# Attachment 23. Geotechnical Engineering Study

# UPDATED GEOTECHNICAL ENGINEERING STUDY
# EASTMOOR AVENUE MULTI STORY FAMILY DEVELOPMENT
# 493 EASTMOOR AVENUE
# DALY CITY, CALIFORNIA

December 12, 2018
*(Revised March 11, 2020)*

Prepared for

The Core Companies
470 South Market Street
San Jose, CA 95113
Attention: Mr. Carl Hertel

Prepared by

Earth Systems Pacific
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December 12, 2018 File No.: 302778-001
*(Revised March 11, 2020)*

Mr. Carl Hertel
The Core Companies
470 South Market Street
San Jose, CA 95113

PROJECT: EASTMOOR AVENUE MULTI STORY FAMILY DEVELOPMENT
493 EASTMOOR AVENUE
DALY CITY, CALIFORNIA

SUBJECT: Updated Geotechnical Engineering Study

Dear Mr. Hertel:

In accordance with your authorization of the above referenced proposal, this geotechnical engineering study has been prepared by Earth Systems Pacific (Earth Systems) for use in the design of the proposed Multi Story Family Development in Daly City, California. The conclusions presented herein are based on a review of the data collected as a part of our September 2015 study at the site. No new subsurface exploration or laboratory testing was performed as a part of this study. This report includes recommendations for the site grading, retaining wall and foundation construction and other geotechnical aspects of the project.

We appreciate the opportunity to have provided services for this project. Please do not hesitate to contact this office if there are any questions concerning this report.

Sincerely,

Earth Systems Pacific

Ajay Singh, GE 3057
Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
AJAY SINGH
GE 3057
GEOTECHNICAL
STATE OF CALIFORNIA

Doc. No.: 1812-031.SER/kt

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## 1.0 INTRODUCTION

### Site Setting

The subject 16,016 square foot (SF) property is generally trapezoidal in shape, and located at 493 Eastmoor Avenue in Daly City, California (APN 008-082-200). The site is located at the northwest corner of Eastmoor Avenue and Sullivan Avenue. The approximate center of the site is 37.6847°N latitude and 122.4727°W longitude on the United States Geological Survey's San Francisco South 7.5-Minute Quadrangle (See Figure 1).

### Site Description

The property is currently undeveloped, with portions of it containing remnants of a gas station that previously occupied the site. It is our understanding that the gas station was razed in 2003. A majority of the site is covered in asphaltic concrete with the exception of landscape areas in the northeast and northwest corners of the property. A review of the topographical map of the site indicates that the site area slopes down from the southwestern corner with ground surface elevation of 246 to the northeastern corner with ground surface elevation of 228 feet. The slope is relatively steep in the southwestern corner, relatively flat in the roughly the middle portion of the site, and slopes steeply to the east in the eastern portion.

The property is bounded by Eastmoor Avenue on the south, Sullivan Avenue on the east, and residential buildings on other two sides.

### Project Description

Based on the project plans prepared by LPMD Architects and JMH Weiss Inc., dated January 14, 2019, it is our understanding that the site will be developed by constructing a 7-story, 72-dwelling unit development. The proposed development will occupy the majority of the site and will include 5 floors of wood frame construction over reinforced concrete podium decks. The first floor will be a partial level on the eastern portion of the building. The first floor will have a finished floor elevation of 230, will be at-grade on the east side of the story and approximately 11 feet below grade on the west side of the story. The first floor will contain a 1,196 square-foot commercial building, a lobby area, an electrical room, and a transformer room. The second floor will be at grade on the western side of the building, will have an elevation 244, and consist of a 14,543 square-foot parking garage, an additional lobby area, a water heater room, and bike storage areas. The third floor will consist of a 640 square-foot mail room, an 820 square-foot communality area, a 460 square-foot leasing office, a 3,383 square-foot podium courtyard area. The upper floors will have studios and one-bedroom units and a laundry area or fitness area.

**Scope of Services**

The scope of work for the geotechnical engineering study included general site reconnaissance to observe current site conditions, review of the subsurface data collected as a part of our September 2015 study, engineering evaluation of the subsurface data in light of the currently proposed development, and preparation of this report.

The report and recommendations included herein are intended to comply with the considerations of Section 1803 of the California Building Code (CBC), 2019 Edition, and common geotechnical engineering practice in this area at this time under similar conditions. The tests were performed in general conformance with the standards noted, as modified by common geotechnical practice in this area at this time under similar conditions.

Preliminary geotechnical recommendations for site preparation and grading, foundations, slab-on-grade and exterior flatwork, utility trench backfill, site drainage and finish improvements, and geotechnical observation and testing are presented to guide the development of project plans and specifications. It is our intent that this report be used by the client to form the geotechnical basis of the design of the project as described herein, and in the preparation of plans and specifications.

Detailed evaluation of the site geology and potential geologic hazards, and analyses of the soil for infiltration rates, mold or other microbial content, asbestos, corrosion potential, radioisotopes, hydrocarbons, or other chemical properties are beyond the scope of this report. This report also does not address issues in the domain of contractors such as, but not limited to, site safety, loss of volume due to stripping of the site, shrinkage of soils during compaction, excavatability, shoring, temporary slope angles, and construction means and methods. Ancillary features such as temporary access roads, fences, light poles, and non-structural fills are not within our scope and are also not addressed.

To verify that pertinent issues have been addressed and to aid in conformance with the intent of this report, it is requested that final grading and foundation plans be submitted to this office for review. In the event that there are any changes in the nature, design, or locations of improvements, or if any assumptions used in the preparation of this report prove to be incorrect, the conclusions and recommendations contained herein should not be considered valid unless the changes are reviewed and the conclusions of this report are verified or modified in writing by the geotechnical engineer. The criteria presented in this report are considered preliminary until such time as they are verified or modified in writing by the geotechnical engineer in the field during construction.

## 2.0 GEOLOGIC SETTING

The subject site is mapped as being underlain by Early or Middle Pleistocene alluvial deposits with Coloma Formation at depth (Bonilla et.al, 1998). The Coloma Formation is described as: *"Friable well sorted fine to medium sand containing a few beds of sandy silt, clay and gravel; yellowish orange to gray in color".*

The State of California has not prepared seismic hazard zone maps for this portion of San Mateo County. The site is not within an earthquake fault rupture zone. According to preliminary mapping by USGS the site in not located in an area susceptible to liquefaction. No known faults cross the subject site.

The entire San Francisco Bay Area, is considered to be an active seismic region due to the presence of several active faults. Three northwest-trending major earthquake faults that are responsible for the majority of the movement on San Andreas fault system extend through the Bay Area. They include the San Andreas fault, the Hayward fault and the Calaveras fault, which are respectively located approximately 1.5 miles to the west, 17.3 miles to the northeast and 26 miles to the northeast. The San Gregorio fault is located approximately 6 miles west of the site. Using information from recent earthquakes, improved mapping of active faults, and a new model for estimating earthquake probabilities, the 2014 Working Group on California Earthquake Probabilities updated the 30 years earthquake forecast for California. They concluded that there is a 72 percent probability (or likelihood) of at least one earthquake of magnitude 6.7 greater striking somewhere in the San Francisco Bay region before 2043. A summary of the significant faults in the near vicinity of the site and their respective probability of exceeding or equaling moment magnitude of 6.7 within 30 years are listed below.

**Major Active Faults**

| Fault | Distance from Site (miles) | Probability of $M_w \geq 6.7$ within 30 Years [1] |
|---|---|---|
| Hayward | 17.3 | 32% |
| Calaveras | 26.0 | 26% |
| San Andreas | 1.5 | 33% |
| San Gregorio | 6.0 | 5% |

[1] Working Group of California Earthquake Probabilities, 2014

## 3.0 FIELD INVESTIGATION AND LABORATORY TESTING

### Subsurface Exploration

The subsurface exploration program consisted of drilling four (4) exploratory borings at the site on July 27, 2015. The exploratory borings were drilled under the direction of an Earth Systems geologist at the approximate locations shown on the Boring Location Map (Figure 2) and they were sampled to maximum depths of 31.5 and 40 feet below the ground surface. The borings were advanced using a truck-mounted Mobile B-53 drill rig equipped with an 8-inch diameter, continuous-flight hollow-stem auger. The drilling process consisted of augering to the desired depth and upon reaching that depth, the plug blocking the hollow portion of the auger was retrieved and a standard sampler connected to steel rods was lowered into the hole through the augers that formed temporary casing of the hole. The standard samplers were driven into the undisturbed ground with a 140-lb, safety hammer falling about 30 inches per drop. The samplers were driven up to 18 inches and the hammer blows required to drive every six inches of the samplers were recorded and presented on the boring logs as penetration resistance. This information was used to interpret soil consistency/density.

Our staff geologist supervised the drilling program, logged the soil conditions encountered in the borehole and collected representative samples for laboratory testing. Subsurface conditions revealed by our borings were described by our staff geologist. The borings were backfilled with lean cement grout. The boring logs show soil description including: color, major and minor components, USCS classification, changes in soil conditions with depth, moisture content, consistency/density, plasticity, sampler type, and sampling depths and laboratory test results. Copies of the boring logs advanced for this investigation are presented in Appendix A.

### Subsurface Profile

The subsurface profile at the boring locations consisted predominantly of medium dense to very dense silty sands. Medium dense to dense silty gravels were encountered near surface in Borings B2, B3 and B4; to depths ranging from 2 to 18.5 feet. The upper 2 to 8.5 feet appears to be fill as noted on the logs. In Boring B4, clayey sand was encountered in the depth range of 18.5 to 24.5 feet, underlain by dense well graded sand to the final depth of boring at 40 feet below ground surface. A distinct petroleum odor was detected in each of the borings.

