R.W. Gillespie & Associates, Inc.
Geotechnical Engineering • Environmental Consulting • Materials Testing Services

08 January 2015

David C. Webster, AIA, LEED AP, Principal
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Subject: Geotechnical Evaluation
Proposed Parking Garage
AE Renovate Parking Garage VAMC WR
VA Medical Center, West Roxbury Healthcare System
West Roxbury, Massachusetts
RWG&A Project No. 0435-010

Dear Mr. Webster:

R. W. Gillespie & Associates, Inc., (RWG&A) is pleased to present the attached *Report of Geotechnical Evaluation for the proposed AE Renovate Parking Garage VAMC WR* in West Roxbury, Massachusetts. This work was performed in general accordance with RWG&A's Proposal No. P-8553.GIENV, Modification No. 2, dated 19 March 2014. RWG&A's scope of services for the project included preparation of an environmental site assessment by OHI Engineering, Inc., as a subconsultant to RWG&A. The environmental site assessment report, dated 05 December 2014, has been transmitted separately.

RWG&A previously made preliminary geotechnical evaluations for the proposed parking garage at other locations on the West Roxbury campus. Results of that work were provided in the RWG&A report titled, *Report of Preliminary Geotechnical Evaluation for AE Renovate Parking Garage VAMC WR VA Medical Center, West Roxbury Healthcare System West Roxbury, MA*, dated 25 April 2014. Based, in part, on the preliminary geotechnical evaluation report, the Veterans Affairs Medical Center West Roxbury selected a location for the proposed parking garage in the Building 2 parking lot that is the subject of the attached report.

RWG&A appreciates the opportunity to be of service on this most needed project. If there are any questions regarding the attached report or if RWG&A can be of further service, then please do not hesitate to contact us.

Sincerely,
R. W. GILLESPIE & ASSOCIATES, INC.

Charles R. Nickerson, P.E.
Principal Geotechnical Engineer

CRN:md
In duplicate

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R.W. Gillespie & Associates, Inc.

Report
of
GEOTECHNICAL EVALUATION
AE RENOVATE PARKING GARAGE VAMC WR
VA MEDICAL CENTER, WEST ROXBURY HEALTHCARE SYSTEM
WEST ROXBURY, MASSACHUSETTS

Prepared
for
PDT ARCHITECTS
PORTLAND, MAINE

Prepared
by
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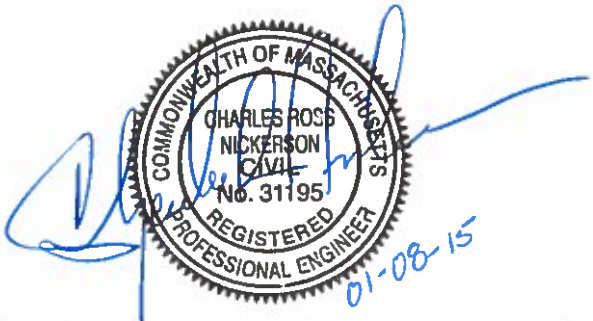

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RWG&A Project No. 0435-010

08 January 2015

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1.0 INTRODUCTION

1.01 Background

This report provides final geotechnical evaluations for a proposed multi-story parking garage at 1400 VFW Parkway in West Roxbury, Massachusetts, as illustrated on Figure 1, *Locus Map*. R.W. Gillespie & Associates, Inc.'s (RWG&A's) understanding of the proposed parking garage and requested scope of services was based on the Request for Proposal VA-241-1-R-0369 (RFP) dated 01 March 2013, communications with Veterans Affairs (VA), PDT Architects, and Becker Structural Engineers, Inc., review of subsurface information for existing facilities, site visits, design team meetings, and review of *60% Design Development* drawings dated 21 November 2014 by PDT Architects.

RWG&A previously made preliminary geotechnical evaluations for the proposed parking garage at locations on the north and south sides of the West Roxbury site. Results of that work were provided in the report titled, *Report of Preliminary Geotechnical Evaluation for AE Renovate Parking Garage VAMC WR VA Medical Center, West Roxbury Healthcare System West Roxbury, MA*, dated 25 April 2014. Based on the preliminary geotechnical evaluations of subsurface conditions, associated foundation considerations, and other project design issues, the Veterans Affairs Medical Center West Roxbury (VAMC WR) selected a location for the proposed parking garage in the Building 2 parking lot that is the subject of this report.

1.02 Scope of Services

Geotechnical evaluations were performed to develop site-specific subsurface soil, bedrock, and groundwater information, and to make foundation recommendations for the proposed parking garage. The scope of services included preparation of an environmental Phase I Environmental Site Assessment by OHI Engineering, Inc., (OHI) as a subconsultant to RWG&A. The OHI environmental report, titled, *Phase I Environmental Site Assessment Update 1400 Veterans of Foreign Wars Parkway West Roxbury, MA*, dated 05 December 2014 has been transmitted separately.

As performed, RWG&A's scope of services for this Phase of the project included the following items:

B1. Prepared a geotechnical subsurface exploration and environmental sampling program to obtain specific subsurface information.

B2. Marked the test boring locations in the field by tape and survey methods from features visible at ground surface. Contacted DigSafe and non-DigSafe member utilities to verify boring and probe locations did not conflict with underground utilities.

B3. Arranged to have the explorations drilled by New England Boring Contractors, as a subcontractor to RWG&A. OHI provided technical monitoring of exploration activities so that depths, locations, and sampling could be modified in response to the subsurface conditions encountered.

B4. OHI selected soil samples for environmental analytical testing. Soil samples were selected where PID/FID readings were high, and/or where staining and odors were observed. Environmental samples were delivered by OHI to a US EPA/MassDEP approved, fixed-based laboratory.

B5. Retained the services of OHI to evaluate analytical testing results relative to regulatory standards established by the Massachusetts Department of Environmental Protection policy COMM-97-01.

B6. Conducted final geotechnical evaluations of the proposed construction, for the VA selected parking garage location in the Building 2 parking lot. Emphasis was placed on site preparation alternatives, foundation depth, soil supported spread footings and slabs-on-grade ground floors, seismic site class, lateral load resistance, foundation drainage, and construction considerations.

B7. Prepared this report of final geotechnical evaluations presenting the findings, conclusions, and recommendations for design and construction the proposed parking garage.

B8. Electronically transmitted this final report of geotechnical evaluation to PDT Architects in Adobe® PDF format and mailed two printed reports via USPS.

B9. Attended project meetings with the design team regarding at VAMC WR.

2.0 SUBSURFACE EXPLORATION

2.01 Subsurface Explorations for Selected Parking Garage Location

The subsurface exploration program for the selected parking garage location included five test borings (designated B101 through B105) and four driven probes (designated P101 through P104) advanced to depths of about 10 to 40 feet below ground surface. Figure 2, *Exploration Location Plan*, shows the approximate locations of the test borings and probes. The test borings and probes were drilled on 06 October 2014 through 08 October 2014 by New England Boring Contractors of Derry, New Hampshire, using a truck-mounted drill rig.

Split-barrel sampling with standard penetration testing (*ASTM D1586, Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*) was generally performed continuously in the test borings and probes until naturally deposited inorganic soil was encountered, and then at about 5-foot intervals in the test borings to the total exploration depths drilled. The test borings were advanced with drive-casing and wash methods; casing blows are provided on the test boring logs. The probes were advanced using a split-barrel sampler and 140-pound drop weight falling about 30-inches.

Exploration activities were coordinated by RWG&A, and the test borings and probes were sampled and logged by OHI. RWG&A reviewed and revised the OHI test boring and probe logs for the purposes of this geotechnical investigation. The (geotechnical) exploration logs were based on field observations, the OHI (environmental) exploration logs, and review of collected soil samples. The

soil descriptions used on the test boring and probe logs in Appendix A are in general accordance with *ASTM D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).*

Stratification lines shown on the exploration logs represent the estimated boundaries between the different soil types encountered; the actual transitions will be more gradual and vary over short distances. Subsurface information should only be considered representative of subsurface conditions encountered within the vertical reach of the explorations and on the dates the explorations were made.

A groundwater observation well was installed in the completed borehole for B105. The observation well was constructed with 2-inch diameter PVC pipe. The total depth of the well was about 20 feet with a 3-foot machine-slotted screen from a depth of about 17 to 20 feet below ground surface. The annulus between the borehole and PVC pipe was backfilled with #2 quartz filter sand from a depth of about 20 to 11 feet, and then with bentonite from about 11 to 8 feet to seal the screen in the soils underlying the anticipated foundation excavation depth. The observation well was backfilled with cuttings from a depth of about 8 feet to ground surface. A roadway box was installed to protect the well from surface water infiltration at the asphalt paved ground surface. Subsequent to the installation of the observation well, the parking lot was repaved in selected areas including the location of B105-OW; the top of the roadway box was exposed so that water level measurements could be made. The well installation detail with water level readings is presented in Appendix B.

Exploration locations were marked in the field by representatives of RWG&A by taping and/or pacing from identifiable site features prior to drilling. Locations and elevations should be considered accurate only to the degree implied by the methodology used to determine them. It is recommended that as-drilled exploration locations and associated ground surface elevations be surveyed. The locations and elevations of the explorations will need to be shown on construction drawings.

2.02 Previous Subsurface Explorations

Test borings and probes were made for the preliminary geotechnical evaluation of the proposed parking garage at four optional locations on the West Roxbury Campus. The selected location for the parking garage is about 200 feet west of the closest of the four optional locations considered. Logs of recent and past subsurface explorations made near the four optional locations are presented in the 25 April 2014 RWG&A report of preliminary geotechnical evaluation. Logs of the recent test borings and probes designated B-03-14, P-3, P-4 and P-6, which were made near the selected parking garage location, are presented in Appendix C of this report.

Subsurface information from past soil and foundation studies at VAMC WR provided by VA is presented in Appendix D. This information consists of subsurface exploration logs dated 1983 (designated A-10) and 1984 (designated G-1 and G-2). The past subsurface information is presented for informational purposes only. RWG&A is unable to ensure the locations, accuracy or completeness of the provided subsurface information, either because doing so is impossible, or because errors and omissions others may have committed when assembling the information.

RWG&A does not accept responsibility for the use, interpretation, or accuracy of information prepared by others.

3.0 GEOTECHNICAL LABORATORY TESTING

Laboratory testing was performed to assist in soil description and estimation of engineering properties of encountered soils. The laboratory testing program included three organic content and three moisture content determinations. The tests were performed in general accordance with the following methods:

- *ASTM D2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*
- *AASHTO T-267, Standard Test Method for Determination of Organic Content of Soils by Loss on Ignition.*

The test results with the subsurface exploration designation, sample numbers, and depth intervals of the marsh peat and organic silt samples are listed below.

Exploration Designation	B102	B104	P104
Sample Number	S-4	S-4	S-3
Sample Depth Interval (feet)	7 to 9	7 to 9	9 to 10
Moisture Content (percent)	246	78	130
Organic Content (percent)	197	32	45

Results of the laboratory tests are also presented on the exploration logs in Appendix A. All tests were conducted at the RWG&A soil and materials testing laboratory in Saco, Maine, which is accredited by the American Association of State Highway and Transportation Officials (AASHTO) for the tests performed.

4.0 SUBSURFACE CONDITIONS

Subsurface soils, bedrock and groundwater encountered in the subsurface explorations at and near the selected parking garage location are summarized below. See the exploration logs presented in Appendices A, C, and D for descriptions at particular locations and depths.

4.01 Subsurface Soils

The encountered thickness of the asphalt pavement was typically about 4 inches when the recent explorations were drilled at the selected garage location. Beneath the asphalt pavement, the test borings and probes encountered aggregate base/subbase materials over common fill. The common fill covers a layer of marsh peat and organic silt that overlies alluvial and glacial fluvial soils underlain by glacial till, all over bedrock; individual soil units were not encountered in some of the explorations. Interpreted thickness and classifications of the soil units are presented in the attached

Table. Due to limitations in the interpretation of drilled subsurface explorations, estimated thicknesses and depth ranges of the soil units provided below should be anticipated to be accurate to a tolerance of about one foot.

