HILLIS-CARNES
ENGINEERING ASSOCIATES

Geotechnical Engineering Study
The Maryland Zoo in Baltimore – Red Panda Exhibit
1 Safari Pl, Baltimore, MD 21217
HCEA Job No. 24146A

Prepared for:

The Maryland Zoo in Baltimore
1876 Mansion House Drive
Baltimore, MD 21217

HILLIS-CARNES
ENGINEERING ASSOCIATES

10975 Guilford Road, Suite A
Annapolis Junction, MD 20701
Phone (410) 880-4788
Fax (410) 880-4098
www.hcea.com

May 16, 2024

Mr. Adam Wyatt
Project Manager
The Maryland Zoo in Baltimore
1876 Mansion House Drive
Baltimore, MD 21217

Re: Geotechnical Engineering Study
The Maryland Zoo in Baltimore – Red Panda Exhibit
1 Safari Pl
Baltimore, MD 21217
HCEA Job No. 24146A

Mr. Wyatt:

Hillis-Carnes Engineering Associates, Inc. (HCEA) is pleased to submit this report conveying the results of the subsurface exploration and laboratory testing for the proposed project referenced above.

The material samples collected during the site exploration will be stored at our Annapolis Junction, Maryland office for a period of 30 days from the date of this letter. If you require the samples to be stored for a longer period of time or to be delivered to you or another party, please make a request in writing prior to the end of the 30-day period. Otherwise, the samples will be discarded at the end of the 30-day storage period.

HCEA appreciates having had the opportunity to provide the geotechnical consultation for this project, and we will remain available for further consultation during the various design stages. Please contact our office if questions arise concerning the contents of this report, or if additional consultation, design, inspection, or testing services are required.

Sincerely,

HILLIS-CARNES ENGINEERING ASSOCIATES, INC.

STATE OF MARYLAND WILLIAM S. HARRIS No. 39819 PROFESSIONAL ENGINEER

John R. Gruber, P.E.
Project Engineer

William S. Harris, P.E.
Geotechnical Division Manager

Senior Review: Grant K. Autry, P.E.
Principal Engineer

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1.0 PURPOSE AND SCOPE

The purpose of this study was to determine the general subsurface conditions at the boring and hand auger locations and to evaluate those conditions with respect to estimated geotechnical engineering properties for the proposed construction.

Our understanding of the proposed construction is informed by the Construction Documents entitled "Red Panda" prepared by BKP Architects, dated August 18, 2023. These drawings were used to understand the location and configuration of the proposed red panda exhibit and retaining wall.

The evaluations and recommendations presented in this report were developed from a review of project characteristics and an interpretation of the subsurface conditions based on the results of the site exploration. The stratification lines indicated on the Records of Soil Exploration (boring logs) represent the approximate boundaries between soil types. The in-situ transitions may actually be gradual and/or at different depths.

An evaluation of the site with respect to potential construction problems and recommendations dealing with the earthwork and inspection during construction are also included. The inspection is considered necessary to verify the subsurface conditions and to verify that the soil-related construction phases are performed properly. The Appendix of this report contains a summary of the field and laboratory work performed for this study.

2.0 PROJECT CHARACTERISTICS

The project site is located at the address of 1 Safari Place in Baltimore, Maryland. The project site is located within The Maryland Zoo in Baltimore in the Historic Main Valley Area in the vicinity of the existing snowy owl exhibit and historic enclosure. The existing conditions of the site are shown on the Project Location Map (Figure 1) included in the Appendix of this report.

Based on our correspondence with the client we understand that the proposed construction includes the development of a new red panda exhibit, as well as an associated retaining wall and stormwater management (SWM) facilities. The proposed retaining wall is expected to be approximately 88-feet long and 11-feet tall. Information regarding the details for the proposed SWM facilities was not available at the time this report was prepared.

Structural loading information for the proposed red panda exhibit was not available at the time this report was prepared. It has therefore been assumed that maximum wall loads will be on the order of 2 kips per linear foot, and that maximum column-type loads will be on the order of 50 kips. Settlements on the order of 1-inch total and ½-inch differential have been assumed to be tolerable by the structures.

The exhibit concept is still in development at the time this report is being prepared. As such, the total number of stories and finished floor elevations are not yet known. The assumptions made in this report are based on a combination of existing site conditions and preliminary discussions with the Client.

Additional details concerning the proposed construction were not available at the time that this report was being prepared. Should any of the project characteristics, structural loading conditions or required settlement criteria differ from those outlined above, then this office should be contacted for a re-evaluation of the site.

3.0 FIELD EXPLORATION AND LABORATORY TESTING

In order to determine the general foundation soil types and to develop design parameters, three (3) Standard Penetration Test (SPT) soil borings were drilled at the site (Ref. Borings B-1, B-3, and B-4), as well as a single hand auger soil boring (Ref. Boring B-2). Boring B-2 was located between the existing snowy owl enclosure and the existing retaining wall, making it inaccessible by a drill rig. For this reason, a hand auger was performed at Boring B-2. The SPT soil borings were each drilled to a depth of 15± ft below existing grades, and the hand auger boring reached auger refusal at a depth of 3.3± feet below existing grade. An additional hand auger boring (Ref. Boring B-2 O/S) was performed at an offset location and reached auger refusal at a depth of 3.2± ft below existing grade.

Boring locations were proposed by the Client prior to the subsurface exploration, then staked in the field by HCEA by utilizing RTK GPS surveying equipment. The boring elevation data presented in this report should be considered approximate. Elevations indicated on the boring logs are in the NAVD 88 datum. The approximate boring locations are shown on the Boring Location Plan (Figure 2) in the Appendix.

The borings were advanced with hollow-stem augers and the subsurface soils were generally sampled at 2.5 ft. to 5.0 ft. intervals. Samples were taken by driving a 1-3/8-inch I.D. (2-inch O.D.) split-spoon sampler in general accordance with ASTM D-1586 specifications. The sampler was first seated 6 inches to penetrate any loose cuttings and then was driven an additional 12 inches with blows of a 140-pound hammer, falling 30 inches. The number of hammer blows required to drive the sampler the final 12 inches is designated as the "Penetration Resistance" or "N-value." The penetration resistance (N-value) can be used as an indication of the soil strength and compression characteristics.

Portions of each SPT soil sample were placed in glass jars and transported to HCEA's laboratory. All of the jarred samples were visually examined in the laboratory by the Geotechnical Engineer and visually-manually classified in general accordance with the Unified Soil Classification System (USCS) and ASTM D-2488. The Unified Soil Classification Symbols appear on the Records of Soil

Exploration and the system nomenclature is generally described in the Soil Description Sheet in the Appendix.

Laboratory testing was performed on representative samples of on-site material, which consisted of Atterberg limits, sieve distribution analysis, moisture content, and hydrometer tests. The tests were performed on selected samples to verify the visual classifications and evaluate engineering properties. The USCS symbols appear on the Records of Soil Exploration (boring logs) and the system nomenclature is briefly described in the Appendix. The results of the laboratory testing are also included in the Appendix.

4.0 SUBSURFACE CONDITIONS

Details of the subsurface conditions encountered at the specific boring locations are shown on the Records of Soil Exploration (Boring Logs and Hand Auger Logs). Strata divisions shown on the Records of Soil Exploration have been estimated based on visual examinations of the recovered boring samples and the collection intervals. In the field, strata changes could occur gradually and/or at different levels than indicated on the Records of Soil Exploration.

Groundwater conditions indicated on the Records of Soil Exploration are those observed during the subsurface exploration. Fluctuations in groundwater levels should be expected and are typically influenced by changes in seasons, grading, runoff, infiltration rates, and may be influenced by other factors.

4.1 Site Geology

According to the *"The Generalized Geologic Map of Maryland* (K. Weaver, 1967)" the project site falls within the Piedmont Province, where naturally occurring soils are derived from the weathering of the parent bedrock.

More specifically, the "*Geologic Map of Baltimore County and City* (W.P. Crowley, J. Reinhardt, E.T. Cleaves, 1976)" shows the project site falling within the Druid Hill Amphibolite Member, in close proximity to the Sand Facies of the Patuxent Formation, the Jones Falls Schist, and Alluvium.

Druid Hill Amphibolite Member: *"Fine- to medium-grained, generally well-foliated amphibolite, locally with irregular anastomosing patches of coarser-grained, lighter colored amphibolite."*

Patuxent Fomation, Sand Facies: *"Highly variable, intercalated sand, gravel, silt, and clay with hematite-limonite cements. Sands and gravels are typically quartzose and well-rounded; a buff kaolinitic clay-quartz silt matrix is common throughout the Formation."*

Jones Falls Schist: *"Medium- to coarse-grained biotite-plagioclase-muscovite-quartz schist, in places accompanied by fine-grained biotite-plagioclase-quartz gneiss in layers a few centimeters thick."*

Alluvium: *"Interbedded gravel, sand, silt, and clay of variable composition and sorting. Typically confined to flood plains of perennial streams, upland gathering areas, and marshes adjacent to estuaries. Sediment size, sorting, and minerology are strongly controlled by the source geology and geomorphic setting"*

4.2 Surface and Man-Placed Fill Materials

The Records of Soil Exploration indicate varying types of surficial cover at each of the boring locations. Borings B-1 and B-4 were located in an existing pathway within the zoo and were each noted as having a 3-inch surficial layer of asphalt, underlain by a 9-inch layer of concrete. Boring B-3 was located on a vegetated hillside and was noted as having a 4-inch-thick layer of topsoil. No surficial cover was observed at Hand Auger Boring B-2, however a 3-inch layer of asphalt was noted at Hand Auger Boring B-2 O/S.

Man-placed fill materials are those materials showing evidence of having been man-placed or worked in the past. Fill or suspected fill materials were encountered at two of the three SPT soil borings (Ref. Borings B-1 and B-4) to depths of approximately 8.5± ft below existing site during this subsurface exploration program. These materials consisted of clay (CL) and silt (ML) with varying amounts of sand and gravel. Consistencies of the man-placed fill soils ranged from medium stiff to hard

Fill or suspected fill materials were encountered at each of the two hand auger borings (Ref. Borings B-2 and B-2 O/S) within the depths explored. These materials were encountered to the depth of refusal at the two hand auger boring locations. These materials consisted of silty sand (SM) and clay (CL) with varying amounts of sand and gravel.

