National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23681-2199

Reply to Attn of: 12/Stubbs March 25, 2013

TO: ALL CONCERNED

FROM: M.T. Stubbs, Contracting Officer

SUBJECT: Solicitation NNL13467671E - Upgrades to Fire Station and Emergency Operations Center, Building 1248, Questions #1

1. The following questions have been submitted in response to the subject solicitation. The Government response is adjacent to each question.

2. The IFB response date remains unchanged.

MICHAEL STUBBS

Digitally signed by MICHAEL STUBBS
DN: c=US, o=U.S. Government, ou=NASA, ou=PIV, cn=MICHAEL STUBBS, 0.9.2342.19200300.100.1.1=mstubbs
Date: 2013.03.25 14:51:27 -04'00'

Michael T. Stubbs
Contracting Officer

NASA SOLICITATION NNL13467671E; UPGRADES TO FIRE STATION AND EMERGENCY OPERATIONS CENTER BUILDING

1. The following questions have been submitted regarding the subject solicitation. The Government's response follows each question.

ITEM NO.	**REFERENCE** (Section/Para//Page)	**QUESTION**	**GOVERNMENT RESPONSE**
1.	Drawings A-102, A-103 and A-401	The Kitchen, Room 136 and the Laundry, Room 237 both show appliances i.e. (3) refrigerators, (1) dishwasher, (1) range/oven, (1) clothes washer and (1) dryer. There is no specification for these items and no description on the drawings. Will these items be furnished and installed by the government? If they are to be furnished and installed by the contractor please provide additional information for pricing.	The kitchen appliances and washer and dryer are Not In Contract (NIC).
2.	Drawing A-401, Detail H/A-401	It appears that Detail H/A-401 should be labeled G/A-401 to correlate with the Enlarged Floor Plan 1/A-401. Please confirm.	The island base cabinet has elevations F & G shown – H/A-401 is a section (cut through F). The drawings are correct.
3.	Specification Section 095100, Part 2, Paragraph 2.1.1.a	Section 095100, Part 2, Paragraph 2.1.1a calls for a Type I ceiling tile. We have been informed that Type 1 has been discontinued. Per ASTM 1264, it should be a Type III. We also need a Form # and pattern, such as type III, Form 2, Pattern C or D. Also, the specs call for a very high NRC value of .75. Is this correct? Normally the NRC would be between .55 and .70. The cost of the tile is 2 to 3 times the normal cost.	Provide Type III, Form 2; Pattern C,D ,E; NRC 0.55; CAC 35; LR 0.75; Fire Class A.
4.	Specification Section 21 13 13.00 10, Paragraph 1.4.1	Specification section 21 13 13.00 10, Paragraph 1.4.1 states that work under this section is to be performed under the supervision and certified by the fire protection specialist (which is defined as a professional engineer with a minimum of five years experience dedicated to fire protection engineering) or a NICET IV technician. General Note 6 on Sheet F-101 states that the sprinkler system is to be designed by a registered professional engineer. Generally sprinkler system shop drawings are not required to be prepared by a professional engineer. Please confirm that the shop drawings for this project must be prepared and sealed by a registered professional engineer.	The specifications are correct, work can be done by a fire protection specialist (which is defined as a professional engineer with a minimum of five years experience dedicated to fire protection engineering) or a NICET IV technician.

ITEM NO.	**REFERENCE** (Section/Para//Page)	**QUESTION**	**GOVERNMENT RESPONSE**
5.	Drawing S-101	Note 2 on Drawing S-101 states to over-excavate up to a six foot depth below the existing site elevations and expose stable natural soils from below footings. It later states to refer to the Geotechnical Report for earthwork procedures, compaction and additional information. The Geotechnical Report is not included in the bid documents posted on FedBizOPPS. Please provide the Geotechnical Report prepared by ECS Mid-Atlantic, Dated March 2, 2012 (ECS Project No. 07:1446).	Report is attached.

SUBSURFACE EXPLORATION
AND GEOTECHNICAL ENGINEERING REPORT

SOIL BORING AND REPORT, B-1248
NASA LANGLEY RESEARCH CENTER
HAMPTON, VIRGINIA

FOR

Mr. William R. Rash
Jacob's Technology, Inc.
5 Manhattan Square
Hampton, Virginia 23666

March 2, 2012

ECS Project No. 07:11446

March 2, 2012

Mr. William R. Rash
Jacob's Technology, Inc.
5 Manhattan Square
Hampton, Virginia 23666

ECS Project No. 07:11446

Reference: Subsurface Exploration and Geotechnical Engineering Report
Soil Boring and Report, B-1248
Nasa Langley Research Center
Hampton, Virginia

Dear Mr. Rash:

ECS Mid-Atlantic, LLC (ECS) has completed a subsurface exploration and geotechnical engineering analysis for the referenced project. This study has been completed in general accordance with your authorization of our proposal No. 07:16022 dated January 31, 2012.

We have enjoyed being of service to you during the design and planning phase of this project. If you should have any questions regarding the information and recommendations contained in the accompanying report, or if we can be of further assistance, please do not hesitate to contact us.