4.01.01 Selected Parking Garage Location

Proceeding downward from ground surface the six soils units were described as follows:

Aggregate Base/Subbase: The recent test borings and probes encountered aggregate base/subbase materials to depths ranging from about 3 to 4.5 feet below local ground surface. Descriptions of the aggregate base/subbase materials vary from sand with gravel to silty sand with gravel, black, gray, and brown. Based on the standard penetration test N-value blow counts, it is likely these materials were compacted when they were placed for support of the pavement section.

Common Fill: Common fill consisting of fine to coarse sand, some to little silt, and little to few gravel, tan, brown, and gray were encountered below the aggregate base/subbase materials. Based on standard penetration test N-value blow counts, RWG&A believes the common fill was compacted when it was placed. The estimated encountered thickness of the common fill within and near the selected parking garage location ranged from about 2 to 6.5 feet. It is likely the common fill was placed to raise, level and stabilize ground surface for support of the parking lot pavement section.

Marsh: Marsh deposits consisting of wet, soft to stiff consistency peat and organic silt, with fibrous matter and organic odor, gray, brown to dark brown, was encountered below the common fill. The estimated encountered thicknesses of the marsh deposits within and beneath the selected parking garage location ranged from about 1 to 5 feet. The depth to the bottom of the peat and organic silt varied from about 9 to 10.5 feet below current, local ground surface. Consistency/undrained shear strength of the peat and organic silt was estimated at about 500 to 1,000 pounds per square foot based on correlation with standard penetration test N-value blow counts.

Alluvial: Alluvial soils consisting of medium to very dense (i.e., relative density about 35 to 85 percent) sand with gravel soils were encountered below the peat and organic silt. Sand with gravel soils were described as fine to coarse sand, some to little gravel, few to trace silt, gray. Sand with gravel extended from about 12 to 18 feet below the marsh peat and organic silt. Medium dense silty sand and clayey sand was locally encountered in explorations B101 and B105, respectively, below the sand with gravel. The silty sand and clayey sand consisted of fine sand with some to little silt and clay, gray.

Glacial Fluvial: Test boring B105 encountered glacial fluvial sand with gravel and silt. The soils were described as wet, dense, fine to coarse sand, little gravel and silt, gray. It is likely that glacial fluvial soils are present at other locations, but might not have been noted because they appear similar to the underlying glacial till.

Glacial Till: Glacial till soils were encountered below the alluvial soils and consisted of fine to coarse sand, some gravel, some to little silt, gray and tan. Standard penetration test N-value blow counts indicate the glacial till soils have medium to very dense relative density. Where

encountered, the glacial till was not typically penetrated by the subsurface explorations. Test boring B105 was stopped when high blow counts were encountered on the 4-inch diameter drill casing (125 blows with a 300-pound hammer for less than a foot of penetration) and on the standard penetration test split-spoon sampler (more than 100 blows for 3 inches of penetration with the 140-pound hammer) at about 40 feet below ground surface. The high blow counts were interpreted by RWG&A to have occurred on bedrock, but they might have been on a boulder or been caused by the very dense soil conditions.

Test Boring B-03-14 and auger probes P-3, P-4 and P-6 were located east and northeast of the selected parking garage location and were made in connection with optional locations for the parking garage presented in the preliminary geotechnical evaluation report. These explorations encountered aggregate base/subbase and common fill to a depth of about 6 to 7 feet, about 3 feet of the marsh peat and organic silt was encountered beneath the common fill in P-6. The peat and organic silt was not detected in P-3 and P-4. Alluvial soils underlain by glacial till were also encountered below the common fill and marsh peat and organic silt. These test borings and probes were advanced 27 to 31 feet without encountering refusal. Free water was not observed in P-3, but was measured at depths of about 6 to 10 feet below ground surface in B-03-14, P-4 and P-6.

Borings A-10 (June 1983), G-1, and G-2 (December 1984) were located south and southeast of the selected parking garage location. These borings encountered 4 to 5 feet of common fill over 0.5 to 3 feet of peat underlain by dense sand to sand and gravel. A-10 encountered silt to clayey silt below the sand. These borings were advanced to depths ranging from 11.5 to 15 feet, without encountering refusal. Free water levels on the logs of A-10 and G-2 were reported to be at depths of 5 and 3.8 feet, respectively, when the explorations were made. Classifications of the soils indicated for A-10, G-1 and G-2 in the attached Table were based on RWG&A's interpretation of soil descriptions on the boring logs.

4.02 Bedrock

Bedrock was cored in subsurface explorations made for the preliminary geotechnical report. Recovered NQ-size rock core samples were described as fresh, moderately hard, aphanitic, blue-gray argillite with occasional quartz filled fractures. Fracture spacing ranged from 2 to 12 inches, exhibiting fresh to slightly weathered, rough, low angle to moderate dipping fractures. Rock quality designation (RQD) which is a modified recovery ration and general indicator of rock quality was about 73 percent to 75 percent (note: "fair" rock quality). Refer to the preliminary geotechnical evaluation report for additional information.

4.03 Groundwater

Free water levels measured in the test borings and probes are indicated on the exploration logs in Appendices A and C. Based on the soil types encountered, the water levels observed in the subsurface explorations were likely influenced (i.e., slow groundwater response due to low soil permeability) and are not considered representative of stabilized groundwater when the subsurface explorations were made.

Groundwater level measurements made in the observation well B105-OW ranged from about 7.9 to 5.4 feet below ground surface and are tabulated on the installation detail provided in Appendix B. The observation was sealed through the peat and organic silt layer, in turn, the water levels measured in the observation well are considered representative of groundwater levels in the alluvial soils beneath the peat and organic silt layer. Measured water levels reported in Appendix B rose about 2.5 feet, and appear to correspond to heavy precipitation that occurred during the approximately two month period before the measurement was made. Water levels at the site will fluctuate due to season, temperature, precipitation, snow melt, seasonal thawing, proximity to underground utilities, and construction activity near the area of the proposed parking garage. The water levels measured in B105-OW ranged from about 2.6 to 5.1 feet above the bottom of the peat and organic silt layer.

5.0 GEOTECHNICAL ENGINEERING EVALUATIONS

Engineering evaluations for this project are based primarily on the April and October 2014 subsurface explorations, geotechnical laboratory testing data, and the design information currently available to RWG&A. In particular, geotechnical evaluations made for this report have been based on the following:

- Test borings at the selected parking garage location drilled by New England Boring Contractors Inc. in October 2014.
- Test borings drilled by Great Works Test Borings in April 2014 for the preliminary geotechnical evaluation of the proposed parking garage.
- The sketch titled *VA West Roxbury P.G., Column & Footing Reactions*, dated 22 October 2014, prepared by Becker Structural Engineers.
- The drawing set titled *West Roxbury Garage – 60% Design Development* dated 21 November 2014.

If additional and/or differing information becomes known during final design, prior to and/or during construction, then the evaluations and recommendations provided in the report will need to be reviewed by RWG&A to confirm their continued applicability.

5.01 Foundation Reactions

It is understood that, as currently planned the parking garage will have five above grade levels including the ground floor with no basement. Construction will be a cast-in-place foundation with precast columns, shear walls, wall panels, and decks. The garage will have two elevators located at the northeast corner. The ground floor of the drive and parking areas will be bituminous concrete pavement comprised of 1 ½-inch surface course on 2 ½-inch binder course over a 12-inch aggregate base course.

Becker Structural Engineers, Inc. provided foundation reactions dated 22 October 2014. The isolated column foundation reactions ranged from 495 kips to 1110 kips Allowable Stress Design

(ASD) and from 635 kips to 1315 kips Load Resistance Factor Design (LRFD). Exterior wall reactions provided by Becker Structural Engineers were 5.3 kips per linear foot ASD and 6.6 kips per linear foot LRFD; interior wall reactions provided were 34 to 39 kips per linear foot ASD and 44 to 57 kips per linear foot LRFD. In accordance with the *2012 International Building Code*® (2012 IBC), and the *Massachusetts Amendments to the International Building Code 2009 (Basic/ Commercial) Eighth Edition*, (MA Building Code) the geotechnical design criteria and foundation recommendations provided in this report are intended to be used with the ASD reactions.

5.02 Allowable Foundation Settlement

This report anticipates that total foundation settlements of about 1 ½ inches and differential settlements of about ¾ inches over a distance of 35 feet would be tolerable for the garage decks, columns, and walls. If differing information becomes available or tolerable settlements are less than anticipated, then RWG&A should be provided the opportunity to review and verify the continued applicability of the geotechnical design criteria and recommendations provided in this report.

5.03 Foundation Depth

In accordance with 2012 IBC Subsection 1809.5, it is recommended that the proposed parking garage foundations be protected from frost action by locating the foundations below the frost line at the project locality. Based on local depth of freezing and consistent with geotechnical engineering practice in Boston, Massachusetts, the proposed parking garage foundations need to be a minimum of 4 feet below the lowest adjacent ground surface exposed to freezing. RWG&A understands the garage will be unheated, in turn, the above foundation depth criteria applies to interior and exterior foundations.

5.04 Foundation Design

The marsh peat and organic silt do not have adequate load bearing capacity and settlement characteristics for support of the proposed garage column and wall foundations. The underlying alluvial soils, glacial fluvial and till, and bedrock are considered adequate for support of the proposed garage foundations. Either removal and replacement, ground modification, or deep foundations would be needed to carry the structural reactions down to the adequate soil units or bedrock as noted below:

- Remove the inadequate soil units and replace them with compacted fill or controlled low-strength material in accordance with 2012 IBC Subsections 1803.5.8 and 1803.5.9, respectively.

- Improve the inadequate soils with ground modification in accordance with MA Building Code Subsection 1801.3.

- Deep foundations are not recommended because they not considered economically practical for the proposed parking garage project and due to possible vibration issues associated with pile driving.

5.04.01 Removal and Replacement

The proposed parking garage columns and walls may be supported on spread footings bearing no deeper than 5 feet below finished ground surface elevation on compacted fill. Lowering spread footings to direct bearing on the naturally deposited medium to very dense, sand and gravel alluvial soil is not recommended.

Earthwork for support of the garage on spread footings will require removal of the aggregate base/subbase, common fill and marsh peat and organic silt to depths of about 9 to 10.5 feet below current ground surface. Earthwork methods for removal of the inadequate soil units should not excessively disturb the underlying naturally deposited alluvial soils.

Based on water levels observed in the subsurface explorations and observation well B105-OW, construction dewatering will be needed. Contract documents should provide for construction dewatering by open-pumping and/or predrainage in accordance with the following criteria:

- If groundwater levels encountered at the time of construction are less than about 2 to 3 feet above the removal and replacement soil subgrade elevation, then construction dewatering by open-pumping from sumps concurrent with excavation may be allowed.

- If groundwater levels encountered at the time of construction are more than about 2 to 3 feet above the removal and replacement soil subgrade elevation, then construction dewatering by predrainage with shallow wells and/or wellpoints to lower groundwater levels below the soil subgrade elevation in advance of excavation will be required.

Once removal of the marsh peat and organic silt has commenced it will need to be performed in a continuous manner. Proof-rolling and/or compaction of subgrades in the alluvial soils are not recommended due to possible disturbance associated with "pumping" of groundwater. Placement and compaction of fill up to footing subgrade level should be performed as soon as practical after the alluvial soil subgrade has been fully exposed. In no case should exposed soil subgrades be left un-backfilled overnight.

At the minimum, compacted fill below spread footings will need to extend to the lateral limits defined by a plane pitched down and outward at a slope of 1 Horizontal to 1 Vertical from a line located 2 feet outside of and adjacent to the plan limits at the bottom of the spread footing. It is recommended that the construction drawings include a detail of the limits of compacted fill beneath spread footings. Compacted fill should be placed in uniform level lifts and be densified to a minimum of 95 percent relative compaction determined by *ASTM D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m^3))*, (ASTM D1557).

