SCOTT, COX & ASSOCIATES, INC. consulting engineers • surveyors

March 24, 2010

Boulder Housing Partners
4800 N. Broadway
Boulder, CO 80304

Attn: Ms. Liz Wolfert

Project: 10164S

Dear Ms. Wolfert:

Enclosed with this letter are three copies of the Preliminary Subsurface Investigation Report that we have completed for the proposed residential development project to be constructed at 4990 Moorhead Avenue (High Mar) in Boulder, Colorado.

If there are any questions regarding our investigation or the report, please do not hesitate to contact us.

Sincerely,

SCOTT, COX & ASSOCIATES, INC.

By [signature]
Kevin L. Hinds, P.E.

Enclosures

1530 55th Street • Boulder, Colorado 80303 • (303) 444-3051 • Fax: (303) 444-3387

Project 10164S

PRELIMINARY SUBSURFACE INVESTIGATION

Residential Development Project
4990 Moorhead Avenue
High Mar
Boulder, Colorado

Prepared For:

Boulder Housing Partners
4800 N. Broadway
Boulder, CO 80304

March 2010

Prepared By:

Scott, Cox & Associates, Inc.
1530 55th Street
Boulder, Colorado 80303
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Project 10164S

PRELIMINARY SUBSURFACE INVESTIGATION
RESIDENTIAL DEVELOPMENT PROJECT
4990 MOORHEAD AVENUE
HIGH MAR
BOULDER, COLORADO

PURPOSE

This report presents the results of a preliminary subsurface investigation performed March 12, 2010, at the site of a proposed residential development at 4990 Moorhead Avenue (High Mar) in Boulder, Colorado. This investigation was made to provide preliminary engineering data for typical foundation systems for proposed residential structures to be constructed at the site. A total of three (3) borings were completed during the course of the investigation. The locations of the borings are indicated on the Boring Location Map (Figure 1).

Factual data gathered during the field and laboratory work is summarized in Figure 2 and Table 1 attached. The results of this investigation, our opinions, which are based on this investigation and our experience in the general area, are summarized in this report.

INVESTIGATION DETAILS

The field investigation consisted of drilling three (3) borings. The borings were completed with 4-inch diameter, continuous flight power augers using a truck-mounted drill rig.

The augers are utilized to bore and clean the hole to the desired sampling depth. The augers are then removed, and a 2-inch I.D. California spoon sampler is inserted to the desired testing depth. The sampler is then driven with blows of a standard 140-pound hammer falling a distance of 30 inches.

The sampler is driven a total of 12 inches or a maximum of 50 blows. The number of blows required to drive the sampler 12 inches, or a fraction thereof, constitutes the penetration test. The test is similar to the Standard Penetration Test described in ASTM D1586. This test, when properly evaluated, is a measure of the soil strength and density. The results of these tests are shown on the Graphic Boring Logs (Figure 2). Bulk auger samples of the subgrade level soils were also taken from the borings.

All soil samples recovered were inspected, and some samples were selected for testing by the project engineer. The testing program consisted of performing the following tests where appropriate:

Consolidation/Swell

- Consolidation/Swell tests were performed to determine the relative stability of the different subsurface soil types.

Natural Dry Density

- The dry density of the soils provides us with an indication of the relative compaction of the surficial soils.

Natural Moisture Content

- The moisture content test provides us with information that may indicate the probability of instability due to consolidation or swell that may be caused by excessive wetting or drying.

Unconfined Compressive Strength

- The approximate unconfined compressive strength was determined by use of a calibrated hand penetrometer. The unconfined compressive strength can be useful in determining the bearing capacity of a soil.

PROPOSED DEVELOPMENT

For purposes of this report, we understand that the structures are to consist of two to three-story, single family or multi-family residential structures. The buildings will be constructed using conventional wood framing and will be supported by poured-in-place reinforced concrete foundation walls over crawl space or basements. The loadings are anticipated to be light to moderate with no unusual loading conditions.

SITE CONDITIONS

The site consisted of an existing swimming pool and tennis court recreation center at 4990 Moorhead Avenue in Boulder, Colorado. There were structures on the site at the time of our investigation. The site is bordered to the north and west by existing residences, to the east by Moorhead Avenue and commercial or multi-family properties, and to the south by multi-family properties. The site was relatively flat with a slope down from the west to the east. Vegetation on the site consisted of a sparse to heavy growth of grasses and weeds along with some trees.

