Appendix E
Geotechnical Report

ESA

NMG
Geotechnical, Inc.

August 14, 2019

Project No. 18181-01

To: Mark Thomas
16795 Von Karmen Avenue, Suite 240
Irvine, California 92606

Attention: Mr. Arturo Vivar

Subject: Geotechnical Design Report for Proposed Firestone Boulevard Widening, Hoxie Avenue to Imperial Highway, Approximate Station 10+00 to 57+00, City of Norwalk, California

In accordance with your reqe st, NMG Geotechnical, Inc. (NMG) has prepared this report to provide our geotechnical findings of the site-specific geotechnical study for the proposed Firestone Boulevard widening project. The subject widening extends approximately 4,800 feet, from Hoxie Avenue to Imperial Highway, in the city of Norwalk. The proposed improvements include demolition of the existing street pavements and reconstruction of new structural street pavements and medians, street and bridge widening, streetscape, and parkway modifications based on the project Geometric Approval Drawing (GAD). New bike lanes and landscape improvements are included. Significant utility improvements and/or relocations are anticipated. The majority of the proposed street improvements will necessitate approximately 2 feet of widening on both sides of the street and reducing the center medians. The section of the street along the existing fill embankment will be widened on the north side by approximately 17 feet. This will require widening the existing bridge crossing over the Union Pacific Railroad (UPR) tracks and construction of new retaining walls.

Our scope of services for this study included review of background material (prior reports and plans), site reconnaissance to observe existing conditions and mark boring locations, drilling of hollow-stem auger boings and Cone Penetration Tests (CPTs) to evaluate the existing subsurface conditions, laboratory testing, geotechnical engineering analysis and preparation of this report. This report provides recommendations for new structural pavement sections and preliminary geotechnical recommendations to assist in the type selection and foundation design for the bridge and retaining walls. Final geotechnical recommendations for the structures will be provided once the location, geometry and design loading for the new structures is established.

References pertinent to the project are included in Appendix A. The boring logs and laboratory test results from our exploration are included in Appendices B and C of this report, respectively. The seismicity data is provided in Appendix D and slope stability analysis is presented in

Appendix E. Alternative reinforced pavement recommendations are presented in Appendix F. NMG's general earthwork and grading specifications are presented in Appendix G. The Geotechnical Map (50-scale) presents the subject site and locations of the recent and prior borings (Plate 1). A geologic cross-section at the bridge widening location is presented on Plate 2. The Log of Test Boring (LOTB) sheets for the bridge expansion are also attached. The LOTBs include the as-built bridge design sheet from 1954 and two new LOTB sheets for the bridge widening (east and west side of the UPR).

If you have any q estions regarding this report, please contact our office. We appreciate the opportunity to provide our services.

Respectfully submitted,

NMG GEOTECHNICAL, INC.

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AZ/KGM/grd

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1.0 INTRODUCTION

NMG Geotechnical, Inc. (NMG) has conducted a geotechnical investigation that included background review, subsurface exploration, laboratory testing and analyses for the proposed Firestone Boulevard widening project. The basis of our investigation and scope of work included communications with the project team and review of preliminary design information. The GAD depicts the proposed street improvements, bridge widening and new retaining walls. The type of structures, foundations, and magnitude of the structural loads are not known at this time.

The purpose of this investigation was to evaluate the existing subsurface conditions and provide geotechnical recommendations for design and construction. The geotechnical information provided is intended to help evaluate pavement alternatives, select the type of structures, design foundations, design other improvements and associated earthwork/grading. The geotechnical recommendations and parameters are preliminary and will be further evaluated as the structural and project plans are developed.

1.1 Scope of Work

Our scope of work for this investigation included the following tasks:

- Review of background geotechnical information pertaining to the subject street, including site geology, historic groundwater data, seismic hazard maps and prior reports (Appendix A).
- Site reconnaissance to identify the existing site conditions and marking of boring locations.
- Notification of and coordination with Underground Service Alert and the city of Norwalk to identify and locate any underground utilities.
- Application for and acquisition of an encroachment permit from the city of Norwalk. In accordance with the permit requirements, traffic control was provided during subsurface exploration operations performed within the existing roadway.
- Drilling, logging, and sampling of hollow-stem auger borings (H-1 through H-16) to depths ranging from 2.5 to 66.5 feet below existing ground surface (bgs). Relatively undisturbed soil samples were obtained from the borings at 2.5 to 5-foot intervals. Bulk samples were collected from selected borings during the exploration. Two Cone Penetration Tests (CPTs) were advanced to depths of 80 to 100 feet bgs. Boring and CPT logs are included in Appendix B.
- Laboratory testing to classify and evaluate onsite soils. A corrosion engineer was retained by NMG to provide recommendations related to soil corrosivity to metals and concrete. Laboratory test results and the corrosion engineers report are included in Appendix C.
- Geotechnical review of the GAD and preliminary design information provided by the project team. Interpretation of subsurface data and laboratory test results to establish engineering properties of the onsite soils. Engineering evaluation and analysis was performed for foundations and structures, settlement, slope stability, pavement and earthwork as they pertain to the proposed improvements.
- Preparation of this report, including our findings, conclusions, and preliminary recommendations related to the project.

1.2 Site Location

Firestone Boulevard is a major arterial roadway (formerly State Route 42) in the city of Norwalk, California (Figure 1). The subject project consists of an approximately 4,800 foot stretch of Firestone Boulevard, from Hoxie Avenue to Imperial Highway. The existing roadway varies from 4 to 5 lanes with some on-street parking and several turn pockets and center medians that contain plants, trees, and raised planters. Apartment communities, single-family homes, and commercial and retail businesses/strip malls are located adjacent to the parkways.

There are existing fill embankments for the bridge/railroad overcrossing up to 25 feet in height, generally sloped at 2H:1V or flatter, and approximately 700 to 800 feet in length. There are access roads parallel to the embankments and railroad area that are fenced off. The surface of the embankment slopes have grasses, low ground cover, small plants, and trees with some unplanted areas. The roadway includes an existing bridge crossing over the Union Pacific Railroad (UPR). The bridge is approximately 25 feet in height, 89 feet wide and spans 40 feet.

1.3 Project Description

Widening and reconstruction of Firestone Boulevard will involve the complete demolition of the existing street pavements and reconstruction of street pavements and medians. The proposed street improvements will accommodate six lanes of traffic, a center median, street parking, bike lanes and sidewalks. Widening of the bridge and adjacent embankment slopes along the north side of the UPR overcrossing will be required. Retaining walls will also be required to accommodate the additional roadway width. New lighting, planting and irrigation will also be constructed. Utility relocation and parkway modification is also anticipated.

Improvements will significantly enhance the corridor by increasing the overall number of lanes; synchronizing traffic signals; landscaped and hardscaped raised medians; and adding aesthetically pleasing features. The new travel lanes will vary from 10 to 17 feet in width. The center median/islands will vary from 2.5 to 7.5 feet in width. The designated street parking areas will be 7 feet wide. Dual left turn lanes are planned at Hoxie Avenue, Studebaker Road and Imperial Highway. A Class III bike lane will be added between Hoxie and Studebaker. The other areas will have Class II bike lanes. The typical width of the bike lane is 4 to 6 feet. The street improvements also include a minimum 8-foot-wide sidewalk. Numerous driveways and pedestrian ramps at intersections will be reconstructed.

1.4 Field Exploration

Our subsurface exploration was performed on March 8 and 11 through 14, 2019, and included excavation of 16 hollow-stem auger borings (H-1 through H-16) and two CPTs (CPT-1 and CPT-2). The approximate boring locations are shown on the Geotechnical Map (Plate 1). The locations of the borings were selected to avoid existing utilities and cleared through Underground Service Alert (USA) prior to excavation. The total depth of the borings ranged from 2.5 to 66.5 feet bgs, were geotechnically logged, and samples were obtained at selected intervals. The borings were backfilled with cuttings, tamped, and the surface was repaired with black dyed concrete. Excess soil cuttings were drummed and removed from the site. The geotechnical boring logs are included in Appendix B.

Soil sampling was performed using a modified California ring sampler. Ring samples were obtained from the exploratory borings with a 2.5-inch, inside-diameter, split-barrel sampler. The sampler was driven with a 140-pound automatic trip hammer, free-falling 30 inches. The sampling was used to assess the soil beneath the site, as well as to obtain a measure of resistance of the soil to penetration (recorded as blows-per-foot on the geotechnical boring logs). Representative bulk samples of onsite soils were collected from the hollow-stem cuttings and used for additional soil identification purposes and laboratory testing. The existing pavement section was measured and recorded for the borings located in the street.

The CPT uses an integrated electronic cone system to measure and record tip resistance, sleeve friction, and friction ratio parameters at 5-cm depth intervals. The cone is a 1.25-inch-diameter pointed steel probe that is hydraulically pushed into the ground. The CPT provides a detailed subsurface soil stratigraphy profile and is used in conjunction with soil data collected from the borings and laboratory testing. The total depth of the CPTs ranged from 80 to 100 feet bgs and were backfilled with bentonite granules. A seismic cone was used on CPT-2 to collect shear-wave velocities at 10-foot intervals down to 80 feet in order to determine the site soil classification as it pertains to seismic design. The CPT data and shear wave velocity measurements are presented in Appendix B.

1.5 Laboratory Testing

Laboratory testing was performed on representative samples of onsite soils collected during our field exploration to characterize their engineering properties. Laboratory tests performed on selected relatively undisturbed and bulk soil samples included:

- Moisture content and dry density;
- Grain-size distribution;
- R-value;
- Atterberg limits;
- Direct shear;
- Consolidation;
- Maximum dry density and optimum moisture content;
- Expansion index; and
- Corrosivity, including corrosion engineering report.

Laboratory tests were conducted in general conformance with applicable ASTM International standards. Laboratory test results for this study are provided in Appendix C. In-situ moisture content and dry density data are included on the geotechnical boring logs (Appendix B).

2.0 GEOTECHNICAL FINDINGS

2.1 Existing Pavements and Subgrade

Firestone Boulevard was found to have variable pavement conditions, likely the result of various street and utility improvements since its original construction (in the 1930s). At this time, NMG has not received plans providing the design or as-built pavement information. The summary table below lists the Asphalt Cement (AC) and Aggregate Base (AB) layer thicknesses for the existing structural pavements based on measurements taken during our exploration for the eastbound, westbound and center median. Table 1 (rear of text) provides a more detailed summary of the existing structural pavement sections.

Firestone Boulevard	Existing AC	Existing AB
Eastbound Lanes (5 Borings)	2.5"- 8"	0" – 12"
Westbound Lanes (5 Borings)	3"	11" – 13"
Center Median (4 Borings)	2" – 6"	12" – 16"

The existing AC thickness varies from 2.5 to 8 inches along the eastbound travel lanes and center median. The existing asphalt thickness along the westbound lanes was consistently 3 inches. Based on our general field observations, the existing pavements have slight to moderate distress and are distributed intermittently along the subject roadway.

The base layer thickness along the center median and westbound lanes varied from 11 to 16 inches. The base layer thickness along the eastbound lanes was generally less and was more variable (ranging from 0 to 12 inches). Boring H-10 found no base below the asphalt. The existing base consisted of different layers and composition of untreated granular materials. The base materials included crushed gravel, fine to coarse sand and fragments of crushed asphalt and asphalt dust. The color of the base materials varied from gray to dark brown to black. The lighter base material was designated AB1 and the darker base was designated AB2, as noted in Table 1 and the boring logs. Given that the road construction began in the 1930s, the specific type and specification of the existing base material is uncertain. The existing base materials were not tested for durability, quality and gradation.

Between Hoxie Avenue and Elmcroft Avenue, the soils were found to be fine-grained (silty) subgrade material (Borings H-3, H-4 and H-5). From Elmcroft Avenue to Imperial Highway, the soils were found to be granular (sandy) subgrade materials. Laboratory test results and additional information pertaining to the characteristics and quality of the subgrade soils are discussed in Section 2.9.

2.2 Existing Bridge

The existing bridge was constructed in the early 1950s and is a cast-in-place concrete structure crossing over the Union Pacific Railroad (UPR). The bridge layout is on a skew with a single span, approximately 45 feet in length, 85 feet wide, and 25 feet in height. Each end of the bridge has portal and pylon structures. Presently, the bridge has five traffic lanes and a wide center median with planters, small trees and street lighting. The top of the embankment and bridge have a sidewalk and guardrails.

Based on the as-built plan, the bridge is supported on strip footings that were constructed to be at a design bottom elevation of 88 mean sea level (msl) (approximately 15 feet deep). The pylon structures are also supported on shallow strip footings. The backfill for the bridge and pylon structures have select sandy soils. Cross-Section A-A' presents the general bridge and foundation information (Plate 2). The original Log of Test Boring (LOTB) sheet for the bridge includes 4 prior borings up to 50 feet deep and is included for reference.

NMG was provided the Caltrans Bridge Inspection Records Information System (BIRIS) report that included inspection reports dating from 1955 to 2013. Based on our review, we noted the following regarding the condition of the structure and observed cracking, joint separations and water seepage:

- Seepage and efflorescence in the center construction joint of the deck soffit is first mentioned in 1981, with four longitudinal hairline cracks being mentioned in 2005 and onward. Minor erosion underneath the curb is mentioned in reports prior to 1981, and erosion under the roadway is mentioned in 1982, with additional fill being placed as a fix in both cases. The erosion is not mentioned again after 1982.
- Vertical hairline cracks in the abutment walls are first mentioned in 1983. The cracks are reported as being up to 1/16 inch in 1989, 2 mm in 1995, and up to 3 mm***** in 1999, and on all subseqe nt reports.
- The bridge "joins" were first mentioned to have opened up to ¼ inch in 1991 and to 6 mm in 1995. In 1998, the bridge joins are first referred to as bridge abutment joints. In 1999, the contact joints between the bridge and the approach pavement are reported to have opened to 12mm. In 2001, the bridge contact joints are reported to have opened up to 19 mm. In 2009, the bridge contact joints are reported to have opened up to 25 mm.
- A large AC crack with water seepage in the center median is mentioned in 1999. The crack is mentioned to be up to 50 mm in 2001, with additional random 1 mm cracks in the AC. In 2009, random AC cracks up to 13 mm are mentioned, but are not mentioned again as the bridge deck was repaved.
- In 2013, four longitudinal hairline cracks with minor efflorescence in the bridge soffit were noted. Additionally, vertical cracks up to 3 mm* wide were observed in the abutment walls.

********measurement "corrected" from reported 0.3 mm width in BIRIS believed to be a typographical error*

2.3 Existing Fill Embankment and Slope Stability

The existing fill embankments for the bridge are up to 25 feet in height and sloped at 2H:1V or flatter. The embankments were likely graded in the 1950s and consist of compacted fill over alluvium. It appears the embankment fill was placed directly over the existing pavement. The embankments are approximately 700 to 800 feet in length on both sides. On the southeast side of the embankment, there is a variable height retaining wall (varies from 2 to 6 feet) at the toe. The embankment fill consists of very dense sandy soils.

We received information from the City that a surficial slope failure and heavy erosion occurred in June 2018 along a northern portion of the embankment (westbound Firestone west of Orr and Day Road), near Station 41+00, which also impacted the street pavement. The approximate area is shown on Plate 1. The trench, slope, and pavement repair included cement slurry and backfill.

Slope stability analysis was performed to evaluate the static and pseudo static stability of the embankment and to evaluate the surficial stability. The slope stability is presented in Appendix E. Based on our analysis, the existing slope has a static factor-of-safety greater than 1.5 and pseudo static factor-of-safety greater than 1.1. The surficial stability was calculated to have a factor-of-safety less than 1.5, but could be higher with the existing vegetation and in-situ cohesion.

2.4 Existing Utilities

The subject roadway alignment has many existing utilities including but not limited to water, sewer, storm drain, gas, and other dry utilities. Some of the known utility locations are shown on Plate 1. In addition to those shown, NMG encountered two unknown/unmarked utilities during excavation of borings H-2 and H-12, consisting of steel and concrete pipelines.

2.5 Geologic Setting

The site is located in the central portion of the Downey Plain, and is mapped by Dibblee (2001) as underlain by thick sequences of Quaternary-aged alluvial floodplain deposits consisting of interlayered clay, silt, sand, and gravel.

The site is capped with minimal artificial fill (**Map Symbol: Af**) on the order of 0 to 5 feet and up to 30 feet along the bridge approach. The fill materials were found to generally consist of sandy silt, silty sands and clayey sand. The bridge approach/embankment fills were found to be generally damp to moist and very dense.

The alluvium (**Map Symbol: Qha**) along the project alignment generally consists of interlayered yellowish- to grayish-brown silty/clayey sands, pale brown to gray, fine to medium sand (clean), dark brown, grayish-brown and olive brown sandy and clayey silt, and minor gravelly sand and low to high plasticity clays. The alluvium was generally damp to wet and loose/medium stiff near-surface to very dense/very stiff at depth.

2.6 Groundwater

Groundwater was not encountered during excavation of our borings down to 66.5 feet bgs. Mapping by the State indicates that the groundwater levels have been historically recorded as shallow as 8 feet bgs (CDMG, 1998). However, groundwater monitoring data on the GeoTracker website indicates that current groundwater levels for sites along Firestone Boulevard have been recorded greater than 50 feet bgs.

Based on the collected subsurface data, the fine-grained (silty/clayey) soil layers in the alluvium, generally below 30 feet deep, are saturated. This is likely a result of water migrating though the upper sandy soils and perching on finer soils. Perched water may also exist locally at shallower depths or around utilities and structures with select granular backfill and/or near areas with landscaping.

2.7 Faulting and Seismicity

The site is not located within a fault-rupture hazard zone as defined by the Alqi st-Priolo Special Studies Zones Act (CGS, 2018). Also, there are no active faults mapped at the site by the State (Jennings, 2010) and there has been no evidence of active faulting during the prior geotechnical investigations near the site (Appendix A). Thus, the potential for primary ground rupture is considered slight to nil at the site.

The site will undergo future seismic shaking during earthqa ke events on regionally active faults. Based on the USGS program (2017), the closest active fault is the Puente Hills Blind Thrust Fault located 1.8 mi from the site and has a moment magnitude of 6.5.

The site is located within an area of potential liqe faction, as defined by the State's Seismic Hazard Mapping Act (Figure 2). Secondary seismic hazards, such as tsunami and seiche, are considered slight to nil, as the site is located away from the ocean or confined bodies of water and at elevations approximately well above mean sea level.

Based on the CPTs, the average shear wave velocity of the underlying soils to 80 feet bgs varies from 842 to 1283 feet per second (ft/sec). Based on the site shear wave velocities, the underlying soils may be classified as Site Class D per 2016 CBC and "Competent Soil" per Caltrans seismic design criteria.

2.8 Liquefaction Potential

The California Geologic Survey has developed seismic hazard maps as part of the Seismic Hazards Mapping Act of 1991. Figure 2 (Seismic Hazards Map) includes a portion of the CGS Seismic Hazard Maps for the Whittier Quadrangle as the base and shows that the subject site is located within a zone of potential liqe faction (CDMG, 1999). However, based on our subsurface exploration and depth to groundwater, the potential for seismic liquefaction at the site is considered to be very low.

2.9 Geotechnical Properties and Engineering Parameters

A summary of the geotechnical properties, including soil parameters and corrosion are discussed below based on the field data and laboratory test results (Appendix C). The Geotechnical Map and cross-section depict the generalized subsurface conditions (Plates 1 and 2). The CPTs provide nearly continuous data that was used to develop a detailed assessment of the subsurface conditions and soil interlayering.

Soil Cla sifica in : Grain-size distribution tests were conducted on eight samples collected within the upper 25 feet. The fines content (passing No. 200 sieve) varied from 2 to 72 percent. The

Atterberg limits test was performed on two samples which had Liquid Limits (LL) in the range of 37 to 48 percent and Plasticity Indices (PI) in the range of 14 and 19. In general, the alluvium encountered consisted of alternating layers of sand/silty sand, silt and clay and sandy gravel (USCS Classification of GM, SP, SM, SC, ML, and CL).

Soil Density and Moisture Content: The soil moisture content varies from 4 to 32 percent. Borings H-1 through H-5 were generally fine-grained, thus had higher soil moisture contents. Based on the soil samples collected during drilling, the field dry density varied from 86 to 125 pounds per cubic foot (pcf). In general, fine-grained soil samples were found to be medium stiff and coarse-grained soils to be dense to very dense, with local loose zones. Four samples collected within the upper 5 feet had maximum densities ranging from 120.0 to 131.0 pcf at optimum moisture contents ranging from 7.5 of 12.5 percent.

Soil Shear Strength: Direct shear testing was conducted on five relatively undisturbed ring samples collected at a depth ranging from 5 to 32.5 feet in order to evaluate the soil strength parameters of the existing fill material and alluvium. The results of this testing indicate that the fill materials have ultimate internal friction angles of 28 and 34.5 degrees with cohesions of 60 to 110 pounds per square foot (psf). Peak values for friction angles were 37 and 39 degrees with cohesions of 220 to 310 psf. Alluvial materials have ultimate internal friction angles ranging from 27 to 30 degrees with cohesions ranging from 120 to 250 psf. Peak values for friction angles range from 27 to 30 degrees with cohesions of 320 to 520 psf.

Compressibility: Consolidation testing was conducted on four relatively undisturbed ring samples collected within the upper 40 feet. The samples tested consisted of fine-grained alluvium with dry densities less than 100 pcf. The results of this testing indicate that the alluvial materials have low to moderate compressibility. The alluvium in the upper 15 feet was found to be overconsolidated (preconsolidation pressures on the order of 4,000 psf or higher). The alluvium at 40 feet was normally to slightly overconsolidated (preconsolidation pressures on the order of 5,000 psf). The collapse potential (settlement upon the addition of water at a load of 3.2 ksf) was less than 0.5 percent.

Expansion Potential: Two soil samples collected within the upper 5 feet have "very low" to "low" expansion potential with expansion indices of 5 and 34.

R-Value: A total of four R-value tests were performed on subgrade soil samples collected within the upper 5 feet of the existing roadway. Three of the R-value tests were performed on granular soil and indicated results of 46 to 66. One R-value test was performed on fine-grained soil and indicated an R-value of 13.

Corrosivity: Soil corrosivity testing was performed by HDR, Inc. on five selected onsite soil samples collected by NMG from the upper 5 feet. The testing included electrical resistivity (saturated), pH, and chloride content. The following table summarizes the test results:

Soil Corrosion Test	***Test Results***
Saturated Resistivity (ohm-cm)	2,000 to 18,400
pH	7.8 to 8.4
Soluble Sulfate Content (ppm)	9.7 to 51
Chloride Content (ppm)	2.0 to 19

The electrical resistivity and chloride tests indicate that onsite soils are mildly to moderately corrosive to ferrous metals. Sulfate contents indicate that onsite soils are negligible/low corrosive to concrete. Soil pH values indicate mildly alkaline.

3.0 CONCLUSIONS AND PRELIMINARY RECOMMENDATIONS

Based on our geotechnical study, the proposed street widening and improvements are feasible provided the recommendations in this report are implemented during design and construction. The existing structural pavement was found to be variable and generally not adeqa te for the design traffic loading conditions. This report provides recommendations for new structural pavements and preliminary geotechnical recommendations to assist in the type selection and foundation design for the bridge and retaining walls. The primary geotechnical constraints at the site include low R-value subgrade soils (Hoxie Ave to Elmcroft Ave), potential settlement of the silty and clayey alluvium, and the potential for strong seismic shaking during the design earthqa ke. The project will also be constrained by existing improvements and the UPR that will need to be protected and/or relocated during construction. Project designers will need to take the soil conditions into account for the roadway, structures, earthwork and other associated street improvements. NMG will coordinate with the structural designer once the location, geometry and loading of the new structures are established to provide final geotechnical design recommendations.

Our recommendations are considered minimum and may be superseded by more stringent reqi rements of the city of Norwalk, the Standard Specifications for Public Work Construction (Greenbook), Caltrans, or other designers, and may need to be revised as more specific design information becomes available. Additional measures may also be reqi red during grading and construction if unanticipated geotechnical conditions are encountered.

3.1 General Earthwork and Grading

Grading and excavations should be performed in accordance with the project specifications and the city of Norwalk grading code. Caltrans standard specifications may be utilized/appropriate for the excavation and backfill of the bridge and retaining wall structures. Select sandy material is reqi red for the backfill of structures. In general, clearing and grubbing of the site includes removal of vegetation (grass, plants and trees) and miscellaneous trash/debris that are to be disposed of offsite. If encountered, unused foundations, pipelines, manholes, vaults, septic systems, or other buried/abandoned structures should also be removed and disposed of offsite. The majority of the proposed street widening and improvements will require shallow design cuts and replacement of the existing pavement section. Deeper cuts and/or temporary excavations will likely be required during construction of the bridge and retaining walls. Grading may be constrained by existing improvements and right-of way or other existing property boundaries.

Geotechnical field observation and testing, along with laboratory testing, should be performed during grading operations to assess the fill placement and fill compaction. Fill should be placed in nearly horizontal loose lifts no more than 8 inches in thickness, moisture-conditioned, and compacted to a minimum relative compaction of 90 percent. Fills are to be placed at or above optimum moisture content as determined in the field during grading operations. Compaction testing should be in accordance with ASTM Test Method D 1557 (or California Test Methods 216 and 231 if indicated in the project specifications).

The moisture of the onsite soils range from damp to wet and will vary with depth and location. Additional measures (e.g., mixing, drying or moisture-conditioning) may be required to achieve uniform and suitable moisture content for fill placement and compaction. The moisture content of near-surface soils in existing landscaped areas may be wet based on the amount of irrigation being performed.

Grading and excavations adjacent to the existing structures, improvements and pipelines should be performed with care so as not to undermine or destabilize the adjacent ground. Existing improvements and utilities to be protected in-place should be located and visually marked prior to grading operations. Operation of heavy equipment over existing utilities/pipelines should be in conformance with the appropriate city and utility-company guidelines (and may require plating, ramps, etc.). Placement of design fill and/or stockpiling of soils over existing pipelines should not be allowed without prior approval of the utility company.

NMG's general earthwork and grading specifications are presented in Appendix G.

3.2 Remedial Grading

The design cuts are anticipated to be on the order 1 to 2 feet below existing grade. At minimum, we recommend an additional 6 to 12 inches of processing and recompaction below design subgrade elevation to provide uniform compacted fill below the new structural pavement. We expect that near-vertical excavation down to competent material can be performed for new pavements. The limits of remedial grading should be extended to include the proposed sidewalk, ramps and other street improvements.

Locally, deeper removals may be required in locations that encounter existing soils that are soft, loose, poorly compacted or otherwise unsuitable. Soils disturbed during demolition operations will also need to be removed and/or recompacted.

The remedial removal bottoms and subgrade should expose competent existing fill or native alluvial materials and be approved by the geotechnical consultant prior to placement of compacted fill. If the recommended removals cannot be performed, additional measures may be required to stabilize the existing soils in-place or reinforce the structural pavement section.

Excavations for the bridge, retaining wall and the fill embankment should conform to Caltrans standard plan requirements. Deeper removals and overexcavation may also be required for shallow footings to help limit settlement.

3.3 Slope Stability and Temporary Excavations

Exposed sandy soils with low cohesion will be prone to shallow/surficial slope failures and/or erosion. Based on our slope stability analysis, a 25-foot-high temporary 1:1 slope excavation will have a factor of safety of 1.1 to 1.3 depending on the amount of soil cohesion. The deeper temporary excavation/slopes that expose sandy soils may need to be excavated at a 1.5H:1V or flatter.

The actual stability of the temporary excavations/slopes (backcuts) will depend on many factors, including soil types, the amount of unloading done prior to the excavation, the amount of time the excavation remains exposed, and the weather conditions. In general, we do not anticipate the temporary slopes will encounter groundwater; however, some soil wetting could occur during the construction period (i.e., winter storms or broken water lines).

Measures to mitigate the potential for failure of the temporary slope excavations include the following:

- The temporary slopes should be carefully excavated to reduce oversteepened areas.
- Slopes higher than 20 feet or steeper excavations may need to be provided with temporary shoring. If needed, an appropriate shoring system should be designed by a structural engineer in accordance with City and other governing codes (i.e., Cal/OSHA).
- Provide temporary shoring to increase the factor-of-safety, particularly in areas that have existing improvements to be protected in-place.
- Excavated soils or heavy construction eqi pment/material should not be stockpiled immediately adjacent to top of excavations.

Slope failures during construction will not only be a safety issue, but could cause damage to adjacent areas and increase the reqi red earthwork yardage.

Additional analysis for global stability for the finish/final slopes and retaining walls/bridge abutments will need to be performed as part of the final design process.

3.4 Trench Excavation and Backfill

We recommend that all trench excavations be performed in accordance with the requirements set forth by the Greenbook, Section 306 and CAL/OSHA Excavation Safety Regulations (Construction Safety Orders, Sections 1504, 1539 through 1547, Title 8, California Code of Regulations). The native soils at the site are anticipated to be classified as Type B and locally Type C. Excavations adjacent to existing utilities or structures to be protected in-place may require special measures (i.e., providing a minimum setback distance, layback or temporary shoring) to reduce the potential for ground movement and other adverse impacts. Additional review and measures will likely be required for temporary excavations near the UPR tracks.

Geotechnical observation and testing should be performed during trench excavation and backfill operations. Field and laboratory testing should be conducted in accordance with project specifications and the relevant test procedures related to fill placement and compaction control. Lift thickness of trench backfill should not exceed those allowed in the Greenbook (Section 306). Proper bedding and shading of underground structures, pipes and conduits installed in trenches will be reqi red by the utility agency or the project specifications.

Onsite soils that are relatively free of deleterious material should be suitable for use as trench backfill. Fills should be moisture-conditioned and processed as necessary to achieve a uniform moisture content that is over optimum and within moisture limits required to assure adequate bonding and compaction. Trenches should be either backfilled with approved onsite soil and compacted to a minimum of 90 percent relative compaction, backfilled with clean sand (minimum SE = 30) and densified, or backfilled with a one sack slurry. Rocky material (materials greater than 3 inches) may not be suitable for structural backfill.

Heavy construction loads and stockpiles of excavated soils should be kept away from the edge of the trench, at minimum, a distance eqa l to the depth of the excavation. Otherwise, these surcharges will need to be considered for the design of the shoring system.

3.5 Groundwater

Based on our review of recent groundwater data and our geotechnical exploration, groundwater is deep and not expected to rise significantly. Locally perched groundwater may be encountered near existing utilities and structures with select sandy backfill. Excavations near landscape areas with heavy irrigation may also encounter perched water or wet soils.

3.6 Seismic Design Parameters

The following table summarizes the seismic design criteria for the subject site. The seismic design parameters are developed in general accordance with Caltrans seismic design criteria (ARS Online, Version 2.3.09). The site-specific probabilistic, deterministic, and design envelope seismic evaluations are provided in Appendix D.

Seismic Design Parameters

Latitude	33.9203 North
Longitude	117.0961 West
Distances to Known Source	1.7 miles
Closest Known Seismic Source	Puente Hills (Santa Fe Springs)
Magnitude of Controlling Fault	6.6
Largest Magnitude of Faults Analyzed	6.9 (Puente Hills - LA)
Shear Wave Velocity	885 ft/s
Peak Ground Acceleration	0.67 g
Soil Profile/Site Class	D

3.7 Settlement

The bridge widening, new retaining walls and design fills will create additional loads that cause settlement. We anticipate that the proposed bridge foundations will be supported mainly on the alluvium. Depending on the new retaining wall locations, they could be supported on existing compacted fill or the native alluvium. The native alluvium underlying the site has layers of soft to medium stiff fine-grained alluvium that are moderately compressible. The existing compacted fill and some alluvium is dense granular soils that are less compressible.

The remedial grading measures and foundations should be designed to limit the settlement to a maximum of 2 inches. NMG will evaluate the settlement potential of the proposed design fills and the foundation loading once design information is available that provides the location, configuration and loads. Preliminary settlement estimates for a standard Type 1 (Case 1) per Caltrans 2018 Standard Plans B3-1A retaining walls and the additional fill loading is included with the foundation design data in Section 3.8.

3.8 Preliminary Foundation Design

Walls and other structures with conventional shallow footings should be founded in competent alluvium or certified fill. Remedial grading (i.e., removal and recompaction) may be required for shallow footings where poor quality soils are present. The tables below provide preliminary bearing information for shallow footings founded on competent soils information based on LRFD methodology (Caltrans, 2014). The spread footing data table below also includes our preliminary settlement estimates that will need to be verified based on future structural design information that will be provided.

Spread Footing Table
Preliminary Permissible Net Contact Stress and Settlement
Service Limit State Analysis, Caltrans Retaining Wall Type 1 (Case 1)

Retaining Wall Height, H	16'	14'	12'	10'	8'	6'	4'
Service B', Width	8.6'	7.5'	6.3'	6'	6.2'	6.5'	6.8'
Permissible Net Contact Stress (q_{pn}), ksf	2.2	2.1	2.0	1.6	1.3	1.0	0.7
Settlement (in)	1.25	1.1	1	0.8	0.7	0.6	0.5

Retaining walls within the existing embankment utilizing Caltrans Type 1 (Case 1) standard retaining plan may be satisfactory but will require additional design review based on the descending slope condition below the footing. Retaining walls located within the embankment would be founded on existing compacted fill and limit the earthwork/grading required. The estimated settlement based on the permissible net contact stress and assumed fill loading is less than 1.3 inch. Caltrans Type 5 (Case 3) or Type 1 (Case 2) standard retaining walls may be other alternatives to be considered for this project.

Shallow foundations similar to the existing bridge strip footings may be feasible provided settlement is within an acceptable range. Note that existing bridge footings were constructed in the alluvium at elevation 88 feet msl per prior elevation datum (approximately 90.5 feet msl) as depicted on Plate 2. The new bridge abutments and foundation for the widening will need to take into account potential settlement impacts and constructability for the adjacent UPR tracks.

The foundations should be designed by a structural engineer; however, we recommend that the footings be a minimum of 2 feet deep in compacted fill and minimum 5 feet deep in the alluvium. Deeper footings may be required if remedial grading will not be performed and unsuitable soils are present. Footings located near slopes should have a minimum 5-foot setback (from the bottom front edge of the footing to the slope face) for slopes up to 10 feet in height. The footing setback where the slopes are higher (up to 25 feet in height) should be increased to a distance equal to half the slope height.

As an alternative, a deep/pile foundation system may be utilized for the bridge and new retaining walls. Deep foundations could be driven piles or cast-in-drilled-hole (CIDH) piles/piers. We recommend that the dimensions (depths and diameters) for the deep foundation system be designed from a soil-interaction standpoint by the geotechnical engineer with loads provided by the structural engineer. The axial capacity of the piles is a function of the skin friction and end bearing capacity of the foundation soils. The lateral resistance of the piles is a function of the passive soil pressures. Axial and lateral pile capacities are also impacted by group effects, which would be reviewed once a foundation layout is known. The structural design of the deep foundation system should be performed by a structural engineer in coordination with the geotechnical consultant.

3.9 Lateral Earth Pressures

The recommended lateral earth pressures for non-standard Caltrans retaining walls and structures with drained conditions are listed below. The recommendations below are based on compacted fill soil properties; however, we have also provided passive pressure for alluvium.

Lateral Earth Pressures
Equivalent Fluid Pressure (psf/ft.)
Existing Fill and approved Import (unless noted)

Conditions	***Level Backfill/ Ground***	***2H:1V Sloping Backfill/Ground***
Active	34	50
At Rest	56	82
Passive	400	200 (downward slope)
Passive (Alluvium)	300	N/A

Alternatively, select granular import may be used for the wall backfill and would have lower lateral earth pressures. Caltrans standard retaining wall plans are based on structure backfill having a minimum soil internal friction angle of 34 degrees. If import soils will be utilized, they should be evaluated by the geotechnical and environmental consultants prior to transport to the site to verify suitability. At minimum, the import soil should have the same strength as the onsite sandy fill soils.

To design an unrestrained retaining wall, such as a cantilever wall, the active earth pressure may be used. For a restrained retaining wall, such as at restrained wall corners, the at-rest pressure should be used. Passive pressure is used to compute lateral soils resistance developed against lateral structural movement. The passive resistance is taken into account only if it is ensured that the soil against embedded structure will remain intact with time. The retaining walls may also need to be designed for additional lateral loads if other structures or walls are planned within a 1H:1V projection.

Drainage behind retaining walls should be provided in accordance with the attached Figure 3. If drainage is not provided, the walls can be designed for the higher undrained earth pressures. The waterproofing and drainage systems measures for the retaining walls are recommended to reduce the potential for nuisance seepage. Specific drainage connections, outlets and avoiding open joints should be considered for the retaining wall design to avoid nuisance seepage.

Future landscaping and improvements adjacent to the retaining walls should also be taken into account in the design of the retaining walls. Excessive soil disturbance, trenches, future landscaping adjacent to footings and over-saturation can adversely impact retaining structures and result in additional loading and reduced lateral resistance.

3.9.1 Alternative Earth Retaining Structures

As possible alternatives, a segmental/mechanically stabilized earth (MSE) retaining wall system or steepened geogrid reinforced slope (1.5H:1V) could be considered. An MSE retaining wall provides some additional benefits over traditional/conventional retaining walls since they are flexible and generally can tolerate a larger amount of movement. The reqi red foundation for an MSE wall is generally limited to compacted aggregate footing/leveling course. However, select backfill and geogrid reinforcement are required for MSE walls. Depending on the design, wall height, and product types, this may result in larger temporary excavations for construction. A steepened reinforced slope would have similar design and construction reqi rements as the MSE wall but would not reqi re the facing elements. MSE wall systems or oversteepened reinforced slopes would need to be reviewed and accepted by the project team and the governing agency.

3.10 Structural Pavement Sections

The native subgrade materials within the planned road widening alignments range in composition and are spilt into the following two sections and categories:

1. Hoxie Ave to Elmcroft Ave : Fine-grained subgrade (Design R-value =13)
2. Elmcroft to Imperial Highway: Coarse-grained subgrade (Design R-value=50)

Based on the transportation impact analysis / traffic study performed by Kittleson & Associates (2019), a design traffic index (TI) of 9 was calculated for the project (20-year design life). The recommended structural pavement sections below were designed using the program Newcon90 and Caltrans highway design guidelines:

New Composite Structural Pavement Section R-Value = 13 (Fine-grained subgrade)		
Design Traffic Index	***Composite Structural Pavement Section***	***Full Depth Pavement Section)***
9	0.65' AC/HMA over 1.10' AB (Total = 1.75')	1.10' AC/HMA

New Composite Structural Pavement Section R-Value = 50 (Coarse grained subgrade)		
Design Traffic Index	***Composite Asphalt Concrete (AC) and Aggregate Base (AB) Section (ft.)***	***Full Depth AC Pavement Section (ft.)***
9	0.45' AC/HMA over 0.55' AB (Total = 1.00')	0.75' AC/HMA
AC = Asphalt Concrete ; HMA = Hox Mix Asphalt ; AB = Aggregate Base		

The pavement surface may be capped with a 0.2-foot Rubberized Hot Mix Asphalt – Gap Graded (RHMA-G) finish course.

Street pavement should be placed in accordance with the reqi rements of Section 301 and 302 of the Standard Specifications of Public Works Construction (Greenbook). Prior to construction of pavement sections, subgrade soils should be scarified to a minimum depth of 6 inches, moisture-conditioned as needed, and recompacted. Street subgrade should have uniform soil and moisture-conditions. Processing and compaction of street subgrade soils may be impacted by the moisture-conditions encountered or locally restricted due to shallow utilities. Special measures or compaction eqi pment may be reqi red for grading the subgrade and protection of the existing improvements. Subgrade should be observed and tested by the geotechnical consultant prior to placement of any base or concrete material to verify that it is firm, unyielding and compacted to a minimum of 90 percent relative compaction (based on ASTM Test Method D1557) for composite pavement sections, and 95 percent for full-depth pavement sections. Compaction testing in accordance with California Test Methods 216 and 231 is acceptable if indicated in the project specifications.

