June 30, 2009
Project No. 104804035

Mr. Anthony Podegracz, P.E.
Kimley-Horn
c/o San Diego Association of Governments
401 B Street, Suite 600
San Diego, California 92101

Subject: Geotechnical Evaluation
San Ysidro Rail Yard Expansion
San Diego, California

Dear Mr. Podegracz:

In accordance with your authorization, we have performed a geotechnical evaluation for the proposed San Ysidro Rail Yard expansion in San Diego, California. This report presents our geotechnical findings, conclusions, and recommendations regarding the proposed project.

We appreciate the opportunity to be of service on this project.

Sincerely,

NINYO & MOORE

Chet E. Robinson, P.E.
Project Engineer

Gregory T. Farrand, C.E.G.
Principal Geologist

CER/FOM/GTF/gg

Distribution: (6) Addressee
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Appendix A – Test Pit Logs
Appendix B – Laboratory Testing
Appendix C – Typical Earthwork Guidelines
1. **INTRODUCTION**

In accordance with your request, we have performed a geotechnical evaluation for the proposed San Ysidro Rail Yard expansion in the San Diego, California community of San Ysidro (see Figure 1). We previously performed a preliminary geotechnical evaluation for the rail yard the results of which were presented in our report dated May 2, 2008. This report presents our conclusions regarding the geotechnical conditions at the subject site and the geotechnical feasibility of the project.

2. **SCOPE OF SERVICES**

Ninyo & Moore’s scope of services for the project included review of pertinent background data, performance of a geologic reconnaissance, subsurface exploration, laboratory testing, and engineering analysis with regard to the proposed project. Specifically, we performed the following tasks:

- **Reviewing background data listed in the References section of this report.** The data reviewed included geotechnical reports, topographic maps, geologic data, fault maps, and a site plan for the project.

- **Performing a geologic reconnaissance of the proposed site,** including the observation and mapping of geologic conditions and the evaluation of possible geologic hazards which may impact the proposed project.

- **Coordinating of our field exploration with the client, San Diego Association of Governments (SANDAG), property owners, and the Metropolitan Transit System (MTS).**

- **Acquiring MTS and San Diego and Arizona Eastern Railway Company Right-of Entry Permits.**

- **Marking 12 test pit locations for clearance of utilities.** Underground Service Alert (USA) was notified to mark the existing underground utilities at the project site.

- **Performing a subsurface evaluation consisting of excavating, logging, and sampling 12 test pits to evaluate the subsurface conditions.**

- **Performing geotechnical laboratory testing on selected soil samples.**

- **Compiling and analyzing the data obtained.**

- **Preparing this report presenting our findings, conclusions, and recommendations regarding the geotechnical design of the project.**
3. PROJECT DESCRIPTION

The San Diego Association of Governments proposes to improve the San Ysidro Rail Yard (proposed project). The purpose of the project is to improve operational capacity and efficiency at the Rail Yard to accommodate existing and future freight rail operations in the region. The project intends to provide additional storage capacity to the Yard by the construction of two new track extensions to the north and realignment of existing tracks. Improvements will also be made to improve truck access, circulation and cargo transfer at the site, including construction of a new access road that will parallel the tracks and connect to East Beyer Boulevard and installation of a paved track area in the vicinity of the existing Maintenance Building. Other improvements are also included in the project including security, lighting, fencing and drainage improvements.

4. SITE DESCRIPTION

The study area consists of an undeveloped, 1.2-mile long strip of land located east (upslope) of the San Diego and Arizona Eastern Railway freight rail tracks. The subject property extends from the rail switch approximately 100 feet north of the United States/Mexico International Border (on the south) to the East Beyer Boulevard bridge undercrossing at the railroad tracks (on the north), a distance of approximately 1.2 miles. The study area is a few hundred feet in width.

5. SUBSURFACE EXPLORATION AND LABORATORY TESTING

Our field exploration of the subject site included a geologic reconnaissance and subsurface exploration conducted on June 5, and 8, 2009. The subsurface evaluation consisted of excavating 12 test pits to depths of up to approximately 11.6 feet. The test pit locations were selected based on the results of our background review and field reconnaissance. Prior to commencing the subsurface exploration, USA was notified for mark-out of the existing utilities. The approximate locations of the test pits are presented on Figures 2 and 3. The test pit logs are presented in Appendix A.

Geotechnical laboratory testing of representative soil samples included moisture content and dry density, gradation (sieve) analysis, shear strength, R-value, and corrosivity (pH, resistivity, sulfate content, and chloride content). The results of the moisture content and dry density tests are
presented on the test pit logs in Appendix A. The results of the other laboratory tests performed are presented in Appendix B.

6. GEOLOGY AND SUBSURFACE CONDITIONS
Our findings regarding regional and site geology, including faulting and seismicity, landslides, rippability (excavatability), and groundwater conditions at the subject site are provided in the following sections.

6.1. Regional Geologic Setting
The project area is situated in the southwestern San Diego County section of the Peninsular Ranges Geomorphic Province. This geomorphic province encompasses an area that extends approximately 900 miles from the Transverse Ranges and the Los Angeles Basin south to the southern tip of Baja California (Norris and Webb, 1990). The province varies in width from approximately 30 to 100 miles. In general, the province consists of rugged mountains underlain by Jurassic metavolcanic and metasedimentary rocks, and Cretaceous igneous rocks of the southern California batholith. The portion of the province in San Diego County that includes the project area consists generally of uplifted Tertiary and Quaternary sedimentary rock.

The Peninsular Ranges Province is traversed by a group of sub-parallel faults and fault zones trending roughly northwest. Several of these faults, which are shown on Figure 4, Fault Location Map, are considered active faults. The Elsinore, San Jacinto, and San Andreas faults are active fault systems located northeast of the project area and the Agua Blanca–Coronado Bank, and San Clemente faults are active faults located west of the project area. Major San Diego Trough tectonic activity associated with these and other faults within this regional tectonic framework consists primarily of right-lateral, strike-slip movement. Further discussion of faulting relative to the site is provided in the Faulting and Seismicity section of this report.

6.2. Site Geology
Geologic units present in the vicinity of the site included topsoil, fill, alluvium, landslide deposits, and Otay Formation. Lindavista and San Diego Formations are present on the top of
the hills to the east of the site. Generalized descriptions of the earth units encountered in our test pits are provided in the subsequent sections.

6.2.1. Topsoil

Development of topsoil was observed on some of the landslide deposits. This material was encountered from the ground surface, up to a depth of 3.5 feet in test pits TP-2, -3, -8, and -9. In test pit TP-11, topsoil was encountered from the ground surface to the total depth explored of 6.5 feet, and in test pit TP-12, topsoil was encountered underlying fill materials at a depth of 1 foot below the ground surface. The topsoil material generally consisted of brown, dry to damp, stiff to very stiff, fine to medium sandy clay, light brown, dry, loose, fine sandy silt, and grayish brown, yellow to olive brown with pinkish brown mottling, damp to moist, loose to medium dense, silty fine to medium sand with gravel, cobbles, and chunks of clay. Calcium carbonate flecks were observed throughout the topsoil materials.

6.2.2. Fill

In general, fill is present along the railroad alignment and access roads, both associated with the original construction. Fill material was encountered in test pits TP-7 and TP-12 from the ground surface to 1.6 feet and 1 foot, respectively. The fill material consists of various shades of grayish brown, dry, loose to medium dense, silty sand and sandy silt with gravel.

6.2.3. Alluvium

Alluvium is present in the bottoms of tributary drainages to the east of the rail yard as encountered in test pits TP-1 and TP-10. In general, the alluvium encountered in the project site generally consists of various shades of brown, dry to moist, loose to medium dense, clayey, silty sand and firm, sandy clay with gravel, cobbles, and boulders nested in a sandy matrix. The gravel, cobbles, and boulders encountered are associated with larger drainages descending from the hills to the east of the rail yard.

6.2.4. Landslide Deposits

Landslide deposits underlie most of the hillside to the east of the project site as well as portions of the project site. The majority of the landslide deposits are derived from mate-
rials of the Otay Formation. Based on our previous work at the site and borings performed by others, the landslide deposits in the site area extend to depths of more than 120 feet below the existing grade (about 25 feet below mean sea level [MSL]). Terrace deposits overlie the landslide deposits in borings by others on the west side of the railroad alignment indicating that the landslide deposits underlying the alignment are ancient. In the area of the rail yard expansion, landslide deposits were encountered in test pits TP-2 through TP-9 and TP-12 and the material generally consisted of a combination of silty sand, gravel and cobbles, and clay with gravel with varying degrees of cementation.

6.2.5. Otay Formation

Based on our previous borings and borings performed by others (Ninyo & Moore, 1992 and 2008; Leighton and Associates, 1980, 1985a, and 1985b; Amec Earth & Environmental, 2000a and 2000b), the Otay Formation underlies the terrace deposits and mud flow deposits at the northern end of the study area and the landslide deposits in the remaining portions of the study area. In general, the Otay Formation generally consists of beds of weakly to moderately indurated claystone and siltstone, and weakly to moderately cemented sandstone.

6.3. Groundwater

Based on our experience in the site vicinity and our previous subsurface evaluation (Ninyo & Moore, 1992 and 2008), we anticipate that the depth to groundwater at the study site is on the order of 50 feet. Fluctuations in the groundwater level may occur due to variations in ground surface topography, subsurface geologic conditions and structure, rainfall, and other factors.

6.4. Faulting and Seismicity

The project area is considered to be seismically active. Based on our review of the referenced geologic maps and stereoscopic aerial photographs, as well as our geologic field reconnaissance, the subject site is not underlain by known active or potentially active faults (i.e., faults that exhibit evidence of ground displacement in the last 11,000 years and 2,000,000 years, respectively).
The closest known active fault is the Rose Canyon fault, which can generate an earthquake magnitude of up to 7.2 (Cao, et al, 2003). It is located approximately 7 miles northwest of the project site. The La Nacion Fault system crosses the northern portion of the project site, and consists of moderate- to high-angle normal faults trending generally to the north. Movement along this fault system may be associated with unexplained seismic activity in the region during the Holocene. This potentially active fault system is estimated to have a maximum likely quake magnitude of 6.2 to 6.7 (Artim and Pinckney, 1973, and Jennings and Saucedo, 1999).