SUBSOILS

The subsoils on the site generally consisted of approximately 3-inch thick layer of concrete over a 5-foot thick layer of mottled brown, silty, sand and clay fill material at the surface in one of the borings. The other two borings encountered an approximate 1 to 1½-foot thick layer of topsoil over approximately 6 to 7 feet of red-brown to brown, silty, sandy clay or clayey sand with gravel. Bedrock was encountered in all of the borings at depths of approximately 5½ to 7 feet and extended to the maximum depths explored of 20 to 25 feet. The bedrock consisted of silty, slightly sandy to sandy claystone.

A detailed description of the soils encountered in this investigation is presented in the Graphic Boring Logs (Figure 2).

GROUNDWATER CONDITIONS

Groundwater was encountered during our investigation in one of the borings when checked just subsequent to drilling at a depth of approximately 13 feet below the existing ground surface. One of the borings had caved off at a depth of approximately 9 feet. We are past the time of the seasonal low groundwater table. Therefore, some rise of the groundwater table is anticipated. It is not possible to forecast the seasonal high groundwater table based on short duration monitoring. The only sure method of such determination is monitoring of the water table through the spring and early summer (typical high groundwater levels occur about July 1). Any nearby ditches, streams or water features can influence groundwater at the site. We recommend that the bottom of any below grade spaces be maintained at least 4 feet above the seasonal high groundwater levels, unless special drainage considerations are made (special subdivision-wide drainage systems and/or individual lot drainage systems). Additionally, due to the presence of shallow, relatively impermeable soils, improper drainage could result in a "perched" groundwater table. This is discussed further in the "Site Drainage Considerations" section that is included later in this report.

FOUNDATION RECOMMENDATIONS

The existing fill is not considered suitable for foundation support. The on-site silty, sandy clays and clayey sands are considered to be of low expansive potential. The claystone bedrock has a moderate to high expansive potential. Due to the expansive potential and the variable nature of most of the on-site soils, footings are generally not considered appropriate for use at this site. It is conceivable that soils exist that could be suitable for support of a footing foundation system. However, such a circumstance will be rare and require more site specific investigation at the time of construction.

Drilled Piers

We recommend the use of drilled piers for this the support of the foundations of the structures constructed on this site. The piers should be designed for end bearing pressures of 20,000 and side shears of 2,000 PSF based on the end area and length of embedment greater than 2 feet. The design pressures should be based on the dead load plus 100% of maximum anticipated live load. The piers should be drilled to obtain a minimum bedrock embedment of 14 feet with a minimum total length of 24 feet. The minimum embedment lengths should be taken below any weathered portions of the bedrock.

We recommend that the piers be reinforced with a minimum of two #5 bars (grade 60 steel - 10 inch piers assumed) for their full length. A 6-inch minimum void space should be provided beneath the grade beams to assure effective concentration of the loads upon the piers. The grade beams should be centered upon the piers, and the tops of the piers should not be enlarged. The grade beams spanning the piers should be designed for appropriate loading conditions and reinforced accordingly.

We anticipate that casing will not be needed for most of the pier drilling operations. Also, the concrete should be placed in the holes immediately after drilling, thorough cleaning and inspection. Concrete should not be placed in the pier holes with more than 4 inches of water present in the holes, unless a concrete pump truck is utilized to pump the pier holes full of concrete from the bottom.

General

Due to the variable site conditions and unknown proposed cuts and fills at the site, it is possible that other foundation types may be possible. However that will depend on the fill soils utilized with the proposed building excavation depths.

In general, where expansive clays are near foundation depths, piers will be necessary and if low expansive sand soils are present then some type of shallow foundation may be suitable.

The above recommendations are for preliminary use only, and are based upon the borings drilled for this investigation. We recommend that additional investigation be done after all overlot grading has been completed. At that time, site-specific foundation recommendations can be made.

