# SECTION 023200 - GEOTECHNICAL INVESTIGATIONS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. This Section includes geotechnical investigations.

### 1.3 DESCRIPTION

A. Subsurface explorations have been done at the location of the project and soils reports have been compiled for the purpose of guidance in the design of the project facilities. This work can include open excavation test pits, observation wells and soil borings.

B. The logs are not intended to indicate subsurface conditions except at the locations of the exploration (at the time explorations were made) and any interpretation the Contractor may make is his responsibility.

C. The subsurface investigations of the site were made in conjunction with design of the facility to be constructed under this Contract. Portions of this investigation are presented in reports which are a part of the Contract Documents. The reports present the opinion of the Geotechnical Engineer and shall not be interpreted to prescribe or dictate construction procedures or relieve the Contractor in any way of his responsibility for the construction. The explorations are shown on the drawings and the logs are include in Appendix A and B.

D. The water levels shown on the log at the exploration locations are based on observations made by the Field personnel at the same time the explorations were made and may or may not represent the groundwater surface in the immediate vicinity of the explorations. They are presented only as an observation of the free-standing water surface in the exploration on the date noted.

E. The refusal depths shown at the exploration locations indicate only, that in the drill foreman's opinion, sufficient resistance to the advance of the casing, auger, probe rod or sampler was encountered to render further advance impossible or impractical by the procedures and equipment being used. Although refusal may indicate the encountering of the bedrock surface, it may indicate the striking of large cobbles, boulders, very dense or cemented soil, or other buried natural or man- made objects or it may indicate the encountering of a harder zone after penetrating a considerable depth through a weathered or disintegrated zone of the bedrock.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 023200

SUMMIT
GEOENGINEERING SERVICES

# GEOTECHNICAL REPORT

## New Apartment Building
## 665 Congress Street
## Portland, Maine

Prepared for:

Redfern Properties
P.O. Box 8816
Portland, Maine 04104

Prepared by:

Summit Geoengineering Services
145 Lisbon St.
Lewiston, Maine

Project #15040
May 2015

SUMMIT
GEOENGINEERING SERVICES

May 1, 2015
SGS #15040

Jonathan Culley
Redfern Properties
P.O. Box 8816
Portland, Maine 04104

Reference: Geotechnical Report, New Apartment Building
665 Congress Street, Portland, Maine

Dear Jonathan;

Summit Geoengineering Services, Inc. (SGS) has completed a geotechnical investigation for the proposed apartment building at the site reference above. Our scope of services included the drilling of 13 borings and 9 probes and preparing this geotechnical report summarizing our findings and providing geotechnical recommendations.

## 1.0 Project Description

We understand that the project consists of the construction of an 8 story building at the site referenced above. The existing site contains Joe's Smoke Shop abutting Congress Street with a paved parking lot behind. The grade at the site slopes gently down towards the back of the parking lot. The site is bordered by Avon Street on the east and Vernon Street on the west. There used to be a church at the southern portion of the site which was demolished in 1965.

We understand that the newly proposed 8 story building is a steel framed structure which will consist of combined retail space and parking on the first floor and apartment living spaces in the top 7 floors. We also understand there is a proposed full basement for parking. We further understand that the proposed finish floor elevation of the first floor is near existing grade. There will be two elevator shafts on either end of the building (north and south).

We have been provided with preliminary structural loads which include the following:

Columns loads: 200 – 350 kip
Line loads: 2 – 15 k/lf
Uplift load: 100 kips

## 2.0 Exploration

### 2.1 Exploration

Summit Geoengineering Services (SGS) observed the subsurface conditions at the site with the drilling of 5 borings and six probes (B-1 through B-5 and P-1 through P-6) on March 31, 2015. All of the borings and probes were drilled to refusal, ranging in depth from 0.8 to 15.8 feet below ground surface. Borings and probes were advanced using 2-1/2" hollow stem augers. During the borings, split spoon sampling was conducted in general accordance with ASTM D1586 to collect blow counts and soil samples. Probes were advanced to refusal in order to document the bedrock topography throughout the site. Auger cuttings (if present) and relative drilling resistance were used to estimate the soil types in absence of soil sampling.

SGS performed a second investigation on April 15, 2015 with the drilling of 8 borings and 3 probes (B-101 through B-108 and P-101 through P-103). The drilling was conducted by Great Works Test Boring of Berwick, Maine under the supervision of SGS. All of the borings and probes were drilled to refusal using a Mobile B-53 tracked rig and 4" hollow stem augers. Borings B-105 and B-106 were pre-augered and then cased washed to refusal where rock core samples were collected. Split spoon sampling was conducted in general accordance with ASTM D1586 to collected blow counts and soil samples. Probes were advanced to refusal in order to further document the bedrock topography throughout the site. Auger cuttings (if present) and relative drilling resistance were used to estimate the soil types in absence of soil sampling.

Locations of the borings and probes were marked by SGS prior to drilling by measuring from the existing building and surrounding landmarks. These locations can be seen in the SGS Exploration Plan in Appendix A. The boring and probe logs can be found in Exploration Logs in Appendix B.

## 3.0 Subsurface Conditions

### 3.1 Soil

The soil at the site generally consists of ***pavement*** overlying ***fill*** overlying ***glacial till*** overlying ***weathered bedrock*** overlying ***bedrock***.

The ***pavement*** at the site was present at the location of all drilled borings and probes. It ranged from 2.5" to 4.0" in thickness.

The ***fill*** layer was encountered in all borings directly below the pavement and ranged from 4.3 feet to 8.8 feet in thickness, generally increasing in thickness towards the end of the site containing Joe's Smoke Shop. The ***fill*** is described as dark brown gravelly sand to brown and black sandy silt with varying amounts of ash and brick fragments. It is very loose to compact and humid to frozen. The ***fill*** located at the southern end of the site nearer to Joe's Smoke Shop

contained large voids and frequent rubble apparent from inspection of the open bore hole and difficult drilling conditions. The ***fill*** classifies as ML, SP, GP, SM, or SP-SM, in accordance with the Unified Soil Classification System.

The ***glacial till*** was encountered in borings B-1, B-2, B-3, B-101, B-103, B-104, B-107, and probe P-3 and P-101. ***Glacial till*** may also be present at the locations of other probes but the cuttings from the layer did not make it to the ground surface for visual inspection. The ***glacial till*** is described as olive green silt with trace to little clay, sand, and gravel. It is humid to damp, compact to dense, and ranges in thickness from 1.2 feet to 6.8 feet. Standard Penetration Test (SPT-N) blow counts in this layer ranged from 18 to 44 with an average of 28. Pocket penetrometer measurements (a rough estimate of unconfined compressive strength) ranged from 4,000 psf to greater than 9,000 psf. It classifies as ML in accordance with the Unified Soil Classification System.

The ***weathered bedrock*** was encountered in borings B-4, B-104, B-105, and B-107 and probes P-1, P-2, and P-3. It ranged in thickness from 1.0 feet to 2.9 feet.

Soil profile cross sections of the site can be found in Appendix A titled “Interpretive Soil Profiles”.

### 3.2 Groundwater

Groundwater was not encountered in any of the borings or probes. The glacial till recovered in borings B-1, B-2, B-101, B-104, and B-107 from depth 5 feet to 15 feet was slightly to heavily mottled, indicating that groundwater may be confined in this layer during wet periods.

### 3.3 Bedrock

Bedrock was encountered at the site ranging from 4.8 feet to 15.8 feet below existing ground surface. The bedrock elevation ranges from 99.8 feet to 107.3 feet. The table below summarizes the depth to bedrock encountered in the borings and probes and the approximate elevation at each location. Bedrock mapping by the Maine Geologic Survey classifies the bedrock at the site as the Precambrian Z Spring Point Formation consisting of green schist and amphibolites facies ranging from and mafic to felsic volcanic rock.

| **BEDROCK DEPTH & ELEVATION** | | |
|---|---|---|
| **Boring/Probe** | **Depth (ft)** | **Elevation (ft)** |
| B-1 | 15.8 | 100.1 |
| B-2 | 11.6 | 102.4 |
| B-3 | 6.2 | 106.7 |
| B-4 | 7.2 | 105.3 |
| B-5 | 4.8 | 107.7 |
| B-101 | 11.9 | 106.6 |
| B-102 | - | - |
| B-103 | 14.5 | 100.5 |
| B-104 | 9.5 | 103.6 |

| | | |
|---|---|---|
| *B-105 | 10.0 | 103.8 |
| *B-106 | 10.0 | 102.0 |
| B-107 | 10.5 | 102.4 |
| B-108 | 8.5 | 101.7 |
| P-1 | 10.0 | 104.9 |
| P-2 | 10.0 | 103.9 |
| P-3 | 9.9 | 102.9 |
| P-4 | - | - |
| P-5 | - | - |
| P-6 | 5.0 | 107.3 |
| P-101 | 10.8 | 105.6 |
| P-102 | 12.1 | 99.8 |
| P-103 | 9.6 | 102.7 |

* = Core samples obtained

Three rock core samples were obtained, one from B-105 and two from B-106. The recovered samples are classified as moderately weathered, very thinly spaced joints/fractures, medium to light gray schist. Rock Quality Designation (RQD) of the samples ranged from 0% (very poor) to 80% (good), increasing in quality as the sample depth increased. A majority of the joints and fractures were $45^{o}$ to vertical. A photograph log of the collected sample can be found in Appendix C.

## 4.0 Evaluation

The key geotechnical issues at the site include the following:

- Potential for differential settlement of the building supported partially by bedrock and partially by native soil (glacial till)
- Presence of rubble fill in the southern portion of the site presenting excavation difficulty and poor foundation and slab support
- Large uplift loads requiring the use of grouted rock anchors

Based on the preliminary design loads and the proposed building layout, we believe that the new building can be adequately supported by a conventional frost wall on continuous spread footing foundation. The interior columns can be supported by isolated column footings. Based on the finish floor elevations, interior and exterior footings will likely be supported by a combination of glacial till and bedrock. There is also a chance that existing rubble fill will be present at the bottom of footing elevation (near the southern portion of the building). It will be critical to remove all rubble fill from below the footings to ensure that tolerable settlements are not exceeded.

Uplift loading on the new building appears to be significant. We anticipate that rock anchors will be necessary to support the uplift loading on the foundation.

## 5.0 Foundation Recommendations

### *5.1. Allowable Bearing Pressure*

We recommend that footings be proportioned using an allowable bearing pressure of 10,000 psf for foundations constructed on bedrock and an allowable bearing pressure of 4,000 psf for footings constructed on glacial till and Structural Fill (SF, see Section 5.2). Total settlement is expected to be less than 1.0" for footings constructed on glacial till and SF. Total settlement will be negligible for footings constructed on bedrock. Differential settlement is not anticipated to exceed 1.0" between footings on bedrock and footings on the native glacial till soil. The allowable bearing pressures above are based on the following conditions:

- All rubble and debris is removed from beneath the footings
- Footings are constructed on glacial till, placed Structural Fill (SF, see Section 5.2), or bedrock. If existing fill is exposed at the bottom of the footing excavation, it should be removed in its entirety down to the glacial till layer and laterally equal to a distance of the footing width on each side of the footing.
- All placed fill within the building footprint consist of SF placed in a maximum of 12" lifts and compacted to 95% of its optimum dry density in accordance with ASTM D1557.
- For footings supported on bedrock, any loose or weathered bedrock is removed to expose hard bedrock.
- Transition zones for footings spanning bedrock to native soil/placed fill be constructed in accordance with the Transition Zone Construction Detail provided in Appendix D.
- Exposed native soil is proofrolled with a minimum of 2 passes in each of two perpendicular directions with a 5 ton minimum (operating weight) vibratory roller or a large vibratory plate compactor. Any soft or unsuitable soil is removed and replaced with ¾" crushed stone or SF.

### *5.2 Slabs-on-grade*

Based on a finish floor elevation of 108 feet for the basement level parking, the slab-on-grade will be supported by a combination of existing rubble fill, glacial till (native), and existing sandy silt fill. Although unlikely, the bedrock surface may rise up to this elevation in some isolated locations. To avoid differential settlement of the slab, we recommend a minimum of 12" of Structural Fill (SF, see table below) be placed under the slab for the entire building footprint to act as a cushion between the slab and underlying soil/bedrock.

Any exposed native soil should be proofrolled with a minimum of 2 passes in each of two perpendicular directions with a 5 ton minimum (operating weight) vibratory roller. Any exposed rubble, debris, or other non-soil materials should be removed and replaced with SF. Any loose or weathered bedrock should be removed to expose a hard bedrock surface.

The slab subgrade soil should be observed by SGS after proofrolling and prior to the placement of SF. A layer of geotextile or other subgrade improvement method may be necessary.

The portion of SF passing the 3" sieve shall meet the following gradation requirements.

| STRUCTURAL FILL (SF) | |
|---|---|
| **Sieve Size** | **Percent finer** |
| 3 inch | 100 |
| ½ inch | 38 to 80 |
| ¼ inch | 25 to 65 |
| No. 40 | 0 to 30 |
| No. 200 | 0 to 7 |

**Reference**: MDOT Specification 703.06, Type D

The maximum particle size should be limited to 6 inches. Structural Fill should be placed in 6 to 12 inch lifts and should be compacted to a minimum of 95 percent of its maximum dry density, determined in accordance with ASTM D1557.

For the conditions described above, the slab can be designed using a subgrade modulus value of 150 pci.