Free groundwater was not encountered in the borings. The logs of the test borings are presented in Appendix A.

### Laboratory Testing

Selected liner samples were tested for moisture content and dry density (ASTM D 2216-10 and D 2937-10). One sample was tested to determine its Atterberg Limits (ASTM D 4318-10), and two samples were tested for direct shear strength parameters (ASTM D 3080/D3080M-11). Copies of the laboratory test results are included in Appendix B.

## 4.0 DATA ANALYSIS

### Subsurface Soil Classification

Based on the data acquired during our subsurface investigation (See Appendix A), the site is assigned to Site Class C ("very dense soil and soft rock") as defined by Table 20.3-1 of the ASCE 7-16.

### Seismic Design Parameters

The following seismic design parameters represent the general procedure as outlined in Section 1613 of the California Building Code and in ASCE 7. The values were obtained using the OSHPD Seismic Design Maps Web Application. on.

**Summary of Seismic Parameters - CBC 2019**
**(Site Coordinates 37.6847°N, 122.4727°W)**

| Parameter | Design Value |
|---|---|
| Site Class | C |
| Mapped Short Term Spectral Response Parameter, ($S_s$) | 2.24g |
| Mapped 1-second Spectral Response Parameter, ($S_1$) | 0.94g |
| Site Coefficient, ($F_a$) | 1.2 |
| Site Coefficient, ($F_v$) | 1.4 |
| Site Modified Short Term Response Parameter, ($S_{Ms}$) | 2.69g |
| Site Modified 1-second Response Parameter, ($S_{M1}$) | 1.31g |
| Design Short Term Response Parameter, ($S_{Ds}$) | 1.79g |
| Design 1-second Response Parameter, ($S_{D1}$) | 0.87g |

### Liquefaction

Soil liquefaction is a phenomenon where saturated granular soils near the ground surface undergo a substantial loss of strength due to increased pore water pressure resulting from cyclic stress applications induced by earthquakes or other vibrations. In this process, the soil acquires mobility sufficient to permit both vertical and horizontal movements, if not confined, which may result in significant deformations. It is generally acknowledged that the effects of liquefaction will not affect surface improvements if the liquefied soil deposits are located at a depth greater than 50 feet below the ground surface. In the deeper deposits, the greater overburden pressure is sufficient to reduce the potential for liquefaction effects from occurring.

The site is not in a liquefaction hazard zone according to preliminary mapping by USGS. Groundwater water was not encountered in our borings to the maximum depth of exploration at 40 feet below ground surface. Previous investigation at the site indicate that groundwater was not encountered to the depth of 60 feet below ground surface (GeoTracker website of the California State Water Resources Control Board). Due to the dense soil profile and absence of groundwater in the upper deposits, it is our opinion that the probability of liquefaction at the site is very low. However, seismically-induced, dry-sand related settlement is possible at the site.

## 5.0 CONCLUSIONS

### Site Suitability

The subject site is suitable for the proposed residential development from a geotechnical engineering standpoint, provided the recommendations included in this report are followed. The primary geotechnical considerations at the site include seismic shaking, seismically induced settlement, potentially unstable ground at first-floor (partial basement) level for construction traffic, shoring for first-floor (partial basement) construction, and the variable depths of cut and fills due to the sloping nature of the site.

### Seismicity

The San Francisco Bay area is recognized by geologists and seismologists as one of the most seismically active regions in the United States. The significant earthquakes in this area are generally associated with crustal movement along well-defined, active fault zones which regionally trend in a northwesterly direction. Although research on earthquake prediction has greatly increased in recent years, seismologists cannot predict when and where an earthquake will occur. Nevertheless, on the basis of current technology, it is reasonable to assume that the proposed development will be subjected to at least one moderate to severe earthquake during their lifetime. During such an earthquake, the danger from fault offset on the site is low, but strong shaking of the site is likely to occur and, therefore, the project should be designed in accordance with the seismic design provisions of the latest California Building Code. It should be understood that the California Building Code seismic design parameters are not intended to prevent structural damage during an earthquake, but to reduce damage and minimize loss of life.

### Seismically-Induced Settlement

Seismically-induced, dry-sand related settlement on the order of 1 inch with differential settlement of 0.5 inches is possible at the site.

### Basement Floor Subgrade Stabilization

The test borings drilled at the site indicate the presence of medium dense, very silty sands with gravel at the first-floor (partial basement) subgrade level (assumed approximately 11 to 13 feet below existing surface grade). The soil samples collected during subsurface exploration from the borings had moisture contents on the order of 13.0 to 18.7 percent, and are potentially unstable under construction traffic, and may undergo deep rutting. Therefore, the subgrade may need to be stabilized to allow for smooth operation of the construction process. If it is deemed necessary during the construction phase of the project, the soil subgrade may be stabilized by aeration and recompaction, removal and replacement, or the use of gravel and geotextiles as stabilizing measures. Another alternative would be to mix cement in the top 12 to 18 inches of the basement subgrade. The nature and percentage of additive needed to stabilize the basement floor will be determined when the basement subgrade is exposed during construction.

**Subterranean Shoring Considerations**

The excavation for the subterranean parking garage is anticipated to be extend to the property lines. Therefore, the contractor should investigate the foundation types of the nearby structures and install an underpinning/shoring system to adequately support the existing nearby structures up until the basement walls are constructed and are able to support the loads. A preconstruction survey should be conducted to document the conditions of the nearby structures and pavements to evaluate the potential impacts of the basement excavation and construction. Settlement of the surrounding area should be monitored with surveying techniques prior to and during construction.

**Soil Expansion Potential**

A plasticity index test of a sample of the silty sand near an assumed basement subgrade level of 12 feet resulted in a liquid limit (LL) of 21 and a plasticity index (PI) of 4, indicating that the sample tested has a low expansion potential.

**Foundations**

The soil conditions appear to be consistent throughout the site. The proposed structures may be supported on a structural mat foundation. Details of the mat foundation recommendations are included in the following sections of the report. The basement wall foundations may be combined with the structural mat foundations.

**Static Settlement**

Anticipated static settlements are on the order of 0.75 to 1 inch with differential settlement of about 0.5 inches between adjacent foundation elements. Due to the coarse-grained nature of the site soils, a majority of the anticipated static settlements are expected to occur rapidly; probability during the construction period.

**Groundwater**

Groundwater was not encountered in any of the borings drilled by our firm as a part of the September 2015 geotechnical engineering study. These borings were drilled to a maximum depth of 40 feet below the existing ground surface. Previous investigations at the site indicate that groundwater was not encountered to the depth of 60 feet below ground surface (GeoTracker website of the California State Water Resources Control Board). Variations in rainfall, irrigation, temperature, and other factors may affect water levels, and therefore groundwater levels should not be considered constant. However, groundwater is not anticipated to have an adverse impact on the construction or performance of the development.

## 6.0 RECOMMENDATIONS

### Site Preparation and Grading

General Site Preparation

1. The site should be prepared for grading by removing existing trees to be removed and their root systems, vegetation, debris, and other potentially deleterious materials from areas to receive improvements. Compaction recommendations for site grading can be found later in this section.

2. Existing utilities, where known, should be located on the grading plans, to assist the geotechnical engineer during grading operations. Existing utility lines that will not be serving the proposed development should be either removed or properly abandoned. The necessity of removing abandoned underground utility lines should be determined by the geotechnical engineer during site grading.

3. Vegetation (weeds, shrubs, etc.), and organically contaminated topsoil must be removed from areas to be graded. The depth of stripping will probably vary and should be determined by the geotechnical engineer during grading operations. Organically contaminated soils may either be stockpiled and later used as topsoil in landscaping areas or removed from the site.

4. Buried debris, concrete pieces, and remnants of the former use of the site that are discovered during site grading should be removed from areas to be graded.

5. The geotechnical engineer should be notified at least 48 hours prior to commencement of grading operations.

6. Due to the high moisture content of the soils at the basement garage level, there is a potential for the soils to become unstable during grading. Unstable soils hinder compactive effort and are inappropriate for placement of additional fill. Alternatives to correct instability include aeration to dry the soils, over-excavation and recompaction, the use of gravel or geotextiles as stabilizing measures, or cement treatment. Recommendations for stabilization should be provide by a representative of Earth Systems, as needed, during construction.

Compaction Recommendations

1. In general, the underlying native soil should be scarified at least 8 inches, moisture conditioned and recompacted to the recommended relative compaction presented below, unless noted otherwise. This scarification operation should be performed at locations designated for proposed structural fill, concrete flatwork, foundations, and asphalt pavement areas.

2. Recompacted native soils and fill soils should be compacted to a minimum relative compaction of 90 percent of maximum dry density at a moisture content slightly above optimum.

3. In areas to be paved, the upper 8 inches of subgrade soil should be compacted to a minimum 92 percent of maximum dry density at moisture content slightly over optimum. The aggregate base courses should be compacted to a minimum 95 percent of maximum dry density at a moisture content that is slightly over optimum. The subgrade and base should be firm and unyielding when proof-rolled with heavy, rubber-tired equipment prior to paving. The pavement subgrade soils should be periodically moistened as necessary prior to placement of the aggregate base to maintain the soil moisture content near optimum.

Fill Recommendations

1. Structural fill is defined herein as a native or import fill material which, when properly compacted, will support foundations, building slabs, pavements, and other fills. The on-site native fill soils that are free of debris, organics and other deleterious material, may be used as structural fill.

2. Should import fill be required, the soil should meet the following criteria:
    a. Be coarse grained and have a plasticity index of less than 15;
    b. Be free of organics, debris or other deleterious material;
    c. Have a maximum rock size of 3 inches; and

   d. Contain sufficient clay binder to allow for stable foundation and utility trench excavations.