SLABS-ON- GRADE

The soils anticipated to be beneath most of the slabs would have low to high swell potential. These soils are stable at their natural moisture content, but upon fluctuation of their moisture content, can cause heaving and cracking of lightly loaded slabs-on-grade. If slabs are founded on these potentially expansive soils, cracking and slab distortions possible. Slab-on-grade construction can be used as long as the owners realize and accept the risk that some slab cracking and heaving is likely to occur. **However, the only way to eliminate damage as a result of floor slab movement will be to construct a structural floor, independent of the underlying expansive soils.**

The actual amount of possible slab heave is very subjective due to variability in the soils resulting in variability in expansion and also the degree and depth of wetting beneath the slabs. Outlined below is a prediction of the possible slab movements for the general soils at this site based upon a typical maximum wetting depths of five feet, which is an average worse case scenario. There were typically three different soils types at the site, which could influence the slabs-on-grade. The first would be the silty, sand and clay fill material which cannot be predicted due to its highly variable characteristics. The second would be a low expansive sand and clay stratum, and the third being the moderate to highly expansive claystone.

Sand and Clay, (Low expansion potential) – approximately ½ to 2 inches
Claystone, (Moderate to High expansion potential) – approximately 3 to 5 inches

It should be noted that these potential movements are only a prediction based upon the soils tested and typical slab movements seen from similar soils and wetting conditions.

If slabs-on-grade are utilized on potentially expansive soils, the following construction techniques will help to prevent secondary damage that could be caused by slab movement.

1. Separate slabs from the foundation elements with a slip joint. One method of doing this is to use two layers of tempered hardboard with a silicone lubricant between the boards. A slip joint should be used around the perimeter of the slab and adjacent to any other structural elements.

2. Moderately reinforce slabs with reinforcement continuous through interior slab joints. Slab joints must be provided to control the cracking. The floor joint grid should be designed to allow no more than 200 square feet of continuous slab area.

3. Any load bearing partitions or columns must be provided with their own foundation system and the slab separated as outlined above.

4. Provide a 2-inch minimum air space below any interior non-load bearing partition to provide for slab movement without immediate damage to the structure. If unsure of the proper construction methods to achieve the recommended air space, we should be contacted for further recommendations.

5. Any pipes rising through the slab should be provided with flexible couplings or other means to allow substantial movement without damage

to the piping. Any ducts connecting to equipment founded on the slab should be equipped with flexible or crushable connections to allow for some slab movement.

6. Equipment and other building appurtenances constructed on the slab should be constructed so that slab movement will not cause damage.

Following the recommendations given above will not prevent movement of the floor slabs in the event that the moisture content of the soil beneath the slab changes. However, if movement occurs, damage will have been reduced for a relatively small investment.

Topsoil, debris, and organic materials should be stripped prior to placing any slab. Prior to placing the slab, we recommend that the area on which the slab is to be placed be carefully inspected to delineate any areas of soft or loose soil. These areas should be densified in place or removed down to acceptable soil and replaced with compacted fill. It is our opinion that select site materials would be satisfactory for this purpose. If fill is required to bring the site to the desired slab elevation, we recommend that granular fill be utilized and that the fill be compacted in maximum 9 inch lifts to a minimum of 95% maximum density, as determined by the standard moisture/density relationship test ASTM D698. It should be noted that failure to provide adequate fill compaction could result in settlement, which may cause slab damage such as cracking and tilting.

SITE DRAINAGE CONSIDERATIONS

It is essential that site grading be provided to prevent infiltration of surface water into the foundation system. The following methods of preventing this infiltration are recommended. These recommendations will also assist in preventing a "perched" groundwater table.

1. Mechanically compact all fill around the building, including the backfill. Compaction by ponding or saturation must not be permitted. The backfill should be compacted to not less than 90% of maximum density as determined by the standard moisture/density relationship ASTM D698. Note that some moisture may need to be added to the soils in order to obtain the proper compaction. Improper backfill compaction can cause settlement of exterior slabs such as walks, patios and driveways.

2. Provide an adequate grade for rapid runoff of surface water away from the structure (10% minimum for the first 10 feet away from the structure is recommended).

3. A well constructed, leak-resistant series of gutters, or other roof drainage system, is recommended.

4. Discharge roof downspouts and all other water collection systems well beyond the limits of the backfill.

5. No irrigation within five feet of the foundation. Avoid heavy watering of any foundation plantings.

6. Observe and comply with any other precautions that may be indicated during design and construction.

It is our opinion that perimeter drainage systems should be installed at this site if the structures are to have below grade space (basement, garden level, or crawlspace). The perimeter drainage system should consist of 4-inch perforated pipe, surrounded by ¾ to 1½ inch washed rock. The drains should be placed a minimum of 12 inches below the surface of the adjacent concrete slab or crawlspace level and should drain to a positive gravity discharge (surface discharge strongly recommended) or to a sump from which water can be pumped. Attached to this report (Figure 3) is a drawing, which illustrates a typical perimeter drain configuration for a drilled pier foundation system. Additionally, more extensive drainage systems, such as subfloor drainage systems, may be necessary if the excavations are to extend within 4 feet of the seasonal high groundwater. We are available to discuss such systems as necessary.