Aggregate base (AB) should be crushed aggregate base (CAB), crushed miscellaneous base (CMB) in accordance with Standard Specifications for Public Works Construction (Greenbook), or Class 2 base in accordance with Caltrans standard specifications. The material should be free of detrimental quantity of deleterious materials. The AB should be observed and tested by the geotechnical consultant to verify that it is compacted to a minimum of 95 percent relative compaction, based on ASTM Test Method D1557.

Design of proper surface drainage away from the pavement and/or additional subdrainage is very important to prevent over-wetting of the subgrade material. Moisture barriers and/or root barriers should be installed where planter or natural areas with irrigation are located adjacent to the pavements and other concrete improvements.

3.10.1 Alternative Structural Pavement Sections

Alternative structural pavement sections that include fiber reinforced asphalt (FRAC) or geogrid (MSL = Mechanically Stabilized Layer) could be utilized to stabilize the subgrade soil and optimize the pavement section (reducing the thickness and cost). Alternative reinforced pavement recommendations were prepared by Pacific Geosource and are presented in Appendix F. The design pavement alternatives are preliminary and can vary based on the final geogrid/geotextile to be utilized and the contractor's methodology. Additional review and design coordination would be required if the reinforced pavement alternatives are selected.

3.11 Soil Corrosivity

The corrosion potential of the soils is generally classified as mildly corrosive to both metal and concrete. The soil corrosivity study performed by HDR includes preparation of the report provided in Appendix C. The report provides specific corrosion-control recommendations for pipes (concrete, steel, ductile iron, cast iron, copper, plastic and vitrified clay) and concrete structures.

3.12 Structural Concrete

The soluble sulfates exposure in the onsite soils is classified as "S1" per Table 19.3.1.1 of ACI-318-14. Structural concrete elements in contact with soil include footings and building slabs-on-grade. The flatwork and sidewalk concrete are typically not considered structural elements. Concrete mix for these elements should be based on the "S1" soluble sulfate exposure class of Table 19.3.2.1 in ACI-318-14. Additional provisions/recommendations by the structural engineer and/or the city of Norwalk are also applicable.

3.13 Concrete Street Improvements

The exterior concrete improvements within the street right-of-way should be constructed in accordance with approved plan, applicable City standards and the recommendations provided below.

Subgrade: The subgrade for the concrete pavement areas should be competent material that has been compacted and moisture-conditioned in accordance with the geotechnical recommendations for the site grading. The subgrade soils should be uniformly processed and should be compacted to a minimum of 90 percent relative compaction per ASTM test Method D 1557.

Subgrade Presaturation: For reducing the potential effects of expansive soils, we recommend presaturation of the subgrade prior to placement of the exterior concrete. The recommended presaturation is 1.2 x optimum moisture to a minimum depth of 12 inches. Additionally, a minimum of 4 inches of base material (compacted to a minimum 95 percent relative compaction) can be placed for concrete pavements when fine-grained subgrade soils are present (to further improve the subgrade conditions and uniformity).

Concrete Thickness: The nominal thickness for the non-structural concrete walks should be 4 inches, except where heavier loads are anticipated. Pavements anticipated to have infreqe nt vehicular traffic (H-5 to H-20 loading) should be a minimum 6 inches thick. City standards may govern the reqi red minimum thicknesses for the exterior concrete elements in the right-of-way. The pavement for bus stop pads or heavy truck traffic lanes typically reqi res a minimum thickness of 8 inches.

Reinforcement: Decorative/enhanced concrete pavements can include reinforcement with No. 4 rebar at 24 inches, on-center spacing (both ways) if allowed by the City. The reinforcement will help limit the potential for cracking and lifting of the concrete pavements. Slip dowels across expansion and control joints can also help improve concrete performance. If utilized, slip dowels should be installed at 18-inch spacing and with a minimum 6-inch embedment.

J nts: We recommend that longitudinal and transverse joint spacing for the concrete pavement be no more than 10 feet apart to control cracking. The depth of jointing must be at least ¼ of the slab thickness. Expansion joints need to be incorporated into the concrete pavements to allow for soil and thermal expansion.

Cement Type: Type II cement should be used for concrete in contact with onsite soils. The city or Greenbook standards for concrete should be utilized for typical surface street improvements. The minimum compressive strength is typically 2,500 psi.

Other Design Considerations:

- The design and construction should also be performed in adherence with the American Concrete Institute (ACI) and Portland Cement Association (PCA) guidelines for concrete improvements.
- Reducing cracking of concrete is also a function of proper concrete mix design, placement, and curing/finishing practices.
- The amount of post-construction watering, or lack thereof, can also have a significant impact on the adjacent concrete pavements, particularly when onsite soils are expansive. Proper landscape irrigation should be maintained.
- Additional measures, such as subdrains and/or moisture and root barriers, should be considered where planters or landscaping with irrigation are located adjacent to concrete improvements. Grading and landscape improvement plans should be designed with these measures in mind.
- Design and maintenance of proper surface drainage is important as described in Section 3.14.

3.14 Surface Drainage

Design of proper surface drainage away from the pavement and/or additional subdrainage is important to prevent over-wetting of the subgrade material. Inadeqa te control of surface runoff or heavy landscape irrigation post construction may result in nuisance seepage conditions, erosion and/or soil movement (expansion). Maintaining adeqa te surface drainage, proper disposal of runoff water and control of irrigation will help reduce the potential for future moisture-related problems. Surface drainage should be carefully taken into consideration during grading, landscaping and construction. Ponding of water adjacent to streets or structures should not be allowed.

3.15 Additional Geotechnical Review

NMG will work in with the civil engineer and structural designer once the street improvements plans and location, geometry and loading for the new structures are established to provide final geotechnical recommendations. The future project improvement, bridge, wall and landscape plans should be reviewed and accepted by the geotechnical consultant prior to construction. Additional geotechnical recommendations will be provided as needed.

3.16 Geotechnical Observation and Testing

The findings, conclusions and recommendations in this report are based upon interpretation of data and data points having limited spatial extent. Verification and refinement of actual geotechnical conditions during grading is very important. At minimum, geotechnical observation and testing should be conducted during grading and construction at the following stages:

- Abandonment or demolition of existing pavements, utilities and structures,
- Clearing and grubbing, prior to site processing or fill placement,
- Precise grading which includes remedial removals and compacted fill placement;
- Excavation and construction of utilities and pipelines,
- Structure and trench excavation and backfill,
- Foundation excavation prior to placement of reinforcement or concrete;
- Bridge foundation excavations, prior to foundation construction;
- Retaining wall foundation excavations, prior to foundation construction;
- Installation of retaining wall subdrains;
- Retaining wall backfill placement;
- Curb and gutter, driveway, sidewalk and flatwork (if any) subgrade preparation;
- Placement and/or compaction of road subgrade soils and aggregate base materials;
- Placement and compaction of asphaltic paving; and
- When any unusual or unexpected geotechnical conditions are encountered during construction.

4.0 LIMITATIONS

This report has been prepared for the exclusive use of our client, Mark Thomas, within the specific scope of services reqe sted by them for the subject project. This report or its contents should not be used or relied upon for other projects or purposes or by other parties without the written consent of NMG and the involvement of a geotechnical professional. The means and methods used by NMG for this study are based on local geotechnical standards of practice, care, and requirements of governing agencies. No warranty or guarantee, express or implied is given.

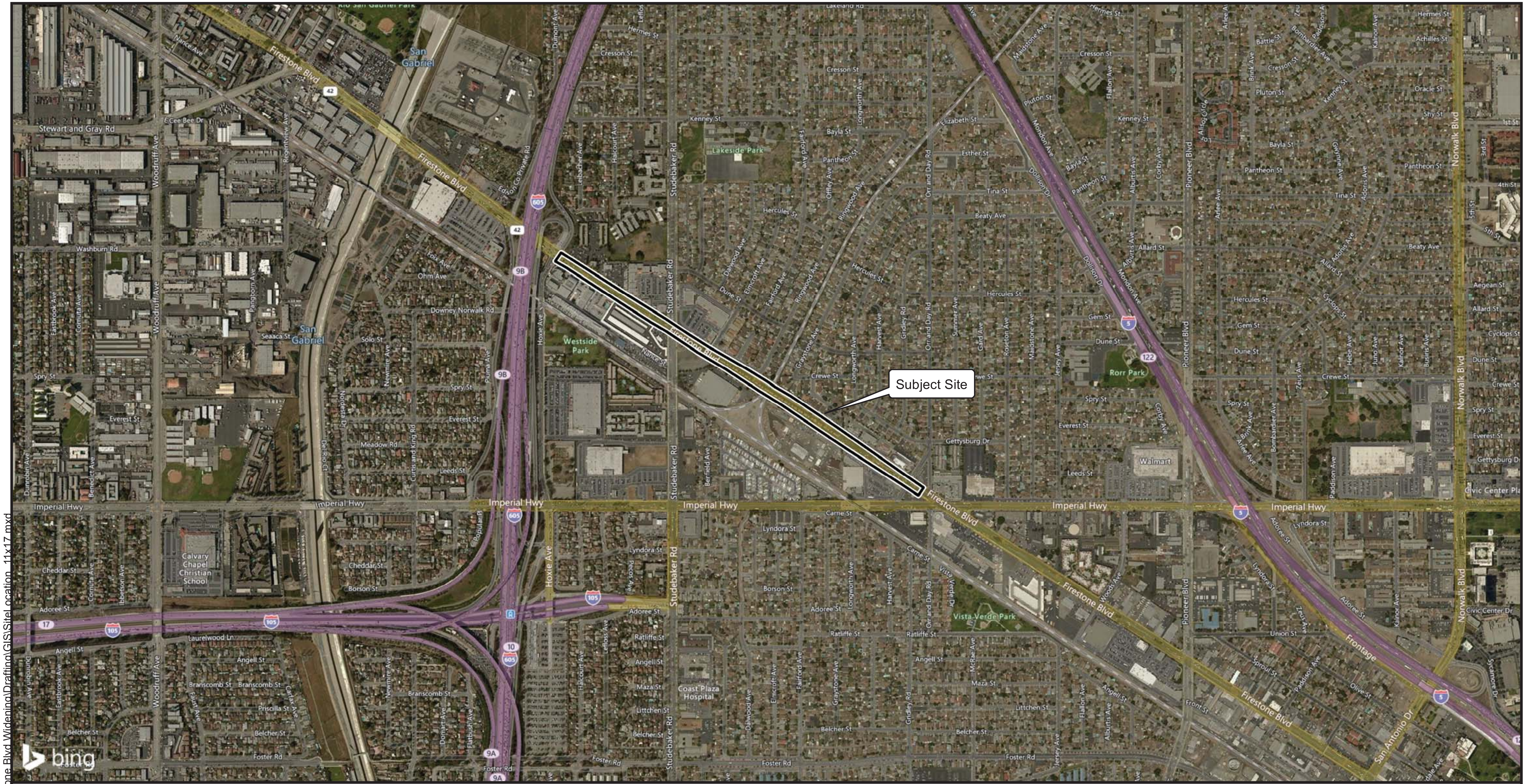
The findings, conclusions, and recommendations herein are professional opinions based on interpretations and inferences made from geologic and engineering data from specific locations and depths, observed or collected at a given time. By nature, geologic conditions can vary from point to point, can be very different in between points, and can also change over time. Our conclusions and recommendations are subject to verification and/or modification during excavation and construction when more subsurface conditions are exposed.

NMG's expertise and scope of services did not include assessment of potential subsurface environmental contaminants or environmental health hazards.

TABLE 1
SUMMARY OF THE EXISTING STRUCTURAL PAVEMENT SECTIONS
Firestone Blvd

Boring No.	TD	Location (Plate 1)	AC	AB	Total Section (AC/AB)	SG	R-Value	Comments
H-1	11.5'	EB	5"	9"	14"	SM		5" AC (2" cap over 3" base coarse); SG is Loose-Med dense.
H-2	2.5	CM	6"	12"	18"	SM		Existing utility encountered.
H-3	11.5'	WB	3"	12"	15"	SM	46	12" AB2
H-4	11.5'	EB	5"	12"	17"	ML-CL		Silty SG soil; lower density and high mositure.
H-5	11.5'	WB	3"	6"	9"	ML	13	6" AB2 ; Silty SG soil.
H-6	6.5'	CM	5"	16"	21"	SM		AB = 7" + 9" of less uniform coarse gravel; >90% RC Fill.
H-7	41..4'	WB	3"	11"	14"	SM		7" AB2 over 4" AB1
H-8	11.5'	EB	8"	0	8"	SP-SM		Full Depth AC - No AB; Fill Embank; >90%RC; low moisture.
H-9	66.5'	WB	3"	13"	16"	SM	66	9" AB2 over 4" AB (coarse gravel).
H-10	11.5'	EB	2.5"	10.5"	13"	SM		5.5" AB2 over 5" AB1 ; Fill Embank; low moisture.
H-11	41.5'	WB	3"	13"	16"	SM		7" AB2 over 6" AB1
H-12	2.5'	CM	3"	13"	16"	SP-SM		13" AB2; Existing utility encountered.
H-13	6.5'	CM	2"	16"	18"	SM	62	16" AB2
H-14	11.5'	EB	8"	8"	16	SM-SC		4" Newer AC over 4" older AC.

CM = Center Median
EB = Eastbound Lanes
WB = Westbound Lanes
AC = Existing Asphalt Concrete
AB1, AB2 = Existing Aggregate Base (see text for description)
SG = Subgrade



0 500 1,000 Feet

N

1 inch = 1,000 feet

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SITE LOCATION MAP

FIRESTONE BOULEVARD WIDENING PROJECT
CITY OF NORWALK
COUNTY OF LOS ANGELES, CALIFORNIA

Project Number: 18181-01
By: AZ/KGM
Project Name: Mark Thomas/Firestone Blvd. Widening
Date: 8/14/2019
Figure 1

NMG

Legend

Liquefaction Zones

0 1,500 3,000 Feet

1 inch = 3,000 feet

N

SEISMIC HAZARD ZONES MAP

Base: California Geological Survey, Earthquake Zones of Required Investigation, Whittier Quadrangle
Dated: March 25, 1999

FIRESTONE BOULEVARD WIDENING PROJECT
CITY OF NORWALK
COUNTY OF LOS ANGELES, CALIFORNIA

Project Number: 18181-01 By: KGM/AZ
Project Name: Mark Thomas/Firestone Blvd.
Date: 8/14/19 Figure 2

NMG

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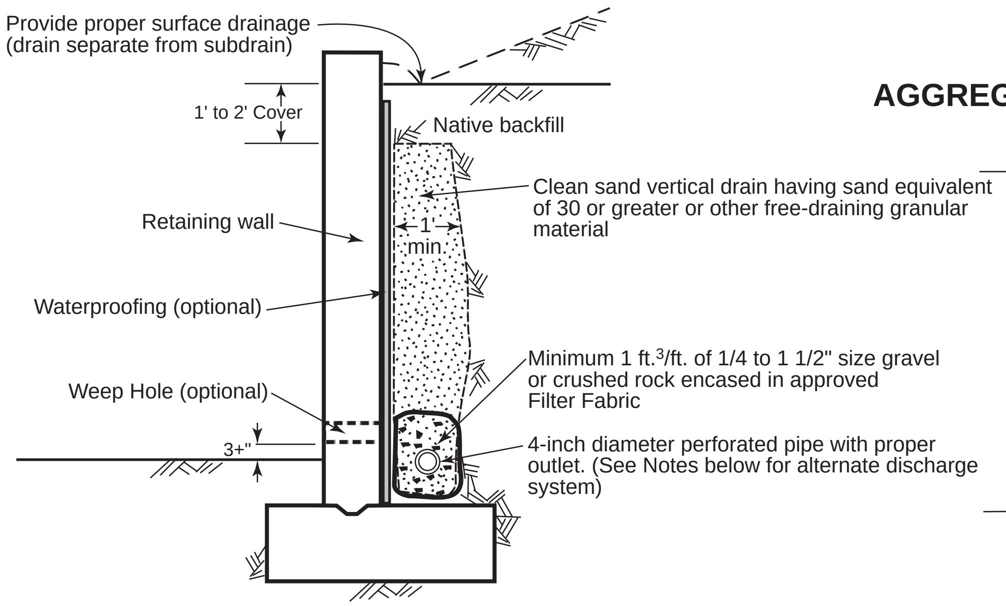
OPTION 1:

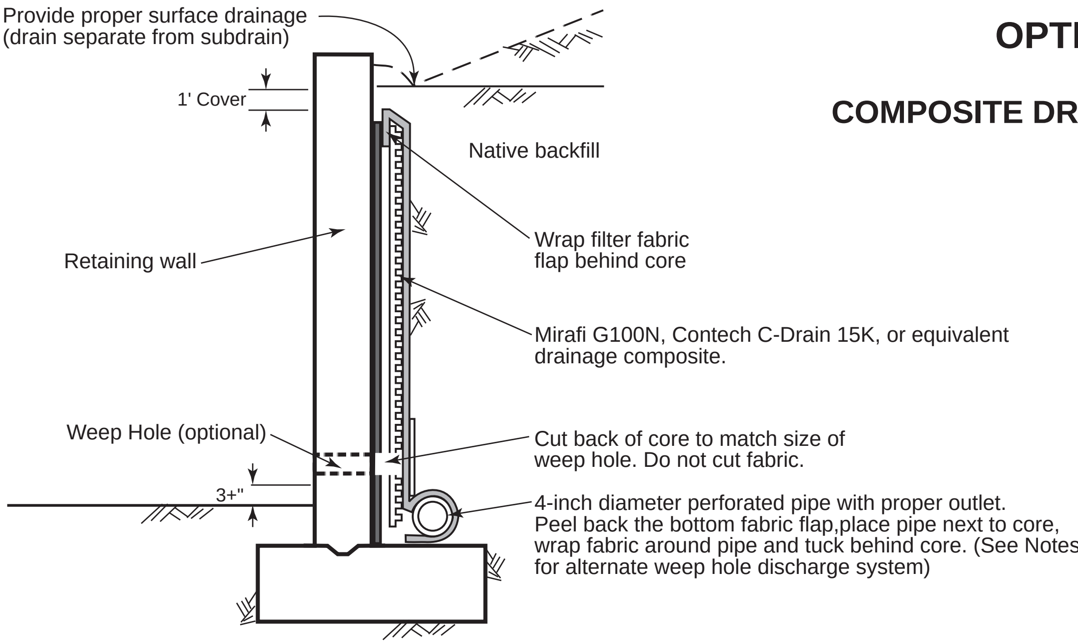
AGGREGATE SYSTEM DRAIN



Alternative: Class 2 permeable filter material (Per Caltrans specifications) may be used for vertical drain and around perforated pipe (without filter fabric)

OPTION 2:

COMPOSITE DRAINAGE SYSTEM



NOTES:

1. **PIPE TYPE SHOULD BE PVC OR ABS, SCHEDULE 40 OR SDR35 SATISFYING THE REQUIREMENTS OF ASTM TEST STANDARD D1527, D1785, D2751 , OR D3034.**
2. **FILTER FABRIC SHALL BE APPROVED PERMEABLE NON-WOVEN POLYESTER, NYLON, OR POLYPROPYLENE MATERIAL.**
3. **DRAIN PIPE SHOULD HAVE A GRADIENT OF 1 PERCENT MINIMUM.**
4. **WATERPROOFING MEMBRANE MAY BE REQUIRED FOR A SPECIFIC RETAINING WALL (SUCH AS A STUCCO OR BASEMENT WALL).**
5. **WEEP HOLES MAY BE PROVIDED FOR LOW RETAINING WALLS (LESS THAN 3 FEET IN HEIGHT) IN LIEU OF A VERTICAL DRAIN AND PIPE AND WHERE POTENTIAL WATER FROM BEHIND THE RETAINING WALL WILL NOT CREATE A NUISANCE WATER CONDITION. IF EXPOSURE IS NOT PERMITTED, A PROPER SUBDRAIN OUTLET SYSTEM SHOULD BE PROVIDED.**
6. **IF EXPOSURE IS PERMITTED, WEEP HOLES SHOULD BE 2-INCH MINIMUM DIAMETER AND PROVIDED AT 25-FOOT MAXIMUM SPACING ALONG WALL. WEEP HOLES SHOULD BE LOCATED 3+ INCHES ABOVE FINISHED GRADE.**
7. **SCREENING SUCH AS WITH A FILTER FABRIC SHOULD BE PROVIDED FOR WEEP HOLES/OPEN JOINTS TO PREVENT EARTH MATERIALS FROM ENTERING THE HOLES/JOINTS.**
8. **OPEN VERTICAL MASONRY JOINTS (I.E., OMIT MORTAR FROM JOINTS OF FIRST COURSE ABOVE FINISHED GRADE) AT 32-INCH MAXIMUM INTERVALS MAY BE SUBSTITUTED FOR WEEP HOLES.**
9 **THE GEOTECHNICAL CONSULTANT MAY PROVIDE ADDITIONAL RECOMMENDATIONS FOR RETAINING WALLS DESIGNED FOR SELECT SAND BACKFILL.**

RETAINING WALL DRAINAGE DETAIL

NMG
Geotechnical, Inc.

FIGURE 3

APPENDIX A

APPENDIX A

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APPENDIX A

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APPENDIX B

Date(s) Drilled	3/11/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	Modified California, Bulk		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 12+20, 53'R (Eastbound Lane).		

H- 1

Sheet 1 of 1

Total Depth Drilled (ft)	11.5
Approximate Ground Surface Elevation (ft)	108.0 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0						Surface: 5" AC over 9" AB1.			
						SM	**Artificial Fill (Af)**			B-1 @ 1.5'-5'
			B-1 D-1	7			@ 2.5': Very dark grayish brown to brown silty fine SAND, moist, loose, trace gravel.	10.5	101.6	
	5		D-2	15		SM-SC	**Alluvium (Qal)** @ 5': Grayish brown silty/clayey fine SAND, moist, medium dense, pinhole pores, micaceous, FeO staining.	14.9	111.4	
100										
	10		D-3	31		CL	@ 10': Upper: Grayish brown to gray silty CLAY, wet, very stiff, FeO staining, trace pencil-tip pores, root hairs, micaceous.	29.6	92.2	
						SM	Lower: Olive brown silty fine SAND, moist, medium dense, micaceous, slightly friable.			
							Notes: Total Depth: 11.5 Feet. No Groundwater Encountered. Backfilled with Cuttings and Tamped. Capped with Dyed Concrete.			
	15									
90										
	20									
	25									
80										
	30									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG

Date(s) Drilled	3/12/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	N/A		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 15+95, 13'R (Center Median).		

H- 2

Sheet 1 of 1

Total Depth Drilled (ft)	2.5
Approximate Ground Surface Elevation (ft)	108.5 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0						Surface: 6" AC over 12" AB1.			
						SM	**Artificial Fill (Af)** @ 1.5'-2.5': Yellowish brown silty SAND with GRAVEL, moist, medium dense. @ 2.5': Encountered two 1" galvanized pipes running parallel to Firestone Blvd. Boring Terminated			
	5						Notes: Total Depth: 2.5 Feet. Abandoned Due to Utility Conflict. No Groundwater Encountered. Backfilled with Cuttings and Tamped. Capped with Dyed Concrete.			
100										
	10									
	15									
90										
	20									
	25									
80										
	30									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG

Date(s) Drilled	3/11/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	Modified California, Bulk		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 18+19, 31'L (Westbound Lane).		

H- 3

Sheet 1 of 1

Total Depth Drilled (ft)	11.5
Approximate Ground Surface Elevation (ft)	107.0 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0	Bulk	B-1				Surface: 3" AC over 12" AB2.			B-1 @ 0.25'-1'
						ML	**Alluvium (Qal)**			B-2 @ 1.5'-5' GS, MD, RV, EI, CC
		Bulk / Drive	B-2 D-1	11		SP	@ 2.5': Upper: Olive brown clayey/sandy SILT, very moist, medium stiff, FeO staining, pinhole pores. Lower: Pale brown to gray fine to medium SAND, damp, loose, friable.	11.7	92.4	
	5	Drive	D-2	8		ML	@ 5': Dark brown to olive brown clayey/sandy SILT, wet, medium stiff, FeO staining, pencil-tip pores, trace rootlets. Less sand in lower rings.	29.5	91.2	
100										
	10	Drive	D-3	9			@ 10': Olive gray clayey/sandy SILT, wet, medium stiff, FeO staining, micaceous.	32.9	86.1	
							Notes: Total Depth: 11.5 Feet. No Groundwater Encountered. Backfilled with Cuttings and Tamped. Capped with Dyed Concrete.			
	15									
90										
	20									
	25									
80										
	30									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG

Date(s) Drilled	3/11/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	Modified California, Bulk		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 21+63, 50'R (Eastbound Lane).		

H- 4

Total Depth Drilled (ft)	11.5
Approximate Ground Surface Elevation (ft)	107.0 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0						Surface: 5" AC over 12" AB1.			B-1 @ 1.5'-5'
						ML-CL	**Alluvium (Qal)**			
			B-1 D-1	9			@ 2.5': Grayish brown clayey SILT/silty CLAY, wet, medium stiff, caliche, pinhole pores, trace pencil-tip pores, micaceous, charcoal fragments.	33.4	88.3	
	5		D-2	9		ML	@ 5': Grayish brown clayey SILT, wet, medium stiff, trace pencil-tip pores, highly micaceous.	29.7	90.5	
100										
	10		D-3	36		SP	@ 10': Light olive brown fine to coarse SAND, damp, medium dense, friable, micaceous.	4.3	106.1	
							Notes: Total Depth: 11.5 Feet. No Groundwater Encountered. Backfilled with Cuttings and Tamped. Capped with Dyed Concrete.			
	15									
90										
	20									
	25									
80										
	30									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
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NMG

Date(s) Drilled	3/12/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	Modified California, Bulk		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 26+57, 24'L(Westbound Lane).		

H- 5

Sheet 1 of 1

Total Depth Drilled (ft)	11.5
Approximate Ground Surface Elevation (ft)	106.0 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0						Surface: 3" AC over 6" AB2.			
						ML	**Alluvium (Qal)**			B-1 @ 1'-5' GS, MD, RV, EI, CC
			B-1 D-1	11			@ 2.5': Olive brown fine sandy SILT, very moist to wet, loose/medium stiff, few pinhole and pencil-tip pores, rootlets, FeO staining.	30.9	89.0	
	5		D-2	17			@ 5': Upper (Not in Sample): Olive brown sandy SILT, moist, stiff, few pinhole and pencil-tip pores.	16.5	91.5	
100						SM	Lower (In Sample): Olive brown silty very fine SAND, moist, medium dense, trace pinhole pores.			
	10		D-3	16		CL	@ 10': Upper: Olive brown silty CLAY, very moist to wet, stiff, few pinhole pores, rootlets, FeO staining.	29.3	87.8	
						ML	Lower: Olive brown sandy/clayey SILT, very moist, stiff, micaceous.			
							Notes: Total Depth: 11.5 Feet. No Groundwater Encountered. Backfilled with Cuttings and Tamped. Capped with Dyed Concrete.			
	15									
90										
	20									
	25									
80										
	30									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
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NMG

Date(s) Drilled	3/12/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	Modified California, Bulk		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 29+13, 10'R (Center Median).		

H- 6

Sheet 1 of 1

Total Depth Drilled (ft)	11.5
Approximate Ground Surface Elevation (ft)	110.5 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
110	0						Surface: 5" AC over 16" AB (7" AB2 over 9" AB1).			
						SM	**Artificial Fill (Af)**			
			D-1 B-1	83			@ 2.5': Grayish brown silty fine to medium SAND, moist, very dense, micaceous, slightly friable.	9.7	125.3	B-1 @ 2'-5'
	5		D-2	50/6"			@ 5': Upper: Very dark grayish brown silty very fine SAND, wet, very dense, micaceous. Lower: Old asphalt road, strong asphalt odor.	15.8		
100	10		D-3	13		ML	**Alluvium (Qal)** @ 10': Olive brown sandy SILT, very moist, stiff, micaceous, few pinhole pores, trace pencil-tip pores.	21.1	94.8	
	15						Notes: Total Depth: 11.5 Feet. No Groundwater Encountered. Backfilled with Cuttings and Tamped. Capped with Dyed Concrete.			
90	20									
	25									
	30									

LOG OF BORING

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NMG

Date(s) Drilled	3/13/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	Modified California, Bulk		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 32+31, 28'L (Westbound Lane).		

H- 7

Sheet 1 of 2

Total Depth Drilled (ft)	41.4
Approximate Ground Surface Elevation (ft)	125.0 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0						Surface: 3" AC over 11" AB (7" AB2 over 4" AB1).			
						SM	**Artificial Fill (Af)**			B-1 @ 1.5'-5'
			B-1 D-1	84			@ 2.5': Yellowish brown silty fine to medium SAND, moist, very dense, micaceous.	6.1	112.8	
120	5		D-2	57			@ 5': Yellowish brown silty fine to medium SAND, moist, very dense, micaceous.	5.8	109.8	
	10		D-3	54			@ 10': Yellowish brown silty fine to medium SAND, damp, very dense, micaceous, slightly friable.	3.6	108.1	DS
110	15		D-4	68			@ 15': Grayish brown silty fine SAND, moist, very dense, micaceous, trace fine gravel.	11.1	112.1	
							@ 17.5'-18': Driller notes thin hard asphalt layer. Trace asphalt in cuttings.			
	20		D-5	15		ML	**Alluvium (Qal)** @ 20': Upper: Dark grayish brown sandy SILT, moist, stiff, micaceous, trace pencil-tip pores.	12.9	95.6	
						ML-CL	Lower: Very dark grayish brown clayey SILT/silty CLAY, moist, stiff, trace pinhole pores, micaceous.			
100	25		D-6	23		SM	@ 25': Light brown silty fine SAND, moist, medium dense, micaceous.	9.4	96.4	
	30									

LOG OF BORING

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NMG

Elevation (ft)	Depth (ft)	SAMPLES Type	Number	Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	30		D-7	43		CL	@ 30': Upper: Olive brown silty CLAY, moist, very stiff, rootlets, FeO stained, pinhole pores.	9.4	95.8	
						SM	Lower: Yellowish brown silty fine SAND, moist, medium dense, highly micaceous.			
90	35		D-8	63		SP-SM	@ 35': Gray silty fine to medium SAND, damp, very dense, micaceous, trace FeO staining, friable.	3.5	103.7	
	40		D-9	90/11"		SP	@ 40': Gray fine to coarse SAND, damp, very dense, friable, micaceous, trace FeO staining.	2.2	109.9	
80	45						Notes: Total Depth: 41.4 Feet. No Groundwater Encountered. Backfilled with Cuttings and Tamped. Capped with Dyed Concrete.			
	50									
70	55									
	60									
60	65									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
Norwalk, California

PROJECT NO. 18181-01

NMG

Date(s) Drilled	3/11/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	Modified California, Bulk		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 32+35, 43'R (Eastbound Lane).		

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Sheet 1 of 1

Total Depth Drilled (ft)	11.5
Approximate Ground Surface Elevation (ft)	125.5 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0						Surface: 8" AC.			
						SP-SM	**Artificial Fill (Af)**			B-1 @ 1'-5'
			B-1 D-1	85/11"			@ 2.5': Olive brown silty fine to medium SAND, moist, very dense, slightly friable, micaceous.	6.2	115.0	
120	5		D-2	57		SM	@ 5': Olive brown silty fine to medium SAND, moist, very dense, micaceous, finer grained in lower rings and sampler tip.	5.2	113.3	
	10		D-3	54			@ 10': Olive brown silty fine to medium SAND, damp, very dense, micaceous.	4.4	110.3	
							Notes: Total Depth: 11.5 Feet. No Groundwater Encountered. Backfilled with Cuttings and Tamped. Capped with Dyed Concrete.			
110	15									
	20									
100	25									
	30									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
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NMG

Date(s) Drilled	3/13/19	Logged By	ZKH	**H- 9**	
Drilling Company	2R Drilling	Drill Bit Size/Type	10"	**Sheet 1 of 3**	
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop		
Sampling Method(s)	Modified California, Bulk				
Approximate Groundwater Depth:	No Groundwater Encountered.			Total Depth Drilled (ft)	66.5
Comments	STA. 36+40, 29'L (Westbound Lane).			Approximate Ground Surface Elevation (ft)	132.0 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0						Surface: 3" AC over 13" AB (9" AB2 over 4" AB1).			
130						SM	**Artificial Fill (Af)**			B-1 @ 1.5'-5' GS, MD, RV, CC
			B-1 D-1	75			@ 2.5': Yellowish brown silty fine to coarse SAND, moist, very dense, trace fine gravel and clayey lenses.	8.6	120.0	
	5		D-2	63			@ 5': Yellowish brown silty fine to coarse SAND, moist, very dense, trace fine gravel.	7.2	115.7	DS
	10		D-3	85			@ 10': Yellowish brown silty fine to coarse SAND, moist, very dense, few fine gravel.	5.0	115.6	
120										
	15		D-4	74			@ 15': Yellowish brown silty fine to coarse SAND, damp, very dense, cleaner sand in upper rings.	2.5	113.3	
	20		D-5	79/11"			@ 20': Yellowish brown fine to medium SAND, moist, very dense, trace fine gravel.	7.3	114.3	
110										
	25		D-6	62		SM	@ 25': Yellowish brown silty fine to coarse SAND, moist, very dense, trace fine gravel.	4.8	104.3	
							@ 29': Driller notes hard thin asphalt layer. Asphalt staining in			
	30									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
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NMG

Elevation (ft)	Depth (ft)	Type	Number	Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	30		D-7	20		ML	cuttings. **Alluvium (Qal)** @ 30': Dark grayish brown sandy SILT, moist, stiff, pinhole pores, FeO staining, trace root hairs and caliche.	16.5	107.9	
100			D-8	23			@ 32.5': Dark gray sandy SILT, wet, very stiff, few pinhole pores, trace pencil-tip pores, slightly more sandy than above sample.	20.5	104.7	DS
	35		D-9	45		SM	@ 35': Light olive brown silty fine SAND, moist, dense, micaceous, trace pinhole pores.	12.0	116.3	
	40		D-10	21		CL	@ 40': Dark grayish brown silty CLAY, wet, stiff, trace pinhole/pencil-tip pores, FeO stained rootlets, moderately plastic, trace silty sand in upper rings and tip.	31.3	88.6	
90										
	45		D-11	78		SP	@ 45': Gray fine SAND, damp, very dense, friable, micaceous.	1.7	103.6	
	50		D-12	85			@ 50': Gray fine to medium SAND, damp, very dense, trace fines, micaceous, friable.	2.0	102.8	
80										
	55		D-13	31		SP-SM	@ 55': Upper: Gray silty fine to medium SAND, damp, medium dense.	2.1	109.1	
						CH	Lower: Black silty CLAY, very moist, very stiff, plastic, micaceous.			
	60		D-14	26		CL-CH	@ 60': Very dark gray silty CLAY, saturated, very stiff, plastic, trace pinhole pores.	16.9	114.5	
70										
	65									

Elevation (ft)	Depth (ft)	SAMPLES Type	Number	Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	65		D-15	32		CL	@ 65': Brown silty/sandy CLAY, saturated, very stiff, micaceous.	17.6	114.5	
							Notes: Total Depth: 66.5 Feet. No Groundwater Encountered. Backfilled with Cuttings and Tamped. Capped with Dyed Concrete.			
	70									
60										
	75									
	80									
50										
	85									
	90									
40										
	95									
	100									

LOG OF BORING
Mark Thomas/Firestone Blvd. Widening
Norwalk, California

PROJECT NO. 18181-01

NMG

Report: HOLLOW STEM; Project: 18181-01.GPJ; Data Template: NMG_GINT_2016.GDT; Printed: 8/14/19

Date(s) Drilled	3/11/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	Modified California, Bulk		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 39+22, 43'R (Eastbound Lane).		

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Sheet 1 of 1

Total Depth Drilled (ft)	11.5
Approximate Ground Surface Elevation (ft)	125.5 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0						Surface: 2.5" AC over 10.5" AB (5.5" AB2 over 5" AB1).			
						SM	**Artificial Fill (Af)**			B-1 @ 1.5'-5'
			D-1 B-1	80/11"			@ 2.5': Olive brown silty fine to medium SAND, damp, very dense, micaceous, trace lenses of clean sand.	5.0	125.5	
120	5		D-2	82			@ 5': Olive brown to brown silty fine to medium SAND, damp, very dense, micaceous, minor clayey sand lifts, FeO stained.	5.7	112.2	
	10		D-3	88		SP-SM	@ 10': Olive brown to brown silty fine to medium SAND, damp, very dense, clean sand lenses.	4.4	115.8	
							Notes: Total Depth: 11.5 Feet. No Groundwater Encountered. Backfilled with Cuttings and Tamped. Capped with Dyed Concrete.			
110	15									
	20									
100	25									
	30									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG

Date(s) Drilled	3/12/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	Modified California, Bulk		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 41+83, 15'L (Westbound Lane).		

H-11

Total Depth Drilled (ft)	41.5
Approximate Ground Surface Elevation (ft)	114.0 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	Number	Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0		B-1				Surface: 3" AC over 13" AB (7" AB2 over 6" AB1).			B-1 @ 0.25'-1' (Treated AB)
						SM	**Artificial Fill (Af)**			B-2 @ 1.5'-5'
110			B-2 D-1	87			@ 2.5': Brown silty fine to medium SAND, moist, very dense, micaceous.	6.7	111.9	
	5		D-2	80			@ 5': Brown silty fine to medium SAND, moist, very dense, micaceous.	5.7	115.7	
	10		D-3	50/3"			@ 10': Upper: Brown silty fine to medium SAND, wet, very dense. Asphalt in lower rings and sampler tip.	14.0	113.6	
100										
	15		D-4	24		ML	**Alluvium (Qal)** @ 15': Grayish brown to light olive brown sandy SILT, moist, stiff, few pinhole/pencil-tip pores.	20.5	101.1	
	20		D-5	45		SM	@ 20': Dark yellowish brown to grayish brown silty fine SAND, damp, medium dense to dense, FeO staining around pinhole pores, micaceous.	2.2	102.2	
90										
	25		D-6	69		SP	@ 25': Grayish brown fine SAND, damp, very dense, friable, micaceous, FeO staining.	1.6	102.2	
	30									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
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NMG

Elevation (ft)	Depth (ft)	SAMPLES Type	Number	Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	30		D-7	84			@ 30': Gray fine SAND, damp, very dense, micaceous, friable.	1.6	103.2	
80										
	35		D-8	58		SP-GP	@ 35': Gray fine to coarse SAND with fine GRAVEL, damp, very dense.	3.9		
	40		D-9	41		SM	@ 40': Upper: Gray silty fine SAND, damp to moist, interlayered gravel and silt lenses in upper rings.	5.5	100.1	
						ML	Lower: Olive sandy SILT, moist to very moist, very stiff, highly micaceous.			
							Notes: Total Depth: 41.5 Feet. No Groundwater Encountered. Backfilled with Cuttings and Tamped. Capped with Dyed Concrete.			
70	45									
	50									
60	55									
	60									
50	65									

Report: HOLLOW STEM; Project: 18181-01.GPJ; Data Template: NMG_GINT_2016.GDT; Printed: 8/14/19

Date(s) Drilled	3/12/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	Bulk		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 44+90, 10'R (Center Median).		

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Sheet 1 of 1

Total Depth Drilled (ft)	2.5
Approximate Ground Surface Elevation (ft)	106.0 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0						Surface: 3" AC, over 13" AB2.			
		Bulk	B-1			SP-SM	**Artificial Fill (Af)** @ 1.3'-2.5': Brown silty to clean SAND with GRAVEL, wet.			B-1 @ 1.5'-2.5'
							@ 2.5': No Sample Collected. Encountered concrete storm drain. Boring Terminated			
							Notes: Total Depth: 2.5 Feet. Abandoned Due to Storm Drain Conflict. No Groundwater Encountered. Backfilled with Cuttings and Tamped. Capped with Dyed Concrete.			
	5									
100										
	10									
	15									
90										
	20									
	25									
80										
	30									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG

Date(s) Drilled	3/12/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	Modified California, Bulk		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 51+59, 2'R (Center Median).		