6.4.1. Ground Surface Rupture

Based on our review of the referenced literature and our site reconnaissance, no active faults are known to cross the project site. Therefore, the potential for ground rupture due to faulting at the site is unlikely. However, lurching or cracking of the ground surface as a result of nearby seismic events is possible.

6.4.2. Strong Ground Motion

The 2007 California Building Code (CBC) recommends that the design of structures be based on the peak horizontal ground acceleration (PGA) having a 2 percent probability of exceedance in 50 years which is defined as the Maximum Considered Earthquake (MCE). The statistical return period for $\text{PGA}_{\text{MCE}}$ is approximately 2,475 years. In evaluating the seismic hazards associated with the project site, we have used a Site Classification D. The site modified $\text{PGA}_{\text{MCE}}$ was estimated to be 0.42g using the United States Geological Survey (USGS) (USGS, 2009) ground motion calculator (web-based). The design PGA was estimated to be 0.30g using the USGS ground motion calculator. These estimates of ground motion do not include near-source factors that may be applicable to the design of structures on site.

6.4.3. Liquefaction and Seismically Induced Settlement

Liquefaction of cohesionless soils can be caused by strong vibratory motion due to earthquakes. Research and historical data indicate that loose granular soils and non-plastic silts that are saturated by a relatively shallow groundwater table are susceptible to liquefaction.
Based on the depth to groundwater and the relatively dense, cohesive nature of the soils that underlie the site, the potential for liquefaction at the site is not a design consideration.

### 6.4.4. Tsunamis
Tsunamis are long wavelength seismic sea waves (long compared to the ocean depth) generated by sudden movements of the ocean bottom during submarine earthquakes, landslides, or volcanic activity. Based on the elevation and inland location of the site, the potential for damage due to tsunami is not a design consideration.

### 6.5. Landsliding
Based on our review of the referenced reports, published geologic literature, and aerial photographs, and our geologic reconnaissance, a large part of the study area is underlain by landslide deposits. The landslides are not known to have moved historically. Based on geologic relationships, the slides likely moved during the late Pleistocene (prior to or subsequent to deposition of the terrace deposits). It is less likely that the slides moved during the Holocene (within the last 11,000 years).

### 6.6. Slope Stability
We performed an analysis of the planned grading for the site as shown on the April 2009 Improvement Plans by Bureau of Veritas North America, Inc. The plans indicate that the slopes east of the new access road will be cut to an inclination of 2H:1V (horizontal to vertical) for heights up to 40 feet. Our analysis indicates that the planned slopes are globally stable with Factors of Safety of at least 1.5 under static conditions and 1.0 during a seismic event with the design peak ground acceleration of 0.30.

### 7. CONCLUSIONS
Based on our review of the referenced background data, geologic field reconnaissance and analysis of subsurface conditions, it is our opinion that construction of the proposed project is feasible from a geotechnical standpoint. Based on our review of published geologic maps and our field
evaluation, the project site is not underlain by active faults. In our opinion, the following considerations will be significant in the planning, design, and construction of the proposed project:

- Large-scale landslide deposits are present to the east of the site and underlie large portions of the site. Based on our evaluation of the planned grading, our analysis shows that the slopes will have an adequate factor of safety against global failure.

- Although not specifically within the scope of this report, it is our understanding that retaining walls may be considered for this project. Reinforced concrete, mechanically stabilized earth, or tie-back walls up to 20 feet high would be suitable for this site.

- Detention basins will be designed and constructed as part of this project. Recommendations for detention basin slopes are provided within the “Slopes” section of this report.

- Gravel and boulders requiring special handling will be encountered during grading.

- Based on Caltrans criteria, the project site is classified as corrosive.

8. RECOMMENDATIONS

Based on our understanding of the project, the following recommendations are provided for the design and construction of the rail yard expansion.

8.1. Earthwork

In general, earthwork should be performed in accordance with the recommendations presented in this report. Ninyo & Moore should be contacted for questions regarding the recommendations or guidelines presented herein. In addition, Typical Earthwork Guidelines for the project are included as Appendix C. In the event of a conflict, the recommendations presented in the following sections of this report should supersede those in Appendix C.

8.1.1. Site Preparation

Prior to excavation, the project site should be cleared of abandoned utilities (if present) and stripped of rubble, debris, vegetation, any loose, wet, or otherwise unstable soils, as well as surface soils containing organic material. Materials generated from the clearing operations should be removed from the site and disposed of at a legal dumpsite away from the project area.
8.1.2. **Excavation Characteristics**

Our evaluation of the excavation characteristics of the on-site materials at the subject site is based on the results of our subsurface exploration and our experience with similar materials. In our opinion, the on-site materials are expected to be rippable with normal heavy-duty earthmoving equipment. Strongly cemented “concretions” and/or zones will be encountered, however, which will entail the use of heavy ripping or rockbreakers. Abundant cobbles and boulders will also be encountered for which special equipment or handling may be needed.

8.1.3. **Materials for Fill**

On-site soils with an organic content of less than approximately 3 percent by volume (or 1 percent by weight) are suitable for use as fill. Fill material should generally not contain rocks or lumps over approximately 4 inches, and generally not more than approximately 40 percent larger than 3/4-inch. Due to the presence of cobbles and boulders, selective grading or special handling may be needed. Utility trench backfill material should not contain rocks or lumps over approximately 3 inches in general. Soils classified as silts or clays should not be used for backfill in the pipe zone. Larger chunks, if generated during excavation, may be broken into acceptably sized pieces or disposed of off site. Imported fill material, if needed for the project, should generally be granular soils with a very low to low expansion potential (i.e., an expansion index of 50 or less as evaluated by American Society for Testing and Materials [ASTM] Test Method D 4829). Import material should also be non-corrosive in accordance with the Caltrans (2003) corrosion guidelines. Materials for use as fill should be evaluated by Ninyo & Moore’s representative prior to filling or importing.

8.1.4. **Compacted Fill**

Prior to placement of compacted fill, the contractor should request an evaluation of the exposed ground surface by Ninyo & Moore. Unless otherwise recommended, the exposed ground surface should then be scarified to a depth of approximately 8 inches and watered or dried, as needed, to achieve moisture contents generally above the optimum moisture content. The scarified materials should then be compacted to a relative compaction of 90 percent as evaluated in accordance with ASTM D 1557. The evaluation of compaction
by the geotechnical consultant should not be considered to preclude any requirements for observation or approval by governing agencies. It is the contractor's responsibility to notify the geotechnical consultant and the appropriate governing agency when the project area is ready for observation, and to provide reasonable time for that review.

Fill materials should be moisture conditioned to generally above the laboratory optimum moisture content prior to placement. The optimum moisture content will vary with material type and other factors. Moisture conditioning of fill soils should be generally consistent within the soil mass.

Prior to placement of additional compacted fill material following a delay in the grading operations, the exposed surface of previously compacted fill should be prepared to receive fill. Preparation may include scarification, moisture conditioning, and recompaction.

Compacted fill should be placed in horizontal lifts of approximately 8 inches in loose thickness. Prior to compaction, each lift should be watered or dried as needed to achieve a moisture content generally above the laboratory optimum, mixed, and then compacted by mechanical methods, using sheepsfoot rollers, multiple-wheel pneumatic-tired rollers or other appropriate compacting rollers, to a relative compaction of 90 percent as evaluated by ASTM D 1557. Successive lifts should be treated in a like manner until the desired finished grades are achieved.

8.1.5. Slopes

Unless otherwise recommended by Ninyo & Moore and approved by the regulating agencies, cut and fill slopes should not be steeper than 2:1 (horizontal:vertical). Compaction of the face of fill slopes should be performed by backrolling at intervals of 4 feet or less in vertical slope height, or as dictated by the capability of the available equipment, whichever is less. Fill slopes should be backrolled utilizing a conventional sheepsfoot-type roller. Care should be taken to maintain the desired moisture conditions and/or reestablish them, as needed, prior to backrolling. The placement, moisture conditioning, and compaction of fill slope materials should be done in accordance with the recommendations presented in the Compacted Fill section of this report.
Site runoff should not be permitted to flow over the tops of slopes. Positive drainage should be established away from the top of slopes. This may be accomplished by utilizing brow ditches placed at the top of slopes to divert surface runoff away from the slope face where drainage devices are not otherwise available.

The on-site soils are susceptible to erosion; therefore, the project plans and specifications should contain design features and construction requirements to mitigate erosion of on-site soils during and after construction. Slopes and other exposed ground surfaces should be appropriately planted with protective ground cover.

8.1.6. **Temporary Excavations, Braced Excavations and Shoring**

We recommend that trenches and excavations be designed and constructed in accordance with Occupational Safety and Health Administration (OSHA) regulations. These regulations provide trench sloping and shoring design parameters for trenches up to 20 feet deep based on the soil types encountered. Trenches over 20 feet deep should be designed by the Contractor’s engineer based on site-specific geotechnical analyses. For planning purposes, we recommend that the following OSHA soil classifications be used:

\[
\begin{align*}
\text{Fill, Alluvium, and Landslide Deposits} & \quad \text{Type D} \\
\text{Otay Formation} & \quad \text{Type C}
\end{align*}
\]

Upon making the excavations, the soil/rock classifications and excavation performance should be evaluated in the field by Ninyo & Moore in accordance with OSHA regulations.

Temporary excavations should be constructed in accordance with OSHA recommendations. For trench or other excavations, OSHA requirements regarding personnel safety should be met by using appropriate shoring (including trench boxes) or by laying back the slopes no steeper than 1.5:1 in fill, alluvium, or landslide deposits and 1:1 in Otay Formation. Temporary excavations that encounter seepage may need shoring or may be stabilized by placing sandbags or gravel along the base of the seepage zone. Excavations encountering seepage should be evaluated on a case-by-case basis. On-site safety of personnel is the responsibility of the contractor.
8.1.7. Drainage

Surface drainage on the site should generally be provided so that water is not permitted to pond. A gradient of 2 percent or steeper should be maintained and drainage patterns should be established to divert and remove water from the site to appropriate outlets.

Care should be taken by the contractor during grading to preserve any berms, drainage terraces, interceptor swales or other drainage devices on or adjacent to the property. Drainage patterns established at the time of grading should be maintained for the life of the project.

8.1.8. Seismic Design Parameters

Design of the proposed improvements should be designed in accordance with the requirements of governing jurisdictions and applicable building codes. Table 1 presents the seismic design parameters for the site in accordance with CBC (2007) guidelines and mapped spectral acceleration parameters (USGS, 2009).

