

**APPENDIX E**  
**GEOTECHNICAL EXPLORATION**

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**GEOTECHNICAL EXPLORATION  
SHEHADEH PROPERTY  
SACRAMENTO, CALIFORNIA**

**SUBMITTED  
TO  
RYLAND HOMES  
SACRAMENTO, CALIFORNIA**

**PREPARED  
BY  
ENGEIO INCORPORATED  
PROJECT NO. 7103.4.001.01  
DECEMBER 17, 2005  
REVISED MARCH 30, 2006**

Project No.  
**7103.4.001.01**

December 17, 2005  
Revised March 30, 2006

Mr. Chad Kiltz  
Ryland Homes  
2400 Del Paso Road, Suite 250  
Sacramento, CA 95834

Subject: Shehadeh Property  
APN 226-0062-004, 226-0062-008, 226-0062-009,  
226-0062-011, and 226-0102-001  
Rio Linda Boulevard  
Sacramento, California

**GEOTECHNICAL EXPLORATION**

Dear Mr. Kiltz:

With your authorization, we conducted a geotechnical exploration for the subject property located in Sacramento, California. In our opinion, the subject property is suitable for future residential construction from a geotechnical standpoint, provided that the recommendations contained herein are implemented. The accompanying report contains the findings of our study and geotechnical recommendations for the proposed development.

We are pleased to have been of service to you on this project, and we will be glad to consult further with you and your design team.

Very truly yours,

ENGEO INCORPORATED

*FOR:*   
Steve Harris, PE  
sdh/jb:gex

Reviewed by:

*D.B.*  
  
Daniel S. Haynesch, GE

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## INTRODUCTION

### Purpose and Scope

The purpose of this report is to provide you and your design team with the results of our geotechnical study, including recommendations for the design and construction of the proposed residential development located in Sacramento, California.

The scope of our work has included a review of available literature and geologic maps pertaining to the site, exploratory drilling and sampling, laboratory testing on selected samples obtained in our borings, engineering analysis, and preparation of this report summarizing our conclusions and recommendations for design of the proposed development.

A parcel map showing the location of the proposed development was provided to us by Ryland Homes to aid us in our exploration.

This report was prepared for the exclusive use of Ryland Homes and their design team consultants for design of the proposed development. In the event that any changes are made in the character, design or layout of the development, the conclusions and recommendations contained in this report should be reviewed by ENGEO Incorporated to determine if modifications to the report are necessary. This report may not be reproduced in whole or in part by any means whatsoever, nor may it be quoted or excerpted without the express written consent of ENGEO Incorporated.

### Site Location and Description

The subject property is located north of the intersection of Rio Linda Boulevard and Marysville Boulevard in Sacramento, California as shown on the Vicinity Map, Figure 1. The

site is approximately 25.2 acres, and identified as Assessor's Parcel Numbers (APN) 226-0062-004, 226-0062-008, 226-0062-009, 226-0062-011, and 226-0102-001 . The site is relatively level and is bordered on the southwest by Rio Linda Boulevard, on the east by a bike path and to the north by undeveloped property.

The property is currently a vacant field. No structures were observed on the site at the time of our reconnaissance. Numerous piles of concrete rubble and debris were located on the northeastern portion of the site and some non-engineered fill was located on the southern portion of the site as shown on the Site Plan, Figure 2.

#### Proposed Development

Based on discussions with Ryland Homes, the proposed development will consist of constructing single-family residences with interior streets and utilities. We anticipate relatively light loadings for one- or two-story, wood-framed single-family structures. It is our understanding that the site grading for this project will likely include only minor cutting and filling to establish pads and streets.

## **GEOLOGY AND SEISMICITY**

### Geology

The geology of the site is mapped as Quaternary Holocene age Riverbank Formation (Qr) (Wagner et al. 1991). The Riverbank Formation is mapped as stream terrace deposits of clay, silt, sand, and gravel lenses. These semi-consolidated lenses are not necessarily continuous and may vary considerably across the site due to ancient stream depositional characteristics.

### Regional Faulting and Seismicity

As with the rest of the Central Valley in Northern California, the site is situated between two seismically active regions (CDMG Open-File Report 96-08). According to parameters of the 1997 Uniform Building Code, this site is in Earthquake Zone 3. Our review of geologic literature did not identify the presence of known active or potentially active faults on the project site. The Geologic Map of the Sacramento Quadrangle (Jennings 1992) shows no faults mapped within the property. The California Geological Survey does not list Sacramento as an area included in the Alquist-Priolo earthquake hazard zones.

To evaluate potential levels of ground shaking, we used Blake's computer program, EQFAULT (2004) to locate potential seismic sources within 100 kilometers (62 miles) of the site. Two of the closest known faults classified as active by the State of California Geologic Survey (CGS) are the Foothills Fault System located approximately 19 miles to the east and the Great Valley fault located approximately 30 miles to the west. The Great Valley fault is omitted from the ICBO 1998 document, "Maps of Known Active Fault Near-Source Zones in California and Adjacent Properties of Nevada" based on a lack of surface expression.

Table I lists distances to the closest known active and potentially active faults and summarizes their estimated earthquake magnitudes and ground shaking potentials.

TABLE I

Fault Name	Approximate Distance Mi. (km)	Maximum Moment Mag. <sup>1</sup>	Peak Site Acc. (G) <sup>2</sup>	Est. Site Intensity Mod. Merc.
Foothills Fault System	19 (30)	6.5	0.15	VIII
Great Valley	30 (49)	6.9	0.11	VII
Hunting Creek - Berryessa	43 (69)	7.1	0.07	VII
Concord / Green Valley	44 (71)	6.7	0.06	VI
West Napa	53 (85)	6.5	0.04	V
Mount Diablo	58 (93)	6.7	0.05	VI
Greenville	58 (93)	6.7	0.04	V
Bartlett Springs Fault System	60 (96)	7.6	0.07	VII

1 - SOURCE: CDMG, OPEN-FILE REPORT 96-08.

2 - ATTENUATION RELATION: IDRIS (1994) HORIZ - DEEP SOIL

### Field Exploration

Four exploratory borings were drilled on December 6, 2005. The approximate exploration locations are shown on the Site Plan, Figure 2, and the logs of the exploratory borings are included as Figures A-1 through A-4 in Appendix A. The exploration locations were approximately located by estimating from existing features.

Exploratory Borings B-1 through B-4 were drilled with a truck-mounted Mobil Drill B-24 drill rig equipped with 4-inch-diameter solid flight augers. An ENGEO engineer logged the borings in the field and collected soil samples using either a 3.0-inch O.D. California-type split-spoon sampler fitted with 6-inch-long brass liners, or a 2-inch O.D. Standard Penetration Test (SPT) split-spoon sampler. The samplers were advanced with a 140-pound hammer with a

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30-inch drop, employing a manual trip hydraulic hammer system. The penetration of the samplers into the native materials was field recorded as the number of blows needed to drive the sampler 18 inches in 6-inch increments. Blow count results on the boring logs were recorded as the number of blows required for the last one foot of penetration and have not been converted using any correction factors.

The logs depict subsurface conditions within the borings at the time the exploration was conducted. Subsurface conditions at other locations may differ from conditions noted at these boring locations. The passage of time may result in altered subsurface conditions. In addition, stratification lines represent the approximate boundaries between soil types and the transitions may be gradual.

Laboratory Testing

Selected samples recovered during drilling were tested to determine the following soil characteristics:

Characteristic	Test Method	Location of Results Within this Report
Natural Unit Weight and Moisture Content	ASTM D-2216	Appendix A
Plasticity Index	ASTM D-4318	Appendix B
Gradation	ASTM D-422	Appendix B

Unit weight and moisture content test results are shown on the boring logs (Appendix A, Figures A1 through A4) while the remaining test results are presented in Appendix B.

### Subsurface Stratigraphy

The soils encountered in our exploration were variable across the site but generally consisted of varying mixtures of clay and silt with occasional thin lenses of silty sand to sandy silt to the maximum depth explored of 20 feet. This description is consistent with the alluvial nature of the soil deposits at the site. All materials encountered were at least dense/stiff in consistency. The surficial soil generally has a moderate to high expansion potential. The exploratory boring logs presented in Appendix A provide detailed descriptions of the soil conditions at each location explored.

### Groundwater Conditions

Groundwater was not encountered within our borings. Based on review of the historical data for a local well, as published on the State of California Department of Water Resources Web Site, the groundwater in the area is approximately 40 feet below the existing ground surface. Fluctuations in groundwater levels are expected to occur seasonally in response to changes in precipitation, irrigation, and other factors not evident at the time of our exploration.

## **GEOLOGIC AND GEOTECHNICAL HAZARDS**

The site was evaluated with respect to known geological and geotechnical hazards common to the Sacramento Area. The primary hazards identified are described below. None of the hazards listed are considered unique to the property and affect most sites in the region.

### Seismic Hazards

Potential seismic hazards resulting from a nearby moderate to major earthquake can generally be classified as primary and secondary. The primary effect is ground rupture, also called surface faulting. The common secondary seismic hazards include ground shaking, ground lurching, soil liquefaction, and lateral spreading. These hazards are discussed in the following sections. Based on topographic and lithologic data, the risk of regional subsidence or uplift, or flooding from tsunamis or seiches is considered low to negligible at the site.

Ground Rupture. Since there are no known active faults crossing the property, and the site is not located within an Earthquake Fault Special Study Zone, it is our opinion that primary fault ground rupture is unlikely at the subject property.

Ground Shaking. The most significant seismic hazard to the proposed site is the secondary hazard of ground shaking. Earthquakes of moderate to high magnitude are expected to occur within Northern California and may occur during the design life of the project. These events may cause moderate ground shaking at the subject site during the design life of the proposed structures.

To mitigate the ground shaking effects, all structures should be designed using sound engineering judgment and the latest Uniform Building Code (UBC) requirements as a minimum.

The site is classified as a stiff soil profile. The following UBC parameters are provided for project design purposes.

1997 UNIFORM BUILDING CODE – Chapter 16

ITEM	DESIGN VALUE	UBC SOURCE
Seismic Zone	3	Figure 16-2
Seismic Zone Factor	0.30	Table 16-I
Soil Profile Type	S <sub>D</sub>	Table 16-J
Seismic Source Type	B	Table 16-U
Seismic Coefficient, C <sub>a</sub>	0.36	Table 16-Q
Seismic Coefficient, C <sub>v</sub>	0.54	Table 16-R

Seismic design provisions of current building codes generally prescribe minimum lateral forces, applied statically to the structure, combined with the gravity forces of dead and live loads. The code-prescribed lateral forces are generally substantially smaller than the expected peak forces that would be associated with a major earthquake. Therefore, structures should be able to: (1) resist minor earthquakes without damage, (2) resist moderate earthquakes without structural damage but with some nonstructural damage, and (3) resist major earthquakes without collapse but with some structural as well as nonstructural damage. Conformance to the current building code recommendations does not constitute a guarantee that significant structural damage would not occur in the event of a maximum magnitude earthquake; however, it is reasonable to expect that a well-designed and well-constructed structure will not collapse or cause loss of life in a major earthquake (SEAOC, 1996).

Liquefaction. Liquefaction is a phenomenon in which saturated, cohesionless soils are subject to a temporary, but essentially total, loss of shear strength because of pore pressure buildup under the reversing cyclic shear stresses associated with earthquakes. The potential for liquefaction is

considered to be low because of the depth to groundwater, dense nature of the site soils, and the relatively low levels of expected ground shaking.

Dynamic Densification Due to Earthquake Shaking. Densification of loose granular soils above the groundwater level can cause settlement due to earthquake-induced vibrations. The potential for dynamic densification at the site is expected to be low.