Preliminary environmental analytical testing results indicate the presence of contaminants at concentrations reportable to Massachusetts Department of Environmental Protection. The limits and estimated volume of contaminated materials were uncertain when this report was prepared; additional soil sampling and analytical testing was proposed. Due to the volumes of soil construction dewatering that would be generate by the removal and replacement alternate, it is possible that earthwork activities and costs might be significantly impacted by the contaminants.

5.04.02 Ground Modification

Ground modification treatment of the inadequate soil units is considered technically feasible to allow the garage columns and walls to be supported on spread footings. Ground modification is performed by contractors with special equipment, trained personnel, and are authorized to install a particular ground modification technology. Ground modification is designed by geotechnical engineers, engaged by the contractor, using proprietary methods and are professionally responsible for their interpretations of subsurface conditions and design of the proprietary ground modification technology.

Design/Build Geotechnical, LLC was provided foundation reactions and preliminary subsurface information for the proposed parking garage to verify if ground modification with semi-rigid and/or rigid inclusions for support of the garage would be technically feasibility and cost effective. Based on the Design/Build Geotechnical, LLC preliminary evaluation, alternate designs using either grouted rammed-aggregate-piers or geo concrete columns (rigid inclusions) for improvement of foundation support were suggested. Un-grouted rammed-aggregate-piers (semi-rigid inclusions) were also suggested for support of the ground level floors.

It is envisioned that ground modification would generate relatively small volumes of soil that would need to be disposed offsite and would not require extensive construction dewatering. In turn, it is anticipated that ground modification should not be significantly impacted by the presence of the contaminants in the soils.

5.05 Ground Level Pavement, Sidewalks, and Floor Slabs

Construction of the existing Building 2 Parking Lot was not intended to support buildings, but appears to have performed well as a parking lot in spite of being built over the layer of marsh peat and organic silt. Calculations indicate current pavement and sidewalk ground surfaces may have settled up to about a half-foot, locally, since they were built. The extent of subgrade preparation for a pavement, sidewalk or floor slab is frequently a function of the amount of settlement the paved area can tolerate, construction costs, and acceptance of the risk of settlement by the Owner.

For the proposed parking garage, removal and replacement or ground modification of the inadequate soils beneath the proposed ground level pavement, sidewalks and slab-on-grade floors would be preferable. However, RWG&A understands that, project budget constraints will not allow removal and replacement or ground modification to be performed. The Owner should be advised that building the garage ground level pavement over the marsh peat and organic silt will necessarily result in post-construction settlements, these settlements would occur as differential settlements between parts of the garage supported on spread footings and the ground level pavement, sidewalks and floor slabs supported over the inadequate soils.

Due to the varying thickness of the marsh peat and organic silt it is not practical to reliably or accurately estimate the amounts of post-construction settlements if the peat and organic silt are left in place or are not improved by ground modification treatment. However, based on the 5-foot thickness of the marsh peat and organic silt encountered in some of the subsurface explorations, approximate post-construction settlement calculations indicate ground level pavement, sidewalks and floor slabs could settle about 3 inches over ten years and about 4 to 5 inches over 50 years;

actual settlements may be more or less. These settlements would be largest away from the columns and walls supported on spread footings and where the marsh peat and organic soils are thickest.

5.06 Foundation Drainage

Seasonal high groundwater level might occur close to finished ground surface and tend to collect around and beneath the proposed parking garage. Perimeter footing drains around the proposed parking garage will be needed to reduce the accumulation of water near the garage foundation and fugitive water from entering the parking garage, reduce humidity, and freeze-thaw action. The foundation drainage would be in addition to and separated from, surface water drainage measures.

6.0 RECOMMENDATIONS

The recommendations presented below are provided for use in design of the proposed parking garage foundation. Foundation design and construction will be greatly influenced by subsurface conditions at the project site. RWG&A recommends foundation design and construction be in compliance with the requirements of all applicable codes, ordinances, regulations, and rules. Based on VA requirements IBC 2012 was used for this geotechnical evaluation and report.

6.01 Site Preparation

1. Contaminated soils and/or water encountered in any excavation should be handled and disposed of in accordance with approved Massachusetts Department of Environmental Protection, and other, applicable regulatory agency, standards, and policies.

2. All existing utilities beneath the area of the proposed parking garage need to be removed and relocated. RWG&A understands that utility relocation will include an electrical duct bank and brick arch drain pipe. Trenches and excavations made to remove utilities should be backfilled with compacted granular fill. At the minimum, underground utility pipes and conduits located outside the limits of the proposed parking garage that are abandoned in place will need to be filled with sand or grout.

3. After demolition of the existing asphalt pavement and utility relocation, and before undertaking removal and replacement or ground modification, remove of the aggregate base/subbase and common fill a depth of 2 feet below current ground surface, or to the subgrade level of the proposed pavement base course, whichever is at a lower elevation.

4. Rough grade the compacted pavement base/subbase and common fill subgrade. Rough grading should provide positive drainage away from the proposed construction during and after construction is complete.

5. Compact the rough graded pavement base/subbase and/or common fill subgrade to a minimum of 95 percent relative compaction as determined by ASTM D1557. Compaction should be performed with a minimum of eight passes, in sets of two passes alternated in mutually perpendicular directions, with a medium-sized (i.e., approximately 8 to 10-ton), smooth-drum, vibratory roller. Compaction limits should

extend to 10 feet outside the exterior plan limits of the parking garage perimeter foundations.

6. In general, where water is encountered it should be practical to accomplish construction dewatering of shallow excavations by open pumping method. Surface runoff and infiltration of groundwater should be controlled so that the excavation, filling, foundation construction, backfilling, and compaction can be completed in-the-dry.

6.01.01 Removal and Replacement

7. Contract documents should require the contractor to submit a Removal and Replacement Plan. The plan would include, but not be limited to, the following items:

    - A sketch indicating the sequence of excavation of inadequate soil units, backfilling and compaction of granular fill, and construction dewatering.

    - Proposed construction dewatering methods and system design based on water levels at the time of construction. Design of predrainage construction dewatering systems using wells and/or wellpoints should be performed by a construction dewatering contractor and submitted for review and comment.

    - The construction documents should advise the Contractor that lowering groundwater levels below the top of the marsh peat and organic silt could result in settlement of nearby buildings, utilities, structures, and the ground surface. As an alternate to predrainage dewatering, working in discreet areas with sheeting around the perimeter of excavations might be used to reduce the need to lower groundwater levels and associated settlements.

    - Copies of permits needed for on- or off-site disposal/discharge of effluent from the construction dewatering system.

    - Information about off-site fill borrow sources including results of geotechnical and environmental testing. Test results should identify the company and facility name/location.

    - Copies of permits needed for off-site disposal of excess soils including receipts/tickets from disposal facilities and results of analytical testing needed for material characterization.

6.01.02 Ground Modification

8. Contract documents shall require the Contractor to submit a ground modification design submittal describing the type, size, locations, anticipated depth of ground modification treatment, and resulting allowable bearing pressure of the modified soils for support of the proposed garage on spread footings. The submittal must be prepared, stamped and signed by a Massachusetts Registered Professional Engineer engaged by the Contractor. The Massachusetts Register Professional Engineer shall have a minimum of ten years

geotechnical engineering experience, and not less than five years training and experience in the design and construction of the proposed ground modification treatment. The submittal shall include a resume documenting the Massachusetts Licensed Professional Engineer's education, training, and experience.

9. At the minimum, the ground modification treatment should consider the allowable bearing pressure and settlement of all footings based on a building design life of 50 years, unless otherwise specified by the Owner, and be in accordance with acceptable engineering practice.

10. The bottom of footings, at frost protection depth, will occur within or close to the top of marsh peat and organic silt layer. This will require a footing bearing pad to be installed between the footing and tops of semi-rigid or rigid inclusions. Design of footing bearing pad(s) will be based on the type, capacity, and spacing of the semi-rigid or rigid inclusions proposed by the Contractor and will necessarily need to be designed by a Massachusetts Registered Professional Engineer engaged by the Contractor.

11. Design of the footing bearing pads will include, but not be limited to, the following information:

    - Bottom elevation.
    - Width, length and thickness.
    - Aggregate type(s), gradation, and relative percent compaction requirements.
    - Type(s) number and location of geotextile or geogrid reinforcement layers.
    - Need for and design of concrete mud-mats.

12. The ground modification design submittal should include descriptions of measures that might be implemented to reduce vibration and noise at the VAMC WR building(s) and associated disturbance of patients, guests, and staff. It is anticipated such measures might include, but not necessarily be limited to: providing results of published or unpublished studies on vibration and noise associated with the ground modification treatment proposed, a test installation program with vibration monitoring, and sequencing the installation and varying the construction schedule to reduce vibration and noise.

6.02 Spread Footings

13. The proposed parking garage may be supported on spread footings bearing on compacted granular fill placed after removal and replacement of existing fill materials and marsh peat and organic silt, or over the common fill and marsh peat and organic silt after ground modification treatment.

14. Spread footings bearing on compacted granular fill may be proportioned for an allowable bearing pressure of 6,000 pounds per square foot. Spread footings supported by semi-rigid and/or rigid inclusions should be proportioned for the allowable bearing pressure determined by the Contractor's Massachusetts Licensed Professional Engineer

after verification by modulus testing. Minimum footing width should be in accordance with structural design and building code requirements, and no less than 3 feet.

15. The garage will not be enclosed or heated, in turn, it is recommended that design bottom of footing level be a minimum of 4 feet below lowest adjacent ground surface.

16. The proposed parking garage foundation should be designed to withstand lateral, uplift, and overturning forces due to earthquake. In accordance with the IBC 2012, the soil profile at the selected parking garage location is classified as Site Class D, with Site Coefficients F_a (short period) of 1.6 and F_v (1-second period) of 2.4. The in-place fill materials and soils encountered in the explorations are not considered susceptible to liquefaction.

17. Lateral loads from wind and earthquake may be resisted by friction between the bottoms of footings and supporting subgrades, and by passive earth pressures against the sides of the foundation. A friction coefficient of 0.35 and an equivalent fluid pressure of 175 pounds per cubic foot against sides of footings may be used in the design of footings.

6.03 Foundation Drainage

18. Perimeter footings drains should be installed around the parking garage. The drains should be installed at the exterior bottom of footing level. The drains should consist of 6-inch diameter flexible perforated pipe bedded in 2 cubic feet of crushed stone per linear foot meeting the requirements of *ASTM C-33, Standard Specification for Concrete Aggregate, Coarse Aggregate Size No. 7*. The crushed stone should be completely wrapped in a geotextile filter fabric such as Mirafi 180N, or equivalent.

19. Flow from the foundation drains should be conveyed by gravity to surface drainage features or storm drains that will be free flowing at all times and under all conditions. Multiple outlets should be provided so as not to be dependent on a single flow path. Surface water drainage features including roof drains, floor drains, catch basins, manholes, drip edges, infiltration trenches and basins, should be isolated from and convey water away from foundation drainage.

20. Coordinate utility design with the foundation drainage so as not to mix the crushed stone with utility bedding, cover, and/or backfill materials or damage the utilities, foundation drain pipes and filter fabric.

6.04 Elevator Pits

21. Design walls and bottom slabs of elevator pits to be waterproof and to resist uplift pressures. A combined backfill and water equivalent fluid unit weight of 95 pounds per cubic foot is recommended for design of the elevator pit walls to retain lateral earth and hydrostatic pressures.

6.05 Retained Fill

22. Foundation and walls for soil filled ramps should be designed to resist lateral loads from retained earth pressure and vehicle surcharge (i.e. cars traveling and parked near the walls). The walls should be designed using and equivalent fluid weight equal to 60 pounds per cubic foot if provisions are made to prevent rise of water above bottom of wall level (i.e., foundation drains). The lateral load from vehicle surcharge can be accommodated by applying an additional horizontal pressure equal to 120 pounds per square foot.

