Appendix E Geotechnical Data Report

GROUP DELTA

DUDEK
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June 1, 2020
Project No. SD521

Attention: Ms. Nicole Rieger, PE

SUBJECT: REPORT OF GEOTECHNICAL INVESTIGATION
Park Drive Street and Drainage Improvements
Carlsbad, California

Ms. Rieger:

The following report presents the results of our geotechnical investigation for the proposed Park Drive Street and Drainage Improvements project in Carlsbad, California. The purposes of this geotechnical investigation were to characterize the subsurface conditions of the existing slopes at the site and to evaluate their surface and overall stability to help develop alternatives to mitigate surface and overall instability where needed. This final version of the report is being submitted to support the development of the 90% Project Drawings through project completion and provides factual data for the development of geotechnical recommendations to support the project design that will be submitted in a forthcoming letter. This report was prepared in general accordance with the provisions of the referenced proposal (GDC, 2017).

Our scope of services consisted of the following tasks:

- Reviewing readily available background references, including geologic, fault, topographic and hazard maps, topographic plans, previous geotechnical studies, and environmental and groundwater data.
- Undertaking a geologic reconnaissance and delineating the boring locations for underground utility mark out by Underground Service Alert (USA). Boring locations were further reviewed relative to existing underground utilities by a private utility locator.
- Obtaining a County of San Diego Department of Environmental Health (DEH) Geotechnical Well Construction Permit (LMWP-003003) and a City of Carlsbad Right-of-Way Permit (2017-0555) to perform our subsurface exploration.
- Undertaking Phase 1 of our subsurface exploration of the site including two exploratory borings. Following drilling, the borings were converted to monitoring wells.
- Performing periodic measurements of the groundwater level in the monitoring wells.
- Undertaking Phase 2 of our subsurface exploration of the site including four hand auger borings, one manually excavated test pit, and collection of five shallow bulk samples.

- Undertaking laboratory testing of soil samples collected from the borings, including in-situ moisture content and dry density, sieve analysis, Plasticity Index, Expansion Index (EI), pH, resistivity, soluble sulfate and chloride contents and direct shear.
- Performing analyses to assess the surficial and overall stability of the existing natural slopes.
- Preparing this report with our findings and conclusions.

SITE AND PROJECT DESCRIPTION

The site is located along the north and east sides of Park Drive in Carlsbad, California, as shown on the Site Location Plan, Figure 1A. The approximate centroid of the site is at a longitude of 33.1445° north and a latitude of 117.3219° west.

The site is mostly undeveloped and covered with coastal shrubs and trees or exposed soil and is mostly bounded on all sides by residential developments, as shown in the Site Vicinity Map, Figure 1B. The site slopes down to the southwest at inclinations ranging from 2 to 1 (horizontal to vertical) in the southern portion of the site up to near vertical in the northern portion of the site. The northern portion is generally more rugged, with some natural drainages running approximately northeast-southwest across the site. Elevations range from a low of about 15 feet above mean sea level (MSL) on Park Drive at the toe of the existing natural slope on the west portion of the site, up to a high of about 120 feet MSL on the east side of the site near the residential community at the top of the slope.

At the toe of the slope, Park Drive is bordered with a concrete masonry unit (CMU) retaining wall up to about 8 feet in height which extends along most of the length of the site. The retaining wall appears to be cracking and tilting, and efflorescence and corrosion is visible on the wall face. In addition, the retaining wall is reportedly routinely overtopped with eroded sediment from the slope face behind the wall during rain events. The eroded sediment flows onto the sidewalk and street, which has become a nuisance to the residents of the area and a maintenance burden for the City of Carlsbad maintenance crews.

As stated in the project RFQ (City of Carlsbad, 2016), this project will address the removal and replacement of the existing retaining wall, slope stabilization and improvement of the drainage conditions around the proposed facility to alleviate potential safety concerns and reduce maintenance effort.

GEOTECHNICAL EVALUATION

Site Reconnaissance

A site reconnaissance was conducted on June 16, 2017 to evaluate the existing slope and surrounding area. Selected photographs of the site are included in Attachment A.

Most of the exposed slope face contains marine sedimentary deposits associated with the Eocene-age Santiago Formation. The upper undeveloped portions of the slope, specifically on the northern portion of the site, appear to contain colluvium overlying the formation.

The slope face is very weathered and contains numerous rills and channels resulting from surface erosion during rain events, especially on the southern portion of the site. Slope wash has accumulated behind the existing retaining wall along Park Drive from this surface erosion. The northern portion of the site has near vertical slope inclinations, and the formation in the area is more cemented than to the south.

No zones of seepage, or wet soils were observed in the slope face during our site reconnaissance. However, seepage was observed on the face of the existing retaining wall northeast of Station 13+45 along Park Drive.

Field and Laboratory Investigation

Phase 1

We completed the first phase of our field investigation that included drilling two exploratory borings (B-1 and B-2) between August 28th through August 30th, 2017. The maximum depth of exploration was approximately 71.5 feet below the existing ground surface. Following drilling, each of the borings was converted into a monitoring well. The approximate locations of the wells are shown on the Exploration Plan and Existing Topography plan, Figures 2A and 2B. The wells were constructed as depicted in the Well Construction Diagram, Figure 3. Logs of the borings are provided in Attachment B.

Bulk, grab and driven disturbed and partially intact soil samples were collected from the borings at selected intervals for laboratory testing and analysis. The geotechnical testing program included in-situ moisture content and density, gradation analysis, Plasticity Index, material classification using the Unified Soil Classification System (USCS), expansion index, corrosivity (including an evaluation of pH, resistivity, sulfate content and chloride content), and direct shear. The laboratory test results are shown in Attachment C.

Phase 2

The second phase of our investigation was completed on January 23, 2020 and included manually excavating four hand augers (HA-101 through HA-104), one test pit (TP-101), and collecting five shallow bulk samples (G-1 through G-5). The maximum depth of exploration was approximately 9½ feet below existing ground surface. The approximate locations of the explorations are shown on the Exploration Plan and Existing Topography plan, Figures 2A and 2B. Logs of the explorations are provided in Attachment B.

Bulk soil samples were collected from the explorations for laboratory testing and analysis. The geotechnical testing program included gradation analysis, Plasticity Index, material classification using the Unified Soil Classification System (USCS), expansion index, maximum density/optimum moisture, corrosivity (including an evaluation of pH, resistivity, sulfate content and chloride content), and remolded direct shear. The laboratory test results are shown in Attachment C.

Previous Investigations

Previous geotechnical studies (Kleinfelder, Inc., 1998; Ninyo & Moore, 2008) for the site were made available for our review. These studies were similar in scope to our current study, and generally provided analyses, conclusions and recommendations regarding the surficial erosion and soil sloughing, retaining walls and general site improvements.

Kleinfelder's (1998) study evaluated "gross bluff stability" under static and pseudo-static conditions (using a horizontal seismic coefficient (k_h) of 0.15) and "erosion and cliff retreat" of the natural slopes at the site. For the "gross bluff stability", Kleinfelder opined, "the results of our analyses indicate the bluff currently possess acceptable factors of safety against deep seated failure for static and pseudo-static conditions" at the time of their report. Regarding "erosion and cliff retreat", Kleinfelder opined, "the bluff in the study area is experiencing progressive failure through mass wasting. Although occasional slabs of sandstone will continue to fail as a result of erosion, the sandstone is relatively massive and not likely to experience large rotational or translational slope failures" and, "Although the steeper portions of the cut face and the steeper side slopes of the drainage ravine exhibit occasional shallow slope and/or slump failures, no recent or ancient landslides are indicated for the site".

The approximate location of the explorations associated with the previous investigations are shown on Figures 2A and 2B, and the corresponding exploratory field logs and laboratory test results are included in Attachment D.

Geologic and Subsurface Conditions

The general geology in the site vicinity is depicted on the Local Geologic Map, Figure 4 (Kennedy and Tan, 2007). Geologic cross sections through the site are provided in Figures 5A through 5E.

In general, the site is underlain by Eocene-age Santiago formation that is covered by up to about 5 feet of colluvium on the upper portions of the slope and about 5 feet of fill at the bottom of the slope. The geologic units at the site are described in more detail below.

The Rose Canyon Fault is the nearest known active fault to the site and is located approximately 5 miles to the west (USGS, 2008). No known active or potentially active faults cross the site.

Santiago Formation

The Eocene-age Santiago Formation underlies the entire site at depth. As observed in relatively intact samples obtained from our borings, the formation generally consists of a massive and relatively flat-lying sandstone. The sandstone was observed to typically be very light gray and light grayish yellow, fine grained, and weakly to moderately cemented with a few strongly cemented beds. The sandstone material generated from excavations within the Santiago Formation typically classifies as silty or clayey sand (SM or SC). Many Standard Penetration Tests (SPT) were conducted within the formation during our investigation. The corrected SPT blow counts (N_{60}) within the sandstone formation were generally well above 50 and averaged 100 or more. This indicates the sandstone possesses a very dense apparent density.

The Santiago Formation at the site also contains beds of claystone. The claystone material generated from excavations within the Santiago Formation typically classifies as lean clay (CL) with variable amounts of fine sand. These claystone beds were observed to be about 10 to 15 feet thick and are olive gray, yellowish gray, light grayish brown and gray in color, with a low to medium plasticity, and are moderately indurated. The corrected SPT blow counts (N_{60}) within the claystone formation were generally 40 and higher and averaged 65 or more, which indicates a hard consistency.

Colluvium/Slopewash

Colluvium is soil and rock that is transported down slope by the force of gravity. Slopewash is eroded deposits washed downslope by rainwater. Colluvium was encountered in our Boring B-2 at the ground surface, overlying the formation near the top of the slope. Interbedded layers of colluvium and slopewash (simplified to just “colluvium” on the records in Attachment B) were also observed along the bottom of the slopes along the project alignment and was encountered in our explorations HA-101 through HA-104 and TP-101. The onsite colluvium and slopewash are derived from the Santiago formation, and were generally observed to consist of light grayish brown, very loose to medium dense, silty sand, clayey sand and poorly-graded sand with silt and clay.

Undocumented Fill

Undocumented fill is soil that has no record of compaction testing and observation by a Geotechnical Engineer. Undocumented fill was encountered below the asphalt concrete pavement section in Boring B-1 and is generally anticipated to be encountered below the roadway and existing retaining walls. The fill is likely associated with the roadway and underground utility improvements at the site. Based on our explorations, the fill was observed to consist of light olive gray, moist, soft to firm, silty fat clay. Test results on the sampled fill materials indicate that the fill has high plasticity and a high potential for expansion.

Groundwater

Groundwater was not encountered during the drilling of our exploratory borings. Perched water was encountered at a depth of about 50 feet below ground surface in Boring B-2 during drilling. As noted previously, seepage was also observed on the face of the existing retaining wall along Park Drive during our site reconnaissance. Following drilling, our subsurface explorations were converted to monitoring wells and groundwater was observed in each well after the completion of our field investigation. We have periodically measured the groundwater level in each well, and a summary of our measurements is shown in the table below.

SUMMARY OF WELL MEASUREMENTS

Measurement Date	Well No.					
	B-1 (Toe of Slope)			B-2 (Top of Slope)		
	Approximate Top of Well Elevation (feet, MSL)	Depth to Groundwater (feet)	**Approximate Groundwater Elevation (feet, MSL)**	Approximate Top of Well Elevation (feet, MSL)	Depth to Groundwater (feet)	**Approximate Groundwater Elevation (feet, MSL)**
10/17/2017	16	4.8	**11.3**	95	36.4	**58.6**
10/31/2017		4.6	**11.5**		36.3	**58.7**
1/12/2018		4.0	**12.0**		36.2	**58.8**
5/4/2018		3.3	**12.7**		36.2	**58.8**
8/31/2018		3.5	**12.5**		36.4	**58.6**
1/23/2020		2.8	**13.2**		35.8	**59.2**

Based on our review of the previous geotechnical and subsurface utility reports for the site, groundwater at the toe of the slope could be encountered at depths as shallow as the elevation of the sidewalk along the alignment of Park Drive (Kleinfelder, Inc., 1998; Ninyo & Moore, 2008; Underground Solutions, Inc., 2020). As shown in the table above and interpreted in our geologic cross sections (Figures 5A through 5E), groundwater levels are expected to increase in elevation east of the project alignment.

It should be noted that changes in rainfall, irrigation practices or site drainage may produce seepage or locally perched groundwater conditions at any location within the fill soil or formational units underlying the site. Such conditions are difficult to predict and are typically mitigated if and where they occur.

Slope Stability Evaluation

The stability of the natural slope was evaluated for static and pseudo-static conditions. The analyses used the cross section locations shown on Figure 2 and Figures 5A through 5D (Section A-A' through D-D'). Section E-E' was not evaluated due to its similarity to Section D-D' and is expected to yield similar results. Slope stability calculations were conducted using Spencer's method as incorporated into the two-dimensional limit equilibrium slope stability analysis software SLOPE/W (Geo-Slope International, 2013). Block search, grid and radius, and entry and exit slip surface geometries were evaluated in the slope stability calculations.

The unit weight and shear strength properties used in the stability analysis were obtained from interpretation of laboratory tests conducted on ring samples obtained from our field investigation and engineering judgement and are summarized in the table below. The laboratory test results are included in Attachment C.

SUMMARY OF STRENGTH PARAMERS FOR SLOPE STABILITY EVALUATION

Soil Type	Friction Angle (Φ), ◦	Cohesion (c), psf
Fill – Toe of Slope	0	500
Fill – Top of Slope	32	50
Colluvium	32	50
Santiago – Claystone	34	600
Santiago – Sandstone	40	150

Previous versions of our slope stability evaluation did not include groundwater as field measurements of groundwater were still be collected (Group Delta, 2018). The current version adopts a groundwater level interpreted from our recent well measurements. The analyses assume the formational materials are massive, where the stability is not controlled by bedding, discontinuities and pre-existing shear zones. Our evaluation considered both deeper-seated, large scale failures as well as shallower surficial failures. The table below summarizes the results of the slope stability evaluation, and representative calculations are included in Attachment E.

SUMMARY OF SLOPE STABILITY EVALUATION RESULTS

Cross Section	Condition	Approximate Natural Slope Height, feet	Calculated FOS – Shallower Surfaces	Calculated FOS – Deeper Surfaces
A-A’	Static	110	1.17	1.32
	Pseudo-static *	110	0.91	1.04
B-B’	Static	90	1.06	1.25
	Pseudo-static *	90	0.87	1.03
C-C’	Static	90	1.39	1.49
	Pseudo-static *	90	1.06	1.10
D-D’	Static	90	1.80	1.86
	Pseudo-static *	90	1.27	1.29

* The analyses adopted a horizontal seismic coefficient (k_h) of 0.18 [one third of Peak Ground Acceleration (PGA)] and a vertical seismic coefficient of (k_v) 0.0. PGA evaluated using U.S. Seismic Design Maps web-based tool (SEAOC/OSHPD, 2020).

CONCLUSIONS

For the cross section evaluated in the southern portion of the project alignment (i.e., D-D'), the slope stability analyses of the existing natural slopes do meet the generally accepted minimum Factor of Safety of 1.5 and 1.1 for static and pseudo-static conditions. For the cross sections evaluated in the northern portion of the project alignment (i.e., A-A' through C-C'), the slope stability analyses of the existing natural slopes do not meet the generally accepted minimum Factor of Safety of 1.5 and 1.1 for static and pseudo-static conditions that are typically applied to newly formed cut or fill slopes (engineered slopes). However, the slip surfaces with the minimum factor of safety are generally shallow and close to the surface of the slope. Therefore, there is a potential for continued surficial slope failure to occur in this area.