Since the size of the samples obtained is relatively small in comparison to the areal extent of the site and since fill materials could be of similar composition to the natural soils encountered at the site, it is often difficult to determine the presence and composition of fill materials from the SPT and hand auger samples. It should be anticipated that man-placed fill materials may be encountered at other locations and/or to different depths below the existing ground surface.

4.3 Natural Materials

Natural soils encountered in the borings are generally consistent with the geology description outlined in Section 4.1 and the more granular materials are classified as silty sand (SM) with varying amounts of silt and clay. The more cohesive natural materials encountered are classified as clay (CL) and silt (ML) with varying amounts of sand and gravel.

The SPT N-values recorded in the borings generally indicated relative densities in the very dense range for the more granular natural materials. N-values recorded for the more cohesive materials indicated consistencies ranging from medium stiff to hard.

4.4 Rock and Disintegrated Rock

Disintegrated rock materials are very dense residual soils with rock-like properties having SPT N-values on the order of 60 blows per foot to 100 blows per 2-inches. Materials identified as disintegrated rock were noted in two of the three SPT borings (Ref. Borings B-3 and B-4) advanced during this study. These materials were observed at depths of between 13.5± ft and 15.0± ft below existing grade in Boring B-3, and at depths of between 8.5± ft and 15.0± ft below existing grade in Boring B-4. The elevation of disintegrated rock material ranged between El. 281.7± ft and EL. 289.7± ft (NAVD 88), where encountered.

4.5 Groundwater

Groundwater levels were observed during drilling and hand auger operation, as well as upon completion and approximately 24 hours after completion. Groundwater was not encountered within the depths explored at any of the SPT or Hand Auger locations during this study.

A more accurate determination of the hydrostatic water table would require the installation of perforated pipes or piezometers which could be monitored over an extended period of time. The actual level of the hydrostatic water table and the amount and level of perched water should be anticipated to fluctuate throughout the year, depending on variations in precipitation, surface run-off, infiltration, site topography, and drainage.

5.0 EVALUATIONS AND RECOMMENDATIONS

Our findings suggest that this site can be developed for the proposed red panda exhibit utilizing conventional spread footings supported on natural soils or newly placed engineered fill and ground-supported slab construction. Special consideration should be given to the proper monitoring of fill operations, footing excavations, and concrete placement in all structural areas. Additionally, shallow foundations will need to be coordinated with any existing exhibits adjacent to the new construction to minimize the risk of induced load acting on the existing structure.

It is strongly recommended that any subsurface utilities that may conflict with the proposed construction be located, removed and the subgrade then properly restored to a suitable condition.

Foundations and floor slabs should not be constructed on or over any existing fill materials unless these materials are specifically observed, tested, and approved by the Geotechnical Engineer or their designated representative in the field during construction. Special consideration should be given to the proper monitoring of fill operations, foundation excavations, and concrete placement in all structural areas.

The following recommendations have been developed based on the previously described project characteristics and subsurface conditions. If there are any changes to the project characteristics, or if different subsurface conditions are encountered during construction, HCEA should be consulted to review and revise the recommendations provided in this report as needed.

5.1 General Site Preparation

All existing structures (including all above and below-ground construction) within the areas to be developed should be removed prior to the initiation of new construction. We suggest that all available information regarding the existing utilities at the site be reviewed prior to construction.

Removal should include all underground pipes, utilities, and underground structures that might interfere with the new construction. If abandoned underground utilities are to be removed prior to the initiation of construction, provisions should be made in the construction specifications and budget to restore the subgrade to stable condition. Restoration should include backfilling and compaction of any excavation areas.

Removal should also include topsoil, unapproved man-placed materials, frozen, wet, soft or very loose soils, and any other deleterious materials These operations should be performed in a manner consistent with good erosion and sediment control practices.

After the initial stripping and removal process is completed, areas of the site to receive fill, or areas of the site at-grade where the structure will be located, should be proofrolled. The proofrolling operations should be performed using a 20-ton, fully-loaded dump truck or another pneumatic-tire vehicle of similar size and weight. The purpose of the proofrolling will be to locate any near-surface pockets of soft or loose soils requiring undercutting. In areas where spatial constraints may limit the ability for proofrolling, it is recommended that subgrade soils be tested with Dynamic Cone Penetrometer (DCP) testing to a depth of at least 2 feet below the exposed subgrade after the recommended 18-inch undercut has been performed. DCP testing is used to determine underlying soil strength by measuring the penetration of the DCP cone into the soil after each hammer blow. The purpose of the DCP testing will be to locate any near-surface pockets of soft or loose soils requiring undercutting. A Geotechnical Engineer or experienced Soils Inspector should witness the proofrolling operations or the DCP operations and should determine which areas need further undercutting and/or stabilization. All unsuitable material should be completely removed and the subgrade observed, tested and proofrolled before any new fill is placed.

Prior to construction, a test pit subsurface exploration program is recommended to explore the areas adjacent to the proposed retaining wall where SPT borings could not be performed. Test pits would allow for the observation of soils at deeper depths, in-situ and relatively intact. Furthermore, this program would provide a better understanding of any man-placed soils in that area, as well as a better understanding of the nature of the groundwater in these areas.

5.2 Fill Selection, Placement, and Compaction

All material to be used as fill or backfill should be inspected, tested and approved by the Geotechnical Engineer or their authorized representative. In general, silty sand or more granular, on-site soils which are free from organic and other deleterious components can be re-used. Materials suitable for various construction purposes can be identified by an experienced Soils Inspector during grading operations.

Moisture conditioning (that is, wetting or drying) of the soils should be anticipated to achieve proper compaction. The moisture contents of the soils should be controlled properly to avoid extensive construction delays. If imported fill material is required, those materials should have Unified Soil Classifications of SM or more granular.

The traffic of heavy equipment, including heavy construction equipment, could create pumping and a general deterioration of these soils if conducted in the presence of water. If exposed to water, these soils can deteriorate and become difficult to work. The grading should therefore, if at all possible, be carried out during a dry season. This should minimize these potential problems, although they may not be eliminated. If such problems arise, the Geotechnical Engineer should be consulted for an evaluation of the conditions.

All fill should be placed in relatively horizontal 8-inch (maximum) loose lifts and should be compacted to a minimum of 95 percent of the Modified Proctor (ASTM D-1557) maximum dry density. Fill materials in landscape and other non-structural areas should be compacted to at least 90 percent of the Modified Proctor maximum dry density if significant subsidence of the fill under its own weight is to be avoided. A sufficient number of in-place density tests should be performed by an experienced Engineering Technician on a full-time basis to verify that the proper degree of compaction is being obtained.

Structural fill should extend a minimum of 10 feet beyond building lines where floor slabs are to be constructed on fill material, and 5 feet beyond the edges of all pavement areas. Fill slopes no steeper than 2(H):1(V) should be used. A sufficient number of in-place density tests should be performed by an experienced Engineering Technician on a full-time basis to verify that the proper degree of compaction is obtained.

5.3 Foundations

Based on the results of our geotechnical study done to date, it is currently the opinion of HCEA that the proposed red panda exhibit can be supported on spread footings bearing on firm natural soils, new engineered fill placed over natural soils, or a combination thereof. Foundations should not be supported on or over any existing fill materials unless those fill materials are specifically observed, tested, and approved by the Geotechnical Engineer or their designated representative in the field during construction.

Based on the assumed maximum structural loads, the maximum allowable settlement, and the general soils conditions encountered onsite during this investigation, it is our judgment that a design allowable soil bearing pressure of **2,000 lbs/sq ft** will be available for proportioning footings on firm, stable ground at the proposed red panda exhibit.

It should be noted that this allowable soil bearing pressure recommendation is based on a combination of the subsurface encountered during this exploration and the anticipated imported fill material. Fill selection, placement, and compaction should meet the recommendations outlined in Sections 5.1 and 5.2. Should imported fill material deviate from the recommendations provided in this report, this office should be contacted to reevaluate the allowable soil bearing pressure recommendations.

All footing excavations should be inspected by a Geotechnical Engineer or experienced Soils Inspector prior to the placement of concrete. The purpose of the inspection would be to verify that the exposed materials are both capable of supporting the design bearing pressure and are suitable for use as structural subgrade material. Due to the potential for man-placed fill in and around the proposed red panda exhibit, it is strongly recommended that Dynamic Cone Penetrometer (DCP) be performed at new foundation subgrade areas to demonstrate stable conditions.

If soft or loose pockets are encountered in the footing excavations, the unsuitable materials should be removed and the footings should be located at a lower elevation. Soft existing fill materials should similarly be removed where encountered, as discussed in Section 5.2. Alternatively, the unsuitable materials could be replaced with lean (2000 psi) concrete.

In all areas where foundations will be supported on structural fill, the structural fill should extend a sufficient distance laterally beyond the perimeters of footings. For design purposes, plans should reflect structural fill extending a minimum distance of 9 inches laterally beyond a footing perimeter for each linear foot of structural fill below the bearing level.

To preclude punching shear failure, wall footings should be at least 16 inches wide and column footings should be at least 24 inches wide. It is recommended that wall footings be provided with longitudinal reinforcement to provide the footings with greater bending capacity. This would enable the footings to span across small localized weak zones that may go undetected during construction. Since a net soil pressure is specified, the weights of the footing concrete and backfill need not be added to the structural loads when proportioning the footings.

Exterior footings and footings in unheated areas should be located at depths of at least 30-inches below final exterior grades so as to provide adequate protection from frost heave. All footings should be provided with adequate frost cover protection since it is anticipated that the structure will be subject to freezing temperatures.

The Seismic Site Classification based on the recommendations found in the International Building Code 2018 standard is D. This seismic site class recommendation is based on a combination of HCEA's previous experience of the site geology and interpolated SPT values observed during this exploration.

5.4 Ground-Supported Slabs

Floor slabs should be supported on approved, firm subsoils, or on new compacted fill. The slab subgrade should be prepared in accordance with the procedures outlined in Sections 5.1 and 5.2 of this report. In particular, the slab subgrade should be proofrolled to verify stability or delineate any soft or loose areas requiring undercutting and/or stabilization. The Geotechnical Engineer or their designated representative should be on-site to confirm the suitability of subgrade materials.

