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JOHN TURNER CONSULTING
GEOTECHNICAL ▼ ENVIRONMENTAL ▼ RESIDENT ENGINEERING ▼ TESTING

# PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

## PROPOSED ADDITION TO THE WHEELER MEMORIAL LIBRARY
## 49 EAST MAIN STREET
## ORANGE, MASSACHUSETTS

**Prepared For:**

$P^3$ Project Planning Professionals
150 Longwater Drive, Suite 102
Norwell, Massachusetts 02061-1618

**Prepared By:**

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JTC Project No.: 16-15-069

January 13, 2017

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# PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

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Senior Geotechnical Engineer

**DATE:** January 13, 2017

**RE:** **PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT**
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**ORANGE, MASSACHUSETTS**
**JTC Project No. 16-15-069**

John Turner Consulting, Inc. (JTC) is pleased to present this *Preliminary Geotechnical Investigation Report* for a proposed Addition to the Wheeler Memorial Library located at 49 East Main Street in Orange, Massachusetts. JTC conducted geotechnical explorations, laboratory testing, and engineering evaluations in general accordance with our proposed scope of services submitted to P³ Project Planning Professionals (P³) on November 15, 2016. P³ authorized our work on November 29, 2016.

The purpose of this preliminary geotechnical investigation was to obtain general information on the subsurface conditions at the site and to provide preliminary geotechnical engineering recommendations to support the planning and preliminary design of the proposed development. A supplemental/pre-design geotechnical investigation program should be performed at the appropriate time in order to provide geotechnical engineering recommendations to support final design and construction.

Geotechnical explorations and laboratory testing services were performed in December of 2016. This report summarizes available project information, presents the geotechnical exploration and laboratory testing programs, describes the subsurface conditions encountered, and provides geotechnical engineering recommendations to support the planning, design, and construction of the proposed development. The contents of this report are subject to the attached *Limitations*.

## 1.0 PROJECT INFORMATION

The following subsections provide general descriptions of the site, the regional geologic setting, and the proposed development.

### 1.1 Site Description

The site is located along the north side of East Main Street (Route 2A) and just west of Grove Street in Orange, Massachusetts. Presently, the existing 4,030 square foot (footprint) library building occupies the southwest corner of the site. The southeast side of the site is open/undeveloped and primarily grass-covered. The northern half of the site is occupied by asphalt-paved parking and unpaved parking areas. The provided *Existing Conditions Plan* (attached) indicates a very gradual downward slope from the northeast to the southwest with existing grades ranging from about +518 feet to +511 feet across the site.

### 1.2 Regional Geologic Setting

JTC's review of the "Surficial Geologic Map of the Orange Quadrangle, Massachusetts" (Stone, J.R., 2013; Open File Report 2006-1260-I, sheet 5 of 24) indicates that site soils are characterized by Alluvial-Fan Deposits which includes generally coarse gravel and sand deposited on steep slopes where high-gradient streams entered lower gradient valleys.

### 1.3 Proposed Development

JTC understands that the proposed development involves the construction of a new one-story approximately 6,000 square foot addition to the existing library and associated asphalt-concrete paved parking and driveway areas (see attached *Site Plan*). The construction will also include a renovation of the lower level/basement of the existing library building. We understand that design details are still being developed, but that the intent is to support the new addition on a conventional shallow spread footing foundation with a concrete floor slab-on-grade (and no basement). The provided *Site Plan* indicates a first-floor finish-floor-elevation (FFE) of +515.88 feet, which will result in cuts and fills of about 1.5 feet and 4 feet, respectively, based on existing ground surface elevations of about +517 feet to +512 feet within the footprint of the proposed addition.

Site-specific structural loading was not available at the time of this report. As such, JTC has assumed the following structural loading conditions based on our experience with similar developments:

- Strip/wall footing loads will be on the order of 6 kips per linear foot or less;
- Column loads will be on the order of 100 kips or less; and
- Live loads applied to the floor slab-on-grade will be on the order of 125 pounds per square foot (psf) or less.

## 2.0 GEOTECHNICAL EXPLORATIONS & LABORATORY TESTING

The primary components of the geotechnical exploration and laboratory testing programs are described in the following subsections.

### 2.1 Geotechnical Explorations

JTC subcontracted Seaboard Drilling, Inc. to perform two (2) geotechnical test borings (designated as B-1 and B-2) via a truck-mounted Mobile B-53 drill rig. JTC directed the drilling, testing, and sampling activities and logged the subsurface conditions encountered at each boring location. $P^3$ selected the proposed boring locations. JTC field-located the proposed borings considering the existing site features and proposed development, and under the constraints of drill rig access and utility conflicts. Subsequently, the relative location of each exploration was established via measurements from existing site features and scaling the dimensions onto the provided plan(s). The attached *Test Boring Location Plan* depicts the approximate boring locations.

The test borings were advanced to a depth of 27 feet below the ground surface (bgs) utilizing 4½-inch inside-diameter continuous-flight hollow-stem-augers (HSAs). As the borings were advanced, standard penetration tests (SPTs) were conducted at regular intervals and soil samples were obtained via 2-inch outside-diameter split-spoon samplers driven by an automatic 140-pound hammer. SPTs were performed in general accordance with ASTM D1586, Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils. The test borings were backfilled with soil cuttings upon completion of drilling. Soil samples were sealed in moisture-tight containers and returned to JTC's office for further review, classification, and/or geotechnical laboratory testing. Detailed records of the drilling, testing, and sampling performed and the soil, bedrock, and groundwater conditions observed at each test boring location are provided on the attached *Test Boring Logs*.

### 2.2 Geotechnical Laboratory Testing

JTC selected representative soil samples for geotechnical laboratory testing at our in-house laboratory. The following tests were performed:

- 3 Moisture contents; and
- 3 Particle-size analyses.

Geotechnical laboratory testing was performed in general accordance with ASTM procedures. Test results are provided on the attached *Geotechnical Laboratory Testing Reports*.

## 3.0 SUBSURFACE CONDITIONS

The following subsections describe the site soil, bedrock, and groundwater conditions encountered, based on results of the geotechnical explorations and laboratory testing. Detailed descriptions of the conditions observed at each test boring are provided on the attached *Test Boring Logs*.

## 3.1 Soils

The overburden soils encountered at the test boring locations appear to be generally consistent with those described by the published geologic data. The primary soil strata are briefly described in the paragraphs below.

### 3.1.1 Topsoil

Topsoil materials were encountered at the ground surface at each test boring location. The Topsoil consisted of dark brown silty fine to medium sand (SM) and contained occasional to frequent roots, rootlets, and organics. The Topsoil was about 0.5 feet thick at each boring location.

### 3.1.2 Existing Fill

A layer of granular soil described as dark brown silty fine to coarse sand (SM) with trace amounts of gravel was encountered beneath the Topsoil in Boring B-2 at a depth of 0.5 feet bgs. This stratum contained occasional fragments of asphalt-concrete pavement. JTC interprets these soils to be Existing Fill materials. Where encountered, the Existing Fill was about 2 feet thick and extended to a depth of about 2.5 feet bgs. The Existing Fill was described as medium dense based on an SPT N-value of 15.

### 3.1.3 Alluvial Sand and Silt

Olive brown, brown, and/or gray soils generally described as silty fine sand (SM), fine to medium sand with silt (SW-SM), and silty fine to medium sand (SM) were encountered beneath the Topsoil and/or Existing Fill materials at depths of 0.5 feet bgs (B-1) and 2.5 feet bgs (B-2). JTC interprets this stratum to be Alluvial Sand. The Alluvial Sand appears to be stratified/interlayered with layers of olive brown to gray silt (ML) and/or silt with sand (ML) (i.e., Alluvial Silt) at depths greater than about 15 feet bgs. The Alluvial Sand and Silt was described as loose to medium dense based on SPT N-values ranging from 6 to 30 with an average of about 18.

## 3.2 Bedrock

Bedrock was not encountered at any of the exploration locations.

## 3.3 Groundwater

Groundwater was encountered at depths of 3 feet bgs and 5 feet bgs at the time of drilling. These depths correspond to groundwater elevations of +509.5 feet and +511.0 feet. However, short-term (i.e., during drilling, upon completion of drilling, and/or a few hours after drilling) water levels observed in test borings performed in silty soils should be considered approximate. JTC estimates that this investigation occurred during a period of seasonally normal ground water. Site groundwater levels should be expected to fluctuate seasonally and in response to precipitation events, construction activity, site use, and adjacent site use.

## 4.0 PRELIMINARY GEOTECHNICAL ENGINEERING RECOMMENDATIONS

This preliminary evaluation of the site and the proposed development was based on the subsurface conditions encountered at the geotechnical test borings, results of geotechnical laboratory testing, provided site/grading plans, and assumed/preliminary structural loading conditions, as described herein. A supplemental/pre-design geotechnical investigation should be performed at the appropriate time to obtain additional subsurface information within the footprint of the proposed development in order to provide geotechnical engineering recommendations to support final design and construction.

The Topsoil and Existing Fill materials are not suitable for direct support of foundations. These soils should be completely removed from the building pad (i.e., the proposed building/addition footprint plus at least 5 feet laterally) during the initial phases of site preparation and grading. Subsequently, JTC believes that the proposed addition can be supported upon shallow foundations bearing on undisturbed native Alluvial Sand and/or *Structural Fill* or Crushed Stone built-up from properly prepared native soils, provided that the geotechnical design and construction recommendations presented herein are satisfied.