Based on the stability analyses in the northern portion of the project alignment, the potential for deep seated, overall instability is less than that calculated for the surficial failures. The deeper failure surfaces have calculated factors of safety approximately equal to or greater than 1.3 and 1.0 for static and pseudo-static conditions. While the deeper failure surfaces do not have the calculated minimum Factors of Safety for engineered slopes, there is precedent that these factors of safety can be acceptable for natural slopes. Due to biological, environmental and right-of-way restrictions, we understand that the City of Carlsbad has opted to design and construct the improvements for this project in a manner that will allow for ongoing maintenance to manage soil or debris that may result from continued erosion and surface failures in these areas. Geotechnical recommendations for those improvements are to be provided in a separate letter.

CLOSURE

The conclusions made herein assume that soil and geologic conditions do not deviate appreciably from those observed or reported in the referenced geotechnical reports. Geotechnical engineering and the geologic sciences are characterized by uncertainty. Professional judgments presented herein are based partly on our understanding of the proposed construction, and partly on our general experience. Our engineering work and judgments rendered meet current professional standards; we do not guarantee the performance of the project in any respect.

We appreciate this opportunity to be of continued professional service. Please feel free to contact the office with any questions or comments, or if you need anything else.

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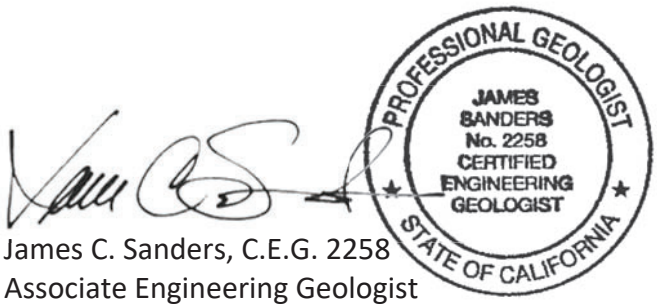
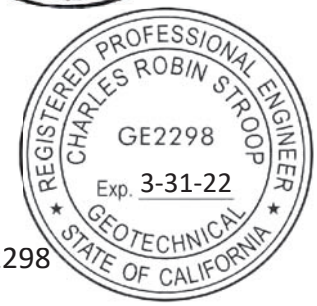
Project Engineer



James C. Sanders, C.E.G. 2258
Associate Engineering Geologist



Charles Robin (Rob) Stroop, G.E. 2298
Associate Geotechnical Engineer

Attachments: References

Figure 1A – Site Location Map
Figure 1B – Site Vicinity Map
Figure 2A – Exploration Plan
Figure 2B – Existing Topography
Figure 3 – Well Construction Diagram
Figure 4 – Regional Geologic Map
Figures 5A through 5E – Cross Sections A-A' through E-E'

Attachment A – Site Photographs
Attachment B – Field Exploration Logs
Attachment C – Laboratory Testing
Attachment D – Previous Geotechnical Investigations
Attachment E – Representative Slope Stability Calculations

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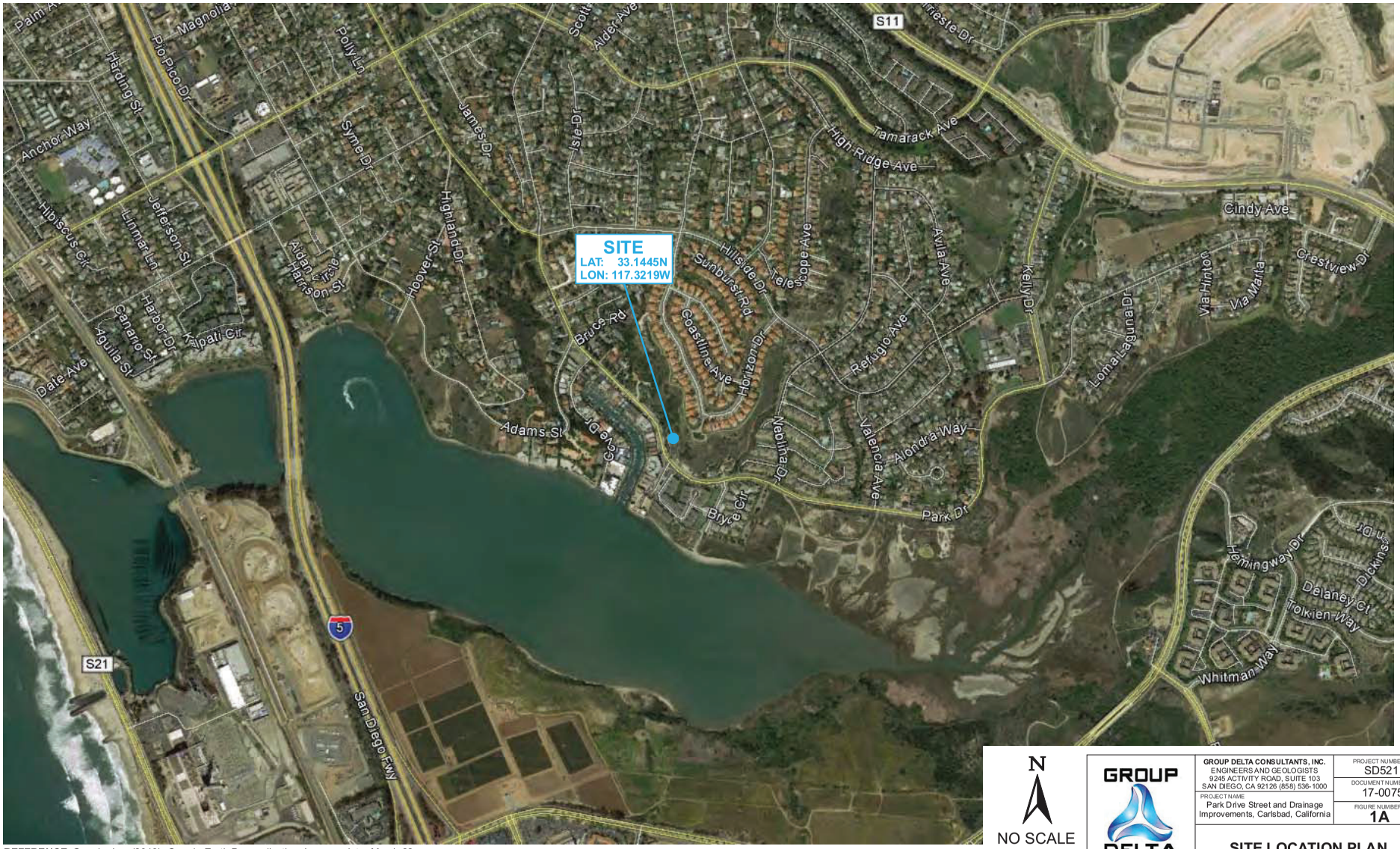
FIGURES



REFERENCE: Google, Inc. (2016). *Google Earth Pro* application, Imagery date: March 22.

N

NO SCALE

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Park Drive Street and Drainage Improvements, Carlsbad, California

PROJECT NUMBER
SD521

DOCUMENT NUMBER
17-0075

FIGURE NUMBER
1A

SITE LOCATION PLAN

LEGEND:

Approximate Site Boundary

N

NO SCALE

REFERENCE: Google, Inc. (2016). *Google Earth Pro* application, Imagery date: November 8.

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FIGURE NUMBER
1B

SITE VICINITY PLAN

LEGEND:

- G-5 — Grab Sample Location
- HA-104 TD=71.5 — Hand Auger Location (TD = Total Depth (Feet))
- B-2 TD=71.5 — Monitoring Well Location (TD = Total Well Depth (Feet))
- B-5 (KLN, '98) — Previous Boring Location (Kleinfelder, 1998)
- TP-101 — Test Pit Location
- TP-3 (N&M, '08) — Previous Test Pit Location (Ninyo & Moore, 2008)
- C-2 (N&M, '08) — Previous Pavement Core Location (Ninyo & Moore, 2008)
- E — E' — Cross Section (Figures 5A through 5D)
- Approximate Site Boundary
- Tsa — Santiago Formation
- Qcol — Colluvium
- Approximate Geologic Contact (Queried Where Uncertain)

N

NO SCALE

REFERENCE: Google, Inc. (2016). *Google Earth Pro* application, Imagery date: November 8.

NOTE: All locations, directions, and distances are approximate

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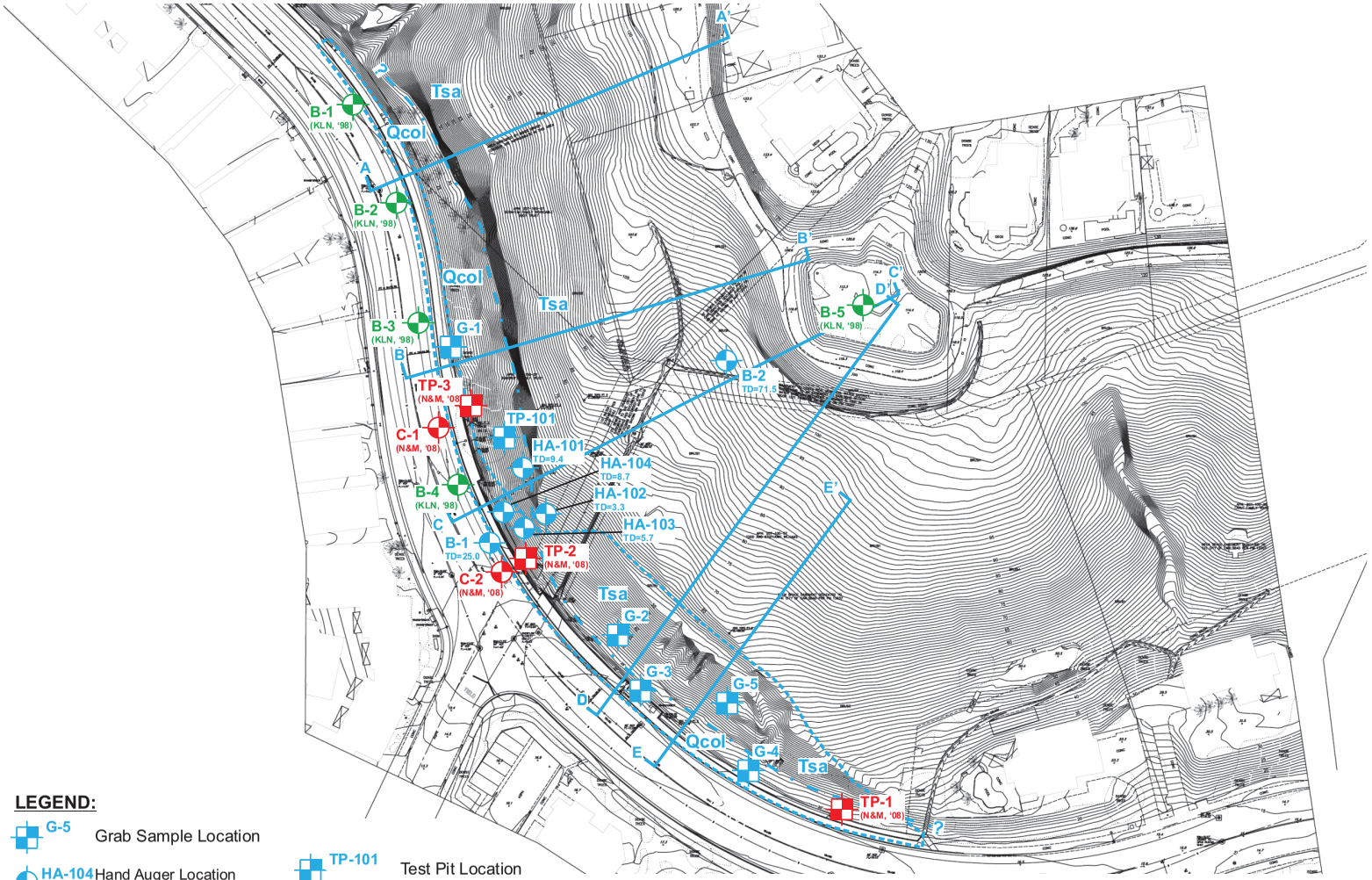
FIGURE NUMBER: 2A

EXPLORATION PLAN



LEGEND:

- G-5 — Grab Sample Location
- HA-104 (TD=71.5) — Hand Auger Location (TD = Total Depth (Feet))
- B-2 (TD=71.5) — Monitoring Well Location (TD = Total Well Depth (Feet))
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- E — E' — Cross Section (Figures 5A through 5E)
- Approximate Site Boundary
- Tsa — Santiago Formation
- Qcol — Colluvium
- Approximate Geologic Contact (Queried Where Uncertain)

N

NO SCALE

REFERENCE: Dudek (2017). Park Drive Base Topography. **NOTE**: All locations, directions, and distances are approximate

