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August 9, 2024
Project 1323-9

FRASER DEVELOPMENT
43264 Christy Street
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Attention: Dave Atwal

Gentlemen:

Preliminary Report
Proposed Panorama Heights Development
Tract 8057, Fairview Garden
Hayward, California

Introduction

As requested, we have completed a preliminary geotechnical investigation at the site for the proposed Panorama Heights Development. The undeveloped parcel of land is located on the north side Fairview Avenue between an unimproved gravel road to the east and a private driveway to the west and extends from Fairview Avenue northwesterly past the terminus of Karina Court in an unincorporated area in Alameda near the city of Hayward, California. The general location is shown on the attached Vicinity Map, Figure 1.

This report provides design and construction information for the proposed improvements for the subdivision. We understand that each lot in the proposed subdivision will have their individual soil investigation for the individual lot improvement

Background

The property is to be developed into a residential subdivision consisting of 28 homes and other improvements. The topography of the property requires a major earthwork and grading to achieve design grades in addition to the construction of soil retaining structures. The subsurface conditions at property for the proposed subdivision had been investigated by Berlogar, Stevens & Associates (BSA) and submitted a draft report dated November 12, 2018. The report was prepared for another subdivision titled HL Fairview Garden, Tracts 7921 and 8057

Proposed Construction

The property is to be subdivided into 29 individual homesites. Site development will involve a substantial amount of grading including excavations and placement of fill for the proposed access roads and the proposed building pads. Retaining walls will be constructed as part of the site grading. Site drainage including the provisions of subsurface drains will be done as part of the site grading and retaining wall construction.

Information Provided

We were provided with digital copies of the Panorama Heights Illustrative Site Plan prepared by Ruggeri-Jensen-Azar and dated June 12, 2024. A copy of the illustrative site plan was used to prepare our Site Plan, Figure 2. In addition to showing the layout of the proposed subdivision, Figure 2 also shows the approximate location of the exploratory holes we excavated as part of this soil study.

Scope of Work

Our scope of was to evaluate the current site conditions (both surface and subsurface) from a geotechnical engineering viewpoint and to develop information for the design and construction of the proposed infrastructures and other geotechnically related portions of the proposed development. Our scope of work included providing information on earthwork, site grading and compaction. We should note that our scope of work did not include or cover any environmental evaluations or chemical analyses of the site soils. Specifically, we performed the following work:

1. Made site reconnaissance visits to evaluate the current conditions at the property and plan the field exploration program.

2. Reviewed available seismic and geologic maps pertaining to the subject property and adjacent development.

3. Review in-house files for projects we have completed in the vicinity of the subject property. Particularly, we reviewed our files for the work we have completed on the adjacent subdivision (Tract 6102) at Jelincic Drive.

4. Explored the subsurface soils in the area of the proposed development by means of four small diameter exploratory holes using a truck-mounted drill rig with an auger attachment to a maximum depth of 6.5 feet below the ground surface. The field exploration was supervised by an engineer on staff who logged the materials exposed during the field exploration and collected samples for laboratory testing.

5. Performed pertinent laboratory testing on selected samples obtained from the field exploratory work to evaluate their index and mechanical properties.

6. Collated and analyzed the field and laboratory data obtained to develop geotechnical recommendations for site preparation, grading and compaction; provided parameters for the design and construction of the proposed building foundations, concrete slabs-on-grade, site retaining walls, utility trench backfilling and site drainage.

7. Developed information for the design of the pavement section for the proposed roadways based on the site soils and projected traffic indices.

8. Summarized our findings, conclusions and recommendations in this written report.

Findings

Surface Conditions

The ground surface at the property is located on a southwest facing hill with variable gradients. The ground surface slopes are uniform indicating that there is no ground surface movement or the presence of any surficial movements in the near surface soils. A single family residential building is located in the southwestern area. Except for that, the ground surface at the time of the field exploration was covered by some brush, seasonal grass and a couple of small trees. The average ground surface elevation is about 624 feet above the Mean Sea Level.

