GEOTECHNICAL EVALUATION

FOR

2192 WEST HIGHLAND AVENUE
PROPOSED RECYCLING FACILITY
CITY OF SAN BERNARDINO, SAN BERNARDINO COUNTY, CALIFORNIA

PREPARED FOR

S. D. ENGINEERING AND ASSOCIATES
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PREPARED BY

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PROJECT NO. 1262-CR3 DECEMBER 29, 2014

GEOTEK

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December 29, 2014
Project No. 1262-CR3

S.D. Engineering and Associates
242 East Airport Drive, Suite 212
San Bernardino, California 92408

Attention: Mr. Suresh Doddiah

Subject: Geotechnical Evaluation
2192 West Highland Avenue
Proposed Recycling Facility
City of San Bernardino, San Bernardino County, California

Dear Mr. Doddiah:

We are pleased to provide herein the results of our geotechnical evaluation for the subject property located in the city of San Bernardino, San Bernardino County, California. This report presents a discussion of our evaluation and provides preliminary geotechnical recommendations for earthwork, foundation design, and construction. In our opinion, site development appears feasible from a geotechnical viewpoint provided that the recommendations included herein are incorporated into the design and construction phases of site development.

The opportunity to be of service is sincerely appreciated. If you have any questions please do not hesitate to call our office.

Respectfully submitted,
GeoTek, Inc.

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1. PURPOSE AND SCOPE OF SERVICES

The purpose of this study was to evaluate the geotechnical conditions for the proposed development. Services provided for this study included the following:

- Research and review of available geologic data and general information pertinent to the site,
- A site reconnaissance,
- Excavation of four (4) exploratory borings on-site,
- Collection of soil samples of the on-site materials,
- Laboratory testing of selected soil samples collected from the site,
- Review and evaluation of site seismicity, and;
- Compilation of this geotechnical report which presents our preliminary recommendations for site development.

The intent of this report is to aid in the evaluation of the site for future proposed development from a geotechnical perspective. The professional opinions and geotechnical information contained in this report will likely need to be updated based upon our review of the final site development plans. These plans should be provided to GeoTek for review when available.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

2.1 SITE DESCRIPTION

The subject project is located at 2192 West Highland Avenue in the city of San Bernardino, San Bernardino County, California (see Figures 1 through 3). The site is bounded by North Macy Street to the west, West Highland Avenue to the south and an existing storage facility to the north and east. The rectangular shaped property is comprised of approximately 3.28 acres. Topography across the site generally slopes down toward the southeast at a gradient of less than two (2) percent, with a total relief on the order of roughly five (5) feet.

The subject property is currently occupied by an existing metal building, which is approximately 14,958 square feet in size, and asphaltic concrete parking and drive areas in the southerly portion of the site in front of the existing metal building. Also, two (2) concrete slabs are located in the northerly portion of the site to the rear of the existing metal building which are remnants from two previously existing shelters.

2.2 PROPOSED DEVELOPMENT

We understand that the proposed site improvements include, but are not limited to, renovation and remodeling of the existing metal building, the construction of a proposed metal covered storage area, which is proposed to be approximately 29,450 square feet in size and located in the northeastern portion of the site, paved parking and drive areas between the existing metal building and the new metal covered storage area and an eight (8) foot high masonry block wall along the western and southern property boundaries.

It is assumed that the new metal covered storage area will be supported by conventional shallow isolated and continuous foundations. Structural loads are anticipated to be typical for this type of construction. The finished grade is expected to be within approximately five (5) feet of existing grades.

If the site development differs from the assumptions made herein, the recommendations included in this report should be subject to further review and evaluation by GeoTek. Site development plans should be reviewed by GeoTek when they become available.

3. FIELD EXPLORATION AND LABORATORY TESTING

3.1 FIELD EXPLORATION

Our geotechnical field exploration was conducted on December 9, 2014. A geologist from GeoTek logged four (4) exploratory borings, excavated by a hollow-stem auger drill rig. The borings were situated at various locations across the site (see Boring Location Map, Figure 3). The approximate depths of the borings were up to approximately twenty-one and a half (21.5) feet below the existing ground surface. Logs of the exploratory borings are included in Appendix A. GeoTek collected samples of on-site soil materials encountered in the excavations.

3.2 LABORATORY TESTING

Laboratory testing was performed on selected relatively undisturbed and bulk soil samples collected during our field exploration. The purpose of the laboratory testing was to confirm the field classification of the soil materials encountered and to evaluate the physical properties of the soils for use in the engineering design and analysis. Results of the laboratory testing program along with a brief description and relevant information regarding testing procedures are included in Appendix B.

4. GEOLOGIC AND SOILS CONDITIONS

4.1 REGIONAL SETTING

The subject property is situated in the Peninsular Ranges geomorphic province. The Peninsular Ranges province is one of the largest geomorphic units in western North America. Basically, it extends roughly 975 miles from the north and northeasterly adjacent the Transverse Ranges geomorphic province to the tip of Baja California. This province varies in width from about 30 to 100 miles. It is bounded on the west by the Pacific Ocean, on the south by the Gulf of California and on the east by the Colorado Desert Province.

The Peninsular Ranges are essentially a series of northwest-southeast oriented fault blocks. Several major fault zones are found in this province. The Elsinore Fault zone and the San Jacinto Fault zones trend northwest-southeast and are found in the near middle of the province. The San Andreas Fault zone borders the northeasterly margin of the province.

More specific to the subject property, the site is located in an area geologically mapped to be underlain by Quaternary age alluvial deposits (Dibblee, T.W. and Minch, J.A., 2004). No faults are shown presently in the immediate site vicinity on the maps reviewed for the area.

4.2 GENERAL SOIL/GEOLOGIC CONDITIONS

A brief description of the earth materials encountered at the subject site is presented in the following sections. Based on our field exploration and observations, the site is generally underlain by native alluvial deposits.

4.2.1 Alluvial Deposits

Quaternary-age alluvial deposits were encountered in all of the borings excavated on the site. In general, the alluvial deposits typically consist of loose to dense silty fine to coarse sand with gravel. These soils were relatively loose to depths ranging from one (1) foot to two (2) feet.

According to the results of the laboratory testing performed, one (1) sample of alluvial deposits tested indicated a "very low" expansion potential (EI = 0) when tested and classified in accordance with ASTM D 4829. The test results are shown in Appendix B.

4.3 SURFACE AND GROUNDWATER

4.3.1 Surface Water

Surface water was not specifically observed at the site during our subsurface exploration; however, due to recent rains, puddles of water were observed on the site in low lying areas to the north/rear of the existing metal building. If encountered during the earthwork construction, surface water on this site is the result of precipitation or surface run-off from surrounding sites. Overall surface drainage in the area is generally to the southeast.

4.3.2 Groundwater

Regional groundwater was not encountered in our exploratory excavations. Based on a review of groundwater levels (http://www.water.ca.gov/waterdatalibrary/) in the vicinity of the site, the depth to regional groundwater is greater than 100 feet.

4.4 FAULTING AND SEISMICITY

The geologic structure of the entire southern California area is dominated mainly by northwest-trending faults associated with the San Andreas system. The site is in a seismically active region. No active or potentially active fault is presently known to exist at this site nor is the site situated within an *"Alquist-Priolo"* Earthquake Fault Zone. The site is currently not located within an area designated by the County of San Bernardino as potentially being liquefiable or being susceptible to landslides (http://cms.sbcounty.gov/lus/Planning/ZoningOverlayMaps/GeologicHazardMaps.aspx).

4.4.1 Seismic Design Parameters

The site is located at approximately 34.1369 Latitude and -117.3392 Longitude. Site spectral accelerations (Ss and S_1), for 0.2 and 1.0 second periods for a Class "D" site, were determined from the USGS Website, Earthquake Hazards Program, U.S. Seismic Design Maps for Risk-Targeted Maximum Considered Earthquake (MCE_R) Ground Motion Response Accelerations for the Conterminous 48 States by Latitude/Longitude. The results are presented in the following table:

SITE SEISMIC PARAMETERS	
Mapped 0.2 sec Period Spectral Acceleration, S_s	2.506g
Mapped 1.0 sec Period Spectral Acceleration, S_1	1.148g
Site Coefficient for Site Class "D", F_a	1.0
Site Coefficient for Site Class "D", F_v	1.5
Maximum Considered Earthquake Spectral Response Acceleration for 0.2 Second, S_{MS}	2.506g
Maximum Considered Earthquake Spectral Response Acceleration for 1.0 Second, S_{M1}	1.723g
5% Damped Design Spectral Response Acceleration Parameter at 0.2 Second, S_{DS}	1.671g
5% Damped Design Spectral Response Acceleration Parameter at 1 second, S_{D1}	1.148g

Final selection of the appropriate seismic design coefficients should be made by the project structural engineer based upon the local practices and ordinances, expected building response and desired level of conservatism.

4.5 LIQUEFACTION AND SEISMICALLY-INDUCED SETTLEMENT

The depth to groundwater in the vicinity of the site is greater than 100 feet. Loose soil will be removed and recompacted below the proposed covered area, and the remaining natural soils are in a relatively dense condition. It is therefore our opinion that liquefaction will not occur, and that seismically-induced settlement should not be a consideration in the design of the structure.

4.6 OTHER SEISMIC HAZARDS

Evidence of ancient landslides or slope instabilities at this site was not observed during our investigation and the project site is relatively flat. Thus, the potential for landslides is considered negligible for design purposes.

The potential for secondary seismic hazards such as a seiche or tsunami is considered negligible due to site elevation and distance to an open body of water.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 GENERAL

The anticipated site development appears feasible from a geotechnical viewpoint provided that the following recommendations, and those provided by this firm at a later date, are properly incorporated into the design and construction phases of development. Site development and grading plans should be reviewed by GeoTek when they become available.

5.2 EARTHWORK CONSIDERATIONS

Earthwork and grading should be performed in accordance with the applicable grading ordinances of the city of San Bernardino, the 2013 California Building Code (CBC), and recommendations contained in this report. The Grading Guidelines included in Appendix C outline general procedures and do not anticipate all site-specific situations. In the event of conflict, the recommendations presented in the text of this report should supersede those contained in Appendix C.

5.2.1 Site Clearing and Demolition

In areas of planned grading and improvements, the site should be cleared of existing structures, vegetation, roots, and trash and debris. The debris should be properly disposed of off-site. Voids resulting from site clearing should be replaced with engineered fill materials with expansion characteristics similar to the on-site materials.

5.2.2 Removals/Overexcavations

A representative of this firm should observe the bottom of all excavations. Upon approval, the exposed soils and all soils in areas to receive engineered fill should be scarified to a depth of approximately eight (8) inches, moistened to at least optimum moisture content and compacted to a minimum relative compaction of 90 percent (ASTM D 1557).

Improvement Areas

The natural soils below and within three (3) feet of the covered area envelope should be removed to a depth of three (3) feet below existing grade or one (1) feet below the bottom of the deepest footing, whichever is greater/deeper. A representative of this firm should observe the bottom of all excavations. In areas where loose soil is present in the bottom of the excavations, the removals should continue until competent natural materials are encountered.

Competent materials are defined as natural soils with an in-place relative compaction of at least 85 percent, uniform in appearance, with little to no visible porosity.