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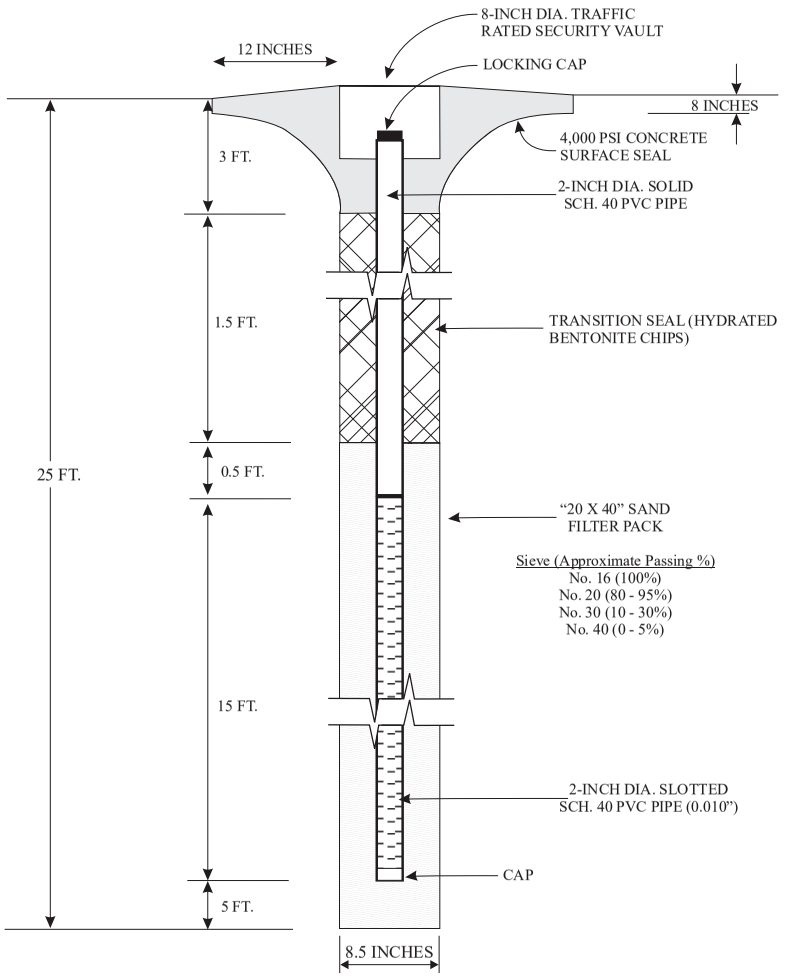
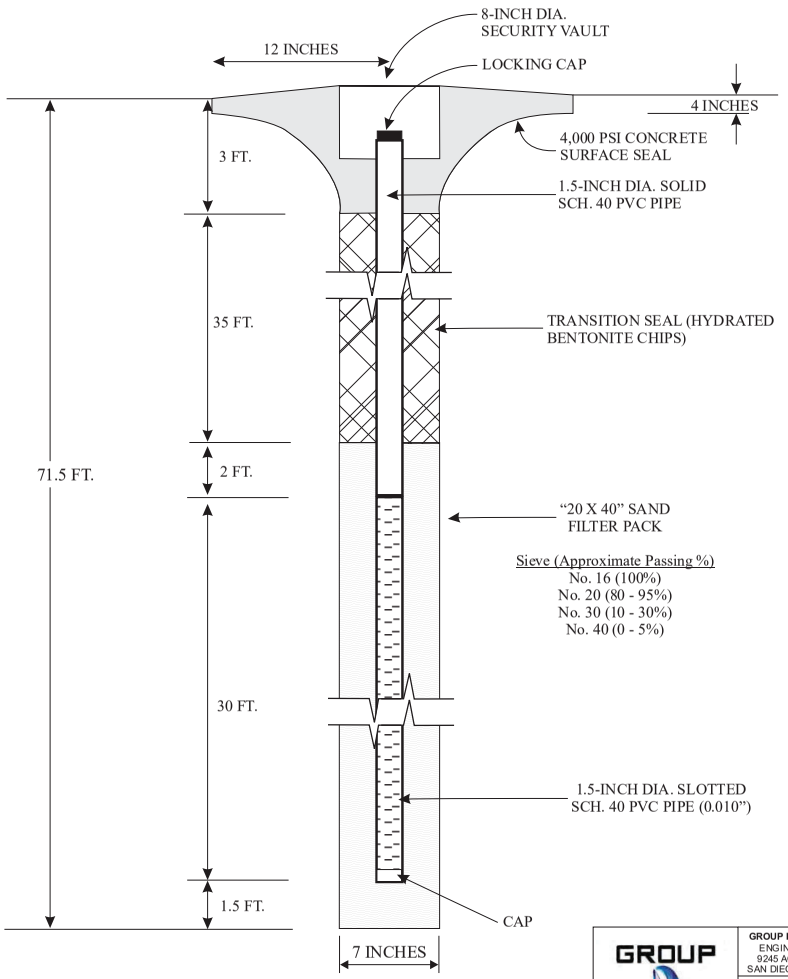
FIGURE NUMBER: 2B

EXISTING TOPOGRAPHY

MONITORING WELL B-1



MONITORING WELL B-2



NO SCALE

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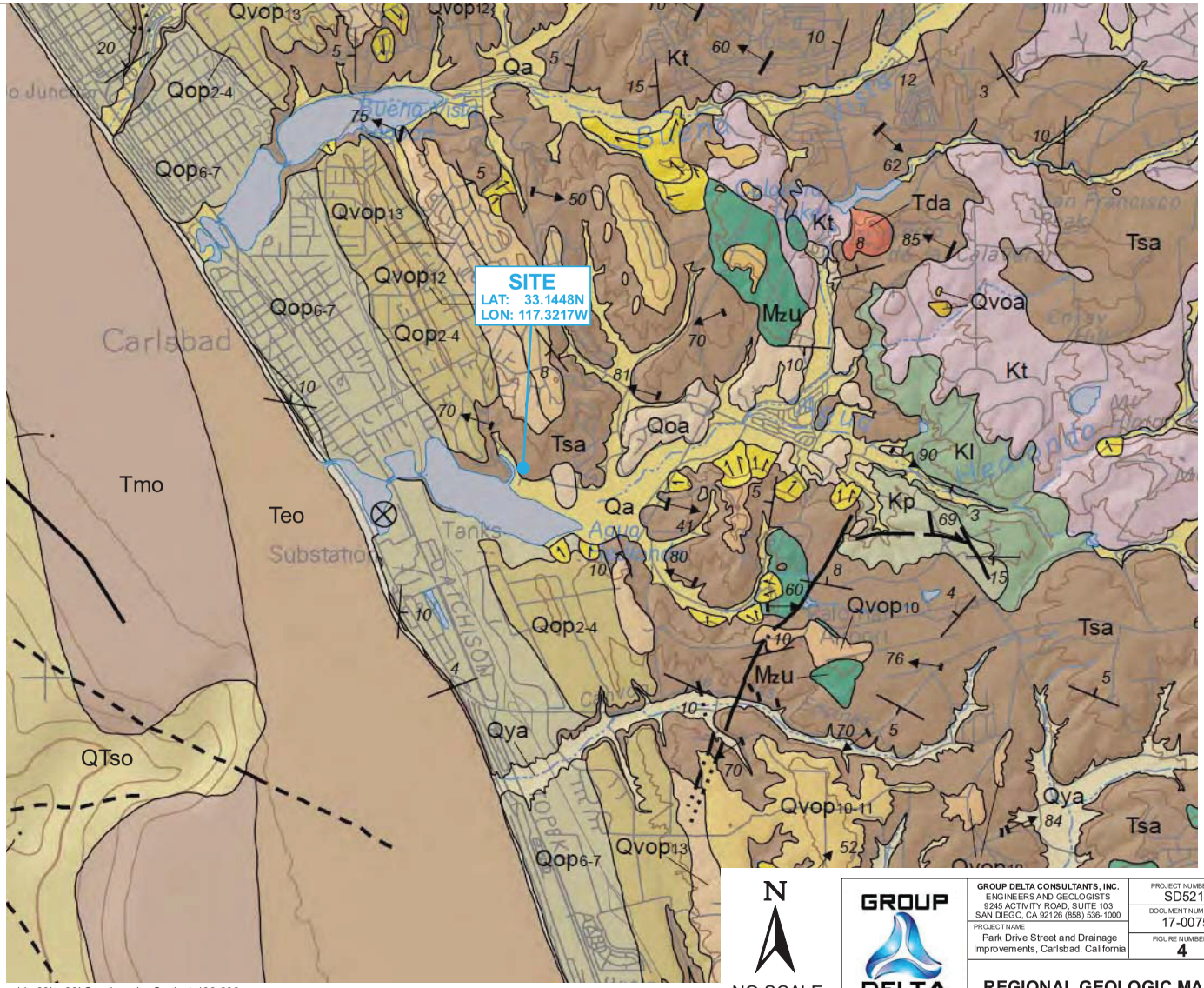
FIGURE NUMBER
3

WELL CONSTRUCTION DIAGRAM

LEGEND:

- **Qya** - Young Alluvial Flood-Plain Deposits
- **Qa** - Alluvial Flood-Plain Deposits
- **Qoa** - Old Alluvial Flood-Plain Deposits
- **Qvoa** - Very Old Alluvial Flood-Plain Deposits
- **Qls** - Landslide Deposits, Undivided (Arrow Indicates Principal Direction of Movement)
- **Qop** - Old Paralic Deposits (Units 2-4)
- (Units 6-7)
- **Qvop** - Very Old Paralic Deposits (Unit 10)
- (Units 10-11)
- (Unit 12)
- (Unit 13)
- **QTso** - Undivided Sediments and Sedimentary Rocks in Offshore Region
- **Tda** - Dacite Stock
- **Teo** - Undivided Eocene Rocks in Offshore Region
- **Tmo** - Undivided Sedimentary Rocks in Offshore Region
- **Tsa** - Santiago Formation
- **Kl** - Lusardi Formation
- **Kt** - Tonalite, Undivided
- **Kp** - Point Loma Formation
- **Mzu** - Metamorphosed and Unmetamorphosed Volcanic and Sedimentary Rocks
- **Geologic Contact**
- **Strike and Dip of Inclined Sedimentary Bed** (10)
- **Fault** - Solid Where Accurately Located, Dashed Where Approximated, Dotted Where Concealed. Arrow And Number Indicate Direction and Angle of Fault Plane Dip (80)



REFERENCE: Kennedy, M.P. and Tan, S.S. (2007). Geologic Map of the Oceanside 30' x 60' Quadrangle, Scale 1:100,000.

GROUP DELTA

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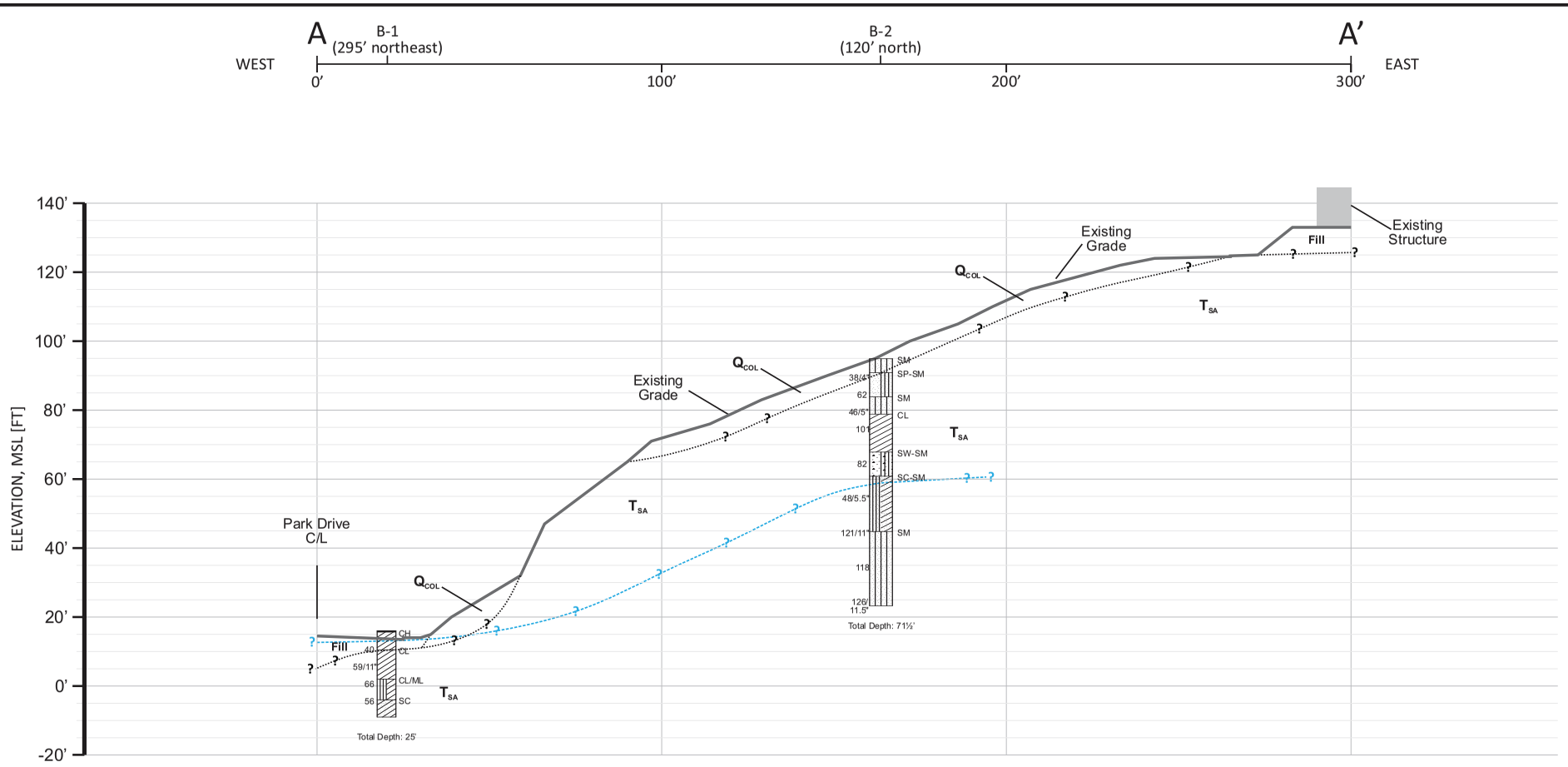
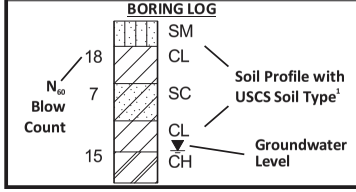
PROJECT NUMBER: SD521
DOCUMENT NUMBER: 17-0075
PROJECT NAME: Park Drive Street and Drainage Improvements, Carlsbad, California
FIGURE NUMBER: 4

REGIONAL GEOLOGIC MAP

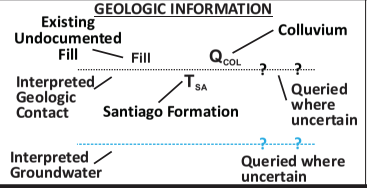


EXPLANATION:

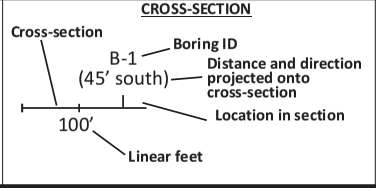
BORING LOG



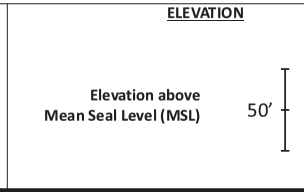
GEOLOGIC INFORMATION

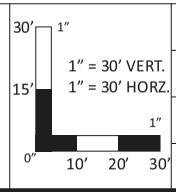


CROSS-SECTION



ELEVATION





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PROJECT NAME
Park Drive Street and Drainage Improvements, Carlsbad, California