### 4.1 Site Preparation and Grading

Site preparation and grading should be performed in accordance with the following procedures:

- A geotechnical engineer should directly observe site preparation and grading activities;
- The site soils contain substantial proportions of fine sand, silt, and/or clay, and may degrade and/or become unworkable when subjected to construction traffic or other disturbance during wet conditions. As such, site preparations, grading, and earthworks should be performed during a dry season if possible. The Contractor shall be aware of these conditions and must take precautions to minimize subgrade disturbance. Such precautions may include diverting storm run-off away from construction areas, reducing traffic in sensitive areas, minimizing the extent of exposed subgrade if inclement weather is forecast, backfilling excavations and footings as soon as practicable, grading (and compacting) exposed subgrades to promote surface water run-off, and maintaining an effective dewatering program, as necessary. Over-excavation to remove degraded or unworkable subgrade soils should be anticipated and budgeted (cost and schedule);
- Any existing buildings, structures, and/or associated foundations (including footings, foundation walls, slabs-on-grade, and/or basements) should be completely removed from proposed building and pavement areas and replaced/backfilled with properly placed and compacted *Structural Fill;*
- Any existing subsurface utilities and underground structures, including any private septic tank, leach field, and associated piping, should be completely removed from the footprint of the proposed building and replaced/backfilled with properly placed and compacted *Structural Fill.* Any existing subsurface utilities in proposed pavement areas should be removed and/or appropriately abandoned in place (e.g., pressure grouting), as approved by the on-site geotechnical engineer;

- The site should be cleared and stripped of any existing pavement/concrete not designated to remain; existing trees/vegetation not designated to remain; Topsoil, Rootmat, Forest Mat; loamy/organic-laden Subsoil; and any otherwise unsuitable materials;
    - The geotechnical explorations indicated a 0.5-foot thick layer of Topsoil; and
    - The geotechnical explorations indicated that the Topsoil may be underlain by 0.5 to 1 foot of silty, loose, and/or organic-laden Subsoil that should be stripped/removed from the proposed building pad area, where encountered.
- Existing Fill and/or any otherwise unsuitable materials should be completely removed from the proposed building footprint, plus about 5 feet laterally;
    - The geotechnical explorations indicate Existing Fill extend about 2.5 feet bgs in some areas of the proposed building; and
    - Additional Existing/Undocumented Fill materials should be expected proximate to any former building(s), foundations, and/or subsurface utilities.
- In cut areas, the final foot of excavation should be performed using a smooth-edged cutting bucket (no teeth) to minimize subgrade disturbance;
- Following clearing, stripping, removal of any Existing Fill/Undocumented Fill/unsuitable soil, and/or cutting to subgrade, the exposed subgrade soils should be proof-rolled using a large smooth-drum roller with successive passes aligned perpendicularly. However, proof-rolling should not be performed if/when the exposed subgrade soils are wet (i.e., due to presence of groundwater, stormwater, perched water, etc.) because this may result in soil pumping and instability. Therefore, the proof-rolling efforts, including the number of passes and whether to employ static or vibratory methods, should be directed by the on-site geotechnical engineer (static methods should be anticipated based on the results of the test borings);
    - Any loose, soft, wet, and/or otherwise unsuitable soils (typically evidenced by rutting, pumping, and/or deflection of the subgrade) should be over-excavated to expose suitable soils, or other remedial measures should be taken, as approved by the on-site geotechnical engineer; and
    - Any over-excavations should be backfilled with properly placed and compacted *Structural Fill.*
- *Structural Fill* should be used for subgrade fill within the building pad. The placement of *Structural Fill* materials to achieve design subgrades in the building pad should not begin until the exposed subgrade soils have been directly observed and approved by the on-site geotechnical engineer;
- *Common Fill* is acceptable for subgrade fill in parking and driveway areas. The placement of *Common Fill* materials to achieve design subgrades in pavement areas should not begin until the exposed subgrade soils have been directly observed and approved by the on-site geotechnical engineer; and
- *Structural Fill* and *Common Fill* materials and placement and compaction requirements are provided in *Table 1* (attached).

## 4.2 Shallow Foundations and Walls

Based on the subsurface conditions encountered at the exploration locations and our current understanding and assumptions relative to the proposed development, the following foundation design recommendations are provided:

- The Topsoil and Existing Fill materials are not suitable for direct support of shallow foundations. These materials should be completely removed from the footprint of the addition, plus 5 feet laterally, as described in Section 4.1.
- The addition may be supported on a system of continuous and/or isolated shallow spread footings bearing on undisturbed native Alluvial Sand and/or on *Structural Fill* or Crushed Stone built-up from properly prepared native soil subgrades;
- Shallow foundations may be designed using an allowable bearing pressure of 3,000 psf. Design bearing pressures may be increased by one-third (⅓) when considering seismic and or transient wind loading conditions;
- Continuous wall footings should have a minimum width of 2 feet. Isolated column footings should have a minimum width of 3 feet;
- Exterior footings should be founded at least 4 feet below the lowest adjacent grade to provide adequate frost protection. Interior footings in heated portions of the building should be founded at least 2 feet below FFE to develop adequate bearing capacity;
- Total post-construction settlements due to applied foundation loads are estimated to be on the order of 1 inch or less, based on strip footing widths and column footing widths of up to 2 feet and 6 feet, respectively. Differential settlements along continuous wall footings and/or between isolated column footings are estimated to be on the order of 0.5 inches or less. The estimated settlements and resulting angular distortion are anticipated to be within the allowable limits for this type of structure;
- A foundation drain system should be installed around the perimeter of the building at the exterior toe of the exterior footings. Foundation drains should consist of 4-inch diameter PVC-SDR35 perforated pipe encased in at least 6 inches of ¾-inch stone protected with a filter fabric such as Mirafi 140N or equal. The drains should be graded to positively drain to a suitable discharge point away from the proposed structure. Drains should not be connected to surface or roof drain discharge points. Clean-outs should be located at bends and no greater than 150 feet on-center. It is recommended that a backflow preventer be installed at the outlet of the drains to reduce the impact of potential surcharges; and
- Recommended lateral earth pressures, drainage requirements, and friction factors for unbalanced walls are provided in Table 2 (attached).

Recommendations for shallow foundation subgrade preparation and construction are provided as follows:

- A geotechnical engineer or his/her representative should directly observe foundation subgrade preparation activities;

- If shallow and/or perched groundwater is encountered, it must be removed in advance of excavation and continuously maintained at least 2 feet below the bottom of excavation and subsequent construction grade until the backfilling is complete;
- Excavations for shallow foundations must extend into undisturbed native Alluvial Sand and/or *Structural Fill* built-up from properly prepared native soils, as described herein;
- The native foundation subgrade soils will be sensitive to moisture and may disturb or soften if exposed to wet conditions and construction activities. Therefore, the final foot, at a minimum, of excavation for foundations should be performed using a smooth-edged cutting bucket (no teeth) to minimize subgrade disturbance. Furthermore, if wet conditions are present or anticipated due to groundwater seepage, perched groundwater, and/or precipitation/stormwater, the foundation subgrade should be protected with a 6-inch (minimum) thick layer of ¾-inch minus crushed stone encased in a geotextile fabric (e.g., Mirafi 140N or equal). The fabric and Crushed Stone shall be placed immediately upon exposure of the native foundation subgrade soils and densified with a plate compactor until exhibiting stable conditions. The purpose of the Crushed Stone is to protect the subgrade soils from disturbance, facilitate construction dewatering (if necessary), and provide a dry/stable subgrade upon which to progress construction;
    - If Undocumented Fill and/or otherwise unsuitable soils/materials are encountered at the foundation subgrade, over-excavations should remove all Fill and/or unsuitable soils within the footing zone of influence, which is defined as the area extending laterally 1 foot from edges of the footing and then outward and downward at a 1H:1.5V (horizontal to vertical) splay of bearing until a suitable native subgrade soil is encountered; and
    - Any over-excavations should be backfilled with properly placed and compacted *Structural Fill* or Crushed Stone as approved by the on-site geotechnical engineer.
- Prior to setting forms and placing reinforcing steel, a geotechnical engineer should directly observe footing subgrades;
    - Footing subgrades should be level or suitably benched and free of standing water and/or debris;
    - Loose, soft, wet, frozen, or otherwise unsuitable soils should either be re-compacted or over-excavated to a suitable subgrade, as approved by the on-site geotechnical engineer; and
    - Over-excavations should be backfilled with properly placed and compacted *Structural Fill* or crushed stone as approved by the on-site geotechnical engineer.
- Foundation subgrade soils should be protected against physical disturbance, precipitation, and/or frost throughout construction. Surface water run-on/run-off should be diverted away from open foundation excavations. The Contractor shall ultimately be responsible for the means and methods to protect the foundation subgrade during construction;

- Interior footings, piers, and/or walls and the interior side of balanced perimeter foundation walls should be backfilled with *Clean Granular Fill* and/or 3-inch minus material meeting the requirements of *Structural Fill,* as described in the attached *Specifications*;
- Exterior footings, piers, and the exterior side of balanced foundation walls should be backfilled with non-frost-susceptible fill in order to mitigate potential adverse effects of frost. Backfill for exterior footings, piers, and foundation walls should consist of well-graded, free-draining, granular soil conforming to the requirements of *Clean Granular Fill*, as described in the attached *Specifications*. Alternatively, a suitable bond break (such as rigid polystyrene insulation) may be provided as approved by the on-site geotechnical engineer. In this case, footings and walls (excluding unbalanced/basement walls) may be backfilled with *Common Fill* (see attached *Specifications*) having a maximum particle-size of 3 inches, as approved by the on-site geotechnical engineer;
- Backfill for footings, piers, and foundation walls should be placed in uniform horizontal lifts having a maximum loose lift thickness of 8 inches and compacted to 95 percent of its modified proctor maximum dry density (MPMDD; per ASTM D1557). Thinner lifts may be required in order to achieve the required compaction criteria;
- To minimize the potential for foundation wall damage during the backfill and compaction activities, it is recommended that foundation wall backfill be placed in a manner that maintains a balanced fill height on both sides of the wall (except for unbalanced walls); and
- Drainage and backfill requirements for unbalanced walls are provided in Table 2 (attached).

### 4.3 Protection of Existing Foundations

It is recommended that where the new foundation is within close proximity to the existing building, that the new footings be constructed at similar grade as the existing footings to mitigate the overlapping of stresses. An imaginary line drawn between the lower edges of adjoining/adjacent footings shall not have a steeper slope than 26.5° (2H:1V) relative to horizontal unless the materials supporting the higher footing are braced or otherwise retained. Furthermore, in no case should the FZOI of the existing foundation be encroached or disturbed without review by a Professional Engineer. In this case, the FZOI is defined as that area extending laterally 1 foot from the edge of the existing footing then projecting laterally outward and downward at a 1H:1V splay.

Underpinning may be required if the existing foundation needs to be undermined to accommodate the new construction. If the existing footings do need to be undermined, it is expected that conventional concrete pit underpinning will be the most practical means of support. Such underpinning involves staggered limited-width excavations beneath the existing foundation and subsequent backfilling of the pits with new concrete. The process essentially lowers the bottom of footing (BOF) of the existing foundation. It is recommended that an experienced Contractor be retained for the underpinning. The Contractor should provide a Technical Submittal to outline the proposed means and methods to protect the existing building and construct the new underpinning pits. JTC can provide technical assistance if underpinning or shoring is necessary for the project.

