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May 16, 2019

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Geotechnical Engineering Report Update
2021 Park Vista Court Garage
2021 Park Vista Court
Santa Rosa, California

Project Number: 4382.01.13.1

The purpose of this letter is to update our previous geotechnical report for the project to current design standards. The results of our geotechnical study for the site were presented in our report dated October 1, 1997. That report addressed a project that included construction of the Howarth Heights subdivision, which included the construction of 8 residential lots, including the subject property. On May 3, 2019, we visited the site and noted that the site surface conditions have not changed significantly since our report was issued.

Based on our review and reconnaissance, it is our opinion that the recommendations in our report, with the updated criteria presented below, are valid for design and construction of the improvements.

Seismic Design

Seismic design parameters presented below are based on Section 1613 titled "Earthquake Loads" of the 2016 California Building Code (CBC). Based on Table 20.3-1 of American Society of Civil Engineers (ASCE) Standard 7-10, titled "Minimum Design Loads for Buildings and Other Structures" (2010), we have determined a Site Class of C should be used for the site. Using a site latitude and longitude of 38.4461°N and 122.6641°W, respectively, and the OSHPD Seismic Design Maps website (https://seismicmaps.org), we recommend that the following seismic design criteria be used for structures at the site.

2016 CBC Seismic Criteria	
Spectral Response Parameter	**Acceleration (g)**
S_S (0.2 second period)	2.178
S_1 (1 second period)	0.899
S_{MS} (0.2 second period)	2.178
S_{M1} (1 second period)	1.168
S_{DS} (0.2 second period)	1.452
S_{D1} (1 second period)	0.779

Retaining Walls

Retaining walls should be designed to resist the following earth equivalent fluid pressures (triangular distribution):

EARTH EQUIVALENT FLUID PRESSURES		
Loading Condition	Pressure (pcf)	Additional Seismic Pressure (pcf)*
Active - Level Backfill	42	17
Active - Sloping Backfill 3:1 or Flatter	53	46
At Rest - Level Backfill	63	43

* If required

These pressures do not consider additional loads resulting from adjacent foundations or other loads. If these additional surcharge loadings are anticipated, we can assist in evaluating their effects. Where retaining wall backfill is subject to vehicular traffic, the walls should be designed to resist an additional surcharge pressure equivalent to two feet of additional backfill. Walls should be backfilled with material that has a low expansion potential. Retaining walls should be backdrained in accordance with the recommendations presented in our report.

Retaining walls will yield slightly during backfilling. Therefore, walls should be backfilled prior to building on, or adjacent to, the walls. Backfill against retaining walls should be compacted to at least 90 and not more than 95 percent relative compaction. Over-compaction or the use of large compaction equipment should be avoided because increased compactive effort can result in lateral pressures higher than those recommended above.

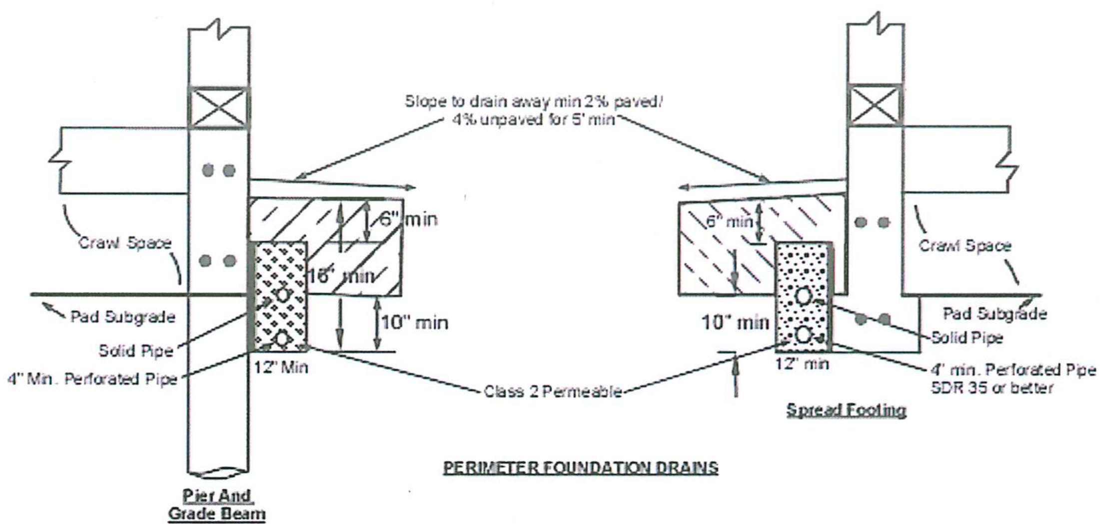
Geotechnical Drainage

Surface water should be diverted away from slopes and foundations. Surface drainage gradients should slope away from building foundations in accordance with the requirements of the CBC or local governing agency. Where a gradient flatter than 2 percent for paved areas and 4 percent for unpaved areas is required to satisfy design constraints, area drains should be installed within the rear and side yard swales with a spacing no greater than about 20 feet. Roofs should be provided with gutters and the downspouts should be connected to closed (glued Schedule 40 PVC or ABS with SDR of 35 or better) conduits discharging well away from foundations, onto paved areas or erosion resistant natural drainages or into the site's surface drainage system. Roof downspouts and surface drains must be maintained entirely separate from the slab underdrains recommended hereinafter.

Water seepage or the spread of extensive root systems into the soil subgrade of footings and slabs could cause differential movements and consequent distress in these structural elements. Landscaping should be planned with consideration for these potential problems.

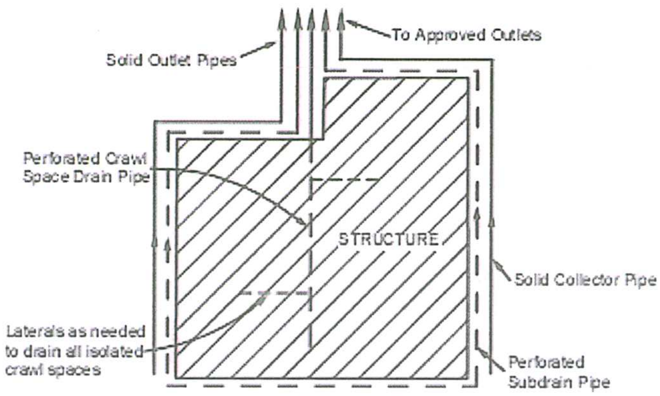
Perimeter Foundation Drains

Where interior crawl spaces are lower than adjacent exterior grade, subdrains should be installed adjacent to perimeter foundations, except on the downhill side, to prevent surface runoff from entering the crawl space. Foundation drains should consist of trenches that are at least 10 inches below the crawl space surface and are sloped to drain by gravity. Four-inch diameter perforated pipe sloped to drain to outlets by gravity should be placed in the bottom of the trenches. The top of subdrain pipes should be at least 6 inches lower than the adjacent crawl space. The perimeter subdrain trenches should be backfilled to within 6 inches of the surface with Class 2 permeable material. The upper 6 inches should be backfilled with compacted soil to exclude surface water. An illustration of this system is shown below. Where perimeter foundation drains are not used, water ponding in the crawl space should be anticipated. Where retaining walls are used for perimeter foundations, retaining wall backdrains may be used in lieu of foundation drains.

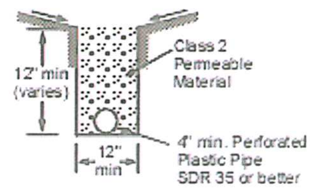


Crawl Space Drains

Crawl spaces are inherently damp and humid. In addition, groundwater seepage is unpredictable and difficult to control and, regardless of the care used in installing perimeter foundation drains, can find its way into crawl spaces. The ground surface within the crawl space should be sloped to drain away from foundations and toward a 12-inch square drain trench that is excavated through the longitudinal axis of the crawl space. A 4-inch diameter perforated drain pipe (SDR 35 or better) should be embedded in Class 2 permeable materials near the bottom of the trench. The drain rock should extend to the surface of the crawl space. Piped outlets should be provided to allow drainage of the collected water through foundations and discharge into the storm drain system. An illustration of this system is shown below. Additional protection against water seepage into crawl spaces can be obtained by compacting fill placed adjacent to perimeter walls to at least 90 percent relative compaction.



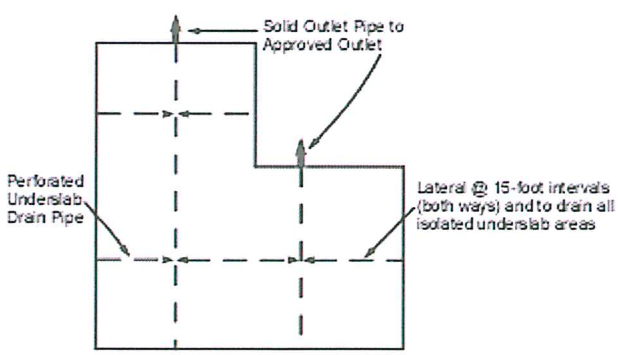
TYPICAL FOUNDATION DRAIN PLAN



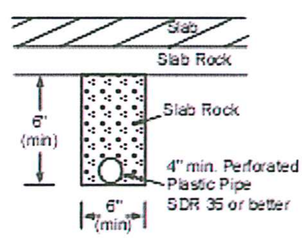
CRAWL SPACE DRAIN

Slab Underdrains

Where interior slab subgrades are less than 6 inches above adjacent exterior grade and where migration of moisture through the slab would be detrimental, slab underdrains should be installed to dispose of surface and/or groundwater that may seep and collect in the slab rock. Slab underdrains should consist of 6-inch wide trenches that extend at least 6 inches below the bottom of the slab rock and slope to drain by gravity. The slab underdrain trenches should be spaced no further than 15 feet, both ways. Additional drain trenches should be installed, as necessary, to drain all isolated under slab areas. Four-inch diameter perforated pipe (SDR 35 or better) sloped to drain to outlets by gravity should be placed in the bottom of the trenches. Slab underdrain trenches should be backfilled to subgrade level with clean, free draining slab rock. An illustration of this system is shown below. If slab underdrains are not used, it should be anticipated that water will enter the slab rock, permeate through the concrete slab and ruin floor coverings.



TYPICAL UNDERSLAB DRAIN PLAN



SLAB UNDERDRAIN

We trust this provides the information you require at this time. If you have questions please call.

