# REPORT ON
# PROPOSED HOUSING
# ANDERSON STREET
# PORTLAND, MAINE

by


Haley & Aldrich, Inc.
South Portland, Maine


for

TFH Architects
Portland, Maine

File No. 29834-000
May 2003

HALEY & ALDRICH

UNDERGROUND
ENGINEERING &
ENVIRONMENTAL
SOLUTIONS

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HALEY & ALDRICH

19 May 2003
File No. 29834-000

TFH Architects
100 Commercial Street
Portland, Maine 04101

Attention: Mr. Scott Teas

Subject: Proposed Housing
Anderson Street
Portland, Maine

Ladies and Gentlemen:

This report presents our evaluation of the subsurface conditions and foundation requirements for the proposed housing on Anderson Street in Portland, Maine. This work was undertaken in accordance with our proposal dated 4 April 2003.

In summary, we recommend that the proposed buildings be founded on spread footings bearing on the existing fill, naturally deposited soil or on compacted structural fill placed after removal of unsuitable soil. In addition, slabs-on-grade may be used for the lowest floor of the buildings with full basements. Intensive surface compaction of the existing fill will be required prior to earthwork and foundation construction for building on Lot #1. Specific recommendations regarding foundation design and construction considerations are presented below.

## INTRODUCTION

The proposed site is located at 135 Anderson Street in Portland, Maine. We understand that the project consists of three 3-story prefabricated modular wood-framed residential buildings with plan areas of approximately 1,400 sq. ft. The buildings will be constructed in phases. The first phase consists of the buildings in the eastern portion (Lot #2) of the site and the next phase consists of the building in the western eastern portion (Lot #1) of the site. The existing ground surface within the site varies from approximately El. 11 in the west to El. 23 in the east. Within the building limits, ground surface varies from approximately El. 11 to El. 19. The first phase buildings will have the first floor at approximately El. 16.5 with full basements. The next phase building will have a first floor at approximately El. 13.0 with a crawl space below the floor.

## SUBSURFACE CONDITIONS

On 11 February 2003, Northern Test Boring, Inc. (Northern) drilled three borings, B-1 to B-3, at the site under the observation of S.W. Cole Engineering, Inc. Northern drilled the borings at locations shown in Appendix A to depths below ground surface varying from 17.0 ft. to 22.0 ft. Logs of borings, prepared by S.W. Cole Engineering, Inc., are included in Appendix A. Borings were drilled using hollow stem augers. Standard Penetration Resistance (N) was measured at each sample interval in the overburden soil in accordance with ASTM test designation D1586.

In addition, Kenneth L. Recker observed the subgrade soils in the eastern half of the south building in the eastern portion of the site on 14 May 2003.

The exploration logs and related information depict subsurface conditions and water levels at their specific locations at the time of the exploration. Soil conditions at other locations may differ from conditions at these locations. Also, the passage of time may result in a change in groundwater conditions at the boring locations.

The borings encountered two principal soil units, fill and marine deposit, at the site. The soil units are discussed below in order of increasing depth below ground surface.

**Fill** – Fill is described as loose to medium dense, dark brown to black silty SAND with various amounts of bricks, concrete, glass and gravel. Encountered thickness ranged from 8.5 ft. to 10.4 ft.

**Marine Deposit** – The marine deposit consists of medium stiff to soft, gray to brown silty CLAY. Borings penetrated up to 8.0 ft. into the clay.

The borings were drilled with hollow stem augers and samples of the sand were recovered below the groundwater level. Therefore, the penetration resistance may have been affected by groundwater flow into the augers.

Water was reported in the boring B-1 at a depth of 5.1 ft. below ground surface. Observations of water were made over a relatively short period of time and may not reflect the stabilized groundwater condition. In addition, groundwater levels will fluctuate with season, precipitation, temperature and construction activities in the area. Therefore, groundwater levels during and following construction may vary from that indicated in the explorations.

## ENGINEERING PROPERTIES OF THE CLAY STRATUM

Shear strength of the clay was reported to vary from 250 psf to 1,250 psf. Shear strengths of the clay were compared with correlations of strength with stress history and compressibility for similar clays in the area. The correlations indicate that the clay is overconsolidated, that is, the maximum previous stress of the deposit is greater than the existing overburden stress. It is likely that the clay became overconsolidated due to desiccation resulting from a lowering of the groundwater level for an extended time period at some time in the geologic past.