Lateral Spreading. Lateral spreading is a failure within a nearly horizontal soil zone that causes the overlying soil mass to move down a gentle slope or toward a free face such as a creek or open body of water. Lateral spreading is most often associated with strength loss due to liquefaction. As described above, the liquefaction potential of the subsurface soils is considered to be low. For this reason, the potential for lateral spreading at the site during seismic shaking is also considered to be low.

Lurching. Ground lurching occurs as a result of the rolling motion imparted to the ground surface during energy released by an earthquake. The deformation of the ground surface by such rolling motion can cause ground cracks to form. The potential for the formation of these cracks is considered greater at contacts between material with significantly different properties, such as deep soft soil and bedrock. Such an occurrence is possible at the subject site as in other locations in the Sacramento Area, but the offset or strain is expected to be minor.

## CONCLUSIONS AND RECOMMENDATIONS

### General

Based on the exploration and laboratory test results, it is our opinion that the site is feasible for construction of the proposed single-family residential subdivision from a geotechnical standpoint. The recommendations included in this report, along with other sound engineering practices, should be incorporated in the design and construction of the project. ENGEO should be retained to review the development plan prior to construction to confirm that the conclusions contained herein are appropriate and valid for the design-specific details.

Based on a review of the surrounding developments, we anticipate that minor grading will be required to provide drainable grades for the site and building pads. Grading operations should meet the requirements of the Guide Contract Specifications included in Appendix C and must be observed and tested by ENGEO's field representative. ENGEO should be notified a minimum of 72 hours prior to grading in order to coordinate its schedule with the grading contractor.

Ponding of stormwater, other than within engineered detention basins, should not be permitted at the site, particularly during work stoppage for rainy weather. Before the grading is halted by rain, positive slopes should be provided to carry the surface runoff to storm drainage structures in a controlled manner to prevent erosion damage.

### Demolition and Stripping

Grading should begin with the removal of non-engineered fill, buried pipes, irrigation lines, debris piles, old foundations, designated fences, trees and associated root systems, and any other

deleterious materials. Underground structures that will be abandoned or are expected to extend below proposed finished grades should be removed from the project site.

All vegetation in areas to be graded should also be removed as necessary for project requirements. The depth of removal of these materials should be determined by ENGEO at the time of grading.

Tree roots should be removed to a depth of 2 to 3 feet below existing grades. The organically contaminated materials should not be used in proposed building pads or pavement areas. The organics should be stockpiled and may be used in landscape areas or may be off hauled. Any debris found within any areas to be graded should be removed.

The actual depth of removal should be determined in the field by a representative of ENGEO based on actual conditions encountered during the site grading. Excavations resulting from demolition and stripping below design grades should be cleaned to a firm undisturbed, non-yielding soil surface as determined by ENGEO.

As an alternative to stripping of organic material, agricultural fields and/or fallow open fields may be cut/harvested as low to the ground as possible and as close to the time of grading as practical. The organic material should be hauled off site or to landscaping areas subject to approval by the landscape architect. The remaining stubs of the crops/grass and roots then may be thoroughly disced into the underlying soil providing the organic content of the resulting soil does not exceed 3 percent organic content.

All backfilling of depressions resulting from demolition, stripping, or removal of tree root bulb excavations, should be observed by ENGEO. ENGEO should be notified prior to the backfill of

any depression to observe the backfill operations. Tree removal should be monitored by ENGEO on a part-time basis, with full-time observation of the backfill operations.

### Subgrade Preparation

After the site has been properly cleared, stripped and necessary excavations have been made, a minimum of the upper 12 inches should be scarified, moisture conditioned, and compacted in accordance with the recommendations presented below in the “Fill Placement” section.

Except for landscaping areas, the site should be underlain by a minimum depth of 12 inches of moisture conditioned and compacted engineered fill. The compaction recommendations for the preparation of existing soil prior to fill placement are the same as those for engineered fill, as described in a subsequent section of this report.

### Selection of Materials

With the exception of any organically contaminated materials (soil that contains more than 3 percent organic material by weight), the site soils are suitable for use as engineered fill. ENGEO should be informed when import materials are planned for the site. Import materials should be submitted and approved by ENGEO prior to delivery at the site; should be free of organic material, debris, and fragments larger than 6 inches in greatest dimension; and should have a Plasticity Index consistent with the on-site material.

### Fill Placement

Once the subgrade is prepared in accordance with the above recommendations, the surface of all areas to receive fill should be scarified to a minimum depth of 12 inches, moisture conditioned, and recompacted as engineered fill to provide adequate bonding with the initial lift of fill. All fills

should be placed in uncompacted lifts not exceeding 8 inches. In cut portions of the site, a 12-inch scarification, moisture conditioning and recompaction of the exposed subgrade will be necessary, below the finished subgrade elevation.

The following compaction control recommendations should be applied to all fills:

Test Procedures:	ASTM D-1557 (latest edition).
Required Moisture Content:	A minimum of 4 percentage points above optimum moisture content.
Relative Compaction:	At between 88 and 92 percent relative compaction.

It is important that all site preparation, including demolition and stripping, be done under the observation of ENGEO and should be carried out according to the requirements contained herein.

### Foundation Design

It is our understanding that Ryland Homes prefers to use post-tensioned (PT) concrete mat slabs at the subject site. It is our opinion that PT mat foundations would be appropriate for the proposed residential structures. Post-tensioned mats should be designed according to methods recommended in the Post Tensioning Institute “Design and Construction of Post-Tensioned Slabs-on-ground” Second Edition dated 1996.

PT mats should be a minimum of 10 inches thick with a 2-inch thickened edge and be designed for an average allowable bearing pressure of 1,000 pounds per square foot (psf) for dead plus live loads, with maximum localized bearing pressures of 1,500 psf at column or wall loads. Allowable bearing pressures can be increased by one-third for all loads including wind or seismic.

Post-tensioned mats should be designed according to the method recommended in “Design and Construction of Post-Tensioned Slabs-On-Ground” (Post-Tensioning Institute, 1996). Based upon the existing soil conditions, we recommend using the following soil criteria for design of the post-tensioned mat foundations:

Center Lift Condition:                      Edge Moisture Variation Distance,  $e_m = 5.0$  feet  
Differential Soil Movement,  $y_m = 2.6$  inches

Edge Lift Condition:                         Edge Moisture Variation Distance,  $e_m = 4.0$  feet  
Differential Soil Movement,  $y_m = 1.1$  inch

Recommended minimum mat thickness = 10 inches, with 2-inch thickened edge if sand bedding is used.

The actual thickness of the slab should be determined by the project Structural Engineer using the above-mentioned criteria. The minimum soil backfill height against the slab at the perimeter should be 6 inches.

Subgrade Treatment for Post-Tensioned Mat Foundations. The subgrade material under post-tensioned mats should be uniform. The pad subgrade should be moisture conditioned to a moisture content of at least 5 percentage points above optimum to a depth of 12 inches. The subgrade should be thoroughly soaked prior to placing the concrete. The subgrade should not be allowed to dry prior to concrete placement.

Foundation Concrete. No sulfate testing was performed as part of this study. We recommend that sulfate testing be performed on the graded lots prior to placing foundation concrete. As an alternative to performing sulfate testing, we recommend that the Structural Engineer consider using Type V plus pozzolan cement in the foundation and slab concrete for the subject site. A maximum water cement ratio of 0.45 and a minimum compressive strength of 4,500 psi should

be used for the foundation concrete if sulfate testing is not performed. Structural engineering requirements for strength design may result in more stringent concrete specifications.

Slab Moisture Vapor Reduction. When buildings are constructed with concrete mat foundations, water vapor from beneath the concrete mat will migrate through the slab and into the building. This water vapor can be reduced but not stopped. Vapor transmission can negatively affect floor coverings and lead to increased moisture within a building. When water vapor migrating through the slab would be undesirable, we recommend that the concrete be underlain by a moisture retarder that meets ASTM E 1745 – 97 Class A requirements for water vapor permeance, tensile strength, and puncture resistance. All joints and penetrations of the vapor retarder medium should be sealed.

The Structural Engineer or a Concrete Technology expert should be consulted on the advisability of using a 2-inch-thick sand cushion (Section 2.03, Part I of Guide Contract Specifications) under slabs for concrete curing purposes.

#### Secondary Slab-on-Grade Construction

Secondary slabs include exterior walkways, driveways and steps. Secondary slabs-on-grade should be designed specifically for their intended use and loading requirements. Cracking of the exterior flatwork is normal as it is part of the concrete curing process and should be expected. Frequent control joints should be provided during slab construction for control of cracking.

Secondary slabs-on-grade should have a minimum thickness of 4 inches and should be underlain by a 4-inch-thick layer of clean, crushed rock or gravel. As a minimum requirement, slabs-on-grade should be reinforced with steel bars; in our experience, welded wire mesh may

not be sufficient to control slab cracking. The Structural Engineer should design the actual slab reinforcement.

Exterior slabs should be constructed with thickened edges extending at least 6 inches into compacted soil to minimize water infiltration and should slope away from the building to prevent water from flowing toward the foundations. Consideration should be given to lightly moistening the site soils just prior to concrete placement.

### Retaining Walls

Unrestrained drained retaining walls constructed on level ground may be designed for active lateral fluid pressures determined as follows:

<u>Backfill Slope Condition</u> <u>(horizontal:vertical)</u>	<u>Active Pressure</u> <u>(pound per cubic foot (pcf))</u>
Level	50
4:1	55
3:1	60
2:1	70

Passive pressures acting on foundations and keyways may be assumed as 250 pounds per cubic foot (pcf) provided that the area in front of the retaining wall is level for a distance of at least 10 feet or three times the depth of foundation and keyway, whichever is greater. The upper one foot of soil should be excluded from passive pressure computations unless it is confined by pavement or a concrete slab.

The friction factor for sliding resistance may be assumed as 0.35. We recommend that retaining wall footings be designed using an allowable bearing pressure of 2,500 pounds per square foot in firm native materials or fill. Appropriate safety factors against overturning and sliding should be incorporated into the design calculations.

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The Geotechnical Engineer should be consulted on design values where surcharge loads, such as from automobiles, are expected or where a downhill slope exists below a proposed wall.

All retaining walls should be provided with drainage facilities to prevent the build-up of hydrostatic pressures behind the walls. Wall drainage may be provided using a 4-inch-diameter perforated pipe embedded in Class 2 permeable material (Part I of Guide Contract Specifications, Section 2.05B), or free-draining gravel surrounded by synthetic filter fabric. The width of the drain blanket should be at least 12 inches. The drain blanket should extend to about one foot below the finished grades. As an alternative, prefabricated synthetic wall drain panels can be used. The upper one foot of wall backfill should consist of on-site clayey soils. Collector perforated pipes should be directed to an outlet approved by the Civil Engineer. Subdrain pipe, drain blanket and synthetic filter fabric should meet the minimum requirement as listed in Part I of the Guide Contract Specifications.

All backfill should be placed in accordance with recommendations provided above for engineered fill. Light equipment should be used during backfill compaction to minimize possible overstressing of the walls.

### Sound Walls

Sound walls may be supported by a pier-and-grade-beam foundation provided the following recommendations are incorporated into the design. Pier design and construction criteria are as follows:

Pier diameter:	Minimum 12 inches.
Pier depth:	Minimum 8 feet deep.

- Maximum allowable skin friction: 500 pounds per square foot (psf). This value may be increased by one-third when considering seismic or wind loads. Exclude the upper 36 inches from pier load capacity computations.
- Minimum pier spacing: 3 pier diameters, center-to-center. Where closer spacings are unavoidable, the piers should be designed with a reduced skin friction of 330 psf.