Very truly yours,
RGH Consultants

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Attachments: RGH Consultants, October 1, 1997, *Geotechnical Investigation, Proposed Howard Heights*, Santa Rosa, California, Project Number 1353.01.00.1

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G *REPORT*

H

GEOTECHNICAL INVESTIGATION
PROPOSED HOWARTH HEIGHTS
SANTA ROSA, CALIFORNIA

Project Number 1353.01.00.1

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October 1, 1997

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INTRODUCTION

This report presents the results of our geotechnical investigation for the proposed Howarth Heights Subdivision in Santa Rosa, California. The property currently contains a paved road, two residences, a well, septic fields and several outbuildings. The site location is shown on Plate 1, Appendix A.

We understand the 5.05 acre property will be subdivided into 8 single-family residential lots. One of the existing residences will remain on Lot 4. We anticipate one-story, wood-frame structures with wood floors supported on joists-above-grade will be constructed on the remaining seven lots. Slab-on-grade will be used in garages. The subdivision will be accessible by a paved cul-de-sac off of Sumner Lane. The project will be served by City of Santa Rosa Municipal Utilities. The existing well and septic systems will be removed.

Actual foundation loads are not known at this time. We anticipate the loads will be typical for the light to moderately heavy type of construction planned and that wall foundation loads will range from about 3/4 to 1½ kips per lineal foot.

Grading plans are not available, but we anticipate that the planned grading will be the minimum amount needed to construct level building pads and provide the cul-de-sac with adequate drainage.

SCOPE

The purpose of our investigation, as outlined in our Professional Service Agreement dated September 17, 1997, was to generate geotechnical information for the design and construction of the project. Our scope of services included reviewing selected published geologic data pertinent to the site; evaluating subsurface conditions with test pits and laboratory tests; analyzing the field and laboratory data; and presenting this report with the following geotechnical information:

1. A brief description of soil, bedrock and groundwater conditions observed during our investigation;

2. A discussion of seismic hazards that may affect the proposed development;

3. Conclusions and recommendations regarding:
   a. Primary geotechnical engineering concerns and mitigating measures, as applicable;

   b. Site preparation and grading including treatment of weak, porous, compressible surface soils and the construction of hillside fills;

   c. Foundation type(s), design criteria and estimated settlement behavior;

   d. Lateral loads for retaining wall design, if applicable;

   e. Support of concrete slabs-on-grade;

   f. Preliminary pavement thickness based on our experience with similar soils and projects and the results of an R-Value and expansion index test on anticipated subgrade soils;

   g. Utility trench backfill;

h. Geotechnical engineering drainage improvements; and

i. Supplemental geotechnical engineering services.

INVESTIGATION

Site Exploration

We reviewed our previous work in the vicinity and selected geologic references pertinent to the site. The geologic literature reviewed is listed in Appendix B.

On September 11, 1997, we performed a geotechnical reconnaissance of the site and explored the subsurface conditions by excavating five test pits to depths ranging from about 2 to 5 feet. The test pits were excavated with a track-mounted excavator at the approximate locations shown on the Exploration Plan, Plate 2. The test pit locations were determined approximately by pacing their distance from features shown on the Exploration Plan and should be considered accurate only to the degree implied by the method used. Our geologist located and logged the pits, and obtained samples of the materials encountered for visual examination, classification and laboratory testing.

Relatively undisturbed samples were obtained from the pits at selected intervals by hand-driving a 2.43-inch inside diameter, split spoon sampler, containing 6-inch long brass liners. The sampler was driven approximately 12 inches with a steel fence post hammer.

The logs of the pits showing the materials encountered are summarized on Plate 3. The soils are described in accordance with the Unified Soil Classification System, outlined on Plate 4. Bedrock is described in accordance with Engineering Geology Rock Terms shown on Plate 5.

The test pit logs show our interpretation of subsurface soil and bedrock conditions on the date and at the locations indicated. Subsurface conditions may vary at other locations and times. Our interpretation is based on visual inspection of soil and bedrock samples, laboratory test results, and interpretation of excavation and sampling resistance. The location of the soil and bedrock boundaries should be considered approximate. The transition between soil and bedrock types may be gradual.

Laboratory Testing

The samples obtained from the pits were transported to our office, and re-examined by the project engineer to verify soil classifications, evaluate characteristics, and assign tests pertinent to our analysis. Selected samples were laboratory tested to determine their water content, dry density, classification (Atterberg Limits, percent of silt and clay), expansion potential, expansion index and R-value. Results of the classification (Atterberg Limits, percent of silt and clay), are presented on Plate 6, and expansion index and R-value tests are presented on Plate 7.

SITE CONDITIONS

General

Sonoma County is located within the California Coast Range geomorphic province. This province is a geologically complex and seismically active region characterized by sub-parallel northwest-trending faults, mountain ranges and valleys. The oldest bedrock units are the Jurassic-Cretaceous Franciscan assemblage, and the Upper Cretaceous Great Valley sequence sediments originally deposited in a marine environment. Subsequently, younger rocks such as the Tertiary-age Sonoma Volcanics group, the Plio-Pleistocene-age Clearlake Volcanics and sedimentary rocks such as the Guinda, Domingine, Petaluma, Wilson Grove, Cache, Huichica and Glen Ellen formations were deposited throughout the province. Extensive folding and thrust faulting during late Cretaceous through early Tertiary geologic time created complex geologic conditions that underlie the highly varied topography of today. In valleys, the bedrock is covered by alluvial soils. The site is located on the lowest flanks on the west side of Sonoma Mountain.

Geology and Soils

The United States Geological Survey (USGS) geologic maps reviewed, Fox et al. (1973), indicate the property is underlain by the andesite and basalt member of the Sonoma Volcanics.

Mapping by the U. S. Soil Conservation Service (Miller, 1978) has classified soil over the portion of this property proposed for development as belonging to the Pleasanton series. The Pleasanton series is comprised of well-drained gravelly loams that have a gravelly clay loam subsoil. They generally have low plasticity (LL = 20-30; PI = 5-15) and expansion potential. Runoff over these soils is medium. The hazard of erosion is high depending on slope. The risk of corrosion is given as low for uncoated steel. We did not perform corrosivity tests to verify these values.

Landslides

The California Division of Mines and Geology's reconnaissance photo interpretation maps of landslides (Huffman, 1980 and Dwyer, 1976) reviewed do not indicate large-scale slope instability at the Howarth Heights Subdivision, and we did not observe landslides at the site during our investigation.

Surface

The property extends primarily over gentle to moderate, west-facing slopes. Portions of the site are developed and include two residences, a paved driveway extending eastward from Summerfield Road, a well and septic fields, and several outbuildings. In undeveloped areas along Sumner Lane, there are scattered to moderately dense stands of oak and other trees amid grassland. Natural drainage consists of sheet flow westward across the site.

Subsurface

Our pits and laboratory tests indicate that the portion of the site we investigated is blanketed by one to three feet of dark red sandy clays and clayey sands that are porous, and soft to medium stiff and dry at the time of exploration. These surface materials generally have low plasticity and expansion potential (LL = 35%; PI = 15%; Free Swell = 10%). In Test Pit (TP)-3, the surface soils are underlain by dark red sandy clays (subsoil) that are non-porous and stiff and moist at the time of exploration. TP-3 was terminated at a depth of about five feet in the relatively strong and incompressible subsoil.

Andesite bedrock of the Sonoma Volcanics extends from beneath the surface materials (topsoils and residual soils) to the maximum depths explored (1½ to 3 feet). The andesite bedrock is generally hard to moderately hard, strong to moderately strong, and moderately to slightly weathered. There are various locations on the undeveloped eastern-southeastern portions of the site where the rock outcrops on the surface. A detailed description of subsurface conditions found in our test pits is given in Appendix A.

Groundwater

Free groundwater was not observed in our test pits at the time of excavation. On hillsides, rainwater typically percolates through the porous topsoil and migrates downslope in the form of seepage at the interface of the topsoil and bedrock, and through fractures in the bedrock. Fluctuations in the seepage rates typically occur due to variations in rainfall and other factors such as periodic irrigation.

DISCUSSION

Seismic Hazards

General

We did not observe subsurface conditions within the portion of the property we investigated that would suggest the presence of materials that may be susceptible to seismically induced liquefaction, lateral spreading or lurching. Therefore, due to shallow bedrock and gentle to moderate slopes, we judge the potential for occurrence of these phenomena at the Howarth Heights site to be low.

It has been documented that past quarry activities occurred in this region. It was typical at the time to backfill the quarry excavations with loose rock and the excavated spoils. In the absence of an exhaustive subsurface investigation, these sites are difficult to identify with the current level of study. Such features were not evident during our exploration, but they could exist. If anomalies are encountered during grading or foundation excavation, they can be mitigated at that time.

Faulting

We did not observe land forms within the area that would indicate the presence of active faults and the site is not within a current Alquist-Priolo Earthquake Fault Zone. Therefore, we believe the risk of fault rupture at the site is low. However, the site is within an area affected by strong seismic activity. Several northwest-trending Earthquake Fault Zones exist in close proximity to, and within several miles of, the site (Brown, 1970; Helley and Herd, 1977; Bortugno, 1982). The shortest distances from the site to these faults are presented below in Table 1.

TABLE 1

ACTIVE FAULT PROXIMITY

Fault	Distance-Miles
San Andreas	22 SW
Hayward	34 SE
Healdsburg - Rodgers Creek	3½ SW
West Napa (Zoned)	16½ SE
Maacama	10½ NW

Seismicity

Historical earthquake records indicate a potential for strong ground shaking throughout the entire San Francisco Bay and Sonoma County areas, and future seismic shaking should be anticipated at the site. It will be necessary to design and construct the proposed residences in strict adherence with current standards for earthquake-resistant construction.

CONCLUSIONS

Based on our investigation, we judge the proposed Howarth Heights Subdivision can be built as planned, provided the recommendations presented in this report are incorporated into its design and construction.

The primary geotechnical concerns during design and construction of the project are:

1. The weakness and compressibility of the upper one to three feet of surface soils at the site.

2. The de-stabilizing effects of uncontrolled surface runoff and groundwater seepage on hillside residential developments.

3. The strong ground shaking predicted to impact the site during the life of the project.

Weak, Porous Surface Soils

Weak, porous soils, such as those found at the site, appear hard and strong when dry but will lose strength rapidly and settle under the load of fills, foundation, slabs and pavements as their moisture content increases and approaches saturation. The moisture content of these soils can increase as the result of rainfall, flooding or when the natural upward migration of water vapor through the soils is impeded by, and condenses under fills, foundations, pavements, slabs. The detrimental effects of such movements can be remediated by improving the soils load supporting capacity during grading. This can be achieved by excavating the weak soils and replacing them as properly compacted (engineered) fill, or by obtaining foundation support beneath the weak surface soils.