Subsurface Conditions

The descriptions of the subsurface conditions given below pertain only to the subsurface conditions found at the site at the time of our field exploration on July 16, 2024. Subsurface conditions, particularly, groundwater levels and the consistency of the near-surface soils will vary with the seasons.

Subsurface soils at the site were explored by means of four small diameter exploratory holes using a truck-mounted drill rig with an auger attachment. Samples were obtained by driving down a sampler using a 140-pound hammer. The hammer was dropped freely a distance of 30 inches to drive the sampler a distance of 18 inches into “undisturbed” soil. The number of blows required (unless otherwise stated) to drive the sampler the last 12 inches into the soil is shown on the attached boring logs.

In general, the exploratory holes encountered colluvium underlain by bedrock at shallow depths. The near surface soils consist of medium brown to light yellowish brown clayey sand that is damp and medium dense. Bedrock consisting of dense sandstone was encountered below the clayey sand. No free groundwater was encountered in any of the exploratory holes. We should note that the depth to groundwater is expected to fluctuate with time and the seasons.

Detailed descriptions of the materials encountered in the borings are shown on the attached boring logs together with the results of some of the laboratory tests performed on selected samples obtained from the exploratory holes.

Seismic Considerations

This site is located within a seismically active region but outside of any area designated within the Alquist-Priolo Earthquake Fault Zones. A portion of the property in the northeast area, however, is mapped in area that is prone to seismically induced landslide.

Type A and Type B faults close to the site are listed in the following table.

TABLE 1 - TYPES A AND B FAULTS CLOSE TO THE SITE*

Fault	Type	Maximum Moment Magnitude	Slip Rate (mm/yr)	Distance (miles/km)
San Andreas (1906 Segment)	A	7.9	24	19.8/32
Hayward	A	7.1	9	1.6/2.5
Calaveras (North of Calaveras Reservoir)	B	6.8	6	6.2/10

*California Division of Mines & Geology

Seismic hazards can be divided into two general categories, hazards due to ground rupture and hazards due to ground shaking. The proximity of the site to the Hayward fault means the risk of earthquake-induced ground rupture occurring across the project site appears to be possible.

Should a major earthquake occur with an epicentral location close to the site, ground shaking at the site will undoubtedly be severe, as it will for other properties in the general area. Even under the influence of severe ground shaking, the soils that underlie the property are unlikely to liquefy due to the presence of bedrock at shallow depths.

The following general site seismic parameters may be used for design in accordance with the ASCE7-16/2022 California Building Code: Seismic Design Category (SDC) value: E

Site Class: C Site Coordinates; Latitude = 37.678467 degrees; Longitude = -122.041873 degrees; F_a = 1.2; F_v =1.4; S_S = 2.343; S_1 = 0.887

$S_{MS} = F_a S_s$ and $S_{M1} = F_v S_1$; For Site Class C with $F_a = 1.2$, and $F_v = 1.4$; Spectral Response Accelerations S_{MS} and S_{M1}

Period (sec)	Sa (g)
0.2	2.812 (S_{MS}, Site Class C)
1.0	1.242 (S_{M1}, Site Class C)

$S_{DS} = 2/3 \times S_{MS}$ and $S_{D1} = 2/3 \times S_{M1}$; For Site Class C with $F_a = 1.2$, and $F_v = 1.4$

Period (sec)	Sa (g)
0.2	1.874 (S_{DS}, Site Class C)
1.0	0.828 (S_{D1}, Site Class C)

Discussion

After review of the field and laboratory data obtained and after the review of the adjacent subdivision, we conclude that the subsurface materials encountered in the exploratory holes at the subject property are similar to the materials encountered at Tract 6102 Subdivision at Jelincic Drive. Typically, the materials encountered consist of shallow colluvium underlain by dense sandstone. The soil thickness varied between 1.5 feet and three feet. We did not observe any surface features at the property that could be suggestive of as landslide. The northeast area of the property that is mapped as an area prone to seismically induced landslide does not necessarily mean that the area is a landslide; however, during site grading, special attention to that area during site grading should be emphasized and addressed.

