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REPORT ON
GEOTECHNICAL ENGINEERING STUDY
CONSTRUCT ARABIAN LEOPARD FACILITY
NATIONAL ZOOLOGIAL PARK
3001 CONNECTICUT AVE NW
WASHINGTON, DC

by
Haley & Aldrich, Inc.
Vienna, Virginia

for
SmithGroup
Washington, District of Columbia

File No. 0213691-000
March 2026

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March 13, 2026
File No. 0213691-000

SmithGroup
1700 New York Avenue NW
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Attention: Matthew Reiskin

Subject: Report on Geotechnical Engineering Study
Construct Arabian Leopard Facility (ALF)
National Zoological Park
3100 Connecticut Avenue NW
Washington, DC

Ladies and Gentlemen:

This report presents the results of our geotechnical engineering study for the Construct Arabian Leopard Facility project located at the Smithsonian Institut ion's National Zoological Park at 3100 Connecticut Avenue NW, Washington, DC. This report has been prepared in accordance with the A/E Scope of Work dated May 23, 2025, and your subsequent authorization.

This report includes background information regarding the project, the results of our field investigation program, and our engineering recommendations.

Background

The project site is located between the Panda Habitat and the Elephant House Exhibit at the National Zoological Park located at 3100 Connecticut Ave NW in Washington, DC. The general site location is shown on **Figure 1, "Project Locus"**. The site is approximately 32,000 square feet and is currently occupied by the Bison Habitat exhibit, which is no longer in service, and the Zoo in Your Backyard exhibit.

The proposed project consists of construction of a new Arabian Leopard Facility (ALF). The facility will consist of a mesh enclosure, faux rocks, site retaining walls, and a single-story building with a partial basement. The building will consist of a leopard care facility and climate-controlled day room for leopard viewing. Stormwater management will be provided in the form of bioretention. We understand the existing Bison Habitat and Zoo in Your Backyard features will be removed to accommodate the Arabian Leopard Facility.

Purpose and Scope

The purpose of this study was to investigate the subsurface soil and groundwater conditions at the proposed site and develop foundation design recommendations. To achieve the objective discussed above, the scope of work undertaken for this investigation included the tasks listed below:

- Planning and executing a field investigation program to obtain subsurface information for foundation support evaluation and design. The program included drilling nine soil borings to depths that ranged from 11.5 to 18 feet (ft) below existing ground surface (bgs).
- Performing infiltration tests offset from three boring locations for stormwater management design purposes.
- Conducting a laboratory testing program on soil samples recovered from subsurface explorations to aid soil classification and determine engineering properties required for foundation design and site development studies.
- Performing analyses for foundation support methods including foundation type, allowable bearing pressure for foundations, foundation depths, and estimated settlement of structures.
- Providing recommendations for design groundwater level, seismic site classification, retaining walls, and site backfill and compaction requirements.
- Evaluating geotechnical construction considerations for site preparation, existing utilities and underground obstructions, drainage and subgrade protection, temporary construction dewatering, excavation, site backfill and compaction requirements, and construction monitoring.

Field Investigation Program

SUBSURFACE EXPLORATION PROGRAM

Previous Test Borings by Others

Test borings were performed by Schnabel Engineering, Inc as part of the geotechnical investigation for the Bison Exhibit. Three borings (SB-1, SB-2, and SB-3) were located within the central area of the currently proposed Arabian Leopard Exhibit. The locations of these borings are shown on **Figure 2, "Boring Location Plan"**. The boring logs are presented in **Appendix A.** The borings were performed in 2013 prior to earthwork to construct the Bison Exhibit.

Test Borings

Haley & Aldrich conducted test borings at the project site on December 18 and 19, 2025, to obtain subsurface information for engineering evaluations. The program included nine test borings designated HA-1 through HA-9 drilled by Free State Drilling, Inc of Walkersville, MD (Freestate). A Haley & Aldrich representative was present in the field to monitor the exploration.

The locations of the test borings are shown on **Figure 2, "Boring Location Plan"**. The as-drilled locations of the test borings were determined by Haley & Aldrich in the field using tape measurements from existing site features. The elevations of the test borings were determined by Haley & Aldrich by linear interpolation between ground surface elevation contour lines shown on a Topographic and Utility Survey plan (dated April 29, 2025) of the site provided to Haley & Aldrich by SmithGroup. The locations and elevations of the test borings should be considered accurate only to the degree implied by the method used to make the determination.

The test borings were drilled to depths between 11.5 and 18 feet below ground surface. The borings were advanced using 3-¼ inch (in.) inside diameter hollow stem augers. In all borings, except borings HA-8, and HA-9, split-spoon sampling was performed continuously from the ground surface to a depth of approximately 10 ft bgs, and at intervals of 5 ft thereafter, unless otherwise required by field conditions. Sampling was only taken from 8 to 12 ft in borings HA-8 and HA-9. The standard penetration resistance was determined at each sample level by counting the number of blows required to drive a standard split-spoon sampler (1-3/8-in. inside diameter, 2-in. outside diameter) a distance of 18 in. or 24 in. into undisturbed soil under the impact of a 140-pound hammer free-falling 30 in. The number of blows required to advance the sampler was recorded for each 6-in. interval. The standard penetration resistance N-value is determined by summing the number of blows required to advance the sampler to the 6-in. to 12-in. and 12-in to 18-in. sampling range.

Samples recovered from the borings were taken to Haley & Aldrich's office for further evaluation. Some of these samples were selected for laboratory testing. The boring logs are presented in **Appendix A**. The boring logs and related information depict subsurface conditions only at the specific locations and at the particular time designated on the logs. Soil conditions at other locations may differ from conditions occurring at the boring locations. Also, the passage of time may result in a change in the soil conditions at these boring locations.

Infiltration Test Holes

Freestate installed temporary 4-in. diameter solid PVC pipes immediately adjacent to borings HA-5, HA-8, and HA-9 for infiltration testing.

The test holes were prepared by drilling to a depth of 8 to 10 ft bgs using 3-¼ in. i.d. hollow stem augers. After removing the augers, an open-ended 4-in i.d. solid wall schedule 40 PVC was installed vertically in the borehole to facilitate testing at depth below ground surface. Following completion of the infiltration tests, the PVC pipes were removed, and the boreholes were backfilled.

GEOTECHNICAL LABORATORY TESTING

A laboratory testing program was conducted on selected soil samples recovered from subsurface explorations to aid in classification and determination of engineering properties required for design. The primary purpose of the geotechnical testing program was to evaluate the index properties of the soils present at the site. Testing included natural moisture contents, Atterberg limits, grain size analysis, and percent passing the No. 200 sieve. The results are presented in **Appendix A** following the boring logs.

Subsurface Conditions

Descriptions of the soil, rock, and groundwater conditions encountered during the subsurface exploration program conducted at the site are provided below in order of increasing depth below ground surface. Actual conditions between boring locations may differ from these typical descriptions. Refer to the test boring logs for specific descriptions of samples obtained from the borings.

GEOLOGIC SETTING

The site is locally overlain with a thin blanket of artificial fill, up to 8 ft thick, much of it most likely placed during original construction of the National Zoological Park, and portions later placed during construction of the Bison Exhibit. Beneath the fill, residual soils (residuum) derived from the underlying metasedimentary bedrock of the Laurel Formation were encountered in the explored borings and extended to maximum boring termination depth of approximately 18 ft bgs.

The Laurel Formation is a sedimentary mélange containing mica gneiss, muscovite-biotite schist, and meta-arenite clasts. Based on regional mapping, the rock body is generally medium- to coarse-grained, and moderately to well-foliated. At the site, the formation is interpreted to be highly weathered, with the residual material observed as fine to medium micaceous sand/silty sand with preserved rock fabric (residuum). The Laurel Formation is considered Early Cambrian in geologic age.

SUBSURFACE SOIL CONDITIONS

Based on the test borings (HA-1 through HA-9) and the boring location plan, existing grade elevations across the site generally range from about elevation (El.)[1] 180 in the south to El. 199 in the north. Subsurface conditions encountered in the borings were generally similar and consisted of variable-thickness fill below the thin surficial cover (eg, pavement, topsoil) underlain by residuum. Residuum is residual soils and disintegrated rock derived from the weathering of competent and intact bedrock. Explorations extended to depths of approximately 11.5 to 18 ft bgs, and groundwater was not encountered in the borings during drilling.

Surficial Cover - Surficial cover consisted of either concrete slab pavement (typically on the order of 6 to 12 inches) or topsoil (typically on the order of less than an inch to 12 inches), depending on boring location.

Fill - FILL placed during historical construction was encountered beneath the surficial cover in most borings. Based on the boring location plan, the base of FILL / top of underlying natural soil was interpreted at approximate elevations ranging from about El. 173.5 to El. 195, corresponding to a FILL

[1] Ground surface elevations were determined by linear interpolation between ground surface contour lines shown on the topographic site plan provided by SmithGroup.

thickness on the order of about less than 1 to 8 ft across the site (thinnest in the vicinity of HA-6 and thickest in the vicinity of HA-5). FILL materials were typically described as silty SAND (SM) and clayey SAND (SC), locally containing gravel and construction-related debris (e.g., former pavement/brick fragments in places). In one location (HA-7), gravelly FILL was logged as well-graded GRAVEL with clay and sand (GW-GC) beneath concrete. Standard Penetration Test (SPT) results generally indicated the FILL to be loose to medium dense, becoming locally dense with depth.

Residuum - Below the FILL, the borings generally encountered micaceous, sand-dominant soils with preserved rock fabric, interpreted as residual soils and disintegrated bedrock (residuum). These materials were commonly logged as silty SAND (SM) and poorly graded SAND (SP), typically tan, red, and/or gray, and frequently noted as mica-rich with preserved rock fabric, consistent with in-situ weathering of the metasedimentary bedrock. SPT results in these materials generally indicated relative density of medium dense to dense conditions. Disintegrated rock is defined as a residual material with a penetration resistance (N-value) ranging from 60 blows per foot to 50 blows per 1-inch penetration. It typically retains the rock structure of the parent rock (i.e., is saprolitic) but exhibits the engineering characteristics of a soil when removed. Within a disintegrated rock zone, slabs of rock, rock lenses, and/or boulders of intact rock may be encountered during excavation. Disintegrated rock (often sampled as silty sand with preserved rock fabric and mica) was encountered in most of the borings. The top of disintegrated rock was interpreted at approximate elevations of about El. 170 to El. 184, with the contact typically occurring at depths on the order of about 10 to 15 ft bgs (depending on ground surface elevation and fill thickness). Competent bedrock (i.e., intact, strong, and relatively unweathered) was not encountered within the depths explored.

GROUNDWATER CONDITIONS

No groundwater was encountered during or at completion of subsurface investigations. Groundwater level readings have been made in the boreholes at times and under conditions discussed herein. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in season, rainfall, temperature, dewatering activities, and other factors not evident at the time measurements were made and reported herein.

Design Recommendations

The design recommendations presented herein for the design of the subject project are based on the structural loadings, configurations, and site development plans as understood by Haley & Aldrich at this time. If modifications are made to any of these elements, the design criteria presented herein should be reviewed by Haley & Aldrich for continued applicability.

PROPOSED CONSTRUCTION

Our understanding of the proposed project is based on a February 20, 2026 Progress Set of construction drawings. Refer to Figures 3 and 4 for an overlay of field investigation locations on the progress civil and structural designs. The steel arch bases and ends of the mesh enclosure will be founded on new foundations capable of resisting a 23-kips vertical downward load, 19-kips upward load, and 21-kips lateral load and the proposed building will have a maximum column load of 100-kips and wall load of 3 kips per foot. Refer to the latest project drawings for the current design.

SEISMIC

Seismic design recommendations have been developed in accordance with the 2024 International Building Code ("Building Code") for consideration by the structural engineer. The Building Code references ASCE/SEI 7-22 Minimum Design Loads for Buildings and Other Structures ("ASCE 7-22") for seismic design parameters. As per ASCE 7-22, site-specific subsurface data to a depth of 100 ft must be known in sufficient detail to make a seismic site classification; otherwise, site class D shall be used. Accordingly, site class D was used to determine the seismic design parameters for this site. Seismic design parameters were evaluated for Risk Categories I and II and are summarized in **Table I**.

TABLE I: Seismic Design Parameters

DESIGN PARAMETER	Risk Category I and II
Horizontal response spectral acceleration coefficient at 0.2-s period, S_S (g)	0.15
Horizontal response spectral acceleration coefficient at 1.0-s period, S_1 (g)	0.042
Peak seismic ground acceleration coefficient, PGA_M (g)	0.085
Horizontal response spectral acceleration coefficient at 0.2-s period modified by F_a, S_{DS} (g)	0.13
Horizontal response spectral acceleration coefficient at 1.0-s period modified by F_v, S_{D1} (g)	0.059
Seismic Design Category	A

DESIGN GROUNDWATER LEVEL

As stated earlier, groundwater was not encountered in the borings at the time of drilling to the explored depths. For design conditions involving hydrostatic loading, groundwater may be assumed to occur at or below the maximum depths explored in the borings, provided that positive surface drainage and subdrainage systems are implemented to prevent the buildup of hydrostatic pressures resulting from surface water infiltration and stormwater accumulation.

FOUNDATION RECOMMENDATIONS

The following key considerations were identified in our evaluations:

- FILL materials extending to depths of 4 to 8 ft bgs were encountered in all borings, except HA-6. Haley & Aldrich is not aware of any records of compaction quality control during placement of the existing FILL soils. Therefore, we consider the FILL to be uncontrolled. The primary concern for supporting new foundations on uncontrolled fill is that it is difficult to predict how it may settle in the future particularly under increased load, and excessive foundation movement is more likely to occur, possibly leading to loss of service and potentially failure.

- The enclosure structure will impart significant lateral loads at its foundation level, which varies across the site. At most foundation locations and anticipated bearing levels, either FILL or loose residuum materials are present. These materials have low lateral bearing capacity and will likely shift excessively under lateral loads.
- Some new foundations may be located on the retained side of new or existing foundations and site retaining walls. Foundations bearing within the retained soil will impart a lateral surcharge to the walls, which must be accounted for in design.
- Space constraints and the potential for large excavations appear to limit the cost-effectiveness of shallow foundations for the enclosure where lateral loads must be resolved by the earth.
- Space constraints and the low tolerance for construction vibration and noise impacts to the surrounding exhibits limit the range of potential deep foundation solutions for the enclosure.

After considering these implications, recommendations are provided below for deep foundation support where shallow foundations are impractical.

Deep Foundations - Micropiles

The ends and steel arch bases of the mesh enclosure should be supported by deep foundations because of their high lateral and uplift loads to avoid large excavations and shallow foundations. Micropiles (small-diameter, drilled-in, cast-in-place cement-grouted steel-reinforced piles) are recommended. Our evaluations considered pile arrangements shown on the Progress Set.

Micropiles should be designed based on side friction capacity in the residuum stratum only. The FILL soil should be assumed to provide no contribution to the micropile side friction capacity and end-bearing should not be considered in the design. A permanent steel outer casing should be provided through the existing FILL and extend to the underlying residuum. Additional recommended design criteria are provided below:

- Micropiles are typically designed by a specialty contractor to satisfy the requirements of a performance-based specification. Therefore, the pile diameter and length will vary depending on the contractor's design and equipment. For bidding purposes, the drawings should indicate a 12-in nominal diameter micropile with a single No. 18 threaded steel bar (minimum 60 ksi steel) over the full length of the pile, tremie grouted with minimum 5 ksi 28-day unconfined compressive strength cement grout. The top 15 ft of the pile should be cased with permanent steel, ½-in. thick wall Grade 80 casing, and the minimum bond length in residuum should be a minimum of 5 ft. Drawings should indicate the pile design is delegated to the Contractor and their Professional Engineer licensed in Washington DC.
- Micropiles should be drilled using rotary duplex (internal fluid flush) methods and be reinforced with a centrally installed reinforcement bar in a tremie-grouted hole. Re-grouting the micropiles may improve load carrying capacity but is likely not warranted for the relatively light axial loads.
- For compressive loads, the maximum allowable stress in the grout should be 33 percent of the 28-day grout unconfined compressive strength. The allowable design tensile strength of the grout shall be zero. The minimum grout thickness surrounding the core steel should be 1 in.

- The maximum allowable stress in the steel core should be 50 percent of the minimum specified yield strength, not exceeding 32 kips per square inch (ksi), for compressive loads and 60 percent of the minimum specified yield strength for tensile loads. The core steel should extend the full length of the micropile and be designed to carry at least 40 percent of the design compressive load. The outer casing shall have a minimum wall thickness of ½ in.
- Piles should be designed to accommodate seismic loading conditions in accordance with the Building Code as applicable.
- The center-to-center micropile spacing should be 24 in. minimum. Micropiles shall be arranged and braced to provide lateral stability in all directions where necessary.
- An allowable compression capacity of 28 kips and tension capacity of 22 kips is feasible per pile for micropiles designed and installed in accordance with these recommendations. These capacities were calculated using a factor of safety of 2. The tension capacity per pile should be reduced for pile groups where vertical piles are planned to be spaced closer than 4 ft center-to-center. A reduced tension capacity is not provided since lateral capacities should govern at these pile groups.
- Lateral capacities for a maximum deflection of 0.5 in. and the cap configurations of the Progress Set are below. To achieve fixity for the capacities shown below, the micropile's permanent steel casing must be a minimum of 15 ft deep below the cap. Lateral capacities of vertical micropiles may be reduced because of group effects that apply when the center-to-center (c-c) spacing is less than 8 ft. Pile group capacities below may be increase by 6% for each 1 ft increase in pile c-c spacing. Piles are assumed to be oriented vertically except as noted. Capacities assume pile caps are backfilled with Structural Fill.