6.06 Backfilling

23. Backfill foundations with Massachusetts Highway of Department *Standard Specifications for Highways and Bridges, M1.03.0 Gravel Borrow Type b,* latest supplement, meeting the following particle-size distribution requirements:

Screen or Sieve Size	Percent Passing
3 inches	100
½ inch	50-85
No. 4	40 - 70
No. 50	8-28
No. 200	0-10

24. Place fill within open-areas in level, uniform lifts not exceeding 12 inches in uncompacted thickness, within confined areas fill should be placed in lifts not exceeding 6 inches in uncompacted thickness. Compact fill to at least 95 percent of the maximum dry density as determined by ASTM D1557.

6.07 Ground Level Pavements, Sidewalks and Floor Slabs

25. After foundation and utility backfilling have been completed, compact the subgrade for the ground level pavement, sidewalk and floor slabs to a minimum of 95 percent of the maximum dry density as determined ASTM D1557, and a minimum of eight passes with an 8 to 10-ton smooth drum vibratory roller in pairs at each of two mutually perpendicular directions. Areas where unstable materials are encountered should be undercut a minimum of 2 feet and replaced with compacted granular fill.

26. Entrance slabs and sidewalks at doorways and other locations sensitive to frost heaving should be underlain by a minimum of 4 feet of compacted granular fill. The surrounding area should be pitched to drain away in order to reduce available moisture for ice and frost lens generation.

27. Design interior cast-in-place slab-on-grade floors based on a subgrade modulus of 90 pounds per cubic inch. Alternately, ground floor slabs could be structural slabs supported by column and wall spread footings after removal and replacement or ground modification treatment.

28. Interior ground floor slabs should be underlain by a minimum of 12 inches of compacted granular fill. A vapor retarder should be provided below the floor slab to minimize moisture infiltration of enclosed spaces. It is anticipated design and construction details of cast-in-place ground floors, including concrete thickness, reinforcing, bedding, control joint depth and spacing, and the vapor retarder type and thickness, will be provided by the project Structural Engineer.

7.0 CONSTRUCTION CONSIDERATIONS

This Report of Geotechnical Evaluation for the proposed AE Renovate Parking Garage VAMC WR has been limited to consideration of the geotechnical aspects of the proposed parking garage in West Roxbury, Massachusetts. The primary purpose of RWG&A's services was to obtain information regarding subsurface conditions and soil properties on which to base recommendations for design and construction of the proposed parking garage. In particular, this report identifies geotechnical criteria and construction considerations intended to assist engineers that will design the project and monitor its construction.

RWG&A is providing this report as a service to PDT Architects. This geotechnical evaluation might also be of aid to Contractors responsible for construction of the proposed parking garage. However, the recommendations and comments provided herein are not intended to be instructions or directives to the project Contractor. The project Contractor must evaluate construction issues encountered in the work on the basis of their experience with similar projects taking in to account their own interpretation of subsurface information and proposed construction means and methods.

RWG&A has not considered the construction activities from a worker safety perspective. Construction safety is the sole responsibility of the Contractor, who is also solely responsible for the means, methods, and sequencing of construction operations. Under no circumstance should the Contractor assume or interpreted this report to mean that VA., RWG&A, PDT Architects, and Becker Structural Engineers, Inc. are assuming responsibility for construction safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.

7.01 Temporary Excavations

1. Contractors should make themselves aware of, and become familiar with, applicable local, state, and federal safety regulations, including the current *OSHA Excavation and Trench Safety Standards*.

2. As a precautionary measure, all vehicles and spoil piles should be kept a minimum lateral distance from the top of excavations equal to no less than 100 percent of the excavation height.

3. Subsurface soils at this site encountered within the anticipated depths of excavations consist of aggregate base/subbase materials, common fill, marsh peat and organic silt. The naturally deposited soils at bearing subgrade levels are sensitive to disturbance, especially when wet. Excavation of compacted fill, spread footing and floor slab bearing surfaces should be performed by earthwork equipment fitted with smooth-edged buckets. To reduce

disturbance of exposed subgrade soils, it will be important to divert runoff and provide positive temporary grading to shed seepage and runoff.

4. The integrity of natural soils and fill must be maintained during cold weather conditions. Footing and floor slab subgrades should not be allowed to freeze. Freezing of subgrade soils beneath spread footings and floor slabs may result in frost heaving and post-construction settlement and cracking. Every effort should be made to prevent freezing of subgrade soils. In the event that frost penetration occurs, fill or naturally deposited soils should be removed and replaced to the depth of the frozen soils with compacted granular fill. At no time should material that is frozen be placed as fill. After footings are built, they should be protected from freezing temperatures by insulation, heating or other suitable methods.

7.02 Construction Vibrations

5. Vibrations from Removal and Replacement construction activities might have deleterious effects on existing buildings, occupants, and vibration sensitive equipment in the VAMC WR. Where self-propelled drum rollers are used to compact fill, they might need to be operated in static mode. If compaction requirements cannot be met with this approach, then smaller sized compaction equipment and thinner fill lifts might be needed to reduce construction vibrations and achieve compaction requirements.

6. Installation of Ground Modification may generate vibrations. Construction activities will need to be coordinated with VAMC WR. Production installation of semi-rigid and/or rigid inclusions should not proceed until it has been demonstrated that ground improvement activities do not have deleterious effects on existing buildings, occupants, and vibration sensitive equipment at VAMC WR.

7.03 Construction Dewatering

7. Stabilized water levels observed in B105-OW during the approximately three month period after the observation well was installed ranged from about 2.6 to 5.1 feet above the bottom of marsh peat and organic silt encountered in B105. Water levels across the proposed garage area should be evaluated prior to beginning of construction through test pits and/or groundwater observation wells. RWG&A anticipates that groundwater control might be accomplished through the use of ditches, sumps, and open pumping methods where waters are less than about 2 to 3 feet above excavation depths. If water levels are encountered at shallower depths (i.e., higher elevations), then construction dewatering for foundation construction and/or utility installation by predrainage methods and/or use of cut-off sheeting might be needed to reduce disturbance of subgrade soils.

8. The Contractor should provide any applicable construction permits for the discharge and/or disposal of effluent from construction dewatering.

7.04 Use of On-site Materials

9. This report has only considered the use of the on-site fill and naturally deposited soils from a geotechnical perspective. Contaminated soils were detected in the subsurface explorations made at the selected garage location. When this report was prepared, results of analytical tests on the contaminated soils needed to be reported to Massachusetts Department of Environmental Protection; additional exploration and analytical testing were proposed to provide guidance regarding disposal requirements.

10. Aggregate base/subbase materials beneath the existing asphalt pavement *might* be suitable for use as fill in the proposed construction. If on-site materials are proposed for use in the new construction, then the materials should be stockpiled separately and tested to determine if they meet specification requirements for the proposed use.

8.0 GEOTECHNICAL OBSERVATION

The geotechnical recommendations provided herein as the basis for design of this project were developed using limited numbers of subsurface explorations, field observations and tests. The Owner and Contractor should be sensitive to the potential need for adjustment in the field. It is recommended that the Owner retain RWG&A to review submittals and make periodic observations of the geotechnical construction aspects of earthwork construction. These services would include observing general compliance with the design concepts, geotechnical recommendations and criteria, and assisting in developing design changes should subsurface conditions differ from those anticipated prior to the start of construction. Geotechnical review and observation during construction improves the likelihood that the design intent will be carried out during construction. In addition, it allows RWG&A to confirm its recommendations. For this project, submittal review and geotechnical observation of the following aspects is recommended:

- Removal and Replacement of aggregate base/subbase materials, common fill, and marsh peat and organic silt for support of the proposed garage column and wall foundations.

- Ground Modification for improvements of the inadequate soils for support of the proposed garage column and wall foundations.

- Open pumping and/or predrainage construction dewatering.

In addition to geotechnical observation, RWG&A can also assist the VA or their inspection and testing contractor with quality assurance, materials testing and construction inspections. This could include soils, portland cement, bituminous pavement, structural steel and welding inspections, and special inspection services in fulfillment of building code requirements.

9.0 CLOSURE

This report has been prepared for specific application to the AE Renovate Parking Garage VAMC in West Roxbury, Massachusetts and for the exclusive use of PDT Architects and the design team. These services have been completed in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made. In the event any changes are made in the nature, design, or location of the proposed construction, the conclusions and recommendations of this report should be reviewed by RWG&A.

The recommendations presented are based on the results of widely spaced explorations. The nature of variations between the explorations may not become evident until construction has begun. If variations are encountered, it will be necessary for RWG&A to re-evaluate the recommendations presented in this preliminary report. RWG&A requests an opportunity for a general review of the final design and specifications in order to determine that earthwork and foundation recommendations have been interpreted in the manner in which they were intended.

TABLE
SUMMARY OF SUBSURFACE EXPLORATIONS
AE RENOVATE PARKING GARAGE VAMC WR
WEST ROXBURY, MA

Exploration Designation	Date Drilled	Encountered Soil Unit Thicknesses (feet) with Increasing Depth Below Ground Surface							Refusal Depth (feet)	Water Depth (feet)
		Fill		Marsh Peat and Organic Silt	Alluvial		Glacial Fluvial	Glacial Till		
		Aggregate Base/Subbase	Common		Sand	Sand and Gravel				
A-10	June 1983	--	5	3	4	--	3+	--	Below 15	5
G-1	Dec. 1984	--	4	2.5	--	5+	--	--	Below 11.5	Not Observed
G-2	Dec. 1984	--	6.5	0.5	--	4.5+	--	--	Below 11.5	3.8
P-3	April 2014	--	6	--	25		--	--	Below 31	Not Observed
P-4	April 2014	--	7	--	16		--	8+	Below 31	10
P-6	April 2014	5.7		3	19		--	5+	Below 30	6
B-03-14	April 2014	4.3	2.5	3	6.5	8.5	--	2+	Below 27	6.5
B101	October 2014	2.7	6.5	1	15.5	1+	--	--	Below 27	9
B102	October 2014	2.7	3.5	3.5	--	13.5	--	2.5+	Below 26	9
B103	October 2014	2.8	2	5	10	6	--	1+	Below 27	9
B104	October 2014	2.7	2	4	9.5	--	--	8.5+	Below 27	7
B105-OW	October 2014	3.7	4	2.5	18		5	6.5R	40	5.4 to 7.9
P101	October 2014	2.7	4	2	--	2	--	--	Below 11	7
P102	October 2014	2.7	2	5	--	3	--	--	Below 13	7
P103	October 2014	2.7	5.5	1.5	--	3	--	--	Below 13	7
P104	October 2014	2.7	3.5	3	--	0.5R	--	--	10	7

\+ Indicates boring terminated in this layer without encountering refusal.
R Indicates refusal surface encountered at the bottom of this layer/exploration.

FIGURE 1
LOCUS MAP
GEOTECHNICAL EVALUATION
AE RENOVATE PARKING GARAGE VAMC WR
WEST ROXBURY, MASSACHUSETTS

JANUARY 2015 PROJECT NO. 0435-010

SOURCE:
USGS 7.5-MINUTE TOPOGRAPHIC QUADRANGLE OF NEWTON, MASSACHUSETTS, DATED 1970.