Perimeter Walls

The natural soils below and within three (3) feet of the bottom of proposed perimeter wall footings should be removed to a depth of three (3) feet below existing grade or one (1) feet below the bottom of the footings, whichever is greater/deeper.

Pavement and Hardscape Areas

The natural soils below asphaltic concrete pavement and Portland Cement Concrete (PCC) hardscape areas should be removed to a depth of two (2) feet below proposed finish grade. Finish grade is defined as the elevation of the top of the subgrade.

5.2.2 Engineered Fills

The on-site soils are generally considered suitable for reuse as engineered fill provided they are free from vegetation, debris and other deleterious material. The undercut areas should be brought to the final subgrade elevations with fill materials that are placed and compacted in general accordance with the minimum project standards. Fill materials should be placed at optimum moisture content and should be compacted to a minimum relative compaction of 90% as determined by ASTM Test Method D 1557.

5.2.3 Excavation Characteristics

Excavation in the on-site soils is expected to be feasible utilizing heavy-duty grading equipment in good operating condition. All temporary excavations for grading purposes and installation of underground utilities should be constructed in accordance with local and Cal-OSHA guidelines. Temporary excavations within the on-site materials should be stable at 1½:1 (horizontal: vertical) inclinations for cuts less than five (5) feet in height.

5.2.4 Shrinkage

Several factors will impact earthwork balancing on the site, including shrinkage, trench spoil from utilities and footing excavations, as well as the accuracy of topography.

Shrinkage is primarily dependent upon the degree of compactive effort achieved during construction. For planning purposes, a shrinkage factor of 5 to 10 percent may be considered for the materials requiring removal and/or recompaction. Site balance areas should be available in order to adjust project grades, depending on actual field conditions at the conclusion of site earthwork construction.

5.3 DESIGN RECOMMENDATIONS

5.3.1 Foundation Design Criteria

Foundation design criteria for a conventional foundation system, in general conformance with the 2013 CBC, are presented herein. Based on the results of our laboratory testing, it is anticipated that the soils near subgrade will classify as having a "very low" expansion potential ($0 \leq EI \leq 20$) in accordance with ASTM D 4829. Below is typical design criteria for the area based upon a "very low" expansion potential. These are minimal recommendations and are not intended to supersede the design by the project structural engineer.

The foundation elements for the proposed structures and other improvements should be founded entirely in engineered fill soils. Foundations should be designed in accordance with the *2013 California Building Code* (CBC).

Additional expansion index, corrosivity and soluble sulfate testing of the soils should be performed during construction to evaluate the as-graded conditions. Final recommendations should be based upon the as-graded soils conditions.

A summary of our foundation design recommendations is presented in the following table:

GEOTECHNICAL RECOMMENDATIONS FOR THE MINIMUM DESIGN REQUIREMENTS

Design Parameter	"Very Low" Expansion Potential 0≤**EI**≤20
Foundation Depth or Minimum Perimeter Beam Depth (inches below the lowest adjacent grade)	18
Minimum Foundation Width (Inches)*	15
Minimum Slab Thickness (inches)	4 - Actual
Minimum Slab Reinforcing	No. 3 rebar 18-inches on-center, each way, placed in the middle 1/3 of thickness of the slab
Minimum Footing Reinforcement for Spread Footings	No. 4 Reinforcing Bars, Spaced at a Maximum 24-inches on-center, both ways, suitably placed at bottom of footings
Minimum Footing Reinforcement for Continuous Footings, Grade Beams and Retaining Wall Footings	Two (2) No. 4 Reinforcing Bars One (1) top and One (1) bottom
Presaturation of Subgrade Soil (Percent of Optimum/Depth in Inches)	Minimum of 100% of the optimum moisture content to a depth of at least 12 inches prior to placing concrete

An allowable bearing capacity of 2000 pounds per square foot (psf) may be used for design of building and retaining wall footings. This value may be increased by 300 psf for each additional 12 inches of embedment depth and by 200 psf for each additional 12 inches in width to a maximum of 3000 psf. The allowable bearing capacity may be increased by one-third when considering short-term wind and seismic loads.

For footings designed in accordance with the recommendations presented in this report, we would anticipate a maximum settlement of less than one (1) inch and a maximum differential settlement of less than one (1) inch in a 40-foot span.

The passive earth pressure may be computed as an equivalent fluid having a density of 300 psf per foot of depth, to a maximum earth pressure of 2000 psf for footings founded on engineered fill. A coefficient of friction between soil and concrete of 0.30 may be used with dead load forces. The upper one foot of soil below the adjacent grade should not be used in calculating passive pressure. When combining passive and frictional resistance, the passive pressure component should be reduced by one-third.

A moisture and vapor retarding system should be placed below slabs-on-grade where moisture migration through the slab is undesirable. Guidelines for these are provided in the 2013 California Green Building Standards Code (CALGreen) Section 4.505.2 and the 2013 CBC Section 1907.1, ACI 360R-10 and ACI 203.2R-06. The vapor retarder design and construction should also meet the requirements of ASTM E1643.

It should be realized that the effectiveness of the vapor retarding membrane can be adversely impacted as a result of construction related punctures (e.g. stake penetrations, tears, punctures from walking on the aggregate layer, etc.). These occurrences should be limited as much as possible during construction. Thicker membranes are generally more resistant to accidental puncture than thinner ones. Products specifically designed for use as moisture/vapor retarders may also be more puncture resistant. Although the CBC specifies a six (6) mil vapor retarder membrane, it is GeoTek's opinion that a minimum 10 mil thick membrane with joints properly overlapped and sealed should be considered, unless otherwise specified by the slab design professional. The membrane should consist of Stego wrap or the equivalent.

A two (2) inch layer of clean sand (i.e. SE>30) should be placed over the moisture vapor retardant membrane to promote setting of the concrete. The moisture in the sand should not exceed two (2) percent below the optimum moisture content.

Moisture and vapor retarding systems are intended to provide a certain level of resistance to vapor and moisture transmission through the concrete, but do not eliminate it. The acceptable level of moisture transmission through the slab is to a large extent based on the type of flooring used and environmental conditions. Ultimately, the vapor retarding system should be comprised of suitable elements to limit migration of water and reduce transmission of water vapor through the slab to acceptable levels. The selected elements should have suitable properties (i.e., thickness, composition, strength, and permeability) to achieve the desired performance level. Consideration should be given to consulting with an individual possessing specific expertise in this area for additional evaluation.

Moisture retarders can reduce, but not eliminate, moisture vapor rise from the underlying soils up through the slab. Moisture retarders should be designed and constructed in accordance with applicable American Concrete Institute, Portland Cement Association, Post-Tensioning Concrete Institute, ASTM and California Building Code requirements and guidelines. GeoTek does not practice in the field of moisture vapor transmission evaluation/mitigation, since this does not fall under the geotechnical disciplines. Therefore, we recommend that a qualified person, such as the flooring contractor, structural engineer, and/or architect be consulted to evaluate the general and specific moisture vapor transmission paths and any impact on the proposed construction. That person (or persons) should provide recommendations for mitigation of potential adverse impact of moisture vapor transmission on various components of the structures as deemed appropriate. In addition, the recommendations in this report and our services in general are not intended to address mold prevention, since we along with geotechnical consultants in general, do no practice in areas of mold prevention. If specific recommendations are desired, a professional mold prevention consultant should be contacted.

5.3.2 Miscellaneous Foundation Recommendations

- To reduce moisture penetration beneath the slab on grade areas, utility trenches should be backfilled with engineered fill, lean concrete or concrete slurry where they intercept the perimeter footing or thickened slab edge.
- Soils from the footing excavations should not be placed in the slab-on-grade areas unless properly compacted and tested. The excavations should be free of loose/sloughed materials and be neatly trimmed at the time of concrete placement.
- Under-slab utility trenches should be compacted to project specifications. Compaction should be achieved with a mechanical compaction device. If backfill soils have dried out, they should be thoroughly moisture conditioned prior to placement in trenches.
- Utility trench excavations should be shored or laid back in accordance with applicable CAL/OSHA standards.
- On-site materials may not be suitable for use as bedding material, but will be suitable as engineered fill provided oversized materials are removed. Jetting of native soils will not be acceptable.
- Unsuitable soil removals along the property lines will likely be restricted due to adjacent improvements. Special considerations will be required for foundation elements in these areas. Such considerations may include deepening of foundations, reduced bearing capacity, or other measures. This issue should be further evaluated once site plans become available and/or during earthwork construction.

5.3.3 Foundation Set Backs

Minimum setbacks to all foundations should comply with the 2013 CBC or city of San Bernardino requirements, whichever is more stringent. Improvements not conforming to these setbacks are subject to the increased likelihood of excessive lateral movements and/or differential settlements. If large enough, these movements can compromise the integrity of the improvements. The following recommendations are presented:

- The outside bottom edge of all footings should be set back a minimum of H/3 (where H is the slope height) from the face of any descending slope. The setback should be at least seven (7) feet and need not exceed 40 feet.

- The bottom of all footings for new structures near retaining walls should be deepened so as to extend below a 1:1 projection upward from the bottom inside edge of the wall stem.

5.3.4 Retaining and Garden Wall Design and Construction

5.3.4.1 General Design Criteria

Recommendations presented herein apply to typical masonry or concrete vertical retaining walls to a maximum height of up to six (6) feet. Additional review and recommendations should be requested for higher walls. These are typical design criteria and are not intended to supersede the design by the structural engineer

Retaining wall foundations should be embedded a minimum of 24 inches into engineered fill. Retaining wall foundations should be designed in accordance with Section 5.3.1 of this report. Structural needs may govern and should be evaluated by the project structural engineer.

All earth retention structures plans, as applicable, should be reviewed by this office prior to finalization. The seismic design parameters as discussed in this report remain applicable to all proposed earth retention structures at this site, and should be properly incorporated into the design and construction of the respective earth retention structures.

Earthwork considerations, site clearing and remedial earthwork for all earth retention structures should meet the requirements of this report, unless specifically provided otherwise, or more stringent requirements or recommendations made by the earth retention structure designer. The backfill material placement for all earth retention structures should meet the requirement of Engineered Fill of this report.

In general, cantilever earth retention structures, which are designed to yield at least 0.001H, where H is equal to the height of the earth retention structure to the base of its footing (as applicable), may be designed using the active condition. Rigid earth retention structures (including but not limited to rigid walls, and walls braced at top, such as typical basement walls) should be designed using the at-rest condition.

In addition to the design lateral forces due to retained earth, surcharge due to improvements, such as an adjacent structure or traffic loading, should be considered in the design of the earth retention structures. Loads applied within a 1:1 (h:v) projection from the surcharging structure on the stem of the earth retention structure should be considered in the design.

Final selection of the appropriate design parameters should be made by the project earth retention structure designer (geo-structural), based upon the local practices and ordinates, expected retaining structure response, and desired level of conservatism.

5.3.4.2 Cantilevered Walls

The recommendations presented below are for cantilevered retaining walls up to six (6) feet high. Active earth pressure may be used for retaining wall design, provided the top of the wall is not restrained from minor deflections. An equivalent fluid pressure approach may be used to compute the horizontal pressure against the wall. Appropriate fluid unit weights are given below for specific slope gradients of the retained material. These do not include other superimposed loading conditions such as traffic, structures, seismic events, or adverse geologic conditions.