## 4.4 Floor Slab-On-Grade

Design recommendations for the floor slab-on-grade are provided as follows:

- A modulus of vertical subgrade reaction, $k_{vi}$, of 150 pounds per cubic inch (pci) should be available for structural design of floor slabs-on-grade, provided that the subgrade, *Structural Fill*, and the *Clean Granular Fill* are prepared as recommended in Subsections 4.1, 4.2, and 4.4;
- The floor slab-on-grade should be underlain by a minimum 9-inch thick layer of *Clean Granular Fill* to provide a capillary break and a stable working surface;
- The floor slab should be isolated structurally from foundation walls and columns/piers to allow for differential movement; and
- The need/desire to provide a moisture/vapor barrier beneath floor slab-on-grade should be evaluated by the architect and/or the structural engineer, based on the building's specific interior usage requirements.

During construction, we expect that much of the building footprint will be excavated or disturbed during site preparation and grading (Subsection 4.1), excavations for shallow foundations (Subsection 4.2), and/or excavations for new underground utilities. It is imperative that the subgrade beneath the floor slab-on-grade be reinstated with properly placed and compacted *Structural Fill* and/or prepared as recommended herein. Additionally:

- A geotechnical engineer should directly observe the subgrade soils prior to the placement of the recommended *Clean Granular Fill* base course;
    - The subgrade should be level and free of standing water and/or debris;
    - Loose, soft, wet, frozen, or otherwise unsuitable soils should either be re-compacted or over-excavated to a suitable subgrade, as approved by the on-site geotechnical engineer; and
    - Over-excavations should be backfilled with properly placed and compacted *Structural Fill.*
- The *Clean Granular Fill* base course should not be placed until the subgrade has been reviewed by the on-site geotechnical engineer. Subsequently, the *Clean Granular Fill* should be compacted to the satisfaction of the geotechnical engineer to 95% of its MPMDD.

## 4.5 Seismic Considerations

A site class "D" is recommended based on site class definitions of the American Society of Civil Engineers (ASCE) Standard 7-10, Minimum Design Loads for Buildings and Other Structures. The site is not considered to be susceptible to liquefaction, based on the conditions encountered at the test boring locations.

## 4.6 Re-Use of Site Soils

The Topsoil and any Subsoil materials encountered at the exploration locations are not suitable for re-use as *Structural Fill, Clean Granular Fill,* or *Common Fill.* These soils may be re-used in areas to be landscaped, subject to conformance with the project specifications.

The Alluvial Sand and Silt materials encountered at the exploration locations are not suitable for re-use as *Structural Fill or Clean Granular Fill.* Some of the Alluvial Sand may be suitable for re-use as Common Fill, subject to laboratory testing to demonstrate conformance with the project specifications. Otherwise, these soils may be re-used in areas to be landscaped, subject to conformance with the project specifications.

## 4.7 Construction Monitoring and Quality Control Testing

A qualified geotechnical engineer or representative should be retained to review the site preparation and grading activities and foundation subgrade preparations, at a minimum. Similarly, quality control testing, including in-place field density and moisture tests, should be performed to confirm that the specified compaction is achieved. It is recommended that JTC be retained to provide earthwork construction monitoring and quality control testing services.

Quality control testing recommendations are provided as follows:

- During site grading and foundation subgrade preparation, 3 field density tests should be performed for every 5,000 square feet (per lift) of *Structural Fill* placement, at a minimum. At least 3 tests should be performed on each lift of material even if the lift is less than 5,000 square feet;
- During foundation wall backfilling, 3 field density tests should be performed for every 100 linear feet (per lift) of fill placement, at a minimum. At least 3 tests should be performed on each lift of material even if the lift is less than 100 linear feet;
- During placement and compaction of *Clean Granular Fill* as the base course below the floor slab-on-grade and sidewalks, 3 field density tests should be performed for every 5,000 square feet of placement. At least 3 tests should be performed on each lift of material even if the lift is less than 5,000 square feet;
- During backfilling of utility trenches, at least 1 test should be conducted on *Structural Fill* per 50 linear feet (per lift) of trench; and
- During site grading and pavement subgrade preparation, 3 field density tests should be performed for every 5,000 square feet (per lift) of *Common Fill,* at a minimum. At least 3 tests should be performed on each lift even if the lift is less than 5,000 square feet.

## 4.8 Additional Considerations

Additional design recommendations are provided as follows:

- Exterior concrete sidewalks shall be underlain by at least 18 inches of *Clean Granular Fill*. The thickness of the *Clean Granular Fill* shall be increased to no less than 24 inches for exterior concrete slabs located adjacent to exterior doorways and ramps to provide additional frost protection at building entry/exit points;
- Roof drains or similar features should be provided to collect roof run-off and prevent ponding near the building. Roof drains and other stormwater controls should not discharge to foundation drains;
- The exterior ground surface adjacent to the building should be sloped away from the building to provide for positive drainage. Similarly, the final surface materials adjacent to the building should be relatively impermeable to reduce the volume of precipitation infiltrating into the subsurface proximate to building foundations. Such impermeable materials include cement concrete, bituminous concrete, and/or vegetated silty/clayey topsoil; and
- Permanent fill or cut slopes should have a maximum slope of 2.5H:1V (horizontal to vertical) or flatter for dry conditions. Permanent fill or cut slopes should be no steeper than 3H:1V for wet/submerged conditions (e.g., stormwater basin) unless a properly designed surface slope stabilization system (e.g. rip rap, geosynthetics) is provided.

Additional construction considerations/recommendations are provided as follows:

- Safe temporary excavation and/or fill slopes are the responsibility of the Contractor. Excavations should be conducted in accordance with local, state, and federal (OSHA) requirements, at a minimum. If an excavation cannot be properly sloped or benched due to space limitations, adjacent structures, and/or seepage, the Contractor should install an engineered shoring system to support the temporary excavation;
- Subgrade conditions will be influenced by excavation methods, precipitation, stormwater management, groundwater control(s), and/or construction activities. Most of the site soils are poorly-drained, moisture-sensitive, and considered susceptible to disturbance when exposed to wet conditions and construction activities. As such, the Contractor shall be aware of these conditions and must take precautions to minimize subgrade disturbance. Such precautions may include diverting storm run-off away from construction areas, reducing traffic in sensitive areas, minimizing the extent of exposed subgrade if inclement weather is forecast, backfilling excavations and footings as soon as practicable, and maintaining an effective dewatering program, as necessary;
- Proper groundwater control and stormwater management are necessary to maintain site stability. Groundwater should be removed in advance and continuously maintained at least 2 feet below the working construction grade until earthworks and/or backfilling are complete;

- If groundwater seepage and/or wet soils due to shallow groundwater are observed, a ¾-inch minus crushed stone base should be placed atop the exposed subgrade soils. The stone should be immediately placed atop the undisturbed subgrade and then tamped with a plate compactor until exhibiting stable conditions. The stone shall be protected, as required, with a geotextile filter fabric such as Mirafi 140N or equal. The purpose of the stone base is to protect the wet subgrade, facilitate dewatering, and provide a dry/stable base upon which to progress construction; and
- All slopes should be protected from erosion during (and after) construction.

## 5.0 CLOSING

We trust the contents of this report are responsive to your needs at this time. Should you have any questions or require additional assistance, please do not hesitate to contact our office.

# LIMITATIONS

Explorations

1. The analyses and recommendations presented in this report are based in part upon the data obtained from widely-spaced subsurface explorations. Subsurface conditions between exploration locations may vary from those encountered at the exploration locations. The nature and extent of variations between explorations may not become evident until construction. If variations appear, it will be necessary to re-evaluate the recommendations of this report.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretation of widely-spaced explorations and samples; actual strata transitions are probably more gradual. For specific information, refer to the individual test pit and/or boring logs.

3. Water level readings have been made in the test pits and/or test borings under conditions stated on the logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors differing from the time the measurements were made.

Review

4. It is recommended that John Turner Consulting, Inc. be given the opportunity to review final design drawings and specifications to evaluate the appropriate implementation of the geotechnical engineering recommendations provided herein.

5. In the event that any changes in the nature, design, or location of the proposed areas are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of the report modified or verified in writing by John Turner Consulting, Inc.

Construction

6. It is recommended that John Turner Consulting, Inc. be retained to provide geotechnical engineering services during the earthwork phases of the work. This is to observe compliance with the design concepts, specifications, and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction.

Use of Report

7. This report has been prepared for the exclusive use of P$^3$ Project Planning Professionals in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

8. This report has been prepared for this project by John Turner Consulting, Inc. This report was completed for preliminary design purposes and may be limited in its scope to complete an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to preliminary geotechnical design considerations.

# TABLE 1

## Recommended Soil Gradation & Compaction Specifications

**Structural Fill**

| SIEVE SIZE | PERCENT PASSING BY WEIGHT |
|---|---|
| 5-inch | 100 |
| ¾-inch | 60 - 100 |
| No. 4 | 20 - 80 |
| No. 200 | 0 - 10 |

NOTES:

1. For use as structural load support below foundations and within the building pad. Structural Fill placed beneath building foundations should include the Footing Zone of Influence which is defined as that area extending laterally one foot from the edge of the footing then outward and downward at a 1H:1.5V splay.
2. ¾-inch crushed stone may be used in wet conditions.
3. Structural Fill should be free of construction and demolition debris, frozen soil, organic soil, peat, stumps, brush, trash, and refuse;
4. Structural Fill should not be placed on soft, saturated, or frozen subgrade soils;
5. Structural Fill should be placed in lifts not exceeding 12 inches for heavy vibratory rollers and 8 inches for vibratory plate compactors.
6. Place and compact within ± 3% of optimum moisture content.
7. Compact to at least 95% relative compaction per ASTM D1557.
8. The adequacy of the compaction efforts should be verified by field density testing.

## Clean Granular Fill

| SIEVE SIZE | PERCENT PASSING BY WEIGHT |
|---|---|
| 3-inch | 100 |
| ¾-inch | 60 – 90 |
| No. 4 | 20 – 70 |
| No. 200 | 2 – 8 |

NOTES:

1. For minimum 9-inch base below floor slabs-on-grade.
2. For minimum 18-inch base for exterior concrete slabs exposed to frost.
3. For minimum 24-inch base at exterior ramps, aprons, and loading bays adjacent to entrances/exit ways.
4. For use as footing and foundation wall backfill.
5. For use as backfill behind unbalanced foundation/retaining walls.
6. Place in lifts not exceeding 12 inches for heavy vibratory rollers and 8 inches for vibratory plate compactors.
7. Place and compact within ± 3% of optimum moisture content.
8. Compact to at least 95% relative compaction per ASTM D1557.
9. Compaction efforts should be verified by field density testing.