We anticipate that the existing rubble fill in the southern portion of the site will be difficult to compact and place fill on. Our experience from the geotechnical investigation indicates that there are frequent large voids and large rubble pieces throughout the layer. Flowable fill and/or ¾" crushed stone can be used to fill the voids and create a flat surface on which to place the SF for the building slab if needed.

### *5.3 Frost Protection and Foundation Backfill*

Based on a 10-year design air freezing index of 1,200 degree F days for the Portland, Maine region, all foundation walls exposed to freezing temperatures should be constructed at a minimum depth of 4 feet below finish basement floor grade. However, in locations where the footing is supported by bedrock, footings may be constructed at a minimum depth of 2 feet below finish basement floor grade. We recommend that these elements be backfilled with Foundation Backfill (FB). The portion of FB passing the 3" sieve size should meet the following gradation requirements:

| FOUNDATION BACKFILL (FB) | |
|---|---|
| **Sieve Size** | **Percent finer** |
| 3 inch | 100 |
| ¼ inch | 25 to 100 |
| No. 40 | 0 to 50 |
| No. 200 | 0 to 7 |

**Reference**: MDOT Specification 703.06, Type E

Maximum particle size should be limited to 6 inches. Foundation backfill should be placed in 6 to 12 inch lifts and compacted to 95% of its optimum dry density determined in accordance with ASTM D1557.

### *5.4 Seismic Site Class and Design Criteria*

Based on the blow counts collected during split spoon sampling and the fractured/jointed condition of the bedrock surface, the site classifies as Site Class C "very dense soil and soft rock" for footings constructed on glacial till and Site Class B "rock" in accordance with the 2009 International Building Code. The site can be conservatively classified entirely as site class C if desired. The following seismic site coefficients should be used:

| SEISMIC DESIGN COEFFICIENTS | | |
|---|---|---|
| **Seismic Coefficient** | **Site Class B** | **Site Class C** |
| Short period spectral response ($S_S$) | 0.315 | 0.315 |
| 1 second spectral response ($S_1$) | 0.077 | 0.077 |
| Maximum factored spectral response ($S_{MS}$) | 0.315 | 0.378 |
| 1 second factored spectral response ($S_{M1}$) | 0.077 | 0.131 |
| Design short period spectral response ($S_{DS}$) | 0.210 | 0.252 |
| Design 1 second spectral response ($S_{D1}$) | 0.051 | 0.087 |

No liquefiable soils were encountered in the investigation.

### *5.4 Groundwater Considerations*

Groundwater was not encountered in the borings. However, apparent from the mottling of the native glacial till, groundwater is anticipated to fluctuate within the glacial till layer on a seasonal basis. Based on this, we recommend that perimeter underdrains be installed along the entire perimeter of exterior foundations. We recommend that underdrains consist of 4-inch diameter, perforated PVC pipe surrounded by a minimum of 6 inches of crushed stone wrapped in filter fabric. The underdrains should be placed at the base of the foundation and outlet to a free draining location or pumped if necessary. An underdrain or sump pump is highly recommended for the elevator shaft foundation.

### *5.5 Foundation Uplift and Sliding Capacity*

Uplift capacity of the foundation includes the dead weight of the foundation, skin friction of the mobilized soil, and weight of soil above the footings. Sliding resistance of the foundation includes the passive resistance of the soil against the side of the foundation wall and the friction between the bottom of the footing and the underlying soil/bedrock. We recommend that the following coefficients be used in the uplift and sliding capacity of the foundation.

| PARAMETER | FOUNDATION BACKFILL | BEDROCK | GLACIAL TILL (NATIVE) |
|---|---|---|---|
| Total Natural (moist) Unit Weight ($\gamma_t$) | 130 pcf [1] | 150 pcf | 135 pcf |
| Saturated (buoyant) Unit Weight ($\gamma_s$) | 68 pcf [1] | - | 73 pcf |
| Friction Coefficient (f) | 0.55 | 0.65 | 0.45 |
| Active Earth Pressure Coefficient ($K_a$) | 0.28 | - | 0.25 |
| Passive Earth Pressure Coefficient ($K_p$) | 3.57 | - | 4.0 |
| At Rest Earth Pressure Coefficient ($K_o$) | 0.47 | - | 0.41 |
| Uplift Earth Pressure Coefficient ($K_u$) | 0.92 | - | 0.94 |
| Friction Angle ($\phi_c$) | $34^0$ [1] | $37^0$ | $36^0$ |
| Cohesion (c) | 0 | 1000 psi [2] | 5.2 psi (750 psf) |

[1] Based on 95% compaction of Foundation Backfill by ASTM D1557, Modified Proctor Test Method

[2] For near surface localized shear (i.e., bearing capacity, uplift, and sliding), the rock should be assumed to be cohesionless.

### *5.5.1 Rock Anchors*

If additional foundation uplift capacity is needed, rock anchors can be used. Based on the recovered rock core samples at the site, we recommend an ultimate rock-grout bond stress of 120 psi be used in the design of the rock anchors. We recommend that the bonded zone start at a minimum length of 10 feet below the bedrock surface to allow for a free stressing zone. We further recommend that the rock anchors be installed with a Class 1 corrosion protection system. A minimum factor of safety of 2.5 should be used in bond stress calculations. If a 6" diameter hole is used for an anchor, this provides approximately 16 kips of uplift resistance per foot of bonded length.

To ensure adequate rock breakout capacity, we recommend that bond length of the anchors be a minimum of 5 feet. The calculation of the rock breakout was based on a failure cone projected $45^o$ from the midpoint of the bonded zone, using a rock unit weight of 150 pcf and a factor of safety of 1.0 on the rock weight resistance. Based on this, we recommend a minimum rock anchor spacing of 5 feet. We recommend a maximum of two rock anchors per footing. In total, the rock anchor tendons should extend a minimum of 15 feet below bedrock surface (free stress zone + bond zone). Centralizers should be used for all installed anchors.

Due to the potential presence of joints in the rock, we recommend that grouting be conducted in two stages. The first stage would comprise pressure grouting in the bond zone to fill in open joints and fractures. Final grouting of the bond zone would occur when pressure grouting had been shown to seal off the bond zone. All installed anchors should be proof tested to a minimum of 120% of the design load, not to exceed 60% of the tensile strength of the steel. We

recommend that the proof testing of all of the anchors be performed in accordance with the Post Tensioning Institute 2014 recommendations.

## 6.0 Construction Consideration

Based on proposed basement floor elevations, we anticipate that shoring will be necessary to excavate for footings and the basement slab. Due to the presence of shallow bedrock, we believe that installed sheeting will need to be braced with either a tie-back system or raker. Steel H-piles socketed into bedrock with timber lagging is also an option. The design of the temporary shoring system should be performed by the shoring contractor.

Based on the groundwater levels observed from our explorations, we do not anticipate that groundwater will be encountered within the building excavations. Diversion and control of surface water should be performed to prevent water flow from adjacent wet areas or from rain or snowmelt from entering the excavations.

All exposed native soil which will be load bearing should be proofrolled with a minimum of 2 passes in each of two perpendicular directions with a 5-ton (operating weight) vibratory roller. All exposed load bearing bedrock surface should be cleared of loose and weathered rock to expose hard, competent bedrock.

All exposed rubble fill below footings should be removed in its entirety down to the native glacial till soil and outwards equal to a distance of the footing width on each side of the footing. Exposed rubble fill below the basement slab should be removed a minimum of 12" below the finished slab elevation. Voids in the rubble fill can be filled with ¾" crushed stone or flowable fill.

All installed rock anchors will need to be proof tested to 120% of the design uplift load. The procedure for the proof testing is outlined in the Post Tensioning Institute 2014 recommendations.

If controlled blasting is required to construct the building foundations, we recommend that blasting be performed in accordance with the General Blasting Criteria included in Appendix F.

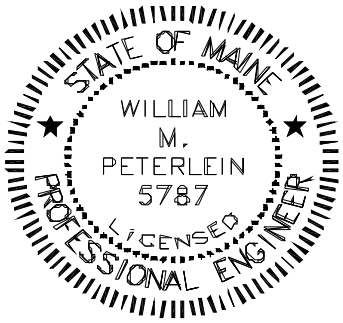
## 7.0 Closure

Our recommendations are based on professional judgment and generally accepted principles of geotechnical engineering. Some changes in subsurface conditions from those presented in this report may occur. Should these conditions differ materially from those described in this report, or should building loads and configurations change significantly, SGS should be notified so that we can re-evaluate our recommendations.

We appreciate the opportunity to serve you during this phase of your project. If there are any questions or additional information is required, please do not hesitate to call.

Sincerely,
**Summit Geoengineering Services, Inc.**

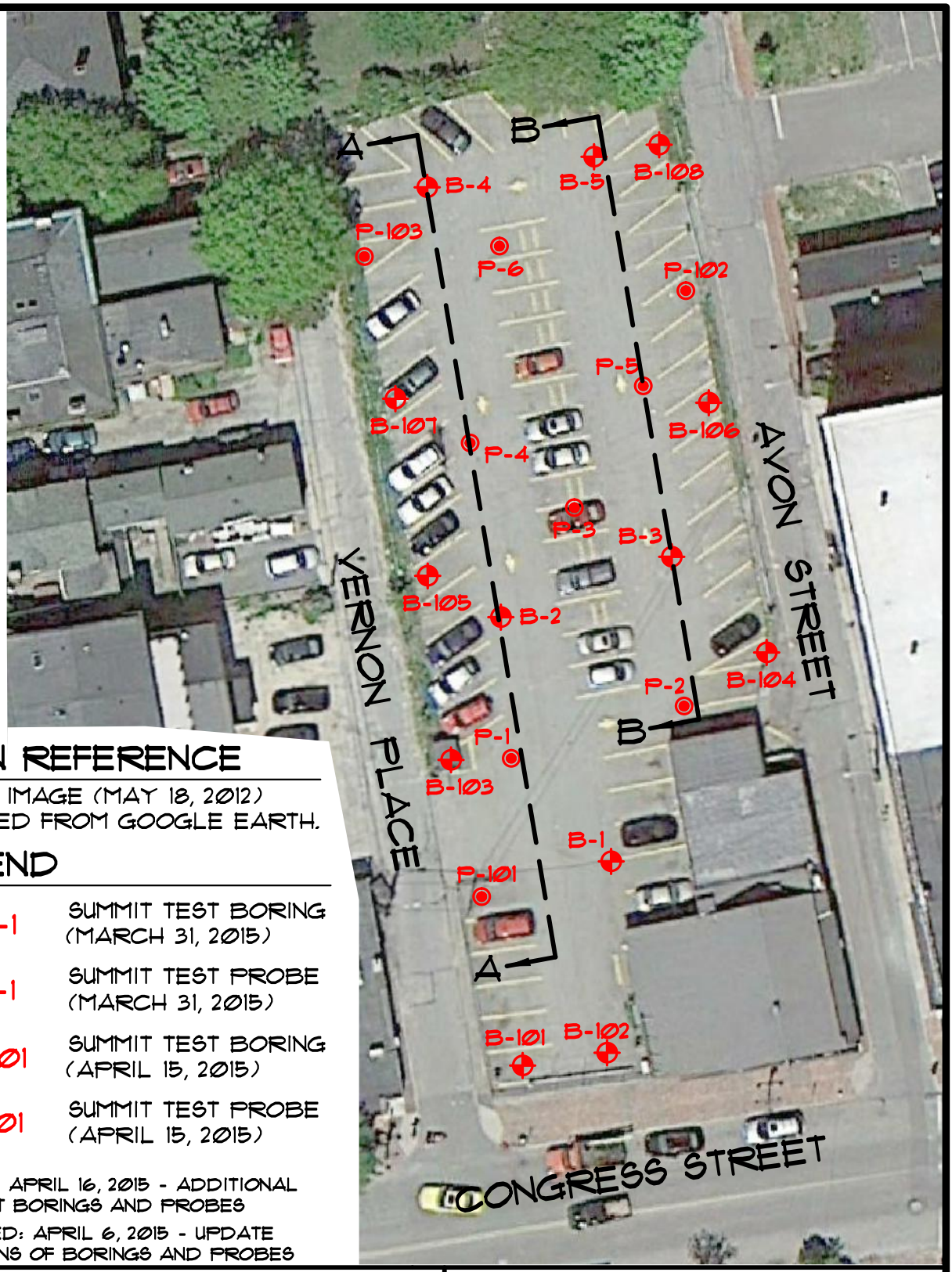
Mathew Hardison, EI
Geotechnical Engineer




William M. Peterlein, PE
Principal Geotechnical Engineer

# APPENDIX A

# EXPLORATION PLAN




## PLAN REFERENCE

AERIAL IMAGE (MAY 18, 2012)
OBTAINED FROM GOOGLE EARTH.