ACTIVE EARTH PRESSURES	
Surface Slope of Retained Materials (h:v)	Equivalent Fluid Pressure (pcf)
Level	39
2:1	61

* The design pressures assume the backfill materials have an EI ≤ 20 and a SE>30. Backfill zone includes area between back of the wall to plane (1:1, h:v) up from bottom of the wall foundation (on the backside of the wall) to the (sloped) ground surface.

5.3.4.3 Retaining Wall Backfill and Drainage

Retaining wall backfill should consist of granular, non-expansive soil (EI ≤ 20 and an SE>30). The wall backfill should also include a minimum one (1) foot wide section of ¾ to 1-inch clean crushed rock (or an approved equivalent). The rock should be placed immediately adjacent to the back of wall and extend up from the back drain to within approximately 12 inches of the finish grade. The upper 12 inches should consist of compacted on-site materials. The presence of other materials might necessitate revision to the parameters provided and modification of the wall designs. The backfill materials should be placed in lifts no greater than eight (8)-inches in thickness and compacted to a minimum of 90% relative compaction in accordance with ASTM Test Method D 1557. Proper surface drainage needs to be provided and maintained.

Retaining walls should be provided with an adequate pipe and gravel back drain system to help prevent buildup of hydrostatic pressures. Backdrains should consist of a four (4)-inch diameter perforated collector pipe (Schedule 40, SDR 35, or approved equivalent) embedded in a minimum of one (1) cubic foot per lineal foot of ¾- to 1-inch clean crushed rock or an approved equivalent, wrapped in filter fabric (Mirafi 140N or an approved equivalent). The drain system should be connected to a suitable outlet. Spacing between drain outlets should not exceed 50 feet. Waterproofing of site walls should be performed where moisture migration through the wall is undesirable.

5.3.4.4 Restrained Retaining Walls

Retaining walls that will be restrained prior to placing and compacting backfill material or that have reentrant or male corners, should be designed for an at-rest equivalent fluid pressure of 60 pcf, plus any applicable surcharge loading. For areas of male or reentrant corners, the restrained wall design should extend a minimum distance of twice the height of the wall laterally from the corner, or a distance otherwise determined by the project structural engineer.

5.3.4.5 Other Design Considerations

- Retaining and garden wall foundation elements should be designed in accordance with building code setback requirements. A minimum horizontal setback distance of seven (7) feet as measured from the bottom outside edge of the footing to a sloped face is recommended.
- Wall design should consider the additional surcharge loads from superjacent slopes and/or footings, where appropriate.
- No backfill should be placed against concrete until minimum design strengths are evident by compression tests of cylinders.
- The retaining wall footing excavations, backcuts, and backfill materials should be approved the project geotechnical engineer or their authorized representative.
- Positive separations should be provided in garden walls at horizontal distances not exceeding 20 feet.

5.3.5 Soil Corrosivity

The soil resistivity at this site was tested in the laboratory on one (1) sample collected during the field investigation. The results of the testing indicate that the on-site soils are considered "mildly corrosive" to buried ferrous metal in accordance with current standards used by corrosion engineers. We recommend that a corrosion engineer be consulted to provide recommendations for the protection of buried ferrous metal at this site.

5.3.6 Soil Sulfate Content

The sulfate content was determined in the laboratory for an on-site soil sample. The results indicate that the water soluble sulfate result is less than 0.1 percent by weight, which is considered "not applicable" (negligible) as per Table 4.2.1 of ACI 318.

5.3.7 Import Soils

Import soils should have expansion characteristics similar to the on-site soils. GeoTek also recommends that the proposed import soils be tested for expansion and corrosivity potential. GeoTek should be notified a minimum of 72 hours prior to importing so that appropriate sampling and laboratory testing can be performed.

5.3.8 Concrete Flatwork

5.3.8.1 Exterior Concrete Slabs, Sidewalks and Driveways

Exterior concrete slabs, sidewalks and driveways should be designed using a four (4) inch minimum thickness. No specific reinforcement is required from a geotechnical perspective. However, some shrinkage and cracking of the concrete should be anticipated as a result of typical mix designs and curing practices commonly utilized in industrial construction.

Sidewalks and driveways may be under the jurisdiction of the governing agency. If so, jurisdictional design and construction criteria would apply, if more restrictive than the recommendations presented herein.

Subgrade soils (typically "very low" expansion potential) should be pre-moistened prior to placing concrete. The subgrade soils below exterior slabs, sidewalks, driveways, etc. at the subject site should be pre-saturated to a minimum of 100% of optimum moisture content to a depth of at least 18 inches.

All concrete installation, including preparation and compaction of subgrade, should be done in accordance with the city of San Bernardino specifications, and under the observation and testing of GeoTek and a city Inspector, if necessary.

5.3.8.2 Concrete Performance

Concrete cracks should be expected. These cracks can vary from sizes that are essentially unnoticeable to more than 0.125-inch in width. Most cracks in concrete, while unsightly, do not significantly impact long-term performance. While it is possible to take measures (proper concrete mix, placement, curing, control joints, etc.) to reduce the extent and size of cracks that occur, some cracking will occur despite the best efforts to minimize it. Concrete can also undergo chemical processes that are dependent upon a wide range of variables, which are difficult, at best, to control. Concrete, while seemingly a stable material, is also subject to internal expansion and contraction due to the external changes over time.

One of the simplest means to control cracking is to provide weakened control joints for cracking to occur along. These do not prevent cracks from developing; they simply provide a relief point for the stresses that develop. These joints are a widely accepted means to control cracks but are not always effective. Control joints are more effective the more closely spaced they are. GeoTek suggests that control joints be placed in two directions and located a distance apart roughly equal to 24 to 36 times the slab thickness.

Exterior concrete flatwork (patios, walkways, driveways, etc.) is often some of the most visible aspects of site development. They are typically given the least level of quality control, being considered "non-structural" components. We suggest that the same standards of care be applied to these features as to the structure itself.

5.4 PAVEMENT DESIGN AND CONSTRUCTION

5.4.1 Asphaltic and Portland Cement Concrete Pavement Design

At the time this report was prepared, the anticipated conventional passenger vehicle and truck traffic volumes that will be imposed on the site were not known. For design purposes, we have assumed twenty semi-trucks each weighing 80,000 pounds accessing the site on a daily basis, six (6) days per week. Once the actual vehicle volumes are known, this form should be contacted to review the design.

Based upon the design procedure outlined in the current Caltrans Highway Design Manual, flexible pavement cross sections may consist of the following for the Traffic Indices (TIs) indicated. Although laboratory testing of the surficial on-site soil (performed by others as provided in Appendix B) indicated an R-value of 73, based upon current standards of practice and our understanding of the site conditions, we used a design R-value of 50. The modulus of subgrade reaction (k-value) for pavement design is estimated to be 200 pci.

Recommendations for Asphaltic Concrete Pavement Construction

Traffic Index	Typical Traffic Index Assignment	Asphaltic Concrete (AC) Thickness (inches)	Class 2 Aggregate Base (AB) Thickness (inches)
4.0	Auto Parking	3	4
5.0	Auto Access	3	4
7.5	Trucks	4	6

Portland Cement Concrete (PCC) pavement is recommended for truck access lanes (such as trash enclosures) or in other areas as recommended by the project civil engineer. Based on an assumed volume of 20 trucks per day, six days per week for 20 years, and a maximum truck weight of 80 kips, a minimum of six (6) inches PCC over four (4) inches of compacted aggregate base (AB) is recommended. PCC design and construction should meet the latest edition of ACI 330R – Guide for Design and Construction of Concrete Parking Lots. Reinforcement and control joints should be placed in accordance with the project structural engineer's recommendation.

The PCC pavement should have a minimum modulus of rupture of 500 pounds per square inch, and a minimum 28-day compressive strength of 3000 pounds per square inch. Where the concrete section is at least 7.5 inches thick, control joints should be spaced at maximum horizontal intervals of 14 feet. Concrete should incorporate 1-inch maximum size aggregate, and should be proportioned to achieve a maximum slump of four (4) inches. Instead of increasing the water content, a plasticizing admixture may be utilized to increase the workability of the concrete. The concrete should be properly cured after placement. Concrete should not be placed during hot and windy weather.

The upper twelve (12) inches of subgrade below PCC pavement should be densified to at least 95 percent relative compaction (ASTM D 1557).

5.5 POST CONSTRUCTION CONSIDERATIONS

5.5.1 Landscape Maintenance and Planting

Water has been shown to weaken the inherent strength of soil, and slope stability is significantly reduced by overly wet conditions. Positive surface drainage away from graded slopes should be maintained and only the amount of irrigation necessary to sustain plant life should be provided for planted slopes. Controlling surface drainage and runoff, and maintaining a suitable vegetation cover can minimize erosion. Plants selected for landscaping should be lightweight, deep-rooted types that require little water and are capable of surviving the prevailing climate.

Overwatering should be avoided. Care should be taken when adding soil amendments to avoid excessive watering. Leaching as a method of soil preparation prior to planting is not recommended. An abatement program to control ground-burrowing rodents should be implemented and maintained. This is critical as burrowing rodents can decreased the long-term performance of slopes.

It is common for planting to be placed adjacent to the structures in planter or lawn areas. This will result in the introduction of water into the ground adjacent to the foundation. This type of landscaping should be avoided. If used, then extreme care should be exercised with regard to the irrigation and drainage in these areas.

5.5.2 Drainage

The need to maintain proper surface drainage and subsurface systems cannot be overly emphasized. Positive site drainage should be maintained at all times. Drainage should not flow uncontrolled down any descending slope. Water should be directed away from foundations and not allowed to pond or seep into the ground. Pad drainage should be directed toward approved area(s) and not be blocked by other improvements.

It is the owner's responsibility to maintain and clean drainage devices on or contiguous to their lot. In order to be effective, maintenance should be conducted on a regular and routine schedule and necessary corrections made prior to each rainy season.

5.6 PLAN REVIEW AND CONSTRUCTION OBSERVATIONS

We recommend that site grading, specifications and foundation plans be reviewed by this office prior to construction to check for conformance with the recommendations of this report. We also recommend that GeoTek representatives be present during site grading and foundation construction to observe and document proper implementation of the geotechnical recommendations. The owner/developer should verify that GeoTek representatives perform at least the following duties:

- Observe site clearing and grubbing operations for proper removal of unsuitable materials.
- Observe and test bottom of removals prior to fill placement.
- Evaluate the suitability of on-site and import materials for fill placement, and collect soil samples for laboratory testing where necessary.

- Observe the fill for uniformity during placement, including utility trenches. Also, perform field density testing of the fill materials.
- Observe and probe foundation excavations to confirm suitability of bearing materials.

If requested, a construction observation and compaction report can be provided by GeoTek, which can comply with the requirements of the governmental agencies having jurisdiction over the project. We recommend that these agencies be notified prior to commencement of construction so that necessary grading permits can be obtained.

6. INTENT

It is the intent of this report to aid in the design and construction of the proposed development. Implementation of the advice presented in this report is intended to reduce risk associated with construction projects. The professional opinions and geotechnical advice contained in this report are not intended to imply total performance of the project or guarantee that unusual or variable conditions will not be discovered during or after construction.