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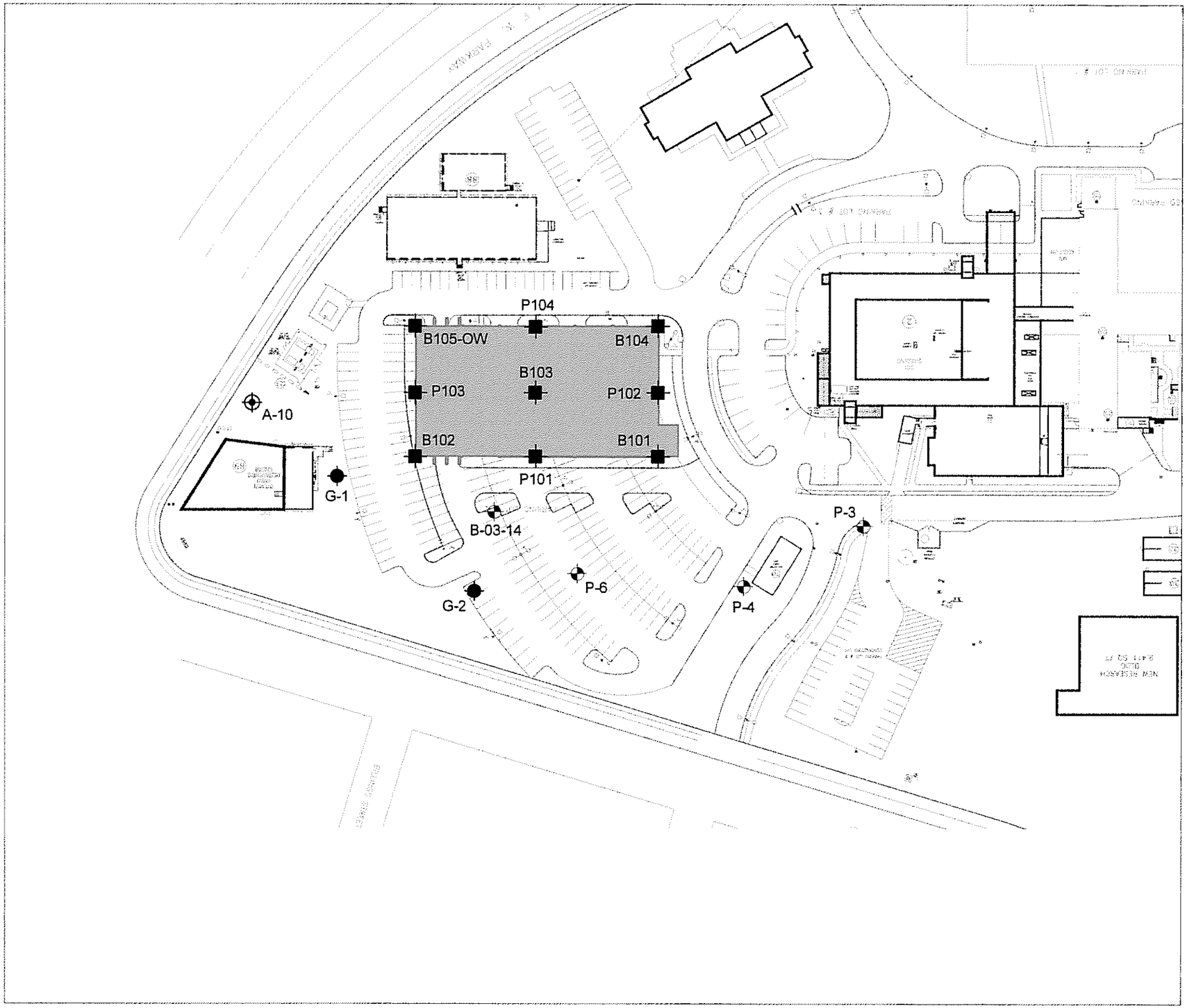
G:\AutoCad\4000\435-010\FIG 1, LOCUS MAP 0435-010.dwg, 1/7/2015 11:59:19 AM, Xerox WorkCentre 7855 GPD



LEGEND:

B105	APPROXIMATE LOCATION OF SUBSURFACE EXPLORATION BY NEW ENGLAND BORING CONTRACTORS DRILLED OCTOBER 2014.
B-01-14	APPROXIMATE LOCATION OF SUBSURFACE EXPLORATION BY GREAT WORKS TEST BORINGS FOR THE PRELIMINARY GEOTECHNICAL EVALUATION DRILLED APRIL 2014.
A-1	APPROXIMATE LOCATION OF SUBSURFACE EXPLORATION DRILLED JUNE 1983.
G-1	APPROXIMATE LOCATION OF SUBSURFACE EXPLORATION DRILLED DECEMBER 1984.
OW	INDICATES A GROUNDWATER OBSERVATION WELL WAS INSTALLED IN THE COMPLETED BOREHOLE.

SOURCE:
DRAWING TITLED "DRAFT SITE PLAN OPTION 7", PREPARED BY STANTEC, DATED 09/19/2014.

N

0 200 300 400

SCALE, FEET

FIGURE 2
EXPLORATION LOCATION PLAN
GEOTECHNICAL EVALUATION
AE RENOVATE PARKING GARAGE VAMC WR
WEST ROXBURY, MASSACHUSETTS

JANUARY 2015 PROJECT NO. 0435-010

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APPENDIX A

TEST BORING AND PROBE LOGS

OCTOBER 2014

SELECTED PARKING GARAGE LOCATION

Report of Geotechnical Evaluation
AE Renovate Parking Garage VAMC WR
West Roxbury, Massachusetts

RWG&A, Inc. soil descriptions are based on the following criteria. Descriptive terminology is used to denote the grain size and percentage of each component. The soil descriptions are based on visual-manual classification procedures, Standard Penetration Test results, and the results of laboratory testing on selected soil samples, where available. The Unified Soil Classification Group Symbol will be indicated in capital letters.

COMPONENT DEFINITIONS BY GRADATION SIEVE LIMITS

Materials	Definitions	Fractions	Upper	Lower
Boulders	Material too large to pass through an opening 12 in. square.			
Cobbles	Material passing through a 12 in. opening and retained on the 3 in. sieve.			
Gravel	Material passing the 3 in. sieve and retained on 1/4" (No. 4 sieve).	Coarse Fine	3 in. 3/4 in.	3/4 in. 1/4 in.
Sand	Material passing the No. 4 sieve and retained on the No. 200 sieve.	Coarse Medium Fine	No. 4 (1/4") No. 10 (1/8") No. 40 (1/32")	No. 10 (1/8") No. 40 (1/32") No. 200
Silt	Material passing the No. 200 sieve which is usually non-plastic in character and exhibits little or no strength when air dried.		No. 200	
Clay	Material passing the No. 200 sieve which can also be made to exhibit plasticity within a certain range of moisture contents and which exhibits considerable strength when air dried.		No. 200	

SOIL DESCRIPTION

General

Soils are described as to the Unified Soil Classification Systems Group Symbol, density or consistency, color, grain size distribution and other pertinent properties such as plasticity and dry strength. The RWG&A order of descriptors is as follows:

1. USCS Group Name and Symbol, or Fill
2. Density or Consistency
3. Moisture
4. Grain Size & Constituent percentages
5. Other pertinent descriptors
6. Color

DESCRIPTIVE TERMINOLOGY DENOTING COMPONENT PROPORTIONS

Descriptive Terms	Range of Proportions
Noun (major component)	≥50%
Adjective (secondary component)	20 - 50%
Some (third component)	25 - 45%
Little (second or third component)	15 - 25%
Few (second or third component)	5 - 15%
Trace	0 - 5%
With	Amount of component not determined. Used as a conjunction only. Does not indicate component percentile

OTHER DESCRIPTIVE TERMS

Where appropriate, geological classifications are also used (Glacial Till, etc.)

TYPICAL DESCRIPTIONS

SAND WITH SILT (SP-SM): Medium dense, moist, coarse to medium sand, few silt, brown.
FILL; Loose, dry, fine sand, some gravel and silt, with brick and concrete fragments, dark brown.
SILTY CLAY (CL); Very stiff, moist, silty clay, olive-brown.

DENSITY OR CONSISTENCY OF SOILS

COHESIVE SOILS

Consistency of Cohesive Soils	Standard Penetration Test (Blows Per Foot) (N)	Undrained Shear Strength (TSF)
Very Soft	0 - 2	Below 0.13 (250 psf)
Soft	2 - 4	0.13 to 0.25 (to 500 psf)
Medium	4 - 8	0.25 to 0.5 (to 1,000 psf)
Stiff	8 - 15	0.5 to 1.0 (to 2,000 psf)
Very Stiff	15 - 30	1.0 to 2.0 (to 4,000 psf)
Hard	Over 30	over 2.0 (over 4,000 psf)

Consistency of cohesive soils is based upon field vane shear, torvane, or pocket penetrometer, or laboratory vane shear or Unconsolidated-Undrained Triaxial Compression tests. Consistency of cohesive soils is based upon the Standard Penetration test when no other data is available.

COHESIONLESS SOILS

Density of Cohesionless Soils	Standard Penetration Test (Blows per Foot) (in)
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	over 50

PENETRATION RESISTANCE

STANDARD PENETRATION TEST (ASTM D1586) - a 2.0-inch diameter, 1-3/8 inch inside diameter split barrel sample is driven into soil by means of a 140-pound weight falling freely through a vertical distance of 30 inches. The total number of blows required for penetration from 6 to 18 inches is the Standard Penetration Resistance (N).

COBBLES AND BOULDERS

The percentage of cobbles and boulders is estimated visually where possible.

Descriptive Term	Estimated Percentage
Very Few	0 - 10%
Few	10 - 25%
Common	25 - 40%
Numerous	40 - 50%

If the percentage cannot be determined, as in a typical test boring, then use “with” to indicate the presence of cobbles and/or boulders. (i.e., gravelly sand with cobbles and boulders).

FILLS

The following terminology is used to denote size range of man-made materials within fill deposits:

Size Range	Comparative Soil Terms
<No. 200 Sieve	Silt - size
No. 200 to 1/4 in.	Sand - size
1/4 in. to 3 in.	Gravel - size
3 in. to 12 in.	Cobble - size
>12 in.	Boulder - size

SUPPLEMENTAL SOIL DESCRIPTION TERMINOLOGY

Term	Example	
Seam	Typically 1/16 to 1/2 inch thick	1/4 inch sand seams
Layer	Greater than 1/2 inch thick	2-inch sand layers
Occasional	One or less per foot of thickness	
Frequent	More than one per foot of thickness	
Interbedded	Alternating soil layers of different composition	
Varved	Alternating thin seams of silt and clay	
Mottled	Variations in color	

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Boring Log: B101
Total Depth (ft): 27
Sheet 1 of 1

Project Name: Proposed VAWR Parking Garage
RWG&A Project No. 0435-010
Location: West Roxbury, MA
Client: PDT Architects
RWG&A Representative: OHI Rep. B. Snow
Boring Location: See Exploration Location Plan
Boring Abandonment Method: Backfilled with Cuttings
Observed Water Depth: 9'

Drilling Contractor: New England Boring Contractors
Drill Rig: Truck Rig
Driller Rep.: M. D'Ambrosio
Date Started: 10/07/2014
Date Completed: 10/07/2014
Surface Elevation: ()
Drilling Method: Rotary Wash
Casing Type: 4" steel

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	LAB TESTS	CASING BLOWS 300 lb. HAMMER PER FOOT
0				ASPHALTIC PAVEMENT (4 inches).					
			S-1	AGGREGATE BASE/SUBBASE; Moist, very dense, silty sand with gravel, medium to fine sand, some gravel and silt, black, gray, and brown.	14	11 31 42	73		
			S-2	COMMON FILL; Moist, very dense, medium to coarse sand, some gravel and silt, black and gray to tan and brown.	18	40 24 41	78		29 56
5			S-3		12	37 35 41	55		69 36
			S-4		8	31 24 14	13		26 29
	▽		S-5	COMMON FILL; Wet, loose, medium to coarse sand, little gravel, few silt, gray.	20	13 7 6	10		27 19
10				PEAT AND ORGANIC SILT (PT); Wet, loose, fibrous, organic odor, gray to dark brown.		7 7 4			49 78
				-MARSH-		6 20			77
				SAND (SP); Wet, loose, medium to coarse sand, little gravel, few silt, gray.					76
15			S-6	-ALLUVIAL-	16	10 8 8	16		26 37
				SILTY SAND (SM); Wet, medium dense, medium to fine sand, some silt, gray.		9			38 47
20			S-7		4	9 15 12 11	27		
25			S-8	-ALLUVIAL-	18	8 7 13 14	20		
				SILTY SAND WITH GRAVEL (SM); Wet, medium dense, medium to coarse sand, some silt, little gravel, gray and orange.					
				-ALLUVIAL-					
				Bottom of Exploration at 27'; Not Refusal.					