3. A sample of proposed imported soils should be submitted at least three days before being transported to the site for evaluation by the geotechnical engineer. During importation to the site the material should be further reviewed on an intermittent basis.

<u>Basement Excavation/ Temporary Cuts</u>

1. The proposed basement excavation should be completed in accordance with CAL-OSHA requirements. Based on the soil profile identified in the boring log, the site soil is classified as Type C. Temporary construction slopes should not be graded steeper that 1½ to 1 (horizontal to vertical). Steeper slopes will require temporary shoring. If a construction ramp is excavated leading into the basement under the structural area, it should be backfilled in lifts compacted to a minimum of 90 percent relative compaction when it is later backfilled. Similarly, if the ramp is excavated in a planter area, that area should be backfilled in lifts with a sufficient amount of compaction effort to also achieve 90 percent compaction.

2. Vertical cut portions of excavations greater than 4 feet in height should be shored. Typical shoring systems include steel soldier beam and wood lagging, soil nailing and sheet piling. Soldier beam and lagging is the most common. Temporary shoring should be designed for an equivalent fluid pressure of 35 psf for the active case. A passive equivalent fluid pressure of 300 psf may be used for the shoring foundation.

**Foundations**

1. The proposed development may be supported by a concrete mat foundation bearing on the stiff native or engineered fill material. The mat slab should be designed using a maximum localized allowable bearing pressure of 1,700 psf for dead plus live load. This value may be increased by one-third when transient loads such as wind or seismicity are included. The mat slab should be sufficiently thick to uniformly spread the concentrated loads imposed by any building columns and basement walls. The mat should be designed using a modulus of subgrade reaction value of 10 psi per inch.

2. Resistance to lateral loads should be calculated based on a passive equivalent fluid pressure of 300 pcf and a friction factor of 0.35. Passive and frictional resistance can be combined in the calculations without reductions. These values may be used in combination without reduction of either value. These values are based on the assumption that backfill adjacent to foundations is properly compacted.

3. The basement slab should be underlain by a drain blanket at least 4 inches thick to control potential groundwater seepage. The drain blanket may consist of clean crushed rock underlain by a non-woven filters fabric or Class 2 permeable material. The soil subgrade should be shaped to slope from the center to the perimeter at a gradient of at least 1 percent. The basement slab and walls should be waterproofed as directed by the architect/engineer.

4. Rigid PVC perforated pipe consisting of Schedule 40 or SDR 35 pipe with a minimum 2 percent slope, should be placed around the perimeter of the drain blanket connecting to a catch basin, drain outlet, or sump, which discharges groundwater away from the project site.

**Basement Retaining Walls**

1. The foundations of the retaining walls can be combined with the mat foundations of the building.

2. Design criteria for retaining walls to laterally retain the on-site soils are presented below:

| | |
|---|---|
| Active equivalent fluid pressure (level backfill) | 40 pcf |
| At-rest equivalent fluid pressure (level backfill) | 55 pcf |

The above earth pressures are for level backfill conditions. For sloping backfill, the above pressures should be increased by 3 pcf per every 5 degree increase in the backfill slope angle. No surcharge loads are taken into consideration in the above provided equivalent fluid pressures.

3. Surcharge loads applied at the surface on the backfill should be considered to be a uniformly distributed horizontal load. This load would equal to approximately 1/3 and 1/2 of the uniform surcharge load for “active” and “at-rest” conditions, respectively.
4. Retaining walls that are constructed as part of the building or are connected to the building foundations should be designed for at-rest pressures. Walls that are not restrained from rotation may be designed for active pressures.

5. If seismic forces are to be considered in the retaining wall design, the seismic increment of earth pressure should be 10H pounds per linear foot, where H is the height of the retained soil. The seismic pressure should be applied uniformly on the back of the wall along the height of the retained soil.

6. A concrete lined drainage ditch should be constructed at the top of exterior retaining walls to prevent surface irrigation or rain water originating upslope of the walls from flowing over the walls. The drainage ditch should lead to one or both ends of the retaining walls and discharge into an approved collection system.

7. In order to provide proper drainage, an import drain rock blanket should be placed behind the retaining walls. The drain rock blanket should be at least 12 inches wide, and extend along the entire length of the retaining wall. The drain rock blanket should extend from the top of the footing upward to within 2 feet of the top of the wall backfill. The upper 2 feet of backfill over the drainage medium should consist of native soil, compacted to at least 90 of maximum dry density, to reduce the flow of surface drainage into the wall drain system. The drain rock blanket should be separated from the backfill soil using a permeable synthetic fabric conforming to Caltrans Standard Specifications, Section 88-1.02B, Class A. Permeable material should conform to Section 68-2.02F(3), Class 2, of the Caltrans Standard Specifications. Manufactured synthetic drains such as Miradrain or Enkadrain may be used in lieu of drain rock and should be installed in accordance with the recommendations of the manufacturer. A 4-inch diameter, perforated/horizontal pipe should be placed at the bottom of the drain blanket/synthetic drains with perforations down. The pipe should discharge to an approved discharge point beyond and down slope of the wall. Provisions should be made to remove any surface water or water collected behind the retaining walls.

8. The architect/engineer should bear in mind that retaining walls by their nature are flexible structures, and the flexibility can often cause cracking in surface coatings. Where walls are to be plastered or will otherwise have a finish surface applied, this flexibility should be considered in determining the suitability of the surfacing material, spacing of horizontal and vertical joints, connections to structures, etc.

9. Retaining walls facing habitable areas, or areas where intrusion of moisture would be undesirable, should be waterproofed in accordance with the specifications of the architect/engineer.

10. Retaining walls should be backfilled with either native soil or clean imported granular material. The backfill material should be placed in thin, moisture conditioned lifts, compacted in accordance with the recommendations provided in the Site Preparation and Grading section of this report.

11. Long-term settlement of properly compacted sand or gravel retaining wall backfill should be assumed to be about ½ percent of the depth of the backfill. Long-term settlement of properly compacted clayey retaining wall backfill should be assumed to be about 1 percent of the depth of the backfill. Improvements constructed near the tops of retaining walls should be designed to accommodate the estimated settlement.

**Exterior Flatwork**

1. Exterior flatwork should have a minimum thickness of 4 full inches and should be reinforced as directed by the architect/engineer.

2. The flatwork can be cast directly on properly prepared subgrade. However, a 2 to 4-inch cushion layer of compacted low-expansive material such as clean sand or aggregate base would enhance the slab performance. Flatwork which will receive vehicular traffic should be underlain by at least 6 inches of aggregate base.

3. Assuming that movement (i.e., 1/4-inch or more) of exterior flatwork beyond the structure is acceptable, the flatwork should be designed to be independent of the building foundations. The flatwork should not be doweled to foundations, and a separator should be placed between the two.

4. To reduce shrinkage cracks in concrete, the concrete aggregates should be of appropriate size and proportion, the water/cement ratio should be low, the concrete should be properly placed and finished, contraction joints should be installed, and the concrete should be properly cured. Concrete materials, placement and curing specifications should be at the direction of the designer; ACI 302.1R-04 and ACI 302.2R-04 are suggested as resources for the designer in preparing such specifications.

**Utility Trench Backfill**

1. A select, noncorrosive, granular, easily compacted material should be used as bedding and shading immediately around utility pipes. The site soils may be used for trench backfill above the select material.

2. Trench backfill should be compacted to a minimum of 90 percent of maximum dry density. Jetting of utility trench backfill should not be allowed.

3. Where utility trenches extend under perimeter foundations, the trenches should be backfilled entirely with native soil compacted to a minimum of 90 percent of maximum

dry density. The zone of native soil should extend a minimum distance of 2 feet on both sides of the foundation. If utility pipes pass through sleeves cast into the perimeter foundations, the annulus between the pipes and sleeves should be completely sealed.

4. Parallel trenches excavated in the area under foundations defined by a plane radiating at a 45-degree angle downward from the bottom edge of the footing should be avoided, if possible. Trench backfill within this zone, if necessary, should consist of Controlled Density Fill (Flowable Fill).

5. In landscape areas, at least the final 24 inches of backfill should be compacted, approved fill soil to reduce the potential for surface rain or irrigation water from rapidly penetrating down into the trench. Under pavement areas, the top 12 inches should be compacted, approved fill soil.

6. Where trenches pass from landscape areas to pavement areas, at least a four foot length of trench, centered on the curb line, should be backfilled with native soil to reduce the potential for lateral migration of water from the planter to the pavement area.

**Post -Construction Surface Water Management**

1. Unpaved ground surfaces should be finish graded to direct surface runoff away from site improvements at a minimum 5 percent grade for a minimum distance of 10 feet. If this is not practical due to the terrain or other site features, swales with improved surfaces should be provided to divert drainage away from improvements. The landscaping should be planned and installed to maintain proper surface drainage conditions.

2. Runoff from driveways, roof gutters, downspouts, planter drains and other improvements should discharge in a non-erosive manner away from foundations, pavements, and other improvements. The downspouts may discharge onto splash blocks that direct the flow away from the foundation.

3. The site should be graded so that runoff is not allowed to flow in an uncontrolled manor over cut, fill, or natural slopes.

4. Stabilization of surface soils, particularly those disturbed during construction, by vegetation or other means during and following construction is essential to protect the site from erosion damage. Care should be taken to establish and maintain vegetation.

5. Raised planter beds adjacent to foundations should be provided with sealed sides and bottoms so that irrigation water is not allowed to penetrate the subsurface beneath foundations. Outlets should be provided in the planters to direct accumulated irrigation water away from foundations.