Design Case	Allowable Lateral Capacity
Continuous Ret. Walls, Mesh Curbs, staggered, c-c > 4 ft	5.5 kips/pile
Pile Group PC-12	45 kips
Pile Group PC-9	35 kips
Pile Group PC-6	23 kips
Battered at 20 deg., opposing pair within a cap	add 1.5 kips/pair

- Compression, tension, and lateral capacities above may be used simultaneously without applying a reduction.
- For micropile foundations designed in accordance with the recommendations presented above, we estimate that total post-construction settlements should not exceed 1 in, and deflection at pile head should be less than ½ in.
- Moments and shears acting at the pile head under the above allowable capacities are preliminarily 0 kip-in. (pinned) and 175 kip-in. (fixed), and 6.5 kips (pinned) and 6.7 kips (fixed), respectively.
- The design pile capacity should be verified by one static axial and one static lateral load test per American Society for Testing and Materials (ASTM) D3689 and ASTM D3966.

- The bottoms of exterior pile caps should extend a minimum of 30 in. below the lowest finished adjacent grade for frost protection.

Shallow Foundation

Shallow foundations that are constructed in accordance with the recommendations included herein can be used to support the building, walkway tunnel walls, site retaining walls, and curbs at the edge of enclosures:

- Conventional shallow spread footing foundations bearing on residuum or compacted structural fill placed following removal of FILL (if encountered at bottom of footing) can be designed using the allowable vertical bearing capacities summarized below.

Structure	Allowable Vertical Bearing Capacity	Coefficient of Friction
Building	2,750 psf	0.45
Tunnel Walls	2,000 psf	0.4
Site Retaining Walls	2,000 psf	0.4
Curbs at Edge of Enclosure	2,000 psf	0.4

- All uncontrolled FILL materials below the proposed footings should be removed to the underlying residuum stratum and replaced with compacted structural fill to achieve the allowable bearing pressures summarized above.
- For footings designed in accordance with these allowable bearing pressures, we estimate that total settlements will not exceed 1 in., and differential settlement will be less than 0.5 in. Where shallow foundations transition to deep foundations, differential settlement of supported elements is estimated to be 3/4 in. (but will not exceed 1 in.) because micropiles bond in residuum will be stiffer than soil below footings. Allowable vertical bearing capacities can be reduced by 50 percent to reduce estimated settlements by a similar magnitude, or footings can be lowered to a stiffer residuum layer to reduce the amount of differential settlement across a transition area. The recommended approach and size of the transition area depends on the specific location and footing bearing level among other factors.
- If lateral resistance is required, passive earth pressure resistance against the sides of the footing can be utilized. We recommend that the passive earth pressure resistance of soils adjacent to footings be calculated using a passive earth pressure coefficient, Kp, of 2.7 (ultimate) assuming the footing is backfilled with compacted structural fill. Relatively large deflections are required to develop full passive pressure resistance. Therefore, a minimum safety factor of 3.0 should be used to estimate allowable passive earth pressures to control movement. In addition, the coefficient of sliding friction values provided above can be used for the base of footings constructed using poured cast-in-place concrete.
- To reduce the possibility of localized shear failures, strip and rectangular footings should have a minimum width of 18 in. and 30 in., respectively.

- Footings in exterior and unheated areas should bear a minimum of 30 in. below the lowest finished adjacent grade for frost protection.
- The bottom of the footings should bear below a 1 horizontal to 1 vertical (1H:1V) slope line drawn upward and outward from the bottom of any adjacent foundation or site retaining wall or utility. Where that is not possible, consideration should be given to using micropiles for foundation support.
  - For footings set above this line, the retaining wall will be subject to a lateral surcharge with a magnitude of 0.5q or 0.3q (psf), where q is the vertical surcharge load (psf), uniformly distributed over the height of the wall for restrained and unrestrained walls, respectively, from the bottom of the footing to the bottom of the wall.

LOWEST LEVEL FLOOR SLAB

Based upon the results of our current study, it is our opinion that the lowest level floor slabs within the building may be designed as slab-on-grade units supported by approved on-site soils and/or structural fill placed over approved on-site soils. Since undocumented fill materials are present at the proposed site, the floor slab areas should be heavily proof rolled as detailed in the Preparation of Subgrade section of this report.

We recommend that the slab-on-grade be supported on a minimum 6-in. thick layer of crushed stone installed above the finished soil subgrade. The crushed stone should meet the requirements of American Association of State Highway and Transportation Officials (AASHTO) No. 57 stone. The purpose of the crushed stone is to provide uniformity of support and act as a capillary break against moisture migration through the slab. In addition, a moisture barrier such as a 6-millimeter polyethylene membrane, or similarly rated vapor barrier, should be installed between the underside of the floor slab and the crushed stone layer to reduce the potential for excess moisture loss from the concrete during finishing and curing. Design and construction details of vapor barriers should be coordinated with the structural engineer of record to ensure proper slab curing.

A modulus of subgrade reaction (K) of 150 pci can be used for properly compacted subgrade in the design of the slab-on-grade. This recommended value is based on at least 6 in. of crushed stone being present below the lowest level floor slabs.

RETAINING WALLS

We understand that the building and walkway tunnel will have below-grade walls. We also understand that the project consists of the construction of maximum 10-ft tall cantilever site retaining walls.

Restrained Below-Grade Walls

Permanent perimeter building and walkway tunnel below-grade walls should be designed for the at-rest earth pressure condition if they are braced at the top. Recommended design parameters are shown below in **Table II**.

Table II. Recommended Properties For Restrained Below-Grade Wall Design						
Moist Unit Weight (pcf)	Saturated Unit Weight (pcf)	Angle of Internal Friction, ϕ	K_o	K_p	Equivalent At-Rest Lateral Earth Pressure (psf/ft)	Coefficient of Sliding Friction
120	125	30°	0.50	2.7	60	0.45

Lateral earth pressure on unyielding walls is estimated using the K_o coefficient. Passive earth pressures estimated using the K_p values presented above are ultimate values. Relatively large wall deflections are required to develop full passive pressure resistance. Therefore, a minimum safety factor of 3.0 should be used to estimate allowable passive earth pressures to control movement.

The walls should be designed with a drainage system to reduce the potential for collection of water behind the walls. If water were to collect behind the retaining walls without draining away properly, hydrostatic pressure would develop, which would increase lateral load on the retaining walls. Accordingly, we recommend the backfill materials behind the walls to consist of granular materials (silty sand or coarser) with a perforated (minimum 4-in. diameter) PVC drainage pipe installed parallel to the length of the walls just above the top of the footing level to collect and drain the water. The drainage pipe should be surrounded by a minimum of 6 in. of AASHTO No. 57 stone on all sides, and pipe perforations should be oriented downward. The drainage stone and pipe should be wrapped in a geotextile filter fabric, such as Mirafi 160N or approved equal. The drainage pipe should drain by gravity, pumping from sumps or be connected directly to a storm water drain line. Cleanouts extending vertically from the 4-in. diameter pipe to the ground surface should be provided at each end of the wall, at 100-ft intervals along the backside of the wall, at locations where the direction of the drainage pipe changes, and at terminations. Retaining wall and below-grade wall drainage systems should be separated from roof runoff water or other storm water sources. Measures should be taken to prevent backup of site storm water into the retaining wall and below-grade wall drain systems.

The backfill materials behind the walls should be placed and compacted to 95 percent of the maximum dry density as determined by ASTM D 1557 (Modified Proctor) and to within ± 2 percentage points of the optimum moisture content as discussed in the “Site Backfill and Compaction Requirements” section of this report.

Unrestrained Site Retaining Walls

We have assumed that the proposed site retaining walls will be cantilever concrete retaining walls free to rotate about their base. The walls should be designed for the active condition using the properties shown in **Table III** below.

Table III. Recommended Properties For Cantilever Wall Design						
Moist Unit Weight (pcf)	Saturated Unit Weight (pcf)	Angle of Internal Friction, ϕ	K_a	K_p	Equivalent Active Lateral Earth Pressure (psf/ft)	Coefficient of Sliding Friction
120	125	30°	0.33	2.7	40	0.4

Passive earth pressures estimated using the K_p values presented above are ultimate values. Relatively large wall deflections are required to develop full passive pressure resistance. Therefore, a minimum safety factor of 3.0 should be used to estimate allowable passive earth pressures to control movement.

The value of the coefficient of sliding friction shown in the table above assumes that the base of the retaining wall will be constructed using cast-in-place concrete poured directly against the exposed soils. We recommend that the following minimum factors of safety be used in design of the retaining wall.

- FS against sliding = 1.5
- FS against overturning = 1.5

The retaining walls and associated footings will be constructed above the design groundwater level. However, water from precipitation may collect behind the retaining walls, which would add lateral load to the retaining walls. Accordingly, it is recommended that the walls be designed with a drainage system to reduce the potential for collection of water behind the walls. We recommend the backfill materials behind the walls to consist of granular materials (silty sand or coarser) with a perforated (minimum 4-in. diameter) PVC drainage pipe installed parallel to the length of the walls just above the top of the footing level to collect and drain the water. The drainage pipe should be surrounded by a minimum of 6 in. of AASHTO No. 57 stone on all sides and pipe perforations should be oriented downward. The drainage stone and pipe should be wrapped in a geotextile filter fabric, such as Mirafi 160N or approved equal. The drainage pipe should drain by gravity, pumping from sumps, or be connected directly to a storm water drain line. Cleanouts extending vertically from the 4-in. diameter pipe to the ground surface should be provided at each end of the wall, at 100-ft intervals along the backside of the wall, at locations where the direction of the drainage pipe changes, and at terminations. Retaining wall and below-grade wall drainage systems should be separated from roof runoff water or other storm water sources. Measures should be taken to prevent backup of site storm water into the retaining wall and below-grade wall drain systems.

The backfill materials should be placed and compacted to 95 percent of the maximum dry density as determined by ASTM D 1557 (Modified Proctor) and to within ± 2 percentage points of the optimum moisture content as discussed in the “Site Backfill and Compaction Requirements” section of this report.

STORMWATER MANAGEMENT FACILITIES

We understand that a bioretention and infiltration trench facilities may be constructed as summarized below.

SWM Pond	Representative Boring(s)	Bottom of Facility (ft)	Highest Water Level (ft)
Bioretention	HA-5	El. 172	Not encountered
Infiltration Trench	HA-8 and HA-9	El. 182	Not encountered

Falling Head Infiltration Testing

Infiltration testing was performed at three temporary infiltration test holes immediately adjacent to test borings HA-5, HA-8, and HA-9. The test borings were performed to evaluate subsurface conditions at the test locations and extended to approximately 12 to 14 ft below existing site grades, which is approximately 4 ft below the infiltration test depths. The test holes were prepared by drilling to the infiltration test depths using 2-¼ in. i.d. hollow-stem augers. After removing the augers, open-ended, 4-in. i.d. solid-wall schedule 40 PVC pipes were installed vertically in the boreholes to facilitate testing at depth below the ground surface.

In-situ infiltration testing was performed using the falling head method. The falling head method involves pre-soaking the infiltration pipes for 24 hours, then adding water to a depth of 2 ft above the bottom of the test holes. The water level is then recorded hourly four times. Following completion of the infiltration testing, the PVC pipes were removed, and the boreholes were backfilled.

The calculated field infiltration rates are summarized below in **Table IV**.

Table IV. Summary of Infiltration Test Results

Facility	Boring Designation	Infiltration Test Depth (ft)	Infiltration Test Elevation (ft)	Probable Bedrock Elevation[1] (ft)	Infiltration Rate[2] (In./hr)	Saturated Hydraulic Conductivity[3] (in/hr)
Bioretention	HA-5	10	172	169	2	1
Infiltration Trench	HA-8	8	182	179	0.3	0.2
Infiltration Trench	HA-9	8	182	178	0.3	0.2

1. Identified by SPT refusal.
2. A safety factor has not been applied to the infiltration rate.
3. Estimated from field infiltration rate based on the equation provided in the DOEE handbook

As noted in the table above, a safety factor has not been applied to the field infiltration rate discussed herein. The designer of the infiltration system should determine the design infiltration rate. The designer of the infiltration system should use their judgment when interpreting the results of the infiltration testing presented herein.

SITE BACKFILL AND COMPACTION REQUIREMENTS

Recommendations for preparation of subgrade, use of on-site soils, structural fill, and treatment of backfill for utility trenches are provided below.

Preparation of Subgrade

All unsuitable soils within the limits of the proposed structures should be removed down to the top of the inorganic soil prior to foundation and floor slab construction. After removal of the unsuitable soils, new compacted structural fill should be placed to raise existing site grades to design subgrade levels, where necessary.

After excavation to the design subgrade level and prior to placement of new fill or structure, the subgrade should be proof rolled using a fully loaded 20-ton payload dump truck or other pneumatic-tired vehicle of similar size and weight. In confined areas, the subgrade should be proof-rolled with a minimum of two passes of a walk-behind or trench roller. Areas that show signs of movement, rutting, or instability should be undercut to competent material and be replaced with structural fill as described below.

Use of On-Site Soils

On-site soils with USCS group symbols of CL, CH, CL-ML, ML, MH, OL and OH are not suitable for use as structural fill but may be used as common fill. During our subsurface exploration program, soils falling into these categories were not frequently encountered. The near surface on-site soils with a USCS group symbol of SC, SW, SM, SP-SM, SW-SM, GM, GW, and GW-GM are suitable for use as structural fill.

Structural Fill

Structural fill to support footings, slabs, and hardscaping, and backfill pile caps, should consist of soil consisting of a mixture of clean sandy gravel, gravelly sand, or sand and gravel (USCS group symbols of SP-SM, SW-SM, GM, GW, and GW-GM) that is free of organic material, snow, ice, frozen soil, or other objectionable materials. The structural fill should be a well-graded material with a maximum particle size of 3 in. The fines in the fill material should have a liquid limit no greater than 40 percent and a plasticity index no greater than 10.

In addition to the above requirements, structural fill to be placed in the upper 3 ft of filled areas during periods of wet and/or freezing weather should contain less than 5 percent passing the No. 200 sieve. Material proposed as structural fill should be tested and approved by the Owner, or their designated representative, prior to its use. To evaluate the suitability and the quality of the fill source, we recommend that laboratory testing of fill material be performed in accordance with the ASTM Test Methods indicated below in **Table V**.

Table V. Summary Of ASTM Test Methods

Test	ASTM Designation
Moisture Content	D 2216
Modified Proctor	D 1557
Sieve Analysis	D 422
Atterberg Limits	D 4318

Structural fill in confined areas should be placed in horizontal lifts not exceeding 6-in. in loose thickness and compacted to at least 95 percent of the laboratory maximum dry density, as determined by ASTM Test D1557 (Modified Proctor). Structural fill should be moisture conditioned to within ± 2 percentage points of the optimum moisture content.

Hand-guided equipment compaction equipment for confined areas should impart a dynamic force of at least 2,500 pounds. Foundation and site retaining wall fills within 5 ft laterally of the wall's rear face should be placed in lift thicknesses not exceeding 6 in. in loose measure and compacted using vibratory equipment imparting dynamic forces of at least 2,500 pounds and no greater than 7,500 pounds. A minimum of four systematic passes of the compaction equipment should be used to compact each lift.

Structural fill should not be placed on frozen ground or uncompacted soil. During periods of freezing weather, each lift of fill should be compacted immediately following placement.

Placement and compaction of all fill materials should be monitored and tested by a qualified technician under supervision of a professional geotechnical engineer. We recommend that all fill placement be tested in accordance with ASTM D2922 and D3017 (Nuclear Density Method) to verify the density, degree of compaction, and moisture content of the fill. The project specifications should call for frequent testing on each lift. In the event that any portion of the fill fails to meet the compaction requirements, the area should be reworked, recompacted, and retested until the specified compaction is achieved.

Common Fill

Common fill for use in landscaped areas may consist of imported or on-site soils that do not contain degradable materials. The maximum particle size for common fill should be no greater than 3 in.

Common fill in unconfined areas should be placed in horizontal lifts not exceeding 8 in. in loose thickness and compacted to at least 90 percent of the laboratory maximum dry density, as determined by ASTM D 1557 (Modified Proctor). Common fill should be moisture conditioned to within ± 2 percentage points of the optimum moisture content. In confined areas, common fill should be placed in lifts not exceeding 6 in. in loose thickness and tamped in place by hand-guided power tampers.

Treatment of Backfill for Utility Trenches

Bedding material for pipelines may consist of sandy soil meeting the requirements of AASHTO No. 9 stone or other approved material. The bedding material should be placed below the pipe, alongside the pipe, and up to 1 ft above the pipe. A minimum 6-in. thick bedding layer should be placed and compacted below utilities. Alongside and up to 1 ft above the pipe, the bedding (side embedment and top embedment) should be compacted using hand-guided compaction equipment to reduce the potential for damage to the pipe. The side and the top embedment material should be placed evenly on both sides of the pipe so that the pipe is not displaced either laterally or vertically and compacted by hand tampers (or light mechanical equipment if it would not damage the pipe).

It is recommended that the bedding material be placed in no more than 6-in. thick horizontal lifts (loose measure) and compacted below the pipe invert by a walk-behind or trench roller. All bedding material should be compacted to at least 100 percent of the maximum dry density as determined by ASTM Test D 1557 (Modified Proctor). Above the bedding material, structural backfill should be placed. Trench backfill that will support loads from structure foundations, paved areas, or sidewalks should consist of structural fill.

Crushed Stone Drainage Fill

Drainage fill should consist of crushed stone meeting the specifications for AASHTO No. 57 stone or other approved material. In unconfined areas, drainage fill should be placed in lifts not exceeding 8 in. in loose thickness and compacted with at least two passes of a heavy vibratory compactor. In confined areas, drainage fill should be placed in lifts not exceeding 6 in. in thickness and tamped in place by hand-guided power tampers.

Construction Considerations

The following sections of the report include comments on items related to geotechnical engineering aspects of the proposed construction. This section is written primarily for the engineer responsible for preparation of plans and specifications. Since this section identifies potential construction problems related to foundations and earthwork, it will also aid personnel who monitor the construction activity.

Prospective contractors for the project must evaluate potential construction problems on the basis of their own knowledge and experience in the District of Columbia, and on the basis of similar projects in other localities, taking into account their own proposed construction methods and procedures.

In addition to the construction guidelines and recommendations made herein, construction activities should conform to the requirements of Occupational Safety and Health Administration (OSHA) and other applicable state and regulatory agencies.

EXISTING UTILITIES AND UNDERGROUND OBSTRUCTIONS

Existing utilities, foundations, and underground obstructions that will not be removed or relocated during construction should be clearly marked and protected during construction. If any existing utilities, foundations, or underground obstructions are removed, the materials generated from clearing and demolition of such utilities should be disposed of in an approved off-site disposal facility.

