FINAL GEOTECHNICAL REPORT

Shipping and Receiving Facility
Building 35
NASA Goddard Space Flight Center
Greenbelt, Maryland

Prepared for:

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INTRODUCTION

EBA Engineering, Inc. (EBA) was retained by Parsons Infrastructure & Technology Group (Parsons) to perform a subsurface investigation for the proposed Shipping and Receiving Facility at the NASA Goddard Space Flight Center in Greenbelt, Maryland. The project includes the construction of a shipping and receiving building, warehouse building, loading docks and truck loading areas, parking lot, improvements to an existing service road, new access drive and storm water management (SWM) facilities. This report presents the findings of the subsurface investigation and provides recommendations for the design and construction of the proposed building foundations, slabs-on-grade, pavements and SWM facilities as well as requirements for groundwater control, fill and backfill, inspection and testing. The location of the project site is shown on the Vicinity Map included in Appendix A.

It is understood that the construction will be divided into two phases with the initial construction planned to begin in the Fall, 2009, (Phase 1) and the future expansion at an undetermined date (Phase 2). The Phase 1 construction will include the shipping and receiving building, the northern loading dock and northern truck loading area, new access drive, parking lot, widening of the existing service road and storm water management facilities. The proposed shipping and receiving building area in Phase 1 is approximately 25,000 gross square feet. This includes approximately 18,000 gross square feet of high roof warehouse and approximately 7,000 gross square feet of low roof office space. A loading dock with an area of 4,000 gross square feet will be provided at the north end of the shipping and receiving building. A truck loading area will be provided north of the loading dock. A parking lot will be provided to the east and south of the proposed shipping and receiving building. A compressed gas cylinder storage building may be included at the north end of the northern loading area.

The future expansion in Phase 2 includes the addition of a two-level high roof warehouse of approximately 42,000 gross square feet to the south end of the shipping and receiving building. The future expansion also includes a loading dock and truck loading area to the south of the future warehouse. An addition to the parking lot will be provided during this phase to the east and south of the proposed warehouse.

An existing soil stockpile covers most of the proposed building area, parking lot and truck loading areas. It is understood that this soil was placed at various times beginning

in the 1970's thru the 1990's and consists of spoils from other construction projects at the Goddard Space Flight Center. The stockpile area is overgrown with weeds, small trees and shrubby vegetation. An existing asphalt-paved service road, that is oriented north to south, runs along the east side of the proposed building area. There is a chain-link perimeter fence on the east side of the service road.

The service road will be widened and a new access drive approximately 630 feet long will be constructed from intersection with the service road and northern truck loading area to Soil Conservation Road. The widening of the service road will extend approximately 1,000 feet from the intersection with the proposed access drive and northern truck loading area to the intersection with Explorer Road.

The existing ground surface elevations within the proposed building area vary widely with the highest elevation at the north end at approximately 194 feet and lowest elevation at the south end at approximately 173 feet. The ground surface elevations outside the proposed building area also vary widely, ranging from 192 feet at one high point to 177 in the low lying areas. There are also steep slopes within the proposed building area. The ground surface elevations along the existing service road range from about 203 feet at the south end to about 180 feet at the middle of the section to be improved. The ground surface elevations along the proposed access drive range from about 185 feet at the west end to about 166 feet at the east end.

The project site is bound by wooded areas to the north, east, south and west with the exception of the new access drive, which will extend east to Soil Conservation Road. The area at the south end of the project site, including the area of future parking lot expansion and southern truck loading area, was a firing range, which has undergone lead abatement.

SITE GEOLOGY

The project site lies within the Atlantic Coastal Plain physiographic province. According to the Geologic Map of Maryland, 1968, the project site is underlain by the Potomac Group of Cretaceous age. The Potomac Group consists of interbedded quartzose gravels; protoquartzitic to orthoquartzitic argillaceous sands; and white, dark gray and multicolored silts and clays.

SUBSURFACE EXPLORATION

Thirty soil borings, numbered B-01 through B-15, R-01 through R-09, S-01, S-02, S-02A, SWM-1, SWM-2 and SWM-3 were performed at the site. The borings were advanced to depths varying from 5.0 to 35.0 feet. Each boring was advanced by the hollow-stem auger drilling method with an ATV-mounted drilling rig with the exception of Boring B-02A, which was performed with a hand auger. The "B" series borings were performed in proposed building areas. The "R" series borings were performed in proposed and existing paved areas. The "S" and "SWM" series borings were performed at proposed storm water management locations. The boring locations were selected

and staked in the field by EBA. The drilling was performed by EBA in July and August, 2008, and April and May, 2009. The location of each boring is shown on the Boring Location Plans included in Appendix B.

Standard Penetration Tests (SPT) were performed at 2.5-foot intervals in each boring except Boring S-02A, which was performed with a hand auger. A soil sample was collected from each SPT location with a split barrel sampler. The groundwater depth in each boring was observed upon completion and at several locations the water level was observed approximately 24 hours after completion. Two subsurface profiles are presented in Appendix C. Descriptions of the soils encountered, SPT results, groundwater observations and other information are provided on the boring logs presented in Appendix D. A legend to the soil descriptions is provided at the beginning of Appendix D.

Infiltration testing was performed adjacent to Boring S-01 and within Boring S-02A. Infiltration testing was planned at the location of Boring SWM-3, but was not performed due to shallow groundwater at this location. Each infiltration test involved augering to the test depth, installing a casing and filling the casing with approximately 2 feet of water to presoak the soil. Approximately 24 hours later, the water level was restored to approximately 2 feet above the bottom of the test hole. The falling water level in the casing was monitored for a period of 4 hours. The infiltration test results are presented in Appendix E.

Five test holes, numbered PT-1, PT-2, PT-3, SOH-1 and WT-1, were performed using an 8-inch diameter hand auger in the area of the proposed septic field. The test holes were advanced to depths ranging from 4.5 to 13.0 feet. Percolation tests were performed in Test Holes PT-1, PT-2 and PT-3 under the supervision of a Sanitarian from the Prince George's County Health Department. The percolation test results and summary letter provided by the Prince George's County Health Department are included in Appendix F. Logs of the test holes are included in Appendix D.

LABORATORY TESTING

All the soil samples were delivered to EBA's laboratory. Selected samples were tested to determine the moisture content, particle size distribution, liquid and plastic limits, California Bearing Ratio (CBR), and/or moisture-density relationship of the soil. Graphic plots and a summary of the laboratory test results are provided in Appendix G.

SUBSURFACE CONDITIONS

The boring information and laboratory test results were used to determine the primary subsurface strata. Descriptions of the soil layers follow. A statistical summary of the SPT N-values for each layer is provided in Appendix H. The averages, standard deviations and 95% confidence intervals are provided.

Pavement

An asphalt pavement was encountered at the surface at the location of Boring R-04. The thickness of the pavement was 6 inches. A sand and gravel subbase was encountered under the asphalt pavement. The thickness of the subbase was 3 inches.

Topsoil and Rootmat

Topsoil and/or rootmat were encountered at the surface at all the boring locations except Borings B-05, B-10 and R-04. The thickness of the topsoil ranged from 2 to 6 inches. The thickness of the topsoil at each location is provided in the "Remarks" column of the respective boring logs.

Existing Fill

Existing fill was encountered at the surface at the locations of Borings B-05 and B-10, and underlying the topsoil in Borings B-01, B-02, B-04, B-06, B-08, B-09, B-14, R-03, and R-05 through R-07. The depth to the bottom of the Existing Fill ranged from 2.5 to 18.0 feet. The depths and elevations of the Existing Fill as well as other boring information are summarized in Table 1 below. The Existing Fill generally consisted of damp to wet, soft to very stiff, SILT, silty CLAY and CLAY, and very loose to dense, silty and clayey SAND and poorly graded SAND. Wood and brick were observed in the Existing Fill layer at several locations. The SPT N-values within this stratum ranged from 2 to 36 blows per foot, the average was 14 blows per foot and the standard deviation was 7 blows per foot.

The natural moisture contents of selected samples from this layer ranged from 6.9 to 22.7 percent. The liquid limits of selected samples from this layer ranged from 17 to 33 and the plasticity indexes ranged non plastic to 12. The USCS symbols for the soils in this layer include ML, CL, CL-ML, SM, SC-SM and SP based on the laboratory test results and visual classifications.

Table 1

Summary of Existing Fill Depths and Elevations

Boring No.	Surface Elevation (ft)	Boring Depth (ft)	Bottom of Boring Elevation (ft)	Depth of Existing Fill (ft)	Bottom of Existing Fill Elevation (ft)
B-01	180.3	30	150.3	10.5	169.8
B-02	182.2	35	147.2	11	171.2
B-03	171.9	25	146.9	---	---
B-04	182.8	35	147.8	10	172.8
B-05	180.6	25	155.6	15.5	165.1
B-06	180.7	20	160.7	5	175.7

Boring No.	Surface Elevation (ft)	Boring Depth (ft)	Bottom of Boring Elevation (ft)	Depth of Existing Fill (ft)	Bottom of Existing Fill Elevation (ft)
B-07	172.5	20	152.5	---	---
B-08	184.9	25	159.9	10	174.9
B-09	185.2	25	160.2	9	176.2
B-10	193.9	35	158.9	18	175.9
B-11	170.7	25	145.7	---	---
B-12	173.2	35	138.2	---	---
B-13	175.1	25	150.1	---	---
B-14	183.2	35	148.2	10.5	172.7
B-15	175.2	30	145.2	---	---
PT-1	179.5*	7	172.5	---	---
PT-2	179.5*	7	172.5	---	---
PT-3	178.5*	7	171.5	---	---
R-01	169.3	5	164.3	---	---
R-02	183.8	5	178.8	---	---
R-03	179.2	5	174.2	3	---
R-04	193.4	5	188.4	---	190.4
R-05	193.0	20	173.0	10	183.0
R-06	184.8	15	169.8	> 15.0	< 169.8
R-07	191.8	20	171.8	15.5	176.3
R-08	176.0	5	171.0	---	---
R-09	175.9	5	170.9	---	---
S-01	172.3	10	162.3	---	---
S-02	178.4	10	168.4	---	---
S-02A	182*	5	177	---	---
SOH-1	179*	4.5	174.5	---	---
SWM-1	166.3	15	151.3	---	---
SWM-2	167.2	15	152.2	---	---
SWM-3	168.2	15	153.2	---	---
WT-1	177*	13	164.0	---	---

∗ Elevation estimated from site plan

Moisture-density tests, performed in accordance with ASTM D 1557, were conducted on bulk samples collected from this layer in Borings B-05, B-10, R-05 and R-07. The maximum dry densities were 127.7, 118.3, 122.7 and 120.0 pcf, respectively. The optimum moisture contents were 8.5, 13.1, 12.2 and 12.4 percent, respectively.

A California Bearing Ratio (CBR) test was performed on the bulk sample collected from Boring R-07. The CBR value was 5.4.

Sand

Layers of sand were encountered underlying the pavement in Boring R-04, underlying the topsoil in Borings B-03, B-07, B-13, PT-1, PT-2, PT-3, R-01, R-02, R-09, S-01, S-02, SOH-1, SWM-2, SWM-3 and WT-1; underlying the Existing Fill in Borings B-02, B-04, B-05, B-06, B-08, B-09, B-10, B-14 and R-07; and underlying the Clay and Silt layers in Borings B-01, B-11, B-12, B-15, R-05, R-08 and SWM-1. The depth to the bottom of this layer ranged from 11.5 to 28.5 feet. The soils in this layer consisted of damp to wet, very loose to dense, poorly-graded SAND with silt, clayey SAND and silty SAND. The SPT N-values in this stratum ranged from 2 blows per foot, to more than 100 blows per foot, the average was 19 blows per foot and the standard deviation was 14 blows per foot. Seams of iron pan or hard pan (i.e., ironstone or cemented sand) were observed in this layer at some locations. Iron pan and hard pan are common in the Potomac Formation at the boundary between sand and clay facies. Seams of clay and silt were encountered within this stratum in Borings B-11 and B-12. The SPT N-values of 4 or less at depths greater than 10 feet may be the result of running sands in the boreholes and not representative of the consistency at these depths. Running sands are common in uniformly graded sands below the water table.

The natural moisture contents of selected samples from this layer ranged from 3.1 to 19.4 percent. The USCS symbols for the soils in this layer include SP, SP-SM, SC-SM, SC and SM based on the laboratory test results and visual classifications.

A moisture-density test, performed in accordance with ASTM D 1557, was conducted on a bulk sample collected from this layer in Boring R-04. The maximum dry density was 129.0 pcf and the optimum moisture content was 8.4 percent.

A California Bearing Ratio (CBR) test was performed on the bulk sample collected from Boring R-04. The CBR value was 9.9.

Clay and Silt

Layers of clay and silt were encountered underlying the topsoil in Borings B-11, B-12, R-08 and SWM-1; underlying the Existing Fill in Borings B-01, R-03 and R-05; and underlying the Sand layers in Borings B-01 through B-05, B-07, B-10 and B-14. The Clay and Silt layers were interlayered with the SAND layer in Borings B-11 and B-12. The depths to the bottom of the Clay and Silt layers ranged from 8.5 to more than 35.0 feet (i.e., exceeded the maximum boring depth). The soils consisted of moist to wet, soft to hard, CLAY, sandy SILT, SILT and elastic SILT. The SPT N-values in the Clay and Silt layers ranged from 3 blows per foot to more than 100 blows per foot, the average was 32 blows per foot and the standard deviation was 20 blows per foot.

The natural moisture contents of selected samples from this layer ranged from 12.3 to 21.8 percent. The USCS symbols for the soils in this layer include CL-ML, CL, MH and ML based on the laboratory test results and visual classifications.

A moisture-density test, performed in accordance with ASTM D 1557, was conducted on a bulk sample collected from this layer in Boring R-05. The maximum dry density was 122.7 pcf and the optimum moisture content was 12.2 percent.

Water Level Observations in the Boreholes

The water level in each borehole was observed at completion. The water level was also observed in several boreholes 24 hours after completion. The water level and cave-in depth observations are summarized in Table 2 on the next page.

Table 2

Summary of Water Level and Cave-in Depth Observations

Boring No.	Ground Surface Elev. (ft)	Boring Depth (ft)	Bottom of Boring Elev. (ft)	At Completion		After 24 hours			
				Water Level Depth (ft)	Cave-in Depth (ft)	Water Level Depth (ft)	Cave-in Depth (ft)	Water Level Elev. (ft)	Cave-in Elev. (ft)
B-01	180.3	30.0	150.3	15.3	15.5	14.6	15.0	165.7	165.3
B-02	182.2	35.0	147.2	15.0	15.5	14.8	15.2	167.4	167.0
B-03	171.9	25.0	146.9	10.3	22.5	4.7	9.2	167.2	162.7
B-04	182.8	35.0	147.8	Dry	22.0	14.6	15.2	168.2	167.6
B-05	180.6	25.0	155.6	12.0	15.3	10.0	10.2	170.6	170.4
B-06	180.7	20.0	160.7	Dry	11.8	Dry	11.8	---	168.9
B-07	172.5	20.0	152.5	5.4	5.5	N/A		---	---
B-08	184.9	25.0	159.9	Dry	17.0	Dry	17.0	---	167.9
B-09	185.2	25.0	160.2	Dry	19.5	Dry	16.8	---	168.4
B-10	193.9	35.0	158.9	30.7	31.2	15.7	22.4	178.2	171.5
B-11	170.7	25.0	145.7	7.2	9.7	1.5	5.2	169.2	165.5
B-12	173.2	35.0	138.2	4.2	6.5	0.0	5.0	173.2	168.2
B-13	175.1	25.0	150.1	Dry	2.5				
B-14	183.2	35.0	148.2	18.0	18.3				
B-15	175.2	30.0	145.2	5.4	5.7	5.5	5.9	169.7	169.3
PT-1	179.5*	7.0	172.5	Dry	7.0				
PT-2	179.5*	7.0	172.5	Dry	7.0				
PT-3	178.5*	7.0	171.5	Dry	7.0				
R-01	169.3	5.0	164.3	Dry	3.1	Dry	3.5	---	165.8
R-02	183.8	5.0	178.8	Dry	3.0	Dry	3.1	---	180.7
R-03	179.2	5.0	174.2	Dry	2.2	Dry	2.5	---	176.7
R-04	193.4	5.0	188.4	Dry	2.2			---	---
R-05	193.0	20.0	173.0	Dry	15.5	Dry	14.1	---	178.9
R-06	184.8	15.0	169.8	N/A		Dry	13.1	---	171.7
R-07	191.8	20.0	171.8	N/A		Dry	16.8	---	175.0
R-08	176.0	5.0	171.0	Dry	2.5				
R-09	175.9	5.0	170.9	Dry	2.5				
S-01	172.3	10.0	162.3	6.8	7.0	Dry	7.0	---	165.3
S-02	178.4	10.0	168.4	Dry	7.3	Dry	7.4	---	171.0
S-02A	182*	5.0	177.0	Dry	5.0				
SOH-1	179*	4.5	175.0	Dry	4.5				
SWM-1	166.3	15.0	151.3	8.5	10.3	0.0	4.0	166.3	162.3
SWM-2	167.2	15.0	152.2	Dry	7.0	2.0	4.3	165.2	162.9
SWM-3	168.2	15.0	153.2	Dry	7.4	0.9	2.4	167.3	165.8
WT-1	177*	13.0	164.0	Dry	13.0	Dry	13.0	---	164.0

A water level of “Dry” indicates that the borehole was dry at the cave-in depth.

∗ Elevation estimated from site plan

Based on observations during drilling and the water level depth measurements in the boreholes after completion, it appears that the elevation of the ground water surface in the building area generally ranges from 166 to 170 feet. Perched water may be present at higher elevations at some locations.

Be advised that fluctuations in groundwater levels occur due to variations in season, rainfall, construction activity, and other site-specific factors.

RECOMMENDATIONS

Seismic Site Classification

The following seismic design information is based on a review of the site specific test boring data, published geological data, and the seismic design guidelines provided in the International Building Code. The seismic site class was determined by the Standard Penetration Resistance method in accordance with Table 1613.5.2 of the *International Building Code, 2009*. It is our opinion that the subsurface conditions at the site should be categorized as Site Class D. A derivation of the seismic site classification is provided in Appendix H. The following seismic design parameters should be used for structural design.

Table 3

Seismic Design Parameters

SPECTRAL RESPONSE ACCELERATION AT SHORT PERIODS, S_s (1)	SPECTRAL RESPONSE ACCELERATION AT 1-SECOND PERIOD, S_1 (2)	SITE COEFFICIENT, F_a (3)	SITE COEFFICIENT, F_v (4)
0.166	0.080	1.6	2.4

(1) Per Figure 1613.5(1) of the 2009 IBC
(2) Per Figure 1613.5(2) of the 2009 IBC
(3) Per Table 1613.5.3(1) of the 2009 IBC
(4) Per Table 1613.5.3(2) of the 2009 IBC

Building Foundations

Shallow Foundations

The finished floor elevation of the proposed shipping and receiving building is 183.0 feet. Based on our discussions with the project structural engineer, the maximum column load for the shipping and receiving building and warehouse building is approximately 300 kips. Lighter column loads are expected for the low roof office portion of the shipping and receiving building. The column loads for the compressed gas cylinder storage building are anticipated to be less than 100 kips.

The Existing Fill was encountered in all of the building borings except Borings B-03, B-07, B-11, B-12, B-13 and B-15, which are located on the west side of the proposed shipping and receiving building and warehouse building. The soil borings performed within the building footprints indicate that the Existing Fill contains materials of variable texture and consistency as well as degradable organic matter. The variable conditions in the Existing Fill can cause unacceptable settlement below foundations and slabs-on-grade. Thus, the Existing Fill is not suitable for direct support of shallow foundations or slabs-on-grade.

The natural soils, including the Sand and Clay and Silt layers, are suitable for support of shallow foundations with a maximum bearing pressure of 3,000 pounds per square foot (psf). Additionally, shallow foundations with a maximum bearing pressure of 3,000 psf may be supported on compacted structural fill. If shallow foundations are selected for support of the shipping and receiving building and the warehouse building, it is recommended that the Existing Fill be completely removed from within the proposed building footprints, plus 10 feet on all sides, and replaced with structural fill. The depths and elevations of the top of the natural soils at the boring locations are summarized in Table 4 below.

Table 4

Top Elevation of the Top of Natural Soil

Boring No.	Surface Elevation (ft)	Depth to Top of Natural Soils (ft)	Top Elevation of Natural Soils (ft)
B-01	180.3	10.5	169.8
B-02	182.2	11.0	171.2
B-03	171.9	0.0	---
B-04	182.8	10.0	172.8
B-05	180.6	15.5	165.1
B-06	180.7	5.0	175.7
B-07	172.5	0.0	---
B-08	184.9	10.0	174.9
B-09	185.2	9.0	176.2
B-10	193.9	18.0	175.9
B-11	170.7	0.0	---
B-12	173.2	0.0	---
B-13	175.1	0.0	---
B-14	183.2	10.5	172.7
B-15	175.2	0.0	---

Table 4 indicates that the elevations of the top of the natural soils within the footprint of the proposed shipping and receiving building range from 165.1 to 176.2 feet. A comparison of the proposed finished floor elevation of 183.0 feet to the elevations of the natural soils within the building footprints indicates that the depth of the structural fill within the building footprints would range from 6.8 to 17.9 feet.

After the Existing Fill has been removed from within the building footprints, the subgrades should be thoroughly proofrolled with a fully loaded tandem axle dump truck or equivalent in the presence of a geotechnical engineer or designated representative. The purpose of the proofroll will be to confirm that the existing fill has been thoroughly removed and to locate any soft, wet, or otherwise unsuitable pockets of soils. Unsuitable soils should be undercut until a stable subgrade is encountered.

Structural fill should be placed on the undercut subgrade to achieve the desired grading within the building footprints. Shallow foundations may be constructed on the natural soils or newly-placed structural fill. The estimated total settlement of shallow foundations constructed on the natural soils or compacted structural fill is 1.5 inches or less and the estimated differential settlement is 0.75 inch or less. Shallow foundations should be founded at least 2.5 feet below the finished grade for frost protection.

The excavations should be kept dry and concrete should be poured the same day to avoid disturbance of the subgrade. The bearing capacity of the foundation subgrades should be verified by a geotechnical engineer or qualified technician prior to pouring concrete.

Compacted Aggregate Piers

Compacted aggregate piers are suitable for ground improvement for support of shallow foundations and slabs-on-grade in the area of Existing Fill. As an alternative to excavation and replacement of the fill, the shallow foundations and slabs-on-grade may be constructed on the Existing Fill after improving the soils through the installation of compacted aggregate piers. A compacted aggregate pier consists of a highly densified inclusion of crushed aggregate that is installed by drilling a 24 to 36 inch diameter hole and densifying the aggregate in thin lifts within the hole. The high-energy compaction process produces a coupling between the aggregate pier and the surrounding soils, resulting in improved soil strength and stiffness, and reduced compressibility.

The bottoms of the aggregate piers should be founded on the natural soils including the Sand and Clay and Silt layers. The depth from the proposed finished floor elevation to the elevations of the natural soils encountered in the building borings ranges from 6.8 to 17.9 feet. Compacted aggregate piers should be provided for each column footing and under the slab area. Generally, one to four aggregate piers is installed at each column footing location and one for each 10 by 10 feet of slab area.

It should be noted that a significant amount of wood was encountered in Boring B-05. Because the Existing Fill contains wood and other debris that can affect the installation

of these support elements, it should be anticipated that techniques such as pre-drilling or removal of these materials with an excavator will be required in some areas. Field engineering may be required to adjust the aggregate pier locations during construction if obstructions are encountered

Shallow foundations can be constructed on the Existing Fill after aggregate piers. It is expected that the allowable bearing capacity will be 3,000 psf or more depending upon the level of improvement achieved. It is recommended that at least two field modulus load tests be performed to verify the design parameters for the compacted aggregate piers. The tests should be conducted on a small number of test piers prior to the general installation of the compacted aggregate piers to establish the installation criteria. The settlement of shallow foundations bearing on the improved soils and compacted aggregate piers can be expected to be no more than 1 inch, with no more than ½ inch of differential settlement.

Compacted aggregate piers are normally constructed by an experienced specialty contractor engaged by means of a design-build process. The owner may also specify that the work be accomplished under a performance specification.

It should be expected that groundwater will be encountered in the excavations for compacted aggregate piers at elevations generally ranging from 166 to 170 feet and possibly higher in areas of perched water. Open excavations in sandy soils will tend to collapse at the groundwater interface or at higher elevations. For this reason, it should be assumed that the excavations for the compacted aggregate piers will need to be cased to prevent cave-ins and to ensure the integrity of the aggregate piers.

Drilled Shafts

Drilled shafts are suitable for the support of the proposed buildings columns and floor slabs in the area of Existing Fill. Drilled shafts may be founded in the Sand or Clay layers with a maximum allowable end bearing pressure of 10,000 psf. Drilled shafts should be embedded to a depth of at least 6 times the shaft diameter from the final grade at the top of the shaft. The estimated total settlement of drilled shafts is 0.5 inches or less. Straight shafts should be used for this project (i.e., no belling) since bells in Sand layer would likely collapse.

A drilled pier consists of a drilled hole filled with concrete and reinforcing steel. A shaft diameter of 30 inches is common for projects with similar column loads. All drilled pier construction should be performed under the supervision of a geotechnical engineer. It should be expected that workers will be required to enter the shaft to clean the bottom and inspect the quality of the shaft. The geotechnical engineer may direct the contractor to extend the bottom of a shaft if the material at the bottom of the shaft does not have the required bearing capacity. The shaft diameter should not be less than 30 inches since workers cannot enter a smaller shaft for cleaning and inspection.

Augered Cast-in-Place Piles

Augered cast-in-place (ACIP) piles with tips embedded in the Sand and/or Clay and Silt layers are suitable for support of the proposed building columns and floor slabs in the area of the Existing Fill. An ACIP pile consists of an augered boring where grout is injected into the borehole as the augers are retracted. Table 5 on the next page provides recommended tip elevations for ACIP piles for various allowable capacities:

Table 5: Recommended ACIP Tip Elevations

Allowable Capacity (kips)	Tip Elevation (ft) for 10-inch Diameter ACIP Piles		
	Shipping and Receiving Building	Warehouse Building	Compressed Gas Cylinder Storage Building
50	144	143	167
75	138	137	160
100	132	130	154

Negative skin friction was considered in the determination of the axial capacity of the auger cast-in-place piles. The estimated total settlement of ACIP piles is 0.2 inches or less. It is recommended that the ultimate capacity of at least one ACIP test pile be verified by a static pile load test performed in accordance with ASTM D1143 prior to the installation of the production piles. The static pile load test should be performed on a test pile installed at the location of Boring B-5, where the Existing Fill is deepest. A qualified contractor (with verifiable previous experience) should perform the ACIP pile installations. The Deep Foundations Institute's "*Augered Cast-In-Place Piles Manual*" should be used to develop the contract specifications with regard to specifying materials, equipment, installation and pile acceptance.

ACIP piles should be installed in the presence of a qualified geotechnical engineer or other qualified representative of the owner. The engineer/representative should be present to observe the installation of the test piles and production piles. It is recommended that the Deep Foundations Institute's "*Inspector's Guide to Augered Cast-In-Place Piles*" be used to develop the specifications with regard to the inspector's duties and responsibilities.

Slabs-on-Grade

The finished floor elevation of the proposed shipping and receiving building and warehouse building is 183.0 feet. The proposed shipping and receiving building will have a high roof warehouse portion and a low roof office portion. The average slab loading for the high roof portion of the shipping and receiving building and the warehouse is assumed to be 250 psf and the average slab loading for the low roof office portion is assumed to be 100 psf. The average slab loading for the compressed gas cylinder storage building is assumed to be 250 psf.

If the shallow foundation option is selected for the proposed shipping and receiving building and warehouse building, it is anticipated that the subgrades for the slabs-on-grade will consist of newly-placed structural fill. All subgrades for slabs-on-grade should be proofrolled with a fully-loaded tandem axle dump truck in the presence of a geotechnical engineer or qualified technician prior to the placement of the gravel drainage layer. If soft or loose material is encountered during the proofroll, these materials should be undercut until a firm subgrade is encountered and then replaced with structural fill. The recommended modulus of subgrade reaction (k_s) for the slab-on-grade for the proposed shipping and receiving building and warehouse is 100 pci. This value was derived from Table 4-1 of the Department of the Army, *Technical Manual 5-809-12*, 1987. A copy of Table 4-1 is provided in Appendix H.

If the compacted aggregate pier option is selected for the proposed shipping and receiving building and warehouse building, it is anticipated that the subgrades for the slabs-on-grade will consist of compacted aggregate piers and the improved soils of the Existing Fill layer. In this case, the proofroll and undercut should be closely supervised by a geotechnical engineer so that benefit of the compacted aggregate piers is considered in the determination of undercut depths in the slab areas.

Slabs-on-grade should be reinforced with steel reinforcing bars or welded wire fabric, and supported on at least 4 inches of washed gravel. A 6-mil polyethylene vapor barrier should be placed over the gravel prior to concrete placement. The slab should be separated from walls and columns by isolation joints. Control joints should be provided to control shrinkage cracks in the concrete floor system.

If the drilled shaft or ACIP pile option is selected for support of the building columns, then it is recommended that the slab be designed as a structural slab to be supported by the drilled shafts or ACIP piles.

Pavements

Paved areas for this project include the following:

1) The Phase I parking lot on the east side of the proposed warehouse with an area of approximately 60 feet by 225 feet.
2) The Phase II parking lot to the south and east of the proposed warehouse with an area of approximately 110 feet by 125 feet.
3) A truck loading area on the north side of the proposed shipping and receiving building with an area of approximately 125 feet by 220 feet.
4) A truck loading area to the south of the proposed warehouse with an area of approximately 60 feet by 175 feet.
5) A new access drive will be constructed from the north truck loading area to Soil Conservation Road with a length of approximately 630 feet and a width of 24 feet (i.e., two 12-foot lanes)
6) Widening of the existing service road from Explorer Road to the truck loading

area; with a length of approximately 1,000 feet and a final width of 24 feet.

An informal estimate of the anticipated traffic volume and truck mix was developed by EBA and NASA for the proposed roadways, loading areas and parking lots. The estimate for the proposed access drive and north loading area included a volume of 30 two-axle box trucks, 30 five-axle tractor semi-trailers and 30 tandem axle dump truck per day. This traffic mix equated to approximately 440,000 ESALs for the access drive with a 20 year design period and assuming a growth factor of 2% per year. A value 330,000 ESALs was assumed for the service road which is 75% of the volume of the north truck loading area and access drive. The parking lot is intended for use by passenger vehicles only.

Soils of the Existing Fill layer were encountered in Borings R-03, R-05, R-06 and R-07. Thus, it is anticipated that the pavement subgrades for the north truck loading area, Phase 1 portion of the parking lot and northern portion of the service road will consist of soils of the Existing Fill layer. Soils of the Sand layer were encountered in Borings R-01, R-02, R-04, R-08 and R-09. Thus, it is anticipated that the pavement subgrade for the access drive, south truck loading area, Phase II parking area and southern portion of the service road will consist of soils of the Sand layer.

The CBR value for the soils of the Existing Fill layer (collected from Boring R-07) was 5.4. The CBR value for the soils of the Sand layer (collected from Boring R-04) was 9.9. A CBR value of 5.0 was used for the pavement design at all locations because site grading will require the placement of fill at some locations.

The pavement design was performed in accordance with the *AASHTO Guide for Design of Pavement Structures* (1993). The recommended pavement section for the access drive and north loading area consists of 6 inches of hot-mix asphalt pavement over 8 inches of graded aggregate subbase. The hot-mix asphalt pavement for the access drive should consist of one 2.0-inch lift of HMA Superpave, 9.5 mm for Surface, PG 64-22, Level 2, and one 4.0-inch lift of HMA Superpave, 19.0 mm for Base, PG 64-22, Level 2.

The recommended pavement section for the service road consists of 5 inches of hot-mix asphalt pavement over 8 inches of graded aggregate subbase. The hot-mix asphalt pavement for the service road and truck loading areas should consist of one 2.0-inch lift of HMA Superpave, 9.5 mm for Surface, PG 64-22, Level 2, and one 3.0-inch lift of HMA Superpave, 19.0 mm for Base, PG 64-22, Level 2.

The recommended pavement section for the parking lot consists of 4.0 inches of hot-mix asphalt pavement over 8 inches of graded aggregate subbase. The hot-mix asphalt pavement should consist of one 1.5-inch lift of HMA Superpave, 9.5 mm for Surface, PG 64-22, Level 2, and one 2.5-inch lift of HMA Superpave, 19.0 mm for Base, PG 64-22, Level 2.