An equivalent fluid weight of 250 pounds per cubic foot acting on 1½ times the pier diameter may be used to evaluate passive resistance. The passive pressure may be increased by one-third for transient loads such as wind or seismic. The passive earth pressure starts at a depth of 12 inches or where there is 10 feet horizontal distance to daylight in sloping areas.

The Structural Engineer should design the pier reinforcement, but, as a minimum, at least two No. 4 rebars should extend the full length of each pier. Where applicable, the pier reinforcement should be tied to the grade beam as recommended by the Structural Engineer.

If the base of the sound wall retains soil, we recommend the design consider the lateral loads imposed by the soils using the design criteria presented in the Retaining Walls section above.

#### Preliminary Pavement Design

No R-Value testing was performed as part of this exploration; however, based on our experience in the area, we estimate that an R-value of 5 is appropriate for preliminary design. Using estimated traffic indices for various pavement loading requirements, we developed the following recommended pavement sections using Procedure 608 of the Caltrans Highway Design Manual (including the asphalt factor of safety), presented in the table below.

PRELIMINARY PAVEMENT SECTIONS

Traffic Index	AC (inches)	AB (inches)
4.5	2.5	9.0
5	3.0	10.0
5.5	3.5	11.0
6	3.5	13.0
6.5	4.0	14.0
7	4.0	16.0
8	4.5	19.0
9	5.5	21.0

Notes: AC is asphaltic concrete

AB is aggregate base Class 2 Material with minimum R = 78

The Traffic Index should be determined by the Civil Engineer or appropriate public agency. Once grading of the proposed street subgrade is completed, additional R-Value testing should be performed to verify or change the above preliminary pavement sections. Pavement construction and materials should comply with the requirements of the Standard Specifications of the State of California Division of Highways, City of Sacramento requirements and the following minimum requirements.

- All pavement subgrades should be scarified to a depth of 12 inches below finished subgrade elevation, moisture conditioned to at least 2 percentage points above optimum moisture, and compacted to a minimum of 95 percent relative compaction.
- Subgrade soils should be in a stable, non-yielding condition at the time aggregate base materials are placed and compacted.
- Adequate drainage must be designed by the project Civil Engineer such that the subgrade soils and aggregate base materials are not allowed to become saturated.
- Aggregate base materials should meet current Caltrans specifications for Class 2 aggregate base and should be compacted to at least 95 percent of maximum dry density at a minimum moisture content of optimum.
- Asphalt paving materials should meet current Caltrans specifications for asphalt concrete.

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- All concrete curbs separating pavement and irrigated landscaped areas should extend into the subgrade and below the bottom of adjacent aggregate base materials.

### Site Surface Drainage

The project site should be positively graded at all times to provide for rapid removal of surface water runoff away from foundation systems and to prevent ponding of water under floors or seepage toward foundations, pavements, or flatwork at any time during or after construction. Ponding of water may result in undesirable weakening of the subgrade materials, loss of compaction, slab and excessive slab or foundation movements.

No ponding of stormwater should be permitted on the building pads. All lots should be graded to drain individually. As a minimum requirement, finished grades should provide a slope of at least 3 percent within 5 feet from the exterior walls at right angles to them to allow surface water to drain positively away from the structures. Care should be exercised to provide that landscape mounds will not interfere with the above requirements.

Stormwater from roof downspouts should be carried away in closed conduits to the curb or an approved outlet structure.

### Requirements for Landscaping Irrigation

Planted areas should be avoided immediately adjacent to the residences. If planting adjacent to the residences is desired, the use of plants that require very little moisture is recommended. Sprinkler systems should not be installed where they may cause ponding or saturation of foundation soils within 3 feet from building walls or under the structures.

Irrigation of landscape areas should be limited strictly to that necessary for plant growth. Excessive irrigation could result in progressive saturation, weakening and possible swelling of the foundation soils. The Landscape Architect should be aware of these requirements. Water that is allowed to saturate foundation soils may have adverse effects on the structures.

The project Landscape Architect and prospective owners and their landscape maintenance personnel should be informed of the grading and surface drainage requirements included in this report.

### Utilities

It is recommended that all utility trench backfill be done under the observation of ENGEO. Utility trenches in areas to be paved should also be constructed in accordance with Sacramento County requirements.

Where trenches are located outside of city pavement and sidewalk areas, the pipe zone backfill (i.e. material beneath and immediately surrounding the pipe) may consist of a well-graded import or native material less than  $\frac{3}{4}$  inch in maximum dimension. Trench backfill compaction and moisture conditioning should be in accordance with general fill compaction recommendations.

In general, uniformly graded gravel should not be used for pipe or trench zone backfill because of the potential for migration of: (1) soil into the relatively large void spaces found in this type of material and (2) water along trenches backfilled with this type of material.

It is the responsibility of the contractor to provide safe and stable trench side walls during utility trench construction. The trench side wall should either be sloped back to a safe or stable angle or be supported by shoring in accordance with the CAL-OSHA and/or the Sacramento County requirements.

Utility trenches should not be located adjacent to any foundation areas unless the placement, depth and backfill materials to be used are reviewed by ENGEO. Utility trenches constructed parallel to foundations should be located entirely above a plane extending down from the lower edge of the footing at an angle of 45 degrees. Utility companies and Landscape Architects should be made aware of this recommendation. Compaction of trench backfill by jetting should not be allowed at this site.

## **LIMITATIONS AND UNIFORMITY OF CONDITIONS**

This report is issued with the understanding that it is the responsibility of the owner to transmit the information and recommendations of this report to developers, contractors, buyers, architects, engineers, and designers for the project so that the necessary steps can be taken by the contractors and subcontractors to carry out such recommendations in the field. The conclusions and recommendations contained in this report are solely professional opinions.

We strived to perform our professional services in accordance with generally accepted geotechnical engineering principles and practices currently employed in the area; no warranty is expressed or implied.

We developed this report with limited subsurface exploration data. We assumed that our subsurface exploration data is representative of soil and groundwater conditions across the site. Considering possible underground variability of soil and groundwater, additional costs may be required to complete the project. We recommend that the owner establish a contingency fund to cover such costs. If unexpected conditions are encountered, notify ENGEO immediately to review these conditions and provide additional and/or modified recommendations, as necessary.

This report is based upon field and other conditions discovered at the time of preparation of ENGEO's work. This document must not be subject to unauthorized reuse, that is, use without written authorization of ENGEO. Such authorization is essential because it requires ENGEO to evaluate the document's applicability given new circumstances, not the least of which is passage of time. Actual field or other conditions will necessitate clarifications, adjustments, modifications or other changes to ENGEO's work. Therefore, ENGEO must be engaged to prepare the necessary clarifications, adjustments, modifications or other changes before construction activities commence or further activity proceeds. If ENGEO's scope of services does not include on-site construction

observation, or if other persons or entities are retained to provide such services, ENGEO cannot be held responsible for any or all claims, including, but not limited to claims arising from or resulting from the performance of such services by other persons or entities, and any or all claims arising from or resulting from clarifications, adjustments, modifications, discrepancies or other changes necessary to reflect changed field or other conditions.

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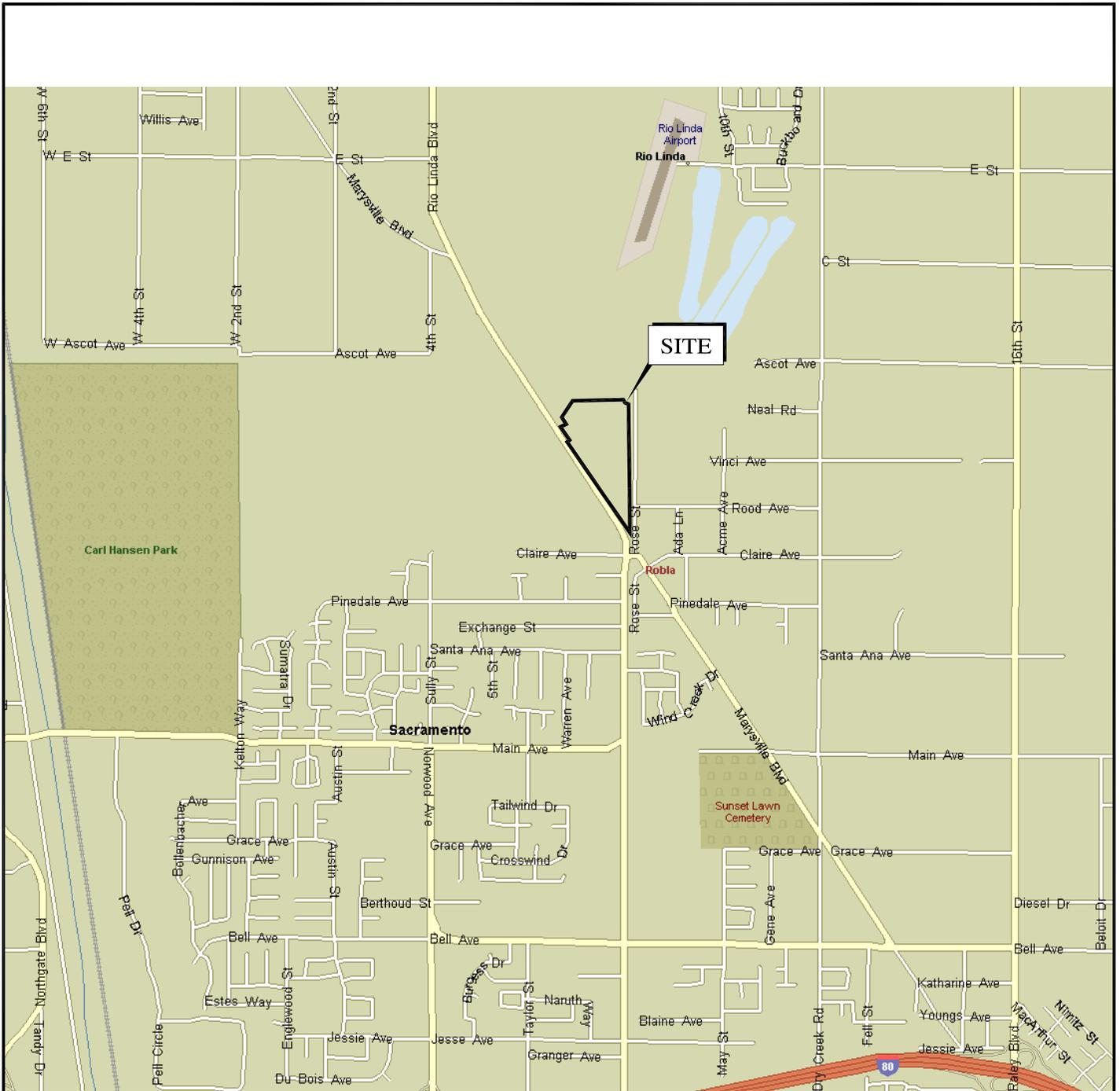
December 17, 2005

Revised March 30, 2006

**LIST OF FIGURES**

Figure 1	Vicinity Map
Figure 2	Site Plan

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BASE MAP SOURCE: MS STREETS AND TRIPS