The scope of our evaluation is limited to the boundaries of the subject property. This review does not and should in no way be construed to encompass any areas beyond the specific area of the proposed construction as indicated to us by the client. Further, no evaluation of any existing site improvements is included. The scope is based on our understanding of the project and the client's needs, our fee estimate (Proposal No. P3-1102514) dated November 19, 2014 and geotechnical engineering standards normally used on similar projects in this locality at the present.

7. LIMITATIONS

Our findings are based on site conditions observed and the stated sources. Thus, our comments are professional opinions that are limited to the extent of the available data.

GeoTek has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report.

Since our recommendations are based on the site conditions observed and encountered, and laboratory testing, our conclusions and recommendations are professional opinions that are limited to the extent of the available data. Observations during construction are important to allow for any change in recommendations found to be warranted. These opinions have been derived in accordance with current standards of practice and no warranty of any kind is expressed or implied. Standards of care/practice are subject to change with time.

8. SELECTED REFERENCES

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State of California, California Geological Survey (CGS, formerly referred to as the California Division of Mines and Geology), 2008, "Guidelines for Evaluating and Mitigating Seismic Hazards in California," Special Publication 117A.

S.D. Engineering and Associates
2192 West Highland Avenue
City of San Bernardino
San Bernardino County, California

GeoTek Project No. 1262-CR

N

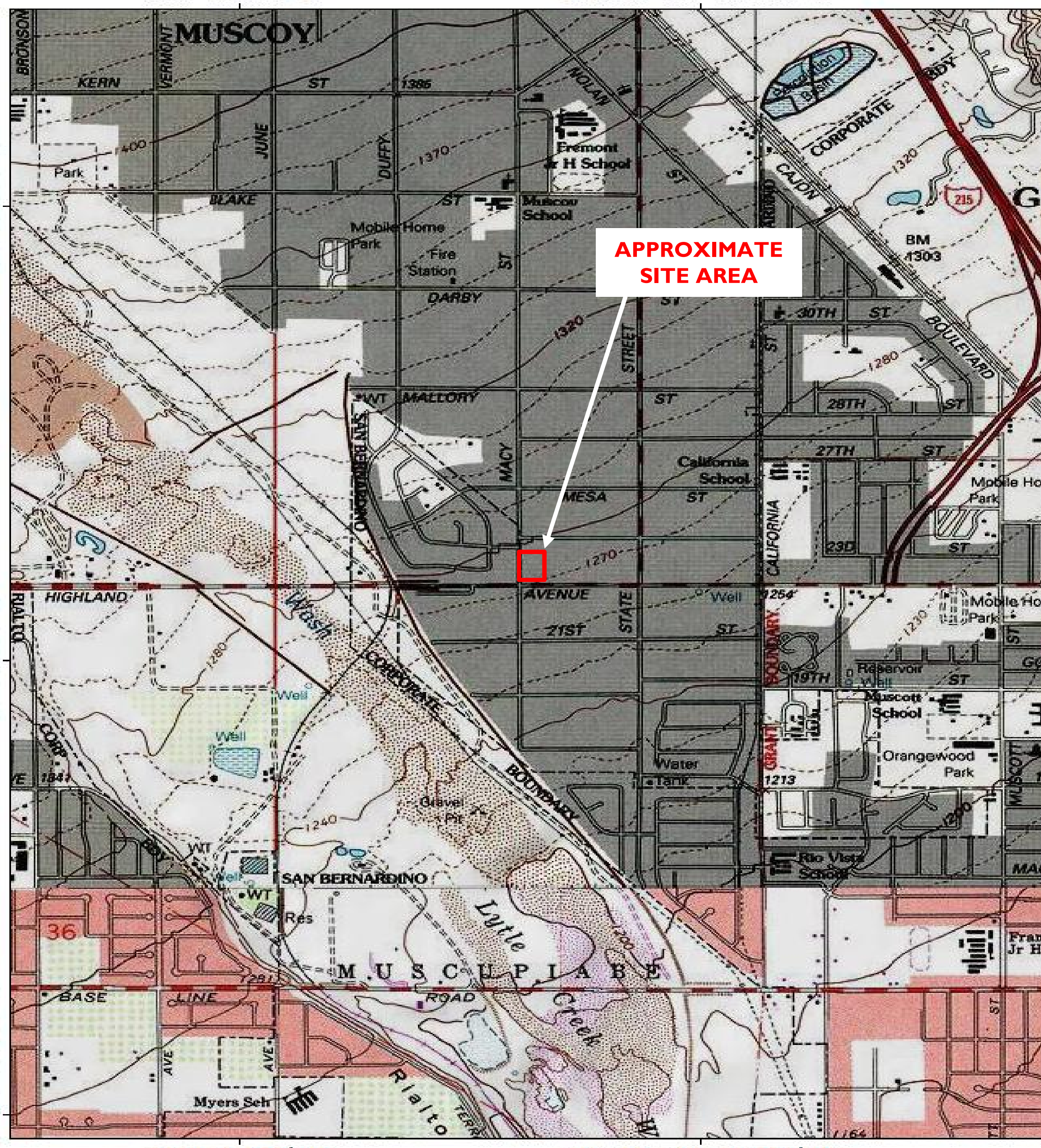
Figure 1

Site Location Map

GEOTEK

TOPO! map printed on 12/18/14 from "Untitled.tpo"

117°21.000' W WGS84 117°20.000' W



34°09.000' N
34°08.000' N
34°07.000' N

117°21.000' W WGS84 117°20.000' W

TN MN 13°

0 .5 1 MILE

0 1000 FEET 0 500 1000 METERS

Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

S.D. Engineering and Associates
2192 West Highland Avenue
City of San Bernardino
San Bernardino County, California

GeoTek Project No. 1262-CR

N

Modified from USGS 7.5 Topographic Map

Figure 2

General Site Topography Map

GEOTEK

S.D. Engineering and Associates
2192 West Highland Avenue
City of San Bernardino
County of San Bernardino, California

GeoTek Project No. 1262-CR

N

Figure 3

Boring Location Map

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APPENDIX A

LOGS OF EXPLORATORY BORINGS

1292 West Highland Avenue
City of San Bernardino, San Bernardino County, California
Project No. 1262-CR3

GEOTEK

A - FIELD TESTING AND SAMPLING PROCEDURES

The Modified Split-Barrel Sampler (Ring)
The Ring sampler is driven into the ground in accordance with ASTM Test Method D 3550. The sampler, with an external diameter of 3.0 inches, is lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sampler is typically driven into the ground 12 or 18 inches with a 140-pound hammer free falling from a height of 30 inches. Blow counts are recorded for every 6 inches of penetration as indicated on the log of boring. The samples are removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

Bulk Samples (Large)
These samples are normally large bags of earth materials over 20 pounds in weight collected from the field by means of hand digging or exploratory cuttings.

Bulk Samples (Small)
These are plastic bag samples which are normally airtight and contain less than 5 pounds in weight of earth materials collected from the field by means of hand digging or exploratory cuttings. These samples are primarily used for determining natural moisture content and classification indices.

B – BORING LOG LEGEND

The following abbreviations and symbols often appear in the classification and description of soil and rock on the logs of borings:

SOILS

USCS	Unified Soil Classification System
f-c	Fine to coarse
f-m	Fine to medium

GEOLOGIC

B: Attitudes	Bedding: strike/dip
J: Attitudes	Joint: strike/dip
C: Contact line	
………..	Dashed line denotes USCS material change
———	Solid Line denotes unit / formational change
━━━	Thick solid line denotes end of boring

(Additional denotations and symbols are provided on the log of borings)

GeoTek, Inc.
LOG OF EXPLORATORY BORING

CLIENT:	SD Engineering and Associates	**DRILLER:**	2R Drilling	**LOGGED BY:**	AMS
PROJECT NAME:	2192 West Highland Avenue	**DRILL METHOD:**	8" Hollow Stem	**OPERATOR:**	Jerry
PROJECT NO.:	1262-CR	**HAMMER:**	Auto 140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	12/9/2014

BORING NO.: B-1

Depth (ft)	Sample Type	Blows/ 6 in	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Water Content (%)	Dry Density (pcf)	Others
0	Large Bulk				**Alluvium:**			SH, MD, EI, SR
				SM	Silty f-c SAND with trace gravel, light brown gray, slightly moist, medium dense to dense			
	Ring	10 19 26	B1-1		SAME	1.5	112.8	
5	No Recovery	12 21 50-2"	B1-2					
10	Ring	24 46 46	B1-3		Silty f-c SAND with gravel, light brown gray, slightly moist, dense	1.7		
15	Ring	13 43 50-5"	B1-4		SAME	2.1	104.9	
20	Ring	28 33 50-4.5"	B1-5		SAME			
					BORING TERMINATED AT 21.5 FEET			
					No groundwater encountered Boring backfilled with cuttings			
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing:
AL = Atterberg Limits EI = Expansion Index SA = Sieve Analysis RV = R-Value Test
SR = Sulfate/Resisitivity Test SH = Shear Test HC= Consolidation MD = Maximum Density

GeoTek, Inc.
LOG OF EXPLORATORY BORING

CLIENT:	SD Engineering and Associates	**DRILLER:**	2R Drilling	**LOGGED BY:**	AMS
PROJECT NAME:	2192 West Highland Avenue	**DRILL METHOD:**	8" Hollow Stem	**OPERATOR:**	Jerry
PROJECT NO.:	1262-CR	**HAMMER:**	Auto 140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	12/9/2014

BORING NO.: B-2

Depth (ft)	Sample Type (SAMPLES)	Blows/ 6 in (SAMPLES)	Sample Number (SAMPLES)	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Water Content (%) (Laboratory Testing)	Dry Density (pcf) (Laboratory Testing)	Others (Laboratory Testing)
0					**Alluvium:**			
				SM	Silty f-c SAND with trace gravel, light brown gray, slightly moist, medium dense to dense			
	SPT	8 22 16	B2-1		Silty f-c SAND with scattered gravel, slightly moist, light gray brown, dense	4.8	110.5	HC
5								
	SPT	11 28 27	B2-2		SAME	3.3	113.3	
10								
	SPT	12 17 50	B2-3		Silty fine SAND, light brown, moist, dense	7.9	110.2	
15								
	SPT	11 22 21	B2-4		Silty fine SAND, light gray, moist, dense			
					BORING TERMINATED AT 18.5 FEET			
20					No groundwater encountered Boring backfilled with cuttings			
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing:
AL = Atterberg Limits | EI = Expansion Index | SA = Sieve Analysis | RV = R-Value Test
SR = Sulfate/Resisitivity Test | SH = Shear Test | HC= Consolidation | MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	SD Engineering and Associates	**DRILLER:**	2R Drilling	**LOGGED BY:**	AMS
PROJECT NAME:	2192 West Highland Avenue	**DRILL METHOD:**	8" Hollow Stem	**OPERATOR:**	Jerry
PROJECT NO.:	1262-CR	**HAMMER:**	Auto 140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	12/9/2014

