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August 7, 2024

Mr. Mark J. Mrofchak *e-mail*: mmrofchak@libraryvisit.org
The Public Library of Youngstown & Mahoning County
305 Wick Avenue
Youngstown, Ohio 44503

Reference: Floor Slab Heave Assessment
Poland Library
311 South Main Street - Poland, Ohio 44514
GCI Project No.: 24-G-29241

Dear Mr. Mrofchak:

As you requested and authorized, Geotechnical Consultants, Inc. (GCI) visited the project site on July 22, 2024 to perform floor slab cores and shallow hand borings to assess the soil conditions below the floor slab. Presently, the floor slab along the southeast side of the building is exhibiting slab heave.

Available for our use in preparation of this study were the following items:

- *2001 Construction Drawings*, prepared by the 4M Company, and dated 3/15/2000.
- *Subsurface Exploration Report* for the Poland Library, prepared by J.N. Cernica & Associates (Cernica), dated 1/9/1997.
- *Supplementary Subsurface Exploration Report* for the Poland Library, prepared by J.N. Cernica & Associates (Cernica), dated 10/29/1998.

This letter summarizes our field findings, the results of laboratory testing, our conclusions and recommendations.

PROJECT DESCRIPTION

The Poland Library is located at 311 South Main Street in Poland, Ohio. The current library configuration was constructed in 2001 and is presently experiencing floor slab heave in portions of the bookstore and electrical room areas (southeast side of building).

Based on walk-over site observations, it appears that the slab heave (up to ±3-inches, locally) is occurring along a *generalized* line on the southeast side of the building. Presently, the heaving appears to only be impacting the floor slab. General observations of the building structure do not reveal any overt signs of foundation heave or structural framing distress. GCI understands that a structural engineer has been retained to evaluate if any impact to the structural components of the building has occurred. The aerial image on the next page shows the approximate location of the floor slab heave within the building footprint.

Aerial image obtained from Google Earth©

The current building is a 3-story (including the slab-on-grade lower level basement) structure that is constructed into the slope. Plans indicates that foundations are extended to shale and sandstone bedrock, resulting in foundation level subgrades ranging between ±4.5 and ±9 feet below the lower level finish floor elevation (1007.55 feet). The building is located approximately 25 feet west of Yellow Creek. Observations of Yellow Creek indicate a bedrock streambed, approximately 7 to 9 feet below the finish floor elevation along the southeast side of the building.

The provided building plans indicate that the lower level floor slab elevation is 1007.55 feet. While the plans that GCI was provided do not include the civil drawings, topographic information in the Cernica geotechnical reports (1997 and 1998 reports) suggest that cuts up to ±4 feet would have been required to achieve proposed grades in the southeast portion of the lower level. Additionally, site walk-over observations suggest that cuts would have been required to achieve current grades in this portion of the building.

FIELD WORK – SLAB CORING & SHALLOW HAND BORINGS

On July 22, 2024, GCI performed (3) floor slab cores (C-1 through C-3) at the project site. We performed (2) cores in areas exhibiting severe floor heave and (1) core in an area not exhibiting any signs of distress. The cores were obtained using a nominal 6-inch diameter diamond core barrel. Water was used to facilitate coring.

Following slab coring, we extended shallow borings to depths ranging between 2.7 and 3.6 feet below the finish floor elevation. The borings were continuously sampled and advanced using a combination of hand augering, drill augering, and coring methods. The diameter of the shallow boring was approximately 4-inches.

We have attached the boring logs and a copy of the *Coring/Boring Location Plan* to the appendix of this report. Note: We show the approximate location of nearby borings from the Cernica reports (1997 and 1998 reports) on the *Coring/Boring Location Plan* and include those boring logs in the appendix. The paragraphs below summarize our subsurface findings at the boring locations. Refer to the individual boring logs for more detailed subsurface information each the boring location.

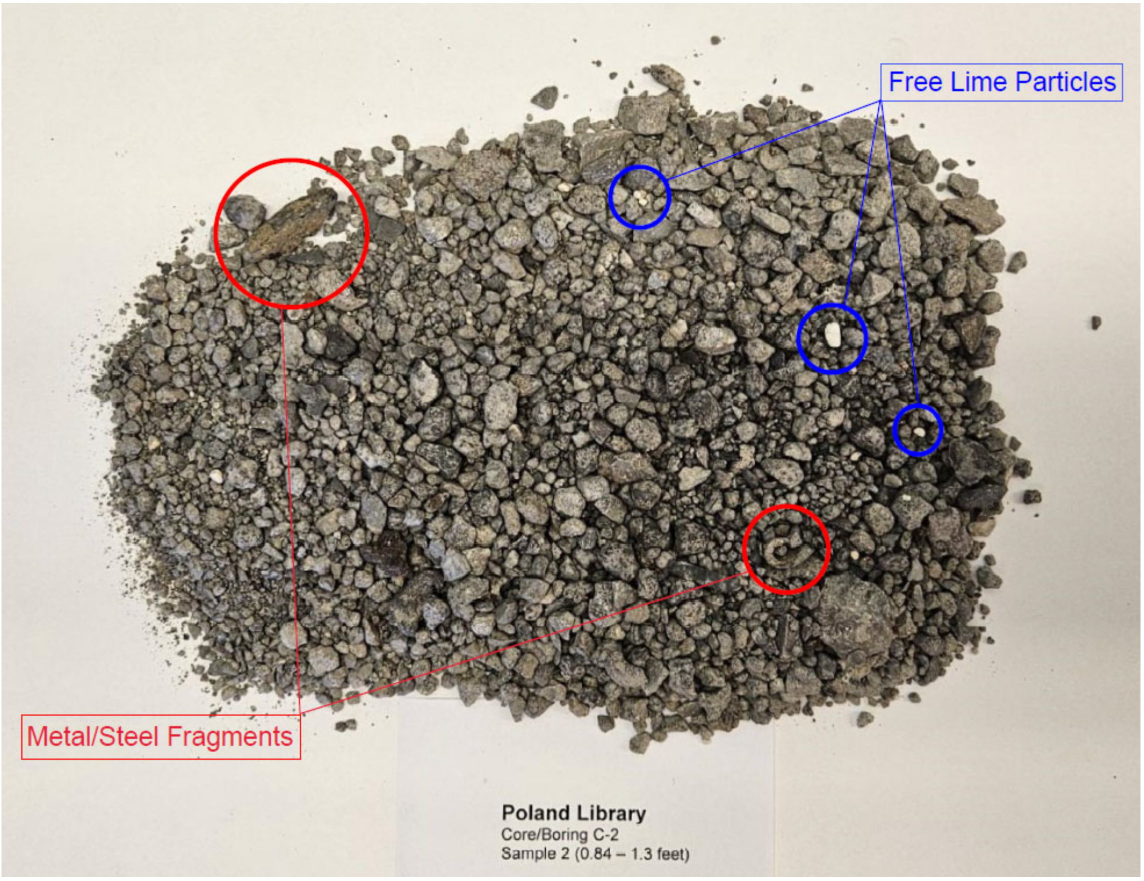
Concrete Slab

The floor slab at the core locations ranged between 4.1 and 5.1 inches thick, with an average thickness of 4.5 inches. A vapor barrier was encountered below the slab at each core location. Welded wire mesh (WWM) reinforcing was observed near the bottom of each core.