EARTH RETAINING STRUCTURES

At this site we recommend that the walls (including foundation walls and other grade beams) be designed using a lateral earth pressure equivalent to that developed by a fluid weighing 55 PCF plus any additional surcharge loads. Use of this value assumes that the wall will be backfilled with the site soils and that these soils will not be allowed to become saturated at any time during the life of the wall. Proper site grading and drainage, and installation of drainage systems at the base of any walls that are to retain soil above grade, will help to prevent saturation of the soils behind the walls. This value is valid for walls up to 10 feet in height.

PRELIMINARY PAVEMENT RECOMMENDATIONS

Samples were obtained from the borings to investigate the soils that will underlie the paved areas. The locations of the borings are indicated on the attached Boring Location Map (Figure 1).

Representative samples were classified by laboratory analysis. The results are presented below.

Boring No.	Unified Classsif.	AASHTO Classif.	Plasticity Index
TH-1	SC	A-2-6 (1)	15.2

Based on the above lab testing results, an "R" value of 10 was determined for the subgrade soils from the above borings (converted to a resilient modulus of subgrade of 3,562) is considered appropriate for use at this site. A design ESAL of 36,500 (EDLA of 5) is used for car and light truck parking and a design ESAL of 146,000 (EDLA of 20) is used for travelways and truck access. Design parameters are as shown on the tables below:

	Car & Light Truck Parking	**Residential Streets**
ESAL	36,500	146,000
Reliability	80.00	80.00
Overall Deviation	0.440	0.440
Resilient modulus of subgrade	3,562	3,025
PSI Loss due to traffic	2.50	2.50

Utilizing the CDOH flexible pavement computer design program, we obtained design a structural number of 2.40 for car and light truck parking and a design structural number of 2.96 for travelways and truck access. These values are the basis for the design calculations.

Groundwater was encountered in the borings during our investigation at depths greater than 5 feet below the proposed pavement grades. It is our opinion that groundwater is not a major factor in the pavement design provided no major cuts occur to bring the site to construction grade.

Car and Light Truck Parking

Alternative 1	3.0" Asphaltic Concrete Over 8.0" Aggregate Base Course (Class 6)
Alternative 2	6.0" Full Depth Asphaltic Concrete
Alternative 3	6.0" Portland Cement Concrete

Travelway and Truck Access

Alternative 1	4.0″ Asphaltic Concrete Over 9.0″ Aggregate Base Course (Class 6)
Alternative 2	7.0″ Full Depth Asphaltic Concrete
Alternative 3	7.0″ Portland Cement Concrete

Additionally, we recommend that areas that are subject to loadings such as trash truck stopping, turning, and trash truck off-loading dumpsters be designed with concrete pads. The pads should be a minimum of 10 inches thick and reinforced with a minimum of #4 bars at 12 inch centers, both directions. The bars should be placed 3 inches above the bottom of the pad.

It should be noted that this design is based on typical strength coefficients for road pavement materials being utilized in the area. The assumptions are as follows:

Material	Strength Coefficient (per inch)
Asphaltic concrete pavement	.43
Base Course	.14

The strength coefficients of the materials to be used in the construction should be obtained from the contractor supplying the materials. Adjustment in the pavement section should be made to reflect the actual strength of the materials being utilized to achieve a total design structural number required for the specific street. Concrete pavement should have a minimum specification as outlined under Class "P" concrete in the State Highway Department Materials Manual.

SUBGRADE PREPARATION

It is important to note that successful implementation of any of the pavement sections assumes a properly prepared subgrade. In connection with subgrade preparation, we recommend that:

1. Topsoil, any organic materials and any debris should be stripped from all areas to be paved.

2. The subgrade soils should be brought to proper grade for the selected section.

3. The subgrade materials should be subexcavated as needed and recompacted to 95% of maximum dry density near optimum moisture content as determined by the ASTM D698 specification. Further, any fills which are required should utilize, if available, on-site materials with a classification equal to or greater than the subgrade soils on which the design is based. Any fill material shall be subject to the approval of the geotechnical engineer. Compaction of any fill should be to the above requirements. When compaction of the subgrade is achieved, the pavement section should be placed on the compacted subgrade to the specifications required by local standards.