Foundation Support

After remedial grading, satisfactory foundation support for the residences can then be obtained from spread footings bottomed on the engineered fill. Slab-on-grade floors and pavements can also be satisfactorily supported on the engineered fill.

As an alternative to the extensive grading required to upgrade weak surface soils, satisfactory foundation support for the residences can be obtained from deep spread footings that bottom entirely on the relatively strong and incompressible clayey subsoil or bedrock found beneath the weak surface soils.

Floor Systems

As previously discussed, wood floors supported on joists above-grade can be used in living areas, as planned. Slab-on-grade floors can be used in garages provided that:

1. The planned grading either removes the weak surface soils or upgrades the supporting capacity by mechanical compaction in the garage areas;

2. The subgrade materials are pre-swelled by soaking prior to installation of the slabs;

3. The slabs are cast separate from foundations to allow differential settlement to occur without distressing the slabs;

4. The slabs are reinforced to reduce cracks;

5. The slabs are grooved to induce cracking in a non-obtrusive manner; and

6. Some slab differential settlement is acceptable to the user, unless garage areas are underlain by firm rock or fills of even thickness, entirely.

On-Site Soil Quality

We anticipate that, with the exception of organic matter and of rocks or lumps larger than six inches in diameter, the excavated material will be suitable for re-use as compacted (select) fill.

Settlement

Provided all foundations bear on firm, undisturbed bedrock, or buttressed fill of even thickness, we estimate that post-construction differential settlements across the building should be about one inch.

Surface Drainage

The site soils are susceptible to erosion and sloughing. Surface runoff typically sheet flows over slopes but can be concentrated by the planned site grading and drainage. The ensuing erosion can create sloughing and promote slope instability or the surface runoff can pond against structures. Therefore, strict control of surface runoff is necessary to provide long-term satisfactory performance of projects constructed on hillsides. It will be necessary to divert surface runoff around slopes and improvements, provide positive drainage away from structures and install energy dissipators at discharge points of concentrated runoff.

Groundwater

We anticipate that rainwater will percolate through the porous topsoil and migrate downslope at the interface of the topsoil and bedrock, and through fractures in the bedrock. Groundwater will seep into excavations exposing the water migration zone or into hillside fills and crawl spaces. Therefore, it will be necessary to intercept, collect and divert groundwater upslope of the proposed improvements. This can be accomplished by installing perimeter foundation drains and retaining wall backdrains (if walls are used) as recommended herein.

RECOMMENDATIONS

Seismic Design

The site is within Uniform Building Code (UBC) seismic zone 4; therefore, a Seismic Zone Factor "Z" of 0.4 should be used. The soil profile at the site approximates type S1 and a site coefficient (SFACTOR) of 1.0 should be used in determining total design lateral force in accordance with the UBC.

Grading

Site Preparation

Areas to be developed should be cleared of vegetation and debris. Trees and shrubs that will not be part of the proposed development should be removed and their primary root systems grubbed. Cleared and grubbed material should be removed from the site and disposed of in accordance with County Health Department guidelines. We did not uncover septic tanks, leach lines or underground fuel tanks during our investigation. Any such appurtenances found during grading should be capped and sealed and/or excavated and removed from the site, respectively, in accordance with established guidelines and requirements of the County Health Department. Voids created during clearing should be backfilled with engineered fill as recommended herein.

Stripping

Areas to be graded should be stripped of the upper few inches of soil containing organic matter. Soil containing more than two percent by weight of organic matter should be considered organic. Actual stripping depth should be determined by a representative of the geotechnical engineer in the field at the time of stripping. The strippings should be removed from the site, or if suitable, stockpiled for re-use as topsoil in landscaping.

Excavations

Our subsurface exploration was performed with a track-mounted excavator. We encountered areas of hard, resistant rock in our test pits which may be similarly encountered elsewhere during construction activities. This rock may require jack-hammering and/or light blasting to accomplish the needed excavation.

Following initial site preparation, excavation should be performed as planned or recommended herein. Excavations extending below the proposed finished grade should be backfilled with suitable materials compacted to the requirements given below.

In all building areas where shallow spread footings are used for foundation support or where slab-on-grade floors are used in building areas, the weak, porous, compressible soils and quarry backfill, if encountered, should be excavated to within six inches of their entire depth.

On sloping terrain, fills should be constructed by excavating level keyways that expose firm, natural soils or bedrock as determined by the geotechnical engineer. The keyways should be at least 10 feet wide, extend at least 3 feet below the existing ground surface on the downhill side and should be sloped to drain to the rear.

The excavation of weak, porous soil should extend at least five feet beyond the limits of the proposed buildings. Keyway excavations should extend laterally at least 2 feet beyond a 1:1 imaginary line extending down from the toe of the fill. The excavated materials should be stockpiled for later use as compacted fill, or removed from the site, as applicable.

Where evidence of seepage is observed and/or where fill is to extend beneath structures, a subsurface drain should be installed at the rear of the keyways as recommended by the geotechnical engineer. The subdrain consist of a 4-inch diameter perforated plastic pipe with SDR 35 or better embedded in 3/4-inch drain rock should be wrapped in geotextile filter fabric (Mirafi 140N or equivalent). The geotextile fabric can be deleted where Class 2 permeable material is used as drain rock. The drain should be at least 12 inches thick and extend at least 4 feet above the bottom of the keyway. The depth and extent of subdrains should be determined and approved by the geotechnical engineer in the field during construction.

At all times, temporary construction excavations should conform to the regulations of the State of California, Department of Industrial Relations, Division of Industrial Safety or other stricter governing regulations. The stability of temporary cut slopes should be the responsibility of the contractor. The tops of the temporary cut slopes should be rounded back to 2:1 in weak soil zones. Depending on the time of year when grading is performed, and the surface conditions exposed, temporary cut slopes may need to be excavated to 1¼:1, or flatter.

Fill Quality

All fill materials should be free of perishable matter and rocks or lumps over four inches in diameter, and must be approved by the geotechnical engineer prior to use. The fill beneath and within five feet of building area must be select fill. The on-site soils are generally suitable for use as (select) fill as long as rocks greater than 6 inches are removed.

Select Fill

Select fill should be free of organic matter, have a low expansion potential, and conform in general to the following requirements:

SIEVE SIZE	PERCENT PASSING (By Dry Weight)
6 inch	100
4 inch	90 - 100
No. 200	10 - 60

Liquid Limit - 40 Percent Maximum
Plasticity Index - 15 Percent Maximum

In general, imported fill, if needed, should be select fill. Material not conforming to these requirements may be suitable for use as import fill; however, it shall be the contractor's responsibility to demonstrate that the proposed material will perform in an equivalent manner. Imported materials should be approved by the geotechnical engineer prior to use as compacted fill.

Fill Placement

The surface exposed by stripping and removal of weak soils should be scarified to a depth of at least six inches, uniformly moisture-conditioned to near optimum, and compacted to at least 90 percent of the maximum dry density of the materials as determined by the ASTM D-1557 laboratory compaction test procedure. Approved on-site soils or select fill material should then be spread in thin lifts, uniformly moisture-conditioned and compacted to at least 90 percent relative compaction. Fills placed on terrain sloping at 5:1 or steeper should be continually keyed and benched into firm, undisturbed soil or bedrock. The benches should allow space for the placement of select fill of even thickness under settlement sensitive structural elements supported directly on the fill. An illustration of this grading technique is shown on Plate 8.

Permanent Cut and Fill Slopes

In general, cut and fill slopes should be no steeper than 2:1. Where steeper slopes in soil are required, retaining walls should be used. Steeper slopes may be suitable in bedrock, but should be observed by the geotechnical engineer in the field. Permanent cut slopes should be observed in the field by the geotechnical engineer to verify that the exposed soil/bedrock conditions are as anticipated. The geotechnical engineer is not responsible for measuring the angles of these slopes. Denuded slopes should be planted with fast-growing, deep-rooted ground cover to reduce sloughing or erosion.

Wet Weather Grading

Generally, grading is performed more economically during the summer months when on-site soils are usually dry of optimum moisture content. Delays should be anticipated in site grading performed during the rainy season or early spring due to excessive moisture in on-site soils. Special and relatively expensive construction procedures, including dewatering of excavations, should be anticipated if grading must be completed during the winter and early spring or if localized areas of soft saturated soils are found during grading in the summer and fall.

Foundation Support

Provided the weak surface soils and old fill materials, if encountered, are upgraded by grading as recommended herein, the proposed structures can be supported on conventional continuous and isolated spread footings that bottom at minimum depth on select engineered fill. Alternatively, deep spread footings founded on bedrock may be used if remedial grading is not performed. In general, bedrock was found in our test pits at depths ranging from 12 to 36 inches, but may be shallower or deeper depending on the location of the buildings.

Spread Footings

Spread footings should be at least 12 inches wide and should bottom on select compacted fill or on undisturbed bedrock at least 12 inches below lowest adjacent grade. On sloping terrain where grading is not performed, the footings should be stepped as necessary to produce level tops and bottoms. Footings should be deepened as necessary to provide at least seven feet of horizontal confinement between the footing bottoms and the face of the nearest slope.

On sloping terrain where grading is not performed to create a level pad that exposes bedrock, all continuous and isolated footings should be connected in the upslope-downslope and cross-slope direction with tie beams to form a "grid-type" foundation system. Perimeter and interior strip footings can be considered part of the grid. The maximum plan dimensions of this grid should be on the order of 15 feet in each direction. The continuous footings should have sufficient reinforcement to span, as a simple beam, an unsupported distance of approximately ten feet. At corners, the continuous footings should be designed to cantilever at least five feet.

Where bedrock is exposed (outcrop) on the surface, the foundation may have to be dowelled into the rock as recommended by the project structural engineer.

The bottoms of all footing excavations should be thoroughly cleaned out or wetted and compacted using hand-operated tamping equipment prior to placing steel and concrete. This will remove the supporting soils disturbed during footing excavations, or restore their adequate bearing capacity, and reduce post-construction settlements.

Bearing Pressures - Footings installed in accordance with these recommendations may be designed using allowable bearing pressures of 2000, 2500, and 3000 pounds per square foot (psf), for dead loads, dead plus code live loads, and total loads (including wind and seismic), respectively. For footings bottomed entirely on bedrock, the above pressures can be increased by 25 percent.