## Common Fill

| SIEVE SIZE | PERCENT PASSING BY WEIGHT |
|---|---|
| 6-inch | 100 |
| ¾-inch | 60 – 100 |
| No. 4 | 20 – 85 |
| No. 200 | 0 – 25 |

NOTES:

1. For use as common/subgrade fill in parking areas and roadway embankments.
2. For use as foundation wall backfill if used in conjunction with a bond break and sized/screened to 3-inch minus.
3. Place in lifts not exceeding 12 inches.
4. Maximum stone size should not exceed ½ the actual lift thickness.
5. Compact to at least 93% relative compaction per ASTM D1557 when placed as subgrade fill in parking areas or roadway embankments.
6. Compact to at least 95% relative compaction per ASTM D1557 when placed as foundation wall backfill in conjunction with a bond break.
7. Compaction efforts should be verified by field density testing.

# TABLE 2

## Recommended Lateral Earth Pressures, Drainage Requirements, & Friction Factor for Unbalanced Walls

Lateral earth pressures for the structural design and stability analysis of unbalanced foundation walls (basement walls, retaining walls, elevator pits, etc.) are provided herein. The following table outlines the recommended lateral earth pressure coefficients and equivalent fluid weights:

| WALL CONDITION | LATERAL TRANSLATION ($\Delta/H$) | EARTH PRESSURE COEFFICIENT (K) | EQUIVALENT FLUID WEIGHT ($\gamma_{EFW}$) |
|---|---|---|---|
| restrained | 0 | $K_o = 0.50$ | 70 pcf |
| no restraint | 0.002 | $K_a = 0.33$ | 45 pcf |
| no restraint | 0.02 | $K_p = 3.0$ | 135 pcf<br>(FS = 3) |
| seismic | n/a | $K_{eq}$ | see note |

where: $\Delta$ = movement at top of wall by rotation or lateral translation
H = height of wall

The recommended lateral earth pressure are based upon and/or assume:

1. Rankine earth pressure theory;
2. Retaining wall backfilled with *Clean Granular Fill* (Table 1);
3. Unit weight of backfill less than 135 pcf;
4. No hydrostatic pressures;
5. No surcharge loading;
6. A level backfill in front and behind of wall;
7. Dynamic/compaction stresses limited to 200 psf/foot;
8. The top 2 feet should not be considered for passive resistance;
9. Seismic loading shall be applied as required by the *IBC*. Seismic loads shall be a 15% increase from those values outlined in Table 2; and
10. Use of only small plate compactors within 3 feet of the wall.

The lateral resistance of retaining walls should also accommodate surcharge loads. Uniformly distributed loads should be superimposed along the face of the wall at a magnitude equal to the surcharge pressure multiplied by the appropriate earth pressure coefficient. Surcharge loads should be considered where they are located within a horizontal distance equivalent to 1 times the height of the wall. Any anticipated point or line loads situated behind the wall should be evaluated in accordance with linear elastic theory.

For frost protection and proper drainage, it is recommended that *Clean Granular Fill* be placed directly behind unbalanced walls. The ground surface immediately adjacent to the unbalanced wall should be sloped away from the building to allow for positive drainage. It is also recommended that the surficial materials adjacent to the building be relatively impermeable to reduce the volume of precipitation infiltrating into the subgrade. Such impermeable materials include cement concrete, bituminous concrete, and/or vegetated silty/clayey topsoil.

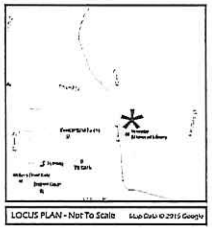
Unbalanced foundation walls (including basement walls) should be provided with adequate footing drains per the *IBC*. The drains should be located along the periphery of the basement footprint. The perimeter foundation drain should be located at least 4 inches above the bottom of footing elevation and six inches outward from the edge of footing. The drains should not encroach within the Footing Zone of Influence, which is defined as that area extending laterally one foot from the edge of footing then outward and downward at a 1H:1.5V splay. Furthermore, the invert elevation of the drain should be at least 12 inches below the underside of the adjacent floor slab. The drains should consist of minimum 4-inch diameter perforated PVC-SDR 35 drain pipe encased within 12 inches of ¾-inch stone and wrapped with a filter fabric such as Mirafi 140N or equal. If the unbalanced foundation walls cannot be drained to alleviate hydrostatic forces, then the lateral earth pressure equivalent fluid weight should be increased to 90 pcf. Such earth pressures should be used for elevator pits, if necessary.

The footing drains may discharge via gravity to a storm drain line not subject to surcharge. The Civil Engineer should review the discharge of the drains. The drains should be provided with permanent clean-outs at convenient locations to facilitate access to all sections of the system. Roof gutters and other storm collection should not be discharged to the footing/under-slab drains. Any recharge systems, infiltrators, and/or dry wells shall be kept away from the basement to prevent hydrostatic surcharge.

The following interface friction angle(s), φ, and associated friction factors (=tan φ) are recommended for sliding resistance/overturning:

| Condition | Interface Friction Angle | Friction Factor |
|---|---|---|
| Mass concrete (base of wall) on crushed gravel/stone | 30 | 0.57 |
| Mass concrete (base of wall) on Alluvia Sand | 22 | 0.40 |
| Formed concrete (wall) against Clean Granular Fill | 22 | 0.40 |

# Existing Conditions Plan, Site Plan, & Test Boring Location Plan



## Owner Of Record

The Inhabitants Of The Town Of Orange
49 East Main Street
Orange, Massachusetts 01364
PID: 107-53, 107-54 & 107-55
Deed Book 601, Page 85
Deed Book 632, Page 4
Deed Book 3697, Page 151
Deed Book 3937, Page 156
No Plan Reference

## Notes

1. The Record Conditions And Boundary Retracement Survey Depicted Hereon Was Obtained By A Field Survey On September 14, 2016 By The Berkshire Design Group, Inc.

2. The Purpose Of This Plan Is To Provide A Plan Illustrating This Surveyors Interpretation Of Constructed Improvements, Natural Features, Observable Monuments, Obtainable Plans And Deeds Of Record, Witness Testimony, And Any Other Plans And Deeds Which May Affect The Locus Property At The Time And Date Of The Partial Field Survey.

3. This Plan Does Not Show Any Unrecorded Or Unwritten Easements Which May Exist. A Reasonable And Diligent Attempt Has Been Made To Observe Any Apparent, Visible Uses Of The Land; However, This Does Not Constitute A Guarantee That No Such Easements Exist.

4. This Plan And Survey Were Prepared Using GNSS And Conventional Survey Methods. A Leica TS15 Total Station Was Used Having An Accuracy Of 5" And 5 PPM. A Leica GS14 Network RTK Was Used Having Subcentimeter Accuracy.

5. The Basis Of Bearings, Azimuths, And The North Arrow Shown Hereon Is The Massachusetts State Plane Coordinate System (NAD83). The Basis Of The Elevations Depicted Hereon Is A Grid Separation Calculation Based On Geoid12A Resulting In NAVD88.

## Reference Plans

1. "Land In Orange, Mass. Surveyed For Robert D. & Karen R. Anderson" Dated: May 1999 By Gary D. Lampher, Land Surveyor And Recorded In Plan Book 101, Page 35.

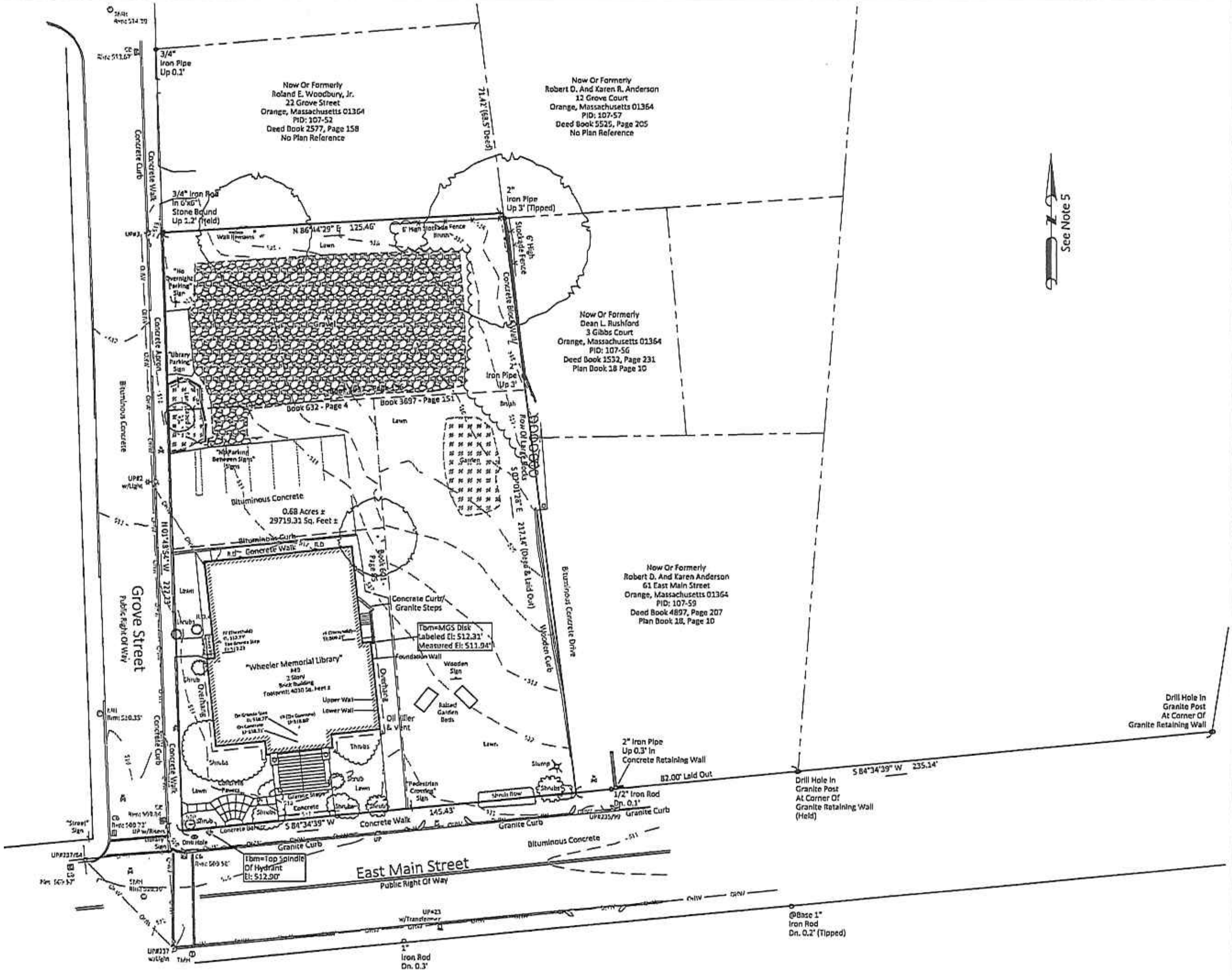
2. "Plan Of Land In Orange Owned By Robert J. & Margaret A. Dyer" Dated: April 23, 1980 By Berry Engineering, Inc. And recorded In Plan Book 48, Page 59.