The stress-strain or compressibility characteristics of clay are highly dependent on their stress history. If the soil is stressed within the limits of the maximum previous stress, the strain (settlement) will be proportional to the recompression ratio of the clay. If the applied stress exceeds the maximum previous stress, the strain will also be proportional to the virgin compression ratio of the clay. The magnitude of the virgin compression ration is often on the order of 10 times the recompression ratio.

## RECOMMENDATIONS FOR FOUNDATION DESIGN

### Recommended Foundation Type and Design Criteria

The fill below the building in the western portion of the site in its present condition is not considered suitable for support of the building. Borings indicated that the fill consists primarily of silty SAND with various amounts of gravel, bricks, concrete and glass. In our opinion, the fill will provide adequate support for the foundations provided the fill is compacted by Intensive Surface Compaction as described below. Therefore, it is our opinion that the building may be supported on the improved fill, naturally deposited, inorganic soil or on compacted structural fill placed after removal of unsuitable materials (fill containing wood and organics).

Due to the proposed basements in the buildings in the eastern portion of the site, soils at proposed subgrade will consist partially of naturally deposited clay and partially of sand fill. In our opinion, the buildings may be supported on a four-in. thick layer of ½ to ¾-in. crushed stone placed after overexcavation of the existing soils. A non-woven geotextile filter fabric should be placed on the excavated subgrade prior to placing the crushed stone. The crushed stone will act as a working surface for construction foot traffic and minimize disturbance to the clay soils.

We recommend that for uniformity the footings be proportioned for an allowable bearing stress, in lbs. per sq. ft., equal to 700 multiplied by the least lateral dimension of the footing in feet, up to a maximum of 2,000 lbs. per sq. ft. All footings should be at least 1.5 ft. wide.

Exterior footings should be founded at least 4.5 ft. below the lowest adjacent ground surface exposed to freezing. Interior footings should be founded a minimum of 1.5 ft. below the ground floor slab. Alternatively, for the building in the western portion of the site, exterior footings may be founded at least 2.0 ft. below the lowest adjacent ground surface exposed to freezing provided a minimum of 2 in. rigid insulation extending a minimum of 4 ft. beyond the foundation is provided above the footings to prevent the bearing surfaces from freezing. We anticipate that design for less embedment and the use of insulation will require the approval of the appropriate code official.

Compacted structural fill supporting footings should extend laterally from the footings to at least the limits defined by 1 horizontal to 1 vertical lines sloped outward and downward from points located at least 2 ft. horizontally beyond the bottom edges of the footings.

In order to consider the impact of site filling and foundations bearing above the clay stratum, we performed a settlement analysis. Engineering evaluations were based on the anticipated consolidation of the clay stratum due to the combined stresses of the raise-in-grade and building loads.

Calculated total settlement is estimated on the order of 1.5 in. with differential settlement on the order of 0.75 in. We anticipate that settlement of this magnitude is acceptable. However, Structural Design Consultants should determine final acceptability of settlement.

Intensive surface compaction for the fill soils below the building in the western portion of the site should be performed using a minimum 30,000 lb. vibratory roller operating at 30 cycles per sec. (Hz) and a forward speed of 1 to 2 ft. per sec. Compaction should consist of 10 coverages of the vibratory roller. The direction of each 2 successive coverages should be rotated perpendicular to the previous 2 coverages. Following intensive surface compaction, a minimum of 2 coverages of the roller should be applied without vibration to recompact the upper portion of the fill. Fill containing debris and wood and organics should be removed and replaced with structural fill prior to surface compaction. Any soft or unsuitable areas encountered should be excavated and replaced with compacted structural fill.

**Ground Floor Slab**

We recommend that the lowest level floor slabs for the buildings in the eastern portion of the site be designed as earth-supported slabs-on-grade bearing on the crushed stone layer discussed avove. All fill containing debris and wood and organics should be removed from within the building limits prior to placing the crushed stone.

We recommend a perimeter and underslab drain system be constructed on the outside of the foundation walls and below the slab to minimize hydrostatic pressure and seepage into the basements of the buildings in the eastern portion of the site. The crushed stone layer below the footings and floor slab, in combination with perforated pipes, may be used to collect any groundwater or surface water that infiltrates into the system.

We anticipate that gravity discharge is available for the system. If gravity discharge is not available, discharge will require collection into sumps and pumping. Normal dampproofing should be provided for the lower level slab and walls.