Lateral Pressures - The portion of spread footing foundations extending into firm natural soil undisturbed bedrock or select engineered fill may impose a passive equivalent fluid pressure and a friction factor of 350 pcf and 0.35, respectively, to resist sliding. Passive pressure should be neglected within the upper 6 inches, unless the soils are confined by concrete slabs or pavements.

Retaining Walls

Retaining walls constructed at the site must be designed to resist lateral earth pressures plus additional lateral pressures that may be caused by surcharge loads applied at the ground surface behind the walls.

Retaining walls free to rotate (yielding greater than 0.1 percent of the wall height at the top of the backfill) should be designed for active lateral earth pressures. If walls are restrained by rigid elements to prevent rotation, they should be designed for "at rest" lateral earth pressures.

Lateral Loads

Retaining walls supporting level backfill should be designed to resist an active equivalent fluid pressure of 40 pcf acting in a triangular pressure distribution. Where the backfill slopes up 3:1 or flatter, the walls should be designed for an equivalent fluid pressure of 55 pcf. Retaining walls restrained from movement at the top should be designed for equivalent fluid pressures of 60 and 80 pcf for level backfill and backfill steeper than 3:1, respectively. Where an imaginary 1½:1 line projected down from building or retaining wall foundations intersects a lower retaining wall, the portions of the retaining wall below the intersection should be designed for an additional horizontal surcharge load. The surcharge load is directly proportional to the vertical and horizontal distance between the footings, and the upper wall height and active pressure. We should be consulted to provide surcharge load design criteria for specific cases. Where retaining wall backfill is subject to vehicular traffic, the walls should be designed to resist an additional surcharge pressure equivalent to two feet of additional backfill. Retaining walls will yield slightly during backfilling. Therefore, walls should be backfilled prior to building on or adjacent to the walls.

Foundation Support

Retaining walls should be supported on spread footings designed in accordance with the recommendations presented in this report. Retaining wall footings should be designed by the project civil or structural engineer to resist the lateral forces set forth in this section.

Wall Drainage and Backfill

Retaining walls should be backdrained as shown on Plate 9, Appendix A. The backdrains should consist of 4-inch diameter, rigid perforated pipe embedded in drain rock. The pipe should be PVC Schedule 40 or ABS with SDR 35 or better, and the pipe should be sloped to drain to outlets by gravity. Drain rock should consist of clean, free-draining crushed rock or gravel. The rock should be wrapped in filter fabric such as Mirafi 140N or equivalent. The filter fabric can be deleted where Class 2 permeable material is used as drain rock. The top of the pipe should be at least eight inches below lowest adjacent grade. The crushed rock or gravel should extend to within one foot of the surface. The upper 1½ feet should be backfilled with compacted soil to exclude surface water. Expansive soils should not be used for wall backfill. The ground surface behind retaining walls should be sloped to drain. Where migration of moisture through retaining walls would be detrimental, retaining walls should be waterproofed.

Slab-On-Grade

Provided grading is performed in accordance with grading recommendations presented herein, garage slabs should be underlain by firm undisturbed bedrock or at least 6 inches of (select) engineered fill.

Slab-on-grade subgrade should be rolled to produce a dense, uniform surface. The future expansion potential of the subgrade soils should be reduced by thoroughly presoaking the slab subgrade prior to concrete placement. The slabs should be underlain with a capillary moisture break consisting of at least four inches of clean, free-draining crushed rock or gravel at least ¼-inch and no larger than ¾-inch in size. Where subjected to vehicular traffic, slabs should be underlain by crushed rock. Where migration of moisture vapor through slabs would be detrimental, an impermeable membrane moisture vapor barrier should be provided between the drain rock and the slabs. On sloping terrain, outlets should be provided for the slab drain rock through foundation walls.

Slabs should be at least four inches thick, and should be reinforced to reduce cracking. Slabs should be grooved at regular intervals to induce and control cracking, as recommended by the structural engineer.

Utility Trenches

As mentioned previously, hard resistant rock was encountered in our test pits using a track-mounted excavator. If such rock is similarly encountered in utility trench excavations, jack-hammering and/or light blasting may be needed to accomplish the required excavation.

Trench excavations shoring and safety is the sole responsibility of the contractor. Attention is drawn to the State of California Safety Orders dealing with "Excavations and Trenches".

Unless otherwise specified by the City of Santa Rosa, on-site, inorganic soil may be used as (general) utility trench backfill. Where utility trenches support pavements, slabs and foundations, trench backfill should consist of aggregate baserock. Baserock should conform to the requirements for aggregate base recommended in the "Pavement" section below. Trench backfill should be moisture-conditioned as necessary, and placed in horizontal layers not exceeding eight inches in thickness, before compaction. Each layer should be compacted to at least 90 percent relative compaction as determined by ASTM Test D-1557. The top lift of trench backfill under vehicle pavements should be moisture conditioned as necessary and compacted to at least 95 percent relative compaction. Jetting or ponding of trench backfill to aid in achieving the recommended degree of compaction should not be used.

Pavements

Based on our investigation, we believe the near-surface sandy clays/clayey sands will have a moderate supporting capacity, after proper compaction, when used as a pavement subgrade. An R-value of 26 was measured on a bulk sample of near-surface soil obtained near the proposed cul-de-sac. An R-value of 25 was used in pavement design calculations. Expansion index testing performed on the bulk sample was determined to be 21, indicating a low expansion potential. Based on the R-value test results and our experience with similar projects and soils, we recommend that the pavement section listed on Table 2 below be used.

TABLE 2

PAVEMENT SECTIONS

TI	THICKNESS (inches)		
	ASPHALT CONCRETE	CLASS 2 AGGREGATE BASE	AGGREGATE SUBBASE
6.0	3.0	9.5	-
5.5	3.0	8.0	-
5.0	2.5	7.5	-
4.5	2.5	6.0	-

The project engineer, in consultation with City/County officials, should choose the pertinent (TI) for this project.

Pavement thicknesses were computed using Method 301 F of the CalTrans Highway Design Manual and are based on a pavement life of 20 years.

Prior to placement of aggregate base materials, the upper six inches of the pavement subgrade soils should be scarified, uniformly moisture conditioned to near optimum, and compacted to at least 95 percent relative compaction to form a firm, non-yielding surface. Aggregate base materials should be spread in thin layers, uniformly moisture conditioned, and compacted to at least 95 percent relative compaction to form a firm non-yielding surface.

The materials and methods used should conform to the requirements of the City of Santa Rosa and the current edition of the CalTrans Standard Specifications, except that compaction requirements should be based on ASTM Test Method D-1557. Aggregate used for the base course should comply with the minimum requirements specified in CalTrans Standard Specifications, Section 26 for Class 2 Aggregate Base.

These recommendations are intended to provide support for auto and light truck traffic for the indicated TI's. They are not intended to provide pavement sections for heavy concentrated storage or construction wheel loads such as parked truck-trailers, concrete trucks and moving vans, or for concentrated wheel loads such as forklifts or self-loading dumpster trucks.

In areas where heavy or concentrated storage and construction wheel loads are anticipated, the pavements should be designed to support these loads. Support could be provided by increasing pavement sections or by providing reinforced concrete slabs. Alternatively, paving can be deferred until heavy storage and construction wheel loads are no longer present. Loading areas for self loading dumpster trucks should be provided with reinforced concrete slabs at least six inches thick, and reinforced with #4 bars at 12-inch centers each way. Alternatively, the asphalt concrete section should be increased to at least 10 inches in these areas.

Pavement Drainage

Water tends to migrate under pavements and collect in the aggregate courses at low areas on subgrade soils such as around storm drain inlets and the thread of paved swales leading to inlets. The ponded water will soften subgrade soils and, under repetitive heavy-wheel loads, will induce inordinately high stresses on the pavement components that could result in untimely maintenance. Under-pavement drainage can be improved and maintenance reduced by replacing a 12-inch wide strip (extending at least 15 feet on either side of the inlet) of the select subbase layer or subgrade soils with ¾-inch or 1½-inch free-draining crushed rock. The drain rock should be separated from the subgrade soils and the base rock with a geotextile filter membrane. The drain rock should be outletted into the inlet.

Where pavements will abut landscaped areas, the pavement baserock layer and subgrade soils should be protected against saturation from irrigation and rain water with a concrete curb and gutter, redwood header-board, a subdrain, or a thickened asphalt concrete section. The curb and gutter, header-board, subdrain or thickened asphalt should extend to a depth of at least six inches below the bottom of the baserock layer.

Wet Weather Paving

In general, the pavements should be constructed during the dry season to avoid the saturation of the subgrade and base materials which often occurs during the wet winter months. If pavements are constructed during the winter, a cost increase relative to drier weather construction should be anticipated. Unstable areas may have to be over-excavated to remove soft soils. The excavations will probably require backfilling with imported crushed (ballast) rock. The geotechnical engineer should be consulted for recommendations at the time of construction.

Geotechnical Drainage

Surface water should be diverted away from slopes, foundations and edges of pavements. Surface drainage gradients within 5 feet of building foundations should be constructed with a minimum slope of 2 percent for paved areas and 4 percent for unpaved areas. Roofs should be provided with gutters, and the downspouts should empty onto splash blocks that discharge directly onto paved areas or be connected to closed (glued Schedule 40 PVC or better) conduits discharging well away from foundations, preferably onto paved areas or into the storm drainage system.

On sloping terrain, where interior crawl spaces are lower than adjacent exterior grade, subdrains should be installed adjacent to perimeter foundations to prevent surface runoff from entering the crawl space. Foundation drains should be installed adjacent to perimeter foundations, except the downhill side. Foundation drains should consist of trenches at least 18 inches deep and sloped to drain by gravity. Three-inch diameter perforated pipe sloped to drain to outlets by gravity should be placed in the bottom of the trenches. The top of subdrain pipes should be at least eight inches lower than the adjacent crawl space. The trenches should be backfilled to within six inches of the surface with clean, free-draining crushed rock or gravel. The gravel should be wrapped in a filter fabric such as Mirafi 140N or equivalent. The upper six inches should be backfilled with compacted soil to exclude surface water. An illustration of this system is shown on Plate 10.