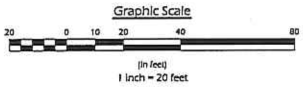
3. "Plan Of Land In Orange Owned By Eastern Star Of Massachusetts Charitable Foundation, Inc." Dated: November 27, 1973 By Berry Engineering And Recorded In Plan Book 39, Page 69.

4. "Plan Of Land Of Marvis E. Webster Et All Orange, Mass. From A Tape Survey" Dated: May 1956 By M.A. Casella C.E. And Recorded In Plan Book 18, Page 10.

I Declare That This Survey And Plan Were Prepared In Accordance With The Procedural And Technical Standards For The Practice Of Land Surveying In The Commonwealth Of Massachusetts And That This Plan And Survey Have Been Prepared In Accordance With The Rules And Regulations Of The Registers Of Deeds And That This Plan Shows The Property Lines Of Existing Ownership And The Lines Of Streets And Ways Shown Are Those Of Public Or Private Ways Already Established And That No New Lines For The Division Of Existing Ownership, Or New Ways Are Shown.

David R. Enberg, PLS #47142 Date





The Location Of All Underground Utilities Shown Are Approximate And Are Based Upon A Field Survey And Compilation Of Plans Of Record. Berkshire Design Group, Inc. Does Not Warranty The Location Of All Utilities Depicted. Only Record Information Provided By The Respective Utility Owner And Independently Verified By Berkshire Design Group, Inc. Is Shown Hereon. The Contractor, Engineer, Or Architect Prior To Commencement Of Construction or Design, Shall Verify The Location Of All Utilities And Contact Dig Safe At 1-888-344-7233.

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Civil Engineering
Planning
Land Surveying
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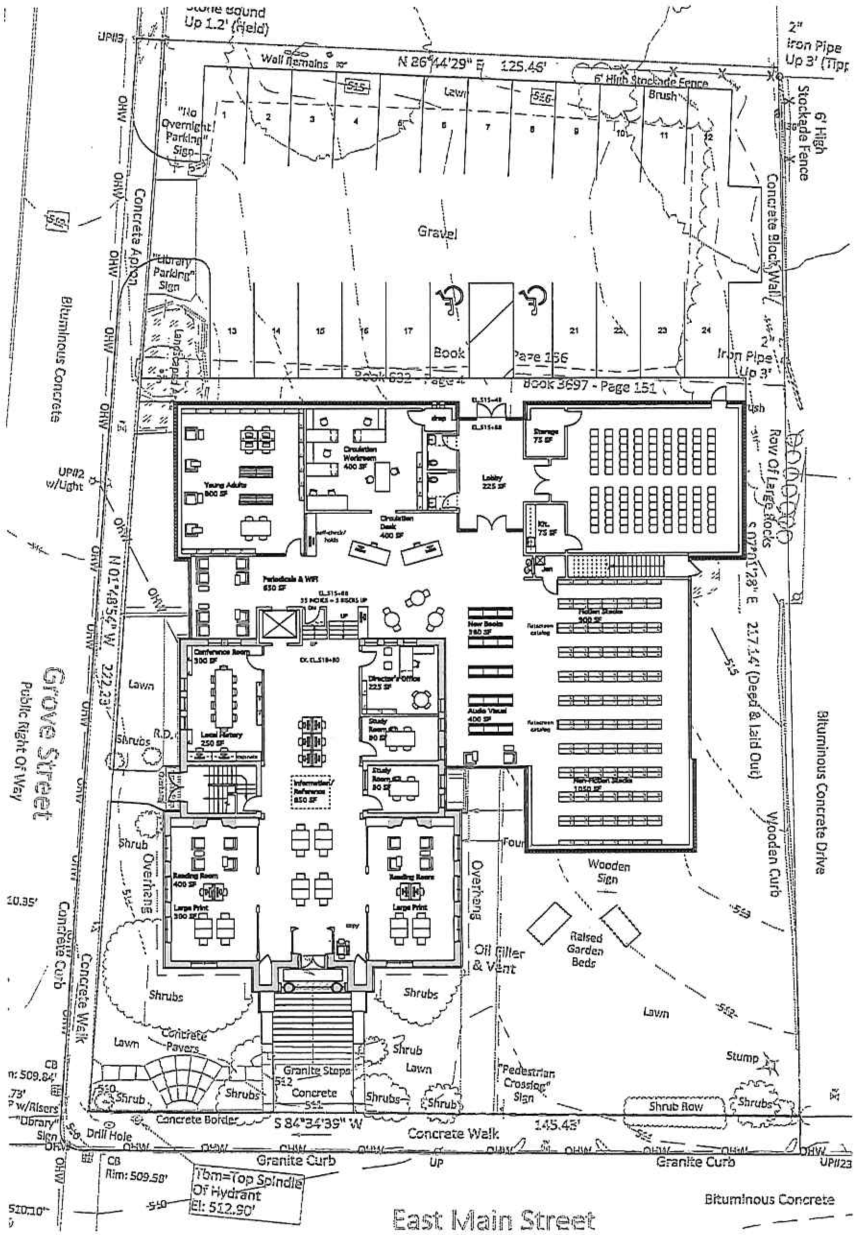
REGISTRY USE ONLY

# Plan Of Land
Located In
## Orange, Massachusetts
(Franklin County)

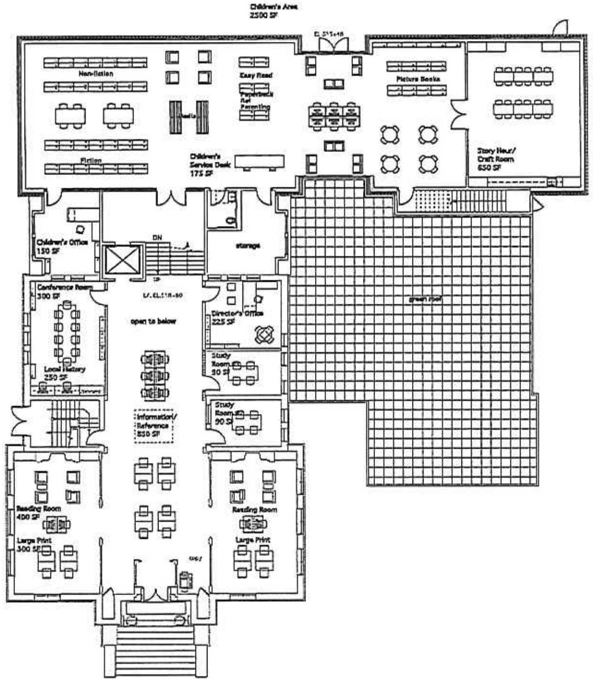
Prepared For
P3 Project Planning Professionals

Revisions

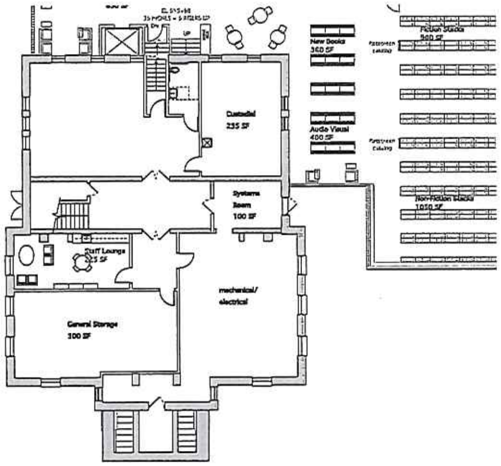
Date: September 20, 2016
Scale: 1"=20'
Drawn By: JSM
Checked By: DRE
Sheet Number 1 of 1