Below the slab, an aggregate sub-base was encountered consisting of dense, well-graded, limestone sand and gravel (ODOT Item 304 type gradation). The aggregate sub-base ranged between 4 and 6 inches in thickness at the core locations.

Slag-Based Fill

Below the floor slab section (concrete and underlying sub-base) at locations C-1 and C-2, we encountered dark gray slag-based fill. The slag-based fill consisted of mostly open-hearth slag and contained traces of gravel, sand, and metal fragments. In general, the slag profile had a gradation resembling a poorly graded sand with silt and gravel. The retrieved slag samples contained visible Calcium Oxide (CaO) at all depths. Calcium Oxide is un-hydrated free lime, which is added to the molten steel to facilitate the removal of ore impurities during the steel making process. The photograph below shows the typical slag-based fill gradation (after washing).



Typical slag-based fill at the project site

In portions of the slag profile in borings C-1 and C-2, the slag was found to be in a *fused* condition. Slag particles have the potential to fuse together (crystalize) when exposed to moisture as a result of the chemical compounds within the slag, typically Magnesium Oxide (MgO) and Iron Oxides (Fe_2O_3). In our experience, fused slag typically has a comparable hardness similar to asphalt or occasionally as high as concrete. The photograph below shows a portion of the fused slag, obtained by coring methods from boring C-1.

Fused slag obtained (cored) from C-1 (nominal diameter 4 inches).
Note the presence of free lime within the specimen (white inclusions).

Field observations generally indicated the slag-based fill to be medium dense to dense in cohesionless density. The slag profile was noted to be damp, with in-situ moisture contents ranging between 4.7 and 7.9%. Borings C-1 and C-2 were terminated within the slag deposit at depths of 3.6 and 3.3 feet below finish floor elevation, respectively. For more information regarding slag, see the *Slag Considerations* section of this report.

Natural Soils & Weathered Bedrock
Below the floor slab section at location C-3, we encountered stable, natural soils generally comprised of brown Silty Sand with Gravel (SM)*. The silty sand soils were mostly coarse to fine sand and contained little gravel with little to some slightly plastic fines. Field

observations generally indicated the silty sand soils to be medium dense in cohesionless density. We generally described the retrieved soil samples from the silty sand deposit as moist. The silty sand deposit extended a depth of 2.6 feet below the floor slab elevation.

Below the silty sand deposit, we encountered brown weathered sandstone. Due to the hardness of the weathered sandstone, penetration into the rock layer with our hand drilling equipment was not feasible. Boring C-3 terminated within the weathered sandstone layer at a depth of 2.7 feet below the floor slab elevation.

* Soil classification under the ASTM/Unified Soil Classification System

Groundwater

No groundwater seepage was encountered in our borings. Retrieved soil samples from the slag-based fill layer were generally noted as damp. Retrieved samples from the silty sand deposit were generally noted as moist.

It should be noted that soil moisture conditions and groundwater observations fluctuate due to changes in precipitation, climate, stabilization time and other factors that may differ from the time the measurements were made.

EXISTING BORINGS

We reviewed (2) existing geotechnical reports prepared by J.N. Cernica & Associates for the project, dated 1997 and 1998. Four (4) borings (B-1, B-11, B-12, and B-13) were the closest borings to the current study. We show the *approximate* location of nearby borings from the Cernica reports (1997 and 1998 reports) on the *Coring/Boring Location Plan* and include those boring logs in the appendix.

The Cernica borings identify a variable depth, existing fill layer across the site, generally containing traces to some amounts of slag. Fill soils encountered in our borings (C-1 and C-2) were mostly slag based, with slag constituting approximately 95% of the fill layer. The silt-sand based soils and underlying bedrock encountered in C-3, correspond relatively well to the nearby Cernica boring, when adjusted for construction grade changes (i.e. existing fill soils were cut during construction to achieve proposed grades).

It is our opinion that the slag-based fill encountered in the current study is identified as existing fill in the Cernica studies (i.e. existing fill that was left in-place during construction). Due to the magnitude of slab heaving, both its lateral extents and overall vertical displacement, we feel that the majority of existing fill below the slab in the southeast portion of the building is likely slag-based. Based on the elevation data contained in the Cernica reports and the current finish floor elevation, it is likely that existing slag-based fill extends to depths ranging between ±2 and ±4 feet below the current slab elevation along the southeast side of the building.

LABORATORY TESTING

Our laboratory testing program consisted of natural moisture content, grain size analysis, and expansion testing on select samples obtained from the slag-based fill. The purpose of the laboratory testing was to provide information to refine our soil classifications and to evaluate the characteristics of the subsurface strata. Results of the lab testing are incorporated in the soil descriptions within this report and in the attached boring logs. The results of the laboratory testing are included in the appendix and are summarized in the sections below.

Slag-Based Fill Particle Size Analysis & In-situ Moisture Contents					
Boring Number	Sample Depth (ft.)	Moisture Content (%)	Grain Size Distribution		
			% Gravel[1]	% Sand[1]	% Fines[1]
C-1	1.3 - 1.7	5.1	-	-	-
C-1	1.7 - 2.0	5.4	41.9	53.0	5.1
C-1	2.0 - 2.4	7.4	-	-	-
C-1	2.4 - 2.8	7.9	-	-	-
C-1	2.8 - 3.2	7.3	-	-	-
C-1	3.2 - 3.6	7.9	-	-	-
C-2	0.8 - 1.3	4.9	25.7	66.4	7.9
C-2	1.3 - 1.8	4.7	-	-	-
C-2	1.8 - 2.3	6.1	-	-	-
C-2	2.3 - 2.8	6.7	-	-	-
C-2	2.8 - 3.3	7.0	-	-	-

1. Note: Natural occurring gravel, sand, and fines sized particles only constitutes a small fraction (<5%) of the slag-based fill layer. In the table above gravel denotes particles sizes between 4.75mm and 3", sand denotes particle sizes between 0.075mm and 4.75mm, and fines denotes particles sizes less than 0.075mm.

Expansion Testing

GCI performed an expansion test on (2) samples of slag-based fill obtained from the borings in general accordance with ASTM D 4729 *Standard Test Method for Potential Expansion of Aggregates from Hydration Reactions*. The results of the swell/expansion test are summarized in the table below.