Respectfully,

ECS Mid-Atlantic, LLC

Sara B. Phillips
Project Geologist

COMMONWEALTH OF VIRGINIA
W. LLOYD WARD
Lic. No. 034612
PROFESSIONAL ENGINEER

W. Lloyd Ward, P.E.
Principal Engineer

cc: - client via e-mail; Mr. Kirk Wolf via e-mail

SUBSURFACE EXPLORATION
AND GEOTECHNICAL ENGINEERING REPORT
SOIL BORING AND REPORT, B-1248
NASA LANGLEY RESEARCH CENTER
HAMPTON, VIRGINIA

TABLE OF CONTENTS

EXECUTIVE SUMMARY		**i**
1.0	**PROJECT OVERVIEW**	**1**
1.1	Scope of Work	1
1.2	Purposes of Exploration	2
1.3	Proposed Construction	2
2.0	**EXPLORATION PROCEDURES**	**2**
2.1	Subsurface Exploration Procedures	2
2.2	Laboratory Analysis Program	3
3.0	**EXPLORATION RESULTS**	**4**
3.1	Site Characteristics	4
3.2	Subsurface Conditions	4
3.3	Groundwater Observations	5
4.0	**ANALYSIS AND RECOMMENDATIONS**	**5**
4.1	Subgrade Preparation and Earthwork Operations	5
4.2	Foundation Recommendations	8
4.3	Floor Slab Recommendations	9
4.4	Seismic Design Recommendations	11
4.5	Construction Considerations	11
5.0	**CLOSING**	**12**

APPENDICES

APPENDIX I
Boring Location Plan
APPENDIX II
Boring Logs
APPENDIX III
Unified Soil Classification System
Reference Notes for Boring Logs
APPENDIX IV
Laboratory Testing Summary

REPORT

Subsurface Exploration and
Geotechnical Engineering Report

PROJECT

Soil Boring and Report, B-1248
Nasa Langley Research Center
Hampton, Virginia

PREPARED FOR

Mr. William R. Rash
Jacob's Technology, Inc.
5 Manhattan Square
Hampton, Virginia 23666

PREPARED BY

ECS Mid-Atlantic, LLC
108 Ingram Road, Unit 1
Williamsburg, Virginia 23188

ECS PROJECT NO.

07:11446

DATE

March 2, 2012

EXECUTIVE SUMMARY

This report contains the results of our subsurface exploration and geotechnical engineering analysis for the proposed Soil Boring and Report, B-1248 project, located at Nasa Langley Research Center in Hampton, Virginia.

The project will consist of the construction of a 2-story building addition to the existing building no. 1248. Floors will be supported as slabs-on-grade. The column and wall loads are not expected to exceed 50 kips and 3 kips per linear foot. Cuts and fills required to establish finished grades in the building addition area will be less than about 2 feet.

At the time of our field exploration the majority of the site was an open, grass covered area containing one asphalt drive lane on the northeast side of the existing building. Underground utilities are present across the project site.

Surface cover encountered at the boring locations included approximately up to 18 inches of topsoil/rootmat materials. Uncontrolled FILL materials ranging in depth from 2 to 6 ft in depth were encountered at the boring locations. The FILL materials were comprised of Clayey SAND (SC) with trace Gravel, Organics, and marine shell fragments. Underlying the near surface topsoil or FILL, the natural subsurface soils were arranged in a 2-layer configuration. The initial soil layer was granular in nature and consisted of Silty and Clayey SAND (SM and SC) with trace marine shell fragments and trace rounded Gravel to a depth of 13 feet below the existing site elevations. Standard Penetration Test (SPT) N-values for the granular materials ranged from 7 to 11 blows per foot (bpf), indicating a loose to medium dense relative density. The second and final soil layer was granular in nature and extended to the boring termination depth of 60 feet below the existing site elevations. This layer consisted of Silty SAND (SM) with trace Clay and marine shell fragments, which comprises the “Yorktown Formation.” The SPT N-values for the granular materials ranged from 4 to 11 bpf, indicating a very loose to medium dense relative density. Boring logs describing soil conditions encountered are included in Appendix II of this report.

The proposed building addition can be supported on shallow spread foundation systems, bearing on suitable undisturbed natural soils or on properly placed and compacted Engineered Fill. For planning purposes, a net allowable soil bearing pressure of 2,000 pounds per square foot (psf) can be used, assuming the minimum widths and embedment depth recommended herein are employed. In order to achieve this soil bearing pressure and limit foundation settlements to one inch or less, all existing FILL should be undercut from below footings such that they bear directly in approved natural subgrades or compacted and documented Engineered Fill. Detailed foundation design recommendations are provided in this report.

The first floor can be supported as a slab-on-grade bearing on approved natural soils or compacted and documented Engineered Fill. Test pits or hand augers should be performed at the time of construction to determine the content and extent of the FILL present on site. All existing FILL should be removed from the foundation excavations and replaced with Engineered Fill, VDOT gradation No 57 Stone, or Flowable Fill. Detailed floor slab-on-grade design recommendations are provided in this report.

Further information regarding the subsurface exploration procedures used; soil and groundwater conditions observed; recommended earthwork specifications; and design and construction recommendations for foundations and slabs-on-grade is included in the text of this report.

This summary briefly discusses some of the major topics mentioned in the attached report. Accordingly, this report should be read in its entirety to thoroughly evaluate the contents.

1.0 PROJECT OVERVIEW

The professional consulting services for this project were performed in accordance with your authorization of our proposal No. 07:16022 dated January 31, 2012. The boring locations were provided by the client's representative on-site at the time of our subsurface exploration. Our understanding of the project site and the proposed construction are outlined in the following sections.

1.1 Scope of Work

This subsurface exploration was completed on February 22, 2012, by advancing a total of two (2) soil borings to a depth of 60 feet below the existing site elevations within the lateral limits of the proposed building addition area. Appendix I presents the approximate location of the soil borings relative to the site layout. The horizontal locations of the soil test borings were marked in the field by the client's representatives. The boring locations were determined in the field as to avoid buried and overhead utilities, or other obstructions that prevented drill rig access to the boring location.

Our services included a site reconnaissance, a subsurface exploration with soil sampling and groundwater observations, laboratory testing of selected soil samples, and analyzing of the field and laboratory data to develop geotechnical engineering recommendations related to the design and construction of the project.