The graded aggregate subbase should be compacted to 95 percent of the maximum dry density of the materials, determined in accordance with ASTM D1557, prior to the placement of asphalt.

The pavement subgrades should be thoroughly proofrolled with a fully loaded tandem axle dump truck or equivalent in the presence of a geotechnical engineer or designated representative. The purpose of the proofroll is to locate any soft, wet or otherwise unsuitable pockets of soils. The soft, wet or otherwise unsuitable soils should be removed and replaced with structural fill.

Due to the variable nature of the existing fill at the proposed north truck loading area, undercutting and replacement of the pavement subgrades with structural fill should be expected. The expected undercut depth in this area will be about 12 to 18 inches. As an alternative to undercutting these areas, the use of soil cement should be considered. An improvement of the subgrade soil can typically be achieved using 4 to 5 percent by weight of cement thoroughly mixed in the upper 12 to 18 inches of the pavement subgrades. Soil cement can be utilized to improve poor quality subgrade soils (i.e., CBR < 5) to a subgrade consistent with the pavement design which assumed a subgrade CBR of 5.

The site plan indicated that the existing service road, which is approximately 15 feet wide, will be widened to 24 feet. The existing pavement at the location of Boring R-04 consisted of 6 inches of asphalt and 3 inches of sand and gravel subbase. Depending on the adjustments to the existing grade, it may be feasible to incorporate the existing pavement into the final pavement. Typically, the existing pavement would be saw cut at the edge adjacent to the new pavement and the subgrade would be prepared for the new portion of roadway. The asphalt base course would be placed to be flush with the surface of the existing pavement and the asphalt surface course would be placed over the entire roadway width. The existing asphalt pavement may be milled prior to placing the overlay to adjust the cross-slope, provide a better bond with the new overlay and remove surface damage. It is recommended that a pavement distress study of the existing pavement be performed prior to the roadway improvement to determine if remedial repairs such as full depth patching or crack sealing are needed at some locations.

The pavement designs are based on a service life of 20 years before reaching the terminal serviceability of 2.0 with a reliability of 90 percent. The pavement designs also assume “good” drainage at all paved locations. Therefore, the grading should be designed so that surface water drains away from all paved areas to prevent saturation of the pavement subgrades.

Groundwater Control

Based on the subsurface data collected from the soil borings, groundwater should be expected at elevations ranging from about 166 to 170 (feet) in the building area. Perched water may be encountered in localized areas at higher elevations.

Groundwater should be expected at shallow depths in the area of the proposed stormwater management pond. It is expected that this water can be removed by pumping from sumps within the excavations.

Fill and Backfill

Topsoil, muck, rubble, trash, frozen material, organic matter and other deleterious materials should be removed from fill subgrades, pavement subgrades and slab subgrades. Subgrades for structural fill, pavements and slabs-on-grade should be compacted to 95% of the maximum dry density determined in accordance with ASTM D 1557 (modified proctor). Subgrades for structural fill, pavements and slabs-on-grade should be thoroughly proofrolled with a fully loaded tandem axle dump truck or equivalent in the presence of a geotechnical engineer or designated representative. The purpose of the proofroll will be to locate any soft, wet, or otherwise unsuitable pockets of soils. Unsuitable soils should be undercut until a stable subgrade is encountered and replaced with compacted structural fill.

Structural fill and backfill should be placed for new fills under pavements, slabs-on-grade, foundations, and for embankment fill for finished slopes steeper than 3 horizontal to 1 vertical. Structural fill and backfill should consist of soils classified as GW, GP, GM, GC, SW, SP, SM, and SC in accordance with ASTM D 2487 and the liquid limits and plasticity indices of the soils should not exceed 40 and 10, respectively. In addition, the maximum dry density, determined in accordance with ASTM D 1557, should be no less than 120 pcf. Structural fill and backfill should be placed in horizontal layers not more than 8 inches thick. Structural fill and backfill should be compacted to no less than 95% of the maximum dry density of the soil determined in accordance with ASTM D 1557.

Common fill and backfill may be placed for new fills in open areas more than 10 feet from pavements, structures and slopes steeper than 3 horizontal to 1 vertical. Common fill and backfill should consist of soils classified as GW, GP, GM, GC, SW, SP, SM, SC, ML and CL in accordance with ASTM D 2487. In addition, the maximum dry density, determined in accordance with ASTM D 698, should be no less than 100 pcf. Common fill and backfill should be compacted to no less than 92% of the maximum dry density determined in accordance with ASTM D 698 (Standard Proctor).

Common fill and backfill may also be used in building areas with ACIP piles and structural slabs or compacted aggregate piers. In this case the common fill and backfill should be compacted to no less than 95% of the maximum dry density determined in accordance with ASTM D 698 (Standard Proctor).

Impervious fill should be placed for the impervious core and cutoff trench in stormwater management pond embankments. Impervious fill should consist of soils free of muck, trash, organic matter, frozen material and classified as SC, CL, and CH in accordance with ASTM D 2487. In addition, impervious fill should have at least 30% passing the No. 200 Sieve. Impervious fill should be compacted to no less than 95% of

the maximum dry density determined in accordance with ASTM D 698 (Standard Proctor).

Each lift of fill and backfill should be compacted to the specified dry density prior to the addition of subsequent lifts and the thickness of each lift should not exceed 8 inches. Wet material should be dried and dry material should be moistened to within 2% of their optimum moisture contents prior to compaction. All fill and backfill soils should be free of muck, trash, organic matter, frozen material and particles larger than 3 inches.

Based on the information obtained from the borings, the soils in the Existing Fill layer consist of SM, SP, SC-SM, CL and CL-ML. The soils in the Sand layer consist of SP, SP-SM, SC and SM, and the soils in the Clay and Silt layer consist of ML, CL and MH. The soils classified as SM, SP and SC-SM are generally suitable for use as structural fill under foundations, slabs-on-grade, pavements, and embankments steeper than 3 Horizontal to 1 Vertical. The on-site soils are generally suitable for use as common fill and backfill.

A comparison of the natural moisture content of the onsite soils to their optimum moisture contents indicates the moisture contents of the onsite soils range from 1.0 to 10.3 percent above the respective optimum moisture contents. This suggests that the onsite materials will require drying or mixing with drier soils prior to reuse as fill or backfill provided that the material meets the above stated criteria.

Structural fill and backfill placement should extend at least 10 feet beyond the building perimeter or 1 foot laterally for each 1 foot of vertical fill placement. Where fill is to be placed on existing slopes, the slopes should be benched to allow for compaction against the slope. The benches should be level, with a maximum vertical height of 2 feet.

The clay and silt present at the project site will be moisture sensitive and susceptible to rapid erosion and degradation once exposed to wet or freezing conditions and heavy construction traffic. Earthwork construction should be scheduled during the drier months of the year, if possible. Care should be exercised to maintain positive surface drainage and limit heavy construction vehicle traffic in order to preserve the onsite soils following subgrade preparation.

Infiltration for Storm Water Management

From a geotechnical perspective, the implementation of infiltration methods for storm water management practices at the site will depend on certain criteria established by the State and County agencies as follows:

- Soil texture, the corresponding infiltration rate and nature of the soils at the site.
- Proximity of the seasonal high groundwater table to the bottom of the best management practice.

The data obtained from Borings S-1, S-2 and S-02A indicates that the conditions are favorable at these locations for infiltration. The conditions are not favorable for infiltration at the location of Boring SWM-3 as discussed below. The considerations for the use of infiltration practices at these locations are as follows:

1. The test boring information, results of the field infiltration tests and Particle Size Distribution Reports on selected samples collected from the borings indicate the following regarding soil texture, hydrologic soil group, infiltration rates and nature of the soil:

Table 6

Hydrologic Soil Group and Infiltration Rates of Selected Samples

Boring No.	Sample Depth (ft)	Percent Clay	Percent Silt & Clay	USDA Soil Description	Hydrologic Soil Group	Infiltration Rate Based on Field Test	Nature of Soil
S-01	3.5-5.0	---	22.8	Loamy Sand	A	> 8.02 in/hr	Natural
S-02	3.5-5.0	---	18.6	Loamy Sand	A	N/A	Natural
S-02A	4.7-5.0	3.8	12.7	Sand	A	> 8.02 in/hr	Natural
SWM-3	3.5-5.0	---	37.1	Loamy Sand	A	N/A	Natural

2. The USDA soil classifications for soils at the bottom of the proposed infiltration device should be in hydrologic soil groups A or B as determined from *Hydrologic Soil Properties Classified by Soil Texture* (Rawls et. al. 1982). Based on visual classifications of the samples collected from depths of 3.5 to 5.0 feet in Borings S-01 and S-02, and 4.7 to 5.0 feet in Boring S-02A, these soils are in hydrologic soil group A.

2. For infiltration, MDE specifies that the seasonally high water table should be at least 4 feet below the bottom of infiltration basins. Water was observed in Boring SWM-3 at a depth of 0.9 feet at twenty-four hours after completion, which correspond to an elevation of 167.3 feet. Based on this information, infiltration is not feasible at the location of Boring SWM-3. Groundwater was observed in Boring S-01 at a depth of 6.8 feet. The depth of groundwater in Borings S-02 and S-02A was more than 7.4 and 5.0 feet, respectively.

3. MDE specifies that the bottom of the infiltration devices will not be in fill soils. The boring data indicates that fill soils are not present at the locations of Borings S-01, S-02, S-02A and SWM-3.

Storm Water Management Pond Embankments

Fill placed for impervious core and cutoff trench should meet the requirements for impervious fill described in the Fill and Backfill section of this report. The final grade of the embankment slopes should be 3 horizontal to 1 vertical or flatter at completion. The spillway pipe should be provided with concrete collars and a concrete cradle in accordance with the requirements of MDE Pond Code 378.

The subgrades for dam embankments should be thoroughly proofrolled with a fully loaded tandem axle dump truck or equivalent in the presence of a geotechnical engineer or designated representative. The purpose of the proofroll will be to locate any soft, wet, or otherwise unsuitable pockets of soils. Unsuitable soils should be undercut until a stable subgrade is encountered and replaced with compacted fill.

Inspection and Testing

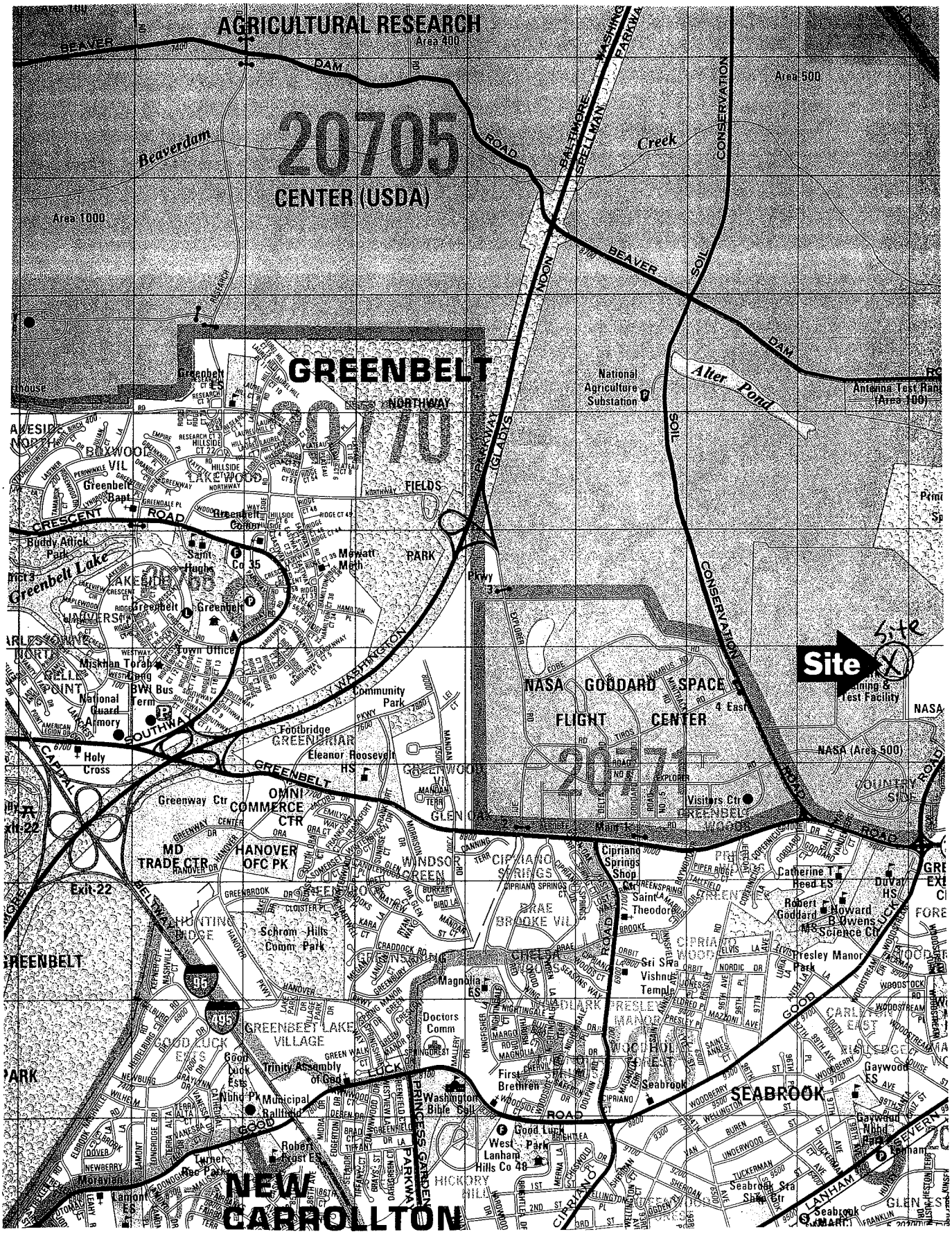
All earthwork, foundation and pavement construction should be inspected by a testing agency experienced in similar work. The testing agency should observe ground improvement and deep foundation installation, perform soil bearing capacity verifications, proofrolling inspections, field density tests (i.e. compaction tests), and laboratory testing of all fill and paving materials. All inspections and testing should be performed under the supervision of a registered professional engineer experienced in geotechnical engineering.

LIMITATIONS

The conclusions and recommendations presented in this report are based on the data collected during the subsurface investigation. Variations in the subsurface conditions may be discovered during construction. EBA will be available to assist in determining a solution to any geotechnical problem that may arise during the construction of this project.

Appendix A

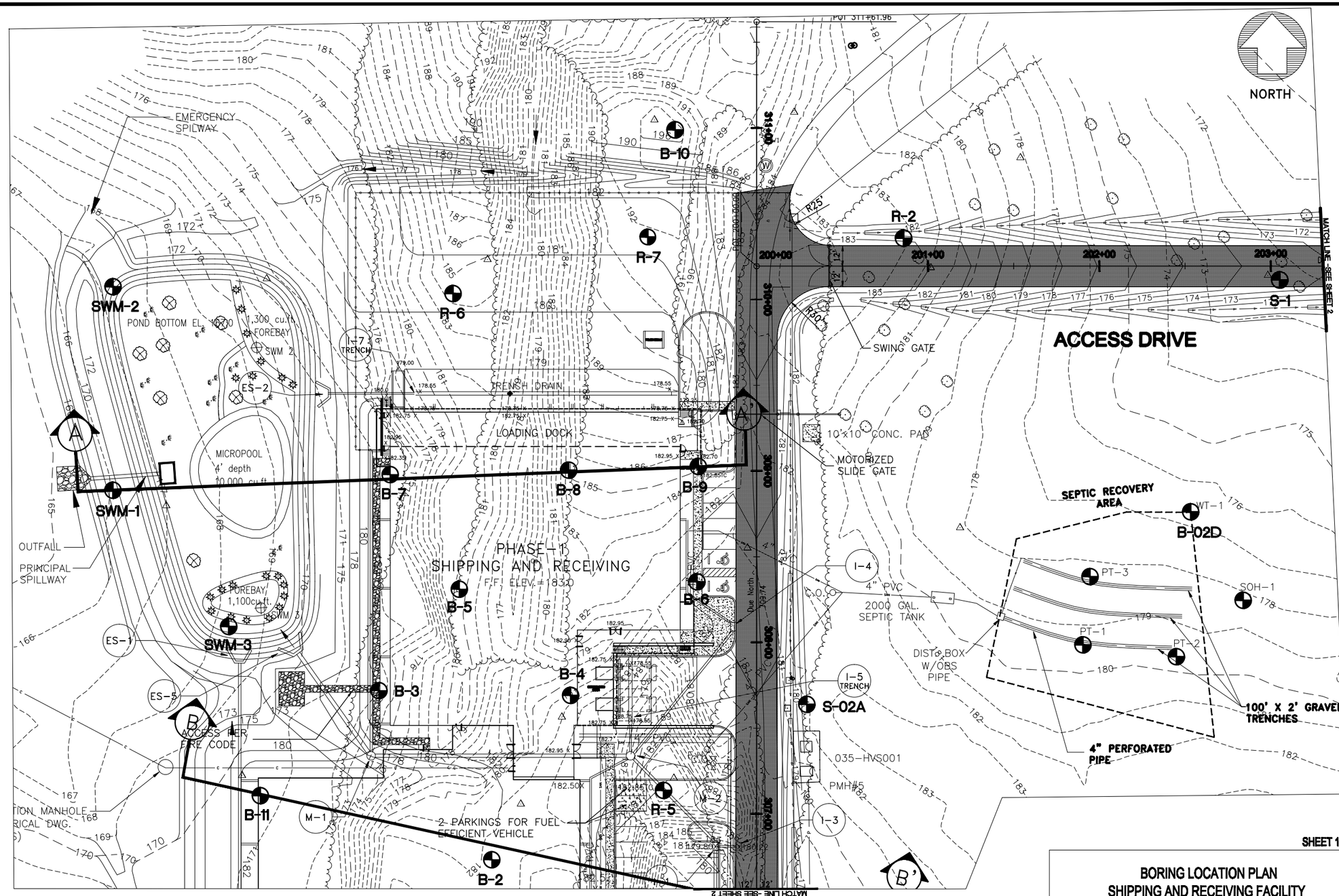
Vicinity Map



EBA ENGINEERING, INC. 4813 Seton Drive Baltimore, Maryland 21215	Project Name: **NASA Shipping and Receiving Facility**	Figure: **VICINITY MAP** Date: 9/18/08 Job No.: 2554-23 Prepared By: JMK Not to Scale	

Appendix B

Boring Location Plan



BORING LOCATION PLAN
SCALE 1"=60'

60 30 0 60 120 FEET
GRAPHIC SCALE: 1"=60'

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4813 SETON DRIVE
BALTIMORE, MD. 21215
(410) 358 7171

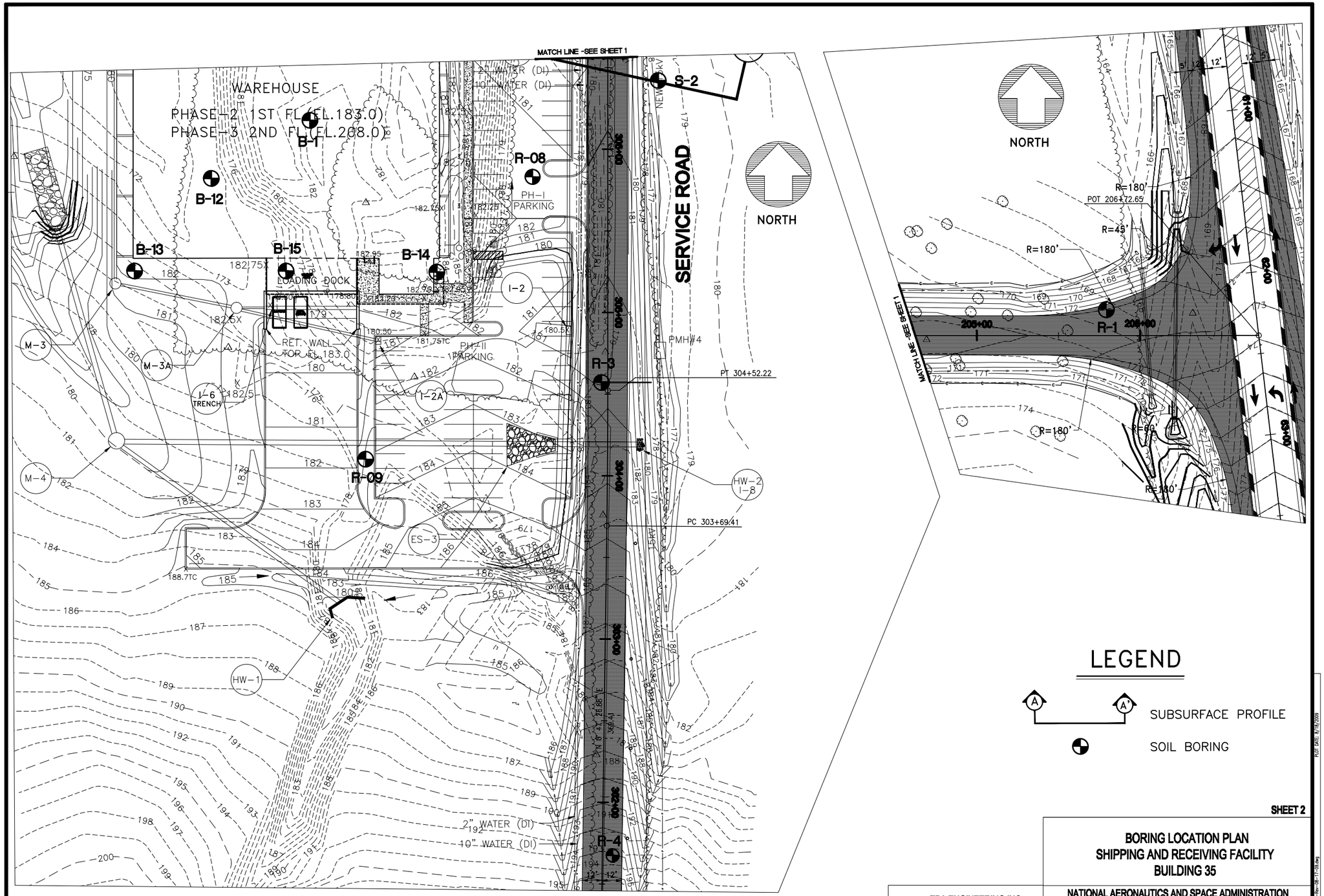
SHEET 1

BORING LOCATION PLAN
SHIPPING AND RECEIVING FACILITY
BUILDING 35

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER GREENBELT, MARYLAND
FACILITIES MANAGEMENT DIVISION

DATE ISSUED : 7/08/09	1"=60'	DRAWN BY: PB	REVIEWED BY: JK

FILE NAME: Boring Plan-Rev-09-11-10.dwg
PLOT DATE: 9/16/2009
FORM F 03-07-04



BORING LOCATION PLAN
SCALE=1"=60'

60 30 0 60 120 FEET
GRAPHIC SCALE: 1"=60'

LEGEND

SUBSURFACE PROFILE

SOIL BORING

SHEET 2

BORING LOCATION PLAN
SHIPPING AND RECEIVING FACILITY
BUILDING 35

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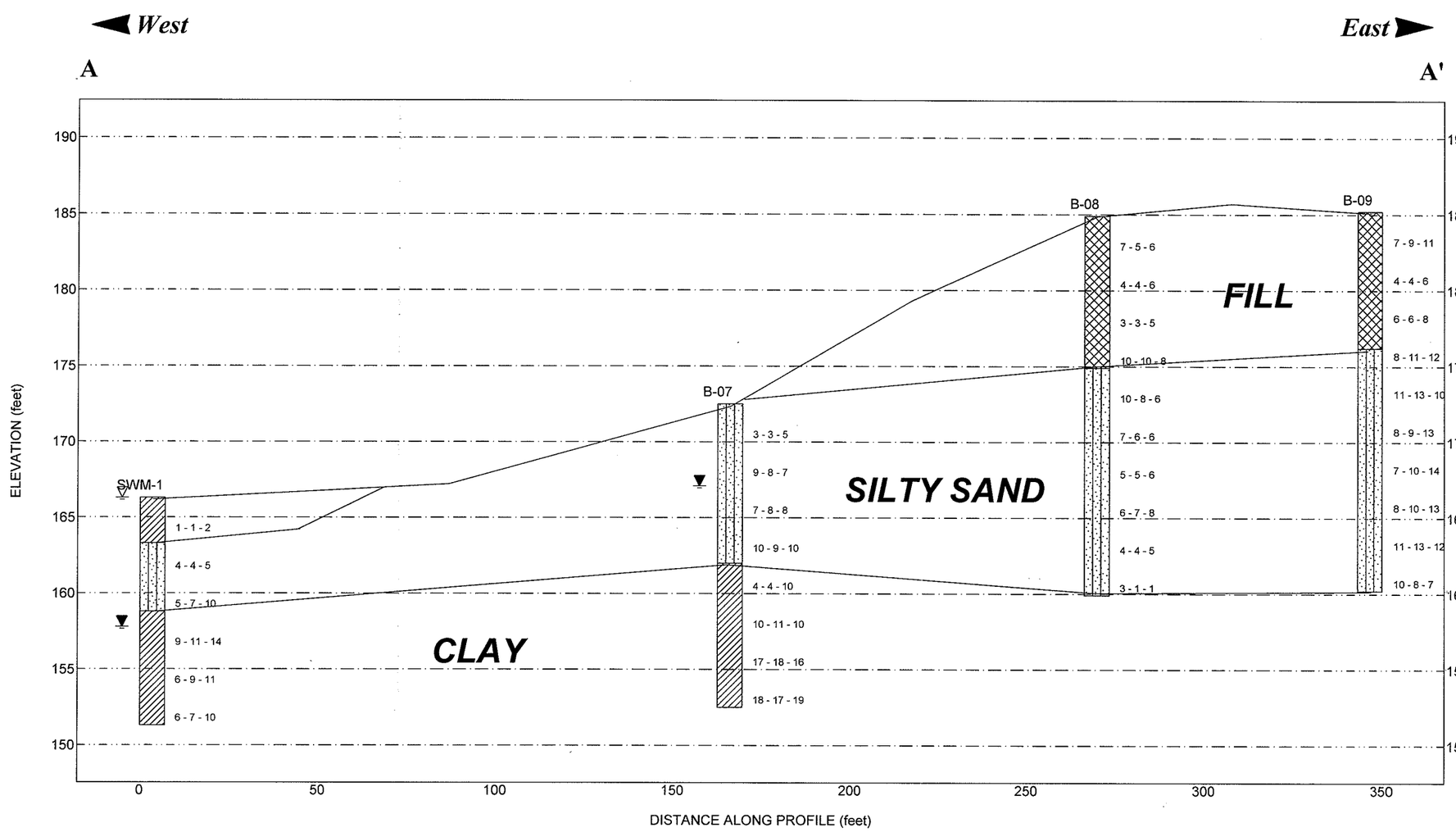
BALTIMORE, MD. 21215
(410) 358 7171

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER GREENBELT, MARYLAND
FACILITIES MANAGEMENT DIVISION

DATE ISSUED : 7/08/09	1"=60'	DRAWN BY: PB	REVIEWED BY: JK

FILE: BORING PLAN-Rev-09-11-09.dwg
PLOT DATE: 9/14/2009

Appendix C
Subsurface Profiles

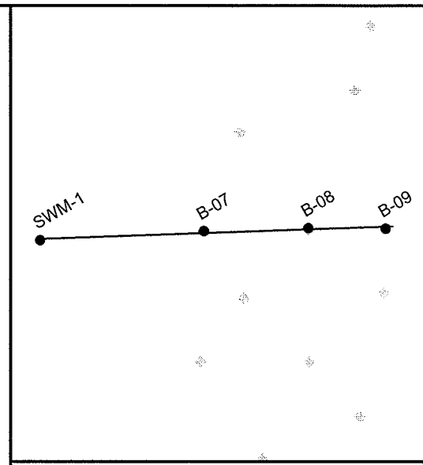


Lithology Graphics

USCS Silty Sand

USCS Low Plasticity Clay

Fill (made ground)



Site Map Scale 1 inch equals 130 feet

Explanation:

B-07 — Borehole Number

Borehole Lithology — 1-2-3 — SPT Blows

Water Level after 24 Hours

Water Level at Completion

0 — 35

Horizontal Scale (feet)

Vertical Exaggeration: 4.5x

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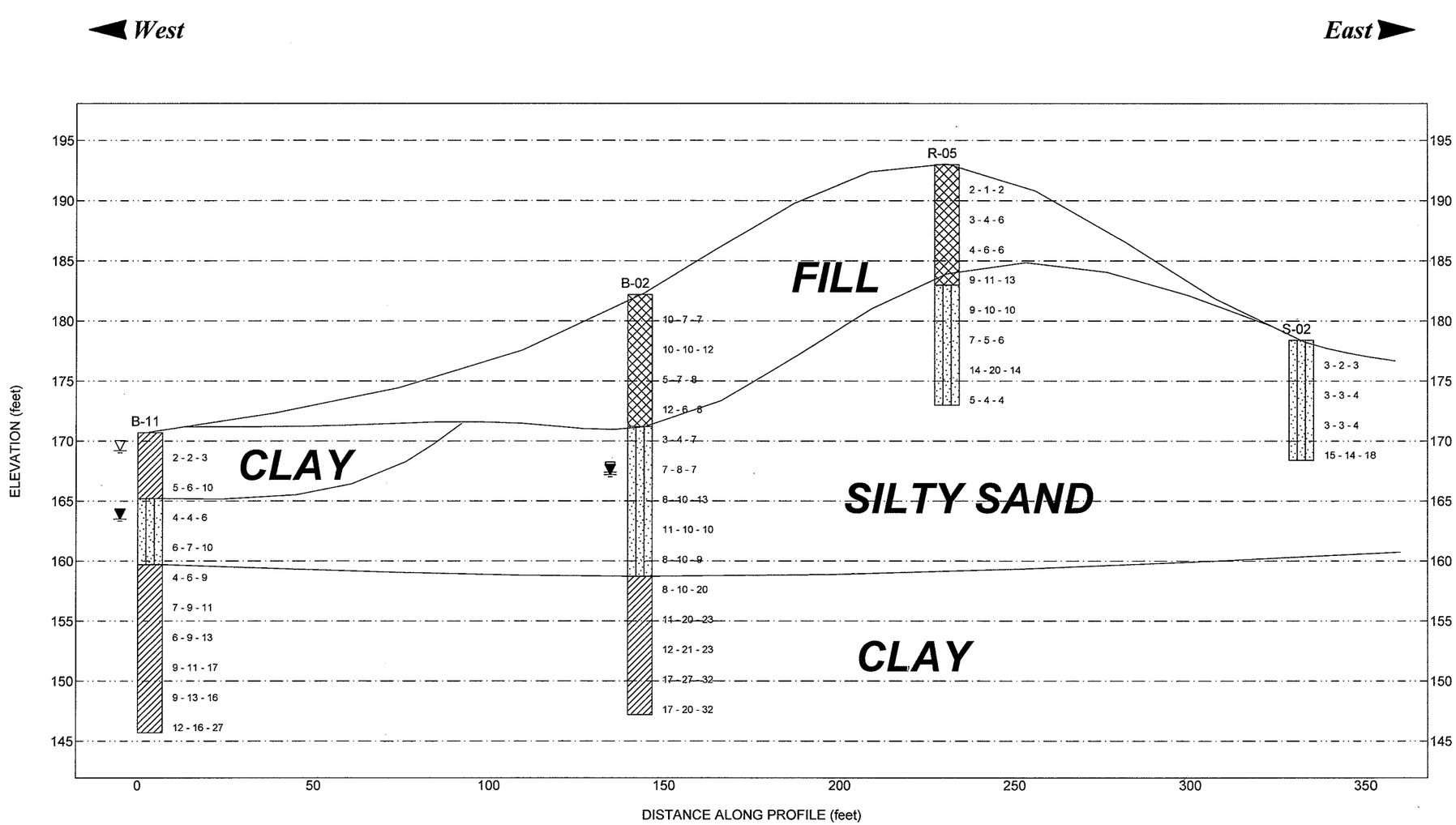
Baltimore, MD

NASA Shipping & Receiving Facility
Greenbelt, Maryland

Profile A-A'
Subsurface Profile

JOB NUMBER	PLATE NUMBER
2554C2339	Plate A

B SIZE WITH SPT NASA SHIPPING & RECEIVING FACILITY.GPJ FNC AB NWNL01.GDT 6/19/09

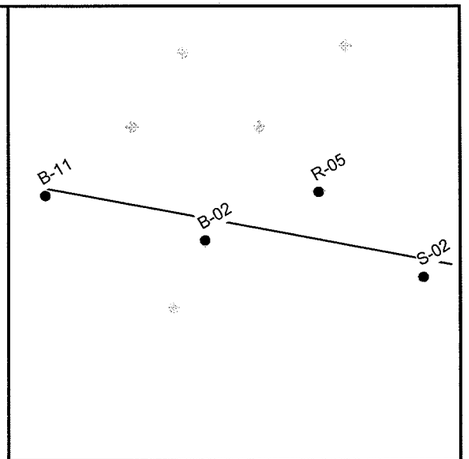


Lithology Graphics

Fill (made ground)

