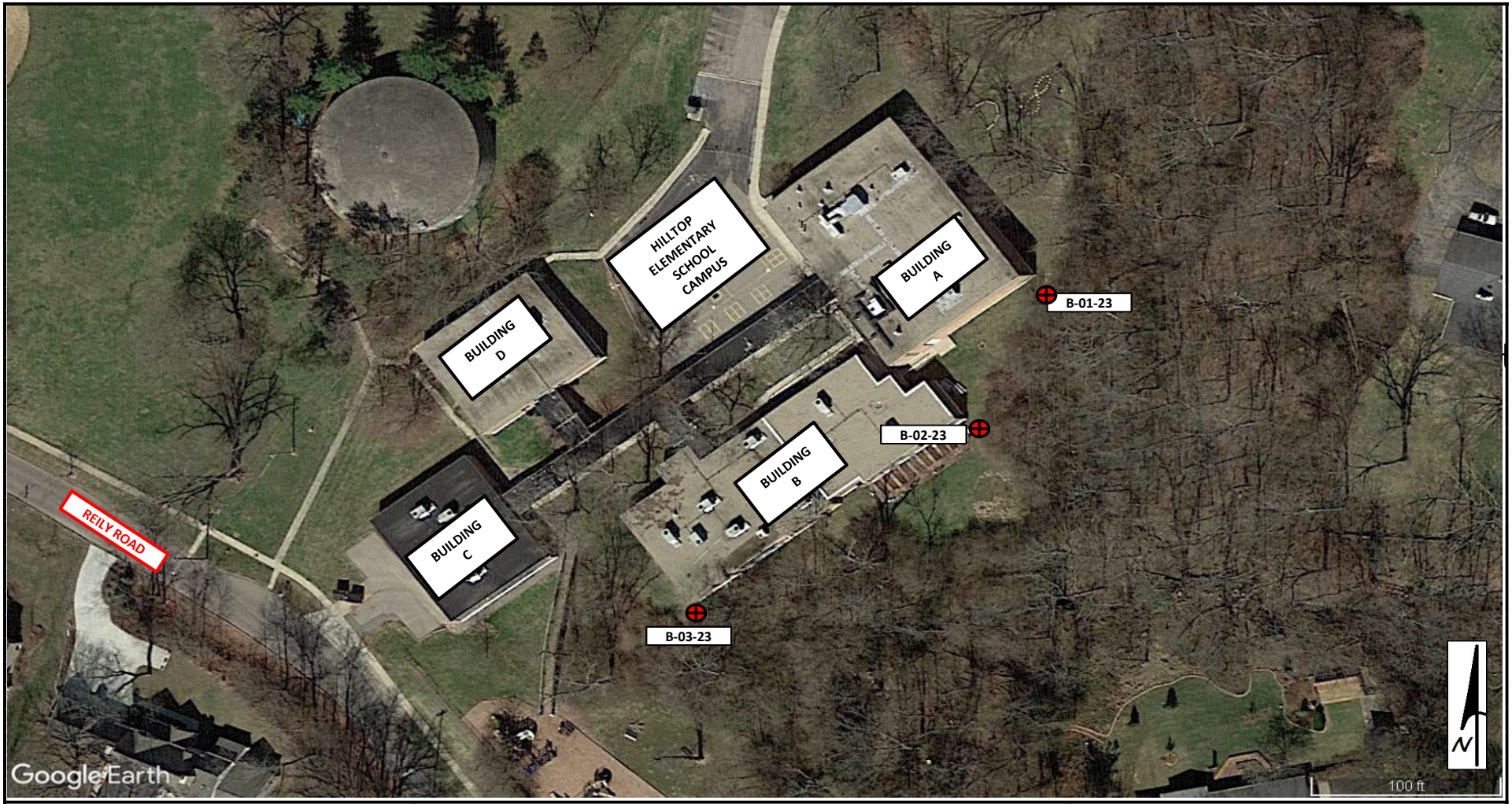
Christopher D. Carey, E.I.
Project Engineer

Doug R. Batt, P.E.
Project Engineer
Licensed Ohio No. E-58801

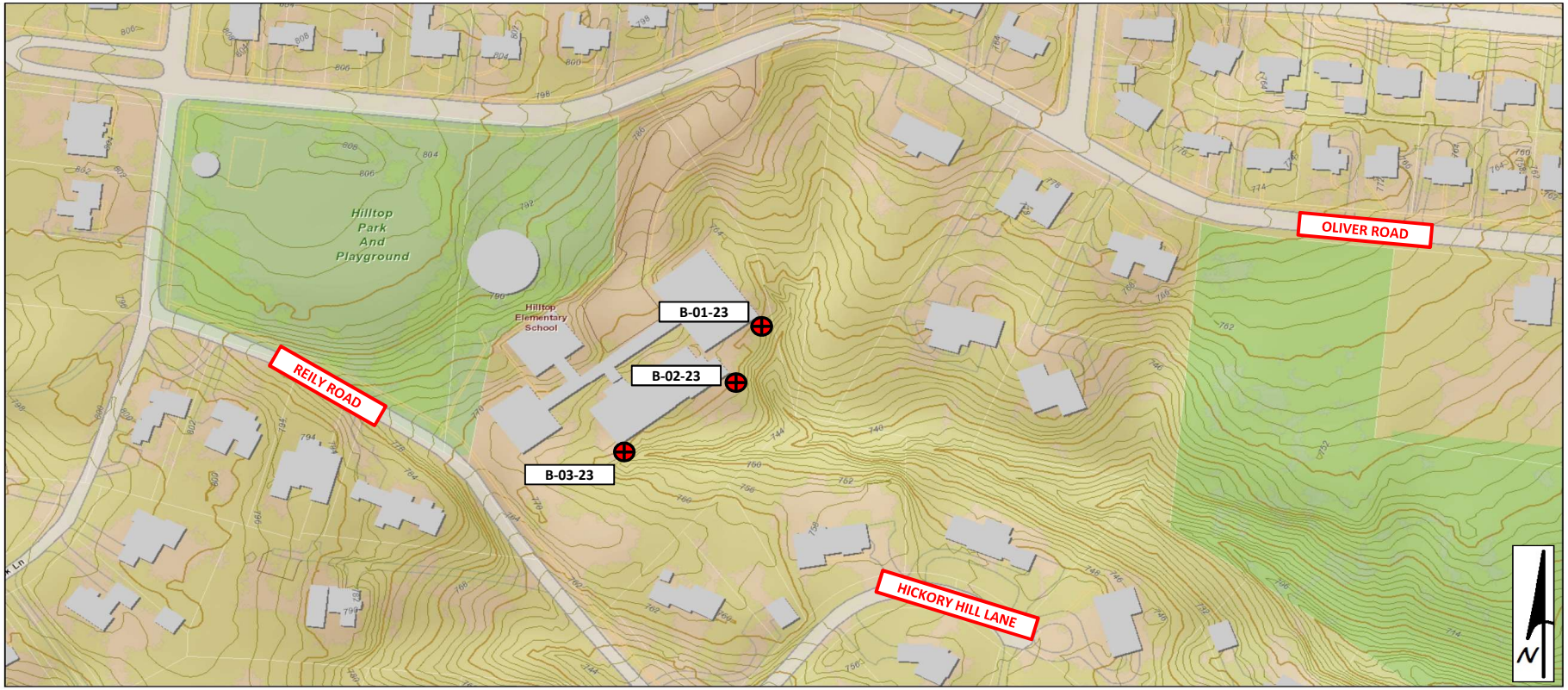
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APPENDIX A