Boring Number	Sample Depth (ft.)	Moist Unit Weight (pcf)	Moisture Content 1 (%)[1]	Moisture Content 2 (%)[2]	Maximum Swell (%)[3]
C-1	2.0 – 2.4	152.0	7.4	22.8	5.8
C-2	2.3 – 2.8	150.9	6.7	22.2	5.4

1. Natural (in-situ) moisture content – before test
2. Moisture content following test – saturated moisture
3. At the termination of the test, the samples were still expanding

The intent of the ASTM D4729 test is only to assess the expansion potential of ferrous slag. Our test results indicate that the slag-based fill materials encountered in borings C-1 and C-2 are expansive. While our tests showed expansion ranging between 5.4% and 5.8%, it should be noted that expansion within the samples was still occurring when we terminated the tests.

Expansion within slag-based materials generally occurs over a very long time period at an often unpredictable, or varying, expansion rate. This makes quantifying (predicting) the total expansion of a slag mass difficult, since the slag-based materials can vary in age, chemical properties, the amount of free lime available for hydration, and the hydration rate. Total expansion exceeding 10% is not uncommon in expansive slag-based materials.

SLAG CONSIDERATIONS

Slag is a by-product of metal production, typically steel making in our region. For decades steel slag was abundant in our region and often used as a fill material. Due to the potential for expansion, which can lead to determinantal impacts, slag is typically not recommended as a fill material below structures or pavements any more.

The slag encountered in the borings represents open hearth furnace steel slag. Due to different chemical components and cooling conditions, the appearance and color of open-hearth steel slag can vary greatly. Steel slag with a higher alkalinity is often gray, while steel slag with lower alkalinity is often brown or off-white. The steel slag encountered in GCI's current borings was gray in color.

The main chemical components of open-hearth steel slag are Calcium Oxide (CaO), Silicone Oxide (SiO_2), Magnesium Oxide (MgO), Iron Oxide (Fe_2O_3), Aluminum Oxide (Al_2O_3), and Phosphorus Pentoxide (P_2O_5). Open hearth steel slag typically contains 25% to 35% un-hydrated lime (primarily Calcium Oxide). This lime is added as a fluxing agent during the smelting process to aid in removing impurities from the iron ore. This free lime has an affinity for moisture and can absorb moisture through hydration for decades after the slag has been produced.

This hydration process can fuel a chemical reaction with the other oxides (primarily Magnesium Oxide and Iron Oxide) that can produce volume changes (swell and expansion). Volume changes exceeding 10% are not uncommon in open hearth steel slag. Under the right conditions, moisture absorption and slag expansion are not necessarily time dependent, with absorption and expansion occurring for a long period after the slag was produced or placed as a fill material. Soil and air moisture in the vapor phase are often sufficient to result in lime hydration.

Visual observations indicate that the floor slab is heaving, and our laboratory testing indicated that the slag is expansive. In addition to laboratory testing, research has shown other correlations between physical properties of slag and its potential expansiveness. Below we have outlined some of relative physical properties and their significance relating to the slag samples obtained in the borings.

- **Color**: The steel slag encountered in the borings was gray. Steel slag with a higher alkalinity is typically gray. Slag materials with a higher alkalinity typically allow for easier hydration, versus slags with lower alkalinities (i.e. more acidic slags are often less prone to volume change/expansion).

- **High Iron Content**: The steel slag obtained from the borings has a high metallic content. A significant metallic content, when subjected to a magnet, was observed across all particle sizes within the samples. Iron Oxide is one of the primary chemicals that contributes to slag expansion.

- **High Unit Weight**: Due to the high metallic content (noted above), it is not surprising that the obtained slag samples have a high unit weight, further suggesting a high metallic content. Samples prepared for laboratory testing had unit weights in excess of 150 pounds per cubic foot (PCF). Note: Natural occurring soils with similar gradations typically have unit weights on the order of 115 to 120 PCF.

- **<u>Gradation</u>**: Gradation (particle size distribution) contributes to potential expansiveness of slag materials. The expansion potential of well-graded slag materials with a maximum particle size of ¾" is generally increased. Well-graded materials typically possess a low void ratio (i.e. the volume of void space between the individual solid particles). This low void ratio (i.e. not much room between individual particles) can permit expansion forces to transmit more easily to between individual particles, often resulting in uplifting forces (i.e. surface heaving).

  While laboratory testing on the slag samples obtained from our borings generally indicate them to have a gradation similar to poorly-graded sand with silt and gravel; they contained a sufficient amount of variable sized, smaller diameter particles, that in a compacted state produce a relatively low void ratio.

- **<u>Free Lime (CaO – Calcium Oxide) Content</u>**: While all slag contains free lime, the samples obtained from the borings contained a readily observable, significant lime content. As previously mentioned, this free lime has an affinity for moisture and its hydration process is the catalyst for the chemical reaction that can produce volume changes.

- **<u>Moisture Content</u>**: The slag obtained from the borings had an in-situ moisture content between 4.7 and 7.9%. We consider this less moisture than normal for this type of material (composition and gradation). This low in-situ moisture condition, in conjunction with the relatively high free lime content, suggests that the slag materials below the slab have a high moisture absorption potential. As previously noted, soil and air moisture in the vapor phase is often sufficient to result in lime hydration.

CONCLUSIONS & RECOMMENDATIONS

Portions of the floor slab have heaved up to ±3 inches. Results of laboratory expansion testing on slag-based samples obtained below the slab indicate expansion values ranging between 5.4 and 5.8%, with expansion still occurring when the tests were terminated. Based on the results of laboratory testing and the overall composition of the slag-based fill materials below the slab, GCI is of the opinion that the slag-based fill is expanding in-place, resulting in the observable floor slab heave.

The borings performed in the area of floor slab heave extended to depths ranging between 3.3 and 3.6 feet below the slab elevation. It is our opinion that the slag-based fill encountered in our borings is identified as existing fill in the Cernica studies. Due to the magnitude of slab heaving, both its lateral extents and overall vertical displacement, we feel that the majority of existing fill below the slab in the southeast portion of the building is likely slag-based. Based on the elevation data contained in the Cernica reports and the current finish floor elevation, it is likely that existing slag-based fill extends to depths on the order of ±2 to ±4 feet below the finish floor elevation.

Remediation

Based on our conversations, GCI anticipates that only the floor slab in public areas will be addressed at this time. As previously stated, quantifying or predicting the total heave potential is difficult, as is the time required to reach total expansion. Final floor heaves up to ±5 inches could be realistic (assuming 10% expansion and 4 feet of existing slag-based fill).

The only way to completely eliminate the expansion potential is to remove the slag-based materials, in their entirety, from below the slab. If the current floor heave is unacceptable, then GCI recommends removing the floor slab and removing all the slag-based fill from below the slab. While previous boring data (Cernica borings) suggest that 4 feet of existing fill is likely present below the slab, we suspect it varies and could be deeper in some locations.