USCS Silty Sand

USCS Low Plasticity Clay



Site Map Scale 1 inch equals 130 feet

Explanation:

B-02 — Borehole Number

Borehole Lithology — 1-2-3 — SPT Blows

Water Level after 24 Hours

Water Level at Completion

0 35

Horizontal Scale (feet)

Vertical Exaggeration: 3.5x

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Greenbelt, Maryland

Profile B-B'
Subsurface Profile

JOB NUMBER	PLATE NUMBER
2554C2339	Plate B

B SIZE WITH SPT NASA SHIPPING & RECEIVING FACILITY.GPJ FNC AB NWNL01.GDT 7/10/09

Appendix D

Boring Logs

UNIFIED SOIL CLASSIFICATION (ASTM D-2487-98)

MATERIAL TYPES	CRITERIA FOR ASSIGNING SOIL GROUP NAMES			GROUP SYMBOL	SOIL GROUP NAMES & LEGEND
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO 4. SIEVE	CLEAN GRAVELS <5% FINES	Cu>4 AND 1<Cc<3	GW	WELL-GRADED GRAVEL
			Cu>4 AND 1>Cc>3	GP	POORLY-GRADED GRAVEL
		GRAVELS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR CL	GM	SILTY GRAVEL
			FINES CLASSIFY AS CL OR CH	GC	CLAYEY GRAVEL
	SANDS >50% OF COARSE FRACTION PASSES ON NO 4. SIEVE	CLEAN SANDS <5% FINES	Cu>6 AND 1<Cc<3	SW	WELL-GRADED SAND
			Cu>6 AND 1>Cc>3	SP	POORLY-GRADED SAND
		SANDS AND FINES >12% FINES	FINES CLASSIFY AS ML OR CL	SM	SILTY SAND
			FINES CLASSIFY AS CL OR CH	SC	CLAYEY SAND
FINE-GRAINED SOILS >50% PASSES NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT<50	INORGANIC	PI>7 AND PLOTS>"A" LINE	CL	LEAN CLAY
			PI>4 AND PLOTS<"A" LINE	ML	SILT
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OL	ORGANIC CLAY OR SILT
	SILTS AND CLAYS LIQUID LIMIT>50	INORGANIC	PI PLOTS >"A" LINE	CH	FAT CLAY
			PI PLOTS <"A" LINE	MH	ELASTIC SILT
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OH	ORGANIC CLAY OR SILT
HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK IN COLOR, AND ORGANIC ODOR		PT	PEAT

OTHER MATERIAL SYMBOLS

- Poorly Graded Sand with Clay
- Clayey Sand
- Sandy Silt
- Low to High Plasticity Clay
- Gravelly Silt
- Topsoil
- Well Graded Gravel with Clay
- Well Graded Gravel with Silt
- Asphalt
- Boulders and Cobble
- Fill

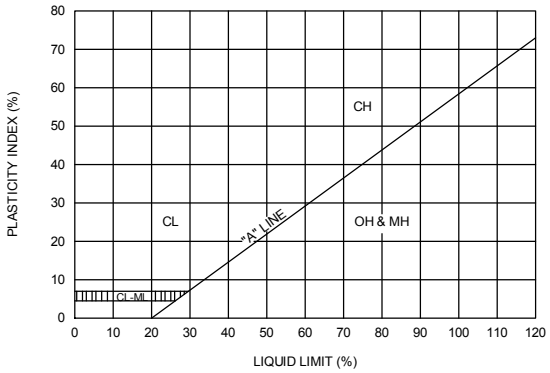
SAMPLE TYPES

- = Split Spoon
- Grab Sample

WATER LEVEL and CAVE-IN DEPTH INDICATORS

- Water Level at Completion
- Water Level after 24 hours
- Cave-in Depth at Completion
- Cave-in Depth after 24 hours

PLASTICITY CHART



PENETRATION RESISTANCE

SAND & GRAVEL		SILT & CLAY		
RELATIVE DENSITY	BLOWS/FOOT*	CONSISTENCY	BLOWS/FOOT*	COMPRESSIVE STRENGTH (TSF)
VERY LOOSE	0 - 4	VERY SOFT	0 - 2	0 - 0.25
LOOSE	4 - 10	SOFT	2 - 4	0.25 - 0.50
MEDIUM DENSE	10 - 30	FIRM	4 - 8	0.50 - 1.0
DENSE	30 - 50	STIFF	8 - 15	1.0 - 2.0
VERY DENSE	OVER 50	VERY STIFF	15 - 30	2.0 - 4.0
		HARD	OVER 30	OVER 4.0

* NUMBER OF BLOWS OF 140 LB HAMMER FALLING 30 INCHES TO DRIVE A 2 INCH O.D. (1-3/8 INCH I.D.) SPLIT-BARREL SAMPLER THE LAST 12 INCHES OF AN 18-INCH DRIVE (ASTM-1586 STANDARD PENETRATION TEST).

EBA Engineering, Inc.

Job No. 2554C2339

LEGEND TO SOIL DESCRIPTIONS

Soil Legend

SOIL LEGEND NASA SHIPPING & RECEIVING FACILITY.GPJ 8/19/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Girish Bhatt
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: 15.3 ', caved @ 15.5 '

Boring Number: B-01
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 08-04-08
Surface Elevation: 180.3'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: 14.6 ', caved @ 15.0 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
180.3			0					2 inches of topsoil.
		Reddish brown, moist, medium dense, silty SAND, trace leaves (Fill).		■	S-1	6 - 10 - 6	12	
		Reddish brown and red, moist, stiff, CLAY, with sand, trace gravel (Fill).	5	■	S-2	3 - 5 - 7	10	
		Reddish brown and gray, moist, medium stiff, CLAY, with sand (Fill).		■	S-3	3 - 3 - 5	8	
		Gray, wet, very loose, silty clayey SAND, trace wood (Fill).	10	■	S-4	2 - 1 - 1	10	
		Gray and yellowish brown, moist, very stiff, CLAY, with sand.		■	S-5	9 - 10 - 13	18	
	▼	Brown and gray, wet, dense, silty SAND.	15	■	S-6	8 - 12 - 20	18	
		Light brown and yellowish brown, wet, medium dense, silty clayey SAND.		■	S-7	8 - 8 - 11	18	
		Gray and yellowish brown, wet, loose, clayey SAND.	20	■	S-8	4 - 4 - 3	18	Observed wet spoon.
		Yellowish brown and gray, wet, medium dense, silty SAND.		■	S-9	8 - 10 - 12	13	
		Yellowish brown and gray, wet, medium dense, silty SAND.	25	■	S-10	7 - 8 - 9	18	
		Yellowish brown and reddish brown, wet, dense, silty SAND.		■	S-11	10 - 17 - 16	18	
				■	S-12	10 - 14 - 14	18	
		Red and gray and yellowish brown, moist, hard, CLAY.	30					
		Bottom of Boring @ 30.0 ft						
			35					

EBA Engineering, Inc.
4813 Seton Drive
Baltimore, Maryland 21215

■ = Split Spoon

▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥ Caved Depth At Completion
▼ Caved Depth After 24 hrs

Sheet: 1 of 1

RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Girish Bhatt
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: 15.0 ', caved @ 15.5 '

Boring Number: B-02
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 08-01-08 & 08-04-08
Surface Elevation: 182.2'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: 14.8 ', caved @ 15.2 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
182.2			0					2 inches of topsoil.
181		Reddish brown, moist, medium dense, silty SAND (Fill).		■	S-1	10 - 7 - 7	10	
178		Reddish brown, moist, medium dense, silty SAND, with gravel (Fill).	5	■	S-2	10 - 10 - 12	2	Two attempts.
176		Reddish brown, moist, medium dense, silty SAND, with gravel (Fill).		■	S-3	5 - 7 - 8	1	Two attempts.
173		Brown and black, moist, medium dense, silty SAND, trace asphalt (Fill).	10	■	S-4	12 - 6 - 8	7	
171		Brown, moist, medium dense, silty clayey SAND.		■	S-5	3 - 4 - 7	12	
168		Brown, wet, medium dense, silty SAND.	15	■	S-6	7 - 8 - 7	18	
166		Brown and light gray, very moist, medium dense, silty clayey SAND.		■	S-7	8 - 10 - 13	18	
163		Light gray, wet, medium dense, silty SAND.	20	■	S-8	11 - 10 - 10	18	
161		Brown, wet, medium dense, silty SAND.		■	S-9	8 - 10 - 9	18	Observed wet spoon.
158		Gray and yellowish brown, moist, hard, CLAY.	25	■	S-10	8 - 10 - 20	18	
156		Gray and red, moist, hard, CLAY.		■	S-11	11 - 20 - 23	18	
153		Gray and red, moist, hard, CLAY.	30	■	S-12	12 - 21 - 23	18	
151		Gray and red, moist, hard, CLAY.		■	S-13	17 - 27 - 32	18	
148		Gray and red, moist, hard, CLAY.	35	■	S-14	17 - 20 - 32	18	
146		Bottom of Boring @ 35.0 ft						

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■ = Split Spoon

Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

Sheet: 1 of 1

RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: 10.3 ', caved @ 22.5 '

Boring Number: B-03
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 08-05-08
Surface Elevation: 171.9'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: 4.7 ', caved @ 9.2 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
171.9			0					6 inches of topsoil.
		LIght brown, very moist, medium dense, silty SAND		■	S-1	6 - 7 - 5	18	
		Reddish brown, moist, dense, silty SAND	5	■	S-2	9 - 17 - 23	18	
		Reddish brown, wet, medium dense, silty SAND		■	S-3	8 - 5 - 5	12	
		Pale brown, wet, medium dense, silty SAND	10	■	S-4	10 - 11 - 10	18	
		Gray, damp, very stiff, elastic SILT		■	S-5	9 - 9 - 12	18	
		Gray, damp, very stiff, elastic SILT	15	■	S-6	7 - 9 - 12	18	
		Gray, damp, hard, elastic SILT		■	S-7	10 - 13 - 17	18	
		Red, damp, very stiff, CLAY	20	■	S-8	9 - 11 - 15	18	
		Red, damp, very stiff, CLAY		■	S-9	9 - 13 - 16	18	
		Red, damp, very stiff, CLAY	25	■	S-10	8 - 13 - 14	18	
		Bottom of Boring @ 25.0 ft						

171 170 169 168 167 166 165 164 163 162 161 160 159 158 157 156 155 154 153 152 151 150 149 148 147 146 145 144 143 142 141 140 139 138 137 136

30 35

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■ = Split Spoon

Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

Sheet: 1 of 1

RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Girish Bhatt
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 22.0 '

Boring Number: B-04
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 08-01-08
Surface Elevation: 182.8'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: 14.6 ', caved @ 15.2 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
182.8			0					4 inches of topsoil.
182		Reddish brown, moist, medium dense, clayey SAND (Fill).		■	S-1	17 - 12 - 9	13	
181								
180								
179		Greenish gray, moist, medium dense, silty SAND (Fill).		■	S-2	8 - 9 - 10	12	
178			5					Bulk sample collected from 1.0 to 10.0 feet.
177								
176		Brown and reddish brown, moist, stiff, CLAY, with sand (Fill).		■	S-3	6 - 6 - 5	12	
175								
174		Brown, moist, medium dense, silty SAND (Fill).		■	S-4	13 - 9 - 6	10	
173			10					
172								
171		Brown and light brown, moist, medium dense, silty SAND.		■	S-5	8 - 10 - 7	18	
170								
169		Light brown and light gray, moist to wet, medium dense, silty SAND.		■	S-6	7 - 8 - 8	13	
168	▼		15					
167								
166		Reddish brown, wet, medium dense, clayey SAND.		■	S-7	9 - 13 - 16	18	
165								
164		Reddish brown and light brown, wet, medium dense, silty clayey SAND.		■	S-8	12 - 9 - 14	18	
163			20					
162								
161	⊥	Reddish brown, wet, medium dense, silty SAND.		■	S-9	7 - 8 - 9	18	Observed wet spoon.
160								
159		Reddish brown and brown, wet, medium dense, clayey SAND.		■	S-10	7 - 9 - 11	18	
158			25					
157								
156				■	S-11	17 - 42 - 70	18	
155		Gray and yellowish brown, moist, hard, CLAY, possible iron pan or hard pan.						
154		Gray and yellowish brown, moist, hard, CLAY, possible iron pan or hard pan.		▬	S-12	50/4"	4	
153			30					
152								
151		Gray and yellowish brown, moist, hard, CLAY.		■	S-13	17 - 22 - 34	14	
150								
149		Gray and yellowish brown, moist, hard, CLAY.		■	S-14	22 - 27 - 29	18	
148			35					
147		Bottom of Boring @ 35.0 ft						

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■ = Split Spoon

▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥ Caved Depth At Completion
⊥ Caved Depth After 24 hrs

Sheet: 1 of 1

RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: 12.0 ', caved @ 15.3 '

Boring Number: B-05
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 08-05-08
Surface Elevation: 180.6'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: 10.0 ', caved @ 10.2 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
180.6			0					0 inches of topsoil.
180, 179		Light brown, moist, medium dense, silty SAND (Fill)		■	S-1	12 - 15 - 18	13	
178, 177, 176		Light brown, moist, loose, silty SAND (Fill)	5	■	S-2	5 - 4 - 4	13	Bulk sampled collected from 1.0 to 10.0 feet.
175, 174, 173		Gray, moist, medium dense, silty SAND (Fill)		■	S-3	5 - 6 - 6	12	
172, 171		Light gray, moist, loose, silty SAND (Fill)	10	■	S-4	3 - 3 - 2	10	
170, 169, 168	▽	Light brown, moist, loose, silty SAND, with wood, possible stump (Fill)		■	S-5	12 - 5 - 4	6	Rods bouncing on wood at 11 feet.
167, 166, 165	⊥⊥	Wood, possible stump (Fill)	15	■	S-6	10 - 9 - 9	4	
164, 163		Pale brown, wet, medium dense, silty SAND		■	S-7	11 - 11 - 11	10	Wet spoon at 16 feet.
162, 161, 160		Pale brown, wet, loose, silty SAND	20	■	S-8	4 - 3 - 2	14	
159, 158		Pale brown, wet, medium dense, silty SAND		■	S-9	7 - 5 - 5	14	
157, 156		Pale brown, wet, very stiff, CLAY	25	■	S-10	9 - 10 - 9	18	
155, 154, 153, 152, 151, 150, 149, 148, 147, 146, 145, 144		Bottom of Boring @ 25.0 ft	30, 35					

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■ = Split Spoon

▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥⊥ Caved Depth At Completion
⊥⊥ Caved Depth After 24 hrs

Sheet: 1 of 1

RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Girish Bhatt
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 11.8 '

Boring Number: B-06
Drilling Company: EBA Engineering, Inc.
Driller: Duane Addison
Date Drilled: 07-28-08
Surface Elevation: 180.7'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: Dry, caved @ 11.8 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
180.7			0					3 inches of topsoil.
180								
179		Reddish brown, moist, medium dense, clayey SAND, trace gravel (Fill).		■	S-1	3 - 13 - 17	11	
178								
177		Reddish brown, moist, medium dense, clayey SAND, trace gravel (Fill).		■	S-2	8 - 13 - 17	13	
176			5					
175								
174		Light brown, moist, medium dense, silty SAND.		■	S-3	8 - 11 - 9	14	
173								
172		Light brown, moist, medium dense, silty SAND.		■	S-4	9 - 10 - 9	13	
171			10					
170								
169	▨							
168		Light brown, wet, medium dense, silty SAND.		■	S-5	10 - 9 - 20	12	
167		Light brown, wet, dense, silty SAND.		■	S-6	10 - 13 - 27	14	Observed wet spoon.
166			15					
165								
164		Light brown, wet, medium dense, silty SAND.		■	S-7	6 - 12 - 17	17	
163								
162		Light brown, wet, medium dense, silty clayey SAND.		■	S-8	6 - 9 - 9	15	
161			20					
160		Bottom of Boring @ 20.0 ft						
159								
158								
157								
156			25					
155								
154								
153								
152								
151			30					
150								
149								
148								
147								
146			35					
145								
144								

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■ = Split Spoon

▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥ Caved Depth At Completion
▨ Caved Depth After 24 hrs

Sheet: 1 of 1

RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: 5.4 ', caved @ 5.5 '

Boring Number: B-07
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 08-06-08
Surface Elevation: 172.5'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: N/A

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
172.5			0					6 inches of topsoil.
		Brown and gray, moist, loose, silty SAND		■	S-1	3 - 3 - 5	12	
		Brown and gray, moist, medium dense, silty SAND	5	■	S-2	9 - 8 - 7	18	
	▽	Light brown, wet, medium dense, poorly graded SAND		■	S-3	7 - 8 - 8	12	
		Light reddish brown, wet, medium dense, silty SAND	10	■	S-4	10 - 9 - 10	18	
		Red and gray, damp, stiff, CLAY, little sand		■	S-5	4 - 4 - 10	16	
		Red and gray, damp, very stiff, CLAY, little sand	15	■	S-6	10 - 11 - 10	18	
		Gray, damp, hard, CLAY		■	S-7	17 - 18 - 16	18	
		Gray, damp, hard, CLAY	20	■	S-8	18 - 17 - 19	18	
		Bottom of Boring @ 20.0 ft	25					
			30					
			35					

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■ = Split Spoon

▽ Water Level At Completion
▼ Water Level After 24 hrs
⊔ Caved Depth At Completion
⊠ Caved Depth After 24 hrs

Sheet: 1 of 1

RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Girish Bhatt
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 17.0 '

Boring Number: B-08
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 07-31-08
Surface Elevation: 184.9'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: Dry, caved @ 17.0 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
184.9			0					2 inches of topsoil.
184		Brown, moist, medium dense, silty clayey SAND (Fill).		■	S-1	7 - 5 - 6	10	
183								
182								
181		Brown and reddish brown, moist, stiff, CLAY, with sand (Fill).		■	S-2	4 - 4 - 6	8	
180			5					Bulk sample collected from 1.0 to 10.0 feet.
179		Reddish brown and brown, moist, medium stiff, CLAY, trace sand and wood (Fill).		■	S-3	3 - 3 - 5	18	
178								
177								
176		Brown, moist, medium dense, silty SAND (Fill).		■	S-4	10 - 10 - 8	12	
175			10					
174		Reddish brown, medium dense, silty SAND.		■	S-5	10 - 8 - 6	14	
173								
172								
171		Light brown, moist, medium dense, silty SAND.		■	S-6	7 - 6 - 6	14	
170			15					
169								
168	▨	Light brown, wet, medium dense, silty SAND.		■	S-7	5 - 5 - 6	13	
167								
166		Light brown, wet, medium dense, silty SAND.		■	S-8	6 - 7 - 8	15	Observed wet spoon.
165			20					
164								
163		Reddish brown, wet, loose, silty SAND.		■	S-9	4 - 4 - 5	18	
162								
161		Reddish brown and light brown, wet, very loose, silty SAND.		■	S-10	3 - 1 - 1	18	
160			25					
159		Bottom of Boring @ 25.0 ft						
158								
157								
156								
155			30					
154								
153								
152								
151								
150			35					
149								

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■ = Split Spoon

▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥ Caved Depth At Completion
▨ Caved Depth After 24 hrs

Sheet: 1 of 1

RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Girish Bhatt
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 19.5 '

Boring Number: B-09
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 07-30-08
Surface Elevation: 185.2'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: Dry, caved @ 16.8 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
185.2			0					2 inches of topsoil.
184, 183		Brown, moist, medium dense, silty SAND (Fill).		■	S-1	7 - 9 - 11	3	
182, 181, 180		Brown, moist, loose, silty SAND, trace clay and gravel (Fill).	5	■	S-2	4 - 4 - 6	7	Two attempts.
179, 178, 177		Gray and brown, moist, sandy silty CLAY, trace wood (Fill).		■	S-3	6 - 6 - 8	14	
176, 175		Brown, moist, medium dense, silty SAND.	10	■	S-4	8 - 11 - 12	18	
174, 173		Brown and reddish brown, moist, medium dense, clayey SAND.		■	S-5	11 - 13 - 10	18	
172, 171, 170		Brown and light brown, moist, medium dense, silty SAND.	15	■	S-6	8 - 9 - 13	18	
169, 168, 167	⊠	Light brown, wet, medium dense, silty SAND.		■	S-7	7 - 10 - 14	14	Observed wet spoon.
166, 165	⊔	Light brown, wet, medium dense, silty clayey SAND.	20	■	S-8	8 - 10 - 13	18	
164, 163, 162		Light brown, wet, medium dense, silty clayey SAND.		■	S-9	11 - 13 - 12	18	
161		Reddish brown, wet, medium dense, silty SAND.	25	■	S-10	10 - 8 - 7	18	
160, 159, 158, 157, 156, 155, 154, 153, 152, 151, 150, 149		Bottom of Boring @ 25.0 ft	30, 35					

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Baltimore, Maryland 21215

■ = Split Spoon

▽ Water Level At Completion
▼ Water Level After 24 hrs
⊔ Caved Depth At Completion
⊠ Caved Depth After 24 hrs

Sheet: 1 of 1

RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: 30.7 ', caved @ 31.2 '

Boring Number: B-10
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 08-05-08
Surface Elevation: 193.9'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: 15.7 ', caved @ 22.4 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
193.9			0					0 inches of topsoil
193, 192		Reddish brown, stiff, damp, sandy silty CLAY (Fill)		■	S-1	8 - 6 - 5	8	
191, 190, 189		Reddish brown, damp, medium stiff, sandy silty CLAY (Fill)	5	■	S-2	4 - 3 - 3	4	Bulk sampled collected from 1.0 to 10.0 feet.
188, 187, 186		Reddish brown and gray, moist, medium stiff, CLAY, little sand and organic matter (Fill)		■	S-3	4 - 3 - 2	8	Sample recovered on second attempt
185, 184		Gray, moist, medium stiff, CLAY, trace gravel (Fill)	10	■	S-4	4 - 2 - 5	12	
183, 182		Brown, very moist, stiff, CLAY, trace gravel (Fill)		■	S-5	4 - 5 - 5	18	
181, 180, 179		Brown, very moist, medium stiff, sandy CLAY, trace organic matter (Fill)	15	■	S-6	3 - 3 - 3	18	
178, 177, 176	▼	Brown, red and gray, moist, medium dense, SAND, with clay pods, trace organic matter (Fill)		■	S-7	3 - 5 - 17	18	
175, 174		Pale brown, damp, medium dense, poorly graded SAND, trace silt	20	■	S-8	9 - 12 - 17	13	
173, 172, 171	▒	Pale brown, moist, dense, silty SAND		■	S-9	20 - 21 - 23	18	
170, 169		Pale reddish brown, wet, medium dense, silty SAND	25	■	S-10	6 - 6 - 8	18	
168, 167		Pale reddish brown, wet, dense, silty SAND		■	S-11	17 - 18 - 20	18	
166, 165, 164		Dark red and gray, damp, hard, CLAY	30	■	S-12	17 - 23 - 25	18	
163, 162, 161	▽	Red, moist, hard, sandy CLAY		■	S-13	20 - 27 - 26	12	
160, 159		Dark red, purple and gray, damp, hard, CLAY	35	■	S-14	17 - 28 - 32	18	
158		Bottom of Boring @ 35.0 ft						

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■ = Split Spoon

▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥ Caved Depth At Completion
▒ Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: 7.2 ', caved @ 9.7 '

Boring Number: B-11
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 04-29-09
Surface Elevation: 170.7'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: 1.5 ', caved @ 5.2 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
170.7			0					4 inches of rootmat
170, 169	▼	Gray and light brown, very moist, medium stiff, CLAY, little sand		■	S-1	2 - 2 - 3	14	
168, 167, 166		Gray and light brown, moist, very stiff, sandy SILT	5	■	S-2	5 - 6 - 10	15	
165, 164, 163	▽	Light gray, wet, medium dense, silty fine SAND		■	S-3	4 - 4 - 6	16	
162, 161	⊥⊥	Red and gray, moist, very stiff, CLAY	10	■	S-4	6 - 7 - 10	16	
160, 159		Red and gray, moist, very stiff, CLAY		■	S-5	4 - 6 - 9	12	
158, 157, 156		Red and gray, damp, very stiff, CLAY	15	■	S-6	7 - 9 - 11	12	
155, 154		Red and gray, damp, very stiff, CLAY		■	S-7	6 - 9 - 13	13	
153, 152, 151		Red and gray, damp, very stiff, CLAY	20	■	S-8	9 - 11 - 17	13	
150, 149		Red and gray, very moist, very stiff, CLAY, little sand		■	S-9	9 - 13 - 16	5	
148, 147, 146		Red, moist, hard, CLAY	25	■	S-10	12 - 16 - 27	3	
145, 144, 143, 142, 141		Bottom of Boring @ 25.0 ft	30					
140, 139, 138, 137, 136, 135, 134			35					

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■ = Split Spoon

▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥⊥ Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: 4.2 ', caved @ 6.5 '

Boring Number: B-12
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 04-23-09
Surface Elevation: 173.2'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: 0.0 ', caved @ 5.0 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
173.2			0					6 inches of rootmat
172, 171		Brown and gray, moist, stiff, sandy SILT		■	S-1	2 - 4 - 9	18	
170, 169, 168	▽	Brown and gray, moist, very stiff, sandy SILT	5	■	S-2	8 - 14 - 13	16	
167, 166	⊥⊥	Reddish brown, wet, medium dense, silty SAND, little gravel		■	S-3	10 - 12 - 7	17	Wet @ 6.0 feet
165, 164, 163		Light brown, wet, loose, silty SAND	10	■	S-4	4 - 4 - 4	16	Bulk sample collected from 1.0 to 8.5 feet
162, 161		Light brown, wet, medium dense, clayey SAND, with seams of gray clay		■	S-5	5 - 5 - 7	18	
160, 159, 158		Pale gray, wet, loose, fine SAND, little silt	15	■	S-6	3 - 3 - 3	18	
157, 156		Light brown, wet, medium dense, fine SAND, little silt		■	S-7	5 - 6 - 6	18	
155, 154, 153		Light brown, wet, loose, fine SAND, little silt	20	■	S-8	4 - 4 - 5	18	
152, 151		LIght brown, wet, medium dense, fine SAND, little silt		■	S-9	5 - 7 - 6	18	
150, 149		Reddish brown, wet, medium dense, fine SAND, little silt	25	■	S-10	4 - 8 - 4	16	
148, 147, 146		Red and gray, damp, hard, CLAY		■	S-11	8 - 14 - 18	18	
145, 144, 143		Red and gray, damp, hard, CLAY	30	■	S-12	9 - 16 - 19	13	
142, 141		Red and gray, damp, hard, CLAY		■	S-13	13 - 23 - 35	18	
140, 139		Red and gray, damp, hard, CLAY	35	■	S-14	18 - 23 - 35	18	
138, 137		Bottom of Boring @ 35.0 ft						

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■ = Split Spoon

▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥⊥ Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 2.5 '

Boring Number: B-13
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 04-30-09
Surface Elevation: 175.1'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs:

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
175.1			0					5 inches of rootmat
174, 173, 172		Light reddish brown, moist, loose, silty clayey SAND		■	S-1	2 - 2 - 2	12	
171, 170		Reddish brown, moist, medium dense, fine SAND, little silt	5	■	S-2	7 - 8 - 9	17	
169, 168, 167		Light brown, wet, loose, fine SAND, trace silt		■	S-3	5 - 4 - 5	15	Wet at 6.0 feet.
166, 165		Light reddish brown, wet, medium dense, fine SAND, with clay	10	■	S-4	7 - 11 - 15	16	
164, 163, 162		Reddish brown, wet, very dense, fine SAND, little silt		■	S-5	14 - 30 - 56	16	
161, 160		Light brown, wet, dense, fine SAND, little silt	15	■	S-6	28 - 21 - 17	16	
159, 158, 157		Red and gray, damp, stiff, CLAY		■	S-7	6 - 3 - 6	18	
156, 155		Red and gray, moist, very stiff, sandy SILT	20	■	S-8	8 - 11 - 15	18	
154, 153, 152		Red and gray, moist, hard, CLAY, with seams wet fine sand		■	S-9	12 - 17 - 19	18	
151		Red and gray, damp, stiff, CLAY		■	S-10	11 - 17 - 15	18	
150			25					
149, 148, 147, 146		Bottom of Boring @ 25.0 ft						
145, 144, 143, 142, 141			30					
140, 139			35					

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■ = Split Spoon

Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: 18.0 ', caved @ 18.3 '

Boring Number: B-14
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 04-30-09
Surface Elevation: 183.2'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs:

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
183.2			0					5 inches of rootmat
182, 181		Reddish brown, moist, stiff, sandy SILT (Fill)		■	S-1	4 - 4 - 4	14	
180, 179, 178		Red, moist, stiff, CLAY, with sand (Fill)	5	■	S-2	4 - 4 - 5	13	
177, 176		Gray and dark brown, moist, medium stiff, CLAY, little sand, trace organic matter (Fill)		■	S-3	2 - 2 - 5	10	
175, 174, 173		Dark brown, moist, medium stiff, SILT, little sand (Fill)	10	■	S-4	4 - 3 - 3	18	Bulk sample collected from 1.0 to 8.5 feet
172, 171		Light reddish brown, moist, medium dense, silty SAND		■	S-5	6 - 7 - 10	16	
170, 169, 168		Light reddish brown, moist, medium dense, fine SAND, little silt	15	■	S-6	12 - 10 - 6	18	
167, 166		Red and gray, very moist, loose, clayey SAND, with gravel		■	S-7	3 - 2 - 5	14	
165, 164, 163	▽	Pale brown, very moist, medium dense, silty fine SAND	20	■	S-8	10 - 9 - 7	16	
162, 161		Light brown, moist, medium dense, fine SAND, little silt		■	S-9	5 - 6 - 8	16	
160, 159, 158		Light brown, wet, medium dense, fine SAND, little silt	25	■	S-10	6 - 4 - 6	18	
157, 156		Red and gray, very moist, soft, CLAY		■	S-11	WOR/12" - 3	15	
155, 154, 153		Red and gray, damp, very stiff, CLAY	30	■	S-12	7 - 8 - 10	13	
152, 151, 150		Gray and light brown, damp, hard, CLAY		■	S-13	14 - 20 - 22	18	
149		Yellow brown, moist, very stiff, CLAY, little fine sand	35	■	S-14	9 - 9 - 8	14	
148, 147		Bottom of Boring @ 35.0 ft						

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■ = Split Spoon

▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥ Caved Depth At Completion
⊥ Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: 5.4 ', caved @ 5.7 '

Boring Number: B-15
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 04-23-09
Surface Elevation: 175.2'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: 5.5 ', caved @ 5.9 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
175.2			0					4.5 inches of rootmat
174, 173		Brown and gray, moist, stiff, sandy CLAY		■	S-1	2 - 4 - 8	16	
172, 171		Brown and pale gray, damp, very stiff, CLAY, little sand		■	S-2	7 - 12 - 15	16	
170	▼		5					
169, 168		Light brown, wet, medium to fine SAND, trace silt		■	S-3	7 - 8 - 9	16	Wet @ 6.0 feet
167, 166, 165		Light reddish brown, wet, medium dense, medium to fine SAND, little silt	10	■	S-4	8 - 9 - 6	18	
164, 163		Pale brown, wet, medium dense, fine SAND, little silt		■	S-5	7 - 7 - 10	14	
162, 161, 160		Light reddish brown, wet, medium dense, fine SAND, little silt	15	■	S-6	7 - 8 - 7	13	
159, 158		Pale brown, wet, medium dense, fine SAND, little silt		■	S-7	5 - 6 - 9	16	
157, 156, 155		Light reddish brown, wet, dense, fine SAND, little silt, few clasts or red clay, trace of ironite	20	■	S-8	5 - 4 - 8	18	
154, 153		Light brown, very moist, medium dense, silty SAND		■	S-9	7 - 8 - 18	18	
152, 151, 150		Red and gray, damp, hard, CLAY	25	■	S-10	7 - 4 - 8	18	
149, 148		Red and gray, damp, hard, CLAY		■	S-11	13 - 23 - 38	18	
147, 146		Red and gray, damp, hard, CLAY		■	S-12	17 - 23 - 33	10	
145			30					
144, 143, 142, 141, 140, 139		Bottom of Boring @ 30.0 ft	35					

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■ = Split Spoon

▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥ Caved Depth At Completion
⊥ Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hand Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 7.0 '