We recommend that a qualified geotechnical engineer inspects all work and that density tests be performed to assure that the required compaction is being obtained.

LIMITATIONS

The borings in this investigation are believed to present a reasonably accurate knowledge of the existing subsoils. However, variations of subsoils not indicated by the borings are always possible. Therefore, we recommend that excavation inspections be performed to confirm that the soils actually are as indicated by the investigation and to make final recommendations.

Due to the changing nature of geotechnical engineering practices, the information and recommendations provided in this report shall only be valid for two (2) years following the date of issue. After that time, our office should be contacted to review the information presented in this report and provide updated recommendations and design criteria appropriate for the engineering methodologies used in standard practice at that time.

Identification of potential hazardous waste material, if any, at this site is beyond the scope of work for which the activities of this project were intended.

It should be noted that the foundation system recommendations in this report are in accordance with the normal standard of practice assuming that the drainage recommendations provided in this report are strictly adhered to. If the soil supporting the foundation becomes wetted over a substantial period of time due to poor grading and drainage (or any other cause) , it is very possible that there could be damage to the foundation system and the slabs-on-grade. It is impractical to design a foundation system on expansive clay soils where poor site grading and drainage is allowed. In many areas along the front range expansive soil layers are relatively thick and when abnormally deep whetting occurs then typical foundation systems would not be adequate.

We would like to stress that it is not possible to fully determine the seasonal groundwater table fluctuations (and, therefore, the seasonal high groundwater table) with the short duration monitoring completed during the scope of this investigation. We have presented the method necessary to do such determination in the section titled "Groundwater Conditions". It is always possible that the groundwater table could rise to unanticipated levels, due to unknown or unrecognized groundwater sources. Unanticipated groundwater levels will also impact the recommendations, contained in this report, for the perimeter drainage system type and extent, which may be inappropriate for groundwater table levels that rise to unanticipated levels.

INSPECTION AND QUALITY CONTROL

Placement of any significant thickness of fill, particularly fill that is to remain in place beneath loaded slabs or other structural elements, should be inspected and tested in order to verify proper compaction is being obtained. Drilled piers or the placement of any pavement section should be inspected and tested by a qualified engineer from our office.

Sincerely,

SCOTT, COX & ASSOCIATES, INC.

By Kevin L. Hinds

Kevin Hinds, P.E.