Provided the Library is willing to accept some risk (albeit small risk) of future slab movement, GCI is of the opinion that any slag-based existing fill below the 5-foot depth (5 feet below finish floor elevation) can remain in place. We suspect that any slag-based fill left below the 5-foot depth will be minor (i.e. relatively thin). Additionally, the fill required to achieve the subgrade elevation, following slag removal, will act as a cushion should any expansion occur within the left in-place slag-based materials. If the Library is unwilling to accept this risk, then all slag-based materials should be removed.

We provide the following general recommendations regarding removal and replacement of the floor slab and underlying slag-based fill:

1. Remove the existing floor slab from areas experiencing floor heave, plus **at least** 5 feet laterally. It should be noted, the lateral extents of the under-slab slag-based fill may not correlate to the slab areas exhibiting heave, and could extend further. Lateral extents of slab replacement may be dictated by observations made in the field during removal of the existing slab and slag-based fill materials.

2. If the owner is willing to assume some risk, remove existing slag-based fill materials to a depth of 5 feet below finish floor elevation. See comments above regarding leaving slag-base materials in-place below the 5-foot depth. If the owner is not willing to assume the risk, then **all** slag-based fill materials should be removed.

3. Following removal of the existing slag-based fill, the exposed subgrade (anticipated to be brown silty sand with gravel) should be thoroughly re-compacted using the largest feasible compaction equipment available (likely a plate tamper or remote/walk-behind vibratory roller). Any soft, yielding, or otherwise unstable subgrade areas should be stabilized prior to placing controlled fill to finished subgrade elevation.

4. We recommend utilizing a natural (inert), non-organic granular material (less than 25% passing the No. 200 sieve) as controlled fill (backfill) to return the remediation area to original design grade. We consider bank run sand and gravel and ODOT Item 304 or similar, acceptable controlled fill (backfill) materials. Due to the depth of the building foundations (extended to bedrock at depths up to 8 feet below finish floor elevation), we anticipate that gravel backfill will be encountered adjacent to foundation walls. Provided this gravel backfill is inert and does not contain slag, it can remain in-place.

5. New fill materials should be placed in a controlled manner. Controlled fill should be placed in maximum 8-inch thick loose lifts and compacted to 98% of the maximum Standard Proctor (ASTM D-698) dry density, within ±2% of the optimum moisture content. The specified compaction will be difficult to obtain if soft/unstable subgrades are not properly remediated before starting to place fill, or if the proposed fill materials

contain excess moisture.

6. For the floor slab, we recommend a minimum concrete floor slab thickness of at least 4 inches underlain by at least 4 inches of aggregate sub-base (ODOT Item 304-limestone). The slab should utilize concrete with a 28-day compressive strength of at least 4,000 psi and be reinforced as appropriate, using welded wire mesh (WWM) or fiber concrete admixtures. We recommend placing a vapor barrier below the floor slab.

Alternative Remediations
GCI was asked about alternative remediation possibilities that would permit the slag-based materials to remain in-place, while limiting/eliminating the expansive characteristics.

Extensive research, primariliy by DOT's, has been done to determine if low viscosity polyurethane can used to "seal" in-situ slag deposits. In theory, sealing of in-place slag, to prevent moisture hydration, is possible. Small scale testing has shown that in controlled laboratory settings, it is possible. However, real world, non-controlled settings have not been very successful, showing only minor reductions in expansiveness. Sealing a slag deposit, in-situ, requires injection of polyurethane material at the top, bottom, and sides of the deposit (to prevent vapor phase moisture from entering the slag deposit from any direction). The presence of "fused" slag layers would likely make adequate distribution of the polyurethane materials difficult.

Additionally, injecting acid solutions into slag deposits to lower the alkalinity and eliminate the free lime has been shown to reduce to expansiveness in laboratory settings. Again, in real world, non-controlled settings, success has been limited. The variables involved with treating slag deposits using injection methods in actual field conditions are too great and vary significantly.

While research has shown slag expansiveness can be reduced, it still does not provide predictable, long-term acceptable results. As such, the only proven method for remediating slag expansiveness is to remove it from beneath problem areas. Based on this, and our experience with expansive slag, GCI recommends utilizing the remove and replace method outlined above.

CONSTRUCTION MATERIALS ENGINEERING AND TESTING
GCI provides construction materials engineering and testing services. For project continuity throughout construction, we recommend that GCI be retained to observe, test, and document the following:

- Verify slag removal from within the extents of the remediation area.
- Verify subgrade stability following slag removal.
- Evaluation of the material to be used as controlled fill.
- Observe and test controlled fill placement and compaction.
- Floor slab replacement (subgrade preparation and concrete testing).

The purpose of this work is to assess that the intent of our recommendations is being followed and to make timely changes to our recommendations (as needed) in the event site conditions vary from those encountered in our borings. Please contact our field department to initiate these services.

FINAL

The intent of this study was to assess floor slab heaving, evaluate subsurface conditions, and offer geotechnical recommendations pertinent to the remediation of the floor slab issues currently being experienced at the above referenced site. Geotechnical Consultants Inc. prepared this report for the exclusive use of The Public Library of Youngstown & Mahoning County and their associated consultants for the specific application to the ongoing floor slab heave study at the Poland Library in Poland, Ohio. GCI prepared this report in accordance with generally accepted soil and foundation engineering practices. No warranty, expressed or implied, is made.

In the event that any changes in the nature, design or location of the project are planned, conclusions and recommendations contained in this report shall not be considered valid unless changes are reviewed and conclusions of this report are modified or verified in writing. It should be noted that the nature and extent of variations from the conditions found in the borings might not become evident until construction. If variations appear evident, it will be necessary to re-evaluate the recommendations of this report.

We appreciate the opportunity to provide our services for this project and hope to continue providing our services through construction. Please do not hesitate to contact us with any questions you may have.

Respectfully submitted,
Geotechnical Consultants, Inc.

Tim Petrilla, E.I.
Project Manager

Joseph D. Stafford, P.E.
In-House Reviewer

Attachments: General Notes for Soil Sampling and Classifications
General Site Location Map (DeLorme Street Atlas USA – 2016)
Coring/Boring Location Plan (1 page)
GCI Test Boring Logs (C-1 to C-3)
J.N. Cernica & Associates 1997/1998 Test Boring Logs (B-1, B-11, B-12, and B-13)
Laboratory Test Results (1 page)

Distribution: Mr. Mark Mrofchak @ PLY&MC – pdf via email
Ms. Aimee Fifarek @ PLY&MC – pdf via email
Mr. John Orsini, AIA @ BSHM Architects, Inc. – pdf via email
Mr. Kurt Seidler, PE @ Seidler Engineering, Inc. – pdf via email
GCI File 24-G-29241

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GENERAL NOTES FOR SOIL SAMPLING AND CLASSIFICATIONS

BORINGS, SAMPLING AND GROUNDWATER OBSERVATIONS:

Drilling and sampling were conducted in accordance with procedures generally recognized and accepted as standard methods of exploration of subsurface conditions. The borings were drilled using a truck-mounted drill rig using auger boring methods with standard penetration testing performed in each boring at intervals ranging from 1.5 to 5.0 feet. The stratification lines on the logs represent the approximate boundary between soil types at that specific location and the transition may be gradual.