Boring Number: PT-1
Drilling Company: Smoyer Home Improvements
Driller: Jerome Smoyer
Date Drilled: 04-17-09
Surface Elevation: 179.5' (est)
Hammer Weight/Drop: N/A/N/A
Water Level After 24 hrs:

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
179.5			0					4 inches of topsoil.
179								
178								
177		Light to pale brown, damp, fine SAND, trace silt						
176								
175								
174			5					Percolation test performed by Smoyer Home Improvements and observed by Prince George's County Health Department. See test report provided by Prince George's County Health Dept dated May 7, 2009 for details (Application No. 2874-2009).
173								
172		Bottom of Boring @ 7.0 ft						
171								
170			10					
169								
168								
167								
166								
165			15					
164								
163								
162								
161								
160			20					
159								
158								
157								
156								
155			25					
154								
153								
152								
151								
150			30					
149								
148								
147								
146								
145			35					
144								
143								

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Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hand Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 7.0 '

Boring Number: PT-2
Drilling Company: Smoyer Home Improvements
Driller: Jerome Smoyer
Date Drilled: 04-17-09
Surface Elevation: 179.5' (est)
Hammer Weight/Drop: N/A/N/A
Water Level After 24 hrs:

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
179.5			0					3 inches of rootmat
179								
178								
177		Light to pale brown, damp, fine SAND, trace silt						
176								
175								
174			5					Percolation test performed by Smoyer Home Improvements and observed by Prince George's County Health Department. See test report provided by Prince George's County Health Dept dated May 7, 2009 for details (Application No. 2874-2009).
173								
172		Bottom of Boring @ 7.0 ft						
171								
170								
169			10					
168								
167								
166								
165								
164			15					
163								
162								
161								
160								
159			20					
158								
157								
156								
155								
154			25					
153								
152								
151								
150								
149			30					
148								
147								
146								
145								
144			35					
143								

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Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hand Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 7.0 '

Boring Number: PT-3
Drilling Company: Smoyer Home Improvements
Driller: Jerome Smoyer
Date Drilled: 04-17-09
Surface Elevation: 178.5' (est)
Hammer Weight/Drop: N/A/N/A
Water Level After 24 hrs:

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
178.5			0					3 inches of rootmat
178								
177								
176		Light to pale brown, damp, fine SAND, trace silt						
175								
174								
173			5					Percolation test performed by Smoyer Home Improvements and observed by Prince George's County Health Department. See test report provided by Prince George's County Health Dept dated May 7, 2009 for details (Application No. 2874-2009).
172								
171		Bottom of Boring @ 7.0 ft						
170								
169								
168			10					
167								
166								
165								
164								
163			15					
162								
161								
160								
159								
158			20					
157								
156								
155								
154								
153			25					
152								
151								
150								
149								
148			30					
147								
146								
145								
144								
143			35					
142								

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Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 3.1 '

Boring Number: R-01
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 08-07-08
Surface Elevation: 169.3'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: Dry, caved @ 3.5 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
169.3			0					
		Light brown, damp, loose, silty SAND		■	S-1	3 - 4 - 3	12	
		Light brown, moist, poorly graded SAND, trace silt		■	S-2	3 - 3 - 4	14	
			5					
		Bottom of Boring @ 5.0 ft						

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■ = Split Spoon

Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 3.0 '

Boring Number: R-02
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 08-07-08
Surface Elevation: 183.8'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: Dry, caved @ 3.1 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
183.8			0					
183								
182		Light reddish brown, damp, loose, silty SAND		■	S-1	3 - 2 - 3	10	
181								
180		Light brown, moist, loose, poorly graded SAND		■	S-2	3 - 3 - 4	12	
179			5					
178		Bottom of Boring @ 5.0 ft						
177								
176								
175								
174			10					
173								
172								
171								
170								
169			15					
168								
167								
166								
165								
164			20					
163								
162								
161								
160								
159			25					
158								
157								
156								
155								
154			30					
153								
152								
151								
150								
149			35					
148								

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■ = Split Spoon

▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥ Caved Depth At Completion
⊥ Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Girish Bhatt
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 2.2 '

Boring Number: R-03
Drilling Company: EBA Engineering, Inc.
Driller: Duane Addison
Date Drilled: 07-28-08
Surface Elevation: 179.2'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: Dry, caved @ 2.5 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
179.2			0					2 inches of topsoil.
178, 177		Brown, moist, medium dense, silty clayey SAND, trace gravel & brick pieces (Fill).		■	S-1	7 - 10 - 10	12	
176, 175		Reddish brown, moist, stiff, CLAY.		■	S-2	6 - 4 - 6	10	
174			5					
173		Bottom of Boring @ 5.0 ft						
172, 171, 170, 169			10					
168, 167, 166, 165, 164			15					
163, 162, 161, 160, 159			20					
158, 157, 156, 155, 154			25					
153, 152, 151, 150, 149			30					
148, 147, 146, 145, 144			35					
143								

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■ = Split Spoon

Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Girish Bhatt
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 2.2 '

Boring Number: R-04
Drilling Company: EBA Engineering, Inc.
Driller: Duane Addison
Date Drilled: 07-28-08
Surface Elevation: 193.4'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: Backfilled upon completion.

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
193.4			0					6 inches of asphalt.
193								3 inches of sand and gravel.
192		Red and reddish brown, moist, medium dense, silty SAND.		■	S-1	6 - 11 - 10	9	
191								
190								
189		Red and reddish brown, moist, medium dense, silty SAND.		■	S-2	12 - 14 - 14	14	
188			5					Bulk sample collected from 1.0 to 5.0 feet.
187		Bottom of Boring @ 5.0 ft						
186								
185								
184								
183			10					
182								
181								
180								
179								
178			15					
177								
176								
175								
174								
173			20					
172								
171								
170								
169								
168			25					
167								
166								
165								
164								
163			30					
162								
161								
160								
159								
158			35					
157								

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■ = Split Spoon

Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

Sheet: 1 of 1

RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Girish Bhatt
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 15.5 '

Boring Number: R-05
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 08-01-08
Surface Elevation: 193.0'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: Dry, caved @ 14.1 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
193			0					2 inches of topsoil.
192		Reddish brown, soft, CLAY, with sand (FIll).		■	S-1	2 - 1 - 2	10	
191								
190								
189		Reddish brown and gray, moist, stiff, CLAY, with sand (Fill).		■	S-2	3 - 4 - 6	12	
188			5					Bulk sample collected from 1.0 to 8.5 feet.
187		Reddish brown and gray, moist, stiff, CLAY, with sand (Fill).		■	S-3	4 - 6 - 6	12	
186								
185								
184		Brown, moist, medium dense, silty SAND (Fill).		■	S-4	9 - 11 - 13	10	
183			10					
182		Brown, moist, medium dense, silty SAND.		■	S-5	9 - 10 - 10	18	
181								
180								
179		Brown and gray, moist, medium dense, silty SAND.		■	S-6	7 - 5 - 6	13	
178			15					
177		Brown, moist, dense, silty SAND.		■	S-7	14 - 20 - 14	16	
176								
175								
174		Brown, moist to wet, loose, silty SAND.		■	S-8	5 - 4 - 4	10	
173			20					
172		Bottom of Boring @ 20.0 ft						
171								
170								
169								
168			25					
167								
166								
165								
164								
163			30					
162								
161								
160								
159								
158			35					
157								

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Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: N/A

Boring Number: R-06
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 08-07-08
Surface Elevation: 184.8'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: Dry, caved @ 13.1 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
184.8			0					
		Light reddish brown, damp, medium dense, silty SAND, little gravel (Fill)		■	S-1	10 - 12 - 8	10	
		Red, damp, very stiff, sandy SILT (Fill)	5	■	S-2	8 - 9 - 8	10	Bulk sampled collected from 1.0 to 10.0 feet.
		Light brown, moist, medium dense, silty SAND (Fill)		■	S-3	7 - 8 - 9	18	
		Pale brown, moist, very stiff, SILT, little sand (Fill)	10	■	S-4	8 - 8 - 8	12	
		Light brown, very moist, medium dense, silty SAND (Fill)		■	S-5	7 - 9 - 11	18	
	▽	Dark brown, very moist, very stiff, CLAY, little organic matter and gravel (Fill)	15	■	S-6	8 - 12 - 14	15	
		Bottom of Boring @ 15.0 ft						
			20					
			25					
			30					
			35					

184 183 182 181 180 179 178 177 176 175 174 173 172 171 170 169 168 167 166 165 164 163 162 161 160 159 158 157 156 155 154 153 152 151 150 149

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▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥ Caved Depth At Completion
▽ Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: N/A

Boring Number: R-07
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 08-07-08
Surface Elevation: 191.8'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: Dry, caved @ 16.8 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
191.8			0					
		Dark brown, moist, very stiff, CLAY, with sand, organic matter and gravel (Fill)		■	S-1	7 - 8 - 11	12	
		Dark brown, very moist, medium stiff, CLAY, with sand, trace organic matter (Fill)	5	■	S-2	3 - 3 - 4	10	Bulk sampled collected from 1.0 to 10.0 feet.
		Dark brown, very moist, stiff, CLAY, with sand, trace organic matter (Fill)		■	S-3	3 - 4 - 5	18	
		Dark brown, very moist, stiff, CLAY, with sand, trace organic matter (Fill)	10	■	S-4	4 - 5 - 5	18	
		Dark brown, moist, stiff, CLAY, little sand, trace organic matter (Fill)		■	S-5	5 - 5 - 5	14	
		Brown, very moist, stiff, CLAY, little sand, trace organic matter (Fill)	15	■	S-6	4 - 4 - 4	18	
	▨	Light brown, moist, dense, silty SAND		■	S-7	8 - 23 - 20	18	
		Light brown, very moist, very dense, silty SAND	20	■	S-8	13 - 27 - 23	18	
		Bottom of Boring @ 20.0 ft						

191 190 189 188 187 186 185 184 183 182 181 180 179 178 177 176 175 174 173 172 171 170 169 168 167 166 165 164 163 162 161 160 159 158 157 156

25 30 35

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▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥ Caved Depth At Completion
▨ Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 2.5 '

Boring Number: R-08
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 04-30-09
Surface Elevation: 176.0'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs:

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
176			0					5 inches of rootmat
175		Reddish brown, moist, stiff, silty SAND		■	S-1	2 - 3 - 6	17	
174								
173								
172		Light reddish brown, very moist, medium dense, fine SAND, little silt		■	S-2	5 - 6 - 8	18	
171			5					Bulk sample collected from 1.0 to 5.0 feet
170		Bottom of Boring @ 5.0 ft						
169								
168								
167								
166			10					
165								
164								
163								
162								
161			15					
160								
159								
158								
157								
156			20					
155								
154								
153								
152								
151			25					
150								
149								
148								
147								
146			30					
145								
144								
143								
142								
141			35					
140								

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▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥ Caved Depth At Completion
⊥ Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 2.5 '

Boring Number: R-09
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 04-30-09
Surface Elevation: 175.9'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs:

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
175.9			0					5 inches of rootmat.
175		Reddish brown, very moist, very loose, clayey SAND		■	S-1	1 - 1 - 1	14	
174								
173								
172		Reddish brown, moist, medium dense, fine SAND, little silt		■	S-2	6 - 10 - 7	15	
171			5					Bulks sample collected from 1.0 to 5.0 feet.
170		Bottom of Boring @ 5.0 ft						
169								
168								
167								
166			10					
165								
164								
163								
162								
161			15					
160								
159								
158								
157								
156			20					
155								
154								
153								
152								
151			25					
150								
149								
148								
147								
146			30					
145								
144								
143								
142								
141			35					
140								

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Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: 6.8 ', caved @ 7.0 '

Boring Number: S-01
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 08-07-08
Surface Elevation: 172.3'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: Dry, caved @ 7.0 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
172.3			0					
		Light brown, damp, medium dense, silty SAND		■	S-1	6 - 8 - 8	12	
		Reddish brown, moist, loose, silty SAND	5	■	S-2	5 - 4 - 5	14	Infiltration test performed @ 3.5 feet.
	▽	Light brown, very moist, medium dense, poorly graded SAND, little silt		■	S-3	4 - 6 - 12	16	
		Light brown, very moist, medium dense, silty SAND	10	■	S-4	7 - 6 - 8	12	
		Bottom of Boring @ 10.0 ft						

172 171 170 169 168 167 166 165 164 163 162 161 160 159 158 157 156 155 154 153 152 151 150 149 148 147 146 145 144 143 142 141 140 139 138 137 136

15 20 25 30 35

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▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥ Caved Depth At Completion
▽ Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 7.3 '

Boring Number: S-02
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 08-07-08
Surface Elevation: 178.4'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: Dry, caved @ 7.4 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
178.4			0					
		Reddish brown, damp, loose, poorly graded SAND, little silt		■	S-1	3 - 2 - 3	10	
		Reddish brown, damp, loose, silty SAND	5	■	S-2	3 - 3 - 4	12	
		Dark reddish brown, moist, medium stiff, sandy SILT		■	S-3	3 - 3 - 4	18	
		Reddish brown, moist, dense, silty SAND, little gravel, trace ironite and cemented sand	10	■	S-4	15 - 14 - 18	14	
		Bottom of Boring @ 10.0 ft						

178 177 176 175 174 173 172 171 170 169 168 167 166 165 164 163 162 161 160 159 158 157 156 155 154 153 152 151 150 149 148 147 146 145 144 143 142

15 20 25 30 35

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■ = Split Spoon

Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hand Auger
Hole Diameter: 3.5 in
Water Level at Completion: Dry, caved @ 5.0 '

Boring Number: S-02A
Drilling Company: EBA Engineering, Inc.
Driller: Jason Kolenda
Date Drilled: 05-05-09
Surface Elevation: 182' (est)
Hammer Weight/Drop: N/A/N/A
Water Level After 24 hrs:

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
182			0					4 inches of rootmat
181		Reddish brown, moist, sandy SILT						
180								
179								Infiltration test performed @ 3.0 feet.
178		Reddish brown, moist, poorly graded SAND, with silt						
177			5		S-1			
176		Bottom of Boring @ 5.0 ft						
175								
174								
173								
172			10					
171								
170								
169								
168								
167			15					
166								
165								
164								
163								
162			20					
161								
160								
159								
158								
157			25					
156								
155								
154								
153								
152			30					
151								
150								
149								
148								
147			35					
146								

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Grab Sample

Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hand Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 4.5 '

Boring Number: SOH-1
Drilling Company: Smoyer Home Improvements
Driller: Jerome Smoyer
Date Drilled: 04-17-09
Surface Elevation: 179' (est)
Hammer Weight/Drop: N/A/N/A
Water Level After 24 hrs:

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
179			0					3 inches of rootmat
178								
177								
176		Light to pale brown, damp, fine SAND, trace silt						
175								
174		Fragments of ironstone at 4.5 feet.	5					
173		Bottom of Boring @ 4.5 ft						Test hole abandoned for percolation test due to ironstone fragments per direction of the Sanitarian.
172								
171								
170								
169			10					
168								
167								
166								
165								
164			15					
163								
162								
161								
160								
159			20					
158								
157								
156								
155								
154			25					
153								
152								
151								
150								
149			30					
148								
147								
146								
145								
144			35					
143								

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Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: 8.5 ', caved @ 10.3 '

Boring Number: SWM-1
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 04-29-09
Surface Elevation: 166.3'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: 0.0 ', caved @ 4.0 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
166.3			0					4 inches of rootmat
166								
165		Gray and light brown, very moist, soft, sandy CLAY		■	S-1	1 - 1 - 2	18	
164								
163								
162		Gray and light brown, wet, loose, clayey SAND		■	S-2	4 - 4 - 5	18	
161			5					
160		Light gray, wet, medium dense, silty fine SAND		■	S-3	5 - 7 - 10	18	
159								
158								
157		Red and gray, damp, very stiff, CLAY		■	S-4	9 - 11 - 14	14	
156			10					
155		Red and gray, damp, very stiff, CLAY		■	S-5	6 - 9 - 11	12	
154								
153								
152		Red and gray, damp, very stiff, CLAY		■	S-6	6 - 7 - 10	12	
151			15					
150		Bottom of Boring @ 15.0 ft						
149								
148								
147								
146			20					
145								
144								
143								
142								
141			25					
140								
139								
138								
137								
136			30					
135								
134								
133								
132								
131			35					
130								

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Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 7.0 '

Boring Number: SWM-2
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 04-29-09
Surface Elevation: 167.2'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: 2.0 ', caved @ 4.3 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
167.2			0					
166, 165	▼	Light brown, moist, loose, silty fine SAND		■	S-1	2 - 3 - 6	16	
164, 163, 162	▨	Light reddish brown, very moist, medium dense, silty fine SAND	5	■	S-2	7 - 10 - 11	18	
161, 160	⊥	Light brown and reddish brown, very moist, medium dense, clayey SAND		■	S-3	7 - 6 - 7	14	
159, 158		Light brown, very moist, medium dense, silty fine SAND		■	S-4	7 - 9 - 12	5	
157			10					
156, 155		Brown, moist, hard, SILT		■	S-5	9 - 13 - 17	18	
154, 153		Red and gray, damp, hard, CLAY		■	S-6	12 - 17 - 23	10	
152			15					
151		Bottom of Boring @ 15.0 ft						
150, 149, 148, 147			20					
146, 145, 144, 143, 142			25					
141, 140, 139, 138, 137			30					
136, 135, 134, 133, 132			35					
131								

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▽ Water Level At Completion
▼ Water Level After 24 hrs
⊥ Caved Depth At Completion
▨ Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hollow Stem Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 7.4 '

Boring Number: SWM-3
Drilling Company: EBA Engineering, Inc.
Driller: Matt Voelker
Date Drilled: 04-29-09
Surface Elevation: 168.2'
Hammer Weight/Drop: 140 lb/30 in
Water Level After 24 hrs: 0.9 ', caved @ 2.4 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
168.2			0					4 inches of rootmat.
167		Gray and light brown, moist, medium dense, silty SAND		■	S-1	2 - 3 - 8	18	
166								
165								
164		Gray and light brown, moist, medium dense, silty SAND		■	S-2	7 - 9 - 10	18	
163			5					Bulk sample collected from 1.0 to 5.0 feet.
162		Gray and light brown, damp, very stiff, CLAY		■	S-3	5 - 7 - 10	16	
161								
160								
159		Red and light brown, damp, very stiff, CLAY		■	S-4	5 - 9 - 11	10	
158			10					
157		Gray and light brown, damp, hard, CLAY, with seams of silty sand		■	S-5	7 - 12 - 18	8	
156								
155								
154		Red, damp, hard, CLAY		■	S-6	9 - 13 - 17	14	
153			15					
152		Bottom of Boring @ 15.0 ft						
151								
150								
149								
148			20					
147								
146								
145								
144								
143			25					
142								
141								
140								
139								
138			30					
137								
136								
135								
134								
133			35					
132								

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Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

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RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

RECORD OF SUBSURFACE EXPLORATION

Project: NASA Shipping & Receiving Facility
Location: Greenbelt, Maryland
Job Number: 2554C2339
Inspector: Jason Kolenda
Boring Method: Hand Auger
Hole Diameter: 8 in
Water Level at Completion: Dry, caved @ 13.0 '

Boring Number: WT-1
Drilling Company: Smoyer Home Improvements
Driller: Jerome Smoyer
Date Drilled: 04-16-09
Surface Elevation: 177' (est)
Hammer Weight/Drop: N/A/N/A
Water Level After 24 hrs: Dry, caved @ 13.0 '

Elevation (ft)	Water/Caved Depth (ft)	Description	Depth (ft)	Sampler	Number	Blows/6"	Recovery (inches)	Remarks
177			0					3 inches of rootmat
176, 175, 174, 173, 172, 171, 170, 169, 168, 167, 166, 165, 164		Light to pale brown, damp, fine SAND, trace silt	5, 10					This water table observation hole was for the purpose of developing the percolation test depths. See test report provided by Prince George's County Health Dept dated May 7, 2009 for details (Application No. 2874-2009).
163, 162, 161, 160, 159, 158, 157, 156, 155, 154, 153, 152, 151, 150, 149, 148, 147, 146, 145, 144, 143, 142, 141		Bottom of Boring @ 13.0 ft	15, 20, 25, 30, 35					

EBA Engineering, Inc.
4813 Seton Drive
Baltimore, Maryland 21215

Water Level At Completion
Water Level After 24 hrs
Caved Depth At Completion
Caved Depth After 24 hrs

Sheet: 1 of 1

RECORD OF SUBSURFACE EXPLORATION NASA SHIPPING & RECEIVING FACILITY.GPJ EBA ENGINEERING INC.GDT 8/18/09

Appendix E
Infiltration Test Results

INFILTRATION TEST

PROJECT: NASA Shipping and Receiving Facility

PROJECT NO: 2554C2339

HOLE NO.: **S-01**

SURFACE ELEVATION: 172.3 feet

PIPE SIZE: 4 in

TEST HOLE DEPTH: 3.5 feet

PRE-SOAK: May 5, 2009

TEST DATE: May 6, 2009

TIME	TIME ELAPSED (min)	WATER LEVEL (in, below ref.)	DROP IN LEVEL (in/hr)	Remarks
10:40 AM	0	43		
11:40 AM	60	Dry	19	
11:40 AM	0	46		
12:40 PM	60	Dry	16	
12:40 PM	0	38		
1:40 PM	60	Dry	22	
1:40 PM	0	40 ½		
2:40 PM	60	Dry	21.5	

Remarks:

Recommended Infiltration Rate: > 8.02 in/hr.

PERFORMED BY: Jason Kolenda

G:\2008\2554-23 NASA Shipping and Receiving Facility\Boring Logs\SWM-02 - Infiltration test.doc

INFILTRATION TEST

PROJECT: NASA Shipping and Receiving Facility

PROJECT NO: 2554C2339

HOLE NO.: S-02A

SURFACE ELEVATION: 182 feet (est.)

PIPE SIZE: 4 in

TEST HOLE DEPTH: 3.0 feet

PRE-SOAK: May 5, 2009

TEST DATE: May 6, 2009

TIME	TIME ELAPSED (min)	WATER LEVEL (in, below ref.)	DROP IN LEVEL (in/hr)	Remarks
10:40 AM	0	41 ¼		
11:40 AM	60	Dry	16 ½	
11:40 AM	0	42		
12:40 PM	60	Dry	17 ¼	
12:40 PM	0	41 3/4		
1:40 PM	60	Dry	17	
1:40 PM	0	40 ½		
2:40 PM	60	Dry	15 ¾	

Remarks:

Recommended Infiltration Rate: > 8.02 in/hr.

PERFORMED BY: Jason Kolenda

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Appendix F

Soil Percolation Test Results and Summary Letter

HEALTH
DEPARTMENT
Prince George's County

May 7, 2009

Division of Environmental Health

Mr. Timothy Regan
NASA Gooddard Space Flight Center
Code 224, Building 18, Room 140
Greenbelt, Maryland 20771

Re: Percolation Test Application 2874-2009
Tax Account Number 02410850
Tax Map 35, Grid C1, Parcel 185
Soil Conservation Road
Greenbelt, Maryland

Dear Mr. Regan:

SOIL PERCOLATION TEST RESULTS FOR:
(X) Initial Testing
( ) Retest

( ) Unsatisfactory - If you have any questions about the advisability of conducting additional tests, please call the area sanitarian.

( ) Satisfactory - Additional testing may be necessary and house size may be limited.

(X) Satisfactory for the water uses shown on the application provided the system is installed in accordance with the location and elevation where the soil percolation tests were conducted. PT's 1,2 and 3

Please be advised that a satisfactory percolation test is not the sole criteria evaluated to determine if a sewage disposal permit will be issued. The grading of the site, the location of the proposed building and well (if applicable), along with topography, hydrologic conditions of the lot, location of surrounding sewage disposal systems and wells, and usable lot area are also considered in determining if the property is suitable for development on an individual sewage disposal system. Please be aware that any disturbance of the proposed sewage disposal area or any other conditions causing the tested lot to be in violation of the Prince George's County Code, Subtitle 22, may result in additional percolation tests being required and could possibly result in having the lot declared unbuildable until public sewer is available to the property. In addition, supplementary percolation tests may be required after three years from the date of testing or if the percolation requirement under which the original tests were conducted are no longer valid.

If you have any questions, please call Mr. Chris Cohl, Area Sanitarian, at 301/883-7683 weekdays between 7:00 and 9:00 a.m.

Sincerely,

Evelyn Hoban, Chief
Environmental Engineering Program

EH:CHT:db
Enclosures
Cc: Mr. Jerome Smoyer
Mr. Jason Kolenda, P.E.
EH/EEP-168 (8/00)

Environmental Engineering Program
Largo Government Center
9201 Basil Court, Suite 318, Largo, MD 20774
301-883-7681, *fax* 301-883-7266 *tdd* 301-883-5025
www.goprincegeorgescounty.com
Jack B. Johnson
County Executive

PERCOLATION TEST REPORT

Prince George's County Health Department
Division of Environmental Health

Property Description: Soil Conservation Road TM 35, Grid C1, Parcel 185 — Case No. 2874-2009

Owner/Agent: NASA / Goddard Space Flight Center — T/A No. 02410850

Test performed by: Jerome Smoyer — Page 1 of 2

Water Table Data

Water Table # 1

Date 4-16-09 — Time 9:00 am

Depth 13'0" — Wet/Dry dry

Date 4/17/09 — Time 9:30 am

Depth 13'0" — ~~SWL~~ dry

Absorptive Soils Layers 18" → 7'6"

Water Table #

Date ____ — Time ____

Depth ____ — Wet/Dry ____

Date ____ — Time ____

Depth ____ — SWL ____

Absorptive Soils Layers

Soil Profile

WT1
0 – Brown, friable, damp, VSL
1'10" – tan, loose VSL
3'0" – dryer, loose LS
6'9" – blond soft LS
7'6" – orange, firm coarse SL
7'8" – white, firm SiL
10'0" – white, firm fSL
11'0" – soft, white fS
13'0 – stop dry

PT1
0 – damp, brown SL
12" – soft, orange LS
3' – soft, pale VLS
7' – stop

PT2
0 – brown, friable SL
6" – soft, gold LS
3'6" – soft, blond, loose sand
7' – stop

PT3
0 – Brown, sticky SL
2' – brown, friable soft LS
4½' – soft, gold VLS
7' – stop

Soil1
0 – Brown, firm SCL
3' – Lt. brown, friable, SL
3'6" – Lt. brown, firm, SL
3'9" – soft, gold LS
3'11" – broken layer of ironstone
4'6" – hold abandoned due to ironstone.

Percolation Test(s) No.	1	2	3
Date 2009	4/17	4/17	4/17
Diameter	8"	8"	8"
Total Depth	7'	7'	7'
Required Buffer	6'	6'	6'
Water Table Depth (SWL/Dry)	13'	13'	13'
Absorptive Layer	18" to 7'0"	18" to 7'0"	2' to 7'0"
Height of Water in Test Hole	4'	4'	4
Pre-Wet #1 Start time	10:52	10:10	9:43
End time	10:53	10:11	9:44
Elapsed Time (mins.)	1	1	1
Drop in Inches	8	8	8
Pre-Wet #2 Start time			
End time			
Elapsed Time (mins.)			
Drop in Inches			
Pre-Wet #3 Start time			
End time			
Elapsed Time (mins.)			
Drop in Inches			
Perc Test Start time	10:53	10:11	9:44
End time	10:54	10:14	9:46
Elapsed Time (mins.)	1	3	2
Drop in Inches	8	8	8
State Equivalent Rate (mins/in)	1	3	2

Comment/Key

Bk = Blocky Gran = Granular G = Gravel
F = Fine VF = Very fine M = Medium
Si = Silt S = Sand C = Clay L = Loam
P = Platy Sub = Subangular Blocky

Test Witnessed by: CM Cohl — Date 4/20/09

Health Department Sanitarian

EH-EEP 199a (rev. 2/03)

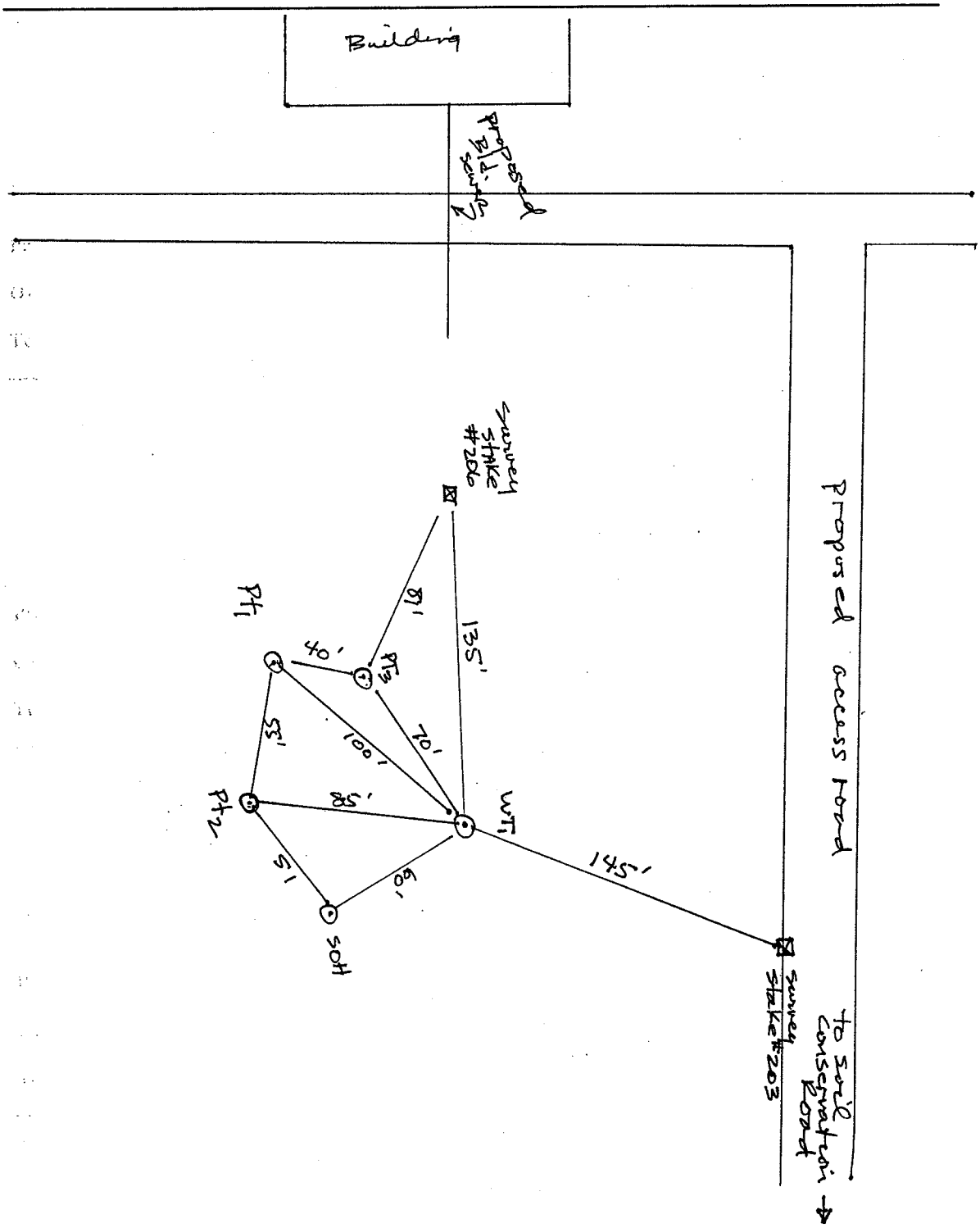
PRINCE GEORGE'S COUNTY HEALTH DEPARTMENT
DIVISION OF ENVIRONMENTAL HEALTH

PERCOLATION TEST REPORT – SITE DIAGRAM

Property Description: TM 35, Grid C1, Parcel 185 / Soil Conservation Rd.