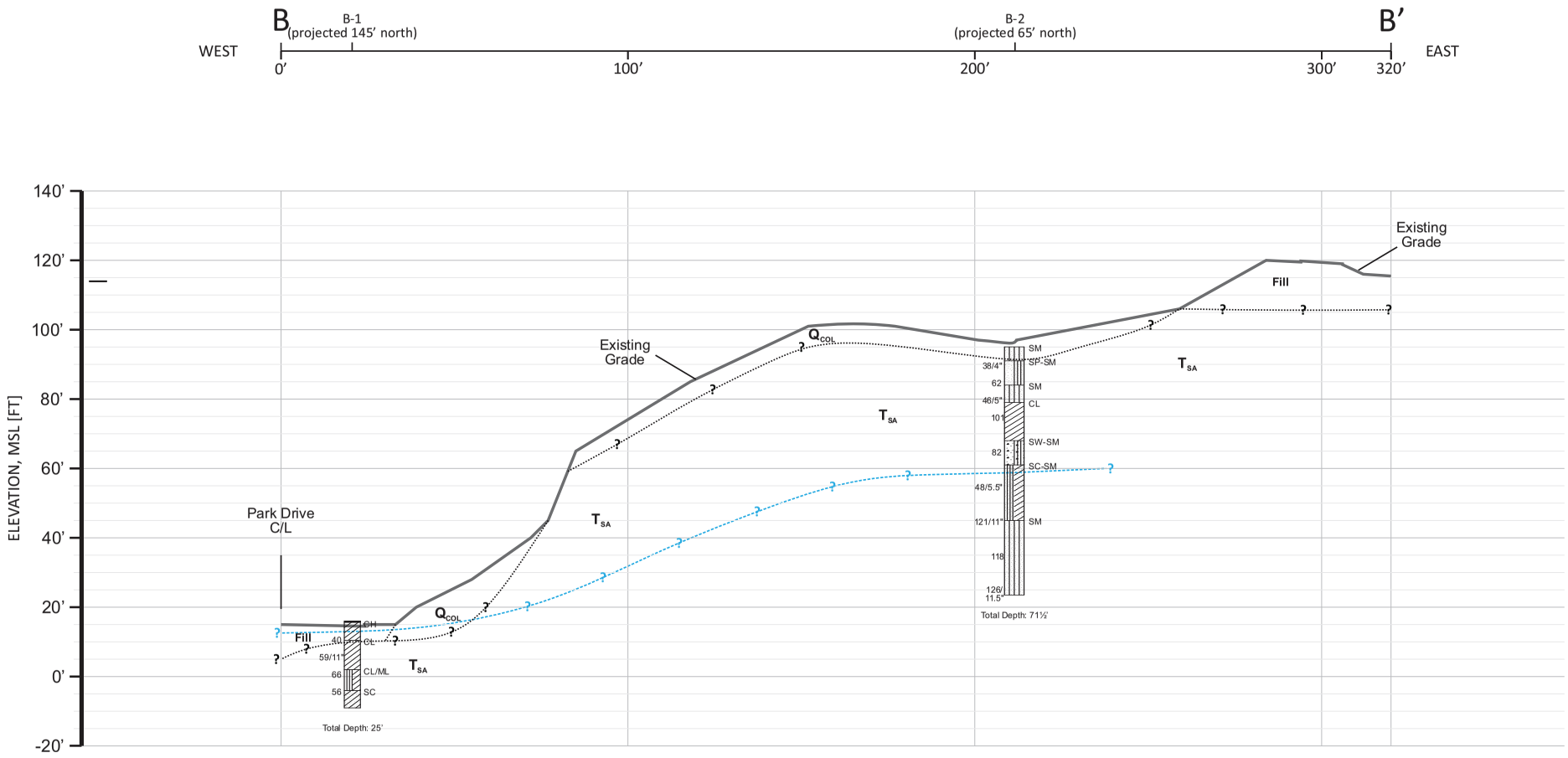
PROJECT NUMBER
SD521

DOCUMENT NUMBER
17-0075

FIGURE NUMBER
5A

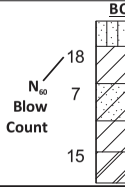
CROSS SECTION A-A'

1: Refer to Legend in Appendix B.

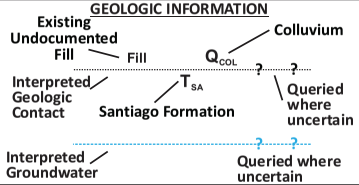


EXPLANATION:

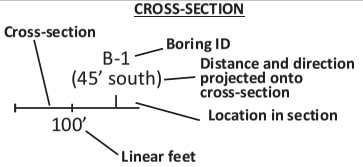
BORING LOG



GEOLOGIC INFORMATION



CROSS-SECTION



ELEVATION

Elevation above Mean Seal Level (MSL)

50'

30'
15'
0"
1"
1" = 30' VERT.
1" = 30' HORZ.
1"
10'
20'
30'

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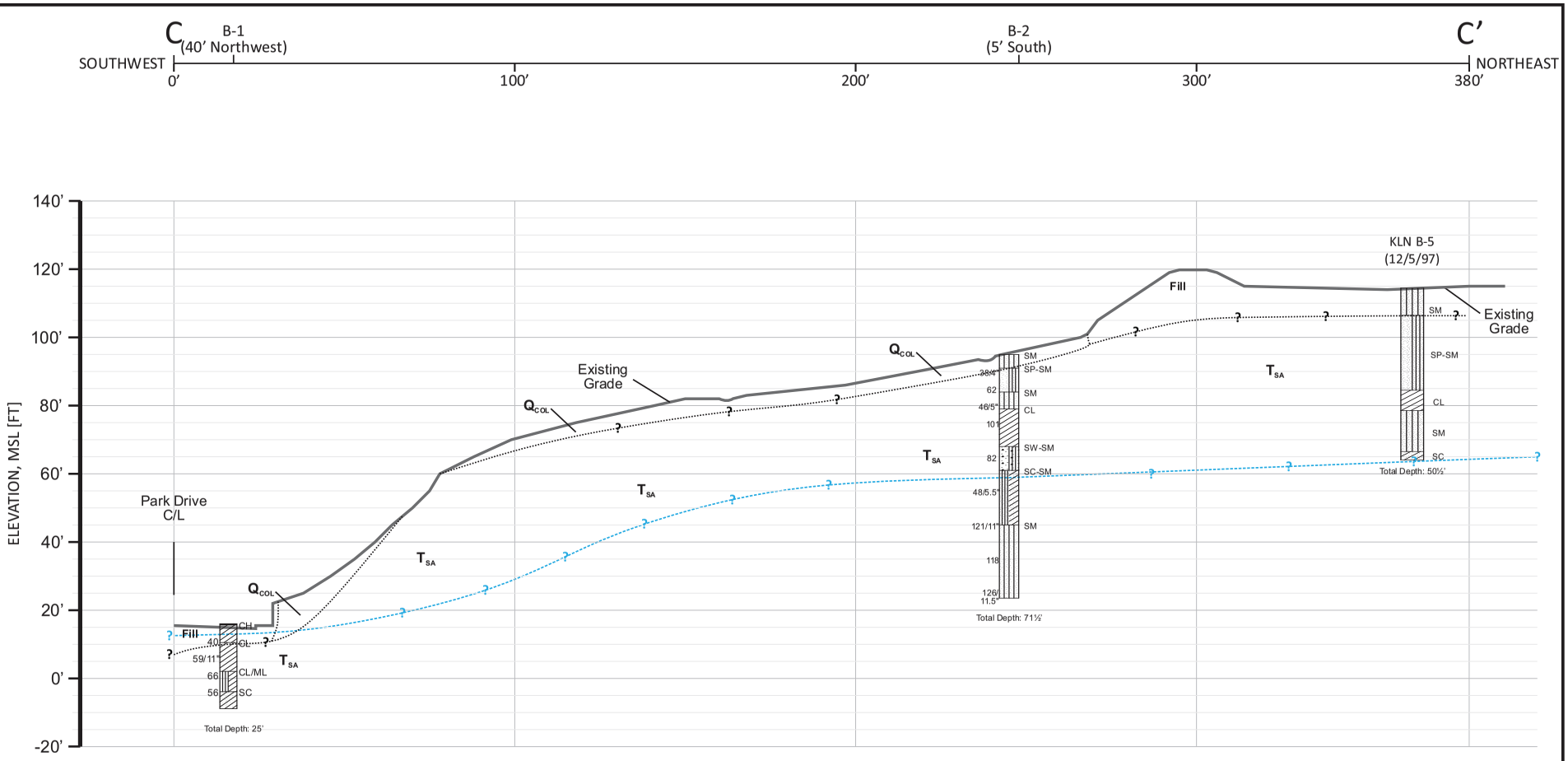
PROJECT NUMBER
SD521

DOCUMENT NUMBER
17-0075

FIGURE NUMBER
5B

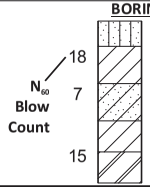
CROSS SECTION B-B'

1: Refer to Legend in Appendix A.

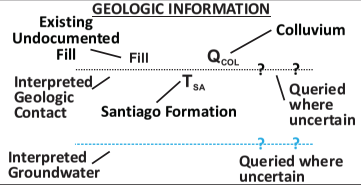


EXPLANATION:

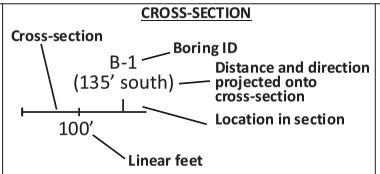
BORING LOG



GEOLOGIC INFORMATION



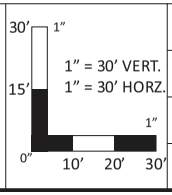
CROSS-SECTION



ELEVATION

Elevation above
Mean Seal Level (MSL)

50'



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PROJECT NAME
Park Drive Street and Drainage Improvements, Carlsbad, California

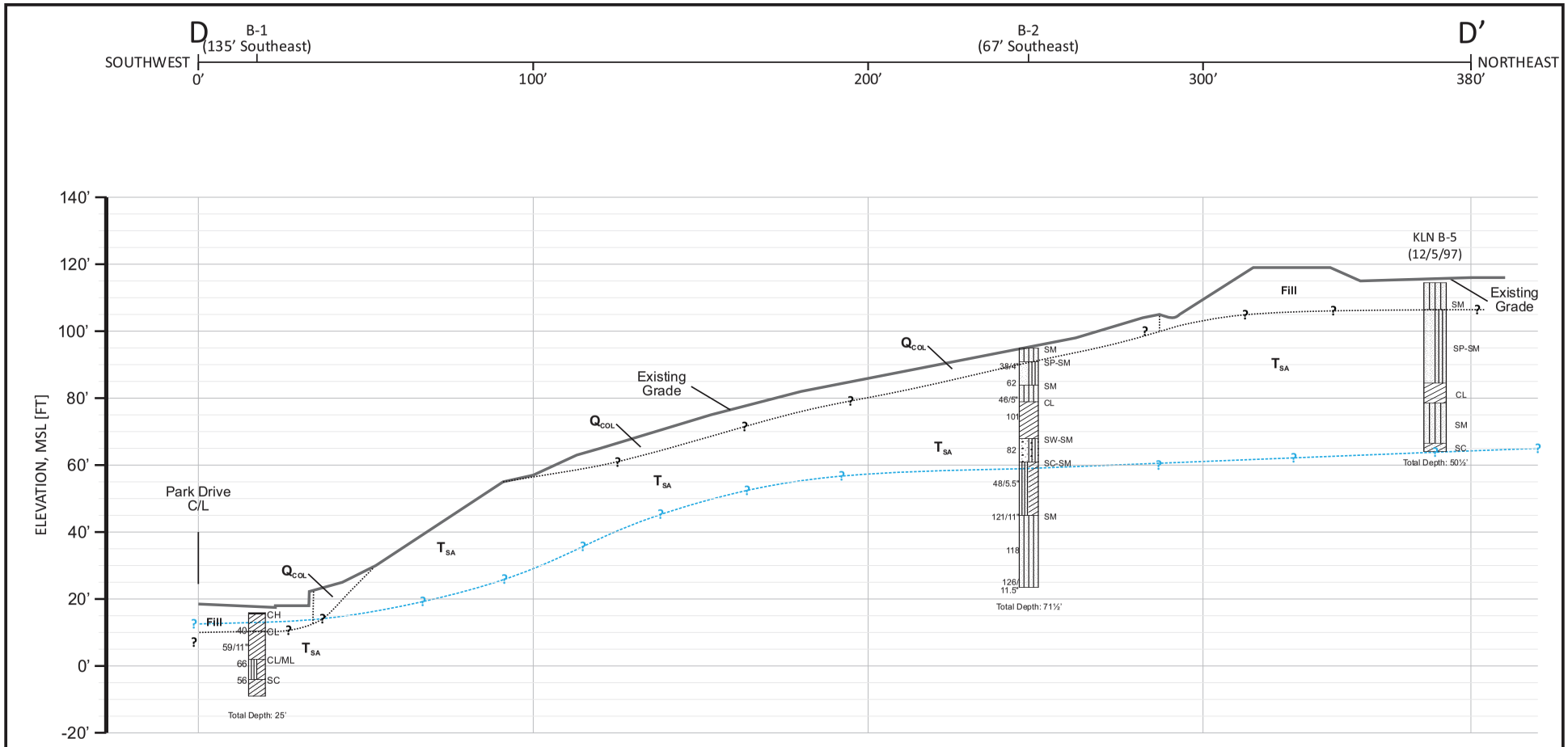
PROJECT NUMBER
SD521

DOCUMENT NUMBER
17-0075

FIGURE NUMBER
5C

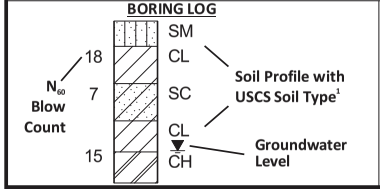
CROSS SECTION C-C'

1: Refer to Legend in Appendix A.

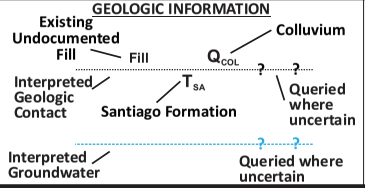


EXPLANATION:

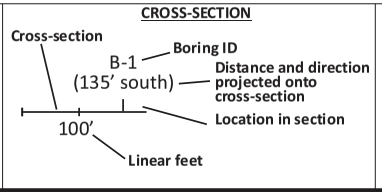
BORING LOG



GEOLOGIC INFORMATION



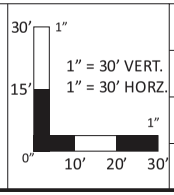
CROSS-SECTION



ELEVATION

Elevation above
Mean Seal Level (MSL)

50'



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PROJECT NUMBER: SD521

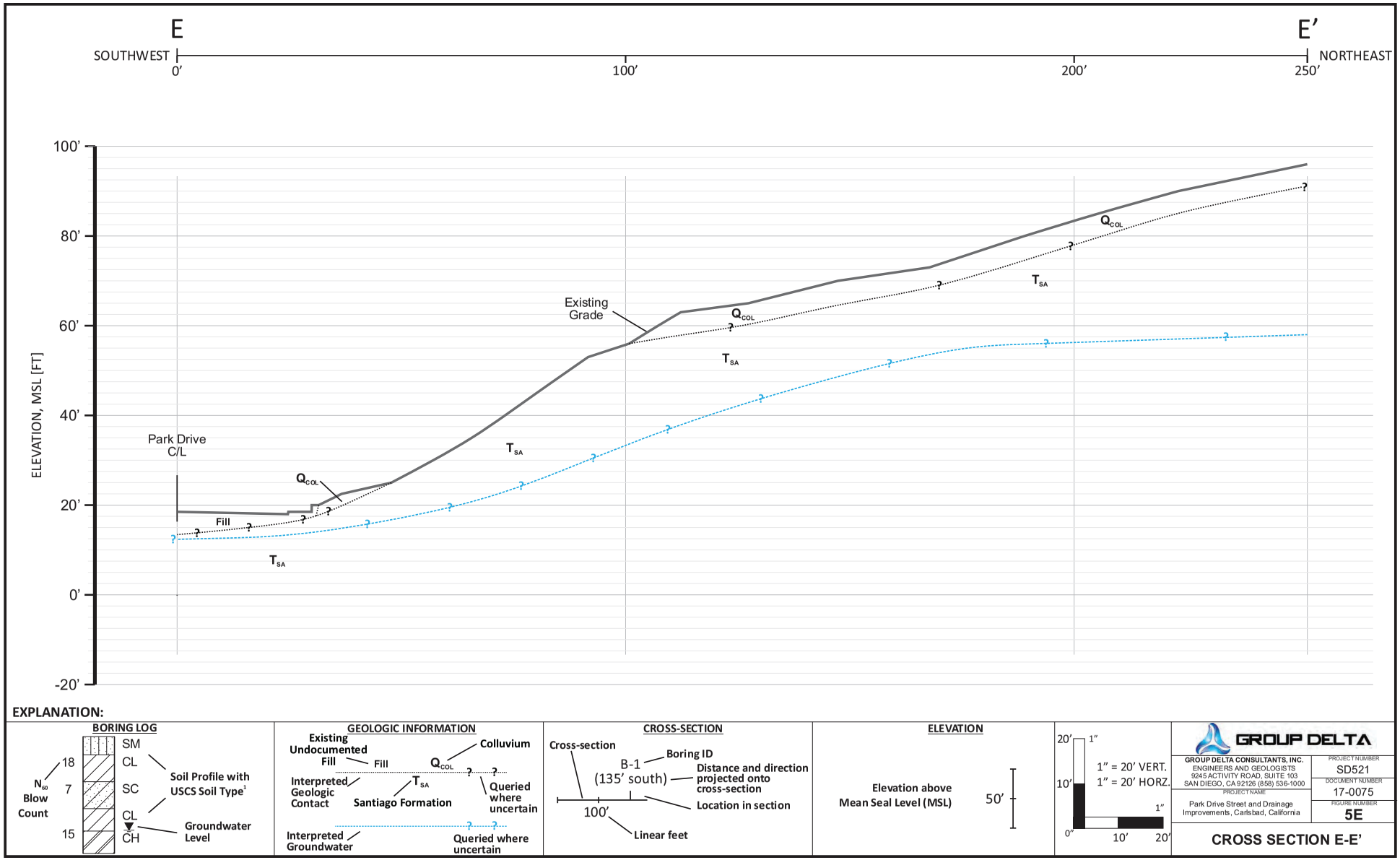
DOCUMENT NUMBER: 17-0075

PROJECT NAME: Park Drive Street and Drainage Improvements, Carlsbad, California

FIGURE NUMBER: 5D

CROSS SECTION D-D'

1: Refer to Legend in Appendix A.