BORING NO.: B-3

Depth (ft)	Sample Type (SAMPLES)	Blows/ 6 in (SAMPLES)	Sample Number (SAMPLES)	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Water Content (%) (Laboratory Testing)	Dry Density (pcf) (Laboratory Testing)	Others (Laboratory Testing)
0					**Alluvium:**			
				SM	Silty f-c SAND with trace gravel, light brown gray, slightly moist, medium dense to dense			
5	Ring	7 16 23	B3-1		Silty f-c SAND with gravel, light brown gray, slightly moist, dense	1.9	115.2	
10	Ring	13 19 29	B3-2		Silty f-c SAND with scattered gravel, light brown gray, slightly moist, dense	2.1	112.6	
	Ring	26 49 50-5"	B3-3		SAME	2.1		
15	Ring	35 48 50-5"	B3-4		Silty f-c SAND with gravel, light brown gray, slightly moist, dense	2.0	115.0	
20	Ring	29 44 44	B3-5		SAME			
					BORING TERMINATED AT 21.5 FEET			
					No groundwater encountered Boring backfilled with cuttings			
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing:
AL = Atterberg Limits
EI = Expansion Index
SA = Sieve Analysis
RV = R-Value Test
SR = Sulfate/Resisitivity Test
SH = Shear Test
HC= Consolidation
MD = Maximum Density

GeoTek, Inc.
LOG OF EXPLORATORY BORING

CLIENT:	SD Engineering and Associates	**DRILLER:**	2R Drilling	**LOGGED BY:**	AMS
PROJECT NAME:	2192 West Highland Avenue	**DRILL METHOD:**	8" Hollow Stem	**OPERATOR:**	Jerry
PROJECT NO.:	1262-CR	**HAMMER:**	Auto 140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	12/9/2014

BORING NO.: B-4

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
0	Large Bulk				**Alluvium:**			RV
				SM	Silty f-c SAND with trace gravel, light brown gray, slightly moist, medium dense to dense			
5	SPT	14 24 21	B4-1		Silty f-c SAND with trace gravel, light brown gray, slightly moist, dense	2.1	115.2	
10	SPT	36 44 44	B4-2		Silty f-c SAND with scattered gravel, light gray brown, slightly moist, dense	2.6	119.1	
15	SPT	21 35 41	B4-3		Silty f-c SAND with trace gravel, light brown, slightly moist, dense	2.2	118.8	
20	SPT	45 33 41	B4-4		SAME			
					BORING TERMINATED AT 21.5 FEET			
					No groundwater encountered Boring backfilled with cuttings			
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing:
AL = Atterberg Limits | EI = Expansion Index | SA = Sieve Analysis | RV = R-Value Test
SR = Sulfate/Resisitivity Test | SH = Shear Test | HC= Consolidation | MD = Maximum Density

APPENDIX B

LABORATORY TESTING RESULTS

2192 West Highland Avenue
City of San Bernardino, San Bernardino County, California
Project No. 1262-CR3

GEOTEK

SUMMARY OF LABORATORY TESTING

Classification
Soils were classified visually in general accordance to the Unified Soil Classification System (ASTM Test Method D 2487). The soil classifications are shown on the log of borings in Appendix A.

Consolidation
Consolidation testing was performed on selected samples of the site soils according to ASTM Test Method D 2435. The results of this testing is presented herein.

Direct Shear
Shear testing was performed in a direct shear machine of the strain-control type in general accordance with ASTM Test Method D 3080. The rate of deformation is approximately 0.025 inches per minute. The samples were sheared under varying confining loads in order to determine the coulomb shear strength parameters, angle of internal friction and cohesion. One (1) test was performed on a remolded sample of bulk soils collected on the site. The results of the testing are included herein.

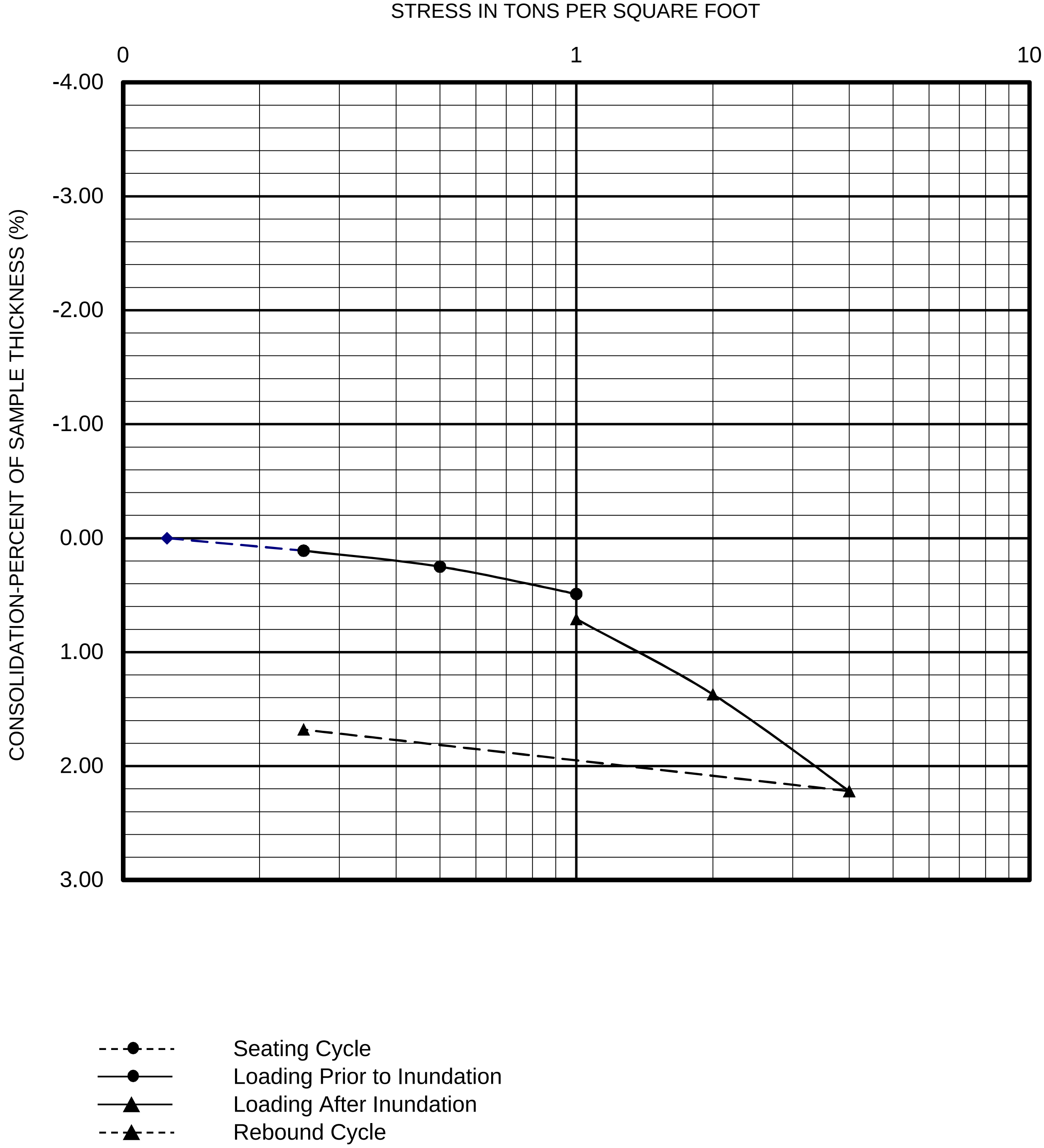
Expansion Index
Expansion Index testing was performed on one (1) soil sample. Testing was performed in general accordance with ASTM Test Method D 4829. The results of the testing is included herein.

In-Situ Moisture and Density
The natural water content was determined (ASTM D 2216) on samples of the materials recovered from the subsurface exploration. In addition, in-place dry density determination (ASTM D 2937) were performed on relatively undisturbed samples to measure the unity weight of the subsurface soils. Results of these tests are shown on the logs at the appropriate sample depths in Appendix A.

Moisture-Density Relationship
Laboratory testing was performed on a sample collected during the subsurface exploration. The laboratory maximum dry density and optimum moisture content for the soil type was determined in general accordance with test method ASTM Test Procedure D 1557. The results are included herein.

R-Value
Resistance value testing in general accordance with Caltrans Test Method 301 was performed by others on a soil samples collected from the site. The test result is provided herein.

Sulfate Content, Resistivity and Chloride Content
Testing to determine the water-soluble sulfate content was performed by others in general accordance with California Test No. 417. Resistivity testing was completed by others in general accordance with California Test No. 643. Testing to determine the chloride content was performed by others in general accordance with California Test No. 422. The results of the testing are included herein.



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

GEOTEK

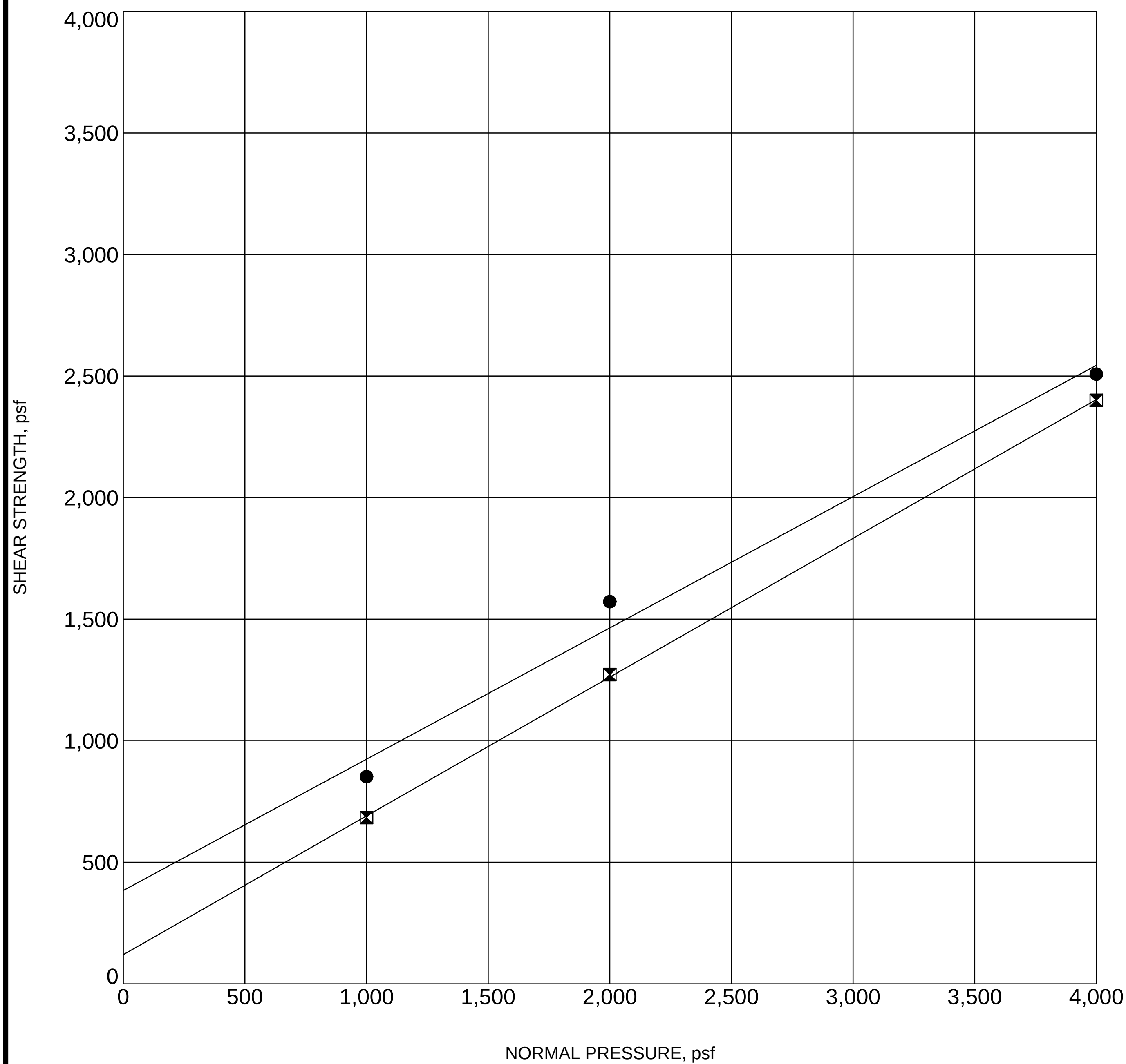
CONSOLIDATION REPORT

Sample: B-2 @ 3'