Water levels were measured at drill locations under conditions stated on the logs. This data has been reviewed and interpretations made in the text of the report. Fluctuations in the level of the groundwater may occur due to other factors than those present at the time the measurements were made.

The Standard Penetration Test (ASTM-D-1586) is performed by driving a 2.0 inch O.D. split barrel sampler a distance of 18 inches utilizing a 140 pound hammer free falling 30 inches. The number of blows required to drive the sampler each 6 inches of penetration are recorded. The summation of the blows required to drive the sampler for the final 12 inches of penetration is termed the Standard Penetration Resistance (N). Soil density/consistency in terms of the N-value is as follows:

COHESIONLESS DENSITY		COHESIVE CONSISTENCY	
0-10	Loose	0-4	Soft
10-30	Medium Dense	4-8	Medium Stiff
30-50	Dense	8-15	Stiff
50 +	Very Dense	15-30	Very Stiff
		30 +	Hard

SOIL MOISTURE TERMS

Soil Samples obtained during the drilling process are visually characterized for moisture content as follows:

MOISTURE CONTENT	DESCRIPTION
Damp	Soil moisture is much drier than the Atterberg plastic limit (where soils are cohesive) and generally more than 3% below Standard Proctor "optimum" moisture conditions. Soils of this moisture generally require added moisture to achieve proper compaction.
Moist	Soil moisture is near the Atterberg plastic limit (cohesive soils) and generally within ±3% of the Standard Proctor "optimum" moisture content. Little to no moisture conditioning is anticipated to be required to achieve proper compaction and stable subgrades.
Very Moist	Soil moisture conditions are above the Atterberg plastic limit (cohesive soils) and generally greater than 3% above Standard Proctor "optimum" moisture conditions. Drying of the soils to near "optimum" conditions is anticipated to achieve proper compaction and stable subgrades.
Wet	Soils are saturated. Significant drying of soils is anticipated to achieve proper compaction and stable subgrades.

SOIL CLASSIFICATION PROCEDURE:

Soil samples obtained during the drilling process are preserved in plastic bags and visually classified in the laboratory. Select soil samples may be subjected to laboratory testing to determine natural moisture content, gradation, Atterberg limits and unit weight. Soil classifications on logs may be adjusted based on results of laboratory testing.

Soils are classified in accordance with the ASTM version of the Unified Soil Classification System. ASTM D-2487 "Classification of Soils for Engineering Purposes (Unified Soil Classification System) describes a system for classifying soils based on laboratory testing. ASTM D-2488 "Description and Identification of Soil (Visual-Manual Procedure) describes a system for classifying soils based on visual examination and manual tests.

Soil classifications are based on the following tables (see reverse side):

GENERAL NOTES FOR SOIL SAMPLING AND CLASSIFICATIONS

PARTICLE SIZE DEFINITION			CONSTITUENT MODIFIERS	
Boulders:		>12”		
Cobbles:		3” to 12”	Trace	Less than 5%
Gravel:	Coarse:	3/4” to 3”	Few	5-10%
	Fine:	No. 4 (3/16”) to 3/4”	Little	15-25%
Sand:	Coarse	No. 10 (2.0mm) to No. 4 (4.75mm)	Some	30-45%
	Medium	No. 40 (0.425mm) to No. 10 (2.0mm)	Mostly	50-100%
	Fine	No. 200 (0.074mm) to No. 40 (0.425mm)		
Silt & Clay		<0.074mm; classification based on overall plasticity; in general clay particles <0.005mm.		

ASTM/UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS
(more than 50% of materials is larger than No. 200 sieve size)

GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size		*Clean Gravel (less than 5% fines)*
	GW	Well-graded gravel, 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 More than 50% 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

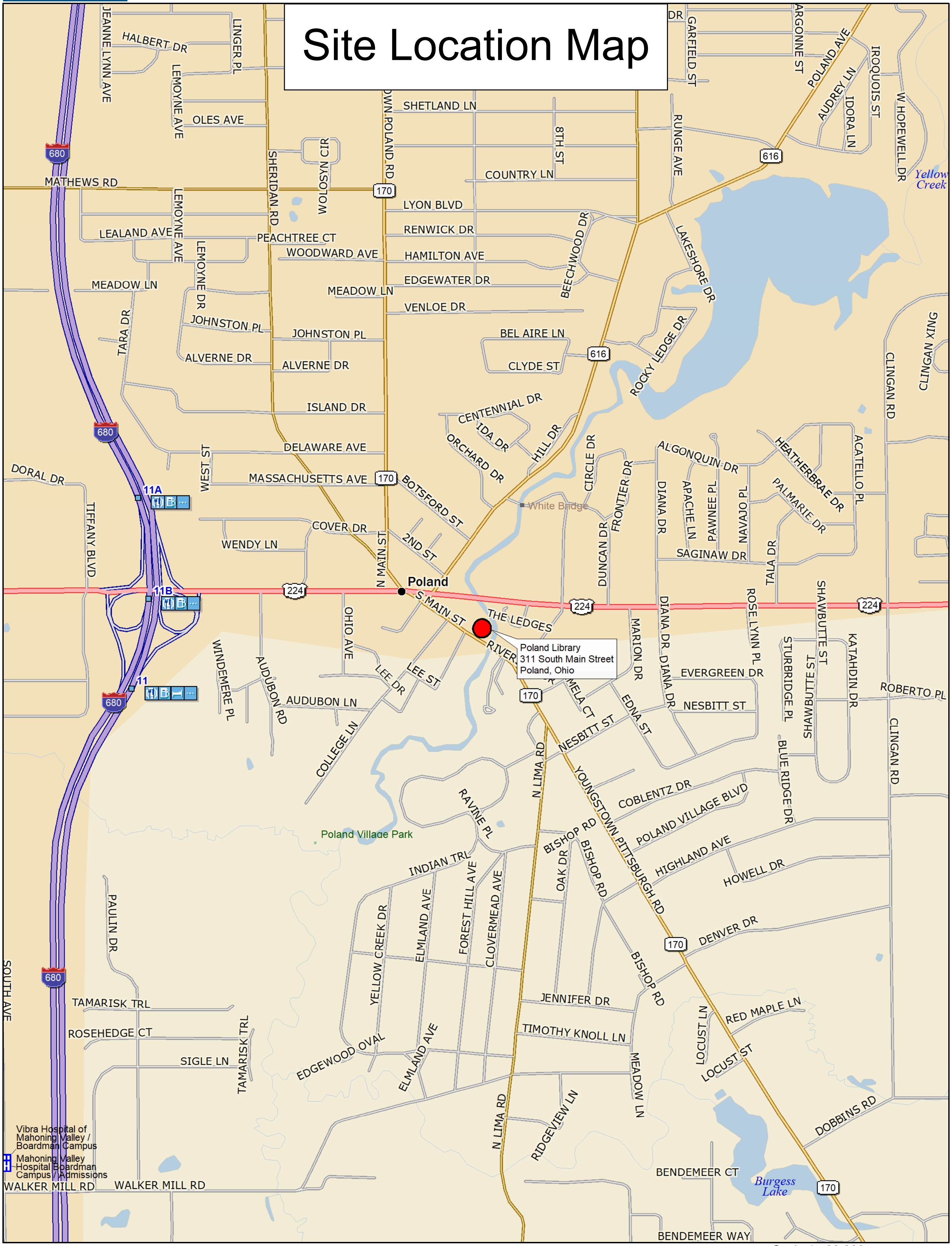
Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent ……………………………………………GW, GP, SW, SP
Greater than 12 percent ……………………………………………GM, GC, SM, SC
5 to 12 percent ……………………………Borderline cases requiring dual symbols: SP-SM, GP-GM, etc.