## LEGEND

| | |
|---|---|
| B-1 | SUMMIT TEST BORING (MARCH 31, 2015) |
| P-1 | SUMMIT TEST PROBE (MARCH 31, 2015) |
| B-101 | SUMMIT TEST BORING (APRIL 15, 2015) |
| P-101 | SUMMIT TEST PROBE (APRIL 15, 2015) |

REVISED: APRIL 16, 2015 - ADDITIONAL TEST BORINGS AND PROBES

REVISED: APRIL 6, 2015 - UPDATE LOCATIONS OF BORINGS AND PROBES

# SUBSURFACE EXPLORATION LOCATION PLAN

## PROPOSED BUILDING SITE

665 CONGRESS STREET - PORTLAND, MAINE

PREPARED FOR

## REDFERN PROPERTIES

| | | |
|---|---|---|
| DATE: 4-1-2015 | DRAWN BY: KRF | CHECKED BY: WMP |
| JOB: 15040 | SCALE: 1" = 40' | FILE: 15040 BOR |


145 LISBON ST. - SUITE 601
LEWISTON, ME 04240
Tel.: (207) 576-3313

173 PLEASANT STREET
ROCKLAND, ME 04841
Tel.: (207) 318-7761

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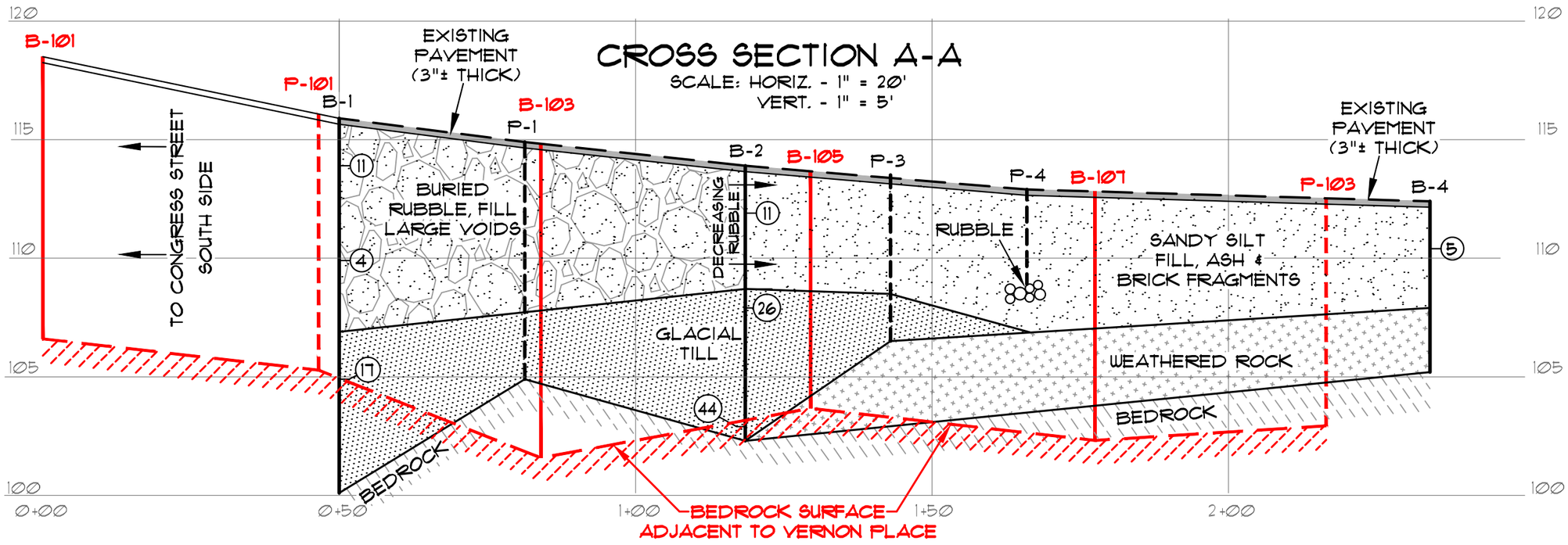
GEOENGINEERING SERVICES
www.summitgeoeng.com

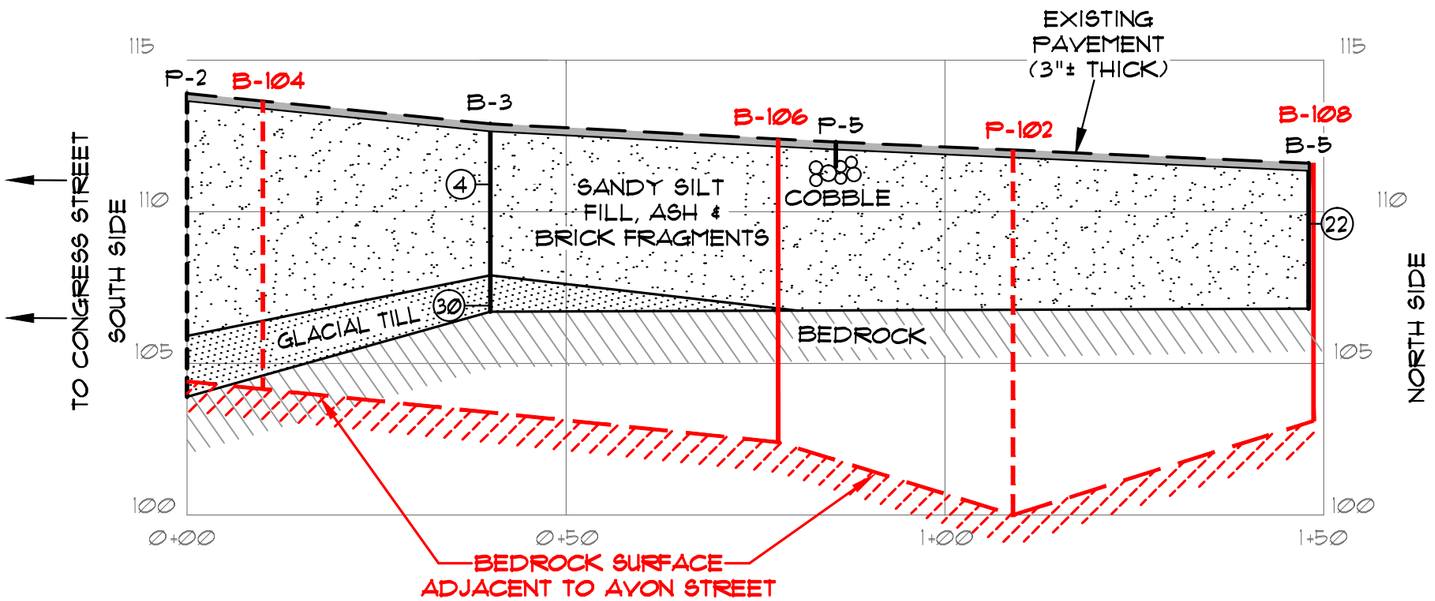
# CROSS SECTION A-A

SCALE: HORIZ. - 1" = 20'
VERT. - 1" = 5'

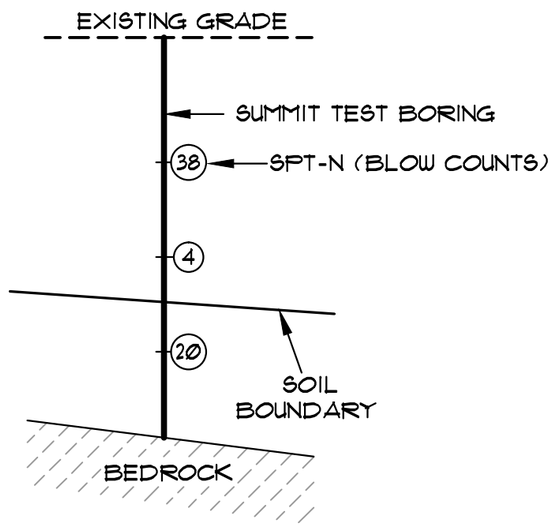



# CROSS SECTION B-B

SCALE: HORIZ. - 1" = 20'
VERT. - 1" = 5'




## LEGEND




REVISED: APRIL 20, 2015 - CORRECTED SCALE OF CROSS SECTION B-B AND ADDED RED LINES
REVISED: APRIL 6, 2015 - UPDATE LOCATIONS AND ELEVATIONS OF BORINGS AND PROBES

PROJECT:
**PROPOSED BUILDING SITE**
665 CONGRESS STREET - PORTLAND, MAINE

CLIENT:
**REDFERN PROPERTIES**

TITLE:
**INTERPRETIVE SOIL PROFILES**

SCALE: AS NOTED
DRAWN BY: KRF
DATE: APRIL 2, 2015
APPR. BY: WAP


173 PLEASANT STREET
ROCKLAND, ME 04841
Tel: (207) 318-7161

145 LISBON ST. - SUITE 601
LEWISTON, ME 04240
Tel: (207) 576-3313

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PROJ.#: 15040

FIGURE:
1

# APPENDIX B

# EXPLORATION LOGS

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# EXPLORATION COVER SHEET

The exploration logs are prepared by the geotechnical engineer from both field and laboratory data. Soil descriptions are based upon the Unified Soil Classification System (USCS) per ASTM D2487 and/or ASTM D2488 as applicable. Supplemental descriptive terms for estimated particle percentage, color, density, moisture condition, and bedrock may also be included to further describe conditions.

***Drilling and Sampling Symbols:***

SS = Split Spoon Sample
UT = Thin Wall Shelby Tube
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RW = Rotary Wash
SV = Shear Vane
PP = Pocket Penetrometer
RC = Rock Core Sample
Hyd = Hydraulic Advancement of Drilling Rods
Push = Direct Push of Drilling Rods
WOH = Weight of Hammer
WOR = Weight of Rod
PI = Plasticity Index
LL = Liquid Limit
W = Natural Water Content
USCS = Unified Soil Classification System

***Water Level Measurements:***

Water levels indicated on the boring logs are the levels measured in the boring at the times indicated. In pervious soils, the indicated elevations are considered reliable groundwater levels. In impervious soils, the accurate determination of groundwater elevations may not be possible, even after several days of observations. Groundwater monitoring wells may be required to record accurate depths and fluctuation.

***Gradation Description and Terminology:***

| | | | |
|---|---|---|---|
| Boulders: | Over 12 inches | Trace: | Less than 5% |
| Cobbles: | 12 inches to 3 inches | Little: | 5% to 15% |
| Gravel: | 3 inches to No.4 sieve | Some: | 15% to 30% |
| Sand: | No.4 to No. 200 sieve | Silty, Sandy, etc.: | Greater than 30% |
| Silt: | No. 200 sieve to 0.005 mm | | |
| Clay: | less than 0.005 mm | | |

***Density of Granular Soils and Consistency of Cohesive Soils:***

| CONSISTENCY OF COHESIVE SOILS | | DENSITY OF GRANULAR SOILS | |
|---|---|---|---|
| **SPT N-value blows/ft** | **Consistency** | **SPT N-value blows/ft** | **Relative Density** |
| 0 to 2 | Very Soft | 0 to 4 | Very Loose |
| 2 to 4 | Soft | 5 to 10 | Loose |
| 5 to 8 | Firm | 11 to 30 | Compact |
| 9 to 15 | Stiff | 31 to 50 | Dense |
| 16 to 30 | Very Stiff | >50 | Very Dense |
| >30 | Hard | | |