EXPLANATION:

BORING LOG

GEOLOGIC INFORMATION

CROSS-SECTION

ELEVATION

Elevation above Mean Seal Level (MSL)

1: Refer to Legend in Appendix A.

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PROJECT NAME
Park Drive Street and Drainage Improvements, Carlsbad, California

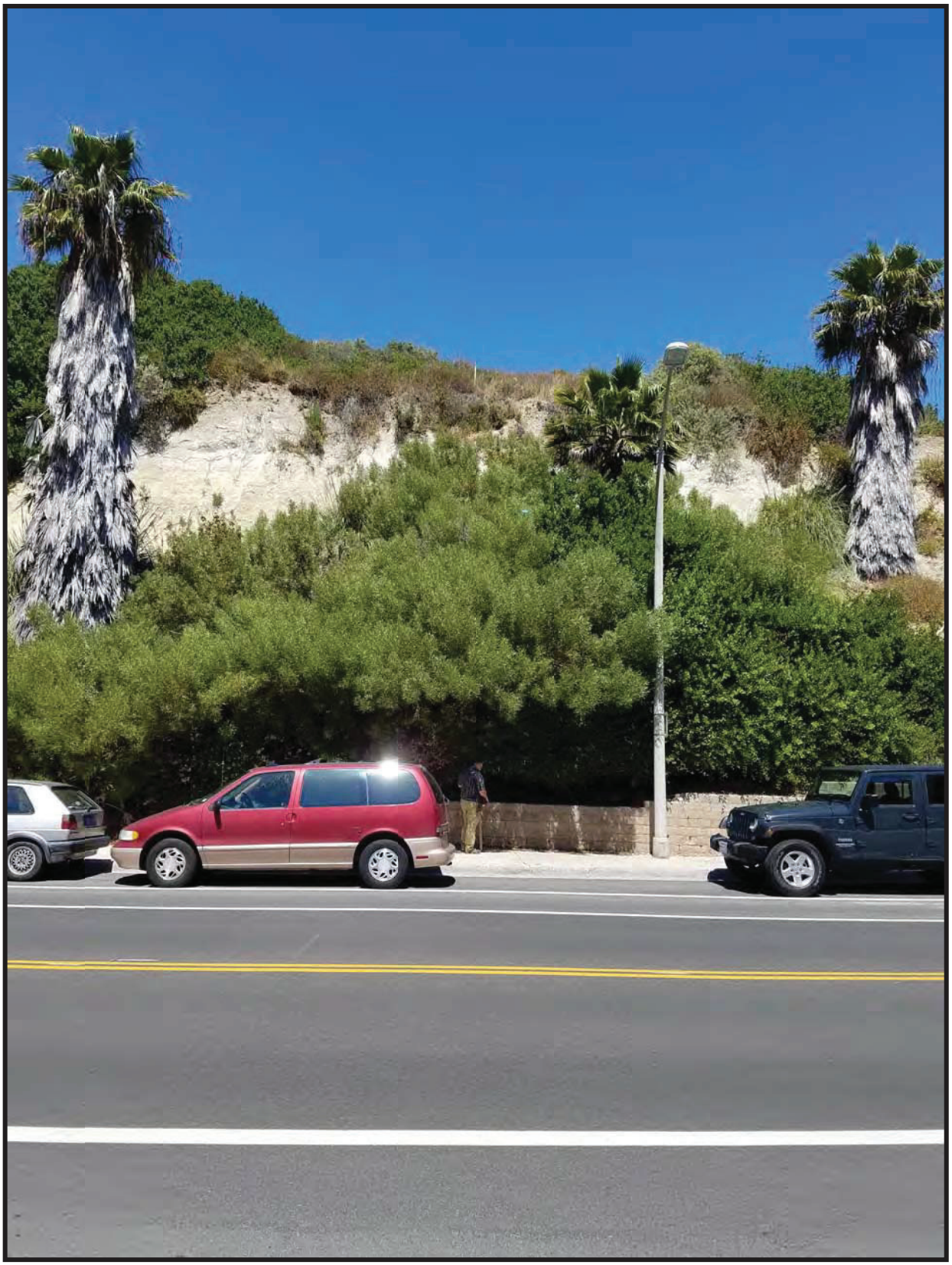
PROJECT NUMBER
SD521

DOCUMENT NUMBER
17-0075

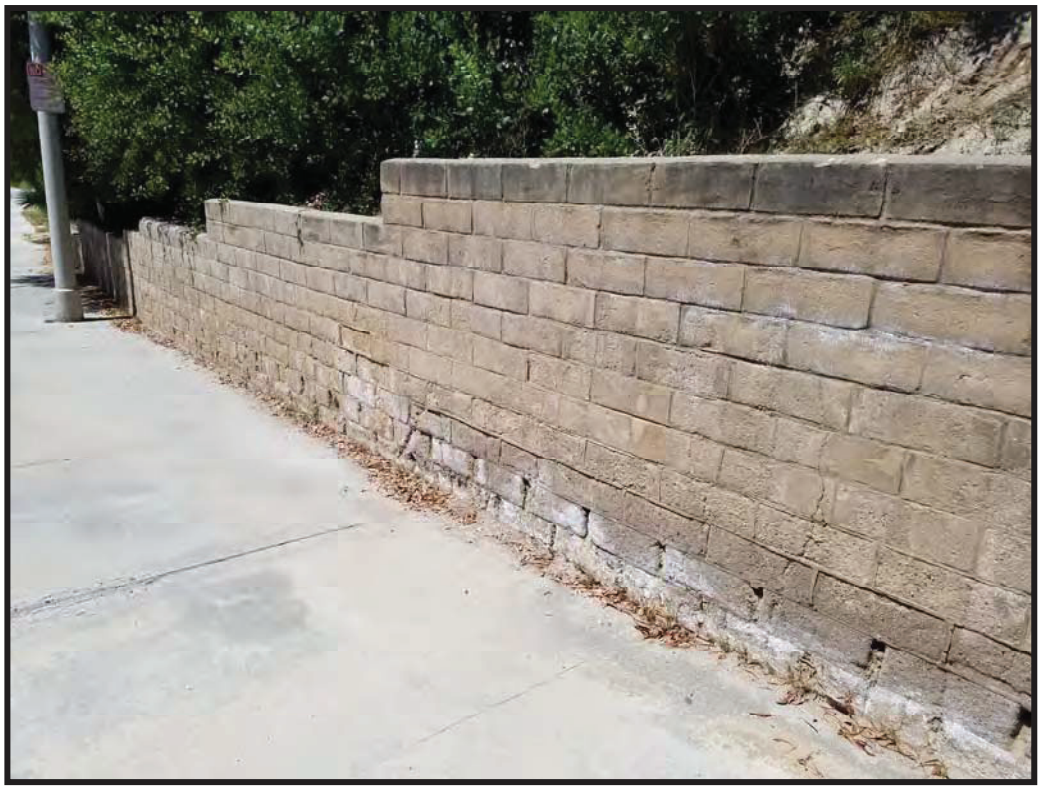
FIGURE NUMBER
5E

CROSS SECTION E-E'

ATTACHMENT A
SITE PHOTOGRAPHS



Photograph 1 – Looking East – Near Vertical Slope Face



Photograph 2 – Northern Portion of Retaining Wall Condition (Note efflorescence and deterioration of CMU block)

Photograph 3 – Retaining Wall Condition (Note efflorescence and deterioration of CMU block)

Photograph 4 – Retaining Wall Crack (Note efflorescence and deterioration of CMU block)

Photograph 5 – Retaining Wall Seepage near Park and Marina (Note corrosion, efflorescence and deterioration of CMU block)

Photograph 6 – Retaining Wall Condition near Park and Marina (Note efflorescence and severe deterioration of CMU block)

Photograph 7 – Looking East – Slope Face Erosion near Park and Marina

Photograph 8 – Looking Northwest – Slope Face Erosion near Park and Marina

ATTACHMENT B
FIELD EXPLORATION LOGS

ATTACHMENT B

FIELD EXPLORATION LOGS

Field exploration included a visual reconnaissance of the site and two phases of subsurface exploration, as described below.

Phase 1

The first phase of subsurface exploration consisted of drilling two exploratory borings (B-1 and B-2) between August 28th and August 30th, 2017. The maximum depth of exploration was about 71.5 feet below surrounding grades. The approximate exploration locations are shown on the Exploration Plan, Figure 2. Logs of the explorations are shown in Figures B-1 and B-2, immediately after the Boring Record Legends. Following drilling, the borings were converted to monitoring wells as shown in Figure 3, Well Construction Diagram.

The exploratory borings were advanced by Pacific Drilling Company using a truck mounted Diedrich D-50 drill rig for Boring B-1 and a track mounted Fraste drill rig for Boring B-2. Drive samples were collected from the borings using an automatic hammer with an average Energy Transfer Ratio (ETR) of about 79 percent for the Diedrich rig and 82 percent for the Fraste. Disturbed samples were collected from the borings using a 2-inch outside diameter Standard Penetration Test (SPT) sampler. Less disturbed samples were collected using a 3-inch outside diameter ring lined sampler (a modified California sampler). These samples were sealed in plastic bags, labeled, and returned to the laboratory for testing. For each sample, the number of blows needed to drive the sampler 12 inches was recorded on the logs. The field blow counts (N) were normalized to approximate the standard 60 percent ETR, as shown on the logs (N_{60}). Bulk samples were also collected from the borings at selected intervals.

Phase 2

The second phase of subsurface exploration consisted of manually excavating four hand auger borings (HA-101 through HA-104), one test pit (TP-101), and five surficial bulk samples (G-1 through G-5) on January 23rd, 2020. The maximum depth of exploration was about 9.5 feet below surrounding grades. The approximate exploration locations are shown on the Exploration Plan, Figure 2. Logs of the explorations are shown in Figures B-3 through B-7, immediately after the Boring Record Legends. Bulk samples were collected from the explorations at selected intervals. A summary of the soils encountered in the surficial bulk samples (G-1 through G-5) is provided in Table B-1 following the exploration logs.

The exploration locations were determined by visually estimating, pacing and taping distances from landmarks shown on the Exploration Plan. The locations shown should not be considered more accurate than is implied by the method of measurement used and the scale of the map. The lines designating the interface between differing soil materials on the logs may be abrupt or gradational. Further, soil conditions at locations between the excavations may be substantially different from those at the specific locations we explored. It should be noted that the passage of time may also result in changes in the soil conditions reported in the logs.

SOIL IDENTIFICATION AND DESCRIPTION SEQUENCE

Sequence	Identification Components	Refer to Section: Field	Refer to Section: Lab	Required	Optional
1	Group Name	2.5.2	3.2.2	●	
2	Group Symbol	2.5.2	3.2.2	●	
	Description Components				
3	Consistency of Cohesive Soil	2.5.3	3.2.3	●	
4	Apparent Density of Cohesionless Soil	2.5.4		●	
5	Color	2.5.5		●	
6	Moisture	2.5.6		●	
7	Percent or Proportion of Soil	2.5.7	3.2.4	●	⬭
	Particle Size	2.5.8	2.5.8	●	⬭
	Particle Angularity	2.5.9			⬭
	Particle Shape	2.5.10			⬭
8	Plasticity (for fine-grained soil)	2.5.11	3.2.5		⬭
9	Dry Strength (for fine-grained soil)	2.5.12			⬭
10	Dilatency (for fine-grained soil)	2.5.13			⬭
11	Toughness (for fine-grained soil)	2.5.14			⬭
12	Structure	2.5.15			⬭
13	Cementation	2.5.16		●	
14	Percent of Cobbles and Boulders	2.5.17		●	
	Description of Cobbles and Boulders	2.5.18		●	
15	Consistency Field Test Result	2.5.3		●	
16	Additional Comments	2.5.19			⬭

Describe the soil using descriptive terms in the order shown

Minimum Required Sequence:

USCS Group Name (Group Symbol); Consistency or Density; Color; Moisture; Percent or Proportion of Soil; Particle Size; Plasticity (optional).

⬭ = optional for non-Caltrans projects

Where applicable:

Cementation; % cobbles & boulders; Description of cobbles & boulders; Consistency field test result

REFERENCE: Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).

HOLE IDENTIFICATION

Holes are identified using the following convention:

H – YY – NNN

Where:

H: Hole Type Code

YY: 2-digit year

NNN: 3-digit number (001-999)

Hole Type Code and Description

Hole Type Code	Description
A	Auger boring (hollow or solid stem, bucket)
R	Rotary drilled boring (conventional)
RC	Rotary core (self-cased wire-line, continuously-sampled)
RW	Rotary core (self-cased wire-line, not continuously sampled)
P	Rotary percussion boring (Air)
HD	Hand driven (1-inch soil tube)
HA	Hand auger
D	Driven (dynamic cone penetrometer)
CPT	Cone Penetration Test
O	Other (note on LOTB)

Description Sequence Examples:

SANDY lean CLAY (CL); very stiff; yellowish brown; moist; mostly fines; some SAND, from fine to medium; few gravels; medium plasticity; PP=2.75.

Well-graded SAND with SILT and GRAVEL and COBBLES (SW-SM); dense; brown; moist; mostly SAND, from fine to coarse; some fine GRAVEL; few fines; weak cementation; 10% GRANITE COBBLES; 3 to 6 inches; hard; subrounded.

Clayey SAND (SC); medium dense, light brown; wet; mostly fine sand,; little fines; low plasticity.