FINE-GRAINED SOILS
(50% or more of material is smaller than No. 200 sieve size)

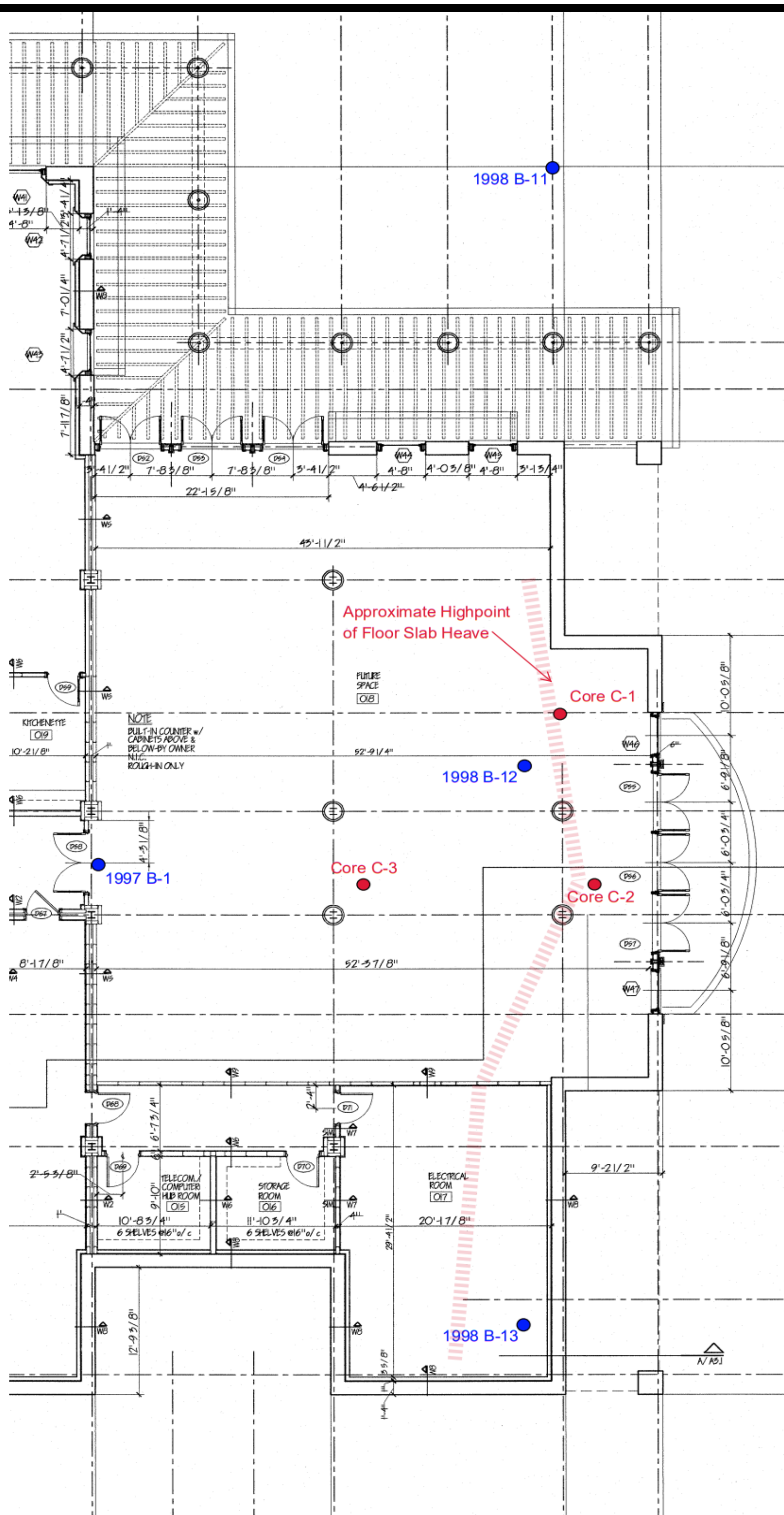
SILTS AND CLAYS Liquid Limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays or low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	CL-ML	Inorganic silty clay of slight plasticity, P.I. between 4 and 7
	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 or medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

Site Location Map



TN
MN (9.3°W)

Scale 1 : 20,800
1" = 1,733.3 ft
Data Zoom 13-3



Current Core/Boring Location (2024)

Cernica Boring Location (1997/1998)

CORING/BORING LOCATION PLAN

Floor Slab Heave Assessment
Poland Library – Poland, Ohio

Base Map: Taken from Sheet A2.2 of the project plans

Project No.: 24-G-29241

Date: 7/24/24 **Drawn By:** T.Petrilla

Scale: N.T.S.

TEST BORING LOG

PROJECT NAME **Poland Public Library Floor Slab Heave - Poland, Ohio** BORING NO. **C-1**

PROJ. SURF. ELEV. **Finish Floor**

CLIENT **The Public Library of Youngstown & Mahoning County** NO. **24-G-29241** DATE DRILLED **7/22/2024**

GROUND WATER OBSERVATION	Proportions Used		140 lb Wt. x 30" fall on 2" O.D. Sampler			
			Cohesionless Density		Cohesive Consistency	
	Trace	Less than 5%				
None FEET BELOW SURFACE AT COMPLETION	Few	5 to 10%	0 - 10	Loose	0 - 4	Soft
______ FEET BELOW SURFACE AT 24 HOURS	Little	15 to 25%	10 - 30	Medium Dense	4 - 8	Medium Stiff
	Some	30 to 45%	30 - 50	Dense	8 - 15	Stiff
					15 - 30	Very Stiff
______ FEET BELOW SURFACE AT _____ HOURS	Mostly	50 to 100%	50 +	Very Dense	30 +	Hard