DRAINAGE AND SUBGRADE PROTECTION

Surface drainage should be maintained throughout the site and channeled to appropriate disposal facilities. All ground surfaces adjacent to structures should be graded to slope away from the exterior walls/foundations at a minimum slope of 5 percent. Ponding of surface water should not be allowed, especially adjacent to pavements and structures. In addition, it is recommended that appropriate sedimentation and erosion controls be implemented in accordance with the approved grading plans prior to commencement of any grading operations.

CONSTRUCTION DEWATERING

We anticipate that general grading and construction activities will be above the static groundwater level. Therefore, we do not anticipate that significant construction dewatering will be required. However, the potential exists to encounter perched water during excavations for utility installation, shallow foundations, and similar activities. In general, a temporary dewatering system to handle perched water conditions may consist of pumping from open sumps installed within the excavation or pumps installed in wellpoints located in close proximity to the excavation.

EXCAVATION

Excavation will be required for foundations, slab-on-grade construction, utilities, and removal of unsuitable and unstable soils encountered within the limits of construction. We anticipate that excavation of the existing FILL should generally be achievable by using conventional earth-moving equipment in proper working condition.

During excavation, care should be taken not to disturb the exposed soils at the excavation subgrade level. The exposed subgrade soils should be examined for the presence of loose or unsuitable soils. If unsuitable soils are encountered, they should be removed and replaced with compacted structural fill.

Construction excavations above the static groundwater table and not exceeding 4.5 ft in depth may be constructed with 1.5H:1V side slopes. Localized instabilities in such excavations may occur due to the heterogeneity of the near-surface soils. In such areas, the sides of the excavation should be flattened to a stable slope. The side slopes should be protected from excessive disturbance and surface water runoff.

In areas where deep excavations are required, laying back the excavation side slopes may not be practical due to space limitations. Accordingly, a temporary excavation support system consisting of soldier piles and wood lagging should be used to retain the soils in these situations. **Table VI** provides recommended soil properties for the design of temporary excavation support systems.

Table VI.Soil Properties for Design of Temporary Excavation Support Systems

Stratum	Moist Unit Weight (pcf)	Buoyant Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
Existing Soil	120	60	30	0

In addition, regardless of the above recommendations, all excavations should be performed in accordance with local, state, and federal regulations, including current OSHA excavation safety standards.

PRE AND POST CONSTRUCTION CONDITION SURVEY

If proposed excavation activities will be close to adjacent structures, consideration should be given to performing a preconstruction condition survey to document existing distress prior to construction and a post construction condition survey to document distress following construction. In addition, an instrumentation program consisting of surface settlement points and optical survey points should be considered where deep excavations are planned adjacent to existing structures.

CONSTRUCTION MONITORING

We recommended that Haley & Aldrich be retained and present during construction to:

- Observe and approve foundation subgrades;
- Observe and record relevant data during micropile installation;
- Observe placement and test compaction of all fill materials in accordance with ASTM D 1556 (sand cone method) or ASTM D 2922 and D3017 (nuclear method) to verify the density, degree of compaction, and moisture content of the fill;
- Collect samples and perform additional laboratory tests, as required during construction, to help determine the suitability of proposed structural fill;
- Prepare a field report for each day's work summarizing the test results and observations, including comments on the day's construction activities.

Limitations

This report has been prepared for specific application to the proposed construction as understood at this time. In the event that changes in the recommended design are planned, the conclusions and recommendations contained in this report should not be considered valid, unless the changes are reviewed by Haley & Aldrich and the conclusions of this report modified or verified in writing.

The geotechnical evaluations and recommendations are based, in part, upon the data obtained from the referenced subsurface explorations. The nature and extent of variations between explorations may not become evident until construction. If variations appear at that time, it may be necessary to re-evaluate the recommendations of this report.

This report is prepared for the exclusive use of SmithGroup and their subconsultants in connection with the subject project. There are no intended beneficiaries other than SmithGroup and Smithsonian Institution. Haley & Aldrich shall owe no duty whatsoever to any other person or entity on account of the Agreement or the report. Use of this report by any person or entity other than SmithGroup and Smithsonian Institution and their subconsultants for any purpose whatsoever is expressly forbidden unless such other person or entity obtains written authorization from SmithGroup, Smithsonian Institution, and from Haley & Aldrich. Use of this report by such other person or entity without the written authorization of SmithGroup, Smithsonian Institution, and from Haley & Aldrich shall be at such other person's or entity's sole risk and shall be without legal exposure or liability to Haley & Aldrich.

Closing

We appreciate the opportunity to provide engineering services on this project. Please do not hesitate to call if you have any questions or comments.

Sincerely yours,
HALEY & ALDRICH, INC.

Robel Gibbe
Senior Project Manager

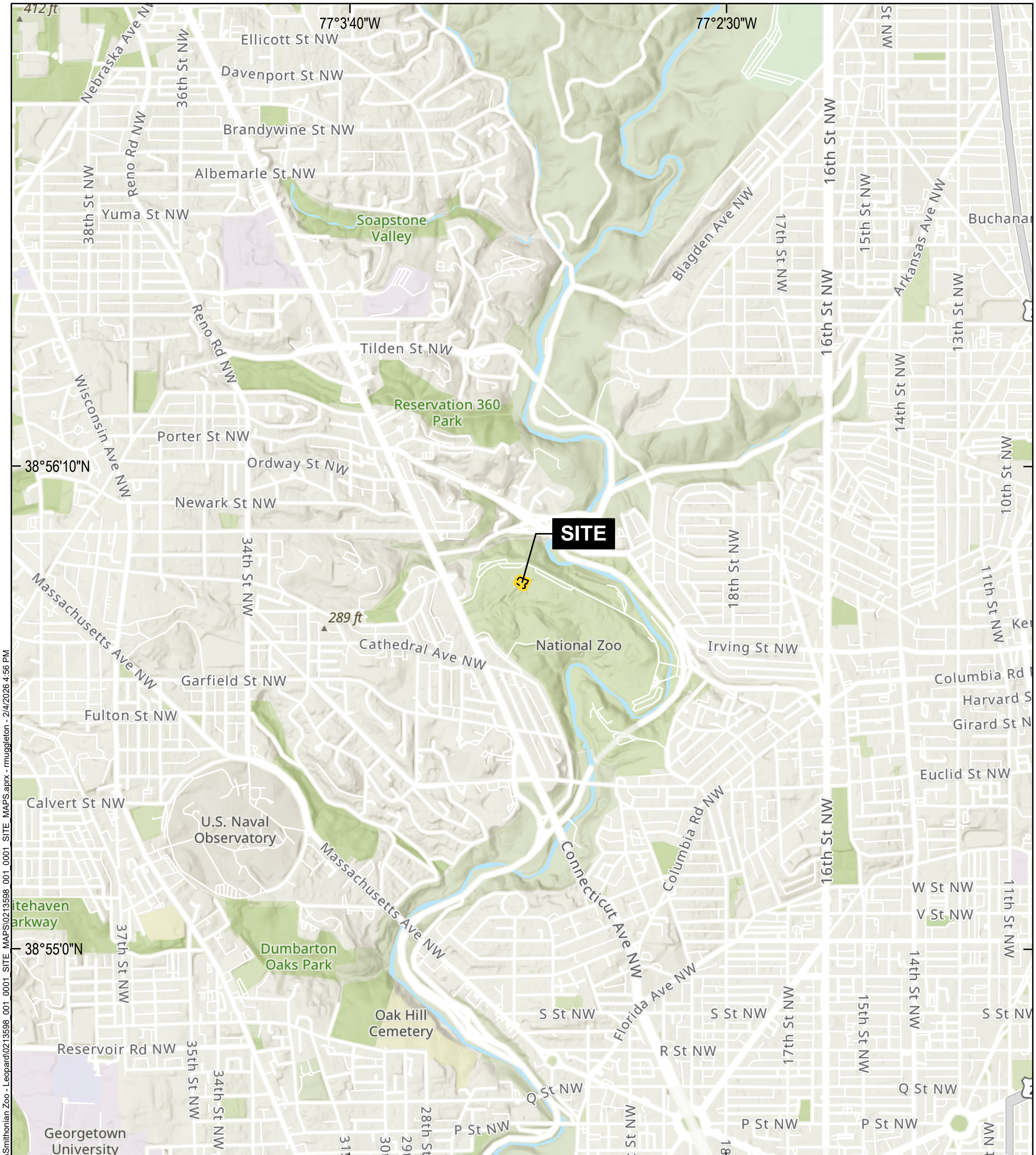
Jeremy A. Haugh, P.E.
Senior Associate

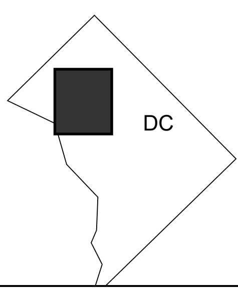
Enclosures:
- Figure 1 – Project Locus
- Figure 2 – Boring Location Plan (Existing Conditions)
- Figure 3 – Boring Location Plan (Civil Design)
- Figure 4 – Boring Location Plan (Structural Design)
- Appendix A – Test Boring Logs, Laboratory Test Results

References

1. Southworth, S. and Denenny, D., 2006. "Geologic Map of the National Parks in the National Capital Region, Wasington, D.C., Virginia, Maryland, and West Virginia", U.S. Geological Society Open-File Report 2005-1331, pg. 19-21.

FIGURES





MAP SOURCE: ESRI
SITE COORDINATES: 1,297,481E, 460,615N

HALEY ALDRICH

CONSTRUCT ARABIAN LEOPARD FACILITY - NZP
3001 CONNECTICUT AVE NW
WASHINGTON, DC 20008

PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
MARCH 2026

FIGURE 1

GIS: \\haleyaldrich.com\share\CF\Projects\0211696\GIS\Smithonian Zoo - Leopard\0213598_001_0001_SITE_MAPS\0213598_001_0001_SITE_MAPS.aprx - rmuggleton - 2/4/2026 4:56 PM

LEGEND

- DESIGNATION, ELEVATION, AND APPROXIMATE LOCATION OF TEST BORINGS PERFORMED BY HALEY & ALDRICH
- DESIGNATION, ELEVATION, AND APPROXIMATE LOCATION OF HISTORIC TEST BORINGS PERFORMED BY SCHNABEL

NOTES

1. BORING PLAN WAS PREPARED FROM EXISTING CONDITIONS SURVEY PLAN PROVIDED BY SMITHGROUP.

2. TECHNICAL MONITORING OF FIELD EXPLORATIONS WAS COMPLETED ON DECEMBER 18 AND 19, 2025 BY HALEY & ALDRICH, INC.

3. AS DRILLED LOCATIONS OF TEST BORINGS WERE DETERMINED IN THE FIELD BY HALEY & ALDRICH, INC. BY TAPE MEASUREMENTS FROM EXISTING SITE FEATURES. GROUND SURFACE ELEVATIONS WERE ESTIMATED BY LINEAR INTERPOLATION USING THE GROUND SURFACE ELEVATION CONTOUR LINES AND SPOT ELEVATIONS SHOWN ON THIS PLAN.

4. BASEMAP IMAGERY SOURCE: SMITHGROUP.

N

0 25 50
SCALE IN FEET

HALEY ALDRICH

CONSTRUCT ARABIAN LEOPARD FACILITY - NZP
3001 CONNECTICUT AVE NW
WASHINGTON, DC 20008

BORING LOCATION PLAN

MARCH 2026

FIGURE 2

LEGEND

- DESIGNATION, ELEVATION, AND APPROXIMATE LOCATION OF TEST BORINGS PERFORMED BY HALEY & ALDRICH
- DESIGNATION, ELEVATION, AND APPROXIMATE LOCATION OF HISTORIC TEST BORINGS PERFORMED BY SCHNABEL

NOTES

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4. BASEMAP IMAGERY SOURCE: SMITHGROUP.

N

0 25 50
SCALE IN FEET

HALEY ALDRICH

CONSTRUCT ARABIAN LEOPARD FCILITY - NZP
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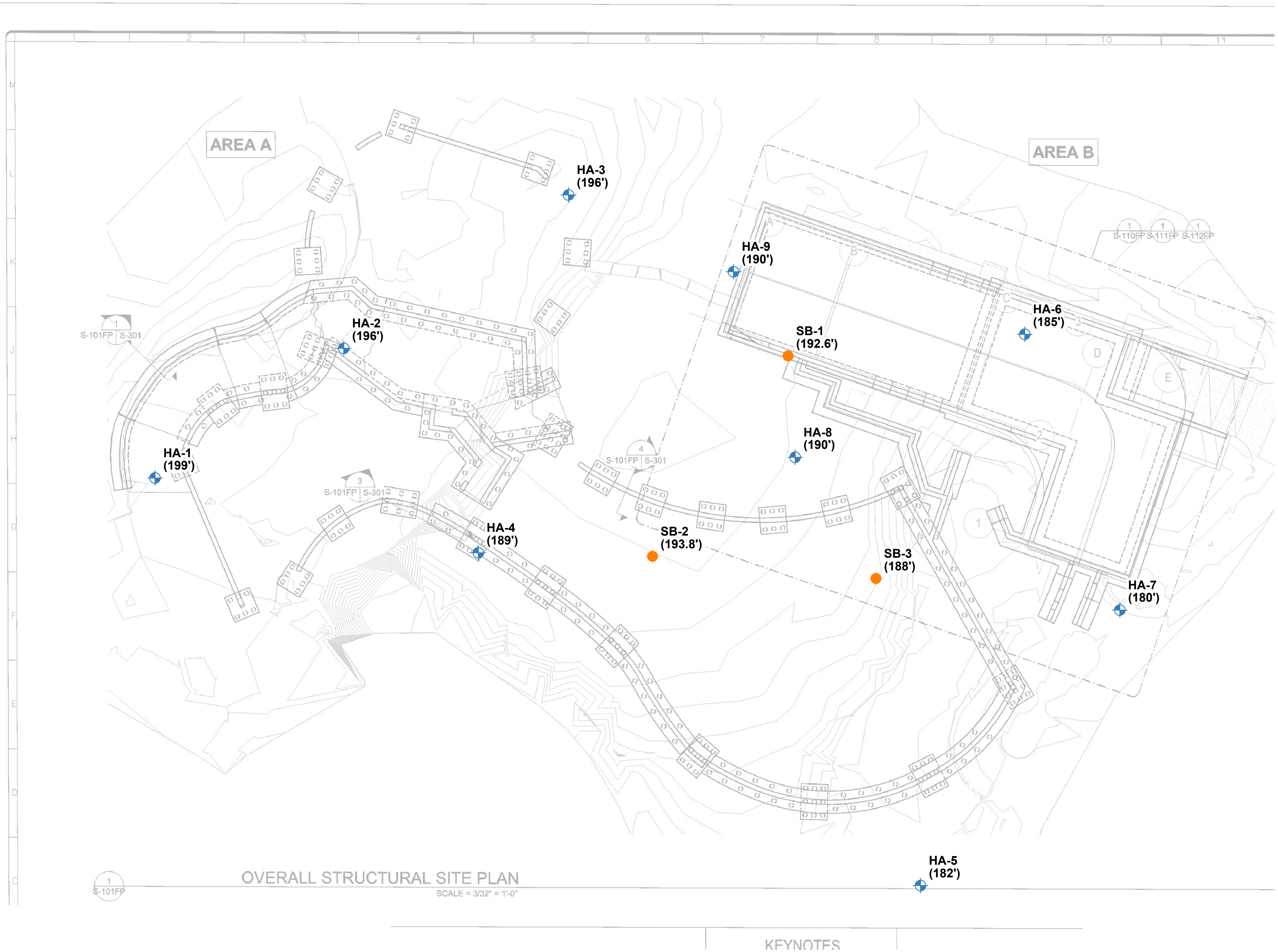
WASHINGTON, DC 20008

BORING LOCATION PLAN

MARCH 2026

FIGURE 3

GIS FILE PATH: \\haleyaldrich.com\share\CF\Projects\0211696\GIS\Smithonian Zoo - Leopard\0213598_001_0001_SITE_MAPS\0213598_001_0001_SITE_MAPS.aprx - USER: rmuggleton - LAST SAVED: 3/13/2026 4:59 PM



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4. BASEMAP IMAGERY SOURCE: SMITHGROUP.

N

0 25 50

SCALE IN FEET

HALEY ALDRICH

CONSTRUCT ARABIAN LEOPARD FACILITY - NZP
3001 CONNECTICUT AVE NW
WASHINGTON, DC 20008

BORING LOCATION PLAN

MARCH 2026

FIGURE 4

GIS FILE PATH: \\haleyaldrich.com\share\CF\Projects\0211696\GIS\Smithonian Zoo - Leopard\0213598_001_0001_SITE_MAPS\0213598_001_0001_SITE_MAPS.aprx - USER: rmuggleton - LAST SAVED: 3/13/2026 4:59 PM

APPENDIX A
Test Boring Logs and Laboratory Test Results

Soil Description Field Guide

HALEY ALDRICH

H&A FIELD SOIL IDENTIFICATION AND DESCRIPTION CHECKLIST

1. Density or Consistency
2. Color
3. Grain Size
4. Dilatancy, Plasticity, Dry Strength, Toughness
5. USCS Group Symbol
6. Maximum Particle Size
7. Oversize Component Estimates
8. Structure/Bonding
9. Odor
10. Moisture
11. Notes
12. Geologic Interpretation

CONSISTENCY COHESIVE SOILS

CONSISTENCY	SPT (# blows/ft)	TORVANE UNDRAINED SHEAR STRENGTH (tsf)	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)
Very soft	0 - 2	<0.13	<0.25
Soft	3 - 4	0.13 - 0.25	0.25 - 0.5
Medium Stiff	5 - 8	0.25 - 0.5	0.5 - 1.0
Stiff	9 - 15	0.5 - 1.0	1.0 - 2.0
Very Stiff	16 - 30	1.0 - 2.0	2.0 - 4.0
Hard	>30	>2.0	>4.0

COLOR EXAMPLES

- GRAY
- GRAY-BROWN
- OLIVE-BROWN
- OLIVE
- OLIVE-GRAY
- DARK BROWN
- RED-GRAY
- RED-BROWN
- BROWN
- RED
- LIGHT BROWN
- TAN
- YELLOW-BROWN
- RED-YELLOW
- YELLOW

RELATIVE DENSITY - NON-COHESIVE SOILS

RELATIVE DENSITY	SPT (# blows/ft)	MODIFIED CA. SAMPLER (# blows/ft)	CALIFORNIA SAMPLER (# blows/ft)
Very loose	0 - 4	0 - 4	0 - 5
Loose	5 - 10	5 - 12	6 - 15
Medium dense	11 - 30	13 - 35	16 - 40
Dense	31 - 50	36 - 60	41 - 70
Very dense	> 50	>60	>70

GRAIN SIZE

Clear Square Sieve Openings **U.S. Standard Series Sieve**

	12"	3"	3/4"	4	10	40	200
	Boulders	Cobbles	Gravel		Sand			Silts and Clays
SOILS			Coarse	Fine	Coarse	Medium	Fine	
FILLS	Blocks	Pieces	Fragments		Particles			Specks
	300mm	75mm	19mm	4.75mm	2.0mm	0.425mm	0.075mm	

CRITERIA FOR DESCRIBING DILATANCY

Description	Criteria
None	No visible change in the specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

CRITERIA FOR DESCRIBING PLASTICITY

Description	Criteria
Nonplastic	A 1/8 in. (3 mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

CRITERIA FOR DESCRIBING DRY STRENGTH

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling.
Low	The dry specimen crumbles into powder with some finger pressure.
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and a hard surface.