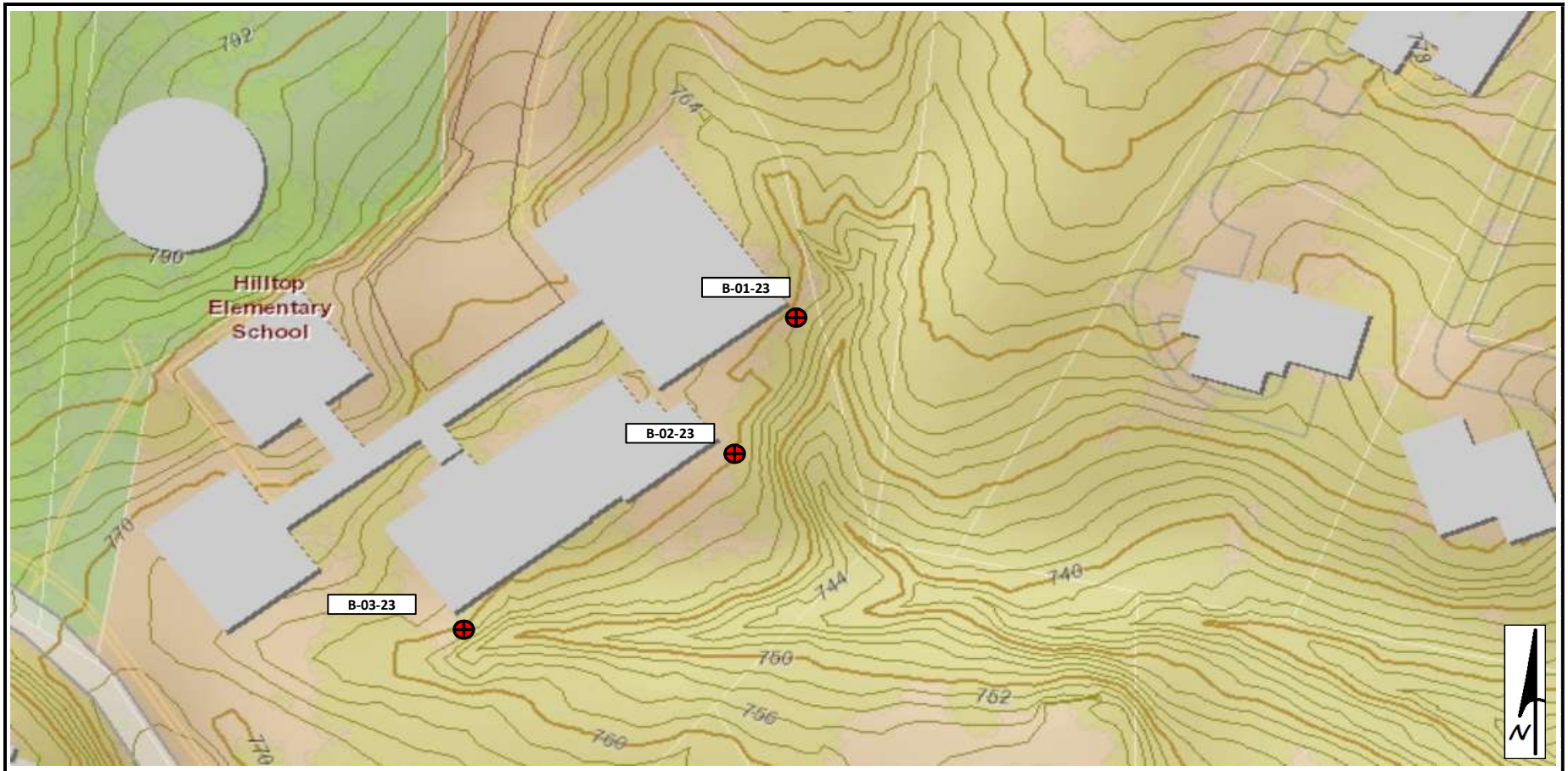
BORING LOCATION PLANS & SOIL PROFILE



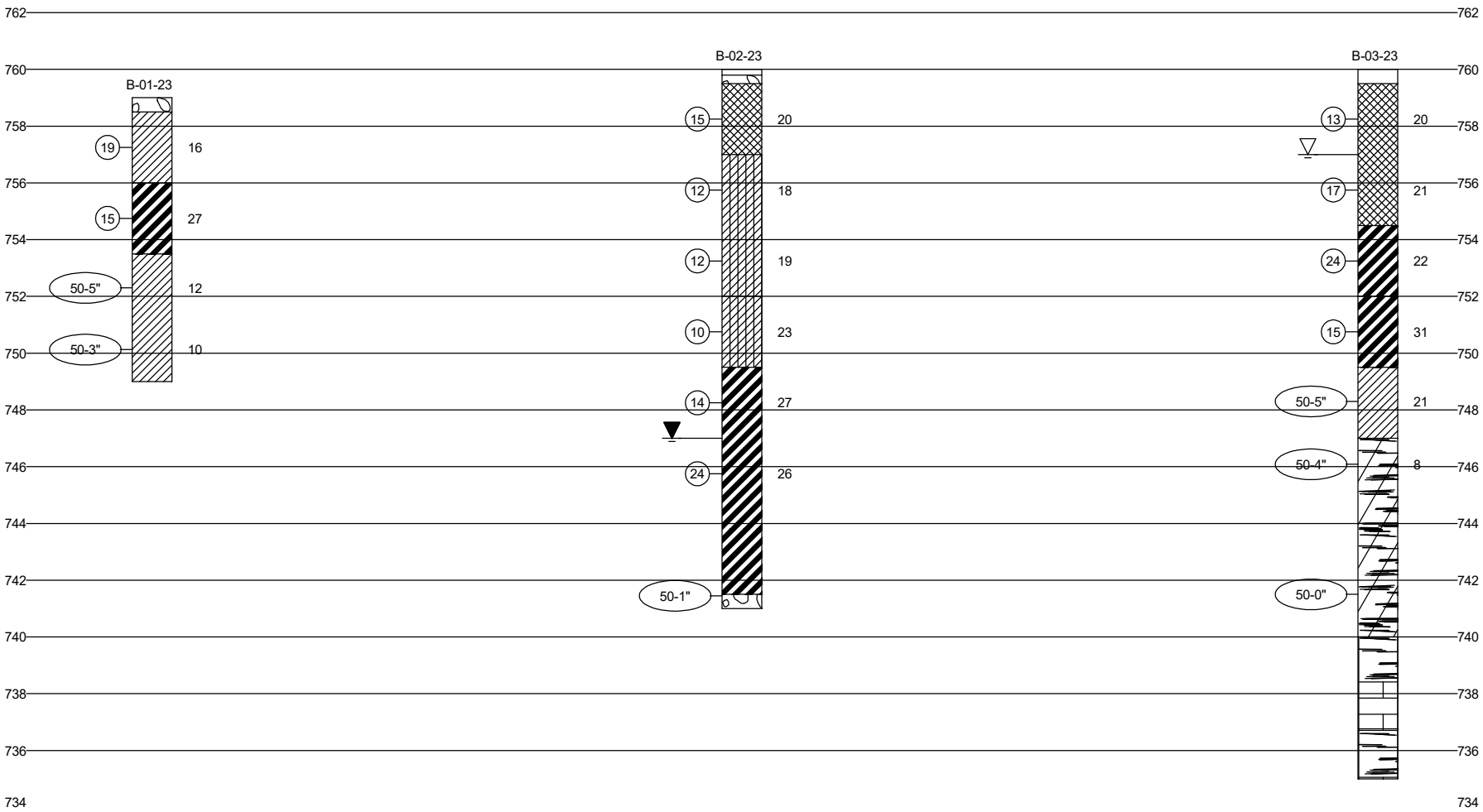
LEGEND				BORING LOCATION PLAN
⊕ Approximate Test Boring Location	**Date** 10/12/2023	NOTE: The test boring locations were marked in the field by CTL personnel.		**Ruetschle Architects** **Hilltop Elementary School - Wyoming City School District** **425 Oliver Road** **Wyoming, Ohio**
CTL ENGINEERING, INC. GEOTECHNICAL ENGINEERS TESTING * INSPECTION LABORATORY SERVICES	**Scale** As Shown			
	Drawn By CC	**Reviewed By** DB	**Page** 1 of 3	**CTL Project No.** **23050027CIN**