3/24/10

Reviewed

By Ed Glassgow

M. Edward Glassgow, P.E.

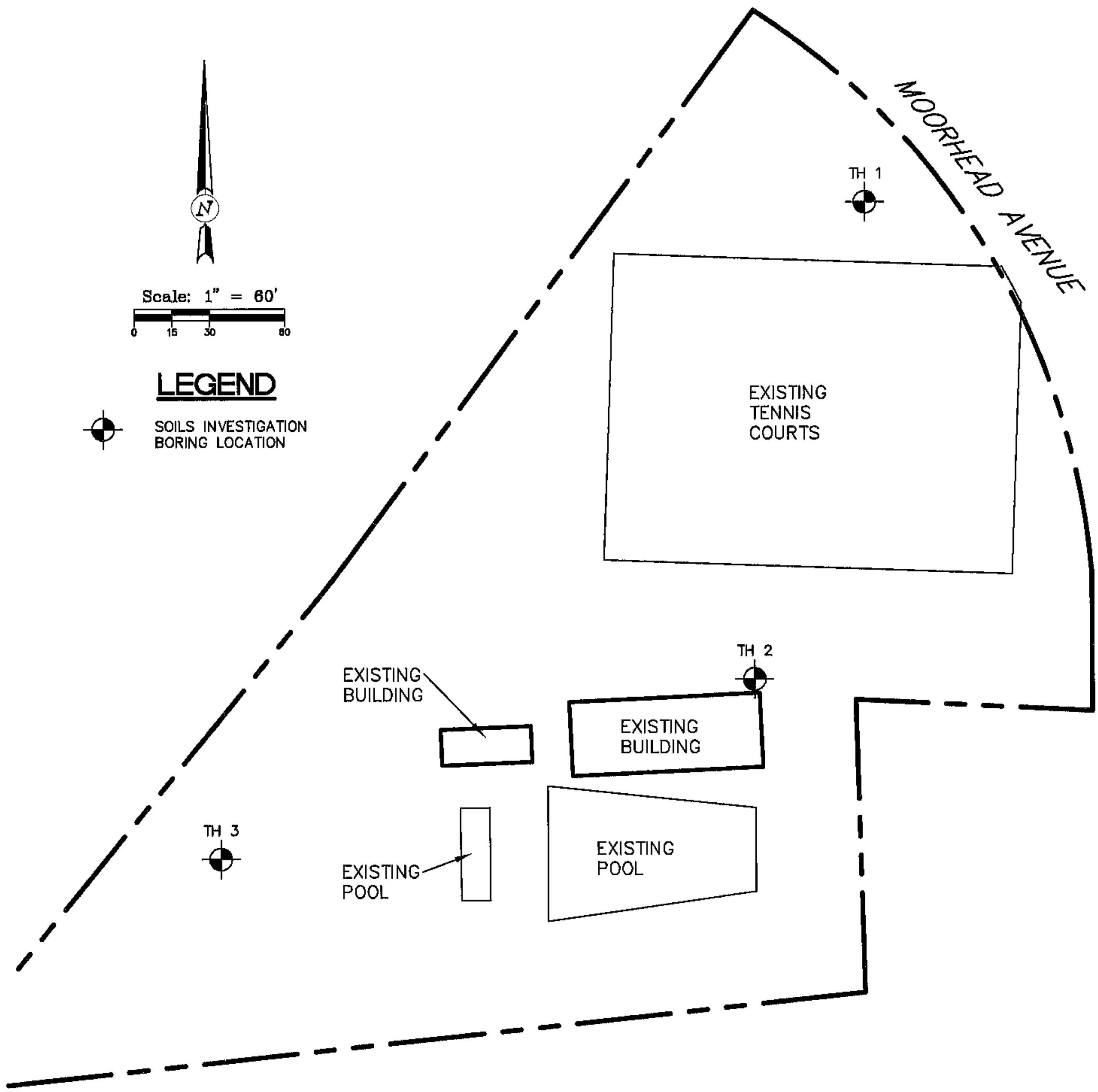

FIGURE 1
BORING LOCATION MAP

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3/17/10 JOB NO. 10164 DRAWING NO. 10164