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8.2. Preliminary Pavement Design

We understand that an asphalt concrete-, Class 2 aggregate base-, or decomposed granite-paved access drive will be constructed on the site. For planning purposes we are providing preliminary pavement designs. Laboratory testing was performed on a representative sample of the on-site soils to evaluate R-value. The test was in general accordance with California Test (CT) Method 301 and the result is presented in Appendix B. The test result indicates an
R-value of 10 for the sample tested. We have used this value for the preliminary design of flexible pavements at the project site. Actual pavement recommendations should be based on R-value tests performed on bulk samples of the soils that are exposed at the finished sub-grade elevations in the areas to be paved once grading operations have been performed.

For design we have used Traffic Index (TI) of 6.0 for site pavements. The preliminary recommended pavement sections are as follows:

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If a geogrid material (such as Tensar BX1200 or equivalent) is used on the subgrade, the full aggregate base section may be reduced to 7 inches and the full decomposed granite section may be reduced to 8 inches.

If traffic loads are different from those assumed, the pavement design should be re-evaluated. In addition, we recommend that the upper 12 inches of the subgrade, the Class 2 aggregate base, and the decomposed granite be compacted to a relative compaction of 95 percent as evaluated by ASTM D 1557.

8.3.  Corrosion

Laboratory testing was performed on a representative sample of the on-site soils to evaluate pH and electrical resistivity, as well as chloride and sulfate contents. The pH and electrical resistivity tests were performed in accordance with CT 643 and the sulfate and chloride content tests were performed in accordance with CT 417 and 422, respectively. These laboratory test results are presented in Appendix B.

The results of the corrosivity testing indicated an electrical resistivity of 220 ohm-cm, a soil pH of 6.7, a chloride content of 2,130 parts per million (ppm) and a sulfate content of
0.168 percent (i.e., 1,680 ppm). Based on the Caltrans (2003) criteria, the project site is classified as corrosive, which is defined as a site having soils with more than 500 ppm of chlorides, more than 0.2 percent sulfates, or a pH less than 5.5.

8.4. Concrete Placement

Concrete in contact with soil or water that contains high concentrations of water-soluble sulfates can be subject to premature chemical and/or physical deterioration. As stated above, the soil sample tested in this evaluation indicated a water-soluble sulfate content of 0.168 percent by weight. According to the American Concrete Institute (ACI) guideline 318-05, the potential for sulfate attack is moderate for water-soluble sulfate content of up to about 0.10 percent by weight in soils. Therefore, the site soils may be considered to have a potential for sulfate attack. Based on ACI (2005) criteria, Type II cement may be used for concrete construction. However, due to the potential variability of site soils, consideration should be given to using Type V cement and concrete with a water-cement ratio no higher than 0.45 by weight for normal weight aggregate concrete and a 28-day compressive strength of 4,500 pounds per square inch or more for the project.

8.5. Pre-Construction Conference

We recommend that a pre-construction meeting be held prior to commencement of grading. The owner or his representative, the agency representatives, the architect, the civil engineer, Ninyo & Moore, and the contractor should be in attendance to discuss the plans, the project, and the proposed construction schedule.

8.6. Plan Review and Construction Observation

The conclusions and recommendations presented in this report are based on analysis of observed conditions in widely spaced exploratory excavations. If conditions are found to vary from those described in this report, Ninyo & Moore should be notified, and additional recommendations will be provided upon request. Ninyo & Moore should review the final project drawings and specifications prior to the commencement of construction. Ninyo & Moore should perform the needed observation and testing services during construction operations.
The recommendations provided in this report are based on the assumption that Ninyo & Moore will provide geotechnical observation and testing services during construction. In the event that it is decided not to utilize the services of Ninyo & Moore during construction, we request that the selected consultant provide the client with a letter (with a copy to Ninyo & Moore) indicating that they fully understand Ninyo & Moore’s recommendations, and that they are in full agreement with the design parameters and recommendations contained in this report. Construction of proposed improvements should be performed by qualified subcontractors utilizing appropriate techniques and construction materials.

9. LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues other than proposed retaining walls, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent
evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified, and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no controls.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties’ sole risk.
10. REFERENCES

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<td>3-31-53</td>
<td>AXN-3M</td>
<td>30 and 31</td>
<td>1:20,000</td>
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</table>
SITE LOCATION MAP

SAN YSIDRO RAIL YARD EXPANSION
SAN DIEGO, CALIFORNIA

REFERENCE: 2005 THOMAS GUIDE FOR SAN DIEGO COUNTY, STREET GUIDE AND DIRECTORY.

NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

APPROXIMATE SCALE IN FEET

PROJECT NO. 104804035
DATE 6/09

FIGURE 1

Map © Rand McNally, R.L.07-S-129
NOTES: ALL DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE

LEGEND

CALIFORNIA FAULT ACTIVITY

- HISTORICALLY ACTIVE
- HOLOCENE ACTIVE
- LATE QUATERNARY (POTENTIALLY ACTIVE)
- QUATERNARY (POTENTIALLY ACTIVE)
- STATE/COUNTY BOUNDARY


APPROXIMATE SCALE

0 12.5 25 50 MILES

PROJECT NO. 104804035 DATE 6/09

FAULT LOCATION MAP

SAN YSIDRO RAIL YARD EXPANSION
SAN DIEGO, CALIFORNIA

FIGURE 4
APPENDIX A

TEST PIT LOGS

Field Procedure for the Collection of Disturbed Samples
Disturbed soil samples were obtained in the field using the following method.

**Bulk Samples**
Bulk samples of representative earth materials were obtained from the exploratory excavations. The samples were bagged and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples
Relatively undisturbed soil samples were obtained in the field using the following method.

**The Modified Split-Barrel Drive Sampler**
The sampler, with an external diameter of 3.0 inches, was lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with a 50-pound weight. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.
# EXCAVATION LOG EXPLANATION SHEET

**Explanation of Test Pit, Core, Trench and Hand Auger Log Symbols**

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<table>
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<tr>
<th>DEPTH (FEET)</th>
<th>SAMPLES</th>
<th>MOISTURE (%)</th>
<th>DRY DENSITY (G/F)</th>
<th>CLASSIFICATION</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>SM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fill</td>
<td></td>
<td></td>
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</tr>
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<td></td>
<td>Bulk sample.</td>
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<td></td>
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</tr>
<tr>
<td>0</td>
<td>ML</td>
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<tr>
<td></td>
<td>Dashed line denotes material change.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drive sample.</td>
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<td></td>
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</tr>
<tr>
<td>1</td>
<td>Sand cone performed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seepage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Groundwater encountered during excavation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No recovery with drive sampler.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Groundwater encountered after excavation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sample retained by others.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shelby tube sample. Distance pushed in inches/length of sample recovered in inches</td>
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<td></td>
<td></td>
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<td></td>
<td>xx/xx</td>
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</tr>
<tr>
<td>3</td>
<td>No recovery with Shelby tube sampler.</td>
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</tr>
<tr>
<td></td>
<td>SM</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Alluvium</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Solid line denotes unit change</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Attitude: Steep/Dip</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b: Bedding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c: Contact</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>j: Joint</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>f: Fracture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p: Fault</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ca: Clay Seam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>s: Shear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b: Bedding Surface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>f: Shear Fracture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ps: Shear Plane</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sbs: Sheared Bedding Surface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The total depth line is a solid line that is drawn at the bottom of the excavation box.</td>
<td></td>
<td></td>
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</table>

**SCALE:** 1 inch = 1 foot
# U.S.C.S. Method of Soil Classification

## Major Divisions

<table>
<thead>
<tr>
<th>GRAVELS</th>
<th>SYMBOL</th>
<th>TYPICAL NAMES</th>
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<tbody>
<tr>
<td>(More than 1/3 of coarse fraction &gt; No. 4 sieve site)</td>
<td>GW</td>
<td>Well graded gravels or gravel-sand mixtures, little or no fines</td>
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<tr>
<td></td>
<td>GP</td>
<td>Poorly graded gravels or gravel-sand mixtures, little or no fines</td>
</tr>
<tr>
<td></td>
<td>GM</td>
<td>Silty gravels, gravel-sand-silt mixtures</td>
</tr>
<tr>
<td></td>
<td>GC</td>
<td>Clayey gravels, gravel-sand-clay mixtures</td>
</tr>
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<td></td>
<td>SW</td>
<td>Well graded sands or gravelly sands, little or no fines</td>
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<td>Poorly graded sands or gravelly sands, little or no fines</td>
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<td>Silty sands, sand-silt mixtures</td>
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<td>SC</td>
<td>Clayey sands, sand-clay mixtures</td>
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<table>
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<tr>
<th>SANDS</th>
<th>(More than 1/2 of coarse fraction &lt; No. 4 sieve size)</th>
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<tr>
<td></td>
<td>MI</td>
</tr>
<tr>
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<tr>
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<td>OH</td>
</tr>
<tr>
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<td>MH</td>
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<td>CH</td>
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<tr>
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<td>OH</td>
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<table>
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<tr>
<th>HIGHLY ORGANIC SOILS</th>
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## Grain Size Chart

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>RANGE OF GRAIN SIZE</th>
<th>U.S. Standard Sieve Size</th>
<th>Grain Size in MM/Inches</th>
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<td>Above 12&quot;</td>
<td>Above 305</td>
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<tr>
<td>COBBLES</td>
<td>12&quot; to 3&quot;</td>
<td>305 to 76.2</td>
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<tr>
<td>GRAVEL</td>
<td>3&quot; to 4&quot;</td>
<td>76.2 to 96</td>
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<td>Course</td>
<td>3/4&quot; to 3/8&quot;</td>
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<td>Fine</td>
<td>3/16&quot; to No. 4</td>
<td>1.6 to 2.0</td>
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<tr>
<td>SAND</td>
<td>No. 4 to No. 200</td>
<td>4.76 to 0.075</td>
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</tr>
<tr>
<td>Course</td>
<td>No. 4 to No. 10</td>
<td>4.76 to 0.075</td>
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<td>Medium</td>
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<tr>
<td>Fine</td>
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<tr>
<td>SILT &amp; CLAY</td>
<td>Below No. 200</td>
<td>Below 0.075</td>
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## Plasticity Chart

- **Liquid Limit (LL)**
- **Plastic Limit (PL)**
- **Plasticity Index (PI)**

*U.S.C.S. Method of Soil Classification*

*Ninny & Moore*
TEST PIT LOG
SAN YSIDRO RAIL YARD EXPANSION
SAN DIEGO, CALIFORNIA

PROJECT NO. DATE
104904035 6/09

DATE EXCAVATED 6/05/09 TEST PIT NO. TP-1
GROUND ELEVATION 85' A.MSL LOGGED BY MAH
METHOD OF EXCAVATION 24" Bucket Backhoe (470 D)
LOCATION See Figure 2

DESRIPTION

SM
ALLUVIUM:
Light gray to brown, dry to damp, medium dense, silty fine SAND.