As with typical hillside development, slope stability should be of major concern. Slope instability is the result of movement within colluvial soils, creep and shallow landsliding within the surficial soils over bedrock. The other cause of slope instability is the uncontrolled flow of surface water (sheet flow) on the surface of the slope and subsurface water (seepage) within the slope. Therefore, the risk of future slope instability can be reduced by controlling both surface and subsurface water during and after construction by providing well designed and properly constructed surface and subsurface drainage system together with good grading practices during excavations and earthwork construction.

The lack of adequate drainage to collect both surface and subsurface water to suitable collection and discharge facilities can adversely affect slope stability in general. Properly designed and adequate drainage (surface and subsurface) system should be incorporated into the planned development. Runoff collected from roof drains and area drains as well as discharge from subdrains (when needed) should be released to appropriate locations away from the existing building foundations and pavement sites and to appropriate drainage facilities located at the property.

No excavations should be made at the property during a period of sustained precipitation. Effective drainage system should be provided as part of the new development. The lack of adequate drainage to collect both surface and subsurface water to suitable collection and discharge facilities can adversely affect slope stability in general and may enhance the flow of water into the crawl space area of the building. Therefore, proper and adequate drainage (surface and subsurface) system should be incorporated into the planned development. Runoff collected from roof drains and area drains as well as discharge from subdrains (when and where needed) should be released to appropriate locations away from critical areas of the property and or to appropriate drainage facilities located either on the property or away from the property.

Conclusion and Recommendations

Based on the site conditions and review of available information that is pertinent to the subject property, it is our opinion that the proposed development is feasible from a geotechnical engineering viewpoint.

The following recommendations, which are presented as guidelines to be used by project planners and designers, have been prepared assuming that FRIAR ASSOCIATES, INCORPORATED will be commissioned to review the grading and foundation plans prior to construction, and to observe and test during any site grading and foundation construction. This additional opportunity to inspect the project site will allow us to compare subsurface conditions exposed during construction with those that were observed during the site investigation.

Site Preparation, Grading and Compaction

The existing residential building and all the other accompanying improvements are to be demolished. Debris resulting from the demolition should be removed from the site and hauled off-site. All subsurface structures and the associated foundation elements of the existing structures to be demolished should be excavated out and hauled off site. Any loose soil that may exist around the building should be removed and replaced as structural fill.

Trees and shrubs that will not be part of the new construction and will be designated for removal on the project plans should be removed and their primary root system should be grubbed. The resulting depressions and cavities from these operations should be backfilled with structural fill.

Areas of the site that will be built on or paved should be stripped to remove surface vegetation and organic laden soil. Soils containing more than two percent by weight of organic matter should be considered organic.

Soil surfaces exposed after the removal of organic laden soil and loose fill should be scarified to a depth of 12 inches, conditioned with water (or allowed to dry, as necessary) to produce a soil water content of about three percent above the optimum water content and then compacted to at least 90 percent of the maximum dry density as determined by ASTM Test Method D1557-12. Structural fill may then be placed to the desired grade in the proposed building and pavement areas.

Structural fill may then be placed up to design grades in the proposed building and pavement areas. Structural fill using on-site inorganic soil, or approved import, should be placed in layers, each not exceeding eight inches thick (before compaction), conditioned with water (or allowed to dry, as necessary) to produce a soil water content of about three percent above the optimum value, and then compacted to 90 percent of the maximum dry density as determined by ASTM Test Method D1557-12.

Structural fill placed on sloping ground should be keyed in accordance with the CALTRANS STANDARD SPECIFICATIONS, latest edition. The following excerpt from subsection 19-6.01 of those specifications is pertinent:

> "When embankment is to be made and compacted on hillsides....the slopes of original hillsides....shall be cut into a minimum of six feet horizontally as the work is brought up in layers. Material thus cut out shall be compacted along with the new embankment material....."