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Sheet 1 of 1

Total Depth Drilled (ft)	6.5
Approximate Ground Surface Elevation (ft)	104.0 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	Number	Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0						Surface: 2" AC over 16" AB2.			
						SM	**Alluvium (Qal)**			B-1 @ 1.5'-5' GS, MD, RV, CC
100			B-1 D-1	14			@ 2.5': Brown silty fine SAND, moist, medium dense, trace pinhole pores, micaceous.	8.5	102.7	
	5		D-2	17			@ 5': Pale yellowish brown silty fine SAND, moist, medium dense, micaceous, trace pinhole pores.	6.7	95.8	
							Notes: Total Depth: 6.5 Feet. No Groundwater Encountered. Backfilled with Cuttings and Tamped. Capped with Dyed Concrete.			
	10									
90										
	15									
	20									
80										
	25									
	30									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG

Report: HOLLOW STEM; Project: 18181-01.GPJ; Data Template: NMG_GINT_2016.GDT; Printed: 8/14/19

Date(s) Drilled	3/11/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	Modified California, Bulk		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 53+96, 50'R (Eastbound Lane).		

H-14

Sheet 1 of 1

Total Depth Drilled (ft)	11.5
Approximate Ground Surface Elevation (ft)	103.0 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0						Surface: 8" AC over 8" AB1.			
						SM-SC	**Artificial Fill (Afu)**			B-1 @ 1.5'-5'
100			B-1 D-1	47			@ 2.5': Dark brown silty/clayey fine SAND, moist, dense, micaceous, trace fine gravel, root hairs.	11.4	124.7	
	5		D-2	12		SM	**Alluvium (Qal)** @ 5': Grayish brown silty fine SAND, moist, loose, few pinhole/trace pencil-tip pores, micaceous.	8.8	99.0	
	10		D-3	14		ML	@ 10': Olive brown clayey/sandy SILT, very moist, stiff, FeO staining, trace pencil-tip pores.	20.9	95.9	
90							Notes: Total Depth: 11.5 Feet. No Groundwater Encountered. Backfilled with Cuttings and Tamped. Capped with Dyed Concrete.			
	15									
	20									
80										
	25									
	30									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG

Report: HOLLOW STEM; Project: 18181-01.GPJ; Data Template: NMG_GINT_2016.GDT; Printed: 8/14/19

Date(s) Drilled	3/14/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	Modified California, Bulk		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 35+41, 96'L (Railroad Easement).		

H-15

Total Depth Drilled (ft)	57.0
Approximate Ground Surface Elevation (ft)	104.5 msl

Elevation (ft)	Depth (ft)	SAMPLES Type	SAMPLES Number	SAMPLES Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0					SC	Surface: Grass/dirt. **Artificial Fill (Af)**			B-1 @ 0'-5'
			B-1							
			D-1	9			@ 2.5': Dark brown clayey fine SAND, very moist, loose, weathered, pinhole pores, root hairs, glass fragment.	21.9	97.3	
100	5		D-2	9			@ 5': Dark brown clayey fine SAND, very moist, loose, slightly weathered, root hairs.	17.1	98.9	
						CL	**Alluvium (Qal)** Lower: Brownish gray silty CLAY, very moist, medium stiff, rootlets, pinhole pores.			
	10		D-3	29		ML	@ 10': Grayish brown fine sandy SILT, damp, medium dense/very stiff, few pinhole/pencil tip pores, micaceous, root hairs.	11.4	103.6	DS
90	15		D-4	37			@ 15': Upper: Grayish brown clayey SILT, moist, very stiff, FeO stained, pinhole pores, rootlets, micaceous.	23.8	92.8	CN
						SM	Lower: Pale brown silty very fine SAND, moist, micaceous.			
	20		D-5	56		SP	@ 20': Pale brown fine to medium SAND, damp, very dense, highly friable, micaceous.	1.0	99.9	GS
80	25		D-6	40		SP	@ 25': Pale brown fine SAND, damp, medium dense, highly friable, micaceous.	1.8	101.7	GS
	30									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG

Elevation (ft)	Depth (ft)	SAMPLES Type	Number	Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	30		D-7	50		SM	@ 30': Pale olive brown silty SAND, damp, very dense, moderately friable, micaceous.	4.5	98.1	
70										
	35		D-8	25		CL	@ 35': Brown CLAY, saturated, very stiff, few pinhole/pencil-tip pores, micaceous, FeO staining.	17.0	114.1	B-2 @ 35'-40'
			B-2							
	40		D-9	21			@ 40': Yellowish brown silty CLAY, saturated, stiff, few pinhole pores, caliche.	19.8	108.6	
						SC	Tip: Yellowish brown clayey fine SAND, saturated, medium dense.			
60										
	45		D-10	51		SM	@ 45': Olive brown silty fine SAND, moist, very dense, micaceous.	14.5	102.6	
	50		D-11	80/10"		SM-GM	@ 50': No Recovery.			
50										
	55		D-12	85/11"		SM-GM	@ 55': No Recovery.			
			SPT-1	62/12"			@ 56': Light gray fine to coarse gravelly SAND/sandy GRAVEL, damp, very dense, highly friable.	1.7		
							Notes: Total Depth: 57.0 Feet. No Groundwater Encountered. Backfilled with Cuttings and Tamped.			
	60									
40										
	65									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
Norwalk, California

PROJECT NO. 18181-01

Date(s) Drilled	3/14/19	Logged By	ZKH
Drilling Company	2R Drilling	Drill Bit Size/Type	10"
Drill Rig Type	CME 75 Hollow Stem	Hammer Data	140 lbs @ 30" drop
Sampling Method(s)	Modified California, Bulk		
Approximate Groundwater Depth:	No Groundwater Encountered.		
Comments	STA. 36+24, 88'L (Railroad Easement).		

H-16

Total Depth Drilled (ft)	55.5
Approximate Ground Surface Elevation (ft)	105.5 msl

Elevation (ft)	Depth (ft)	SAMPLES: Number	SAMPLES: Blows per foot	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	0			SM	Surface: Grass/dirt. **Artificial Fill (Af)**			B-1 @ 0'-5' CC
		B-1						
		D-1	17	CL	@ 2.5': Upper: Yellowish brown silty fine SAND, moist, medium dense, mottled, trace fine gravel, micaceous. **Alluvium (Qal)** Lower: Dark brown sandy CLAY, wet, stiff, pinhole pores, micaceous.	19.9	106.8	
100	5	D-2	24	ML	@ 5': Upper: Dark brown sandy CLAY, wet, stiff, pinhole pores, micaceous. Lower: Light grayish brown clayey/sandy SILT, wet, stiff, trace pinhole pores.	31.7	90.6	AL, CN, DS
	10	D-3	34		@ 10': Light grayish brown fine sandy SILT, damp, stiff, 1/16" diameter root in sample, micaceous.	4.6	100.5	GS, CN
		B-2						B-2 @ 10'-15'
90	15	D-4	49	SM	@ 15': Upper: Light brownish gray sandy SILT, moist, very stiff, few pencil-tip pores, roots up to 1/8" diameter, FeO staining. Lower: Light brownish gray silty very fine SAND, damp, very dense, friable, micaceous, FeO staining.	10.4	97.3	
	20	D-5	53	SP	@ 20': No Recovery. Clean fine to coarse SAND in waste barrel.			
80	25	D-6	15	SP-SM	@ 25': Light brown silty fine SAND, damp, medium dense, micaceous, friable.	6.5	92.2	GS, CN
		B-3						B-3 @ 25'-30'
	30							

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

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Elevation (ft)	Depth (ft)	SAMPLES Type	Number	Blows per foot	Graphic Log	USCS	MATERIAL DESCRIPTION	Moisture Content (%)	Dry Density (pcf)	OTHER TESTS and REMARKS
	30		D-7	19		SM	@ 30': Gray to yellowish brown silty fine to medium SAND, moist, medium dense, FeO staining, trace clayey laminations in tip.	8.0	97.3	
70	35		D-8	29		CL	@ 35': Dark brown to brown CLAY, wet to saturated, very stiff, coarse gravel in upper rings, more plastic at tip.	16.8	115.4	
	40		D-9	16			@ 40': Brown to yellowish brown silty CLAY, saturated, stiff, abundant caliche.	27.2	97.0	AL, CN
60	45		D-10	53		SM	@ 45': Yellowish brown silty fine SAND, moist, very dense, friable, FeO staining.	2.6	108.7	
	50		D-11	90/11"		SM-GM	@ 50': No Recovery. Driller noted rig chatter.			
50	55		D-12	50/6"			@ 55': No Recovery.			
	60						Notes: Total Depth: 55.5 Feet. No Groundwater Encountered. Backfilled with Cuttings and Tamped.			
	65									

LOG OF BORING

Mark Thomas/Firestone Blvd. Widening
Norwalk, California

PROJECT NO. 18181-01

NMG

APPENDIX C

Mark Thomas/Firestone Blvd. Widening
Project Number: 18181-01

APPENDIX
SUMMARY OF SOIL LABORATORY DATA

Norwalk, California

Boring/Sample Information: Boring No.	Sample No.	Depth (feet)	End Depth (feet)	Elevation (feet)	Blow Count (N)	Field Wet Density (pcf)	Field Dry Density (pcf)	Field Moisture Content (%)	Degree of Sat. (%)	Sieve/Hydrometer: Fines Content (% pass. #200)	Sieve/Hydrometer: Clay Content (% pass. 2µ)	Atterberg Limits: LL (%)	Atterberg Limits: PI (%)	USCS Group Symbol	Direct Shear Ultimate: Cohesion (psf)	Direct Shear Ultimate: Friction Angle (°)	Direct Shear Peak: Cohesion (psf)	Direct Shear Peak: Friction Angle (°)	Compaction: Maximum Dry Density (pcf)	Compaction: Optimum Moisture Content (%)	Expansion Index	R-Value	Soluble Sulfate Content (% by wt)	Remarks
H- 1	B-1	1.5	5.0	106.5																				
H- 1	D-1	2.5		105.5	7	112.3	101.6	10.5	43.0															
H- 1	D-2	5.0		103.0	15	128.0	111.4	14.9	78.4															
H- 1	D-3	10.0		98.0	31	119.5	92.2	29.6	96.7															
H- 3	B-1	0.3		106.8																				
H- 3	B-2	1.5	5.0	105.5						45				SM					125.5	9.5	5	46		CR
H- 3	D-1	2.5		104.5	11	103.2	92.4	11.7	38.5															
H- 3	D-2	5.0		102.0	8	118.1	91.2	29.5	93.9															
H- 3	D-3	10.0		97.0	9	114.5	86.1	32.9	93.0															
H- 4	B-1	1.5	5.0	105.5																				
H- 4	D-1	2.5		104.5	9	117.8	88.3	33.4	99.2															
H- 4	D-2	5.0		102.0	9	117.3	90.5	29.7	92.9															
H- 4	D-3	10.0		97.0	36	110.6	106.1	4.3	19.6															
H- 5	B-1	1.0	5.0	105.0						72				ML					120.0	12.5	34	13		CR
H- 5	D-1	2.5		103.5	11	116.5	89.0	30.9	93.5															
H- 5	D-2	5.0		101.0	17	106.6	91.5	16.5	53.0															
H- 5	D-3	10.0		96.0	16	113.5	87.8	29.3	86.1															
H- 6	B-1	2.0	5.0	108.5																				
H- 6	D-1	2.5		108.0	83	137.6	125.3	9.7	76.4															
H- 6	D-2	5.0		105.5	50/6"			15.8																
H- 6	D-3	10.0		100.5	13	114.8	94.8	21.1	73.2															
H- 7	B-1	1.5		123.5																				
H- 7	D-1	2.5		122.5	84	119.7	112.8	6.1	33.4															
H- 7	D-2	5.0		120.0	57	116.2	109.8	5.8	29.2															
H- 7	D-3	10.0		115.0	54	111.9	108.1	3.6	17.2					SM	110	28	220	37.0						
H- 7	D-4	15.0		110.0	68	124.5	112.1	11.1	59.5															
H- 7	D-5	20.0		105.0	15	107.9	95.6	12.9	45.5															
H- 7	D-6	25.0		100.0	23	105.4	96.4	9.4	34.0															
H- 7	D-7	30.0		95.0	43	104.9	95.8	9.4	33.6															
H- 7	D-8	35.0		90.0	63	107.3	103.7	3.5	15.0															
H- 7	D-9	40.0		85.0	90/11"	112.3	109.9	2.2	11.3															
H- 8	B-1	1.0	5.0	124.5																				
H- 8	D-1	2.5		123.0	85/11"	122.2	115.0	6.2	36.1															
H- 8	D-2	5.0		120.5	57	119.2	113.3	5.2	28.9															
H- 8	D-3	10.0		115.5	54	115.2	110.3	4.4	22.4															

NMG Geotechnical, Inc.

Printed: 8/15/19; Template: SUM_SOIL_LAB_ALL; Proj ID: 18181-01.GPJ

APPENDIX
SUMMARY OF SOIL LABORATORY DATA

Boring/Sample Information						Field Wet Density (pcf)	Field Dry Density (pcf)	Field Moisture Content (%)	Degree of Sat. (%)	Sieve/ Hydrometer		Atterberg Limits		USCS Group Symbol	Direct Shear				Compaction		Expansion Index	R-Value	Soluble Sulfate Content (% by wt)	Remarks
															Ultimate		Peak							
Boring No.	Sample No.	Depth (feet)	End Depth (feet)	Elevation (feet)	Blow Count (N)					Fines Content (% pass. #200)	Clay Content (% pass. 2µ)	LL (%)	PI (%)		Cohesion (psf)	Friction Angle (º)	Cohesion (psf)	Friction Angle (º)	Maximum Dry Density (pcf)	Optimum Moisture Content (%)				
H- 9	B-1	1.5	5.0	130.5						13				SM					131.0	7.5		66		CR
H- 9	D-1	2.5		129.5	75	130.3	120.0	8.6	57.4															
H- 9	D-2	5.0		127.0	63	124.0	115.7	7.2	42.4					SM	60	35	310	39.0						
H- 9	D-3	10.0		122.0	85	121.4	115.6	5.0	29.7															
H- 9	D-4	15.0		117.0	74	116.2	113.3	2.5	14.0															
H- 9	D-5	20.0		112.0	79/11"	122.6	114.3	7.3	41.5															
H- 9	D-6	25.0		107.0	62	109.4	104.3	4.8	21.2															
H- 9	D-7	30.0		102.0	20	125.8	107.9	16.5	79.5															
H- 9	D-8	32.5		99.5	23	126.1	104.7	20.5	90.7					ML	150	29	440	28.5						
H- 9	D-9	35.0		97.0	45	130.2	116.3	12.0	72.0															
H- 9	D-10	40.0		92.0	21	116.3	88.6	31.3	93.8															
H- 9	D-11	45.0		87.0	78	105.4	103.6	1.7	7.5															
H- 9	D-12	50.0		82.0	85	104.8	102.8	2.0	8.4															
H- 9	D-13	55.0		77.0	31	111.4	109.1	2.1	10.2															
H- 9	D-14	60.0		72.0	26	133.8	114.5	16.9	96.7															
H- 9	D-15	65.0		67.0	32	134.6	114.5	17.6	100.0															
H-10	B-1	1.5	5.0	124.0																				
H-10	D-1	2.5		123.0	80/11"	131.8	125.5	5.0	39.4															
H-10	D-2	5.0		120.5	82	118.5	112.2	5.7	30.4															
H-10	D-3	10.0		115.5	88	120.9	115.8	4.4	26.1															
H-11	B-1	0.3	1.0	113.8																				
H-11	B-2	1.5	5.0	112.5																				
H-11	D-1	2.5		111.5	87	119.4	111.9	6.7	35.7															
H-11	D-2	5.0		109.0	80	122.2	115.7	5.7	33.5															
H-11	D-3	10.0		104.0	50/3"	129.6	113.6	14.0	78.5															
H-11	D-4	15.0		99.0	24	121.8	101.1	20.5	83.0															
H-11	D-5	20.0		94.0	45	104.4	102.2	2.2	9.0															
H-11	D-6	25.0		89.0	69	103.8	102.2	1.6	6.7															
H-11	D-7	30.0		84.0	84	104.8	103.2	1.6	6.9															
H-11	D-8	35.0		79.0	58			3.9																
H-11	D-9	40.0		74.0	41	105.6	100.1	5.5	21.8															
H-12	B-1	1.5	2.5	104.5																				
H-13	B-1	1.5	5.0	102.5						30				SM					122.0	10.5		61		CR
H-13	D-1	2.5		101.5	14	111.4	102.7	8.5	35.6															
H-13	D-2	5.0		99.0	17	102.2	95.8	6.7	23.8															

NMG Geotechnical, Inc.

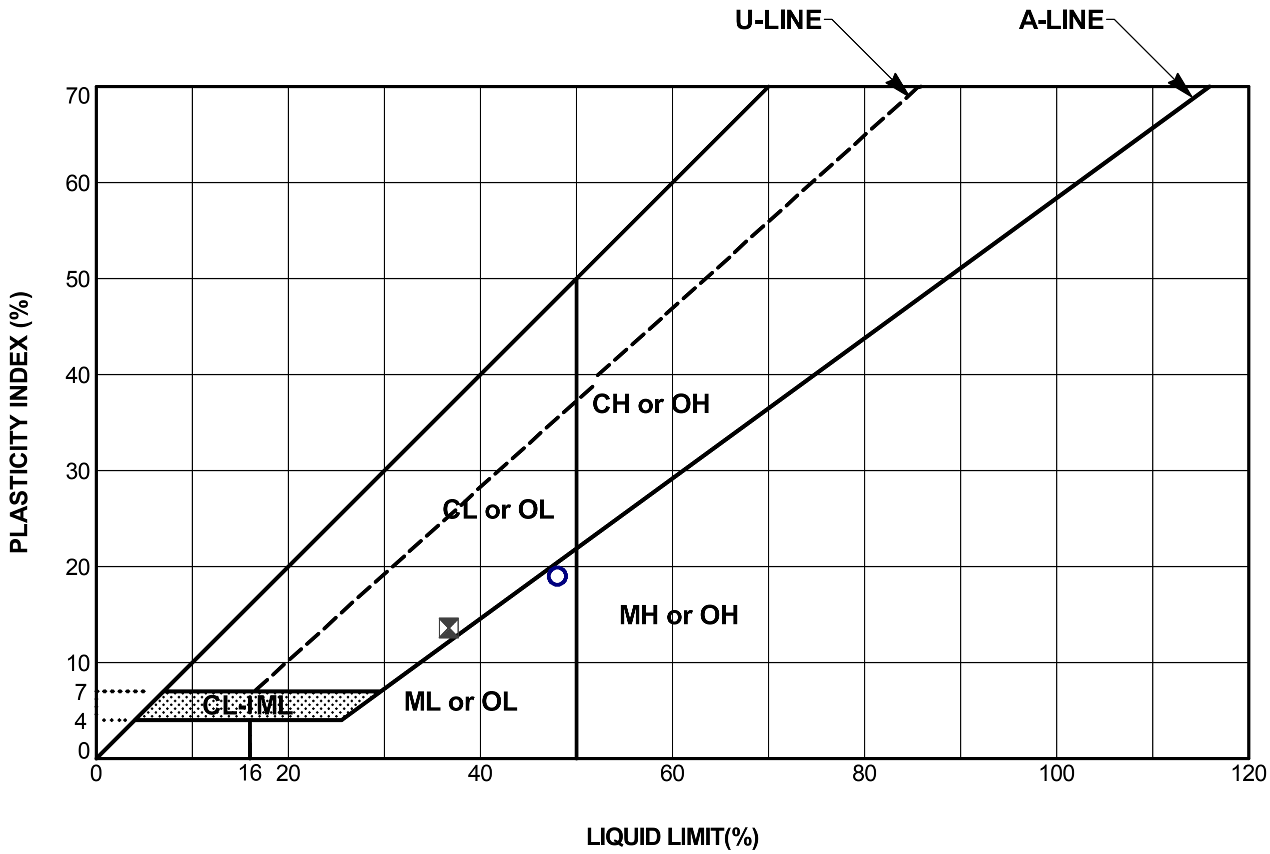
Mark Thomas/Firestone Blvd. Widening
Project Number: 18181-01

APPENDIX
SUMMARY OF SOIL LABORATORY DATA

Norwalk, California

Boring/Sample Information										Sieve/ Hydrometer		Atterberg Limits			Direct Shear				Compaction					
															Ultimate		Peak							
Boring No.	Sample No.	Depth (feet)	End Depth (feet)	Elevation (feet)	Blow Count (N)	Field Wet Density (pcf)	Field Dry Density (pcf)	Field Moisture Content (%)	Degree of Sat. (%)	Fines Content (% pass. #200)	Clay Content (% pass. 2μ)	LL (%)	PI (%)	USCS Group Symbol	Cohesion (psf)	Friction Angle (°)	Cohesion (psf)	Friction Angle (°)	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	Expansion Index	R-Value	Soluble Sulfate Content (% by wt)	Remarks
H-14	B-1	1.5	5.0	101.5																				
H-14	D-1	2.5		100.5	47	138.9	124.7	11.4	87.3															
H-14	D-2	5.0		98.0	12	107.7	99.0	8.8	33.9															
H-14	D-3	10.0		93.0	14	116.0	95.9	20.9	74.6															
H-15	B-1	0.0	5.0	104.5																				
H-15	D-1	2.5		102.0	9	118.5	97.3	21.9	80.7															
H-15	D-2	5.0		99.5	9	115.8	98.9	17.1	65.5															
H-15	D-3	10.0		94.5	29	115.4	103.6	11.4	49.1					ML	120	30	320	30.0						
H-15	D-4	15.0		89.5	37	114.8	92.8	23.8	78.6					ML										CN
H-15	D-5	20.0		84.5	56	100.9	99.9	1.0	3.9	2				SP										
H-15	D-6	25.0		79.5	40	103.6	101.7	1.8	7.5	2				SP										
H-15	D-7	30.0		74.5	50	102.5	98.1	4.5	16.9															
H-15	D-8	35.0		69.5	25	133.5	114.1	17.0	96.3															
H-15	B-2	35.0	40.0	69.5																				
H-15	D-9	40.0		64.5	21	130.1	108.6	19.8	96.8															
H-15	D-10	45.0		59.5	51	117.4	102.6	14.5	60.8															
H-15	D-11	50.0		54.5	80/10"																			
H-15	D-12	55.0		49.5	85/11"																			
H-15	SPT-1	56.0		48.5	62/12"			1.7																
H-16	B-1	0.0	5.0	105.5																				CR
H-16	D-1	2.5		103.0	17	128.1	106.8	19.9	93.2															
H-16	D-2	5.0		100.5	24	119.3	90.6	31.7	99.5			48	19	ML	250	27	520	27.0						CN
H-16	D-3	10.0		95.5	34	105.1	100.5	4.6	18.3	56				ML										CN
H-16	B-2	10.0	15.0	95.5																				
H-16	D-4	15.0		90.5	49	107.5	97.3	10.4	38.4															
H-16	D-5	20.0		85.5	53																			
H-16	D-6	25.0		80.5	15	98.2	92.2	6.5	21.3	11				SP-SM										
H-16	B-3	25.0	30.0	80.5																				
H-16	D-7	30.0		75.5	19	105.1	97.3	8.0	29.6															
H-16	D-8	35.0		70.5	29	134.8	115.4	16.8	98.5															
H-16	D-9	40.0		65.5	16	123.3	97.0	27.2	99.6			37	14	CL										CN
H-16	D-10	45.0		60.5	53	111.6	108.7	2.6	13.0															
H-16	D-11	50.0		55.5	90/11"																			
H-16	D-12	55.0		50.5	50/6"																			

NMG Geotechnical, Inc.

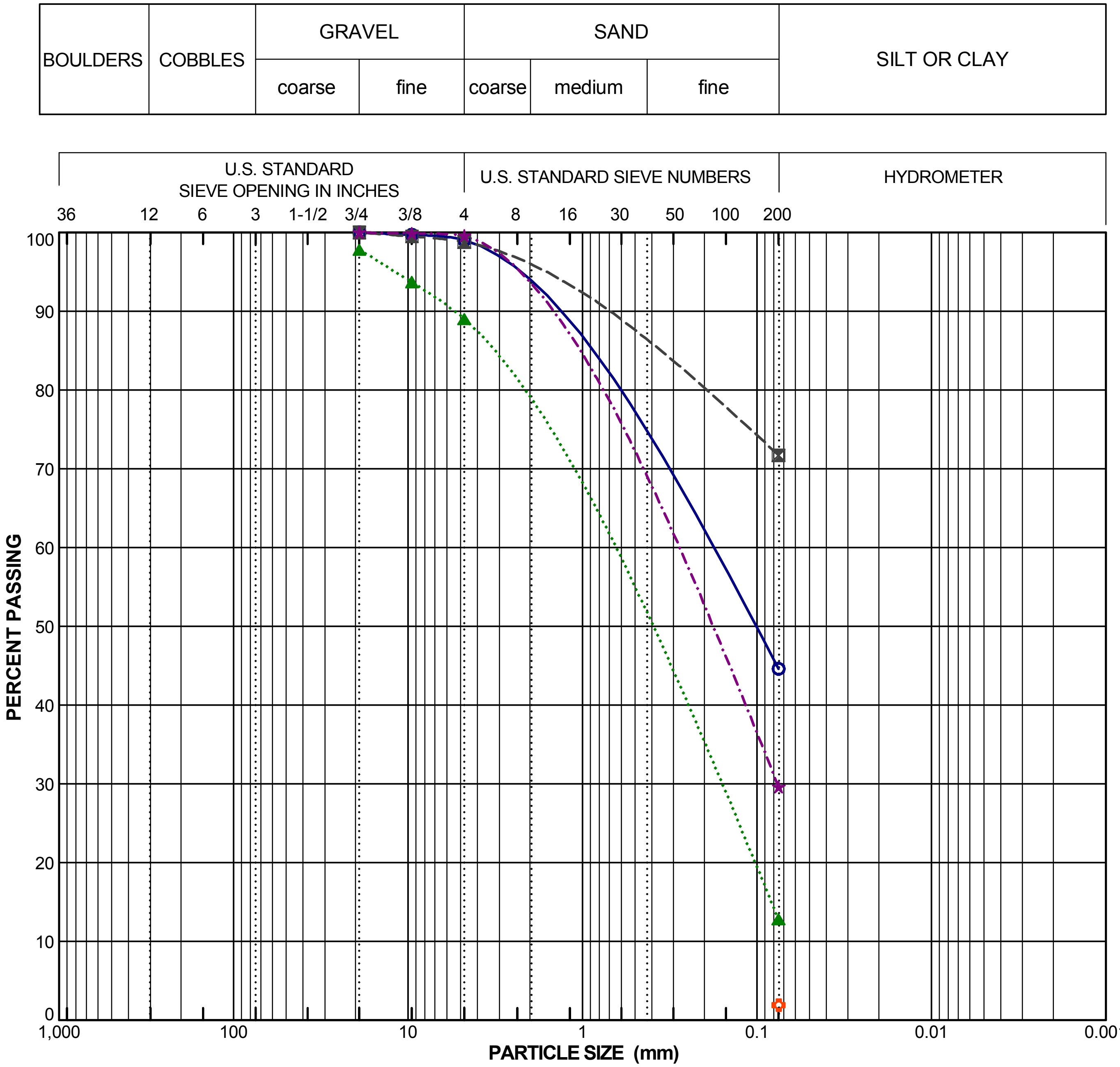


Symbol	Boring Number	Sample Number	Depth (feet)	Passing No. 200 Sieve (%)	LL	PI	USCS	Description
○	H-16	D-2	5.0		48	19	ML	(Qal) Dark brown clayey SILT
⊠	H-16	D-9	40.0		37	14	CL	(Qal) Brown sandy silty CLAY

PLASTICITY CHART

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.

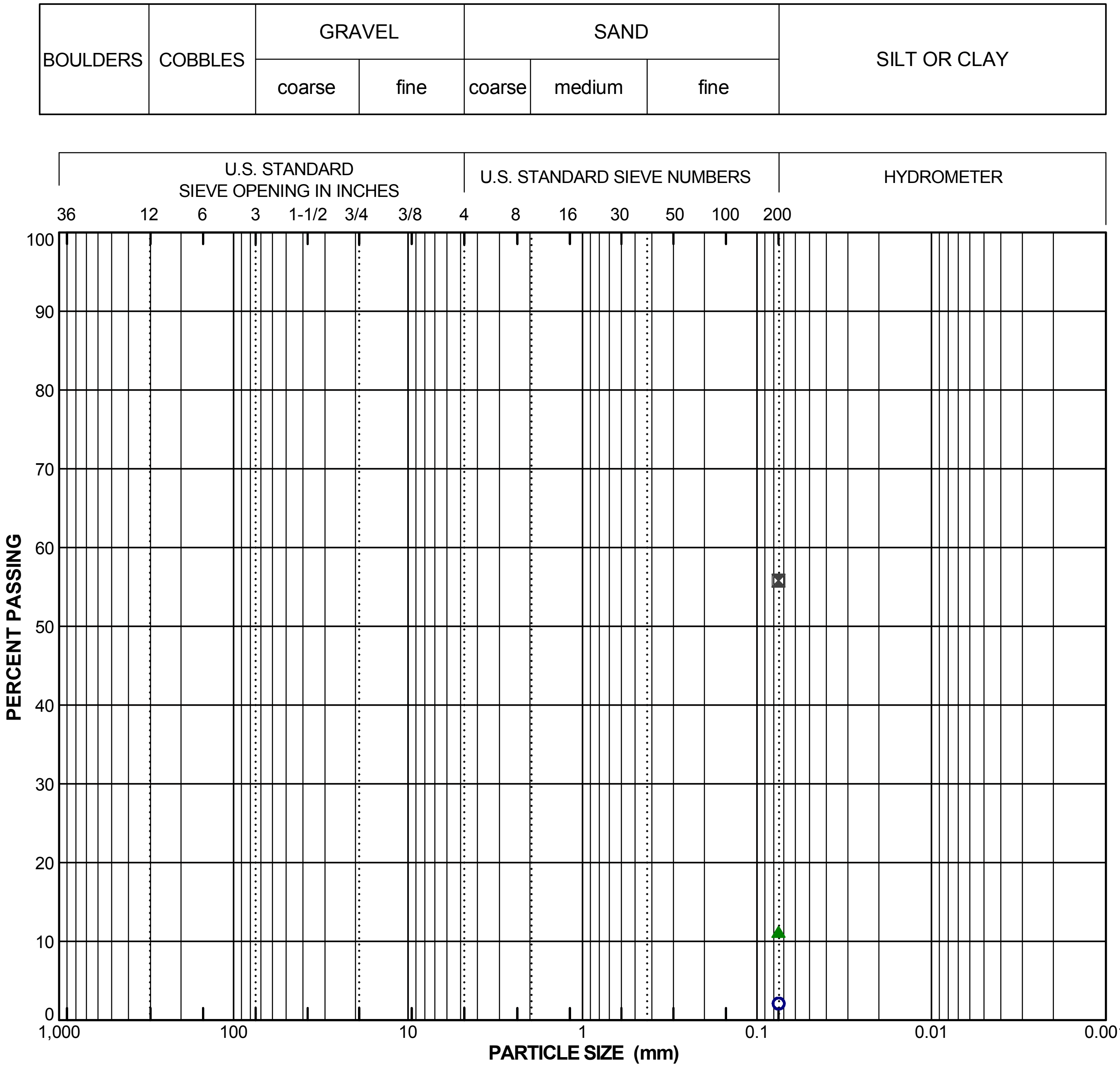


Symbol	Boring Number	Sample Number	Depth (feet)	Field Moisture (%)	LL	PI	Activity PI/-2μ	C_u	C_c	Passing No. 200 Sieve (%)	Passing 2μ (%)	USCS
○	H- 3	B-2	1.5 - 5.0							45		SM
⊠	H- 5	B-1	1.0 - 5.0							72		ML
▲	H- 9	B-1	1.5 - 5.0							13		SM
★	H-13	B-1	1.5 - 5.0							30		SM
✿	H-15	D-5	20.0	1						2		SP

PARTICLE SIZE DISTRIBUTION

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.

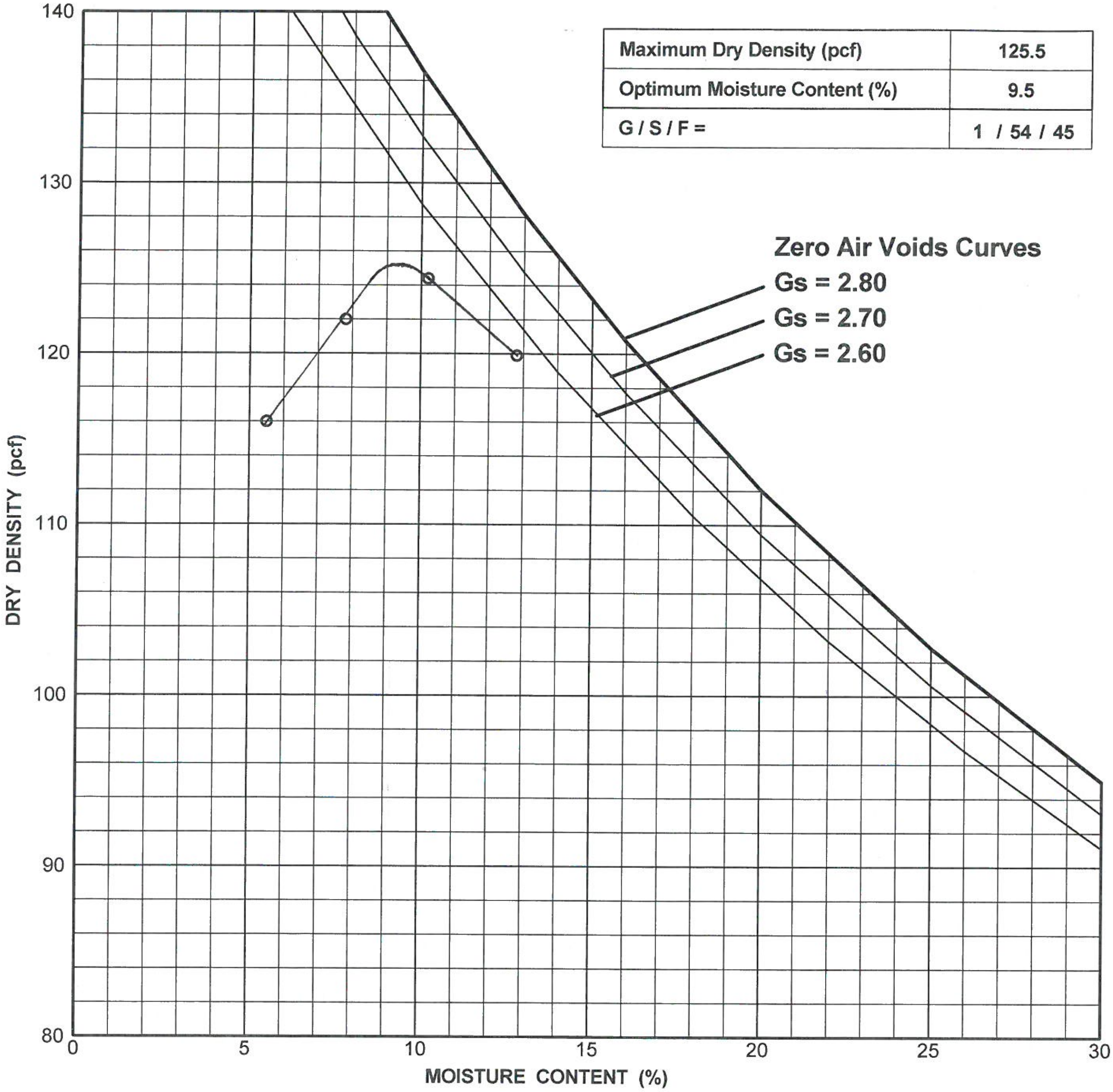


Symbol	Boring Number	Sample Number	Depth (feet)	Field Moisture (%)	LL	PI	Activity PI/-2µ	C_u	C_c	Passing No. 200 Sieve (%)	Passing 2µ (%)	USCS
○	H-15	D-6	25.0	2						2		SP
⊠	H-16	D-3	10.0	5						56		ML
▲	H-16	D-6	25.0	7						11		SP-SM

PARTICLE SIZE DISTRIBUTION

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.



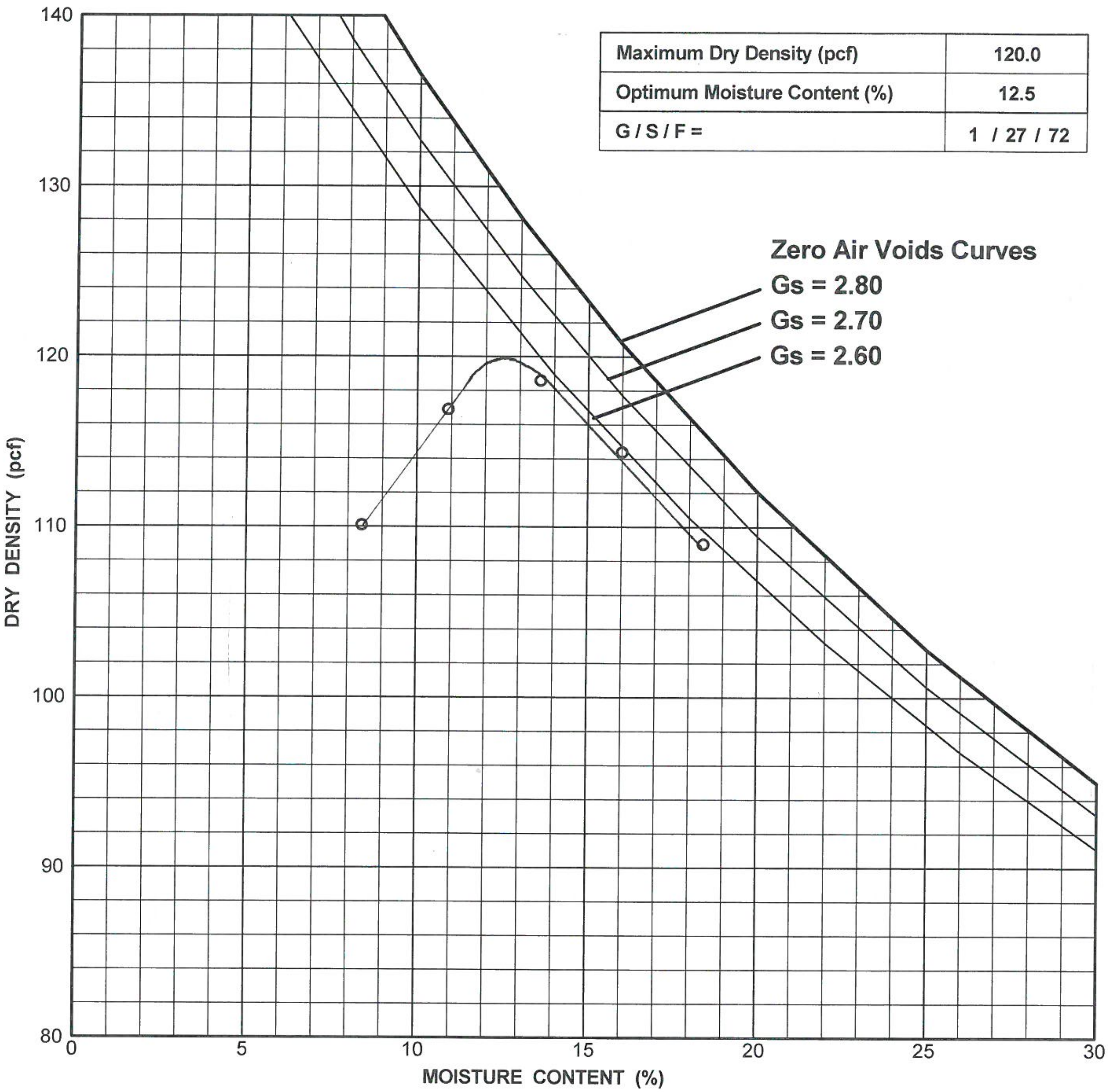
Maximum Dry Density (pcf)	125.5
Optimum Moisture Content (%)	9.5
G / S / F =	1 / 54 / 45

Boring No. H- 3	**Sample No.** B-2	**Depth:** 1.5 - 5.0 ft
Sample Description: (Qal) Brown silty SAND		**USCS:** SM
Liquid Limit:	**Plasticity Index:**	**Percent Passing No. 200 Sieve:** 45
Comments: 1557A		

COMPACTION TEST RESULTS

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.