VICINITY MAP  
SHEHADEH PROPERTY  
SACRAMENTO, CALIFORNIA

PROJECT NO.: 7103.4.001.01

DATE: MARCH 2006

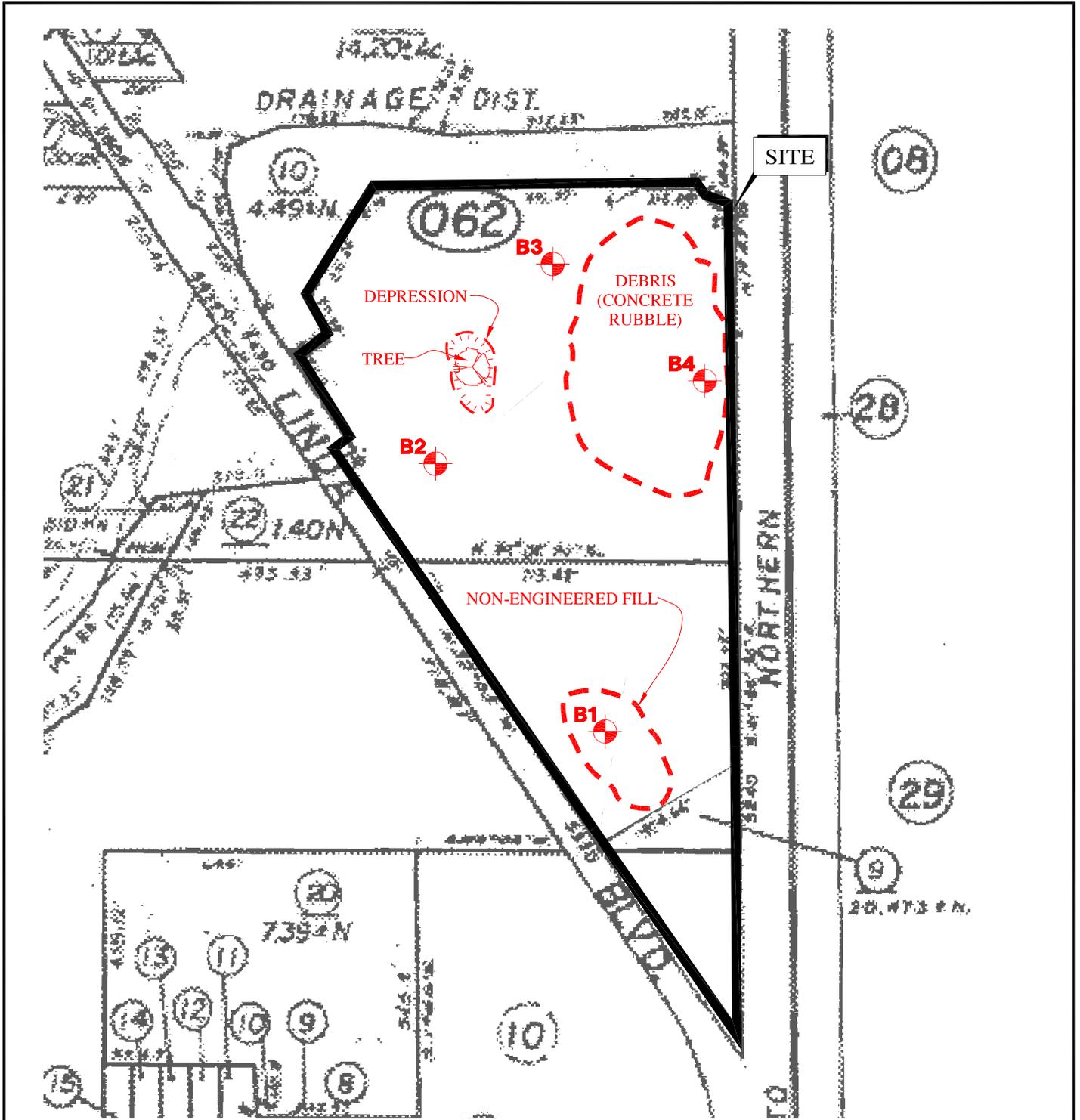
DRAWN BY: PC

CHECKED BY: SH

FIGURE NO.

1

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**EXPLANATION**

**B4**  APPROXIMATE LOCATION OF BORING

BASE MAP SOURCE: ASSESSOR'S OFFICE SACRAMENTO COUNTY



**SITE PLAN**  
**SHEHADEH PROPERTY**  
**SACRAMENTO, CALIFORNIA**

PROJECT NO.: <b>7103.4.001.01</b>	
DATE: <b>MARCH 2006</b>	
DRAWN BY: <b>PC</b>	CHECKED BY: <b>SH</b>

FIGURE NO.  
**2**

ORIGINAL FIGURE PRINTED IN COLOR

**APPENDIX A**

ENGEO INCORPORATED

Boring Logs A-1 through A-4

# KEY TO BORING LOGS

## MAJOR TYPES

## DESCRIPTION

COARSE-GRAINED SOILS MORE THAN HALF OF MAT'L 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 or gravel-sand mixtures
		GRAVELS WITH OVER 12 % FINES		GP - Poorly graded gravels or gravel-sand 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, or gravelly sand mixtures
		SANDS WITH OVER 12 % FINES		SP - Poorly graded sands or gravelly sand mixtures
FINE-GRAINED SOILS MORE THAN HALF OF MAT'L SMALLER THAN #200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50 % OR LESS		ML - Inorganic silt with low to medium plasticity	
			CL - Inorganic clay with low to medium plasticity	
			OL - Low plasticity organic silts and clays	
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50 %		MH - Inorganic silt with high plasticity	
			CH - Inorganic clay with high plasticity	
			OH - Highly plastic organic silts and clays	
HIGHLY ORGANIC SOILS		PT - Peat and other highly organic soils		

## GRAIN SIZES

U.S. STANDARD SERIES SIEVE SIZE				CLEAR SQUARE SIEVE OPENINGS			
200	40	10	4	3/4 "	3"	12"	
SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

### RELATIVE DENSITY

SANDS AND GRAVELS	BLOWS/FOOT (S.P.T.)
VERY LOOSE	0-4
LOOSE	4-10
MEDIUM DENSE	10-30
DENSE	30-50
VERY DENSE	OVER 50

### CONSISTENCY

SILTS AND CLAYS	STRENGTH*	BLOWS/FOOT (S.P.T.)
VERY SOFT	0-1/4	0-2
SOFT	1/4-1/2	2-4
MEDIUM STIFF	1/2-1	4-8
STIFF	1-2	8-15
VERY STIFF	2-4	15-30
HARD	OVER 4	OVER 30

### MOISTURE CONDITION

DRY	Absence of moisture, dusty, dry to touch
MOIST	Damp but no visible water
WET	Visible freewater
SATURATED	Below the water table

### MINOR CONSTITUENT QUANTITIES (BY WEIGHT)

TRACE	Particles are present, but estimated to the less than 5%
SOME	5 to 15%
WITH	15 to 30%
.....Y	30 to 50%

### SAMPLER SYMBOLS

-  Modified California (3" O.D.) sampler
-  California (2.5" O.D.) sampler
-  S.P.T. - Split spoon sampler
-  Shelby Tube
-  Continuous Core
-  Bag Samples
-  Grab Samples
- NR No Recovery

### LINE TYPES

-  Solid - Layer Break
-  Dashed - Gradational or approximate layer break

### GROUND-WATER SYMBOLS

-  Groundwater level during drilling
-  Stabilized groundwater level

(S.P.T.) Number of blows of 140 lb. hammer falling 30" to drive a 2-inch O.D. (1-3/8 inch I.D.) sampler

\* Unconfined compressive strength in tons/sq. ft., asterisk on log means determined by pocket penetrometer







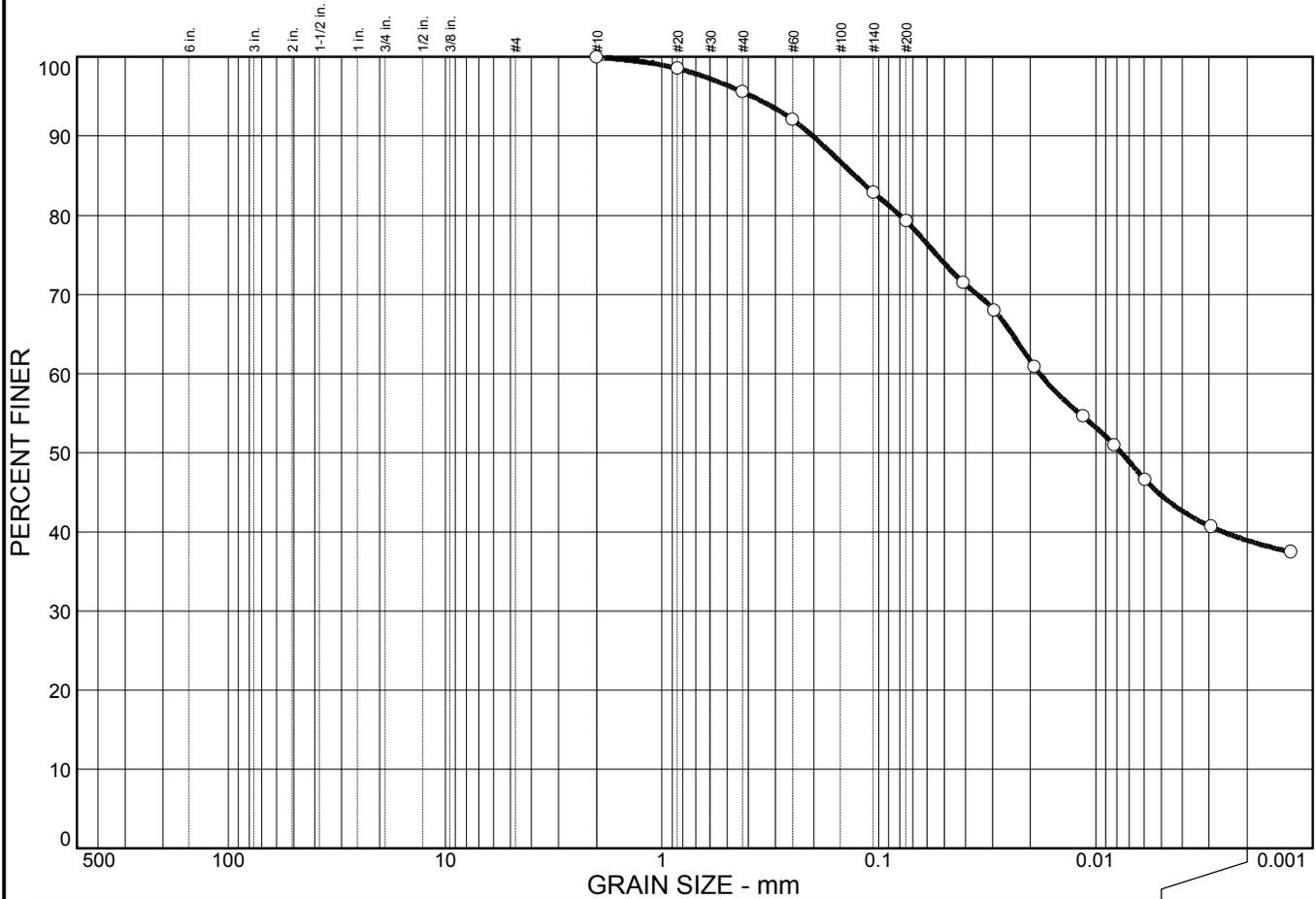


**APPENDIX B**

LABORATORY TEST RESULTS

Particle Size Distribution Reports (2 Pages)  
Liquid and Plastic Limit Test Report (1 Page)

# Particle Size Distribution Report



<b>% COBBLES</b>	<b>% GRAVEL</b>	<b>% SAND</b>	<b>% SILT</b>	<b>% CLAY</b>
0.0	0.0	20.7	40.3	39.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	98.6		
#40	95.6		
#60	92.1		
#140	82.9		
#200	79.3		

**Soil Description**

Black silty clay with sand

**Atterberg Limits**

PL= 16      LL= 47      PI= 31

**Coefficients**

D<sub>85</sub>= 0.129      D<sub>60</sub>= 0.0182      D<sub>50</sub>= 0.0076  
D<sub>30</sub>=              D<sub>15</sub>=              D<sub>10</sub>=  
C<sub>u</sub>=              C<sub>c</sub>=