GROUP DELTA

Project No. SD521

Park Drive Street and Drainage Improvements
Carlsbad, California

BORING RECORD LEGEND #1

GROUP SYMBOLS AND NAMES

Graphic / Symbol	Group Names	Graphic / Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly graded GRAVEL with CLAY (or SILTY CLAY) Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly graded SAND Poorly graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL		
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY elastic ELASTIC SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTING

C	Consolidation (ASTM D 2435)
CL	Collapse Potential (ASTM D 5333)
CP	Compaction Curve (CTM 216)
CR	Corrosion, Sulfates, Chlorides (CTM 643, CTM 417, CTM 422)
CU	Consolidated Undrained Triaxial (ASTM D 4767)
DS	Direct Shear (ASTM D 3080)
EI	Expansion Index (ASTM D 4829)
M	Moisture Content (ASTM D 2216)
OC	Organic Content (ASTM D 2974)
P	Permeability (CTM 220)
PA	Particle Size Analysis (ASTM D 422)
PI	Liquid Limit, Plastic Limit, Plasticity Index (AASHTO T 89, AASHTO T 90)
PL	Point Load Index (ASTM D 5731)
PM	Pressure Meter
R	R-Value (CTM 301)
SE	Sand Equivalent (CTM 217)
SG	Specific Gravity (AASHTO T 100)
SL	Shrinkage Limit (ASTM D 427)
SW	Swell Potential (ASTM D 4546)
UC	Unconfined Compression - Soil (ASTM D 2166) Unconfined Compression - Rock (ASTM D 2938)
UU	Unconsolidated Undrained Triaxial (ASTM D 2850)
UW	Unit Weight (ASTM D 4767)

SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test (SPT)
- Standard California Sampler
- Modified California Sampler (2.4" ID, 3" OD)
- Shelby Tube
- Piston Sampler
- NX Rock Core
- HQ Rock Core
- Bulk Sample
- Other (see remarks)

DRILLING METHOD SYMBOLS

- Auger Drilling
- Rotary Drilling
- Dynamic Cone or Hand Driven
- Diamond Core

WATER LEVEL SYMBOLS

- First Water Level Reading (during drilling)
- Static Water Level Reading (after drilling, date)

Definitions for Change in Material

Term	Definition	Symbol
Material Change	Change in material is observed in the sample or core and the location of change can be accurately located.	———
Estimated Material Change	Change in material cannot be accurately located either because the change is gradational or because of limitations of the drilling and sampling methods.	– – – – –
Soil / Rock Boundary	Material changes from soil characteristics to rock characteristics.	~~~

REFERENCE: Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).

GROUP DELTA

Project No. SD521

Park Drive Street and Drainage Improvements
Carlsbad, California

BORING RECORD LEGEND #2

CONSISTENCY OF COHESIVE SOILS				
Description	**Shear Strength (tsf)**	**Pocket Penetrometer, PP, Measurement (tsf)**	**Torvane, TV, Measurement (tsf)**	**Vane Shear, VS, Measurement (tsf)**
Very Soft	Less than 0.12	Less than 0.25	Less than 0.12	Less than 0.12
Soft	0.12 - 0.25	0.25 - 0.5	0.12 - 0.25	0.12 - 0.25
Medium Stiff	0.25 - 0.5	0.5 - 1	0.25 - 0.5	0.25 - 0.5
Stiff	0.5 - 1	1 - 2	0.5 - 1	0.5 - 1
Very Stiff	1 - 2	2 - 4	1 - 2	1 - 2
Hard	Greater than 2	Greater than 4	Greater than 2	Greater than 2

APPARENT DENSITY OF COHESIONLESS SOILS	
Description	**SPT N_{60} (blows / 12 inches)**
Very Loose	0 - 5
Loose	5 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Greater than 50

MOISTURE	
Description	**Criteria**
Dry	No discernable moisture
Moist	Moisture present, but no free water
Wet	Visible free water

PERCENT OR PROPORTION OF SOILS	
Description	**Criteria**
Trace	Particles are present but estimated to be less than 5%
Few	5 - 10%
Little	15 - 25%
Some	30 - 45%
Mostly	50 - 100%

PARTICLE SIZE		
Description		**Size (in)**
Boulder		Greater than 12
Cobble		3 - 12
Gravel	Coarse	3/4 - 3
	Fine	1/5 - 3/4
Sand	Coarse	1/16 - 1/5
	Medium	1/64 - 1/16
	Fine	1/300 - 1/64
Silt and Clay		Less than 1/300

CEMENTATION	
Description	**Criteria**
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

REFERENCE: Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010), with the exception of consistency of cohesive soils vs. N_{60}.

Plasticity

Description	**Criteria**
Nonplastic	A 1/8-in. thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

CONSISTENCY OF COHESIVE SOILS	
Description	SPT N_{60} (blows/12 inches)
Very Soft	0 - 2
Soft	2 - 4
Medium Stiff	4 - 8
Stiff	8 - 15
Very Stiff	15 - 30
Hard	Greater than 30

Ref: Peck, Hansen, and Thornburn, 1974, "Foundation Engineering," Second Edition.

Note: Only to be used (with caution) when pocket penetrometer or other data on undrained shear strength are unavailable. Not allowed by Caltrans Soil and Rock Logging and Classification Manual, 2010.

GROUP DELTA

Project No. SD521

Park Drive Street and Drainage Improvements
Carlsbad, California

BORING RECORD LEGEND #3

BORING RECORD

PROJECT NAME	PROJECT NUMBER	BORING
Park Drive Street and Drainage Improvements	SD521	**B-1**

SITE LOCATION	START	FINISH	SHEET NO.
Carlsbad, California	8/28/2017	8/28/2017	1 of 2

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
Pacific Drilling	Hollow Stem Auger	J. Sanders	R. Stroop

DRILLING EQUIPMENT	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GROUNDWATER (ft)
Diedrich D-50	8.5	25	16	▼ N/A / *na*

SAMPLING METHOD
Hammer: 140 lbs., Drop: 30 in. (Automatic)

NOTES
ETR ~ 79%, N_{60} ~ N * C_E * C_B * C_S * C_R

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	OTHER TESTS	DEPTH (feet)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
	15											**ASPHALT CONCRETE:** Approximately 4.5" thick.
			B-1						SA PI CR EI			**FILL:** SILTY fat CLAY (CH); soft to firm; light olive gray; moist; mostly fines; little to some fine to medium SAND; trace fine GRAVEL; high plasticity. (4% Gravel; 27% Sand; 69% Fines) (LL: 56; PL: 15; PI: 41) (EI = 118)
5										5		
	10		S-2	10 12 21	33	40	13.1					**SANTIAGO FORMATION (Tsa):** SANDY lean CLAYSTONE (CL); moderatly indurated; olive gray to yellowish gray; moist; mostly fines; some fine to medium SAND; low to medium plasticity; some mottling. (42% Sand; 58% Fines)
10										10		
	5		R-3	7 18 50/5"	68/11"	59/11"	11.6	115.4	SA DS			
15										15		Interbedded sandy CLAYSTONE and SILTSTONE (CL-ML); moderately indurated; olive gray and yellowish gray; moist; mostly fines; low to medium plasticity. Hard drilling.
	0		S-4	9 15 31	46	66						
20										20		
	-5		S-5	7 12 27	39	56	10.4		SA			CLAYEY SANDSTONE (SC); moderatly cemented; light brown to light gray; moist; mostly fine to medium SAND; some fines; low plasticity; massive. (70% Sand; 30% Fines)
												Concretion/strongly cemented layer; very hard drilling.

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San Diego, California 92126

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FIGURE
B-1 a

BORING RECORD

PROJECT NAME	PROJECT NUMBER	BORING
Park Drive Street and Drainage Improvements	SD521	**B-1**

SITE LOCATION	START	FINISH	SHEET NO.
Carlsbad, California	8/28/2017	8/28/2017	2 of 2

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
Pacific Drilling	Hollow Stem Auger	J. Sanders	R. Stroop

DRILLING EQUIPMENT	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GROUNDWATER (ft)
Diedrich D-50	8.5	25	16	▼ N/A / *na*

SAMPLING METHOD
Hammer: 140 lbs., Drop: 30 in. (Automatic)

NOTES
ETR ~ 79%, N_{60} ~ N * C_E * C_B * C_S * C_R

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	OTHER TESTS	DEPTH (feet)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
30	-15									30		Total Depth = 25 feet (Terminated in Santiago Formation). Groundwater not encountered during drilling. Installed monitoring well on 8/28/2017 (See Figure 3 for well construction details). This Boring Record is part of a geotechnical report which must be considered in its entirety.
35	-20									35		
40	-25									40		
45	-30									45		

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FIGURE
B-1 b

BORING RECORD

PROJECT NAME	PROJECT NUMBER	BORING
Park Drive Street and Drainage Improvements	SD521	**B-2**

SITE LOCATION	START	FINISH	SHEET NO.
Carlsbad, California	8/29/2017	8/30/2017	1 of 3

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
Pacific Drilling	Hollow Stem Auger	C. Vonk	R. Stroop

DRILLING EQUIPMENT	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GROUNDWATER (ft)
Fraste PL-G	7	71.5	95	▼ 50.0 / *45.0*

SAMPLING METHOD
Hammer: 140 lbs., Drop: 30 in. (Automatic)

NOTES
ETR ~ 82%, N_{60} ~ N * C_E * C_B * C_S * C_R

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	OTHER TESTS	DEPTH (feet)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
												FILL/COLLUVIUM (UNDIFFERENTIATED): SILTY SAND (SM); light grayish brown; moist; medium dense; mostly fine to medium SAND; some fines; nonplastic; scattered roots.
5	90	■	R-1	41 50/4"	50/4"	38/4"	9.2	117.9		5		**SANTIAGO FORMATION (Tsa):** Poorly-graded SANDSTONE with SILT (SP-SM); weakly cemented; light gray and light grayish brown; moist; mostly fine to medium SAND; few fines; nonplastic.
10	85	⊠	S-2	14 21 30	51	62				10		SILTY SANDSTONE to SANDY SILTSTONE (SM); moderatly cemented; light gray to gray; moist; mostly fine SAND; some fines; low plasticity.
15	80	■	R-3	27 50/5"	50/5"	46/5"	7.9	114.6	DS	15		Scattered iron-oxide staining.
												SANDY CLAYSTONE (CL) to CLAYEY SANDSTONE (SC); moderatly indurated; light grayish brown; moist; mostly fines and fine to medium SAND; low to medium plasticity.
20	75	⊠	S-4	14 31 43	74	101			SA	20		(50% Sand; 50% Fines)

GDC_LOG_BORING_MMX_SOIL_SD SD521 LOGS.GPJ GDCLOG.GDT 2/4/20

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FIGURE
B-2 a

BORING RECORD

PROJECT NAME	PROJECT NUMBER	BORING
Park Drive Street and Drainage Improvements	SD521	**B-2**

SITE LOCATION	START	FINISH	SHEET NO.
Carlsbad, California	8/29/2017	8/30/2017	2 of 3

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
Pacific Drilling	Hollow Stem Auger	C. Vonk	R. Stroop

DRILLING EQUIPMENT	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GROUNDWATER (ft)
Fraste PL-G	7	71.5	95	▼ 50.0 / *45.0*

SAMPLING METHOD
Hammer: 140 lbs., Drop: 30 in. (Automatic)

NOTES
ETR ~ 82%, N_{60} ~ N * C_E * C_B * C_S * C_R

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	OTHER TESTS	DEPTH (feet)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
												SANTIAGO FORMATION (Tsa): Continued See Previous Page for Description.
												Well-graded SANDSTONE with SILT (SW-SM); weakly cemented; very light gray to white; moist; mostly fine to coarse SAND; few fines; nonplastic.
30	65		S-5	18 25 32	57	82	6.6			30		
												Slow advancment.
35	60									35		SILTY to CLAYEY SANDSTONE (SC-SM); weakly to moderately cemented; moist light brownish gray; moist; mostly fine to coarse SAND; little fines; low plasticity.
40	55		R-6	50/5.5"	50/5.5"	48/5.5"	9.8			40		Few to little fines.
												Difficult drilling; very slow advancement.
45	50									45		

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FIGURE
B-2 b

BORING RECORD

PROJECT NAME	PROJECT NUMBER	BORING
Park Drive Street and Drainage Improvements	SD521	**B-2**

SITE LOCATION	START	FINISH	SHEET NO.
Carlsbad, California	8/29/2017	8/30/2017	3 of 3

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
Pacific Drilling	Hollow Stem Auger	C. Vonk	R. Stroop

DRILLING EQUIPMENT	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GROUNDWATER (ft)
Fraste PL-G	7	71.5	95	▼ 50.0 / *45.0*

SAMPLING METHOD
Hammer: 140 lbs., Drop: 30 in. (Automatic)

NOTES
ETR ~ 82%, N_{60} ~ N * C_E * C_B * C_S * C_R

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	OTHER TESTS	DEPTH (feet)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
			S-7	24 34 50/5"	84/11"	121/11"	9.7		SA			**SANTIAGO FORMATION (Tsa):** Continued SILTY SANDSTONE (SM); weakly to moderately cemented; light grayish yellow; mostly fine to medium SAND; little fines; trace fine GRAVEL; nonplastic. (1% Gravel; 77% Sand; 22% Fines) Perched ground water at 50'; sampler wet.
55	40									55		
60	35		S-8	21 32 50	82	118	8.7			60		Moderatly to strongly cemented; no gravel. Very difficult drilling; very slow advancement.
65	30									65		
70	25		S-9	36 38 50/5.5"	88/5.5"	126/ 11.5"	9.0			70		Total Depth = 71.5 feet (Terminated in Santiago Formation). Groundwater not encountered during or after drilling. Perched water encountered at a depth of approximately 50 feet during drilling. Installed monitoring well on 8/30/2017 and 8/31/2017 (See Figure 3). This Boring Record is part of a geotechnical report which must be considered in its entirety.

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FIGURE
B-2 c

BORING RECORD

PROJECT NAME	PROJECT NUMBER	BORING
Park Drive Street and Drainage Improvements	SD521	**HA-101**

SITE LOCATION	START	FINISH	SHEET NO.
Carlsbad, California	1/23/2020	1/23/2020	1 of 1

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
N/A	Hand Auger	S. Narveson	C. Vonk

DRILLING EQUIPMENT	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GROUNDWATER (ft)
Hand Auger	3	9.4	39	▼ N/A / *na*

SAMPLING METHOD	NOTES
N/A	N/A

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	OTHER TESTS	DEPTH (feet)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
0	40									0		**COLLUVIUM:** CLAYEY SAND (SC); loose; dark brown; moist; mostly fine to medium SAND with few coarse SAND; some fines; trace fine GRAVEL; low plasticity; scattered roots and organics.
												SILTY SAND (SM); loose; light yellowish brown; moist; mostly fine to medium SAND; little fines; nonplastic to very low plasticity; scattered roots and organics.
5	35									5		
10	30									10		Total Depth = 9.4 feet (Practical refusal in colluvium due to reaching maximum hand auger depth). Groundwater not encountered during drilling. Backfilled shortly after excavation on 1/23/2020. This Boring Record is part of a geotechnical report which must be considered in its entirety.
15	25									15		
20	20									20		
	15											

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FIGURE
B-3

BORING RECORD

PROJECT NAME	PROJECT NUMBER	BORING
Park Drive Street and Drainage Improvements	SD521	**HA-102**

SITE LOCATION	START	FINISH	SHEET NO.
Carlsbad, California	1/23/2020	1/23/2020	1 of 1

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
N/A	Hand Auger	S. Narveson	C. Vonk

DRILLING EQUIPMENT	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GROUNDWATER (ft)
Hand Auger	3	3.3	43	▼ N/A / *na*

SAMPLING METHOD	NOTES
N/A	N/A

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	OTHER TESTS	DEPTH (feet)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
0	40									0		**COLLUVIUM:** SILTY SAND (SM); loose; light yellowish brown; moist; mostly fine to medium SAND with few coarse SAND; little fines; nonplastic to very low plasticity; scattered roots and organics.
5	35									5		**SANTIAGO FORMATION (Tsa):** CLAYEY SANDSTONE (SC); moderately cemented; light brown to light gray; moist; mostly fine to medium SAND; some fines; low plasticity; massive.
10	30									10		Total Depth = 3.3 feet (Terminated in Santiago Formation).
15	25									15		Groundwater not encountered during drilling.
20	20									20		Backfilled shortly after excavation on 1/23/2020.
												This Boring Record is part of a geotechnical report which must be considered in its entirety.