The engineering recommendations contained herein were developed from the data obtained from the soil test borings, which indicate subsurface conditions at these specific locations at the time of the exploration.

It is anticipated that the building addition will be of wood or steel frame construction with masonry bearing walls. Maximum column and wall loads are not expected to exceed approximately 50 kips and 3 kips/foot, respectively. In our professional opinion, the number and location of the soil test borings are sufficient to provide a reasonable evaluation of the subsurface soil and groundwater conditions of the site.

1.2 Purposes of Exploration

The purpose of this work was to explore the soil and groundwater conditions by completing soil test borings at discrete locations at the project site. The gathered data from this exploration was used to develop our engineering recommendations. This purpose was accomplished by:

- Advancing soil borings to investigate the subsurface soil conditions and identify the depth of groundwater.
- Completing laboratory tests on representative soil samples obtained from the borings to evaluate pertinent engineering properties.
- Analyzing the field and laboratory data to develop appropriate engineering recommendations to aid in the planning of earthwork requirements and the design of foundations and floor slabs.

1.3 Proposed Construction

The project will consist of the construction of a 2-story building addition to the existing building no. 1248, which is located in the southeast quadrant of the intersection of Langley Boulevard and E. Reid Street at Nasa Langley Research Center in Hampton, Virginia, containing roughly 14,000 square feet in plan area. Floors will be supported as slabs-on-grade. Cuts and fills required to establish finished grades in the building addition area will be less than about 2 feet.

2.0 EXPLORATION PROCEDURES

2.1 Subsurface Exploration Procedures

The soil borings were advanced with an ATV-mounted auger drill rig which utilized split spoon and mud rotary drilling techniques to advance the boreholes. Drilling services were provided by Fishburne Drilling, Inc. of Chesapeake, Virginia.

Representative samples were obtained from the soil borings by means of the split-barrel sampling procedure in accordance with ASTM Specification D 1586-99, (Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils). Soil samples were collected at 2 foot intervals to a depth of 10 feet bsg and at 5 foot intervals thereafter. In this procedure, a 2 inch O.D., split barrel sampler is driven into a soil a distance of 24 inches by a 140-pound hammer falling 30 inches,

using an automatic hammer. The first 6-inch depth increment is considered the seating interval. The number of blows required to drive the sampler through the next two 6-inch intervals is designated the Standard Penetration Test (SPT) N-value and is indicated for each sample on the boring logs. Individual Soil Boring Logs can be found in Appendix II, of this report. A copy of the Unified Soil Classification System (USCS) and Reference Notes for Boring Logs are included in Appendix III of this report.

After recovery, representative portions of each sample were removed from the sampler, visually classified and placed in sealed glass jars. A field log of the soils encountered in the soil test borings was maintained by ECS personnel and the drill crew. The samples were taken to our laboratory for classification in accordance with ASTM D 2488-00 (Standard Practice for Description and Identification of Soil (Visual-Manual Procedure)) and laboratory testing. The soil samples will be retained in our laboratory for a period of 60 days after the date of this report, after which, they will be discarded unless other written instructions are received as to their disposition.

2.2 Laboratory Analysis Program

A geologist from our office visually classified each soil sample from the test borings on the basis of texture and plasticity in accordance with the Unified Soil Classification System (USCS) and ASTM D 2488-00 (Description and Identification of Soils-Visual/Manual Procedures). The engineer grouped the various soil types into the major zones noted on the boring logs. The stratification lines designating the interfaces between earth materials on the boring logs are approximate; in situ, the transitions may be gradual. The group symbols for each soil type are indicated in parentheses following the soil descriptions on the boring logs.

Representative jar samples were selected and subjected to classification testing consisting of natural moisture content, gradation (including #200 wash), and Atterberg Limits testing and analysis.

3.0 EXPLORATION RESULTS

3.1 Site Characteristics

The proposed building addition will be located on the north side of the existing building no. 1248 at Nasa Langley Research Center in Hampton, Virginia. A site plan was obtained utilizing Google Earth aerial photography dated April 6, 2010.

At the time of our field investigation the majority of the site was an open, grass covered area containing one asphalt drive lane on the northeast side of the existing building. Underground utilities are present across the project site.

3.2 Subsurface Conditions

Each soil sample obtained from the soil test borings was classified on the basis of texture and plasticity in accordance with the Unified Soil Classification System (USCS). The group symbols for each soil type are indicated in parentheses following the soil descriptions on the boring logs. The various soil types were grouped into the major zones noted on the boring logs. The stratification lines designating the interfaces between subsurface materials on the boring logs are approximate; in-situ; the transitions may be gradual.

Surface cover encountered at the boring locations included approximately up to 18 inches of topsoil/rootmat materials. Uncontrolled FILL materials ranging in depth from 2 to 6 ft in depth were encountered at the boring locations. The FILL materials were comprised of Clayey SAND (SC) with trace Gravel, Organics, and marine shell fragments. Underlying the near surface topsoil or FILL, the natural subsurface soils were arranged in a 2-layer configuration.

The initial soil layer was granular in nature and consisted of Silty and Clayey SAND (SM and SC) with trace marine shell fragments and trace rounded Gravel to a depth of 13 feet below the existing site elevations. Standard Penetration Test (SPT) N-values for the granular materials ranged from 7 to 11 blows per foot (bpf), indicating a loose to medium dense relative density. The second and final soil layer was granular in nature and extended to the boring termination depth of 60 feet below the existing site elevations. This layer consisted of Silty SAND (SM) with trace Clay and marine shell fragments, which comprises the “Yorktown Formation.” The SPT N-values for the granular materials

ranged from 4 to 11 bpf, indicating a very loose to medium dense relative density. Boring logs describing soil conditions encountered are included in Appendix II of this report while a brief explanation of the USCS and Reference Notes for the Boring Logs is contained in Appendix III.