Crawl spaces are inherently damp and humid. In addition, groundwater seepage is unpredictable and difficult to control and regardless of the care used in installing perimeter subdrains can find its way into crawl spaces. The ground surface, within the crawl space, should be sloped to drain away from foundations. Piped outlets should be provided to allow drainage of the collected water through foundations and discharge into the storm drain system. Where retaining walls are used for perimeter foundations, retaining wall backdrains may be used in lieu of foundation drains. In level areas, as an alternative to perimeter foundation subdrains and crawl space drains, building pads can be constructed at least 12 inches higher than the surrounding ground surfaces.

Roof downspouts and surface drains must be maintained entirely separate from foundation drains and retaining wall backdrains. The outlets should discharge into the storm drain system or onto erosion-resistant areas, and should be provided with rock rip-rap or other energy dissipators, if they discharge onto the ground.

Water seepage or the spread of extensive root systems into the soil subgrade of footings, slabs or pavements could cause differential movements and consequent distress in these structural elements. Landscaping should be planned with consideration for these potential problems.

Maintenance

Periodic land maintenance will be required. Surface and subsurface drainage facilities should be checked frequently, and cleaned and maintained as necessary. A dense growth of deep-rooted ground cover must be maintained on all slopes to reduce sloughing and erosion. Sloughing and erosion that occurs must be repaired promptly before it can enlarge into sliding.

Supplemental Services

RGH Geotechnical and Environmental Consultants (RGH) recommends that we be retained to review the project plans and specifications to determine if they are consistent with our recommendations. In addition, we should be retained to observe construction, particularly site excavations, compaction of fill, foundation and subdrain installations, and perform appropriate laboratory testing.

If, during construction, we observe subsurface conditions different from those encountered during the explorations, we should be allowed to amend our recommendations accordingly. If different conditions are observed by others, or appear to be present beneath excavations, RGH should be advised at once so that these conditions may be evaluated and our recommendations reviewed and updated, if warranted. The validity of recommendations made in this report are contingent upon our being notified and retained to review the changed conditions.

If more than 18 months have elapsed between the submission of this report and the start of work at the site, or if conditions have changed because of natural causes or construction operations at, or adjacent to, the site, the recommendations made in this report may no longer be valid or appropriate. In such case, we recommend that we be retained to review this report and verify the applicability of the conclusions and recommendations or modify the same considering the time lapsed or changed conditions. The validity of recommendations made in this report are contingent upon such review.

These supplemental services are performed on an as-requested basis and are in addition to this geotechnical investigation. We cannot accept responsibility for items that we are not notified to observe or for changed conditions we are not allowed to review.

LIMITATIONS

This report has been prepared by RGH for the exclusive use of Frank Rogers and his consultants as an aid in the design and construction of the proposed residences described in this report.

The validity of the recommendations contained in this report depends upon an adequate testing and monitoring program during the construction phase. Unless the construction monitoring and testing program is provided by, or coordinated with, our firm, we will not be held responsible for compliance with design recommendations presented in this report and other addendum submitted as part of this report.

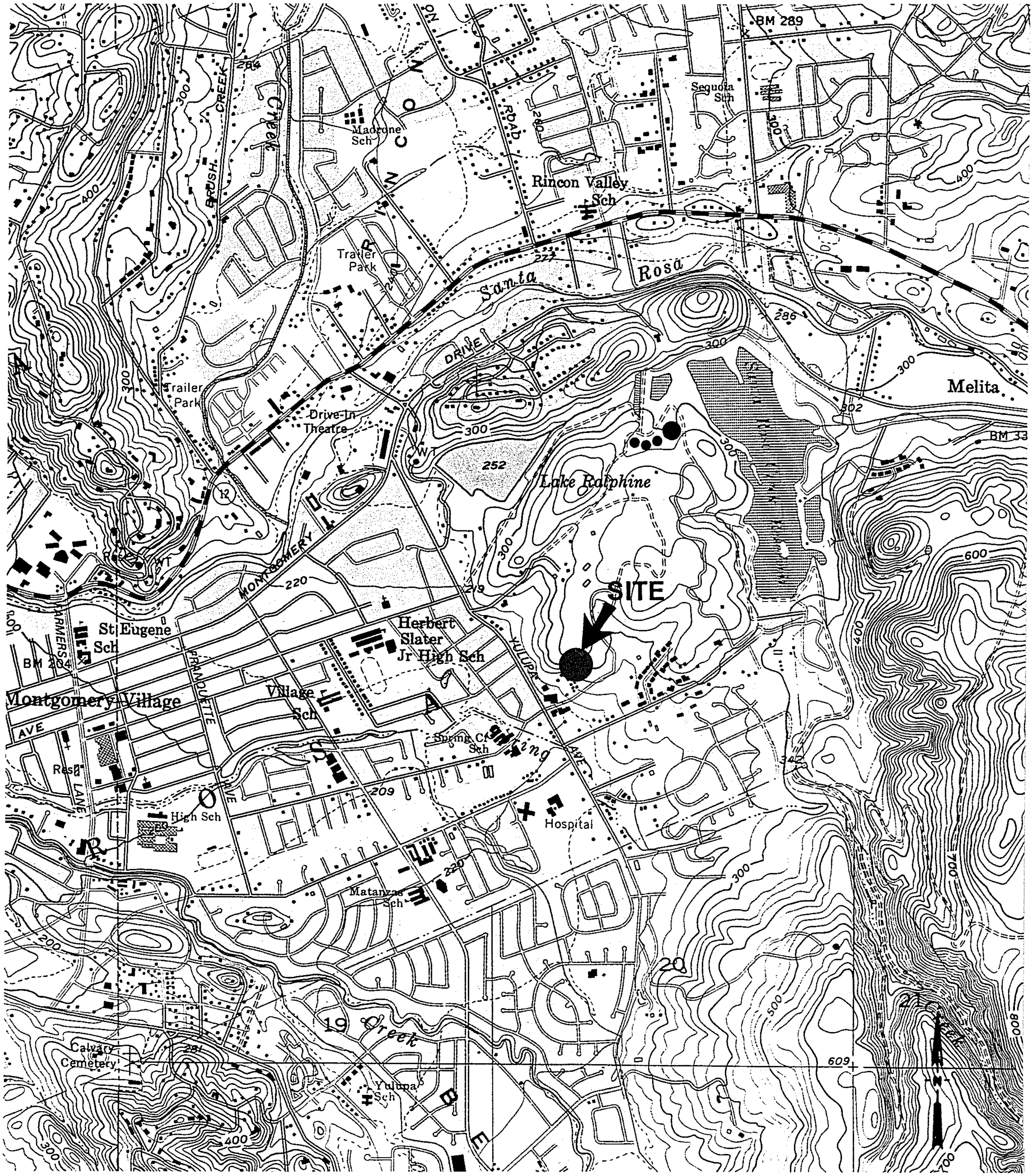
Our services consist of professional opinions and conclusions developed in accordance with generally accepted geotechnical engineering principles and practices. We provide no other warranty, either expressed or implied. Our conclusions and recommendations are based on the information provided to us regarding the proposed construction, the results of our field exploration, laboratory testing program, and professional judgement. Verification of our conclusions and recommendations is subject to our review of the project plans and specifications, and our observation of construction.

The test pits represent subsurface conditions at the locations and on the date indicated. It is not warranted that they are representative of such conditions elsewhere or at other times. Site conditions and cultural features described in the text of this report are those existing at the time of our field exploration and reconnaissance on September 11, 1997, and may not necessarily be the same or comparable at other times.

The scope of our services did not include an environmental assessment or an investigation of the presence or absence of hazardous, toxic or corrosive materials in the soil, surface water, groundwater or air (on, below or around this site), nor did it include an evaluation or investigation for the presence or absence of wetlands.

APPENDIX A - PLATES

LIST OF PLATES



Reference: U.S.G.S. Santa Rosa 7½-Minute Quadrangle

Scale: 1" = 2000'

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Job No: 1353.01.00.1

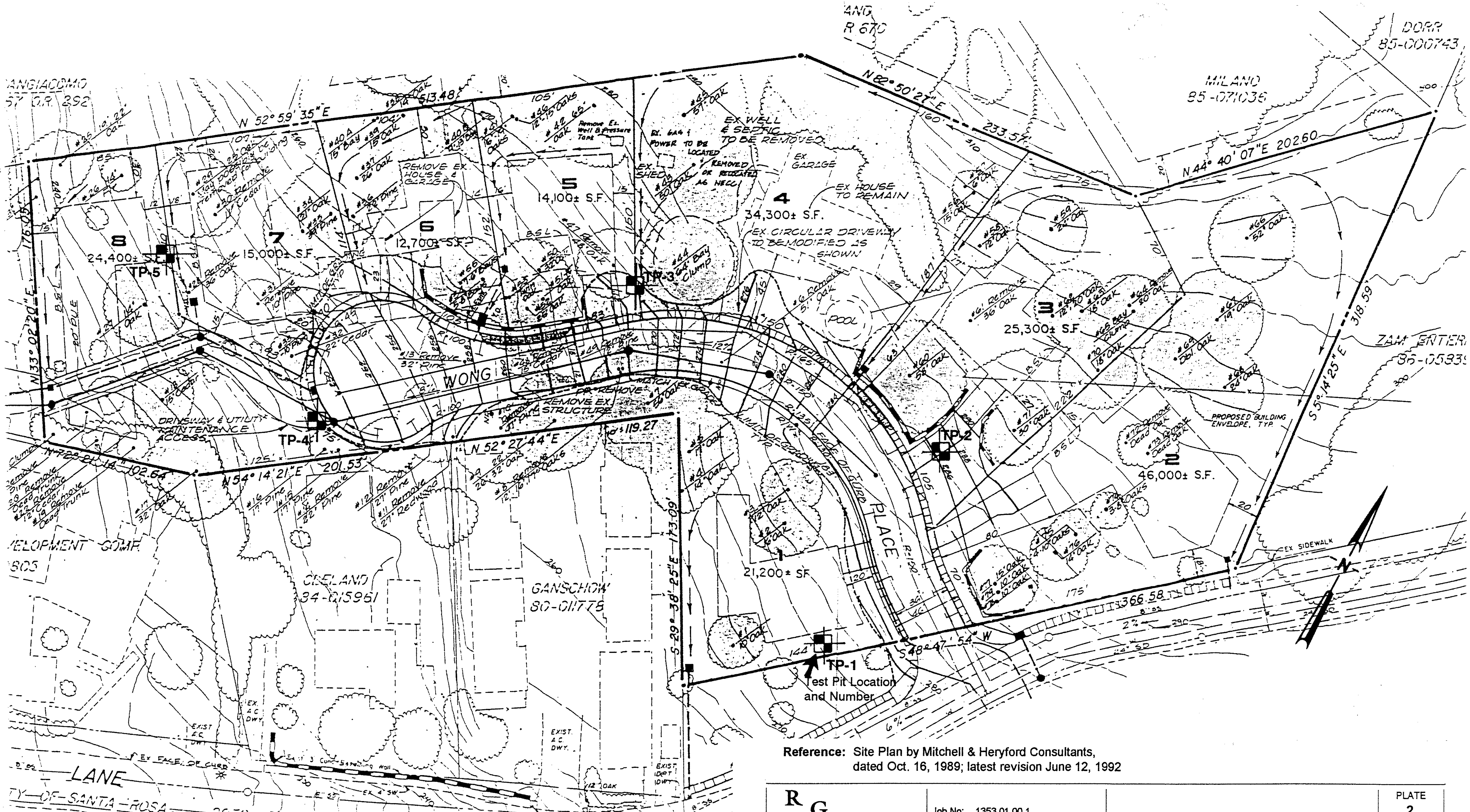
Appr: gra

Drwn: kab

Date: Sept. 1997

SITE LOCATION MAP
HOWARTH HEIGHTS SUBDIVISION
Santa Rosa, California

PLATE
1



Reference: Site Plan by Mitchell & Heryford Consultants, dated Oct. 16, 1989; latest revision June 12, 1992