2192 West Highland Avenue
San Bernardino, California

Plate C-1

CHECKED BY: EHL	Lab: DI
PROJECT NO.: 1262-CR	Date: 12/14



	Specimen Identification		Classification	γ_d	MC%	c	ϕ
●	**B-1; 1262-CR3**	**0.1**	**0-5 ft, Remolded, Peak Stress**			**384**	**28**
⧗	**B-1; 1262-CR3**	**0.2**	**0-5 ft, Remolded, Ultimate Stress**			**120**	**30**

TGR GEOTECHNICAL, INC.
3037 S. Harbor Blvd.
Santa Ana, CA
Telephone:
Fax:

DIRECT SHEAR TEST

Project Number: 10-2700

Project Name: GeoTek (1262-CR3)

GEOTEK

EXPANSION INDEX TEST

(ASTM D4829)

Client:	SD Engineering and Associates	***Tested/ Checked By:***	DI Lab No Corona
Project Number:	1262-CR	***Date Tested:***	12/16/2014
Project Location:	2192 West Highland Avenue, San Bernardino	***Sample Source:***	B-1 @ 0-5'
		Sample Description:	Gray Brown Gravelly Silty m-c Sand

Ring #:______ Ring Dia. : 4.01" Ring Ht.1"

Loading weight: 5516. grams

DENSITY DETERMINATION

A	Weight of compacted sample & ring (gm)	791.9
B	Weight of ring (gm)	368.8
C	Net weight of sample (gm)	423.1
D	Wet Density, lb / ft3 (C*0.3016)	127.6
E	Dry Density, lb / ft3 (D/1.F)	**118.7**

SATURATION DETERMINATION

F	Moisture Content, %	7.5
G	Specific Gravity, assumed	2.70
H	Unit Wt. of Water @ 20°C, (pcf)	62.3
I	% Saturation	**48.5**

READINGS

DATE	TIME	READING	
12/16/2014	10:00	0.3220	Initial
12/16/2014	10:10	0.3220	10 min/Dry
12/16/2014	12:52	0.3220	
12/17/2014	4:50	0.3220	Final

FINAL MOISTURE

Weight of wet sample & tare	Weight of dry sample & tare	Tare	% Moisture
812.8			**12.4%**

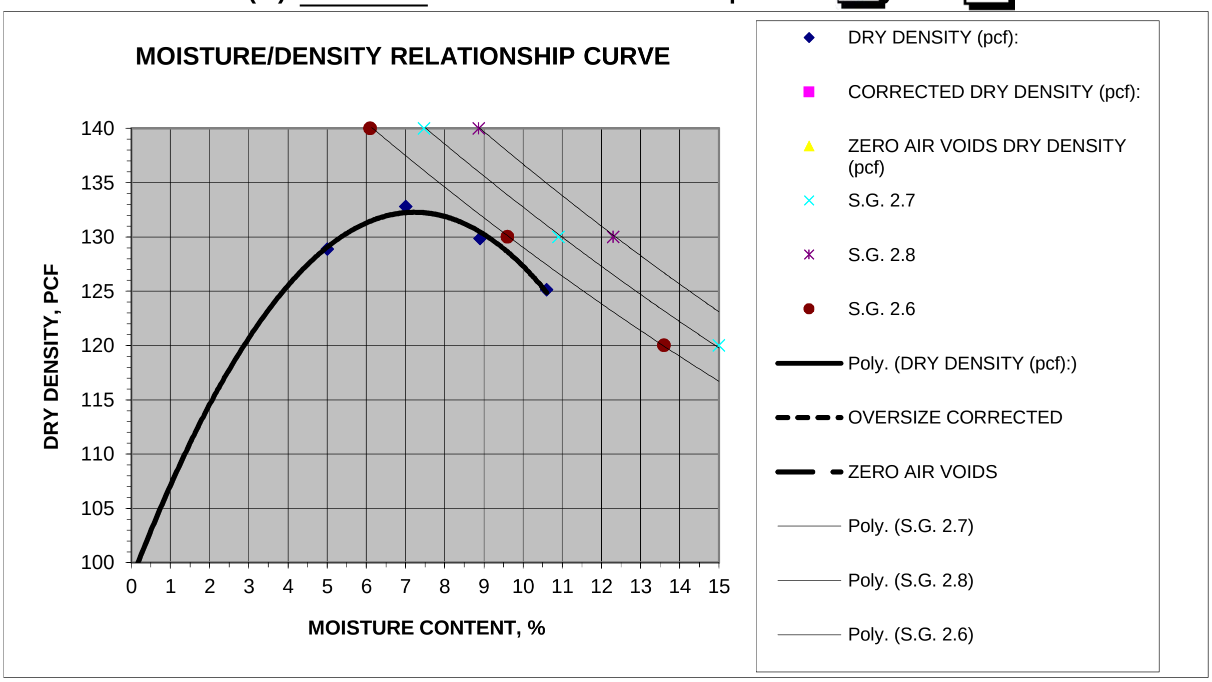
EXPANSION INDEX = 0

GEOTEK

MOISTURE/DENSITY RELATIONSHIP

Client: SD Engineering and Associates
Job No.: 1262-CR
Project: 2192 West Highland Avenue
Lab No.: Corona
Location: San Bernardino
Material Type: Gray Brown Gravelly silty m-c Sand
Material Supplier:
Material Source:
Sample Location: B-1
0-5'
Sampled By: AMS
Date Sampled: 9-Dec-14
Received By: DI
Date Received: 9-Dec-14
Tested By: DI
Date Tested: 15-Dec-14
Reviewed By: AMS
Date Reviewed: 19-Dec-14

Test Procedure: ASTM 1557
Method: C
Oversized Material (%): 13.0
Correction Required: X yes no



MOISTURE DENSITY RELATIONSHIP VALUES

Maximum Dry Density, pcf	133.0	@ **Optimum Moisture, %**	7.0
Corrected Maximum Dry Density, pcf		@ **Optimum Moisture, %**	

MATERIAL DESCRIPTION

Grain Size Distribution:

	% Gravel (retained on No. 4)
	% Sand (Passing No. 4, Retained on No. 200)
	% Silt and Clay (Passing No. 200)

Atterberg Limits:

	Liquid Limit, %
	Plastic Limit, %
	Plasticity Index, %

Classification:

Unified Soils Classification: ______

AASHTO Soils Classification: ______

● ANALYSIS
● DESIGN

LaBelle • Marvin

PROFESSIONAL PAVEMENT ENGINEERING

A CALIFORNIA CORPORATION

● SOILS, ASPHALT TECHNOLOGY

December 16, 2014

Ms. Anna Scott
GeoTek Inc.
710 East Parkridge Avenue, Suite 105
Corona, California 92879

Project No. 39866

Dear Ms. Scott:
Testing of the bulk soil sample delivered to our laboratory on 12/15/2014 has been completed.

Reference:	***W.O. #1262-CR3***
Project:	***San Bernardino, SD Engineering & Associates***
Sample:	***B-4 @ 0'-5'***

R-Value data sheets are attached for your use and file. Any untested portion of the sample will be retained for a period of 60 days prior to disposal. The opportunity to be of service is sincerely appreciated and should you have any questions, kindly call.

Respectfully Submitted,

REGISTERED PROFESSIONAL ENGINEER STEVEN R. MARVIN NO. 30659 CIVIL STATE OF CALIFORNIA

Steven R. Marvin
RCE 30659

SRM:tw

2700 S. GRAND AVENUE • SANTA ANA, CA 92705-5404 • (714) 546-3468 • FAX (714) 546-5841
INFO@LABELLEMARVIN.COM

R - VALUE DATA SHEET

W.O. 1262-CR3
SD Engineering

PROJECT NUMBER 39866 BORING NUMBER: B-4 @ 0'-5'

SAMPLE DESCRIPTION: Brown Sand

Item	SPECIMEN		
	a	b	c
Mold Number	1	2	3
Water added, grams	72	52	58
Initial Test Water, %	10.5	8.8	9.3
Compact Gage Pressure,psi	90	190	145
Exudation Pressure, psi	129	785	617
Height Sample, Inches	2.58	2.58	2.61
Gross Weight Mold, grams	3089	3083	3104
Tare Weight Mold, grams	1965	1969	1977
Sample Wet Weight, grams	1124	1114	1127
Expansion, Inches x 10exp-4	0	0	0
Stability 2,000 lbs (160psi)	16 / 29	12 / 22	13 / 23
Turns Displacement	5.32	5.22	5.27
R-Value Uncorrected	68	75	74
R-Value Corrected	70	76	76
Dry Density, pcf	119.4	120.3	119.7
	DESIGN CALCULATION DATA		
Traffic Index Assumed:	4.0	4.0	4.0
G.E. by Stability	0.31	0.25	0.25
G. E. by Expansion	0.00	0.00	0.00

Equilibrium R-Value	73 by EXUDATION	Examined & Checked: 12 /16/ 14

REMARKS:

Gf = 1.25
5.5% Retained on the 3/4" Sieve.
Partial Free Drainage.

REGISTERED PROFESSIONAL ENGINEER STEVEN R. MARVIN C 30659 CIVIL STATE OF CALIFORNIA

Steven R. Marvin, RCE 30659

The data above is based upon processing and testing samples as received from the field. Test procedures in accordance with latest revisions to Department of Transportation, State of California, Materials & Research Test Method No. 301.