It is recommended that the slab be directly supported on a minimum 4-inch layer of clean, granular materials such as washed sand, clean sand, and gravel, or screened, crushed stone. A suitable moisture/vapor barrier, such as polyethylene sheeting, should also be provided. These procedures will provide a moisture break that will help to prevent capillary rise, dampness of the floor slabs, and also help to cure the slab concrete. It is also recommended that construction joints on the slab surface and isolation joints between the slab and structural walls be provided, such that the slab would be ground-supported.

New, controlled structural fill and existing on-site soils are expected to be present at the floor slab subgrades. A subgrade modulus (k) of 130 pounds pci can be used for the floor slab design. This recommended value is based on fine-grained soils being present below the floor slab crushed stone subbase. Once again, quality control during construction is critical to ensuring that the floor slab subgrade is comprised of suitable soil materials.

On most projects, there is a significant time lag between initial grading and a point when the contractor is ready to pour the slabs-on-grade. Environmental conditions and construction traffic often disturb the subgrade soils, particularly those predominantly clayey soils encountered on-site. Provisions should be made in the construction specifications for the restoration of the subgrade soils to a stable condition before the placement of the concrete for the floor slabs.

5.5 Retaining Wall Recommendations

5.5.1 Retaining Wall Foundation

Our findings indicate that the proposed retaining wall construction can be supported on properly prepared and approved subgrade comprised of newly placed fill, approved existing fill, and/or natural soils. Retaining walls should not be supported on or over any existing fill materials unless the fill materials are specifically observed, tested, and approved by the Geotechnical Engineer or their designated representative in the field during construction. Existing materials at the subgrade level should also be observed, tested, and approved by the Geotechnical Engineer or their designated representative in the field during construction.

It should be noted that the following recommendations were developed from nearby borings (Ref. Boring B-3) and limited hand auger information (Ref. Boring B-2 and B-2 O/S). As such, it is critical that this office be contacted to revise our recommendations should differing subsurface conditions be encountered in the field. Additionally, a test pit subsurface exploration program in the vicinity of the proposed retaining wall is recommended to better characterize the soils in this area.

Based on the available retaining wall details, the proposed foundation elevations and the general subsurface conditions which were encountered, it is our judgment that a design net allowable soil bearing pressure of **2,000 psf** is available for proportioning footings on firm, stable ground at the proposed retaining wall location.

All footing excavations should be inspected by a Geotechnical Engineer or experienced Soils Inspector prior to the placement of the retaining wall. The purpose of the inspection would be to verify that the exposed materials will be capable of supporting the design bearing pressure. If soft or loose pockets and/or soils having significant quantities of potentially deleterious materials are encountered in the footing excavations, the unsuitable materials should be removed, and replaced with suitable fill materials meeting the recommendations outlined in Section 5.2.

5.5.2 Retaining Wall Design Parameters

Special consideration will have to be given to the ultimate design and installation of the proposed retaining wall. In areas to be filled, retaining wall backfill should consist of material meeting the recommendations outlined in Section 5.2, that is, silty sand (SM) or more granular material, having less than 35% of material passing the No. 200 sieve. The retaining wall backfill should be relatively free-draining.

The magnitude of lateral earth pressure against retaining walls is dependent on the type of backfill material, drainage provisions, the slope of grading behind the retaining wall and whether the walls are permitted to yield during and/or after placement of the backfill. Three potential cases of lateral earth pressure are discussed within this report, the three cases of active, passive, and at-rest earth pressures and earth pressure due to surface surcharge loading (assuming level backfill conditions).

These lateral earth pressures are based on the use of granular materials as recommended in Section 5.2 as retaining wall backfill material. For our recommendations below, groundwater is not considered and backfill with a typical unit weight of 120 pcf and a friction angle of 30 degrees are the assumed properties. Retaining wall backfill has been assumed to be free-draining and hydrostatic pressure has therefore not been included in the lateral earth pressures provided below. Should a different wall/soil configuration be developed during further project phases, this office should be contacted for additional recommendations.

Table 1: Retaining Wall Design Parameters

Lateral Earth Pressure Conditions	Assumed Slope Inclination, β (-)	Lateral Earth Pressure Coefficient	Equivalent Fluid Pressure (psf)
At Rest, K_o	0	0.50	60.0
Active, K_a	26.6	0.33	40.0
Passive, K_p	0	2.5	140.0

If the wall is designed as a free-standing wall with unrestricted rotation at the top, then the active condition can be used for design purposes. For walls that are designed such that movement of the top of the wall is prohibited, the at-rest condition can be considered.

Please note that a reduction factor of 2.0 is applied to the equivalent fluid pressure for the passive condition provided in the table above due to the nature of passive pressure development. A coefficient of sliding between concrete (wall footing) and the recommended foundation material (SM or more granular) of 0.30 is recommended.

The lateral earth pressures values provided will be strongly related to the nature of the new fill materials, including both those soils retained by the structure and those materials occurring at the retaining wall subgrade. It is critical therefore that those recommendations outlined in Sections 5.2, 5.3 and 5.4 be closely observed.

Lateral earth pressure due to surcharge loading at the ground surface can be approximated by multiplying the surcharge load at the surface by a lateral earth pressure coefficient. Considering the subsurface materials encountered during our site exploration, a lateral earth pressure coefficient of 0.5 is recommended for surcharge loads. It should be noted that surcharge lateral pressures are in addition to the lateral earth pressure cases discussed above.

As discussed earlier, backfill materials behind the walls should consist of granular soils having classifications of SM or more granular. It is recommended that free-draining soils, having less than 35% fines passing the No. 200 sieve be utilized as backfill within the retaining wall reinforcement zone.

All retaining wall backfill materials should be placed in relatively horizontal 4-inch (maximum) loose lifts and should be compacted to dry densities on the order of 95 percent of the Standard Proctor maximum dry density. If necessary, use smaller walk-behind compaction equipment near the walls or pump equipment to achieve the proper compaction and to avoid damaging the walls. It is essential that all backfill materials be inspected and approved by the Geotechnical Engineer prior to their use.

An adequate drainage system should be provided behind the walls such that any surface infiltration or groundwater is intercepted and disposed of. Otherwise, hydrostatic pressures should also be considered in the wall design.

At the time of this report, specific details relating to the retaining wall such as geometry, loading, potential surcharges, and proposed site features were not available. In addition, the general proposed location of the wall was inaccessible to our drilling equipment, requiring shallower hand auger borings which provided limited data. The actual subsurface conditions present at the wall location should be properly explored and analyzed to determine the appropriate parameters for use in final design, including a global stability analysis. The parameters provided in this report should not be used for developing final designs or plans for the retaining wall.

5.6 Groundwater and Drainage

As discussed in Section 4.4, Groundwater was not encountered in any of the boring locations within the depths explored. While groundwater was not encountered within the depths explored at these locations, it is still recommended that the construction team be prepared to manage surface water and locally perched water onsite.

Any water infiltration resulting from precipitation, surface run-off, or perched water should be able to be controlled by means of sump pits and pumps, or by gravity ditching procedures. If any conditions are encountered which cannot be handled in such a manner, this office should be consulted.

Adequate drainage should be provided at the site to minimize any increases in the moisture contents of the foundation soils. If possible, all pavement or parking areas should be sloped away from structures to prevent the ponding of water.

5.7 Stormwater Management

Each of the three SPT borings, as well as the hand auger borings, were advanced in planned SWM areas. Groundwater was not noted within the depths explored in any of these borings during drilling operations.

An accurate determination of the hydrostatic water table would require the installation of perforated pipes or piezometers which could be monitored over an extended period of time. The actual level of the hydrostatic water table and the amount and level of perched water should be anticipated to fluctuate throughout the year, depending on variations in precipitation, surface runoff, infiltration, site topography, and drainage. Site grading operations at other parts of the site can also influence the level of the groundwater in the stormwater management area significantly. HCEA cannot be responsible for changes in groundwater conditions at the site due to seasonal variation and changes caused by other factors such as grading operations at the site.

Infiltration Testing

In-situ infiltration testing was requested at each of the SWM boring locations for the support of the design of the proposed SWM facility on site. Due to site limitations and access issues in the vicinity of Hand Auger Boring B-2, infiltration testing was not able to be performed at this location. Infiltration testing was performed in general accordance with the 2000 Maryland Stormwater Design Manual. It should be noted that no factor of safety has been applied to the observed infiltration rates. The infiltration rates measured during our subsurface exploration program are summarized below:

Table 2: Summary of In-Situ Test Results

Boring ID	Test Depth (ft)	Measured Infiltration Rate (in/hr)
B-1	8.6	0.0
B-3	7.6	0.0
B-4	7.8	0.0

The State of Maryland's, "2000 Maryland Stormwater Design Manual, Volumes I & II" states that infiltration basins and trenches are not acceptable practices when an infiltration rate of less than 0.52 inches per hour is obtained. Based on the subsurface conditions encountered and on the in-situ infiltration rates measured at the SWM borings, the infiltration rates do not meet the minimum required rate.

6.0 RECOMMENDED ADDITIONAL SERVICES

Additional soil engineering, testing, and consulting services recommended for the project are summarized below:

Site Preparation: A Geotechnical Engineer or their designated representative should examine the site after it has been stripped and excavated. He/she should determine if any undercutting or in-place densification is necessary to prepare a subgrade for fill placement, for building foundations, or for slab support.

Fill Placement and Compaction: A Geotechnical Engineer or their designated representative should witness any required filling operations and should take sufficient in-place density tests to verify that the specified degree of fill compaction is achieved. He/she should observe and approve borrow materials used and should determine if their existing moisture contents are suitable.

Footing Subgrade Monitoring: A Geotechnical Engineer or their designated representative should examine and test the footing excavations for the building foundations. He/she should verify that the design bearing pressure is available and that no loose pockets exist beneath the bearing surfaces of the footing excavations. Based on the results of this examination, the Geotechnical Engineer or their designated representative would either approve the bearing surfaces or recommend that loose or soft soils be undercut, or footing bottoms lowered to expose satisfactory bearing materials.

Test Pit Subsurface Exploration Program: Test pits are recommended in areas adjacent to the proposed retaining wall to further explore the subsurface materials in locations that would be inaccessible for a conventional SPT drill rig. These test pits will aid in the characterization of man-placed fill soil, the nature of groundwater onsite as well as the determination of the quality of soils onsite in the vicinity of the proposed retaining wall.

7.0 REMARKS

This report has been prepared to aid in the evaluation of the site for the proposed construction. It is considered that adequate recommendations have been provided to serve as a basis for the design of plans and specifications. Additional recommendations can be provided as needed.