3.3 Groundwater Observations

Observations for groundwater were made during sampling and upon completion of the drilling operations at each boring location. The groundwater table was encountered at depths ranging from 7.5 to 8.0 feet below the existing site elevations.

It is noted that groundwater levels are influenced by seasonal conditions and periods of significant precipitation or prolonged drought. Based on the soil boring data and our experience with the geology of the project area, a perched groundwater is possible and noted on this site.

4.0 ANALYSIS AND RECOMMENDATIONS

4.1 Subgrade Preparation and Earthwork Operations

The site should be cleared by means of removing all topsoil or organic material, unsuitable FILL, (as determined by the geotechnical engineer), or any other unsuitable materials. The soil test borings encountered up to 18 inches of topsoil materials. It is recommended that the clearing operations extend laterally at least five feet beyond the proposed building addition limits. Allowing stockpiled topsoil and other unsuitable materials to be stored on building addition subgrades for extended periods of time may result in the deterioration of suitable subgrade materials. Stockpiled topsoil and excavated materials, planned for later use, should be placed in a proposed landscaped area, until they can be used as appropriate.

Any voids caused by the removal of Fill material should be backfilled, per the recommendations of the Geotechnical Engineer, which may include compacted Engineered Fill, No. 57 Stone, Flowable Fill, or lean mixed concrete. Existing abandoned underground utility pipe systems (if any) may become conduits for soil migration, and the backfill above them may be inadequately compacted. They should therefore be removed and the resulting excavations backfilled with compacted Engineered Fill.

Existing FILL soils should be evaluated through test pits or hand augers prior to construction to determine the suitability of the FILL for ground slab support. Existing FILL soils are considered unsuitable for new foundation support and should be removed from below all foundations.

After removing all unsuitable materials, cutting to the desired grade, and prior to Engineered Fill placement, subgrades should be observed by the Geotechnical Engineer or their qualified representative. Proofrolling of the subgrade should be accomplished using a loaded tandem axle dump truck having a weight of at least 20 tons to aid in identifying localized soft or unsuitable material. Any soft or unsuitable materials encountered during proofrolling should be removed and replaced with Engineered Fill or scarified, moisture conditioned, and recompacted to the minimum specifications given in this report.

Existing subgrades within the expanded building addition limits to a depth of at least 12 inches and subsequent lifts of Engineered Fill should be compacted to at least 95 percent of maximum dry density as determined per ASTM D698-07 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)). Loose lifts should not exceed 8 inches. Compaction should be accomplished with a large sheepsfoot roller for predominately clayey soil materials and/or a heavy vibratory drum roller for granular soil materials (or equivalent compacting equipment). The Fill should extend at least 10 feet beyond the building addition limits before being sloped to match existing grades. Fill and cut slopes should not be constructed steeper than 3H:1V.

We recommend stripping of any organic material, pavement, or unstable material. The stripping depth should be evaluated at the time of construction by representatives of the Geotechnical Engineer. If additional stripping becomes necessary, suitable methods should be employed to determine additional stripping depths beyond the contract depth (such as elevations determined before and after additional stripping, etc.). If undercuts are recommended and extend into large areas, the undercut volume could be reduced by the use of geotextiles or geogrids. The use of geosynthetic reinforcement should be evaluated by the geotechnical engineer. Cut and fill operations should extend a minimum of 5 feet beyond the project limits.

After stripping or cutting to the desired grade, and prior to fill placement, subgrades should be observed by the Geotechnical Engineer. In an effort to densify any loose surficial subgrade soils, the

stripped area should be proofolled with a smooth drum roller with a minimum of two passes in two perpendicular directions, provided in-situ moisture contents are within 3% of optimum in order to facilitate compaction.

Any soft or unsuitable materials encountered, which cannot be stabilized by reworking the soil, should be removed and replaced with an approved structural fill. Undercut volumes should be determined by cross-sectioning the area before and after undercut. We have found that calculating undercut volumes by truck counts is less accurate and generally results in additional expense to the owner. In order to minimize undercutting and issues during earthwork activities, we recommend earthwork operations be performed during the drier times of the year.

We recommend the contract documents include an allowance for undercutting and/or reworking soft near surface soils (if encountered) and replacement with engineered fill. Add/deduct unit prices should also be established so adjustment for the actual volume of undercut can be made.

The near surface Sandy soils can be reused if the soils are moisture conditioned to within +/-3% of the soils optimum moisture content and do not contain deleterious materials. On site soils to be re-used as structural fill and all proposed select fill soils should be submitted to the geotechnical engineer for approval prior to their use on the project. In the event import fill material is needed, we recommend import engineered fill (select) material consist of approved inorganic material classified as SM, SM-SP, SP, SW, SC or better containing less than about 40% by weight Silt or Clay and free of debris. This material should be placed in horizontal lifts not exceeding 8 inches in loose thickness, moisture conditioned to within +/- 3% of the optimum moisture content, and compacted to a minimum of 95% of the maximum dry density obtained in accordance with ASTM D-698, Standard Proctor method. Select fill slopes should be no greater than 3 horizontal to 1 vertical.

The following is an assessment of the fill materials considered suitable for use on this project:

On-Site Borrow Engineered Fill: Soil material classified as Sand (SM, SC, SP, SW or better) and free of organics, and other unsuitable material. Soils obtained on-site classified as Clay (CL) having a maximum Liquid limit of 40 and maximum Plasticity Index of 20 may also be used as Engineered Fill, if permitted in the final design documents.

Imported Engineered Fill: Granular soil material classified as Sand (SM, SM-SP, SC, SP, SW or better) containing a maximum 40% by weight passing the No. 200 Sieve (Silt or Clay). Imported Engineered Fill should be free of organics, debris, rubble, and other unsuitable material.