CL
Dark brown, moist, firm, fine to medium sandy CLAY.

SC
Light brown, moist, medium dense, clayey fine to medium SAND; with cobbles and boulders.

GM
Brown, moist, medium dense, silty sandy GRAVEL; cobbles and boulders up to 30 inches in diameter.

Boulders 24 to 36 inches in diameter.

Total Depth = 11 feet.
Groundwater not encountered.
Backfilled on 6/05/09.
TOPSOIL:
Brown, damp, stiff, fine to medium sandy CLAY; many calcium carbonate flecks.

LANDSLIDE DEPOSITS:
Light grayish brown, moist, weakly cemented, silty fine-grained SANDSTONE; little clay.
Gravel/cobble layer at 2.6 to 3.1 feet; subrounded; up to 6 inches in diameter.

Total Depth = 6 feet.
Groundwater not encountered.
Backfilled on 6/05/09.
# TEST PIT LOG

**SAN YSIDRO RAIL YARD EXPANSION**
**SAN DIEGO, CALIFORNIA**

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<td>23.0 83.1</td>
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</tr>
<tr>
<td>12</td>
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**DATE EXCAVATED:** 6/08/09  **TEST PIT NO.:** TP-3

**GROUND ELEVATION:** 117' + (MSL)  **LOGGED BY:** MAH

**METHOD OF EXCAVATION:** 24" Bucket Backhoe (470 D)

**LOCATION:** See Figure 2

### DESCRIPTION

**TOPSOIL:**
Grayish brown, dry to damp, loose to medium dense, silty fine SAND; few nested gravel and cobbles; intensely fractured; many carbonate flecks; burrows and rootlets extending down to 3.6 feet.

**LANDSLIDE DEPOSITS:**
Light grayish brown, damp, weakly cemented, fine sandy SILTSTONE; few brown clay lenses.

Moist.

Total Depth = 6 feet.
Groundwater not encountered.
Backfilled on 6/08/09.
**TEST PIT LOG**

SAN YSIDRO RAIL YARD EXPANSION
SAN DIEGO, CALIFORNIA

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**DEPTH (FEET)**

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<th>Depth</th>
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**BULK DENSITY**

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**MOISTURE (%)**

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**DRY DENSITY (PSF)**

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**CLASSIFICATION**

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<th>Classification</th>
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**GROUND ELEVATION**

10' ± (MSL) LOGGED BY MAH

**METHOD OF EXCAVATION**

24' Bucket Backhoe (470 D)

**LOCATION**

See Figure 3

**DESCRIPTION**

**ML**

- Fill: Graysish brown, dry, loose, sandy SILT; with gravel.

**CL**

- Topsoil: Brown, damp, very stiff, sandy CLAY; with gravel.
  
@2.5' to 3': Macy gravel and cobbles up to 6 inches in diameter.

**LANDSLIDE DEPOSITS**

- Olive brown, moist, weakly to moderately cemented, silty fine- to coarse-grained SANDSTONE; little clay; trace gravel; massive.

Damp.

**DATE EXCAVATED**

07/09

**TEST PIT NO.**

TP-12

**GROUNDWORK**

Groundwater not encountered.

Backfilled on 07/09.
# TEST PIT LOG

**San Ysidro Rail Yard Expansion**

**San Diego, California**

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<td>6/09</td>
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</table>

**Date Excavated:** 6/05/09  
**Test Pit No.:** TP-4

**Ground Elevation:** 109'-0" (MSL)  
**Logged By:** MAH

**Method of Excavation:** 24" Bucket Backhoe (470 D)

**Location:** See Figure 2

---

### Description

**Alluvium:**

Light grayish brown, stiff, silty fine to medium sandy CLAY; with gravel (1 to 2 inches in diameter).

Medium dark brown; moist; hard.

Gravel/cobble layer at 2.6 to 3.6 feet (subround; up to 6 inches in diameter).

**Landslide Deposits:**

Olive to light brown, mud, moderately indurated, sandy CLAYSTONE; few gravel.

Total Depth = 5.4 feet.  
Groundwater not encountered.  
Backfilled on 6/05/09.

---

**Scale:** 1 in = 2 ft
TEST PIT LOG
SAN YSIDRO RAIL YARD EXPANSION
SAN DIEGO, CALIFORNIA

<table>
<thead>
<tr>
<th>PROJECT NO.</th>
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<tr>
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<th>DEPTH (FEET)</th>
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DESCRIPTION

- **SM** LANDSLIDE DEPOSITS:
  Brown, dry, damp, loose to medium dense, silty SAND; with gravel and cobbles; many rootlets; fractured.

- **GC** Brown, damp, medium dense, clayey GRAVEL; with cobbles in a clay matrix; cobbles up to 9 inches in diameter.

- **CL** Dark brown, moist, hard, CLAY; few gravel; many carbonate flecks; gravel weathered.

- **CL+GC** Brown, damp to moist, medium dense, gravelly CLAY interlayered with clayey sandy GRAVEL; more sand with depth.

Total Depth = 5.3 feet.
Groundwater not encountered.
Backfilled on 6/08/09.
TEST PIT LOG
SAN YSIDRO RAIL YARD EXPANSION
SAN DIEGO, CALIFORNIA

PROJECT NO. DATE
104804035 6/09

DEPTH (FEET) SAMPLES MOISTURE (%) DRY DENSITY (PCF) CLASSIFICATION U.S.C.S.

0 0 1 2 3 4 5 6 7 8 9 10 11 12

DATE EXCAVATED 6/05/09 TEST PIT NO. TP-6
GROUND ELEVATION 117'- (MSL) LOGGED BY MAH
METHOD OF EXCAVATION 24" Bucket Backhoe (470 D)
LOCATION See Figure 2

DESCRIPTION

SC
Brown, dry to damp, medium dense, clayey silty SAND; few gravel.

CL
Brown, moist, very stiff to hard, fine to medium sandy CLAY.

LANDSLIDE DEPOSITS:
Light olive brown, moist, weakly cemented, clayey fine- to coarse-grained SANDSTONE; with gravel and cobbles (up to 8 inches in diameter).

@ 3.6': Fewer cobbles; more clay, massive.

Total Depth = 5 feet.
Groundwater not encountered.
Backfilled on 6/05/09.
PROJECT NO. 104804035  DATE 6/09

DEPTH (FEET)  SAMPLER  MOISTURE (%)  DRY DENSITY (PCF)  CLASSIFICATION  U.S.C.G.

4.7  SM  FILL: Light gray 'o brown, dry, loose to medium dense, silty SAND; with gravel.

2.6  CL  ALLUVIUM: Brown, damp to moist, hard, sandy CLAY.

@2.6: Gravel/cobble layer (subrounded; up to 6 inches in diameter).

LANDSLIDE DEPOSITS: Light reddish brown to olive brown (mottled), damp, moderately cemented, silty fine-grained SANDSTONE; chunks of brown clay; massive.

TOTAL DEPTH = 5.6 feet.
Groundwater not encountered.
Backfilled on 6/05/09.

DATE EXCAVATED 6/05/09  TEST PIT NO. TP-7
GROUND ELEVATION 112' + (MSL) LOGGED BY MAH
METHOD OF EXCAVATION 24' Bucket Backhoe (470 D)
LOCATION See Figure 2

DESCRIPTION

SCALE = 1 in.2 ft.
TEST PIT LOG
SAN YSIDRO RAIL YARD EXPANSION
SAN DIEGO, CALIFORNIA

PROJECT NO. DATE
104804035 6/09

DEPTH (FEET) DRY DENSITY (pcf) MOISTURE (%) SAMPLES CLASSIFICATION U.S.C.S.
0 0 0 0 0
2 2
4 0
6 0
8 0
10 0
12 0

DATE EXCAVATED 6/08/09 TEST PIT NO. TP-8
GROUND ELEVATION 111' + (MSL) LOGGED BY MAH
METHOD OF EXCAVATION 24" Bucket Backhoe (470 D)
LOCATION See Figure 2

DESCRIPTION

SM
TOPSOIL: Brown, dry to damp, medium dense, silty fine SAND; with gravel and chunks of clay.

LANDSLIDE DEPOSITS:
Reddish brown, moist, moderately indurated, fine- to medium-grained sandy CLAYSTONE; many carbonate flecks; few gravel, massive.

Total Depth = 3.6 feet.
Groundwater not encountered.
Backfilled on 6/08/09.
## TEST PIT LOG

**SAN YSIDRO RAIL YARD EXPANSION**  
**SAN DIEGO, CALIFORNIA**

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<tr>
<td>12</td>
<td>ML.</td>
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</table>

**DESCRIPTION**

**TOPSOIL:**
Light brown, dry, loose, fine sandy SILT; many rocelets; many carbonate flecks.

**LANDSLIDE DEPOSITS:**
Light grayish brown, dry to damp, weakly cemented, fine- to medium-grained SANDSTONE with silt; very intensely fractured.

@4: Less weathered; moderately cemented.

Bedding at approximately 5 feet; b: N56°40'W.

**DATE EXCAVATED:** 6/08/09  
**TEST PIT NO.:** 104804035  
**GROUND ELEVATION:** 130'± (MSL)  
**LOGGED BY:** MAH  
**METHOD OF EXCAVATION:** 24" Bucket Backhoe (470 D)  
**LOCATION:** See Figure 3

Total Depth = 8 feet.  
Groundwater not encountered.  
Backfilled on 6/08/09.
GM  
Light brown, dry to damp, loose to medium dense, GRAVEL, cobbles, boulders in a silty fine to coarse sandy matrix.

Damp; medium dense.

Moist.

SM  
Olive to greenish brown, damp, dense, silty SAND with gravel and cobbles.

Refusal on cobbles.

Total Depth = 11 feet. (Refusal due to cobbles and caving.)
Groundwater not encountered.
Backfilled on 6/05/09.
TOPSOIL:
Yellow to olive brown and pinkish brown (mottled), damp to moist, weakly cemented, silty fine to medium SAND.