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Graphic Boring Logs

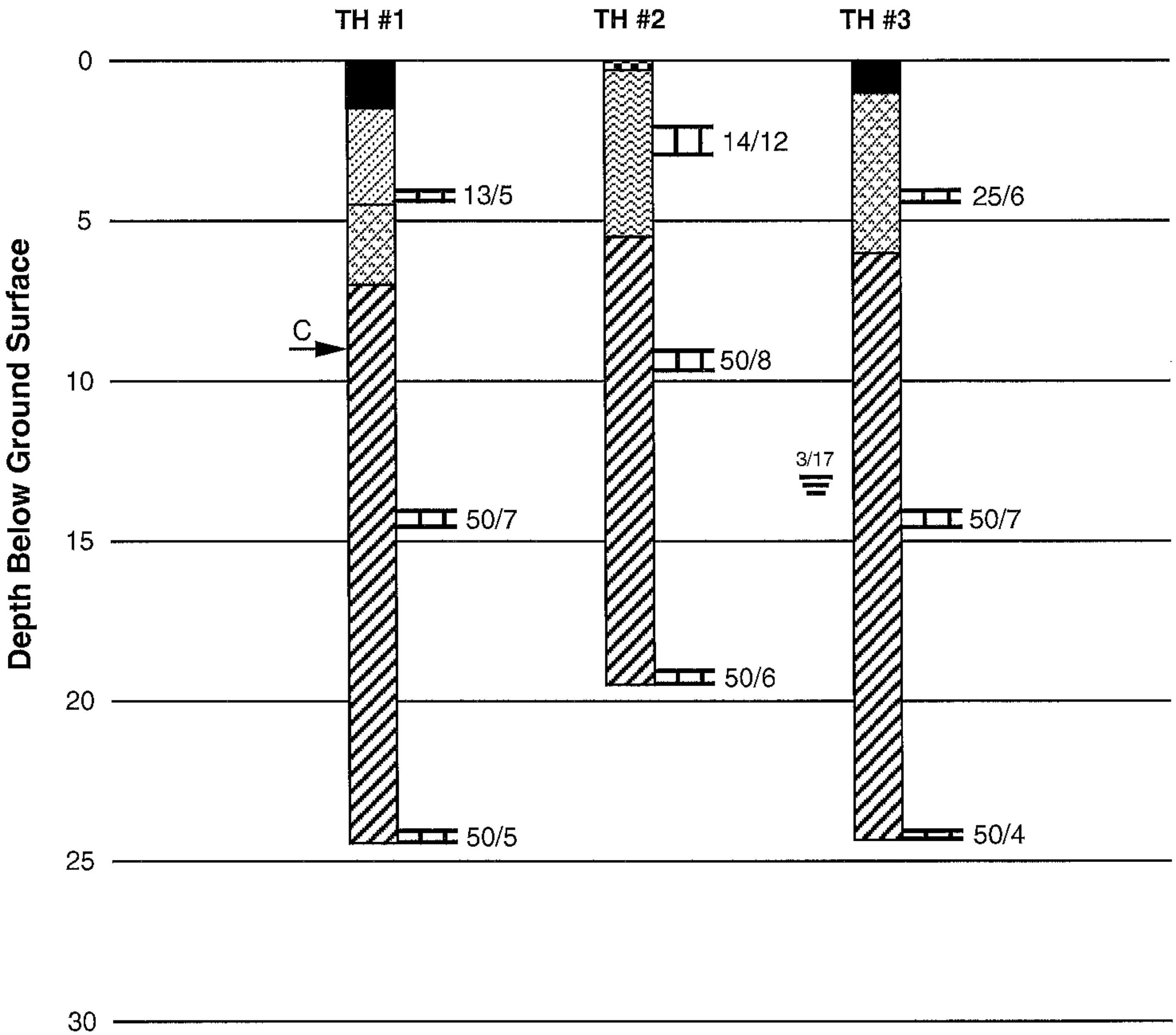

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Figure 2
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Description of Soil Types

Concrete

Fill - Mottled Brown, silty, sand and clay with some gravel

Topsoil - Dark brown, silty, sand and clay - Cointains organics

Red brown to brown, silty, sandy clay to clayey sand with some gravel

Red brown to brown, silty, clayey sand with gravel

Yellow brown to olive to gray, rust, silty, slightly sandy to sandy claystone

TH #1 Soils investigation boring number

Indicates a change in soil type - May be gradual.

12/12 — 12/12 indicates that 12 blows of a 140-pound hammer falling 30 inches were required to drive a 2-inch, inside diameter sampler 12 inches.

3/17 — Indicates the groundwater table and the date that the measurement was taken

C — Indicates depth at which boring caved subsequent to drilling

Notes

1. Borings were performed March 12, 2010 with four-inch diameter, continuous flight power augers.
2. Boring logs shown in this report are subject to the limitations, explanations and conclusions of the report.