Maximum Dry Density (pcf)	120.0
Optimum Moisture Content (%)	12.5
G / S / F =	1 / 27 / 72

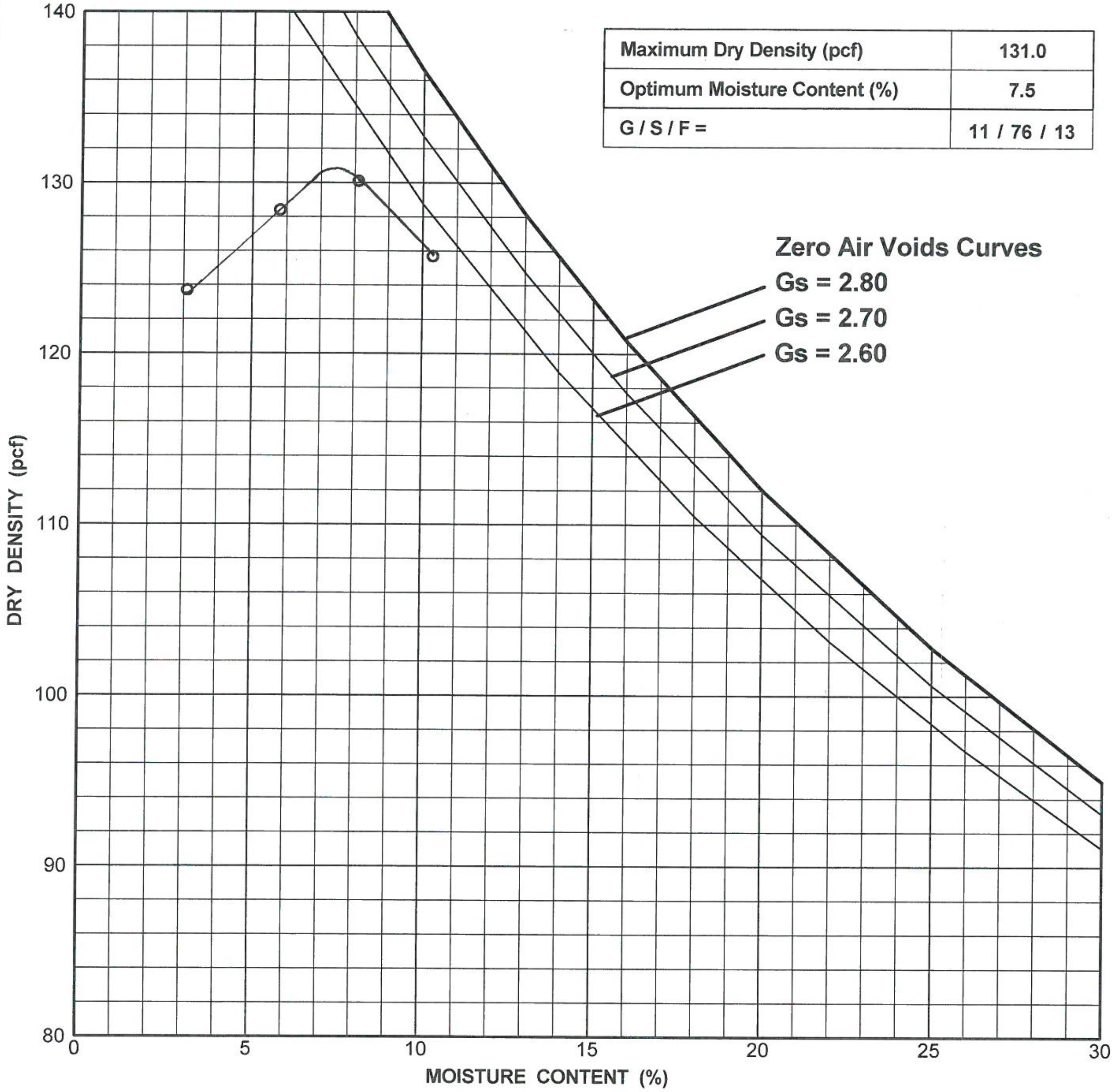
Boring No. H- 5	**Sample No. B-1**	**Depth: 1.0 - 5.0 ft**
Sample Description: (Qal) Brown sandy SILT		**USCS:** ML
Liquid Limit:	**Plasticity Index:**	**Percent Passing No. 200 Sieve:** 72
Comments: 1557A		

COMPACTION TEST RESULTS

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.

Template: NMCOMP_21; Prj ID: 18181-01.GPJ; Printed: 8/15/19



Maximum Dry Density (pcf)	131.0
Optimum Moisture Content (%)	7.5
G / S / F =	11 / 76 / 13

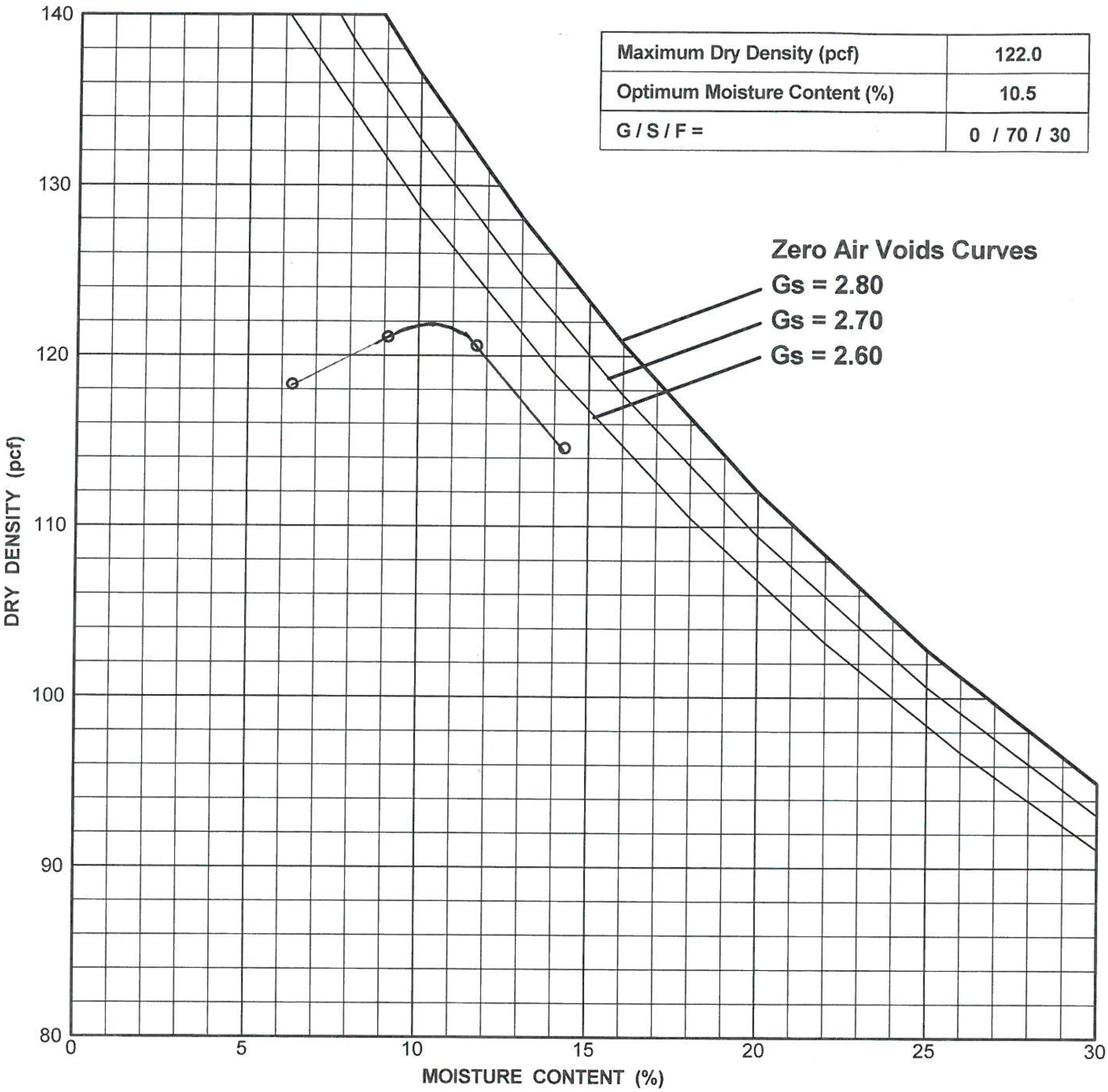
Boring No. H- 9	Sample No. B-1	Depth: 1.5 - 5.0 ft
Sample Description: (Af) Yellowish brown silty SAND		USCS: SM
Liquid Limit:	Plasticity Index:	Percent Passing No. 200 Sieve: 13
Comments: 1557B		

COMPACTION TEST RESULTS

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.

Template: NMCOMP_21; Prj ID: 18181-01.GPJ; Printed: 8/15/19



Maximum Dry Density (pcf)	122.0
Optimum Moisture Content (%)	10.5
G / S / F =	0 / 70 / 30

Boring No. H-13	Sample No. B-1	Depth: 1.5 - 5.0 ft
Sample Description: (Qal) Dark brown silty SAND		USCS: SM
Liquid Limit:	Plasticity Index:	Percent Passing No. 200 Sieve: 30
Comments: 1557A		

COMPACTION TEST RESULTS

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.

Sample	Compacted Moisture (%)	Compacted Dry Density (pcf)	Final Moisture (%)	Volumetric Swell (%)	Expansion Index[1] Value/Method		Expansive Classification[2]	Soluble Sulfate (%)	Sulfate Exposure[3]
H-3 B-2 1.5-5'	10.0	110.6	16.8	0.45	5	A	Very Low	--	--
H-5 B-1 1-5'	12.2	103.0	22.7	3.36	34	A	Low	--	--

Test Method:

ASTM D4829

HACH SF-1 (Turbidimetric)

Notes:

1. Expansion Index (EI) method of determination*:*
   - **[A]** E.I. determined by adjusting water content to achieve a 50 ±1% degree of saturation
   - **[B]** E.I. calculated based on measured saturation within the range of 40% and 60%
2. ASTM D4829 *(Classification of Expansive Soil)*
3. ACI-318-14 Table 19.3.1.1 *(Requirement for Concrete Exposed to Sulfate-Containing Solutions)*

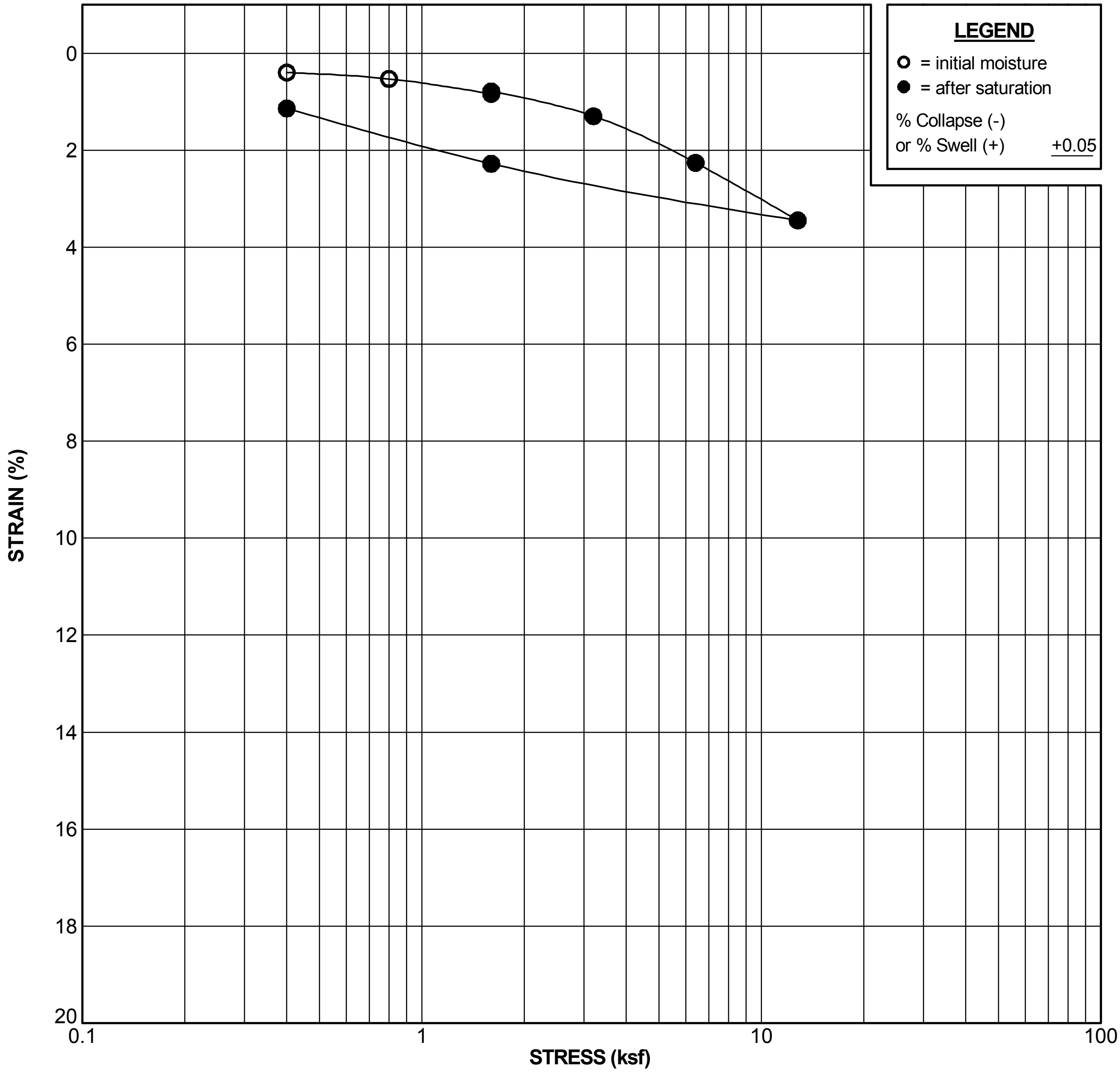
Expansion Index and Soluble Sulfate Test Results

(FRM001 Rev.5)

Project No. 18181-01

Project Name: Mark Thomas / Firestone Blvd

NMG



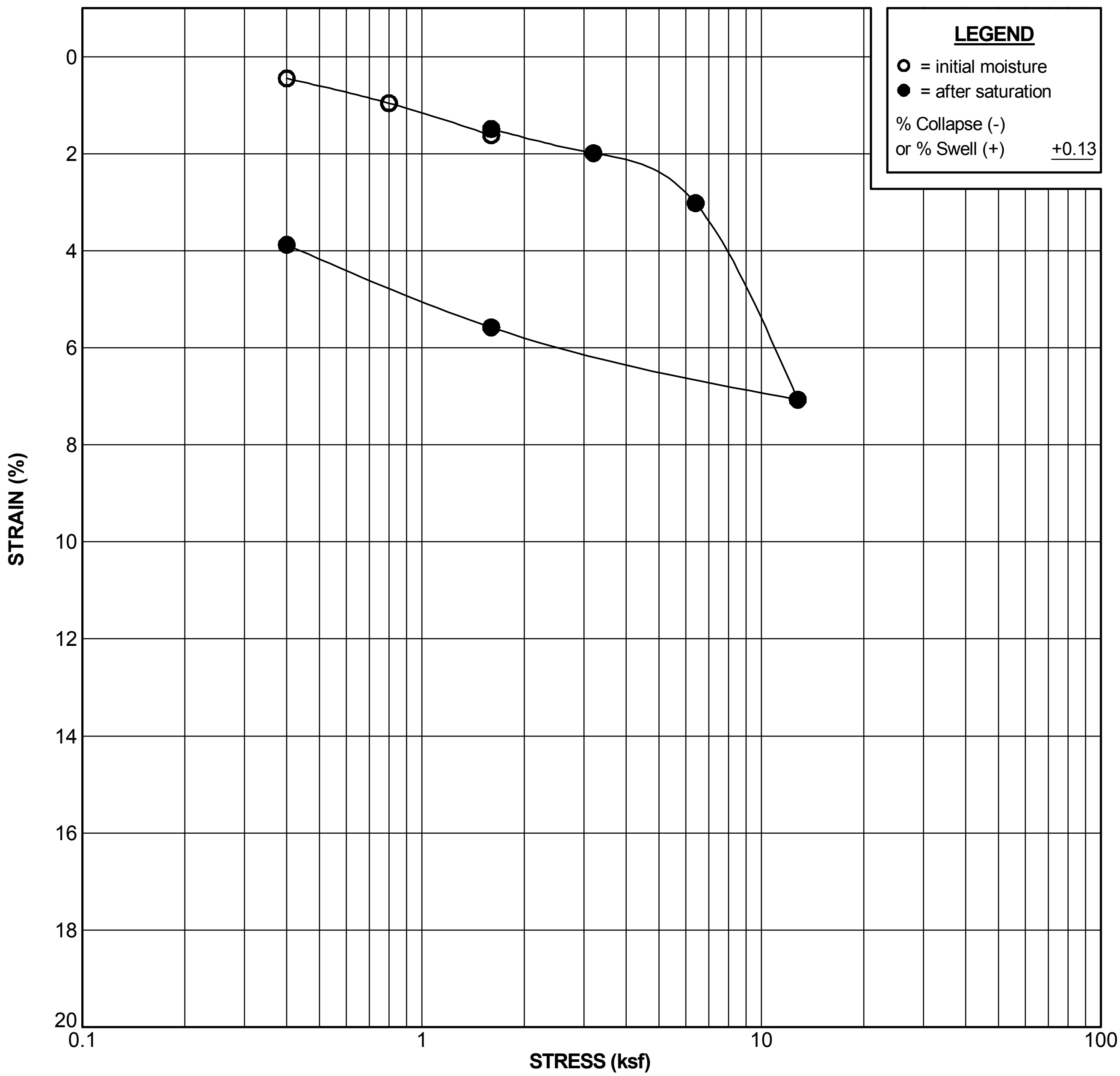
Boring No. H-15	**Sample No. D-4**	**Depth: 15.0 ft**
Sample Description: (Qal) Dark yellowish brown clayey SILT		**USCS:** ML
Liquid Limit:	**Plasticity Index:**	**Percent Passing No. 200 Sieve:**

Test Stage	Moisture Content (%)	Dry Density (pcf)	Degree of Saturation (%)	Void Ratio
Initial	16.7	96.3	60.2	0.750
Final	26.5	97.4	98.0	0.730

CONSOLIDATION TEST RESULTS

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.



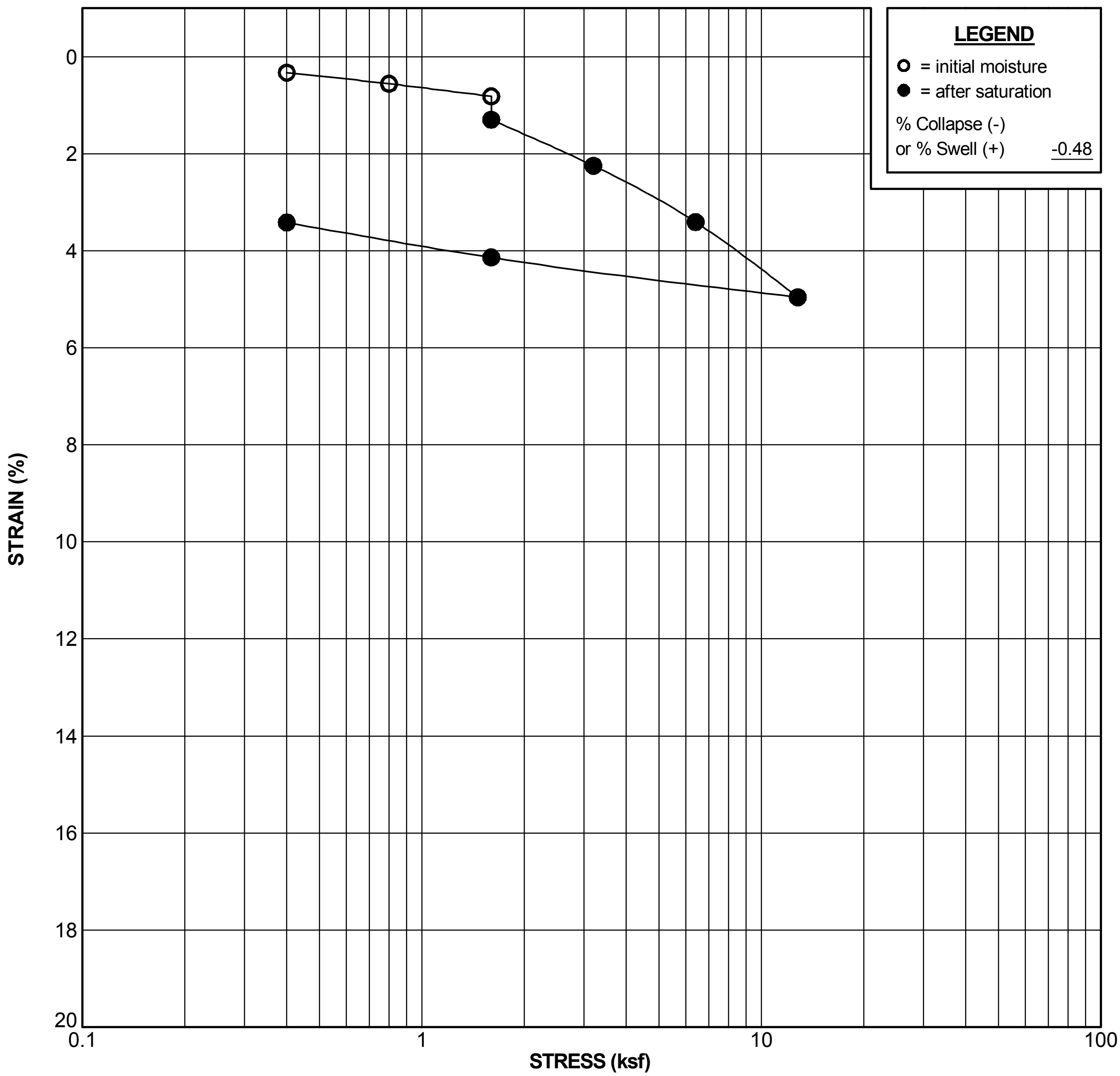
Boring No. H-16	Sample No. D-2	Depth: 5.0 ft
Sample Description: (Qal) Dark brown clayey SILT		**USCS:** ML
Liquid Limit: 48	**Plasticity Index:** 19	**Percent Passing No. 200 Sieve:**

Test Stage	Moisture Content (%)	Dry Density (pcf)	Degree of Saturation (%)	Void Ratio
Initial	28.3	89.1	64.2	1.696
Final	29.7	92.6	71.7	1.594

CONSOLIDATION TEST RESULTS

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.



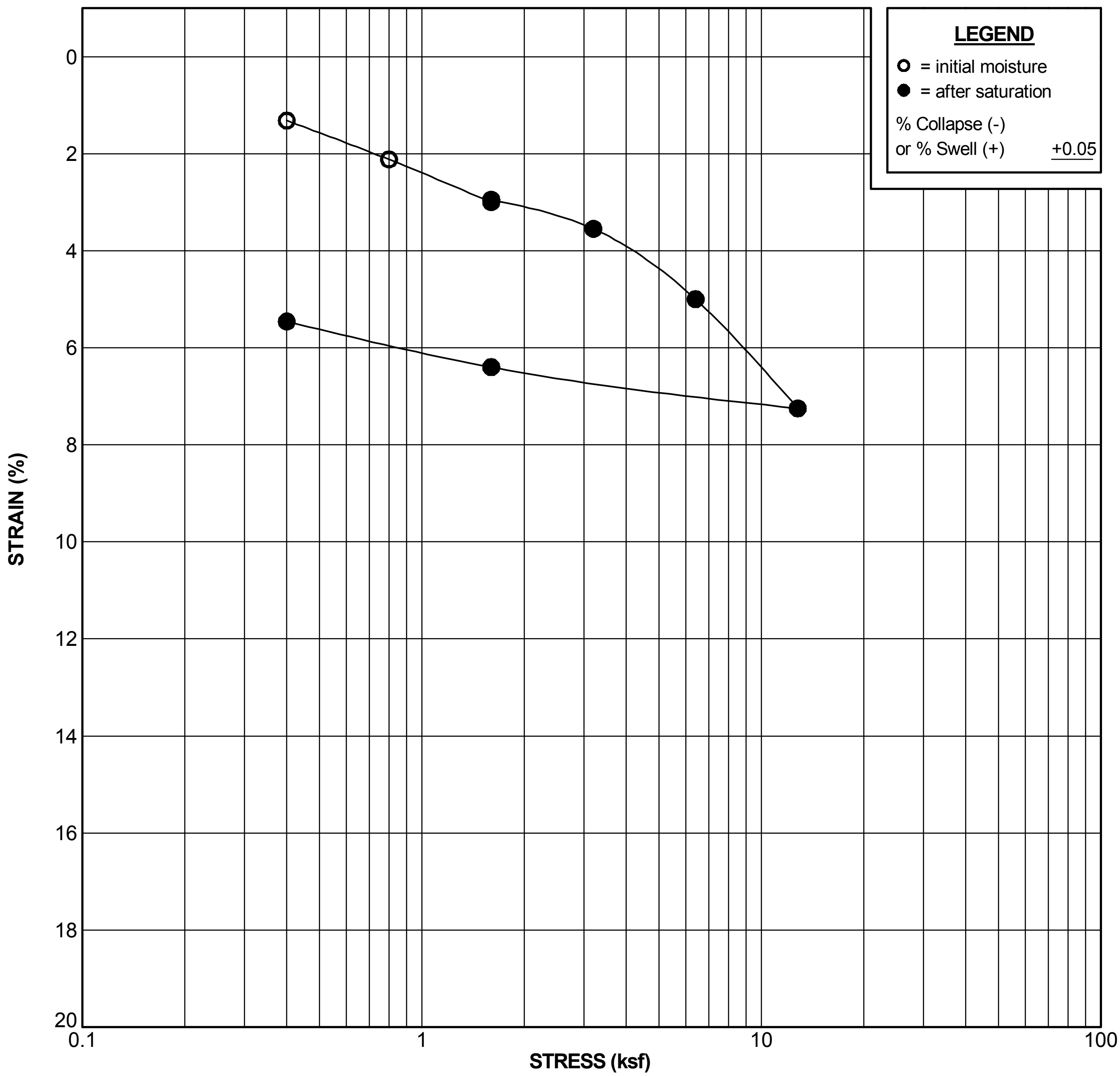
Boring No. H-16	Sample No. D-3	Depth: 10.0 ft
Sample Description: (Qal) Olive brown sandy SILT		**USCS:** ML
Liquid Limit:	**Plasticity Index:**	**Percent Passing No. 200 Sieve:** 56

Test Stage	Moisture Content (%)	Dry Density (pcf)	Degree of Saturation (%)	Void Ratio
Initial	5.6	97.2	20.6	0.733
Final	24.9	100.5	99.4	0.676

CONSOLIDATION TEST RESULTS

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.



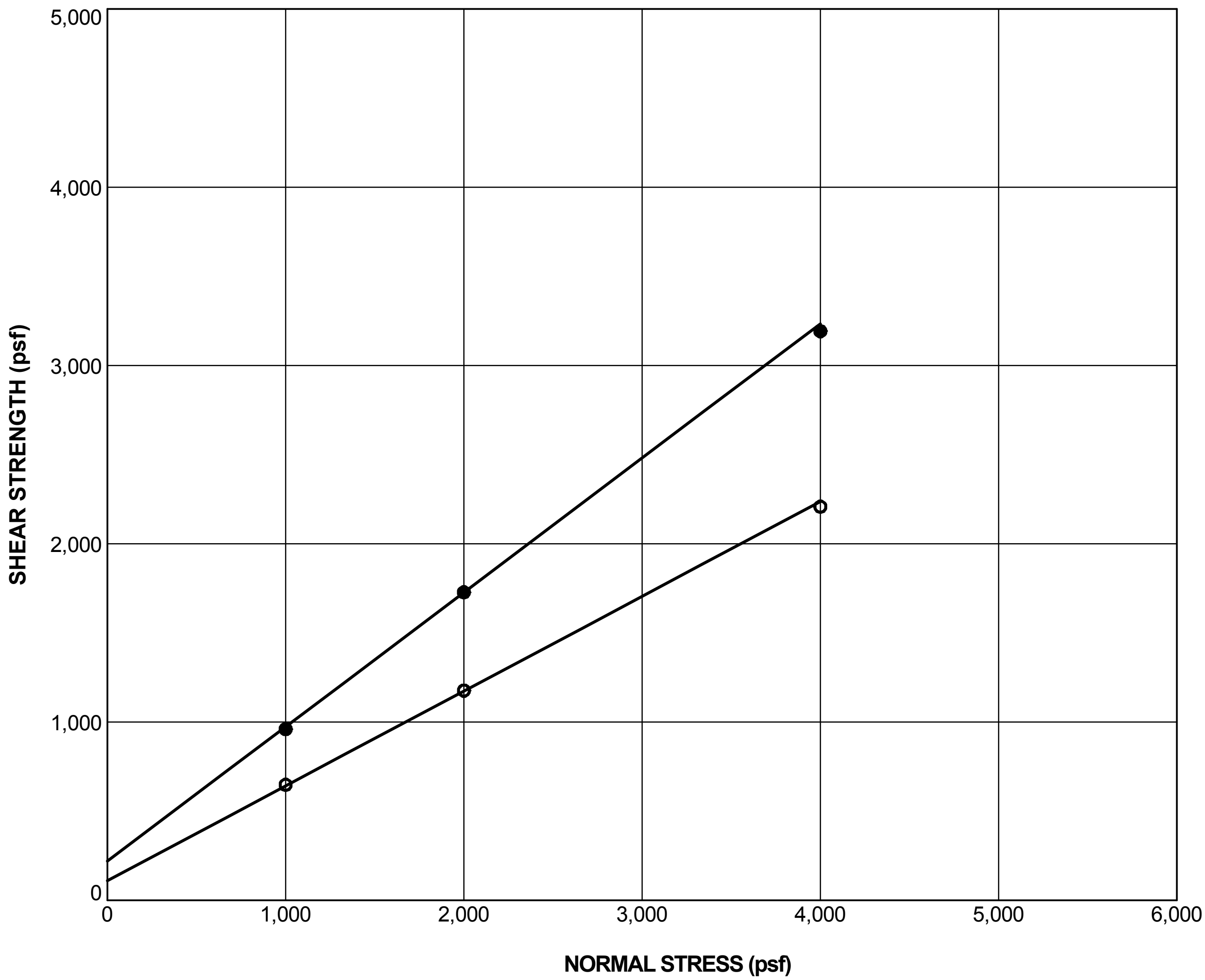
Boring No. H-16	Sample No. D-9	Depth: 40.0 ft
Sample Description: (Qal) Brown sandy silty CLAY		**USCS:** CL
Liquid Limit: 37	**Plasticity Index:** 14	**Percent Passing No. 200 Sieve:**

Test Stage	Moisture Content (%)	Dry Density (pcf)	Degree of Saturation (%)	Void Ratio
Initial	27.0	96.6	97.0	0.757
Final	24.4	101.9	99.7	0.666

CONSOLIDATION TEST RESULTS

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.



Boring No. H- 7		**Sample No. D-3**		**Depth: 10.0 ft**	
Sample Description:	(Afu) Pale gray silty SAND			**USCS:**	SM
Liquid Limit:		**Plasticity Index:**		**Percent Passing No. 200 Sieve:**	
Final Moisture Content (%):	27.1	**Final Dry Density (pcf):**	101.5	**Degree of Saturation (%):**	100
Sample Type:	Undisturbed	**Rate of Shear (in./min.):**	0.05		

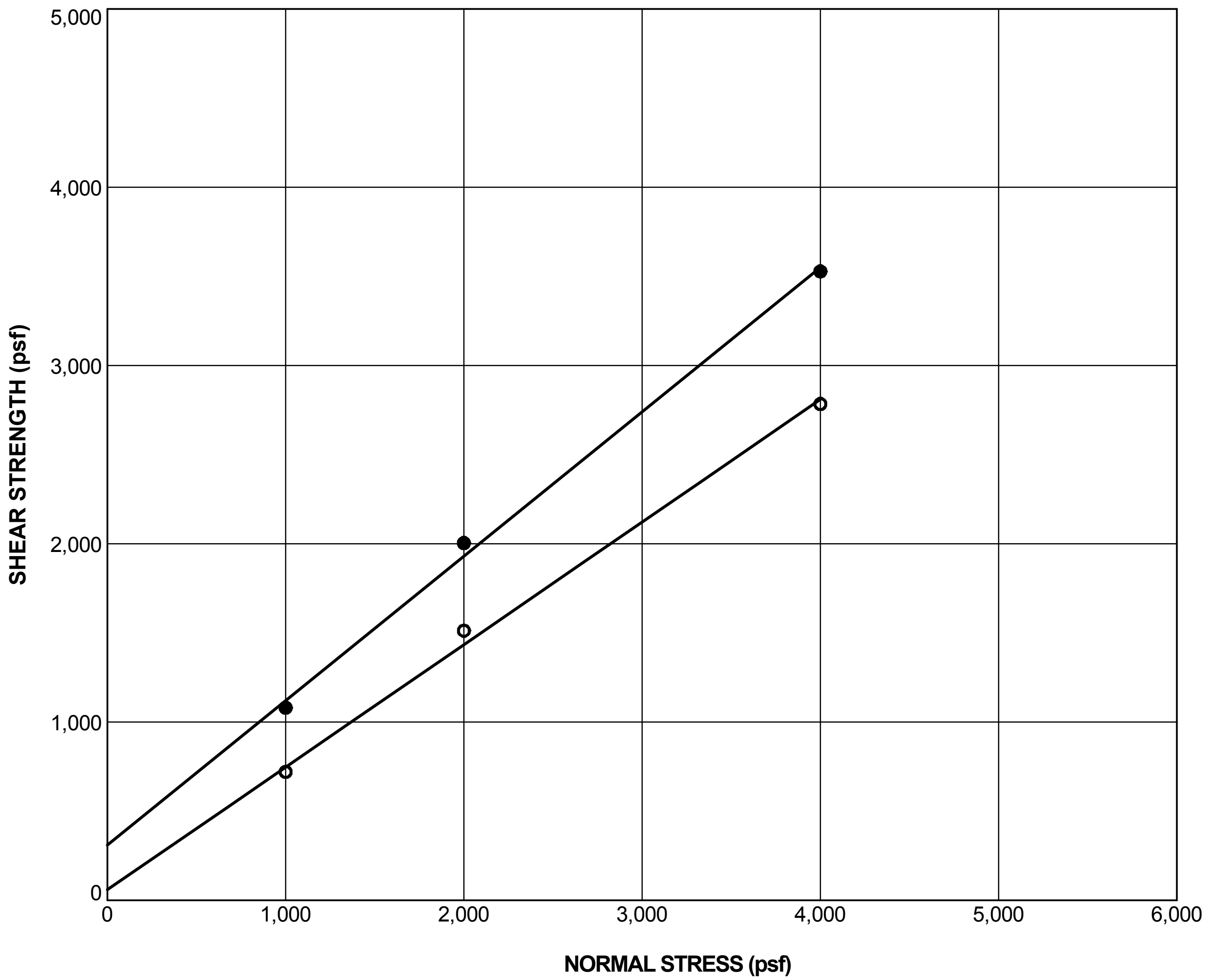
SHEAR STRENGTH PARAMETERS

Parameter	Peak ●	Ultimate ○
Cohesion (psf)	220	110
Friction Angle (degrees)	37.0	28.0

DIRECT SHEAR TEST RESULTS

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.



Boring No. H- 9	Sample No. D-2	Depth: 5.0 ft
Sample Description: (Afu) Yellowish brown silty SAND w/ gravel		**USCS:** SM
Liquid Limit:	**Plasticity Index:**	**Percent Passing No. 200 Sieve:**
Final Moisture Content (%): 24.5	**Final Dry Density (pcf):** 107.9	**Degree of Saturation (%):** 100
Sample Type: Undisturbed	**Rate of Shear (in./min.):** 0.05	

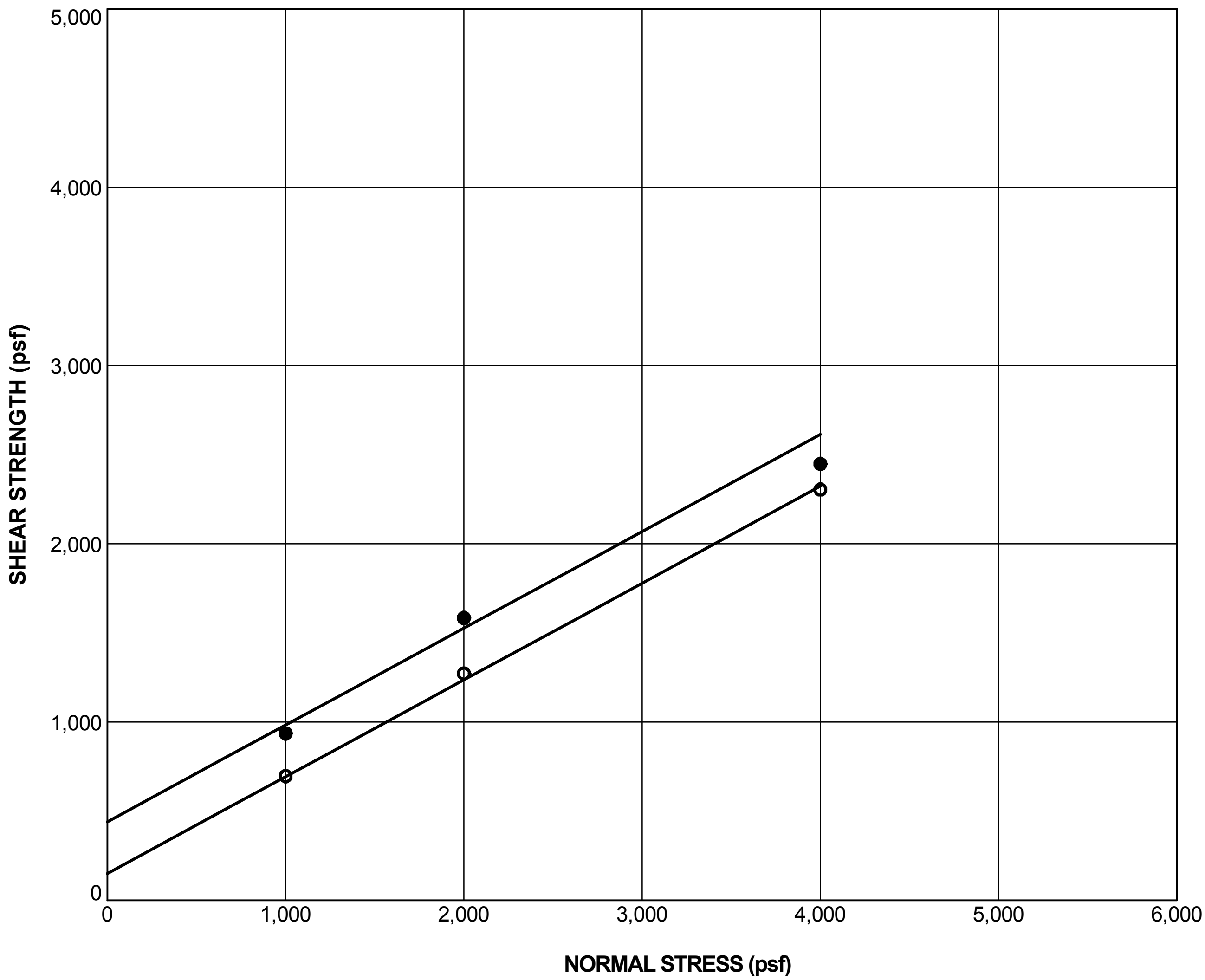
SHEAR STRENGTH PARAMETERS

Parameter	Peak ●	Ultimate ○
Cohesion (psf)	310	60
Friction Angle (degrees)	39.0	34.5

DIRECT SHEAR TEST RESULTS

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.