6. Bio swales located within 10 feet or less of the building should be lined with a 20-mil pond liner.

7. If expansive soils are encountered, open areas adjacent to exterior flatwork should be irrigated or otherwise maintained so that constant moisture conditions are created throughout the year. Irrigation systems should be controlled to the minimum levels that will sustain the vegetation without saturating the soil.

**Geotechnical Observation and Testing**

1. It must be recognized that the recommendations contained in this report are based on a limited number of borings and rely on continuity of the subsurface conditions encountered.

2. It is assumed that the geotechnical engineer will be retained to provide consultation during the design phase, to interpret this report during construction, and to provide construction monitoring in the form of testing and observation.

3. Unless otherwise stated, the terms "compacted" and "recompacted" refer to soils placed in level lifts not exceeding 8 inches in loose thickness and compacted to a minimum of 90 percent of maximum dry density. The standard tests used to define maximum dry density and field density should be ASTM D 1557-12 and ASTM D 6938-10, respectively, or other methods acceptable to the geotechnical engineer and jurisdiction.

4. “Moisture conditioning” refers to adjusting the soil moisture to at least optimum moisture prior to application of compactive effort. If the soils are overly moist so that they become unstable, or if the recommended compaction cannot be readily achieved, drying the soil to optimum moisture content or just above may be necessary. Placement of gravel layers or geotextiles may also be necessary to help stabilize unstable soils. The geotechnical engineer should be contacted for recommendations for mitigating unstable soils.

5. At a minimum, the following should be provided by the geotechnical engineer:

   - Review of final grading and foundation plans
   - Professional observation during site preparation, grading, and foundation excavation
   - Oversight of soil compaction testing during grading
   - Oversight of soil special inspection during grading

6. Special inspection of grading should be provided as per Section 1704.7 and Table 1704.7 of the CBC; the soils special inspector should be under the direction of the geotechnical engineer. In our opinion, the following operations should be subject to *continuous* soils special inspection:

   - Scarification and recompaction
   - Fill placement and compaction

7. In our opinion, the following operations may be subject to *periodic* soils special inspection; subject to approval by the Building Official:

   - Basement subgrade preparation and moisture conditioning
   - Basement wall backfill
   - Compaction of utility trench backfill
   - Compaction of on-site pavements

8. It will be necessary to develop a program of quality control prior to beginning grading. It is the responsibility of the owner, contractor, or project manager to determine any additional inspection items required by the architect/engineer or the governing jurisdiction.

9. The locations and frequencies of compaction tests should be as per the recommendations of the geotechnical engineer at the time of construction. The recommended test locations and frequencies may be subject to modification by the geotechnical engineer based upon soil and moisture conditions encountered, the size and type of equipment used by the contractor, the general trend of the compaction test results, and other factors.

10. A preconstruction conference among a representative of the owner, the geotechnical engineer, soils special inspector, the architect/engineer, and contractors is recommended to discuss planned construction procedures and quality control requirements. Earth Systems should be notified at least 48 hours prior to beginning grading operations.

## 7.0 CLOSURE

This report is valid for conditions as they exist at this time for the type of project described herein. Our intent was to perform the investigation in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing in the locality of this project at this time under similar conditions. No representation, warranty, or guarantee is either expressed or implied. This report is intended for the exclusive use by the client as discussed in the Scope of Services section. Application beyond the stated intent is strictly at the user's risk.
If changes with respect to the project type or location become necessary, if items not addressed in this report are incorporated into plans, or if any of the assumptions stated in this report are not correct, Earth Systems should be notified for modifications to this report. Any items not specifically addressed in this report should comply with the California Building Code and the requirements of the governing jurisdiction.

The preliminary recommendations of this report are based upon the geotechnical conditions encountered during the investigation, and may be augmented by additional requirements of the architect/engineer, or by additional recommendations provided by Earth Systems based on conditions exposed at the time of construction.

If Earth Systems is not retained to provide construction observation and testing services, it will not be responsible for the interpretation of the information by others or any consequences arising there from.

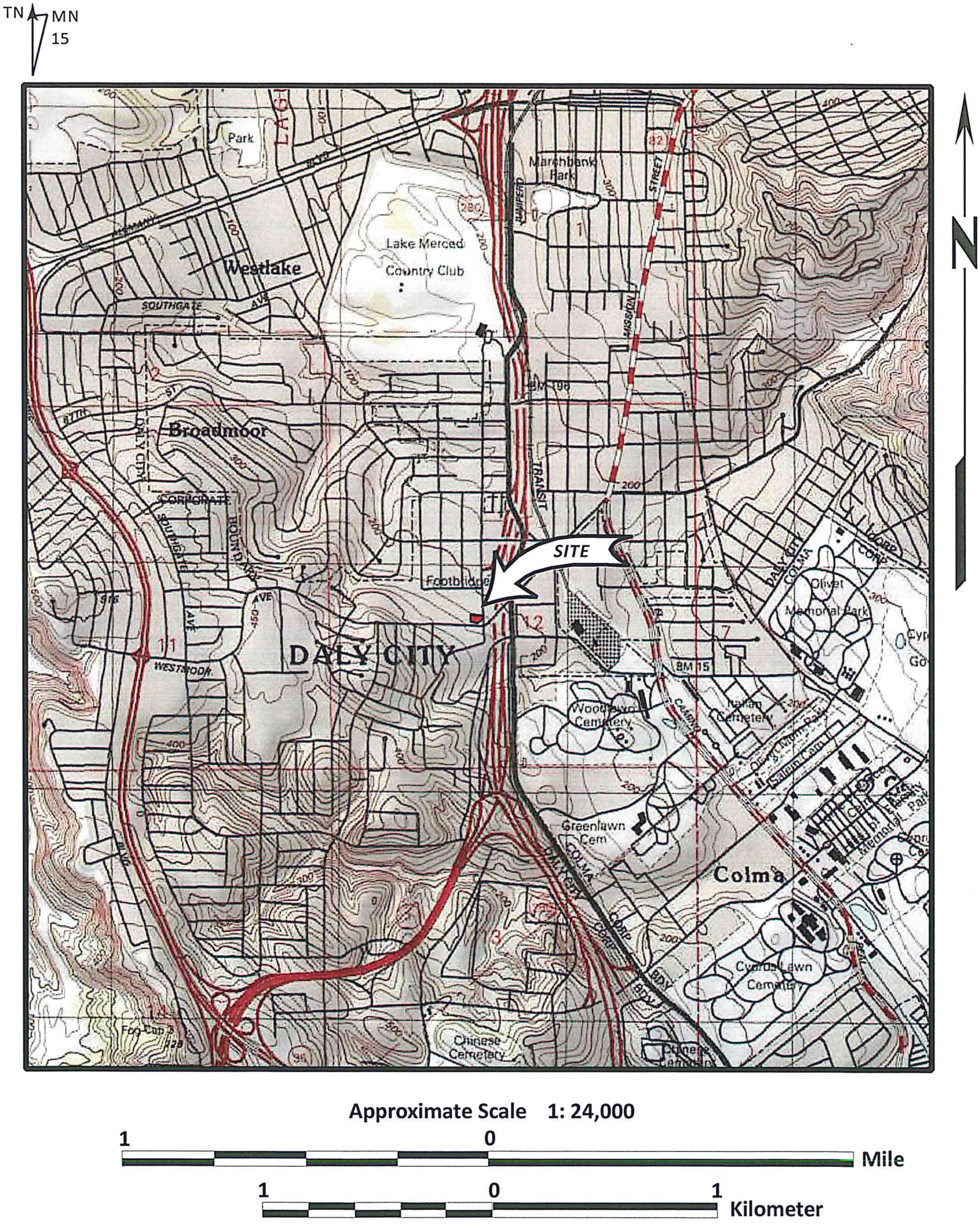
This document, the data, conclusions, and recommendations contained herein are the property of Earth Systems. This report should be used in its entirety, with no individual sections reproduced or used out of context. Copies may be made only by Earth Systems, the client, and his authorized agents for use exclusively on the subject project. Any other use is subject to federal copyright laws and the written approval of Earth Systems.

Thank you for this opportunity to have been of service. Please feel free to contact this office at your convenience if you have any questions regarding this report.