LaBelle • Marvin

R-VALUE GRAPHICAL PRESENTATION

PROJECT NO. 398606
WO# 1262-CR3

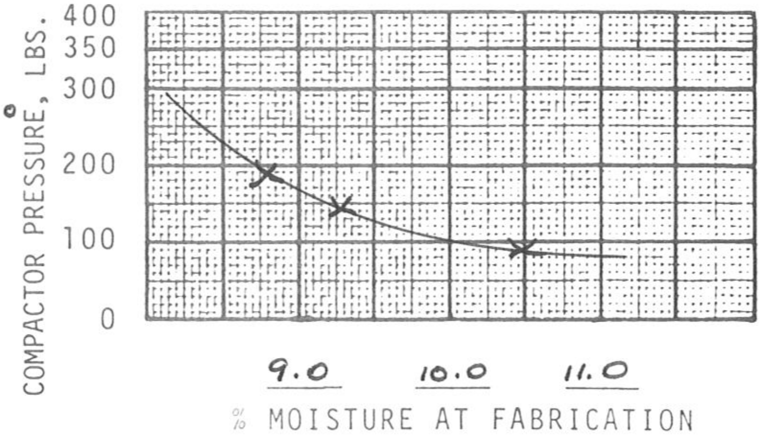
BORING NO. B-A @0'-5'
SD Engineering & Assoc., San Bernardino

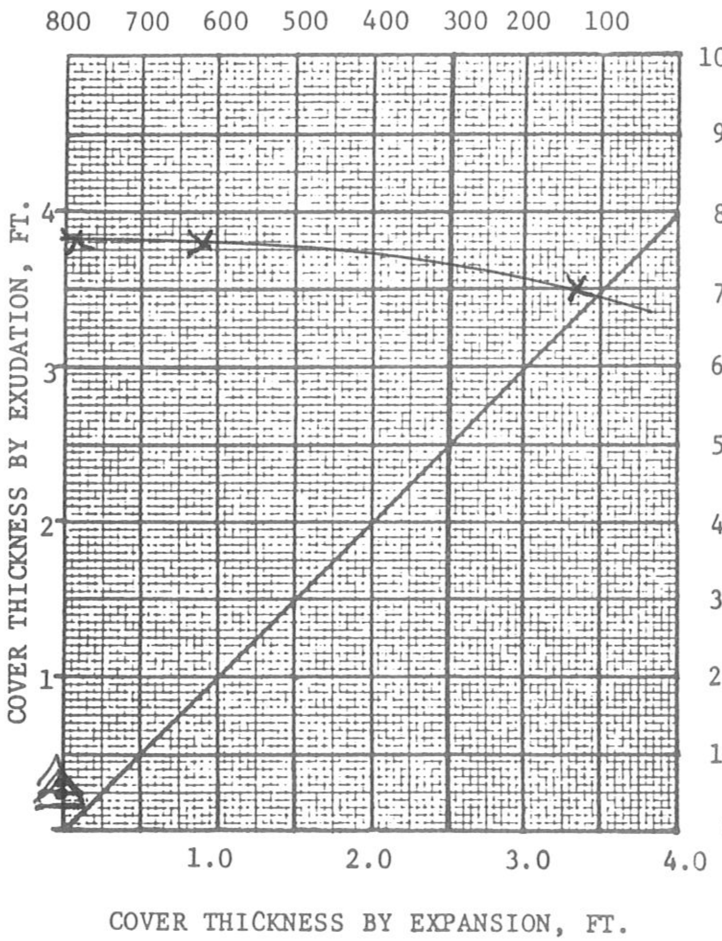
DATE 12/16/14

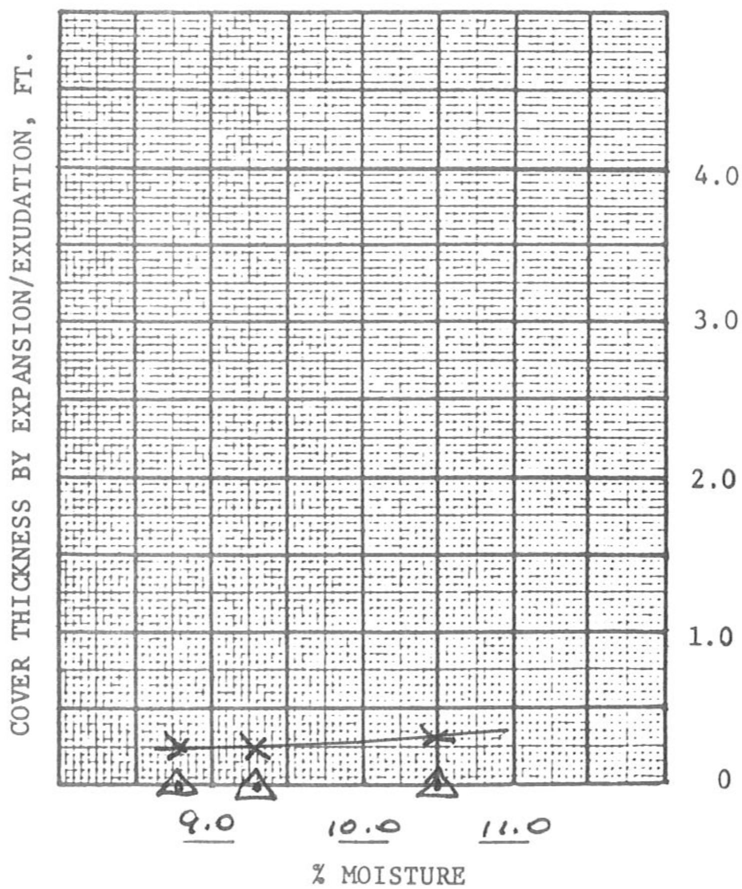
TRAFFIC INDEX Assume 4.0

R-VALUE BY EXUDATION 73

R-VALUE BY EXPANSION —







R-VALUE vs. EXUD. PRES.

T by EXUDATION

EXUD. T vs. EXPAN. T

T by EXPANSION

REMARKS

GF=1.25

LaBelle • Marvin
PROFESSIONAL PAVEMENT ENGINEERING

GeoTek, Inc.
710 East Parkridge Avenue, Suite 105
Corona, California 92879

Client: SD Engineering & Associate
W.O.: 1262-CR3
Project: San Bernardino

Date: December 19, 2014
QCI Project No.: 14-167-012i
Summarized by: KA

Corrosivity Test Results

Sample ID	Sample Depth (Feet)	pH CT-532 (643)	Chloride CT-422 (ppm)	Sulfate CT-417 (% By Weight)	Resistivity CT-532 (643) (ohm-cm)
B-1	0-5’	7.93	170	0.0035	10400

APPENDIX C

GENERAL GRADING GUIDELINES

2192 West Highland Avenue
City of San Bernardino, San Bernardino County, California
Project No. 1262-CR3

GENERAL GRADING GUIDELINES

Guidelines presented herein are intended to address general construction procedures for earthwork construction. Specific situations and conditions often arise which cannot reasonably be discussed in general guidelines, when anticipated these are discussed in the text of the report. Often unanticipated conditions are encountered which may necessitate modification or changes to these guidelines. It is our hope that these will assist the contractor to more efficiently complete the project by providing a reasonable understanding of the procedures that would be expected during earthwork and the testing and observation used to evaluate those procedures.

General

Grading should be performed to at least the minimum requirements of governing agencies, Chapters 18 and 33 of the Uniform Building Code, CBC (2013) and the guidelines presented below.

Preconstruction Meeting

A preconstruction meeting should be held prior to site earthwork. Any questions the contractor has regarding our recommendations, general site conditions, apparent discrepancies between reported and actual conditions and/or differences in procedures the contractor intends to use should be brought up at that meeting. The contractor (including the main onsite representative) should review our report and these guidelines in advance of the meeting. Any comments the contractor may have regarding these guidelines should be brought up at that meeting.

Grading Observation and Testing

1. Observation of the fill placement should be provided by our representative during grading. Verbal communication during the course of each day will be used to inform the contractor of test results. The contractor should receive a copy of the "Daily Field Report" indicating results of field density tests that day. If our representative does not provide the contractor with these reports, our office should be notified.
2. Testing and observation procedures are, by their nature, specific to the work or area observed and location of the tests taken, variability may occur in other locations. The contractor is responsible for the uniformity of the grading operations; our observations and test results are intended to evaluate the contractor’s overall level of efforts during grading. The contractor’s personnel are the only individuals participating in all aspect of site work. Compaction testing and observation should not be considered as relieving the contractor’s responsibility to properly compact the fill.
3. Cleanouts, processed ground to receive fill, key excavations, and subdrains should be observed by our representative prior to placing any fill. It will be the contractor's responsibility to notify our representative or office when such areas are ready for observation.
4. Density tests may be made on the surface material to receive fill, as considered warranted by this firm.

5. In general, density tests would be made at maximum intervals of two feet of fill height or every 1,000 cubic yards of fill placed. Criteria will vary depending on soil conditions and size of the fill. More frequent testing may be performed. In any case, an adequate number of field density tests should be made to evaluate the required compaction and moisture content is generally being obtained.
6. Laboratory testing to support field test procedures will be performed, as considered warranted, based on conditions encountered (e.g. change of material sources, types, etc.) Every effort will be made to process samples in the laboratory as quickly as possible and in progress construction projects are our first priority. However, laboratory workloads may cause in delays and some soils may require a **minimum of 48 to 72 hours to complete test procedures**. Whenever possible, our representative(s) should be informed in advance of operational changes that might result in different source areas for materials.
7. Procedures for testing of fill slopes are as follows:
   a) Density tests should be taken periodically during grading on the flat surface of the fill, three to five feet horizontally from the face of the slope.
   b) If a method other than over building and cutting back to the compacted core is to be employed, slope compaction testing during construction should include testing the outer six inches to three feet in the slope face to determine if the required compaction is being achieved.
8. Finish grade testing of slopes and pad surfaces should be performed after construction is complete.

Site Clearing

1. All vegetation, and other deleterious materials, should be removed from the site. If material is not immediately removed from the site it should be stockpiled in a designated area(s) well outside of all current work areas and delineated with flagging or other means. Site clearing should be performed in advance of any grading in a specific area.
2. Efforts should be made by the contractor to remove all organic or other deleterious material from the fill, as even the most diligent efforts may result in the incorporation of some materials. This is especially important when grading is occurring near the natural grade. All equipment operators should be aware of these efforts. Laborers may be required as root pickers.
3. Nonorganic debris or concrete may be placed in deeper fill areas provided the procedures used are observed and found acceptable by our representative.

Treatment of Existing Ground

1. Following site clearing, all surficial deposits of alluvium and colluvium as well as weathered or creep effected bedrock, should be removed unless otherwise specifically indicated in the text of this report.

2. In some cases, removal may be recommended to a specified depth (e.g. flat sites where partial alluvial removals may be sufficient). The contractor should not exceed these depths unless directed otherwise by our representative.
3. Groundwater existing in alluvial areas may make excavation difficult. Deeper removals than indicated in the text of the report may be necessary due to saturation during winter months.
4. Subsequent to removals, the natural ground should be processed to a depth of six inches, moistened to near optimum moisture conditions and compacted to fill standards.
5. Exploratory back hoe or dozer trenches still remaining after site removal should be excavated and filled with compacted fill if they can be located.