Owner/Agent: NASA, Goddard Space Flight Center **Case Number** 2874-2009

Test Performed by: Jerome Smoyer **Page** 2 **of** 2



Test witnessed by: [signature] **Date:** 4/20/09

Health Department Sanitarian

EH-EEP-198 (2/03)

Appendix G

Laboratory Test Results

NASA Shipping Receiving Facility
Greenbelt, Maryland

SUMMARY OF LABORATORY TEST RESULTS
June, 2009

Boring No.	Sample No.	Depth (ft)	Moisture Content (%)	Atterburg Limits		Grain Size Analysis			Modified Proctor ASTM D 1557		% CBR	Soil Classification	
				LL	PI	% Gravel	% Sand	% Silt & Clay	MDD (pcf)	OMC (%)		USCS	AASHTO
B-01	S-1	3.5-5.0	10.2	---	---	---	---	---	---	---	---	---	---
	S-3	6.0-7.5	17.3	---	---	---	---	---	---	---	---	---	---
	S-4	8.5-10.0	16.0	17	4	0.0	55.2	44.8	---	---	---	SC-SM	A-4
	S-6	13.5-15.0	16.2	---	---	---	---	---	---	---	---	---	---
B-02	S-1	3.5-5.0	9.5	---	---	---	---	---	---	---	---	---	---
	S-6	13.5-15.0	19.4	---	---	---	---	---	---	---	---	---	---
B-03	S-3	6.0-7.5	17.8	---	---	---	---	---	---	---	---	---	---
	S-5	11.0-12.5	12.3	---	---	---	---	---	---	---	---	---	---
B-04	S-3	6.0-7.5	15.5	---	---	---	---	---	---	---	---	---	---
	S-7	16.0-17.5	15.4	---	---	---	---	---	---	---	---	---	---
	S-12	28.5-30.0	13.9	---	---	---	---	---	---	---	---	---	---
B-05	Bulk	1.0-10.0	11.9	NP	NP	0.5	68.1	31.4	127.7	8.5	---	SM	A-2-4
B-06	S-1	1.0-2.5	10.1	---	---	---	---	---	---	---	---	---	---
	S-3	6.0-7.5	8.6	---	---	---	---	---	---	---	---	---	---
B-07	S-2	3.5-5.0	16.8	---	---	---	---	---	---	---	---	---	---
	S-5	11.0-12.5	17.5	34	17	0.0	11.4	88.6	---	---	---	CL	A-6
B-08	S-1	1.0-2.5	18.4	---	---	---	---	---	---	---	---	---	---
	S-3	6.0-7.5	19.6	---	---	---	---	---	---	---	---	---	---
B-09	S-2	3.5-5.0	18.9	---	---	---	---	---	---	---	---	---	---
	S-3	6.0-7.5	14.4	25	7	2.7	21.5	75.8	---	---	---	CL-ML	A-4
B-10	Bulk	1.0-10.0	22.2	33	12	1.1	16.3	82.6	118.3	13.1	---	CL	A-6
	S-6	13.5-15.0	21.8	28	9	0.0	28.4	71.6	---	---	---	CL	A-4
B-11	S-1	1.0-2.5	23.2	---	---	---	---	---	---	---	---	---	---
B-12	S-2	3.5-5.0	17.2	---	---	---	---	---	---	---	---	---	---
B-13	S-3	6.0-7.5	25.7	---	---	---	---	---	---	---	---	---	---

NASA Shipping Receiving Facility
Greenbelt, Maryland

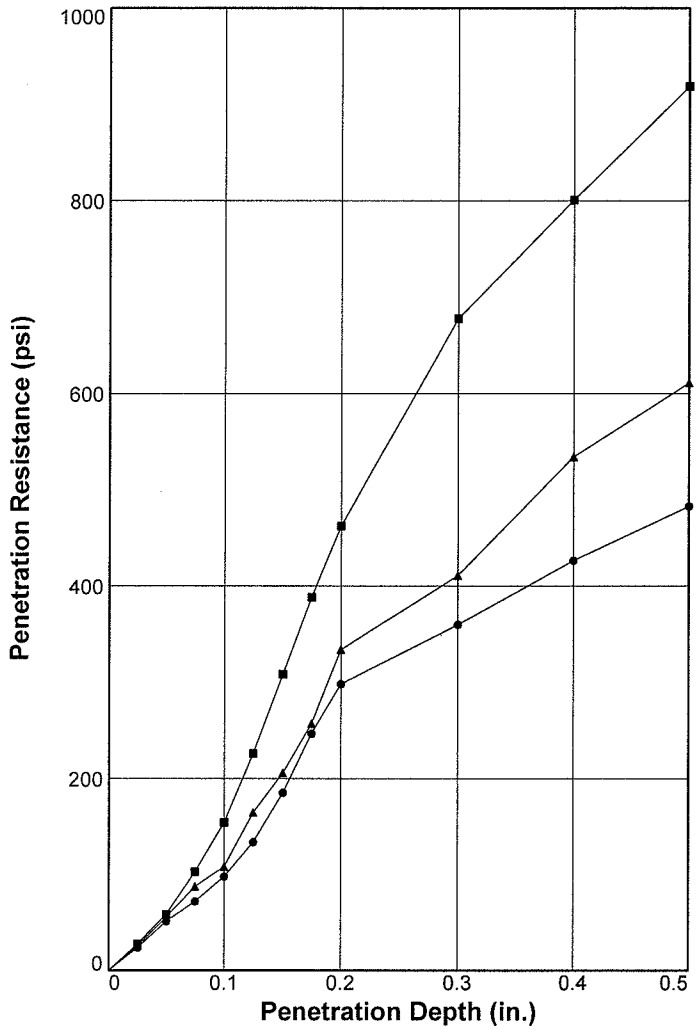
SUMMARY OF LABORATORY TEST RESULTS
June, 2009

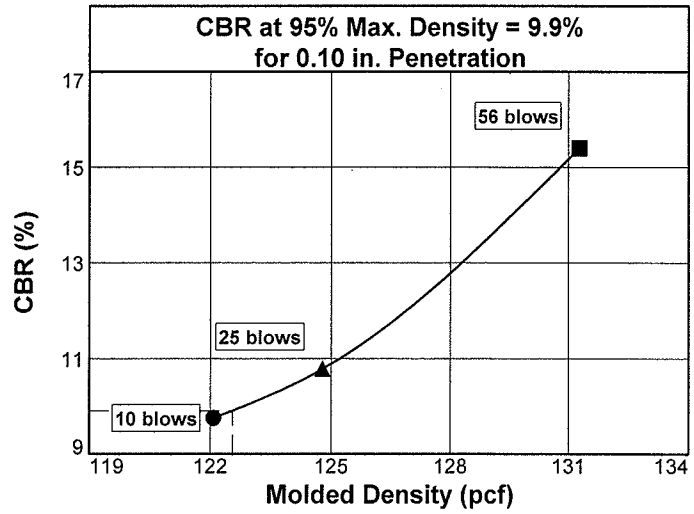
Boring No.	Sample No.	Depth (ft)	Moisture Content (%)	Atterburg Limits		Grain Size Analysis			Modified Proctor ASTM D 1557		% CBR	Soil Classification	
				LL	PI	% Gravel	% Sand	% Silt & Clay	MDD (pcf)	OMC (%)		USCS	AASHTO
B-14	S-2	3.5-5.0	20.0	41	21	1.2	18.8	80.0	---	---	---	CL	A-7-6
B-15	S-1	1.0-2.5	18.2	40	20	0.0	27.5	72.5	---	---	---	CL	A-6
R-01	S-1	1.0-2.5	6.6	---	---	---	---	---	---	---	---	---	---
	S-2	3.5-5.0	10.0	---	---	---	---	---	---	---	---	---	---
R-02	S-1	1.0-2.5	4.1	---	---	---	---	---	---	---	---	---	---
	S-2	3.5-5.0	4.2	---	---	---	---	---	---	---	---	---	---
R-03	S-1	1.0-2.5	15.8	---	---	---	---	---	---	---	---	---	---
	S-2	3.5-5.0	17.7	---	---	---	---	---	---	---	---	---	---
R-04	Bulk	1.0-5.0	9.3	NP	NP	13.1	59.6	27.3	129.0	8.4	9.9	SM	A-2-4
R-05	Bulk	1.0-8.5	21.8	46	27	0.1	25.1	74.8	122.7	12.2	---	CL	A-7-6
	S-4	8.5-10.0	3.1	---	---	---	---	---	---	---	---	---	---
R-06	S-2	3.5-5.0	6.9	---	---	---	---	---	---	---	---	---	---
R-07	Bulk	1.0-10.0	22.7	32	12	1.8	14.5	83.7	120.0	12.4	5.4	CL	A-6
R-08	S-1	1.0-2.5	17.1	NP	NP	1.3	50.7	48.0	---	---	---	SM	A-4
R-09	S-1	1.0-2.5	24.1	24	8	0.6	49.5	49.9	---	---	---	SC-SM	A-4
S-01	S-2	3.5-5.0	6.7	---	---	9.1	68.1	22.8	---	---	---	SM	A-2-4
S-02	S-2	3.5-5.0	6.1	---	---	0.0	81.4	18.6	---	---	---	SM	S-2-4
S-02A	S-1	4.7-5.0	7.0			0.0	87.3	12.7				SM	A-1-b
SWM-1	S-2	3.5-5.0	16.9	---	---	---	---	---	---	---	---	---	---
SWM-2	S-1	1.0-2.5	15.4	---	---	---	---	---	---	---	---	---	---
SWM-3	Bulk	1.0-5.0	23.8	NP	NP	0.0	62.9	37.1	---	---	---	SM	A-4

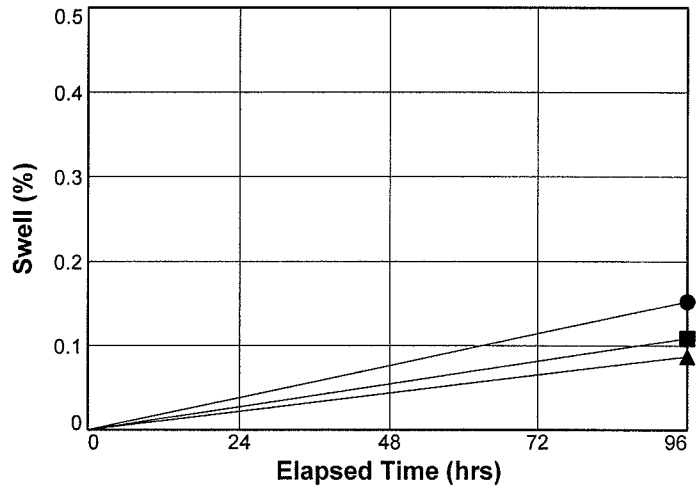
LL: LIQUID LIMIT
PI: PLASTIC INDEX
MDD: MAX DRY DENSITY
OMC: OPTIMUM MOISTURE CONTENT

EBA ENGINEERING, INC.

BEARING RATIO TEST REPORT
ASTM D 1883-05







	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ○	122.1	94.7	8.2	121.9	94.5	11.7	9.8	19.8	0.000	25	0.2
2 △	124.8	96.7	10.3	124.7	96.7	10.5	10.8	22.2	0.000	25	0.1
3 □	131.3	101.8	8.3	131.1	101.7	9.1	15.4	30.8	0.000	25	0.1

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Red & reddish brown silty sand	SM	129.0	8.4	NP	NP

Project No: 2554Z2339

Project: NASA Shipping and Receiving Facility

Source of Sample: R-4 **Depth:** 1.0'-5.0'

Sample Number: Bulk

Date:

Test Description/Remarks:

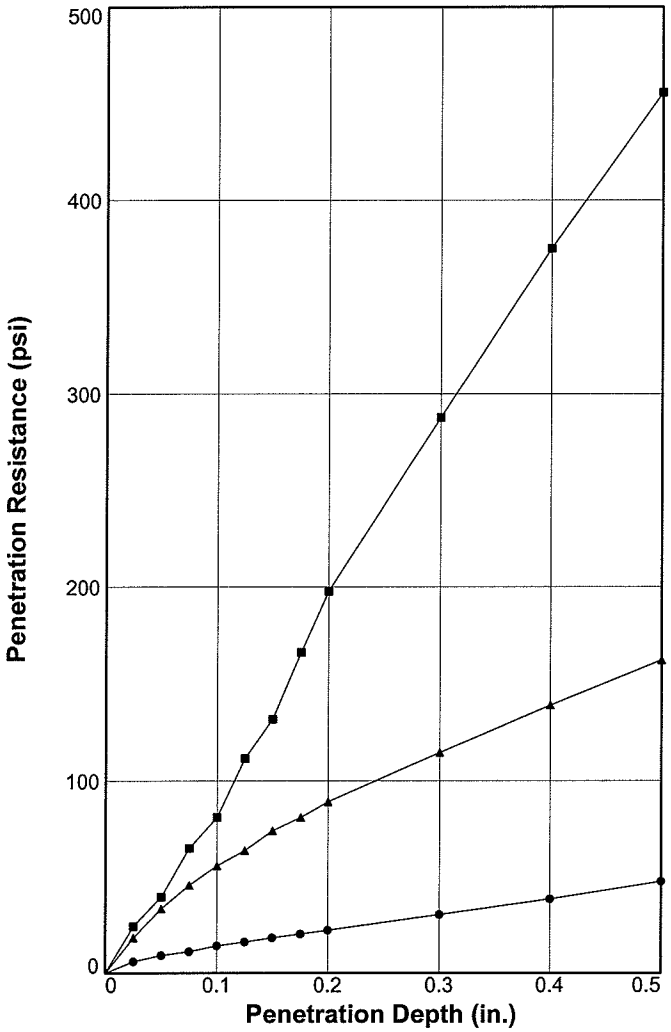
Moisture Content: 9.3%
Tested by: RP
Checked by: JK
Date tested: 8/28/08

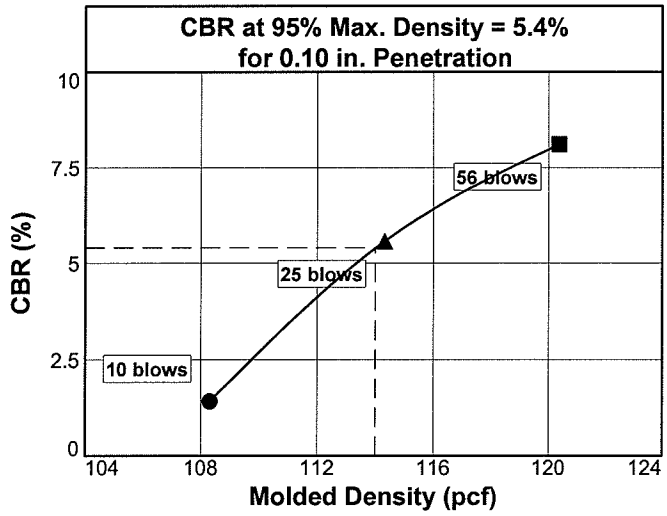
BEARING RATIO TEST REPORT

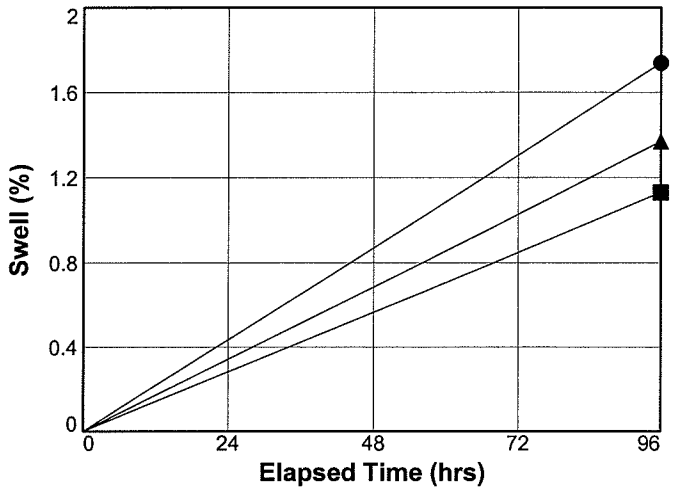
EBA Engineering, Inc.

Figure _____

BEARING RATIO TEST REPORT
ASTM D 1883-99







	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ○	108.3	90.3	12.8	106.5	88.7	20.7	1.4	1.5	0.000	25	1.7
2 △	114.3	95.3	12.4	112.8	94	17.6	5.6	5.9	0.000	25	1.4
3 □	120.4	100.3	12.5	119.0	99.2	14.9	8.1	13.2	0.000	25	1.1

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Dark brown Lean clay with sand	CL	120.0	12.4	32	12

Project No: 2554Z2339

Project: NASA Shipping & Receiving Facility

Source of Sample: R-7 **Depth:** 1.0'-10.0'

Sample Number: Bulk

Date:

Test Description/Remarks:

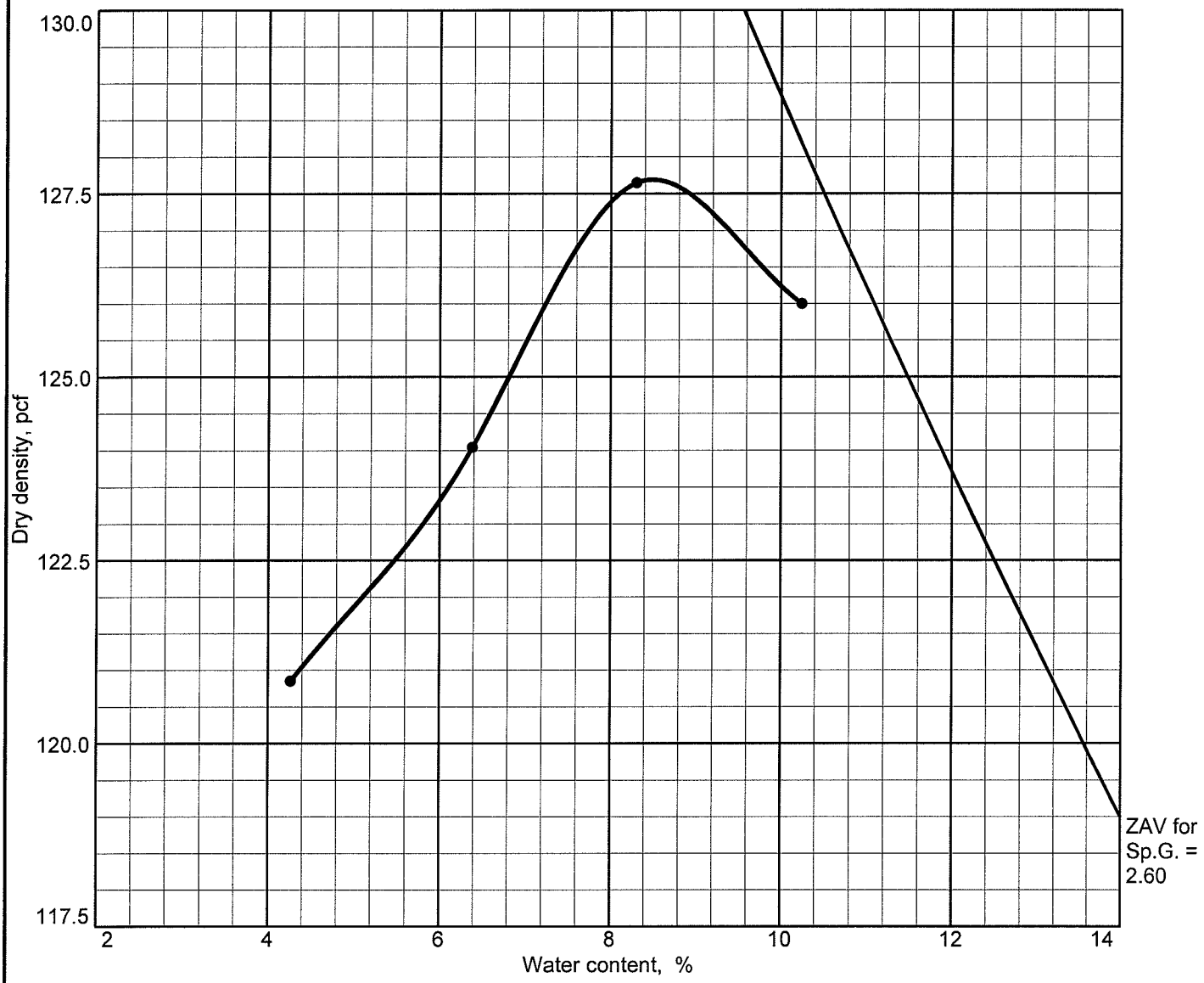
Tested by: VP
Checkedby: JK
Date tested: 9/05/08

BEARING RATIO TEST REPORT

EBA Engineering, Inc.

Plate _____

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure A Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
1.0'-10.0'	SM	A-2-4(0)	11.9%		NP	NP	0.5	31.4

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 127.7 pcf Optimum moisture = 8.5 %	Light brown and gray Silty sand

Project No. 2554Z2339 **Client:** Parsons Infrastructure & Technology Group
Project: NASA Shipping & Receiving Facility

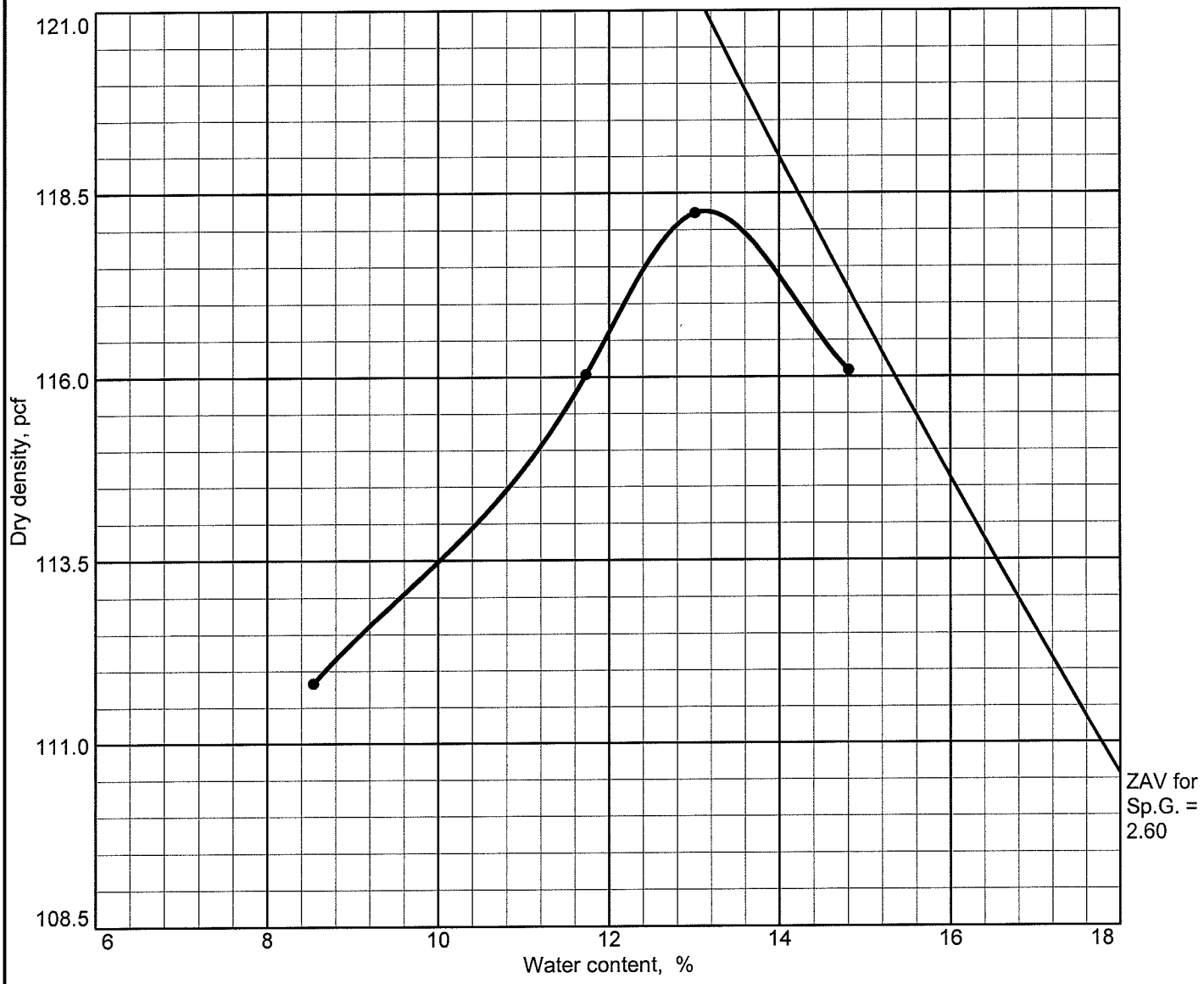
● **Source:** B-5 **Sample No.:** Bulk **Elev./Depth:** 1.0'-10.0'

Remarks:
Tested by: RP
Checked by: JK
Date tested: 8/27/08

EBA Engineering, Inc.
Baltimore, MD

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure A Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
1.0'-10.0'	CL	A-6(9)	22.2%		33	12	1.1	82.6

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 118.3 pcf Optimum moisture = 13.1 %	Reddish brown Lean clay with sand

Project No. 2554Z2339 **Client:** Parsons Infrastructure & Technology Group
Project: NASA Shipping & Receiving Facility

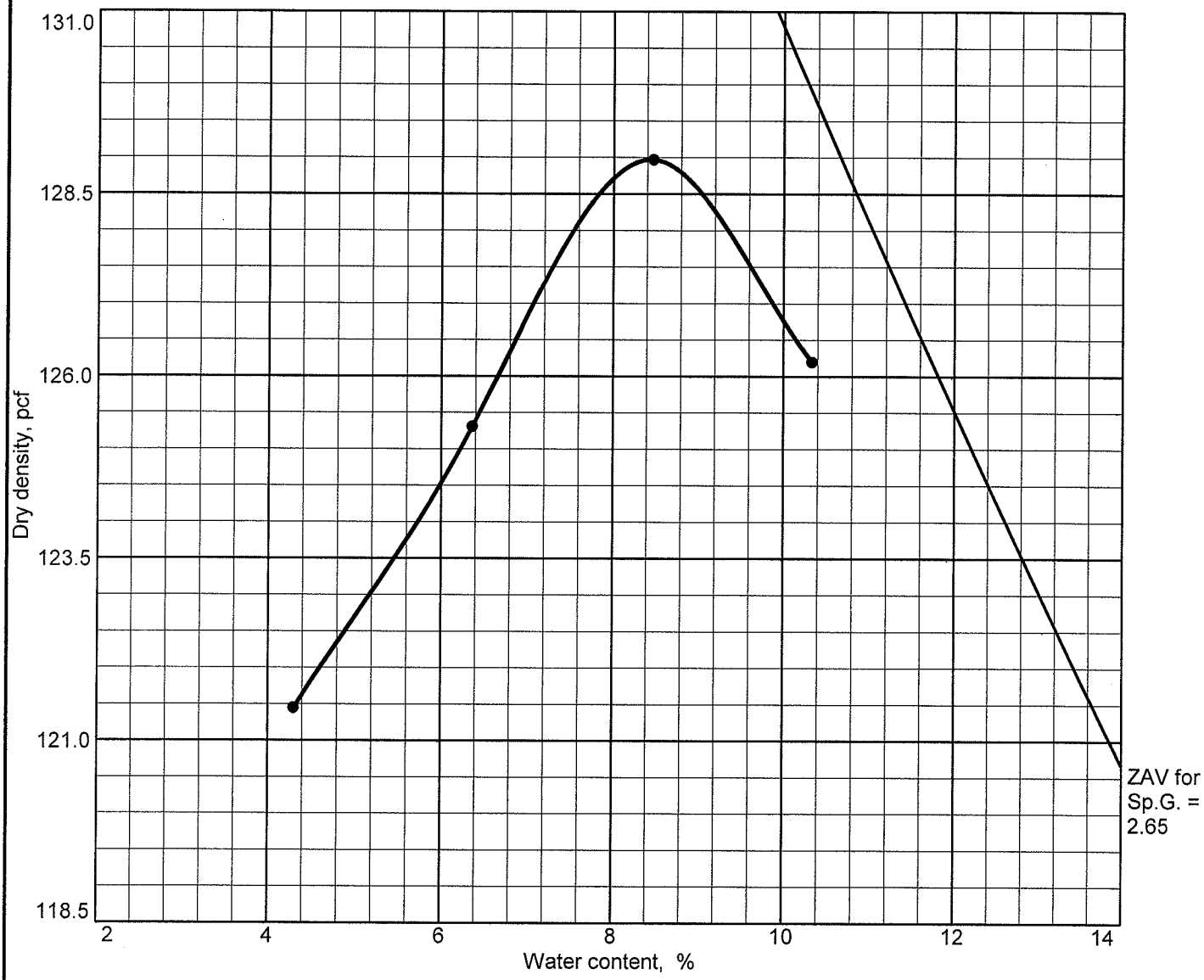
● **Source:** B-10 **Sample No.:** Bulk **Elev./Depth:** 1.0'-10.0'

Remarks:
Tested by: RP
Checked by: JK
Date tested: 8/29/08

EBA Engineering, Inc.
Baltimore, MD

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure A Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
1.0'-5.0'	SM	A-2-4(0)	9.3%	---	NP	NP	13.1	27.3

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 129.0 pcf Optimum moisture = 8.4 %	Red & reddish brown silty sand

Project No. 2554Z2339 **Client:** Parsons IT & T
Project: NASA Shipping and Receiving Facility

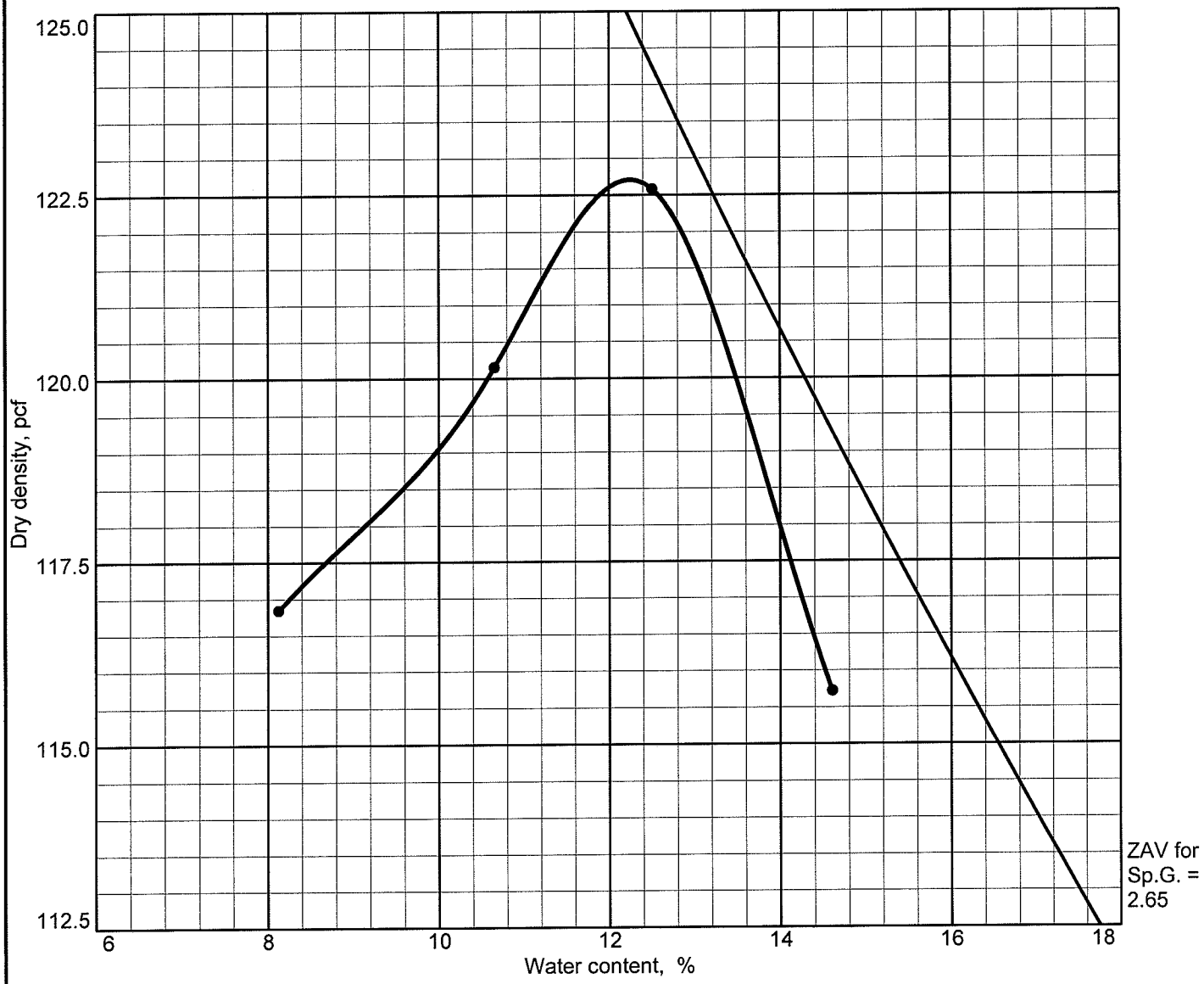
● **Source:** R-4 **Sample No.:** Bulk **Elev./Depth:** 1.0'-5.0'

Remarks:
Tested by: RP
Checked by: JK
Date tested: 8/26/08
ZAV assumed

EBA Engineering, Inc.
Baltimore, MD

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure A Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
1.0'-8.5'	CL	A-7-6(19)	21.8%		46	27	0.1	74.8

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 122.7 pcf Optimum moisture = 12.2 %	Reddish brown Lean clay with sand