These analyses are, of necessity, based on the information made available to us at the time of the actual writing of the report and the on-site conditions (surface and subsurface) that existed at the time the exploratory borings were drilled. A further assumption has been made that the limited exploratory borings, in relation both to the areal extent of the site and to depth, are representative of conditions across the site. Actual subsurface conditions encountered could vary from those outlined in this report.

If subsurface conditions are encountered that differ from those reported herein, this Office should be notified immediately so that the analyses and recommendations can be reviewed and/or revised as necessary. It is also recommended that:

1. We are given the opportunity to review any plans and specifications prepared subsequent to the final geotechnical study in order to comment on the interaction of the soil conditions as described herein and the design requirements.

2. A Geotechnical Engineer or experienced Soils Inspector is present at the site during the construction phase to verify installation according to the approved plans and specifications.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with the generally accepted engineering principles and practices. This warranty is in lieu of all other warranties either implied or expressed. Hillis-Carnes Engineering Associates, Inc. assumes no responsibility for interpretations made by others based on work or recommendations made by HCEA.

APPENDIX

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GBA GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

SITE MAP

0 2000' 4000'

VICINITY MAP

0 2000' 4000'

HILLIS-CARNES
ENGINEERING ASSOCIATES
10975 Guilford Road, Suite A Annapolis Junction, Maryland
(410) 880-4788 WWW.HCEA.COM Fax: (410) 880-4098

PROJECT LOCATION MAPS
MZB RED PANDA
BALTIMORE, MARYLAND

PROJECT NO.	24146A
DATE:	3/14/24
SCALE:	1" = 2000'
DRAWN BY:	AM
CHECKED BY:	WSH

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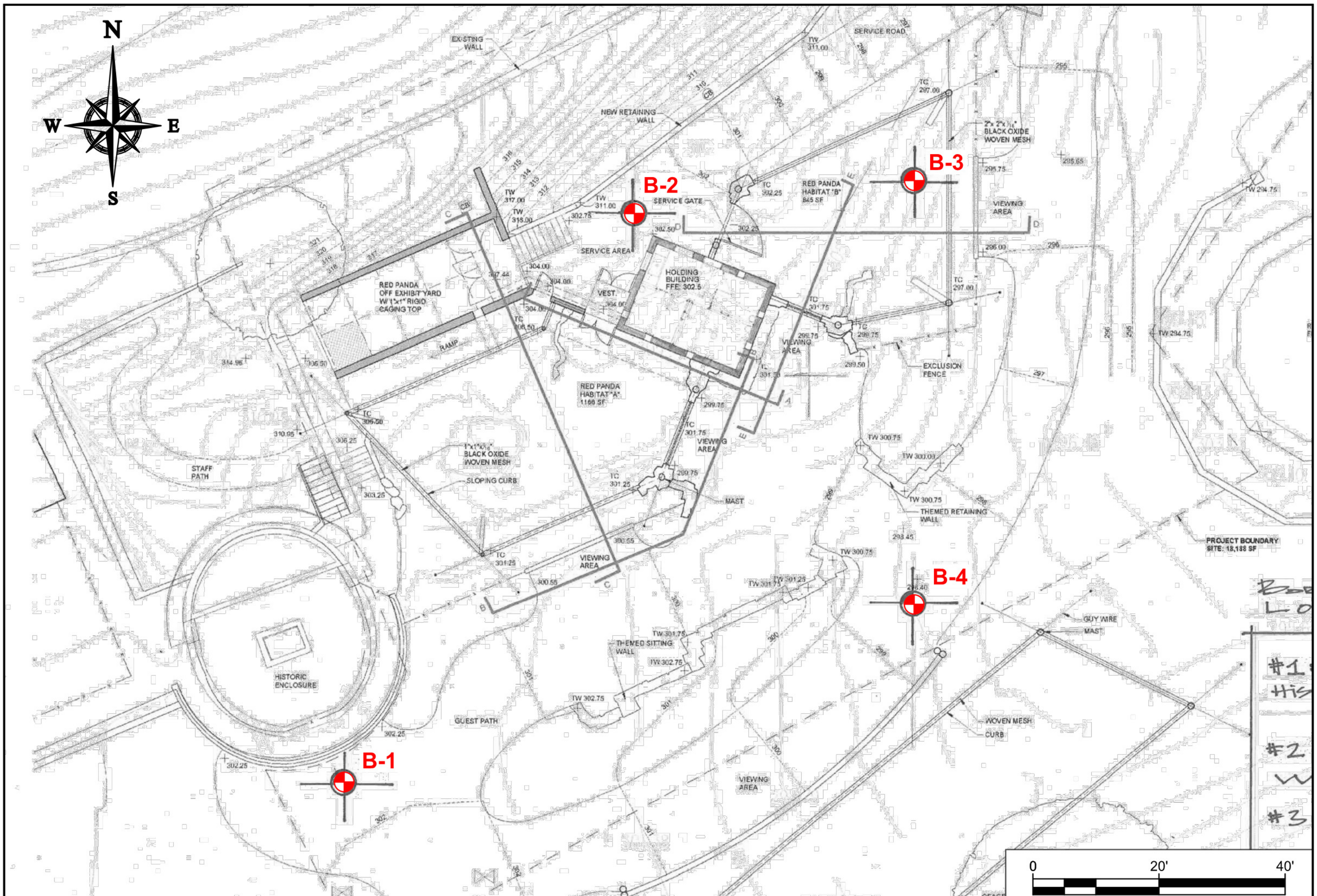

LEGEND:

SOIL BORING LOCATION

HILLIS-CARNES ENGINEERING ASSOCIATES

10975 Guilford Road, Suite A Annapolis Junction, Maryland
(410) 880-4788 www.hcea.com Fax: (410) 880-4098

BORING LOCATION PLAN

MZB RED PANDA

BALTIMORE, MARYLAND

PROJECT NO.	24146A
DATE:	3/14/24
SCALE:	1" = 20'
DRAWN BY:	AM
CHECKED BY:	WSH

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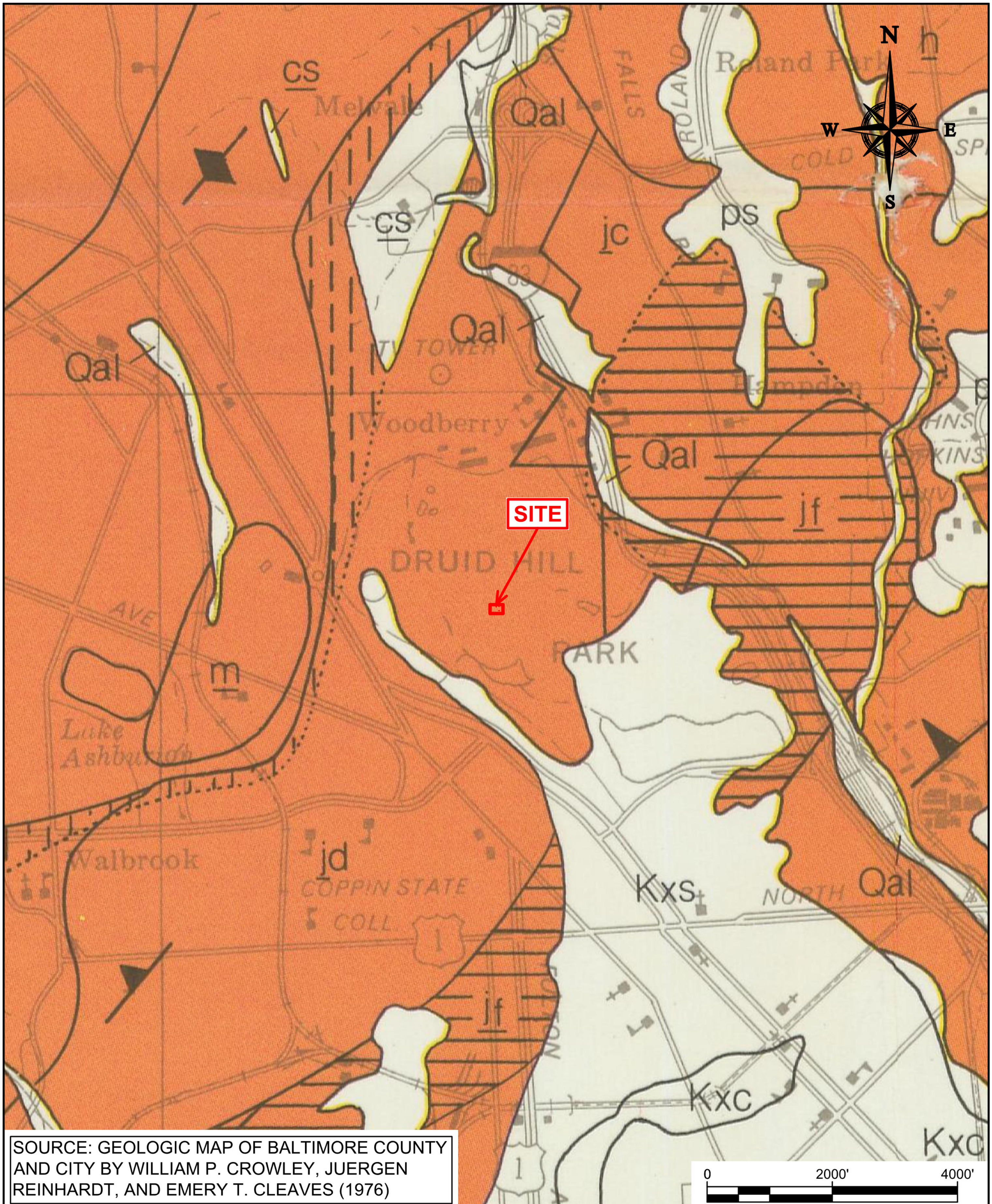

SOURCE: GEOLOGIC MAP OF BALTIMORE COUNTY AND CITY BY WILLIAM P. CROWLEY, JUERGEN REINHARDT, AND EMERY T. CLEAVES (1976)

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10975 Guilford Road, Suite A Annapolis Junction, Maryland
(410) 880-4788 WWW.HCEA.COM Fax: (410) 880-4098

SITE GEOLOGY MAP
MZB RED PANDA
BALTIMORE, MARYLAND

PROJECT NO.	24146A
DATE:	3/14/24
SCALE:	1" = 2000'
DRAWN BY:	AM
CHECKED BY:	WSH

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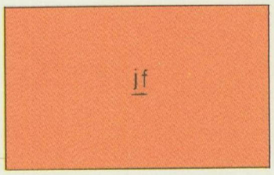
CRYSTALLINE ROCKS

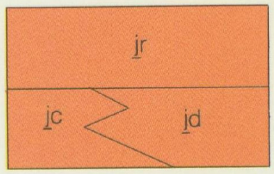
LAUREL BELT

Cambrian (?)*



Jones Falls Schist

Medium- to coarse-grained biotite -plagioclase-muscovite-quartz schist, in places accompanied by fine - grained biotite - plagioclase-quartz gneiss in layers a few centimeters thick. Garnet, and less commonly tourmaline, occur in some outcrops. Includes very minor muscovite-plagioclase-quartz schist, quartzite, amphibolite, and muscovite-quartz-feldspar gneiss.