**Seismic Design Considerations**

We recommend that the addition be designed in accordance with the seismic requirements of the latest edition of the BOCA National Building Code. The site coefficient, S, is 1.2; the effective peak velocity-related acceleration coefficient, Av, is 0.1; the effective peak acceleration coefficient, Aa, is 0.1 and the subsurface soils are not liquefaction susceptible.

**Lateral Foundation Loads**

We recommend that lateral loads be resisted by bottom friction on the foundations. We recommend that a coefficient of friction equal to 0.35 be used for foundations bearing on soil.

**Backfill Materials**

Structural fill used for backfill adjacent to foundations should consist of sandy gravel to gravelly sand. It should be free of organic material, loam, trash, snow, ice, frozen soil and other objectionable material, and should conform to the following gradation:

| Sieve Size | Percent Finer by Weight |
|---|---|
| 6 in. | 100 |
| No. 4 | 30 to 90 |
| No. 40 | 10 to 50 |
| No. 200 | 0 to 8 |

Compacted structural fill should be placed in layers not exceeding 8 in. in loose measure and compacted by self-propelled vibratory equipment at the approximate optimum moisture content to a dry density of at least 95 percent of the maximum dry density, as determined in accordance with ASTM Test Designation D1557. In confined areas, the maximum particle size should be reduced to 3 in. and the loose layer thickness should be reduced to 6 in. and compaction performed by hand-guided equipment.

Compacted structural fill on the outside of the foundation walls should extend laterally a minimum of 2 ft. from the wall. Backfill beyond this limit on the outside of the building may consist of common fill. The top 12-in. of fill on the exterior of the building should consist of low permeability material to minimize water infiltration next to the building. Grading should provide for runoff away from the building.

Common fill may consist of inorganic mineral soil that can be placed in layers not exceeding 12 in. in thickness and compacted with a minimum of two systematic passes of the equipment placing the fill.

## CONSTRUCTION CONSIDERATIONS

### General

The primary purpose of this section of the report is to comment on items related to excavation, earthwork and related geotechnical aspects of proposed construction. It is written primarily for the engineer having responsibility for preparation of plans and specifications. Since it identifies potential construction problems related to foundations and earthwork, it will also aid personnel who monitor the construction activity.

### Excavation, Lateral Support and Control of Water

We anticipate that foundation excavation can be accomplished with sloped open excavation below the floor slab and through the overburden soils, provided safe side slopes can be maintained. Some sloughing and raveling should be anticipated in temporary slopes. Temporary excavations should be made in accordance with all OSHA and other applicable regulatory agency requirements.

We anticipate that groundwater may be encountered during excavation for footings. If encountered, open pumping from sumps can likely control groundwater. In general, the contractor should control groundwater and water from other sources by methods that prevent disturbance of adjacent soils and allow construction in-the-dry.

### Subgrade Preparation

The subgrade soil is susceptible to disturbance from construction traffic. Equipment and personnel should not be permitted to travel across exposed footing bearing surfaces or exposed slab subgrades. Any subgrade areas that are disturbed should be recompacted or excavated and replaced with compacted structural fill prior to placing of concrete. Subgrades should be protected against freezing temperatures if exposed during construction. Final excavation to subgrade should be performed using equipment with smooth-edge buckets.

**Construction Monitoring**

The foundation recommendations contained herein are based on the known and predictable behavior of a properly engineered and constructed foundation. Monitoring of the foundation construction is required to enable the geotechnical engineer to keep in contact with procedures and techniques used in construction. Therefore, we recommend that a person qualified by training and experience be present to provide monitoring at the site during excavation of bearing surfaces and placement of compacted structural fill.

## LIMITATIONS OF RECOMMENDATIONS

This report has been prepared for specific application to the subject project in accordance with generally accepted geotechnical engineering practices. In the event that any changes in the nature, design or location of the addition is planned, the conclusions and recommendations contained in this report should not be considered valid, unless the changes are reviewed and the conclusions of this report modified or verified in writing.

The recommendations presented herein are based in part on the data obtained from the referenced borings. The nature and extent of variations between the explorations may not become evident until construction. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report.

We request that we be provided the opportunity for a general review of final design and specifications in order to determine that our earthwork and foundation recommendations have been interpreted and implemented in the design and specifications as they were intended.