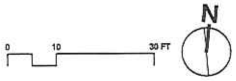
MAIN FLOOR



UPPER FLOOR



LOWER FLOOR

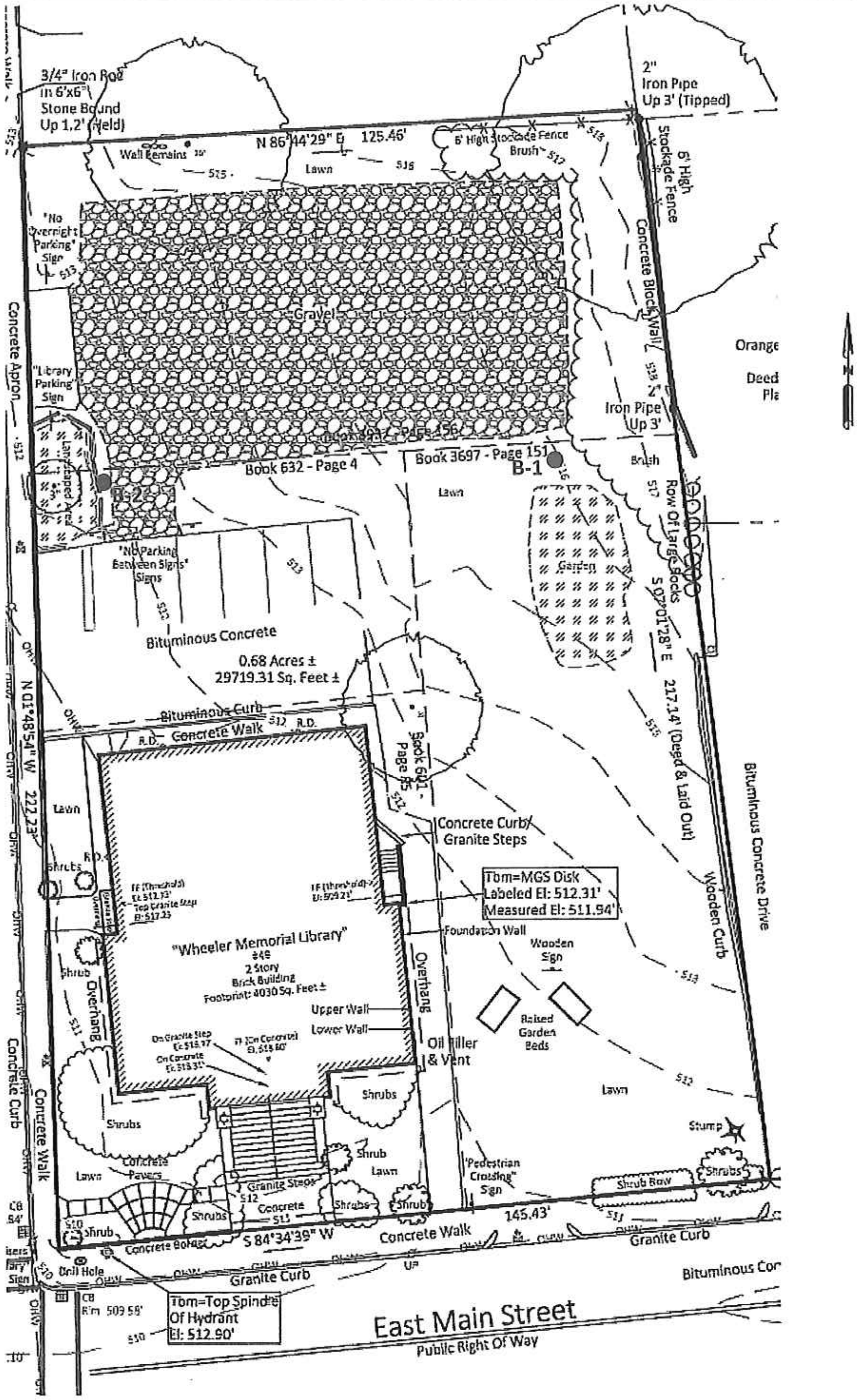


# Wheeler Memorial Library

Orange, MA

Plan Diagrams - Scheme D.3 - 17 Nov 2016

JOHNSON
ROBERTS
ASSOCIATES INC.
ARCHITECTS
16 PROPERZI WAY
SOMERVILLE, MA
02143-3228



Notes:

1. Test borings were performed on December 8, 2016 under the direction of JTC.
2. Test boring locations should be considered approximate.
3. Refer to the Test Boring Logs for the subsurface conditions encountered at each boring location.
4. Basemap source: September 20, 2016 "Plan of Land" prepared by The Berkshire Design Group, Inc.
5. Not to scale.

**P3 Project Planning Professionals**
**150 Longwater Drive, Suite 102**
**Norwell, Massachusetts 02061**

**Proposed Addition to the Wheeler Memorial Library**
**49 East Main Street**
**Orange, Massachusetts**

JTC
John Turner Consulting

**TEST BORING LOCATION PLAN**

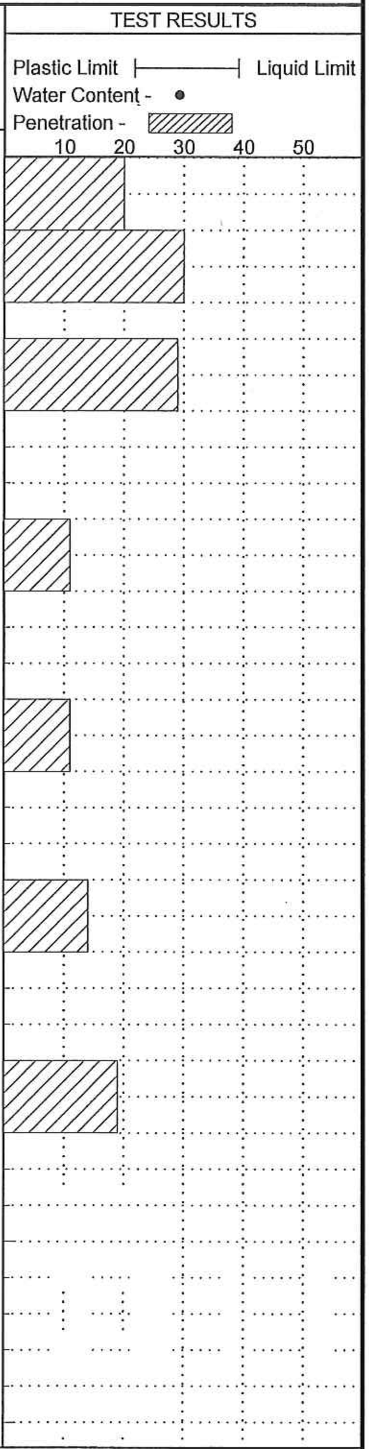
# Test Boring Logs & Key to Symbols and Descriptions

JTC
JOHN TURNER CONSULTING

# LOG OF BORING No. B-1

**PROJECT:** Proposed Addition to the Wheeler Memorial Library **PROJECT NO.:** 16-15-069
**CLIENT:** P3 Project Planning Professionals
**PROJECT LOCATION:** Orange, Massachusetts
**LOCATION:** See Boring Location Plan **ELEVATION:** 516.0
**DRILLER:** Seaboard Drilling, Inc. **LOGGED BY:** S. Kurtzer
**DRILLING METHOD:** 4.25" ID Hollow Stem Augers **DATE:** 12/8/16
**DEPTH TO - WATER> INITIAL:** ▽ 5 **AFTER 24 HOURS:** ▽

| Depth (feet) | Description | Graphic | Elevation (feet) | Sample No. | Blow Counts | % < #200 | TEST RESULTS |
|---|---|---|---|---|---|---|---|
| 0 | Dark brown, silty fine to coarse sand (SM), medium dense, moist; TOPSOIL<br>- frequent rootlets throughout | | 512.5 | 1 | 5<br>9<br>11<br>11 | | |
| | 0.5<br>Olive brown, silty fine sand (SM), medium dense, moist; ALLUVIAL SAND | | | 2 | 8<br>11<br>19<br>22 | | |
| 5 | 3<br>▽ Brown, fine to med. sand with silt (SW-SM), few gravel, medium dense, moist; ALLUVIAL SAND<br>- slight oxidation throughout | | 507.5 | 3 | 10<br>15<br>14<br>14 | | |
| | 5<br>Gray, silty fine to medium sand (SM), medium dense, wet; ALLUVIAL SAND<br>- water @ 5 ft. bgs | | | | | | |
| 10 | | | 502.5 | 4 | 3<br>4<br>7<br>10 | | |
| 15 | | | 497.5 | 5 | 3<br>4<br>7<br>10 | | |
| | - becomes olive brown @ 17 ft. bgs | | | | | | |
| 20 | | | 492.5 | 6 | 3<br>6<br>8<br>12 | | |
| 25 | | | 487.5 | 7 | 5<br>7<br>12<br>13 | | |
| | 26<br>Olive brown, silt (ML), few sand, m. dense, moist; ALLUVIAL SILT | | | | | | |
| | Boring terminated at 27 ft. | | | | | | |
| 30 | | | 482.5 | | | | |
| 35 | | | 477.5 | | | | |



*Boring backfilled with soil cuttings upon completion of drilling.*

This information pertains only to this boring d should not be interpreted as being indicative of the site.

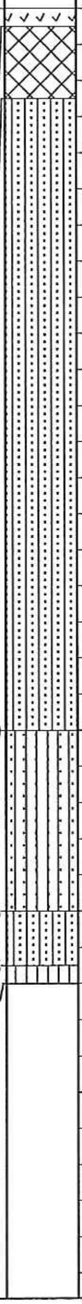
Figure PAGE 1 of 1

JTC
JOHN TURNER CONSULTING

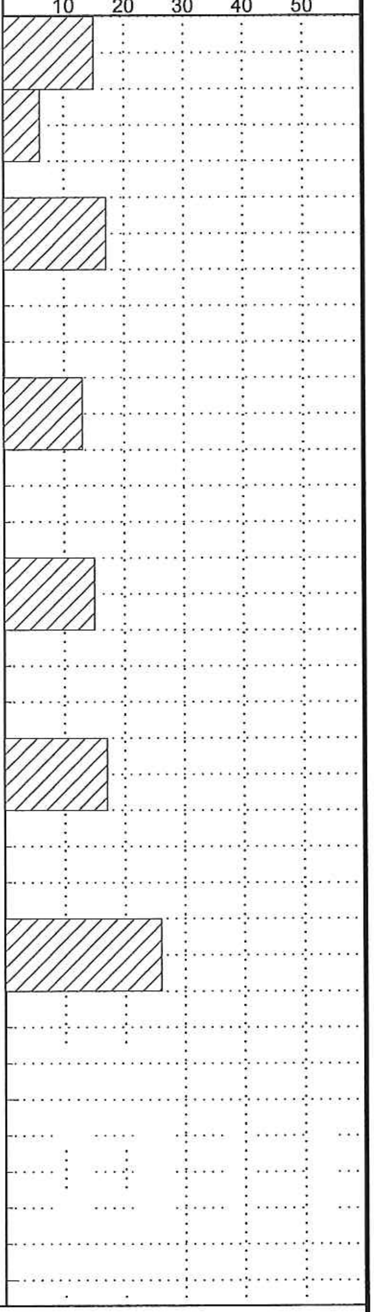
# LOG OF BORING
# No. B-2

**PROJECT:** Proposed Addition to the Wheeler Memorial Library **PROJECT NO.:** 16-15-069
**CLIENT:** P3 Project Planning Professionals
**PROJECT LOCATION:** Orange, Massachusetts
**LOCATION:** See Boring Location Plan **ELEVATION:** 512.5
**DRILLER:** Seaboard Drilling, Inc. **LOGGED BY:** S. Kurtzer
**DRILLING METHOD:** 4.25" ID Hollow Stem Augers **DATE:** 12/8/16
**DEPTH TO - WATER> INITIAL:** ⩸ 3 **AFTER 24 HOURS:** ⩸