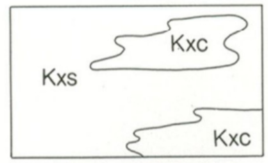


James Run Formation

jr *Relay Gneiss Member. Fine- to medium-grained biotite-quartz-plagioclase gneiss, locally containing muscovite. Mica absent and magnetite present in some outcrops. Commonly cut by numerous, randomly oriented joints.*

jc *Carroll Gneiss Member. Fine- to medium-grained biotite-quartz-plagioclase gneiss, locally with muscovite. Mica absent and magnetite present in some outcrops. Includes subordinate, concordant amphibolite in layers a few centimeters to tens of centimeters thick, but locally several meters thick. Facies equivalent of Druid Hill Amphibolite Member.*

jd *Druid Hill Amphibolite Member. Fine- to medium-grained, generally well-foliated amphibolite, locally with irregularly anastomosing patches of coarser-grained, lighter colored amphibolite. Chlorite fels and actinofels, locally foliated, associated with the amphibolite in places. Includes subordinate quartzo-feldspathic gneiss and granofels to the south which increase northward to nearly half the volume of the unit. Scale of layering ranges from a few tens of centimeters to more than 10 meters. Felsic rocks are generally fine-grained and well-foliated, but may also be coarser-grained, massive, and intricately jointed.*



Patuxent Formation

Sand facies (Kxs) (0.5-35 meters thick): Highly variable, intercalated sand, gravel, silt, and clay with hematite-limonite cements. Sands and gravels are typically quartzose and well-rounded; a buff kaolinitic clay-quartz silt matrix is common throughout the Formation. Sediments are organized into fining-upward packages (3-5 meters thick) with planar-bedded gravels and clay clasts or cross-bedded sands at the base to laminated or massive silt-clay at the top. Elsewhere vertical sequences show abrupt sediment size changes and erosive contacts. The heavy mineral suite is characterized by staurolite, zircon, tourmaline and kyanite.
Sparse silicified, and abundant iron oxide replacements or pseudomorphs of cycadioids and conifers are present throughout the Formation. These sediments were deposited in a high gradient braided and meandering stream complex.

Clay facies (Kxc) (0.5-5 meters thick): Light gray to black and brown clay containing variable amounts of quartz silt, gravel; local concentrations of lignitic, partially pyritized wood, or macerated leaf and cone debris; locally siderite concretions. Thin planar beds of sand and/or gravelly clay are interbedded with massive clays.

Alluvium

Interbedded gravel, sand, silt, and clay of variable composition and sorting. Typically confined to flood plains of perennial streams, upland gathering areas, and marshes adjacent to estuaries. Sediment size, sorting, and mineralogy are strongly controlled by the source geology and geomorphic setting. The quartzose sands and polymict gravels are typically well-bedded and loosely compacted; the silts and clays are often water saturated and poorly bedded.
Minor amounts of colluvium (unmapped) may interfinger with alluvium at or near the bases of slopes. In urban areas Qal cannot be adequately shown since it is commonly overlain by artificial fill and/or has been extensively modified. Unit thickness is 0.5 to 5 meters.

HILLIS-CARNES
ENGINEERING ASSOCIATES
10975 Guilford Road, Suite A Annapolis Junction, Maryland
(410) 880-4788 WWW.HCEA.COM Fax: (410) 880-4098

SITE GEOLOGY MAP LEGEND

MZB RED PANDA

BALTIMORE, MARYLAND

PROJECT NO.	24146A
DATE:	3/14/24
SCALE:	NONE
DRAWN BY:	AM
CHECKED BY:	WSH

HILLIS - CARNES
ENGINEERING ASSOCIATES, INC.

RECORD OF SOIL EXPLORATION

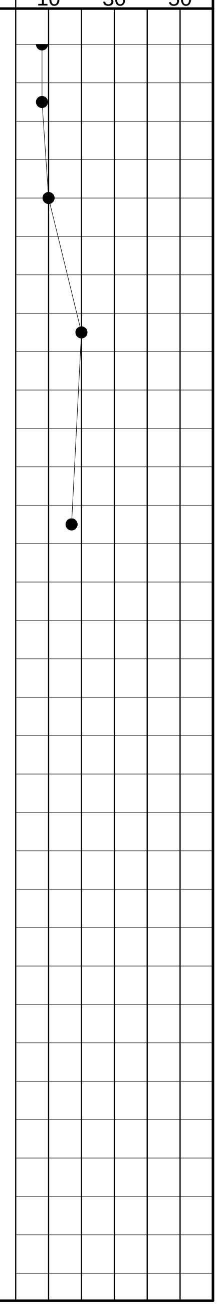
Project Name **MZB Red Panda** Boring No. B-1

Location Baltimore, MD Job # 24146A

SAMPLER

Datum	NAD83 / NAVD88	Hammer Wt.	140 lbs.	Hole Diameter	6 in.	Foreman	N. Comer
Surf. Elev.	302.43 ft	Hammer Drop	30 in.	Rock Core Diameter	N/A	Inspector	J. Gruber
Date Started	4/9/2024	Pipe Size (O.D.)	2 in.	Boring Method	HSA	Date Completed	4/9/2024

Elevation/ Depth (ft)	SOIL SYMBOLS/ SAMPLE CONDITIONS	Description	Boring and Sampling Notes	Sample No.	Rec. (in)	NM (%)	SPT Blows	SPT N (blows/ft) N
300		Brown, moist, medium stiff, sandy CLAY (CL; FILL) Trace gravel	Asphalt - 3" Concrete - 9"	1	14		11-5-3	8
				2	18		5-5-3	8
5		Brown, moist, medium stiff, sandy SILT with trace gravel (ML; FILL)	Groundwater was not encountered during drilling operations	3	18		6-3-7	10
295		Brown and greenish brown, moist, very stiff, sandy SILT (ML) USDA: Sandy Loam		4	18	20.0	3-9-11	20
10								
290		Greenish brown and tan	Boring backfilled 24 hours after completion	5	18		6-5-12	17
15		Bottom of boring at 15.0 feet						
285								
20								
280								
25								
275								
30								
270								



SAMPLER TYPE	SAMPLE CONDITIONS		GROUND WATER	CAVE IN DEPTH	BORING METHOD
DRIVEN SPLIT SPOON UNLESS OTHERWISE	D - DISINTEGRATED	AT COMPLETION	DRY ft.	10.0 ft.	HSA - HOLLOW STEM AUGERS
PT - PRESSED SHELBY TUBE	I - INTACT	AFTER 24 HRS.	DRY ft.	8.7 ft.	CFA - CONTINUOUS FLIGHT AUGERS
CA - CONTINUOUS FLIGHT AUGER	U - UNDISTURBED	AFTER ____ HRS.	ft.	ft.	DC - DRIVING CASING
RC - ROCK CORE	L - LOST				MD - MUD DRILLING

STANDARD PENETRATION TEST-DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS.

HILLIS - CARNES
ENGINEERING ASSOCIATES, INC.

RECORD OF SOIL EXPLORATION

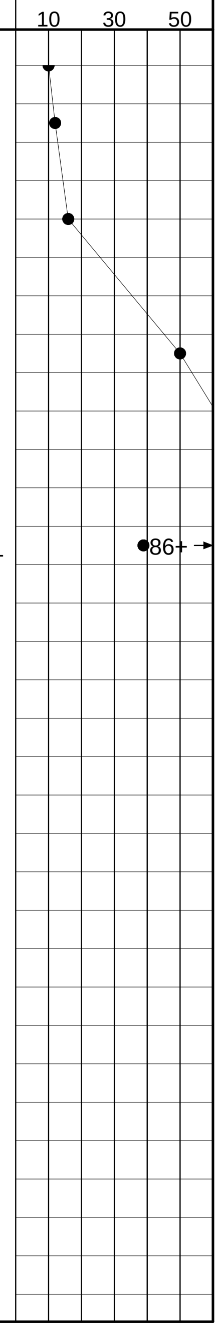
Project Name: **MZB Red Panda** — Boring No.: B-3

Location: Baltimore, MD — Job #: 24146A

SAMPLER

Datum	NAD83 / NAVD88	Hammer Wt.	140 lbs.	Hole Diameter	6 in.	Foreman	N. Comer
Surf. Elev.	303.2 ft	Hammer Drop	30 in.	Rock Core Diameter	N/A	Inspector	J. Gruber
Date Started	4/9/2024	Pipe Size (O.D.)	2 in.	Boring Method	HSA	Date Completed	4/9/2024

Elevation/ Depth (ft)	SOIL SYMBOLS/ SAMPLE CONDITIONS	Description	Boring and Sampling Notes	Sample No.	Rec. (in)	NM (%)	SPT Blows	SPT N (blows/ft) N
		Brown and dark brown, moist, medium stiff, sandy CLAY with trace organics and gravel (CL)	Topsoil - 4"	1	18		3-4-6	10
300				2	18	23.1	5-5-7	12
5		Brown, moist, stiff to hard, sandy SILT with trace organics (ML) Greenish brown	Groundwater was not encountered during drilling operations	3	18		5-7-9	16
295		Dark brown and brownish gray USDA: Sandy Loam		4	18	10.6	8-18-32	50
10								
290		Greenish gray, moist, very dense, silty SAND with some gravel (SM) [DISINTEGRATED ROCK]	Boring backfilled 24 hours after completion	5	15		18-36-50/3	86+
15		Bottom of boring at 15.0 feet						
285								
20								
280								
25								
275								
30								
270								



SAMPLER TYPE
DRIVEN SPLIT SPOON UNLESS OTHERWISE
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

	GROUND WATER	CAVE IN DEPTH
AT COMPLETION	DRY ft.	10.0 ft.
AFTER 24 HRS.	DRY ft.	9.6 ft.
AFTER ____ HRS.	ft.	ft.