LEGEND				BORING LOCATION PLAN
⊕ Approximate Test Boring Location	**Date** 10/12/2023	NOTE: The test boring locations were marked in the field by CTL personnel. The topographic map was obtained utilizing the Cincinnati Area GIS (CAGIS) website (*https://cagis.hamilton-co.org/cagisonline/#*).		**Ruetschle Architects** **Hilltop Elementary School - Wyoming City School District** **425 Oliver Road** **Wyoming, Ohio**
CTL ENGINEERING, INC. GEOTECHNICAL ENGINEERS TESTING * INSPECTION LABORATORY SERVICES	**Scale** As Shown			
	Drawn By CC	**Reviewed By** DB	**Page** 2 of 3	**CTL Project No.** **23050027CIN**



LEGEND				BORING LOCATION PLAN
Approximate Test Boring Location	Date: 10/12/2023	NOTE: The test boring locations were marked in the field by CTL personnel. The topographic map was obtained utilizing the Cincinnati Area GIS (CAGIS) website (*https://cagis.hamilton-co.org/cagisonline/#*).		**Ruetschle Architects** **Hilltop Elementary School - Wyoming City School District** **425 Oliver Road** **Wyoming, Ohio**
CTL ENGINEERING, INC. GEOTECHNICAL ENGINEERS TESTING * INSPECTION LABORATORY SERVICES	**Scale**: NTS			
	Drawn By: CC	**Reviewed By**: DB	**Page**: 3 of 3	**CTL Project No.** **23050027CIN**



LEGEND

TOPSOIL, ASPHALT, GW, GP, GW-GM, GW-GC, GP-GM, GP-GC, GM, GC, GC-GM, SW, SP, SW-SM, SW-SC, SP-SM, SP-SC, SM, SC, SC-SM, ML, CL, CL-ML, OL, CH, MH, OH, PT, SHALE, SILTSTONE, LIMESTONE, FILL

GROUND WATER DURING DRILLING

GROUND WATER AT COMPLETION OF DRILLING

GROUND WATER AT "N" HOURS AFTER COMPLETION

W — MOISTURE CONTENT IN PERCENT (w)

N_{60} — STANDARD PENETRATION NORMALIZED TO 60% DRILL ROD ER

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SOIL PROFILE

DATE	Ruetschle Architects
10/12/2023	Hilltop Elementary School
SCALE AS SHOWN	Wyoming, OH

DRAWN BY	PAGE	PROJECT NUMBER
CC	1 OF 1	23050027CIN

APPENDIX B

TEST BORING RECORDS

AND

ROCK CORE PHOTOGRAPH

EXPLANATION OF TERMS AND SOIL DESCRIPTIONS
(ASTM D2487 & ASTM D2488)

CONSISTENCY AND RELATIVE DENSITY DESCRIPTIONS

Descriptors for soil consistency used in this report are based upon the Standard Penetration Test (SPT), ASTM D 1587, with the penetration (N) values corrected to N_{60} , based upon the efficiency of the SPT Hammer (Energy Ratio) used for the soil sampling.

NON-COHESIVE SOILS [GW, GP, GM, GC, SW, SP, SM, SC]

Relative Density or Consistency	SPT-N_{60} (blows/foot, bpf)	Suitability
Very Loose	0 – 4	Poor
Loose	5 – 10	Marginal
Medium Dense	11 – 30	Satisfactory
Dense	31 - 50	Good
Very Dense	Over 50	Very Good

COHESIVE SOILS [ML, MH, CL, CH]

Stiffness or Consistency	SPT-N_{60} (blows/foot, bpf)	Suitability
Very Soft	0 – 1	Very Poor
Soft	2 – 4	Poor
Medium Stiff	5 – 8	Marginal
Stiff	9 – 15	Satisfactory
Very Stiff	16 – 30	Good
Hard	Over 30	Very Good

COMPONENT MODIFIERS

ASTM D2488 (Visual-Manual)

Modifier	% by Weight
Trace of	0 – 1
Traces of	2 – 10
Little	11 – 20
Some	21 – 35
"And"	36 – 50

ASTM D2487 (USCS)

Modifier	% by Weight
with sand or gravel	15 – 29
Sandy or Gravelly	≥ 30
with silt or clay	5 – 12
Silty or Clayey	> 12
Organic	$LL_{oven}/LL_{air} < 0.75$

Organic Soils

Modifier	% by Weight
Highly	> 10
Moderately	4 – 10
Slightly	2 – 4
Inorganic	< 2

MOISTURE DESCRIPTIONS

Terms	Non-Cohesive Soils	Cohesive Soils	Suitability
Dry	Moisture Absent	Powdery	Marginal
Damp	Some Moisture	Below Plastic Limit	Good
Moist	Damp to the Touch	Between Plastic and Liquid Limits	Marginal
Wet	Visible Water	Above Liquid Limit	Poor

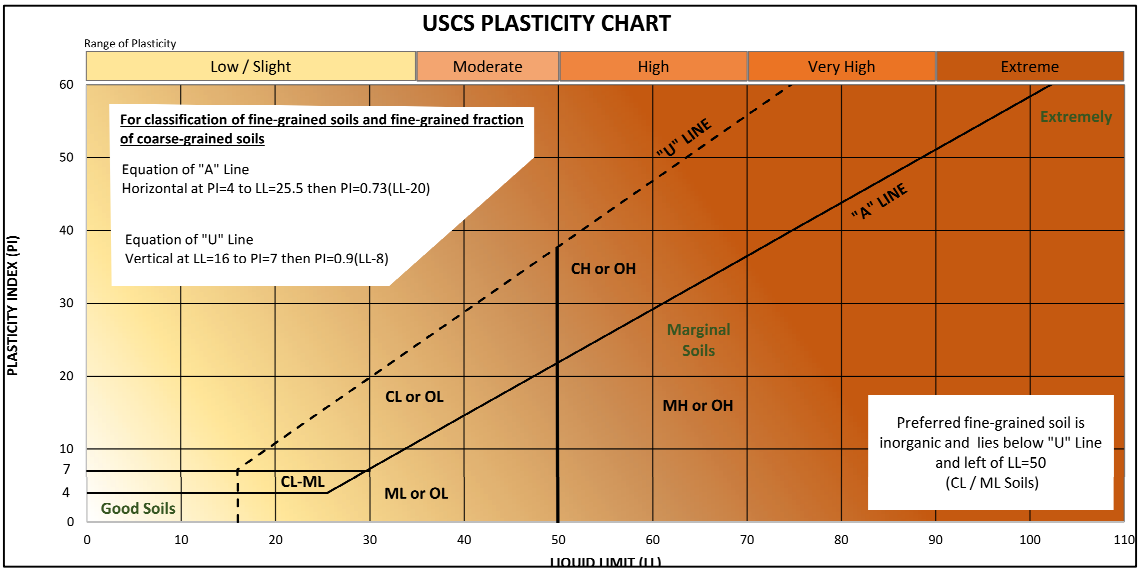
PARTICLE SIZE DESCRIPTIONS

Component	USCS Particle Size
Boulders	≥ 12-in. (300 mm)
Cobbles	< 12-in. (300 mm) to 3-in. (75 mm)
Coarse Gravel	< 3-in. (75 mm) to 3/4-in. (19.05 mm)
Fine Gravel	< 3/4-in. 19.05 mm) to #4 Sieve (4.75 mm)
Coarse Sand	< #4 Sieve (4.75 mm) to #10 Sieve (2.00 mm)
Medium Sand	< #10 Sieve (2.00 mm) to #40 Sieve (0.425 mm)
Fine Sand	< #40 Sieve (0.425 mm) to #200 Sieve (0.074 mm)
Silt	< #200 Sieve (0.074 mm) to 0.005 mm
Clay	< 0.005 mm

SOIL DESCRIPTIONS BASED ON THE UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