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# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | B-1 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 115.9' |
| Driller: | C. Coolidge, P.E. | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 3/31/2015 | Date Completed: 3/31/2015 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | AMS Power Probe | Diameter: | 2"OD/1.5"ID |
| Method: | 2-1/2" H.S.A. | Hammer: | 140 lb |
| Hammer Style: | Auto | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 3/31/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2" to 2.5" of Pavement | | PAVEMENT |
| 1 | | | | | | | | 0.2' |
| | S-1 | 24/4 | 1 to 3 | 6 | | Dark tan Gravelly SAND, little Silt, compact, humid, | | FILL |
| 2 | | | | 11 | | SP-SM | | |
| | | | | * | | * Spoon sampler skewed horizontally, unable to collect | | 2.0' |
| 3 | | | | * | | blow counts. Likely due to encountered rubble | | |
| | | | | | | | | |
| 4 | | | | | | Auger advancement produced no cuttings, likely rubble | | |
| | | | | | | fill with large voids | | |
| 5 | | | | | | | | |
| | S-2 | 24/3 | 5 to 7 | WH | | Light gray Sandy GRAVEL, cobble pieces, little white Ash | | |
| 6 | | | | 1 | | trace Silt, very loose, humid, GP | | |
| | | | | 3 | | | | |
| 7 | | | | 1 | | | | |
| | | | | | | | | |
| 8 | | | | | | | | |
| | | | | | | | | |
| 9 | | | | | | | | |
| | | | | | | | | 9.0' |
| 10 | | | | | | | | GLACIAL TILL |
| | S-3 | 24/20 | 10 to 12 | 6 | | Olive green SILT, little Clay and Sand, trace Gravel, | | |
| 11 | | | | 8 | | compact, humid, ML | PP = 8,000 to | |
| | | | | 9 | | | 9,000 psf | |
| 12 | | | | 12 | | | | |
| | | | | | | | | |
| 13 | | | | | | | | |
| | | | | | | | | |
| 14 | | | | | | | | |
| | | | | | | | | |
| 15 | | | | | | | | |
| | S-4 | 24/9 | 15 to 17 | 6 | | Same as above, slightly mottled | | |
| 16 | | | | 50/3" | | | | |
| | | | | | | End of Exploration at 15.8', Auger and Spoon refusal | | 15.8' |
| 17 | | | | | | | | BEDROCK |
| | | | | | | | | |
| 18 | | | | | | | | |
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| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | B-2 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 114 ft |
| Driller: | C. Coolidge, P.E. | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 3/31/2015 | Date Completed: 3/31/2015 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | AMS Power Probe | Diameter: | 2"OD/1.5"ID |
| Method: | 2-1/2" H.S.A. | Hammer: | 140 lb |
| Hammer Style: | Auto | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 3/31/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2" to 2.5" of Pavement | | PAVEMENT |
| 1 | S-1 | 24/20 | 1 to 3 | 3 | | Dark brown Gravelly SAND, little Silt and black/white Ash, | | 0.2' FILL |
| 2 | | | | 6 | | loose to compact, frozen, SP-SM | | |
| | | | | 5 | | | | |
| 3 | | | | 3 | | | | |
| 4 | | | | | | | | |
| 5 | S-2 | 24/22 | 5 to 7 | 10 | | Same as above | | |
| 6 | | | | 13 | | Olive green slightly mottled SILT, little Sand, trace Clay | | 5.2' GLACIAL TILL |
| | | | | 13 | | and Gravel, compact, damp, ML | | |
| 7 | | | | 14 | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | S-3 | 24/16 | 10 to 12 | 8 | | Same as above, heavily mottled seam at 10.8', dense | PP = 4,000 to 7,000 psf | |
| 11 | | | | 12 | | | | |
| | | | | 32 | | | | |
| 12 | | | | 50/1" | | End of Exploration at 11.6', Spoon refusal | | 11.6' BEDROCK |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
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| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | B-3 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 112.9 ft |
| Driller: | C. Coolidge, P.E. | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 3/31/2015 | Date Completed: 3/31/2015 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | AMS Power Probe | Diameter: | 2"OD/1.5"ID |
| Method: | 2-1/2" H.S.A. | Hammer: | 140 lb |
| Hammer Style: | Auto | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 3/31/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 3" to 3.5" of Pavement | | PAVEMENT |
| 1 | | | | | | | | 0.3' |
| | S-1 | 24/12 | 1 to 3 | 4 | | Dark brown SILT, large brick fragment in spoon, small | | FILL |
| 2 | | | | 11* | | brick fragment in spoon tip, loose, humid, ML | | |
| | | | | 4 | | | | |
| 3 | | | | 2 | | * blow count due to brick fragment | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| | S-2 | 24/12 | 5 to 7 | 12 | | Olive green SILT, little Sand, trace Clay and Gravel, | | 5' +/- |
| 6 | | | | 18 | | compact, humid, ML | PP = 5,000 psf | GLACIAL TILL |
| | | | | 50/3" | | | | |
| 7 | | | | | | End of Exploration at 6.2', Spoon and Auger refusal | | 6.2' |
| | | | | | | | | BEDROCK |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
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| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | B-4 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 112.5 ft |
| Driller: | C. Coolidge, P.E. | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 3/31/2015 | Date Completed: 3/31/2015 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | AMS Power Probe | Diameter: | 2"OD/1.5"ID |
| Method: | 2-1/2" H.S.A. | Hammer: | 140 lb |
| Hammer Style: | Auto | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 3/31/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2.5" of Pavement | | PAVEMENT |
| 1 | | | | | | | | 0.2' |
| | S-1 | 24/10 | 1 to 3 | 2 | | Brown Sandy SILT, little fine Gravel and black Ash, loose, humid, ML | | FILL |
| 2 | | | | 2 | | | | |
| | | | | 3 | | | | |
| 3 | | | | 2 | | | | |
| | | | | | | Auger cuttings show increasing ash content with depth and some brick fragments | | |
| 4 | | | | | | | | |
| | S-2 | 24/2 | 4.5 to 6.5 | 50/5" | | Weathered rock fragments in spoon tip | | |
| 5 | | | | | | | | 4.5' |
| | | | | | | Augered through weathered rock to competent refusal | | WEATHERED ROCK |
| 6 | | | | | | | | |
| | | | | | | | | |
| 7 | | | | | | | | |
| | | | | | | End of Exploration at 7.2', Auger refusal | | 7.2' |
| 8 | | | | | | | | BEDROCK |
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| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | B-5 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 112.5 ft |
| Driller: | C. Coolidge, P.E. | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 3/31/2015 | Date Completed: 3/31/2015 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | AMS Power Probe | Diameter: | 2"OD/1.5"ID |
| Method: | 2-1/2" H.S.A. | Hammer: | 140 lb |
| Hammer Style: | Auto | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 3/31/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 2.5" of Pavement | | PAVEMENT |
| 1 | | | | | | | | 0.2' |
| | S-1 | 24/8 | 1 to 3 | 15 | | Dark brown to black Sandy SILT, little Gravel and black | | FILL |
| 2 | | | | 16 | | and white Ash, ML | | |
| | | | | 6 | | | | |
| 3 | | | | 2 | | | | |
| | | | | | | | | |
| 4 | | | | | | | | |
| | | | | | | Dense drilling at 4.8' | | |
| 5 | S-2 | 24/1 | 4.8 to 6.8 | 50/3" | | Rock in spoon tip | | |
| | | | | | | End of Exploration at 4.8', Spoon and Auger refusal | | 4.8' |
| 6 | | | | | | | | BEDROCK |
| | | | | | | | | |
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| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
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|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | B-101 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Great Works Test Boring | Boring Elevation: | 118.5 ft |
| Driller: | Jeff Lee | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 4/15/2015 | Date Completed: 4/15/2015 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | Mobile B-53 | Diameter: | 2"OD/1.5"ID |
| Method: | 4" Solid Stem Auger | Hammer: | 140 lb |
| Hammer Style: | R&C | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 4/15/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 3" Pavement | | PAVEMENT |
| 1 | S-1 | 24/4 | 0.5 to 2.5 | 4 | | Brown Silty SAND, loose, humid, SM | | 0.25' FILL |
| | | | | 3 | | | | |
| 2 | | | | 3 | | | | |
| | | | | 3 | | | | |
| 3 | | | | | | | | |
| | | | | | | | | |
| 4 | | | | | | Possible rubble encountered at 4' during drilling | | |
| | | | | | | | | |
| 5 | | | | | | | | |
| | S-2 | 24/4 | 5 to 7 | 7 | | Brown Silty SAND, trace Gravel, compact humid, SM | | |
| 6 | | | | 7 | | | | |
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| 8 | | | | | | | | |
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| 9 | | | | | | | | |
| | | | | | | | | |
| 10 | | | | | | | | |
| | S-3 | 24/12 | 10 to 12 | 4 | | Dark olive green SILT, little Sand and Gravel, trace Clay, | | 10.0' +/- |
| 11 | | | | 8 | | dense/very stiff, slightly mottled, humid, ML | PP = *1,000 to *3,000 psf | GLACIAL TILL |
| | | | | 30 | | | | |
| 12 | | | | 50/5 | | * = Specimen failed via tension crack, low clay content | | |
| | | | | | | End of Exploration at 11.9', Auger and Spoon refusal | | 11.9' BEDROCK |
| 13 | | | | | | | | |
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| 14 | | | | | | | | |
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| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | B-102 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Great Works Test Boring | Boring Elevation: | 118.7 ft |
| Driller: | Jeff Lee | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 4/15/2015 | Date Completed: 4/15/2015 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | Mobile B-53 | Diameter: | 2"OD/1.5"ID |
| Method: | 4" Solid Stem Auger | Hammer: | 140 lb |
| Hammer Style: | R&C | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 4/15/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 3" Pavement | | PAVEMENT |
| 1 | S-1 | 24/4 | 0.5 to 2.5 | 4 | | Dark brown Silty SAND, little Gravel, Gravel pieces in spoon tip, loose, dry, SM | | 0.25' FILL |
| | | | | 5 | | | | |
| 2 | | | | 5 | | | | |
| | | | | 3 | | | | |
| 3 | | | | | | Rubble fill, large voids apparent from open hole inpection | | |
| 4 | | | | | | Auger encountered refusal at 4.9' during drilling. Moved over 1' and attempted to drill past, refusal encountered in second hole at 3.2' | | |
| 5 | | | | | | | | |
| | | | | | | End of Exploration at 4.9', Auger refusal on rubble | | 4.9' |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
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| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | B-103 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Great Works Test Boring | Boring Elevation: | 115.0 ft |
| Driller: | Jeff Lee | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 4/15/2015 | Date Completed: 4/15/2015 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | Mobile B-53 | Diameter: | 2"OD/1.5"ID |
| Method: | 4" Solid Stem Auger | Hammer: | 140 lb |
| Hammer Style: | R&C | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 4/15/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 3" Pavement | | PAVEMENT |
| 1 | S-1 | 24/8 | 0.5 to 2.5 | 4 | | Brown to dark brown SAND, trace silt, large brick fragment | | 0.25' |
| | | | | 6 | | in top 4" of sample, brick fragment in spoon tip, loose, | | FILL |
| 2 | | | | 7 | | humid, SP | | |
| | | | | 9 | | | | |
| 3 | | | | | | | | |
| | | | | | | | | |
| 4 | | | | | | | | |
| | | | | | | | | |
| 5 | | | | | | | | |
| | S-2 | 24/6 | 5 to 7 | 5 | | same as above, no brick fragment, some white Ash | | |
| 6 | | | | 7 | | | | |
| | | | | 15 | | | | |
| 7 | | | | 15 | | | | |
| | | | | | | | | |
| 8 | | | | | | | | |
| | | | | | | | | |
| 9 | | | | | | | | |
| | | | | | | | | 9.0' +/- |
| 10 | | | | | | | | GLACIAL TILL |
| | S-3 | 24/20 | 10 to 12 | 14 | | Olive green SILT, little Gravel, Sand, and Clay, cobble | PP = 6,000 to | |
| 11 | | | | 24 | | pieces fro 10.5 to 11.0', humid, dense/hard, ML | > 9,000 psf | |
| | | | | 20 | | | | |
| 12 | | | | 20 | | | | |
| | | | | | | | | |
| 13 | | | | | | | | |
| | | | | | | | | |
| 14 | | | | | | | | |
| | | | | | | | | |
| 15 | | | | | | End of Exploration at 14.5', Auger refusal | | 14.5' |
| | | | | | | | | BEDROCK |
| 16 | | | | | | | | |
| | | | | | | | | |
| 17 | | | | | | | | |
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| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | **B-104** |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Great Works Test Boring | Boring Elevation: | 113.1 ft |
| Driller: | Jeff Lee | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 4/15/2015 | Date Completed: 4/15/2015 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | Mobile B-53 | Diameter: | 2"OD/1.5"ID |
| Method: | 4" Solid Stem Auger | Hammer: | 140 lb |
| Hammer Style: | R&C | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 4/15/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 4" Pavement | | PAVEMENT |
| 1 | | | | | | Augered to 5', relatively easy drillling (no rubble) | | 0.3' FILL |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| | S-1 | 24/18 | 5 to 7 | 7 | | Olive green SILT, little Gravel, Sand, and Clay, mottled, | PP = 5,000 to | 5.0' +/- |
| 6 | | | | 7 | | damp, compact/very stiff, cobble pieces at 6.5', ML | 7,000 psf | GLACIAL TILL |
| | | | | 17 | | | | |
| 7 | | | | 23 | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | 8.5' WEATHERED ROCK |
| 10 | | | | | | End of Exploration at 9.5', Auger refusal | | 9.5' BEDROCK |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
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| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | B-105 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Great Works Test Boring | Boring Elevation: | 113.8 ft |
| Driller: | Jeff Lee | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 4/15/2015 | Date Completed: 4/15/2015 |

| DRILLING METHOD | SAMPLER |
|---|---|
| Vehicle: Tracked | Length: 24" SS |
| Model: Mobile B-53 | Diameter: 2"OD/1.5"ID |
| Method: 4" Cased Wash | Hammer: 140 lb |
| Hammer Style: R&C | Method: ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 4/15/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 3" Pavement | | PAVEMENT |
| 1 | | | | | | Augered to refusal for Rock Core | | 0.25' |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | ROCK CORE DATA | | | | | | | 9.1' +/- WEATHERED ROCK |
| | RUN | DEPTH | RUN | RECOVERY | RQD | | | 10.0' |
| 11 | C-1a | 10 to 13.3 | 40" | 70% | 0% | Moderately weathered, very thinly spaced vertical joints, very hard, light to medium gray SCHIST |  | BEDROCK |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| | C-1b | 13.3 to 15 | 20" | 100% | 80% | Same as above, moderately spaced joints | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| | | | | | | End of Exploration at 15.0', rock core terminated | | 15.0' |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
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| 24 | | | | | | | | |
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| 26 | | | | | | | | |
| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
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Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
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|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
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SUMMIT
GEOENGINEERING SERVICES

# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | B-106 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Great Works Test Boring | Boring Elevation: | 112.0 ft |
| Driller: | Jeff Lee | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 4/15/2015 | Date Completed: 4/15/2015 |

| DRILLING METHOD | SAMPLER |
|---|---|
| Vehicle: Tracked | Length: 24" SS |
| Model: Mobile B-53 | Diameter: 2"OD/1.5"ID |
| Method: 4" Cased Wash | Hammer: 140 lb |
| Hammer Style: R&C | Method: ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 4/15/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 3" Pavement | | PAVEMENT |
| 1 | | | | | | Augered to refusal for Rock Core | | 0.25' |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | Dense drilling from approximately 2' to 8', frequent rubble or cobble | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | ROCK CORE DATA | | | | | | | |
| | RUN | DEPTH | RUN | RECOVERY | RQD | | | 10.0' |
| 11 | C-2 | 10 to 15 | 60" | 66% | 33% | Moderately weathered, very thinly spaced joints, very hard light gray to blue SCHIST |  | BEDROCK |
| 12 | | | | | | most fractures range from 45° to vertical | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| | C-3 | 15 to 19 | 48" | 96% | 65% | Same as above, most joints and fractures are vertical |  | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | End of Exploration at 19.0', rock core terminated | | 19.0' |
| 21 | | | | | | | | |
| 22 | | | | | | | | |
| 23 | | | | | | | | |
| 24 | | | | | | | | |
| 25 | | | | | | | | |
| 26 | | | | | | | | |
| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | B-107 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Great Works Test Boring | Boring Elevation: | 112.9 ft |
| Driller: | Jeff Lee | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 4/15/2015 | Date Completed: 4/15/2015 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | Mobile B-53 | Diameter: | 2"OD/1.5"ID |
| Method: | 4" Solid Stem Auger | Hammer: | 140 lb |
| Hammer Style: | R&C | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 4/15/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 4" Pavement | | PAVEMENT |
| 1 | S-1 | 24/6 | 0.5 to 2.5 | 3 | | Dark brown Sandy SILT, trace Ash and Brick fragments, loose, dry, ML | | 0.3' FILL |
| | | | | 4 | | | | |
| 2 | | | | 4 | | | | |
| | | | | 3 | | | | |
| 3 | | | | | | | | |
| | | | | | | | | |
| 4 | | | | | | | | |
| | | | | | | | | |
| 5 | | | | | | | | |
| | S-2 | 24/24 | 5 to 7 | 7 | | Olive green SILT, slight mottling, litte fine Sand, trace Gravel and Clay, compact/very stiff, humid, ML | | 5.0' +/- GLACIAL TILL |
| 6 | | | | 10 | | | | |
| | | | | 14 | | | | |
| 7 | | | | 14 | | | | |
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| 8 | | | | | | | | |
| | | | | | | | | |
| 9 | | | | | | | | |
| | | | | | | | | |
| 10 | | | | | | Soft rock encountered during augering, drilled 1.5' into rock to hard refusal | | 9.0' +/- WEATHERED ROCK |
| | | | | | | | | |
| 11 | | | | | | End of Exploration at 10.5', Auger refusal | | 10.5' BEDROCK |
| | | | | | | | | |
| 12 | | | | | | | | |
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| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL BORING LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | B-108 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Great Works Test Boring | Boring Elevation: | 110.2 ft |
| Driller: | Jeff Lee | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 4/15/2015 | Date Completed: 4/15/2015 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | Mobile B-53 | Diameter: | 2"OD/1.5"ID |
| Method: | 4" Solid Stem Auger | Hammer: | 140 lb |
| Hammer Style: | R&C | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 4/15/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 4" Pavement | | PAVEMENT |
| 1 | S-1 | 24/10 | | 8 | | Tan fine to coarse SAND, little silt, compacy, humid, SW-SM | | 0.3' |
| | | | | 9 | | | | |
| 2 | | | | 8 | | large Brick fragment and white ASH | | 1.1' +/- |
| | | | | 3 | | | | |
| 3 | | | | | | | | FILL |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| | S-2 | 24/4 | | *50/6" | | Light brown Gravelly SAND, cobble piece in spoon tip, humid, SP | | |
| 6 | | | | | | * high blow count due to cobble in fill | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | End of Exploration at 8.5', Auger refusal | | 8.5' BEDROCK |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
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| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
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Steep = 55 to 90 degrees

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Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL PROBE LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | P-1 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 114.9 ft |
| Driller: | C. Coolidge, P.E. | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 3/31/2015 | Date Completed: 3/31/2015 |

| DRILLING METHOD | SAMPLER |
|---|---|
| Vehicle: Tracked | Length: N/A |
| Model: AMS Power Probe | Diameter: N/A |
| Method: 2-1/2" H.S.A. | Hammer: N/A |
| Hammer Style: Auto | Method: N/A |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 3/31/2015 | | | |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | PROBE | | 2.5" of Pavement | | PAVEMENT |
| 1 | | | | | | | | 0.2' FILL |
| 2 | | | | | | | | |
| 3 | | | | | | Dense drilling at 3', likely rubble | | |
| 4 | | | | | | Auger advancement produced no cuttings, large voids apparent from hole inspection, likely rubble fill | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | 9.0' +/- WEATHERED ROCK |
| 11 | | | | | | End of Probe at 10.0', Auger Refusal | | 10.0' BEDROCK |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
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| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
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Bedrock Joints
Shallow = 0 to 35 degrees
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Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL PROBE LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | P-2 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 113.9 ft |
| Driller: | C. Coolidge, P.E. | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 3/31/2015 | Date Completed: 3/31/2015 |

| DRILLING METHOD | SAMPLER |
|---|---|
| Vehicle: Tracked | Length: N/A |
| Model: AMS Power Probe | Diameter: N/A |
| Method: 2-1/2" H.S.A. | Hammer: N/A |
| Hammer Style: Auto | Method: N/A |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 3/31/2015 | | | |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | PROBE | | 2.5" of Pavement | | PAVEMENT |
| 1 | | | | | | | | 0.2' FILL |
| 2 | | | | | | Auger cuttings: tan Sandy SILT, some brick fragments, | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | 9.0' +/- WEATHERED ROCK |
| 11 | | | | | | End of Probe at 10.0', Auger refusal | | 10.0' BEDROCK |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
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| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
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Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL PROBE LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | P-3 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 112.8 ft |
| Driller: | C. Coolidge, P.E. | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 3/31/2015 | Date Completed: 3/31/2015 |

| DRILLING METHOD | SAMPLER |
|---|---|
| Vehicle: Tracked | Length: N/A |
| Model: AMS Power Probe | Diameter: N/A |
| Method: 2-1/2" H.S.A. | Hammer: N/A |
| Hammer Style: Auto | Method: N/A |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 3/31/2015 | | | |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | PROBE | | 3.5" of Pavement | | PAVEMENT |
| 1 | | | | | | Dense drilling at 8", moved over and started new hole | | 0.3' FILL |
| 2 | | | | | | Auger cuttings: Dark tan SAND, little Silt and Gravel | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | Auger cuttings: similar to above, little Clay | | 5.0' +/- GLACIAL TILL |
| 7 | | | | | | | | |
| 8 | | | | | | Auger cuttings: light tan fine SAND (rock dust) | | 7.0' +/- WEATHERED ROCK |
| 9 | | | | | | | | |
| 10 | | | | ↓ | | | | |
| 11 | | | | | | End of Probe at 9.9', Auger refusal | | 9.9' BEDROCK |
| 12 | | | | | | | | |
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| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

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Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
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Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL PROBE LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | **P-4** |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 112.9 ft |
| Driller: | C. Coolidge, P.E. | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 3/31/2015 | Date Completed: 3/31/2015 |

| DRILLING METHOD | SAMPLER |
|---|---|
| Vehicle: Tracked | Length: N/A |
| Model: AMS Power Probe | Diameter: N/A |
| Method: 2-1/2" H.S.A. | Hammer: N/A |
| Hammer Style: Auto | Method: N/A |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 3/31/2015 | | | |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | PROBE | | 3.5" of Pavement | | PAVEMENT |
| 1 | | | | | | | | 0.3' |
| | | | | | | Auger refusal at 2', moved over and started new hole | | FILL |
| 2 | | | | | | | | |
| | | | | | | Encountered dense drilling at 2' again in second hole, | | |
| 3 | | | | | | drilled past it. Dense driilling ecountered again at 4'. | | |
| | | | | | | Likely rubble | | |
| 4 | | | | | | | | |
| | | | | | | End of Probe at 4.0', Auger refusal | | 4.0' |
| 5 | | | | | | | | RUBBLE |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
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| 26 | | | | | | | | |
| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
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Steep = 55 to 90 degrees

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Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

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|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL PROBE LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | P-5 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 112.3 ft |
| Driller: | C. Coolidge, P.E. | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 3/31/2015 | Date Completed: 3/31/2015 |

| DRILLING METHOD | SAMPLER |
|---|---|
| Vehicle: Tracked | Length: N/A |
| Model: AMS Power Probe | Diameter: N/A |
| Method: 2-1/2" H.S.A. | Hammer: N/A |
| Hammer Style: Auto | Method: N/A |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 3/31/2015 | | | |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | PROBE | | 3" of Pavement | | PAVEMENT |
| 1 | | | | ↓ | | Auger refusal at 9"', moved over and started new hole, encounered same refusal. Likely cobble | | 0.3' |
| 2 | | | | | | End of Probe at 0.8', Auger refusal | | 0.8' COBBLE |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
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| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

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# SOIL PROBE LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | P-6 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Summit Geoengineering Services | Boring Elevation: | 112.3 ft |
| Driller: | C. Coolidge, P.E. | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 3/31/2015 | Date Completed: 3/31/2015 |

| DRILLING METHOD | SAMPLER |
|---|---|
| Vehicle: Tracked | Length: N/A |
| Model: AMS Power Probe | Diameter: N/A |
| Method: 2-1/2" H.S.A. | Hammer: N/A |
| Hammer Style: Auto | Method: N/A |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 3/31/2015 | | | |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | PROBE | | 2.5" of Pavement | | PAVEMENT |
| 1 | | | | | | | | 0.2' FILL |
| 2 | | | | | | Auger cuttings: Black Sandy SILT, frequent brick fragments, little Clay and black Ash | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | End of Probe at 5.0', Auger refusal | | 5.0' BEDROCK |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
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| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

SUMMIT
GEOENGINEERING SERVICES

# SOIL PROBE LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | **P-101** |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Great Works Test Boring | Boring Elevation: | 116.4 ft |
| Driller: | Jeff Lee | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 4/15/2015 | Date Completed: 4/15/2015 |

| DRILLING METHOD | SAMPLER |
|---|---|
| Vehicle: Tracked | Length: N/A |
| Model: Mobile B-53 | Diameter: N/A |
| Method 4" Solid Stem Auger | Hammer: N/A |
| Hammer Style: R&C | Method: N/A |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 4/15/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | PROBE | | 3" Pavement | | PAVEMENT |
| 1 | | | | | | Very difficult drilling, frequent rubbe encountered, refusal encountered in first hole at 4.5', moved over 1' to start new hole | | 0.25' +/- FILL |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | Smoother drilling started around 9', assumed transizion zone into native till | | 9' +/- GLACIAL TILL |
| 11 | | | | | | End of Probe at 10.8', Auger refusal | | 10.8' BEDROCK |
| 12 | | | | | | | | |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
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| 24 | | | | | | | | |
| 25 | | | | | | | | |
| 26 | | | | | | | | |
| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

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# SOIL PROBE LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | P-102 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Great Works Test Boring | Boring Elevation: | 111.9 ft |
| Driller: | Jeff Lee | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 4/15/2015 | Date Completed: 4/15/2015 |

| DRILLING METHOD | | SAMPLER | |
|---|---|---|---|
| Vehicle: | Tracked | Length: | 24" SS |
| Model: | Mobile B-53 | Diameter: | 2"OD/1.5"ID |
| Method | 4" Solid Stem Auger | Hammer: | 140 lb |
| Hammer Style: | R&C | Method: | ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 4/15/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | PROBE | | 3" Pavement | | PAVEMENT |
| 1 | | | | | | | | |
| 2 | | | | | | Smooth drilling throughout fill layer (no rubble/cobbles) | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | Increased resistance at 4.8, potential till or soft rock | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | End of Probe at 12.1', Auger refusal | | 12.1' BEDROCK |
| 13 | | | | | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
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| 26 | | | | | | | | |
| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

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# SOIL PROBE LOG

| | | | |
|---|---|---|---|
| Project: | Proposed Apartment Building | Boring #: | P-103 |
| Location: | 665 Congress St. | Project #: | 15040 |
| City, State: | Portland, ME | Sheet: | 1 of 1 |
| | | Chkd by: | |

| | | | |
|---|---|---|---|
| Drilling Co: | Great Works Test Boring | Boring Elevation: | 112.3 ft |
| Driller: | Jeff Lee | Reference: | Site Survey by Titcomb Associates |
| Summit Staff: | M. Hardison, E.I. | Date started: 4/15/2015 | Date Completed: 4/15/2015 |

| DRILLING METHOD | SAMPLER |
|---|---|
| Vehicle: Tracked | Length: 24" SS |
| Model: Mobile B-53 | Diameter: 2"OD/1.5"ID |
| Method 4" Solid Stem Auger | Hammer: 140 lb |
| Hammer Style: R&C | Method: ASTM D1586 |

ESTIMATED GROUND WATER DEPTH

| Date | Depth | Elevation | Reference |
|---|---|---|---|
| 4/15/2015 | - | | None observed |
| | | | |
| | | | |

| Depth (ft.) | No. | Pen/Rec (in) | Depth (ft) | blows/6" | $N_{60}$ | SAMPLE DESCRIPTION | Geological/ Test Data | Geological Stratum |
|---|---|---|---|---|---|---|---|---|
| | | | | PROBE | | 4" Pavement | | PAVEMENT |
| 1 | | | | | | | | 0.3' |
| 2 | | | | | | | | |
| 3 | | | | | | Relatively easy drilling, no rubbe/cobbles encountered | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | End of Probe at 9.6', Auger refusal | | 9.6' BEDROCK |
| 11 | | | | | | | | |
| 12 | | | | | | | | |
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| 26 | | | | | | | | |
| 27 | | | | | | | | |

| Granular Soils | | Cohesive Soils | | % Composition |
|---|---|---|---|---|
| Blows/ft. | Density | Blows/ft. | Consistency | ASTM D2487 |
| 0-4 | V. Loose | <2 | V. soft | |
| 5-10 | Loose | 2-4 | Soft | < 5% Trace |
| 11-30 | Compact | 5-8 | Firm | 5-15% Little |
| 31-50 | Dense | 9-15 | Stiff | 15-30% Some |
| >50 | V. Dense | 16-30 | V. Stiff | > 30% With |
| | | >30 | Hard | |