Notes:

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Boring Log: B102
Total Depth (ft): 26
Sheet 1 of 1

Project Name: Proposed VAWR Parking Garage
RWG&A Project No. 0435-010
Location: West Roxbury, MA
Client: PDT Architects
RWG&A Representative: OHI Rep. B. Snow
Boring Location: See Exploration Location Plan
Boring Abandonment Method: Backfilled with Cuttings
Observed Water Depth: 9'

Drilling Contractor: New England Boring Contractors
Drill Rig: Truck Rig
Driller Rep.: M. D'Ambrosio
Date Started: 10/07/2014
Date Completed: 10/08/2014
Surface Elevation: ()
Drilling Method: Rotary Wash
Casing Type: 4" steel

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	LAB TESTS	CASING BLOWS 300 lb. HAMMER PER FOOT
0				ASPHALTIC PAVEMENT (4 inches).					
			S-1	AGGREGATE BASE/SUBBASE; Wet, dense, sand with gravel, medium to fine sand, some gravel, tan.	9	22 24 22	46		
			S-2	COMMON FILL; Moist, medium dense, fine to coarse sand, some silt, few gravel, black and gray.	22	15 20 12	26		20 27
5			S-3		10	14 12 13	24		19 15
			S-4	PEAT AND ORGANIC SILT (PT); Wet, loose, fibrous, organic odor, dark brown.	18	14 10 7	8	MC=246% OC=197%	13 10
	▽		S-5	-MARSH-	14	6 4 4	45		10 29
10				SAND WITH GRAVEL (SP); Wet, very dense to medium dense, medium to coarse sand, little gravel, trace silt, gray.		4 11 22 23 23			49 56 63 51
15			S-6		8	15 14 14 13	28		32 25 33 70 72
20			S-7	-ALLUVIAL-	8	73 32 23 18	55		50 67 72 93
25			S-8	SILTY SAND WITH GRAVEL (SM); Wet, very dense, coarse sand, some gravel and silt, gray and tan. -GLACIAL TILL-	16	41 42 48 60	90		116
				Bottom of Exploration at 26'; Not Refusal.					

Notes:

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Boring Log: B103
Total Depth (ft): 27
Sheet 1 of 1

Project Name: Proposed VAWR Parking Garage
RWG&A Project No. 0435-010
Location: West Roxbury, MA
Client: PDT Architects
RWG&A Representative: OHI Rep. B. Snow
Boring Location: See Exploration Location Plan
Boring Abandonment Method: Backfilled with Cuttings
Observed Water Depth: 9'

Drilling Contractor: New England Boring Contractors
Drill Rig: Truck Rig
Driller Rep.: M. D'Ambrosio
Date Started: 10/07/2014
Date Completed: 10/07/2014
Surface Elevation: ()
Drilling Method: Rotary Wash
Casing Type: 4" steel

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	LAB TESTS	CASING BLOWS 300 lb. HAMMER PER FOOT
0				ASPHALTIC PAVEMENT (3 inches).					
			S-1	AGGREGATE BASE/SUBBASE; Moist, dense, silty sand with gravel, medium to fine sand, some gravel, brown.	16	38 19 14	33		
			S-2	COMMON FILL; Moist, very dense, medium to fine sand, some silt, little gravel, black and brown.	8	9 19 15	51		28 35
5			S-3	PEAT AND ORGANIC SILT (PT); Wet, loose, fibrous organic odor, dark brown.	0	36 41 15	11		28 10
			S-4		2	8 3 4	8		11 12
	▽		S-5	-MARSH-	6	6 4 4	52		45 61
10				SAND WITH GRAVEL (SP); Wet, very dense to medium dense, coarse to fine sand, little gravel, trace silt, gray.		5 25 26			52 44
				-ALLUVIAL-		26 27			45 24
15			S-6	SAND (SP); Wet, medium dense, medium to fine sand, some silt, gray.	20	6 12 16	28		36 42
				-ALLUVIAL-		15			50 47 24
20			S-7	SAND WITH GRAVEL (SW); Wet, medium dense, fine to coarse sand, some gravel, trace silt, gray and tan.	4	9 15 12	27		40 41
						11			35 32
25			S-8	-ALLUVIAL-	16	8 18 23	41		
				SILTY SAND WITH GRAVEL (SM); Wet, dense, fine to coarse sand, some gravel and silt, tan and gray.		25			
				-GLACIAL TILL-					
				Bottom of Exploration at 27'; Not Refusal.					

Notes:

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Boring Log: B104
Total Depth (ft): 27
Sheet 1 of 1

Project Name: Proposed VAWR Parking Garage
RWG&A Project No. 0435-010
Location: West Roxbury, MA
Client: PDT Architects
RWG&A Representative: OHI Rep. B. Snow
Boring Location: See Exploration Location Plan
Boring Abandonment Method: Backfilled with Cuttings
Observed Water Depth: 7'

Drilling Contractor: New England Boring Contractors
Drill Rig: Truck Rig
Driller Rep.: M. D'Ambrosio
Date Started: 10/08/2014
Date Completed: 10/08/2014
Surface Elevation: ()
Drilling Method: Rotary Wash
Casing Type: 4" steel

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	LAB TESTS	CASING BLOWS 300 lb. HAMMER PER FOOT
0				ASPHALTIC PAVEMENT (4 inches).					
			S-1	AGGREGATE BASE/SUBBASE; Moist, very dense, silty sand with gravel, coarse to fine sand, some gravel, little silt, gray and tan.	9	20 29 24	53		15
			S-2	COMMON FILL; Moist, dense, fine to medium sand, some silt, little gravel, black and brown.	18	18 16 16	32		21 21
5			S-3	PEAT AND ORGANIC SILT (PT); Wet, loose, fibrous, organic odor, dark brown.	0	16 16 20	41		28 24
			S-4	-MARSH-	8	20 21 9 5	7	MC=78% OC=32%	22 18
10			S-5	SAND WITH GRAVEL (SP); Wet, dense, medium to coarse sand, some gravel, few silt, gray.	18	4 3 8 12 20 24 20	44		16 71 59 62 43 58
15			S-6	-ALLUVIAL-	10	19 20 16 16	36		10 29 40
				GRAVEL WITH SILT AND SAND (GP-GM); Wet, very dense, gravel, fine sand, little silt, tan and gray.					35 60
20			S-7	-GLACIAL TILL-	18	35 40 23 21	63		35 65 53
				SAND WITH GRAVEL (SP); Wet, very dense, coarse sand, little gravel, few silt, gray.					67 87
25			S-8	-GLACIAL TILL-	16	110 46 40 37	86		
				SILTY SAND WITH GRAVEL (SM); Wet, very dense, fine to coarse sand, some gravel and silt, gray.					
				-GLACIAL TILL-					
				Bottom of Exploration at 27'; Not Refusal.					

Notes:

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Boring Log: B105-OW
Total Depth (ft): 40
Sheet 1 of 2

Project Name: Proposed VAWR Parking Garage
RWG&A Project No. 0435-010
Location: West Roxbury, MA
Client: PDT Architects
RWG&A Representative: OHI Rep. B. Snow
Boring Location: See Exploration Location Plan
Boring Abandonment Method: Installed 2" diameter well
Observed Water Depth: 7'

Drilling Contractor: New England Boring Contractors
Drill Rig: Truck Rig
Driller Rep.: M. D'Ambrosio
Date Started: 10/06/2014
Date Completed: 10/06/2014
Surface Elevation: ()
Drilling Method: Rotary Wash
Casing Type: 4" steel

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	LAB TESTS	CASING BLOWS 300 lb. HAMMER PER FOOT
0				ASPHALTIC PAVEMENT (4 inches).					
			S-1	AGGREGATE BASE/SUBBASE; Moist, medium dense, sand with gravel, coarse to fine sand, some gravel, few silt, brown, tan, and black.	18	14 12 9	21		13
			S-2		20	9 10 10	34		18 34
5			S-3	COMMON FILL; Wet, medium dense to dense, fine to medium sand, some silt, black, brown, and gray.	20	24 23 21	38		55 17
	▽		S-4		20	19 19 15	18		8 16
			S-5	PEAT AND ORGANIC SILT (PT); Wet, loose, fibrous, organic odor, dark brown.	24	5 10 8	44		42 47
10				-MARSH-		8 16 22			47 44
				SAND WITH GRAVEL (SP); Wet, dense, medium to coarse sand, some gravel, little silt, gray.		22 17			44
				-ALLUVIAL-					29
15			S-6	SILTY SAND (SM); Wet, medium dense, medium to fine sand, some silt, gray to reddish-brown.	18	6 7 6	13		14 27
				-ALLUVIAL-		11			28
				CLAYEY SANDS (SC) Wet, medium dense, fine sand, some clay and silt, gray and brown.					27
				-ALLUVIAL-					17
20			S-7	SAND WITH GRAVEL (SP); Wet, medium dense, fine to coarse sand, little gravel, few silt, gray.	6	7 7 6	13		26 29
						6			32
									41
									27
25			S-8		10	8 6 6	12		27 31
				-ALLUVIAL-		5			32 53
				SAND WITH GRAVEL AND SILT (SW); Wet, dense, fine to coarse sand,					61

Notes:

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Boring Log: B105-OW
Total Depth: 40
Sheet 2 of 2

Project Name: Proposed VAWR Parking Garage
Location: West Roxbury, MA
Client: PDT Architects
Observed Water Depth: 7'

RWG&A Project No. 0435-010
Surface Elevation: ()
Casing Type: 4" steel

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	LAB TESTS	CASING BLOWS 300 lb. HAMMER PER FOOT
30			S-9	little gravel and silt, gray.	12	21 22 25 24	47		28 40 72 58
				-GLACIAL FLUVIAL-					
				SILTY SAND WITH GRAVEL (SM); Wet, dense, coarse sand, some gravel and silt, gray.					71
35			S-10		3	35 17 21 38	38		53 40 73 70
				-GLACIAL TILL-					125
40				Bottom of Exploration at 40'; SPT Refusal.					
45									
50									
55									

Notes:

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Boring Log: P101
Total Depth (ft): 11
Sheet 1 of 1

Project Name: Proposed VAWR Parking Garage
RWG&A Project No. 0435-010
Location: West Roxbury, MA
Client: PDT Architects
RWG&A Representative: OHI Rep. B. Snow
Boring Location: See Exploration Location Plan
Boring Abandonment Method: Installed 2" diameter well
Observed Water Depth: 7'

Drilling Contractor: New England Boring Contractors
Drill Rig: Truck Rig
Driller Rep.: M. D'Ambrosio
Date Started: 10/06/2014
Date Completed: 10/06/2014
Surface Elevation: ()
Drilling Method: Rotary Wash
Casing Type: 4" steel

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	LAB TESTS	CASING BLOWS 300 lb. HAMMER PER FOOT
0				ASPHALTIC PAVEMENT (4 inches).					
				AGGREGATE BASE/SUBBASE; Moist, sand with gravel, medium to fine sand, some gravel, few silt, brown and tan.					
				COMMON FILL; Wet, medium dense, coarse to medium sand, some silt, gray.					
5			S-1		12	8 8 5	13		
	▽		S-2	PEAT AND ORGANIC SILT (PT); Wet, loose, fibrous, organic odor, dark brown.	20	3 2 0	7		
			S-3	-MARSH-	8	7 5	40		
10				SAND WITH GRAVEL (SW); Wet, dense, fine to coarse sand, some gravel, little silt, gray.		20 20 20 19			
				-ALLUVIAL-					
				Bottom of Exploration at 11'; Not Refusal.					
15									
20									
25									

Notes:

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Boring Log: P102
Total Depth (ft): 13
Sheet 1 of 1

Project Name: Proposed VAWR Parking Garage
RWG&A Project No. 0435-010
Location: West Roxbury, MA
Client: PDT Architects
RWG&A Representative: OHI Rep. B. Snow
Boring Location: See Exploration Location Plan
Boring Abandonment Method: Installed 2" diameter well
Observed Water Depth: 7'