Porous Fill: well graded, clean granular material having a maximum aggregate size of 1.5 inches and no more than 5% passing the #200 Sieve (GW, GP, SW, SP). VDOT Size No. 57 Stone or ASTM C-33 washed concrete Sand are considered acceptable Porous Fill.

Foundation Undercut Backfill: VDOT gradation No.57 crushed stone or Flowable Fill with a minimum compressive strength of 200 psi at 28 days may be utilized for backfill beneath foundations. Footing undercut backfill should be placed under the observation of the Geotechnical Engineer.

Soils intended to be used as Engineered Fill should be thoroughly evaluated by the Geotechnical Engineer prior to placement. The evaluation should be performed per ASTM D2487-06 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

The ease with which suitable on-site soils can be used as Engineered Fill will depend upon their natural moisture contents at the time of construction. Scarifying and drying of the on-site soils may be required before recommended compaction can be achieved.

Drying and compaction of wet soils is typically difficult during the cold, winter months. Accordingly, earthwork should be performed during the warmer, drier times of the year, if practicable. Proper drainage should be maintained during the earthwork phases of construction to prevent ponding of water which has a tendency to degrade soil subgrades.

4.2 Foundation Recommendations

The proposed building addition can be supported on a shallow spread footing foundation system. Footings should be founded on suitable undisturbed natural soils or on newly compacted Engineered Fill. Footings can be designed for a net allowable bearing pressure of 2,000 psf. This bearing pressure provides a factor of safety of at least 3.0 against general shear failure. Minimum footing widths of 24 and 36 inches should be maintained for wall and column footings, respectively, for

general shear considerations. The bottom of all footings should be embedded at least 24 inches below final surrounding grade for frost protection and bearing capacity considerations.

FILL was observed in the proposed building addition area to a depth of up to 6 ft below the existing site elevations. It is recommended that all existing FILL be removed from the foundation excavations. If existing FILL is determined at the time of proofrolling inspection to be suitable for slab support and is therefore left in place, all foundation excavations should penetrate the FILL to expose stable natural soils. Isolated areas of soft, unsuitable, or otherwise deleterious material exposed in the footing excavations should be undercut and removed from below the footings. The footing can be lowered or footing grades can be restored by backfilling with VDOT Size No. 57 Stone or Flowable Fill having a minimum 28-day compressive strength of 200 psi. The bearing capacity at the final footing elevation should be verified in the field by the Geotechnical Engineer or their qualified representative to assure that the in-situ bearing capacity at the bottom of each footing excavation is adequate for the design loads recommended in this study.

Provided our recommendations outlined herein are followed, total foundation settlement is expected to be less than 1 inch. Differential settlement between similarly loaded footings is not expected to exceed ½ inch. This evaluation is based on our engineering experience of the soil conditions and the anticipated structural loading and is to guide the structural engineer with their design.

The footings should be constructed as structurally independent of floor slabs-on-grade as differential settlement between the slabs and foundations could occur. Where this is not possible, the footings should be thickened and reinforced as necessary. New footings should be positioned so as to avoid bearing above or in close proximity to any deep utilities or storm drains.

4.3 Floor Slab Design

The floor slab may be supported on suitable natural soils and/or new Engineered Fill. Slab subgrades should be re-worked to a depth of 8 inches and be re-compacted to 95% of the of Standard Proctor maximum dry density (ASTM D 698). Slab subgrades should be proofrolled by the Geotechnical Engineer or their qualified representative, remediated as required, and approved prior to Engineered Fill placement. Existing FILL should be evaluated to determine its suitability to remain in place below the floor slab. Approved existing FILL material should be re-worked and re-

compacted to achieve stability, as required. In the event that large areas of unstable and unsuitable subgrade are encountered, stabilization utilizing geotextile, geogrid, moderate undercutting or a combination of these remedial type measures could be considered under the advisement of the Geotechnical Engineer.

The building addition slab-on-grade should be directly supported by a minimum of 6 inches of Porous Fill. Porous Fill should consist of a well graded, clean granular material having a maximum aggregate size of 1.5 inches and no more than 5% passing the #200 Sieve (GW, GP, SW, SP). VDOT Size No. 57 Stone or ASTM C-33 washed concrete Sand are considered acceptable Porous Fill. As an alternate, a 6-inch layer of Aggregate Base Material, VDOT Type I, Size 21A can be employed beneath the slabs. This densely graded aggregate will help shed water and protect sensitive, underlying soils during wetter, winter weather. The Porous Fill layer will facilitate the fine grading of the subgrade, provide more uniform bearing conditions, and help minimize the rise of water to the bottom of the slab (capillary action). A vapor barrier consisting of at least a 6 mil polyethylene sheet should be placed on top of the Porous Fill in heated areas prior to the placement of concrete and lapped at least 6 inches. Floor slab subgrades should be recompacted immediately before placing the porous fill to repair any disturbance that may have occurred due to construction operations.

Provided the placement of Engineered Fill and Porous Fill is per the recommendations discussed herein, the slabs may be designed assuming a Modulus of Subgrade Reaction, K_S, of 200 psi per inch.

Thickened slab sections which support relatively lightly loaded walls need not contain the underslab Porous Fill layer provided soils exposed in the excavation bottoms are suitable and stable. However, their excavations should be prepared and, if necessary, undercut in the same manner as the footings.

We recommend that the floor slab be isolated from the foundation footings so differential settlement of the structure will not induce shear stresses in the floor slab. Where this is not possible, the footings should be thickened and reinforced as necessary. Also, in order to minimize the crack width of any shrinkage cracks that may develop near the surface of the slab, we recommend mesh

reinforcement be included in the design of the floor slab. The mesh should be within the top half of the slab to be effective.