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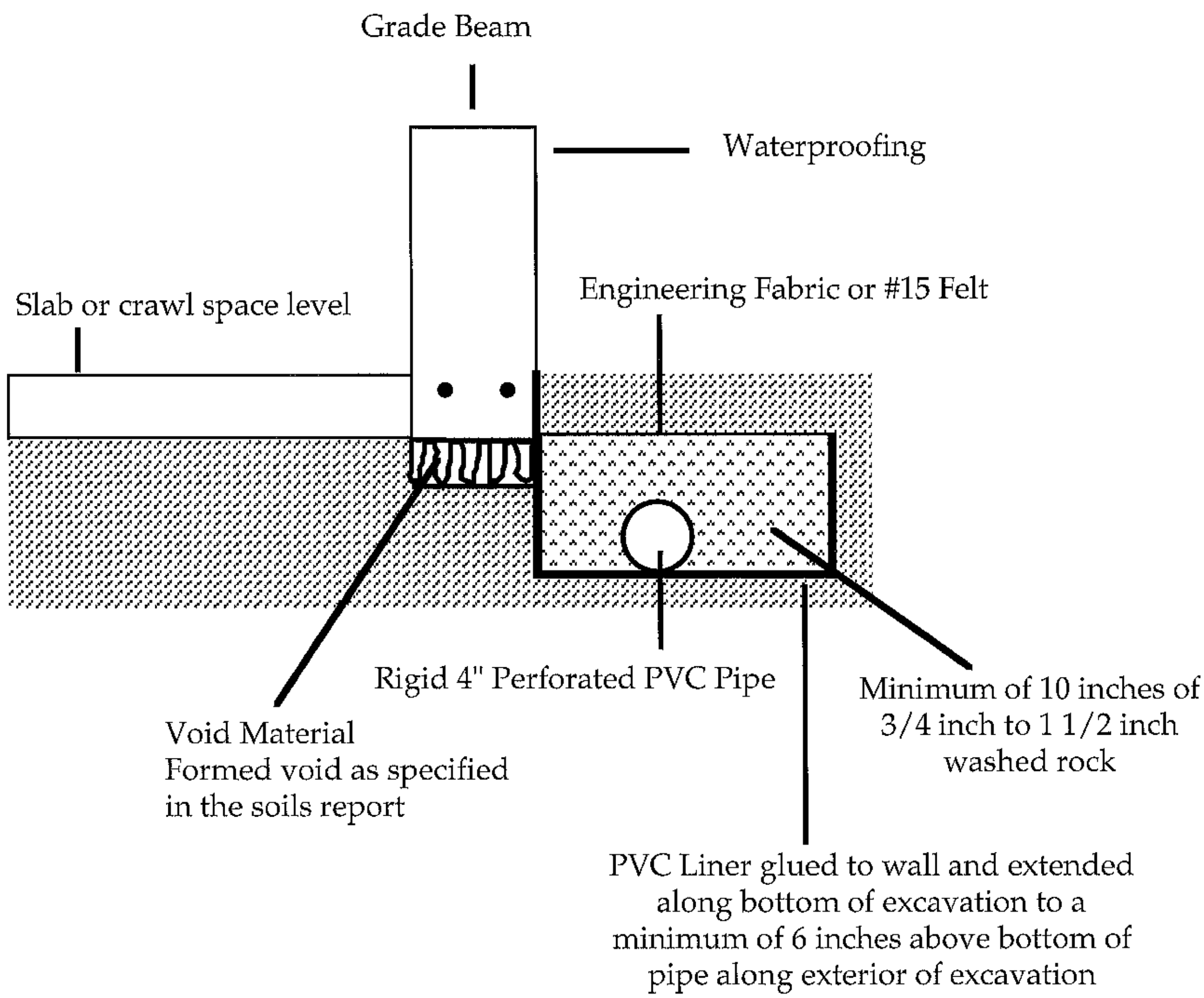
Figure 2

Typical Perimeter Drain Installation
Drilled Pier Foundation System



Notes:

1. **Slope drain and pipe at a minimum of 1/8 inch per foot to suitable outfall (sump pit or daylight outfall).**

2. **Glue all vertical T's and standpipes.**

3. **Install non-perforated pipe from perimeter pipe into sump pit.**

Figure 3

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Table 1
Summary of Soils Properties
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PROPERTIES AT NATURAL MOISTURE CONTENT			**CONSOLIDATION/SWELL**				**DESCRIPTION**
Natural Moisture (%)	Natural Dry Density (PCF)	Unconfined Compression (PSF)	Loading (PSF)	Settlement (Dry) (%)	Settlement (Saturated) (%)	Swell (%)	
TH # 1 @ 14							
14.3	113.8	>9000	100	0.20		7.70	Yellow brown to gray, silty,
			1000			5.00	slightly sandy to sandy
			2000			3.70	claystone
			4000			2.10	
			8000			0.30	
			12000		0.50		
7.9 % Swell upon the addition of water							
TH # 2 @ 2							
17.1	104.9	5000	100	0.30		1.40	Fill - Mottled brown, silty,
			1000			0.10	sand and clay
			2000		0.60		
1.7 % Swell upon the addition of water							
TH # 2 @ 9							
14.0	114.5	>9000	100	0.20		4.50	Yellow brown to gray, silty,
			1000			2.70	slightly sandy claystone
			2000			1.80	
			4000			0.60	
			8000		0.80		
4.7 % Swell upon the addition of water							
TH # 3 @ 9							
16.3	105.3	>9000	100	0.20		6.10	Yellow brown to gray, silty,
			1000			3.90	slightly sandy to sandy
			2000			2.90	claystone
			4000			1.60	
			8000		0.30		
6.3 % Swell upon the addition of water							
TH # 3 @ 24							
13.0	115.0	>9000	100	0.10		7.30	Yellow brown to gray, silty,
			1000			3.30	slightly sandy to sandy
			2000			1.50	claystone
			4000		0.40		
7.4 % Swell upon the addition of water							