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST-DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS.

HILLIS - CARNES
ENGINEERING ASSOCIATES, INC.

RECORD OF SOIL EXPLORATION

Project Name **MZB Red Panda** Boring No. B-4

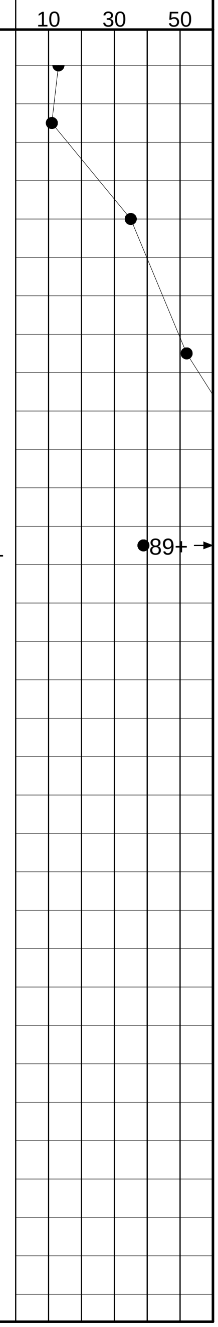
Location Baltimore, MD Job # 24146A

SAMPLER

Datum	NAD83 / NAVD88	Hammer Wt.	140 lbs.	Hole Diameter	6 in.	Foreman	N. Comer
Surf. Elev.	296.7 ft	Hammer Drop	30 in.	Rock Core Diameter	N/A	Inspector	J. Gruber
Date Started	4/9/2024	Pipe Size (O.D.)	2 in.	Boring Method	HSA	Date Completed	4/9/2024

Elevation/ Depth (ft)	Description	Boring and Sampling Notes	Sample No.	Rec. (in)	NM (%)	SPT Blows	N
296.7 – 294.7 (0 – 2)	Brown, moist, stiff, sandy CLAY with trace gravel (CL; FILL)	Asphalt - 3" Concrete - 9"	1	18		7-5-8	13
294.7 – 288.7 (2 – 8)	Brown, moist, stiff to hard, sandy SILT (ML; FILL)		2	18		7-8-3	11
	Some concrete debris	Groundwater was not encountered during drilling operations	3	1		15-16-19	35
288.7 – 281.7 (8 – 15)	Brown and grayish brown, moist, hard, sandy SILT (ML) USDA: Sandy Loam		4	14	13.2	21-23-29	52
	Greenish brown and tan, some gravel [DISINTEGRATED ROCK]	Boring backfilled 24 hours after completion	5	16		29-39-50/6	89+
	Bottom of boring at 15.0 feet						

SPT N (blows/ft)



	GROUND WATER		CAVE IN DEPTH	
AT COMPLETION	DRY	ft.	10.0	ft.
AFTER 24 HRS.	DRY	ft.	8.2	ft.
AFTER ____ HRS.		ft.		ft.

SAMPLER TYPE
DRIVEN SPLIT SPOON UNLESS OTHERWISE
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

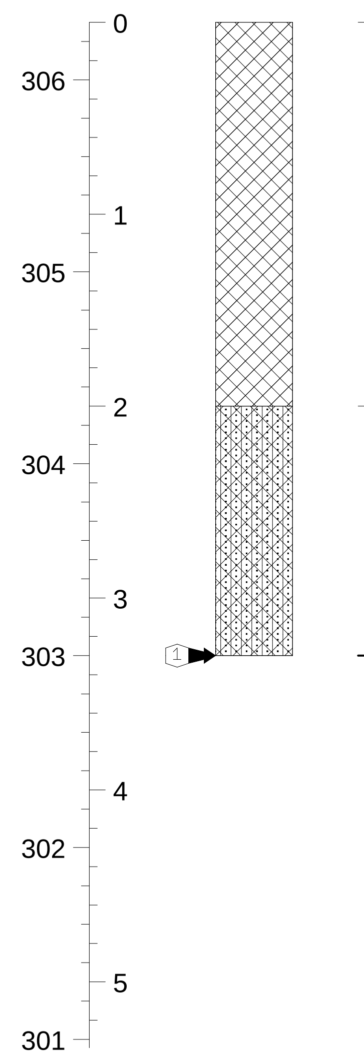
BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST-DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS.

HAND AUGER LOG
Hand Auger No.: B-2

PROJECT	PROJECT NO.
MZB Red Panda	24146A
CLIENT	**DATE**
The Maryland Zoo in Baltimore	4/9/2024
LOCATION	**ELEV.**
Baltimore, MD	306.3
EXCAVATION METHOD	**LOGGER**
Hand Auger	J. Gruber

DEPTH TO - Water: DRY When checked: At Completion Caving: 3.3



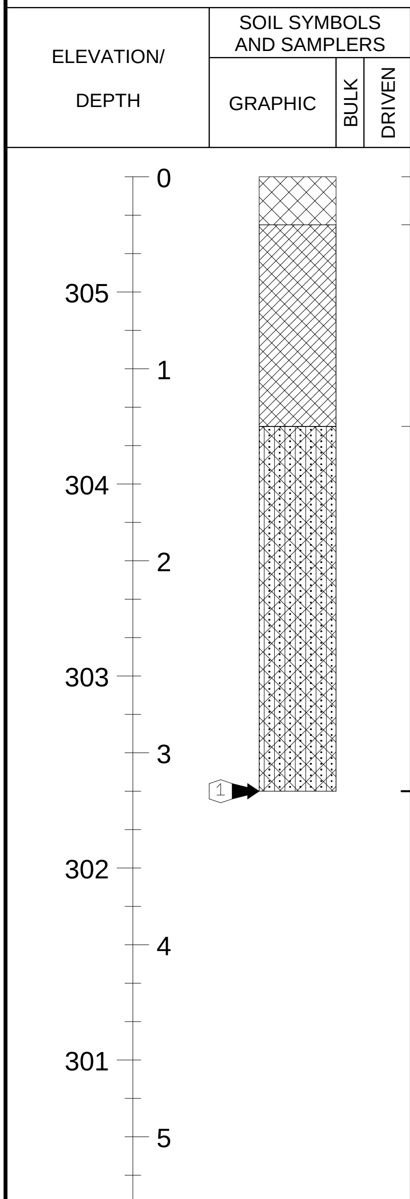
ELEVATION/ DEPTH	SOIL SYMBOLS AND SAMPLERS: GRAPHIC	BULK	DRIVEN	USCS	DESCRIPTION	DENSITY pcf	MOISTURE %
0 – 2				CL	Brown, moist, sandy CLAY with some gravel and trace organics (CL; FILL)		
2 – 3.3				SM	Light brown, moist, silty SAND with trace gravel (SM; FILL)		
3.3					Bottom of boring at 3.3 feet Auger Refusal		

Notes:

HAND AUGER LOG
Hand Auger No.: B-2 O/S

PROJECT	PROJECT NO.
MZB Red Panda	24146A
CLIENT	DATE
The Maryland Zoo in Baltimore	4/9/2024
LOCATION	ELEV.
Baltimore, MD	305.6
EXCAVATION METHOD	LOGGER
Hand Auger	J. Gruber

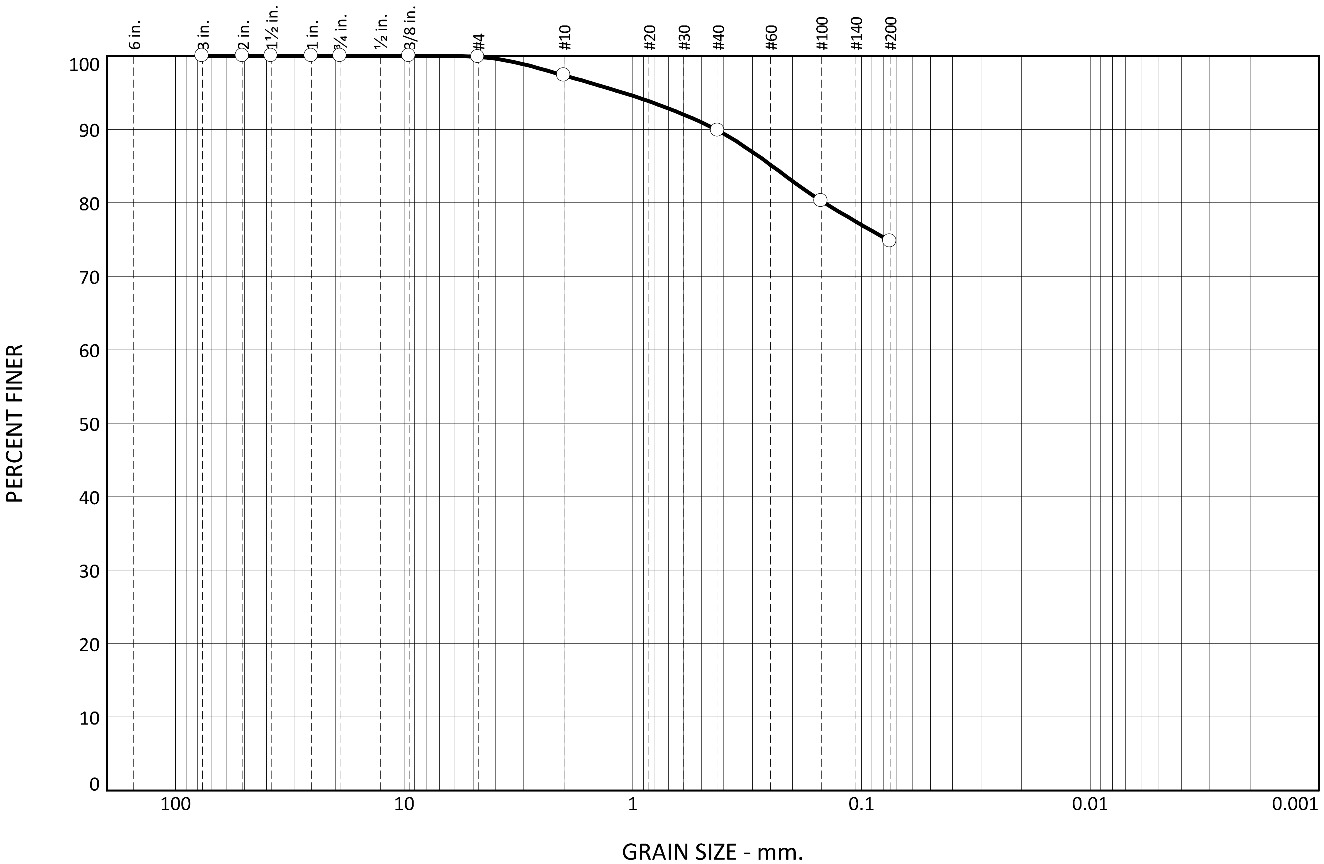
DEPTH TO - Water: DRY When checked: At Completion Caving: 3.2