# APPENDIX A

Figures, September 2014 Investigation

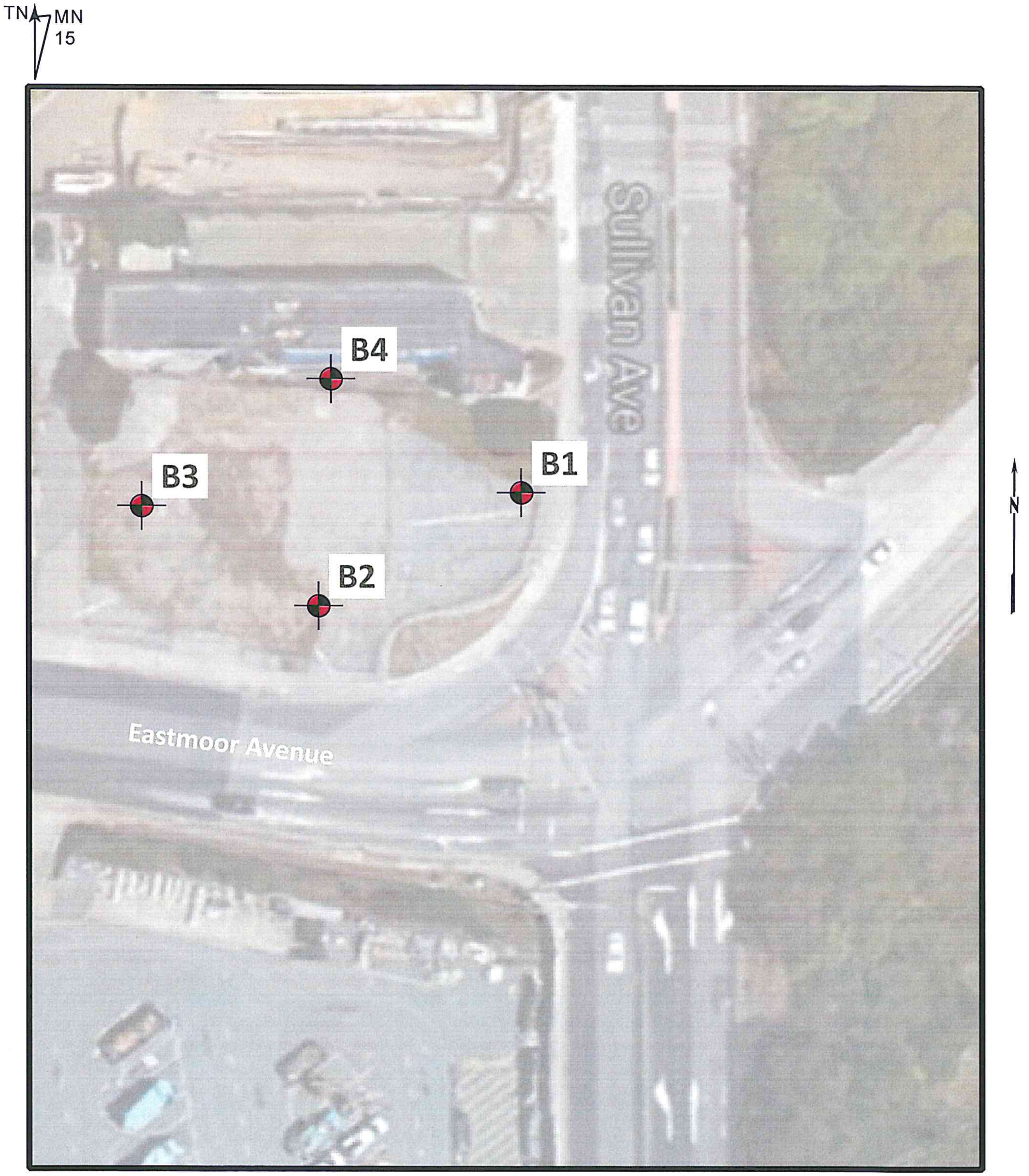
*Figure 1*



Map created with Topo!™ © 2003 National Geographic (www.nationalgeographic.cm/topo)

| Earth Systems Pacific | Eastmoor Avenue Townhouse Development<br>493 Eastmoor Avenue<br>Daly City, California | Site Location Map<br>SH-12820-SA |
|---|---|---|

*Figure 2*



Base: Google Map 2015

**B4** Approximate boring location

| Earth Systems Pacific | Eastmoor Avenue Townhouse Devt<br>493 Eastmoor Avenue<br>Daly City, California | **Boring Location Map**<br>**SH-12820-SA** |
|---|---|---|

**Earth Systems Pacific**

# Boring No. 1

PAGE 1 OF 2

LOGGED BY: GW
DRILL RIG: Mobile B-53
AUGER TYPE: 8" Hollow Stem Auger

JOB NO.: SH-12820-SA
DATE: 07/27/15

## EASTMOOR AVENUE TOWNHOUSE DEVELOPMENT
493 Eastmoor Avenue
Daly City, California

| DEPTH (feet) | USCS CLASS | SYMBOL | SOIL DESCRIPTION | SAMPLE DATA INTERVAL (feet) | SAMPLE TYPE | DRY DENSITY (pcf) | MOISTURE (%) | BLOWS PER 6 IN. |
|---|---|---|---|---|---|---|---|---|
| 0 | | | 8" AC + 6" AB | | | | | |
| 1 | SM | | | 1.0 - 2.5 | ■ | 106.7 | 11.2 | 7<br>8<br>11 |
| 2 | | | SILTY SAND: medium dense, green to gray, moist<br>-black | | | | | |
| 4 | | | | 4.0 - 5.5 | ■ | 117.9 | 12.1 | 5<br>5<br>6 |
| 5 | | | -dark brown, loose | | | | | |
| 8 | | | -greenish gray, medium dense | 8.0 - 9.5 | ■ | 106.8 | 11.8 | 9<br>11<br>12 |
| 9 | | | -smell of hydrocarbons | | | | | |
| 12 | | | | 12.0 - 13.5 | ■ | 104.9 | 14.8 | 9<br>11<br>10 |
| 16 | | | | 16.0 - 17.5 | ■ | 104.2 | 15.3 | 6<br>9<br>10 |
| 19 | | | -brown | | | | | |
| 20 | | | -smell of hyrdocarbons, very dense | 20.0 - 21.5 | ■ | 109.5 | 15.6 | 16<br>50/5.5" |
| 25 | | | -medium dense | 25.0 - 26.5 | ● | | | 10<br>12<br>13 |

LEGEND: ■ Ring Sample ○ Grab Sample ▭ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

## Boring No. 1

LOGGED BY: GW
DRILL RIG: Mobile B-53
AUGER TYPE: 8" Hollow Stem Auger

PAGE 2 OF 2
JOB NO.: SH-12820-SA
DATE: 7/27/15

### EASTMOOR AVENUE TOWNHOUSE DEVELOPMENT

493 Eastmoor Avenue
Daly City, California

| DEPTH (feet) | USCS CLASS | SYMBOL | SOIL DESCRIPTION | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | INTERVAL (feet) | SAMPLE TYPE | DRY DENSITY (pcf) | MOISTURE (%) | BLOWS PER 6 IN. |
| 27 | SM | ▨ | SILTY SAND: as above | | | | | |
| 28 | | ▨ | | | | | | |
| 29 | | ▨ | | | | | | |
| 30 | | ▨ | -very dense | 30.0 - 31.5 | ● | | | 14<br>24<br>37 |
| 31 | | ▨ | | | | | | |
| 32 | | | End of Boring @ 31.5 feet<br>No subsurface water encountered | | | | | |
| 33 | | | | | | | | |
| 34 | | | | | | | | |
| 35 | | | | | | | | |
| 36 | | | | | | | | |
| 37 | | | | | | | | |
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| 41 | | | | | | | | |
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| 52 | | | | | | | | |
| 53 | | | | | | | | |

LEGEND: ▬ Ring Sample ○ Grab Sample ☐ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

**Earth Systems Pacific**

# Boring No. 2

LOGGED BY: GW
DRILL RIG: Mobile B-53
AUGER TYPE: 8" Hollow Stem Auger

PAGE 1 OF 2
JOB NO.: SH-12820-SA
DATE: 07/27/15

## EASTMOOR AVENUE TOWNHOUSE DEVELOPMENT

**493 Eastmoor Avenue**
**Daly City, California**

| DEPTH (feet) | USCS CLASS | SYMBOL | SOIL DESCRIPTION | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | INTERVAL (feet) | SAMPLE TYPE | DRY DENSITY (pcf) | MOISTURE (%) | BLOWS PER 6 IN. |
| 0 | | ■ | 8" AC + 6" AB | | | | | |
| 1 | GM | ⁘ | | | | | | |
| 2 | | | SILTY GRAVEL WITH SAND: dense, brown and gray, slightly moist [FILL] | 2.0 - 3.5 | ■ | 92.5 | 8.0 | 26<br>27<br>31 |
| 6 | | | -loose [ϕ=22°, c=2,587 psf] | 6.0 - 7.5 | ■ | 110.4 | 9.7 | 5<br>7<br>9 |
| 8.5 | SM | ⁞ | SILTY SAND: medium dense gray, very moist | | | | | |
| 10 | | | [LL=21; PI=4] | 10.0 - 11.5 | ■ | 100.4 | 13.8 | 7<br>10<br>12 |
| 10.5 | | | -smell of hydrocarbons | | | | | |
| 13.5 | | | -brown, some clay, less smell of hydrocarbons | 13.5 - 15.0 | ■ | 112.8 | 18.7 | 10<br>13<br>17 |
| 18.5 | | | | 18.5 - 20.0 | ■ | 114.8 | 17.7 | 11<br>13<br>17 |
| 19.5 | | | -smell of hydrocarbons, green gray with black marks | | | | | |
| 21.5 | | | -strong smell of hydrocarbons | | | | | |
| 23.5 | | | -green gray, very dense | 23.5 - 24.5 | ■ | 115.2 | 14.4 | 18<br>50/6 |
| 26 | | | | | | | | |

LEGEND: ■ Ring Sample ○ Grab Sample ▭ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

## Boring No. 2

PAGE 2 OF 2
LOGGED BY: GW
DRILL RIG: Mobile B-53
AUGER TYPE: 8" Hollow Stem Auger
JOB NO.: SH-12820-SA
DATE: 7/27/15