Bed of gravel/cobbles at 3.6 to 4.6 feet.

Light grayish brown: moist; moderately cemented; silty; less weathered; remnant bedding.

Total Depth = 6.5 feet.
Groundwater not encountered.
Backfilled on 6/05/09.
### TEST PIT LOG

**SAN YSIDRO RAIL YARD EXPANSION**  
**SAN DIEGO, CALIFORNIA**

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<tbody>
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<td>104804035</td>
<td>6/09</td>
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#### DESCRIPTION

**FILL:**
- Graysish brown, dry, loose, sandy SILT; with gravel.

**TOPSOIL:**
- Brown, damp, very stiff, sandy CLAY; with gravel.
- @2.6' to 3': Macy gravel and cobbles up to 6 inches in diameter.

**LANDSLIDE DEPOSITS:**
- Olive brown, moist, weakly to moderately cemented, silty fine- to coarse-grained SANDSTONE; little clay; trace gravel; massive.
- Damp.

**Total Depth = 5.6 feet.**  
Groundwater not encountered.  
Backfilled on 6/05/09.
APPENDIX B

LABORATORY TESTING

Classification
Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM Test Method D 2488. Soil classifications are indicated on the logs of the exploratory excavations in Appendix A.

In-Place Moisture and Density Tests
The moisture content and dry density of relatively undisturbed samples obtained from the exploratory test pits were evaluated in general accordance with ASTM D 2937. The test results are presented on the logs of the exploratory test pits in Appendix A.

Gradation Analysis
Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D 422. The grain-size distribution curves are shown on Figures B-1 through B-3. These test results were utilized in evaluating the soil classifications in accordance with USCS.

Direct Shear Test
A direct shear test was performed on a relatively undisturbed sample in general accordance with ASTM D 3080 to evaluate the shear strength characteristics of selected material. The sample was inundated during shearing to represent adverse field conditions. The results are shown on Figure B-4.

Soil Corrosivity Test
A soil pH, and resistivity test was performed on a representative sample in general accordance with CT 643. The soluble sulfate and chloride content of the selected sample was evaluated in general accordance with CT 417 and CT 422, respectively. The test results are presented on Figure B-5.

R-Value
The resistance value, or R-value, for site soils was evaluated in general accordance with CT 301. Samples were prepared and evaluated for exudation pressure and expansion pressure. The equilibrium R-value is reported as the lesser or more conservative of the two calculated results. The test results are shown on Figure B-6.
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3980
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1 PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 643
2 PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 417
3 PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 422
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PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2844/CT 301
APPENDIX C

TYPICAL EARTHWORK GUIDELINES
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## Figures

- Figure A — Fill Slope Over Natural Ground or Cut
- Figure B — Transition and Undercut Lot Details
- Figure C — Canyon Subdrain Detail
- Figure D — Oversized Rock Placement Detail
- Figure E — Slope Drainage Detail
- Figure F — Shear Key Detail
- Figure G — Drain Detail
TYPICAL EARTHWORK GUIDELINES

1. GENERAL

These guidelines and the standard details attached hereto are presented as general procedures for earthwork construction. They are to be utilized in conjunction with the project grading plans. These guidelines are considered a part of the geotechnical report, but are superseded by recommendations in the geotechnical report in the case of conflict. Evaluations performed by the consultant during the course of grading may result in new recommendations which could supersede these specifications and/or the recommendations of the geotechnical report. It is the responsibility of the contractor to read and understand these guidelines as well as the geotechnical report and project grading plans.

1.1. The contractor shall not vary from these guidelines without prior recommendations by the geotechnical consultant and the approval of the client or the client’s authorized representative. Recommendations by the geotechnical consultant and/or client shall not be considered to preclude requirements for approval by the jurisdictional agency prior to the execution of any changes.

1.2. The contractor shall perform the grading operations in accordance with these specifications, and shall be responsible for the quality of the finished product notwithstanding the fact that grading work will be observed and tested by the geotechnical consultant.

1.3. It is the responsibility of the grading contractor to notify the geotechnical consultant and the jurisdictional agencies, as needed, prior to the start of work at the site and as any time that grading resumes after interruption. Each step of the grading operations shall be observed and documented by the geotechnical consultant and, where necessary, reviewed by the appropriate jurisdictional agency prior to proceeding with subsequent work.

1.4. If, during the grading operations, geotechnical conditions are encountered which were not anticipated or described in the geotechnical report, the geotechnical consultant shall be notified immediately and additional recommendations, if applicable, may be provided.

1.5. An as-graded report shall be prepared by the geotechnical consultant and signed by a registered engineer and registered engineering geologist. The report documents the geotechnical consultants’ observations, and field and laboratory test results, and
provides conclusions regarding whether or not earthwork construction was performed in accordance with the geotechnical recommendations and the grading plans. Recommendations for foundation design, paver plate design, subgrade treatment, etc., may also be included in the as-graded report.

1.6. For the purpose of evaluating quantities of materials excavated during grading and/or locating the limits of excavations, a licensed land surveyor or civil engineer shall be retained.

1.7. Definitions of terms utilized in the remainder of these specifications have been provided in Section 11.

2. OBLIGATIONS OF PARTIES

The parties involved in the projects earthwork activities shall be responsible as outlined in the following sections.

2.1. The client is ultimately responsible for the aspects of the project. The client or the client’s authorized representative has a responsibility to review the findings and recommendations of the geotechnical consultant. The client shall authorize the contractor and/or other consultants to perform work and/or provide services. During grading the client or the client’s authorized representative shall remain on site or remain reasonably accessible to the concerned parties to make the decisions that may be needed to maintain the flow of the project.

2.2. The contractor is responsible for the safety of the project and satisfactory completion of grading and other associated operations, including, but not limited to, earthwork in accordance with the project plans, specifications, and jurisdictional agency requirements. During grading, the contractor or the contractor’s authorized representative shall remain on site. The contractor shall further remain accessible during non-working hours, including at night and during days off.

2.3. The geotechnical consultant shall provide observation and testing services and shall make evaluations to advise the client on geotechnical matters. The geotechnical consultant shall report findings and recommendations to the client or the client’s authorized representative.

2.4. Prior to proceeding with any grading operations, the geotechnical consultant shall be notified two working days in advance to schedule the needed observation and testing services.
2.4.1. Prior to any significant expansion or reduction in the grading operation, the geotechnical consultant shall be provided with two working days notice to make appropriate adjustments in scheduling of on-site personnel.

2.4.2. Between phases of grading operations, the geotechnical consultant shall be provided with two working days notice in advance of commencement of additional grading operations.

3. SITE PREPARATION

Site preparation shall be performed in accordance with the recommendations presented in the following sections.

3.1. The client, prior to any site preparation or grading, shall arrange and attend a pre-grading meeting between the grading contractor, the design engineer, the geotechnical consultant, and representatives of appropriate governing authorities, as well as any other involved parties. The parties shall be given two working days notice.

3.2. Clearing and grubbing shall consist of the substantial removal of vegetation, brush, grass, wood, stumps, trees, tree roots greater than 1/2-inch in diameter, and other deleterious materials from the areas to be graded. Clearing and grubbing shall extend to the outside of the proposed excavation and fill areas.

3.3. Demolition in the areas to be graded shall include removal of building structures, foundations, reservoirs, utilities (including underground pipelines, septic tanks, leach fields, seepage pits, cisterns, etc.), and other manmade surface and subsurface improvements, and the backfilling of mining shafts, tunnels and surface depressions. Demolition of utilities shall include capping or rerouting of pipelines at the project perimeter, and abandonment of wells in accordance with the requirements of the governing authorities and the recommendations of the geotechnical consultant at the time of demolition.

3.4. The debris generated during clearing, grubbing and/or demolition operations shall be removed from areas to be graded and disposed of off site at a legal dump site. Clearing, grubbing, and demolition operations shall be performed under the observation of the geotechnical consultant.

3.5. The ground surface beneath proposed fill areas shall be stripped of loose or unsuitable soil. These soils may be used as compacted fill provided they are generally free of organic or other deleterious materials and evaluated for use by the geotechnical consultant. The resulting surface shall be evaluated by the geotechnical consultant prior to proceeding. The cleared, natural ground surface shall be scarri-
fied to a depth of approximately 8 inches, moisture conditioned, and compacted in accordance with the specifications presented in Section 5 of these guidelines.

3.6. Where fills are to be constructed on hillside or slopes, topsoil, slope wash, colluvium, and other materials deemed unsuitable shall be removed. Where the exposed slope is steeper than 5 horizontal units to 1 vertical unit, or where recommended by the geotechnical consultant, the slope of the original ground on which the fill is to be placed shall be benched and a key as shown on Figure A of this document shall be provided by the contractor in accordance with the specifications presented in Section 7 of this document. The benches shall extend into the underlying bedrock or, where bedrock is not present, into suitable compacted fill as evaluated by the geotechnical consultant.

4. REMOVALS AND EXCAVATIONS
Removals and excavations shall be performed as recommended in the following sections.

4.1. Removals

4.1.1. Materials which are considered unsuitable shall be excavated under the observation of the geotechnical consultant in accordance with the recommendations contained herein. Unsuitable materials include, but may not be limited to, dry, loose, soft, wet, organic, compressible natural soils, fractured, weathered, soft bedrock, and undocumented or otherwise deleterious fill materials.

4.1.2. Materials deemed by the geotechnical consultant to be unsatisfactory due to moisture conditions shall be excavated in accordance with the recommendations of the geotechnical consultant, watered or dried as needed, and mixed to a generally uniform moisture content in accordance with the specifications presented in Section 5 of this document.

4.2. Excavations

4.2.1. Temporary excavations no deeper than 5 feet in firm fill or natural materials may be made with vertical side slopes. To satisfy CAL OSHA requirements, any excavation deeper than 5 feet shall be shored or laid back at a 1:1 (horizontal-vertical) inclination or flatter, depending on material type, if construction workers are to enter the excavation.
5. COMPACTED FILL

Fill shall be constructed as specified below or by other methods recommended by the geotechnical consultant. Unless otherwise specified, fill soils shall be compacted to 90 percent relative compaction, as evaluated in accordance with ASTM Test Method D 1557.