| Depth (feet) | Description | Elevation (feet) | Sample No. | Blow Counts | % < #200 |
|---|---|---|---|---|---|
| 0 | Dark brown, silty fine to coarse sand (SM), medium dense, moist; TOPSOIL<br>- frequent rootlets throughout | 516 | 1 | 3<br>8<br>7<br>7 | |
| 0.5 | ⩸ Dark brown, silty fine to coarse sand (SM), medium dense, moist; EXISTING FILL<br>- fragments of asphalt-concrete pavement | | 2 | 3<br>3<br>3<br>9 | |
| 2.5 | Brown, silty fine to medium sand (SM), little coarse sand, loose to medium dense, moist to wet; ALLUVIAL SAND<br>- water @ 3 ft. bgs | | | | |
| 5 | | 511 | 3 | 9<br>14<br>3<br>11 | |
| | Gray, silty fine sand (SM), medium dense, wet; ALLUVIAL SAND | | | | |
| 10 | | 06 | 4 | 5<br>5<br>8<br>12 | |
| 15 | | 501 | 5 | 5<br>7<br>8<br>12 | |
| 20 | Olive brown, silt with sand (ML), medium dense, wet; ALLUVIAL SILT | 496 | 6 | 7<br>8<br>9<br>9 | |
| 25 | Gray, silty fine sand (SM), medium dense, wet; ALLUVIAL SAND | 491 | 7 | 7<br>12<br>14<br>16 | |
| 26.5 | Gray, silt (ML), medium dense, wet; ALLUVIAL SILT<br>Boring terminated at 27 ft. | | | | |
| 30 | | 486 | | | |
| 35 | | 481 | | | |



TEST RESULTS
Plastic Limit ├──┤ Liquid Limit
Water Content - ●
Penetration - ▨



*Boring backfilled with soil cuttings upon completion of drilling.*

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Figure PAGE 1 of 1

| MAJOR DIVISIONS | | | GROUP SYMBOLS | | GENERAL DESCRIPTIONS |
|---|---|---|---|---|---|
| COARSE GRAINED SOILS (More than 50% RETAINED on No. 200 sieve) | GRAVELS (More than 50% of coarse fraction RETAINED on No. 4 sieve) | CLEAN GRAVELS (Less than 5% fines) | ● | GW | Well graded gravels or gravel-sand mixtures; trace or no fines. |
| | | | ○ | GP | Poorly graded gravels or gravel-sand mixtures; trace or no fines. |
| | | GRAVELS WITH FINES (More than 12% fines) | ▥ | GM | Silty gravels or gravel-sand-silt mixtures. |
| | | | ▨ | GC | Clayey gravels or gravel-sand-clay mixtures. |
| | SANDS (50% or more of coarse fraction PASSES the No. 4 sieve) | CLEAN SANDS (Less than 5% fines) | ⁘ | SW | Well graded sands or sand-gravel mixtures; trace or no fines. |
| | | | ⁘ | SP | Poorly graded sands or sand-gravel mixtures, trace or no fines. |
| | | SANDS WITH FINES (More than 12% fines) | ▥ | SM | Silty sands or sand-gravel-silt mixtures. |
| | | | ▨ | SC | Clayey sands or sand-gravel-clay mixtures. |
| FINE GRAINED SOILS (50% or more PASSES the No. 200 sieve) | SILTS AND CLAYS (Liquid Limit LESS than 50) | | ▥ | ML | Inorganic silts or rock flour. Non-plastic or very slightly plastic. PI < 4 or plots below "A" line. |
| | | | ▨ | CL | Inorganic lean clay. Low to medium plasticity. PI > 7 and plots on or above "A" line. |
| | | | ▤ | OL | Organic silts, clays, and silty clays. Low to medium plasticity. |
| | SILTS AND CLAYS (Liquid Limit of 50 or GREATER) | | ▥ | MH | Inorganic elastic silt. PI plots below "A" line. |
| | | | ▨ | CH | Inorganic fat clay. High plasticity. PI plots on or above "A" line. |
| | | | ≋ | OH | Organic silts and clays. High plasticity. |
| HIGHLY ORGANIC SOILS | | | ⁂ | PT | Peat and other highly organic soils. Decomposed vegetable tissue. Fibrous to amorphous texture. |

<u>BOUNDARY CLASSIFICATIONS:</u> Soils possessing characteristics of two groups are designated by combinations of group symbols.

| SILT OR CLAY | SAND | | | GRAVEL | | Cobbles | Boulders |
|---|---|---|---|---|---|---|---|
| | Fine | Medium | Coarse | Fine | Coarse | | |

No.200 No.40 No.10 No.4 3/4" 3" 12"

U.S. STANDARD SIEVE SIZE

<u>References:</u> ASTM D 2487 (Unified Soil Classification System) and ASTM D 2488 (Visual-Manual Procedure).

| TYPICAL SYMBOLS | | | |
|---|---|---|---|
| ▯ | Shelby Tube | ▮ | Auger Cuttings |
| ⊠ | Standard Split Spoon Sample | ⊠ | 3" Split Spoon Sample |
| ▮ | Rock Core | ↓ | Dynamic Cone Penetrometer |
| ▯ | Vane Shear | ✋ | Bulk/Grab Sample |
| ▨ | Geoprobe Sample | ▩ | Sonic or Vibro-Core Sample |
| ▽ | Water Table at time of drilling | ▼ | Water Table after 24 hours |

CORRELATION OF STANDARD PENETRATION TEST (SPT) WITH RELATIVE DENSITY AND CONSISTENCY

| GRAVEL, SAND, & SILT (NON-PLASTIC) | | SILT (PLASTIC) & CLAY | | |
|---|---|---|---|---|
| N-Value | Relative Density | N-Value | Su (psf) | Consistency |
| 0 - 4 | Very Loose | 0 - 2 | 0 - 250 | Very Soft |
| 4 - 10 | Loose | 2 - 4 | 250 - 500 | Soft |
| 10 - 30 | Medium Dense | 4 - 8 | 500 - 1000 | Medium Stiff |
| 30 - 50 | Dense | 8 - 15 | 1000 - 2000 | Stiff |
| Over 50 | Very Dense | 15 - 30 | 2000 - 4000 | Very Stiff |
| | | Over 30 | Over 4000 | Hard |

SPT Notes: WR = Weight of Rods; WH = Weight of Hammer

| TERMS DESCRIBING SOILS (excludes particles > 3", organics, debris, etc.) | | TERMS DESCRIBING MATERIALS (i.e. particles > 3", organics, debris, etc.) | |
|---|---|---|---|
| Trace: | Particles present, but < 5% | Occasional: | Particles present, but < 10% |
| Few: | 5% to 15% | Frequent: | 10% to 25% |
| Little: | 15% to 25% | Many: | > 25% |
| Some: | 25% to 50% | | |

| TERMS DESCRIBING MOISTURE | | TERMS DESCRIBING STRUCTURE | |
|---|---|---|---|
| Dry: | Absence of moisture; dusty | Layer: | > 3" thick |
| Moist: | Damp, but no visible water | Seam: | 1/16" to 3" thick |
| Wet: | Visible/free water | Parting: | < 1/16" thick |

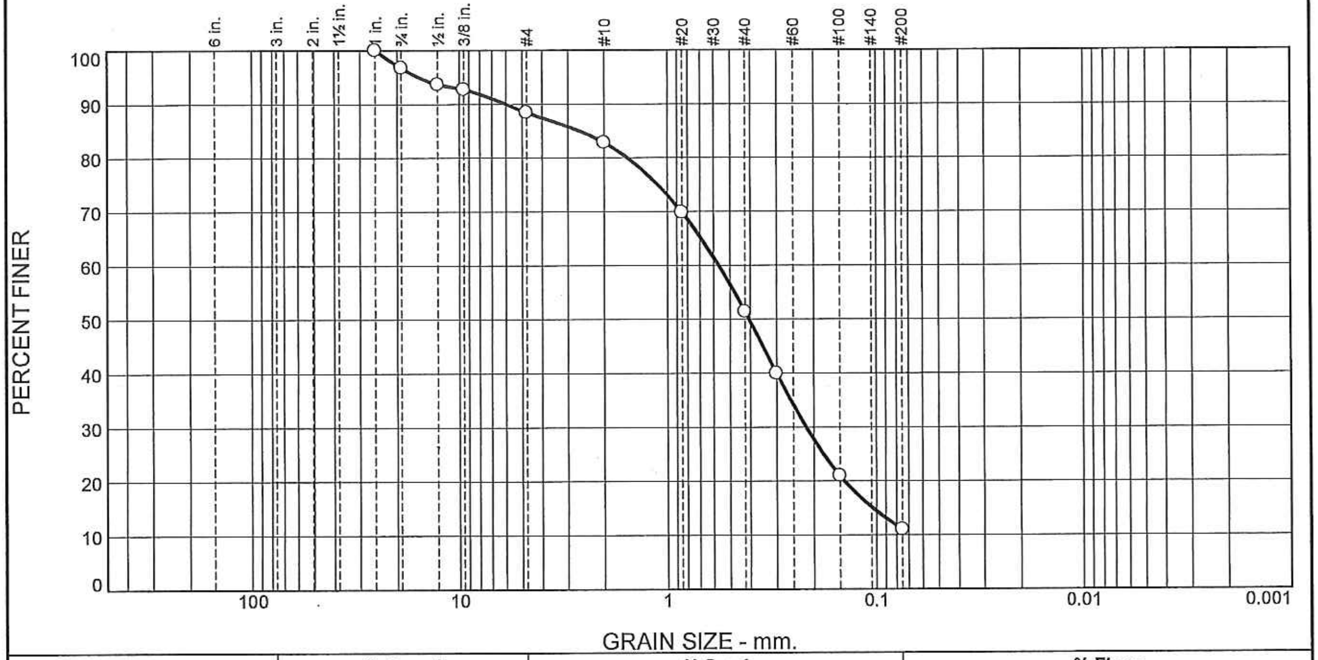
# KEY TO SYMBOLS AND DESCRIPTIONS

JTC

JOHN TURNER CONSULTING

# Geotechnical Laboratory Testing Data

# Particle Size Distribution Report



| % Cobbles | % Gravel |  | % Sand |  |  | % Fines |  |
|---|---|---|---|---|---|---|---|
|  | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 3.3 | 8.3 | 5.6 | 31.4 | 40.4 | 11.0 |  |