Project No. 2554Z2339 **Client:** Parsons Infrastructure & Technology Group
Project: NASA Shipping & Receiving Facility

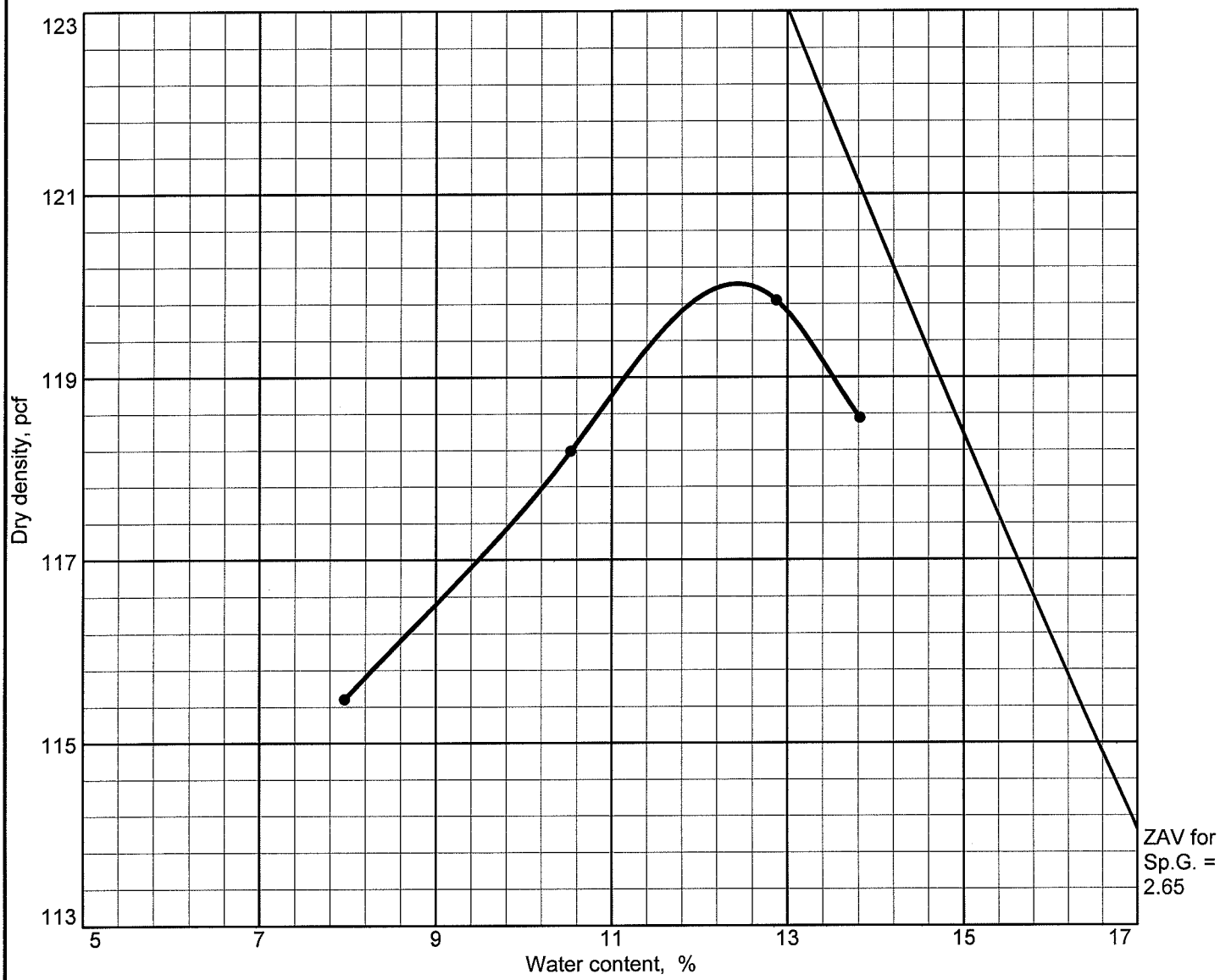
● **Source:** R-5 **Sample No.:** Bulk **Elev./Depth:** 1.0'-8.5'

Remarks:
Tested by: RP
Checked by: JK
Date tested: 9/08/08

EBA Engineering, Inc.
Baltimore, MD

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure A Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
1.0'-10.0'	CL	A-6(9)	22.7%		32	12	1.8	83.7

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 120.0 pcf Optimum moisture = 12.4 %	Dark brown Lean clay with sand

Project No. 2554Z2339 **Client:** Parsons Infrastructure & Technology Group
Project: NASA Shipping & Receiving Facility

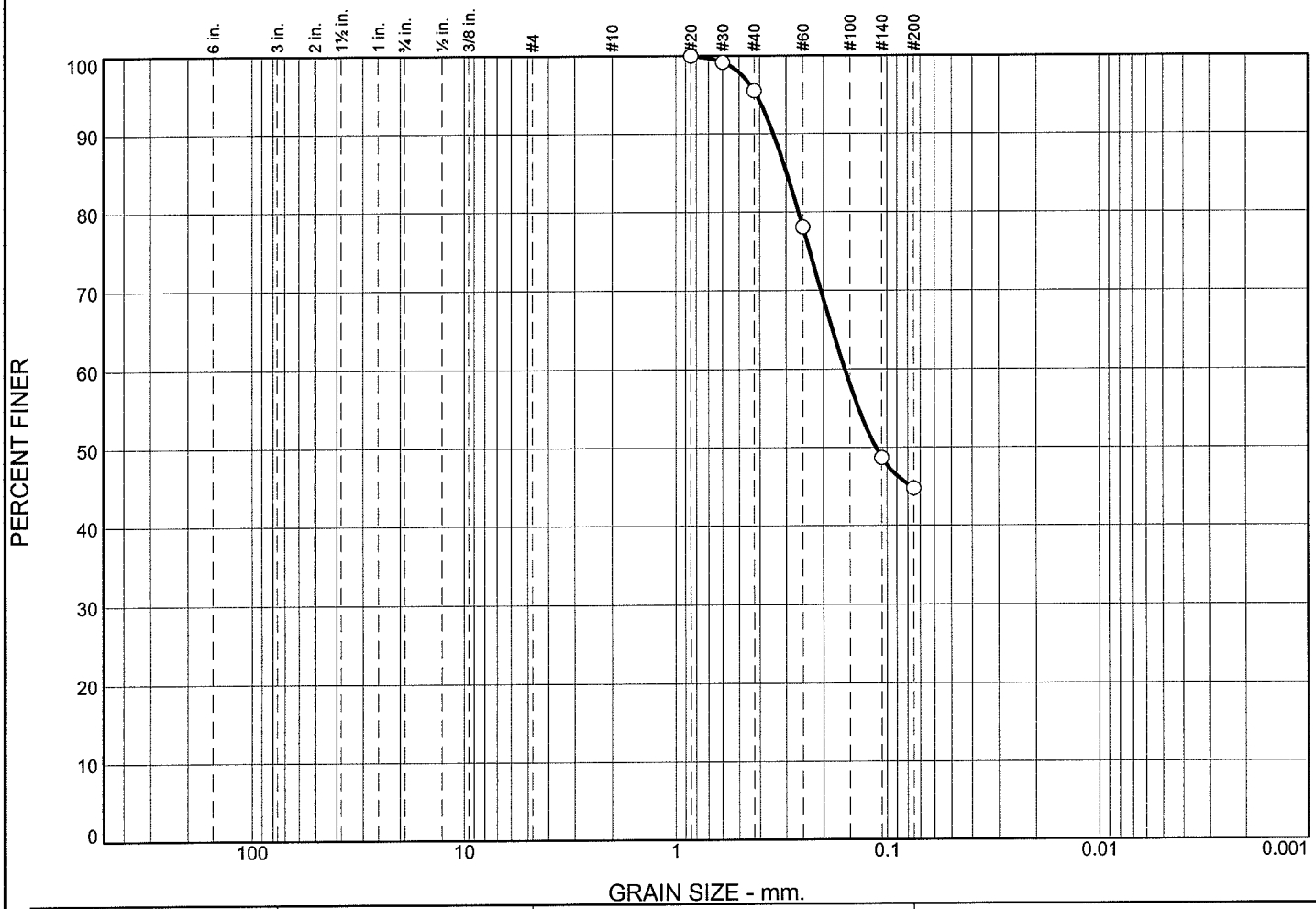
● **Source:** R-7 **Sample No.:** Bulk **Elev./Depth:** 1.0'-10.0'

Remarks:
Tested by: VP
Checked by: JK
Date tested: 8/26/08

EBA Engineering, Inc.
Baltimore, MD

Plate

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	4.5	50.7	44.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	17	13	0.2983	0.1584	0.1131					

Material Description	USCS	AASHTO
○ Gray Silty, clayey sand	SC-SM	A-4(0)

Project No. 2554Z2339 **Client:** Parsons Infrastructure & Technology Group

Project: NASA Shipping & Receiving Facility

○ **Source of Sample:** B-1 **Depth:** 8.5'-10.0' **Sample Number:** S-4

Remarks:

○ Moisture content: 16.0%

Date tested: 8/29/08

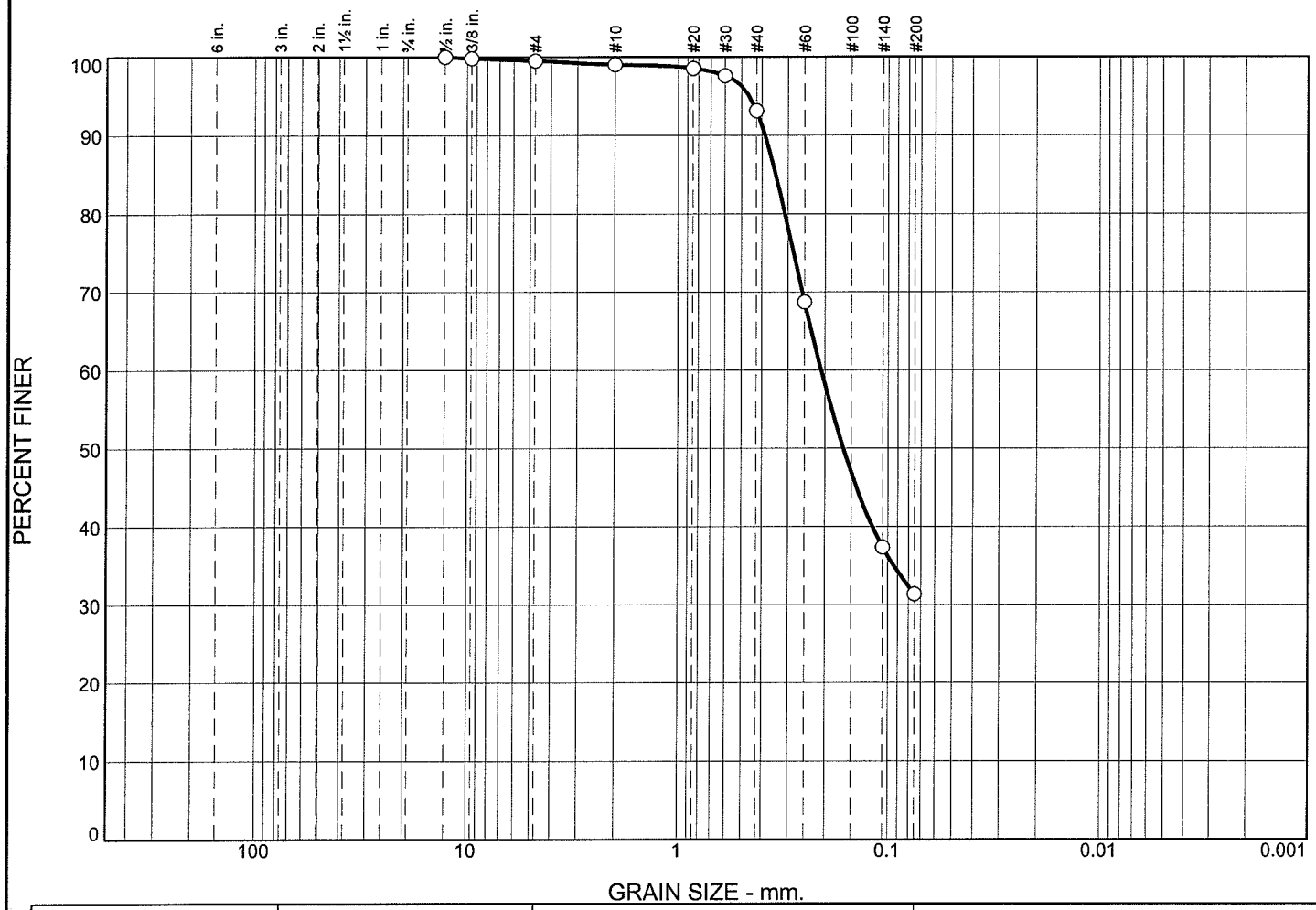
EBA Engineering, Inc.

Baltimore, MD

Figure

Tested By: RP **Checked By:** JK

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.5	0.5	5.8	61.8	31.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NP	NP	0.3433	0.2084	0.1632					

Material Description	USCS	AASHTO
○ Light brown and gray Silty sand	SM	A-2-4(0)

Project No. 2554Z2339 **Client:** Parsons Infrastructure & Technology Group

Project: NASA Shipping & Receiving Facility

○ **Source of Sample:** B-5 **Depth:** 1.0'-10.0' **Sample Number:** Bulk

Remarks:

○ Moisture content: 11.9%

Soil classes: Detetmined without liquid limit

Date tested: 8/27/08

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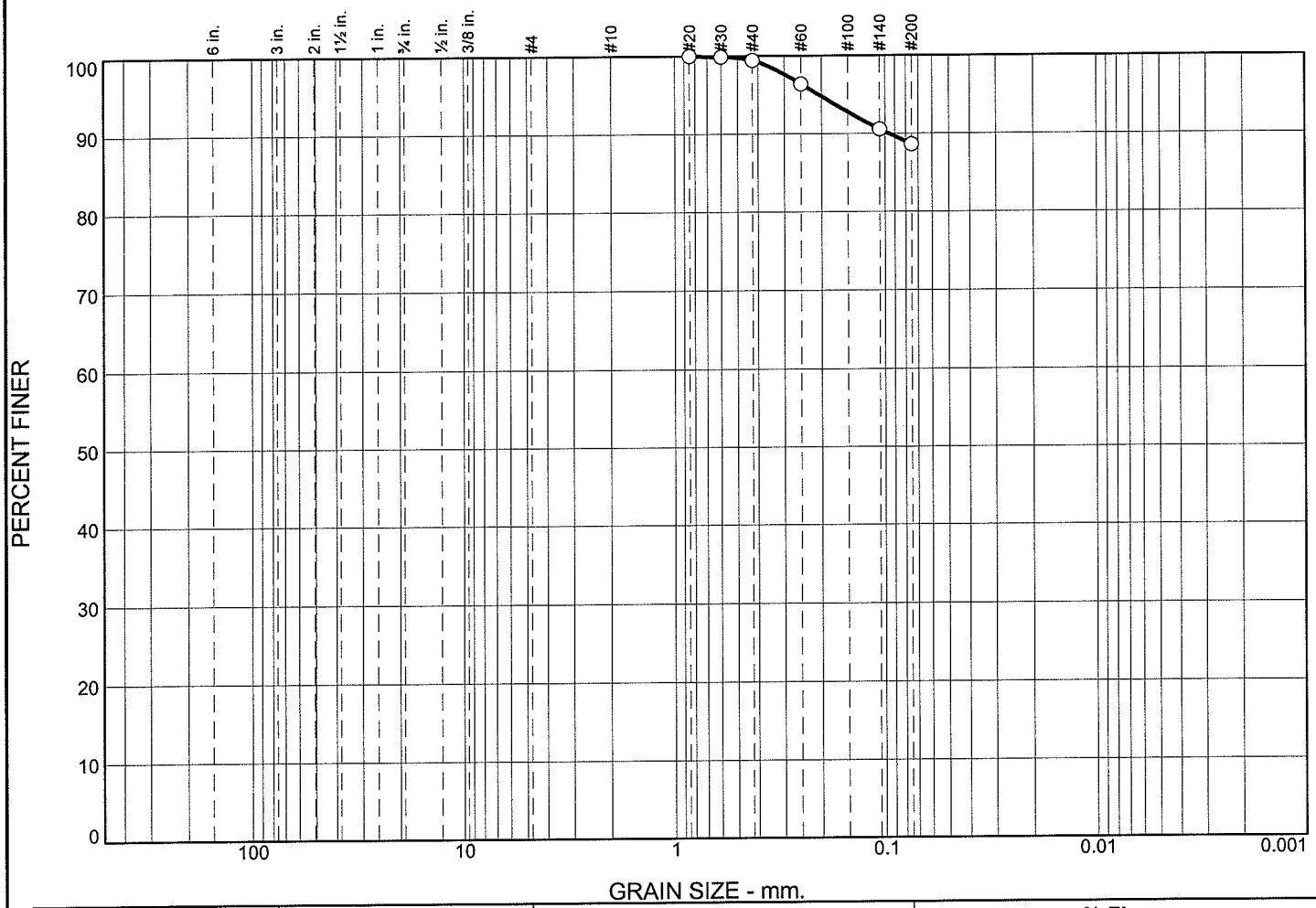
Figure

Tested By: RP **Checked By:** JK

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.6	10.8	88.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	37	17								

Material Description	USCS	AASHTO
○ Red and gray Lean clay	CL	A-6(17)

Project No. 2554Z2339 **Client:** Parsons Infrastructure & Technology Group

Project: NASA Shipping & Receiving Facility

○ **Source of Sample:** B-7 **Depth:** 11.0'-12.5' **Sample Number:** S-5

Remarks:

○ Moisture content: 17.5%

Date tested: 8/29/08

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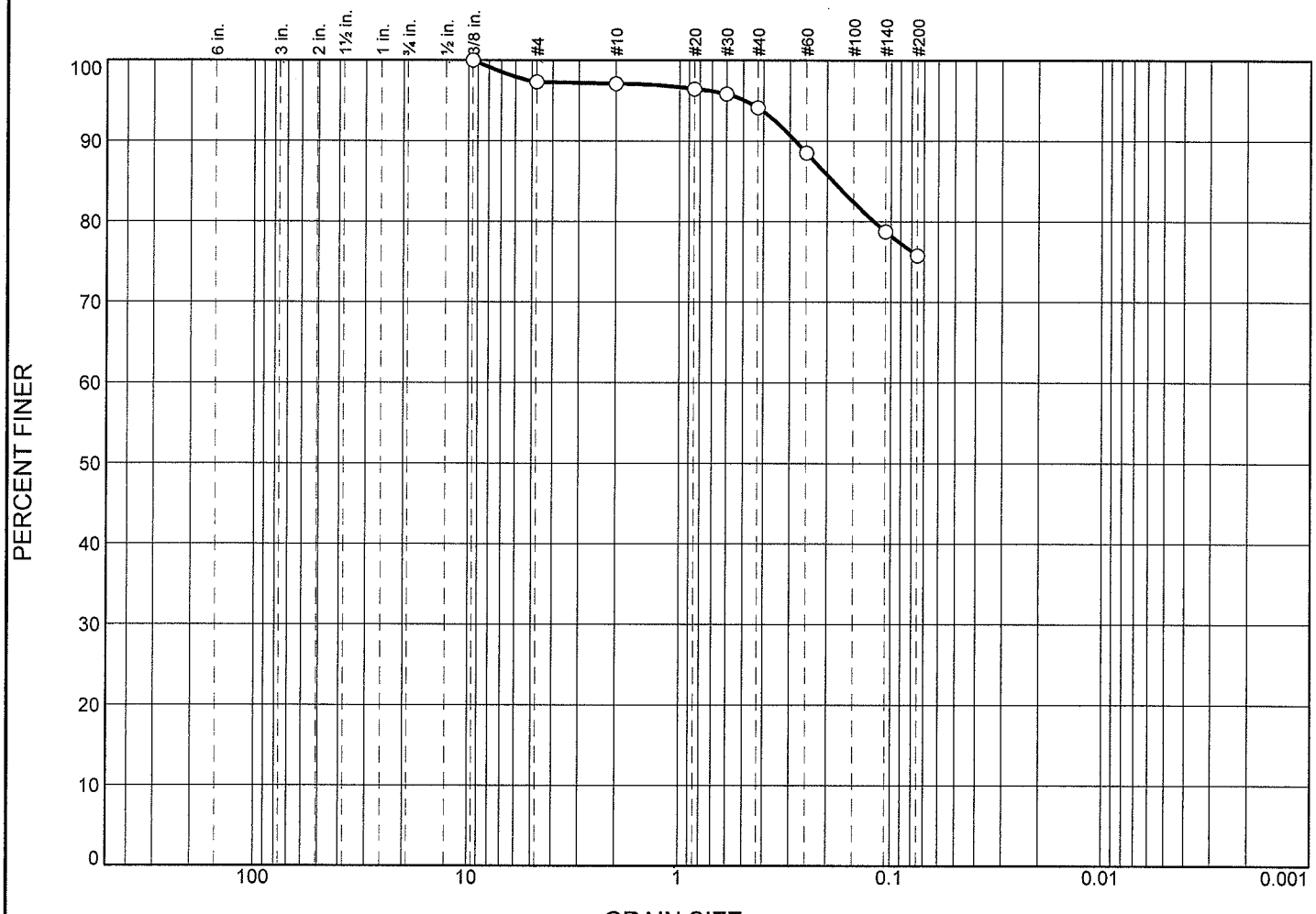
Figure

Tested By: VP **Checked By:** JK

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	2.7	0.2	3.0	18.3	75.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	25	18	0.1872							

Material Description	USCS	AASHTO
○ Gray and brown sandy silty clay with sand	CL-ML	A-4(3)

Project No. 2554Z2339 **Client:** Parsons IT & T

Project: NASA Shipping & Receiving Facility

○ **Source of Sample:** B-9 **Depth:** 6.0'-7.5' **Sample Number:** S-3

Remarks:

○ Moisture Content: 14.4%

Date tested: 8/29/08

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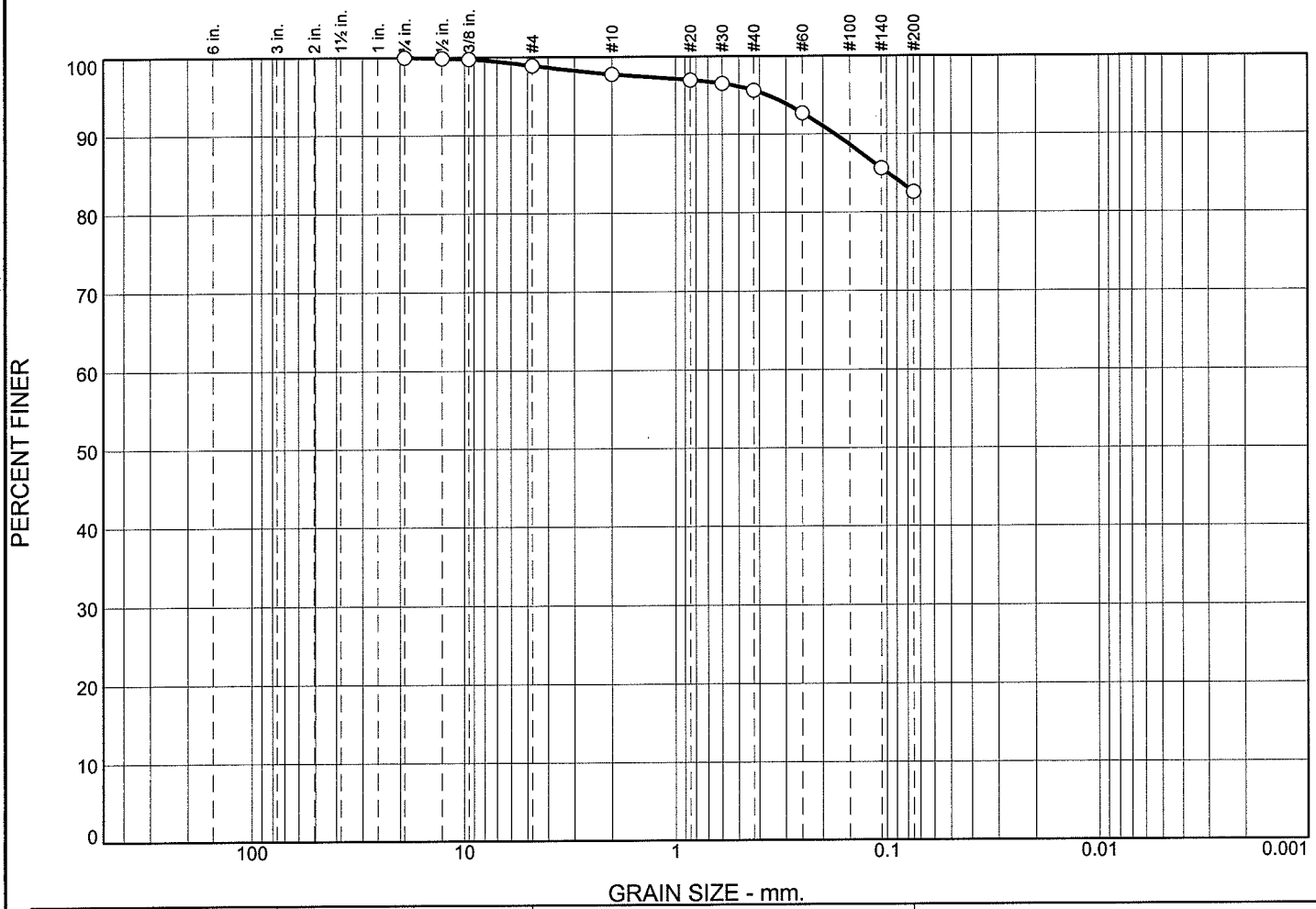
Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.1	1.1	2.1	13.1	82.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	33	21	0.0989							

Material Description	USCS	AASHTO
○ Reddish brown Lean clay with sand	CL	A-6(9)

Project No. 2554Z2339 **Client:** Parsons Infrastructure & Technology Group

Project: NASA Shipping & Receiving Facility

○ **Source of Sample:** B-10 **Depth:** 1.0'-10.0' **Sample Number:** Bulk

Remarks:

○ Moisture content: 22.2%

Date tested: 8/28/08

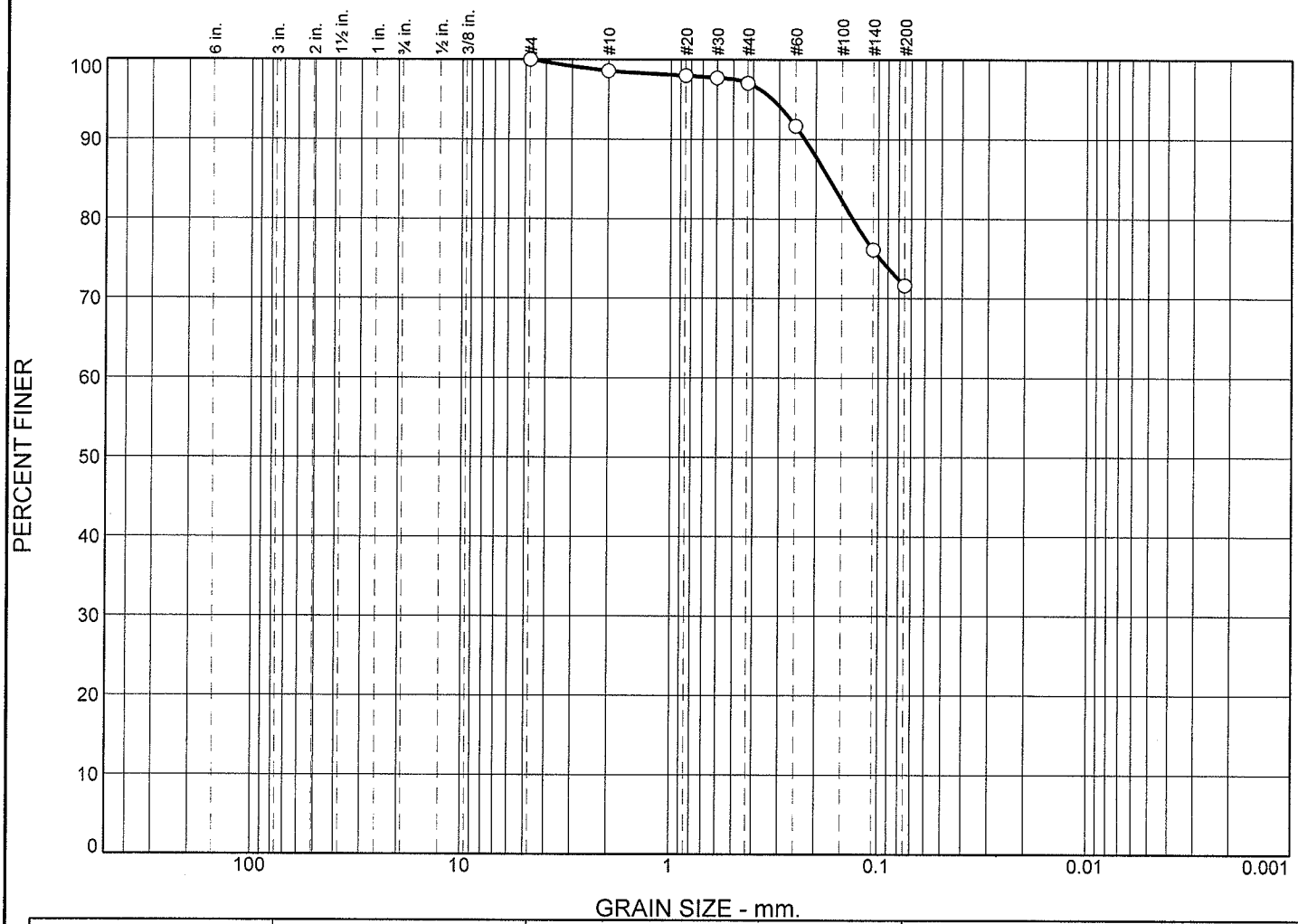
EBA Engineering, Inc.