	Major Division	Group Symbol	Letter Symbol	Group Name*
Coarse Grained Soils Less Than 50 Percent Passing the # 200 Sieve	GRAVEL - Percent GRAVEL > percent SAND	Gravel with < 5% Fines	GW	Well Graded GRAVEL
			GP	Poorly Graded GRAVEL
		Gravel with Between 5 and 15% Fines	GW-GM	Well Graded GRAVEL with silt
			GW-GC	Well Graded Gravel with clay
			GP-GM	Poorly Graded GRAVEL with silt
			GP-GC	Poorly Graded GRAVEL with clay
		Gravel with ≥ 15% Fines	GM	Silty GRAVEL
			GC	Clayey GRAVEL
			GC-GM	Silty, Clayey GRAVEL
	SAND - Percent SAND ≥ percent GRAVEL	Sand with < 5% Fines	SW	Well Graded SAND
			SP	Poorly Graded SAND
		Sand with Between 5 and 15% Fines	SW-SM	Well Graded SAND with silt
			SW-SC	Well Graded SAND with clay
			SP-SM	Poorly Graded SAND with silt
			SP-SC	Poorly Graded SAND with clay
		Sand with ≥ 15% Fines	SM	Silty SAND
			SC	Clayey SAND
			SC-SM	Silty, Clayey SAND
Fine Grained Soils 50 percent or more Passing the # 200 Sieve	SILT and CLAY	Liquid Limit Less Than 50	ML	SILT
			CL	Lean CLAY
			CL-ML	SILTY CLAY
			OL	Organic SILT, CLAY, or SILTY CLAY
		Liquid Limit 50 or Greater	CH	Fat CLAY
			MH	Elastic SILT
			OH	Organic SILT or CLAY
Highly Organic Soils			PT	Peat/Marl

* Additional Modifiers			
	Coarse Grained Soils	with silt or clay	5 to 12 % Silt or Clay by weight
		Silty or Clayey	more than 12 % Silt or Clay by weight
	Fine Grained Soils	with sand or gravel	15 to 29 % Sand or Gravel by weight
		Sandy or Gravelly	30 % or more Sand or Gravel by weight



TEST BORING RECORD

CLIENT : Ruetschle Architects
PROJECT : Hilltop Elementary School
LOCATION : Wyoming, OH
PROJECT NO. : 23050027CIN

BORING NO.: **B-01-23**
SHEET 1 OF 1
DATE STARTED : 09-05-23
DATE COMPLETED : 09-05-23

BORING ELEVATION	: 759.0 Feet	RIG TYPE	: Mobile B-57	DRILLER	: T. Miller (CTL)
NORTHING	: 39.23194	CASING DIA.	: N/A	TEMPERATURE	: Low 90s °F
EASTING	: -84.483555	CORE SIZE	: N/A	WEATHER	: Sunny
DEPTH	: 10.0 Feet	HAMMER	: Automatic		
BORING METHOD	: 3.25" I.D. HSA	ENERGY RATIO	: 76.8		

GROUNDWATER: Encountered at None At completion None ▽ Caved in at 4.0'

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	N_{60}	RECOVERY (%)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS LL	PL	PI
758.5		**GRAVEL (6")**	0.5										
		Very Stiff, Brown **SANDY LEAN CLAY (CL)**, Damp		SS-1	4 6 9	19	100	16		9.0*			
756.0			3.0										
	5	Stiff, Brown **FAT CLAY with SAND (CH)**, Damp		SS-2	6 5 7	15	100	27		9.0*	70	33	37
753.5			5.5										
		Hard, Grayish Brown **SANDY LEAN CLAY with LIMESTONE FRAGMENTS (CL)**, Damp		SS-3	40 38 50-5"		100	12		9.0*			
				SS-4	38 50-3"		100	10		9.0*			
749.0	10	**BOTTOM OF BORING**	10.0										
	15												
	20												

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BORING METHOD	SAMPLING METHOD	ABBREVIATIONS
HSA - Hollow Stem Auger	SS - Split Spoon Sample	* - Hand Penetrometer
SFA - Solid Flight Auger	ST - Shelby Tube Sample	LL - Liquid Limit
RC - Rock Coring	CR - Rock Core Sample	PL - Plastic Limit
MD - Mud Drilling	BS - Bag Sample	PI - Plasticity Index
WD - Wash Drilling		SPT - Standard Penetration Test
HA - Hand Auger		N_{60} - Standard Penetration Normalized to 60% Drill Rod ER

TEST BORING RECORD

CLIENT	: Ruetschle Architects	BORING NO.:	**B-02-23**
PROJECT	: Hilltop Elementary School	SHEET	1 OF 1
LOCATION	: Wyoming, OH	DATE STARTED	: 09-06-23
PROJECT NO.	: 23050027CIN	DATE COMPLETED	: 09-06-23

BORING ELEVATION	: 760.0 Feet	RIG TYPE	: Mobile B-57	DRILLER	: T. Miller (CTL)
NORTHING	: 39.231731	CASING DIA.	: N/A	TEMPERATURE	: Upper 80s °F
EASTING	: -84.483679	CORE SIZE	: N/A	WEATHER	: Sunny
DEPTH	: 18.6 Feet	HAMMER	: Automatic		
BORING METHOD	: 3.25" I.D. HSA	ENERGY RATIO	: 76.8		

GROUNDWATER: ▼ Encountered at 13.0' At completion None ▨ Caved in at 15.0'

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	N_{60}	RECOVERY (%)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS LL	PL	PI
759.8		**TOPSOIL (2")**	0.2										
759.5		**GRAVEL (4")**	0.5										
		Stiff, Gray **FAT CLAY with GRAVEL (CH)**, Damp **(FILL)**		SS-1	6 7 5	15	100	20		8.5*	52	25	27
757.0			3.0										
	5	Stiff, Gray **SILTY CLAY with SAND (CL-ML)**, Damp		SS-2	4 4 5	12	100	18		6.0*			
				SS-3	4 4 5	12	100	19		9.0*			
752.0			8.0										
	10	Stiff, Gray **SILTY CLAY with SAND and ROCK FRAGMENTS (CL-ML)**, Moist		SS-4	4 4 4	10	100	23		3.5*			
749.5			10.5										
				SS-5	4 4 7	14	100	27		4.0*	53	26	27
	15	Stiff to Very Stiff, Brown **FAT CLAY with GRAVEL (CH)**, Moist		SS-6	7 9 10	24	100	26		3.0*			
741.5			18.5										
741.0		Rock Fragments	19.0	SS-7	50-1"		50						
		BOTTOM OF BORING											
	20	Auger Refusal at 19.0'											

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BORING METHOD		SAMPLING METHOD		ABBREVIATIONS	
HSA	Hollow Stem Auger	SS	Split Spoon Sample	*	Hand Penetrometer
SFA	Solid Flight Auger	ST	Shelby Tube Sample	LL	Liquid Limit
RC	Rock Coring	CR	Rock Core Sample	PL	Plastic Limit
MD	Mud Drilling	BS	Bag Sample	PI	Plasticity Index
WD	Wash Drilling			SPT	Standard Penetration Test
HA	Hand Auger			N_{60}	Standard Penetration Normalized to 60% Drill Rod ER

TEST BORING/PIT RECORD 23050027CIN.GPJ CTL CORPORATE.GDT 10/12/23

TEST BORING RECORD

CLIENT	: Ruetschle Architects	BORING NO.:	**B-03-23**
PROJECT	: Hilltop Elementary School	SHEET	1 OF 2
LOCATION	: Wyoming, OH	DATE STARTED	: 09-06-23
PROJECT NO.	: 23050027CIN	DATE COMPLETED	: 09-06-23

BORING ELEVATION	: 760.0 Feet	RIG TYPE	: Mobile B-57	DRILLER	: T. Miller (CTL)
NORTHING	: 39.231435	CASING DIA.	: N/A	TEMPERATURE	: Upper 80s °F
EASTING	: -84.484203	CORE SIZE	: NQ2	WEATHER	: Sunny
DEPTH	: 25.0 Feet	HAMMER	: Automatic		
BORING METHOD	: 3.25" I.D. HSA	ENERGY RATIO	: 76.8		

GROUNDWATER: Encountered at None ▽ At completion 3.0'