USCS	DESCRIPTION	DENSITY pcf	MOISTURE %
FILL	Asphalt - 3"		
CL	Brown, moist, sandy CLAY with some gravel and trace organics (CL; FILL)		
SM	Light brown, moist, silty SAND with trace gravel (SM; FILL)		
	Bottom of boring at 3.2 feet Auger Refusal		

Notes:

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	2.6	7.5	15.0	74.8	

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1-1/2"	100.0		
1"	100.0		
3/4"	100.0		
3/8"	100.0		
#4	99.9		
#10	97.3		
#40	89.8		
#100	80.3		
#200	74.8		

* (no specification provided)

Soil Description

Brown silt with sand

Atterberg Limits

PL= 23 LL= 30 PI= 7

Coefficients

D_{90}= 0.4351 D_{85}= 0.2462 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(4)

Remarks

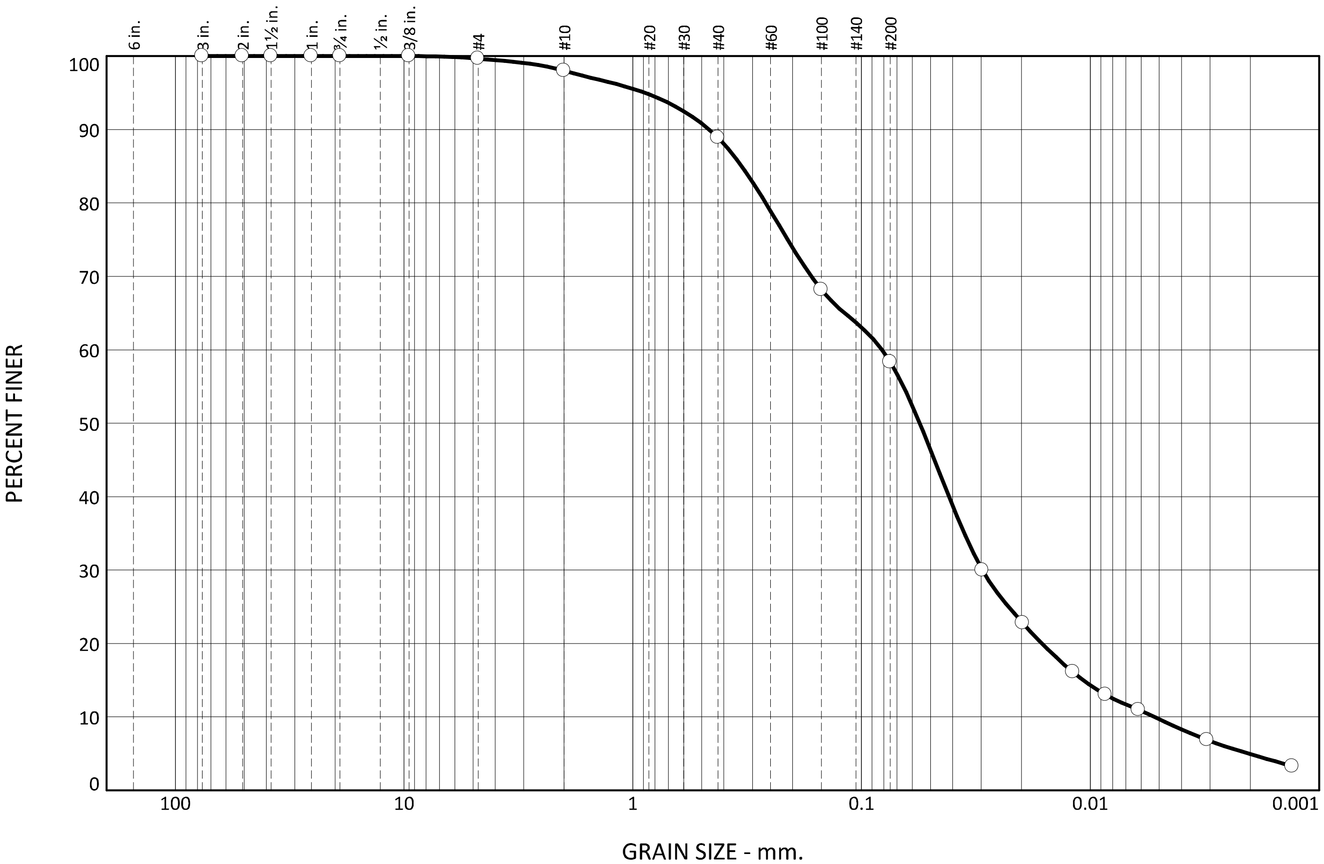
Moisture content: 23.1%

Location: B-3, S-2
Sample Number: 1 **Depth:** 2.5'-4.0' **Date:** 05/07/24

HILLIS-CARNES ENGINEERING ASSOCIATES, INC.
Annapolis Junction, MD

Client: The Maryland Zoo in Baltimore
Project: MZB Red Panda GEO
Project No: 24146A **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.3	1.7	9.1	30.6	48.6	9.7

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1-1/2"	100.0		
1"	100.0		
3/4"	100.0		
3/8"	100.0		
#4	99.7		
#10	98.0		
#40	88.9		
#100	68.2		
#200	58.3		
0.0297 mm.	30.0		
0.0198 mm.	22.8		
0.0119 mm.	16.1		
0.0086 mm.	13.0		
0.0061 mm.	11.0		
0.0031 mm.	6.9		
0.0013 mm.	3.3		

* (no specification provided)

Soil Description

USDA: Gray brown sandy loam

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.4651 D_{85}= 0.3343 D_{60}= 0.0814
D_{50}= 0.0558 D_{30}= 0.0297 D_{15}= 0.0107
D_{10}= 0.0053 C_u= 15.48 C_c= 2.06

Classification

USCS= AASHTO=

Remarks

Moisture content: 20.0%
USDA Fractions- Sand: 50.7%, Silt: 44.3%, Clay: 5.0%

Location: B-1, S-4
Sample Number: 2 **Depth:** 8.5'-10.0' **Date:** 05/07/24

HILLIS-CARNES ENGINEERING ASSOCIATES, INC.
Annapolis Junction, MD

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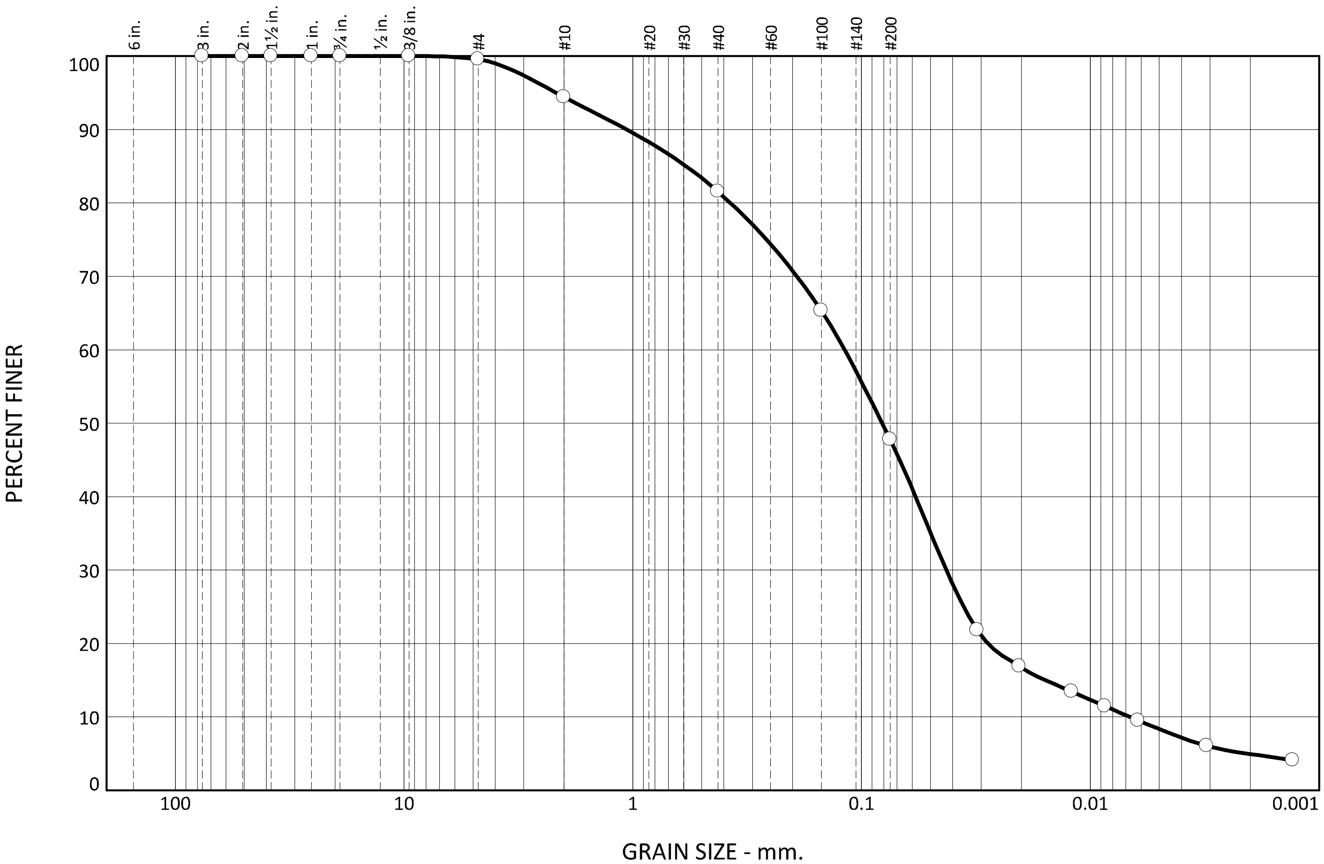
Project No: 24146A **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	5.1	12.8	33.8	39.5	8.3