Baltimore, MD

Figure

Tested By: RP **Checked By:** JK

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	1.4	1.5	25.5	71.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	28	19	0.1726							

Material Description	USCS	AASHTO
○ Brown sandy lean clay	CL	A-4(5)

Project No. 2554Z2339 **Client:** Parsons IT & T

Project: NASA Shipping & Receiving Facility

○ **Source of Sample:** B-10 **Depth:** 13.5'-15.0' **Sample Number:** S-6

Remarks:

○ Moisture Content: 21.8%

Date tested: 8/29/08

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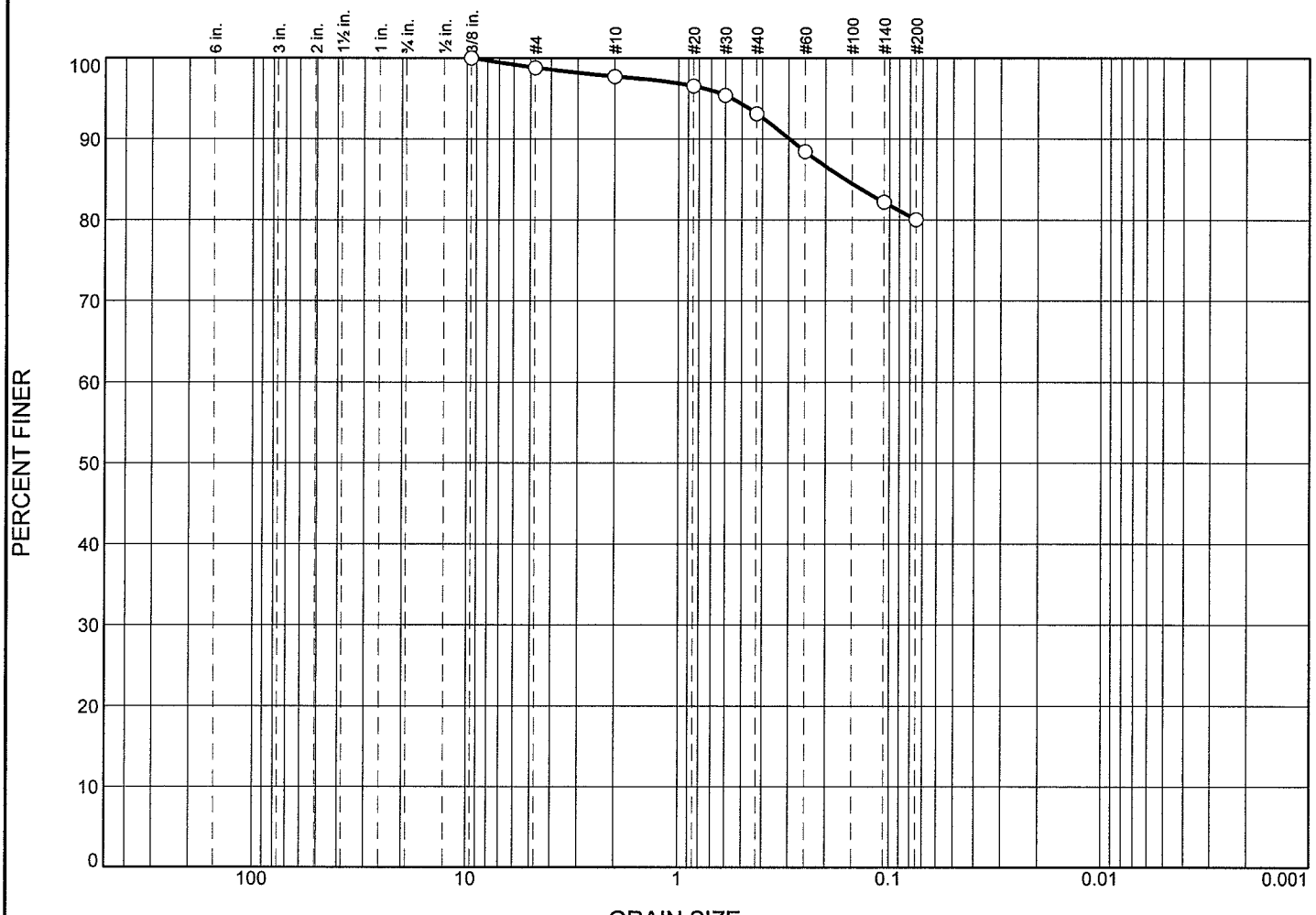
Baltimore, MD

Figure

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	1.2	18.8	80.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	41	20	0.1611							

Material Description	USCS	AASHTO
○ Red lean clay with sand	CL	A-7-6(16)

Project No. 2554Z2339 **Client:** Parsons IT & T

Project: NASA Shipping and Receiving Facility

○ **Source of Sample:** B-14 **Depth:** 3.5'-5.0' **Sample Number:** S-2

Remarks:

○ Moisture Content: 20.0%

Date tested: 5/18/2009

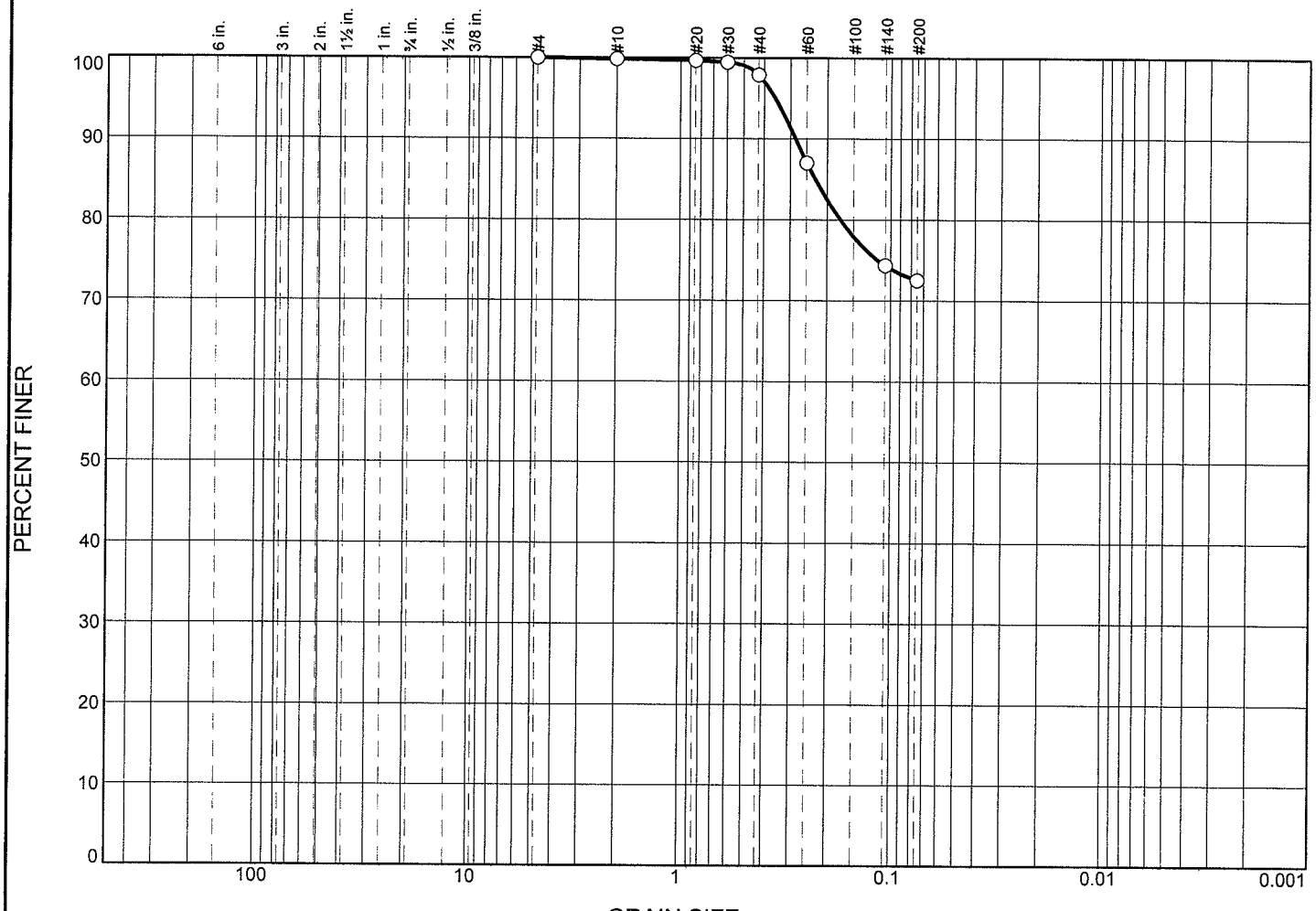
EBA Engineering, Inc.

Baltimore, MD

Figure

Tested By: RD **Checked By:** LS

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0	27.5	72.5	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	40	20	0.2280							

Material Description	USCS	AASHTO
○ Brown and pale gray lean clay with sand	CL	A-6(13)

Project No. 2554Z2339 **Client:** Parsons IT & T

Project: NASA Shipping and Receiving Facility

○ **Source of Sample:** B-15 **Depth:** 1.0'-2.5' **Sample Number:** S-1

Remarks:

○ Moisture Content: 18.2%

Date tested: 5/18/2009

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Baltimore, MD

Figure

Tested By: RD **Checked By:** JK

Particle Size Distribution Report

	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	3.0	10.1	3.7	4.0	51.9	27.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NP	NP	3.2965	0.2147	0.1655	0.0858				

Material Description	USCS	AASHTO
○ Red & reddish brown silty sand	SM	A-2-4(0)

Project No. 2554Z2339 **Client:** Parsons IT & T

Project: NASA Shipping and Receiving Facility

○ **Source of Sample:** R-4 **Depth:** 1.0'-5.0' **Sample Number:** Bulk

Remarks:

○ Moisture Content: 9.3%

Soil Classes: Determined without liquid limit

USDA Class: Sand

Date tested: 8/26/08

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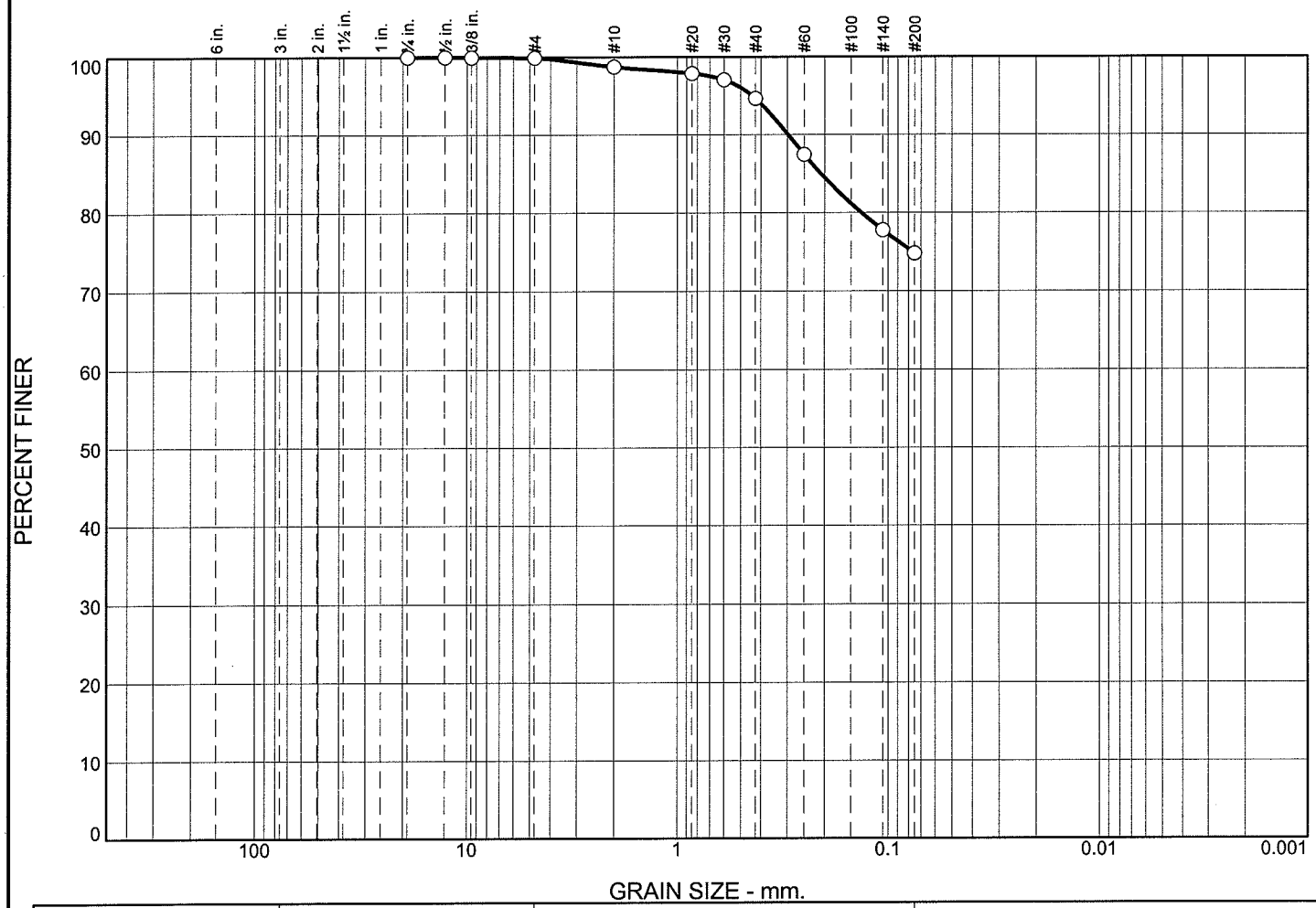
Figure

Tested By: RD **Checked By:** JK

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.1	1.1	4.1	19.9	74.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	46	19	0.2081							

Material Description	USCS	AASHTO
○ Reddish brown Lean clay with sand	CL	A-7-6(19)

Project No. 2554Z2339 **Client:** Parsons Infrastructure & Technology Group

Project: NASA Shipping & Receiving Facility

○ **Source of Sample:** R-5 **Depth:** 1.0'-8.5' **Sample Number:** Bulk

Remarks:

○ Moisture content: 21.8%

Date tested: 9/08/08

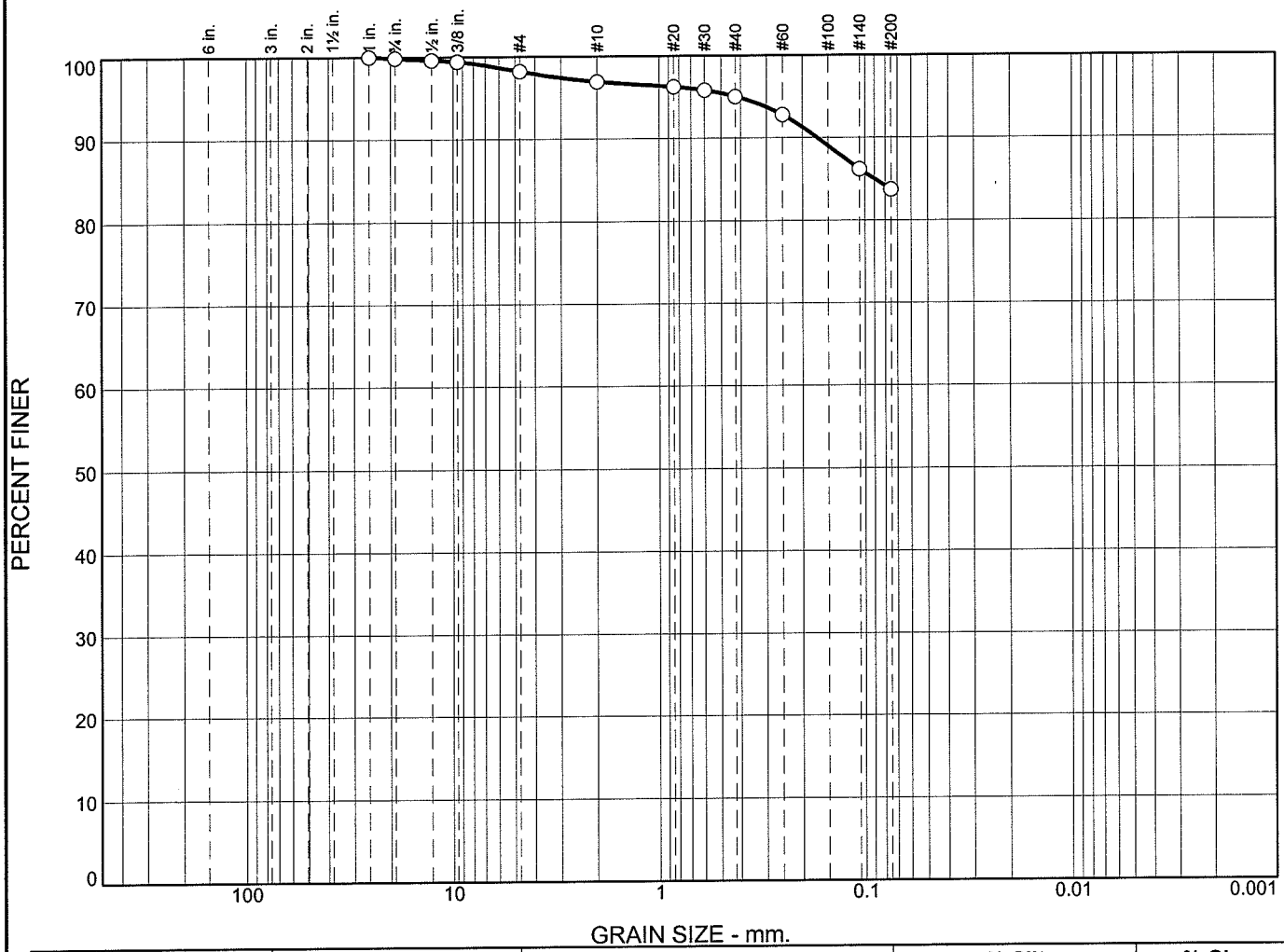
EBA Engineering, Inc.

Baltimore, MD

Figure

Tested By: VP **Checked By:** JK

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	1.8	14.5	83.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	32	20	0.0899							

Material Description	USCS	AASHTO
○ Dark brown Lean clay with sand	CL	A-6(9)

Project No. 2554Z2339 **Client:** Parsons Infrastructure & Technology Group

Project: NASA Shipping & Receiving Facility

○ **Source of Sample:** R-7 **Depth:** 1.0'-10.0' **Sample Number:** Bulk

Remarks:

○ Moisture content: 22.7%

Date tested: 8/26/08

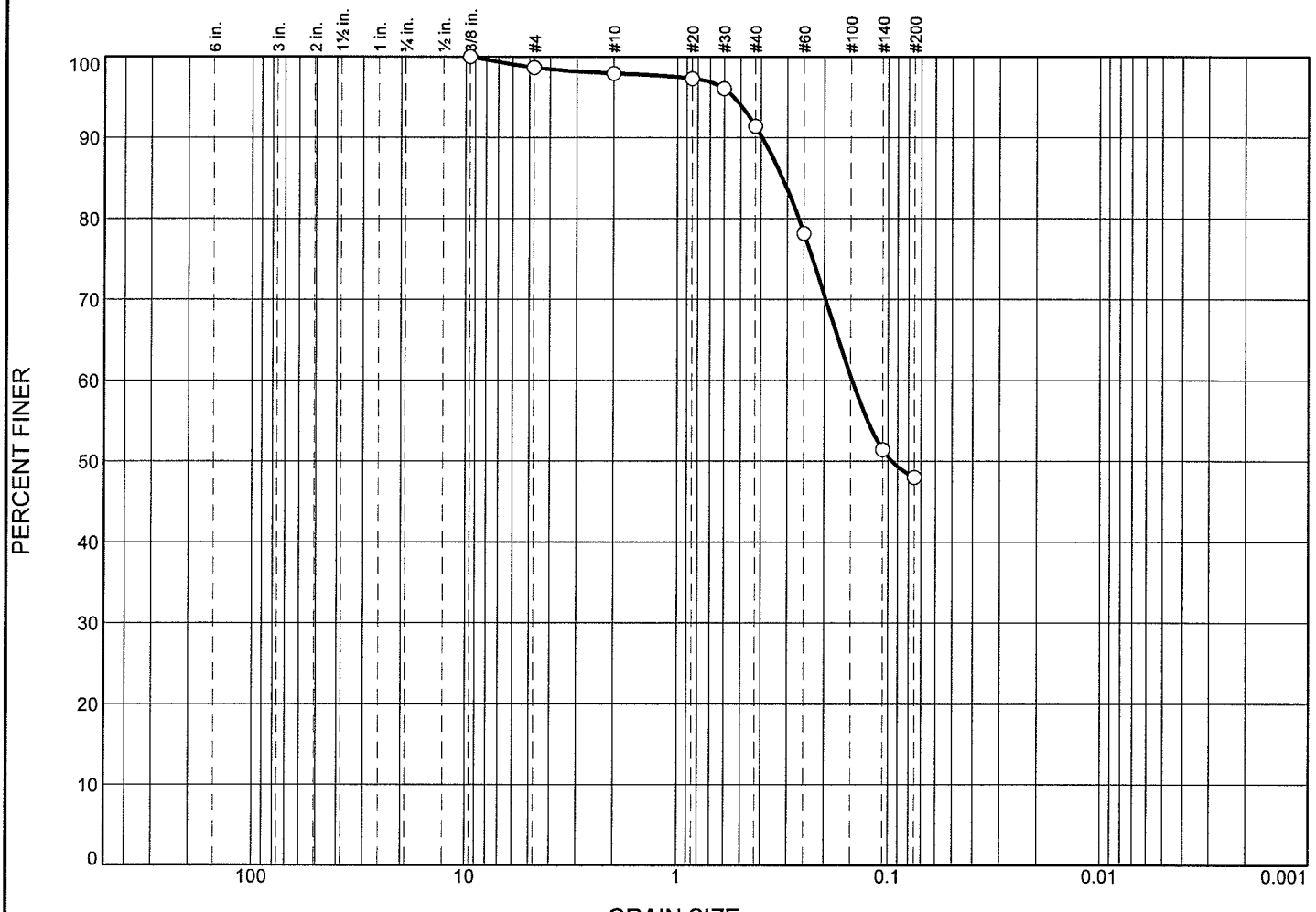
EBA Engineering, Inc.

Baltimore, MD

Plate

Tested By: VP **Checked By:** JK

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	1.3	50.7	48.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NP	NP	0.3174	0.1479	0.0960					

Material Description	USCS	AASHTO
○ Reddish brown silty sand	SM	A-4(0)

Project No. 2554Z2339 **Client:** Parsons IT & T

Project: NASA Shipping and Receiving Facility

○ **Source of Sample:** R-08 **Depth:** 1.0'-2.5' **Sample Number:** S-1

Remarks:

○ Moisture Content: 17.1%

Date tested: 5/18/2009

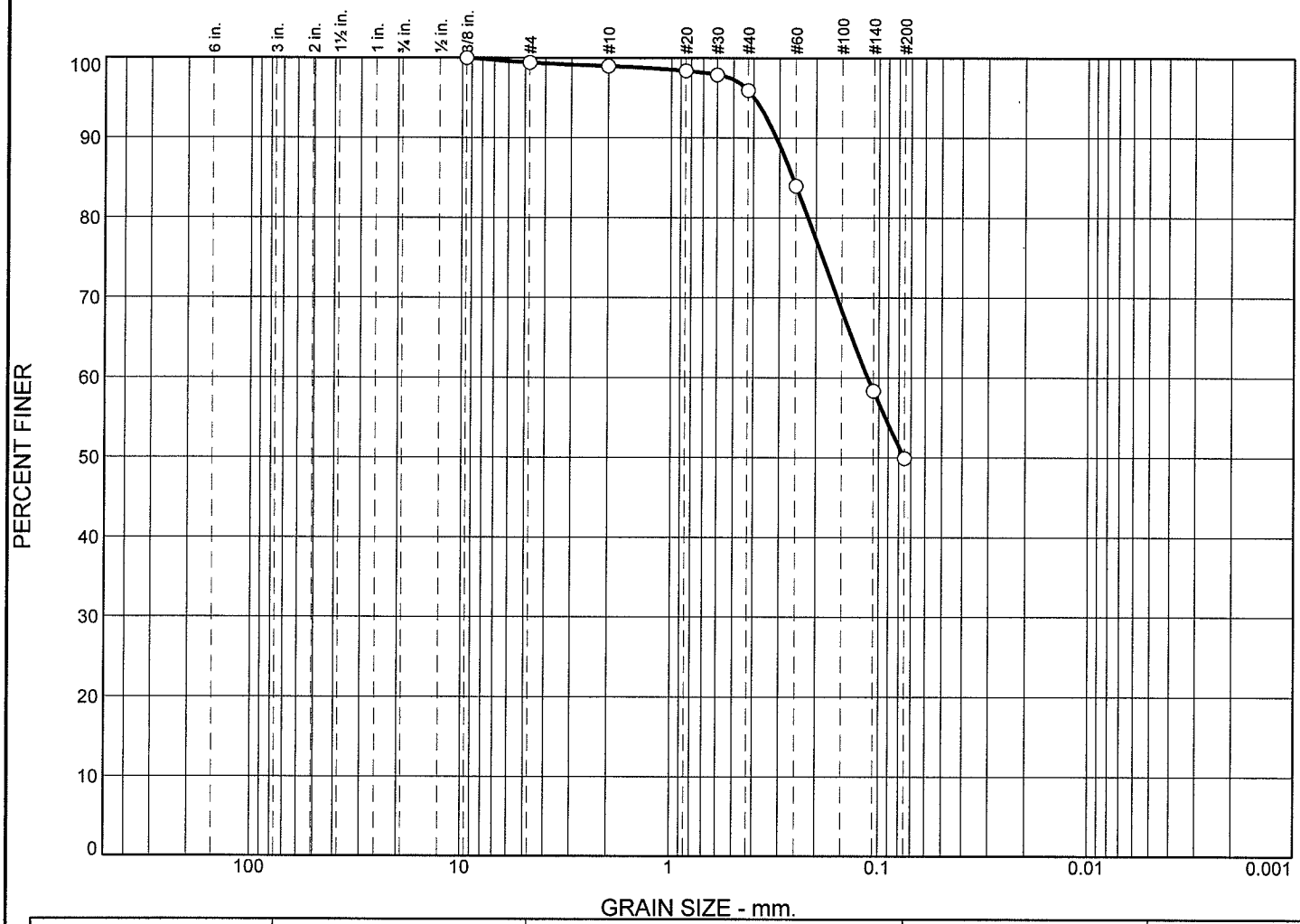
EBA Engineering, Inc.

Baltimore, MD

Figure

Tested By: RD **Checked By:** JK

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.6	49.5	49.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	24	16	0.2589	0.1129	0.0753					

Material Description	USCS	AASHTO
○ Reddish brown clayey sand	SC	A-4(1)

Project No. 2554Z2339 **Client:** Parsons IT & T

Project: NASA Shipping and Receiving Facility

○ **Source of Sample:** R-09 **Depth:** 1.0'-2.5' **Sample Number:** S-1

Remarks:

○ Moisture Content: 24.1%

Date tested: 5/18/2009

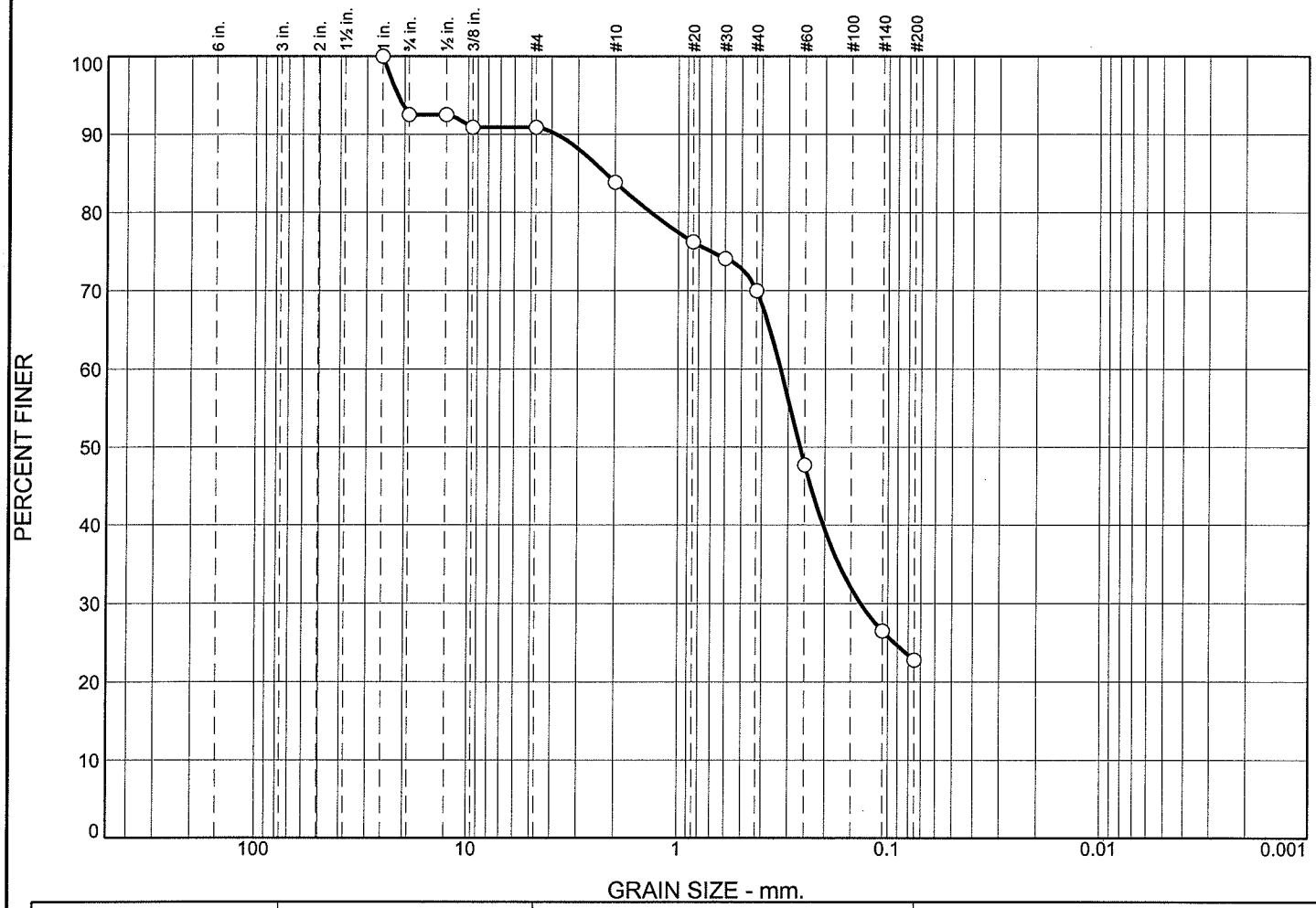
EBA Engineering, Inc.

Baltimore, MD

Figure

Tested By: RD **Checked By:** JK

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	7.5	1.6	7.0	13.9	47.2	22.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	---	---	2.2184	0.3259	0.2634	0.1347				

Material Description	USCS	AASHTO
○ Reddish brown Silty sand	SM	A-2-4(0)

Project No. 2554Z2339 **Client:** Parsons Infrastructure & Technology Group

Project: NASA Shipping & Receiving Facility

○ **Source of Sample:** S-1 **Depth:** 3.5'-5.0' **Sample Number:** S-2

Remarks:

○ Moisture content: 6.7%

Soil classes: Determined without liquid limit

Date tested: 8/27/08

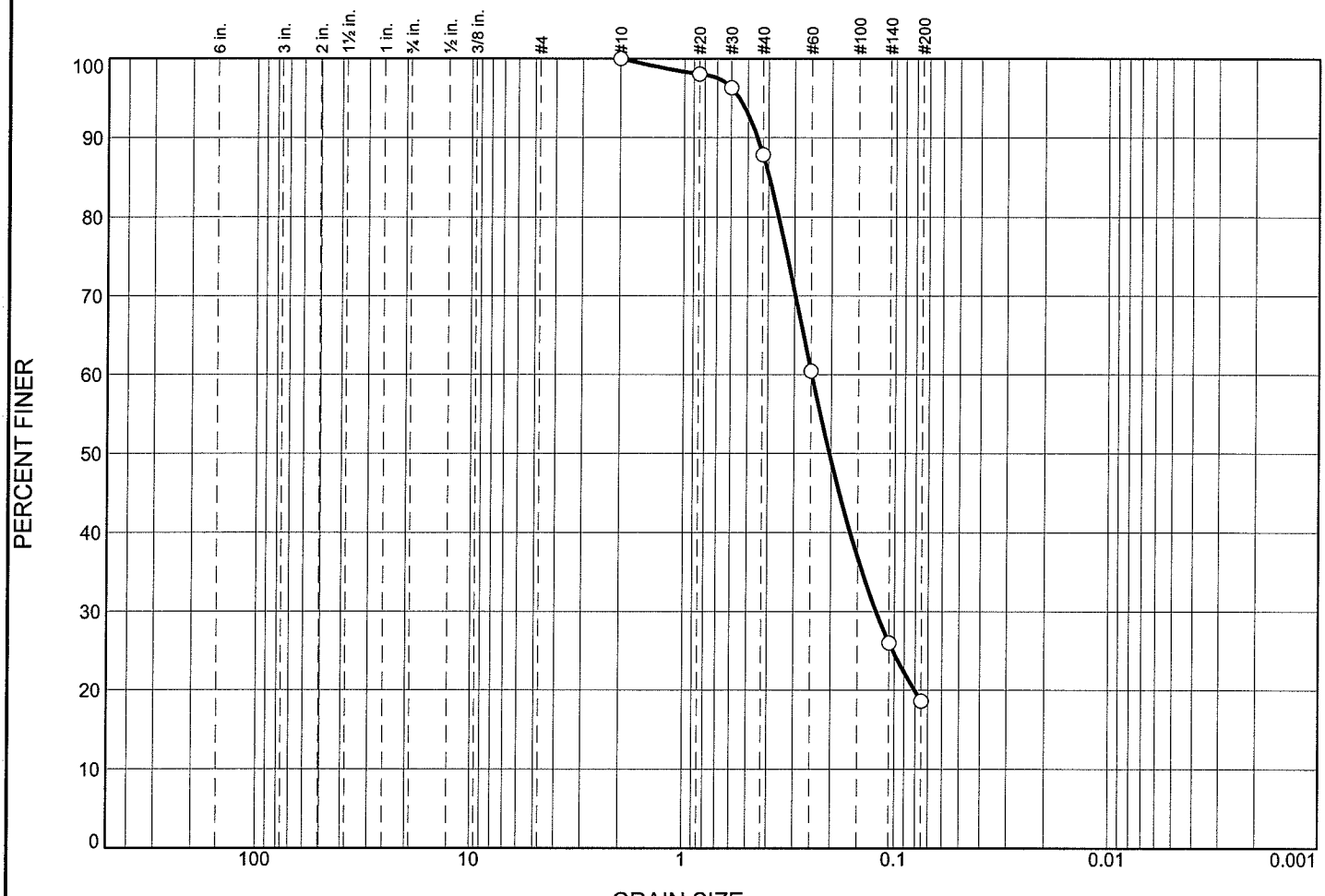
EBA Engineering, Inc.