GDC_LOG_BORING_MMX_SOIL_SD SD521 LOGS.GPJ GDCLOG.GDT 2/4/20

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FIGURE
B-4

BORING RECORD

PROJECT NAME	PROJECT NUMBER	BORING
Park Drive Street and Drainage Improvements	SD521	**HA-103**

SITE LOCATION	START	FINISH	SHEET NO.
Carlsbad, California	1/23/2020	1/23/2020	1 of 1

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
N/A	Hand Auger	S. Narveson	C. Vonk

DRILLING EQUIPMENT	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GROUNDWATER (ft)
Hand Auger	3	5.8	35	▼ N/A / *na*

SAMPLING METHOD	NOTES
N/A	N/A

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	OTHER TESTS	DEPTH (feet)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
5	30									5		**COLLUVIUM:** CLAYEY SAND (SC); loose; dark brown; moist; mostly fine to medium SAND with few coarse SAND; some fines; trace fine GRAVEL; low plasticity; scattered roots and organics. @0.5': Light yellowish brown; mostly fine to medium SAND; medium plasticity. Increasing moisture with depth.
10	25									10		**SANTIAGO FORMATION (Tsa):** CLAYEY SANDSTONE (SC); moderately cemented; light brown to light gray; moist; mostly fine to medium SAND; some fines; low plasticity; massive. Total Depth = 5.8 feet (Terminated in Santiago Formation). Groundwater not encountered during drilling. Backfilled shortly after excavation on 1/23/2020. This Boring Record is part of a geotechnical report which must be considered in its entirety.
15	20									15		
20	15									20		

GDC_LOG_BORING_MMX_SOIL_SD SD521 LOGS.GPJ GDCLOG.GDT 2/4/20

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FIGURE
B-5

BORING RECORD

PROJECT NAME	PROJECT NUMBER	BORING
Park Drive Street and Drainage Improvements	SD521	**HA-104**

SITE LOCATION	START	FINISH	SHEET NO.
Carlsbad, California	1/23/2020	1/23/2020	1 of 1

DRILLING COMPANY	DRILLING METHOD	LOGGED BY	CHECKED BY
N/A	Hand Auger	S. Narveson	C. Vonk

DRILLING EQUIPMENT	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GROUNDWATER (ft)
Hand Auger	3	8.8	30	▼ N/A / *na*

SAMPLING METHOD	NOTES
N/A	N/A

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOW/FT "N"	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	OTHER TESTS	DEPTH (feet)	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
5	25									5		**COLLUVIUM:** SANDY lean CLAY (CL); medium stiff; dark brown; moist; mostly fines; some fine SAND; medium plasticity; scattered roots and organics.
												SILTY SAND (SM); loose; moist; light yellowish brown; mostly fine to coarse SAND; little fines; nonplastic to very low plasticity; scattered roots and organics.
												Increasing moisture and plasticity with depth.
10	20									10		**SANTIAGO FORMATION (Tsa):** CLAYEY SANDSTONE (SC); moderately cemented; light brown to light gray; moist; mostly fine to medium SAND; some fines; low plasticity; massive.
												Total Depth = 8.8 feet (Terminated in Santiago Formation).
												Groundwater not encountered during drilling.
												Backfilled shortly after excavation on 1/23/2020.
15	15									15		This Boring Record is part of a geotechnical report which must be considered in its entirety.
20	10									20		

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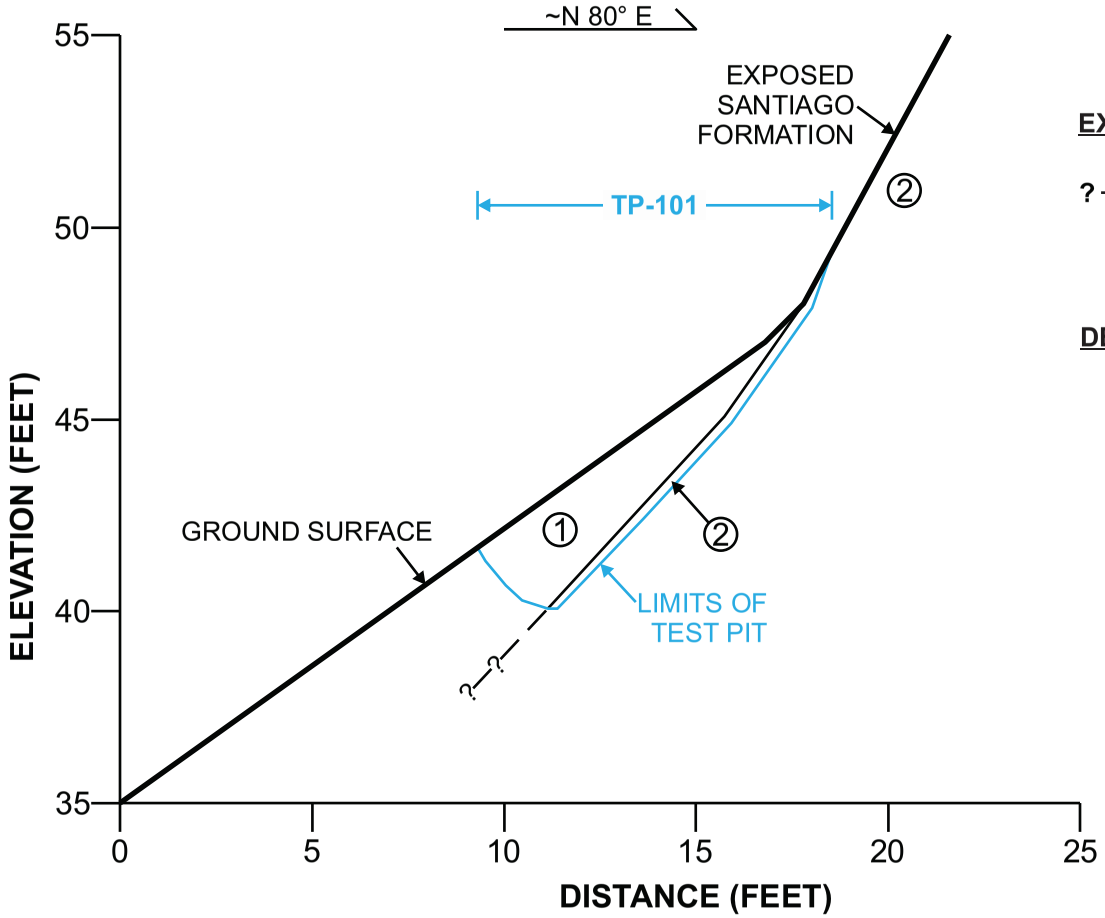
FIGURE
B-6

TEST PIT NUMBER: TP-101
EXCAVATION COMPANY: GROUP DELTA CONSULTANTS, INC.
EXCAVATION METHOD: SHOVEL AND ROCK HAMMER
TEST PIT LOGGED BY: S. NARVESON
BACKFILL METHOD: TAMPED TRENCH SPOILS

DATE OF EXCAVATION: 1/23/2020
EXCAVATION EQUIPMENT: HAND TOOLS
SAMPLING METHOD: BULK
CHECKED BY: C. VONK
DATE OF BACKFILL: 1/23/2020



EXPLANATION:

? — — ——— APPROXIMATE LOCATION OF GEOLOGIC CONTACT, DASHED WHERE INFERRED, QUERIED WHERE UNCERTAIN

DESCRIPTION AND CLASSIFICATION:

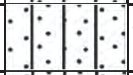
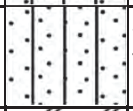
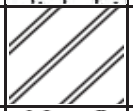
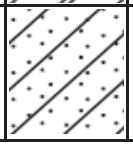
① **COLLUVIUM:** CLAYEY and SILTY SAND (SC-SM); loose; light yellowish brown to brown; moist; mostly fine to medium SAND with few coarse SAND, some fines; nonplastic to low plasticity; scattered roots and organics.

② **SANTIAGO FORMATION (Tsa):** CLAYEY SANDSTONE (SC); moderately cemented; light brown to light gray; moist; mostly fine to medium SAND; some fines; low plasticity; massive.

APPROXIMATE SCALE IN FEET
0 2.5 5
NOTE: DIRECTION, SCALE AND LOCATIONS ARE APPROXIMATE.

PROJECT NAME	FIGURE NAME	GROUP DELTA
PARK DRIVE STREET AND DRAINAGE IMPROVEMENTS CARLSBAD, CALIFORNIA	TEST PIT RECORD TP-101	PROJECT NUMBER: SD521 / FIGURE NUMBER: B-7

TABLE B-1
SUMMARY OF SURFICIAL BULK SAMPLES

Exploration	Approximate Surface Elevation (ft)	Approximate Depth (ft)	USCS Graphic	Soil Description
G-1	18	0 - 1		SILTY SAND (SM); loose; light yellowish brown; moist; mostly fine to coarse SAND; few to little fines; trace fine GRAVEL; low plasticity. (2% Gravel; 85% Sand; 13% Fines)
G-2	22	0 - 1		SILTY SAND (SM); loose; light yellowish brown; mostly fine to coarse SAND; little fines; trace fine GRAVEL; low plasticity.
G-3	24	0 - 1		SILTY SAND (SM); loose; light yellowish brown; mostly fine to coarse SAND; few to little fines; trace fine GRAVEL; medium plasticity. (2% Gravel; 85% Sand; 13% Fines) (LL: 44; PL: 27; PI: 17)
G-4	22	0 - 0.5		FAT CLAY (CH); light grayish brown; mostly fines; trace fine SAND; high plasticity. (Fines filtered from adjacent colluvium/slopewash and ponded behind retaining wall in flat, low lying area)
G-5	36	0 - 1		CLAYEY SANDSTONE (SC); weakly to moderately cemented; light yellowish brown; mostly fine to coarse SAND; few to little fines; few fine GRAVEL; high plasticity. (2% Gravel; 85% Sand; 13% Fines) (LL: 52; PL: 27; PI: 25)

ATTACHMENT C
LABORATORY TESTING

ATTACHMENT C

LABORATORY TESTING

Laboratory testing was conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions and in the same locality. No warranty, express or implied, is made as to the correctness or serviceability of the test results, or the conclusions derived from these tests. Where a specific laboratory test method has been referenced, such as ASTM or Caltrans, the reference only applies to the specified laboratory test method, which has been used only as a guidance document for the general performance of the test and not as a "Test Standard". A brief description of the various tests performed for this project follows.

Classification: Soils were visually classified per the Unified Soil Classification System as established by the American Society of Civil Engineers per ASTM D2487. The soil classifications are shown on the exploration logs in Appendix B.

In-Situ Moisture Content and Density: The in-situ moisture content and density of partially intact soil samples was performed on select soil samples in accordance with ASTM D2937 and D2216. The results are shown on the exploration logs in Appendix B.

Particle Size Analysis: Particle size analyses were performed in accordance with ASTM D422 and were used to supplement visual classifications. The test results are shown in the exploration logs in Appendix B and in Figures C-1.1 through C-1.9.

Plasticity Index: ASTM D4318 was used to evaluate the plastic limit, liquid limit and plasticity index of selected samples. The results are shown on the Particle Size Analysis Figures C-1.1 through C-1.9.

Expansion Index: The expansion potential of selected soil samples was estimated in general accordance with the laboratory procedures outlined in ASTM test method D4829. The test results are summarized in Figure C-2. Figure C-2 also presents common criteria for evaluating the expansion potential based on the expansion index.

Maximum Density/Optimum Moisture: The maximum density and optimum moisture of a selected soil sample was evaluated using ASTM test method D1557. The results were corrected for oversize materials in general accordance with ASTM D4718. The results are summarized in Figure C-2.

Direct Shear: The shear strength of selected samples was assessed using direct shear testing performed in general accordance with ASTM D3080. The test results are shown in Figures C-3 through C-5.

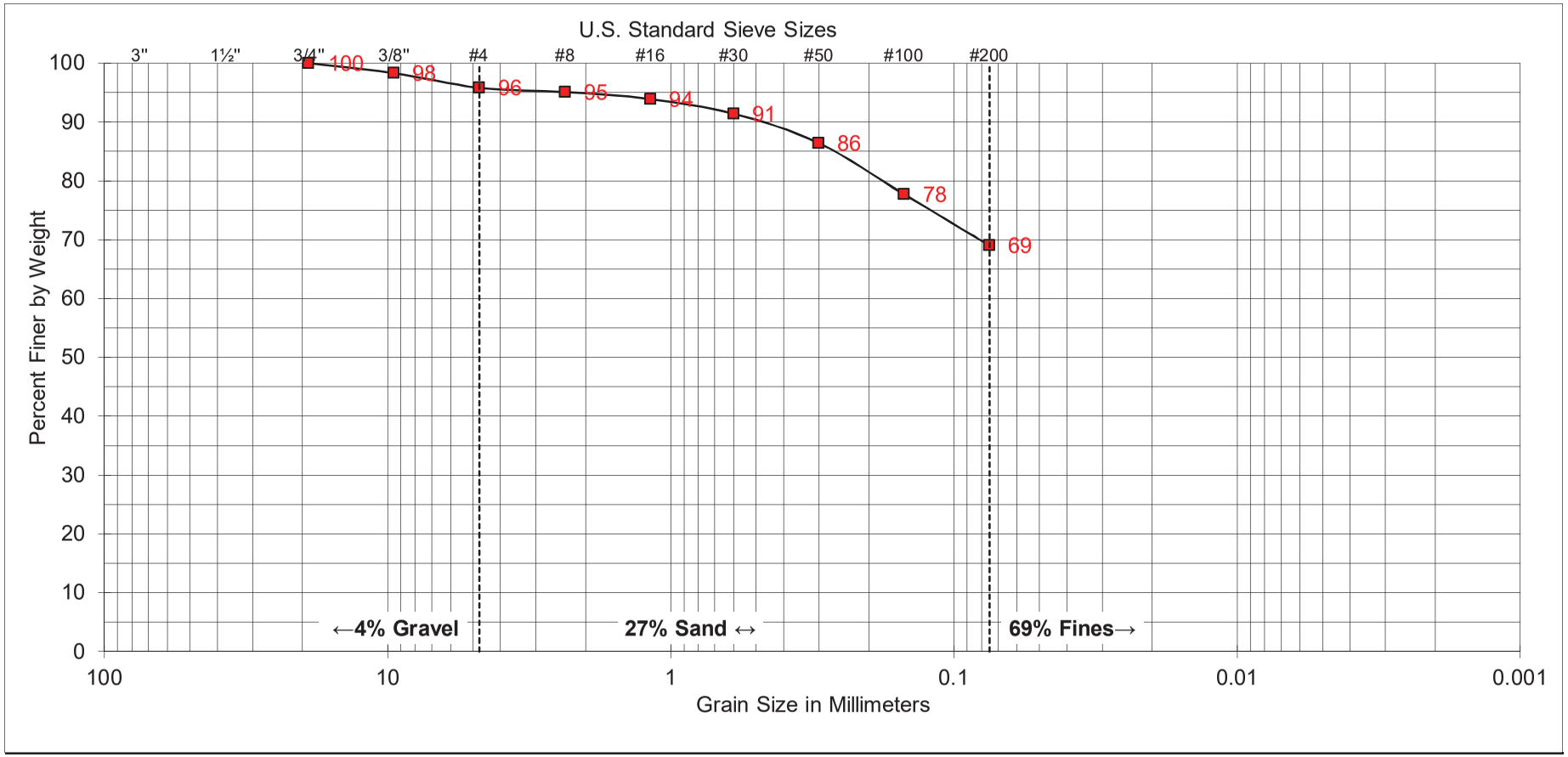
pH and Resistivity: To assess the potential for reactivity with buried metals, selected soil samples were tested for pH and minimum resistivity using Caltrans test method 643. The corrosivity test results are summarized in Figure C-6.