Drilling Contractor: New England Boring Contractors
Drill Rig: Truck Rig
Driller Rep.: M. D'Ambrosio
Date Started: 10/08/2014
Date Completed: 10/08/2014
Surface Elevation: ()
Drilling Method: Rotary Wash
Casing Type: 4" steel

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	LAB TESTS	CASING BLOWS 300 lb. HAMMER PER FOOT
0				ASPHALTIC PAVEMENT (4 inches).					
				AGGREGATE BASE/SUBBASE; Moist, sand with gravel, medium to fine sand, some gravel, few silt, brown and tan.					
				COMMON FILL; Wet, fine to medium sand, some silt, gray.					
5			S-1	PEAT AND ORGANIC SILT (PT); Wet, loose, fibrous, organic odor, dark brown.	0	13 8 5	13		
	▽		S-2		0	5 10	11		
			S-3	-MARSH-	16	6 5 4	13		
10				SILTY SAND WITH GRAVEL (SM); Wet, medium dense to very dense, fine to coarse sand, some gravel, some silt, gray.		4 3			
			S-4	-ALLUVIAL-	20	10 25	65		
				Bottom of Exploration at 13'; Not Refusal.		20 22 43 13			
15									
20									
25									

Notes:

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Boring Log: P103
Total Depth (ft): 13
Sheet 1 of 1

Project Name: Proposed VAWR Parking Garage
RWG&A Project No. 0435-010
Location: West Roxbury, MA
Client: PDT Architects
RWG&A Representative: OHI Rep. B. Snow
Boring Location: See Exploration Location Plan
Boring Abandonment Method: Installed 2" diameter well
Observed Water Depth: 7'

Drilling Contractor: New England Boring Contractors
Drill Rig: Truck Rig
Driller Rep.: M. D'Ambrosio
Date Started: 10/06/2014
Date Completed: 10/06/2014
Surface Elevation: ()
Drilling Method: Rotary Wash
Casing Type: 4" steel

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	LAB TESTS	CASING BLOWS 300 lb. HAMMER PER FOOT
0				ASPHALTIC PAVEMENT (4 inches).					
				AGGREGATE BASE/SUBBASE; Moist, sand with gravel, medium to fine sand, some gravel, few silt, brown and tan.					
				COMMON FILL; Wet, loose, fine to medium sand, some silt, black.					
5			S-1		18	2 3	5		
	▽		S-2		18	2 5 5	7		
						3			
			S-3	PEAT AND ORGANIC SILT (PT); Wet, loose, fibrous, organic odor, dark brown.	18	4 4	52		
10				-MARSH-		15			
			S-4	SAND WITH GRAVEL (SW); Wet, medium dense to very dense, coarse to fine sand, some gravel, little silt, gray.	20	26 26	29		
				-ALLUVIAL-		18			
				Bottom of Exploration at 13'; Not Refusal.		16 15 14 13			
15									
20									
25									

Notes:

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Boring Log: P104
Total Depth (ft): 10
Sheet 1 of 1

Project Name: Proposed VAWR Parking Garage
RWG&A Project No. 0435-010
Location: West Roxbury, MA
Client: PDT Architects
RWG&A Representative: OHI Rep. B. Snow
Boring Location: See Exploration Location Plan
Boring Abandonment Method: Installed 2" diameter well
Observed Water Depth: 7'

Drilling Contractor: New England Boring Contractors
Drill Rig: Truck Rig
Driller Rep.: M. D'Ambrosio
Date Started: 10/08/2014
Date Completed: 10/08/2014
Surface Elevation: ()
Drilling Method: Rotary Wash
Casing Type: 4" steel

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	LAB TESTS	CASING BLOWS 300 lb. HAMMER PER FOOT
0				ASPHALTIC PAVEMENT (4 inches).					
				AGGREGATE BASE/SUBBASE; Moist, sand with gravel, medium to fine sand, some gravel, few silt, brown and tan.					
				COMMON FILL; Wet, medium dense, fine to medium sand, some silt, gray					
5			S-1		18	5 8 5	13		
	▽		S-2	PEAT AND ORGANIC SILT (PT); Wet, loose, fibrous, organic odor, dark brown.	10	18 9 5	8		
				-MARSH-					
			S-3		9	3 2 4	≅ 8	MC=130% OC=45%	
10				SILTY SAND WITH GRAVEL (SM); Wet, very dense, medium to coarse sand, some gravel, some silt, gray.		65/3"			
				-ALLUVIAL-					
				Bottom of Exploration at 10'; SPT Refusal.					
15									
20									
25									

Notes:

APPENDIX B

GROUNDWATER OBSERVATION WELL CONSTRUCTION DETAIL

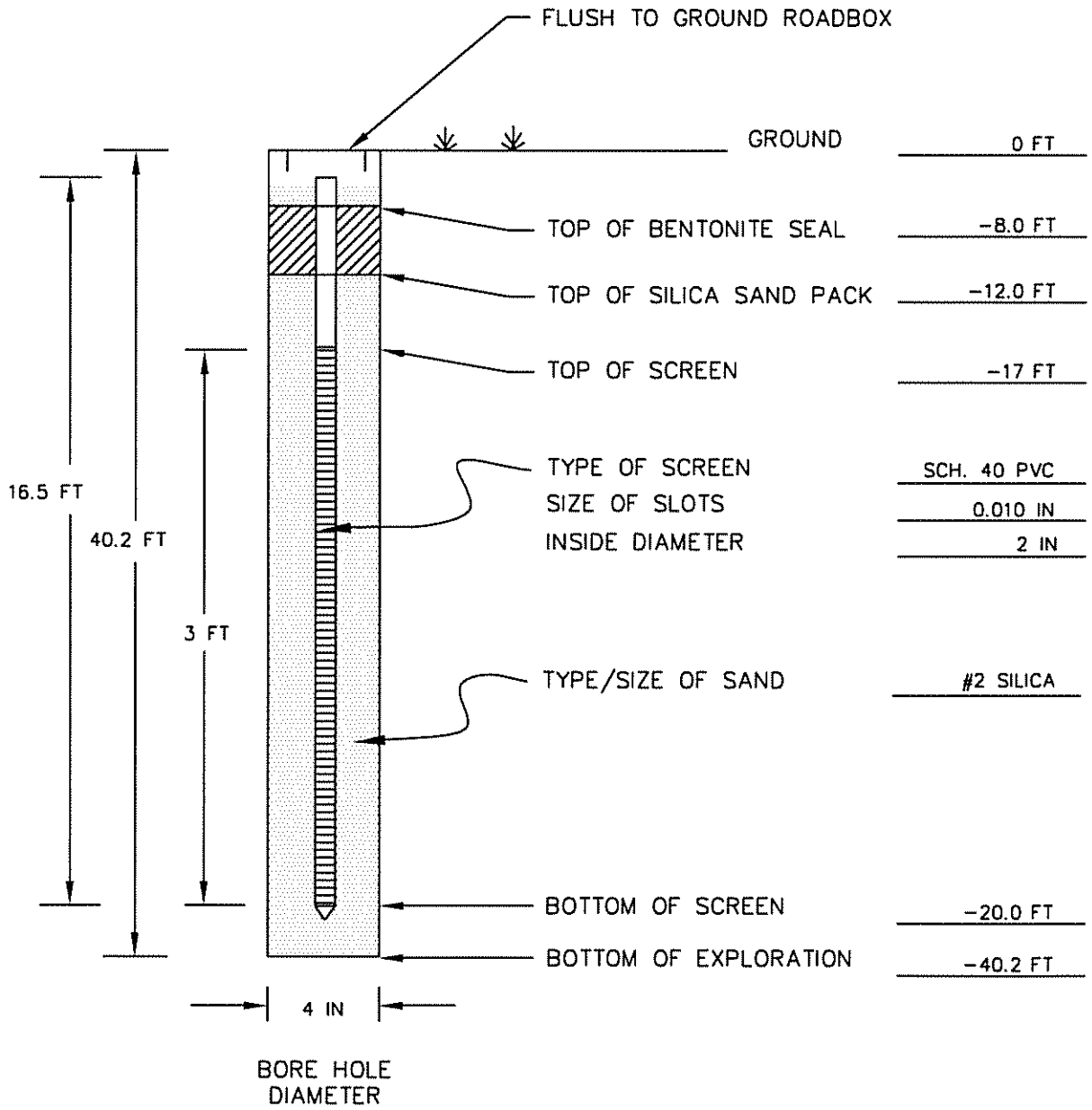
TEST BORING B105-OW

Report of Geotechnical Evaluation
AE Renovate Parking Garage VAMC WR
West Roxbury, Massachusetts

GROUNDWATER OBSERVATION WELL CONSTRUCTION DETAIL

WELL ID: B-105 GROUNDWATER DISTANCE BELOW GROUND: 9 FT

DATE: 10-06-2014



WATER LEVEL READINGS

REFERENCE POINT: GROUND SURFACE ELEVATION:

DATE:	ELAPSED TIME:	WATER DEPTH, BELOW REFERENCE	BY:
10-06-2014	0 DAY	9.0 FT. +/-	BS
10-08-2014	2 DAYS	7.91 FT.	BS
10-17-2014	11 DAYS	7.87 FT.	BS
10-28-2014	20 DAYS	7.09 FT.	BS
12-11-2014	66 DAYS	5.44 FT.	BS
01-06-2015	92 DAYS	6.50 FT.	CSM

R.W. GILLESPIE & ASSOCIATES, INC.

PROJECT: PROPOSED PARKING GARAGE
LOCATION: WEST ROXBURY, MA
PROJECT NO.: 0435-010
DESCRIPTION: GROUNDWATER MONITORING WELL (SHALLOW, CONFINED)
DRILLING DATE: 06 OCTOBER 2014

G:\AutoCad\400\435-010\B-105 GW OBS.WELL 0435-010.dwg, 1/7/2015 12:19:18 PM, Xerox WorkCentre 7855 GPD

APPENDIX C

TEST BORING AND PROBE LOGS

APRIL 2014

PRELIMINARY GEOTECHNICAL EVALUATION

Report of Geotechnical Evaluation
AE Renovate Parking Garage VAMC WR
West Roxbury, Massachusetts

R.W. Gillespie & Associates, Inc.
Geotechnical Engineering•Geohydrology•Materials Testing Services

Boring Log: B-03-14
Total Depth (ft): 27
Sheet 1 of 1

Project Name: AE Renovate Parking Garage - VAMC WR
RWG&A Project No. 0435-010
Location: West Roxbury Massachusetts
Client: PDT Architects
RWG&A Representative: C. Morrell
Boring Location: See Exploration Location Plan
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 6.5'

Drilling Contractor: Great Works Test Boring
Drill Rig: B53 Rubber Track
Driller Rep.: P. Michaud
Date Started: 01 April 2014
Date Completed: 01 April 2014
Surface Elevation: ()
Drilling Method: Rotary Wash
Casing Type: 4" Steel

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0			S-1	ASPHALTIC PAVEMENT (2 inches).	15	5 8 8	16		
				FILL; Silty sand with gravel, medium dense to dense, moist, fine to medium sand, some silt, little gravel, brown then dark gray-brown.					
			S-2		12	10 10 16 25	41		
5			S-3		11	25 8 6	12		
			S-3A	PEAT (PT); silty sand with slight organic odor, possible peat from 7 to 10 feet.	36	6 5		38	GS, MC, OC
10			S-4	SILTY SAND (SM); Medium dense, moist to wet, fine to medium sand, few gravel, gray.	10	14 12 12 12	24		
				SILTY SAND (SM); Medium dense, wet, fine sand, some silt, gray-brown.					
15			S-5		12	9 12 15 10	27		
				SILTY SAND WITH GRAVEL (SM); Medium dense, wet, fine to medium sand, some silt, little gravel, brown.					
20			S-6		2	12 9 10 15	19		
25			S-7	GRAVELLY SAND WITH SILT (GM); Very dense, wet, fine to coarse sand, some gravel, little silt, brown. [Glacial Till]		34 23 28 37	51		
				Bottom of Exploration at 27'; Not Refusal.					
30									

Notes: Used "driller's mud" after losing water around 1.5'. After 20' SPT drove 4" casing to 20'. Lost more water (50 gal ±) around 22', drove casing to 25' then drilling to 25'.