The toe key for structural fill placed on sloping ground should be at least eight feet wide with its base horizontal or gently sloping back into the hillside. For fill slopes in colluvium, the keyway should penetrate a minimum of 24 inches into the site bedrock material.

Where moist soil is encountered, a drainage section should be provided on the uphill area of the keyway. The drainage section should consist of a six-inch diameter perforated pipe (holes down) covered by permeable rock conforming to CALTRANS Class 2 permeable material. The pipe should be provided a minimum gradient of one percent to promote gravity flow. In lieu of the CALTRANS permeable material, crushed rock encapsulated in a filter fabric may be used. Structural fill may then be placed by excavating benches into the slope as the fill is brought up.

On-site soils proposed for use as structural fill should be inorganic, free from deleterious materials, and should contain no more than 15% by weight of rocks larger than three inches (largest dimension) and no rocks larger than six inches. The suitability of existing fill soil for reuse as a structural fill should be determined by a member of our staff at the time of grading.

Where moist soil or water is encountered during the excavation of the keyways or benches, a subdrain consisting of crushed rock encapsulated in a filter fabric should be placed in the uphill side of the excavation. In lieu of the crushed rock encapsulated in a filter fabric, permeable rock complying with CLATRANS Class 2 Permeable rock may be used.

On-site soils proposed for use as structural fill should be inorganic, free from deleterious materials, and should contain no more than 15% by weight of rocks larger than three inches (largest dimension) and no rocks larger than six inches. The suitability of existing fill soil for reuse as a structural fill should be determined by a member of our staff at the time of grading.

If import soil is required for use as structural fill, it should be inorganic, should preferably have a low expansion potential and should be free from clods or rocks larger than four inches in largest dimension. Prior to delivery to the site, proposed import should be tested in our laboratory to verify its suitability for use as structural fill and, if found to be suitable, further tested to estimate the water content and density at which it should be placed.

Cut/Fill Slopes

The topography of the cut/fill areas will influence slope construction. In addition, the subsurface conditions (soil, rock, water) will also impact slope construction. Based on the material exposed during the site investigation, permanent cut and fill slopes should be constructed no steeper than 2horizontal:1vertical (2h:1v) in the site bedrock and competent material. Fill slopes in colluvial soils should be constructed no steeper than 2.5h:1vertical or conform to existing slopes, whichever is flatter. Where steeper slopes are required, these slopes should be supported by properly designed and constructed soil retaining structures.

Earth Pressures

Excavations deeper than five feet should be shored. Lateral pressures to be used will depend on whether the excavations will be temporary or permanent. In addition to the lateral earth pressures, lateral loads due to surcharge loads on adjacent ground should be considered during lateral load analyses. Appropriate lateral earth pressures are provided in a section below under “Retaining Walls.”

Foundation Design Criteria

We have assumed that the proposed buildings for the subdivision will be of wood frame construction. We recommend that the buildings be supported on pier and beam foundations. If site grading is done to create a level building pad for any of the newly created subdivided lots, the proposed building on that lot may be supported on structural slab foundation. For a cut/fill pad supported on a structural slab, the top three feet of the cut portion of the pad should be excavated out and replaced as structural fill.

Pier Foundations

The piers for the proposed buildings may be designed to derive their vertical support from "skin friction" or adhesion between the piers and the surrounding competent soil or bedrock material. The piers should be at least 16 inches in diameter and should extend to a depth of at least 12 feet below the rough pad grade. The piers should penetrate a minimum of eight feet into competent material or the site bedrock material. The project structural engineer should design the foundation piers using the design values provided below but the actual depth of the piers should be determined in the field based on soil conditions and during foundation construction.

The piers should be spaced at least three diameters apart (center to center) but no more than 10 feet apart. The allowable load-carrying capacity (dead plus normal live loads) of each pier may be calculated assuming "skin friction" or adhesion value of 600 pounds per square foot (psf) between the shaft of the pier and the adjacent competent material. No friction should be assumed in the upper three feet of embedment of the pier below the lowest adjacent grade or in any undocumented fill. "End bearing" of the piers should also be ignored in the design of the piers.