CRITERIA FOR DESCRIBING TOUGHNESS

Description	Criteria
Low	Only slightly pressure is required to roll 1/8 in. (3mm) thread near its plastic limit. Thread is weak and soft.
Medium	Medium pressure is required to roll the thread near the the plastic limit. The thread and lump have medium stiffness.
High	Considerable pressure is required to roll the thread near its plastic limit. Thread and lump have a very high plasticity.

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TEST BORING REPORT

HALEY ALDRICH

Boring No. HA-1

Project	ARABIAN LEOPARD EXHIBIT, SMITHSONIAN NATIONAL ZOO	File No.	0213691-000
Client	SMITHSONIAN INSTITUTION	Sheet No.	1 of 1
Contractor	FREESTATE DRILLING	Start	December 19, 2025
		Finish	December 19, 2025
		Driller	N. Meyers
		H&A Rep.	S. Schneckloth
		Elevation	199.0
		Datum	
		Location	See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	S	--	Rig Make & Model: Kodiac Recon ATV
Inside Diameter (in.)	-	1 3/8	--	Bit Type: / Drill Mud:
Hammer Weight (lb)	-	140	-	Casing: Hollow stem auger
Hammer Fall (in.)	-	30	-	Hoist/Hammer: Automatic Hammer / PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size[†], structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0					198.5 0.5	-6 IN. CONCRETE-										
	2 3 5	S1 14	0.5 2.0	SC		Loose dark brown clayey SAND (SC), no odor, moist, trace gravel, intermixed -FILL-		5		10	65	20				
	7 4 5 5	S2 13	2.0 4.0	SM		Loose light brown silty SAND (SM), no odor, moist, some quartz gravel, mica		5			80	15				
5	5 4 4 5	S3 15	4.0 6.0	ML	195.0 4.0	Medium Stiff light brown sandy SILT (ML), no odor, moist, some gravel, mica, rock fabric					35	65				
	7 5 3 4	S4 18	6.0 8.0	SP		Loose light brown poorly-graded SAND (SP), no odor, dry, rock fabric, mica					90	10				
10	3 6 6 7	S5 0	8.0 10.0			No recovery -RESIDUUM-										
	10 17 21	S6 1	13.5 15.0	SM		Dense red silty SAND (SM), low recovery, material could be slough					80	20				
15	26 37 50/5"	S7 0	15.0 16.5			Very dense disintegrated rock										
	15 22 27	S8	16.5 18.0	SP		Very dense tan and gray disintegrated rock sampled as poorly-graded SAND (SP), no odor, dry, trace large gravel					90	10				
					181.0 18.0	BOTTOM OF EXPLORATION 18.0 FT										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/19/2025		not encountered			

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary
- Overburden (ft) 18.0
- Rock Cored (ft) 0.0
- Samples S8

Boring No. HA-1

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

[†]**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA-2

Project	ARABIAN LEOPARD EXHIBIT, SMITHSONIAN NATIONAL ZOO	File No.	0213691-000
Client	SMITHSONIAN INSTITUTION	Sheet No.	1 of 1
Contractor	FREESTATE DRILLING	Start	December 19, 2025
		Finish	December 19, 2025
		Driller	N. Meyers
		H&A Rep.	S. Schneckloth
		Elevation	196.0
		Datum	
		Location	See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	S	--	Rig Make & Model: Kodiac Recon ATV
Inside Diameter (in.)	-	1 3/8	--	Bit Type:
Hammer Weight (lb)	-	140	-	Drill Mud:
Hammer Fall (in.)	-	30	-	Casing: Hollow stem auger
				Hoist/Hammer: Automatic Hammer
				PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0					195.4 0.6	-8 IN. CONCRETE-										
	3 6 8 12	S1 19	1.0 3.0	SC		Medium dense brown and black clayey SAND with gravel (SC), no odor, wood fragments -FILL-	10	5	0	15	40	50				
	6 10 13 7	S2 14	3.0 5.0	SC		Medium dense brown to tan clayey SAND with gravel (SC), no odor, moist, intermixed	9	23	7	7	25	29				
5	6 4 4 4	S3 12	5.0 7.0	SC		Loose red to brown clayey SAND with gravel (SC), no odor Note: Drill chatter at 6 ft.	10	10		5	40	35				
	5 4 3 3	S4 14	7.0 9.0	SM	189.0 7.0	Loose tan to red silty SAND (SM), no odor, dry, mica rock, rock fabric				5	75	20				
10	4 2 3 3	S5 15	9.0 11.0	SM		Loose tan to red silty SAND (SM), no odor, dry, mica rock, rock fabric -RESIDUUM-				5	70	25				
	7 7 8	S6 17	13.5 15.0	SM		Medium dense silty SAND with quartz gravel (SM), no odor, dry, mica rich					80	20				
15	8 12 15 12	S7	15.0 17.0	SM		Medium dense red silty SAND (SM), no odor, dry to moist, mica rich, rock fabric					80	20				
					179.0 17.0	BOTTOM OF EXPLORATION 17.0 FT										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/19/2025		not encountered			

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	17.0
Rock Cored (ft)	0.0
Samples	S7

Boring No. HA-2

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA-3

Project	ARABIAN LEOPARD EXHIBIT, SMITHSONIAN NATIONAL ZOO
Client	SMITHSONIAN INSTITUTION
Contractor	FREESTATE DRILLING

File No.	0213691-000
Sheet No.	1 of 1
Start	December 19, 2025
Finish	December 19, 2025
Driller	N. Meyers
H&A Rep.	S. Schneckloth
Elevation	196.0
Datum	
Location	See Plan

	Casing	Sampler	Barrel
Type	-	S	--
Inside Diameter (in.)	-	1 3/8	--
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Kodiac Recon ATV
Bit Type:
Drill Mud:
Casing: Hollow stem auger
Hoist/Hammer: Automatic Hammer
PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	2 2 3 3	S1 17	0.0 2.0	SC		Loose tan clayey SAND (SC), no odor, moist, contains roots and mulch, intermixed -FILL-	5	5	5	5	40	40				
	10 12 13 17	S2 12	2.0 4.0	SP		Medium dense tan poorly-graded SAND with gravel (SP), no odor, dry, brick fragments	20	10	5	10	50	5				
5	9 14 17 18	S3 19	4.0 6.0	SC	190.0 6.0	Dense tan to brown clayey SAND with gravel (SC), no odor, dry to moist, intermixed	10	10	5	5	40	30				
	5 8 17 18	S4 9	6.0 8.0	SM		Medium dense tan and gray silty SAND (SM), no odor, dry to moist, rock fabric, mica rich, oxidation		1		2	51	46				
	16 23 30 31	S5 16	8.0 10.0	SM		Dense tan and gray silty SAND (SM), no odor, moist, mica rich, rock fabric -RESIDUUM-				5	65	30				
10																
	16 34 50/5"	S6 11	13.5 15.0	SM	181.0 15.0	Very dense gray disintegrated rock sampled as silty SAND (SM), no odor, dry, rock fabric, mica rich					80	20				
15						BOTTOM OF EXPLORATION 15.0 FT										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/19/2025		not encountered			

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft) 15.0
Rock Cored (ft) 0.0
Samples S6

Boring No. HA-3

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA-4

Project	ARABIAN LEOPARD EXHIBIT, SMITHSONIAN NATIONAL ZOO
Client	SMITHSONIAN INSTITUTION
Contractor	FREESTATE DRILLING
File No.	0213691-000
Sheet No.	1 of 1
Start	December 18, 2025
Finish	December 18, 2025
Driller	N. Meyers
H&A Rep.	H. Tavakoli
Elevation	189.0
Datum	
Location	See Plan

	Casing	Sampler	Barrel
Type	-	S	--
Inside Diameter (in.)	-	1 3/8	--
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

- Rig Make & Model: Kodiac Recon ATV
- Bit Type:
- Drill Mud:
- Casing: Hollow stem auger
- Hoist/Hammer: Automatic Hammer
- PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0	2 3 3 5	S1 22	0.0 2.0		188.0 1.0	-12 IN. TOPSOIL-										
				SM		Loose gray-brown silty SAND with gravel (SM)	5	5	5	20	40	25				
	9 6 6 6	S2 18	2.0 4.0	SC		Medium dense gray-brown clayey SAND with gravel (SC), thin layer of former pavement -FILL-										
	5 5 6 6	S3 23	4.0 6.0	SM		Medium dense gray silty SAND with gravel (SM), moist		17	4	10	33	36				
5					183.0 6.0											
	7 13 21 22	S4 29	6.0 8.0	SP		Dense tan poorly-graded SAND (SP), moist, mica				5	90	5				
	12 50/3"	S5 9	8.0 10.0	SM		Very dense gray-brown disintegrated rock sampled as silty sand (SM), moist, mica					80	20				
10						-RESIDUUM-										
	50/5"	S6 9	13.5 15.0	SM		Very dense gray brown disintegrated rock sampled as silty SAND (SM), moist, mica										
15					174.0 15.0	BOTTOM OF EXPLORATION 15.0 FT										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/19/2025		not encountered			

Sample ID

- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	15.0
Rock Cored (ft)	0.0
Samples	S6

Boring No. HA-4

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA-5

Project	ARABIAN LEOPARD EXHIBIT, SMITHSONIAN NATIONAL ZOO	File No.	0213691-000
Client	SMITHSONIAN INSTITUTION	Sheet No.	1 of 1
Contractor	FREESTATE DRILLING	Start	December 18, 2025
		Finish	December 18, 2025
		Driller	N. Meyers
		H&A Rep.	H. Tavakoli
		Elevation	182.0
		Datum	
		Location	See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	S	--	Rig Make & Model: Kodiac Recon ATV
Inside Diameter (in.)	-	1 3/8	--	Bit Type: Drill Mud:
Hammer Weight (lb)	-	140	-	Casing: Hollow stem auger
Hammer Fall (in.)	-	30	-	Hoist/Hammer: Automatic Hammer; PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0					181.7 0.3	-4 IN. TOPSOIL-										
	3 8 8 8	S1 18	0.0 2.0	SM		Medium dense gray-brown silty SAND (SM), no structure, little gravel, roots and mulch -FILL-										
	6 5 6 5	S2 18	2.0 4.0	SM		Medium dense tan silty SAND (SM), moist, some gravel, mica										
5	6 9 8 8	S3 29	4.0 6.0	SM		Medium dense tan silty SAND with gravel (SM), moist, less mica	15	3	1	4	36	41				
	9 9 8 8	S4 0	6.0 8.0	SM		Medium dense, pushed rock, no recovery					100					
	4 6 6 9	S5 29	8.0 10.0	SM	174.0 8.0	Medium dense tan silty SAND with gravel (SM), moist										
10	5 10 19 25	S6 29	10.0 12.0	SM		Medium dense gray-brown silty SAND (SM), moist, mica rich, 5 in. of coarse gravel -RESIDUUM-				1	50	49				
	26 41 50/2"	S7 12	12.0 14.0	SM		Very dense gray-brown disintegrated rock sampled as silty SAND (SM), moist, mica rich					95	5				
					168.0 14.0	BOTTOM OF EXPLORATION 14.0 FT										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/19/2025		not encountered			

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary
- Overburden (ft) 14.0
- Rock Cored (ft) 0.0
- Samples S7

Boring No. HA-5

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None; **Toughness**: L - Low M - Medium H - High; **Plasticity**: N - Nonplastic L - Low M - Medium H - High; **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA-6

Project	ARABIAN LEOPARD EXHIBIT, SMITHSONIAN NATIONAL ZOO	File No.	0213691-000
Client	SMITHSONIAN INSTITUTION	Sheet No.	1 of 1
Contractor	FREESTATE DRILLING	Start	December 19, 2025
		Finish	December 19, 2025
		Driller	N. Meyers
		H&A Rep.	S. Schneckloth
		Elevation	185.0
		Datum	
		Location	See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	-	S	--	Rig Make & Model: Kodiac Recon ATV
Inside Diameter (in.)	-	1 3/8	--	Bit Type: / Drill Mud:
Hammer Weight (lb)	-	140	-	Casing: Hollow stem auger
Hammer Fall (in.)	-	30	-	Hoist/Hammer: Automatic Hammer / PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0					184.0 / 1.0	-12 IN. CONCRETE-										
	10 23 50/5"	S1 12	1.0 3.0	SM		Very dense silty SAND (SM), mica rich, rock fabric				4	49	47				
	14 17 23 29	S2 18	3.0 5.0	SM		Dense red to gray silty SAND (SM), no odor, dry to moist, mica rich				5	70	25				
5	14 16 19 20	S3 24	5.0 7.0	SP		Dense tan and gray poorly-graded SAND (SP), no odor, dry to moist, mica -RESIDUUM-				5	85	10				
	5 8 15 26	S4 24	7.0 9.0	SP		Dense tan and gray poorly-graded SAND (SP), no odor, dry to moist, mica				10	80	10				
	27 50/2"	S5 8	9.0 9.8	SM		Very dense gray and red disintegrated rock sampled as silty SAND (SM), no odor, dry to moist, mica rich, rock fabric					80	20				
10																
	30 50/3"	S6 9	13.5 14.3	SP	170.8 / 14.3	Very dense gray and red disintegrated rock sampled as poorly-graded SAND (SP), no odor, dry, mica, salt and pepper color, rock fabric					90	10				
						BOTTOM OF EXPLORATION 14.25 FT										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/19/2025		not encountered			

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary
- Overburden (ft) 14.25
- Rock Cored (ft) 0.0
- Samples S7

Boring No. HA-6

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. **HA-7**

Project	ARABIAN LEOPARD EXHIBIT, SMITHSONIAN NATIONAL ZOO
Client	SMITHSONIAN INSTITUTION
Contractor	FREESTATE DRILLING

File No.	0213691-000
Sheet No.	1 of 1
Start	December 18, 2025
Finish	December 18, 2025
Driller	J. Scribellito
H&A Rep.	S. Schneckloth
Elevation	180.0
Datum	
Location	See Plan

	Casing	Sampler	Barrel
Type	-	S	--
Inside Diameter (in.)	-	1 3/8	--
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Kodiac Recon ATV
Bit Type:
Drill Mud:
Casing: Hollow stem auger
Hoist/Hammer: Automatic Hammer
PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0					179.5	-6 IN. CONCRETE-										
	9 7 5 4	S1 19	0.5 2.5	GW-GC	0.5	Medium dense tan well-graded GRAVEL with clay and sand (GW-GC), no structure, no odor, moist, contains mica in fines -FILL-	30	40		5	10	15				
	3 3 4 7	S2 18	2.5 4.5	SM		Loose tan silty SAND with gravel (SM), no odor, moist, mica rich, intermixed	5	10		20	30	30				
5	10 7 6 7	S3 0.5	4.5 6.5	SM		Medium dense tan to brown silty SAND (SM), no odor, moist, mica rich, some clay scraps in spoils Note: Low recovery, pushed rock. Sample was recovered from drill cuttings.			10	10	50	30				
	5 3 14 32	S4 14	6.5 8.5	SM	173.5 6.5	Medium dense tan to red silty SAND (SM), no odor, moist, mica rich, preserved rock fabric				3	53	44				
	20 27 50/5.5"	S5 16	8.5 10.0	SM		Very dense tan disintegrated rock sampled as silty SAND (SM), no odor, dry to moist, preserved rock fabric, mica -RESIDUUM-			10	10	40	40				
10																
15	19 50/3"	S6 6	15.0 15.8	SM	164.8 15.3	Very dense tan and orange disintegrated rock sampled as silty SAND (SM), no odor, moist, rock fabric, logs of mica, some black spots				5	65	50				
						BOTTOM OF EXPLORATION 15.75 FT										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/19/2025		not encountered			

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	15.75
Rock Cored (ft)	0.0
Samples	S6

Boring No. **HA-7**

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA-8

Project	ARABIAN LEOPARD EXHIBIT, SMITHSONIAN NATIONAL ZOO
Client	SMITHSONIAN INSTITUTION
Contractor	FREESTATE DRILLING

File No.	0213691-000
Sheet No.	1 of 1
Start	December 19, 2025
Finish	December 19, 2025
Driller	N. Meyers
H&A Rep.	S. Schneckloth
Elevation	190.0
Datum	
Location	See Plan