**Classification**

USCS= CL              AASHTO=

**Remarks**

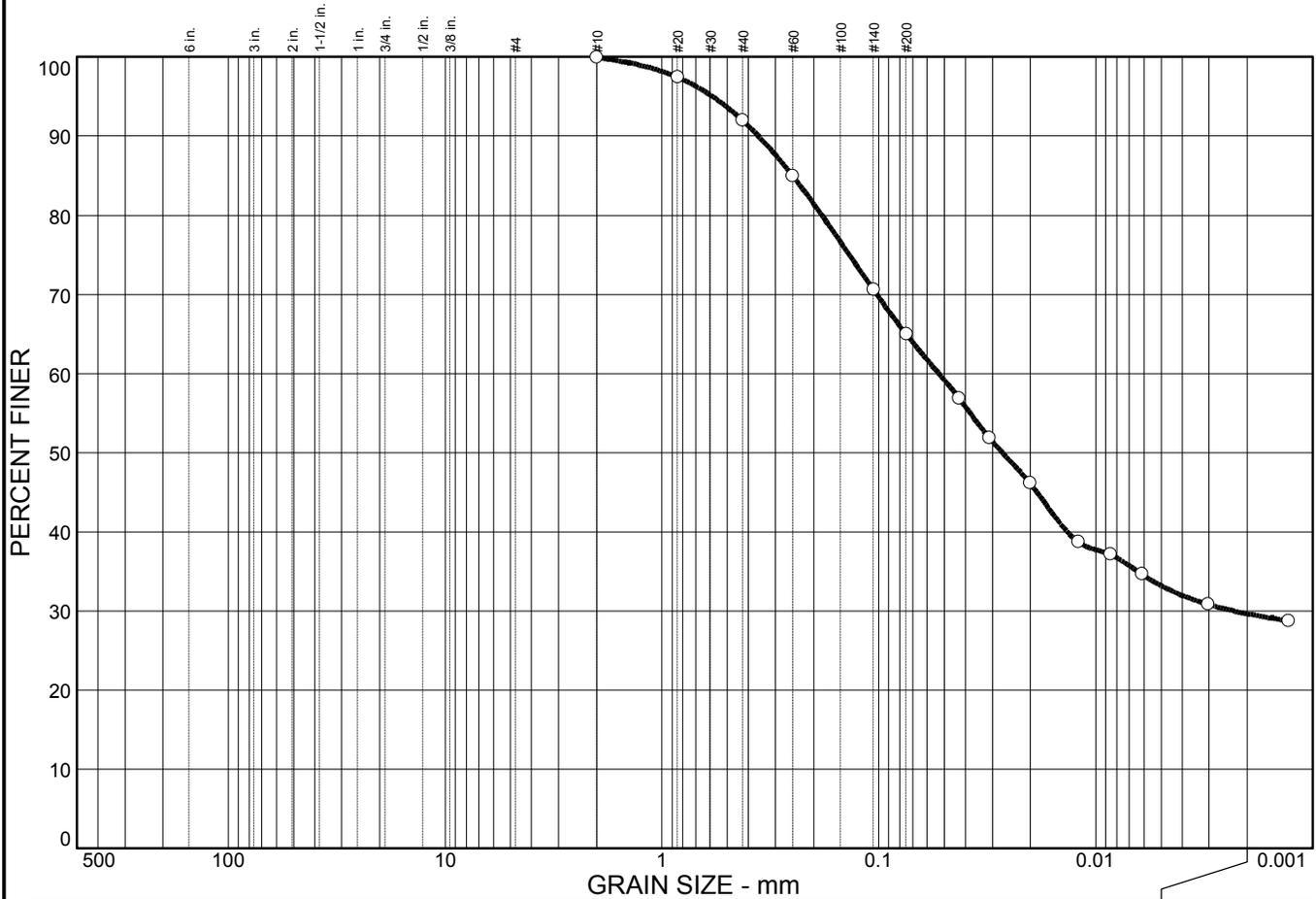
\* (no specification provided)

**Sample No.:** B3@1.5  
**Location:**

**Source of Sample:** GEX

**Date:** 12/14/05  
**Elev./Depth:** 1.5 feet

# Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	35.0	35.3	29.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	97.5		
#40	92.0		
#60	85.0		
#140	70.6		
#200	65.0		

**Soil Description**

Dark gray sandy clay

**Atterberg Limits**

PL= 13      LL= 36      PI= 23

**Coefficients**

D<sub>85</sub>= 0.250      D<sub>60</sub>= 0.0529      D<sub>50</sub>= 0.0269  
D<sub>30</sub>= 0.0022      D<sub>15</sub>=              D<sub>10</sub>=  
C<sub>u</sub>=                      C<sub>c</sub>=

**Classification**

USCS= CL                      AASHTO=

**Remarks**

\* (no specification provided)

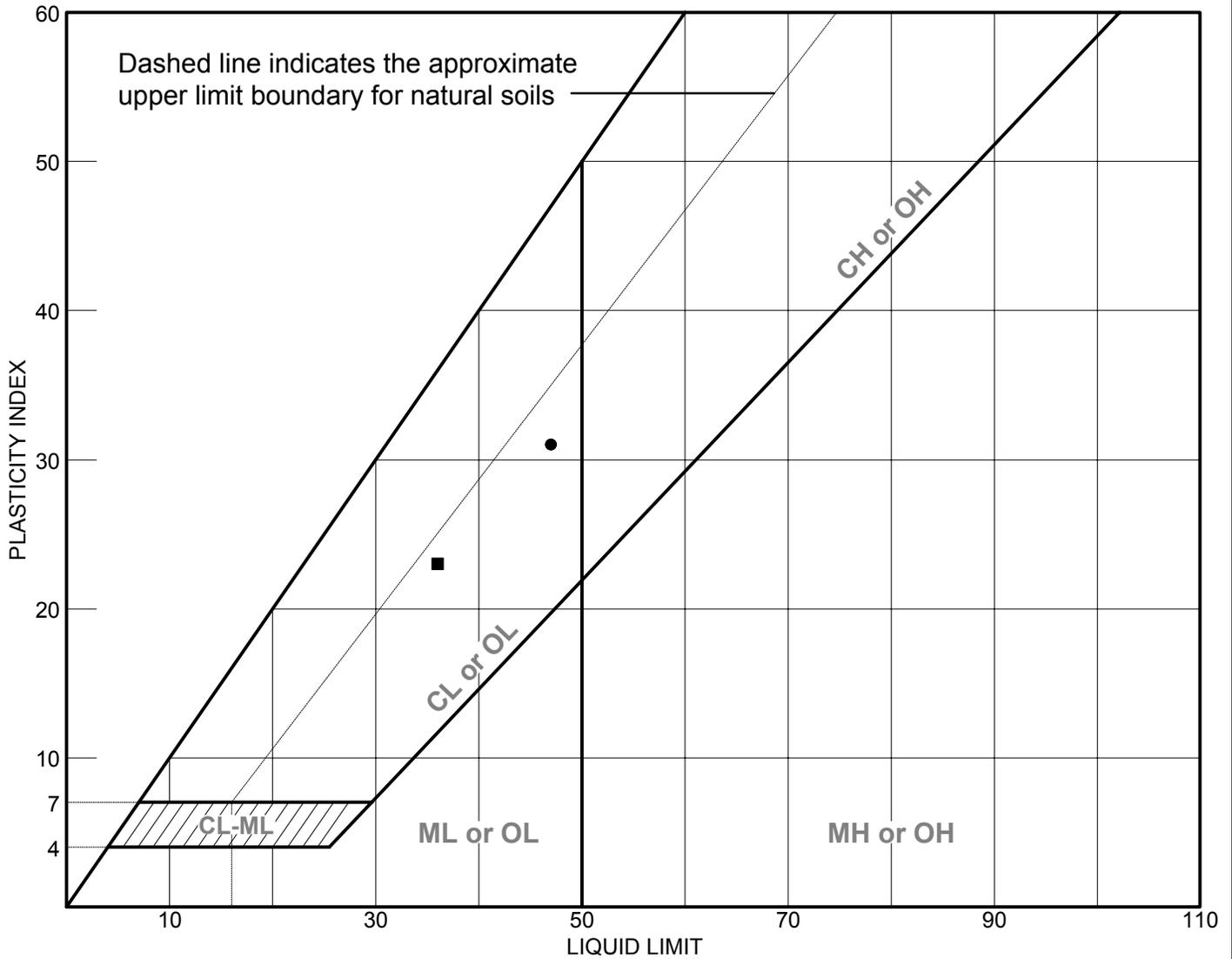
**Sample No.:** B4@2.0  
**Location:**

**Source of Sample:** GEX

**Date:** 12/14/05  
**Elev./Depth:** 2.0 feet

<h2 style="margin: 0;">ENGEO INCORPORATED</h2>	<p><b>Client:</b></p> <p><b>Project:</b> Shehadeh Property-Geotechnical Report</p> <p><b>Project No.:</b> 7103.4.001.01</p> <p style="text-align: right;"><b>Figure</b></p>
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# LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	GEX	B3@1.5	1.5 feet		16	47	31	CL
■	GEX	B4@2.0	2.0 feet		13	36	23	CL

LIQUID AND PLASTIC LIMITS TEST REPORT

**ENGEO  
INCORPORATED**

**Client:**  
**Project:** Shehadeh Property-Geotechnical Report  
**Project No.:** 7103.4.001.01

**Figure**

**APPENDIX C**

Guide Contract Specifications

7103.4.001.01  
December 17, 2005  
Revised March 30, 2006

## **GUIDE CONTRACT SPECIFICATIONS**

### **PART I - EARTHWORK**

#### **PREFACE**

These specifications are intended as a guide for the earthwork performed at the subject development project. If there is a conflict between these specifications (including the recommendations of the geotechnical report) and agency or code requirements, it should be brought to the attention of ENGEO and Owner prior to contract bidding.

#### **PART 1 - GENERAL**

##### **1.01 WORK COVERED**

- A. Grading, excavating, filling and backfilling, including trenching and backfilling for utilities as necessary to complete the Project as indicated on the Drawings.
- B. Subsurface drainage as indicated on the Drawings.

##### **1.02 CODES AND STANDARDS**

- A. Excavating, trenching, filling, backfilling, and grading work shall meet the applicable requirements of the Uniform Building Code and the standards and ordinances of state and local governing authorities.

##### **1.03 SUBSURFACE SOIL CONDITIONS**

- A. The Owners' Geotechnical Exploration report is available for inspection by bidder or Contractor. The Contractor shall refer to the findings and recommendations of the Geotechnical Exploration report in planning and executing his work.

##### **1.04 DEFINITIONS**

- A. Fill: All soil, rock, or soil-rock materials placed to raise the grades of the site or to backfill excavations.
- B. Backfill: All soil, rock or soil-rock material used to fill excavations and trenches.

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- C. On-Site Material: Soil and/or rock material which is obtained from the site.
- D. Imported Material: Soil and/or rock material which is brought to the site from off-site areas.
- E. Select Material: On-site and/or imported material which is approved by ENGEO as a specific-purpose fill.
- F. Engineered Fill: Fill upon which ENGEO has made sufficient observations and tests to confirm that the fill has been placed and compacted in accordance with specifications and requirements.
- G. Degree of Compaction or Relative Compaction: The ratio, expressed as a percentage, of the in-place dry density of the fill and backfill material as compacted in the field to the maximum dry density of the same material as determined by ASTM D-1557 or California 216 compaction test method.
- H. Optimum Moisture: Water content, percentage by dry weight, corresponding to the maximum dry density as determined by ASTM D-1557.
- I. ENGEO: The project geotechnical engineering consulting firm, its employees or its designated representatives.
- J. Drawings: All documents, approved for construction, which describe the Work.