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	N_{60}	RECOVERY (%)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS LL	PL	PI
759.5		**TOPSOIL (6")**	0.5										
		Sitff to Very Stiff, Brown **FAT CLAY (CH)**, Damp **(FILL)**		SS-1	3 5 5	13	100	20		9.0*			
		SS-2: Trace Roots		SS-2	4 5 8	17	100	21		9.0*	62	29	33
754.5	5		5.5										
		Very Stiff, Brown **SANDY FAT CLAY (CH)**, Damp		SS-3	6 9 10	24	100	22		9.0*			
752.0			8.0										
		Stiff, Brown with Dark Brown and Gray Specks **FAT CLAY (CH)**, Moist		SS-4	3 5 7	15	100	31		6.5*	65	30	35
749.5	10		10.5										
		Hard, Brown and Gray **LEAN CLAY (CL)**, Damp, Limestone Fragments		SS-5	15 50-5"		100	21		9.0*			
747.0			13.0										
				SS-6	10 50-4"		100	8					
	15	Gray **SEVERELY WEATHERED SHALE**											
				SS-7	50-0"		0						
740.0	20		20.0										

Continued on next page

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BORING METHOD	SAMPLING METHOD	ABBREVIATIONS
HSA - Hollow Stem Auger	SS - Split Spoon Sample	* - Hand Penetrometer
SFA - Solid Flight Auger	ST - Shelby Tube Sample	LL - Liquid Limit
RC - Rock Coring	CR - Rock Core Sample	PL - Plastic Limit
MD - Mud Drilling	BS - Bag Sample	PI - Plasticity Index
WD - Wash Drilling		SPT - Standard Penetration Test
HA - Hand Auger		N_{60} - Standard Penetration Normalized to 60% Drill Rod ER

TEST BORING RECORD

CLIENT : Ruetschle Architects

BORING NO.: **B-03-23**

PROJECT : Hilltop Elementary School

SHEET 2 OF 2

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	N_{60}	RECOVERY (%)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS LL	PL	PI
		INTERBEDDED SHALE (68%) and LIMESTONE (32%)		CR-1 RQD= 48%			100						
		SHALE, GRAY, HIGHLY WEATHERED, VERY WEAK TO WEAK, THIN BEDDING											
		LIMESTONE, GRAY, SLIGHTLY WEATHERED, STRONG, VERY THIN TO THIN BEDDING, FOSSILIFEROUS											
735.0	25		25.0										
		BOTTOM OF BORING											
		Auger Refusal at 20.0'											
	30												
	35												
	40												
	45												

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HSA	Hollow Stem Auger	SS	Split Spoon Sample	*	Hand Penetrometer
SFA	Solid Flight Auger	ST	Shelby Tube Sample	LL	Liquid Limit
RC	Rock Coring	CR	Rock Core Sample	PL	Plastic Limit
MD	Mud Drilling	BS	Bag Sample	PI	Plasticity Index
WD	Wash Drilling			SPT	Standard Penetration Test
HA	Hand Auger			N_{60}	Standard Penetration Normalized to 60% Drill Rod ER

B-03-23



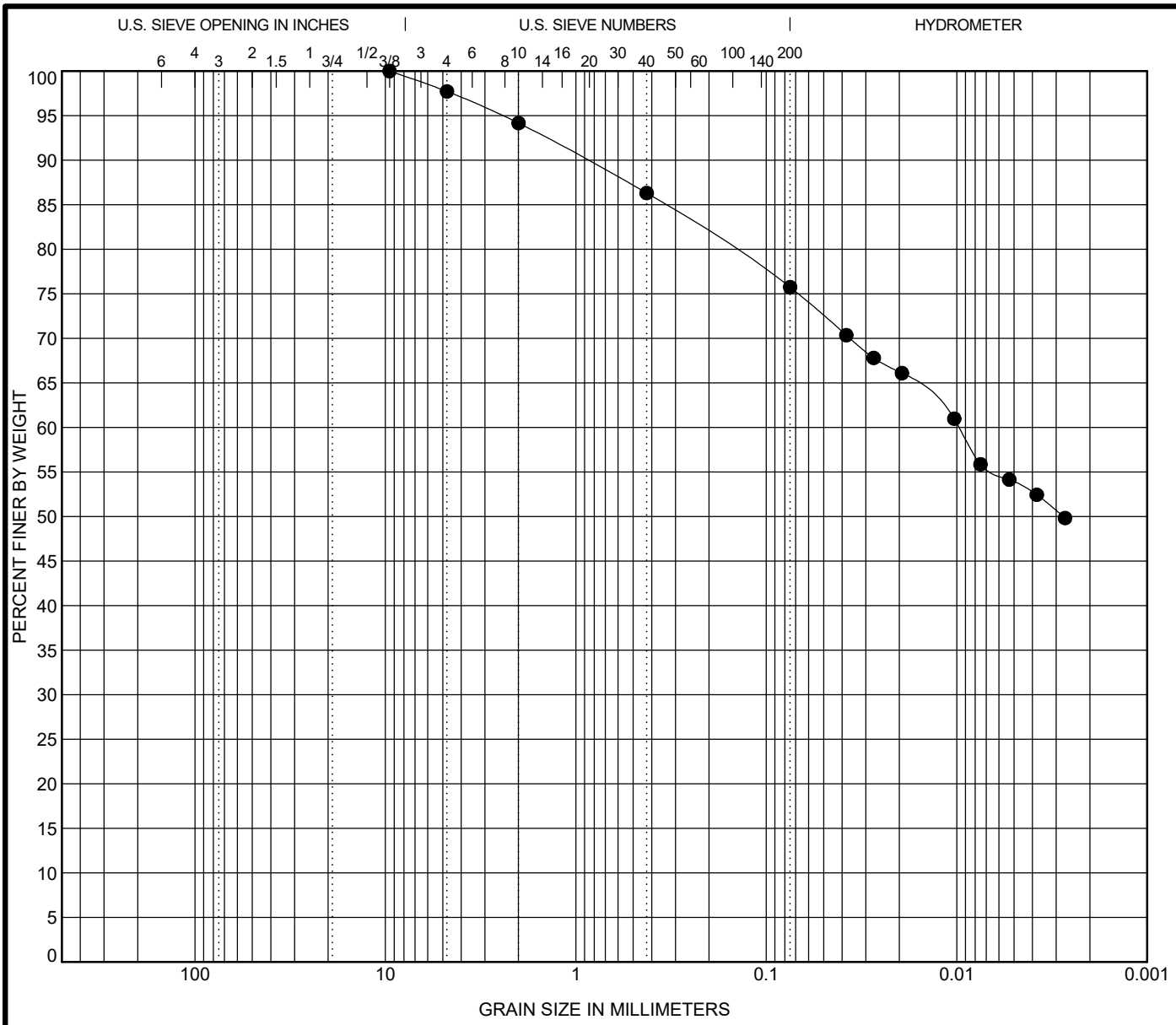
Run #:	Depth		Recovery		RQD	
CR-1	20.0'	25.0'	60"/60"	100%	29"/60"	48%

23050027CIN: Ruetschle Architects - Hilltop Elementary School

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APPENDIX C

RESULTS OF SOIL LABORATORY TESTS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen ID	Sample	Classification	%MC	LL	PL	PI	Cc	Cu
●	**B-01-23**	**SS-2**	**FAT CLAY with SAND (CH)**	**27**	**70**	**33**	**37**		

	Specimen ID	Sample	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-01-23**	**SS-2**	**9.525**	**0.01**	**0.003**			**2**	**22**	**22**	**54**