	Casing	Sampler	Barrel
Type	-	S	--
Inside Diameter (in.)	-	1 3/8	--
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Kodiac Recon ATV
Bit Type:
Drill Mud:
Casing: Hollow stem auger
Hoist/Hammer: Automatic Hammer
PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						Note: Blind drilled to 8 ft. Cuttings looked predominantly to be a tan silty sand, no odor, dry to moist										
5																
	15 22 30 37	S1 10	8.0 10.0	SM		Very dense tan and gray silty SAND (SM), no odor, dry to moist, mica rich, preserved rock fabric -RESIDUUM-				2	49	49				
10	31 38 50/5"	S2 16	10.0 11.5	SM		Very dense tan and gray disintegrated rock sampled as silty SAND (SM), no odor, dry to moist, rock fabric				10	60	30				
					178.5 11.5	BOTTOM OF EXPLORATION 11.5 FT										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/19/2025		not encountered			

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 11.5
Rock Cored (ft) 0.0
Samples S2

Boring No. HA-8

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†**Note: Maximum particle size is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA-9

Project	ARABIAN LEOPARD EXHIBIT, SMITHSONIAN NATIONAL ZOO
Client	SMITHSONIAN INSTITUTION
Contractor	FREESTATE DRILLING

File No.	0213691-000
Sheet No.	1 of 1
Start	December 18, 2025
Finish	December 18, 2025
Driller	N. Meyers
H&A Rep.	S. Schneckloth
Elevation	190.0
Datum	
Location	See Plan

	Casing	Sampler	Barrel
Type	-	S	--
Inside Diameter (in.)	-	1 3/8	--
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

- Rig Make & Model: Kodiac Recon ATV
- Bit Type:
- Drill Mud:
- Casing: Hollow stem auger
- Hoist/Hammer: Automatic Hammer
- PID Make & Model: Not used

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0						Note: Blind drilled to 8 ft. Cuttings looked predominantly to be a tan to brown silty sand. Drill chatter from 5 to 7 ft with lots of rounded gravel coming up in cuttings. Once piece in cuttings looked to be painted concrete.										
5																
	10 13 17 30	S1 18	8.0 10.0	SM		Medium dense tan to orange silty SAND (SM), dry to moist, mica prevalent, preserved rock fabrick, some black stripes -RESIDUUM-		5		1	44	50				
10	8 21 37 45	S2 16	10.0 12.0	SM		Very dense tan and gray silty SAND (SM), dry to moist, mica, preserved rock fabric				10	50	40				
					178.0 12.0	BOTTOM OF EXPLORATION 12.0 FT										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/19/2025		not encountered			

Sample ID

- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	12.0
Rock Cored (ft)	0.0
Samples	S2

Boring No. HA-9

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Schnabel TEST BORING LOG

Project: Bison Exhibit - National Zoo
3001 Connecticut Avenue NW
Washington, DC

Boring Number: **SB-1**
Contract Number: 13612025
Sheet: 1 of 1

Contractor: Connelly and Associates, Inc.
Frederick, Maryland
Contractor Foreman: Nate Bonner
Schnabel Representative: Eoin Durcan
Equipment: T4 Scout
Method: 2-1/4" I.D. Hollow Stem Auger

Hammer Type: Manual
Dates **Started:** 5/14/13 **Finished:** 5/14/13
Location: See Location Plan

Ground Surface Elevation: 58.7± (m) **Total Depth:** 5.91 m

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered	5/14	---	Dry	---	---
Completion	5/14	---	Dry	---	---
Casing Pulled	5/14	---	Dry	---	GROUT

DEPTH (m)	MATERIAL DESCRIPTION	SYMBOL	ELEV (m)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	FILL, sampled as sandy silt; moist, brown, contains roots, quartz fragments and mica, trace black	FILL		A		SS 2+3+3 REC=46cm, 100%		
	Change: contains organics, gravel and fat clay pockets, trace gray				1	SS 3+3+4 REC=46cm, 100%	MC = 14.5%	
						SS 8+9+11 REC=46cm, 100%	MC = 12.5%	
1.83	PROBABLE FILL, sampled as sandy silt; moist, orangish brown with streaks of black, contains mica and rock fragments	FILL	56.90		2			
2.59	SILTY SAND; moist, brownish orange with streaks of black, estimated <5% mica	SM	56.14	B	3	SS 16+18+24 REC=46cm, 100%	LL = 39 PL = 27 MC = 11.9% % Passing #200 = 35.5	
4.11	DISINTEGRATED ROCK, sampled as sandy silt; moist, light brown with streaks of orangish brown, estimated 5 - 10% mica, trace speckles of black	DR	54.62	C	4	SS 15+27+39 REC=46cm, 100%		
					5			
	Change: trace light gray					SS 39+100/13cm REC=28cm, 100%		
5.91			52.82					

Bottom of Boring at 5.91 m.
Borehole grouted upon completion.

Schnabel TEST BORING LOG	Project: Bison Exhibit - National Zoo 3001 Connecticut Avenue NW Washington, DC	Boring Number: SB-2 Contract Number: 13612025 Sheet: 1 of 1

Contractor: Connelly and Associates, Inc.
Frederick, Maryland

Contractor Foreman: Nate Bonner

Schnabel Representative: Eoin Durcan

Equipment: T4 Scout

Method: 2-1/4" I.D. Hollow Stem Auger

Hammer Type: Manual

Dates Started: 5/14/13 **Finished:** 5/14/13

Location: See Location Plan

Ground Surface Elevation: 59.1± (m) **Total Depth:** 6.10 m

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered	5/14	---	Dry	---	---
Completion	5/14	---	Dry	---	---
Casing Pulled	5/14	---	Dry	---	GROUT

DEPTH (m)	MATERIAL DESCRIPTION	SYMBOL	ELEV (m)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	FILL, sampled as sandy silt; moist, brown, contains mica, gravel and roots	FILL		A		SS 2+3+3 REC=46cm, 100%		
	Change: dark brown, contains grass and brick fragments				1	SS 3+4+4 REC=30cm, 67%	MC = 17.1%	
	Change: contains sand pockets, clay pockets and organics				2	SS 4+4+4 REC=46cm, 100%	MC = 16.6%	
2.59	DISINTEGRATED ROCK, sampled as sandy silt; moist, orangish brown and brown, estimated 15 - 25% mica, trace black	DR	56.48	C	3	SS 23+27+38 REC=46cm, 100%		
					4	SS 47+100/15cm REC=25cm, 83%		
					5			
6.10			52.97		6	SS 33+52+63 REC=46cm, 100%		

Bottom of Boring at 6.10 m.
Borehole grouted upon completion.

Schnabel TEST BORING LOG

Project: Bison Exhibit - National Zoo
3001 Connecticut Avenue NW
Washington, DC

Boring Number: SB-3
Contract Number: 13612025
Sheet: 1 of 1

Contractor: Connelly and Associates, Inc.
Frederick, Maryland

Contractor Foreman: Nate Bonner

Schnabel Representative: Eoin Durcan

Equipment: T4 Scout

Method: 2-1/4" I.D. Hollow Stem Auger

Hammer Type: Manual

Dates Started: 5/14/13 **Finished:** 5/14/13

Location: See Location Plan

Ground Surface Elevation: 57.3± (m) **Total Depth:** 6.10 m

Groundwater Observations

	Date	Time	Depth	Casing	Caved
Encountered	5/14	---	Dry	---	---
Completion	5/14	---	Dry	---	---
Casing Pulled	5/14	---	Dry	---	GROUT

DEPTH (m)	MATERIAL DESCRIPTION	SYMBOL	ELEV (m)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	PROBABLE FILL, sampled as sandy silt; moist, orangish brown with mottles of gray, contains mica, roots and rock fragments	FILL		A		SS 2+3+4 REC=46cm, 100%		
0.76	SILTY SAND; moist, orangish brown, estimated 15 - 25% mica, streaks of light brown and black	SM	56.55	B	1	SS 8+5+6 REC=46cm, 100%	MC = 22.1%	
					2	SS 9+8+9 REC=46cm, 100%	LL = 36 PL = 28 MC = 15.2% % Passing #200 = 35.4	
2.59	SANDY SILT; moist, orangish brown, mottles of orange and gray	ML	54.73		3	SS 13+15+17 REC=46cm, 100%	MC = 19.6%	
					4	SS 10+11+15 REC=46cm, 100%		
					5			
5.64	DISINTEGRATED ROCK, sampled as sandy silt; moist, light brown, estimated 5 - 10% mica, speckles black, white and orangish brown	DR	51.68	C	6	SS 27+50+68 REC=46cm, 100%		
6.10			51.22					

Bottom of Boring at 6.10 m.
Borehole grouted upon completion.

JAY KAY TESTING

SUMMARY OF LABORATORY TESTING

Job Name:	**Leopard Exhibit**	Client:	Haley & Aldrich
Job Number:	0213691-000	PM/Reviewer:	RG
Location:	Washington, DC	Tester:	ST/JT
Sample Date:	12/18/2025 & 12/19/2025	Report Date:	01/07/26

Sample Identification		Depth				Atterberg Limits				Compaction					
Boring ID	Sample ID	Top, ft	Bottom, ft	NMC, % (ASTM D-2216)	Organic Matter, % (ASTM D-2974)	Liquid Limit, % (ASTM D-4318)	Plastic Limit, % (ASTM D-4318)	Plasticity Index, % (ASTM D-4318)	Specific Gravity (ASTM D-854)	Maximum Dry Density, lb/ft³	Optimum Moisture Content, %	AASHTO Classification (M-145)	% < 0.002 mm	% Fines	USCS Classification (ASTM D-2487)
HA-1	S-3	4	6	10.2	-	39	30	9	-	-	-	A-4	-	64.6	ML
HA-1	S-4	6	8	9.7	-	-	-	-	-	-	-	-	-	-	-
HA-2	S-2	3	5	11.0	-	30	19	11	-	-	-	A-2-6	-	28.6	SC
HA-2	S-5	9	11	13.1	-	-	-	-	-	-	-	-	-	-	-
HA-3	S-1	0	2	10.9	-	-	-	-	-	-	-	-	-	-	-
HA-3	S-4	6	8	6.4	-	-	-	-	-	-	-	-	-	46.5	-
HA-4	S-2	2	4	15.7	-	-	-	-	-	-	-	-	-	-	-
HA-4	S-3	4	6	14.8	-	-	-	-	-	-	-	-	-	36.2	-
HA-5	S-3	4	6	4.5	-	30	26	4	-	-	-	A-4	-	40.6	SM
HA-5	S-6	10	12	10.0	-	-	-	-	-	-	-	-	2.5	48.4	-
HA-6	S-1	1	3	10.6	-	-	-	-	-	-	-	-	-	47.0	-
HA-6	S-3	5	7	12.2	-	-	-	-	-	-	-	-	-	-	-
HA-7	S-1	0.5	2.5	7.3	-	-	-	-	-	-	-	-	-	-	-
HA-7	S-4	6.5	8.5	11.0	-	29	26	3	-	-	-	A-4	-	43.6	SM
HA-8	S-1	8	10	9.2	-	-	-	-	-	-	-	-	3.6	48.9	-
HA-9	S-1	8	10	10.4	-	-	-	-	-	-	-	-	5.9	49.8	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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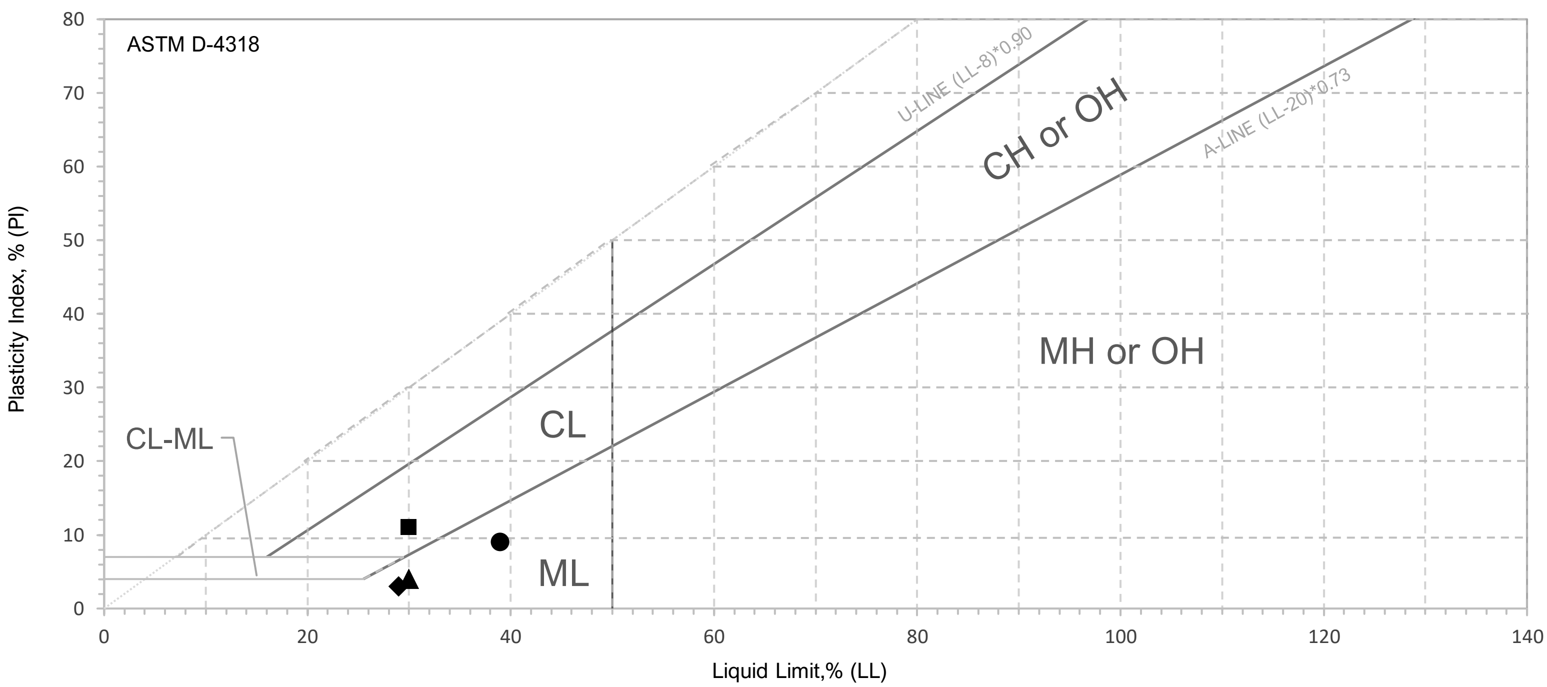
JAY KAY TESTING

SUMMARY OF ATTERBERG LIMIT TESTING

Job Name:	**Leopard Exhibit**	Client:	Haley & Aldrich
Job Number:	0213691-000	PM/Reviewer:	RG
Location:	Washington, DC	Tester:	ST/JT
Sample Date:	12/18/2025 & 12/19/2025	Report Date:	01/07/26

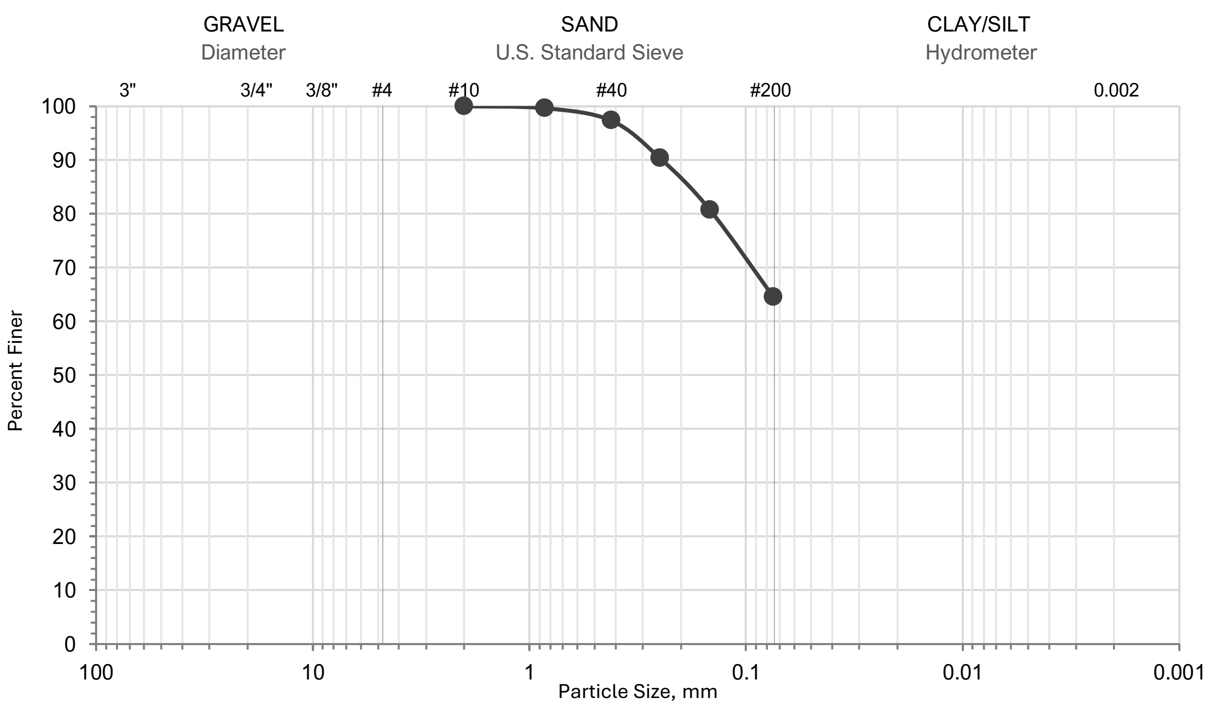


	Boring ID	Sample ID	Top	Btm	LL	PL	PI		Boring ID	Sample ID	Top	Btm	LL	PL	PI
●	HA-1	S-3	4	6	39	30	9								
■	HA-2	S-2	3	5	30	19	11								
▲	HA-5	S-3	4	6	30	26	4								
◆	HA-7	S-4	6.5	8.5	29	26	3								

Job Name:	**Leopard Exhibit**	Client:	Haley & Aldrich
Job Number:	0213691-000	PM/Reviewer:	RG
Location:	Washington, DC	Tester:	ST/JT
Sample Date:	12/18/2025 & 12/19/2025	Report Date:	01/07/26