5.1. Prior to placement of compacted fill, the contractor shall request an evaluation of the exposed ground surface by the geotechnical consultant. Unless otherwise recommended, the exposed ground surface shall then be scarified to a depth of approximately 8 inches and watered or dried, as needed, to achieve a generally uniform moisture content at or near the optimum moisture content. The scarified materials shall then be compacted to 90 percent relative compaction. The evaluation of compaction by the geotechnical consultant shall not be considered to preclude any requirements for observation or approval by governing agencies. It is the contractor's responsibility to notify the geotechnical consultant and the appropriate governing agency when project areas are ready for observation, and to provide reasonable time for that review.

5.2. Excavated on-site materials which are in general compliance with the recommendations of the geotechnical consultant may be utilized as compacted fill provided they are generally free of organic or other deleterious materials and do not contain rock fragments greater than 6 inches in dimension. During grading, the contractor may encounter soil types other than those analyzed during the preliminary geotechnical study. The geotechnical consultant shall be consulted to evaluate the suitability of any such soils for use as compacted fill.

5.3. Where imported materials are to be used on site, the geotechnical consultant shall be notified three working days in advance of importation in order that it may sample and test the materials from the proposed borrow sites. No imported materials shall be delivered for use on site without prior sampling, testing, and evaluation by the geotechnical consultant.

5.4. Soils imported for on-site use shall preferably have very low to low expansion potential (based on UBC Standard 18-2 test procedures). Lots on which expansive soils may be exposed at grade shall be undercut 3 feet or more and capped with very low to low expansion potential fill. Details of the undercutting are provided in the Transition and Undercut Lot Details, Figure B of these guidelines. In the event expansive soils are present near the ground surface, special design and construction considerations shall be utilized in general accordance with the recommendations of the geotechnical consultant.

5.5. Fill materials shall be moisture conditioned to near optimum moisture content prior to placement. The optimum moisture content will vary with material type and other
factors. Moisture conditioning of fill soils shall be generally uniform in the soil mass.

5.6. Prior to placement of additional compacted fill material following a delay in the grading operations, the exposed surface of previously compacted fill shall be prepared to receive fill. Preparation may include scarification, moisture conditioning, and recompaction.

5.7. Compacted fill shall be placed in horizontal lifts of approximately 8 inches in loose thickness. Prior to compaction, each lift shall be watered or dried as needed to achieve near optimum moisture condition, mixed, and then compacted by mechanical methods, using sheepfoot rollers, multiple-wheel pneumatic-tired rollers, or other appropriate compacting rollers, to the specified relative compaction. Successive lifts shall be treated in a like manner until the desired finished grades are achieved.

5.8. Fill shall be tested in the field by the geotechnical consultant for evaluation of general compliance with the recommended relative compaction and moisture conditions. Field density testing shall conform to ASTM D 1556-99 (Sand Cone method), D 2937-70 (Drive-Cylinder method), and/or D 2922-90 and D 3017-96 (Nuclear Gauge method). Generally, one test shall be provided for approximately every 2 vertical feet of fill placed, or for approximately every 1,000 cubic yards of fill placed. In addition, on slope faces one or more tests shall be taken for approximately every 10,000 square feet of slope face and/or approximately every 10 vertical feet of slope height. Actual test intervals may vary as field conditions dictate. Fill found to be out of conformance with the grading recommendations shall be removed, moisture conditioned, and compacted or otherwise handled to accomplish general compliance with the grading recommendations.

5.9. The contractor shall assist the geotechnical consultant by excavating suitable test pits for removal evaluation and/or for testing of compacted fill.

5.10. At the request of the geotechnical consultant, the contractor shall “shut down” or restrict grading equipment from operating in the area being tested to provide adequate testing time and safety for the field technician.

5.11. The geotechnical consultant shall maintain a map with the approximate locations of field density tests. Unless the client provides for surveying of the test locations, the locations shown by the geotechnical consultant will be estimated. The geotechnical consultant shall not be held responsible for the accuracy of the horizontal or vertical location or elevations.

5.12. Grading operations shall be performed under the observation of the geotechnical consultant. Testing and evaluation by the geotechnical consultant does not preclude the need for approval by or other requirements of the jurisdictional agencies.
5.13. Fill materials shall not be placed, spread or compacted during unfavorable weather conditions. When work is interrupted by heavy rains, the filling operation shall not be resumed until tests indicate that moisture content and density of the fill meet the project specifications. Regrading of the near-surface soil may be needed to achieve the specified moisture content and density.

5.14. Upon completion of grading and termination of observation by the geotechnical consultant, no further filling or excavating, including that planted for footings, foundations, retaining walls or other features, shall be performed without the involvement of the geotechnical consultant.

5.15. Fill placed in areas not previously viewed and evaluated by the geotechnical consultant may have to be removed and recompacted at the contractor’s expense. The depth and extent of removal of the unobserved and undocumented fill will be decided based upon review of the field conditions by the geotechnical consultant.

5.16. Off-site fill shall be treated in the same manner as recommended in these specifications for on-site fills. Off-site fill subdrains temporarily terminated (up gradient) shall be surveyed for future locating and connection.

5.17. Prior to placement of a canyon fill, a subdrain shall be installed in bedrock or compacted fill along the approximate alignment of the canyon bottom if recommended by the geotechnical consultant. Details of subdrain placement and configuration have been provided in the Canyon Subdrain Detail, Figure C, of these guidelines.

5.18. Transition (cut/fill) lots shall generally be undercut 3 feet or more below finished grade to provide a generally uniform thickness of fill soil in the pad area. Where the depth of fill on a transition lot greatly exceeds 3 feet, overexcavation may be increased at the discretion of the geotechnical consultant. Details of the undercut for transition lots are provided in the Transition and Undercut Lot Detail, Figure B, of these guidelines.

6. OVERSIZED MATERIAL

Oversized material shall be placed in accordance with the following recommendations.

6.1. During the course of grading operations, rocks or similar irreducible materials greater than 6 inches in dimension (oversized material) may be generated. These materials shall not be placed within the compacted fill unless placed in general accordance with the recommendations of the geotechnical consultant.

6.2. Where oversized rock (greater than 6 inches in dimension) or similar irreducible material is generated during grading, it is recommended, where practical, to waste such material off site, or on site in areas designated as "nonstructural rock disposal
areas." Rock designated for disposal areas shall be placed with sufficient sandy soil to generally fill voids. The disposal area shall be capped with a 5-foot thickness of fill which is generally free of oversized material.

6.3. Rocks 6 inches in dimension and smaller may be utilized within the compacted fill, provided they are placed in such a manner that nesting of rock is not permitted. Fill shall be placed and compacted over and around the rock. The amount of rock greater than 3/4-inch in dimension shall generally not exceed 40 percent of the total dry weight of the fill mass, unless the fill is specially designed and constructed as a "rock fill."

6.4. Rocks or similar irreducible materials greater than 6 inches but less than 4 feet in dimension generated during grading may be placed in windrows and capped with finer materials in accordance with the recommendations of the geotechnical consultant, the approval of the governing agencies, and the Oversized Rock Placement Detail, Figure D of these guidelines. Selected native or imported granular soil (Sand Equivalent of 30 or higher) shall be placed and flooded over and around the windrowed rock such that voids are filled. Windrows of oversized materials shall be staggered so that successive windrows of oversized materials are not in the same vertical plane. Rocks greater than 4 feet in dimension shall be broken down to 4 feet or smaller before placement, or they shall be disposed of off site.

7. SLOPES
The following sections provide recommendations for cut and fill slopes.

7.1. Cut Slopes

7.1.1. Unless otherwise recommended by the geotechnical consultant and accepted by the building official, permanent cut slopes shall not be steeper than 2:1 (horizontal:vertical). The recommended height of a cut slope shall be evaluated by the geotechnical consultant. Slopes in excess of 30 feet high shall be provided with terrace drains (swales) in accordance with the recommendations presented in the Uniform Building Code, Section 3315 and the details provided in Figure E of these guidelines.

7.1.2. The geotechnical consultant shall observe cut slopes during excavation. The geotechnical consultant shall be notified by the contractor prior to beginning slope excavations.

7.1.3. If excavations for cut slopes expose loose, cohesionless, significantly fractured, or otherwise unsuitable materials, overexcavation of the unsuitable material and replacement with a compacted stabilization fill shall be evaluated and may be recommended by the geotechnical consultant. Unless
otherwise specified by the geotechnical consultant, stabilization fill construction shall be in general accordance with the details provided on Figure F of these guidelines.

7.1.4. If, during the course of grading, adverse or potentially adverse geotechnical conditions are encountered in the slope which were not anticipated in the preliminary evaluation report, the geotechnical consultant shall evaluate the conditions and provide appropriate recommendations.

7.2. Fill Slopes

7.2.1. When placing fill on slopes steeper than 5:1 (horizontal:vertical), topsoil, slope wash, colluvium, and other materials deemed unsuitable shall be removed. Near-horizontal keys and near-vertical benches shall be excavated into sound bedrock or firm fill material, in accordance with the recommendation of the geotechnical consultant. Keying and benching shall be accomplished in general accordance with the details provided on Figure A of these guidelines. Compacted fill shall not be placed in an area subsequent to keying and benching until the area has been observed by the geotechnical consultant. Where the natural gradient of a slope is less than 5:1, benching is generally not recommended. However, fill shall not be placed on compressible or otherwise unsuitable materials left on the slope face.

7.2.2. Within a single fill area where grading procedures dictate two or more separate fills, temporary slopes (false slopes) may be created. When placing fill adjacent to a temporary slope, benching shall be conducted in the manner described in Section 7.2.1. A 3-foot or higher near-vertical bench shall be excavated into the documented fill prior to placement of additional fill.

7.2.3. Unless otherwise recommended by the geotechnical consultant and by the building official, permanent fill slopes shall not be steeper than 2:1 (horizontal:vertical). The height of a fill slope shall be evaluated by the geotechnical consultant. Slopes in excess of 30 feet high shall be provided with terrace drains (swales) and backdrains in accordance with the recommendations presented in the Uniform Building Code, Section 3315 and the details provided in Figure E of these guidelines.

7.2.4. Unless specifically recommended otherwise, compacted fill slopes shall be overbuilt and cut back to grade, exposing firm compacted fill. The actual amount of overbuilding may vary as field conditions dictate. If the desired results are not achieved, the existing slopes shall be overexcavated and reconstructed in accordance with the recommendations of the geotechnical consultant. The degree of overbuilding may be increased until the desired compacted slope face condition is achieved. Care shall be taken by the con-
tractor to provide mechanical compaction as close to the outer edge of the overbuilt slope surface as practical.