NOTES: PP = Pocket Penetrometer, MC = Moisture Content
LL = Liquid Limit, PI = Plastic Index

Bedrock Joints
Shallow = 0 to 35 degrees
Dipping = 35 to 55 degrees
Steep = 55 to 90 degrees

Boulders = diameter > 12 inches, Cobbles = diameter < 12 inches and > 3 inches
Gravel = < 3 inch and > No 4, Sand = < No 4 and >No 200, Silt/Clay = < No 200

| Soil Moisture Condition |
|---|
| Dry: S = 0% |
| Humid: S = 1 to 25% |
| Damp: S = 26 to 50% |
| Moist: S = 51 to 75% |
| Wet: S = 76 to 99% |
| Saturated: S = 100% |

# APPENDIX C

## ROCK CORE PHOTOS

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# PHOTOGRAPHIC LOG

| **Project:** | **Project No.** |
|---|---|
| Proposed Apartment Building – 665 Congress St., Portland ME | 15040 |

**Photo No. 1**

**Date:** 4-16-2015

**Site Location:**

665 Congress Street
Portland, Maine

**Description:**

Rock Core C-1 in Boring B-105 from depth 10 feet to 15 feet

Elevation 103.8 feet to Elevation 98.8 feet

Description:

Schist

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# PHOTOGRAPHIC LOG

| **Project:** | **Project No.** |
|---|---|
| Proposed Apartment Building – 665 Congress St., Portland ME | 15040 |

**Photo No. 1**

**Date:** 4-16-2015

**Site Location:**

665 Congress Street
Portland, Maine

**Description:**

Rock Core C-2 in Boring B-106 from depth 10 feet to 15 feet

Elevation 102 feet to Elevation 97 feet

Description:

Schist

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# PHOTOGRAPHIC LOG

| **Project:** | **Project No.** |
|---|---|
| Proposed Apartment Building – 665 Congress St., Portland ME | 15040 |

**Photo No. 1**

**Date:** 4-16-2015

**Site Location:**

665 Congress Street
Portland, Maine

**Description:**

Rock Core C-3 in Boring B-106 from depth 15 feet to 19 feet

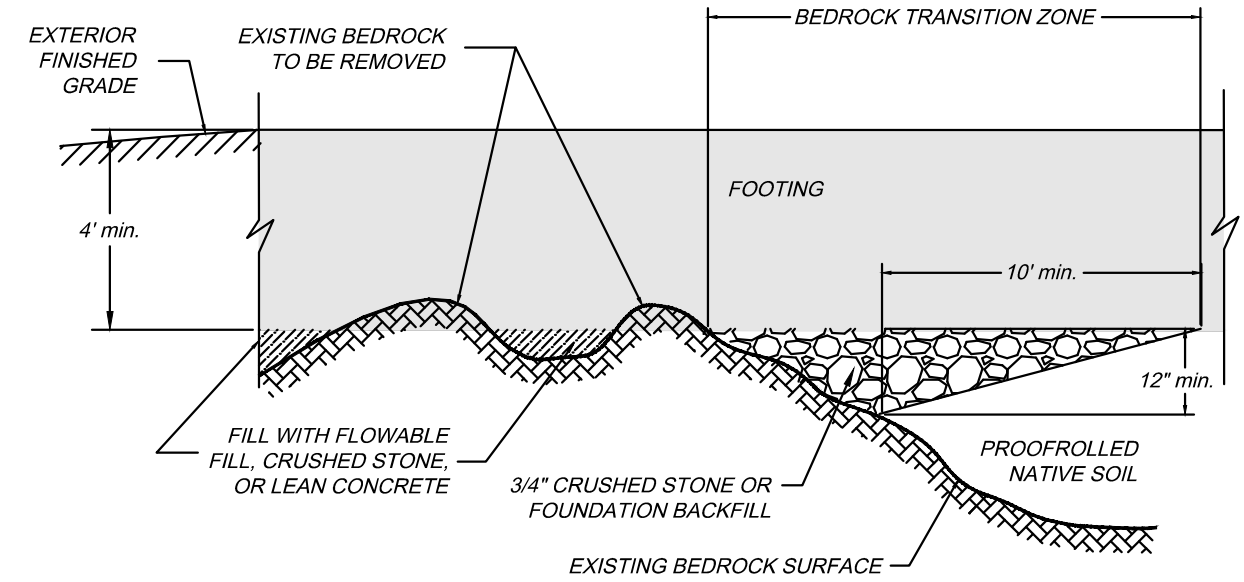
Elevation 97 feet to Elevation 93 feet

Description:

Schist

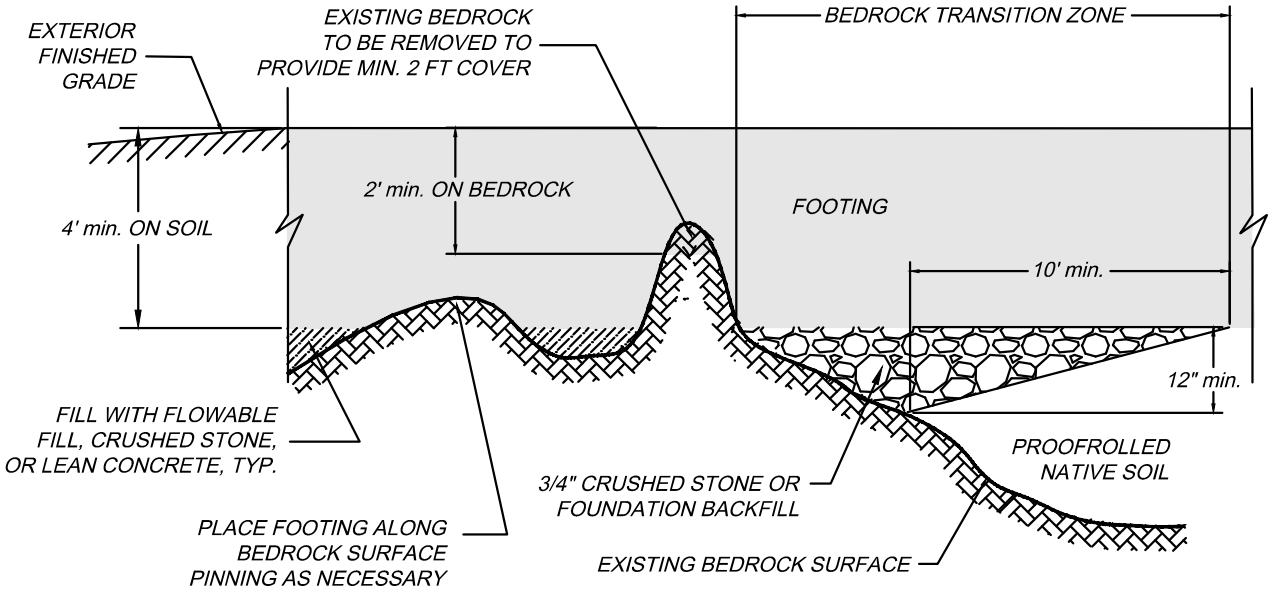
# APPENDIX D

## TRANSITION ZONE CONSTRUCTION DETAIL




## FOOTING SUBGRADE OPTION #1 - FULL FROST PROTECTION

(not to scale)




## FOOTING SUBGRADE OPTION #2 - MINIMUM FROST PROTECTION

(not to scale)

# BEDROCK TO SOIL TRANSITION DETAIL

## PROPOSED BUILDING SITE

665 CONGRESS STREET - PORTLAND, MAINE

PREPARED FOR

## REDFERN PROPERTIES

| | | |
|---|---|---|
| DATE: 5-1-2015 | DRAWN BY: KRF | CHECKED BY: WMP |
| JOB: 15040 | NOT TO SCALE | FILE: 15040 BED |


145 LISBON ST. - SUITE 601
LEWISTON, ME 04240
Tel.: (207) 576-3313

173 PLEASANT STREET
ROCKLAND, ME 04841
Tel.: (207) 318-7761

SUMMIT
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www.summitgeoeng.com

# APPENDIX E

## GENERAL BLASTING CRITERIA

# GENERAL BLASTING RECOMMENDATIONS

## Introduction

Blasting operations will be performed in general accordance with the applicable Maine Revised Statute Title 125 and Title 38, U.S. Department of the Interior Rules, the recommendations provided below, and a normal standard of care.

## Blast Design

The blasting contractor shall submit a blasting plan to the Owner for approval prior to blasting operations. The blasting plan shall include a schedule, sketches of the drill patterns (hole spacing and depth), type and amount of explosives, number and sequence of delays, methods for minimizing flyrock, and any other information pertinent to demonstrating compliance with the applicable U.S. Department of the Interior Rules and the requirements of the applicable Statute requirements of 38 MRSA.

## Notification

Oral notification to the abutters within one-half mile of the blast area shall be provided prior to blasting. Warning and all clear signals of different character or pattern that are audible within one-half mile from the point of the blast shall be given. The meaning of the signals shall be conveyed to the abutters at the time they are notified.

## Pre-blast Surveys

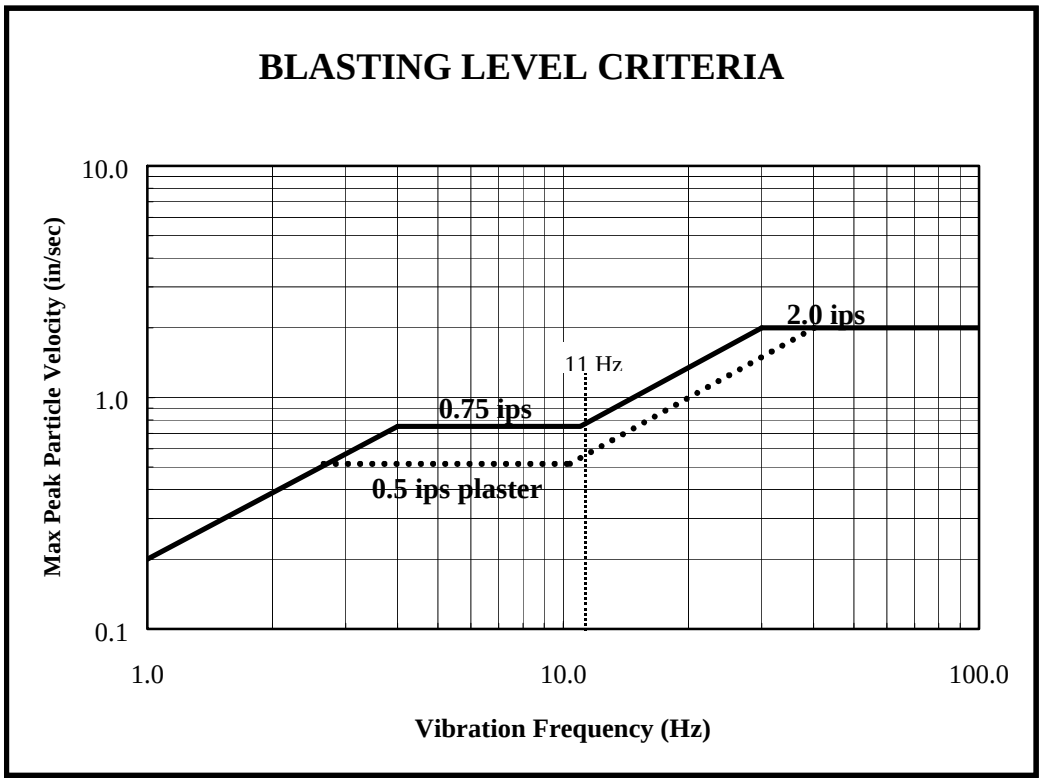
All blasting operations are the direct responsibility of the Blasting Contractor. Reports of damage to structures caused by blasting operations are the sole responsibility of the Blasting Contractor. Therefore, it is incumbent upon the Blasting Contractor to perform pre-blast surveys as they deem necessary.

## Airblast Limits

Airblast overpressure shall not exceed the limits stipulated in 38 MRSA 490-Z(14)(H) at the nearest structure. This currently requires sound from blasting to not exceed 129 decibels peak at inhabited structures and 140 decibels peak at uninhabited structures.

## Ground Vibration Limits

The maximum ground vibration at any structure shall not exceed the limits presented in the following chart:




REFERENCE: OSM alternative blasting criteria (Modified from figure B-1, Bureau of Mines, RI 8507)

The Blasting Contractor shall provide a seismographic record to the Owner for each blast event at the nearest off-site structure. The record shall include the date and time of the blast, peak and resultant particle velocities and associated frequencies, and the airblast overpressure.

## Flyrock

Sufficient stemming, matting, or natural protective cover shall be provided to prevent flyrock from leaving property owned or under control of the operator or from entering protected natural resources or natural buffer strips.

**Records**

Records of blasts shall be recorded in accordance with Maine Statute 38 MRSA 490-Z(14)(L). The current requirements are as follows.