Boring ID: **HA-1** Sample ID: **S-3** Top Depth **4'** Btm Depth **6'**

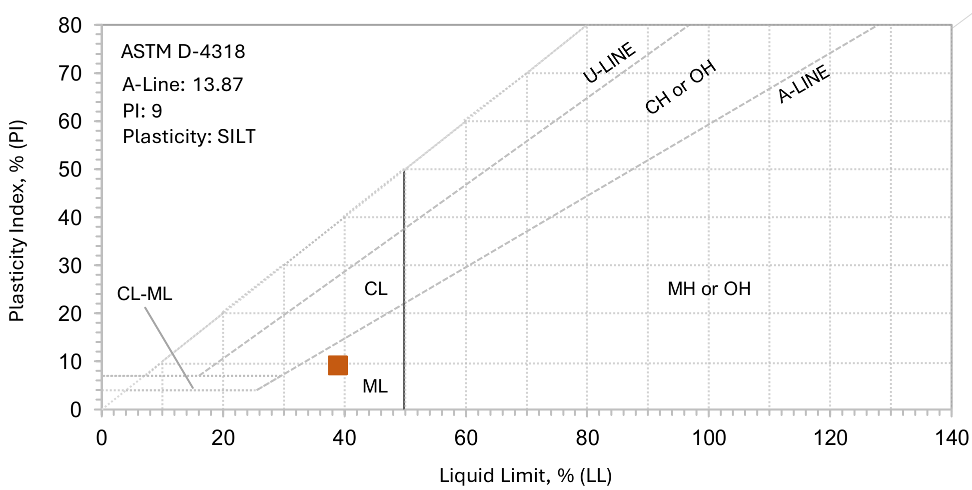
Particle-Size Distribution of Soils — ASTM D-6913



Sieve	Size	Pass, %
-	mm	%
6"	150.0	-
3"	75.0	-
2"	50.8	-
1.5"	37.5	-
1"	25.4	-
3/4"	19.0	-
1/2"	12.7	-
3/8"	9.51	-
#4	4.75	-
#10	2.00	100.0
#20	0.85	99.6
#40	0.42	97.4
#60	0.25	90.4
#100	0.147	80.8
#200	0.075	64.6

% Gravel (> 4.75 mm)			% Sand (≤ 4.75 mm)						
	Coarse	0.0		Coarse	0.0	D_{10}	-	Cc	-
	Fine	0.0		Medium	2.6	D_{30}	-	Cu	-
	Total	**0.0**		Fine	32.8	D_{60}	-		
				Total	**35.4**				

Atterberg Limits & Classification — ASTM D-4318



Specimen Data	
Atterberg Limits	■
Liquid Limit	39
Plastic Limit	30
Plasticity Index	9

AASHTO (M-145)	USCS (D-2487)
A-4	ML

Soil Description (D-2487)

Brown sandy SILT

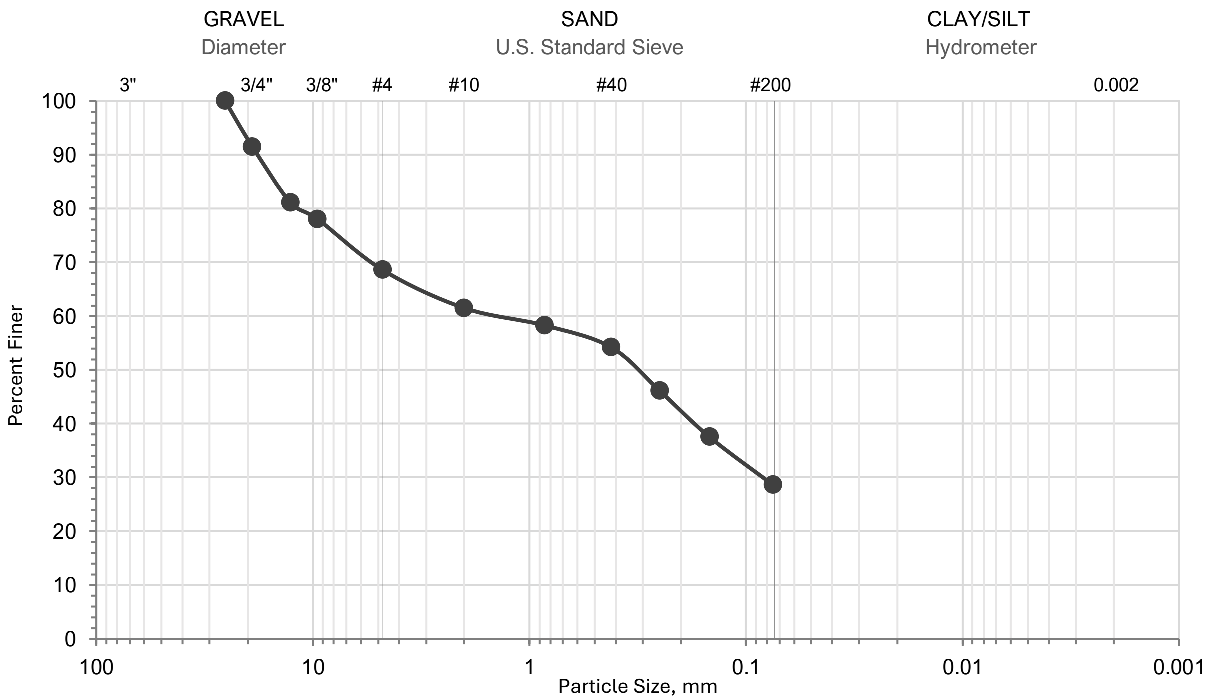
JAY KAY TESTING
(814) 404-9283 www.jaykaytesting.com

Job Name:	**Leopard Exhibit**	Client:	Haley & Aldrich
Job Number:	0213691-000	PM/Reviewer:	RG
Location:	Washington, DC	Tester:	ST/JT
Sample Date:	12/18/2025 & 12/19/2025	Report Date:	01/07/26

Boring ID: **HA-2** Sample ID: **S-2** Top Depth **3'** Btm Depth **5'**

Particle-Size Distribution of Soils

ASTM D-6913

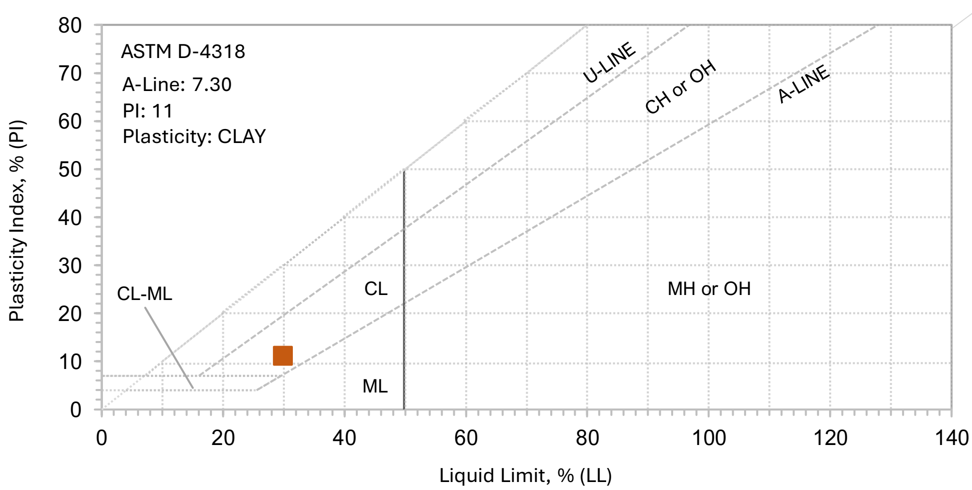


Sieve	Size	Pass, %
-	mm	%
6"	150.0	-
3"	75.0	-
2"	50.8	-
1.5"	37.5	-
1"	25.4	100.0
3/4"	19.0	91.5
1/2"	12.7	81.2
3/8"	9.51	78.1
#4	4.75	68.6
#10	2.00	61.5
#20	0.85	58.3
#40	0.42	54.2
#60	0.25	46.1
#100	0.147	37.5
#200	0.075	28.6

% Gravel (> 4.75 mm)			% Sand (≤ 4.75 mm)						
	Coarse	8.5		Coarse	7.1	D_{10}	-	Cc	-
	Fine	22.9		Medium	7.3	D_{30}	-	Cu	-
	Total	**31.4**		Fine	25.6	D_{60}	-		
				Total	**40.0**				

Atterberg Limits & Classification

ASTM D-4318



Specimen Data	
Atterberg Limits	■
Liquid Limit	30
Plastic Limit	19
Plasticity Index	11

AASHTO (M-145)	USCS (D-2487)
A-2-6	SC

Soil Description (D-2487)

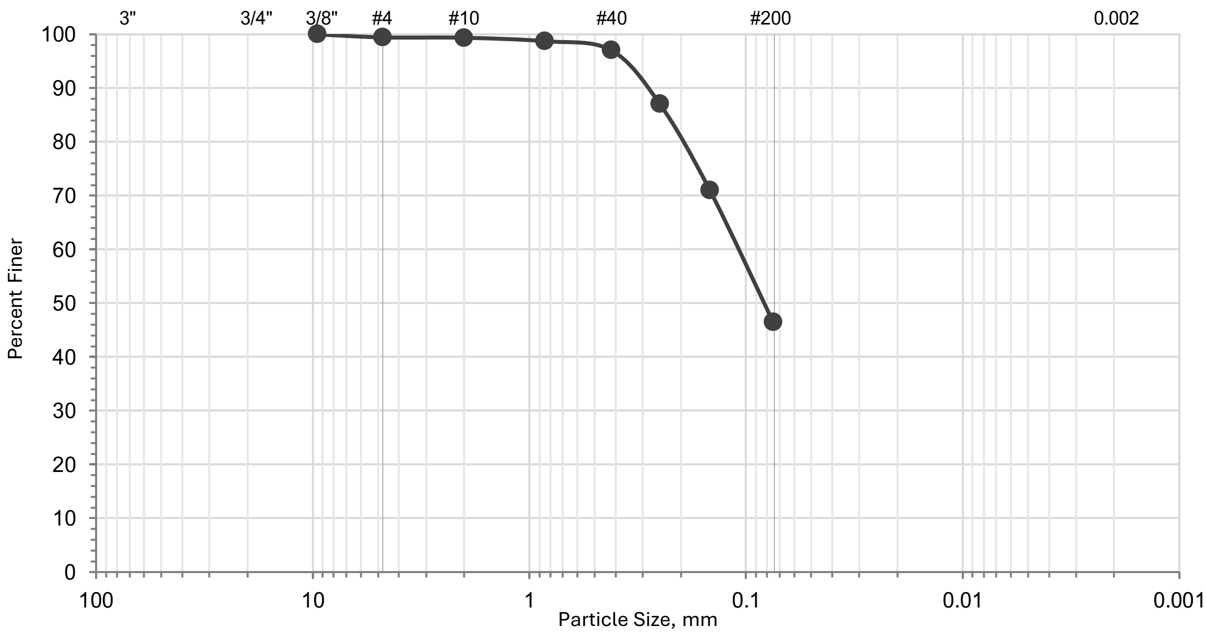
Brown clayey SAND with gravel

JAY KAY TESTING
(814) 404-9283 www.jaykaytesting.com

Job Name:	**Leopard Exhibit**	Client:	Haley & Aldrich
Job Number:	0213691-000	PM/Reviewer:	RG
Location:	Washington, DC	Tester:	ST/JT
Sample Date:	12/18/2025 & 12/19/2025	Report Date:	01/07/26

Boring ID: **HA-3** Sample ID: **S-4** Top Depth **6'** Btm Depth **8'**

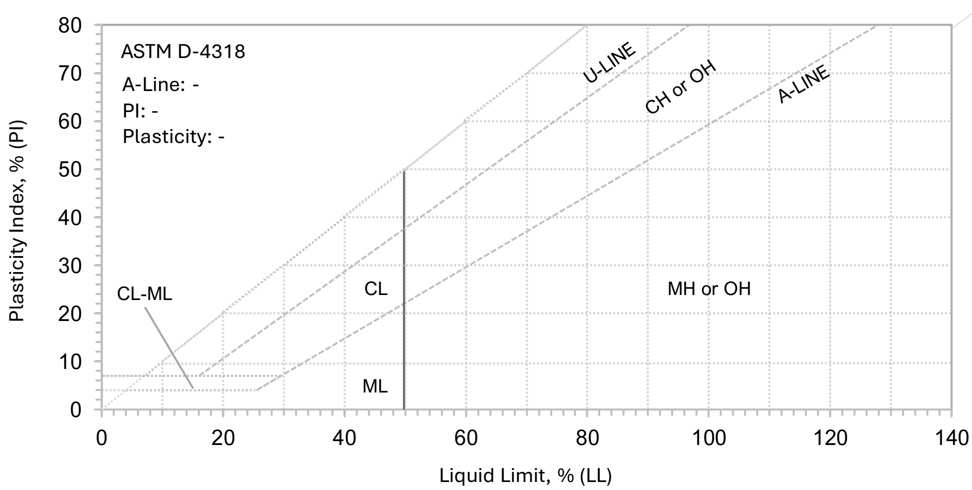
Particle-Size Distribution of Soils ASTM D-6913



Sieve	Size	Pass, %
-	mm	%
6"	150.0	-
3"	75.0	-
2"	50.8	-
1.5"	37.5	-
1"	25.4	-
3/4"	19.0	-
1/2"	12.7	-
3/8"	9.51	100.0
#4	4.75	99.4
#10	2.00	99.4
#20	0.85	98.7
#40	0.42	97.1
#60	0.25	87.0
#100	0.147	71.0
#200	0.075	46.5

% Gravel (> 4.75 mm)			% Sand (≤ 4.75 mm)						
	Coarse	0.0		Coarse	0.0	D_{10}	-	Cc	-
	Fine	0.6		Medium	2.3	D_{30}	-	Cu	-
	Total	**0.6**		Fine	50.6	D_{60}	-		
				Total	**52.9**				

Atterberg Limits & Classification ASTM D-4318



Specimen Data	
Atterberg Limits	
Liquid Limit	-
Plastic Limit	-
Plasticity Index	-

AASHTO (M-145)	USCS (D-2487)
-	-

Visual Soil Description

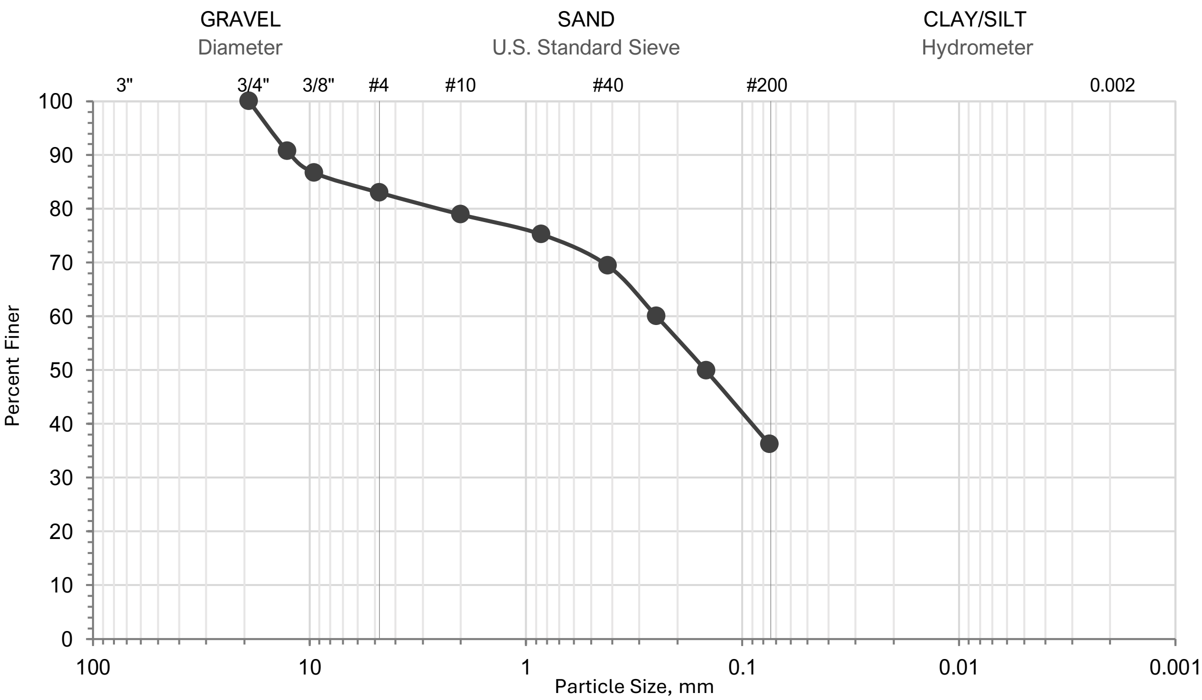
Light brown silty sand

Job Name:	**Leopard Exhibit**	Client:	Haley & Aldrich
Job Number:	0213691-000	PM/Reviewer:	RG
Location:	Washington, DC	Tester:	ST/JT
Sample Date:	12/18/2025 & 12/19/2025	Report Date:	01/07/26

Boring ID: **HA-4** Sample ID: **S-3** Top Depth **4'** Btm Depth **6'**

Particle-Size Distribution of Soils

ASTM D-6913

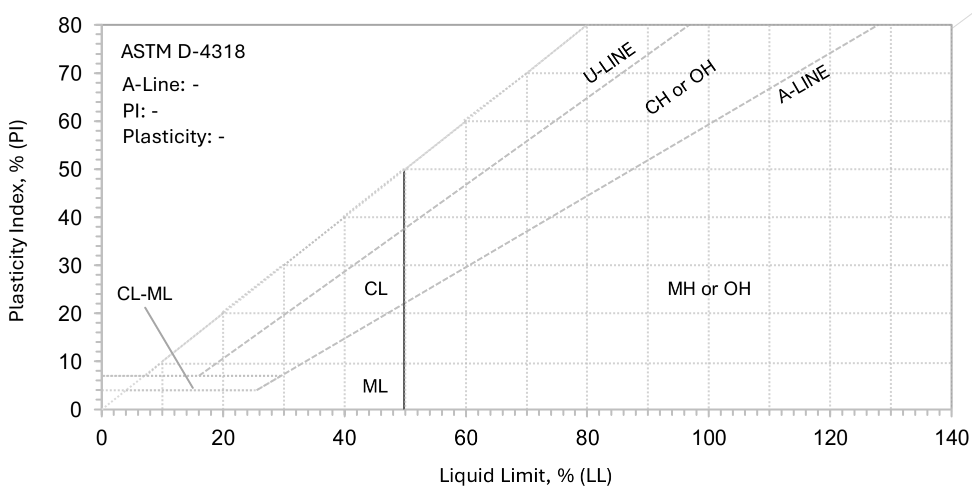


Sieve	Size	Pass, %
-	mm	%
6"	150.0	-
3"	75.0	-
2"	50.8	-
1.5"	37.5	-
1"	25.4	-
3/4"	19.0	100.0
1/2"	12.7	90.8
3/8"	9.51	86.7
#4	4.75	83.0
#10	2.00	79.0
#20	0.85	75.3
#40	0.42	69.5
#60	0.25	60.1
#100	0.147	49.9
#200	0.075	36.2