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1-1/2"	100.0		
1"	100.0		
3/4"	100.0		
3/8"	100.0		
#4	99.5		
#10	94.4		
#40	81.6		
#100	65.3		
#200	47.8		
0.0312 mm.	21.8		
0.0204 mm.	16.9		
0.0121 mm.	13.4		
0.0086 mm.	11.5		
0.0062 mm.	9.5		
0.0031 mm.	6.1		
0.0013 mm.	4.1		

* (no specification provided)

Soil Description

USDA: Dark gray brown sandy loam

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.0647 D_{85}= 0.5849 D_{60}= 0.1186
D_{50}= 0.0813 D_{30}= 0.0426 D_{15}= 0.0158
D_{10}= 0.0067 C_u= 17.59 C_c= 2.27

Classification

USCS= AASHTO=

Remarks

Moisture content: 10.6%
USDA Fractions- Sand: 60.8%, Silt: 34.0%, Clay: 5.2%

Location: B-3, S-4
Sample Number: 3 **Depth:** 8.5'-10.0' **Date:** 05/07/24

HILLIS-CARNES ENGINEERING ASSOCIATES, INC.
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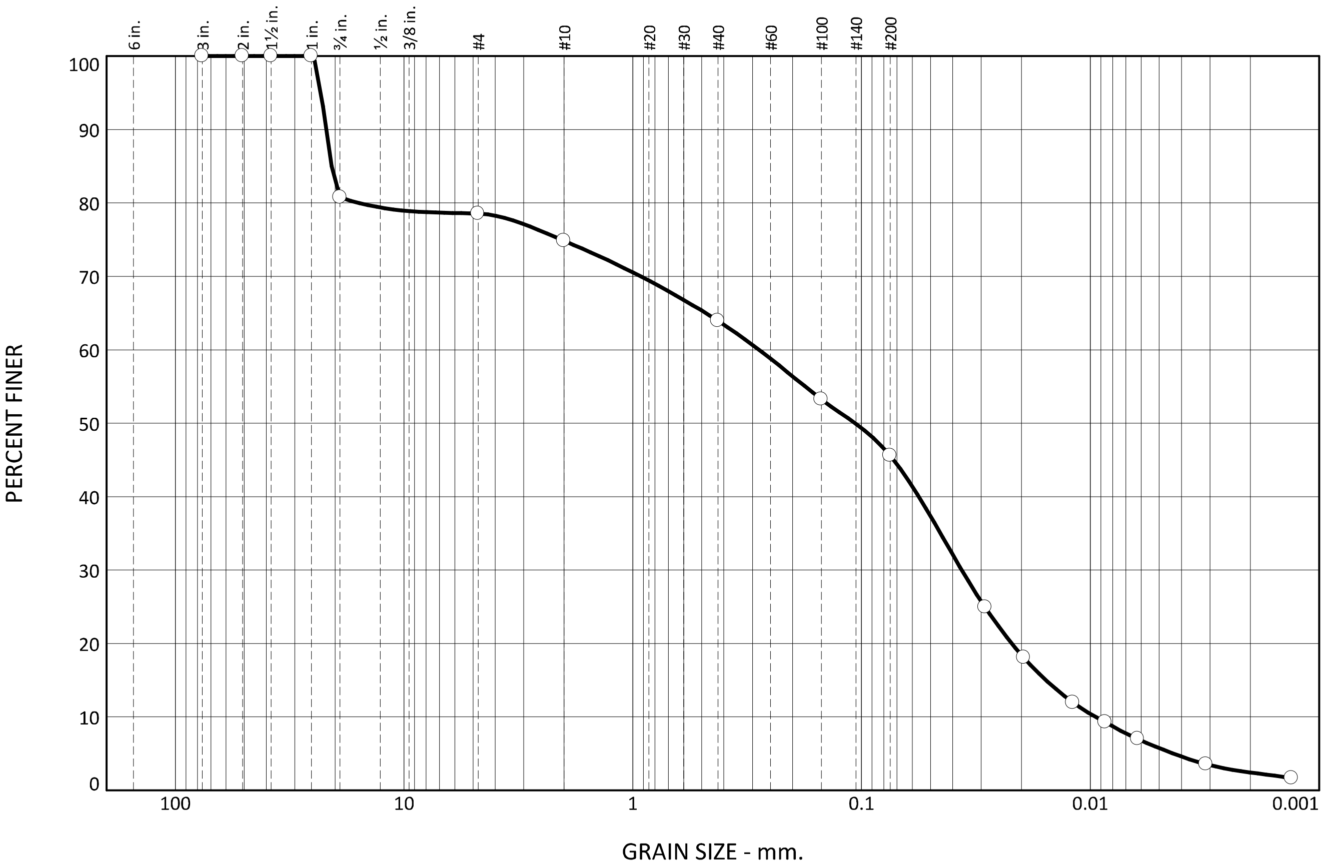
Project: MZB Red Panda GEO
Project No: 24146A **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	19.2	2.3	3.7	10.8	18.4	39.8	5.8

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0		
2"	100.0		
1-1/2"	100.0		
1"	100.0		
3/4"	80.8		
#4	78.5		
#10	74.8		
#40	64.0		
#100	53.3		
#200	45.6		
0.0288 mm.	24.9		
0.0195 mm.	18.0		
0.0119 mm.	11.9		
0.0086 mm.	9.3		
0.0062 mm.	7.0		
0.0031 mm.	3.6		
0.0013 mm.	1.7		

* (no specification provided)

Soil Description

USDA: Gray brown sandy loam

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 21.8736 D_{85}= 20.7359 D_{60}= 0.2811
D_{50}= 0.1070 D_{30}= 0.0365 D_{15}= 0.0156
D_{10}= 0.0095 C_u= 29.64 C_c= 0.50

Classification

USCS= AASHTO=

Remarks

Moisture content: 13.2%
USDA Fractions- Sand: 48.3%, Silt: 48.5%, Clay: 3.2%

Location: B-4, S-4
Sample Number: 4 **Depth:** 8.5'-10.0' **Date:** 05/07/24

HILLIS-CARNES ENGINEERING ASSOCIATES, INC.
Annapolis Junction, MD

Client: The Maryland Zoo in Baltimore
Project: MZB Red Panda GEO
Project No: 24146A **Figure**

HILLIS-CARNES ENGINEERING ASSOCIATES, Inc.

10975 Guilford Road, Suite A • Annapolis Junction, Maryland 20701
Phone: (410)880-4788 • Fax: (410)880-4098

Description of Soils – per ASTM D2487

Major Component	Component Type	Component Description	Symbol	Group Name
Coarse-Grained Soils, More than 50% is retained on the No. 200 sieve	**Gravels** – More than 50% of the coarse fraction is retained on the No. 4 sieve. Coarse = 1” to 3” Medium = ½” to 1” Fine = ¼” to ½”	Clean Gravels <5% Passing No. 200 sieve	**GW**	Well Graded Gravel
			GP	Poorly Graded Gravel
		Gravels with fines, >12% Passing the No. 200 sieve	**GM**	Silty Gravel
			GC	Clayey Gravel
	Sands – More than 50% of the coarse fraction passes the No. 4 sieve. Coarse = No.10 to No.4 Medium = No. 10 to No. 40 Fine = No. 40 to No. 200	Clean Sands <5% Passing No. 200 sieve	**SW**	Well Graded Sand
			SP	Poorly Graded Sand
		Sands with fines, >12% Passing the No. 200 sieve	**SM**	Silty Sand
			SC	Clayey Sand
Fine Grained Soils, More than 50% passes the No. 200 sieve	Silts and Clays Liquid Limit is less than 50 Low to medium plasticity	Inorganic	**ML**	Silt
			CL	Lean Clay
		Organic	**OL**	Organic silt
				Organic Clay
	Silts and Clays Liquid Limit of 50 or greater Medium to high plasticity	Inorganic	**MH**	Elastic Silt
			CH	Fat Clay
		Organic	**OH**	Organic Silt
				Organic Clay
Highly Organic Soils	Primarily Organic matter, dark color, organic odor		**PT**	Peat

Proportions of Soil Components

Component Form	Description	Approximate percent by weight
Noun	Sand, Gravel, Silt, Clay, etc.	50% or more
Adjective	Sandy, silty, clayey, etc.	35% to 49%
Some	Some sand, some silt, etc.	12% to 34%
Trace	Trace sand, trace mica, etc.	1% to 11%
With	With sand, with mica, etc.	Presence only

Particle Size Identification

Particle Size	Particle dimension
Boulder	12” diameter or more
Cobble	3” to 12” diameter
Gravel	¼” to 3” diameter
Sand	0.005” to ¼” diameter
Silt/Clay (fines)	Cannot see particle

Cohesive Soils

Field Description	No. of SPT Blows/ft	Consistency
Easily Molded in Hands	0 – 3	Very Soft
Easily penetrated several inches by thumb	4 – 5	Soft
Penetrated by thumb with moderate effort	6 – 10	Medium
Penetrated by thumb with great effort	11 – 30	Stiff
Indented by thumb only with great effort	Greater than 30	Hard

Granular Soils

No. of SPT Blows/ft	Relative Density
0 – 4	Very Loose
5 – 10	Loose
11 – 30	Medium Dense
31 – 50	Dense
Greater than 50	Very Dense

Other Definitions:

- **Fill:** Encountered soils that were placed by man. Fill soils may be controlled (engineered structural fill) or uncontrolled fills that may contain rubble and/or debris.
- **Saprolite**: Soil material derived from the in-place chemical and physical weathering of the parent rock material. May contain relic structure. Also called residual soils. Occurs in Piedmont soils, found west of the fall line.
- **Disintegrated Roc**k: Residual soil material with rock-like properties, very dense, N = 60 to 51/0”.
- **Karst:** Descriptive term which denotes the potential for solutioning of the limestone rock and the development of sinkholes.
- **Alluvium:** Recently deposited soils placed by water action, typically stream or river floodplain soils.
- **Groundwater Level**: Depth within borehole where water is encountered either during drilling, or after a set period of time to allow groundwater conditions to reach equilibrium.
- **Caved Depth:** Depth at which borehole collapsed after removal of augers/casing. Indicative of loose soils and/or groundwater conditions.