7.2.5. If access restrictions, property line location, or other constraints limit overbuilding and cutting back of the slope face, an alternative method for compaction of the slope face may be attempted by conventional construction procedures including backrolling at intervals of 4 feet or less in vertical slope height, or as dictated by the capability of the available equipment, whichever is less. Fill slopes shall be backrolled utilizing a conventional sheep's foot-type roller. Care shall be taken to maintain the specified moisture conditions and/or reestablish the same, as seeded, prior to backrolling.

7.2.6. The placement, moisture conditioning and compaction of fill slope materials shall be done in accordance with the recommendations presented in Section 5 of these guidelines.

7.2.7. The contractor shall be ultimately responsible for placing and compacting the soil out to the slope face to obtain a relative compaction of 90 percent as evaluated by ASTM D1557 and a moisture content in accordance with Section 5. The geotechnical consultant shall perform field moisture and density tests at intervals of one test for approximately every 10,000 square feet of slope face and/or approximately every 10 feet of vertical height of slope.

7.2.8. Backdrains shall be provided in fill slopes in accordance with the details presented in Figure A of these guidelines, or as recommended by the geotechnical consultant.

7.3. Top-of-Slope Drainage

7.3.1. For pad areas above slopes, positive drainage shall be established away from the top of slope. This may be accomplished utilizing a berm and pad gradient of 2 percent or steeper at the top-of-slope areas. Site runoff shall not be permitted to flow over the tops of slopes.

7.3.2. Gunite-lined brow ditches shall be placed at the top of cut slopes to redirect surface runoff away from the slope face where drainage devices are not otherwise provided.

7.4. Slope Maintenance

7.4.1. In order to enhance surficial slope stability, slope planting shall be accomplished at the completion of grading. Slope plants shall consist of deep-rooting, variable root depth, drought-tolerant vegetation. Native vegetation is generally desirable. Plants native to semiarid and arid areas may also be appropriate. Large-leaved ice plant should not be used on slopes. A landscape
architect shall be consulted regarding the actual types of plants and planting configuration to be used.

7.4.2. Irrigation pipes shall be anchored to slope faces and not placed in trenches excavated into slope faces. Slope irrigation shall be maintained at a level just sufficient to support plant growth. Property owners shall be made aware that over-watering of slopes is detrimental to slope stability. Slopes shall be monitored regularly and broken sprinkler heads and/or pipes shall be repaired immediately.

7.4.3. Periodic observation of landscaped slope areas shall be planned and appropriate measures taken to enhance growth of landscape plants.

7.4.4. Graded swales at the top of slopes and terrace drains shall be installed and the property owners notified that the drains shall be periodically checked so that they may be kept clear. Damage to drainage improvements shall be repaired immediately. To reduce siltation, terrace drains shall be constructed at a gradient of 3 percent or steeper, in accordance with the recommendations of the project civil engineer.

7.4.5. If slope failures occur, the geotechnical consultant shall be contacted immediately for field review of site conditions and development of recommendations for evaluation and repair.

8. TRENCH BACKFILL

The following sections provide recommendations for backfilling of trenches.

8.1. Trench backfill shall consist of granular soils (bedding) extending from the trench bottom to 1 or more feet above the pipe. On-site or imported fill which has been evaluated by the geotechnical consultant may be used above the granular backfill. The cover soils directly in contact with the pipe shall be classified as having a very low expansion potential, in accordance with UBC Standard 18-2, and shall contain no rocks or chucks of hard soil larger than 3/4-inch in diameter.

8.2. Trench backfill shall, unless otherwise recommended, be compacted by mechanical means to 90 percent relative compaction as evaluated in accordance with ASTM D 1557. Backfill soils shall be placed in loose lifts 8-inches thick or thinner, moisture conditioned, and compacted in accordance with the recommendations of Section 5. of these guidelines. The backfill shall be tested by the geotechnical consultant at vertical intervals of approximately 2 feet of backfill placed and at spacings along the trench of approximately 100 feet in the same lift.
8.3. Jetting of trench backfill materials is generally not a recommended method of densification, unless the on-site soils are sufficiently free-draining and provisions have been made for adequate dissipation of the water utilized in the jetting process.

8.4. If it is decided that jetting may be utilized, granular material with a sand equivalent greater than 30 shall be used for backfilling in the areas to be jetted. Jetting shall generally be considered for trenches 2 feet or narrower in width and 4 feet or shallower in depth. Following jetting operations, trench backfill shall be mechanically compacted to the specified compaction to finish grade.

8.5. Trench backfill which underlies the zone of influence of foundations shall be mechanically compacted to 90 percent relative compaction, as evaluated in accordance with ASTM D 1557. The zone of influence of the foundations is generally defined as the roughly triangular area within the limits of a 1:1 projection from the inner and outer edges of the foundation, projected down and out from both edges.

8.6. Trench backfill within slab areas shall be compacted by mechanical means to a relative compaction of 90 percent relative compaction, as evaluated in accordance with ASTM D 1557. For minor interior trenches, density testing may be omitted or spot testing may be performed, as deemed appropriate by the geotechnical consultant.

8.7. When compacting soil in close proximity to utilities, care shall be taken by the grading contractor so that mechanical methods used to compact the soils do not damage the utilities. If the utility contractors indicate that it is undesirable to use compaction equipment in close proximity to a buried conduit, then the grading contractor may elect to use light mechanical compaction equipment or, with the approval of the geotechnical consultant, cover the conduit with clean granular material. These granular materials shall be jetted in place to the top of the conduit in accordance with the recommendations of Section 8.4 prior to initiating mechanical compaction procedures. Other methods of utility trench compaction may also be appropriate, upon review by the geotechnical consultant and the utility contractor, at the time of construction.

8.8. Clean granular backfill and/or bedding materials are not recommended for use in slope areas unless provisions are made for a drainage system to mitigate the potential for buildup of seepage forces or piping of backfill materials.

8.9. The contractor shall exercise the specified safety precautions in accordance with OSHA Trench Safety Regulations, while conducting trenching operations. Such precautions include shoring or laying back trench excavations at 1:1 or flatter, depending on material type, for trenches in excess of 5 feet in depth. The geotechnical consultant is not responsible for the safety of trench operations or stability of the trenches.
9. DRAINAGE

The following sections provide recommendations pertaining to site drainage.

9.1. Canyon subdrain systems recommended by the geotechnical consultant shall be installed in accordance with the Canyon Subdrain Detail, Figure C, provided in these guidelines. Canyon subdrains shall be installed to conform to the approximate alignment and details shown on project plans. The actual subdrain location shall be evaluated by the geotechnical consultant in the field during grading. Materials specified in the attached Canyon Subdrain Detail shall not be changed or modified unless so recommended by the geotechnical consultant. Subdrains shall be surveyed by a licensed land surveyor/civil engineer for line and grade after installation. Sufficient time shall be allowed for the surveys prior to commencement of filling over the subdrains.

9.2. Typical backdrains for stability, side hill, and shear key fills shall be installed in accordance with the details provided on Figure A, Figure F, and Figure G of these guidelines.

9.3. Roof, pad, and slope drainage shall be such that it is away from slopes and structures to suitable discharge areas by nonperforable devices (e.g., gutters, downspouts, concrete swales, etc.).

9.4. Positive drainage adjacent to structures shall be established and maintained. Positive drainage may be accomplished by providing drainage away from the foundations of the structure at a gradient of 2 percent or steeper for a distance of 5 feet or more outside the building perimeter, further maintained by a graded swale leading to an appropriate outlet, in accordance with the recommendations of the project civil engineer and/or landscape architect.

9.5. Surface drainage on the site shall be provided so that water is not permitted to pond. A gradient of 2 percent or steeper shall be maintained over the pad area and drainage patterns shall be established to remove water from the site to an appropriate outlet.

9.6. Care shall be taken by the contractor during finish grading to preserve any berms, drainage terraces, interceptor swales or other drainage devices of a permanent nature on or adjacent to the property. Drainage patterns established at the time of finish grading shall be maintained for the life of the project. Property owners shall be made very clearly aware that altering drainage patterns may be detrimental to slope stability and foundation performance.
10. SITE PROTECTION

The site shall be protected as outlined in the following sections.

10.1. Protection of the site during the period of grading shall be the responsibility of the contractor unless other provisions are made in writing and agreed upon among the concerned parties. Completion of a portion of the project shall not be considered to preclude that portion or adjacent areas from the need for site protection, until such time as the project is finished as agreed upon by the geotechnical consultant, the client, and the regulatory agency.

10.2. The contractor is responsible for the stability of temporary excavations. Recommendations by the geotechnical consultant pertaining to temporary excavations are made in consideration of stability of the finished project and, therefore, shall not be considered to preclude the responsibilities of the contractor. Recommendations by the geotechnical consultant shall also not be considered to preclude more restrictive requirements by the applicable regulatory agencies.

10.3. Precautions shall be taken during the performance of site clearing, excavation, and grading to protect the site from flooding, ponding, or inundation by surface runoff. Temporary provisions shall be made during the rainy season so that surface runoff is away from and off the working site. Where low areas cannot be avoided, pumps shall be provided to remove water as needed during periods of rainfall.

10.4. During periods of rainfall, plastic sheeting shall be used as needed to reduce the potential for unprotected slopes to become saturated. Where needed, the contractor shall install check dams, desilting basins, riprap, sandbags or other appropriate devices or methods to reduce erosion and provide the recommended conditions during inclement weather.

10.5. During periods of rainfall, the geotechnical consultant shall be kept informed by the contractor of the nature of remedial or precautionary work being performed on site (e.g., pumping, placement of sandbags or plastic sheeting, other labor, dozing, etc.).

10.5. Following periods of rainfall, the contractor shall contact the geotechnical consultant and arrange a walk-over of the site in order to visually assess rain-related damage. The geotechnical consultant may also recommend excavation and testing in order to aid in the evaluation. At the request of the geotechnical consultant, the contractor shall make excavations in order to aid in evaluation of the extent of rain-related damage.

10.7. Rain- or irrigation-related damage shall be considered to include, but may not be limited to, erosion, silting, saturation, swelling, structural distress, and other adverse conditions noted by the geotechnical consultant. Soil adversely affected shall be classified as "Unsuitable Material" and shall be subject to overexcavation and
replacement with compacted fill or to other remedial grading as recommended by the geotechnical consultant.