RGH Geotechnical and Environmental Consultants	Job No: 1353.01.00.1 Appr: go Drwn: kab Date: Sept. 1997	**EXPLORATION PLAN** **HOWARTH HEIGHTS SUBDIVISION** Santa Rosa, California	PLATE 2

Test Pit #	Depth (ft)	Description
1	0-1.0	DARK RED SANDY CLAY (CL) - dry; porous, weak, with low plasticity; abundant andesite rocks to 30" ϕ
	1.0-1.5	GRAY-REDDISH GRAY ANDESITE - massive, closely spaced fractures, hard, strong, moderately-slightly weathered (Sonoma Volcanics)
		No Free Water Observed
2	0-1.0	DARK RED SANDY CLAY (CL) - dry; porous, weak; abundant andesite rocks up to 8" ϕ
	1.0-1.75	GRAY ANDESITE - massive, closely spaced fractures, hard, strong, moderately-slightly weathered (Sonoma Volcanics)
		No Free Water Observed
3	0-2.75	DARK RED CLAYEY SANDY (SC) / SANDY CLAY (CL) - medium stiff, dry; porous to 2.8', with small rock fragments
	2.75-5.0	DARK RED SANDY CLAY (CL) - stiff, moist; with volcanic rock to 16" ϕ
		No Free Water Observed
4	0-2.0	DARK RED SANDY CLAY (CL) - soft-medium stiff, dry; porous, with low plasticity
	2.0-3.0	LIGHT GRAY ANDESITE - moderately hard, moderately strong, moderately weathered (Sonoma Volcanics)
		No Free Water Observed
5	0-1.5	DARK RED SANDY CLAY (CL) - soft-medium stiff, dry; porous
	1.5-3.0	LIGHT GRAY ANDESITE - moderately hard, moderately strong, moderately weathered (Sonoma Volcanics)
		No Free Water Observed

R G H

Geotechnical and Environmental Consultants

Job No: 1353.01.00.1

Appr:

Drwn: kab

Date: Sept. 1997

SUMMARY OF TEST PIT DATA
HOWARTH HEIGHTS SUBDIVISION
Santa Rosa, California

PLATE
3

MAJOR DIVISIONS					TYPICAL NAMES
COARSE GRAINED SOILS More Than Half Is Larger Than #200 Sieve	GRAVELS More Than Half Coarse Fraction Is larger Than No. 4 Sieve Size	Clean Gravels With Little or No Fines	GW		Well Graded Gravels, Gravel - Sand Mixtures
			GP		Poorly Graded Gravels, Gravel - Sand Mixtures
		Gravels With Over 12% Fines	GM		Silty Gravels, Poorly Graded Gravel - Silt - Silt Mixtures
			GC		Clayey Gravels, Poorly Graded Gravel - Sand - Clay Mixtures
	SANDS More Than Half Coarse Fraction Is Smaller Than No. 4 Sieve Size	Clean Sands With Little or No Fines	SW		Well Graded Sands, Gravelly Sands
			SP		Poorly Graded Sands, Gravelly Sands
		Sands With Over 12% Fines	SM		Silty Sands, Poorly Graded Sand - Silt Mixtures
			SC		Clayey Sands, Poorly Graded Sand - Clay Mixtures
FINE GRAINED SOILS More Than Half Is Smaller Than #200 Sieve	SILTS AND CLAYS Liquid Limit Less Than 50		ML		Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands, or Clayey Silts with Slight Plasticity
			CL		Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
			OL		Organic Clays and Organic Silty Clays of Low Plasticity
	SILTS AND CLAYS Liquid Limit Greater Than 50		MH		Organic Silts, Micaceous or Diatomacious Fine Sandy or Silty Soils, Elastic Silts
			CH		Inorganic Clays of High Plasticity, Fat Clays
			OH		Organic Clays of Medium to High Plasticity, Organic Silts
HIGHLY ORGANIC SOILS			Pt		Peat and Other Highly Organic Soils

UNIFIED SOIL CLASSIFICATION SYSTEM

Shear Strength, psf
Confining Pressure, psf

Consol	-	Consolidation
LL	-	Liquid Limit (In %)
PL	-	Plastic Limit (In %)
PI	-	Plastic Index
G_s	-	Specific Gravity
SA	-	Sieve Analysis
■		"Undisturbed" Sample
⊠		Bulk or Disturbed Sample
◩		Standard Penetration Test
□		Sample Attempt With No Recovery

Tx	320	(2600)	Unconsolidated Undrained Triaxial
Tx CU	320	(2600)	Consolidated Undrained Triaxial
DS	2750	(2000)	Consolidated Drained Direct Shear
FVS	470		Field Vane Shear
UC	2000		Unconfined Compression
LVS	700		Laboratory Vane Shear
SS -	Shrink Swell		
EXP -	Expansion		
P -	Permeability		

Note: All strength tests on 2.8" or 2.4" diameter sample unless otherwise indicated.

KEY TO TEST DATA

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SOIL CLASSIFICATION CHART AND KEY TO TEST DATA
HOWARTH HEIGHTS SUBDIVISION
Santa Rosa, California

PLATE
4

ROCK SYMBOLS

SHALE OR CLAYSTONE	CHERT	SERPENTINITE
SILTSTONE	PYROCLASTIC	METAMORPHIC ROCKS
SANDSTONE	VOLCANIC	ALTERED ROCKS
CONGLOMERATE	PLUTONIC	SHEARED ROCK

LAYERING

MASSIVE	Greater than 6 feet
THICKLY BEDDED	2 to 6 feet
MEDIUM BEDDED	8 to 24 inches
THINLY BEDDED	2-1/2 to 8 inches
VERY THINLY BEDDED	3/4 to 2-1/2 inches
CLOSELY LAMINATED	1/4 to 3/4 inches
VERY CLOSELY LAMINATED	Less than 1/4 inch

JOINT, FRACTURE, OR SHEAR SPACING

VERY WIDELY SPACED	Greater than 6 feet
WIDELY SPACED	2 to 6 feet
MODERATELY SPACED	8 to 24 inches
CLOSELY SPACED	2-1/2 to 8 inches
VERY CLOSELY SPACED	3/4 to 2-1/2 inches
EXTREMELY CLOSELY SPACED	Less than 3/4 inch

HARDNESS

Soft - pliable; can be dug by hand

Firm - can be gouged deeply or carved with a pocket knife

Moderately Hard - can be readily scratched by a knife blade; scratch leaves heavy trace of dust and is readily visable after the powder has been blown away

Hard - can be scratched with difficulty; scratch produces little powder and is often faintly visible

Very Hard - cannot be scratched with pocket knife, leaves a metallic streak

STRENGTH

Plastic - capable of being molded by hand

Friable - crumbles by rubbing with fingers

Weak - an unfractured specimen of such material will crumble under light hammer blows

Moderately Strong - specimen will withstand a few heavy hammer blows before breaking

Strong - specimen will withstand a few heavy ringing hammer blows and usually yields large fragments

Very Strong - rock will resist heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments

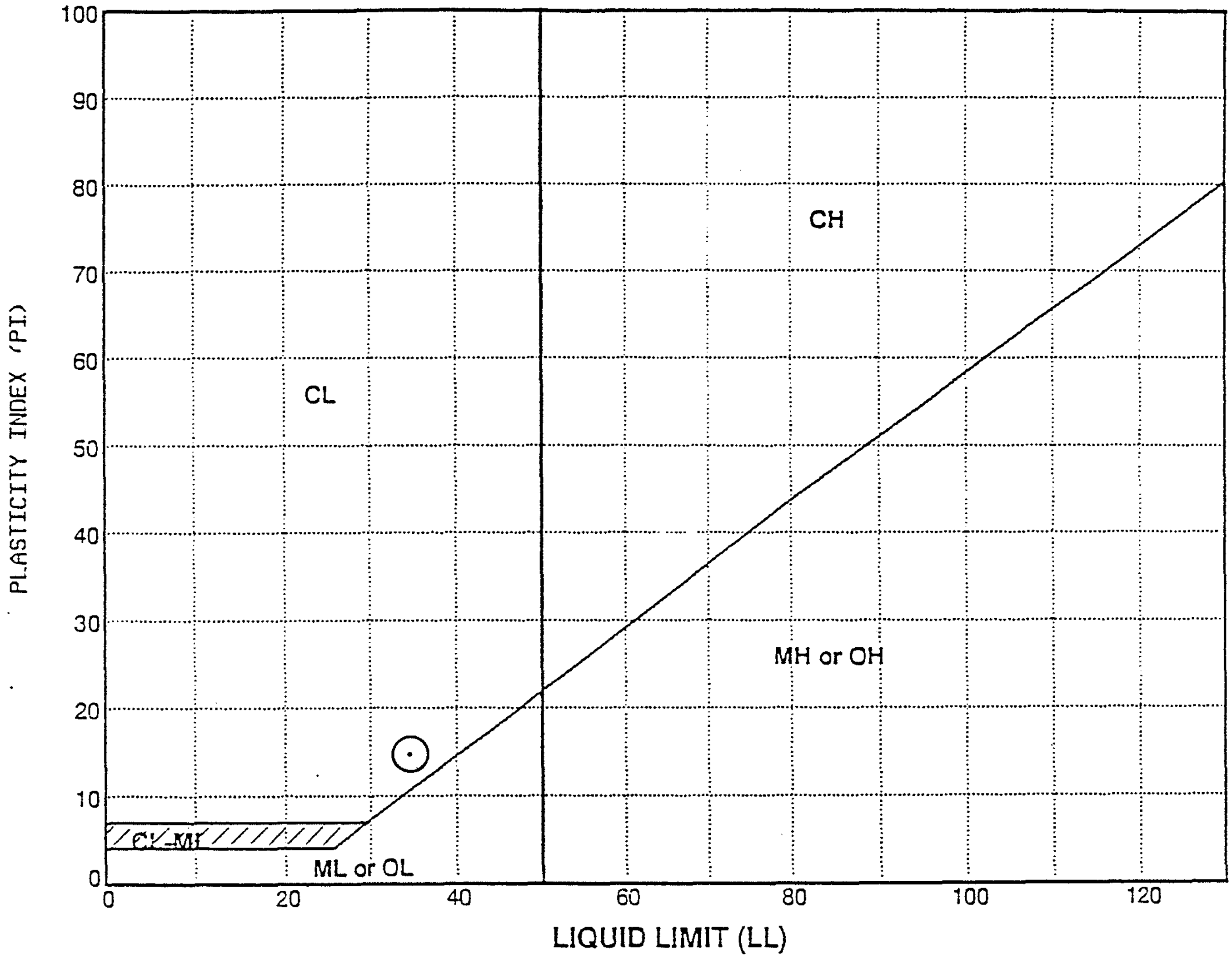
DEGREE OF WEATHERING

Highly Weathered - abundant fractures coated with oxides, carbonates, sulphates, mud, etc., thorough discoloration, rock disintegration, mineral decomposition

Moderately Weathered - some fracture coating, moderate or localized discoloration, little to no effect on cementation, slight mineral decomposition

Slightly Weathered - a few stained fractures, slight discoloration, little or no effect on cementation, no mineral decomposition

Fresh - unaffected by weathering agents, no appreciable change with depth



SAMPLE SOURCE	CLASSIFICATION	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	FREE SWELL (%)	% PASSING #200 SIEVE
⊙ TP-3 @ 0.5'	Dark Red Sandy Clay (CL)	35	20	15	10	43

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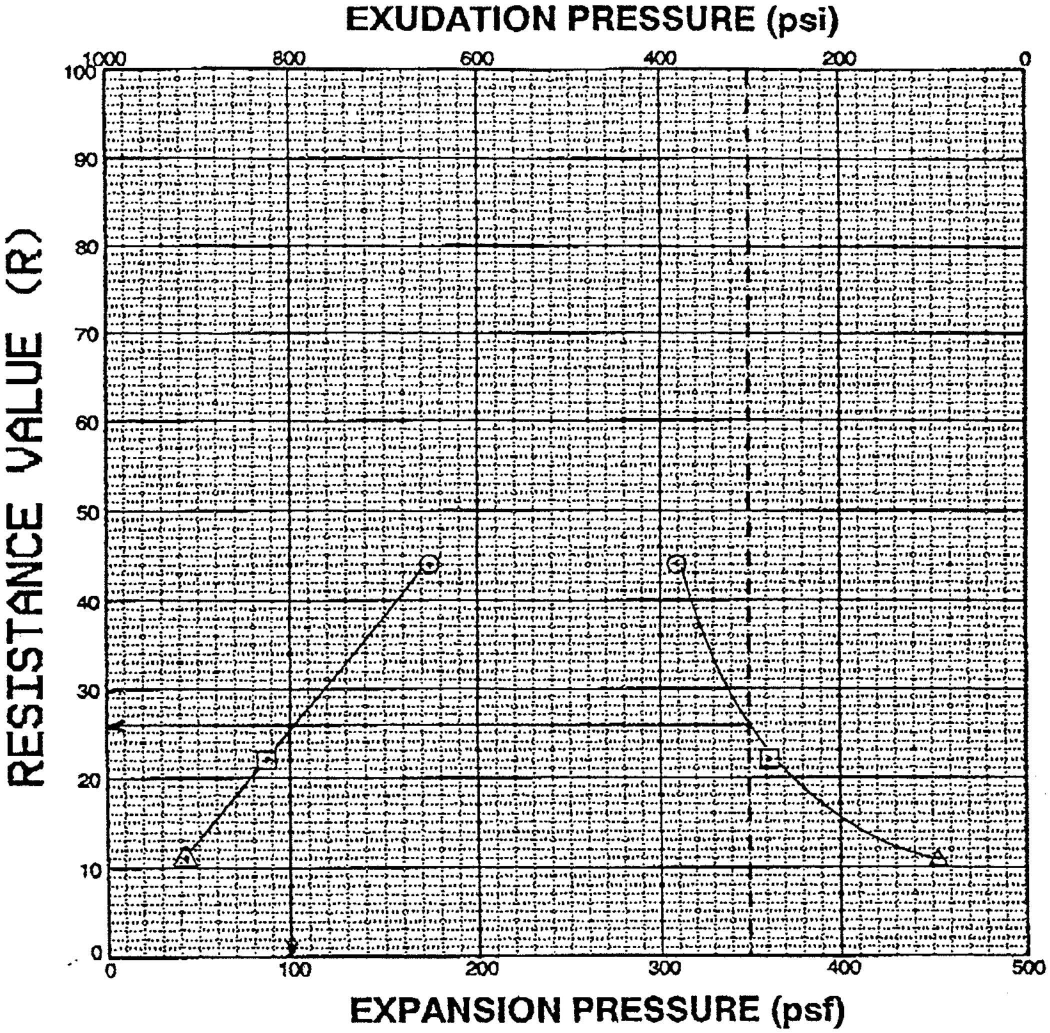
Date: Sept. 1997

CLASSIFICATION TEST DATA
HOWARTH HEIGHTS SUBDIVISION
Santa Rosa, California

PLATE
6



SPECIMEN NO.	⊙	⊡	△
MOISTURE CONTENT (%)	18.2	19.0	19.7
DRY DENSITY (PCF)	107	105	104
EXUDATION PRESSURE (PSI)	382	278	95
EXPANSION PRESSURE (PSF)	173	87	43
RESISTANCE VALUE (R)	44	22	11

SAMPLE SOURCE	CLASSIFICATION	UBC EXPANSION INDEX	EXPANSION PRESSURE	R-VALUE
BULK A @ 0.50	Red Brown Sandy Silty Clay (CL-ML)	21	100	26

ASTM D 2844, Cal Test 301

Expansion Index = 21 (Low)

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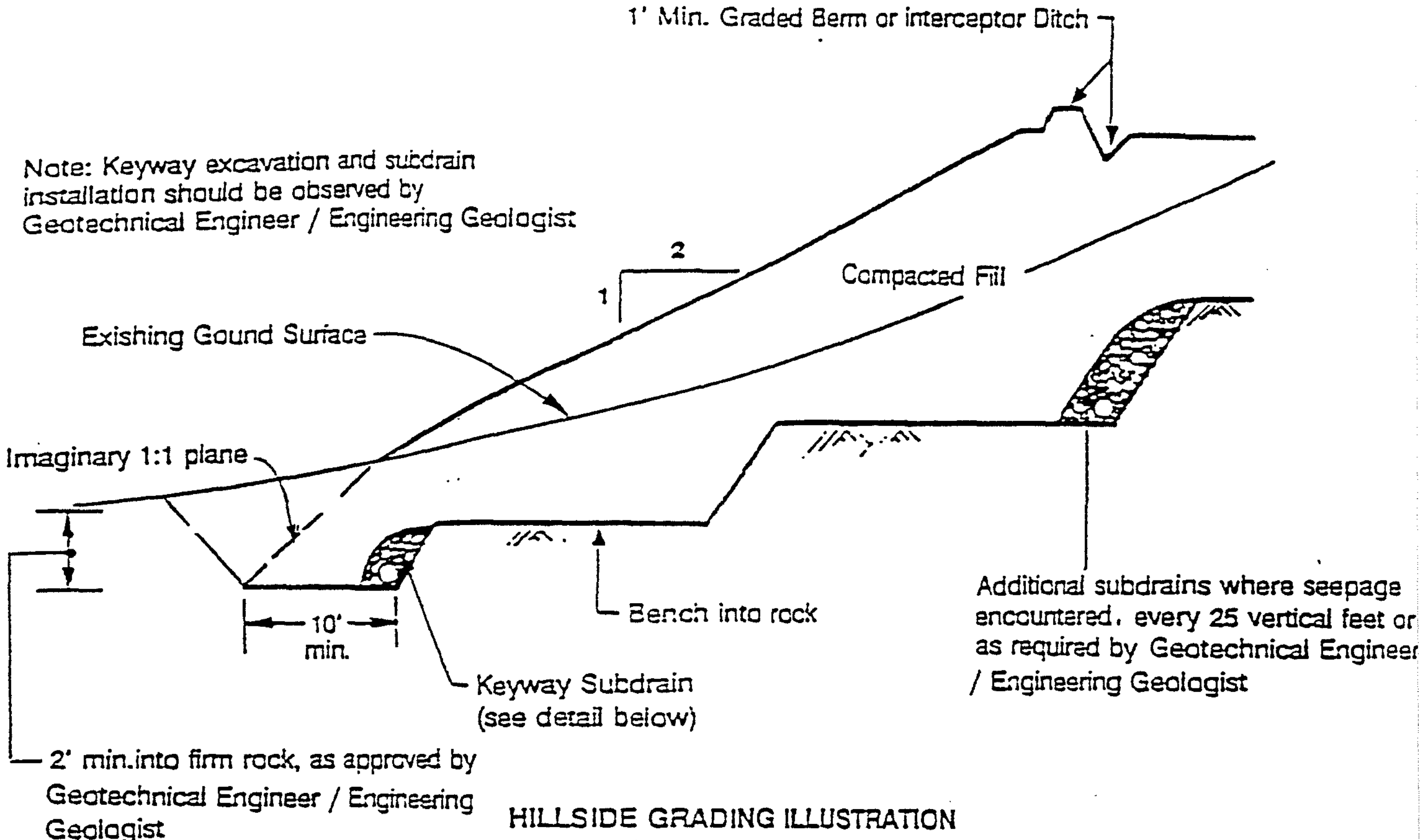
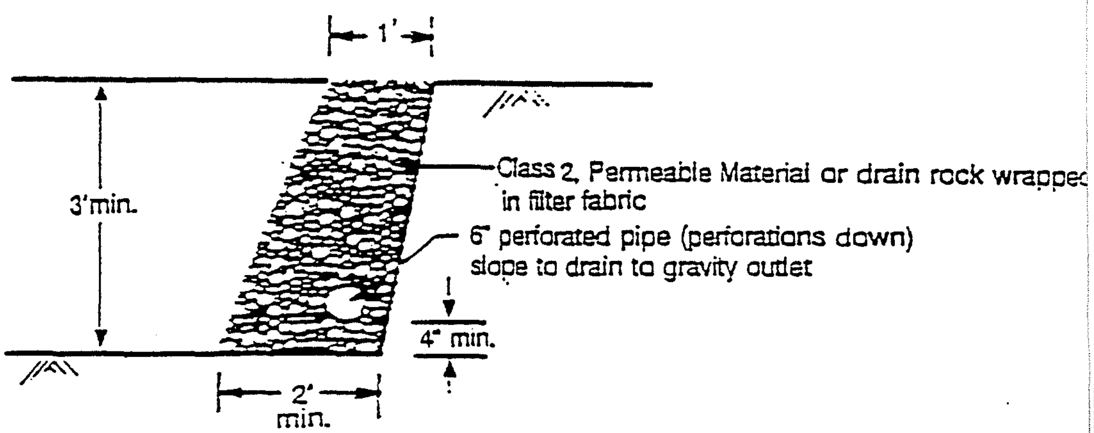
Date: Sept. 1997