Reinforced concrete piers located in a sloping ground with a gradient of 5horizontal:1vertical or steeper should be designed to resist lateral loads resulting from potential creep of the surficial layer of fill/colluvium. A lateral soil pressure of at least 50 pounds per cubic foot acting over 2½ pier diameters may be assumed to act on the top four feet of the piers

The allowable lateral bearing pressure of the ground in front of the piers may be taken as 350 pounds per square foot per foot of depth below three feet over two pier diameters to a maximum value of 3500 psf.

Mat Foundations

For a structural slab, a modulus of vertical subgrade reaction K_{vi} = 150 tons per cubic foot. Resistance to lateral loads may be taken as 350 pounds per cubic foot or a friction factor of 0.4 in the bedrock. Unless the ground surface adjacent to the building foundations is paved, no passive resistance should be assumed in the top 12 inches of foundation soils. If both passive resistance and friction factors are used, the smaller value should be reduced by fifty percent.

Foundations for the proposed building loads may be designed to impose pressures on foundation soils up to 2000 pounds per square foot from dead plus normal live loading. The slabs should be at least nine inches in thickness and should be thickened at the edges to withstand lateral loads.

The allowable foundation pressures given previously may be increased by one-third when considering additional short-term wind or seismic loading.

During foundation construction, care should be taken to minimize evaporation of water from foundation and floor subgrade. Scheduling the construction sequence to minimize the time interval between foundation excavation and concrete placement is important. Concrete should be placed only in foundation excavations that have been kept moist, are free from drying cracks and contain no loose or soft soil or debris.

Concrete Slabs-on-Grade

Concrete floor slabs should be constructed on compacted soil subgrade prepared as described in the section under "Site Preparation, Grading and Compaction."

To minimize floor dampness at concrete slabs-on-grade, a section of capillary break material at least five inches thick and covered with a membrane vapor barrier should be placed between the floor slab and the compacted soil subgrade. This is particularly true for the proposed basement floor. The capillary break should be a free-draining material, such as 3/8" pea gravel or a permeable aggregate complying with CALTRANS Standard Specifications, Section 68, Class 1, Type A or Type B. The material proposed for use as a capillary break should be tested in our laboratory to verify its effectiveness as a capillary break. The membrane vapor barrier should be a high quality membrane. A protective cushion of sand or capillary break material at least two inches thick should be placed between the membrane vapor barrier and the floor slab.

If floor dampness is not objectionable, concrete slabs may be constructed over a minimum five-inch thick compacted aggregate base material placed over the water-conditioned and compacted soil subgrade.

Retaining Walls

Site retaining walls should be supported on pier foundation system using the pier design parameters provided above. Retaining walls that will be part of any of the proposed buildings should be waterproofed on the backfill side. Design information for proposed building retaining walls should be obtained from site specific lot geotechnical investigations. The following may be used in the design calculations for the site reinforced concrete retaining walls:

- The average bulk density of material placed on the backfill side of the wall will be 120 pcf.

- The vertical plane extending down from the ground surface to the bottom of the heel of the wall will be subject to pressure that increases linearly with depth as follows:

Condition	Design Pressure
Active, drained, level backfill	45 pcf
Active, drained, 2h:1v slope backfill	55 pcf
At-Rest, drained, 2h:1v slope backfill	80 pcf

The above values are for non-seismic conditions.

- The effects of earthquakes may be simulated by applying a horizontal line load surcharge to the stem of the wall (for house retaining walls) at a rate of $20H^2$ lb/horizontal foot of wall (based on a peak ground acceleration of 0.45g corresponding to a maximum credible earthquake at the site and the surrounding area), where H is the height of the surface of the backfill above the base of the wall. This surcharge should be applied at a height of 0.6H above the base of the wall.

- A coefficient of "friction" of 0.40 may be used to calculate the ultimate resistance to horizontal sliding of the wall base over the ground beneath the base.