Baltimore, MD

Figure

Tested By: RP **Checked By:** JK

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	12.1	69.3	18.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	---	---	0.3963	0.2480	0.2037	0.1223				

Material Description	USCS	AASHTO
○ Reddish brown Silty sand	SM	A-2-4(0)

Project No. 2554Z2339 **Client:** Parsons Infrastructure & Technology Group

Project: NASA Shipping & Receiving Facility

○ **Source of Sample:** S-2 **Depth:** 3.5'-5.0' **Sample Number:** S-2

Remarks:

○ Moisture content: 6.1%

Soil classes: Determined without liquid limit

Date tested: 8/28/08

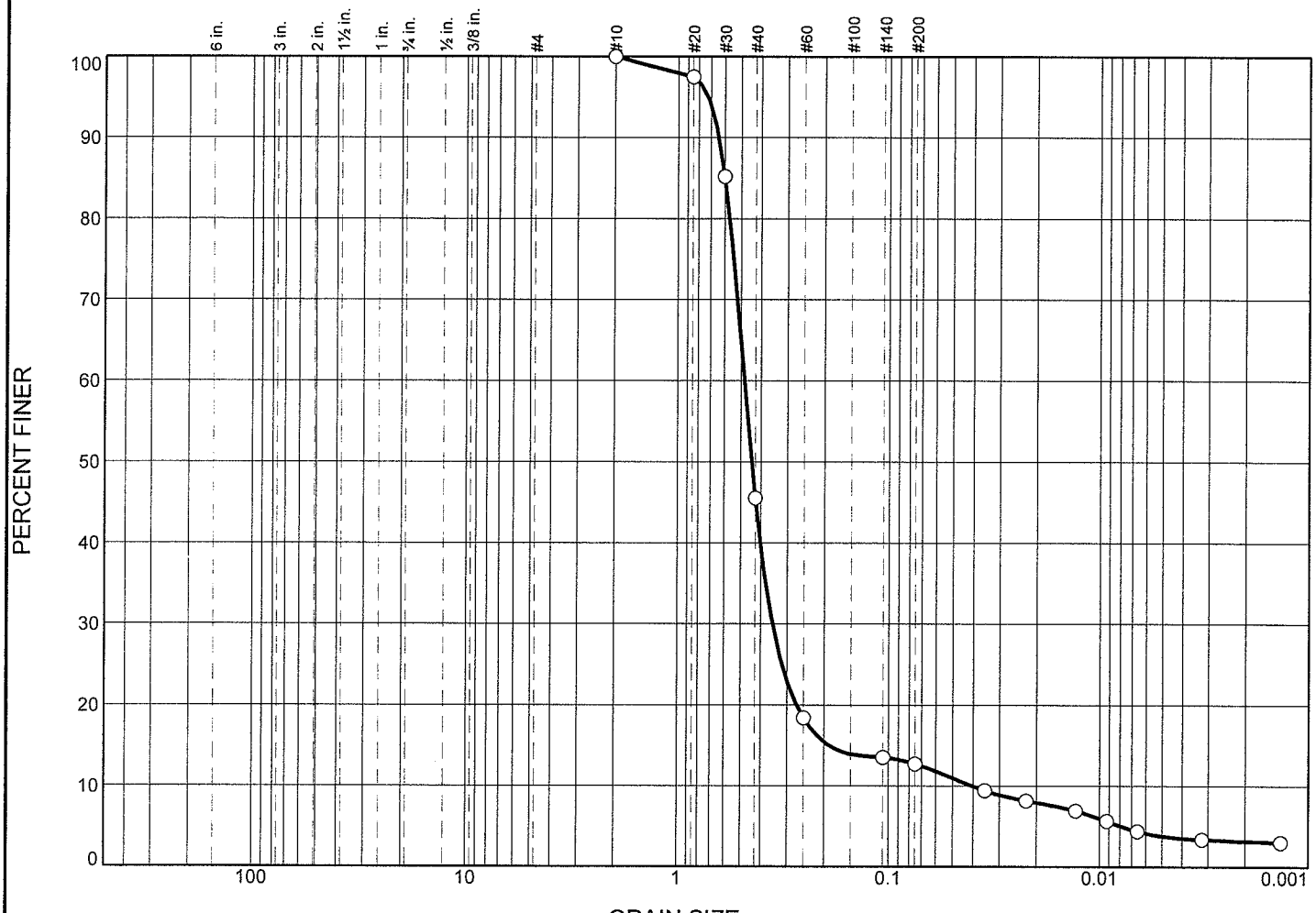
EBA Engineering, Inc.

Baltimore, MD

Figure

Tested By: RP **Checked By:** JK

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0	87.3	8.9	3.8

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	---	---	0.5986	0.4804	0.4425	0.3511	0.1894	0.0404	6.35	11.88

Material Description	USCS	AASHTO
○ Reddish brown Silty sand	SM	A-1-b

Project No. 2554Z2339 **Client:** Parsons IT & T

Project: NASA Shipping and Receiving Facility

○ **Source of Sample:** S-02A **Depth:** 4.7'-5.0' **Sample Number:** S-1

Remarks:

○ Moisture Content: 7.0%

Soil Classes: Determined without liquid limit

USDA Class: Sand

Date tested: 5/18/2009

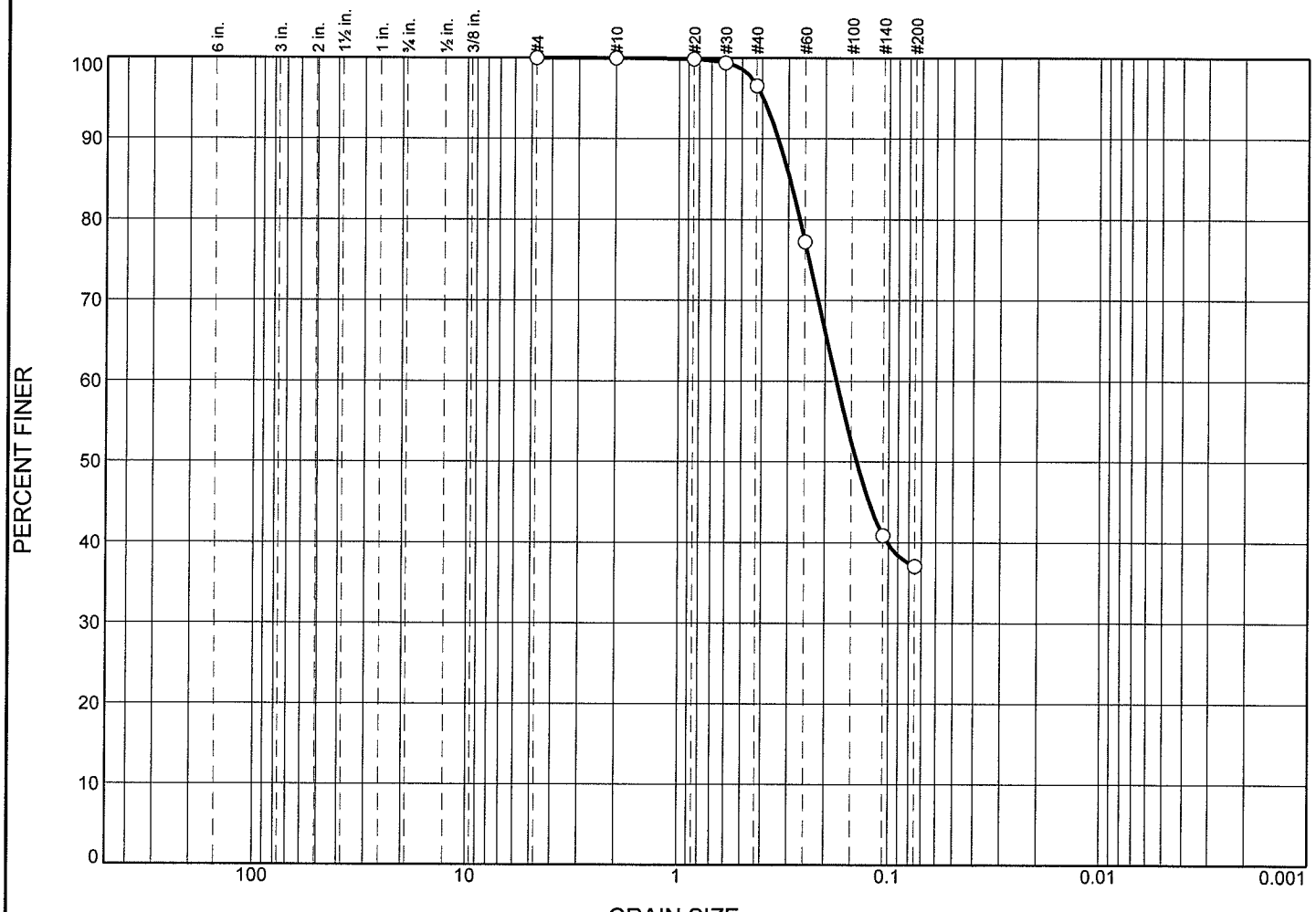
EBA Engineering, Inc.

Baltimore, MD

Figure

Tested By: RD **Checked By:** JK

Particle Size Distribution Report



	% +3"	% Gravel	% Sand	% Silt	% Clay
○	0.0	0.0	62.9	37.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NP	NP	0.2963	0.1767	0.1416					

Material Description	USCS	AASHTO
○ Gray and light brown silty sand	SM	A-4(0)

Project No. 2554Z2339 **Client:** Parsons IT & T

Project: NASA Shipping and Receiving Facility

○ **Source of Sample:** SWM-3 **Depth:** 1.0'-5.0' **Sample Number:** Bulk

Remarks:

○ Moisture Content: 23.8%

Date tested: 5/18/2009

EBA Engineering, Inc.

Baltimore, MD

Figure

Tested By: RD **Checked By:** JK

Appendix H
Supporting Calculations

Derivation of Seismic Site Classification

Boring B-10

Depth (ft)	N-Value	N_i	d_i	$\frac{d_i}{N_i}$
	1	11	2.5	0.23
	3.5	6	2.5	0.42
	6	5	2.5	0.50
	8.5	7	2.5	0.36
	11	10	2.5	0.25
	13.5	6	2.5	0.42
	16	22	2.5	0.11
	18.5	29	2.5	0.09
	21	44	2.5	0.06
	23.5	14	2.5	0.18
	26	38	2.5	0.07
	28.5	48	2.5	0.05
	31	53	2.5	0.05
	33.5	60	2.5	0.04
		60	65	1.08

$\sum d_i = 100$ ft 3.89 $= \sum \frac{d_i}{N_i}$

25.69 $= \overline{N}$

Seismic site Classification = D

(Eq 16-42) $$\overline{N} = \frac{\sum d_i}{\sum_{i=1}^{n} \frac{d_i}{N_i}}$$ IBC 2009

Derivation of Standard Deviation of SPT N-values by Subsurface Layer
NASA Shipping and Receiving Facility

Fill	Sand	Clay	
16	32	7	28
12	19	7	30
8	7	5	44
2	22	7	44
14	17	21	59
22	33	28	52
15	11	20	21
14	15	11	21
21	23	34	30
19	20	8	26
11	19	43	29
15	12	50	27
33	40	16	100
8	10	9	100
12	21	18	56
5	17	14	56
7	16	5	19
18	29	7	14
30	23	7	21
30	23	32	34
11	17	10	36
10	20	21	48
8	100	8	54
18	22	12	60
20	7	6	10
10	10	12	5
12	19	9	16
11	20	13	17
5	19	12	15
7	29	4	20
10	40	17	22
6	29	9	28
19	18	26	29
20	8	86	43
3	15	38	13
10	16	17	27
12	19	16	32
24	14	7	35
20	12	16	58
17	11	14	58
17	15	12	9
16	9	17	26
20	2	15	36
36	23	17	32
19	23	15	3
7	22	15	18
9	24	12	42
10	23	26	17
10	25	14	12
8	15	2	61
9	29	17	55
9	44	9	9
7	14	17	3
6	38	9	25
		21	20
		13	17
		21	30
		11	40
		19	17
			20
			30
			30

Statisical Summary			
Fill	**Sand**	**Clay**	
Count			
	54	**113**	**62**
Sum			
	748	**2144**	**1989**
Avg.			
	13.85	**18.97**	**32.08**
SD			
	7.47	**13.72**	**19.99**
95% Confidence Interval			
	1.99	**2.53**	**4.98**
(11.64, 16.06)	(16.44, 21.55)	(27.10, 37.06)	

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BEARING CAPACITY ANALYSIS OF SPREAD FOUNDATION

$q_{all} = 3{,}000$ psf $\qquad \gamma \cong 120$ pcf

$P_{MAX} = 300{,}000$ lbs (maximum column load)

$$B_{max} = \sqrt{\frac{P_{max}}{q_{all}}} = 10' \text{ square}$$

$$q_{ULT} = \gamma D N_q + \frac{\gamma B}{2} N_\gamma$$ NAVFAC DM 7.2 p 131

$N_\gamma = 20$ for $\phi = 32°$

$N_q = 20$ for $\phi = 32°$

$$q_{ULT} = (120)(1.0)(20) + \frac{120(10)(20)}{2} = 14{,}400 \text{ lbs}$$

Embedment

$FS = 4.81$ O.K.

$14{,}400/3000$

This analysis assumes granular compacted structural fill under the footings

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SETTLEMENT OF SHALLOW SPREAD FDN ON NEW STRUCTURAL FILL

$B_{max} = 10'$

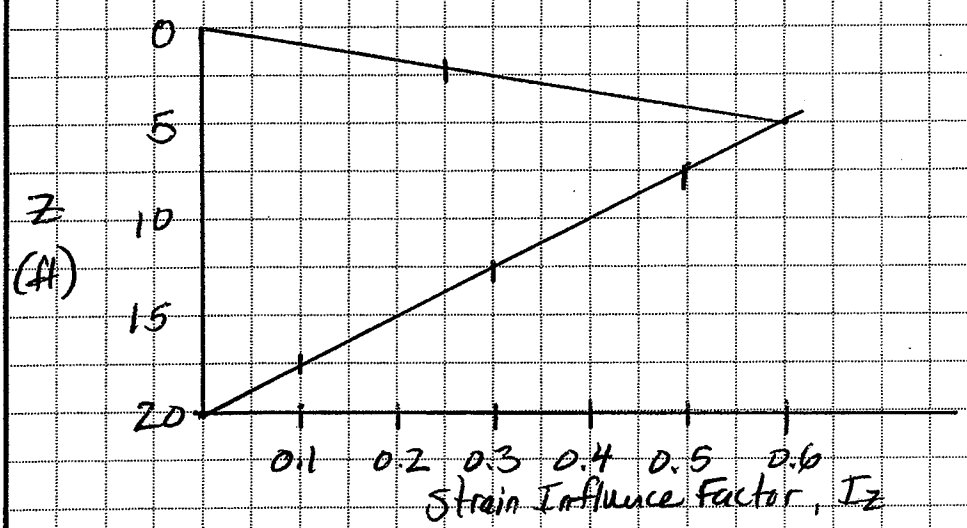
$q_{all} = 3$ ksf

$z = d =$ 0' – 15' New Structural Fill, SC or better N~10 bpf

15'+ Sand and/or clay, potomac group N=15 bpf

Use Schmertmann's Method NAVFAC DM 7.1 p 220, 221

Total settlement $= \Delta H = C_1 C_2 \Delta p \sum_0^{2B} \left(\frac{I_z}{E_s}\right) \Delta z$



Depth, z	Δz (in)	N	Es/N	Es	I_z	$\frac{I_z}{E_s}\Delta z$ (tsf)
0-5	60	10	7	70	0.25	0.214
5-10	↓	10	7	70	0.5	0.429
10-15		10	7	70	0.3	0.257
15-20		15	7	105	0.1	0.057
						0.957 in

$C_1 C_2 = 1.0$ $\Delta p = 1.44$ tsf $\Delta H = (1)(1.44)(0.957) = \boxed{1.38''}$

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ALLOWABLE BEARING CAPACITY OF DRILLED SHAFT

$Q_{ULT} = P_T N_q A_T$ (NAVFAC DM 7.2 p 193)

N_q = Bearing Capacity Factor = 21 for $\phi = 34^\circ$

P_T = effective vertical stress

$\gamma = 130$ pcf 0'-10'

$\gamma_b = 68$ >10'

$P_T = 10 \times 130 + 5 \times 68 = 1640$ psf

$q_{ULT} = P_T N_q A_T$

$= (1640)(21) = 34{,}440$

$FS = 34{,}440 / 10{,}000 = 3.4$ O.K.

use 10,000 psf bearing pressure

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SETTLEMENT OF DRILLED SHAFT

$\Delta H = W_s + W_{pp} + W_{ps}$ (NAVFAC pg 207)

W_s = elastic shortening $\cong 0$

W_{pp} = Settlement at pile point

W_{ps} = settlement along shaft $\cong 0$

$$W_{pp} = \frac{C_p Q_p}{B q_o}$$

C_p = coefficient depending on soil type $\cong 0.07$, Table 5 pg 208

Q_p = load at pile point (lbs)

B = shaft diam. (ft)

q_o = ultimate end bearing capacity (psf)

$$\Delta = W_{pp} = \frac{(0.07)(49{,}000)}{(2.5)(30{,}000)} = 0.045' = 0.55''$$

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DETERMINATION OF AUGER-CAST PILE TIP ELEVATIONS

Shipping and Receiving Building

P = 50, 75, 100 kips

D = Pile diameter = 10 inches

Soil Information (BORING B-5)

EL 180' > FILL
165 > Sand $N_{AVE} \sim 12$ bpf
157 — CLAY $N_{AVE} = 30$ bpf +

Shaft Resistance (ultimate) FHWA-SA-97-070 ~~P_G - allowable ultimate~~ α_{BOND}

SAND, loose to medium dense 70 KPa
CLAY, hard 160 KPa

Downdrag

New Fill EL 180'-183' $\gamma \sim 120$ pcf consider downdrag along top 12'

$\sigma_v' = 6 \times 120 = 720$ psf
$\sigma_h' = 0.5\,\sigma_v' = 360$ psf

$P_D = 360 \times 12 \times \pi D = 11{,}309$ lbs

$$L = \frac{P_G\text{-allowable} \times FS}{\alpha_{BOND} \times \pi D}$$

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Resistance from Sand Layer EL 157' to 165'

$$P_G\text{-allowable} = \frac{(L)(\sigma_{BOND})\,\pi D}{F.S.}$$

$$= \frac{(8')(70\ KPa \times 20.89\ KPa/psf)(\pi)(10/12)}{2.25}$$

$$= \boxed{13{,}611\ lbs}$$

Resistence from Clay Layer

$$L = \frac{P_G\text{-allowable} \times F.S.}{\sigma_{BOND} \times \pi D} \Rightarrow \frac{(L)(\sigma_{BOND})\,\pi D}{2.25}$$

$$= \frac{(1')(160\ KPa \times 20.89\ KPa/psf)(\pi)(10/12)}{2.25}$$

L = 3889 lbs / foot of embedment in clay layer

(4375 lbs/ft using F.S. = 2.0)

$$P = P_{allowable} + P_{DOWNDRAG}$$

$$P_1 = 100{,}000 + 11{,}309 = 111{,}309\ lbs$$

$$P_2 = 75{,}000 + 11{,}309 = 86{,}309$$

$$P_3 = 50{,}000 + 11{,}309 = 61{,}309$$

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Required Tip Elevations

For 100 kip Pile:

$$EL\,157' - \frac{(111{,}309 - 13611)}{3889} \cong \underline{EL\ 132 \text{ feet}}$$

For 75 kip Pile

$$EL\ 157' - \frac{(86\,309 - 13{,}611)}{3889} = \underline{EL\ 138'}$$

For 50 kip Pile

$$EL\ 157' - \frac{(61\,309 - 13611)}{3889} = \underline{EL\ 144'}$$

WAREHOUSE : Use Boring B-1

SURFACE	~ EL 180'
Fill	170'
SAND ~~CLAY~~	150'
CLAY	

34,029 lbs allowable shaft resistance

$P_1 = (111{,}309 - 34{,}029)/3889 = 19.87' \Rightarrow EL\ 150 - 20 = EL\ 130'$

$P_2 = (86{,}309 - 34{,}029)/3889 = 13.44' \Rightarrow 150 - 13 = 137'$

$P_3 = (61{,}309 - 34{,}029)/3889 \overset{107}{=} 7.01' \Rightarrow 150 - 7 = 143'$

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COMPRESSED GAS CYLINDER STORAGE BUILDING (B-10)

SURFACE 194' (i.e. all cut, no downdrag)

176' - 183' Fill

167 - 176 SAND

- 176' CLAY

$P_1 = 100{,}000$ lbs

$P_2 = 75{,}000$ lbs

$P_3 = 50{,}000$ lbs

$$P_{allowable\text{-}sand} = \frac{(9')(70\ KPa * 20.89\ KPa/psf)\,\pi\,(10/12)}{2.25}$$

$$= 15{,}313 \text{ lbs}$$

$L_1 = (100{,}000 - 15{,}313)/3889 = 21.77'$

$176 - 21.77 \cong$ EL 154'

$L_2 = (75{,}000 - 15{,}313)/3889 = 15.34$

$176 - 15.34 \sim$ EL 160'

$L_3 = (50{,}000 - 15{,}313)/3889 = 8.91'$

$176 - 8.9 = 167'$

PRODUCT 204-1 (Single Sheets) 205-1 (Padded)

5.D.3.1 Geotechnical Bond Length Tension And Compression Allowable Axial Load – SLD

$$P_{G\text{-allowable}} = \frac{\alpha_{\text{bond nominal strength}}}{FS} \times 3.14 \times DIA_{bond} \times (\text{bond length})$$

(L_b)

Use FS = 2.5 (soil or rock) for non-seismic load groups.

$$L_b = \frac{P_{G\text{-allowable}} \times FS}{\alpha_{bond\text{-nominal}} \times \pi \times DIA_{bond}}$$

5.D.3.2 Geotechnical Bond Length Tension And Compression Design Axial Strength – LFD

$$P_{G\text{-design strength}} = \varphi_G \times (\alpha_{\text{bond nominal strength}}) \times 3.14 \times DIA_{bond} \times (\text{bond length})$$

Use $\varphi_G = 0.60$ for typical designs for non-seismic load groups or calibrated to SLD as shown in section 5.C.

Use $\varphi_G = 1.0$ for seismic load groups.

5.D.4 Geotechnical End Bearing Capacity

Moderately loaded micropiles have been designed for end bearing on rock. The design may be done similar to end bearing drilled shafts or driven piles, or may be based on previous load test experience of similar micropiles.

5.D.5 Group Effect For Axially Loaded Micropiles

The design of foundation support systems incorporating micropiles may require the installation of groups of closely spaced piles. With conventional piles, depending on the pile type, installation method, and soil conditions, the capacity of a pile group can be significantly smaller and the settlement of the group larger than the capacity and settlement of a single pile under the same average load per pile in the group.

Table 5-2. Summary of Typical $\alpha_{\text{bond nominal strength}}$ Values (Grout-to-Ground Bond) for Preliminary Micropile Design that have been used in Practice.

Soil / Rock Description	Typical Range of Grout-to-Ground Bond Nominal Strengths (kPa)			
	Type A	Type B	Type C	Type D
Silt & Clay (some sand) (soft, medium plastic)	35-70	35-95	50-120	50-145
Silt & Clay (some sand) (stiff, dense to very dense)	50-120	70-190	95-190	95-190
Sand (some silt) (fine, loose-medium dense)	70-145	70-190	95-190	95- 240
Sand (some silt, gravel) (fine-coarse, med.-very dense)	95-215	120-360	145-360	145-385
Gravel (some sand) (medium-very dense)	95-265	120-360	145-360	145-385
Glacial Till (silt, sand, gravel) (medium-very dense, cemented)	95-190	95-310	120-310	120-335
Soft Shales (fresh-moderate fracturing, little to no weathering)	205-550	N/A	N/A	N/A
Slates and Hard Shales (fresh-moderate fracturing, little to no weathering)	515-1,380	N/A	N/A	N/A
Limestone (fresh-moderate fracturing, little to no weathering)	1,035-2,070	N/A	N/A	N/A
Sandstone (fresh-moderate fracturing, little to no weathering)	520-1,725	N/A	N/A	N/A
Granite and Basalt (fresh-moderate fracturing, little to no weathering)	1,380-4,200	N/A	N/A	N/A

Type A - Gravity grout only

Type B - Pressure grouted through the casing during casing withdrawal

Type C - Primary grout placed under gravity head, then one phase of secondary "global" pressure grouting

Type D - Primary grout placed under gravity head, then one or more phases of secondary "global" pressure grouting

5.E.1 Notation

C_c = column slenderness ratio (SLD and LFD)

DL = Design Load (SLD)

E_{steel} = modulus of elasticity of steel (SLD and LFD)

FS = factor-of-safety (SLD)

F_a = allowable axial unit stress (SLD)

F_a = nominal axial steel stress (LFD)

$f'_{c\text{-grout}}$ = compression strength of grout (SLD and LFD)

F_y = specified minimum yield point of steel (SLD and LFD)

K = effective length factor (see AASHTO for a table of values) (SLD and LFD)

L = actual unbraced length (SLD and LFD)

$P_{c\text{-allowable}}$ = allowable structural axial compression load (SLD)

$P_{t\text{-allowable}}$ = allowable structural axial tension load (SLD)

$P_{c\text{-nominal}}$ = nominal structural compression strength (LFD)

$P_{t\text{-nominal}}$ = nominal structural tension strength (LFD)

$P_{c\text{-design}}$ = design structural compression strength (LFD)

$P_{t\text{-design}}$ = design structural tension strength (LFD)

r = governing radius of gyration (SLD and LFD)

φ = strength reduction factor (LFD)

$\alpha_{\text{bond nominal strength}}$ = geotechnical unit grout-to-ground bond strength (SLD and LFD)

$P_{G\text{-allowable}}$ = allowable geotechnical bond axial load (SLD)

$P_{G\text{-design strength}}$ = geotechnical bond axial design strength (LFD)

$P_{\text{transfer allowable}}$ = cased bond length (plunge zone) allowable transfer load (SLD)

$P_{\text{transfer design}}$ = cased bond length (plunge zone) design strength (LFD)

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SETTLEMENT OF AUGER-CAST PILE

NAVFAC DM 7.2 p.207

$$\Delta H = W_{ps} + \cancel{W_{pp}}^{\,0}$$

W_{ps} = Settlement along pile shaft

W_{pp} = Settlement at pile point $\cong 0$

$$W_{ps} = \frac{C_s Q_s}{D q_o}$$

$$C_s = \left(0.93 + 0.16\sqrt{D/B}\right) C_p$$

$C_p = 0.07$

$D = EL181 - 146 = 35'$ ✓

$B = 10/12 = 0.83'$ ✓

$$C_s = \left(0.93 + 0.16\sqrt{35/0.83}\right)(0.07) = 0.138$$ ✓

$q_o = 30{,}000$ psf

$Q_s = 100{,}000$ lbs

$$W_{ps} = \frac{(0.138)(100{,}000)}{(35)(30{,}000)} = 0.013' = \boxed{0.158''}$$ ✓

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Table 4-1. Typical values of modulus of subgrade reaction

Types of Materials	Modulus of Subgrade Reaction, k, in lb/in³ for Moisture Contents of 1 to 4%	5 to 8%	9 to 12%	13 to 16%	17 to 20%	21 to 24%	25 to 28%	Over 29%
Silts and clays Liquid limit > 50 (OH, CH, MH)	--	175	150	125	100	75	50	25
Silts and clays Liquid limit < 50 (OL, CL, ML)	--	200	175	150	125	100	75	50
Silty and clayey sands (SM & SC)	300	250	225	200	150	—	—	--
Gravelly sands (SW & SP)	300+	300	250	—	—	—	—	--
Silty and clayey gravels (GM & GC)	300+	300+	300	250	—	—	—	--
Gravel and sandy gravels (GW & GP)	300+	300+	—	—	—	—	—	--

NOTE: k values shown are typical for materials having dry densities equal to 90 to 95 percent of the maximum CE 55 density. For materials having dry densities less than 90 percent of maximum CE 55 density, values should be reduced by 50 lb/in³, except that a k of 25 lb/in³ will be the minimum used for design.

Source: Army TM 5-809-12 (1987)

Table D.19. Worksheet for Calculating 18-kip Equivalent Single Axle Load (ESAL) Applications

Location Access Drive

Analysis Period = 20 **Years**

Assumed SN or D = 5

Vehicle Types	Current Traffic (A)	Growth Factors (B)	Design Traffic (C)	E.S.A.L. Factor (D)	Design E.S.A.L. (E)
Passenger Cars Buses		2% 24.3			
Panel and Pickup Trucks Other 2-Axle/4-Tire Trucks Box Trucks 2-Axle/6-Tire Trucks Dump Trucks 3 or More Axle Trucks All Single Unit Trucks	30 x 365 30 x 365	24.3 24.3	266,085	0.109 0.466	29,003 123,995
3 Axle Tractor Semi-Trailers 4 Axle Tractor Semi-Trailers Tractor/Trailer 5+ Axle Tractor Semi-Trailers All Tractor Semi-Trailers	30 x 365	24.3	266,085	1.08	287,371
5 Axle Double Trailers 6+ Axle Double Trailers All Double Trailer Combos					
3 Axle Truck-Trailers 4 Axle Truck-Trailers 5+ Axle Truck-Trailers All Truck-Trailer Combos					
All Vehicles				**Design E.S.A.L.**	440369

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Flexible Pavement Design (AASHTO 1993)

Design CBR = 5.0

Reliability = 90%

$S_o = 0.35$

W_{18} = 4.4 E5 for Acess Drive
4.4 E5 for North Loading Dock
3.3 E5 for Service Road

M_R = CBR x 1500 = 7,500 psi

Structural Number Determination from Nomograph Solution

Access Drive SN = 3.0
North Loading Area SN =
Service Road SN = 2.8

Access Drive / North Loading Area

drainage factor = 1.0 (good drainage)

$3.0 = a_1 d_1 + a_2 d_2 + a_3 d_3 m$
$(0.4)(2) + (0.4)(4) + (0.11)(8)(1)$
$= 3.28$

Service Road

$2.8 = (0.4)(2) + (0.4)(3) + (0.11)(8)(1)$
$= 2.88$

SUMMARY:	Access Drive / North Loading Area	Service Road
HMA	6"	5"
GAB	8"	8"

VI.B.1.3 HMA Mix Selection

Use the table to select the appropriate HMA Superpave mix based on the application of that mix in the pavement structure:

Lift Thickness				Mix Size	Design Application
Minimum	Preferred	Maximum	Total Maximum		
4.0"	5.0"	6.0"		37.5 mm	Base, Deep Patching
3.0"	3.5"	5.0"	10.5"	25.0 mm	Base, Patching
2.0"	2.5"	4.0"	9.0"	19.0 mm	Surface, Base, Patching
2.0"	2.5"	2.0"	2.5"	19.0 mm	GAP Graded
1.5"	2.0"	3.0"	6.0"	12.5 mm	Surface
1.5"	1.5"	2.0"	2.0"	12.5 mm	GAP Graded
1.0"	1.5"	2.0"	3.0"	9.5 mm	Surface, Leveling
1.0"	1.0"	1.5"	1.5"	9.5 mm	GAP Graded
0.5"	0.75"	0.75"	0.75"	4.75 mm	Surface, Rut Fill

VI.B.1.4 Number of ESAL Categories per Mix

One (1) ESAL category will be specified for each mix within a contract. Exceptions to this policy will be granted if the quantity of the mixes exceed 1,000 tons for each ESAL category. The Asphalt Team must approve any exception to this policy.

VI.B.1.5 Number of PG Binders per Contract

Two (2) PG binders will be specified as the maximum number of PG Binders allowable within a contract. If a minimum PG binder can be specified for a particular project, the contractor can provide a higher grade PG binder without objection. The temperature range for the PG Binder has to be the same or greater than that specified in the contract specifications.

VI.B.1.6 Number of HMA Mixes per Contract

At a maximum, the goal is to have three (3) HMA Superpave mixes per contract. Exceptions to this policy will be granted if the quantity of the mixes exceed 1,000 tons for HMA mix.

VI.B.1.7 Placement of Final Surface Material

The final surface layer shall be placed on a HMA Superpave 19.0 mm base layer or finer material when grinding is not included in the project. This surface layer policy also includes the placement of the surface layer over full-depth and partial-depth patch areas.

VI.B.2 Wearing Coarse Selection

The wearing coarse in an HMA pavement can vary depending on the existing site conditions, anticipated traffic conditions, and material availability. Some of the decisions made about the wearing coarse selection can greatly alter the cost of the materials in a particular project. For that reason and to provide a level of consistency through the state, material selection policies were developed for a wearing coarse.

Source: MDSHA Pavement Design Guide, 2002