- Name of blasting company or blasting contractor
- Location, date and time of blast
- Name, signature and social security number of blaster
- Type of material blasted
- Number and spacing of holes and depth of burden or stemming
- Diameter and depth of holes
- Type of explosives used
- Total amount of explosives used
- Maximum amount of explosives used per delay period of 8 milliseconds or greater
- Maximum number of holes per delay period of 8 milliseconds or greater
- Method of firing and type of circuit
- Direction and distance in feet to the nearest dwelling, public building, school, church or commercial or institutional building neither owned nor controlled by the developer
- Weather conditions, including factors such as wind direction and cloud cover
- Height or length of stemming
- Amount of mats or other protection used
- Type of detonators used and delay periods used
- The exact location of each seismograph and the distance of each seismograph from the blast
- Seismographic readings
- Name and signature of the person operating each seismograph
- Names of the person and the firm analyzing the seismographic data

**MAXIMUM PARTICLE VELOCITY/DISTANCE CRITERIA**
**FOR BLASTING NEAR UNCURED CONCRETE**

| Time From Batching (hr) | Non-Structural Concrete | Structural Concrete |
|---|---|---|
| 0 – 4 | 4D | 2D |
| 4 – 24 | 1D | 0.25D |
| 24 – 72 | 1.5D | 1D |
| 72 – 168 | 3D | 2D |
| 168 – 240 | 8D | 5D |
| Over 240 | 15D | 10D |

| Distance (ft) | D (in/sec) |
|---|---|
| 0 to 50 | 1.0 |
| 50 to 150 | 0.8 |
| 150 to 250 | 0.7 |
| Over 250 | 0.6 |

NOTE: Allowable vibration levels are reduced with increasing distance since concrete can withstand higher vibration levels at higher frequencies. Vibration frequencies decrease as the distance from the blast increases because there is an attenuation of frequency with distance.

**Reference:** Wyllie, Duncan C. Foundations on Rock, 1st Ed, Chapman & Hall, London, 1992

# SECTION 024116 - STRUCTURE DEMOLITION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. This Section includes the following:

1. Demolition and removal of buildings and site improvements.
2. Removing below-grade construction.
3. Disconnecting, capping or sealing, and removing site utilities.

### 1.3 DEFINITIONS

A. Demolish: Completely remove and legally dispose of off-site.

B. Recycle: Recovery of demolition waste for subsequent processing in preparation for reuse.

### 1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

### 1.5 SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.

B. Proposed Protection Measures: Submit informational report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.

1. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain.

C. Predemolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by building demolition operations.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI A10.6 and NFPA 241.

1.7 PROJECT CONDITIONS

A. Buildings to be demolished will be vacated and their use discontinued before start of the Work.

B. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.

1. Provide not less than 72 hours' notice of activities that will affect operations of adjacent occupied buildings.
2. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.

a. Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.

C. Owner assumes no responsibility for buildings and structures to be demolished.

1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soils: Comply with requirements in Division 31 Section "Earth Moving."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting demolition operations.

B. Review Project Record Documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

## 3.2 PREPARATION

A. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.

1. Owner will arrange to shut off indicated utilities when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.
3. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
4. Cut off pipe or conduit a minimum of 24 inches below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.

B. Existing Utilities: Refer to Divisions 22 and 26 Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

## 3.3 PROTECTION

A. Existing Facilities: Protect adjacent walkways, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.

B. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.

1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and authorities having jurisdiction.

    a. Provide at least 72 hours' notice to occupants of affected buildings if shutdown of service is required during changeover.

C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated. Comply with requirements in Division 01 Section "Temporary Facilities and Controls."

1. Protect adjacent buildings and facilities from damage due to demolition activities.
2. Protect existing site improvements, appurtenances, and landscaping to remain.

3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
5. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
6. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
7. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.

D. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

## 3.4 DEMOLITION, GENERAL

A. General: Demolish indicated existing buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
2. Maintain fire watch during and for at least one hour after flame cutting operations.
3. Maintain adequate ventilation when using cutting torches.
4. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

B. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

C. Explosives: Use of explosives is not permitted.

## 3.5 DEMOLITION BY MECHANICAL MEANS

A. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.

B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.

C. Below-Grade Construction: Demolish foundation walls and other below-grade construction.

1. Remove below-grade construction, including basements, foundation walls, and footings, completely.

D. Existing Utilities: Demolish and remove existing utilities and below-grade utility structures.

1. Piping: Disconnect piping at unions, flanges, valves, or fittings.
2. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

## 3.6 SITE RESTORATION

A. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.

B. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

## 3.7 REPAIRS

A. Promptly repair damage to adjacent buildings caused by demolition operations.

## 3.8 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site. See Division 01 Section "Construction Waste Management and Disposal" for recycling and disposal of demolition waste.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Do not burn demolished materials.

## 3.9 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.

END OF SECTION 024116

# SECTION 033000 - CAST-IN-PLACE CONCRETE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.

B. Cast-in-place concrete includes the following:

1. Foundations and footings.
2. Slabs-on-grade.
3. Foundation walls.
4. Slabs on metal decking.
5. **Exposed Finished Interior Slabs**
   **(-Provide mockup for architect and owner’s approval prior to placement)**

### 1.2 SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and Division 1 Specification Sections.

B. Product data for proprietary materials and items, including reinforcement and forming accessories, pour stops, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others if requested by Architect.

C. Shop drawings for reinforcement detailing fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, bent bar diagrams, and arrangement of concrete reinforcement. Include special reinforcing required for openings through concrete structures.

D. Shop drawings for formwork indicating fabrication and erection of forms for specific finished concrete surfaces. Show form construction including jointing, special form joints or reveals, location and pattern of form tie placement, and other items that affect exposed concrete visually.

1. Architect's review is for general architectural applications and features only. Designing formwork for structural stability and efficiency is Contractor's responsibility.

E. Samples of materials as requested by Architect, including names, sources, and descriptions, as follows:

1. Normal weight aggregates.
2. Fiber reinforcement.
3. Reglets.
4. Waterstops.
5. Form liners.

F. Laboratory test reports for concrete materials and mix design test.

G. Material certificates in lieu of material laboratory test reports when permitted by Architect. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

H. Minutes of pre-installation conference.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:

1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings."
2. ACI 318, "Building Code Requirements for Reinforced Concrete."
3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."

B. Concrete Testing Service: Engage a testing agency acceptable to Architect to perform material evaluation tests and to design concrete mixes per the requirements of chapter 17 of the IBC.

C. Materials and installed work may require testing and retesting at any time during progress of Work. Tests, including retesting of rejected materials for installed Work, shall be done at Contractor's expense.

D. Mockup: At the architects request cast mockup of size indicated or as required to demonstrate typical joints, form tie spacing, and proposed surface finish, texture, and color. Maintain sample panel exposed to view for duration of Project, after Architect's acceptance of visual qualities.

1. Demolish mockup and remove from site when directed by Architect.

E. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1. At least 7 days prior to submitting design mixes, conduct a meeting to review detailed requirements for preparing concrete design mixes and to determine procedures for satisfactory concrete operations. Review requirements for submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend conference, including, but not limited to, the following:

a. Contractor's superintendent.
b. Agency responsible for concrete design mixes.
c. Agency responsible for field quality control.
d. Agency responsible for quality assurance testing.
e. Ready-mix concrete producer.
f. Concrete subcontractor.
g. Primary admixture manufacturers.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.

1. Use overlaid plywood complying with U.S. Product Standard PS-1 "A-C or B-B High Density Overlaid Concrete Form," Class I.

2. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.

B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or another acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration to match Architect's control sample. Provide solid backing and form supports to ensure stability of textured form liners.

D. Forms for Cylindrical Columns and Supports: Metal, glass-fiber-reinforced plastic, or paper or fiber tubes that will produce smooth surfaces without joint indications. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.

G. Form Release Agent: Provide commercial formulation form release agent with a maximum of 350 g/L volatile organic compounds (VOCs) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces. Do not allow form release agent to be applied on reinforcing steel.

H. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties designed to prevent form deflection and to prevent spalling of concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches (38 mm) to the plane of the exposed concrete surface.

1. Provide ties that, when removed, will leave holes not larger than 1 inch (25 mm) in diameter in the concrete surface.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615 Grade 60 (ASTM A 615M Grade 400), deformed.

B. Steel Wire: ASTM A 82, plain, cold-drawn steel.

C. Welded Wire Fabric: ASTM A 185, welded steel wire fabric.

D. Deformed-Steel Welded Wire Fabric: ASTM A 497.

E. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

2. For exposed-to-view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I, use Type II at all concrete in contact with soils.

1. Use one brand of cement throughout Project unless otherwise acceptable to Architect.

B. Fly Ash: ASTM C 618, Type F. The use of Fly Ash and/or Blast Furnace Slag is **encouraged**. Do not exceed 35% of cement weight.

C. Normal-Weight Aggregates: ASTM C 33 and as specified. Provide aggregates from a single source for exposed concrete.

1. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.

2. Local aggregates not complying with ASTM C 33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to Architect and Engineer.

D. Water: Potable.

E. Fiber Reinforcement: Polypropylene fibrillated fibers engineered and designed for secondary reinforcement of concrete slabs, complying with ASTM C 1116, Type III, not less than 3/4 inch long.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Gilco Fibers, Cormix Construction Chemicals.

b. Durafiber, Durafiber Corp.

c. Fiberstrand 100, Euclid Chemical Co.

d. Fibermesh, Fibermesh Co., Div. Synthetic Industries, Inc.

e. Forta, Forta Corp.

f. Grace Fibers, W.R. Grace & Co.

g. Polystrand, Metalcrete Industries

F. Admixtures, General: Provide concrete admixtures that contain not more than 0.1 percent chloride ions.

G. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Air-Tite, Cormix Construction Chemicals.

b. Air-Mix or Perma-Air, Euclid Chemical Co.

c. Darex AEA or Daravair, W.R. Grace & Co.

d. MB-VR or Micro-Air, Master Builders, Inc.

e. Sealtight AEA, W.R. Meadows, Inc.

f. Sika AER, Sika Corp.

H. Water-Reducing Admixture: ASTM C 494, Type A.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Chemtard, ChemMasters Corp.

b. PSI N, Cormix Construction Chemicals.

c. Eucon WR-75, Euclid Chemical Co.

d. WRDA, W.R. Grace & Co.

e. Pozzolith Normal or Polyheed, Master Builders, Inc.

f. Metco W.R., Metalcrete Industries.

g. Prokrete-N, Prokrete Industries.

h. Plastocrete 161, Sika Corp.

I. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Super P, Anti-Hydro Co., Inc.

b. Cormix 200, Cormix Construction Chemicals.

c. Eucon 37, Euclid Chemical Co.

d. WRDA 19 or Daracem, W.R. Grace & Co.

e. Rheobuild or Polyheed, Master Builders, Inc.

f. Superslump, Metalcrete Industries.

g. PSPL, Prokrete Industries.

h. Sikament 300, Sika Corp.

J. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Q-Set, Conspec Marketing & Manufacturing Co.

b. Lubricon NCA, Cormix Construction Chemicals.

c. Accelguard 80, Euclid Chemical Co.

d. Daraset, W.R. Grace & Co.

e. Pozzutec 20, Master Builders, Inc.

f. Accel-Set, Metalcrete Industries.

K. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. PSI-R Plus, Cormix Construction Chemicals.

b. Eucon Retarder 75, Euclid Chemical Co.

c. Daratard-17, W.R. Grace & Co.

d. Pozzolith R, Master Builders, Inc.

e. Protard, Prokrete Industries.

f. Plastiment, Sika Corporation.

2.4 RELATED MATERIALS

A. Reglets: Where sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 0.0217- inch- (0.46-mm-) thick galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.

B. Waterstops: Provide flat, dumbbell-type or centerbulb-type waterstops at construction joints and other joints as indicated. Size to suit joints.

C. Rubber Waterstops: Corps of Engineers CRD-C 513.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products of one of the following:

a. The Burke Co.

b. Progress Unlimited.

c. Williams Products, Inc.

D. Polyvinyl Chloride Waterstops: Corps of Engineers CRD-C 572.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products of one of the following:

a. The Burke Co.

b. Greenstreak Plastic Products Co.

c. W.R. Meadows, Inc.

d. Progress Unlimited.

e. Schlegel Corp.

f. Vinylex Corp.

E. Nonslip Aggregate Finish: Provide fused aluminum oxide granules or crushed emery as the abrasive aggregate for a nonslip finish, with emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rustproof, nonglazing, and unaffected by freezing, moisture, and cleaning materials.

F. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m), complying with AASHTO M 182, Class 2.

G. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.

1. Waterproof paper.

2. Polyethylene film.

3. Polyethylene-coated burlap.

H. Liquid Membrane-Forming Curing Compound: Liquid-type membrane-forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.55 kg/sq. m when applied at 200 sq. ft./gal (4.9 sq. m/L).

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. A-H 3 Way Sealer, Anti-Hydro Co., Inc.

b. Spartan-Cote, The Burke Co.

c. Conspec #1, Conspec Marketing & Mfg. Co.

d. Sealco 309, Cormix Construction Chemicals.

e. Day-Chem Cure and Seal, Dayton Superior Corp.

f. Eucocure, Euclid Chemical Co.

g. Horn Clear Seal, A.C. Horn, Inc.

h. L&M Cure R, L&M Construction Chemicals, Inc.

i. Masterkure, Master Builders, Inc.

j. CS-309, W.R. Meadows, Inc.

k. Seal N Kure, Metalcrete Industries.

l. Kure-N-Seal, Sonneborn-Chemrex.

m. Stontop CS2, Stonhard, Inc.

I. Water-Based Acrylic Membrane Curing Compound: ASTM C 309, Type I, Class B.

1. Provide material that has a maximum volatile organic compound (VOC) rating of 350 g/L.

2. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

3. Products: Subject to compliance with requirements, provide one of the following:

    a. Highseal, Conspec Marketing and Mfg. Co.

    b. Sealco - VOC, Cormix Construction Chemicals.

    c. Safe Cure and Seal, Dayton Superior Corp.

    d. Aqua-Cure, Euclid Chemical Co.

    e. Dress & Seal WB, L&M Construction Chemicals, Inc.

    f. Masterkure 100W, Master Builders, Inc.

    g. Vocomp-20, W.R. Meadows, Inc.

    h. Metcure, Metalcrete Industries.

    i. Stontop CS1, Stonhard, Inc.

J. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

    a. Aquafilm, Conspec Marketing and Mfg. Co.

    b. Eucobar, Euclid Chemical Co.

    c. E-Con, L&M Construction Chemicals, Inc.

    d. Confilm, Master Builders, Inc.

    e. Waterhold, Metalcrete Industries.

K. Bonding Agent: Polyvinyl acetate or acrylic base.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

    a. Polyvinyl Acetate (Interior Only):

        1) Superior Concrete Bonder, Dayton Superior Corp.

        2) Euco Weld, Euclid Chemical Co.

        3) Weld-Crete, Larsen Products Corp.

4) Everweld, L&M Construction Chemicals, Inc.

5) Herculox, Metalcrete Industries.

6) Ready Bond, Symons Corp.

b. Acrylic or Styrene Butadiene:

1) Acrylic Bondcrete, The Burke Co.

2) Strongbond, Conspec Marketing and Mfg. Co.

3) Day-Chem Ad Bond, Dayton Superior Corp.

4) SBR Latex, Euclid Chemical Co.

5) Daraweld C, W.R. Grace & Co.

6) Hornweld, A.C. Horn, Inc.

7) Everbond, L&M Construction Chemicals, Inc.

8) Acryl-Set, Master Builders Inc.

9) Intralok, W.R. Meadows, Inc.

10) Acrylpave, Metalcrete Industries.

11) Sonocrete, Sonneborn-Chemrex.

12) Stonlock LB2, Stonhard, Inc.

13) Strong Bond, Symons Corp.

L. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material type, grade, and class to suit Project requirements.

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Burke Epoxy M.V., The Burke Co.

b. Spec-Bond 100, Conspec Marketing and Mfg. Co.

c. Resi-Bond (J-58), Dayton Superior.

d. Euco Epoxy System #452 or #620, Euclid Chemical Co.

e. Epoxtite Binder 2390, A.C. Horn, Inc.

f. Epabond, L&M Construction Chemicals, Inc.

g. Concresive Standard Liquid, Master Builders, Inc.

h. Rezi-Weld 1000, W.R. Meadows, Inc.

i. Metco Hi-Mod Epoxy, Metalcrete Industries.

j. Sikadur 32 Hi-Mod, Sika Corp.

k. Stonset LV5, Stonhard, Inc.

l. R-600 Series, Symons Corp.

2.5 PROPORTIONING AND DESIGNING MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use an independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.

1. Do not use the same testing agency for field quality control testing.

2. Limit use of fly ash and blast furnace slag to not exceed 35 percent of cement content by weight.

B. Submit written reports to Architect of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed by Architect and Engineer of Record.

C. Design mixes to provide normal weight concrete with the following properties as indicated on drawings and schedules:

1. 3,000 psi, 28-day compressive strength; water-cement ratio, 0.60 maximum (non-air-entrained)

2. 4,000 psi, 28-day compressive strength; water-cement ratio, 0.5 maximum, (5% air-entrained)

3. 4,000 psi, 28-day compressive strength; water-cement ratio, 0.45 maximum ( 6% air-entrained), w/ Fibermesh

3. 3,500 psi, 28-day compressive strength; water-cement ratio, 050 maximum ( 3% air-entrained), w/ Fibermesh

D. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (W/C) ratios as follows:

1. Subjected to freezing and thawing: W/C 0.45.

E. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

1. Ramps, slabs, and sloping surfaces: Not more than 3 inches (75 mm).

2. Reinforced foundation systems: Not less than 2 inch and not more than 6 inches.

3. Concrete containing high-range water-reducing admixture (superplasticizer): Not more than 8 inches (200 mm) after adding admixture to site-verified 2 - 3 inch (50 - 75 mm) slump concrete.

4. Other concrete: Not more than 4 inches (100 mm).

F. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Architect. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Architect before using in Work.

G. Fiber Reinforcement: Add at manufacturer's recommended rate but not less than 1.5 lb/cu. yd. (0.9 kg/cu. m).

2.6 ADMIXTURES

A. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.

B. Use accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).

C. Use high-range water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs, architectural concrete, parking structure slabs, concrete required to be watertight, and concrete with water-cement ratios below 0.50.

D. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within the following limits:

1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:

a. 4.0 percent (moderate exposure); 6.0 percent (severe exposure) for 3/4 inch (19 mm) maximum aggregate.

2. Other concrete not exposed to freezing, thawing, or hydraulic pressure, or to receive a surface hardener: 2 to 4 percent air.

E. Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements of ASTM C 94, and as specified.

1. When air temperature is between 85 deg F (29 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel and Insulated Concrete Forms

3.2 FORMS

A. General: Design, erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 347 limits:

1. **Provide Class A tolerances for concrete surfaces exposed to view.**

2. Provide Class C tolerances for other concrete surfaces.

B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.

C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like for easy removal.

D. Provide temporary openings for clean-outs and inspections where interior area of formwork is inaccessible before and during concrete placement. Securely brace temporary openings and set tightly to forms to prevent losing concrete mortar. Locate temporary openings in forms at inconspicuous locations.

E. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

F. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

G. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.3 PLACING REINFORCEMENT

A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as specified.

1. Avoiding cutting or puncturing vapor retarder/barrier during reinforcement placement and concreting operations. Repair damages before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Architect.

D. Place reinforcement to maintain minimum coverages as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.4 JOINTS

A. Construction Joints: Locate and install construction joints so they do not impair strength or appearance of the structure, as acceptable to Architect.

B. Provide keyways at least 1-1/2 inches (38 mm) deep in construction joints in walls and slabs. Bulkheads designed and accepted for this purpose may be used for slabs.

C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as indicated otherwise. Do not continue reinforcement through sides of strip placements.

D. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.

E. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to manufacturer's printed instructions.

F. Isolation Joints in Slabs-on-Grade: Construct isolation joints in slabs-on-grade at points of contact between slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Joint fillers and sealants are specified in Division 7 Section "Joint Sealants."

G. Contraction (Control) Joints in Slabs-on-Grade: Construct contraction joints in slabs-on-grade to form panels of patterns as shown. Use saw cuts 1/8 inch (3 mm) wide by one-fourth of slab depth or inserts 1/4 inch (6 mm) wide by one-fourth of slab depth, unless otherwise indicated.

1. Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round

on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.

2. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.

3. If joint pattern is not shown, provide joints not exceeding 12 ft. (4.5 m) in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).

4. Joint fillers and sealants are specified in Division 7 Section "Joint Sealants."

3.5 INSTALLING EMBEDDED ITEMS

A. General: Set and build into formwork anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.

B. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.

C. Install dovetail anchor slots in concrete structures as indicated on drawings.

D. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.6 PREPARING FORM SURFACES

A. General: Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.

B. Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.

1. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

3.7 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.

C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.

D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than 24 inches (600 mm) and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.

2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.

E. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until completing placement of a panel or section.

1. Consolidate concrete during placement operations so that concrete is thoroughly worked around reinforcement, other embedded items and into corners.

2. Bring slab surfaces to correct level with a straightedge and strike off. Use bull floats or darbies to smooth surface free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.

3. Maintain reinforcing in proper position on chairs during concrete placement.

F. Cold-Weather Placement: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

G. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.

1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

H. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305 and as specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F (32 deg C). Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.

3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.

4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Architect.

3.8 FINISHING FORMED SURFACES

A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch (6 mm) in height rubbed down or chipped off.

B. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

C. Smooth-Rubbed Finish: Provide smooth-rubbed finish on scheduled concrete surfaces that have received smooth-formed finish treatment not later than 1 day after form removal.

1. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

D. Grout-Cleaned Finish: Provide grout-cleaned finish on scheduled concrete surfaces that have received smooth-formed finish treatment.

1. Combine one part portland cement to one and one-half parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint. Blend standard portland cement and white portland cement in amounts determined by trial patches so that final color of dry grout will match adjacent surfaces.

2. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

E. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.9 MONOLITHIC SLAB FINISHES

A. Scratch Finish: Apply scratch finish to monolithic slab surfaces to receive concrete floor topping or mortar setting beds for tile, portland cement terrazzo, and other bonded applied cementitious finish flooring material, and where indicated.

1. After placing slabs, finish surface to tolerances of F(F) 15 (floor flatness) and F(L) 13 (floor levelness) measured according to ASTM E 1155 (ASTM E 1155M). Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.

B. Float Finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and where indicated.

1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Finish surfaces to tolerances of F(F) 18 (floor flatness) and F(L) 15 (floor levelness) measured according to ASTM E 1155 (ASTM E 1155M). Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

C. Trowel Finish: Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.

1. After floating, begin first trowel-finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and finish surfaces to tolerances of F(F) 20 (floor flatness) and F(L) 17 (floor levelness) measured according to ASTM E 1155 (ASTM E 1155M). Grind smooth any surface defects that would telegraph through applied floor covering system.

D. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply a trowel finish as specified, then immediately follow by slightly scarifying the surface with a fine broom.

E. Nonslip Broom/Grooved Finish: Apply a nonslip broom/grooved finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen concrete surface by brooming/grooveing with fiber-bristle broom perpendicular to main traffic route or groove trowel as specified by Architect. Coordinate required final finish with Architect before application.

F. Nonslip Aggregate Finish: Apply nonslip aggregate finish to concrete stair treads, platforms, ramps, sloped walks, and where indicated.

1. After completing float finishing and before starting trowel finish, uniformly spread dampened nonslip aggregate at a rate of 25 lb per 100 sq. ft. (12 kg/10 sq. m) of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as specified.

2. After curing, lightly work surface with a steel wire brush or an abrasive stone, and water to expose nonslip aggregate.

G. Colored Wear-Resistant Finish: Apply a colored wear-resistant finish to monolithic slab surface indicated.

1. Apply dry shake materials for the colored wear-resistant finish at a rate of 100 lb per 100 sq. ft. (49 kg/10 sq. m), unless a greater amount is recommended by material manufacturer.

2. Cast a trial slab approximately 10 ft. (3 m) square to determine actual application rate, color, and finish, as acceptable to Architect.

3. Immediately following the first floating operation, uniformly distribute with mechanical spreader approximately two-thirds of the required weight of the dry shake material over the concrete surface, and embed by power floating. Follow floating operation with second shake application, uniformly distributing remainder of dry shake material with overlapping applications to ensure uniform color, and embed by power floating.

4. After broadcasting and floating, apply a trowel finish as specified. Cure slab surface with a curing compound recommended by the dry shake material manufacturer. Apply the curing compound immediately after the final finishing.

## 3.10 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as specified to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in safety inserts and accessories as shown on drawings. Screed, tamp, and trowel-finish concrete surfaces.

## 3.11 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.

B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.

C. Curing Methods: Cure concrete by curing compound, by moist curing, by moisture-retaining cover curing, or by combining these methods, as specified.

D. Provide moisture curing by the following methods:

1. Keep concrete surface continuously wet by covering with water.

2. Use continuous water-fog spray.

3. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4 inch (100 mm) lap over adjacent absorptive covers.

E. Provide moisture-retaining cover curing as follows:

1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches (75 mm) and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

F. Apply curing compound on exposed interior slabs and on exterior slabs, walks, and curbs as follows:

1. Apply curing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

2. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.

G. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

H. Curing Unformed Surfaces: Cure unformed surfaces, including slabs, floor topping, and other flat surfaces, by applying the appropriate curing method.

1. Final cure concrete surfaces to receive finish flooring with a moisture-retaining cover, unless otherwise directed.

## 3.12 REMOVING FORMS

A. General: Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days or until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

C. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

3.13 REUSING FORMS

A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as acceptable to Architect.

3.14 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removing forms, when acceptable to Architect.

B. Mix dry-pack mortar, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh (1.2 mm) sieve, using only enough water as required for handling and placing.

1. Cut out honeycombs, rock pockets, voids over 1/4 inch (6 mm) in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch (25 mm). Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.

2. For surfaces exposed to view, blend white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.

1. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.

1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to the reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.

2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.

3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Architect.

4. Repair defective areas, except random cracks and single holes not exceeding 1 inch (25 mm) in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4 inch (19 mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

E. Repair isolated random cracks and single holes 1 inch (25 mm) or less in diameter by dry-pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Place dry-pack before bonding agent has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

F. Perform structural repairs with prior approval of Architect for method and procedure, using specified epoxy adhesive and mortar.

G. Repair methods not specified above may be used, subject to acceptance of Architect.

3.15 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. General: The Owner will employ a testing agency to perform tests and to submit test reports.

B. Sampling and testing for quality control during concrete placement **may** include the following, as directed by Architect or Owners Representative.

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94. Provide one set of tests for each 50 cu. yd. of each type of concrete for each day's pour; provide one set of tests of the following:

a. Slump: ASTM C 143; one test at point of discharge; additional tests when concrete consistency seems to have changed.

b. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231, pressure method for normal weight concrete.

c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4 deg C) and below.

d. Compression Test Specimen: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.

e. Compressive-Strength Tests: ASTM C 39; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.

3. When total quantity of a given class of concrete is less than 50 cu. yd. (38 cu. m), Architect may waive strength testing if adequate evidence of satisfactory strength is provided.

4. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

5. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi (3.4 MPa).

C. Test results will be reported in writing to Architect, Structural Engineer, ready-mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

E. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

END OF SECTION 033000