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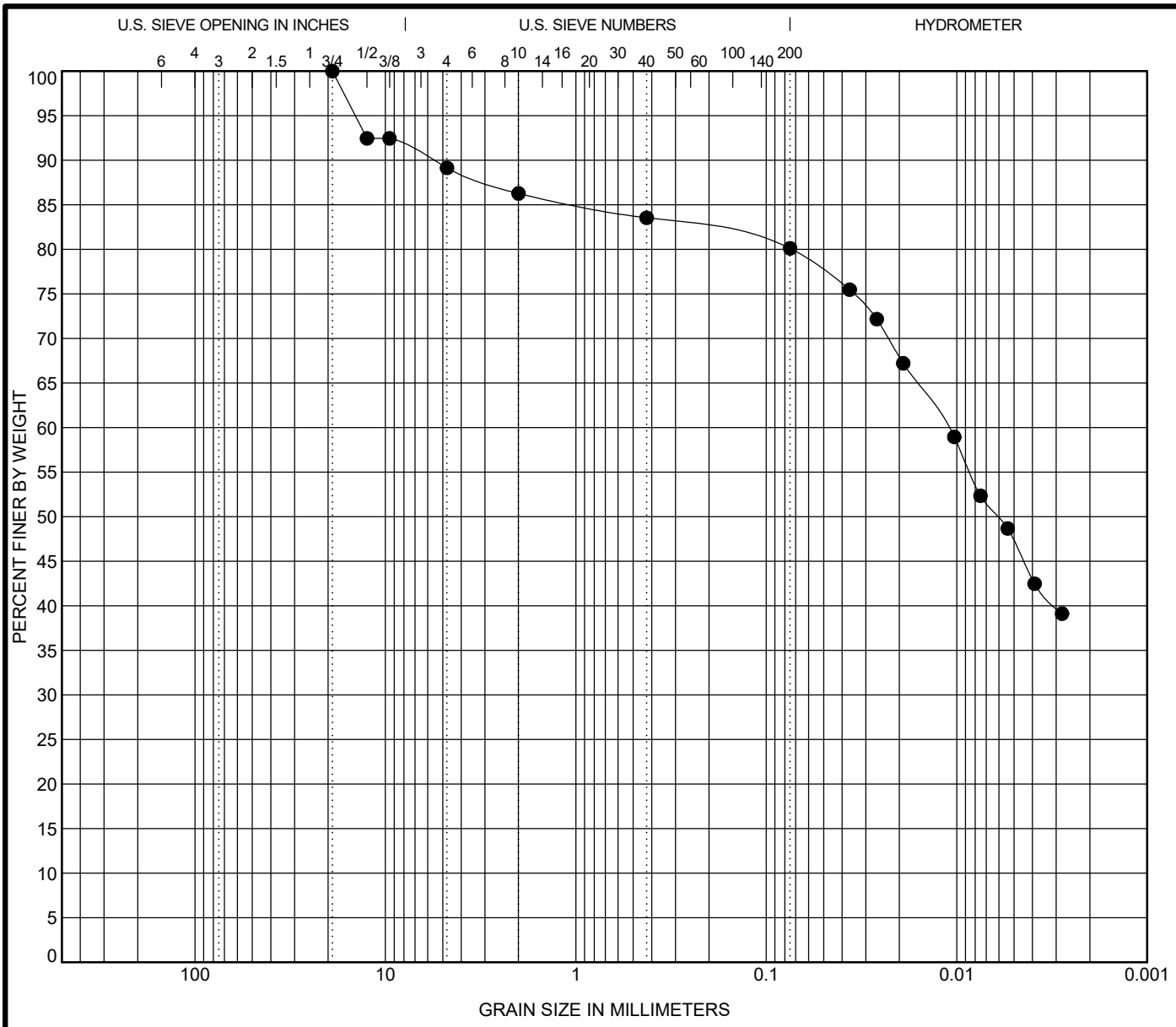
GRAIN SIZE DISTRIBUTION (ASTM D6913, D 7928, D 4318)

Project: Hilltop Elementary School

Location: Wyoming, OH

CTL Project Number: 23050027CIN

CTLLAB_GRAINSIZE 2305027CIN.GPJ CTL_CORPORATE.GDT 9/14/23



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen ID	Sample	Classification	%MC	LL	PL	PI	Cc	Cu
●	**B-02-23**	**SS-1**	**FAT CLAY with GRAVEL (CH)**	**20**	**52**	**25**	**27**		

	Specimen ID	Sample	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-02-23**	**SS-1**	**19**	**0.011**	**0.006**			**11**	**9**	**33**	**47**

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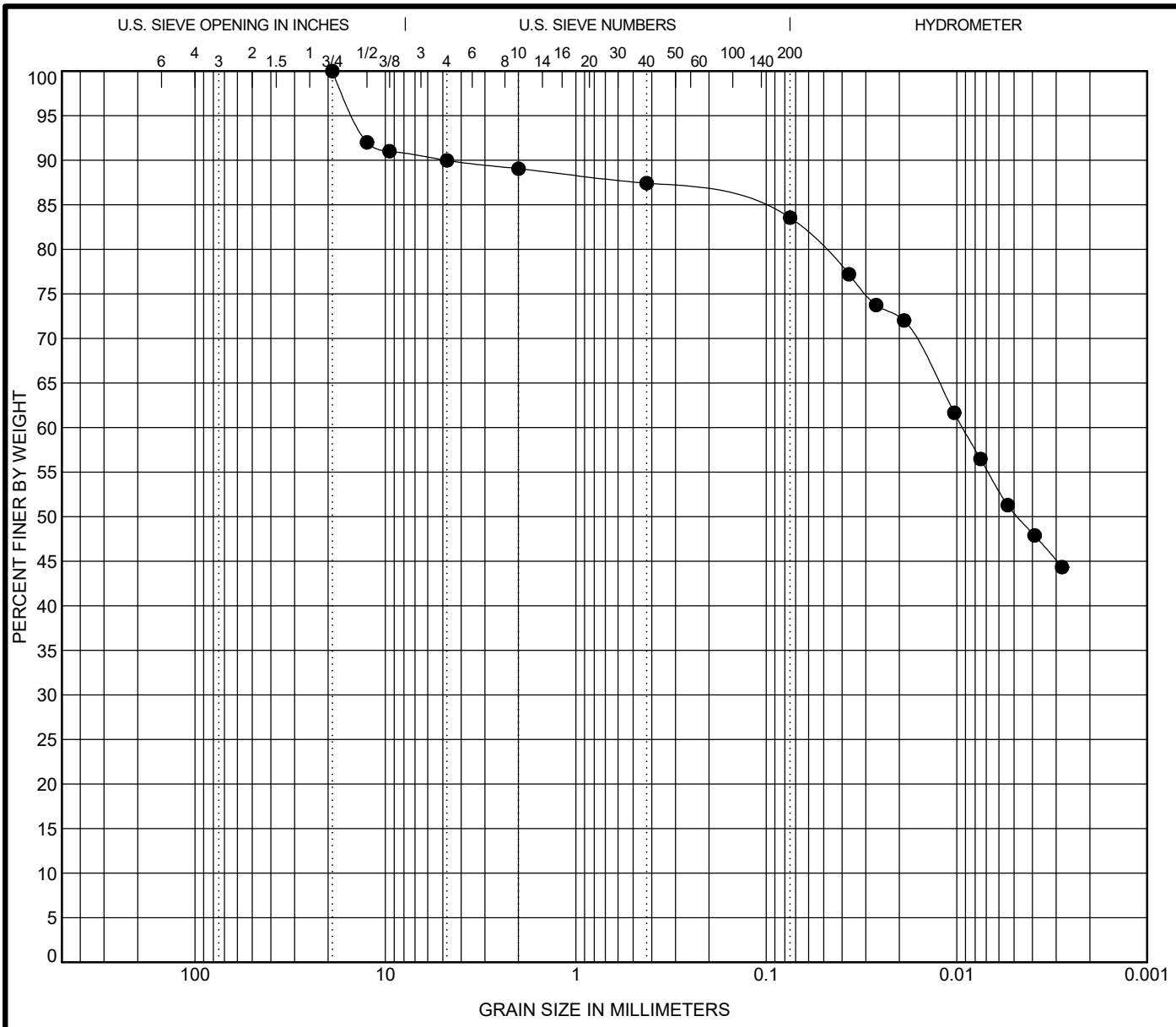
GRAIN SIZE DISTRIBUTION (ASTM D6913, D 7928, D 4318)