### EASTMOOR AVENUE TOWNHOUSE DEVELOPMENT
**493 Eastmoor Avenue**
**Daly City, California**

| DEPTH (feet) | USCS CLASS | SYMBOL | SOIL DESCRIPTION | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | INTERVAL (feet) | SAMPLE TYPE | DRY DENSITY (pcf) | MOISTURE (%) | BLOWS PER 6 IN. |
| 27 | SM | | SILTY SAND: as above | | | | | |
| 28 | | | | 28.5 - 30.0 | ● | | | 9<br>11<br>14 |
| 29 | | | -mottled brown and gray, medium dense, strong smell of hydrocarbons | | | | | |
| 30 | | | | | | | | |
| 31 | | | | | | | | |
| 32 | | | | | | | | |
| 33 | | | | 33.5 - 35.0 | ● | | | 24<br>29<br>36 |
| 34 | | | very dense, brown, no significant smell | | | | | |
| 35 | | | | | | | | |
| 36 | | | | | | | | |
| 37 | | | | | | | | |
| 38 | | | | 38.5 - 40.0 | ● | | | 18<br>24<br>40 |
| 39 | | | | | | | | |
| 40 | | | End of Boring @ 40.0 feet<br>No subsurface water encountered | | | | | |
| 41 | | | | | | | | |
| 42 | | | | | | | | |
| 43 | | | | | | | | |
| 44 | | | | | | | | |
| 45 | | | | | | | | |
| 46 | | | | | | | | |
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LEGEND: ▬ Ring Sample ○ Grab Sample ▭ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

**Earth Systems Pacific**

LOGGED BY: GW
DRILL RIG: Mobile B-53
AUGER TYPE: 8" Hollow Stem Auger

## Boring No. 3

PAGE 1 OF 2
JOB NO.: SH-12820-SA
DATE: 07/27/15

### EASTMOOR AVENUE TOWNHOUSE DEVELOPMENT

**493 Eastmoor Avenue**
**Daly City, California**

| DEPTH (feet) | USCS CLASS | SYMBOL | SOIL DESCRIPTION | INTERVAL (feet) | SAMPLE TYPE | DRY DENSITY (pcf) | MOISTURE (%) | BLOWS PER 6 IN. |
|---|---|---|---|---|---|---|---|---|
| 0 | GM | | SILTY GRAVEL WITH SAND: brown and gray, medium dense, slightly moist, medium angular gravel [FILL] | | | | | |
| 1 | | | | 1.0 - 2.5 | ▬ | 114.7 | 6.4 | 14<br>14<br>15 |
| 3 | | | | 3.0 - 4.5 | ▬ | 100.3 | 7.7 | 13<br>16<br>21 |
| 4 | GM<br>-SM | | SILTY SANDY GRAVEL: gray and brown, medium dense, slightly moist | | | | | |
| 7 | | | | 7.0 - 8.5 | ▬ | 102.7 | 8.2 | 12<br>14<br>15 |
| 11 | | | [ϕ=48°, c=677 psf] | 11.0 - 12.5 | ▬ | 99.7 | 7.1 | 8<br>11<br>16 |
| 15 | | | | 15.0 - 16.5 | ▬ | 103.4 | 5.4 | 6<br>7<br>7 |
| 16 | GM | | SILTY GRAVEL: mottled gray, brown and black, loose, subrounded medium gravel, smell of hydrocarbons, moist | | | | | |
| 19 | SM | | SILTY SAND: green gray, medium dense, very moist, very strong smell of hydrocarbons | | | | | |
| 20 | | | | 20.0 - 21.5 | ▬ | 120.1 | 15.4 | 12<br>23<br>29 |
| 24 | | | -orange brown, no significant smell | | | | | |
| 25 | | | | 25.0 - 26.5 | ▬ | | | 12<br>14<br>18 |
| 26 | | | | | | | | |

LEGEND: ▬ Ring Sample ○ Grab Sample ▭ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

# Boring No. 3

PAGE 2 OF 2

LOGGED BY: GW
DRILL RIG: Mobile B-53
AUGER TYPE: 8" Hollow Stem Auger

JOB NO.: SH-12820-SA
DATE: 7/27/15

**EASTMOOR AVENUE TOWNHOUSE DEVELOPMENT**
**493 Eastmoor Avenue**
**Daly City, California**

| DEPTH (feet) | USCS CLASS | SYMBOL | SOIL DESCRIPTION | INTERVAL (feet) | SAMPLE TYPE | DRY DENSITY (pcf) | MOISTURE (%) | BLOWS PER 6 IN. |
|---|---|---|---|---|---|---|---|---|
| 27 | SM | ▨ | SILTY SAND: as above | | | | | |
| 28 | | | | | | | | |
| 29 | | | | | | | | |
| 30 | | | | 30.0 - 31.5 | ● | | | 14<br>14<br>17 |
| 31 | | | | | | | | |
| 31.5 | | | End of Boring @ 31.5 feet<br>No subsurface water encountered | | | | | |
| 32 | | | | | | | | |
| 33 | | | | | | | | |
| 34 | | | | | | | | |
| 35 | | | | | | | | |
| 36 | | | | | | | | |
| 37 | | | | | | | | |
| 38 | | | | | | | | |
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| 40 | | | | | | | | |
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| 52 | | | | | | | | |
| 53 | | | | | | | | |

LEGEND: ▬ Ring Sample ○ Grab Sample ▭ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

**Earth Systems Pacific**

# Boring No. 4

PAGE 1 OF 2

LOGGED BY: GW
DRILL RIG: Mobile B-53
AUGER TYPE: 8" Hollow Stem Auger

JOB NO.: SH-12820-SA
DATE: 07/27/15

**EASTMOOR AVENUE TOWNHOUSE DEVELOPMENT**
**493 Eastmoor Avenue**
**Daly City, California**

| DEPTH (feet) | USCS CLASS | SYMBOL | SOIL DESCRIPTION | INTERVAL (feet) | SAMPLE TYPE | DRY DENSITY (pcf) | MOISTURE (%) | BLOWS PER 6 IN. |
|---|---|---|---|---|---|---|---|---|
| 0 | GM | | SILTY GRAVEL WITH SAND: gray brown, dense, slightly moist [FILL] | 1.0 - 2.5 | ■ | 103.6 | 3.7 | 13<br>20<br>24 |
| 2 | SP | | POORLY GRADED SAND: yellow brown, dense, very moist [FILL} | | | | | |
| 4 | SM | | SILTY SAND: black, loose, very moist | 5.0 - 6.5 | ■ | 104.7 | 13.3 | 5<br>7<br>8 |
| 6 | | | -strong smell of hydrocarbons | | | | | |
| 9 | | | | 9.0 - 10.5 | ■ | 119.9 | 13.0 | 6<br>7<br>7 |
| 12 | | | -trapped water | | | | | |
| 13 | | | -green gray, medium dense, smell of hydrocarbons | 13.0 - 14.5 | ■ | 103.0 | 10.3 | 7<br>12<br>19 |
| 18.5 | SC | | CLAYEY SAND: orange brown, medium dense, very moist, no significant smell | 18.5-20.0 | ■ | 117.7 | 18.2 | 16<br>20<br>29 |
| 23.5 | | | -decreasing clay, dense | 23.5-25.0 | ■ | 137.1 | 13.9 | 17<br>24<br>30 |
| 25 | SW | | WELL GRADED SAND: brown, dense, very moist | | | | | |

LEGEND: ■ Ring Sample ○ Grab Sample ☐ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

**Earth Systems Pacific**

# Boring No. 4

PAGE 2 OF 2
JOB NO.: SH-12820-SA
DATE: 7/27/15

LOGGED BY: GW
DRILL RIG: Mobile B-53
AUGER TYPE: 8" Hollow Stem Auger

## EASTMOOR AVENUE TOWNHOUSE DEVELOPMENT

493 Eastmoor Avenue
Daly City, California

| DEPTH (feet) | USCS CLASS | SYMBOL | SOIL DESCRIPTION | SAMPLE DATA | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | INTERVAL (feet) | SAMPLE TYPE | DRY DENSITY (pcf) | MOISTURE (%) | BLOWS PER 6 IN. |
| 27 | SW | ░ | WELL GRADED SAND: as above | | | | | |
| 28 | | ░ | | | | | | 6 |
| - | | ░ | | 28.5 - 30.0 | ● | | | 7 |
| 29 | | ░ | | | | | | 9 |
| - | | ░ | -medium dense | | | | | |
| 30 | | ░ | | | | | | |
| 31 | | ░ | | | | | | |
| 32 | | ░ | | | | | | |
| 33 | | ░ | | | | | | 14 |
| - | | ░ | | 33.5 - 35.0 | ● | | | 17 |
| 34 | | ░ | | | | | | 22 |
| - | | ░ | -dense | | | | | |
| 35 | | ░ | | | | | | |
| 36 | | ░ | | | | | | |
| 37 | | ░ | | | | | | |
| 38 | | ░ | | | | | | 15 |
| - | | ░ | | 38.5 - 40.0 | ● | | | 22 |
| 39 | | ░ | | | | | | 27 |
| 40 | | | | | | | | |
| - | | | End of Boring @ 40.0 feet<br>No subsurface water encountered | | | | | |
| 41 | | | | | | | | |
| 42 | | | | | | | | |
| 43 | | | | | | | | |
| 44 | | | | | | | | |
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| 52 | | | | | | | | |
| 53 | | | | | | | | |

LEGEND: ▬ Ring Sample ○ Grab Sample ☐ Shelby Tube Sample ● SPT

NOTE: This log of subsurface conditions is a simplification of actual conditions encountered. It applies at the location and time of drilling. Subsurface conditions may differ at other locations and times.