- An equivalent fluid pressure of 350 psf/ft may be used to calculate the ultimate passive resistance to lateral movement of the ground in front of the toe of the wall and in front of any "key" beneath the toe or stem of the wall.

- 2500 psf may be used as the maximum allowable bearing pressure for the ground beneath the toe of the wall. This value is for non-seismic conditions and may be increased to 3325 psf when considering additional loads on the wall resulting from earthquakes.

A zone of drainage material at least 12 inches wide should be placed on the backfill side of walls designed for drained condition. This zone should extend up the back of the wall to about 12 inches down from the proposed ground surface above. The upper 12 inches or so of material above the drainage material should consist of native, clayey soil.

The drainage material and the clayey soil cap should be placed in layers about 6 inches thick and moderately compacted by hand-operated equipment to eliminate voids and to minimize post-construction settlement. Heavy compaction should not be applied; otherwise, the design pressure on the wall may be exceeded.

The drainage material should consist of either Class 2 Permeable Material complying with Section 68 of the CALTRANS Standard Specifications, latest edition, or 3/4 to 1½ inch clean, durable coarse aggregate. If the coarse aggregate is chosen as the drainage material, it should be separated from all adjacent soil by a filter fabric approved by the project Engineer.

The drainage material should consist of either Class 2 Permeable Material complying with Section 68 of the CALTRANS Standard Specifications, latest edition, or 3/4 to 1½ inch clean, durable coarse aggregate. If the coarse aggregate is chosen as the drainage material, it should be separated from all adjacent soil by a filter fabric approved by the project engineer or this office.

Any water that may accumulate in the drainage material should be collected and discharged by a 4-inch-diameter, perforated pipe placed "holes down" near the bottom of the drainage material. The perforated pipe should have holes no larger that 1/4-inch diameter.

Roadway Pavement

An R-value of 10 was assumed in pavement design calculations shown below for the proposed subdivision roadways. Since these roadways will be used as public streets, a minimum Traffic Index of 5.0 should be used for the design of roadway pavement section to accommodate garbage trucks and occasional fire trucks.

TABLE 2 - RECOMMENDED MINIMUM ASPHALT CONCRETE PAVEMENT SECTIONS

Traffic Index (T.I.)	Asphalt Concrete (inches)	Class 2 Aggregate Base (inches)	Total Thickness (inches)
4.5	2.5	9.0	11.5
5.0	3.0	9.0	12.0
5.5	3.5	10.0	13.5
6.0	4.0	11.0	15.0

Pavement subgrade should be compacted as described above in the section under "Site Preparation Grading and Compaction."

Curbs and gutters should be constructed directly on the soil subgrade rather than on a layer of aggregate base. This will minimize the amount of surface water that seeps below the curb and into the pavement subgrade. The seepage of water into subgrade soils beneath vehicle pavements, can result in subgrade softening and premature pavement distress.

Pavement construction should comply with the requirements of the CALTRANS Standard

Specifications, latest editions, except that compaction requirements for pavement soil subgrade and aggregate base should be based on ASTM Test D1557-12, as described in the part of this report dealing with "Site Preparation, Grading and Compaction."

Utility Trenches

All trenches and excavations five feet and deeper should be supported. A lateral active pressure of 45 pcf equivalent fluid pressure may be used for the design of shoring for temporary excavation. The attention of contractors, particularly the underground contractor, should be drawn to the requirements of California Code of Regulations, Title 8, Construction Code Section 1540 regarding Safety Orders for "Excavations, Trenches, Earthwork."