Boring No. H- 9		Sample No. D-8		Depth: 32.5 ft	
Sample Description:	(Qal) Dark olive gray clayey SILT			**USCS:**	ML
Liquid Limit:		**Plasticity Index:**		**Percent Passing No. 200 Sieve:**	
Final Moisture Content (%):	28.1	**Final Dry Density (pcf):**	101.2	**Degree of Saturation (%):**	100
Sample Type:	Normal	**Rate of Shear (in./min.):**	0.005		

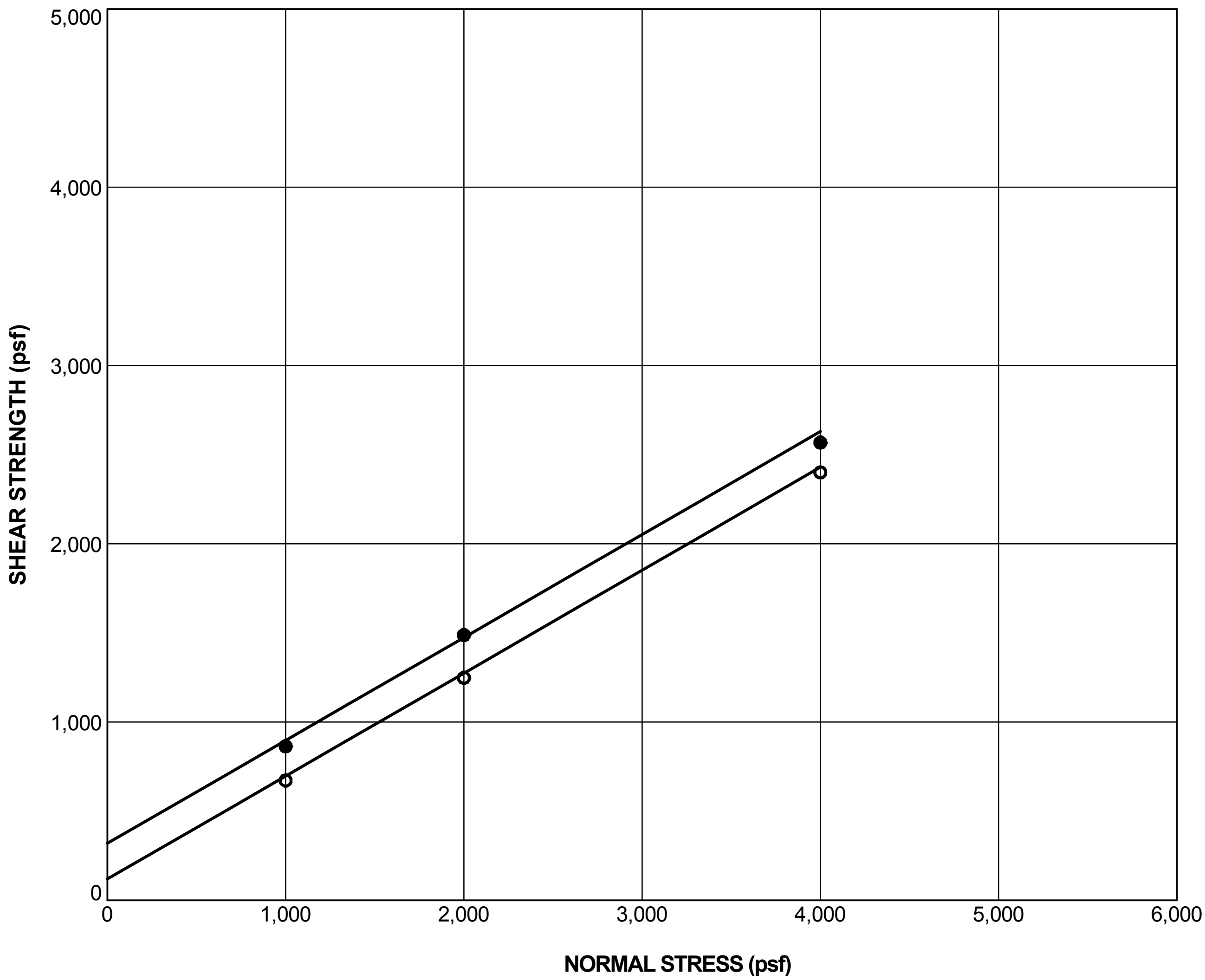
SHEAR STRENGTH PARAMETERS

Parameter	Peak ●	Ultimate ○
Cohesion (psf)	440	150
Friction Angle (degrees)	28.5	28.5

DIRECT SHEAR TEST RESULTS

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.



Boring No. H-15	Sample No. D-3	Depth: 10.0 ft
Sample Description: (Qal) Reddish brown sandy SILT		**USCS:** ML
Liquid Limit:	**Plasticity Index:**	**Percent Passing No. 200 Sieve:**
Final Moisture Content (%): 27.4	**Final Dry Density (pcf):** 101.7	**Degree of Saturation (%):** 100
Sample Type: Undisturbed	**Rate of Shear (in./min.):** 0.05	

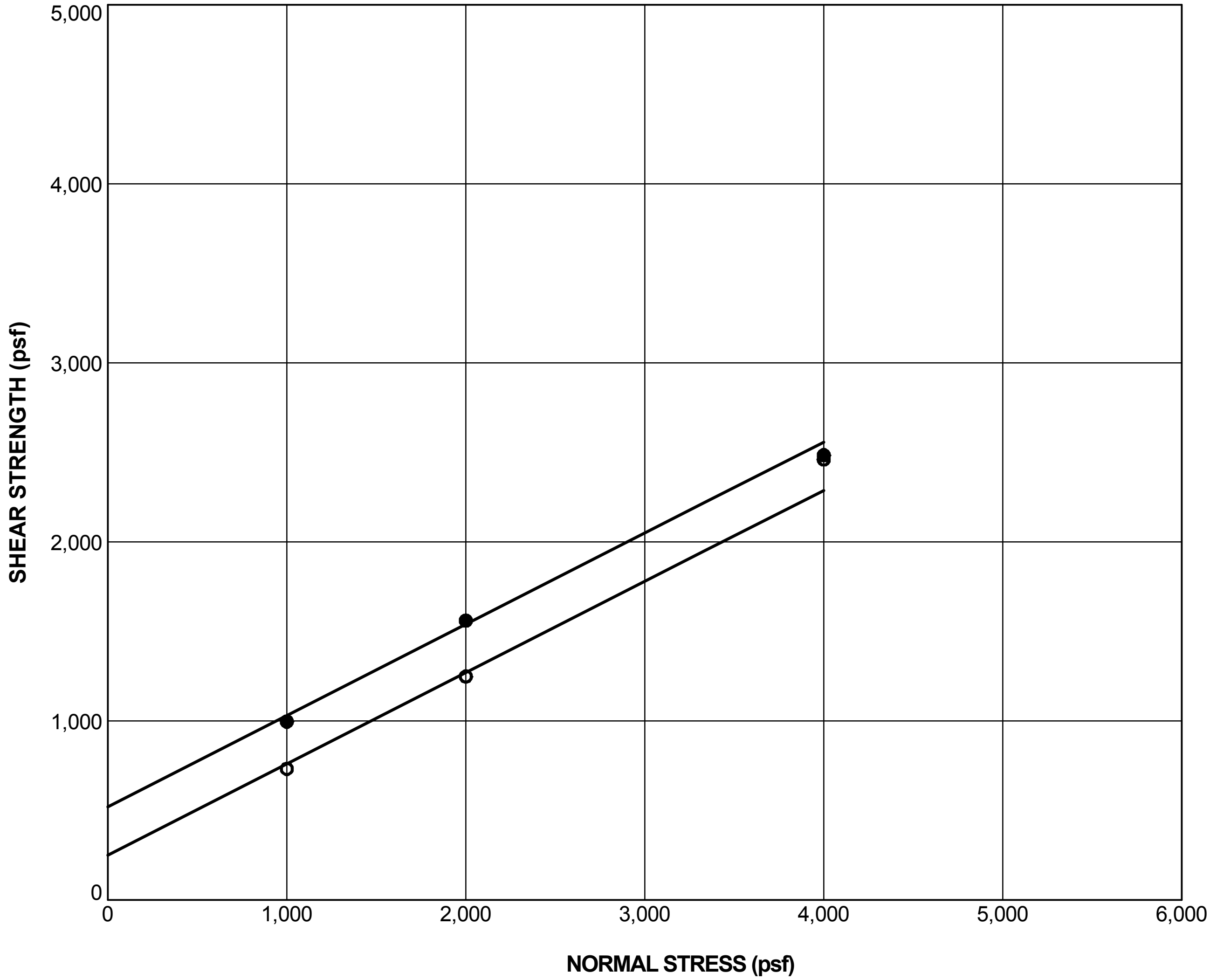
SHEAR STRENGTH PARAMETERS

Parameter	Peak ●	Ultimate ○
Cohesion (psf)	320	120
Friction Angle (degrees)	30.0	30.0

DIRECT SHEAR TEST RESULTS

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.



Boring No. H-16		Sample No. D-2		Depth: 5.0 ft	
Sample Description:	(Qal) Dark brown clayey SILT			**USCS:**	ML
Liquid Limit:	48	**Plasticity Index:**	19	**Percent Passing No. 200 Sieve:**	
Final Moisture Content (%):	40.1	**Final Dry Density (pcf):**	94.4	**Degree of Saturation (%):**	100
Sample Type:	Undisturbed	**Rate of Shear (in./min.):**	0.005		

SHEAR STRENGTH PARAMETERS

Parameter	Peak ●	Ultimate ○
Cohesion (psf)	520	250
Friction Angle (degrees)	27.0	27.0

DIRECT SHEAR TEST RESULTS

Mark Thomas/Firestone Blvd. Widening
Norwalk, California
PROJECT NO. 18181-01

NMG Geotechnical, Inc.

R-VALUE TEST DATA CTM 301 / ASTM D2844

Project: MT/Firestone Blvd	Project No: 18181-01	Date: 4/3/2019
Boring Trench No: H-3	Sample No: B-2	Sample Depth: 1.5-5'
Field Description: CL		
Lab Description: Brown clayey silty SAND		

Specimen Number	1		2		3		4	
Mold Number	4		5		6			
Water Adjustment (g)	+110		+102		+94			
Compactor Pressure (psi)	350		350		350			
Exudation Pressure (psi)	213		450		602			
Gross Weight (g)	3211.1		3230.9		3213.0			
Mold Tare (g)	2115.0		2118.4		2115.8			
Wet Weight (g)	1096.1		1112.5		1097.2			
Sample Height (in)	2.45		2.50		2.46			
Initial Dial Reading	0.0418		0.0621		0.0012			
Final Dial Reading	0.0436		0.0654		0.0049			
Expansion (in $x10^{-4}$)	18		33		37			
Stability(psi) at 2,000 lbs (160 psi)	38	66	32	54	26	38		
Turns Displacement	3.95		3.41		3.96			
R-Value Uncorrected	47		59		67			
R-Value Corrected	47		59		67			
Moisture Content (%)	10.3		9.7		8.9			
Dry Density (pcf)	122.9		122.9		124.1			
Assumed Traffic Index	4.0		4.0		4.0			
G.E. by Stability	0.54		0.42		0.34			
G.E. by Expansion	0.60		1.10		1.23			
G_f	1.25							

Moisture Content				
Dish No.	QX	M	PP	
Weight of Moist Soil and Dish (g)	319.0	318.7	320.5	
Weight of Dry Soil and Dish (g)	293.8	294.9	298.3	
Water Loss (g)	25.2	23.8	22.2	
Weight of Dish (g)	50.1	50.4	49.4	
Dry Soil (g)	243.7	244.5	248.9	
Moisture Content (%)	10.3	9.7	8.9	

R-Value by Exudation = 51

R-Value by Expansion = 46

R-Value at Equilibrium = 46 by Expansion

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 and/or ASTM Standard D2844

Remarks: A traffic index of 4.0 was used for calculation purposes.

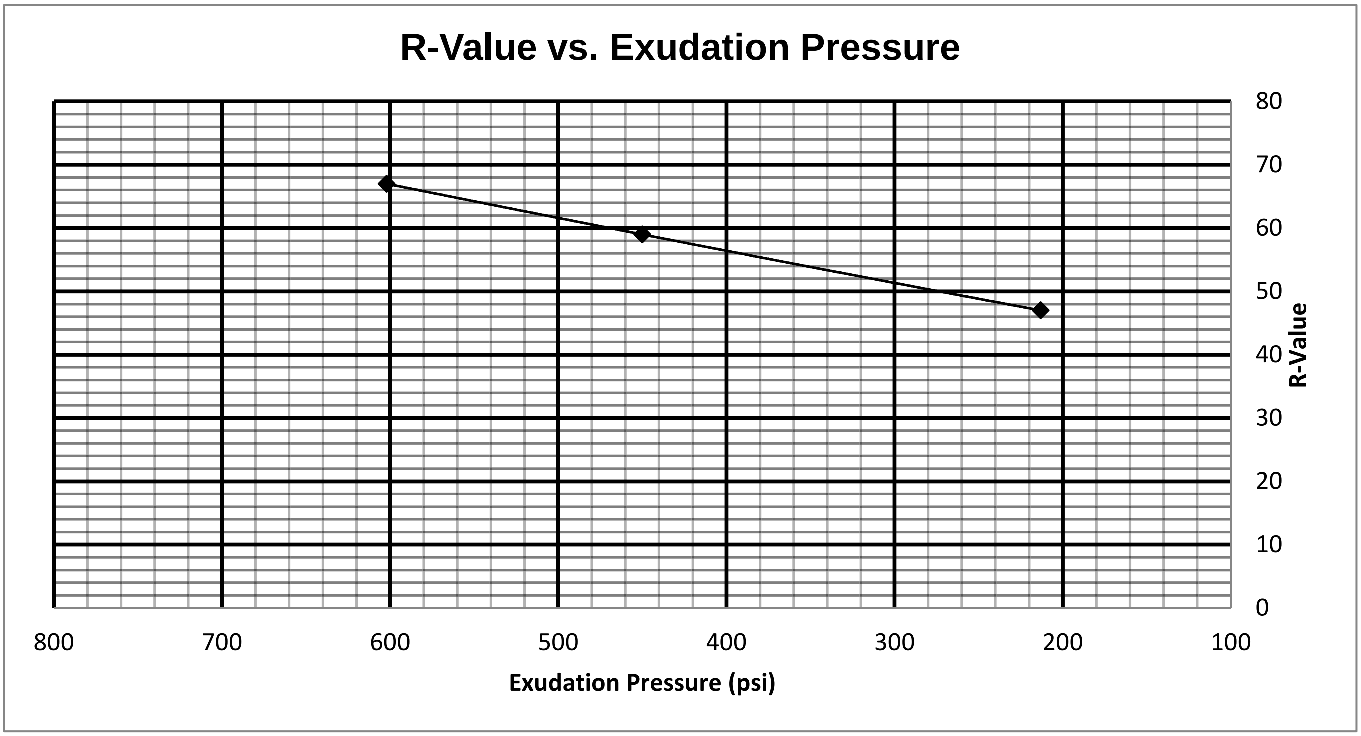
Set up by: BAJ Run by: BAJ

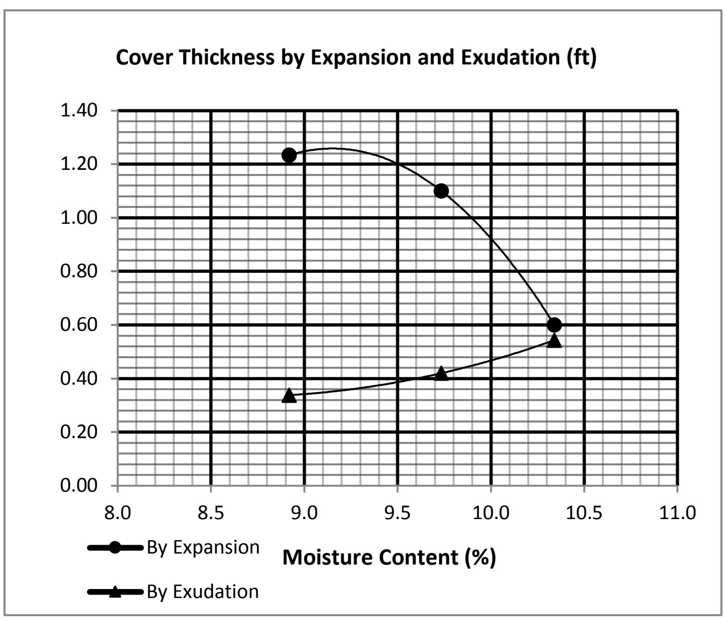
Calculated by: BAJ Checked by: TG/BAJ Date Completed: 4/5/2019

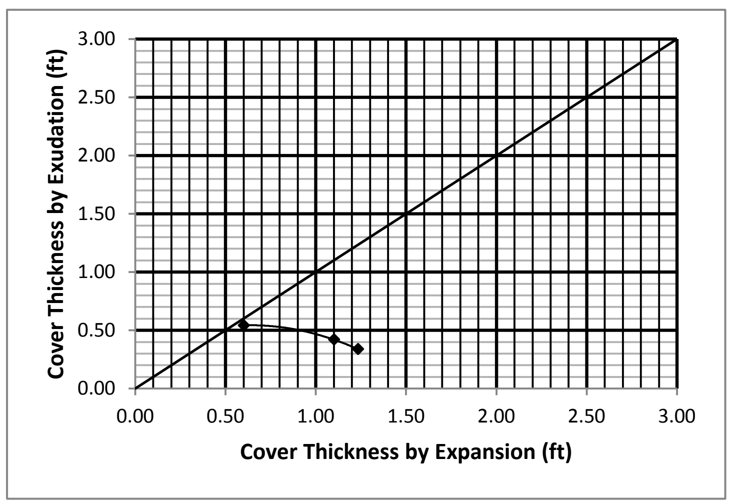
NMG Geotechnical, Inc.

R-VALUE GRAPHICAL PRESENTATION

Project: MT/Firestone Blvd	Project No: 18181-01	Date: 4/3/2019
Boring Trench No: H-3	Sample No: B-2	Sample Depth: 1.5-5'
Field Description: CL		
Lab Description: Brown clayey silty SAND		







Cover Thickness (ft) = 0.55

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 and/or ASTM Standard D2844

Remarks:	A traffic index of 4.0 was used for calculation purposes.				
Set up by:	BAJ	Run by:	BAJ		
Calculated by:	BAJ	Checked by:	TG/BAJ	Date Completed:	4/5/2019

NMG Geotechnical, Inc.

R-VALUE TEST DATA CTM 301 / ASTM D2844

Project: MT/Firestone Blvd	Project No: 18181-01	Date: 4/3/2019
Boring Trench No: H-5	Sample No: B-1	Sample Depth: 1-5'
Field Description: ML		
Lab Description: Brown sandy clayey SILT		

Specimen Number	1		2		3		4	
Mold Number	1		2		3			
Water Adjustment (g)	+120		+113		+106			
Compactor Pressure (psi)	350		350		350			
Exudation Pressure (psi)	285		346		518			
Gross Weight (g)	3196.3		3218.8		3188.1			
Mold Tare (g)	2095.6		2114.7		2099.4			
Wet Weight (g)	1100.7		1104.1		1088.7			
Sample Height (in)	2.49		2.53		2.51			
Initial Dial Reading	0.0517		0.0416		0.0421			
Final Dial Reading	0.0573		0.0496		0.0527			
Expansion (in x10^{-4})	56		80		106			
Stability(psi) at 2,000 lbs (160 psi)	50	102	42	80	40	70		
Turns Displacement	3.48		3.96		3.97			
R-Value Uncorrected	29		39		45			
R-Value Corrected	29		39		45			
Moisture Content (%)	13.3		13.0		12.4			
Dry Density (pcf)	118.2		117.0		116.9			
Assumed Traffic Index	4.0		4.0		4.0			
G.E. by Stability	0.73		0.62		0.56			
G.E. by Expansion	1.87		2.67		3.53			
G_f	1.25							

Moisture Content				
Dish No.	R	BB	F	
Weight of Moist Soil and Dish (g)	314.8	308.8	322.4	
Weight of Dry Soil and Dish (g)	283.6	279.0	292.4	
Water Loss (g)	31.2	29.8	30.0	
Weight of Dish (g)	49.7	49.9	50.3	
Dry Soil (g)	233.9	229.1	242.1	
Moisture Content (%)	13.3	13.0	12.4	

R-Value by Exudation = 32

R-Value by Expansion = 13

R-Value at Equilibrium = 13 by Expansion

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 and/or ASTM Standard D2844

Remarks: A traffic index of 4.0 was used for calculation purposes.

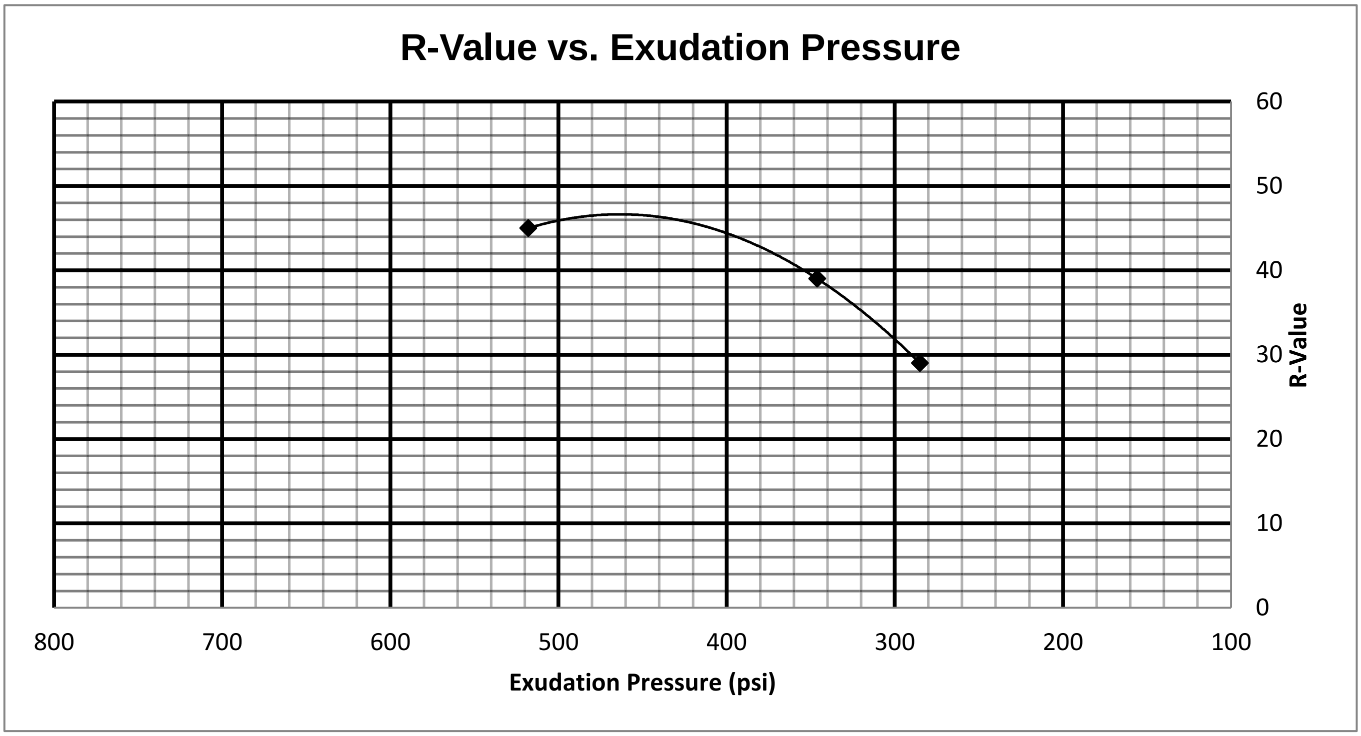
Set up by: BAJ Run by: BAJ

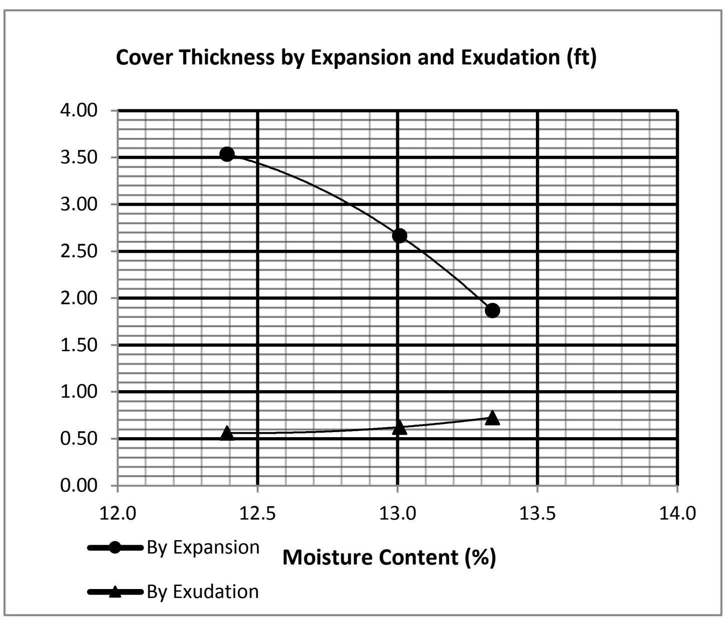
Calculated by: BAJ Checked by: TG/BAJ Date Completed: 4/5/2019

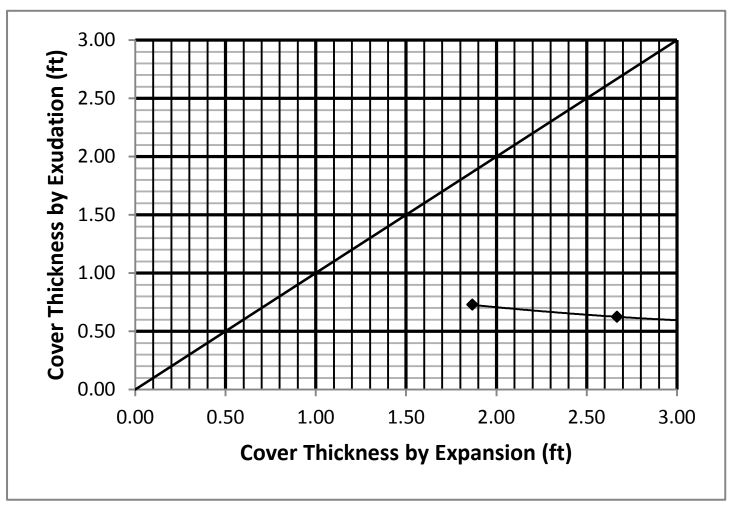
NMG Geotechnical, Inc.

R-VALUE GRAPHICAL PRESENTATION

Project: MT/Firestone Blvd	Project No: 18181-01	Date: 4/3/2019
Boring Trench No: H-5	Sample No: B-1	Sample Depth: 1-5'
Field Description: ML		
Lab Description: Brown sandy clayey SILT		







Cover Thickness (ft) = **0.89**

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 and/or ASTM Standard D2844

Remarks: A traffic index of 4.0 was used for calculation purposes.			
Set up by: BAJ	Run by: BAJ		
Calculated by: BAJ	Checked by: TG/BAJ	Date Completed:	4/5/2019

NMG Geotechnical, Inc.

R-VALUE TEST DATA CTM 301 / ASTM D2844

Project: Mark Thomas/ Firestone Blvd	Project No: 18181-01	Date: 4/1/2019
Boring Trench No: H-9	Sample No: B-1	Sample Depth: 1.5-5'
Field Description: SM		
Lab Description: Brown silty SAND		

Specimen Number	1		2		3		4	
Mold Number	4		5		6			
Water Adjustment (g)	+80		+60		+73			
Compactor Pressure (psi)	350		350		350			
Exudation Pressure (psi)	159		799		343			
Gross Weight (g)	3255.3		3221.6		3240.7			
Mold Tare (g)	2115.0		2118.4		2115.8			
Wet Weight (g)	1140.3		1103.2		1124.9			
Sample Height (in)	2.49		2.46		2.51			
Initial Dial Reading	0.0420		0.0620		0.0015			
Final Dial Reading	0.0426		0.0624		0.0015			
Expansion (in x10^{-4})	6		4		0			
Stability(psi) at 2,000 lbs (160 psi)	34	60	26	40	30	46		
Turns Displacement	3.05		3.09		3.10			
R-Value Uncorrected	58		71		67			
R-Value Corrected	58		71		67			
Moisture Content (%)	9.4		7.4		8.6			
Dry Density (pcf)	126.8		126.5		125.1			
Assumed Traffic Index	4.0		4.0		4.0			
G.E. by Stability	0.43		0.30		0.34			
G.E. by Expansion	0.20		0.13		0.00			
G_f	1.25							

Moisture Content				
Dish No.	HH	GGG	RR	
Weight of Moist Soil and Dish (g)	270.8	306.3	324.7	
Weight of Dry Soil and Dish (g)	251.8	288.6	303.1	
Water Loss (g)	19.0	17.7	21.6	
Weight of Dish (g)	49.8	50.2	50.5	
Dry Soil (g)	202	238.4	252.6	
Moisture Content (%)	9.4	7.4	8.6	

R-Value by Exudation = 66

R-Value by Expansion = 100

R-Value at Equilibrium = 66 by Exudation

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 and/or ASTM Standard D2844

Remarks: A traffic index of 4.0 was used for calculation purposes.

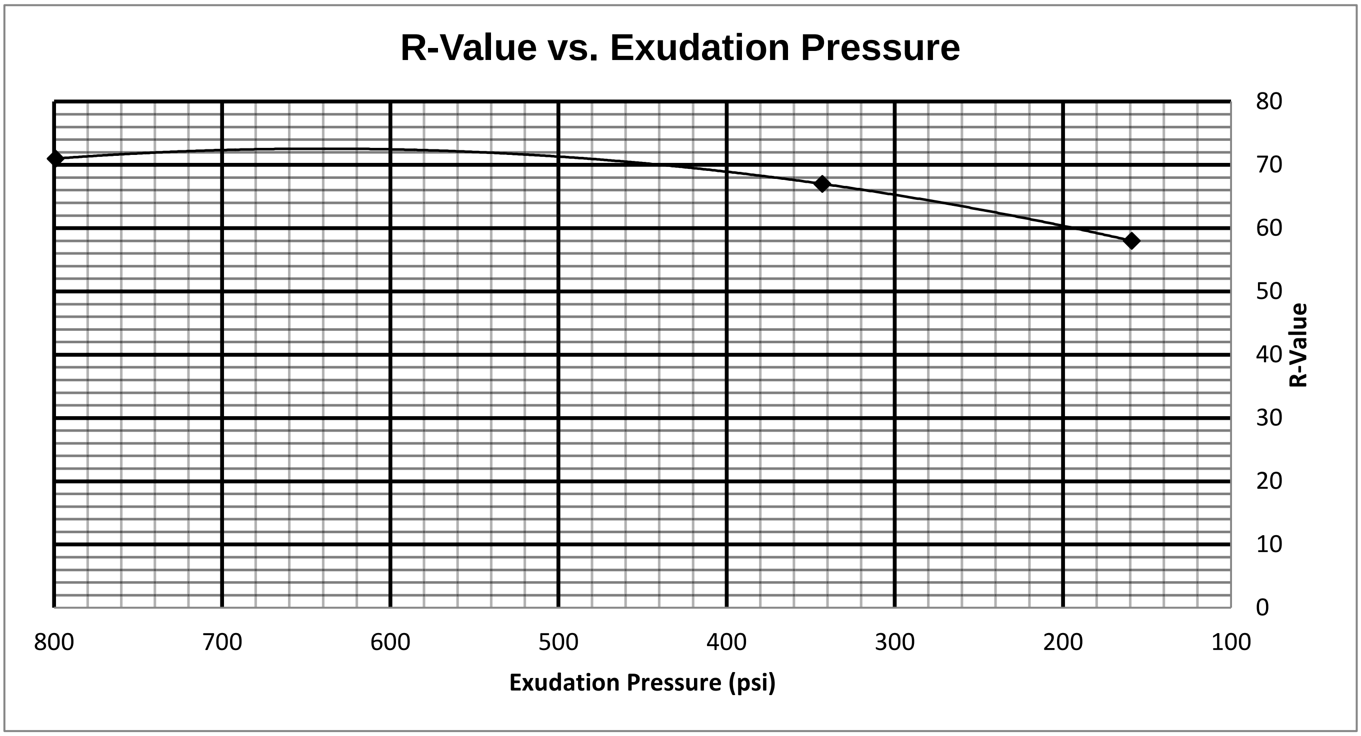
Set up by: BAJ Run by: BAJ/TG

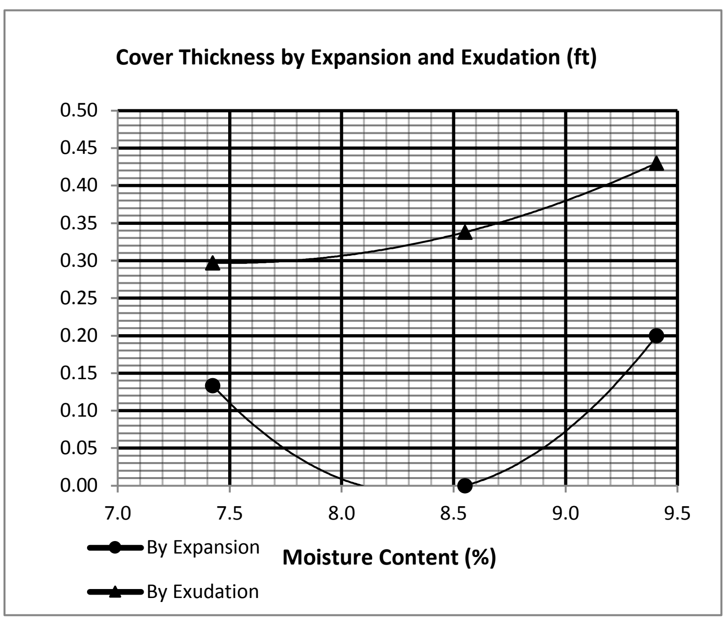
Calculated by: TG Checked by: Date Completed: 4/2/2019

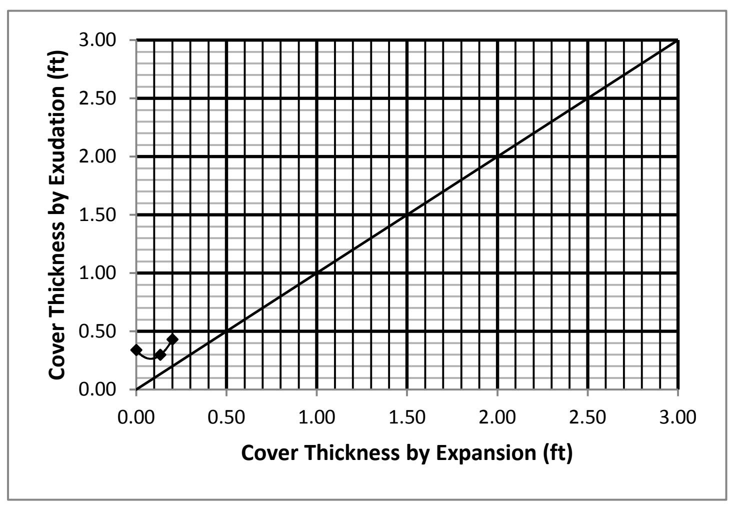
NMG Geotechnical, Inc.

R-VALUE GRAPHICAL PRESENTATION

Project: Mark Thomas/ Firestone Blvd	Project No: 18181-01	Date: 4/1/2019
Boring Trench No: H-9	Sample No: B-1	Sample Depth: 1.5-5'
Field Description: SM		
Lab Description: Brown silty SAND		







Cover Thickness (ft) = 0.00

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 and/or ASTM Standard D2844

Remarks: A traffic index of 4.0 was used for calculation purposes.			
Set up by: BAJ	Run by: BAJ/TG		
Calculated by: TG	Checked by:	Date Completed:	4/2/2019

NMG Geotechnical, Inc.