Eastmoor Avenue
Townhouse Development

SH-12820-SA

## BULK DENSITY TEST RESULTS

**ASTM D 2937-00 (modified for ring liners)**

August 19, 2015

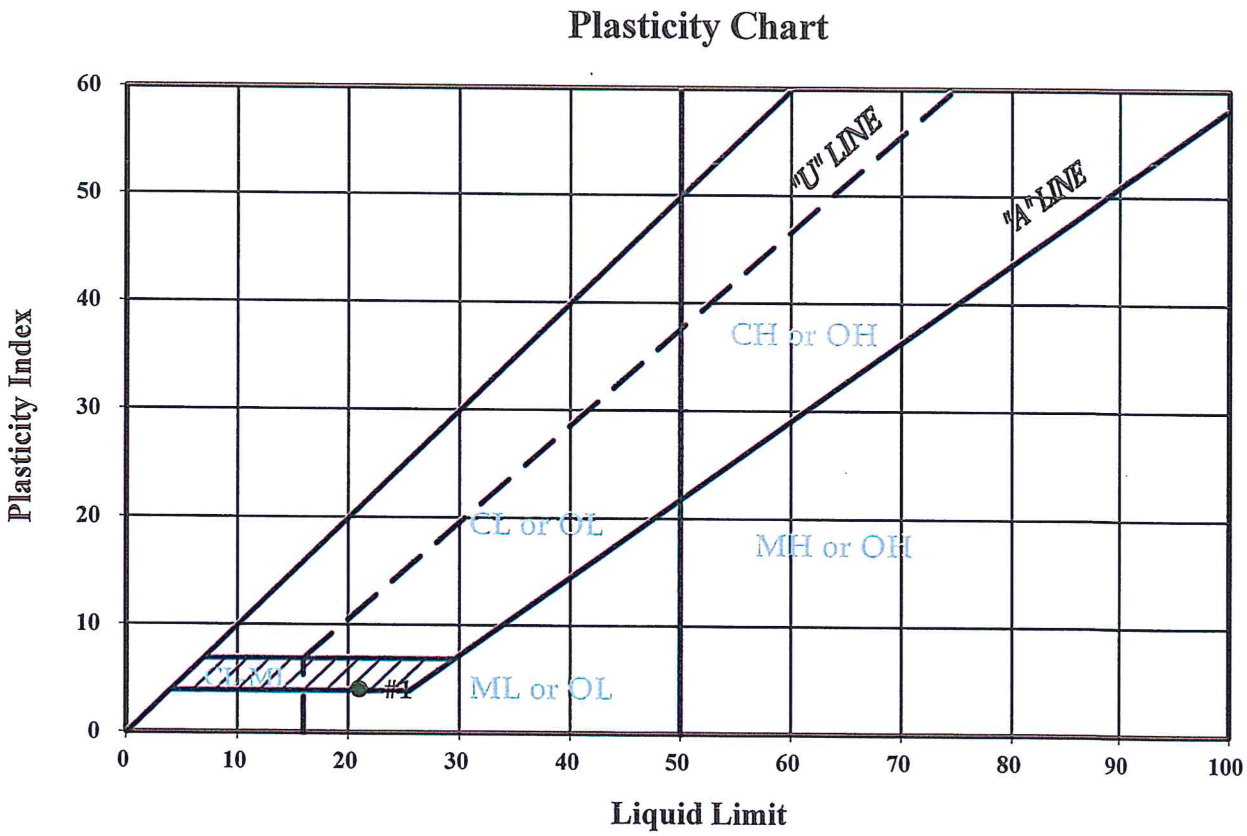
| BORING NO. | DEPTH feet | MOISTURE CONTENT, % | WET DENSITY, pcf | DRY DENSITY, pcf |
|---|---|---|---|---|
| B1-2 | 4.5 - 5.0 | 12.1 | 132.2 | 117.9 |
| B1-6 | 20.5 - 21.0 | 15.6 | 126.6 | 109.5 |
| | | | | |
| B2-4 | 14.5 - 15.0 | 18.7 | 133.9 | 112.8 |
| B2-5 | 19.5 - 20.0 | 17.7 | 135.2 | 114.8 |
| B2-6 | 24.0 - 24.5 | 14.4 | 131.8 | 115.2 |
| | | | | |
| B3-1 | 2.0 - 2.5 | 6.4 | 122.0 | 114.7 |
| B3-5 | 16.0 - 16.5 | 5.4 | 109.0 | 103.4 |
| B3-6 | 21.0 - 21.5 | 15.4 | 138.5 | 120.1 |
| | | | | |
| B4-1 | 1.5 - 2.0 | 3.7 | 107.4 | 103.6 |
| B4-3 | 9.5 - 10.0 | 13.0 | 135.5 | 119.9 |
| B4-5 | 19.5 - 20.0 | 18.2 | 132.0 | 111.7 |
| B4-6 | 24.0 - 24.5 | 13.9 | 156.2 | 137.1 |

## PLASTICITY INDEX

**ASTM D 4318-05**

August 19, 2015

| **Test No.:** | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Boring No.:** | B2 | | | | |
| **Sample Depth:** | 10.5 - 11.0' | | | | |
| **Liquid Limit:** | 21 | | | | |
| **Plastic Limit:** | 17 | | | | |
| **Plasticity Index:** | 4 | | | | |



Eastmoor Avenue Townhouse Development
0.0

SH-12820-SA

## DIRECT SHEAR

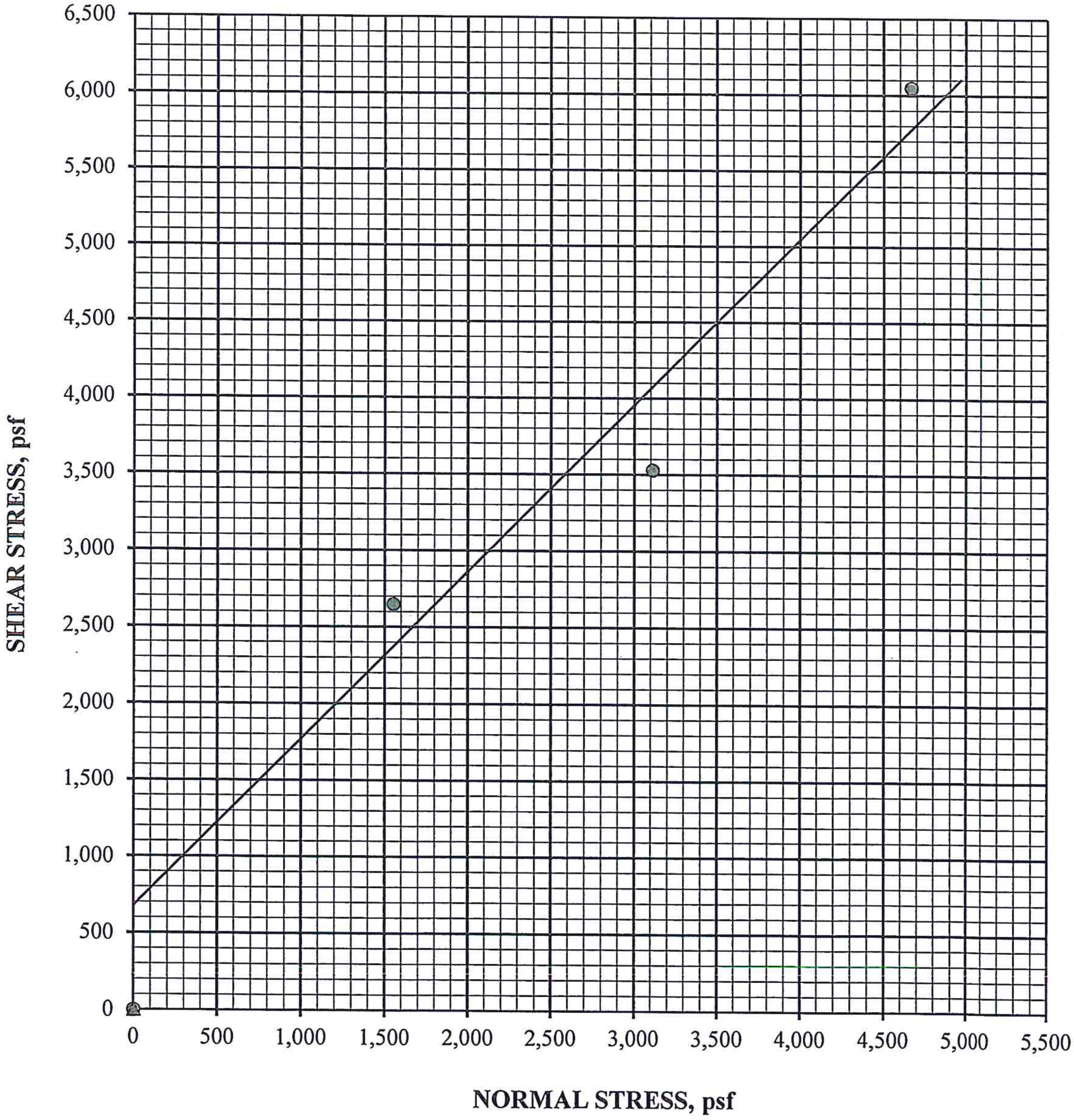
**ASTM D 3080-98 (modified for unconsolidated, undrained conditions)**

August 19, 2015

Boring #3; S-4 @ 11.5 - 12.0'
Silty Sandy Gravel (GM-SM)

INITIAL DRY DENSITY: 116.5 pcf
INITIAL MOISTURE CONTENT: 9.3 %
PEAK SHEAR ANGLE (Ø): 48°
COHESION (C): 677 psf

### SHEAR STRESS vs. NORMAL STRESS



## DIRECT SHEAR continued

ASTM D 3080-98 (modified for unconsolidated, undrained conditions)