% Gravel (> 4.75 mm)			% Sand (≤ 4.75 mm)						
	Coarse	0.0		Coarse	4.0	D_{10}	-	Cc	-
	Fine	17.0		Medium	9.5	D_{30}	-	Cu	-
	Total	**17.0**		Fine	33.3	D_{60}	-		
				Total	**46.8**				

Atterberg Limits & Classification

ASTM D-4318



Specimen Data	
Atterberg Limits	
Liquid Limit	-
Plastic Limit	-
Plasticity Index	-

AASHTO (M-145)	USCS (D-2487)
-	-

Visual Soil Description

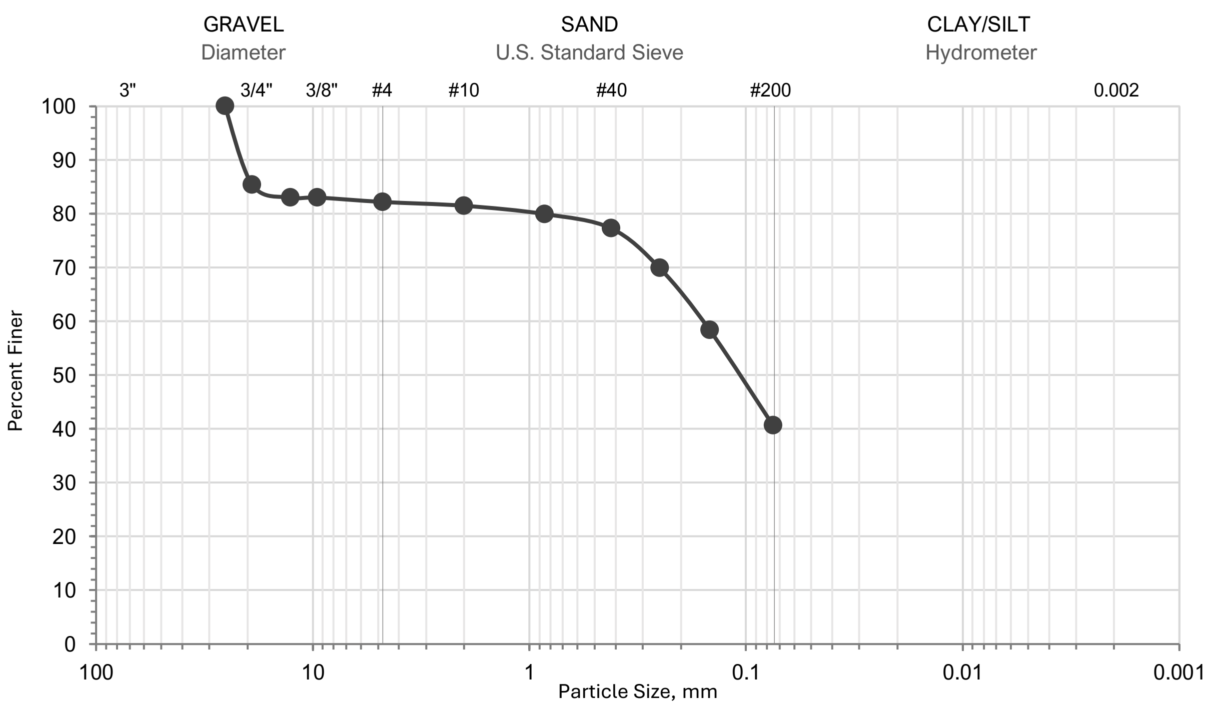
Brown silty sand with gravel

Job Name:	**Leopard Exhibit**	Client:	Haley & Aldrich
Job Number:	0213691-000	PM/Reviewer:	RG
Location:	Washington, DC	Tester:	ST/JT
Sample Date:	12/18/2025 & 12/19/2025	Report Date:	01/07/26

Boring ID: **HA-5** Sample ID: **S-3** Top Depth **4'** Btm Depth **6'**

Particle-Size Distribution of Soils

ASTM D-6913



Sieve	Size	Pass, %
-	mm	%
6"	150.0	-
3"	75.0	-
2"	50.8	-
1.5"	37.5	-
1"	25.4	100.0
3/4"	19.0	85.4
1/2"	12.7	83.0
3/8"	9.51	83.0
#4	4.75	82.2
#10	2.00	81.5
#20	0.85	80.0
#40	0.42	77.3
#60	0.25	69.9
#100	0.147	58.4
#200	0.075	40.6

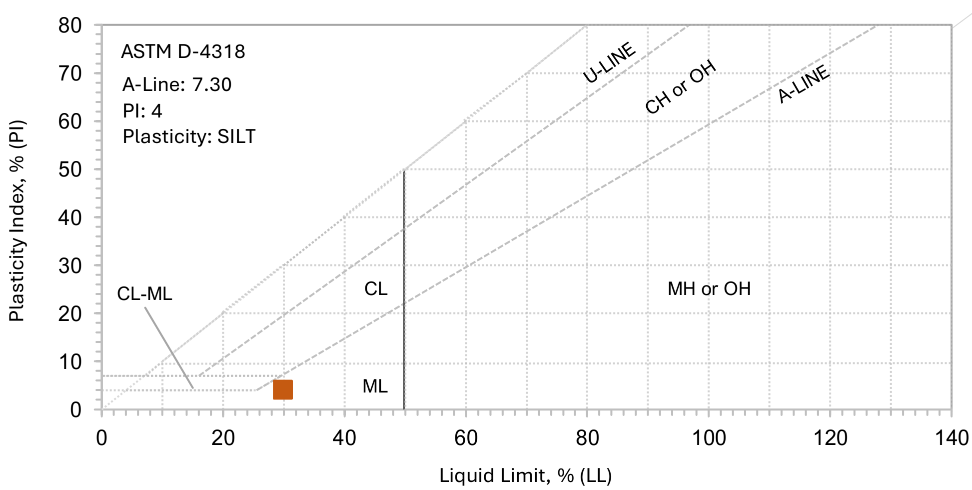
% Gravel (> 4.75 mm)		
	Coarse	14.6
	Fine	3.2
	Total	**17.8**

% Sand (≤ 4.75 mm)		
	Coarse	0.7
	Medium	4.2
	Fine	36.7
	Total	**41.6**

D_{10}	-	Cc	-
D_{30}	-	Cu	-
D_{60}	-		

Atterberg Limits & Classification

ASTM D-4318



Specimen Data	
Atterberg Limits	■
Liquid Limit	30
Plastic Limit	26
Plasticity Index	4

AASHTO (M-145)	USCS (D-2487)
A-4	SM

Soil Description (D-2487)

Light brown silty SAND with gravel

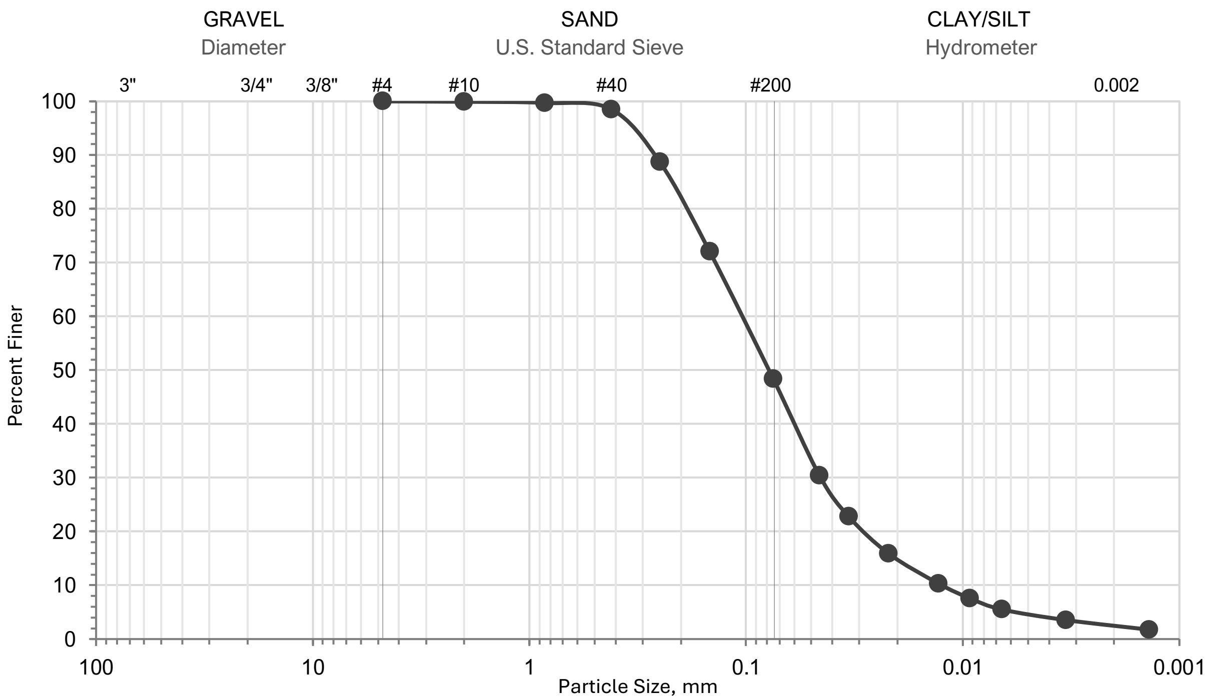
JAY KAY TESTING
(814) 404-9283 www.jaykaytesting.com

Job Name:	**Leopard Exhibit**	Client:	Haley & Aldrich
Job Number:	0213691-000	PM/Reviewer:	RG
Location:	Washington, DC	Tester:	ST/JT
Sample Date:	12/18/2025 & 12/19/2025	Report Date:	01/07/26

Boring ID: **HA-5** Sample ID: **S-6** Top Depth **10'** Btm Depth **12'**

Particle-Size Distribution of Soils

ASTM D-6913 / ASTM D-7928



Sieve	Size	Pass, %
-	mm	%
6"	150.0	-
3"	75.0	-
2"	50.8	-
1.5"	37.5	-
1"	25.4	-
3/4"	19.0	-
1/2"	12.7	-
3/8"	9.51	-
#4	4.75	100.0
#10	2.00	99.9
#20	0.85	99.7
#40	0.42	98.5
#60	0.25	88.7
#100	0.147	72.0
#200	0.075	48.4

% Gravel (> 4.75 mm)		
	Coarse	0.0
	Fine	0.0
	Total	**0.0**

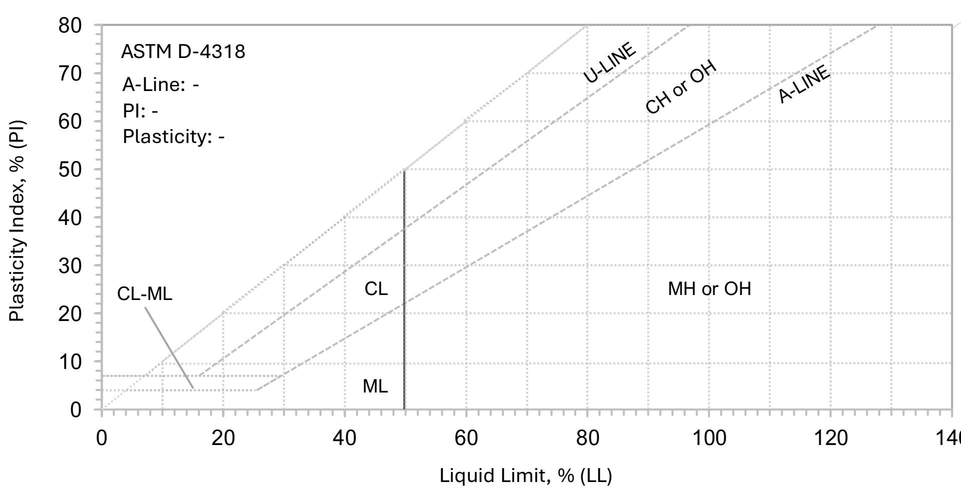
% Sand (≤ 4.75 mm)		
	Coarse	0.1
	Medium	1.4
	Fine	50.1
	Total	**51.6**

D_{10}	-	Cc	-
D_{30}	-	Cu	-
D_{60}	-		

Specific gravity* (assumed)
2.70

Atterberg Limits & Classification

ASTM D-4318



Specimen Data	
Atterberg Limits	
Liquid Limit	-
Plastic Limit	-
Plasticity Index	-

AASHTO (M-145)	USCS (D-2487)
-	-

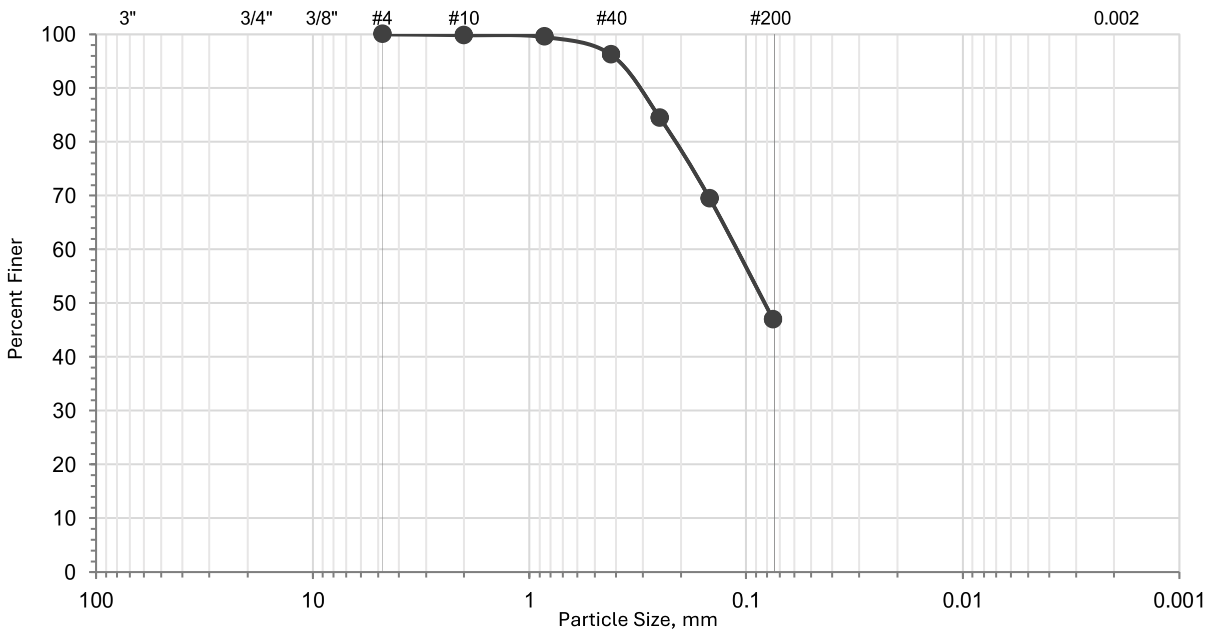
Visual Soil Description
Light brown silty sand

JAY KAY TESTING
(814) 404-9283 www.jaykaytesting.com

Job Name:	**Leopard Exhibit**	Client:	Haley & Aldrich
Job Number:	0213691-000	PM/Reviewer:	RG
Location:	Washington, DC	Tester:	ST/JT
Sample Date:	12/18/2025 & 12/19/2025	Report Date:	01/07/26

Boring ID: **HA-6** Sample ID: **S-1** Top Depth **1'** Btm Depth **3'**

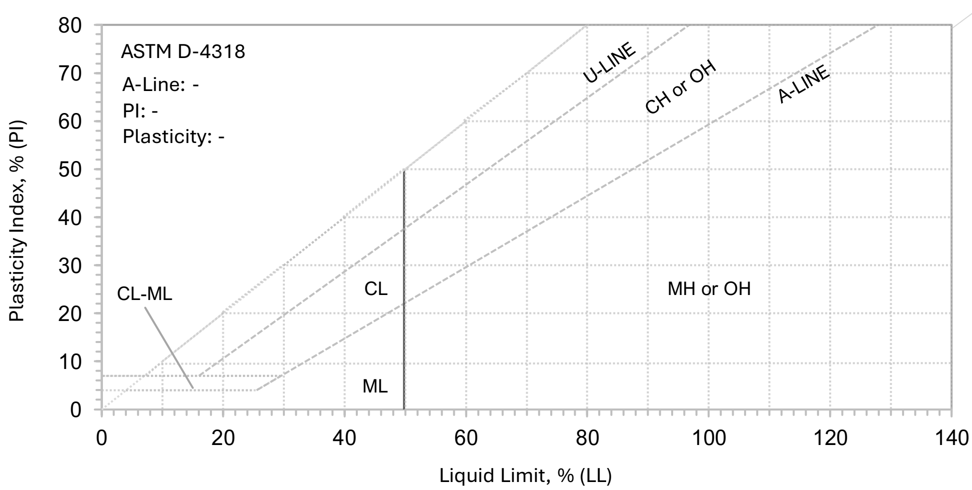
Particle-Size Distribution of Soils ASTM D-6913



Sieve	Size	Pass, %
-	mm	%
6"	150.0	-
3"	75.0	-
2"	50.8	-
1.5"	37.5	-
1"	25.4	-
3/4"	19.0	-
1/2"	12.7	-
3/8"	9.51	-
#4	4.75	100.0
#10	2.00	99.8
#20	0.85	99.5
#40	0.42	96.2
#60	0.25	84.5
#100	0.147	69.4
#200	0.075	47.0