R-VALUE TEST DATA CTM 301 / ASTM D2844

Project: Mark Thomas/ Firestone Blvd	Project No: 18181-01	Date: 4/1/2019
Boring Trench No: H-13	Sample No: B-1	Sample Depth: 1.5-5'
Field Description: SM		
Lab Description: Brown silty fine SAND		

Specimen Number	1		2		3		4	
Mold Number	1		2		3			
Water Adjustment (g)	+65		+45		+55			
Compactor Pressure (psi)	350		350		350			
Exudation Pressure (psi)	133		648		380			
Gross Weight (g)	3191.6		3196.2		3197.1			
Mold Tare (g)	2095.6		2114.6		2099.3			
Wet Weight (g)	1096.0		1081.6		1097.8			
Sample Height (in)	2.50		2.51		2.54			
Initial Dial Reading	0.0516		0.0418		0.0420			
Final Dial Reading	0.0516		0.0440		0.0437			
Expansion (in x10^{-4})	0		22		17			
Stability(psi) at 2,000 lbs (160 psi)	34	58	30	50	34	54		
Turns Displacement	3.03		2.80		2.90			
R-Value Uncorrected	59		66		63			
R-Value Corrected	59		66		63			
Moisture Content (%)	11.1		9.8		10.6			
Dry Density (pcf)	119.6		118.9		118.4			
Assumed Traffic Index	4.0		4.0		4.0			
G.E. by Stability	0.42		0.35		0.38			
G.E. by Expansion	0.00		0.73		0.57			
G_f	1.25							

Moisture Content				
Dish No.	GG	XX	O	
Weight of Moist Soil and Dish (g)	283.2	278.9	252.4	
Weight of Dry Soil and Dish (g)	259.9	258.5	233.0	
Water Loss (g)	23.3	20.4	19.4	
Weight of Dish (g)	49.8	50.1	50.5	
Dry Soil (g)	210.1	208.4	182.5	
Moisture Content (%)	11.1	9.8	10.6	

R-Value by Exudation = 62

R-Value by Expansion = 61

R-Value at Equilibrium = 61 by Expansion

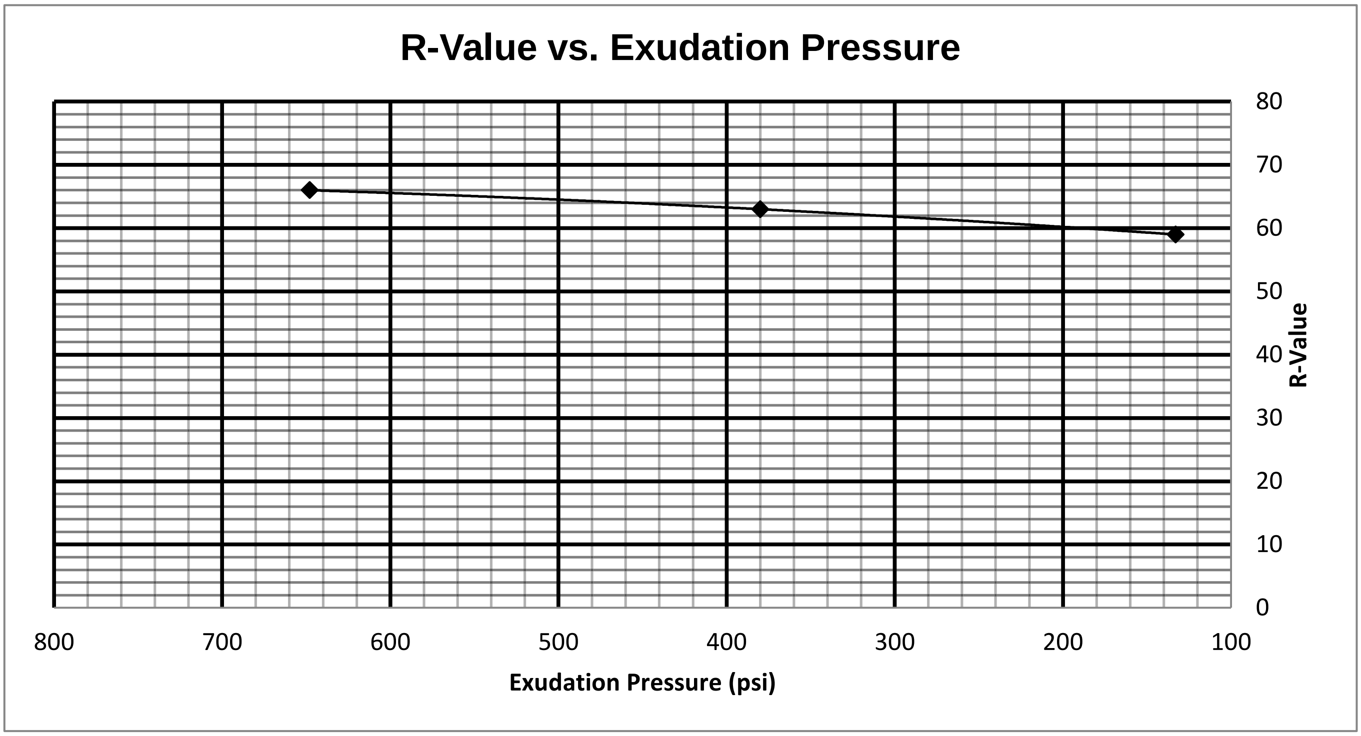
The data above is based upon processing and testing samples as received from the field. Test procedures in accordance with latest revisions to Department of Transportation, State of California, Materials & Research Test Method No. 301 and/or ASTM Standard D2844

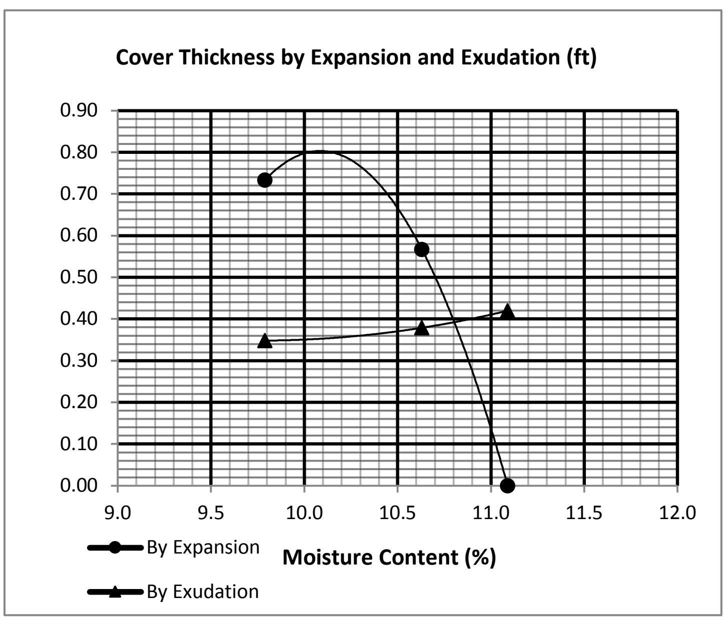
Remarks:	A traffic index of 4.0 was used for calculation purposes.		
Set up by: BAJ	Run by: BAJ/TG		
Calculated by: TG	Checked by:	Date Completed:	4/2/2019

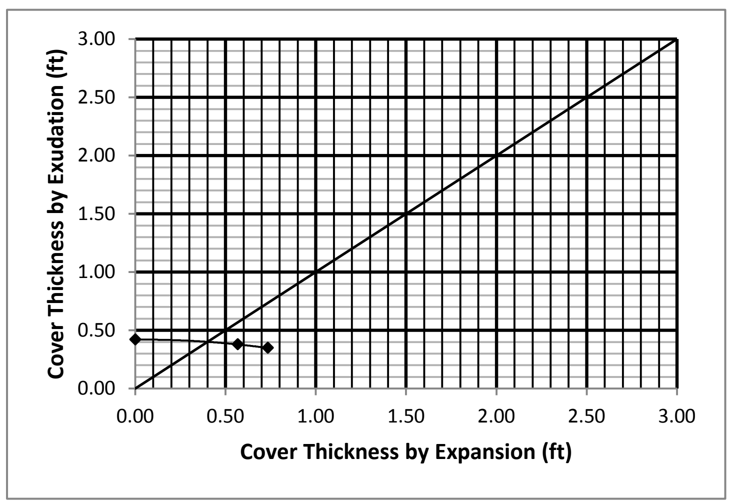
NMG Geotechnical, Inc.

R-VALUE GRAPHICAL PRESENTATION

Project: Mark Thomas/ Firestone Blvd	Project No: 18181-01	Date: 4/1/2019
Boring Trench No: H-13	Sample No: B-1	Sample Depth: 1.5-5'
Field Description: SM		
Lab Description: Brown silty fine SAND		







Cover Thickness (ft) = 0.40

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 and/or ASTM Standard D2844

Remarks: A traffic index of 4.0 was used for calculation purposes.			
Set up by: BAJ	Run by: BAJ/TG		
Calculated by: TG	Checked by:	Date Completed: 4/2/2019	

NMG Geotechnical, Inc.

April 25, 2019 via email: cthompson@nmggeotech.com

NMG Geotechnical, Inc.
17991 Fitch
Irvine, CA 92614

Attention: Mr. Clint Thompson

Re: Soil Corrosivity Study
Mark Thomas Firestone Blvd Widening
Norwalk, CA
HDR #19-0208SCS, NMG #18181-01

Introduction

Laboratory tests have been completed on five soil samples provided for the referenced project. The purpose of these tests was to determine if the soils might have deleterious effects on underground utility piping and concrete structures. HDR Engineering, Inc. (HDR) assumes that the samples provided are representative of the most corrosive soils at the site.

The proposed project consists of the widening of Firestone Blvd from Hoxie Ave to Imperial Highway in Norwalk, CA. The water table is reportedly greater than 50 feet deep.

The scope of this study is limited to a determination of soil corrosivity and general corrosion control recommendations for materials likely to be used for construction. HDR's recommendations do not constitute, and are not meant as a substitute for, design documents for the purpose of construction. If the architects and/or engineers desire more specific information, designs, specifications, or review of design, HDR will be happy to work with them as a separate phase of this project.

431 W. Baseline Road, Claremont, CA 91711-1608
(909) 626-0967

Laboratory Soil Corrosivity Tests

The electrical resistivity of each sample was measured in a soil box per ASTM G187 in its as-received condition and again after saturation with distilled water. Resistivities are at about their lowest value when the soil is saturated. The pH of the saturated samples was measured per CTM 643. A 5:1 water:soil extract from each sample was chemically analyzed for the major soluble salts commonly found in soil per ASTM D4327, ASTM D6919, and Standard Method 2320-B[1]. Laboratory test results are shown in the attached Table 1.

Soil Corrosivity

A major factor in determining soil corrosivity is electrical resistivity. The electrical resistivity of a soil is a measure of its resistance to the flow of electrical current. Corrosion of buried metal is an electrochemical process in which the amount of metal loss due to corrosion is directly proportional to the flow of electrical current (DC) from the metal into the soil. Corrosion currents, following Ohm's Law, are inversely proportional to soil resistivity. Lower electrical resistivities result from higher moisture and soluble salt contents and indicate corrosive soil.

A correlation between electrical resistivity and corrosivity toward ferrous metals is:[2]

Soil Resistivity in ohm-centimeters	Corrosivity Category
Greater than 10,000	Mildly Corrosive
2,001 to 10,000	Moderately Corrosive
1,001 to 2,000	Corrosive
0 to 1,000	Severely Corrosive

---

[1] American Public Health Association (APHA). 2012. Standard Methods of Water and Wastewater. 22nd ed. American Public Health Association, American Water Works Association, Water Environment Federation publication. APHA, Washington D.C.

[2] Romanoff, Melvin. Underground Corrosion, NBS Circular 579. Reprinted by NACE. Houston, TX, 1989, pp. 166–167.

Other soil characteristics that may influence corrosivity towards metals are pH, soluble salt content, soil types, aeration, anaerobic conditions, and site drainage.

Electrical resistivities were in the mildly to moderately corrosive categories with as-received moisture. When saturated, the resistivities were in the mildly to corrosive categories.

Soil pH values varied from 7.8 to 8.4. This range is mildly to moderately alkaline.[3] These values do not particularly increase soil corrosivity.

The soluble salt content of the samples ranged from low to moderate. Chloride and sulfate were found in low concentrations.

Ammonium was detected in one sample at a low concentration. The nitrate concentrations were high enough to be aggressive to copper.

Tests were not made for sulfide and oxidation-reduction (redox) potential because these samples did not exhibit characteristics typically associated with anaerobic conditions.

The variation in soil types can create differential-aeration corrosion cells that would affect all metals.

Variation in soil resistivity of an order of magnitude or more can create differential-aeration corrosion cells that would affect all metals.

This soil is classified as corrosive to ferrous metals and aggressive to copper.

Corrosion Control Recommendations

The life of buried materials depends on thickness, strength, loads, construction details, soil moisture, etc., in addition to soil corrosivity, and is, therefore, difficult to predict. Of more practical value are corrosion control methods that will increase the life of materials that would be subject to significant corrosion.

---

[3] *Romanoff, Melvin. Underground Corrosion, NBS Circular 579. Reprinted by NACE. Houston, TX, 1989, p. 8.*

The following recommendations are based on the soil conditions discussed in the Soil Corrosivity section above. Unless otherwise indicated, these recommendations apply to the entire site or alignment.

Steel Pipe

1. Underground steel pipe with rubber gasketed, mechanical, grooved end, or other nonconductive type joints should be bonded for electrical continuity. Electrical continuity is necessary for corrosion monitoring and cathodic protection.

2. Install corrosion monitoring test stations to facilitate corrosion monitoring and the application of cathodic protection:

    a. At each end of the pipeline.

    b. At each end of all casings.

    c. Other locations as necessary so the interval between test stations does not exceed 1,200 feet.

3. To prevent dissimilar metal corrosion cells and to facilitate the application of cathodic protection, electrically isolate each buried steel pipeline per NACE SP0286 from:

    a. Dissimilar metals.

    b. Dissimilarly coated piping (cement-mortar vs. dielectric).

    c. Above ground steel pipe.

    d. All existing piping.

4. Choose one of the following corrosion control options:

    OPTION 1

    a. Apply a suitable dielectric coating intended for underground use such as:

        i. Polyurethane per AWWA C222 *or*

        ii. Extruded polyethylene per AWWA C215 *or*

iii. A tape coating system per AWWA C214 *or*

iv. Hot applied coal tar enamel per AWWA C203 *or*

v. Fusion bonded epoxy per AWWA C213.

b. Apply cathodic protection to steel piping as per NACE SP0169.

OPTION 2

As an alternative to dielectric coating and cathodic protection, apply a ¾-inch cement mortar coating per AWWA C205 or encase in concrete three inches thick, using any type of ASTM C150 cement. Joint bonds, test stations, and insulated joints are still recommended for this alternative.

NOTE: Some steel piping systems, such as for oil, gas, and high-pressure piping systems, have special corrosion and cathodic protection requirements that must be evaluated for each specific application.

Ductile Iron Pipe

1. To prevent dissimilar metal corrosion cells and to facilitate the application of cathodic protection, electrically insulate underground iron pipe from dissimilar metals and from above ground iron pipe with insulating joints per NACE SP0286.

2. Bond all nonconductive type joints for electrical continuity. Electrical continuity is necessary for corrosion monitoring and cathodic protection.

3. Install corrosion monitoring test stations to facilitate corrosion monitoring and the application of cathodic protection:

    a. At each end of the pipeline.

    b. At each end of any casings.

    c. Other locations as necessary so the interval between test stations does not exceed 1,200 feet.

4. Choose one of the following corrosion control options:

OPTION 1

a. Apply a suitable coating intended for underground use such as:

   i. Polyethylene encasement per AWWA C105; *or*

   ii. Epoxy coating; *or*

   iii. Polyurethane; *or*

   iv. Wax tape.

   NOTE: The thin factory-applied asphaltic coating applied to ductile iron pipe for transportation and aesthetic purposes does not constitute a corrosion control coating.

b. Apply cathodic protection to cast and ductile iron piping as per NACE SP0169.

OPTION 2

As an alternative to the coating systems described in Option 1 and cathodic protection, concrete encase all buried portions of metallic piping so that there is a minimum of three inches of concrete cover provided over and around surfaces of pipe, fittings, and valves using any type of ASTM C150 cement.

NOTE: Some iron piping systems, such as for fire water piping, have special corrosion and cathodic protection requirements that must be evaluated for each specific application.

Cast Iron Soil Pipe

1. Protect cast iron soil pipe with either a double wrap 4-mil or single wrap 8-mil polyethylene encasement per AWWA C105.

2. It is not necessary to bond the pipe joints or apply cathodic protection.

3. Provide six inches of clean sand backfill all around the pipe.

Clean Sand Backfill

1. Clean sand backfill should have the following parameters:

   a. Minimum saturated resistivity of no less than 3,000 ohm-cm; *and*

   b. pH between 6.0 and 8.0.

2. All backfill testing should be performed by a corrosion engineering laboratory.

Copper Tubing

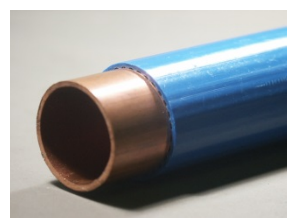
1. Electrically insulate underground copper pipe from dissimilar metals and from above ground copper pipe with insulating devices per NACE SP0286.

2. Electrically insulate cold water piping from hot water piping systems.

3. Protect buried copper tubing by one of the following measures:

   a. Prevention of soil contact. Soil contact may be prevented by placing the tubing above ground or encasing the tubing using PVC pipe with solvent-welded joints.

   b. Installation of a factory-coated copper pipe with a minimum 25-mil thickness such as Kamco's Aqua Shield™, Mueller's Streamline Protec™, or equal. The coating must be continuous with no cuts or defects.



   c. Installation of 12-mil polyethylene pipe wrapping tape with butyl rubber mastic over a suitable primer. Protect wrapped copper tubing by applying cathodic protection per NACE SP0169.

Plastic and Vitrified Clay Pipe

1. No special corrosion control measures are required for plastic and vitrified clay piping placed underground.

2. Protect all metallic fittings and valves with wax tape per AWWA C217, or with epoxy and appropriately sized cathodic protection per NACE SP0169.

All Pipe

1. On all pipes, appurtenances, and fittings not protected by cathodic protection, coat bare metal such as valves, bolts, flange joints, joint harnesses, and flexible couplings with wax tape per AWWA C217 after assembly.

2. Where metallic pipelines penetrate concrete structures such as building floors, vault walls, and thrust blocks use plastic sleeves, rubber seals, or other dielectric material to prevent pipe contact with the concrete and reinforcing steel.

Concrete Structures and Pipe

1. From a corrosion standpoint, any type of ASTM C150 cement may be used for concrete structures and pipe because the sulfate concentration is negligible, from 0 to 0.10 percent.[4,5,6]

2. Standard concrete cover over reinforcing steel may be used for concrete structures and pipe in contact with these soils due to the low chloride concentrations[7] found onsite. Limit the water-soluble chloride ion content in the concrete mix design to less than 0.3 percent by weight of cement.

Closure

The analysis and recommendations presented in this report are based upon data obtained from the laboratory samples. This report does not reflect variations that may occur across the site or due to the modifying effects of construction. If variations appear, HDR should be notified immediately so that further evaluation and supplemental recommendations can be provided.

---

[4] *2015 International Building Code (IBC) which refers to American Concrete Institute (ACI) 318-14 Table 19.3.2.1*

[5] *2015 International Residential Code (IRC) which refers to American Concrete Institute (ACI) 318-14 Table 19.3.2.1*

[6] *2016 California Building Code (CBC) which refers to American Concrete Institute (ACI) 318-14 Table 19.3.2.1*

[7] *Design Manual 303: Concrete Cylinder Pipe. Ameron. p.65*

HDR's services have been performed with the usual thoroughness and competence of the engineering profession. No other warranty or representation, either expressed or implied, is included or intended.

Please call if you have any questions.

Respectfully Submitted,
HDR Engineering, Inc.

James Keegan

Sean O. Hoss, PE

Enc: Table 1

19-0208SCS SCS JK SOH.docx

Table 1 - Laboratory Tests on Soil Samples

NMG Geotechnical, Inc.
Mark Thomas Firestone Blvd Widening
Your #18181-01, HDR Lab #19-0208SCS
16-Apr-19

Sample ID			H-3, B-2 @ 1-5'	H-5, B-1 @ 0-5'	H-9, B-1 @ 1-5'	H-13, B-1 @ 1-5'	H-16, B-1 @ 0-5'
Resistivity		**Units**					
as-received		ohm-cm	8,400	16,000	60,000	44,000	9,200
saturated		ohm-cm	6,800	3,640	18,400	11,200	2,000
pH			8.3	8.1	8.3	8.4	7.8
Electrical Conductivity		mS/cm	0.07	0.13	0.03	0.08	0.21
Chemical Analyses							
Cations							
calcium	Ca^{2+}	mg/kg	116	170	17	93	118
magnesium	Mg^{2+}	mg/kg	18	29	6.0	16	22
sodium	Na^{1+}	mg/kg	15	27	15	11	75
potassium	K^{1+}	mg/kg	5.8	10	4.9	25	11
Anions							
carbonate	CO_3^{2-}	mg/kg	ND	ND	ND	ND	ND
bicarbonate	HCO_3^{1-}	mg/kg	302	305	67	329	299
fluoride	F^{1-}	mg/kg	ND	ND	ND	ND	7.5
chloride	Cl^{1-}	mg/kg	2.3	5.5	2.6	2.0	19
sulfate	SO_4^{2-}	mg/kg	21	51	9.7	14	49
phosphate	PO_4^{3-}	mg/kg	ND	ND	ND	ND	ND
Other Tests							
ammonium	NH_4^{1+}	mg/kg	ND	ND	ND	0.7	ND
nitrate	NO_3^{1-}	mg/kg	8.4	102	2.6	7.0	425
sulfide	S^{2-}	qual	na	na	na	na	na
Redox		mV	na	na	na	na	na

Resistivity per ASTM G187, Cations per ASTM D6919, Anions per ASTM D4327, and Alkalinity per APHA 2320-B.
Electrical conductivity in millisiemens/cm and chemical analyses were made on a 1:5 soil-to-water extract.
mg/kg = milligrams per kilogram (parts per million) of dry soil.
Redox = oxidation-reduction potential in millivolts
ND = not detected
na = not analyzed

431 West Baseline Road · Claremont, CA 91711
Phone: 909.962.5485 · Fax: 909.626.3316

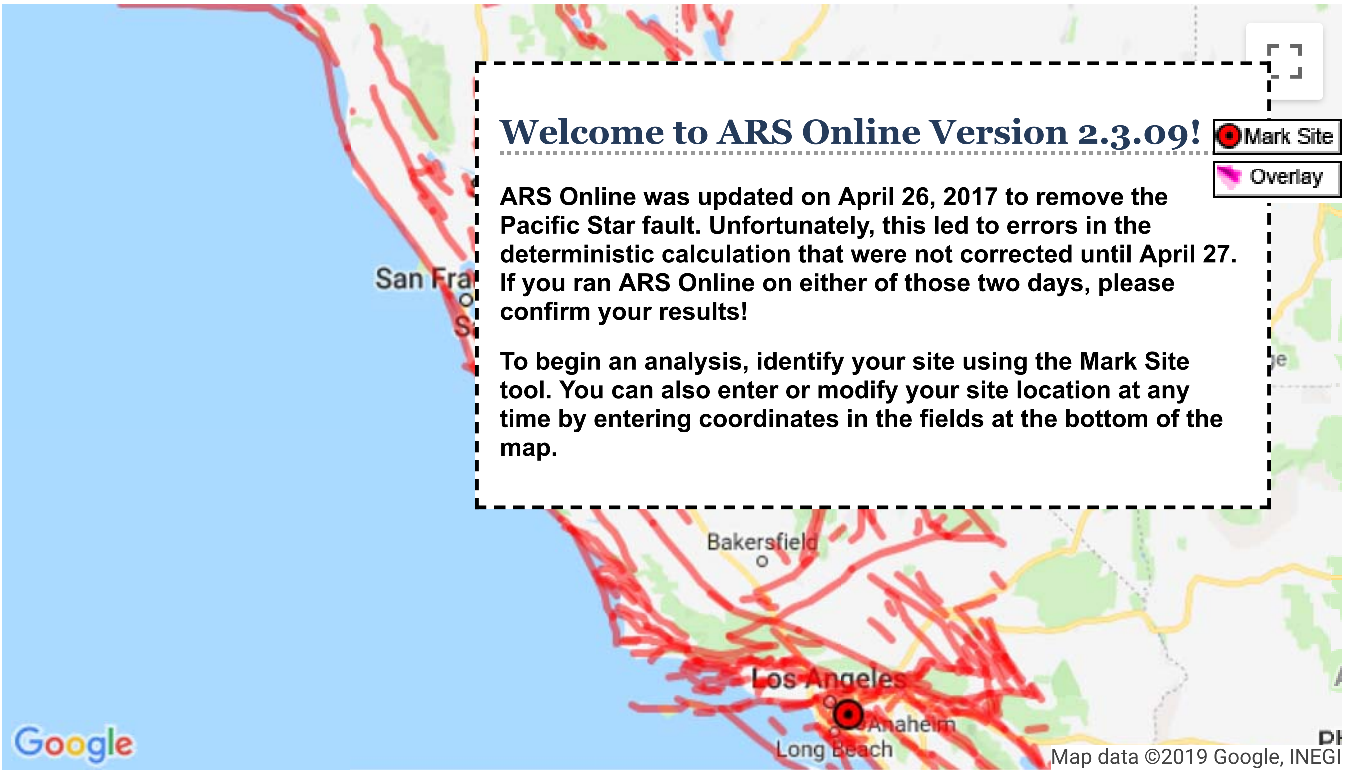
APPENDIX D

CALIFORNIA DEPARTMENT OF
TRANSPORTATION

Caltrans ARS Online (v2.3.09)

This web-based tool calculates both deterministic and probabilistic acceleration response spectra for any location in California based on criteria provided in *Appendix B of Caltrans Seismic Design Criteria*. More...

SELECT SITE LOCATION



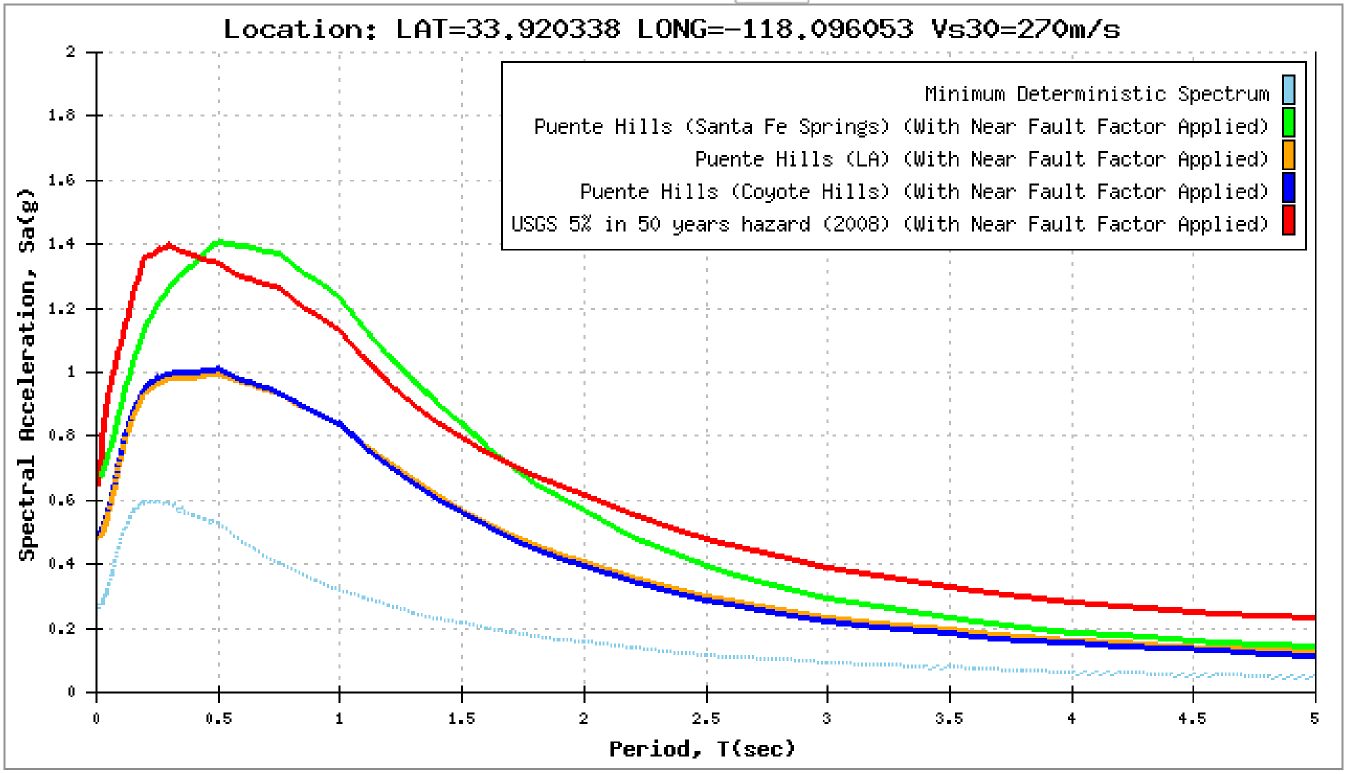
Welcome to ARS Online Version 2.3.09!

ARS Online was updated on April 26, 2017 to remove the Pacific Star fault. Unfortunately, this led to errors in the deterministic calculation that were not corrected until April 27. If you ran ARS Online on either of those two days, please confirm your results!

To begin an analysis, identify your site using the Mark Site tool. You can also enter or modify your site location at any time by entering coordinates in the fields at the bottom of the map.

Latitude: 33.920338 **Longitude:** -118.096053 ***V*s30:** 270 m/s Calculate

CALCULATED SPECTRA Display Curves: 3



Tabular Data | Envelope Only | Hide Near Fault | Axis Scale | Show Basin

Apply Near Fault Adjustment To:
NOTE: Caltrans SDC requires application of a Near Fault Adjustment factor for sites less than 25 km (Rrup) from the causative fault.

☑ Deterministic Spectrum Using

2.90 Km Puente Hills (Santa Fe Springs)
6.45 Km Puente Hills (LA)
6.32 Km Puente Hills (Coyote Hills)

☑ Probabilistic Spectrum Using

2.90 Km (Recommend Performing Deaggregation To Verify)

◉ Show Spectrum with Adjustment Only
○ Show Spectrum with and without near fault Adjustment

OK

SITE DATA (ARS Online Version 2.3.09)

Shear Wave Velocity, *Vs30*:	270 m/s
Latitude:	33.920338
Longitude:	-118.096053
Depth to Vs = 1.0 km/s:	752 m
Depth to Vs = 2.5 km/s:	4.70 km

DETERMINISTIC

Puente Hills (Santa Fe Springs)

Fault ID:	359
Maximum Magnitude (MMax):	6.6
Fault Type:	Rev
Fault Dip:	29 Deg
Dip Direction:	NW
Bottom of Rupture Plane:	14.90 km
Top of Rupture Plane(Ztor):	2.80 km
Rrup	2.90 km
Rjb:	0.00 km
Rx:	0.76 km
Fnorm:	0
Frev:	1

Period	SA(Base Spectrum)	Basin Factor	Near Fault Factor(Applied)	SA(Final Spectrum)
0.01	0.577	1.164	1.000	0.672
0.05	0.644	1.154	1.000	0.743
0.1	0.775	1.149	1.000	0.891
0.15	0.887	1.151	1.000	1.021
0.2	0.982	1.153	1.000	1.133
0.25	1.039	1.162	1.000	1.208
0.3	1.073	1.176	1.000	1.261
0.4	1.109	1.205	1.000	1.336
0.5	1.097	1.284	1.000	1.409
0.6	1.024	1.310	1.040	1.395
0.7	0.962	1.329	1.080	1.380
0.85	0.856	1.346	1.140	1.313
1	0.757	1.360	1.200	1.236
1.2	0.635	1.378	1.200	1.051
1.5	0.501	1.396	1.200	0.839
2	0.333	1.419	1.200	0.567
3	0.170	1.442	1.200	0.295
4	0.108	1.454	1.200	0.188
5	0.080	1.465	1.200	0.141

Puente Hills (LA)	
Fault ID:	347
Maximum Magnitude (MMax):	6.9
Fault Type:	Rev
Fault Dip:	27 Deg
Dip Direction:	NE
Bottom of Rupture Plane:	14.80 km
Top of Rupture Plane(Ztor):	2.10 km
Rrup	6.45 km
Rjb:	6.10 km
Rx:	5.80 km
Fnorm:	0
Frev:	1

Period	SA(Base Spectrum)	Basin Factor	Near Fault Factor(Applied)	SA(Final Spectrum)
0.01	0.415	1.173	1.000	0.487
0.05	0.483	1.162	1.000	0.562
0.1	0.635	1.155	1.000	0.734
0.15	0.745	1.157	1.000	0.862
0.2	0.808	1.163	1.000	0.939
0.25	0.829	1.175	1.000	0.973
0.3	0.833	1.191	1.000	0.992
0.4	0.814	1.225	1.000	0.997
0.5	0.776	1.302	1.000	1.011
0.6	0.712	1.326	1.040	0.982
0.7	0.658	1.344	1.080	0.955
0.85	0.582	1.360	1.140	0.902
1	0.515	1.373	1.200	0.849
1.2	0.433	1.390	1.200	0.722
1.5	0.341	1.407	1.200	0.575
2	0.238	1.425	1.200	0.407
3	0.137	1.443	1.200	0.236
4	0.094	1.453	1.200	0.164
5	0.071	1.464	1.200	0.125

Puente Hills (Coyote Hills)	
Fault ID:	361
Maximum Magnitude (MMax):	6.8
Fault Type:	Rev
Fault Dip:	26 Deg
Dip Direction:	NW
Bottom of Rupture Plane:	14.60 km
Top of Rupture Plane(Ztor):	2.80 km

Rrup	6.32 km
Rjb:	5.44 km
Rx:	1.59 km
Fnorm:	0
Frev:	1

Period	SA(Base Spectrum)	Basin Factor	Near Fault Factor(Applied)	SA(Final Spectrum)
0.01	0.426	1.173	1.000	0.500
0.05	0.495	1.162	1.000	0.575
0.1	0.648	1.155	1.000	0.748
0.15	0.758	1.157	1.000	0.877
0.2	0.822	1.162	1.000	0.955
0.25	0.843	1.174	1.000	0.989
0.3	0.847	1.190	1.000	1.008
0.4	0.828	1.223	1.000	1.012
0.5	0.787	1.301	1.000	1.024
0.6	0.718	1.326	1.040	0.990
0.7	0.662	1.343	1.080	0.960
0.85	0.582	1.359	1.140	0.902
1	0.513	1.373	1.200	0.845
1.2	0.428	1.390	1.200	0.714
1.5	0.334	1.407	1.200	0.565
2	0.230	1.425	1.200	0.394
3	0.129	1.443	1.200	0.224
4	0.088	1.454	1.200	0.153
5	0.066	1.464	1.200	0.116

PROBABILISTIC

Probabilistic Model USGS Seismic Hazard Map(2008) 975 Year Return Period				
Period	**SA(Base Spectrum)**	**Basin Factor**	**Near Fault Factor(Applied)**	**SA(Final Spectrum)**
0.01	0.564	1.148	1.000	0.648
0.05	0.820	1.133	1.000	0.929
0.1	0.963	1.127	1.000	1.085
0.15	1.098	1.127	1.000	1.237
0.2	1.206	1.127	1.000	1.358
0.25	1.209	1.139	1.000	1.378
0.3	1.212	1.150	1.000	1.394
0.4	1.133	1.204	1.000	1.364
0.5	1.075	1.248	1.000	1.342
0.6	0.982	1.274	1.040	1.301
0.7	0.910	1.297	1.080	1.274
0.85	0.800	1.319	1.140	1.203
1	0.708	1.334	1.200	1.134
1.2	0.595	1.353	1.200	0.966
1.5	0.481	1.376	1.200	0.794
2	0.365	1.407	1.200	0.617
3	0.228	1.432	1.200	0.392
4	0.161	1.445	1.200	0.280
5	0.132	1.457	1.200	0.231

MINIMUM DETERMINISTIC SPECTRUM

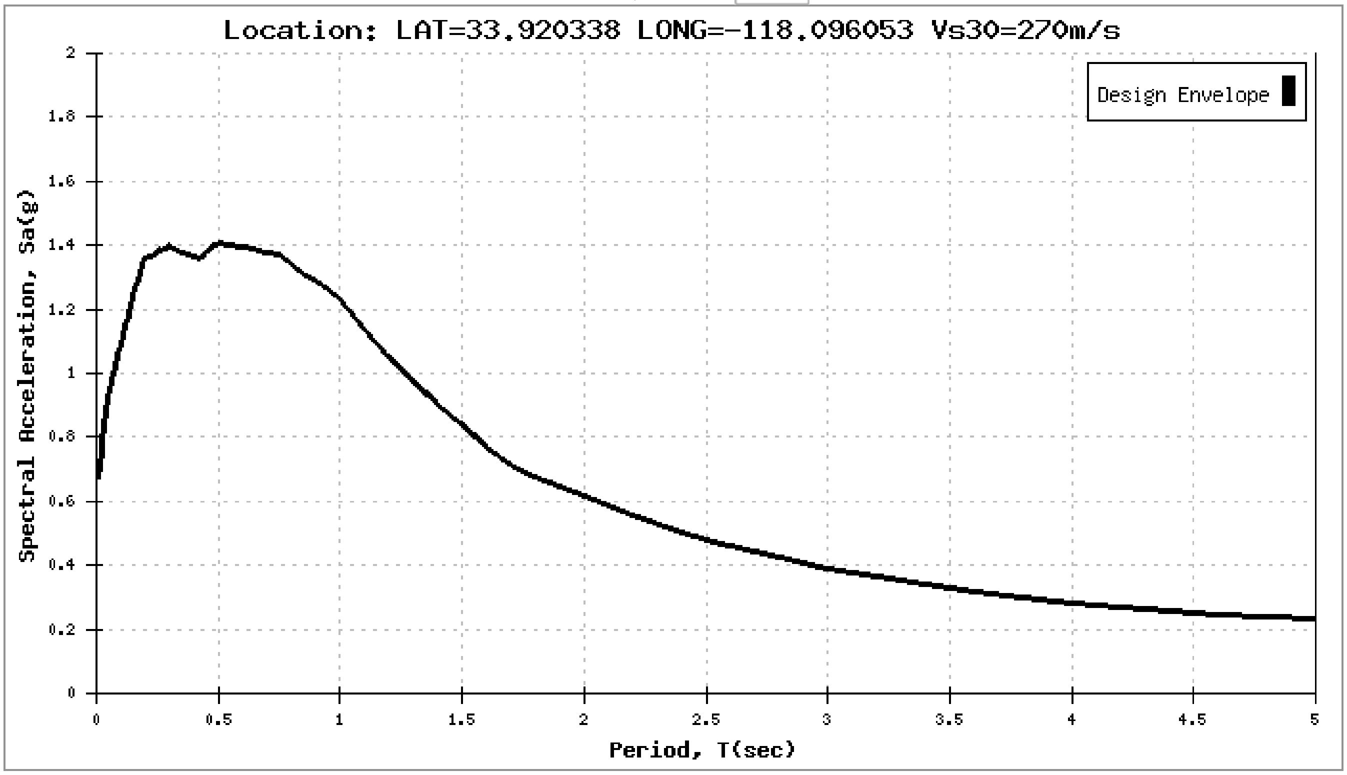
Period	SA
0.01	0.268
0.05	0.322
0.1	0.466
0.15	0.561
0.2	0.594
0.25	0.593
0.3	0.585
0.4	0.551
0.5	0.525
0.6	0.468
0.7	0.422
0.85	0.363
1	0.317
1.2	0.268
1.5	0.215
2	0.153

3	0.092
4	0.063
5	0.047

Envelope Data

Period	SA
0.01	0.672
0.05	0.929
0.1	1.085
0.15	1.237
0.2	1.358
0.25	1.378
0.3	1.394
0.4	1.364
0.5	1.409
0.6	1.395
0.7	1.380
0.85	1.313
1	1.236
1.2	1.051
1.5	0.839
2	0.617
3	0.392
4	0.280
5	0.231

CALCULATED SPECTRA Display Curves: 3 ▼



Tabular Data | Display All | Show Near Fault | Axis Scale | Show Basin

APPENDIX E

Summary of Design Soil Strength Parameters

Soil	Material / Geologic Unit Description	Unit Weight		Static		Pseudostatic	
		Moist (pcf)	Saturate (pcf)	c (psf)	ϕ (psf)	c (psf)	ϕ (deg.)
1	Existing Compacted Fill (AF)	125	125	100	31	100	37
2	Alluvium (Qal)	125	125	150	28	300	28
3							
4							
5							
6							
7							
8							
9							
10							

Project No.: 18181-01

Project Name: MT/Firestone

NMG

18181-01
August 14, 2019

Summary of Slope Stability Analysis

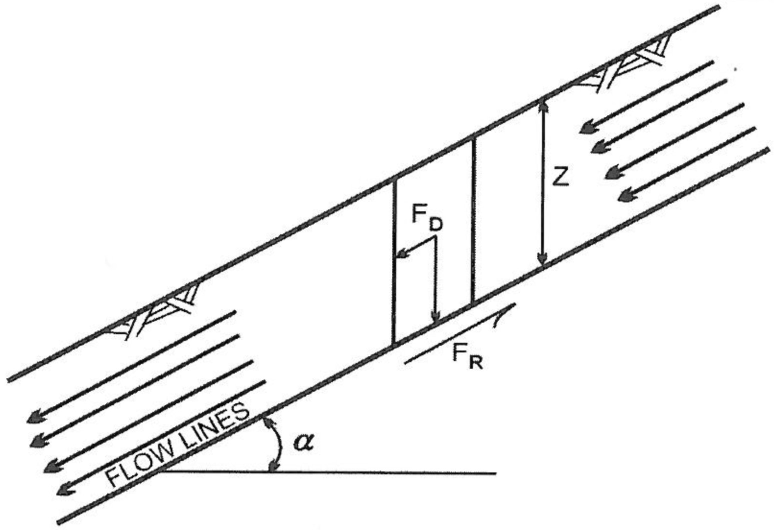
Cross-Section Typical Fill Embankment and Temporary Excavation

Filename	Description	Factor of Safety (FS)	
		Static	***Pseudostatic***
A1/A1s	25' H; 2H:1V Fill Embankment Slope over Alluvium	1.76	1.53
A2a	Temporary 1H:1V Slope in Fill, H = 25'	1.09	---
A2c	Same as A2a with Cohesion Increased to 150 psf	1.25	---
A3a	Same as A2a with Setback	1.50	---
A4	Temporary 1H:1V Slope in Alluvium, H = 15'	1.18	---
A4c	Same as A4 with Cohesion Increased to 150 psf	1.39	---

Project No.: 18181-01

Project Name: MT/Firestone

NMG



z	=	Depth of Saturation	=	4.0	ft
γ_b	=	Buoyant Unit Weight of Soil	=	57.6	pcf
γ_t	=	Total Unit Weight of Soil	=	120.0	pcf
α	=	Slope Angle	=	26.6	degrees
ϕ	=	Angle of Internal Friction	=	31.0	degrees
c	=	Cohesion	=	100.0	psf

Force Tending to Cause Movement:

$$F_D = z\gamma_t \cos\alpha \sin\alpha = 1/2\, z\gamma_t \sin 2\alpha$$

Force Tending to Resist Movement:

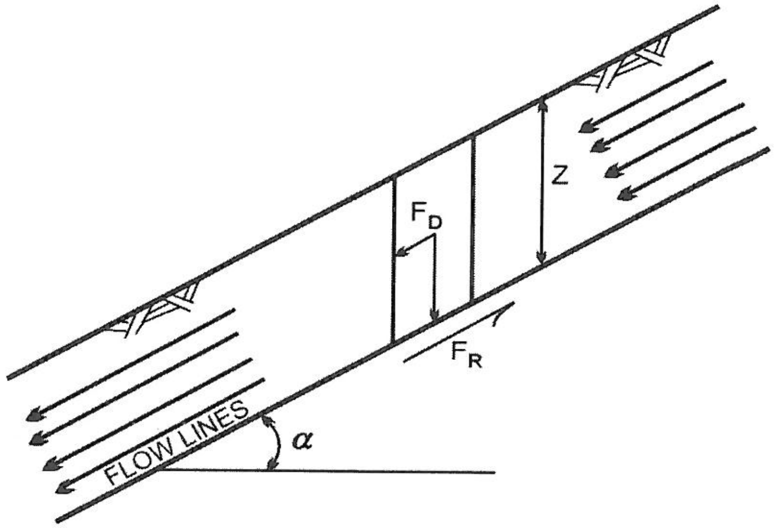
$$F_R = z\gamma_b \cos^2\alpha \tan\phi + c$$

Factor of Safety:

$$F.S. = \frac{2\text{ zgb cos2 a tan f + 2c}}{z\gamma_t \sin 2\alpha} = 1.10$$

Surficial Slope Stability Analysis

NMG Geotechnical, Inc.



z	=	Depth of Saturation	=	4.0	ft
γ_b	=	Buoyant Unit Weight of Soil	=	57.6	pcf
γ_t	=	Total Unit Weight of Soil	=	120.0	pcf
α	=	Slope Angle	=	26.6	degrees
ϕ	=	Angle of Internal Friction	=	31.0	degrees
c	=	Cohesion	=	180.0	psf

Force Tending to Cause Movement:

$$\mathbf{F_D = z\gamma_t \cos\alpha \sin\alpha = 1/2\ z\gamma_t \sin 2\alpha}$$

Force Tending to Resist Movement:

$$\mathbf{F_R = z\gamma_b \cos^2\alpha \tan\phi + c}$$

Factor of Safety:

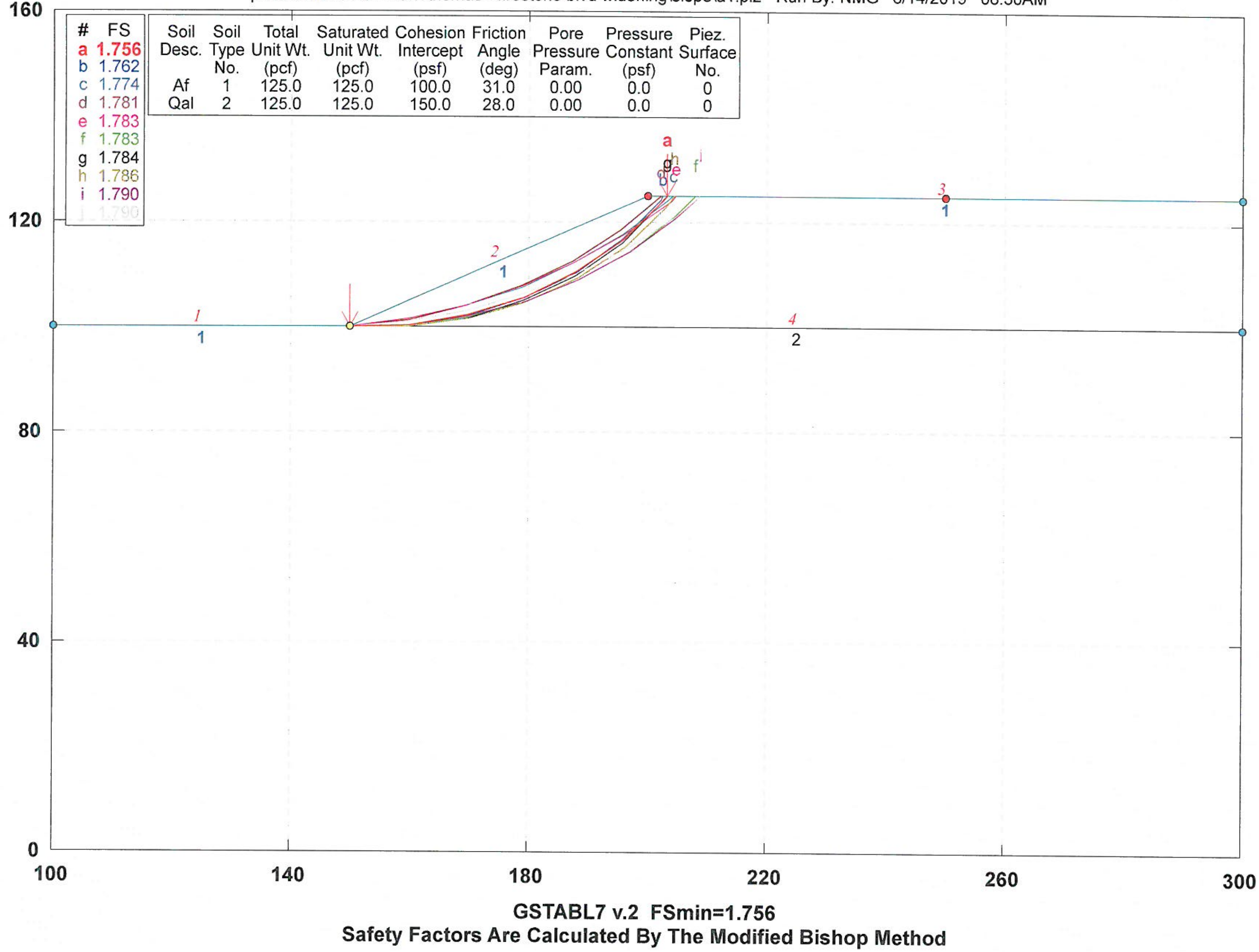
$$\mathbf{F.S. = \frac{2\ zgb\ cos2\ a\ tan\ f + 2c}{z\gamma_t \sin 2\alpha} = 1.51}$$

Surficial Slope Stability Analysis

NMG Geotechnical, Inc.