It has been a pleasure to work with you on this project. Please do not hesitate to contact us if you have any questions or require additional information.

Sincerely yours,
HALEY & ALDRICH, INC.

Kenneth L. Recker, P.E.
Consultant

James W. Weaver
Vice President

STATE OF MAINE
JAMES W. WEAVER
3289
PROFESSIONAL ENGINEER

Enclosures:
Appendix A - Logs of Borings

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# APPENDIX A

## Logs of Borings

HALEY &
ALDRICH

S.W.COLE ENGINEERING, INC.

# BORING LOG

| | |
|---|---|
| BORING NO.: | B-1 |
| SHEET: | 1 OF 1 |
| PROJECT NO.: | 03-0067E |
| DATE START: | 2/11/03 |
| DATE FINISH: | 2/11/03 |
| ELEVATION: | 11' +/- |
| SWC REP.: | KBG |

PRO[illegible]T / CLIENT: 135 ANDERSON STREET / PROP

OCA[illegible]ION: PORTLAND, MAINE

DRILLING FIRM: NORTHERN TEST BORINGS DRILLER: MIKE NADEAU

| | TYPE | SIZE | HAMMER WT. | HAMMER FALL |
|---|---|---|---|---|
| CASING: | HSA | 2 1/4" I.D. | | |
| SAMPLER: | SS | 1 3/8" I.D. | 140 lb | 30" |
| CORE BARREL: | | | | |

WATER LEVEL INFORMATION
WATER 5.1' BELOW GROUND SURFACE
ON 2/12/03

| CASING BLOWS PER FOOT | SAMPLE NO. | PEN. | REC. | DEPTH @ BOT | SAMPLER BLOWS PER 6" 0-6 | 6-12 | 12-18 | 18-24 | DEPTH | STRATA & TEST RESULTS | PID TEST RESULTS (PPM) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AUGER | 1D | 24" | 13" | 3.0' | 3 | 3 | 3 | 3 | 5.5' | BROWN GRAVELLY SILTY SAND TRACE BRICK, TRACE CERAMIC (FILL) ~LOOSE~ | ND |
| | 2D | 24" | 3" | 7.0' | 1 | 1 | 1 | 1 | 8.5' | BROWN FINE TO MEDIUM SAND SOME SILT (FILL) ~LOOSE~ | ND |
| | 3D | 24" | 24" | 12.0' | WOH/24" | | | | 14.0' | GRAY SANDY SILTY CLAY ~SOFT~ | ND |
| | 4D | 24" | 24" | 17.0' | WOM/12" | | 1 | 1 | | GRAY SILTY CLAY ~MEDIUM~ | ND |
| | 5D | 24" | 24" | 22.0' | WOM/24" | | | | 22.0' | | ND |
| | | | | | | | | | | BOTTOM OF EXPLORATION AT 22.0' NOT REFUSAL<br><br>3/4" PVC MONITORING WELL SET AT 20.0' WITH 10' OF SCREEN (20' - 10' BELOW GROUND SURFACE) FILTER SAND PACK TO 10' BELOW SURFACE NATIVE BACKFILL TO SURFACE | |

SAMPLES:
D=SPLIT SPOON
U=3" SHELBY TUBE
U=3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH.-VISUALLY
[ ] LABORATORY TEST

REMARKS: ND = NON-DETECTABLE

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

(2)

BORING NO.: B-1

**S.W.COLE ENGINEERING, INC.**

# BORING LOG

BORING NO.: B-2
SHEET: 1 OF 1
PROJECT NO.: 03-0067E
DATE START: 2/11/03
DATE FINISH: 2/11/03
ELEVATION: 15' +/-
SWC REP.: KBG

PROJECT / CLIENT: 135 ANDERSON STREET / PROP
LOCATION: PORTLAND, MAINE
DRILLING FIRM: NORTHERN TEST BORINGS
DRILLER: MIKE NADEAU

| | TYPE | SIZE | HAMMER WT. | HAMMER FALL |
|---|---|---|---|---|
| CASING: | HSA | 2 1/4" I.D. | | |
| SAMPLER: | SS | 1 3/8" I.D. | 140 lb | 30" |
| CORE BARREL: | | | | |