RESISTANCE (R) VALUE DATA AND EXPANSION INDEX TEST
HOWARTH HEIGHTS SUBDIVISION
Santa Rosa, California

PLATE
7

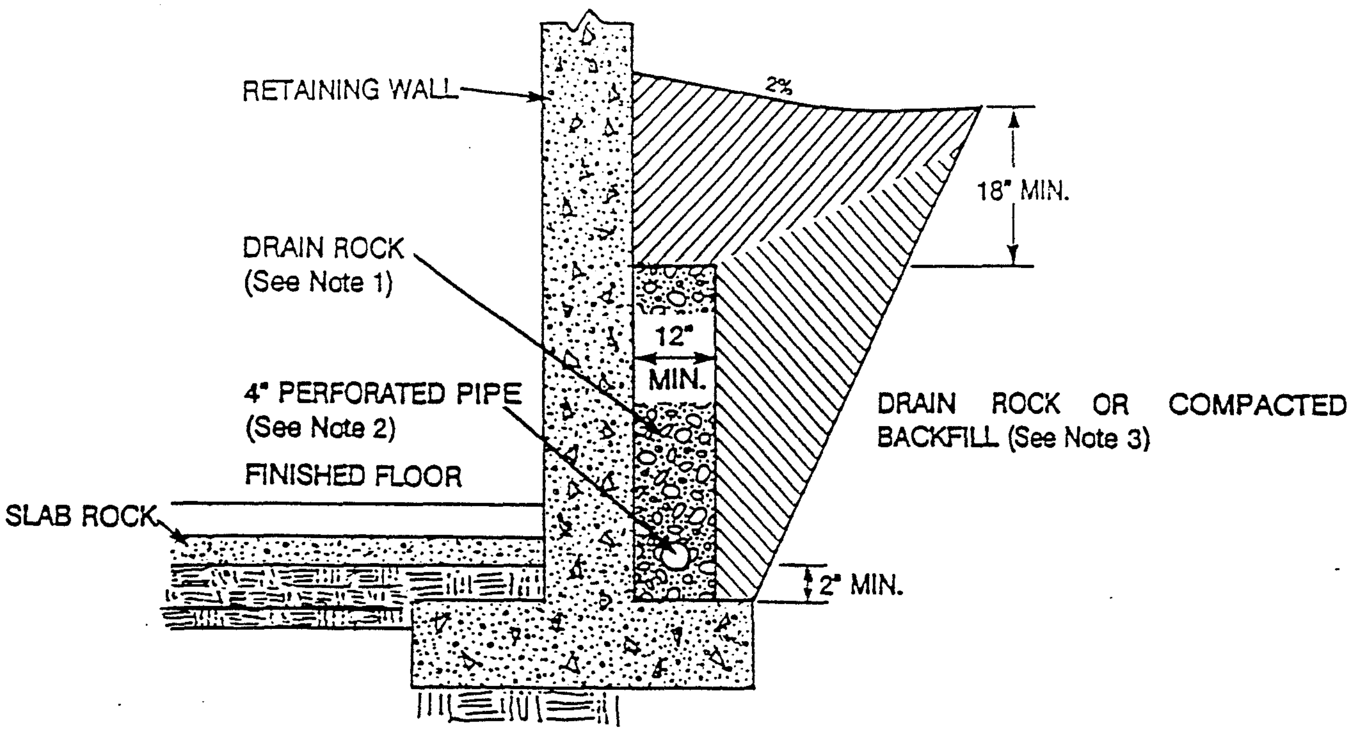


HILLSIDE GRADING ILLUSTRATION
(Not to Scale)



KEYWAY SUBDRAIN
(Not to Scale)

R G H Geotechnical and Environmental Consultants	Job No: 1353.01.00.1 Appr: *(initials)* Drwn: kab Date: Sept. 1997	**HILLSIDE GRADING ILLUSTRATION** **HOWARTH HEIGHTS SUBDIVISION** Santa Rosa, California	PLATE **8**



NOTES:

1. Drain rock should be clean, free-draining ¾-inch crushed rock, or gravel wrapped in filter fabric (Mirafi 140N or equivalent) or Class 2 Permeable Material, Section 68, California, "Caltrans" Standard Specification, latest edition. Drain rock should be placed to approximately three-quarters the height of the retaining wall. Alternatively, a prefabricated drainage structure (Miradrain 6000 or equivalent) installed to the manufacturer's recommendations, may be used in lieu of the drain rock wrapped in filter fabric or Class 2 Permeable Material.

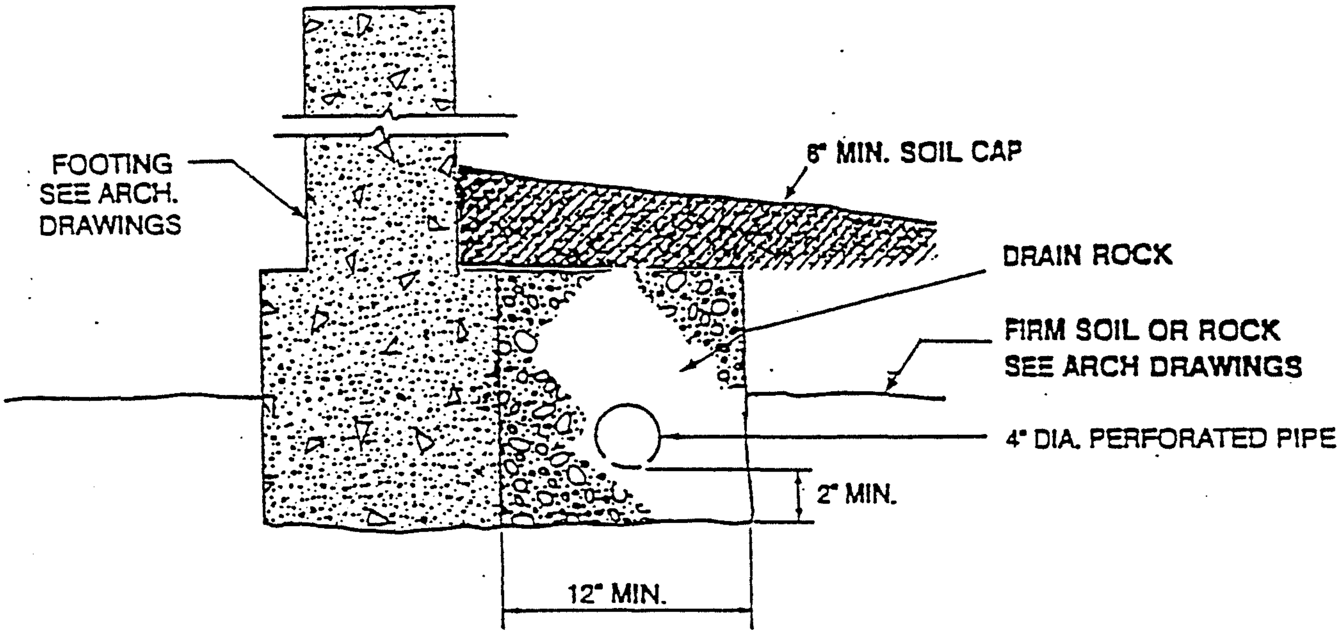
2. Pipe should conform to the requirements of Section 68 of Standard Specification, perforations placed down, sloped at 1 percent for gravity flow to outlet or sump with automatic pump. The pipe invert should be located at least 8 inches below the finished floor grade.

3. During compaction, the contractor should use appropriate methods, such as temporary bracing and/or light compaction equipment to avoid overstressing the walls.

Not to Scale

... Red Sandy Clay (CL)
/Clayed Sand (SC)

RGH Geotechnical and Environmental Consultants	Job No: 1353.01.00.1 Appr: gp Drwn: kab Date: Sept. 1997	**RETAINING WALL BACKDRAIN ILLUSTRATION** **HOWARTH HEIGHTS SUBDIVISION** Santa Rosa, California	PLATE 9



NOTES:

1. Drain rock should be clean, free draining and meet the requirements for Class 1, Type B, Permeable Material, Section 68, State of California "Caltrans" Standard Specification, latest edition. Alternatively, 3/4 inch or 1-1/2 inch crushed drain rock separated from the adjacent soil/rock by non-woven filter fabric could be used.

2. Pipe should conform to the requirements of Section 68 of State of California "Caltrans" Standards, perforations placed down; drain to gravity outlet or storm drain system per plan.

   Perforated pipe should be a minimum of 8" below concrete slab-on grade floor.

Not to Scale

R G H Geotechnical and Environmental Consultants	Job No: 1353.01.00.1 Appr: ga Drwn: kab Date: Sept. 1997	**PERIMETER FOUNDATION DRAIN ILLUSTRATION** **HOWARTH HEIGHTS SUBDIVISION** Santa Rosa, California

PLATE
10

APPENDIX B - REFERENCES

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APPENDIX C - DISTRIBUTION

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