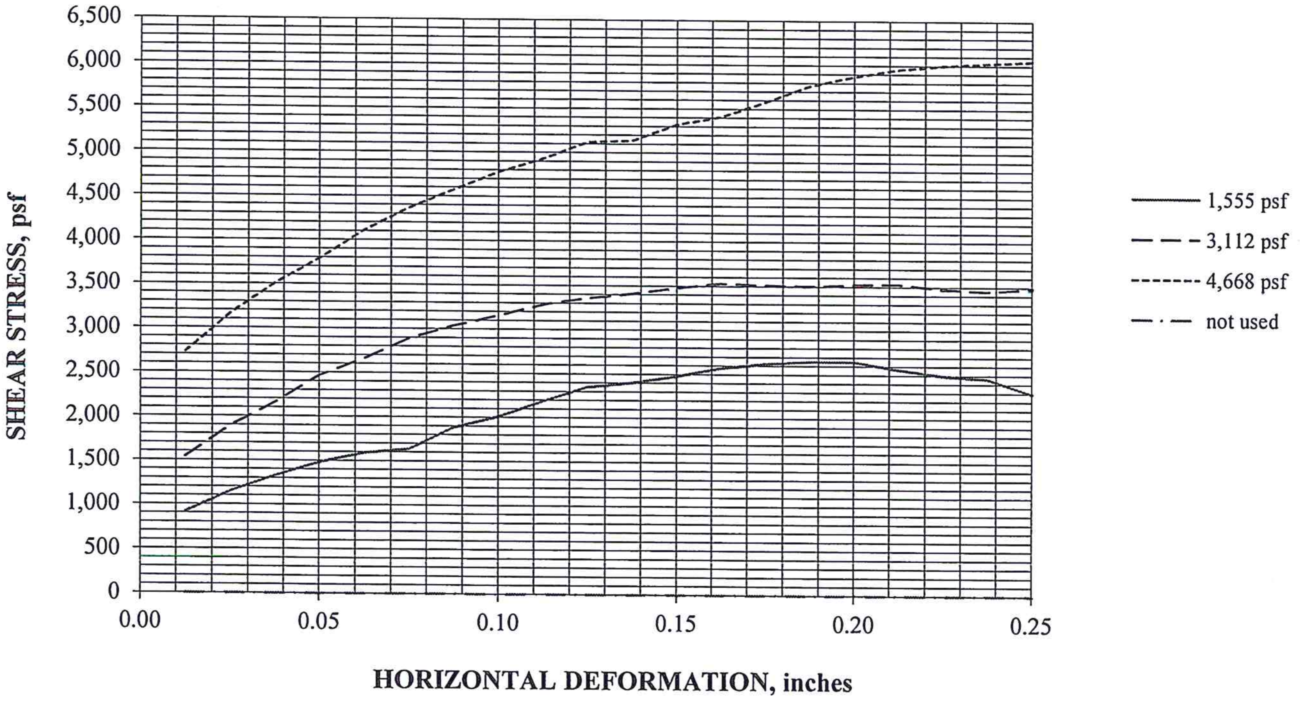
Boring #3; S-4 @ 11.5 - 12.0'
Silty Sandy Gravel (GM-SM)

August 19, 2015

0

SPECIFIC GRAVITY: 2.65 (assumed)

| SAMPLE NO.: | 1 | 2 | 3 | AVERAGE |
|---|---|---|---|---|
| **INITIAL** | | | | |
| WATER CONTENT, % | 9.3 | 9.3 | 9.3 | 9.3 |
| DRY DENSITY, pcf | 118.9 | 114.5 | 116.1 | 116.5 |
| SATURATION, % | 63.2 | 55.5 | 58.1 | 58.9 |
| VOID RATIO | 0.390 | 0.444 | 0.424 | 0.420 |
| DIAMETER, inches | 1.910 | 1.910 | 1.910 | |
| HEIGHT, inches | 1.00 | 1.00 | 1.00 | |
| **AT TEST** | | | | |
| WATER CONTENT, % | 10.3 | 11.4 | 12.5 | |
| DRY DENSITY, pcf | 123.6 | 125.4 | 128.6 | |
| SATURATION, % | 81.1 | 95.1 | 100.0 | |
| VOID RATIO | 0.337 | 0.319 | 0.286 | |
| HEIGHT, inches | 1.00 | 1.00 | 1.00 | |



Eastmoor Avenue Townhouse Development
0.0

SH-12820-SA

## DIRECT SHEAR

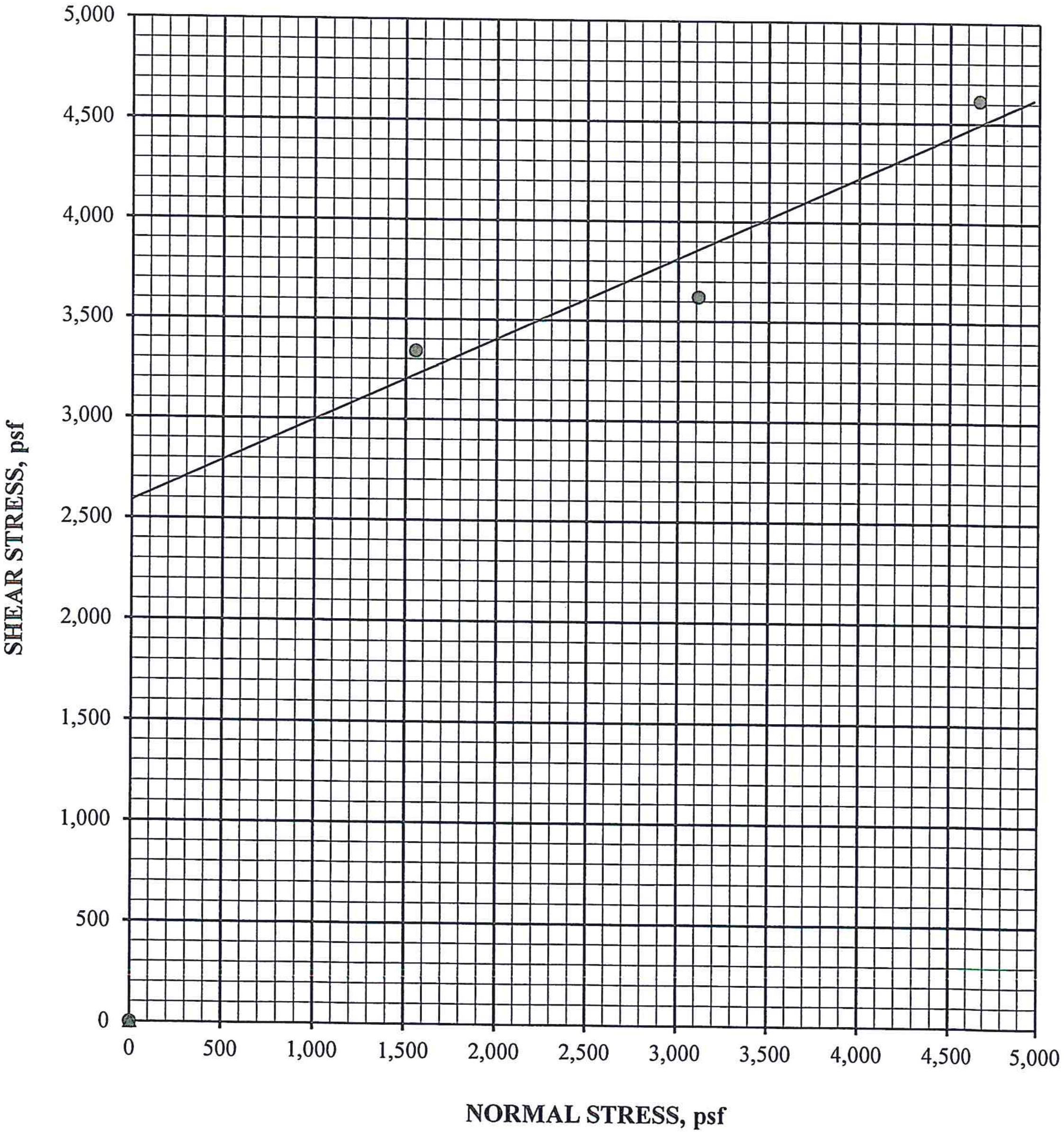
**ASTM D 3080-98 (modified for unconsolidated, undrained conditions)**

August 19, 2015

Boring #2; S-2 @ 6.5 - 7.0'
Brown Silty GRAVEL with sand (GM)
Undisturbed, Saturated

INITIAL DRY DENSITY: 117.6 pcf
INITIAL MOISTURE CONTENT: 12.7 %
PEAK SHEAR ANGLE (Ø): 22°
COHESION (C): 2,587 psf

### SHEAR STRESS vs. NORMAL STRESS



## DIRECT SHEAR continued

ASTM D 3080-98 (modified for unconsolidated, undrained conditions)

Boring #2; S-2 @ 6.5 - 7.0'

Brown Silty GRAVEL with sand (GM)

August 19, 2015

Undisturbed, Saturated

SPECIFIC GRAVITY: 2.65 (assumed)

| **SAMPLE NO.:** | **1** | **2** | **3** | **AVERAGE** |
|---|---|---|---|---|
| **INITIAL** | | | | |
| WATER CONTENT, % | 12.7 | 12.7 | 12.7 | 12.7 |
| DRY DENSITY, pcf | 119.9 | 120.8 | 112.1 | 117.6 |
| SATURATION, % | 88.6 | 91.2 | 70.9 | 83.6 |
| VOID RATIO | 0.380 | 0.369 | 0.475 | 0.408 |
| DIAMETER, inches | 1.910 | 1.910 | 1.910 | |
| HEIGHT, inches | 1.00 | 1.00 | 1.00 | |
| **AT TEST** | | | | |
| WATER CONTENT, % | 13.2 | 12.7 | 13.6 | |
| DRY DENSITY, pcf | 124.6 | 132.3 | 124.2 | |
| SATURATION, % | 100.0 | 100.0 | 100.0 | |
| VOID RATIO | 0.327 | 0.250 | 0.332 | |
| HEIGHT, inches | 1.00 | 1.00 | 1.00 | |