4.4 Seismic Design Recommendations

In accordance with Section 1613.5.2 of the 2009 International Building Code and based on the information collected during the implementation of our subsurface exploration, the site is assigned an initial Site Class of E. This Site Class was determined using the N-Value method (which tends to be a more conservative method) from shallow borings and our experience in the area.

4.5 Construction Considerations

Exposure to the environment may weaken the soils at the footing bearing level if the foundation excavations remain open for too long a time. Therefore, foundation concrete should be placed the same day that excavations are made. If the bearing soils are softened by surface water intrusion or exposure, the softened soils must be removed from the foundation excavation bottom immediately prior to placement of concrete.

All Engineered Fill materials should be placed, compacted, and tested in accordance with the recommendations contained in this report. We recommend that all cut and fill operations be observed on a full-time basis by the Geotechnical Engineer or their qualified representative to determine if minimum earthwork and compaction requirements are being met.

In a dry and undisturbed state, the subgrade soils at the site will provide moderate subgrade support for Engineered Fill placement and construction operations. However, when wet, these soils will degrade quickly either with or without disturbance from contractor operations. Therefore, positive site drainage should be maintained during earthwork operations so as to help maintain the stability of the soil. We recommend that the design depths of stone be placed in the pavement areas early in the construction so as to help protect these subgrades. Any subgrades left exposed to precipitation will quickly degrade, regardless of the construction traffic exposure. Attempting site work during adverse seasonal conditions will have significant effect on the sitework budget as substantially more undercutting may be required. Ideally, earthwork should be performed during the summer or early fall (typically drier and warmer months).

5.0 CLOSING

If changes are made in the overall design or location of the building addition and other structures or if our assumptions differ significantly from the actual design, the recommendations presented in this report must not be considered valid unless the changes are reviewed by ECS and our recommendations are modified or verified in writing. We request the opportunity to review the foundation plan, grading plan, and applicable portions of the project specifications when the design is finalized. This review will allow us to ascertain whether these documents are consistent with the intent of our recommendations.

This report has been prepared for the exclusive use of Jacob's Technology, Inc., its affiliates and subsidiaries and their successors, assigns, and grantees and their designers for specific application to the project described herein. Our conclusions and recommendations have been rendered in a manner consistent with the level and skill ordinarily exercised by members of the geotechnical engineering profession in the Commonwealth of Virginia. No other warranty is expressed or implied.

Our conclusions and recommendations are based on design information furnished to us and our experience with similar projects. They do not necessarily reflect variations in the subsurface conditions, which can occur between borings or in unexplored areas of the site, due to geologic characteristics of the region or past land use. Should such variations become apparent during construction, it will be necessary to reevaluate our conclusions and recommendations based upon site observations of the conditions.

Field observations, monitoring, and quality assurance testing during earthwork and foundation installation are an extension of and integral to the geotechnical design recommendation. We recommend that the owner retain these services and we be allowed to continue our involvement throughout these phases of construction. ECS is not responsible for the conclusions, opinions or recommendations of others based on the data in this report.

APPENDICES

APPENDIX I	**Boring Location Plan**
APPENDIX II	**Boring Logs**
APPENDIX III	**Unified Soil Classification System and Reference Notes for Boring Logs**
APPENDIX IV	**Laboratory Testing Summary**

Appendix I

Boring Location Plan

N
W E
S

LEGEND

- Approximate Boring Location

SCALE

NTS

SOURCE

Google Earth

Dated: 04/6/2010

ECS LLC
MID-ATLANTIC

FIGURE 1

BORING LOCATION PLAN
Soil Boring and Report, B-1248
Nasa Langley Research Center
Hampton, Virginia

ECS PROJECT NO. 07:11446

Appendix II

Boring Logs

CLIENT	JOB #	BORING #	SHEET
Jacobs Technology, Inc.	11446	B-1	1 OF 2

PROJECT NAME: Soil Boring and Report, B-1248

ARCHITECT-ENGINEER:

SITE LOCATION: Nasa Langley Research Center

CALIBRATED PENETROMETER TONS/FT^2: 1 2 3 4 5+

PLASTIC LIMIT — WATER CONTENT % — LIQUID LIMIT %

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — REC.% ——— 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT: 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION

SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	BLOWS/6"	STANDARD PENETRATION BLOWS/FT
1	SS	24	24	18 inches of Topsoil	1 3 4	7
2	SS	24	24	Clayey Fine to Medium SAND, Trace Gravel, Organics, and Marine Shell Fragments, Brown and Black and Orangish Brown, Moist, Loose, (FILL)	5 6 4	9
3	SS	24	24		5 5 3	8
4	SS	24	24	Clayey Fine to Medium SAND, Trace Marine Shell Fragments, Orangish Brown, Moist, Loose, (SC)	4 4 4	10
5	SS	24	24	Silty Fine to Medium SAND, Trace Trace Clay and Rounded Gravel and Marine Shell Fragments, Dark Gray and Tannish Brown, Moist to Wet, Loose, (SM)	5 5 5	10
6	SS	24	24	Silty Fine to Medium SAND, Trace Clay and Marine Shell Fragments, Dark Gray, Wet, Loose to Medium Dense, (SM), "Yorktown Formation"	5 4 6	5
7	SS	24	24		4 6 2	39.3 / 4
8	SS	24	24		2 3 4	9
9	SS	24	24		2 2 2	7
10	SS	24	24		3 4 5	9
11	SS	24	24		4 3 4	6
12	SS	24	24		3 3 5	8

WATER LEVELS — ELEVATION (FT)