LOCATION OF BORING **See Boring Location Plan**

DEPTH	Sample Depths From To	Type of Sample	Blows per 6" on Sampler From To 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Depth*	SOIL IDENTIFICATION Remarks include color, type of soil, etc. Rock-color, type, condition, hardness
							0.4	4.3" Concrete Slab - contains welded wire mesh, underlain by a vapor barrier
							0.9	6" Crush Limestone Sand and Gravel (ODOT Item 304 type gradation)
						Damp	1.4	FILL: Gray "fused" open hearth slag (fused layer approxiamtely 6 inches thick)
						Damp Damp Damp Damp Damp Damp	3.6	FILL: Mostly gray open hearth slag with traces of gravel, sand, and metal fragments
5								Bottom of Boring at 3.6 feet

*** The stratification lines represent the approximate boundary between soil types and the transition may be gradual.**

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TEST BORING LOG

PROJECT NAME **Poland Public Library Floor Slab Heave - Poland, Ohio** BORING NO. **C-2**

SURF. ELEV. **Finish Floor**

CLIENT **The Public Library of Youngstown & Mahoning County** PROJ. NO. **24-G-29241** DATE DRILLED **7/22/2024**

GROUND WATER OBSERVATION	Proportions Used		140 lb Wt. x 30" fall on 2" O.D. Sampler			
			Cohesionless Density		Cohesive Consistency	
	Trace	Less than 5%				
None FEET BELOW SURFACE AT COMPLETION	Few	5 to 10%	0 - 10	Loose	0 - 4	Soft
______ FEET BELOW SURFACE AT 24 HOURS	Little	15 to 25%	10 - 30	Medium Dense	4 - 8	Medium Stiff
	Some	30 to 45%	30 - 50	Dense	8 - 15	Stiff
					15 - 30	Very Stiff
______ FEET BELOW SURFACE AT _____ HOURS	Mostly	50 to 100%	50 +	Very Dense	30 +	Hard

LOCATION OF BORING **See Boring Location Plan**

DEPTH	Sample Depths From To	Type of Sample	Blows per 6" on Sampler From To 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Depth*	SOIL IDENTIFICATION Remarks include color, type of soil, etc. Rock-color, type, condition, hardness
							0.4	5.1" Concrete Slab - contains welded wire mesh, underlain by a vapor barrier
							0.8	5" Crush Limestone Sand and Gravel (ODOT Item 304 type gradation)
						Damp		FILL: Mostly gray open hearth slag with traces of gravel, sand, and metal fragments
						Damp		
						Damp		
						Damp	2.4	
							2.8	FILL: Gray "fused" open hearth slag (fused layer approxiamtely 5 inches thick)
						Damp	3.3	FILL: Mostly gray open hearth slag with traces of gravel, sand, and metal fragments
								Bottom of Boring at 3.3 feet
5								

*** The stratification lines represent the approximate boundary between soil types and the transition may be gradual.**

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TEST BORING LOG

PROJECT NAME **Poland Public Library Floor Slab Heave - Poland, Ohio** BORING NO. **C-3**

CLIENT **The Public Library of Youngstown & Mahoning County** PROJ. NO. **24-G-29241** SURF. ELEV. **Finish Floor** DATE DRILLED **7/22/2024**

GROUND WATER OBSERVATION	Proportions Used		140 lb Wt. x 30" fall on 2" O.D. Sampler			
			Cohesionless Density		Cohesive Consistency	
	Trace	Less than 5%				
None FEET BELOW SURFACE AT COMPLETION	Few	5 to 10%	0 - 10	Loose	0 - 4	Soft
______ FEET BELOW SURFACE AT 24 HOURS	Little	15 to 25%	10 - 30	Medium Dense	4 - 8	Medium Stiff
					8 - 15	Stiff
	Some	30 to 45%	30 - 50	Dense	15 - 30	Very Stiff
______ FEET BELOW SURFACE AT _____ HOURS	Mostly	50 to 100%	50 +	Very Dense	30 +	Hard

LOCATION OF BORING **See Boring Location Plan**

DEPTH	Sample Depths From To	Type of Sample	Blows per 6" on Sampler From To 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Depth*	SOIL IDENTIFICATION Remarks include color, type of soil, etc. Rock-color, type, condition, hardness
							0.3	4.1" Concrete Slab - contains welded wire mesh, underlain by a vapor barrier
							0.7	4" Crush Limestone Sand and Gravel (ODOT Item 304 type gradation)
						Moist		Brown Silty Sand with Gravel (SM) - mostly coarse to fine sand, little gravel, little to some slight plasticity fines
						Moist		
						Moist		
						Moist		
						Moist	2.6	
							2.7	Brown Weathered Sandstone
								Bottom of Boring at 2.7 feet
5								

*** The stratification lines represent the approximate boundary between soil types and the transition may be gradual.**

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Boring log -- Boring # 1

Elevation at top of hole: 1010.64

Water levels (ft): Initial: Final:

Project: POLAND LIBRARY ADDITION

Location: POLAND, OHIO

J.N. Cernica & Associates
Consulting Engineers

Remarks: BORING REPORTED TO BE DRY @ COMPLETION OF DRILLING

Sample Number & Type	Blows/6" Or %Rec. And RQD	Depth (feet)	Soil Description
1 SS	2		4" TOPSOIL
	4	0.5	FILL: DARK BROWN SANDY SILT (ORGANIC), SOME ASHES, VEGETATION, BRICK AND ROCK FRAGMENTS
	6	1.0	
		1.5	
2 ST		2.0	
		3.5	
		4.0	DARK BROWN SANDY SILT, SOME CLAY, TRACE OF GRAVEL AND SOME ORGANIC MATERIAL
3 SS	2	4.5	
	4	5.0	
	7	5.5	BROWN SILTY SAND, GRAVEL AND SANDROCK FRAGMENTS
		7.5	
4 SS	31	8.0	BROWN AND GRAY SANDY SHALE
	50/5"	8.4	AUGER REFUSAL @ 7.5'

SS=Split Spoon   ST=Shelby Tube

Boring log -- Boring # 11

Elevation at top of hole: 1004.65

Water levels (ft): Initial: 4.6 Final:

Project: POLAND LIBRARY ADDITION

Location: POLAND, OHIO

J.N. Cernica & Associates

Consulting Engineers

Remarks: INITIAL WATER LEVEL TAKEN @ COMPLETION OF DRILLING

Sample Number & Type	Blows/6" Or %Rec. And RQD	Depth (feet)	Soil Description
1 SS	3		5" TOPSOIL
	4	0.5	FILL: BROWN SILTY SAND, GRAVEL AND ROCK FRAGMENTS, SOME SLAG AND ASHES, TRACE OF GLASS, VEGETATION AND BRICK FRAGMENTS
	6	1.0	
		1.5	
2 ST		2.0	BROWN SILTY SAND, SOME CLAY
		4.0	
3 SS	7	4.5	INITIAL WATER LEVEL @ 4.5'
	7	5.0	BROWN SILTY SAND AND ROCK FRAGMENTS
	9	5.5	
		6.5	
4 SS	50/2"	6.7	GRAY SANDY SHALE AND SANDROCK