Project: Hilltop Elementary School

Location: Wyoming, OH

CTL Project Number: 23050027CIN

CTLLAB_GRAINSIZE 2305027CIN.GPJ CTL_CORPORATE.GDT 9/14/23



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen ID	Sample	Classification	%MC	LL	PL	PI	Cc	Cu
●	**B-02-23**	**SS-5**	**FAT CLAY with GRAVEL (CH)**	**27**	**53**	**26**	**27**		

	Specimen ID	Sample	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-02-23**	**SS-5**	**19**	**0.009**	**0.005**			**10**	**6**	**34**	**50**

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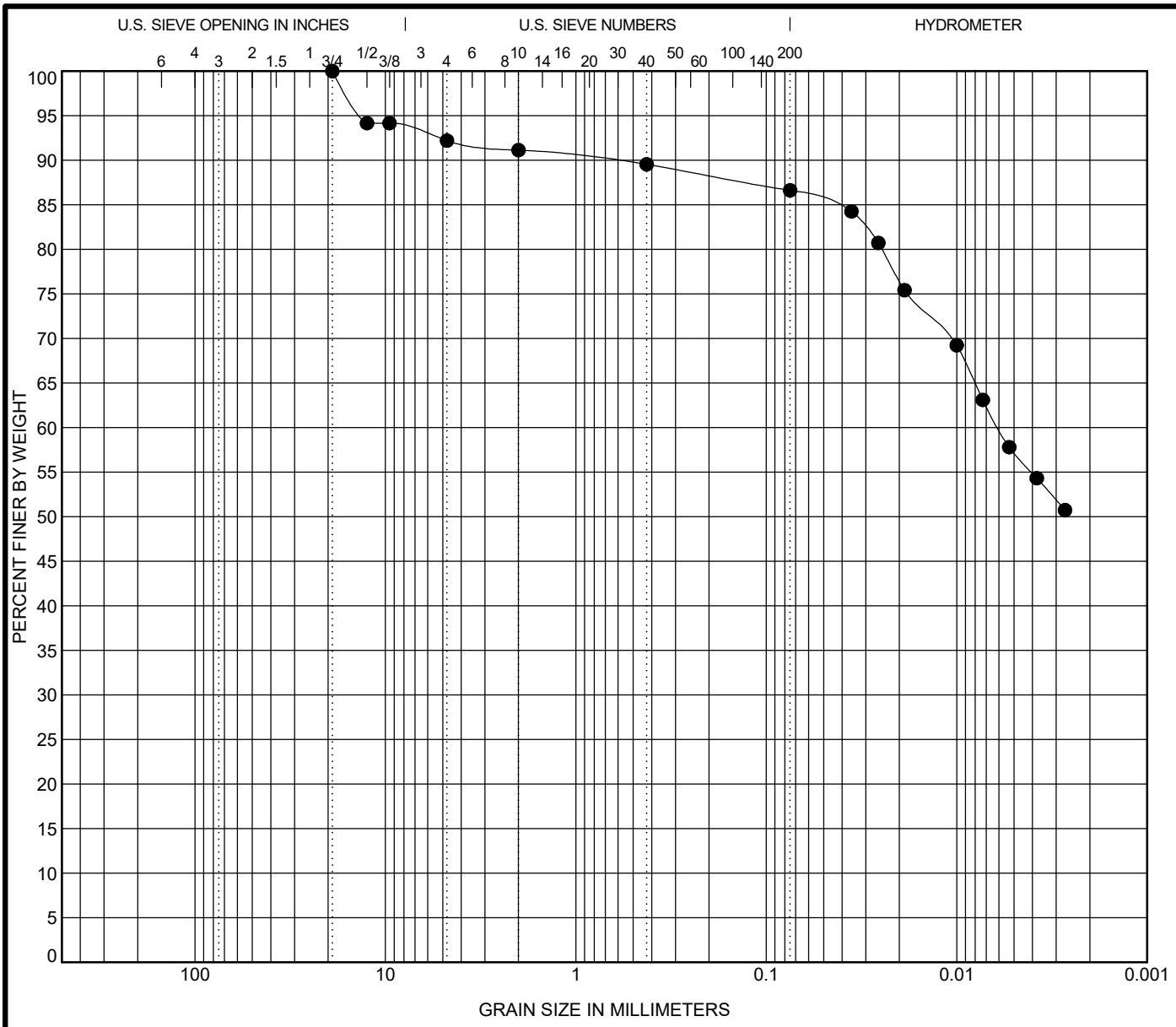
GRAIN SIZE DISTRIBUTION (ASTM D6913, D 7928, D 4318)

Project: Hilltop Elementary School

Location: Wyoming, OH

CTL Project Number: 23050027CIN

CTLLAB_GRAINSIZE 23050027CIN.GPJ CTL_CORPORATE.GDT 9/14/23



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen ID	Sample	Classification	%MC	LL	PL	PI	Cc	Cu
●	**B-03-23**	**SS-2**	**FAT CLAY (CH)**	**21**	**62**	**29**	**33**		

	Specimen ID	Sample	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-03-23**	**SS-2**	**19**	**0.006**				**8**	**6**	**29**	**57**

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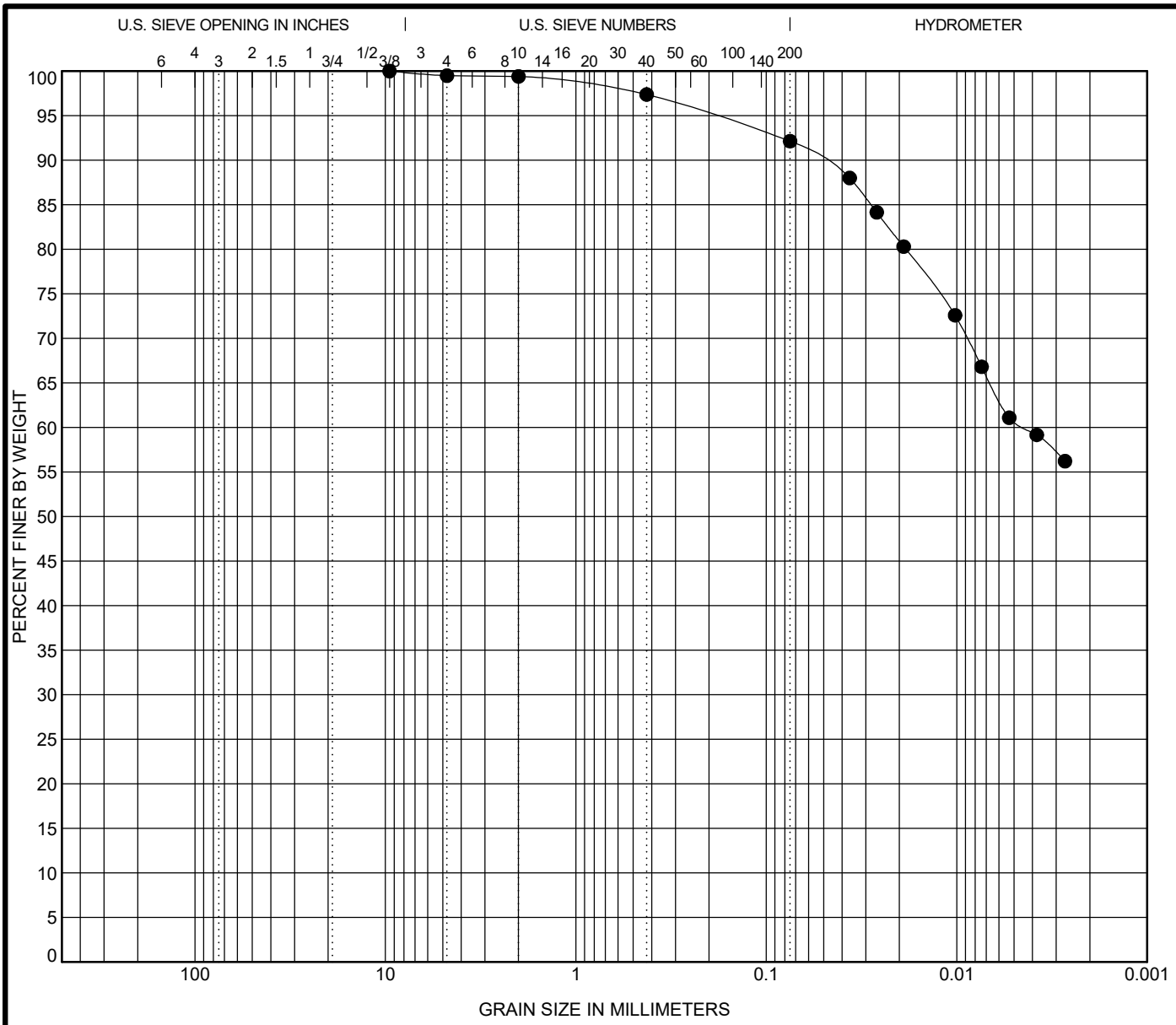
GRAIN SIZE DISTRIBUTION (ASTM D6913, D 7928, D 4318)