Fill Placement

1. Unless otherwise indicated, all site soil and bedrock may be reused for compacted fill; however, some special processing or handling may be required (see text of report).
2. Material used in the compacting process should be evenly spread, moisture conditioned, processed, and compacted in thin lifts six (6) to eight (8) inches in compacted thickness to obtain a uniformly dense layer. The fill should be placed and compacted on a nearly horizontal plane, unless otherwise found acceptable by our representative.
3. If the moisture content or relative density varies from that recommended by this firm, the contractor should rework the fill until it is in accordance with the following:
    a) Moisture content of the fill should be at or above optimum moisture. Moisture should be evenly distributed without wet and dry pockets. Pre-watering of cut or removal areas should be considered in addition to watering during fill placement, particularly in clay or dry surficial soils. The ability of the contractor to obtain the proper moisture content will control production rates.
    b) Each six-inch layer should be compacted to at least 90 percent of the maximum dry density in compliance with the testing method specified by the controlling governmental agency. In most cases, the testing method is ASTM Test Designation D 1557.
4. Rock fragments less than eight inches in diameter may be utilized in the fill, provided:
    a) They are not placed in concentrated pockets;
    b) There is a sufficient percentage of fine-grained material to surround the rocks;
    c) The distribution of the rocks is observed by, and acceptable to, our representative.
5. Rocks exceeding eight (8) inches in diameter should be taken off site, broken into smaller fragments, or placed in accordance with recommendations of this firm in areas designated suitable for rock disposal. On projects where significant large quantities of oversized materials are anticipated, alternate guidelines for placement may be included. If significant oversize materials are encountered during construction, these guidelines should be requested.
6. In clay soil, dry or large chunks or blocks are common. If in excess of eight (8) inches minimum dimension, then they are considered as oversized. Sheepsfoot compactors or other suitable

methods should be used to break up blocks. When dry, they should be moisture conditioned to provide a uniform condition with the surrounding fill.

Slope Construction

1. The contractor should obtain a minimum relative compaction of 90 percent out to the finished slope face of fill slopes. This may be achieved by either overbuilding the slope and cutting back to the compacted core, or by direct compaction of the slope face with suitable equipment.
2. Slopes trimmed to the compacted core should be overbuilt by at least three (3) feet with compaction efforts out to the edge of the false slope. Failure to properly compact the outer edge results in trimming not exposing the compacted core and additional compaction after trimming may be necessary.
3. If fill slopes are built "at grade" using direct compaction methods, then the slope construction should be performed so that a constant gradient is maintained throughout construction. Soil should not be "spilled" over the slope face nor should slopes be "pushed out" to obtain grades. Compaction equipment should compact each lift along the immediate top of slope. Slopes should be back rolled or otherwise compacted at approximately every 4 feet vertically as the slope is built.
4. Corners and bends in slopes should have special attention during construction as these are the most difficult areas to obtain proper compaction.
5. Cut slopes should be cut to the finished surface. Excessive undercutting and smoothing of the face with fill may necessitate stabilization.

UTILITY TRENCH CONSTRUCTION AND BACKFILL

Utility trench excavation and backfill is the contractors responsibility. The geotechnical consultant typically provides periodic observation and testing of these operations. While efforts are made to make sufficient observations and tests to verify that the contractors' methods and procedures are adequate to achieve proper compaction, it is typically impractical to observe all backfill procedures. As such, it is critical that the contractor use consistent backfill procedures.

Compaction methods vary for trench compaction and experience indicates many methods can be successful. However, procedures that "worked" on previous projects may or may not prove effective on a given site. The contractor(s) should outline the procedures proposed, so that we may discuss them **prior** to construction. We will offer comments based on our knowledge of site conditions and experience.

1. Utility trench backfill in slopes, structural areas, in streets and beneath flat work or hardscape should be brought to at least optimum moisture and compacted to at least 90 percent of the laboratory standard. Soil should be moisture conditioned prior to placing in the trench.

2. Flooding and jetting are not typically recommended or acceptable for native soils. Flooding or jetting may be used with select sand having a Sand Equivalent (SE) of 30 or higher. This is typically limited to the following uses:
   a) shallow (12 + inches) under slab interior trenches and,
   b) as bedding in pipe zone.

   The water should be allowed to dissipate prior to pouring slabs or completing trench compaction.
3. Care should be taken not to place soils at high moisture content within the upper three feet of the trench backfill in street areas, as overly wet soils may impact subgrade preparation. Moisture may be reduced to 2% below optimum moisture in areas to be paved within the upper three feet below sub grade.
4. Sand backfill should not be allowed in exterior trenches adjacent to and within an area extending below a 1:1 projection from the outside bottom edge of a footing, unless it is similar to the surrounding soil.
5. Trench compaction testing is generally at the discretion of the geotechnical consultant. Testing frequency will be based on trench depth and the contractors procedures. A probing rod would be used to assess the consistency of compaction between tested areas and untested areas. If zones are found that are considered less compact than other areas, this would be brought to the contractors attention.

JOB SAFETY

General

Personnel safety is a primary concern on all job sites. The following summaries are safety considerations for use by all our employees on multi-employer construction sites. On ground personnel are at highest risk of injury and possible fatality on grading construction projects. The company recognizes that construction activities will vary on each site and that job site safety is the contractor's responsibility. However, it is, imperative that all personnel be safety conscious to avoid accidents and potential injury.

In an effort to minimize risks associated with geotechnical testing and observation, the following precautions are to be implemented for the safety of our field personnel on grading and construction projects.

1. Safety Meetings: Our field personnel are directed to attend the contractor's regularly scheduled safety meetings.
2. Safety Vests: Safety vests are provided for and are to be worn by our personnel while on the job site.
3. Safety Flags: Safety flags are provided to our field technicians; one is to be affixed to the vehicle when on site, the other is to be placed atop the spoil pile on all test pits.

In the event that the contractor's representative observes any of our personnel not following the above, we request that it be brought to the attention of our office.

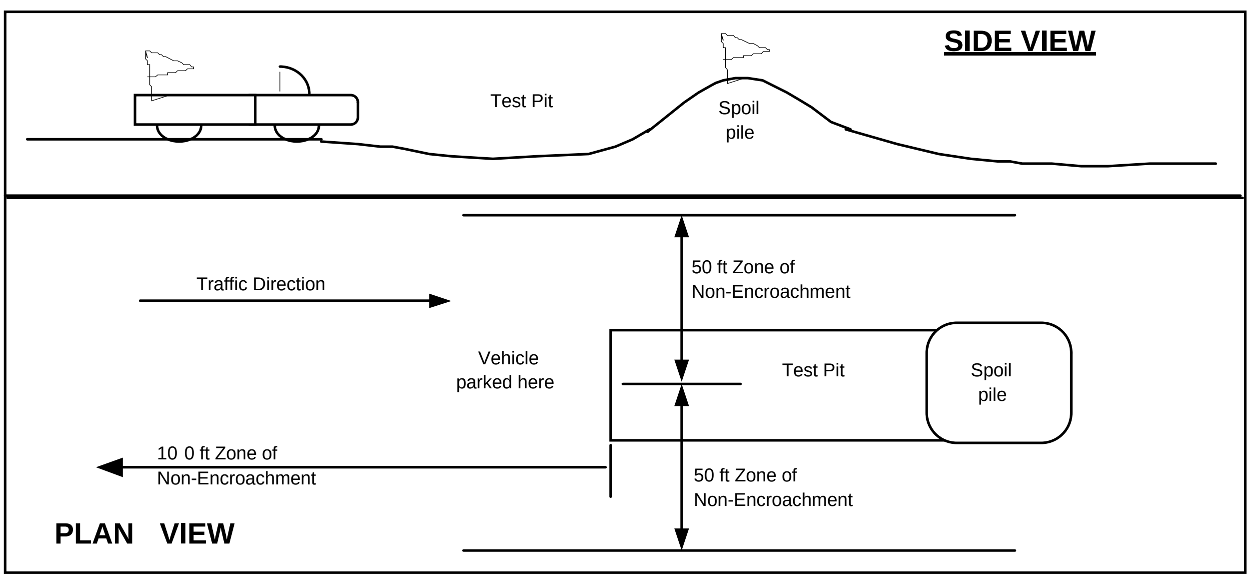
Test Pits Location, Orientation and Clearance

The technician is responsible for selecting test pit locations. The primary concern is the technician's safety. However, it is necessary to take sufficient tests at various locations to obtain a representative sampling of the fill. As such, efforts will be made to coordinate locations with the grading contractors authorized representatives (e.g. dump man, operator, supervisor, grade checker, etc.), and to select locations following or behind the established traffic pattern, preferably outside of current traffic. The contractors authorized representative should direct excavation of the pit and safety during the test period. Again, safety is the paramount concern.

Test pits should be excavated so that the spoil pile is placed away from oncoming traffic. The technician's vehicle is to be placed next to the test pit, opposite the spoil pile. This necessitates that the fill be maintained in a drivable condition. Alternatively, the contractor may opt to park a piece of equipment in front of test pits, particularly in small fill areas or those with limited access.

A zone of non-encroachment should be established for all test pits (see diagram below). No grading equipment should enter this zone during the test procedure. The zone should extend outward to the sides approximately 50 feet from the center of the test pit and 100 feet in the direction of traffic flow. This zone is established both for safety and to avoid excessive ground vibration, which typically decreases test results.

TEST PIT SAFETY PLAN



Slope Tests

When taking slope tests, the technician should park their vehicle directly above or below the test location on the slope. The contractor's representative should effectively keep all equipment at a safe operation distance (e.g. 50 feet) away from the slope during testing.

The technician is directed to withdraw from the active portion of the fill as soon as possible following testing. The technician's vehicle should be parked at the perimeter of the fill in a highly visible location.

Trench Safety

It is the contractor's responsibility to provide safe access into trenches where compaction testing is needed. Trenches for all utilities should be excavated in accordance with CAL-OSHA and any other applicable safety standards. Safe conditions will be required to enable compaction testing of the trench backfill.

All utility trench excavations in excess of 5 feet deep, which a person enters, are to be shored or laid back. Trench access should be provided in accordance with OSHA standards. Our personnel are directed not to enter any trench by being lowered or "riding down" on the equipment.

Our personnel are directed not to enter any excavation which;

1. is 5 feet or deeper unless shored or laid back,
2. exit points or ladders are not provided,
3. displays any evidence of instability, has any loose rock or other debris which could fall into the trench, or
4. displays any other evidence of any unsafe conditions regardless of depth.

If the contractor fails to provide safe access to trenches for compaction testing, our company policy requires that the soil technician withdraws and notifies their supervisor. The contractors representative will then be contacted in an effort to effect a solution. All backfill not tested due to safety concerns or other reasons is subject to reprocessing and/or removal.

Procedures

In the event that the technician's safety is jeopardized or compromised as a result of the contractor's failure to comply with any of the above, the technician is directed to inform both the developer's and contractor's representatives. If the condition is not rectified, the technician is required, by company policy, to immediately withdraw and notify their supervisor. The contractor's representative will then be contacted in an effort to effect a solution. No further testing will be performed until the situation is rectified. Any fill placed in the interim can be considered unacceptable and subject to reprocessing, recompaction or removal.

In the event that the soil technician does not comply with the above or other established safety guidelines, we request that the contractor bring this to technicians attention and notify our project manager or office. Effective communication and coordination between the contractors' representative and the field technician(s) is strongly encouraged in order to implement the above safety program and safety in general.

The safety procedures outlined above should be discussed at the contractor's safety meetings. This will serve to inform and remind equipment operators of these safety procedures particularly the zone of non-encroachment.

The safety procedures outlined above should be discussed at the contractor's safety meetings. This will serve to inform and remind equipment operators of these safety procedures particularly the zone of non-encroachment.