#### 1.05 OBSERVATION AND TESTING

- A. All site preparation, cutting and shaping, excavating, filling, and backfilling shall be carried out under the observation of ENGEO, employed and paid for by the Owners. ENGEO will perform appropriate field and laboratory tests to evaluate the suitability of fill material, the proper moisture content for compaction, and the degree of compaction achieved. Any fill that does not meet the specification requirements shall be removed and/or reworked until the requirements are satisfied.
- B. Cutting and shaping, excavating, conditioning, filling, and compacting procedures require approval of ENGEO as they are performed. Any work found unsatisfactory or any work disturbed by subsequent operations before approval is granted shall be corrected in an approved manner as recommended by ENGEO.

- C. Tests for compaction will be made in accordance with test procedures outlined in ASTM D-1557, as applicable. Field testing of soils or compacted fill shall conform with the applicable requirements of ASTM D-2922.
- D. All authorized observation and testing will be paid for by the Owners.

#### 1.06 SITE CONDITIONS

- A. Excavating, filling, backfilling, and grading work shall not be performed during unfavorable weather conditions. When the work is interrupted by rain, excavating, filling, backfilling, and grading work shall not be resumed until the site and soil conditions are suitable.
- B. Contractor shall take the necessary measures to prevent erosion of freshly filled, backfilled, and graded areas until such time as permanent drainage and erosion control measures have been installed.

### PART 2 - PRODUCTS

#### 2.01 GENERAL

- A. Contractor shall furnish all materials, tools, equipment, facilities, and services as required for performing the required excavating, filling, backfilling, and grading work, and trenching and backfilling for utilities.

#### 2.02 SOIL MATERIALS

- A. Fill
  - 1. Material to be used for engineered fill and backfill shall be free from organic matter and other deleterious substances, and of such quality that it will compact thoroughly without excessive voids when watered and rolled. Excavated on-site material will be considered suitable for engineered fill and backfill if it contains no more than 3 percent organic matter, is free of debris and other deleterious substances and conforms to the requirements specified above. Rocks of maximum dimension in excess of two-thirds of the lift thickness shall be removed from any fill material to the satisfaction of ENGEO.
  - 2. Excavated earth material which is suitable for engineered fill or backfill, as determined by ENGEO, shall be conditioned for reuse and properly stockpiled as required for later filling and backfilling operations. Conditioning shall consist of

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spreading material in layers not to exceed 8 inches and raking free of debris and rubble. Rocks and aggregate exceeding the allowed largest dimension, and deleterious material shall be removed from the site and disposed off site in a legal manner.

3. ENGEO shall be immediately notified if potential hazardous materials or suspect soils exhibiting staining or odor are encountered. Work activities shall be discontinued within the area of potentially hazardous materials. ENGEO environmental personnel will conduct an assessment of the suspect hazardous material to determine the appropriate response and mitigation. Regulatory agencies may also be contacted to request concurrence and oversight. *ENGEO will rely on the Owner, or a designated Owner's representative, to make necessary notices to the appropriate regulatory agencies. The Owner may request ENGEO's assistance in notifying regulatory agencies, provided ENGEO receives Owner's written authorization to expand its scope of services.*
  4. ENGEO shall be notified at least 48 hours prior to the start of filling and backfilling operations so that it may evaluate samples of the material intended for use as fill and backfill. All materials to be used for filling and backfilling require the approval of ENGEO.
- B. Import Material: Where conditions require the importation of fill material, the material shall be an inert, nonexpansive soil or soil-rock material free of organic matter and meeting the following requirements unless otherwise approved by ENGEO.

Gradation (ASTM D-421):	<u>Sieve Size</u>	<u>Percent Passing</u>
	2-inch	100
	#200	15 - 70
Plasticity (ASTM D-4318):	<u>Liquid Limit</u>	<u>Plasticity Index</u>
	< 30	< 12
Swell Potential (ASTM D-4546B): (at optimum moisture)	<u>Percent Heave</u>	<u>Swell Pressure</u>
	< 2 percent	< 300 psf
Resistance Value (ASTM D-2844):	Minimum 25	
Organic Content (ASTM D-2974):	Less than 2 percent	

A sample of the proposed import material should be submitted to ENGEO for evaluation prior to delivery at the site.

### 2.03 SAND

- A. Sand for sand cushion under slabs and for bedding of pipe in utility trenches shall be a clean and graded, washed sand, free from clay or organic material, suitable for the intended purpose with 90 to 100 percent passing a No. 4 U.S. Standard Sieve, not more than 5 percent passing a No. 200 U.S. Standard Sieve, and generally conforming to ASTM C33 for fine aggregate.

### 2.04 AGGREGATE DRAINAGE FILL

- A. Aggregate drainage fill under concrete slabs and paving shall consist of broken stone, crushed or uncrushed gravel, clean quarry waste, or a combination thereof. The aggregate shall be free from fines, vegetable matter, loam, volcanic tuff, and other deleterious substances. It shall be of such quality that the absorption of water in a saturated surface dry condition does not exceed 3 percent of the oven dry weight of the samples.
- B. Aggregate drainage fill shall be of such size that the percentage composition by dry weight as determined by laboratory sieves (U. S. Series) will conform to the following grading:

<u>Sieve Size</u>	<u>Percentage Passing Sieve</u>
1½-inches	100
1-inch	90 - 100
#4	0 - 5

### 2.05 SUBDRAINS

- A. Perforated subdrain pipe of the required diameter shall be installed as shown on the drawings. The pipe(s) shall also conform to these specifications unless otherwise specified by ENGEO in the field.

Subdrain pipe shall be manufactured in accordance with one of the following requirements:

Design depths less than 30 feet

- Perforated ABS Solid Wall SDR 35 (ASTM D-2751)
- Perforated PVC Solid Wall SDR 35 (ASTM D-3034)
- Perforated PVC A-2000 (ASTM F949)
- Perforated Corrugated HDPE double-wall (AASHTO M-252 or M-294, Caltrans Type S, 50 psi minimum stiffness)

Design depths less than 50 feet

- Perforated PVC SDR 23.5 Solid Wall (ASTM D-3034)
- Perforated Sch. 40 PVC Solid Wall (ASTM-1785)
- Perforated ABS SDR 23.5 Solid Wall (ASTM D-2751)
- Perforated ABS DWV/Sch. 40 (ASTM D-2661 and D-1527)
- Perforated Corrugated HDPE double-wall (AASHTO M-252 or M-294, Caltrans Type S, 70 psi minimum stiffness)

Design depths less than 70 feet

- Perforated ABS Solid Wall SDR 15.3 (ASTM D-2751)
- Perforated Sch. 80 PVC (ASTM D-1785)
- Perforated Corrugated Aluminum (ASTM B-745)

B. Permeable Material (Class 2): Class 2 permeable material for filling trenches under, around, and over subdrains, behind building and retaining walls, and for pervious blankets shall consist of clean, coarse sand and gravel or crushed stone, conforming to the following grading requirements:

<u>Sieve Size</u>	<u>Percentage Passing Sieve</u>
1-inch	100
¾-inch	90 - 100
⅜-inch	40 - 100
#4	25 - 40
#8	18 - 33
#30	5 - 15
#50	0 - 7
#200	0 - 3

C. Filter Fabric: All filter fabric shall meet the following Minimum Average Roll Values unless otherwise specified by ENGEO.

Grab Strength (ASTM D-4632).....	180 lbs
Mass Per Unit Area (ASTM D-4751).....	6 oz/yd <sup>2</sup>
Apparent Opening Size (ASTM D-4751).....	70-100 U.S. Std. Sieve
Flow Rate (ASTM D-4491).....	80 gal/min/ft <sup>2</sup>
Puncture Strength (ASTM D-4833).....	80 lbs

- D. Vapor Retarder: Vapor Retarders shall consist of PVC, LDPE or HDPE impermeable sheeting at least 10 mils thick.

### 2.06 PERMEABLE MATERIAL (Class 1; Type A)

- A. Class 1 permeable material to be used in conjunction with filter fabric for backfilling of subdrain excavations shall conform to the following grading requirements:

<u>Sieve Size</u>	<u>Percentage Passing Sieve</u>
¾-inch	100
½-inch	95 - 100
⅜-inch	70 - 100
#4	0 - 55
#8	0 - 10
#200	0 - 3

## PART 3 - EXECUTION

### 3.01 STAKING AND GRADES

- A. Contractor shall lay out all his work, establish all necessary markers, bench marks, grading stakes, and other stakes as required to achieve design grades.

### 3.02 EXISTING UTILITIES

- A. Contractor shall verify the location and depth (elevation) of all existing utilities and services before performing any excavation work.

### 3.03 EXCAVATION

- A. Contractor shall perform excavating as indicated and required for concrete footings, drilled piers, foundations, floor slabs, concrete walks, and site leveling and grading, and provide shoring, bracing, underpinning, cribbing, pumping, and planking as

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required. The bottoms of excavations shall be firm undisturbed earth, clean and free from loose material, debris, and foreign matter.

- B. Excavations shall be kept free from water at all times. Adequate dewatering equipment shall be maintained at the site to handle emergency situations until concrete or backfill is placed.
- C. Unauthorized excavations for footings shall be filled with concrete to required elevations, unless other methods of filling are authorized by ENGEO.
- D. Excavated earth material which is suitable for engineered fill or backfill, as determined by ENGEO, shall be conditioned for reuse and properly stockpiled for later filling and backfilling operations as specified under Section 2.02, "Soil Materials."
- E. Abandoned sewers, piping, and other utilities encountered during excavating shall be removed and the resulting excavations shall be backfilled with engineered fill as required by ENGEO.
- F. Any active utility lines encountered shall be reported immediately to the Owner's Representative and authorities involved. The Owner and proper authorities shall be permitted free access to take the measures deemed necessary to repair, relocate, or remove the obstruction as determined by the responsible authority or Owner's Representative.

#### 3.04 SUBGRADE PREPARATION

- A. All brush and other rubbish, as well as trees and root systems not marked for saving, shall be removed from the site and legally disposed of.
- B. Any existing structures, foundations, underground storage tanks, or debris must be removed from the site prior to any building, grading, or fill operations. Septic tanks, including all drain fields and other lines, if encountered, must be totally removed. The resulting depressions shall be properly prepared and filled to the satisfaction of ENGEO.
- C. Vegetation and organic topsoil shall be removed from the surface upon which the fill is to be placed and either removed and legally disposed of or stockpiled for later use in approved landscape areas. The surface shall then be scarified to a depth of at least eight inches until the surface is free from ruts, hummocks, or other uneven features which would tend to prevent uniform compaction by the equipment to be used.

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- D. After the foundation for the fill has been cleared and scarified, it shall be made uniform and free from large clods. The proper moisture content must be obtained by adding water or aerating. The foundation for the fill shall be compacted at the proper moisture content to a relative compaction as specified herein.