CONTINUED ON NEXT PAGE.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 7.5' WS ☐ WD ☐	BORING STARTED 2/22/2012	
WL(BCR) WL(ACR)	BORING COMPLETED 2/22/2012	CAVE IN DEPTH 14.0'
WL	RIG ATV FOREMAN Tim Foster	DRILLING METHOD Rotary Wash "Mud" Drilling

CLIENT	JOB #	BORING #	SHEET
Jacobs Technology, Inc.	11446	B-1	2 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Soil Boring and Report, B-1248	

SITE LOCATION

Nasa Langley Research Center

CALIBRATED PENETROMETER TONS/FT^2: 1 2 3 4 5+

PLASTIC LIMIT — WATER CONTENT % — LIQUID LIMIT %

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — REC.% — 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT: 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT
48	13	SS	24	24	Silty Fine to Medium SAND, Trace Clay and Marine Shell Fragments, Dark Gray, Wet, Loose to Medium Dense, (SM), "Yorktown Formation"			2 3 4 4	7
	14	SS	24	24				4 4 5 5	9
56	15	SS	24	24				4 6 5 6	11
64									
72									
80									
88									
96									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 7.5' WS ☐ WD ☐	BORING STARTED 2/22/2012	
WL(BCR) WL(ACR)	BORING COMPLETED 2/22/2012	CAVE IN DEPTH 14.0'
WL	RIG ATV FOREMAN Tim Foster	DRILLING METHOD Rotary Wash "Mud" Drilling

CLIENT	JOB #	BORING #	SHEET
Jacobs Technology, Inc.	11446	B-2	1 OF 2

PROJECT NAME	ARCHITECT-ENGINEER
Soil Boring and Report, B-1248	

SITE LOCATION

Nasa Langley Research Center

CALIBRATED PENETROMETER TONS/FT^2: 1 2 3 4 5+

PLASTIC LIMIT — WATER CONTENT % — LIQUID LIMIT %

ROCK QUALITY DESIGNATION & RECOVERY: RQD% 20% 40% 60% 80% 100% — REC.%

STANDARD PENETRATION BLOWS/FT: 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	BLOWS/6"	STANDARD PENETRATION BLOWS/FT
0	1	SS	24	24	3 inches of Topsoil Clayey Fine to Medium SAND, Trace Gravel, Organics, and Marine Shell Fragments, Gray and Orangish Brown, Moist, Loose to Medium Dense, (FILL)	4 3 3 4 5 7 8	6, 15
	2	SS	24	24		7 4 6	12
	3	SS	24	24		6 8 3	20.3
	4	SS	24	24	Silty Fine to Medium SAND, Trace Clay and Rounded Gravel and Marine Shell Fragments, Dark Gray and Tannish Brown, Moist to Wet, Medium Dense to Loose, (SM)	4 7 5	11
8	5	SS	24	24		4 4 6	10
	6	SS	24	24	Silty Fine to Medium SAND, Trace Clay and Marine Shell Fragments, Dark Gray, Wet, Loose to Medium Dense, (SM), "Yorktown Formation"	7 3 4	9
16						5 6 4	
	7	SS	24	24		3 3 3	6
24	8	SS	24	24		4 5 4	9
	9	SS	24	24		4 4 3	6
32						3 4	
	10	SS	24	24		3 4 3	7
	11	SS	24	24		6 4 6	11
40						5 5	
	12	SS	24	24		4 3 5	8
48						4	

CONTINUED ON NEXT PAGE.

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL 8.0' WS ☐ WD ☐	BORING STARTED 2/22/2012	
WL(BCR) WL(ACR)	BORING COMPLETED 2/22/2012	CAVE IN DEPTH 10.0'
WL	RIG ATV FOREMAN Tim Foster	DRILLING METHOD Rotary Wash "Mud" Drilling

CLIENT	JOB #	BORING #	SHEET
Jacobs Technology, Inc.	11446	B-2	2 OF 2
PROJECT NAME	ARCHITECT-ENGINEER		
Soil Boring and Report, B-1248			
SITE LOCATION			
Nasa Langley Research Center			

CALIBRATED PENETROMETER TONS/FT^2: 1 2 3 4 5+

PLASTIC LIMIT — WATER CONTENT % — LIQUID LIMIT %

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — REC.% — 20% 40% 60% 80% 100%

STANDARD PENETRATION BLOWS/FT: 10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT
48	13	SS	24	24	Silty Fine to Medium SAND, Trace Clay and Marine Shell Fragments, Dark Gray, Wet, Loose to Medium Dense, (SM), "Yorktown Formation"			4 3 5 6	8
	14	SS	24	24				4 4 4 6	8
56	15	SS	24	24				5 6 5 5	11
64									
72									
80									
88									
96									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

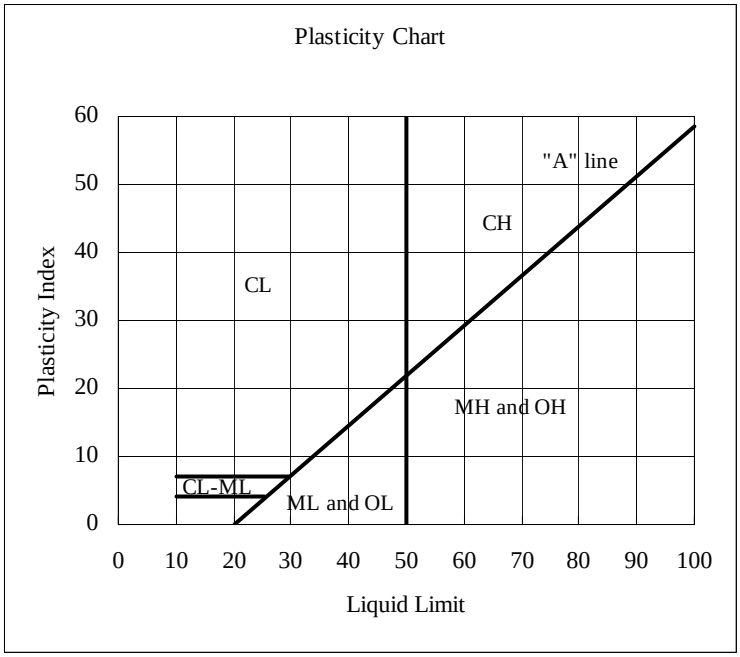
WL 8.0' WS ☐ WD ☐	BORING STARTED 2/22/2012	
WL(BCR) WL(ACR)	BORING COMPLETED 2/22/2012	CAVE IN DEPTH 10.0'
WL	RIG ATV FOREMAN Tim Foster	DRILLING METHOD Rotary Wash "Mud" Drilling