Project: Hilltop Elementary School

Location: Wyoming, OH

CTL Project Number: 23050027CIN

CTLLAB_GRAINSIZE 23050027CIN.GPJ CTL_CORPORATE.GDT 9/14/23



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen ID	Sample	Classification	%MC	LL	PL	PI	Cc	Cu
●	**B-03-23**	**SS-4**	**FAT CLAY (CH)**	**31**	**65**	**30**	**35**		

	Specimen ID	Sample	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-03-23**	**SS-4**	**9.525**	**0.004**				**1**	**7**	**31**	**61**

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GRAIN SIZE DISTRIBUTION (ASTM D6913, D 7928, D 4318)

Project: Hilltop Elementary School

Location: Wyoming, OH

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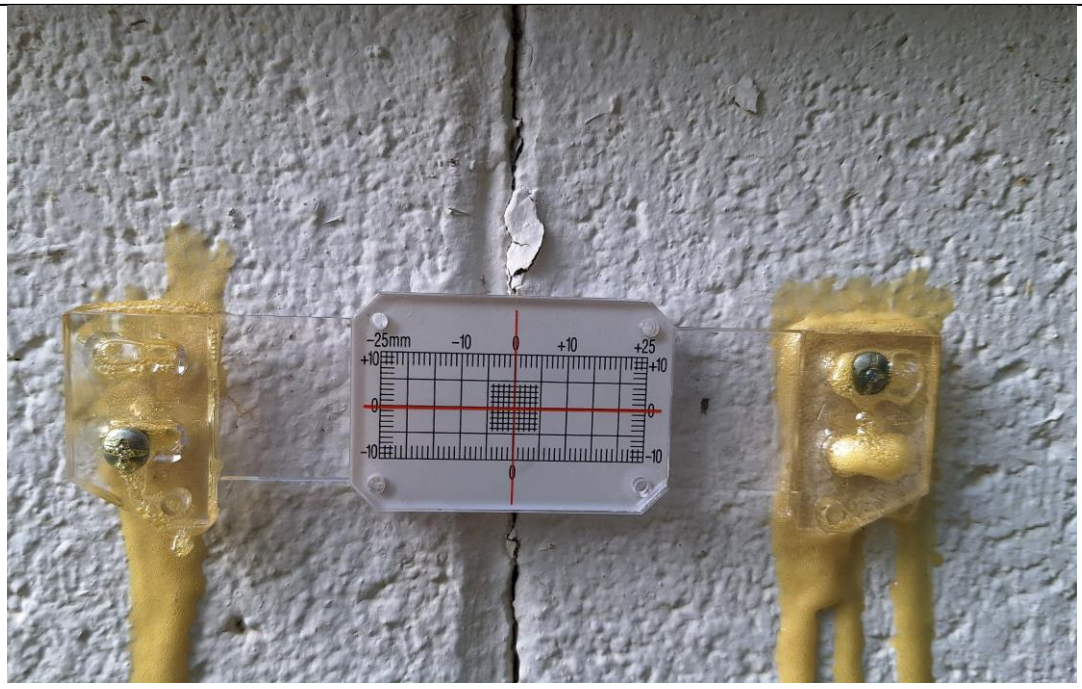
CTLLAB_GRAINSIZE 23050027CIN.GPJ CTL_CORPORATE.GDT 9/14/23

APPENDIX D

CRACK MONITOR PHOTOGRAPHS



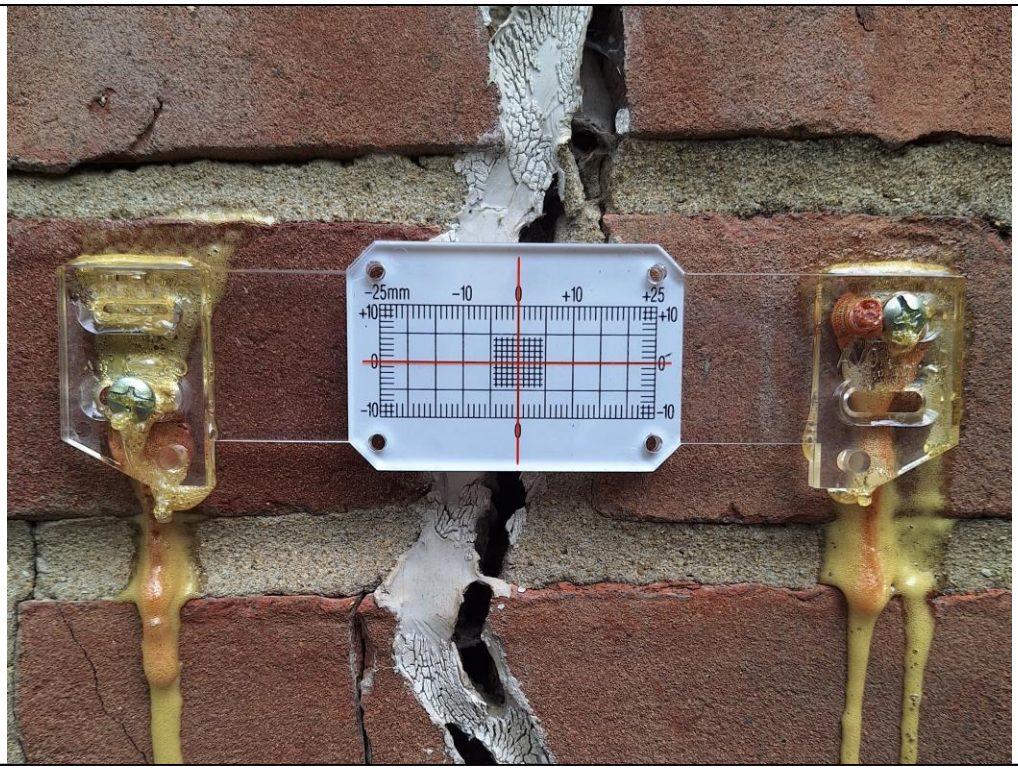
Photograph #1: Crack Monitor #1 located at the Southeast Corner of Building A.



Photograph #2: Crack Monitor #1 located at the Southeast Corner of Building A.



Photograph #3: Crack Monitor #2 located at the Southwest Corner of Building B.



Photograph #4: Crack Monitor #2 located at the Southwest Corner of Building B.

APPENDIX E

SITE OBSERVATION PHOTOGRAPHS



Photograph #1: South of Building A looking east at B-01-23.



Photograph #2: East of Building B looking south at B-02-23 looking south. Significant moisture in surficial layer due to garden watering.



Photograph #3: South of Building B looking northwest at cluster of trees growing directly adjacent to Building B.



Photograph #4: Southwest of Building B looking south at B-03-23. Existing retaining wall approximately 10 feet south of B-03-23.



Photograph #5: Southwest of Building B looking northeast. Cracking observed southwest side of Building B.