% Gravel (> 4.75 mm)			% Sand (≤ 4.75 mm)						
	Coarse	0.0		Coarse	0.2	D_{10}	-	Cc	-
	Fine	0.0		Medium	3.6	D_{30}	-	Cu	-
	Total	**0.0**		Fine	49.2	D_{60}	-		
				Total	**53.0**				

Atterberg Limits & Classification ASTM D-4318



Specimen Data	
Atterberg Limits	
Liquid Limit	-
Plastic Limit	-
Plasticity Index	-

AASHTO (M-145)	USCS (D-2487)
-	-

Visual Soil Description

Light brown silty sand

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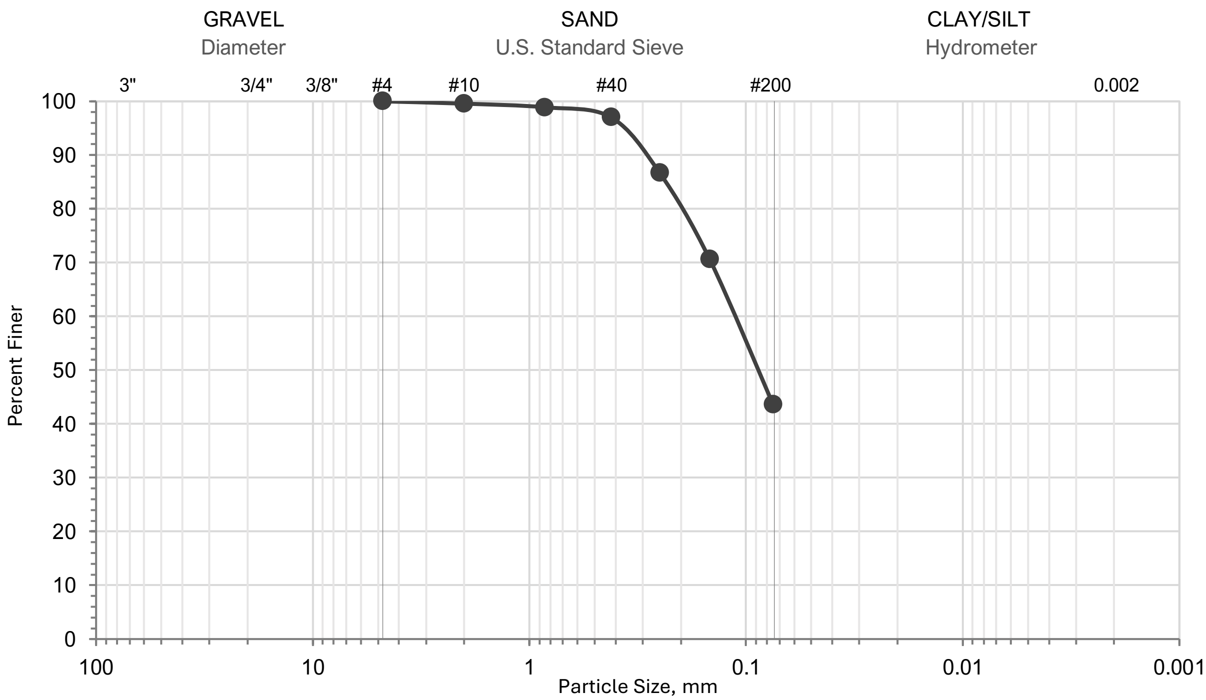
Job Name:	**Leopard Exhibit**	Client:	Haley & Aldrich
Job Number:	0213691-000	PM/Reviewer:	RG
Location:	Washington, DC	Tester:	ST/JT
Sample Date:	12/18/2025 & 12/19/2025	Report Date:	01/07/26

Boring ID: **HA-7** Sample ID: **S-4** Top Depth **6.5'** Btm Depth **8.5'**

Particle-Size Distribution of Soils

ASTM D-6913



Sieve	Size	Pass, %
-	mm	%
6"	150.0	-
3"	75.0	-
2"	50.8	-
1.5"	37.5	-
1"	25.4	-
3/4"	19.0	-
1/2"	12.7	-
3/8"	9.51	-
#4	4.75	100.0
#10	2.00	99.6
#20	0.85	98.9
#40	0.42	97.0
#60	0.25	86.7
#100	0.147	70.6
#200	0.075	43.6

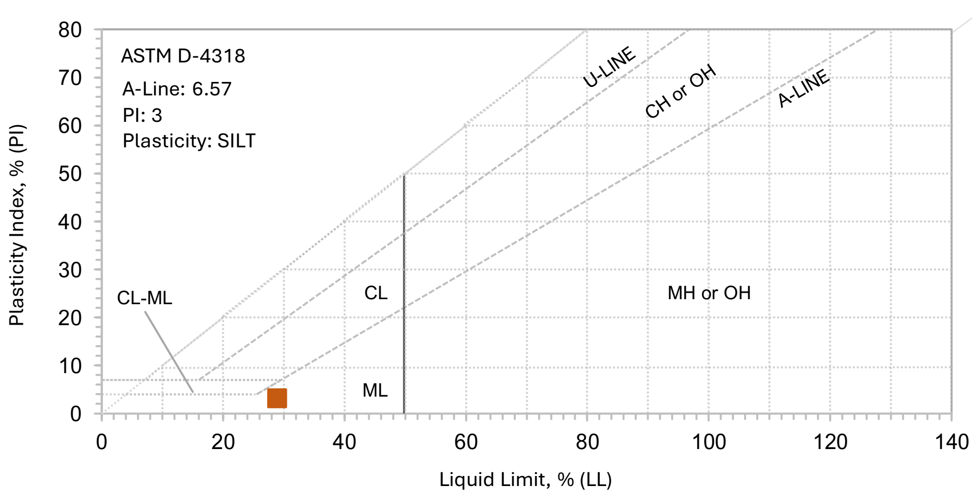
% Gravel (> 4.75 mm)		
	Coarse	0.0
	Fine	0.0
	Total	**0.0**

% Sand (≤ 4.75 mm)		
	Coarse	0.4
	Medium	2.6
	Fine	53.4
	Total	**56.4**

D_{10}	-	Cc	-
D_{30}	-	Cu	-
D_{60}	-		

Atterberg Limits & Classification

ASTM D-4318



Specimen Data	
Atterberg Limits	■
Liquid Limit	29
Plastic Limit	26
Plasticity Index	3

AASHTO (M-145)	USCS (D-2487)
A-4	SM

Soil Description (D-2487)

Brown silty SAND

JAY KAY TESTING
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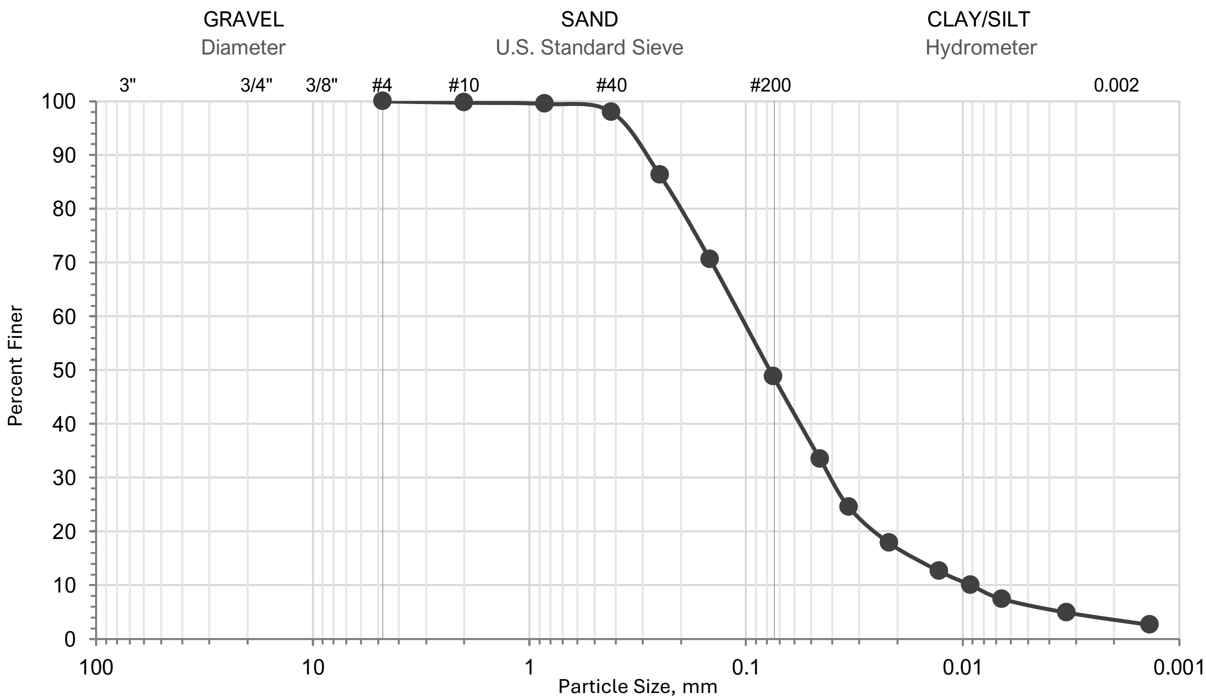
Job Name:	**Leopard Exhibit**	Client:	Haley & Aldrich
Job Number:	0213691-000	PM/Reviewer:	RG
Location:	Washington, DC	Tester:	ST/JT
Sample Date:	12/18/2025 & 12/19/2025	Report Date:	01/07/26

Boring ID: **HA-8** Sample ID: **S-1** Top Depth **8'** Btm Depth **10'**

Particle-Size Distribution of Soils

ASTM D-6913 / ASTM D-7928



Sieve	Size	Pass, %
-	mm	%
6"	150.0	-
3"	75.0	-
2"	50.8	-
1.5"	37.5	-
1"	25.4	-
3/4"	19.0	-
1/2"	12.7	-
3/8"	9.51	-
#4	4.75	100.0
#10	2.00	99.7
#20	0.85	99.5
#40	0.42	98.1
#60	0.25	86.3
#100	0.147	70.7
#200	0.075	48.9

% Gravel (> 4.75 mm)		
	Coarse	0.0
	Fine	0.0
	Total	**0.0**

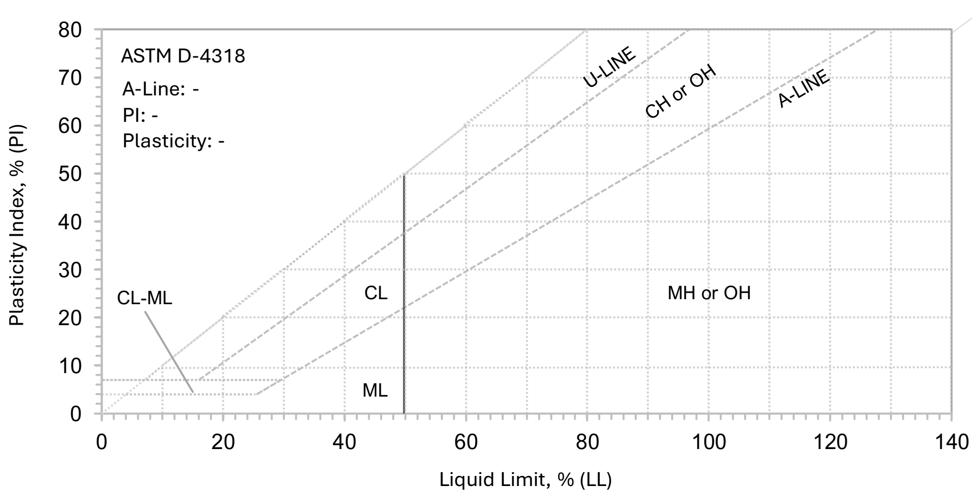
% Sand (≤ 4.75 mm)		
	Coarse	0.3
	Medium	1.6
	Fine	49.2
	Total	**51.1**

D_{10}	-	Cc	-
D_{30}	-	Cu	-
D_{60}	-		

Specific gravity* (assumed) 2.70

Atterberg Limits & Classification

ASTM D-4318



Specimen Data	
Atterberg Limits	
Liquid Limit	-
Plastic Limit	-
Plasticity Index	-

AASHTO (M-145)	USCS (D-2487)
-	-

Visual Soil Description

Light orange-brown silty sand

JAY KAY TESTING
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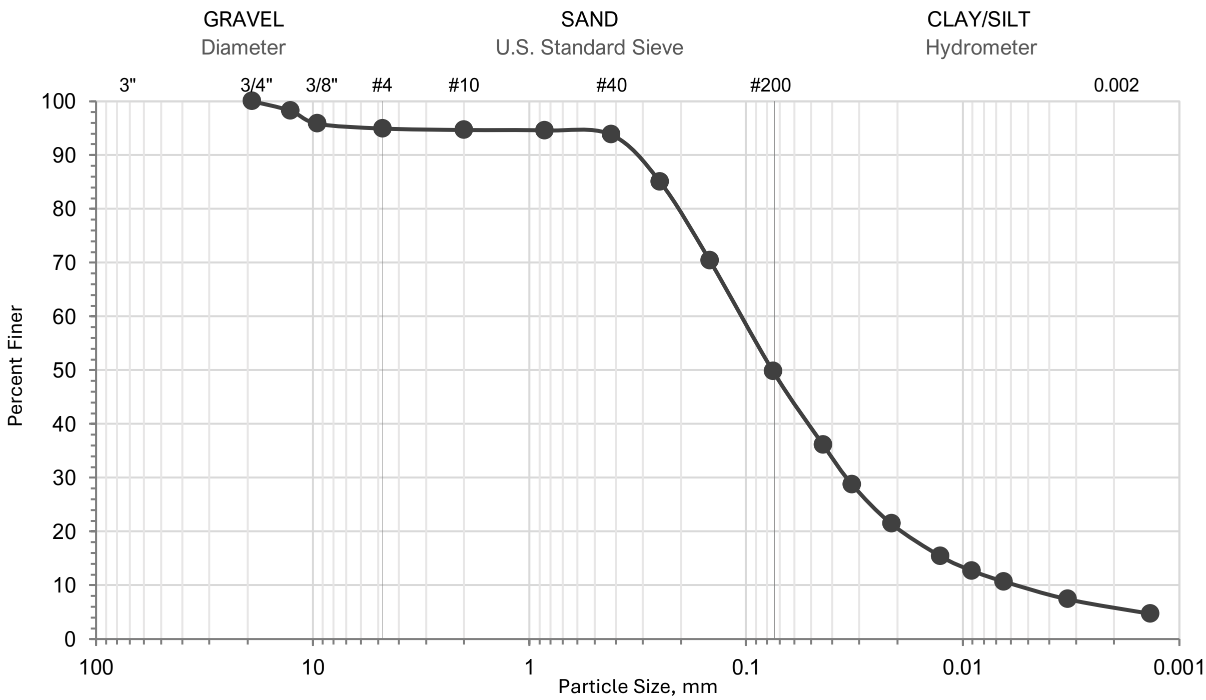
Job Name:	**Leopard Exhibit**	Client:	Haley & Aldrich
Job Number:	0213691-000	PM/Reviewer:	RG
Location:	Washington, DC	Tester:	ST/JT
Sample Date:	12/18/2025 & 12/19/2025	Report Date:	01/07/26

Boring ID: **HA-9** Sample ID: **S-1** Top Depth **8'** Btm Depth **10'**

Particle-Size Distribution of Soils

ASTM D-6913 / ASTM D-7928



Sieve	Size	Pass, %
-	mm	%
6"	150.0	-
3"	75.0	-
2"	50.8	-
1.5"	37.5	-
1"	25.4	-
3/4"	19.0	100.0
1/2"	12.7	98.3
3/8"	9.51	95.8
#4	4.75	94.9
#10	2.00	94.7
#20	0.85	94.6
#40	0.42	93.8
#60	0.25	85.1
#100	0.147	70.4
#200	0.075	49.8

% Gravel (> 4.75 mm)		
	Coarse	0.0
	Fine	5.1
	Total	**5.1**

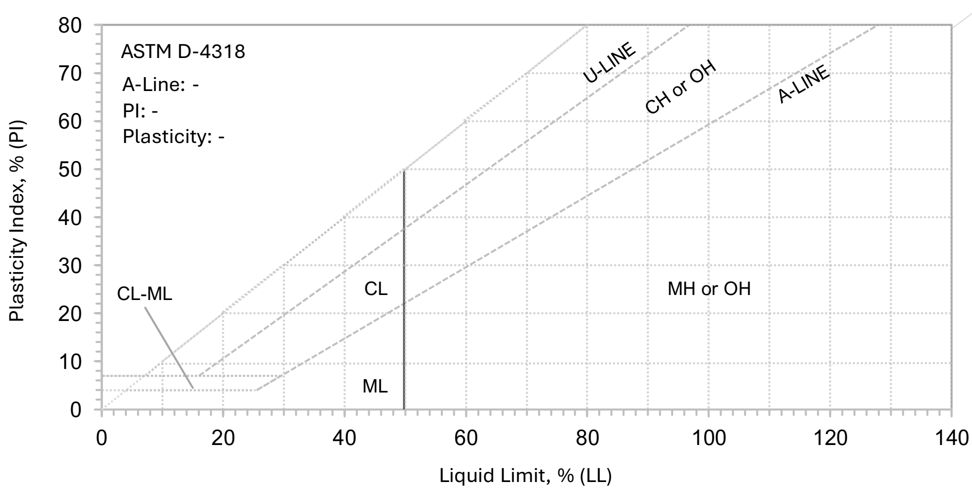
% Sand (≤ 4.75 mm)		
	Coarse	0.2
	Medium	0.9
	Fine	44.0
	Total	**45.1**

D_{10}	-	Cc	-
D_{30}	-	Cu	-
D_{60}	-		

Specific gravity* (assumed) 2.70

Atterberg Limits & Classification

ASTM D-4318



Specimen Data	
Atterberg Limits	
Liquid Limit	-
Plastic Limit	-
Plasticity Index	-

AASHTO (M-145)	USCS (D-2487)
-	-

Visual Soil Description

Light brown silty sand

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