Appendix III

Unified Soil Classification System
Reference Notes for Boring Logs

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is larger than No. 200 Sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP; More than 12 percent GM, GC, SM, SC; 5 to 12 percent Borderline cases requiring dual symbols [b]	$C_u = D_{60}/D_{10}$ greater than 4 $C_c = (D_{30})^2/(D_{10} x D_{60})$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM[a]	d	Silty gravels, gravel-sand mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line or P.I. less than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = D_{60}/D_{10}$ greater than 6 $C_c = (D_{30})^2/(D_{10} x D_{60})$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a]	d	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or P.I. less than 4	Limits plotting in CL-ML zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 Sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly Organic soils		Pt		Peat and other highly organic soils			



[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC,well-graded gravel-sand mixture with clay binder. (From Table 2.16 - Winterkorn and Fang, 1975)

REFERENCE NOTES FOR BORING LOGS

I. Drilling Sampling Symbols

SS	Split Spoon Sampler	ST	Shelby Tube Sampler
RC	Rock Core, NX, BX, AX	PM	Pressuremeter
DC	Dutch Cone Penetrometer	RD	Rock Bit Drilling
BS	Bulk Sample of Cuttings	PA	Power Auger (no sample)
HSA	Hollow Stem Auger	WS	Wash sample
REC	Rock Sample Recovery %	RQD	Rock Quality Designation %

II. Correlation of Penetration Resistances to Soil Properties

Standard Penetration (blows/ft) refers to the blows per foot of a 140 lb. hammer falling 30 inches on a 2-inch OD split-spoon sampler, as specified in ASTM D 1586. The blow count is commonly referred to as the N-value.

A. Non-Cohesive Soils (Silt, Sand, Gravel and Combinations)

Density		*Relative Properties*	
Under 4 blows/ft	Very Loose	Adjective Form	12% to 49%
5 to 10 blows/ft	Loose	With	5% to 12%
11 to 30 blows/ft	Medium Dense		
31 to 50 blows/ft	Dense		
Over 51 blows/ft	Very Dense		

Particle Size Identification		
Boulders		8 inches or larger
Cobbles		3 to 8 inches
Gravel	Coarse	1 to 3 inches
	Medium	½ to 1 inch
	Fine	¼ to ½ inch
Sand	Coarse	2.00 mm to ¼ inch (dia. of lead pencil)
	Medium	0.42 to 2.00 mm (dia. of broom straw)
	Fine	0.074 to 0.42 mm (dia. of human hair)
Silt and Clay		0.0 to 0.074 mm (particles cannot be seen)

B. Cohesive Soils (Clay, Silt, and Combinations)

Blows/ft	*Consistency*	*Unconfined Comp. Strength Q_p (tsf)*	*Degree of Plasticity*	*Plasticity Index*
Under 2	Very Soft	Under 0.25	None to slight	0 – 4
3 to 4	Soft	0.25-0.49	Slight	5 – 7
5 to 8	Medium Stiff	0.50-0.99	Medium	8 – 22
9 to 15	Stiff	1.00-1.99	High to Very High	Over 22
16 to 30	Very Stiff	2.00-3.00		
31 to 50	Hard	4.00–8.00		
Over 51	Very Hard	Over 8.00		

III. Water Level Measurement Symbols

WL	Water Level	BCR	Before Casing Removal	DCI	Dry Cave-In
WS	While Sampling	ACR	After Casing Removal	WCI	Wet Cave-In
WD	While Drilling	▽	Est. Groundwater Level	▼	Est. Seasonal High GWT

The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in a granular soil. In clay and plastic silts, the accurate determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally applied.

Appendix IV

Laboratory Testing Summary

Engineering Consulting Services Mid Atlantic LLC

Williamsburg, VA

Laboratory Testing Summary

Date: 3/2/2012

Project Number: 11446 **Project Name:** Soil Boring and Report, B-1248

Project Engineer: SBP **Principal Engineer:** WLW **Summary By:** JMC

Boring Number	Sample Number	Depth (Feet)	Moisture Content (%)	USC	Liquid Limit	Plastic Limit	Plasticity Index	Percent Passing No. 200 Sieve	Compaction		CBR Value	Other
									Maximum Density (pcf)	Optimum Moisture (%)		
B-1	7	18-20	39.3	SM	*	*	*	22.2	*	*	*	
B-2	4	6-8	20.3	SM	NP	NP	NP	30.3	*	*	*	

Summary Key:

V = Virginia Test Method
S = Standard Proctor
M= Modified Proctor

Hyd = Hydrometer
Con = Consolidation
DS = Direct Shear
GS = Specific Gravity

UCS = Unconfined Compression Soil
UCR = Unconfined Compression Rock
LS = Lime Stabilization
CS = Cement Stabilization

OC = Organic Content
SA = See Attached
NP = Non Plastic
* = Test Not Conducted