### 3.05 ENGINEERED FILL

- A. Select Material: Fill material shall be "Select" or "Imported Material" as previously specified.
- B. Placing and Compacting: Engineered fill shall be constructed by approved and accepted methods. Fill material shall be spread in uniform lifts not exceeding 8 inches in uncompacted thickness. Each layer shall be spread evenly, and thoroughly blade-mixed to obtain uniformity of material. Fill material which does not contain sufficient moisture as specified by ENGEO shall be sprinkled with water; if it contains excess moisture it shall be aerated or blended with drier material to achieve the proper water content. Select material and water shall then be thoroughly mixed before being compacted.
- C. Unless otherwise specified in the Geotechnical Exploration report, each layer of spread select material shall be compacted to at least 90 percent relative compaction at a moisture content of at least three percent above the optimum moisture content. Minimum compaction in all keyways shall be a minimum of 95 percent with a minimum moisture content of at least 1 percentage point above optimum.
- D. Unless otherwise specified in the Geotechnical Exploration report or otherwise required by the local authorities, the upper 6 inches of engineered fill in areas to receive pavement shall be compacted to at least 95 percent relative compaction with a minimum moisture content of at least 3 percentage points above optimum.
- E. Testing and Observation of Fill: The work shall consist of field observation and testing to determine that each layer has been compacted to the required density and that the required moisture is being obtained. Any layer or portion of a layer that does not attain the compaction required shall be reworked until the required density is obtained.
- F. Compaction: Compaction shall be by sheepsfoot rollers, multiple-wheel steel or pneumatic-tired rollers or other types of acceptable compaction equipment. Rollers shall be of such design that they will be able to compact the fill to the specified compaction. Rolling shall be accomplished while the fill material is within the specified moisture content range. Rolling of each layer must be continuous so that the required compaction may be obtained uniformly throughout each layer.

- G. Fill slopes shall be constructed by overfilling the design slopes and later cutting back the slopes to the design grades. No loose soil will be permitted on the faces of the finished slopes.
- H. Strippings and topsoil shall be stockpiled as approved by Owner, then placed in accordance with ENGEO's recommendations to a minimum thickness of 6 inches and a maximum thickness of 12 inches over exposed open space cut slopes which are 3:1 or flatter, and track walked to the satisfaction of ENGEO.
- I. Final Prepared Subgrade: Finish blading and smoothing shall be performed as necessary to produce the required density, with a uniform surface, smooth and true to grade.

### 3.06 BACKFILLING

- A. Backfill shall not be placed against footings, building walls, or other structures until approved by ENGEO.
- B. Backfill material shall be Select Material as specified for engineered fill.
- C. Backfill shall be placed in 6-inch layers, leveled, rammed, and tamped in place. Each layer shall be compacted with suitable compaction equipment to 90 percent relative compaction at a moisture content of at least 3 percent above optimum.

### 3.07 TRENCHING AND BACKFILLING FOR UTILITIES

- A. Trenching:
  - 1. Trenching shall include the removal of material and obstructions, the installation and removal of sheeting and bracing and the control of water as necessary to provide the required utilities and services.
  - 2. Trenches shall be excavated to the lines, grades, and dimensions indicated on the Drawings. Maximum allowable trench width shall be the outside diameter of the pipe plus 24 inches, inclusive of any trench bracing.
  - 3. When the trench bottom is a soft or unstable material as determined by ENGEO, it shall be made firm and solid by removing said unstable material to a sufficient depth and replacing it with on-site material compacted to 90 percent minimum relative compaction.

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4. Where water is encountered in the trench, the contractor must provide materials necessary to drain the water and stabilize the bed.

B. Backfilling:

1. Trenches must be backfilled within 2 days of excavation to minimize desiccation.
2. Bedding material shall be sand and shall not extend more than 6 inches above any utility lines.
3. Backfill material shall be select material.
4. Trenches shall be backfilled as indicated or required and compacted with suitable equipment to 90 percent minimum relative compaction at the required moisture content.

### 3.08 SUBDRAINS

- A. Trenches for subdrain pipe shall be excavated to a minimum width equal to the outside diameter of the pipe plus at least 12 inches and to a depth of approximately 2 inches below the grade established for the invert of the pipe, or as indicated on the Drawings.
- B. The space below the pipe invert shall be filled with a layer of Class 2 permeable material, upon which the pipe shall be laid with perforations down. Sections shall be joined as recommended by the pipe manufacturer.
- C. Rocks, bricks, broken concrete, or other hard material shall not be used to give intermediate support to pipes. Large stones or other hard objects shall not be left in contact with the pipes.
- D. Excavations for subdrains shall be filled as required to fill voids and prevent settlement without damaging the subdrain pipe. Alternatively, excavations for subdrains may be filled with Class 1 permeable material (as defined in Section 2.06) wrapped in Filter Fabric (as defined in Section 2.05).

### 3.09 AGGREGATE DRAINAGE FILL

- A. ENGEO shall approve finished subgrades before aggregate drainage fill is installed.

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- B. Pipes, drains, conduits, and any other mechanical or electrical installations shall be in place before any aggregate drainage fill is placed. Backfill at walls to elevation of drainage fill shall be in place and compacted.
- C. Aggregate drainage fill under slabs and concrete paving shall be the minimum uniform thickness after compaction of dimensions indicated on Drawings. Where not indicated, minimum thickness after compaction shall be 4 inches.
- D. Aggregate drainage fill shall be rolled to form a well-compacted bed.
- E. The finished aggregate drainage fill must be observed and approved by ENGEO before proceeding with any subsequent construction over the compacted base or fill.

### 3.10 SAND CUSHION

- A. A sand cushion shall be placed over the vapor retarder membrane under concrete slabs on grade. Sand cushion shall be placed in uniform thickness as indicated on the Drawings. Where not indicated, the thickness shall be 2 inches.

### 3.11 FINISH GRADING

- A. All areas must be finish graded to elevations and grades indicated on the Drawings. In areas to receive topsoil and landscape planting, finish grading shall be performed to a uniform 6 inches below the grades and elevations indicated on the Drawings, and brought to final grade with topsoil.

### 3.12 DISPOSAL OF WASTE MATERIALS

- A. Excess earth materials and debris shall be removed from the site and disposed of in a legal manner. Location of dump site and length of haul are the Contractor's responsibility.

## **PART II - GEOGRID SOIL REINFORCEMENT**

### 1. DESCRIPTION:

Work shall consist of furnishing geogrid soil reinforcement for use in construction of reinforced soil slopes and retention systems.

### 2. GEOGRID MATERIAL:

2.1 The specific geogrid material shall be preapproved by ENGEO.

2.2 The geogrid shall be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil or rock. The geogrid structure shall be dimensionally stable and able to retain its geometry under construction stresses and shall have high resistance to damage during construction, to ultraviolet degradation, and to all forms of chemical and biological degradation encountered in the soil being reinforced.

2.3 The geogrids shall have an Allowable Strength ( $T_a$ ) and Pullout Resistance, for the soil type(s) indicated, as listed in Table I.

2.4 Certifications: The Contractor shall submit a manufacturer's certification that the geogrids supplied meet the respective index criteria set when geogrid was approved by ENGEO, measured in full accordance with all test methods and standards specified. In case of dispute over validity of values, the Contractor will supply test data from an ENGEO-approved laboratory to support the certified values submitted.

### 3. CONSTRUCTION:

3.1 Delivery, Storage, and Handling: Contractor shall check the geogrid upon delivery to ensure that the proper material has been received. During all periods of shipment and storage, the geogrid shall be protected from temperatures greater than 140 °F, mud, dirt, dust, and debris. Manufacturer's recommendations in regard to protection from direct sunlight must also be followed. At the time of installation, the geogrid will be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by ENGEO, torn or punctured sections may be repaired by placing a patch over the damaged area. Any geogrid

damaged during storage or installation shall be replaced by the Contractor at no additional cost to the owner.

- 3.2 On-Site Representative: Geogrid material suppliers shall provide a qualified and experienced representative on site at the initiation of the project, for a minimum of three days, to assist the Contractor and ENGEO personnel at the start of construction. If there is more than one slope on a project, this criterion will apply to construction of the initial slope only. The representative shall also be available on an as-needed basis, as requested by ENGEO, during construction of the remaining slope(s).
- 3.3 Geogrid reinforcement may be joined with mechanical connections or overlaps as recommended and approved by the Manufacturer. Joints shall not be placed within 6 feet of the slope face, within 4 feet below top of slope, nor horizontally or vertically adjacent to another joint.
- 3.4 Geogrid Placement: The geogrid reinforcement shall be installed in accordance with the manufacturer's recommendations. The geogrid reinforcement shall be placed within the layers of the compacted soil as shown on the plans or as directed.

The geogrid reinforcement shall be placed in continuous longitudinal strips in the direction of main reinforcement. However, if the Contractor is unable to complete a required length with a single continuous length of geogrid, a joint may be made with the Manufacturer's approval. Only one joint per length of geogrid shall be allowed. This joint shall be made for the full width of the strip by using a similar material with similar strength. Joints in geogrid reinforcement shall be pulled and held taut during fill placement.

Adjacent strips, in the case of 100 percent coverage in plan view, need not be overlapped. The minimum horizontal coverage is 50 percent, with horizontal spacings between reinforcement no greater than 40 inches. Horizontal coverage of less than 100 percent shall not be allowed unless specifically detailed in the construction drawings.

Adjacent rolls of geogrid reinforcement shall be overlapped or mechanically connected where exposed in a wrap around face system, as applicable.

The Contractor may place only that amount of geogrid reinforcement required for immediately pending work to prevent undue damage. After a layer of geogrid reinforcement has been placed, the next succeeding layer of soil shall be placed and compacted as appropriate. After the specified soil layer has been placed, the next geogrid reinforcement layer shall be installed. The process shall be repeated for each subsequent layer of geogrid reinforcement and soil.

Geogrid reinforcement shall be placed to lay flat and pulled tight prior to backfilling. After a layer of geogrid reinforcement has been placed, suitable means, such as pins or small piles of soil, shall be used to hold the geogrid reinforcement in position until the subsequent soil layer can be placed.

Under no circumstances shall a track-type vehicle be allowed on the geogrid reinforcement before at least six inches of soil have been placed. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and the geogrid reinforcement. If approved by the Manufacturer, rubber-tired equipment may pass over the geosynthetic reinforcement at slow speeds, less than 10 mph. Sudden braking and sharp turning shall be avoided.

During construction, the surface of the fill should be kept approximately horizontal. Geogrid reinforcement shall be placed directly on the compacted horizontal fill surface. Geogrid reinforcements are to be placed within three inches of the design elevations and extend the length as shown on the elevation view unless otherwise directed by ENGEO. Correct orientation of the geogrid reinforcement shall be verified by ENGEO.

<b>Table I</b> <b>Allowable Geogrid Strength With Various Soil Types</b> <b>For Geosynthetic Reinforcement In</b> <b>Mechanically Stabilized Earth Slopes</b>			
(Geogrid Pullout Resistance and Allowable Strengths vary with reinforced backfill used due to soil anchorage and site damage factors. Guidelines are provided below.)			
SOIL TYPE	MINIMUM ALLOWABLE STRENGTH, T <sub>a</sub> (lb/ft)*		
	GEOGRID Type I	GEOGRID Type II	GEOGRID Type III
A. Gravels, sandy gravels, and gravel-sand-silt mixtures (GW, GP, GC, GM & SP)**	2400	4800	7200
B. Well graded sands, gravelly sands, and sand-silt mixtures (SW & SM)**	2000	4000	6000
C. Silts, very fine sands, clayey sands and clayey silts (SC & ML)**	1000	2000	3000
D. Gravelly clays, sandy clays, silty clays, and lean clays (CL)**	1600	3200	4800
* All partial Factors of Safety for reduction of design strength are included in listed values. Additional factors of safety may be required to further reduce these design strengths based on site conditions.			
** Unified Soil Classifications.			

## **PART III - GEOTEXTILE SOIL REINFORCEMENT**

### 1. DESCRIPTION:

Work shall consist of furnishing geotextile soil reinforcement for use in construction of reinforced soil slopes.