WATER LEVEL INFORMATION
NO FREE WATER OBSERVED
SANDS MOIST / CLAY SATURATED

| CASING BLOWS PER FOOT | SAMPLE NO. | PEN. | REC. | DEPTH @ BOT | 0-6 | 6-12 | 12-18 | 18-24 | DEPTH | STRATA & TEST RESULTS | PID TEST RESULTS (PPM) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AUGER | 1D | 24" | 10" | 3.0' | 12 | 18 | 10 | 8 | 4.0' | BROWN GRAVELLY SAND SOME SILT (FILL) ~DENSE~ | ND |
| | 2D | 24" | 16" | 7.0' | 1 | 2 | 2 | 2 | 10.0' | BROWN TO GRAY SILTY SAND TRACE CLAY (FILL) ~LOOSE~ | ND |
| | 3D | 24" | 24" | 12.0' | 1 | 1 | 1 | 1 | | GRAY SILTY CLAY TRACE SAND WITH OCCASIONAL SAND SEAMS ~MEDIUM~ | ND |
| | 4D | 24" | 24" | 17.0' | WOM/24" | | | | 17.0' | | ND |
| | | | | | | | | | | BOTTOM OF EXPLORATION AT 17.0' NOT REFUSAL | |

SAMPLES:
D=SPLIT SPOON
C=3" SHELBY TUBE
U=3.5" SHELBY TUBE

SOIL CLASSIFIED BY:
[ ] DRILLER - VISUALLY
[X] SOIL TECH.-VISUALLY
[ ] LABORATORY TEST

REMARKS: ND = NON-DETECTABLE

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

3

BORING NO.: B-2

**S.W.COLE ENGINEERING, INC.**

# BORING LOG

| | |
|---|---|
| BORING NO.: | B-3 |
| SHEET: | 1 OF 1 |
| PROJECT NO.: | 03-0067E |
| DATE START: | 2/11/03 |
| DATE FINISH: | 2/11/03 |
| ELEVATION: | 15' +/- |
| SWC REP.: | KBG |

F ECT / CLIENT: 135 ANDERSON STREET / PROP

LOCATION: PORTLAND, MAINE

DRILLING FIRM: NORTHERN TEST BORINGS DRILLER: MIKE NADEAU

| | TYPE | SIZE | HAMMER WT. | HAMMER FALL |
|---|---|---|---|---|
| CASING: | HSA | 2 1/4" I.D. | | |
| SAMPLER: | SS | 1 3/8" I.D. | 140 lb | 30" |
| CORE BARREL: | | | | |

WATER LEVEL INFORMATION

NO FREE WATER OBSERVED

SANDS MOIST / CLAY SATURATED

| CASING BLOWS PER FOOT | SAMPLE NO. | PEN. | REC. | DEPTH @ BOT | SAMPLER BLOWS PER 6" 0-6 | 6-12 | 12-18 | 18-24 | DEPTH | STRATA & TEST RESULTS | PID TEST RESULTS (PPM) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AUGER | | | | | | | | | 1.5' | BLACK SILTY SAND SOME GRAVEL (FILL) ~MEDIUM DENSE~ | |
| ↓ | 1D | 24" | 4" | 3.0' | 5 | 8 | 4 | 4 | 5.0' | BROWN SILTY SAND SOME GRAVEL TRACE CONCRETE, TRACE GLASS (FILL) ~MEDIUM DENSE~ | ND |
| | 2D | 24" | 8" | 7.0' | 2 | 2 | 1 | 2 | 10.4' | BROWN SILTY FINE TO MEDIUM SAND TRACE SILTY CLAY (FILL) ~LOOSE~ | ND |
| | 3D | 24" | 20" | 12.0' | 2 | 2 | 3 | 2 | | $q_p$ = 2.5 ksf GRAY SILTY CLAY TRACE SAND WITH OCCASIONAL SAND SEAMS ~MEDIUM~ | ND |
| | 4D | 24" | 24" | 17.0' | WOM/12" | | 1 | 2 | 17.0' | $q_p$ <= .5 ksf | ND |
| | | | | | | | | | | BOTTOM OF EXPLORATION AT 17.0' NOT REFUSAL | |

SAMPLES:

D=SPLIT SPOON
C=3" SHELBY TUBE
U=3.5" SHELBY TUBE

SOIL CLASSIFIED BY:

- [ ] DRILLER - VISUALLY
- [X] SOIL TECH.-VISUALLY
- [ ] LABORATORY TEST

REMARKS: ND = NON-DETECTABLE

STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.

4

BORING NO.: B-3