TEST RESULTS

| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
|---|---|---|---|
| 1 | 100.0 |  |  |
| 3/4 | 96.7 |  |  |
| 1/2 | 93.7 |  |  |
| 3/8 | 92.7 |  |  |
| #4 | 88.4 |  |  |
| #10 | 82.8 |  |  |
| #20 | 69.8 |  |  |
| #40 | 51.4 |  |  |
| #50 | 39.9 |  |  |
| #100 | 21.0 |  |  |
| #200 | 11.0 |  |  |

* (no specification provided)

## Material Description

Sand with silt

### Atterberg Limits (ASTM D 4318)

**PL=** **LL=** **PI=**

### Classification

**USCS (D 2487)=** SW-SM **AASHTO (M 145)=**

### Coefficients

$D_{90}$= 5.9820 $D_{85}$= 2.6430 $D_{60}$= 0.5686
$D_{50}$= 0.4070 $D_{30}$= 0.2169 $D_{15}$= 0.1044
$D_{10}$= 0.065 $C_u$= 8.7477 $C_c$= 1.273

### Remarks

In-Situ Moisture: 7.4%

**Date Received:** 12-15-16 **Date Tested:** 12-16-16
**Tested By:** Jason Spry
**Checked By:** Travis Carpenter
**Title:** VP of Engineering

**Location:** B-1 (S-2B) **Date Sampled:** 12-8-16
**Sample Number:** 16-1182 **Depth:** 2.5'-4'

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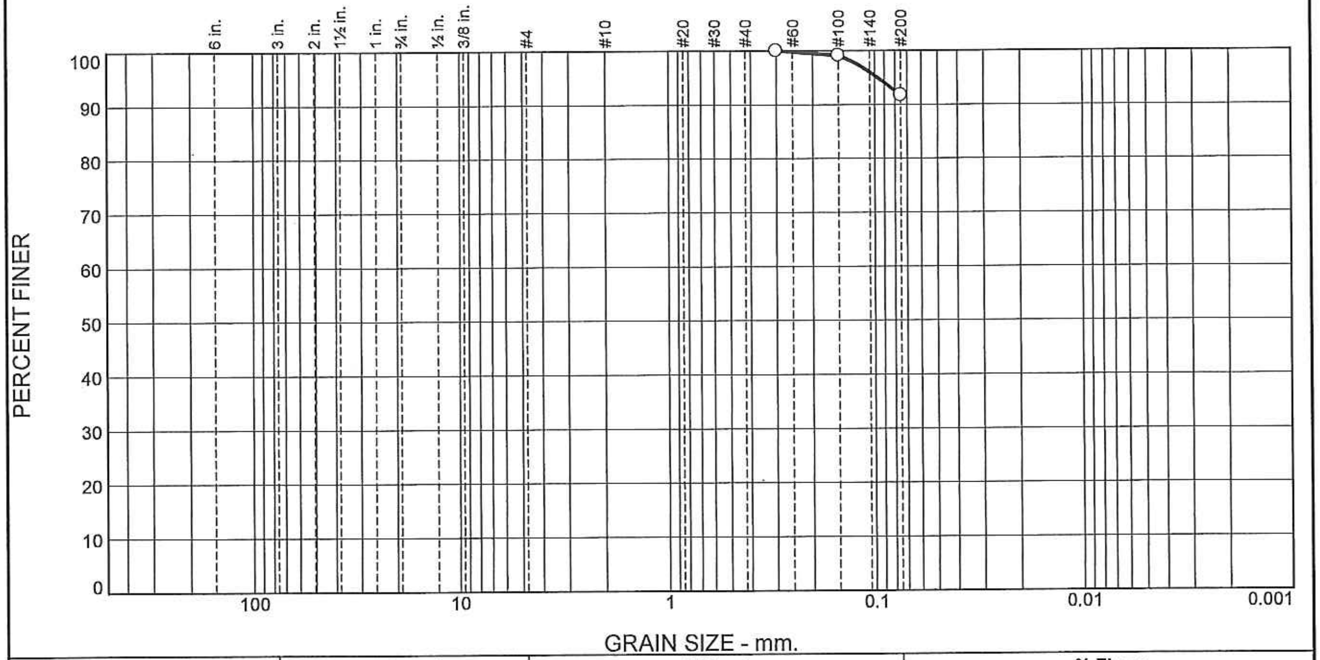
GEOTECHNICAL • CONSTRUCTION

**Client:** P3 Project Planning Professionals
**Project:** Proposed Addition to the Wheeler Memorial Library - Orange, MA

**Project No:** 16-15-069 **Figure** 001

# Particle Size Distribution Report



| % Cobbles | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 8.3 | 91.7 | |

| TEST RESULTS | | | |
|---|---|---|---|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| #50 | 100.0 | | |
| #100 | 99.1 | | |
| #200 | 91.7 | | |

* (no specification provided)

**Material Description**

Silt

**Atterberg Limits (ASTM D 4318)**

PL= LL= PI=

**Classification**

USCS (D 2487)= ML AASHTO (M 145)=

**Coefficients**

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

**Remarks**

In-Situ Moisture: 28.1%

**Date Received:** 12-15-16 **Date Tested:** 12-16-16
**Tested By:** Jason Spry
**Checked By:** Travis Carpenter
**Title:** VP of Engineering

**Location:** B-1 (S-7)
**Sample Number:** 16-1183 **Depth:** 26.5'-27'
**Date Sampled:** 12-8-16

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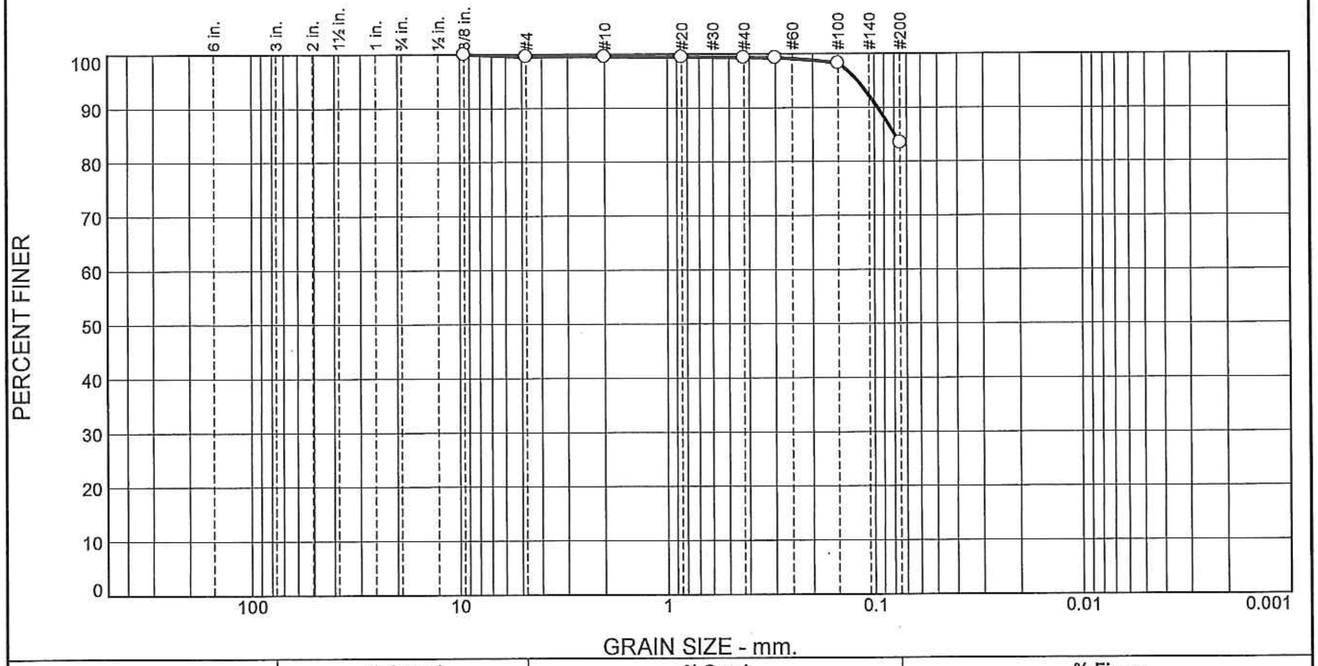
**Client:** P3 Project Planning Professionals
**Project:** Proposed Addition to the Wheeler Memorial Library - Orange, MA
**Project No:** 16-15-069 **Figure** 002

# Particle Size Distribution Report



| % Cobbles | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.4 | 0.1 | 0.2 | 15.8 | 83.5 | |

**TEST RESULTS**

| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
|---|---|---|---|
| 3/8 | 100.0 | | |
| #4 | 99.6 | | |
| #10 | 99.5 | | |
| #20 | 99.4 | | |
| #40 | 99.3 | | |
| #50 | 99.2 | | |
| #100 | 98.2 | | |
| #200 | 83.5 | | |

* (no specification provided)

**Material Description**

Silt with sand

**Atterberg Limits (ASTM D 4318)**

**PL=** **LL=** **PI=**

**Classification**

**USCS (D 2487)=** ML **AASHTO (M 145)=**

**Coefficients**

$D_{90}$= 0.0965 $D_{85}$= 0.0795 $D_{60}$=
$D_{50}$= $D_{30}$= $D_{15}$=
$D_{10}$= $C_u$= $C_c$=

**Remarks**

In-Situ Moisture: 23.4%

**Date Received:** 12-15-16 **Date Tested:** 12-17-16
**Tested By:** Jason Spry
**Checked By:** Travis Carpenter
**Title:** VP of Engineering

**Location:** B-2 (S-6) **Date Sampled:** 12-8-16
**Sample Number:** 16-1184 **Depth:** 20'-22'

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GEOTECHNICAL • CONSTRUCTION

**Client:** P3 Project Planning Professionals
**Project:** Proposed Addition to the Wheeler Memorial Library - Orange, MA

**Project No:** 16-15-069 **Figure** 003

# Site Photographs

# SITE PHOTOGRAPHS

## PROPOSED ADDITION To The WHEELER MEMORIAL LIBRARY
## 49 EAST MAIN STREET
## ORANGE, MASSACHUSETTS

**B-1 to southeast. Typical alluvial deposit.**

**B-2 to northeast. Typical deep alluvial deposit.**

**Truck-mounted rig at B-1.**