### 2. GEOTEXTILE MATERIAL:

- 2.1 The specific geotextile material and supplier shall be preapproved by ENGEO.
- 2.2 The geotextile shall have a high tensile modulus and shall have high resistance to damage during construction, to ultraviolet degradation, and to all forms of chemical and biological degradation encountered in the soil being reinforced.
- 2.3 The geotextiles shall have an Allowable Strength ( $T_a$ ) and Pullout Resistance, for the soil type(s) indicated as listed in Table II.
- 2.4 Certification: The Contractor shall submit a manufacturer's certification that the geotextiles supplied meet the respective index criteria set when geotextile was approved by ENGEO, measured in full accordance with all test methods and standards specified. In case of dispute over validity of values, the Contractor will supply the data from an ENGEO-approved laboratory to support the certified values submitted.

### 3. CONSTRUCTION:

- 3.1 Delivery, Storage and Handling: Contractor shall check the geotextile upon delivery to ensure that the proper material has been received. During all periods of shipment and storage, the geotextile shall be protected from temperatures greater than 140 °F, mud, dirt, dust, and debris. Manufacturer's recommendations in regard to protection from direct sunlight must also be followed. At the time of installation, the geotextile will be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by ENGEO, torn or punctured sections may be repaired by placing a patch over the damaged area. Any geotextile damaged during storage or installation shall be replaced by the Contractor at no additional cost to the owner.

- 3.2 On-Site Representative: Geotextile material suppliers shall provide a qualified and experienced representative on site at the initiation of the project, for a minimum of three days, to assist the Contractor and ENGEO personnel at the start of construction. If there is more than one slope on a project, this criterion will apply to construction of the initial slope only. The representative shall also be available on an as-needed basis, as requested by ENGEO, during construction of the remaining slope(s).
- 3.3 Geotextile Placement: The geotextile reinforcement shall be installed in accordance with the manufacturer's recommendations. The geotextile reinforcement shall be placed within the layers of the compacted soil as shown on the plans or as directed.

The geotextile reinforcement shall be placed in continuous longitudinal strips in the direction of main reinforcement. Joints shall not be used with geotextiles.

Adjacent strips, in the case of 100 percent coverage in plan view, need not be overlapped. The minimum horizontal coverage is 50 percent, with horizontal spacings between reinforcement no greater than 40 inches. Horizontal coverage of less than 100 percent shall not be allowed unless specifically detailed in the construction drawings.

Adjacent rolls of geotextile reinforcement shall be overlapped or mechanically connected where exposed in a wrap around face system, as applicable.

The Contractor may place only that amount of geotextile reinforcement required for immediately pending work to prevent undue damage. After a layer of geotextile reinforcement has been placed, the succeeding layer of soil shall be placed and compacted as appropriate. After the specified soil layer has been placed, the next geotextile reinforcement layer shall be installed. The process shall be repeated for each subsequent layer of geotextile reinforcement and soil.

Geosynthetic reinforcement shall be placed to lay flat and be pulled tight prior to backfilling. After a layer of geotextile reinforcement has been placed, suitable means, such as pins or small piles of soil, shall be used to hold the geotextile reinforcement in position until the subsequent soil layer can be placed.

Under no circumstances shall a track-type vehicle be allowed on the geotextile reinforcement before at least six inches of soil has been placed. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and the geotextile reinforcement. If approved by the Manufacturer, rubber-tired equipment may pass over the geotextile reinforcement at slow speeds, less than 10 mph. Sudden braking and sharp turning shall be avoided.

During construction, the surface of the fill should be kept approximately horizontal. Geotextile reinforcement shall be placed directly on the compacted horizontal fill surface. Geotextile reinforcements are to be placed within three inches of the design elevations and extend the length as shown on the elevation view unless otherwise directed by ENGEO. Correct orientation of the geotextile reinforcement shall be verified by ENGEO.

<b>Table II</b> <b>Allowable Geotextile Strength</b> <b>With Various Soil Types</b> <b>For Geosynthetic Reinforcement In</b> <b>Mechanically Stabilized Earth Slopes</b>			
(Geotextile Pullout Resistance and Allowable Strengths vary with reinforced backfill used due to soil anchorage and site damage factors. Guidelines are provided below.)			
SOIL TYPE	MINIMUM ALLOWABLE STRENGTH, $T_a$ (lb/ft)*		
	GEOTEXTILE Type I	GEOTEXTILE Type II	GEOTEXTILE Type III
A. Gravels, sandy gravels, and gravel-sand-silt mixtures (GW, GP, GC, GM & SP)**	2400	4800	7200
B. Well graded sands, gravelly sands, and sand-silt mixtures (SW & SM)**	2000	4000	6000
C. Silts, very fine sands, clayey sands and clayey silts (SC & ML)**	1000	2000	3000
D. Gravelly clays, sandy clays, silty clays, and lean clays (CL)**	1600	3200	4800
* All partial Factors of Safety for reduction of design strength are included in listed values. Additional factors of safety may be required to further reduce these design strengths based on site conditions.			
** Unified Soil Classifications.			

## **PART IV - EROSION CONTROL MAT OR BLANKET**

### 1. DESCRIPTION:

Work shall consist of furnishing and placing a synthetic erosion control mat and/or degradable erosion control blanket for slope face protection and lining of runoff channels.

### 2. EROSION CONTROL MATERIALS:

2.1 The specific erosion control material and supplier shall be pre-approved by ENGEO.

2.2 Certification: The Contractor shall submit a manufacturer's certification that the erosion mat/blanket supplied meets the criteria specified when the material was approved by ENGEO. The manufacturer's certification shall include a submittal package of documented test results that confirm the property values. In case of a dispute over validity of values, the Contractor will supply property test data from an ENGEO-approved laboratory, to support the certified values submitted. Minimum average roll values, per ASTM D 4759, shall be used for conformance determinations.

### 3. CONSTRUCTION:

3.1 Delivery, Storage, and Handling: Contractor shall check the erosion control material upon delivery to ensure that the proper material has been received. During all periods of shipment and storage, the erosion mat shall be protected from temperatures greater than 140 °F, mud, dirt, and debris. Manufacturer's recommendations in regard to protection from direct sunlight must also be followed. At the time of installation, the erosion mat/blanket shall be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by ENGEO, torn or punctured sections may be removed by cutting OUT a section of the mat. The remaining ends should be overlapped and secured with ground anchors. Any erosion mat/blanket damaged during storage or installation shall be replaced by the Contractor at no additional cost to the Owner.

3.2 On-Site Representative: Erosion control material suppliers shall provide a qualified and experienced representative on site, for a minimum of one day, to assist the Contractor and ENGEO personnel at the start of construction. If there is more than one slope on a project, this criteria will apply to construction of the initial slope only. The representative shall be available on an as-needed basis, as requested by ENGEO, during construction of the remaining slope(s).

- 3.3 Placement: The erosion control material shall be placed and anchored on a smooth graded, firm surface approved by the Engineer. Anchoring terminal ends of the erosion control material shall be accomplished through use of key trenches. The material in the trenches shall be anchored to the soil on maximum 1½ foot centers. Topsoil, if required by construction drawings, placed over final grade prior to installation of the erosion control material shall be limited to a depth not exceeding 3 inches.
- 3.4 Erosion control material shall be anchored, overlapped, and otherwise constructed to ensure performance until vegetation is well established. Anchors shall be as designated on the construction drawings, with a minimum of 12 inches length, and shall be spaced as designated on the construction drawings, with a maximum spacing of 4 feet.
- 3.5 Soil Filling: If noted on the construction drawings, the erosion control mat shall be filled with a fine grained topsoil, as recommended by the manufacturer. Soil shall be lightly raked or brushed on/into the mat to fill the mat voids or to a maximum depth of 1 inch.

## **PART V - GEOSYNTHETIC DRAINAGE COMPOSITE**

### 1. DESCRIPTION:

Work shall consist of furnishing and placing a geosynthetic drainage system as a subsurface drainage medium for reinforced soil slopes.

### 2. DRAINAGE COMPOSITE MATERIALS:

2.1 The specific drainage composite material and supplier shall be preapproved by ENGEO.

2.2 The drain shall be of composite construction consisting of a supporting structure or drainage core material surrounded by a geotextile. The geotextile shall encapsulate the drainage core and prevent random soil intrusion into the drainage structure. The drainage core material shall consist of a three dimensional polymeric material with a structure that permits flow along the core laterally. The core structure shall also be constructed to permit flow regardless of the water inlet surface. The drainage core shall provide support to the geotextile. The fabric shall meet the minimum property requirements for filter fabric listed in Section 2.05C of the Guide Earthwork Specifications.

2.3 A geotextile flap shall be provided along all drainage core edges. This flap shall be of sufficient width for sealing the geotextile to the adjacent drainage structure edge to prevent soil intrusion into the structure during and after installation. The geotextile shall cover the full length of the core.

2.4 The geocomposite core shall be furnished with an approved method of constructing and connecting with outlet pipes or weepholes as shown on the plans. Any fittings shall allow entry of water from the core but prevent intrusion of backfill material into the core material.

2.5 Certification and Acceptance: The Contractor shall submit a manufacturer's certification that the geosynthetic drainage composite meets the design properties and respective index criteria measured in full accordance with all test methods and standards specified. The manufacturer's certification shall include a submittal package of documented test results that confirm the design values. In case of dispute over validity of design values, the Contractor will supply design property test data from an ENGEO-approved laboratory, to support the certified values submitted. Minimum average roll values, per ASTM D 4759, shall be used for determining conformance.

### 3. CONSTRUCTION:

- 3.1 **Delivery, Storage, and Handling:** Contractor shall check the geosynthetic drainage composite upon delivery to ensure that the proper material has been received. During all periods of shipment and storage, the geosynthetic drainage composite shall be protected from temperatures greater than 140 °F, mud, dirt, and debris. Manufacturer's recommendations in regards to protection from direct sunlight must also be followed. At the time of installation, the geosynthetic drainage composite shall be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by ENGEO, torn or punctured sections may be removed or repaired. Any geosynthetic drainage composite damaged during storage or installation shall be replaced by the Contractor at no additional cost to the Owner.
- 3.2 **On-Site Representative:** Geosynthetic drainage composite material suppliers shall provide a qualified and experienced representative on site, for a minimum of one half day, to assist the Contractor and ENGEO personnel at the start of construction with directions on the use of drainage composite. If there is more than one application on a project, this criterion will apply to construction of the initial application only. The representative shall also be available on an as-needed basis, as requested by ENGEO, during construction of the remaining applications.
- 3.3 **Placement:** The soil surface against which the geosynthetic drainage composite is to be placed shall be free of debris and inordinate irregularities that will prevent intimate contact between the soil surface and the drain.
- 3.4 **Seams:** Edge seams shall be formed by utilizing the flap of the geotextile extending from the geocomposite's edge and lapping over the top of the fabric of the adjacent course. The fabric flap shall be securely fastened to the adjacent fabric by means of plastic tape or non-water-soluble construction adhesive, as recommended by the supplier. Where vertical splices are necessary at the end of a geocomposite roll or panel, an 8-inch-wide continuous strip of geotextile may be placed, centering over the seam and continuously fastened on both sides with plastic tape or non-water-soluble construction adhesive. As an alternative, rolls of geocomposite drain material may be joined together by turning back the fabric at the roll edges and interlocking the cuspidations approximately 2 inches. For overlapping in this manner, the fabric shall be lapped and tightly taped beyond the seam with tape or adhesive. Interlocking of the core shall always be made with the upstream edge on top in the direction of water flow. To prevent soil intrusion, all exposed edges of the geocomposite drainage core edge must be covered. Alternatively, a 12-inch-wide strip of fabric may be utilized in the same manner, fastening it to the exposed fabric 8 inches from the edge and folding the remaining flap over the core edge.

3.5 Soil Fill Placement: Structural backfill shall be placed immediately over the geocomposite drain. Care shall be taken during the backfill operation not to damage the geotextile surface of the drain. Care shall also be taken to avoid excessive settlement of the backfill material. The geocomposite drain, once installed, shall not be exposed for more than seven days prior to backfilling.