MT / Firestone #18181-01 Exisitng Embankment, H=25'

p:\2018\18181-01 mark thomas - firestone blvd widening\slope\a1.pl2 Run By: NMG 8/14/2019 08:30AM



*** **GSTABL7** ***

** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **

** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **

****

SLOPE STABILITY ANALYSIS SYSTEM

Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

```
Analysis Run Date:        8/14/2019
Time of Run:              09:18AM
Run By:                   NMG
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\a1.in
Output Filename:          P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a1.OUT
Unit System:              English
Plotted Output Filename:  P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a1.PLT
PROBLEM DESCRIPTION:  MT / Firestone #18181-01
                      Exisitng Embankment, H=25'
```

BOUNDARY COORDINATES
3 Top Boundaries
4 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	100.00	100.00	150.00	100.00	1
2	150.00	100.00	200.00	125.00	1
3	200.00	125.00	300.00	125.00	1
4	150.00	100.00	300.00	100.00	2

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)

ISOTROPIC SOIL PARAMETERS
2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	125.0	125.0	100.0	31.0	0.00	0.0	0
2	125.0	125.0	150.0	28.0	0.00	0.0	0

```
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
 400 Trial Surfaces Have Been Generated.
 400 Surface(s) Initiate(s) From Each Of     1 Points Equally Spaced
Along The Ground Surface Between  X = 150.00(ft)
                             and  X = 150.00(ft)
Each Surface Terminates Between   X = 200.00(ft)
                            and   X = 250.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is  Y =      0.00(ft)
10.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
      Failure Surfaces Evaluated. They Are
      Ordered - Most Critical First.
      * * Safety Factors Are Calculated By The Modified Bishop Method * *
      Total Number of Trial Surfaces Attempted =   400
      Number of Trial Surfaces With Valid FS =  400
      Statistical Data On All Valid FS Values:
         FS Max =   4.295   FS Min =   1.756   FS Ave =   2.894
         Standard Deviation =    0.737   Coefficient of Variation =   25.47 %
      Failure Surface Specified By  8 Coordinate Points
        Point      X-Surf      Y-Surf
         No.        (ft)        (ft)
```

1	150.000	100.000
2	159.996	100.268
3	169.822	102.127
4	179.226	105.529
5	187.966	110.388
6	195.820	116.578
7	202.585	123.942
8	203.283	125.000

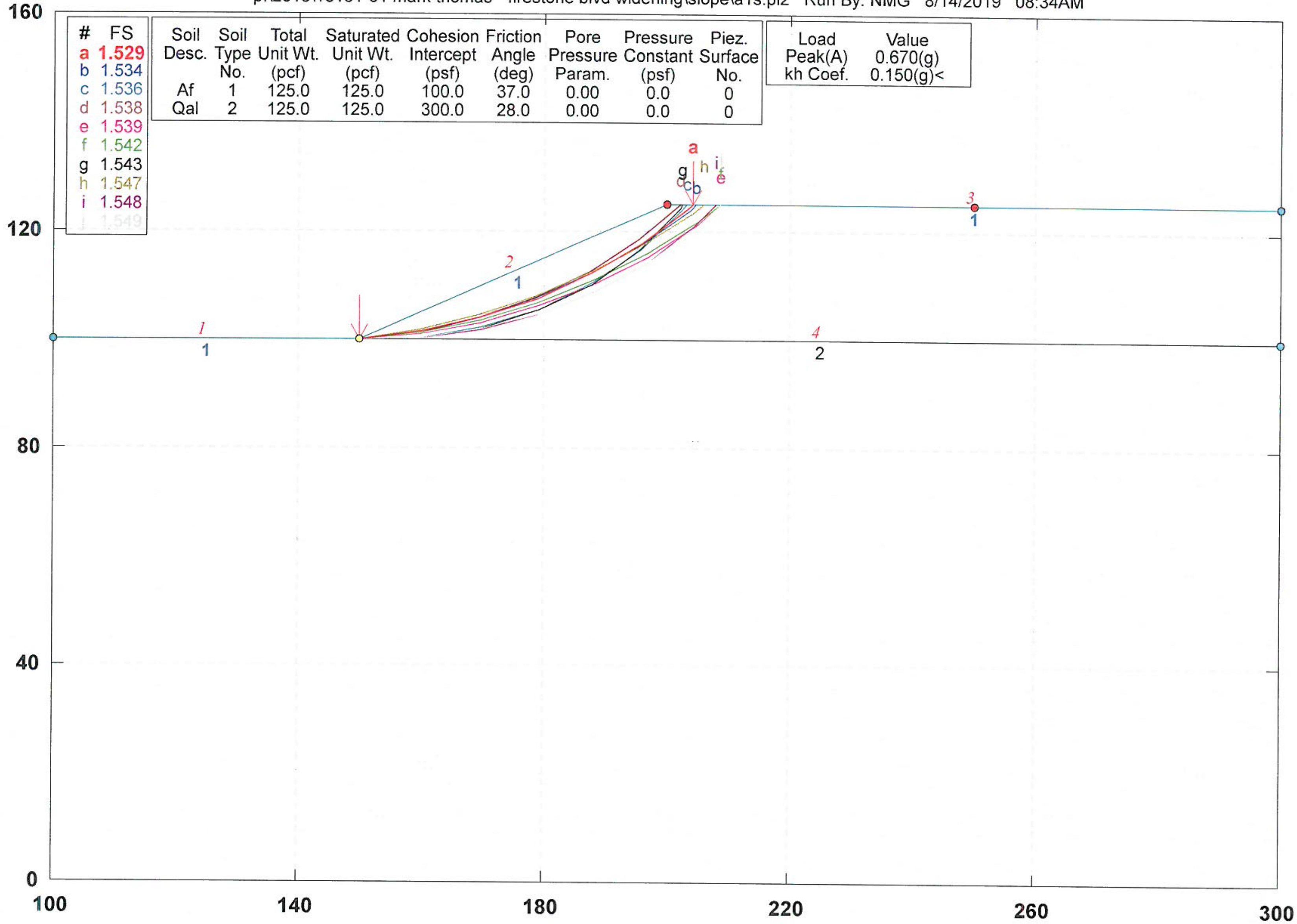
Circle Center At X = 153.399 ; Y = 162.037 ; and Radius = 62.130

Factor of Safety

*** 1.756 ***

MT / Firestone #18181-01 Exisitng Embankment, H=25'

p:\2018\18181-01 mark thomas - firestone blvd widening\slope\a1s.pl2 Run By: NMG 8/14/2019 08:34AM



GSTABL7 v.2 FSmin=1.529

Safety Factors Are Calculated By The Modified Bishop Method

*** **GSTABL7** ***
** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **

****
SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
****

```
Analysis Run Date:        8/14/2019
Time of Run:              08:34AM
Run By:                   NMG
Input Data Filename:      P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a1s.in
Output Filename:          P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a1s.OUT
Unit System:              English
Plotted Output Filename:  P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a1s.PLT
PROBLEM DESCRIPTION:  MT / Firestone #18181-01
                      Exisitng Embankment, H=25'
BOUNDARY COORDINATES
    3 Top   Boundaries
    4 Total Boundaries
```

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	100.00	100.00	150.00	100.00	1
2	150.00	100.00	200.00	125.00	1
3	200.00	125.00	300.00	125.00	1
4	150.00	100.00	300.00	100.00	2

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	125.0	125.0	100.0	37.0	0.00	0.0	0
2	125.0	125.0	300.0	28.0	0.00	0.0	0

```
Specified Peak Ground Acceleration Coefficient (A) =   0.670(g)
Specified Horizontal Earthquake Coefficient (kh) =   0.150(g)
Specified Vertical Earthquake Coefficient (kv) =   0.000(g)
Specified Seismic Pore-Pressure Factor =   0.000
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
 400 Trial Surfaces Have Been Generated.
 400 Surface(s) Initiate(s) From Each Of     1 Points Equally Spaced
Along The Ground Surface Between  X = 150.00(ft)
                             and  X = 150.00(ft)
Each Surface Terminates Between   X = 200.00(ft)
                             and  X = 250.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is  Y =      0.00(ft)
10.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
      Failure Surfaces Evaluated. They Are
      Ordered - Most Critical First.
      * * Safety Factors Are Calculated By The Modified Bishop Method * *
      Total Number of Trial Surfaces Attempted =   400
      Number of Trial Surfaces With Valid FS =  400
      Statistical Data On All Valid FS Values:
         FS Max =   2.879   FS Min =   1.529   FS Ave =   2.191
```

Standard Deviation = 0.399 Coefficient of Variation = 18.21 %

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	150.000	100.000
2	159.902	101.396
3	169.580	103.915
4	178.906	107.524
5	187.758	112.175
6	196.020	117.809
7	203.585	124.349
8	204.183	125.000

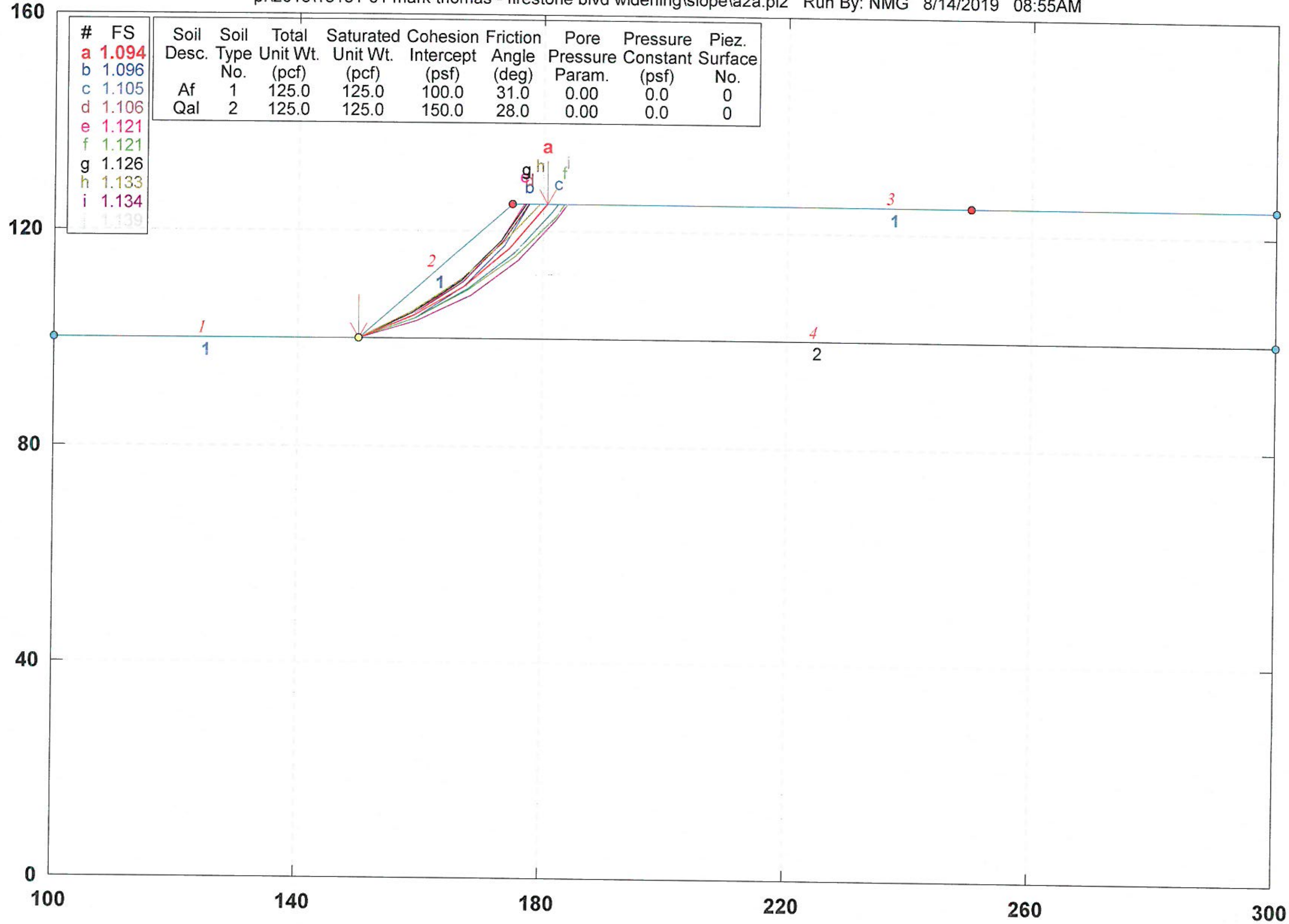
Circle Center At X = 142.877 ; Y = 186.653 ; and Radius = 86.945

Factor of Safety

*** 1.529 ***

MT / Firestone #18181-01 Temp 1:1 Slope, H=25', c=100psf

p:\2018\18181-01 mark thomas - firestone blvd widening\slope\a2a.pl2 Run By: NMG 8/14/2019 08:55AM



GSTABL7 v.2 FSmin=1.094

Safety Factors Are Calculated By The Modified Bishop Method

```
                              *** GSTABL7 ***
               ** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
      ** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
                 (All Rights Reserved-Unauthorized Use Prohibited)
 *****************************************************************************
                         SLOPE STABILITY ANALYSIS SYSTEM
        Modified Bishop, Simplified Janbu, or GLE Method of Slices.
        (Includes Spencer & Morgenstern-Price Type Analysis)
        Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
        Nonlinear Undrained Shear Strength, Curved Phi Envelope,
        Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
        Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
 *****************************************************************************
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    Time of Run:              08:56AM
    Run By:                   NMG
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\a2a.in
    Output Filename:          P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a2a.OUT
    Unit System:              English
    Plotted Output Filename:  P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a2a.PLT
    PROBLEM DESCRIPTION:  MT / Firestone #18181-01
                          Temp 1:1 Slope, H=25', c=100psf
    BOUNDARY COORDINATES
         Note: User origin value specified.
         Add 100.00 to X-values and 0.00 to Y-values listed.

        3 Top   Boundaries
        4 Total Boundaries
    Boundary     X-Left     Y-Left     X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)      Below Bnd
        1        100.00     100.00     150.00     100.00         1
        2        150.00     100.00     175.00     125.00         1
        3        175.00     125.00     300.00     125.00         1
        4        150.00     100.00     300.00     100.00         2
    Default Y-Origin = 0.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     2 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept  Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)    (deg)   Param.   (psf)     No.
      1   125.0    125.0     100.0    31.0    0.00      0.0       0
      2   125.0    125.0     150.0    28.0    0.00      0.0       0
    A Critical Failure Surface Searching Method, Using A Random
    Technique For Generating Circular Surfaces, Has Been Specified.
     400 Trial Surfaces Have Been Generated.
     400 Surface(s) Initiate(s) From Each Of     1 Points Equally Spaced
    Along The Ground Surface Between  X = 150.00(ft)
                                 and  X = 150.00(ft)
    Each Surface Terminates Between   X = 175.00(ft)
                                 and  X = 250.00(ft)
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =     0.00(ft)
    10.00(ft) Line Segments Define Each Trial Failure Surface.
    Following Are Displayed The Ten Most Critical Of The Trial
          Failure Surfaces Evaluated. They Are
          Ordered - Most Critical First.
          * * Safety Factors Are Calculated By The Modified Bishop Method * *
          Total Number of Trial Surfaces Attempted =   400
          Number of Trial Surfaces With Valid FS =  400
          Statistical Data On All Valid FS Values:
             FS Max =    6.160    FS Min =    1.094    FS Ave =    3.234
             Standard Deviation =    1.578   Coefficient of Variation =   48.79 %
```

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	150.000	100.000
2	159.086	104.177
3	167.350	109.807
4	174.562	116.735
5	180.520	124.766
6	180.640	125.000

Circle Center At X = 129.716 ; Y = 156.135 ; and Radius = 59.687

Factor of Safety

*** 1.094 ***

MT / Firestone #18181-01 Temp 1:1 Slope, H=25', c=150 pcf

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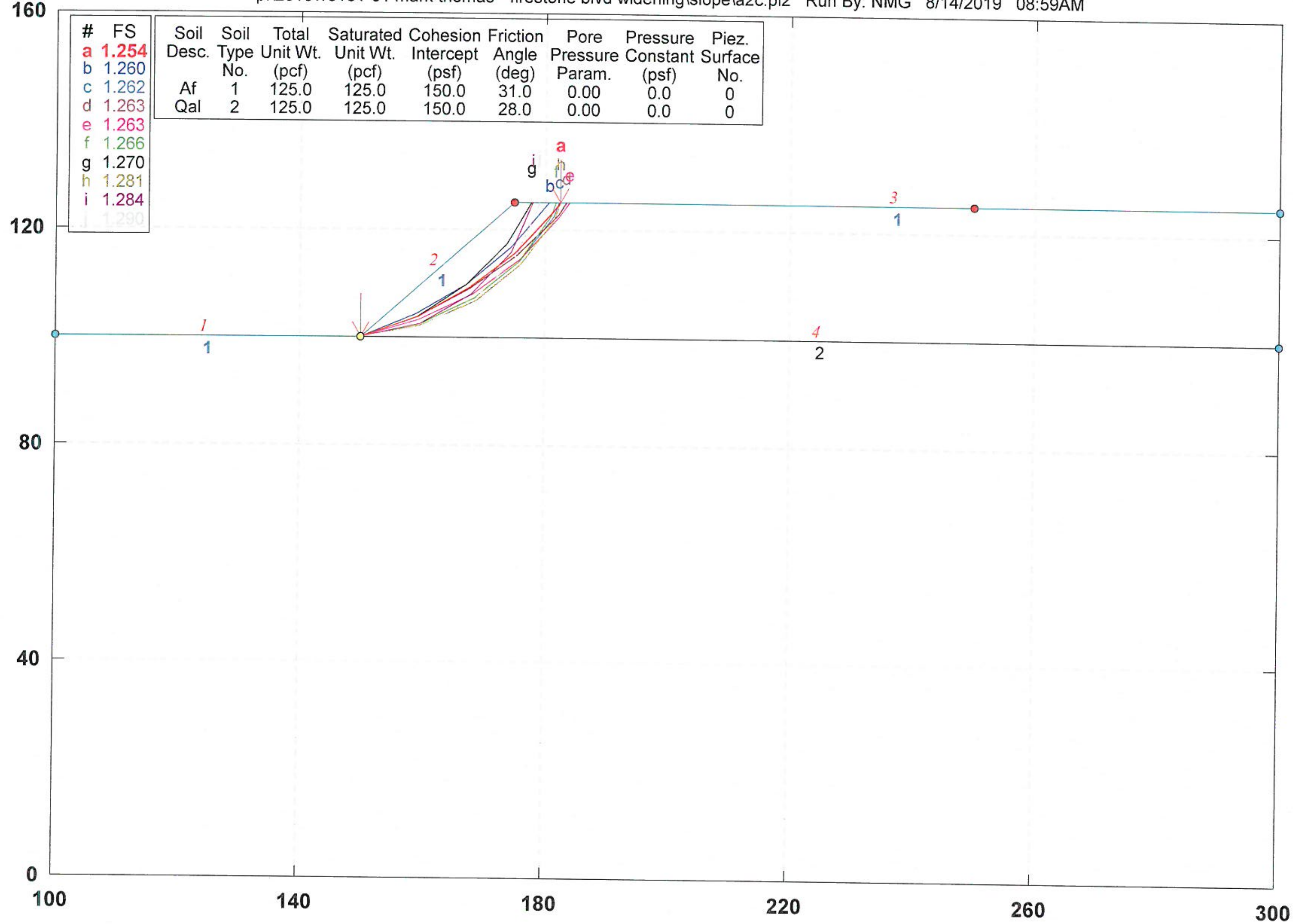


GSTABL7 v.2 FSmin=1.254

Safety Factors Are Calculated By The Modified Bishop Method

***** GSTABL7 *****

** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 8/14/2019
Time of Run: 08:59AM
Run By: NMG
Input Data Filename: P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope\a2c.in
Output Filename: P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope\a2c.OUT
Unit System: English
Plotted Output Filename: P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope\a2c.PLT
PROBLEM DESCRIPTION: MT / Firestone #18181-01
Temp 1:1 Slope, H=25', c=150 pcf

BOUNDARY COORDINATES
3 Top Boundaries
4 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	100.00	100.00	150.00	100.00	1
2	150.00	100.00	175.00	125.00	1
3	175.00	125.00	300.00	125.00	1
4	150.00	100.00	300.00	100.00	2

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)

ISOTROPIC SOIL PARAMETERS
2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	125.0	125.0	150.0	31.0	0.00	0.0	0
2	125.0	125.0	150.0	28.0	0.00	0.0	0

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.
400 Trial Surfaces Have Been Generated.
400 Surface(s) Initiate(s) From Each Of 1 Points Equally Spaced
Along The Ground Surface Between X = 150.00(ft)
and X = 150.00(ft)
Each Surface Terminates Between X = 175.00(ft)
and X = 250.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00(ft)
10.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 400
Number of Trial Surfaces With Valid FS = 400
Statistical Data On All Valid FS Values:
FS Max = 6.187 FS Min = 1.254 FS Ave = 3.309
Standard Deviation = 1.532 Coefficient of Variation = 46.31 %
Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	150.000	100.000
2	159.230	103.849
3	167.710	109.149
4	175.214	115.759
5	181.541	123.502
6	182.402	125.000

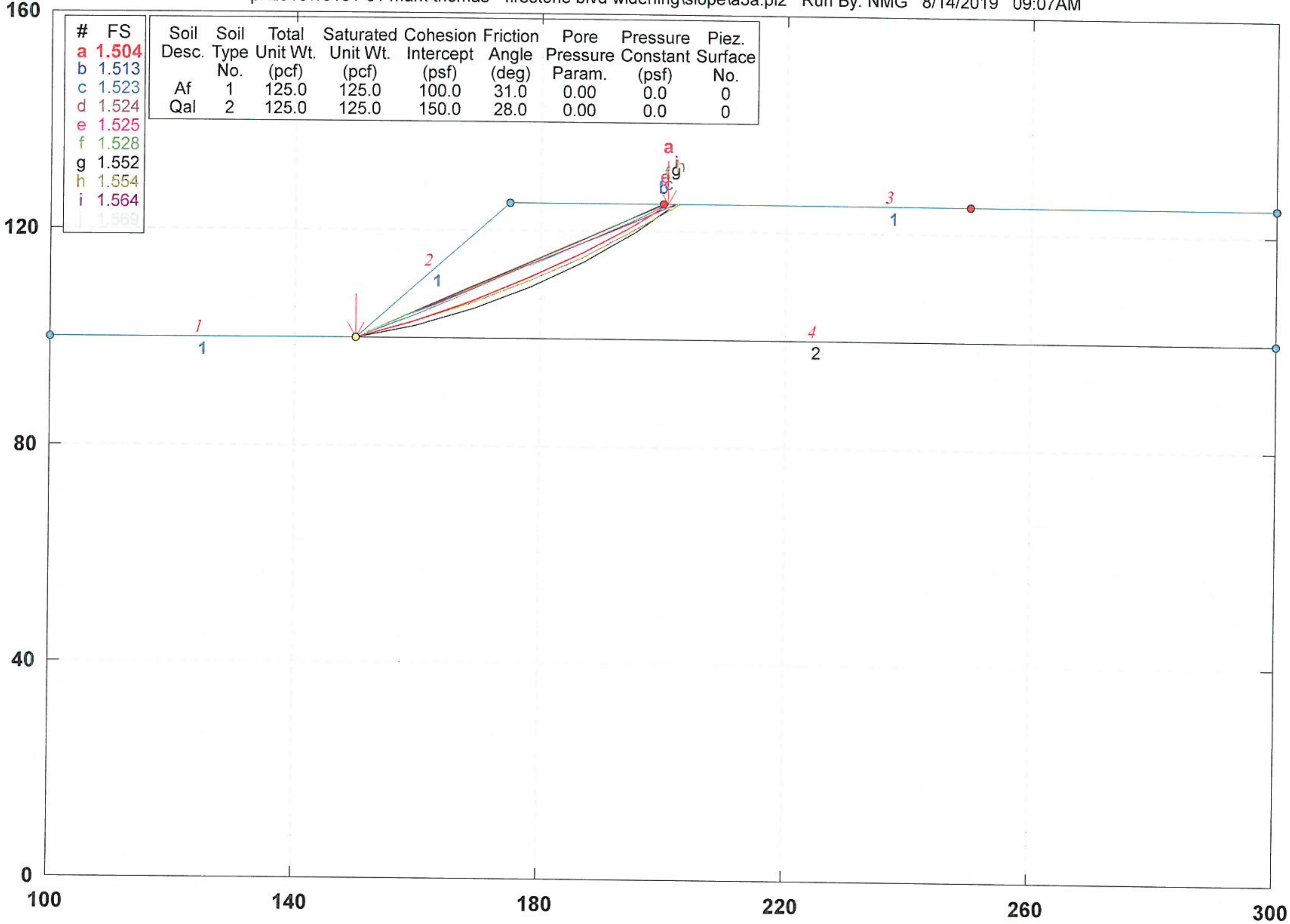
Circle Center At X = 131.580 ; Y = 157.371 ; and Radius = 60.255

Factor of Safety

*** 1.254 ***

MT / Firestone #18181-01 Tep 1:1 Slope, H=25' w/ setback

p:\2018\18181-01 mark thomas - firestone blvd widening\slope\a3a.pl2 Run By: NMG 8/14/2019 09:07AM



GSTABL7 v.2 FSmin=1.504

Safety Factors Are Calculated By The Modified Bishop Method

```
                         ***  GSTABL7  ***
          ** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
   ** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
             (All Rights Reserved-Unauthorized Use Prohibited)
*********************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
       Modified Bishop, Simplified Janbu, or GLE Method of Slices.
       (Includes Spencer & Morgenstern-Price Type Analysis)
       Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
       Nonlinear Undrained Shear Strength, Curved Phi Envelope,
       Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
       Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*********************************************************************************
  Analysis Run Date:        8/14/2019
  Time of Run:              09:07AM
  Run By:                   NMG
  Input Data Filename:      P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a3a.in
  Output Filename:          P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a3a.OUT
  Unit System:              English
  Plotted Output Filename:  P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a3a.PLT
  PROBLEM DESCRIPTION:  MT / Firestone #18181-01
                        Tep 1:1 Slope, H=25' w/ setback
  BOUNDARY COORDINATES
     3 Top   Boundaries
     4 Total Boundaries
  Boundary     X-Left     Y-Left     X-Right    Y-Right     Soil Type
     No.        (ft)       (ft)       (ft)       (ft)       Below Bnd
      1        100.00     100.00     150.00     100.00          1
      2        150.00     100.00     175.00     125.00          1
      3        175.00     125.00     300.00     125.00          1
      4        150.00     100.00     300.00     100.00          2
  Default Y-Origin = 0.00(ft)
  Default X-Plus Value = 0.00(ft)
  Default Y-Plus Value = 0.00(ft)
 ISOTROPIC SOIL PARAMETERS
   2 Type(s) of Soil
  Soil  Total  Saturated  Cohesion Friction   Pore    Pressure   Piez.
  Type Unit Wt. Unit Wt. Intercept  Angle   Pressure Constant Surface
   No.  (pcf)    (pcf)     (psf)    (deg)    Param.    (psf)     No.
    1   125.0    125.0     100.0    31.0     0.00       0.0       0
    2   125.0    125.0     150.0    28.0     0.00       0.0       0
  A Critical Failure Surface Searching Method, Using A Random
  Technique For Generating Circular Surfaces, Has Been Specified.
   400 Trial Surfaces Have Been Generated.
   400 Surface(s) Initiate(s) From Each Of     1 Points Equally Spaced
  Along The Ground Surface Between  X = 150.00(ft)
                                and X = 150.00(ft)
  Each Surface Terminates Between   X = 200.00(ft)
                                and X = 250.00(ft)
  Unless Further Limitations Were Imposed, The Minimum Elevation
  At Which A Surface Extends Is  Y =       0.00(ft)
  10.00(ft) Line Segments Define Each Trial Failure Surface.
  Following Are Displayed The Ten Most Critical Of The Trial
        Failure Surfaces Evaluated. They Are
        Ordered - Most Critical First.
        * * Safety Factors Are Calculated By The Modified Bishop Method * *
        Total Number of Trial Surfaces Attempted =   400
        Number of Trial Surfaces With Valid FS =  400
        Statistical Data On All Valid FS Values:
           FS Max =   6.170   FS Min =   1.504   FS Ave =   3.588
           Standard Deviation =    1.374   Coefficient of Variation =   38.30 %
        Failure Surface Specified By 7 Coordinate Points
          Point      X-Surf      Y-Surf
           No.        (ft)        (ft)
```

1	150.000	100.000
2	159.503	103.114
3	168.804	106.787
4	177.871	111.005
5	186.672	115.753
6	195.175	121.015
7	200.836	125.000

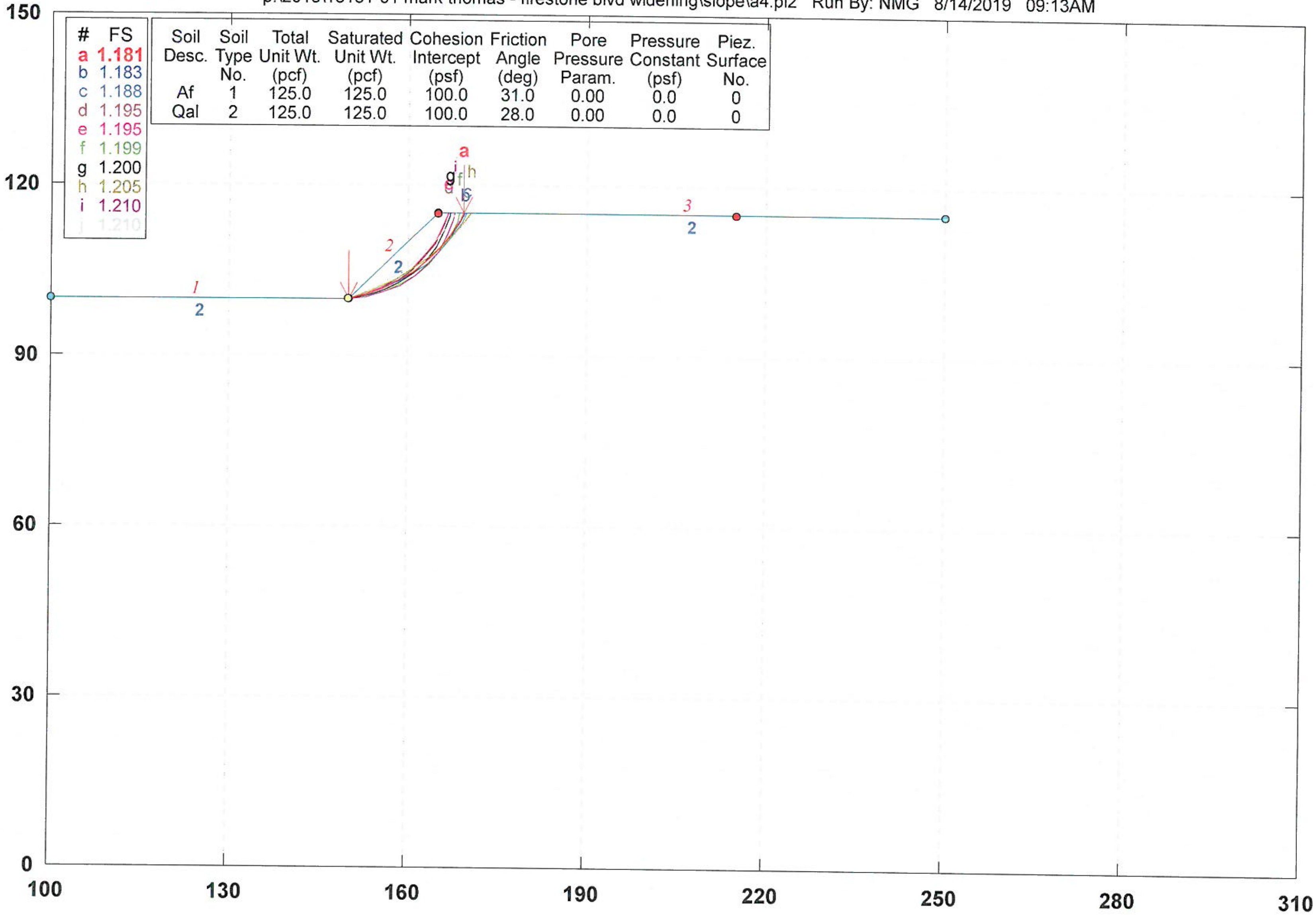
Circle Center At X = 102.287 ; Y = 261.633 ; and Radius = 168.528

Factor of Safety

*** 1.504 ***

MT / Firestone #18181-01 Temp 1:1 Slope, Qal, H=15', c=100 psf

p:\2018\18181-01 mark thomas - firestone blvd widening\slope\a4.pl2 Run By: NMG 8/14/2019 09:13AM



GSTABL7 v.2 FSmin=1.181

Safety Factors Are Calculated By The Modified Bishop Method

```
                         *** GSTABL7 ***
          ** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
   ** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
           (All Rights Reserved-Unauthorized Use Prohibited)
*********************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
      Modified Bishop, Simplified Janbu, or GLE Method of Slices.
      (Includes Spencer & Morgenstern-Price Type Analysis)
      Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
      Nonlinear Undrained Shear Strength, Curved Phi Envelope,
      Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
      Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*********************************************************************************
    Analysis Run Date:          8/14/2019
    Time of Run:                09:13AM
    Run By:                     NMG
    Input Data Filename:        P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a4.in
    Output Filename:            P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a4.OUT
    Unit System:                English
    Plotted Output Filename:    P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a4.PLT
    PROBLEM DESCRIPTION:   MT / Firestone #18181-01
                           Temp 1:1 Slope, Qal, H=15', c=100 psf
    BOUNDARY COORDINATES
        3 Top   Boundaries
        3 Total Boundaries
    Boundary     X-Left     Y-Left     X-Right     Y-Right     Soil Type
       No.        (ft)       (ft)        (ft)        (ft)      Below Bnd
        1        100.00     100.00     150.00      100.00          2
        2        150.00     100.00     165.00      115.00          2
        3        165.00     115.00     250.00      115.00          2
    Default Y-Origin = 0.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     2 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore    Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept  Angle   Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)    (deg)    Param.    (psf)     No.
      1   125.0    125.0     100.0    31.0     0.00       0.0       0
      2   125.0    125.0     100.0    28.0     0.00       0.0       0
    A Critical Failure Surface Searching Method, Using A Random
    Technique For Generating Circular Surfaces, Has Been Specified.
     400 Trial Surfaces Have Been Generated.
     400 Surface(s) Initiate(s) From Each Of     1 Points Equally Spaced
    Along The Ground Surface Between  X = 150.00(ft)
                                 and  X = 150.00(ft)
    Each Surface Terminates Between   X = 165.00(ft)
                                 and  X = 215.00(ft)
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =      0.00(ft)
     3.00(ft) Line Segments Define Each Trial Failure Surface.
    Following Are Displayed The Ten Most Critical Of The Trial
          Failure Surfaces Evaluated. They Are
          Ordered - Most Critical First.
          * * Safety Factors Are Calculated By The Modified Bishop Method * *
          Total Number of Trial Surfaces Attempted =   400
          Number of Trial Surfaces With Valid FS =  400
          Statistical Data On All Valid FS Values:
             FS Max =    6.350   FS Min =    1.181   FS Ave =    3.224
             Standard Deviation =    1.531   Coefficient of Variation =   47.49 %
          Failure Surface Specified By 10 Coordinate Points
            Point       X-Surf       Y-Surf
             No.         (ft)         (ft)
              1        150.000      100.000
              2        152.912      100.721
```