For purposes of this section of the report, bedding is defined as material placed in a trench up to one foot above a utility pipe and backfill is all material placed in the trench above the bedding. Unless concrete bedding is required around utility pipes, free-draining sand should be used as bedding. Sand proposed for use in bedding should be tested in our laboratory to verify its suitability and to measure its compaction characteristics. Sand bedding should be compacted by mechanical means to achieve at least 90 percent compaction density based on ASTM Test Method D1557-12

Approved, on-site, inorganic soil, less expansive soil, or imported material may be used as utility trench backfill. Proper compaction of trench backfill will be necessary under and adjacent to structural fill, building foundations, concrete slabs and vehicle pavement areas. In these areas, backfill should be conditioned with water (or allowed to dry) to produce a soil-water content of at least two percent above the optimum value and placed in horizontal layers not exceeding six inches in thickness (before compaction). Each layer should be compacted to 85-90 percent relative compaction based of ASTM Test D1557-12. The upper eight inches of pavement subgrade should be compacted to at 90 percent relative compaction based on ASTM Test Method D1557-12.

Where any trench crosses the perimeter foundation line of any portion of the proposed buildings, the trench should be completely plugged and sealed with compacted clay soil for a horizontal distance of at least two feet on either side of the foundation.

Surface Drainage

Surface drainage gradients should be planned to prevent ponding and to promote drainage of surface water away from top of slopes, building foundations, slabs, edges of pavements and sidewalks, and toward suitable collection and discharge facilities.

Water seepage or the spread of extensive root systems into the soil subgrade of foundations, slabs, or pavements, could cause differential movements and consequent distress in these structural elements. This potential risk should be given due consideration in the design and construction of landscaping.

Unpaved surfaces adjacent to the building foundations should be provided with positive gradients of five percent away from the building foundations to promote surface water away from the building subgrade and foundations. Paved areas around the building should be provided with a gradient of two percent away from the building foundations.

To minimize the potential for erosion of surface soils that could be caused by surface water runoff, provisions should be made to collect and control surface runoff. Paved ditches with catch basins are recommended on the backfill side of site retaining walls. Water collected in these catch basins should be conveyed by non-perforated pipes to suitable discharge points downslope and away from critical areas of the project site.

Subsurface Drainage

Subsurface drains should be provided in locations where wet soils or groundwater is encountered during site grading. The subdrain should be installed between the exterior continuous foundations and the site retaining wall foundations. The subsurface drain should consist of a minimum 12-inch wide trench filled with Caltrans Class 2 permeable rock or crushed rock encapsulated in a filter fabric.

A minimum four-inch diameter perforated, pipe should be placed (with holes down) at the bottom of the trench and over two inches of the rock. The pipes for the subdrains should have a minimum slope of two percent to promote gravity flow. Where the subdrain pipe daylights, a non-perforated pipe should be connected to the subdrain pipe to discharge to a suitable drainage facility away from any building foundations, slabs, edges of pavements, etc.

Follow-up Geotechnical Services

Our recommendations are based on the assumption that FRIAR ASSOCIATES, INCORPORATED will be commissioned to perform the following services.

- Review the grading and drainage plan and the foundation plan and details prior to construction.

- Observe, test and advise during site preparation, grading and compaction.

- Observe and advise during site excavations for keyways and site retaining walls.

- Observe, test and advise during utility trench backfilling.
- Observe and advise during site drainage provisions, drainage behind site retaining walls.

Limitation

The recommendations contained in this report are based on certain plans, information and data that have been provided to us. Any change in those plans, information and data will render our recommendations invalid unless we are commissioned to review the change and to make any necessary modifications and/or additions to our recommendations.

Subsurface exploration of any site is necessarily confined to selected locations. Conditions may, and often do, vary between and around such locations. Should conditions different from those encountered in our explorations come to light during project development, additional exploration, testing and analysis may be necessary; changes in project design and construction may also be necessary.

Our recommendations have been made in accordance with the principles and practices generally employed by the geotechnical engineering profession. This is in lieu of all other warranties, express or implied.

All earthwork and associated construction should be observed by our field representative, and tested where necessary, to compare the generalized site conditions assumed in this report with those found at the site at the time of construction, and to verify that construction complies with the intent of our recommendations.

Sincerely,

FRIAR ASSOCIATES, INCORPORATED

John H Friar
CE 52281

Attachment