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Boring Log: P-3
Total Depth (ft): 31
Sheet 1 of 2

Project Name: AE Renovate Parking Garage - VAMC WR
RWG&A Project No. 0435-010
Location: West Roxbury, Massachusetts
Client: PDT Architects
RWG&A Representative: C. Morrell
Boring Location: See Exploration Location Plan
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: Not Obs.

Drilling Contractor: Great Works Test Boring
Drill Rig: B53 Rubber Track
Driller Rep.: P. Michaud
Date Started: 01 April 2014
Date Completed: 01 April 2014
Surface Elevation: ()
Drilling Method: SSA
Casing Type: N/A

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				FILL; Silty sand, moist, fine sand, little silt, few fine gravel, dark brown.					
5				FILL; Gravelly sand, moist, fine to medium sand, little gravel, few silt, dark brown.					
				SILTY SAND (SM); Moist, fine sand, little silt, brown.					
10									
15									
20									
25									
30									

Notes:

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Boring Log: P-3
Total Depth: 31
Sheet 2 of 2

Project Name: AE Renovate Parking Garage - VAMC WR
Location: West Roxbury Massachusetts
Client: PDT Architects
Observed Water Depth: Not Obs.

RWG&A Project No. 0435-010
Surface Elevation: ()
Casing Type: N/A

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
30				Bottom of Exploration at 31'; Not Refusal.					
35									
40									
45									
50									
55									
60									

Notes:

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Boring Log: P-4
Total Depth (ft): 31
Sheet 1 of 2

Project Name: AE Renovate Parking Garage - VAMC WR
RWG&A Project No. 0435-010
Location: West Roxbury, Massachusetts
Client: PDT Architects
RWG&A Representative: C. Morrell
Boring Location: See Exploration Location Plan
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 10'

Drilling Contractor: Great Works Test Boring
Drill Rig: B53 Rubber Track
Driller Rep.: P. Michaud
Date Started: 01 April 2014
Date Completed: 01 April 2014
Surface Elevation: ()
Drilling Method: SSA
Casing Type: N/A

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				FILL; TOPSOIL AND ORGANIC MATERIAL (2 inches).					
				FILL; Sand, moist, fine to medium sand, few gravel, few silt, brown.					
5									
				SILTY SAND (SM); Moist then wet, fine to medium sand, some silt, few fine gravel from 10' - 15', brown.					
10 ▽									
15									
20									
				Increased drilling resistance around 23'.					
25									
30									

Notes:

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Boring Log: P-4
Total Depth: 31
Sheet 2 of 2

Project Name: AE Renovate Parking Garage - VAMC WR
Location: West Roxbury Massachusetts
Client: PDT Architects
Observed Water Depth: 10'

RWG&A Project No. 0435-010
Surface Elevation: ()
Casing Type: N/A

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
30									
				Bottom of Exploration at 31'; Not Refusal.					
35									
40									
45									
50									
55									
60									

Notes:

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Boring Log: P-6
Total Depth (ft): 30
Sheet 1 of 2

Project Name: AE Renovate Parking Garage - VAMC WR
RWG&A Project No. 0435-010
Location: West Roxbury, Massachusetts
Client: PDT Architects
RWG&A Representative: C. Morrell
Boring Location: See Exploration Location Plan
Boring Abandonment Method: Backfilled with cuttings
Observed Water Depth: 6'

Drilling Contractor: Great Works Test Boring
Drill Rig: B53 Rubber Track
Driller Rep.: P. Michaud
Date Started: 01 April 2014
Date Completed: 01 April 2014
Surface Elevation: ()
Drilling Method: SSA
Casing Type: N/A

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
0				ASPHALTIC PAVEMENT (4 inches).					
				FILL; Silty sand with gravel, moist, fine to medium sand, some silt, little to few gravel, brown.					
5				SILTY SAND (SM); Moist, fine to coarse sand, some silt and clay, slight organic odor, dark brown, possible peat from 6 to 9 feet.					
10									
15									
20									
25				Probable glacial till around 25', based on drilling resistance.					
30									

Notes:

R.W. Gillespie & Associates, Inc.
Geotechnical Engineering•Geohydrology•Materials Testing Services

Boring Log: P-6
Total Depth: 30
Sheet 2 of 2

Project Name: AE Renovate Parking Garage - VAMC WR
Location: West Roxbury Massachusetts
Client: PDT Architects
Observed Water Depth: 6'

RWG&A Project No. 0435-010
Surface Elevation: ()
Casing Type: N/A

DEPTH, FT.	SYMBOL	SAMPLES	SAMPLE NUMBER	DESCRIPTION OF MATERIAL	SAMPLE RECOVERY, IN.	BLOWS PER 6"	SPT-N BLOWS PER FT.	MOISTURE CONTENT %	LAB TESTS
30				Bottom of Exploration at 30'; Not Refusal.					
35									
40									
45									
50									
55									
60									

Notes:

APPENDIX D

TEST BORING LOGS BY OTHERS

JUNE 1983 and DECEMBER 1984

Report of Geotechnical Evaluation
AE Renovate Parking Garage VAMC WR
West Roxbury, Massachusetts

GOLDBERG-ZOINO & ASSOCIATES, INC.
380 NEEDHAM ST, NEWTON UPPER FALLS, MA.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
V.A. Medical Center
West Roxbury, MA

REPORT OF BORING No A-10
SHEET 1 OF 1
FILE No G-3731
CHKD BY JVE

BORING Co. GZA Drilling, Inc.
FOREMAN F. Prefy
GZA ENGINEER C. Croalone/Alw

BORING LOCATION See Plan
GROUND SURFACE ELEVATION 90.8 DATUM NGVD
DATE START 6/17/93 DATE END 6/17/93

SAMPLER UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140lb HAMMER FALLING 30in.
CASING UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300lb HAMMER FALLING 24 in
CASING SIZE: Hollow Stem Auger OTHER:

WATER LEVEL READINGS	DATE	TIME	DEPTH	CASING	STABILIZATION TIME
	6/17		5.0'		COMPLETION OF

ELEVATION (FT)	DEPTH (FT)	SAMPLE No.	SAMPLE RECOVERY/ATTEMPT (in)	SAMPLE DEPTH (FT)	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION (CONSISTENCY, CLASSIFICATION)	STRATUM	STRATUM DESCRIPTION
		S-1	24/6	0-2	2-4-4-3	Loose, black, fine to medium SAND, little(+) Silt (TOPSOIL/FILL).	1	TOPSOIL/FILL 5.0'
	5	S-2	24/14	5-7	2-2-2-3	Soft, brown PEAT, slightly fibrous.		PEAT 8.0'
	10	S-3	24/8	10-12	11-15-16-16	Dense, gray, fine to coarse SAND, little Silt, trace(+) Gravel.		SAND 13.0'
		S-4	24/9	13-15	11-13-14-15	Medium dense, brown to gray, Clayey SILT, trace fine to medium Sand.		CLAYEY SILT 15.0'
	15							Bottom of hole.
	20							

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	CONSISTENCY
0-4	V LOOSE	< 2	V SOFT
4-10	LOOSE	2-4	SOFT
10-30	M DENSE	4-8	M STIFF
30-50	DENSE	8-15	STIFF
>50	V DENSE	15-30	V STIFF
		>30	HARD

REMARKS 1. Proposed Helipad site.

NOTES: SOIL STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
GROUNDWATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. A-10

GOLDBERG-ZOINO & ASSOCIATES, INC.
390 WEDGEMERE ST., NEWTON UPPER FALLS, MA.
GEOTECHNICAL/HYDROLOGICAL CONSULTANTS

PROJECT
VA Medical Center
Jamaica Plain, MA

REPORT OF BORING No. G-1
SHEET ___ OF ___
FILE No. G-3731.2
CHKD BY JVK

BORING Co. GZA Drilling, Inc.
FOREMAN Paul Farnsworth
GZA ENGINEER C. Petersen/Wells

BORING LOCATION See Plan
GROUND SURFACE ELEVATION 91± DATUM MSVD
DATE START 12/18/84 DATE END 12/18/84

SAMPLER UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140# HAMMER FALLING 30".

CASING UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300# HAMMER FALLING 24".

CASING SIZE 3" OTHER

GROUNDWATER READINGS				
DATE	TIME	HOLE	CASING	STABILIZATION TIME
12/18	1100	C	C	60 min.

BLOWS PER 6"	RECOVERY	SAMPLE No.	SAMPLE TYPE	SAMPLE DEPTH FT.	BLOWS/6"	SAMPLE DESCRIPTION (Burmister CLASSIFICATION)	ELEVATION	STRATUM DESCRIPTION
		S-1	18/8	0-1.5	2-10-14	Medium dense, black, coarse to fine SAND, little Silt, trace Gravel, 40% Cinders, Brick chips and Roots (FILL).		FILL
								4.0'
5		S-2	18/8	5.0-6.5	2-3-2	Soft, black, fibrous PEAT and ROOTS.		PEAT
								6.5'
								SAND and GRAVEL
10		S-3	18/12	10.0-11.5	17-21-29	Dense, blue gray, coarse to fine SAND, some coarse to fine Gravel, little Silt, trace Roots.	1	11.5'
								Bottom of hole at 11.5'.

GRANULAR SOILS			COHESIVE SOILS		
BLOWS/FT	DENSITY		BLOWS/FT	DENSITY	
0-4	V	LOOSE	<2	V	SOFT
4-10		LOOSE	2-4		SOFT
10-30	M	DENSE	4-8	M	STIFF
30-60		DENSE	8-15		STIFF
>60	V	DENSE	15-30	V	STIFF
			>30		HARD

REMARKS

1. Groundwater not encountered, samples damp.

NOTES: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
GROUNDWATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. G-1

GOLDBERG-ZOINO & ASSOCIATES, INC.
320 NEEDHAM ST., NEWTON UPPER FALLS, MA.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
VA Medical Center
West Roxbury, MA

REPORT OF BORING No G-2
SHEET [illegible] OF [illegible]
FILE No. G-3731.[illegible]
CHKD BY JVL

BORING Co. GZA Drilling, Inc.
FOREMAN [illegible]
GZA ENGINEER [illegible]

BORING LOCATION See Plan
GROUND SURFACE ELEVATION 91.5 ± DATUM NGVD
DATE START 12/18/84 DATE END 12/18/84

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140lb HAMMER FALLING 30 in.
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300lb HAMMER FALLING 24 in.
CASING SIZE: 3" OTHER:

GROUNDWATER READINGS

DATE	TIME	[illegible]	[illegible]	STABILIZATION TIME
12/18	9:10	[illegible]	[illegible]	completion

DEPTH (ft)	CASING	SAMPLE No.	PEN/REC	SAMPLE DEPTH (ft)	BLOWS/6"	SAMPLE DESCRIPTION (Burmister Classification)	STRATUM DESCRIPTION
		S-1	18/8	0-1.5	1-2-2	Very loose, dark brown, medium to fine SAND, little Gravel, little Silt, 50% Cinders, Brick chips (FILL).	FILL
5		S-2	18/6	5-6.5	6-4-2	Loose, black, medium to fine SAND, trace Gravel, 50% Cinders.	
		S-3A		6.5-7		Black, fibrous PEAT changing to gray, coarse to fine SAND and GRAVEL, little Silt, trace Roots, Fibers.	6.5' 7.0' PEAT
10		S-3	18/6	10-11.5	22-30-30	Very dense, yellow-gray, coarse to fine SAND, some Gravel, trace+ Silt.	SAND AND GRAVEL
							11.5' Bottom of hole at 11.5'

GRANULAR SOILS BLOWS/FT	DENSITY	COHESIVE SOILS BLOWS/FT	DENSITY
0-4	V. LOOSE	<2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

REMARKS:

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. G-2