3	155.726	101.762
4	158.405	103.111
5	160.918	104.751
6	163.231	106.660
7	165.318	108.816
8	167.150	111.191
9	168.706	113.756
10	169.282	115.000

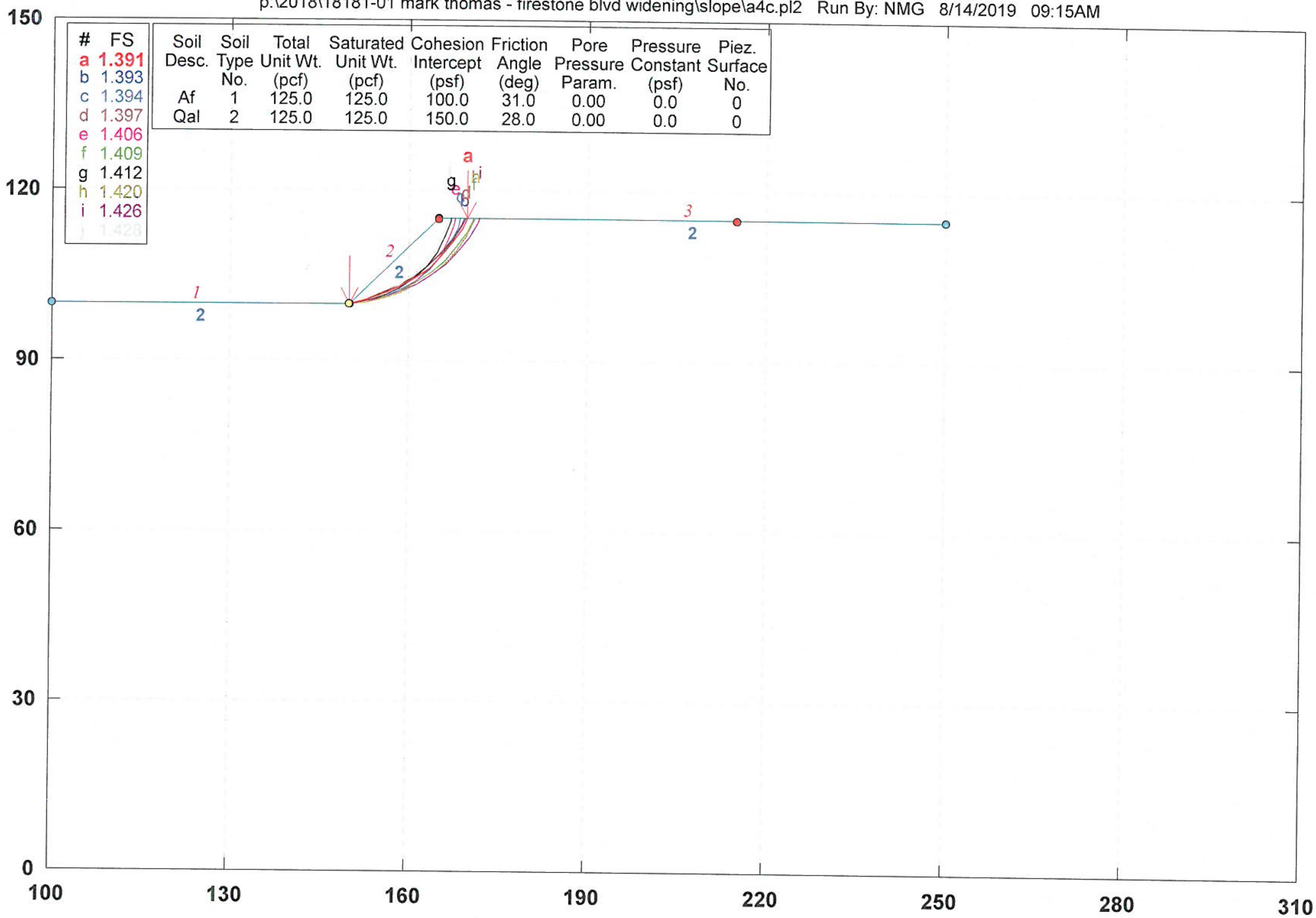
Circle Center At X = 145.090 ; Y = 126.204 ; and Radius = 26.660

Factor of Safety

*** 1.181 ***

MT / Firestone #18181-01 Temp 1:1 Slope, Qal, H = 15' c=150 psf

p:\2018\18181-01 mark thomas - firestone blvd widening\slope\a4c.pl2 Run By: NMG 8/14/2019 09:15AM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Af	1	125.0	125.0	100.0	31.0	0.00	0.0	0
Qal	2	125.0	125.0	150.0	28.0	0.00	0.0	0

GSTABL7 v.2 FSmin=1.391

Safety Factors Are Calculated By The Modified Bishop Method

```
                    *** GSTABL7 ***
        ** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
  ** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
           (All Rights Reserved-Unauthorized Use Prohibited)
*********************************************************************************
                   SLOPE STABILITY ANALYSIS SYSTEM
      Modified Bishop, Simplified Janbu, or GLE Method of Slices.
      (Includes Spencer & Morgenstern-Price Type Analysis)
      Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
      Nonlinear Undrained Shear Strength, Curved Phi Envelope,
      Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
      Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*********************************************************************************
   Analysis Run Date:          8/14/2019
   Time of Run:                09:15AM
   Run By:                     NMG
   Input Data Filename:        P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a4c.in
   Output Filename:            P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a4c.OUT
   Unit System:                English
   Plotted Output Filename:    P:\2018\18181-01 Mark Thomas - Firestone Blvd Widening\Slope
\a4c.PLT
   PROBLEM DESCRIPTION:    MT / Firestone #18181-01
                           Temp 1:1 Slope, Qal,  H = 15' c=150 psf
   BOUNDARY COORDINATES
       3 Top   Boundaries
       3 Total Boundaries
   Boundary     X-Left      Y-Left     X-Right     Y-Right     Soil Type
     No.         (ft)        (ft)        (ft)        (ft)      Below Bnd
      1         100.00      100.00      150.00      100.00         2
      2         150.00      100.00      165.00      115.00         2
      3         165.00      115.00      250.00      115.00         2
   Default Y-Origin = 0.00(ft)
   Default X-Plus Value = 0.00(ft)
   Default Y-Plus Value = 0.00(ft)
  ISOTROPIC SOIL PARAMETERS
    2 Type(s) of Soil
   Soil  Total  Saturated  Cohesion Friction   Pore    Pressure   Piez.
   Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
    No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
     1   125.0    125.0     100.0     31.0     0.00      0.0       0
     2   125.0    125.0     150.0     28.0     0.00      0.0       0
   A Critical Failure Surface Searching Method, Using A Random
   Technique For Generating Circular Surfaces, Has Been Specified.
    400 Trial Surfaces Have Been Generated.
    400 Surface(s) Initiate(s) From Each Of     1 Points Equally Spaced
   Along The Ground Surface Between  X = 150.00(ft)
                                and  X = 150.00(ft)
   Each Surface Terminates Between   X = 165.00(ft)
                                and  X = 215.00(ft)
   Unless Further Limitations Were Imposed, The Minimum Elevation
   At Which A Surface Extends Is  Y =      0.00(ft)
    3.00(ft) Line Segments Define Each Trial Failure Surface.
   Following Are Displayed The Ten Most Critical Of The Trial
         Failure Surfaces Evaluated. They Are
         Ordered - Most Critical First.
         * * Safety Factors Are Calculated By The Modified Bishop Method * *
         Total Number of Trial Surfaces Attempted =   400
         Number of Trial Surfaces With Valid FS =  400
         Statistical Data On All Valid FS Values:
            FS Max =    6.596   FS Min =    1.391   FS Ave =    3.445
            Standard Deviation =    1.532   Coefficient of Variation =   44.46 %
         Failure Surface Specified By 10 Coordinate Points
           Point      X-Surf      Y-Surf
            No.        (ft)        (ft)
             1       150.000     100.000
             2       152.929     100.649
```

```
   3        155.767      101.623
   4        158.477      102.908
   5        161.026      104.490
   6        163.382      106.348
   7        165.514      108.458
   8        167.397      110.794
   9        169.005      113.326
  10        169.820      115.000
Circle Center At X =   145.759 ; Y =   126.199 ; and Radius =    26.540
      Factor of Safety
     ***    1.391   ***
```

APPENDIX F

PACIFIC
GEOSOURCE

Reinforced Pavement Recommendation

To: Karlos Markouizos, PE – NMG Geotechnical
Date: July 30th, 2019
Project Location: Firestone Blvd – Norwalk, CA

Road-Tested Pavement Solutions /

PacificGeoSource.com

Introduction

The incorporation of Pacific GeoSource (PGS) reinforcement systems into flexible pavement leads to the construction of stronger and more sustainable roads and parking lots. Benefits include:

- Increased Structural Capacity
- Reduced Maintenance
- Extended Pavement Life
- Reduced Life-Cycle Costs
- Minimized Reflective Cracking
- Accelerated Construction TIme

The recommendations outlined in this report include the use of pavement reinforcement systems which enhance pavement durability and extend pavement life. Based on initial conversations with project personnel, the goal of the Firestone Blvd reconstruction is to utilize reinforcement in order to:

1) improve pavement durability and performance
2) save on initial material cost
3) mitigate cracking and rutting, specifically with heavy vehicle traffic
4) accelerate construction time

The recommendations outlined in this report include the use of FORTA-FI Reinforced Asphalt Concrete (FRAC) to enhance asphalt performance, add structural capacity, and extend pavement life and RockGrid BX, a biaxial geogrid which stabilizes the unbound base material and bridges over soft subgrades. Designs and recommendations are based on information provided by NMG Geotechnical.

Recommended Reinforcement Strategies

Incorporating PGS asphalt and base reinforcement systems offers a unique yet simple pavement solution to reduce maintenance needs and extend pavement design life.

FORTA-FI Asphalt Reinforcement Fibers are the simplest and most cost-effective way to strengthen asphalt. Adding FORTA-FI to the asphalt mix during production creates a three-dimensional reinforcement matrix that makes the entire pavement layer a more stress-resistant material. Pavement surface strength and durability are improved, reducing rutting and mitigating the potential for thermal, reflective, and fatigue cracking.

FORTA-FI® Reinforced Asphalt

The use of RockGrid™ BX reinforcement increases the tensile strength of the aggregate base layer and provides subgrade/base uniformity critical in any pavement application. Stresses are dispersed through the base by the biaxial geogrid as it interlocks with the aggregate; mechanical interlock prevents lateral movement of the base material, stabilizing the layer and mitigating significant pavement distress associated with base failure.

RockGrid BX

Pavement Design

Pacific GeoSource provides tailored reinforced pavement recommendations to ensure the most cost-effective and longest lasting solution. Based on conversations with NMG Geotechnical and project personnel, we understand that NMG is considering alternative options to maximize performance while reducing upfront material cost. Pavement strength, durability and design life, which correspond directly to reduced future site maintenance costs, will be maximized by adding PGS reinforcement systems to the recommended pavement layers with no change to structural section thickness.

NMG Geotechnical and the City of Norwalk may also consider alternative, optimized pavement sections which use reinforcement to extend pavement design life while offsetting up-front costs through a partial reduction in section thickness. Table 1 and 2 present pavement section alternatives and estimated material costs. See Appendix A for additional pavement design details.

Table 1. Reinforced Flexible Pavement Design Comparison, R=13/T=9

Firestone Blvd Pavement Sections	Conventional	Est. Material Cost[1]	Traffic Index
Conventional AC/AB	0.60-ft AC 1.25-ft Aggregate Base	$44.68/SY	9.0
Reinforced FORTA-FI Only	0.50-ft FRAC 1.05-ft Aggregate Base	$43.46/SY	9.1
Reinforced FORTA-FI & Rockgrid BX	0.50-ft FRAC 0.85-ft Aggregate Base RockGrid BX	$40.45/SY **9% Savings**	9.2
Conventional Full-Depth AC	1.10-ft AC	$55.66/SY	9.5
Reinforced Full-Depth FRAC	0.85-ft FRAC	$49.67/SY **11% Savings**	9.5

[1]Costs reflect average material prices and are used for estimation purposes only. FRAC +$12/ton, RockGrid BX $1.50/sy

Table 2. Reinforced Flexible Pavement Design Comparison, R=50/T=9

Firestone Blvd Pavement Sections	Conventional	Est. Material Cost[1]	Traffic Index
Conventional AC/AB	0.35-ft AC 0.75-ft Aggregate Base	$26.30/SY	9.3
Reinforced FORTA-FI Only	0.30 ft FRAC 0.60-ft Aggregate Base	$24.40/SY	9.1
Conventional Full-Depth AC	0.70-ft AC	$35.42/SY	9.1
Reinforced Full-Depth FRAC	0.55-ft FRAC	$32.14/SY **9% Savings**	9.2

[1]Costs reflect average material prices and are used for estimation purposes only. FRAC +$12/ton, RockGrid BX $1.50/sy

Cost Savings & Sustainability Analysis

Reduction in asphalt, concrete, and base thickness not only decreases raw material usage, but also significantly saves costs due to less excavation, reduced construction time, and fewer truck and man hours. The reinforced pavement sections could also reduce the required number of paving lifts, saving a significant amount of time for project completion. Less truck traffic will also help preserve the integrity of the surrounding streets and limit unwanted carbon emissions. Table 2 provides estimated material cost and construction time savings as well as estimated emission reductions.

Table 2. Cost Savings and Sustainability Analysis

Project Parameters	Reinforced Pavement FORTA-FI & RockGrid BX
Est. Project Size (SY)	50,000
Est. Material Cost Reduction ($)	211,500
Pavement Design Life Increase	Equivalent
Est. Construction Time Savings Reduction in Truck Days[1]	52
Equivalent CO_2 Emissions Reduction[2]	>450,000 Car Miles

Additional Considerations

Mill and Overlay with FORTA-FI

Based on conversations with NMG Geotechnical, the City of Norwalk considered a mill and overlay in the non-expansion areas of the project. If the City reevaluates this option, it is critical FORTA-Fi be added into the asphalt overlays. FORTA-FI has proven to extend the life of the overlay. In side-by-side field trials utilizing 1.5 to 2.0-inch overlays, FORTA-FI significantly slowed surface deterioration while increasing structural capacity. Table 3 provides side-by-side Pavement Condition Index (PCI) after 4-5 years.

Table 3. Side-by-Side Field Trails with FORTA-FI

Pavement Section	Pavement Condition Index FORTA-FI	Pavement Condition Index Control	Deterioration Rate FORTA-FI/Control (PCI Points/Year)
1.5-in Overlay 4-Year Evaluation	95	72	1.3 / 7.0
2.0 Overlay 5-Year Evaluation	82	65	3.6 / 7.0

Reflective Crack Mitigation with FORTA-FI

The unique characteristics and high-tensile strength of FORTA-FI fibers also significantly impacts reflective cracking. Reflective cracking can significantly reduce the durability and overall lifespan of the overlay. FORTA-FI aids in withstanding the vertical propagation of the underlying cracks. In a side-by-side comparison, a completely deteriorated road was overlaid with conventional asphalt in one lane and FORTA-FI in the other lane. After only 6 months cracks reappeared in the control section. After 2 years the control section was rapidly deteriorating while the FORTA-Fi section is still in great condition. Comparative images are found in Figure 2.

Figure 2. Reflective crack mitigation with FORTA-FI.

PGS is your trusted partner, and we appreciate this opportunity to work with NMG Geotechnical and the City of Norwalk. Our years of experience and in-house pavement engineers ensure that your reinforced pavement project exceeds expectations. If you have any questions regarding PGS reinforcement systems or general pavement and/or construction best practices, please do not hesitate to contact us.

Thank you,

Joseph Yaede, M. Sc., P.E.
Lead Pavement Engineer
Joe.y@PacificGeoSource.com
(541) 520-3021

Alex Kotrotsios, PE
Pavement Solutions Manager
alex@PacificGeoSource.com
(949) 610-2627

Disclaimer: This report and associated design recommendations are based on provided data and made in accordance with accepted geotechnical and pavement engineering principles and research and contingent upon proper construction and installation. If during construction, unexpected pavement or subsurface conditions are encountered, we should be notified at once so that we may review such conditions and revise our recommendations. The opinions and recommendations contained within the report are not intended, nor should they be construed, to represent a warranty, either express or implied.

Pacific GeoSource Pavement Design with FORTA-FI®

Introduction

FORTA-FI fibers has emerged as a proven alternative to conventional asphalt mixes. With deteriorating pavements, rising material and labor costs, and shrinking budgets, the innovative strategy of using aramid fibers to decrease initial project costs, reduce required maintenance activities, and extend the pavement design life is gaining the attention of engineers, contractors, and owners. The benefits achieved through reinforcing asphalt with FORTA-FI's blend of aramid and polyolefin fibers include greater resistance to fatigue and thermal cracking, rutting, and crack propagation.

Following years of extensive laboratory testing and field evaluations including agencies such as the Federal Highway Administration, State DOTs, and University Research Facilities, FORTA-FI has repeatedly proven to be the industry leader in providing premium asphalt performance. Table 1 provides a partial list of the completed testing and the average improvement with the incorporation of FORTA-FI. Further information and full reports are available by contacting research@pacificgeosource.com.

Table 1. FORTA-FI Testing Summary Results[1]

Asphalt Test	Test Purpose	Average Improvement versus Control
Flow Number	Rutting Resistance	147%
Hamburg Wheel Tracking	Rutting Resistance Moisture Damage	75%
Indirect Tensile Strength	Crack Resistance Permanent Deformation	26%
Uniaxial Fatigue Testing	Fatigue Cracking	623%
Texas Overlay Test	Reflective Crack Resistance Crack Propagation	119%
Dynamic Modulus	Material Response Cracking & Rutting	10-30%
Resilient Modulus	Material Response Cracking & Rutting	30%
Pavement Condition Index	Field Performance Pavement Durability	PCI FORTA-FI: 94 PCI Control: 75

Incorporation of FORTA-FI with Advanced Mechanistic-Empirical Pavement Design

Given the enhanced structural asphalt properties of FORTA-FI reinforced asphalt concrete, it is critical that pavement designers, engineers, and local and State officials understand how to incorporate and quantify the performance benefit with various pavement design methodologies.

In the efforts to better predict pavement performance in terms of cracking, rutting, and smoothness, significant research efforts have led to the creation of AASHTO's PavementME. AASHTO's PavementME uses a mechanistic-empirical approach in which internal material properties are calculated within the pavement cross-section. These critical stresses and strains are then used to determine the cumulative pavement damage based on transfer functions developed from extensive research and closely monitored field performance from projects throughout the United States (2). The mechanistic-empirical design approach is able to incorporate detailed performance metrics of the asphalt pavement and relate them to pavement performance. This differs from previously established pavement design methods of which is solely based on empirical observations from the AASHO Road Test that began in the 1950's (3).

FORTA-FI has been used to improve the resistance of asphalt concrete materials to permanent deformation and cracking not only by modifying the material strength but also by modifying the material behavior in resisting pavement distresses (4). To appropriately quantify this impact and with assistance of Arizona State University, the enhanced performance characteristics in terms of fatigue life, rutting resistance, and dynamic modulus were used in AASHTO's PavementME to determine both the predicted increased traffic load (life extension) and pavement section reduction (reduced initial cost). Based on the analysis performed on multiple regions throughout the United States and multiple subgrades strengths, the Fiber Reinforced Asphalt Concrete (FRAC) section requires less asphalt concrete pavement thickness as compared to the control pavement to yield equivalent rutting and cracking performance.

AASHTO '93 FORTA-FI Layer Coefficient

Given the results obtained from various subgrade and climatic conditions, a FORTA-FI reinforced layer coefficient was calculated and ranged from 0.52 to 0.62 with an average asphalt reduction of 30 percent (5). While an average asphalt layer coefficient of 0.57 can be used to estimate the performance benefit, it is recommended to consult the Pavement Engineering Department of Pacific GeoSource for project specific values.

Caltrans Pavement Design w/ FORTA-FI

Based on the mechanistic-empirical design approach and reduction in asphalt layer thickness, the enhanced performance of FORTA-FI is incorporated in the Caltrans design method (6) through an increased Gravel Factor (Gf). The percent increase in the asphalt gravel factor ranges from 30 to 55 percent.

References

1. "FORTA-FI Reinforced Asphalt Research Summary". Pacific GeoSource. May 2018.
2. Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures. National Cooperative Highway Research Program, 1-37A. March 2004
3. AASHTO (1993). AASHTO Guide for Design of Pavement Structures. American Association of State Highway and Transportation Officials, Washington, D.C.
4. Zeiada, Waleed., Underwood, B. Shane., Kaloush, Kamil. "Layer Coefficient Calibration of Fiber Reinforced Asplat Concrete Based on Mechanistic Empirical Pavement Design Guide" Arizona State University, September 2014.
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Road-Tested Pavement Solutions /

Pacific GeoSource Will Save You Money /

We significantly reduce the up-front and life-cycle costs for road, highway, and parking lot projects by optimizing layer thicknesses and implementing reinforcement technologies to extend pavement life and lower long-term maintenance costs.

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Our reinforcement solutions can accelerate your paving project's timeline and significantly reduce required future maintenance activities for streets and parking lots.

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Clients turn to us not just for industry-leading pavement systems but also for trusted advice. We use the experience gained from navigating challenges on hundreds of projects around the country to help you make informed decisions about your pavements.

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No matter what stage your project is in when you engage our experts, be it planning, design, or construction, we stick by your side to see your project through to completion. Our organization-wide commitment to service at each step of the process is unparalleled.

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Pacific GeoSource is the source for innovative, value-added pavement solutions. Using our portfolio of of proven asphalt and aggregate reinforcement products and a value-engineering approach, we are uniquely capable of delivering cost-effective, high performance reinforced pavements for projects and clients of all sizes. We know what works. Our passion is building stronger roads and parking lots, and our commitment is saving our clients' money, both now and down the road.

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APPENDIX G

APPENDIX G

GENERAL EARTHWORK AND GRADING SPECIFICATIONS

1.0 General

1.1 Intent: These General Earthwork and Grading Specifications are for the grading and earthwork shown on the approved grading plan(s) and/or indicated in the geotechnical report(s). These Specifications are a part of the recommendations contained in the geotechnical report(s). In case of conflict, the specific recommendations in the geotechnical report shall supersede these more general Specifications. Observations of the earthwork by the project Geotechnical Consultant during the course of grading may result in new or revised recommendations that could supersede these specifications or the recommendations in the geotechnical report(s).

1.2 Geotechnical Consultant: Prior to commencement of work, the owner shall employ a geotechnical consultant. The geotechnical consultant shall be responsible for reviewing the approved geotechnical report(s) and accepting the adequacy of the preliminary geotechnical findings, conclusions, and recommendations prior to the commencement of the grading.

Prior to commencement of grading, the Geotechnical Consultant shall review the "work plan" prepared by the Earthwork Contractor (Contractor) and schedule sufficient personnel to perform the appropriate level of observation, mapping, and compaction testing.

During the grading and earthwork operations, the Geotechnical Consultant shall observe, map, and document the subsurface exposures to verify the geotechnical design assumptions. If the observed conditions are found to be significantly different than the interpreted assumptions during the design phase, the Geotechnical Consultant shall inform the owner, recommend appropriate changes in design to accommodate the observed conditions, and notify the review agency where required. Subsurface areas to be geotechnically observed, mapped, elevations recorded, and/or tested include natural ground after it has been cleared for receiving fill but before fill is placed, bottoms of all "remedial removal" areas, all key bottoms, and benches made on sloping ground to receive fill.

The Geotechnical Consultant shall observe the moisture-conditioning and processing of the subgrade and fill materials and perform relative compaction testing of fill to determine the attained level of compaction. The Geotechnical Consultant shall provide the test results to the owner and the Contractor on a routine and frequent basis.

1.3 The Earthwork Contractor: The Earthwork Contractor (Contractor) shall be qualified, experienced, and knowledgeable in earthwork logistics, preparation and processing of ground to receive fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall review and accept the plans, geotechnical report(s), and these Specifications prior to commencement of grading. The Contractor shall be solely responsible for performing the grading in accordance with the plans and specifications.

The Contractor shall prepare and submit to the owner and the Geotechnical Consultant a work plan that indicates the sequence of earthwork grading, the number of "spreads" of work and the estimated quantities of daily earthwork contemplated for the site prior to commencement of grading. The Contractor shall inform the owner and the Geotechnical Consultant of changes in work schedules and updates to the work plan at least 24 hours in advance of such changes so that appropriate observations and tests can be planned and accomplished. The Contractor shall not assume that the Geotechnical Consultant is aware of all grading operations.

The Contractor shall have the sole responsibility to provide adequate equipment and methods to accomplish the earthwork in accordance with the applicable grading codes and agency ordinances, these Specifications, and the recommendations in the approved geotechnical report(s) and grading plan(s). If, in the opinion of the Geotechnical Consultant, unsatisfactory conditions, such as unsuitable soil, improper moisture condition, inadequate compaction, insufficient buttress key size, adverse weather, etc., are resulting in a quality of work less than required in these specifications, the Geotechnical Consultant shall reject the work and may recommend to the owner that construction be stopped until the conditions are rectified.

2.0 Preparation of Areas to be Filled

2.1 Clearing and Grubbing: Vegetation, such as brush, grass, roots, and other deleterious material shall be sufficiently removed and properly disposed of in a method acceptable to the owner, governing agencies, and the Geotechnical Consultant.

The Geotechnical Consultant shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 1 percent of organic materials (by volume). No fill lift shall contain more than 5 percent of organic matter. Nesting of the organic materials shall not be allowed.

If potentially hazardous materials are encountered, the Contractor shall stop work in the affected area, and a hazardous material specialist shall be informed immediately for proper evaluation and handling of these materials prior to continuing to work in that area.

As presently defined by the State of California, most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) have chemical constituents that are considered to be hazardous waste. As such, the indiscriminate dumping or spillage of these fluids onto the ground may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall not be allowed.

2.2 Processing: Existing ground that has been declared satisfactory for support of fill by the Geotechnical Consultant shall be scarified to a minimum depth of 6 inches. Existing ground that is not satisfactory shall be overexcavated as specified in the following section. Scarification shall continue until soils are broken down and free of large clay lumps or clods and the working surface is reasonably uniform, flat, and free of uneven features that would inhibit uniform compaction.

2.3 Overexcavation: In addition to removals and overexcavations recommended in the approved geotechnical report(s) and the grading plan, soft, loose, dry, saturated, spongy, organic-rich, highly fractured or otherwise unsuitable ground shall be overexcavated to competent ground as evaluated by the Geotechnical Consultant during grading.

2.4 Benching: Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical units), the ground shall be stepped or benched. Please see the Standard Details for a graphic illustration. The lowest bench or key shall be a minimum of 15 feet wide and at least 2 feet deep, into competent material as evaluated by the Geotechnical Consultant. Other benches shall be excavated a minimum height of 4 feet into competent material or as otherwise recommended by the Geotechnical Consultant. Fill placed on ground sloping flatter than 5:1 shall also be benched or otherwise overexcavated to provide a flat subgrade for the fill.

2.5 Evaluation/Acceptance of Fill Areas: All areas to receive fill, including removal and processed areas, key bottoms, and benches, shall be observed, mapped, elevations recorded, and/or tested prior to being accepted by the Geotechnical Consultant as suitable to receive fill. The Contractor shall obtain a written acceptance from the Geotechnical Consultant prior to fill placement. A licensed surveyor shall provide the survey control for determining elevations of processed areas, keys, and benches.

3.0 Fill Material

3.1 General: Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by the Geotechnical Consultant prior to placement. Soils of poor quality, such as those with unacceptable gradation, high expansion potential, or low strength shall be placed in areas acceptable to the Geotechnical Consultant or mixed with other soils to achieve satisfactory fill material.

3.2 Oversize: Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 12 inches, shall not be buried or placed in fill unless location, materials, and placement methods are specifically accepted by the Geotechnical Consultant. Placement operations shall be such that nesting of oversized material does not occur and such that oversize material is completely surrounded by compacted or densified fill. Oversize material shall not be placed within 10 vertical feet of finish grade or within 2 feet of future utilities or underground construction.

3.3 Import: If importing of fill material is required for grading, proposed import material shall meet the requirements of Section 3.1. The potential import source shall be given to the Geotechnical Consultant at least 48 hours (2 working days) before importing begins so that its suitability can be determined and appropriate tests performed.

4.0 Fill Placement and Compaction

4.1 Fill Layers: Approved fill material shall be placed in areas prepared to receive fill (per Section 3.0) in near-horizontal layers not exceeding 8 inches in loose thickness. The Geotechnical Consultant may accept thicker layers if testing indicates the grading procedures can adequately compact the thicker layers. Each layer shall be spread evenly and mixed thoroughly to attain relative uniformity of material and moisture throughout.

4.2 Fill Moisture Conditioning: Fill soils shall be watered, dried back, blended, and/or mixed, as necessary to attain a relatively uniform moisture content at or slightly over optimum. Maximum density and optimum soil moisture content tests shall be performed in accordance with the American Society of Testing and Materials (ASTM Test Method D1557-91).

4.3 Compaction of Fill: After each layer has been moisture-conditioned, mixed, and evenly spread, it shall be uniformly compacted to not less than 90 percent of maximum dry density (ASTM Test Method D1557-91). Compaction equipment shall be adequately sized and be either specifically designed for soil compaction or of proven reliability to efficiently achieve the specified level of compaction with uniformity.

4.4 Compaction of Fill Slopes: In addition to normal compaction procedures specified above, compaction of slopes shall be accomplished by backrolling of slopes with sheepsfoot rollers at increments of 3 to 4 feet in fill elevation, or by other methods producing satisfactory results acceptable to the Geotechnical Consultant. Upon completion of grading, relative compaction of the fill, out to the slope face, shall be at least 90 percent of maximum density per ASTM Test Method D1557-91.

4.5 Compaction Testing: Field tests for moisture content and relative compaction of the fill soils shall be performed by the Geotechnical Consultant. Location and frequency of tests shall be at the Consultant's discretion based on field conditions encountered. Compaction test locations will not necessarily be selected on a random basis. Test locations shall be selected to verify adequacy of compaction levels in areas that are judged to be prone to inadequate compaction (such as close to slope faces and at the fill/bedrock benches).

4.6 Frequency of Compaction Testing: Tests shall be taken at intervals not exceeding 2 feet in vertical rise and/or 1,000 cubic yards of compacted fill soils embankment. In addition, as a guideline, at least one test shall be taken on slope faces for each 5,000 square feet of slope face and/or each 10 feet of vertical height of slope. The Contractor shall assure that fill construction is such that the testing schedule can be accomplished by the Geotechnical Consultant. The Contractor shall stop or slow down the earthwork construction if these minimum standards are not met.

4.7 Compaction Test Locations: The Geotechnical Consultant shall document the approximate elevation and horizontal coordinates of each test location. The Contractor shall coordinate with the project surveyor to assure that sufficient grade stakes are established so that the Geotechnical Consultant can determine the test locations with sufficient accuracy. At a minimum, two grade stakes within a horizontal distance of 100 feet and vertically less than 5 feet apart from potential test locations shall be provided.

5.0 Subdrain Installation

Subdrain systems shall be installed in accordance with the approved geotechnical report(s), the grading plan, and the Standard Details. The Geotechnical Consultant may recommend additional subdrains and/or changes in subdrain extent, location, grade, or material depending on conditions encountered during grading. All subdrains shall be surveyed by a land surveyor/civil engineer for line and grade after installation and prior to burial. Sufficient time should be allowed by the Contractor for these surveys.

6.0 Excavation

Excavations, as well as over-excavation for remedial purposes, shall be evaluated by the Geotechnical Consultant during grading. Remedial removal depths shown on geotechnical plans are estimates only. The actual extent of removal shall be determined by the Geotechnical Consultant based on the field evaluation of exposed conditions during grading. Where fill-over-cut slopes are to be graded, the cut portion of the slope shall be made, evaluated, and accepted by the Geotechnical Consultant prior to placement of materials for construction of the fill portion of the slope, unless otherwise recommended by the Geotechnical Consultant.

7.0 Trench Backfills

7.1 Contractor shall follow all OHSA and Cal/OSHA requirements for safety of trench excavations.

7.2 Bedding and backfill of utility trenches shall be done in accordance with the applicable provisions of Standard Specifications of Public Works Construction. Bedding material shall have a Sand Equivalent greater than 30 (SE>30). The bedding shall be placed to 1 foot over the top of the conduit and densified by jetting. Backfill shall be placed and densified to a minimum 90 percent of maximum from 1 foot above the top of the conduit to the surface, except in traveled ways (see Section 7.6 below).

7.3 Jetting of the bedding around the conduits shall be observed by the Geotechnical Consultant.

7.4 Geotechnical Consultant shall test the trench backfill for relative compaction. At least one test should be made for every 300 feet of trench and 2 feet of fill.

7.5 Lift thickness of trench backfill shall not exceed those allowed in the Standard Specifications of Public Works Construction unless the Contractor can demonstrate to the Geotechnical Consultant that the fill lift can be compacted to the minimum relative compaction by his alternative equipment and method.

7.6 Trench backfill in the upper foot measured from finish grade within existing or future traveled way, shoulder, and other paved areas (or areas to receive pavement) should be placed to a minimum 95 percent relative compaction.

LEGEND

EARTH UNITS - CIRCLED WHERE BURIED

Af — ARTIFICIAL FILL

Qal — ALLUVIUM

SYMBOLS - LOCATIONS ARE APPROXIMATE, QUERIED WHERE UNCERTAIN

— — — ····· GEOLOGIC CONTACT, DOTTED WHERE BURIED

OTHER SYMBOLS - LOCATIONS ARE APPROXIMATE

● H-16 T.D.55.5' Qal@30' — HOLLOW-STEM AUGER BORING, SHOWING TOTAL DEPTH AND EARTH UNITS

▲ CPT-2 T.D.80' — CONE PENETROMETER TEST, SHOWING TOTAL DEPTH

TH-4 T.D.45' — PRIOR BORINGS BY OTHERS FROM DESIGN INVESTIGATION (1951), SHOWING TOTAL DEPTH

A|—|A' — CROSS-SECTION

BASEMAP: MARK THOMAS

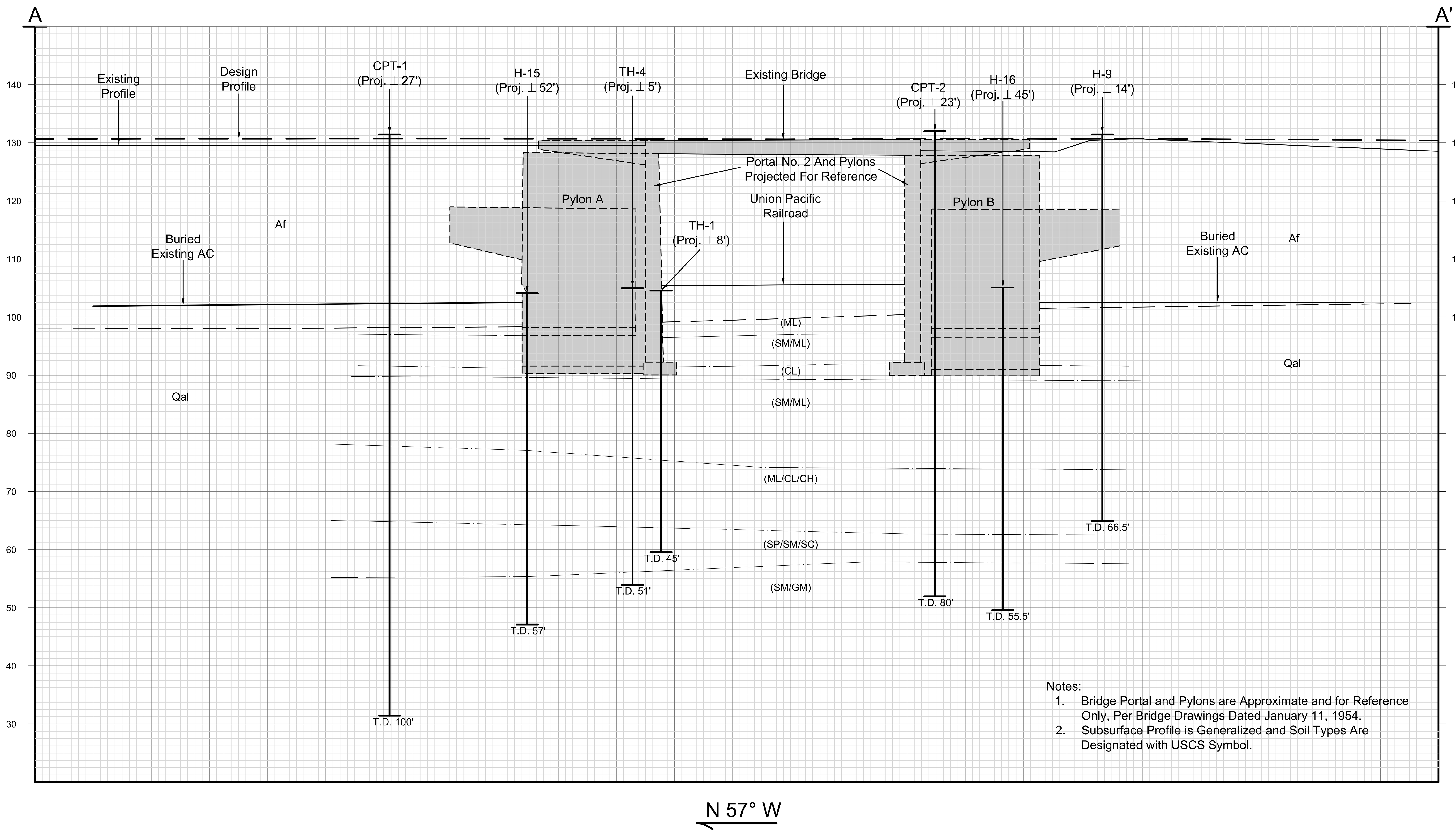
DRAFT

PLATE 1

GEOTECHNICAL MAP
FIRESTONE BOULEVARD WIDENING
HOXIE AVENUE TO IMPERIAL HIGHWAY
APPROXIMATE STREET STATIONS 10+00 TO 57+00
CITY OF NORWALK, CALIFORNIA

Project No.:18181-01	By:KGM/AZ
Project Name: MT/Firestone	
Date: 8/14/2019	SCALE: 1" = 50'

NMG Geotechnical, Inc.



Notes:

1. Bridge Portal and Pylons are Approximate and for Reference Only, Per Bridge Drawings Dated January 11, 1954.
2. Subsurface Profile is Generalized and Soil Types Are Designated with USCS Symbol.

DRAFT

PLATE 2

Project No.:18181-01	By:KGM/AZ
Project Name: MT/Firestone	
Date: 8/14/2019	SCALE: 1" = 10'

NMG Geotechnical, Inc.