10.8. Relatively level areas where saturated soils and/or erosion gullies exist to depths greater than 1 foot shall be overexcavated to competent materials as evaluated by the geotechnical consultant. Where adverse conditions extend to less than 1 foot in depth, saturated and/or eroded materials may be processed in-place. Overexcavated or in-place processed materials shall be moisture conditioned and compacted in accordance with the recommendations provided in Section 5. If the desired results are not achieved, the affected materials shall be overexcavated, moisture conditioned, and compacted until the specifications are met.

10.9. Slope areas where saturated soil and/or erosion gullies exist to depths greater than 1 foot shall be overexcavated and replaced as compacted fill in accordance with the applicable specifications. Where adversely affected materials exist to depths of 1 foot or less below proposed finished grade, remedial grading by moisture conditioning in-place and compaction in accordance with the appropriate specifications may be attempted. If the desired results are not achieved, the affected materials shall be overexcavated, moisture conditioned, and compacted until the specifications are met. As conditions dictate, other slope repair procedures may also be recommended by the geotechnical consultant.

10.10. During construction, the contractor shall grade the site to provide positive drainage away from structures and to keep water from ponding adjacent to structures. Water shall not be allowed to damage adjacent properties. Positive drainage shall be maintained by the contractor until permanent drainage and erosion reducing devices are installed in accordance with project plans.
11. DEFINITIONS OF TERMS

ALLUVIUM: Uncemented detrital deposits deposited by flowing water; includes sediments deposited in river beds, canyons, flood plains, lakes, fans at the foot of slopes, and in estuaries.

AS-GRADED (AS-BUILT): The site conditions upon completion of grading.

BACKCUT: A temporary construction slope at the rear of earth-retaining structures such as buttresses, shear keys, stabilization fills, or retaining walls.

BACKDRAIN: Generally a pipe and gravel or similar drainage system placed behind earth-retaining structures such as buttresses, stabilization fills, and retaining walls.

BEDROCK: Relatively undisturbed in-place rock, either at the surface or beneath surficial deposits of soil.

BENCH: A relatively level step and near-vertical riser excavated into sloping ground on which fill is to be placed.

BORROW (IMPORT): Any fill material hauled to the project site from off-site areas.

BUTTRESS FILL: A fill mass, the configuration of which is designed by engineering calculations, to retain slope or containing adverse geologic features. A buttress is generally specified by a key width and depth and by a backcut angle. A buttress normally contains a back drainage system.

CIVIL ENGINEER: The Registered Civil Engineer or consulting firm responsible for preparation of the grading plans and surveying, and evaluating as-graded topographic conditions.

CLIENT: The developer or a project-responsible authorized representative. The client has the responsibility of reviewing the findings and recommendations made by the geotechnical consultant and authorizing the contractor and/or other consultants to perform work and/or provide services.

COLLUVIUM: Generally loose deposits, usually found on the face or near the base of slopes and brought there chiefly by gravity through slow continuous downhill creep (see also Slope Wash).

COMPACTION: The densification of a fill by mechanical means.
CONTRACTOR: A person or company under contract or otherwise retained by the client to perform demolition, grading, and other site improvements.

DEBRIS: The products of clearing, grubbing, and/or demolition, or contaminated soil material unsuitable for reuse as compacted fill, and/or any other material so designated by the geotechnical consultant.

ENGINEERED FILL: A fill which the geotechnical consultant or the consultant’s representative has observed and/or tested during placement, enabling the consultant to conclude that the fill has been placed in substantial compliance with the recommendations of the geotechnical consultant and the governing agency requirements.

ENGINEERING GEOLOGIST: A geologist registered by the state licensing agency who applies geologic knowledge and principles to the exploration and evaluation of naturally occurring rock and soil, as related to the design of civil works.

EROSION: The wearing away of the ground surface as a result of the movement of wind, water, and/or ice.

EXCAVATION: The mechanical removal of earth materials.

EXISTING GRADE: The ground surface configuration prior to grading; original grade.

FILL: Any deposit of soil, rock, soil-rock blends, or other similar materials placed by man.

FINISH GRADE: The as-graded ground surface elevation that conforms to the grading plan.

GEOFABRIC: An engineering textile utilized in geotechnical applications such as subgrade stabilization and filtering.

GEOENGINEERING CONSULTANT: The geotechnical engineering and engineering geology consulting firm retained to provide technical services for the project. For the purpose of these specifications, observations by the geotechnical consultant include observations by the geotechnical engineer, engineering geologist and other persons employed by and responsible to the geotechnical consultant.
GEOTECHNICAL ENGINEER: A licensed civil engineer and geotechnical engineer, registered by the state licensing agency, who applies scientific methods, engineering principles, and professional experience to the acquisition, interpretation, and use of knowledge of materials of the earth’s crust to the resolution of engineering problems. Geotechnical engineering encompasses many of the engineering aspects of soil mechanics, rock mechanics, geology, geophysics, hydrology, and related sciences.

GRADING: Any operation consisting of excavation, filling, or combinations thereof and associated operations.

LANDSLIDE DEPOSITS: Material, often porous and of low density, produced from instability of natural or manmade slopes.

OPTIMUM MOISTURE: The moisture content that is considered optimum to compaction operations.

RELATIVE COMPACTION: The degree of compaction (expressed as a percentage) of a material as compared to the dry density obtained from ASTM test method D 1557.

ROUGH GRADE: The ground surface configuration at which time the surface elevations approximately conform to the approved plan.

SHEAR KEY: Similar to a subsurface buttress; however, it is generally constructed by excavating a slot within a natural slope in order to stabilize the upper portion of the slope without encroaching into the lower portion of the slope.

SITE: The particular parcel of land where grading is being performed.

SLOPE: An inclined ground surface, the steepness of which is generally specified as a ratio of horizontal units to vertical units.

SLOPE WASH: Soil and/or rock material that has been transported down a slope by gravity assisted by the action of water not confined to channels (see also Coluvium).

SLOUGH: Loose, uncompacted fill material generated during grading operations.

SOIL: Naturally occurring deposits of sand, silt, clay, etc., or combinations thereof.
STABILIZATION FILL: A fill mass, the configuration of which is typically related to slope height and is specified by the standards of practice for enhancing the stability of locally adverse conditions. A stabilization fill is normally specified by a key width and depth and by a backcut angle. A stabilization fill may or may not have a back drainage system specified.

SUBDRAIN: Generally a pipe-and-gravel or similar drainage system placed beneath a fill along the alignment of buried canyons or former drainage channels.

TAILINGS: Non-engineered fill which accumulates on or adjacent to equipment haul roads.

TERRACE: A relatively level bench constructed on the face of a graded slope surface for drainage and maintenance purposes.

TOPSOIL: The upper zone of soil or bedrock materials, which is usually dark in color, loose, and contains organic materials.

WINDROW: A row of large rocks buried within engineered fill in accordance with guidelines set forth by the geotechnical consultant.
FILL SLOPE OVER NATURAL GROUND

OUTLET PIPE DRAWN TO A SUITABLE
OUTLET IN ACCORDANCE WITH THE
RECOMMENDATIONS OF THE
CIVIL ENGINEER

NATURAL GROUND

3' 10" MIN.

OUTLET PIPE DRAWN TO A SUITABLE
OUTLET IN ACCORDANCE WITH THE
RECOMMENDATIONS OF THE
CIVIL ENGINEER

NATURAL GROUND

20' MIN.

FILL SLOPE OVER CUT

OUTLET PIPE DRAWN TO A SUITABLE
OUTLET IN ACCORDANCE WITH THE
RECOMMENDATIONS OF THE
CIVIL ENGINEER

NATURAL GROUND

20' MIN.

NOT TO SCALE

BACKFILL AND T-CONNECTION
(SEE DRAW DETAIL, FIGURE E)

BACKFILL AND T-CONNECTION
(SEE DRAW DETAIL, FIGURE E)

BACKFILL AND T-CONNECTION
(SEE DRAW DETAIL, FIGURE E)

BACKFILL AND T-CONNECTION
(SEE DRAW DETAIL, FIGURE E)

BACKFILL AND T-CONNECTION
(SEE DRAW DETAIL, FIGURE E)

BACKFILL AND T-CONNECTION
(SEE DRAW DETAIL, FIGURE E)
SLOPE DRAINAGE DETAIL

MAXIMUM VERTICAL SLOPE HEIGHT, h (FEET)

LESS THAN 30
40
120

GREATER THAN 120

TERRACE WIDTH AND LOCATION

NO TERRACE REQUIRED
ONE TERRACE AT LEAST 6 FEET WIDE AT MIDHEIGHT
ONE TERRACE AT LEAST 12 FEET WIDE AT APPROXIMATELY MIDHEIGHT AND 8-FOOT WIDE TERRACES CENTERED IN REMAINING SLOPES

DESIGNED BY CIVIL ENGINEER WITH APPROVAL OF GOVERNING AUTHORITIES

NOTE:
1. MIDSLOPE BACKDRAIN SHOULD BE PLACED IN FULL HOLLOW IN CONJUNCTION WITH EACH TERRACE.
2. TERRACES SHOULD HAVE AT LEAST A 0.5% PITCH GRADIENT, AND RUN OFF SHOULD BE DIRECTED TO AN APPROPRIATE SURFACE DRAINAGE COLLECTION.
3. TERRACES SHOULD BE CLEANED OF DIRT AND PLANTS TO ALLOW UNRESTRICTED FLOW OF WATER.
4. TERRACES SHOULD BE KEPT IN GOOD HEALF.
5. REFER TO SITE CHARTER TO FOR ADDITIONAL REQUIREMENTS.
NOTED:
1. THE DEPTH AND WIDTH OF KEY WILL BE PROVIDED BY THE GEO TECHNICAL CONSULTANT BASED ON ANALYSIS OF SITE-SPECIFIC GEO TECHNICAL CONDITIONS.

2. AN ADDITIONAL VENT-SLOPE DRAIN AND TERRACE DRAIN MAY BE RECOMMENDED FOR SLOPES OVER 30 FEET HIGH. SEE SLOPE DRAINAGE DETAIL, FIGURE G.

3. SLOPE DRAINAGE SHOULD BE PROVIDED IN ACCORDANCE WITH RECOMMENDATIONS PRESENTED ON FIGURE G.

SHEAR KEY DETAIL

FIGURE F