SS=Split Spoon ST=Shelby Tube

Boring log -- Boring # 12

Elevation at top of hole: **1007.87**

Water levels (ft): Initial: Final:

Project: POLAND LIBRARY ADDITION

Location: POLAND, OHIO

J.N. Cernica & Associates
Consulting Engineers

Remarks: BORING REPORTED TO BE DRY @ COMPLETION OF DRILLING

Sample Number & Type	Blows/6" Or %Rec. And RQD	Depth (feet)	Soil Description
1 SS	3, 5, 5	0.5, 1.0, 1.5	3" TOPSOIL FILL: DARK BROWN SANDY SILT, SOME ASHES, SLAG AND ROCK FRAGMENTS, TRACE OF WOOD, VEGETATION AND BRICK FRAGMENTS
2 SS	12, 9, 15	3.0, 3.5, 4.0, 4.5	BROWN SILTY SAND AND ROCK FRAGMENTS
3 SS	50/3"	7.0, 7.3	BROWN SANDROCK AUGER REFUSAL @ 7.0'

SS=Split Spoon ST=Shelby Tube

Boring log -- Boring # 13

Elevation at top of hole: **1010.39**

J.N. Cernica & Associates
Consulting Engineers

Water levels (ft): Initial: Final:

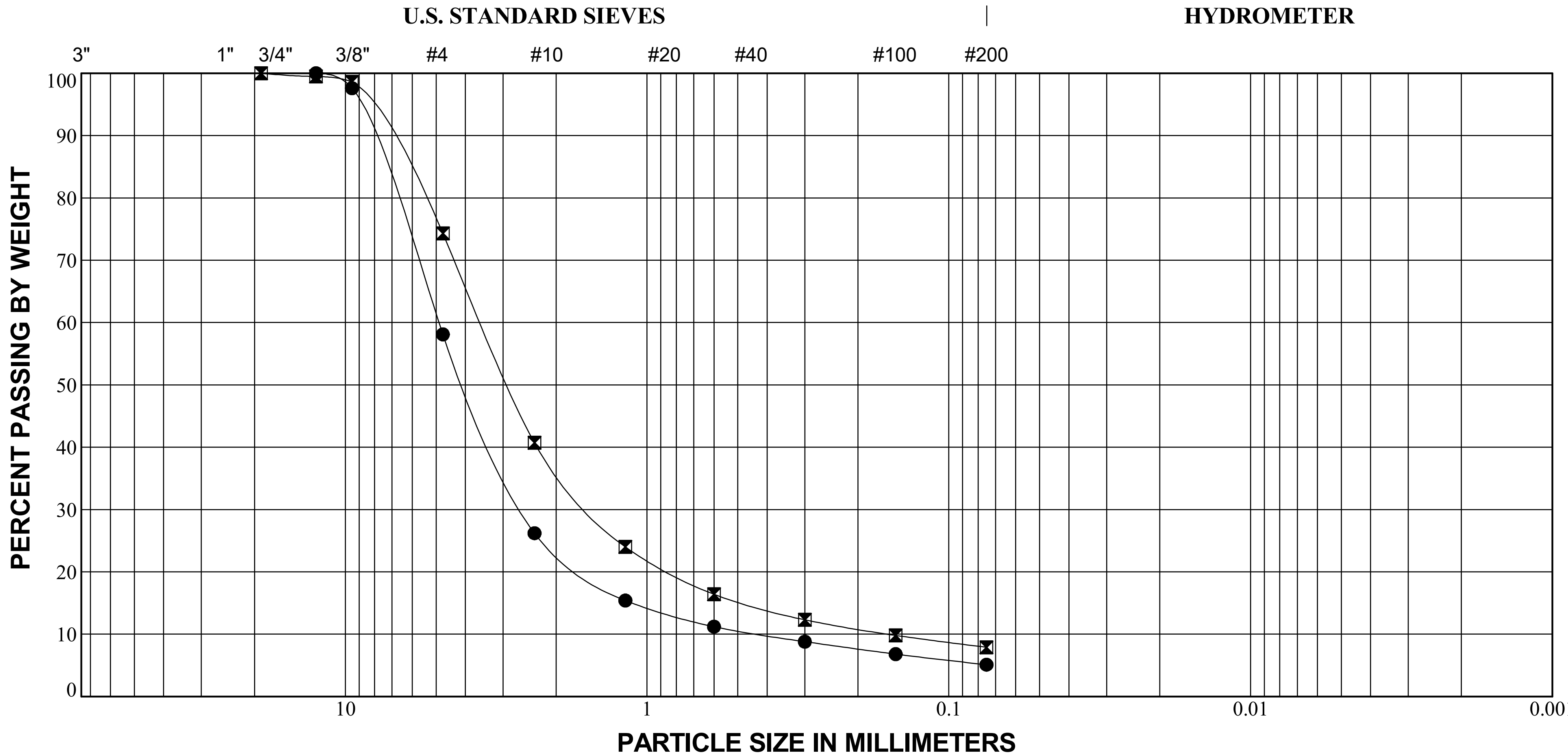
Project: **POLAND LIBRARY ADDITION**

Location: **POLAND, OHIO**

Remarks: BORING REPORTED TO BE DRY @ COMPLETION OF DRILLING

Sample Number & Type	Blows/6" Or %Rec. And RQD	Depth (feet)	Soil Description
1	3		3" TOPSOIL
SS	4	0.5	FILL: DARK BROWN SANDY SILT, SOME GRAVEL, VEGETATION AND ROCK FRAGMENTS, TRACE OF ASHES, SLAG AND BRICK FRAGMENTS
	5	1.0	
		1.5	
		3.5	
2	10	4.0	
SS	15	4.5	BROWN SILTY SAND AND ROCK FRAGMENTS
	17	5.0	
		6.0	
3			
ST		7.0	
4	15	7.5	
SS	27	8.0	
	26	8.5	
5	10	9.0	
SS	15	9.5	
	50/5"	9.9	BROWN WEATHERED SANDROCK AUGER REFUSAL @ 9.5'

SS=Split Spoon   ST=Shelby Tube



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

LEGEND:

	TEST HOLE	DEPTH	LL	w_n	PL	ASTM CLASSIFI-CATION	ASTM SOIL DESCRIPTION
●	C-1	1.7	NP	5.4	NP	SP-SM	Existing Slag-Based Fill - Poorly Graded Sand With Silt And Gravel
⧗	C-2	1.3	NP	4.9	NP	SP-SM	Existing Slag-Based Fill - Poorly Graded Sand With Silt And Gravel

Job No.: *24-G-29241*

Method: *ASTM D421 D422*

Date: *August 2024*

COMBINED PARTICLE SIZE DISTRIBUTION

Poland Public Library Floor Slab Heave - Poland, Ohio

Geotechnical Consultants, Inc. - Westerville, Ohio 43081