ATTACHMENT C

LABORATORY TESTING (CONTINUED)

Sulfate Content: To assess the potential for reactivity with concrete, selected soil samples were tested for water soluble sulfate. The sulfate was extracted from the soil under vacuum using a 10:1 (water to dry soil) dilution ratio. The extracted solution was tested for water soluble sulfate in general accordance with ASTM D516. The test results are also presented in Figure C-6, along with common criteria for evaluating soluble sulfate content.

Chloride Content: Soil samples were also tested for water soluble chloride. The chloride was extracted from the soil under vacuum using a 10:1 (water to dry soil) dilution ratio. The extracted solution was then tested for water soluble chloride using a calibrated ion specific electronic probe. The test results are also shown in Figure C-6.



COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND
GRAVEL		SAND			CLAY

SAMPLE	
BORING NUMBER:	B-1
SAMPLE DEPTH:	1' - 5'

UNIFIED SOIL CLASSIFICATION: CH

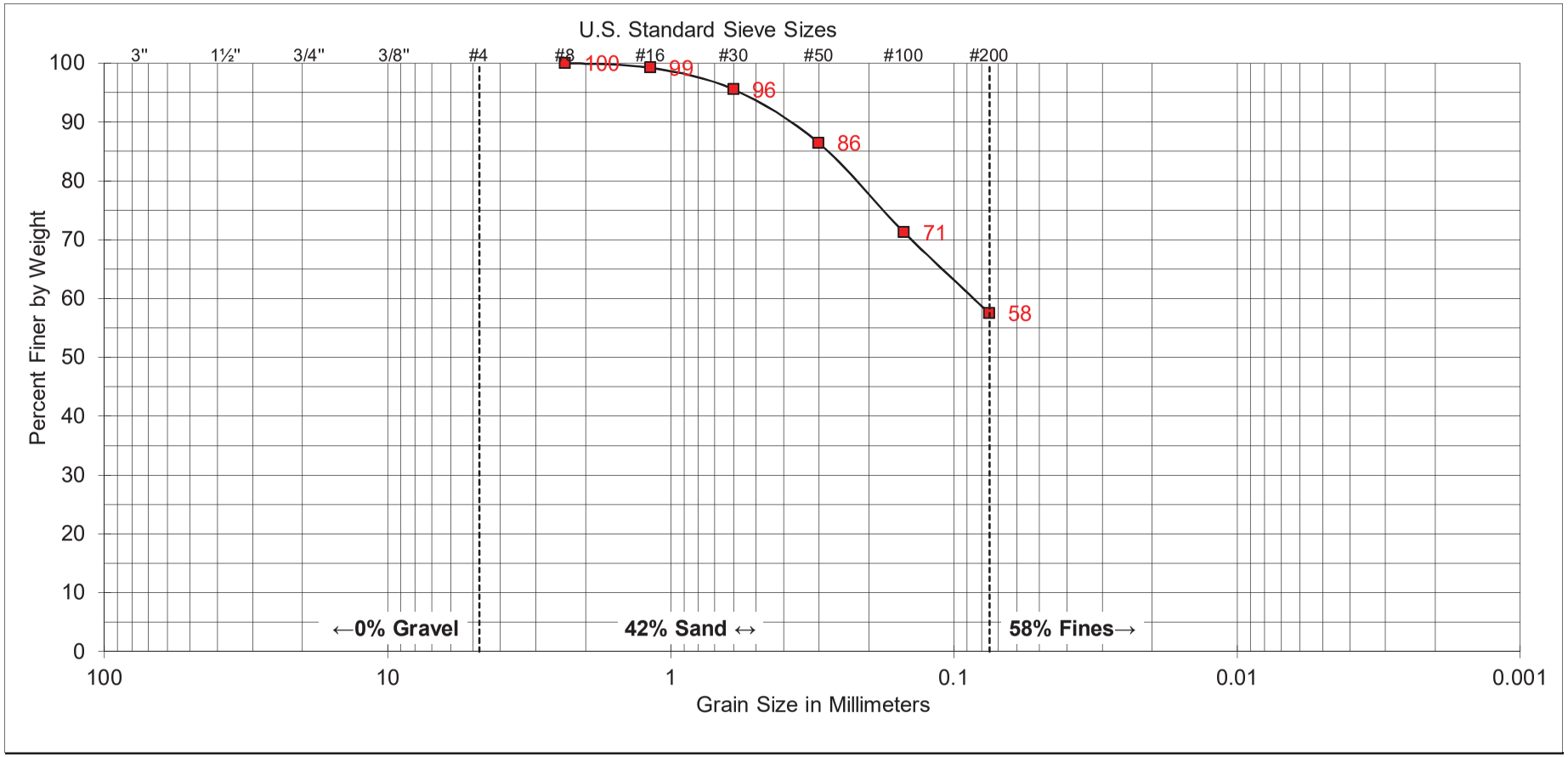
DESCRIPTION: FAT CLAY WITH SAND

ATTERBERG LIMITS	
LIQUID LIMIT:	56
PLASTIC LIMIT:	15
PLASTICITY INDEX:	41

GROUP DELTA

SOIL CLASSIFICATION

Document No. 17-0075
Project No. SD521
FIGURE C-1.1



COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND
GRAVEL		SAND			CLAY

SAMPLE	
BORING NUMBER:	B-1
SAMPLE DEPTH:	10.9' - 11.4'

UNIFIED SOIL CLASSIFICATION: CL

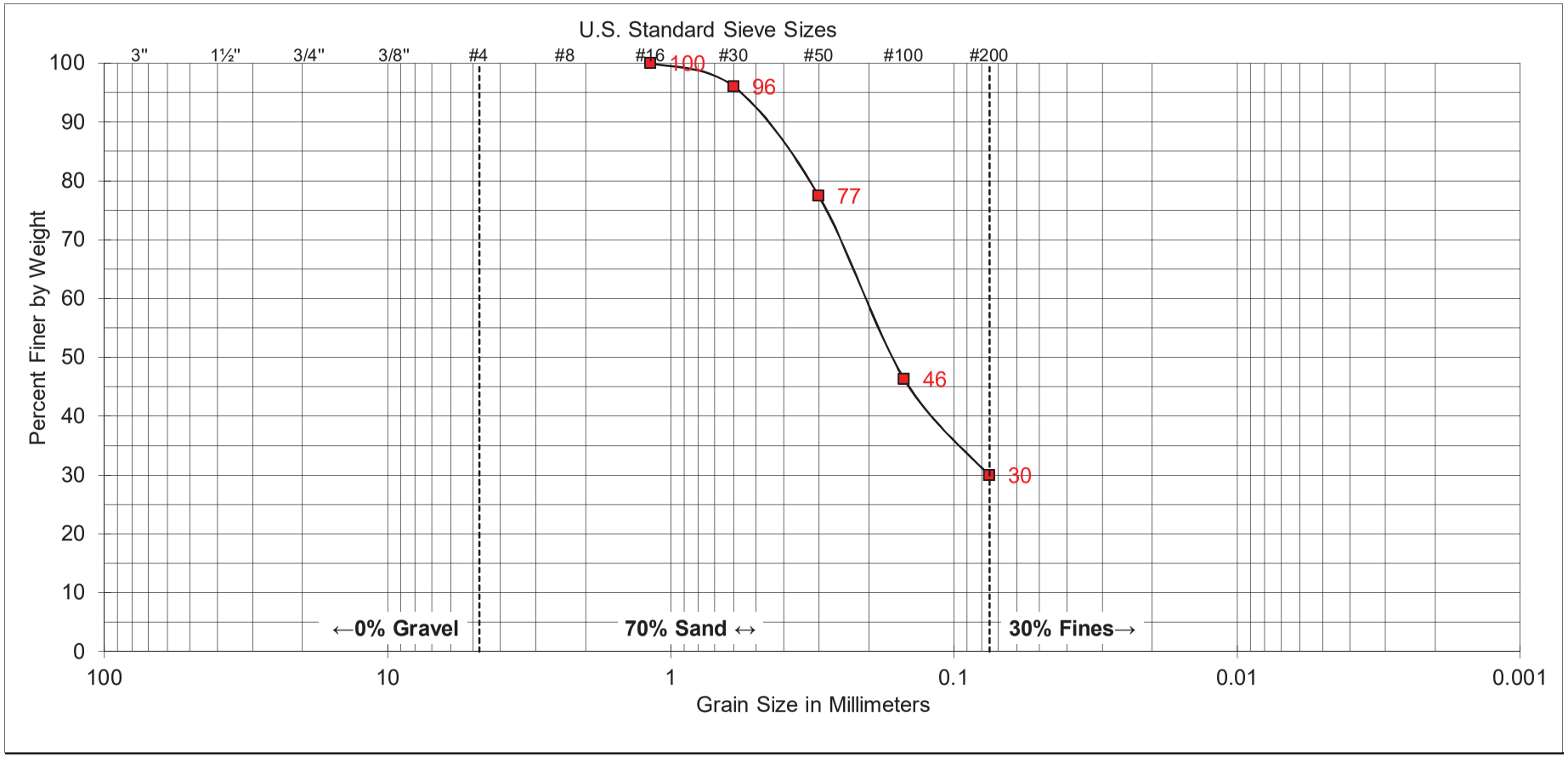
DESCRIPTION: SANDY LEAN CLAYSTONE

ATTERBERG LIMITS	
LIQUID LIMIT:	--
PLASTIC LIMIT:	--
PLASTICITY INDEX:	--

GROUP DELTA

SOIL CLASSIFICATION

Document No. 17-0075
Project No. SD521
FIGURE C-1.2



COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND
GRAVEL		SAND			CLAY

SAMPLE	
BORING NUMBER:	B-1
SAMPLE DEPTH:	20-21.5'

UNIFIED SOIL CLASSIFICATION: SC

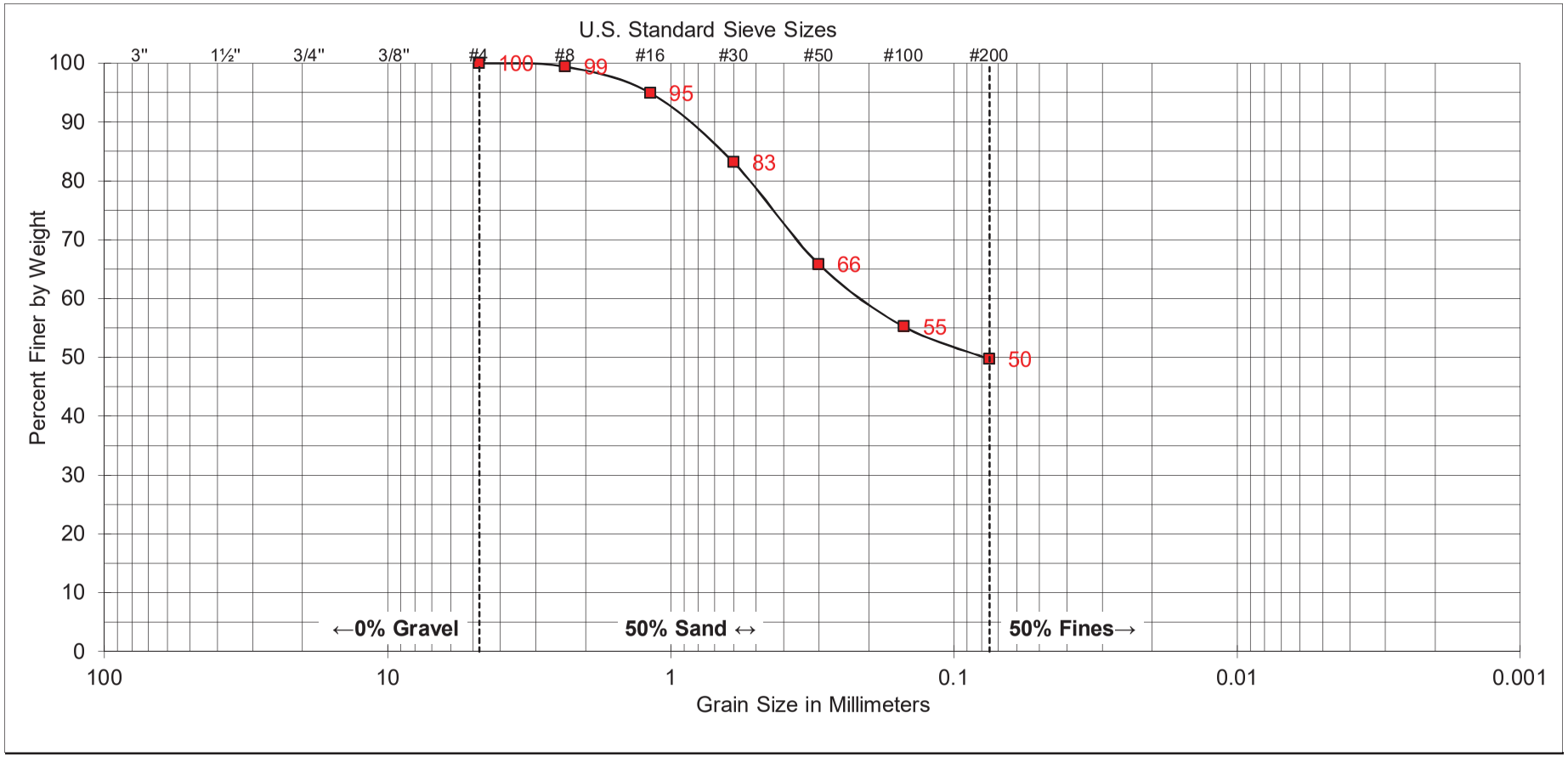
DESCRIPTION: CLAYEY SANDSTONE

ATTERBERG LIMITS	
LIQUID LIMIT:	--
PLASTIC LIMIT:	--
PLASTICITY INDEX:	--

GROUP DELTA

SOIL CLASSIFICATION

Document No. 17-0075
Project No. SD521
FIGURE C-1.3



COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND
GRAVEL		SAND			CLAY

SAMPLE	
BORING NUMBER:	B-2
SAMPLE DEPTH:	20-21.5'

UNIFIED SOIL CLASSIFICATION: SC

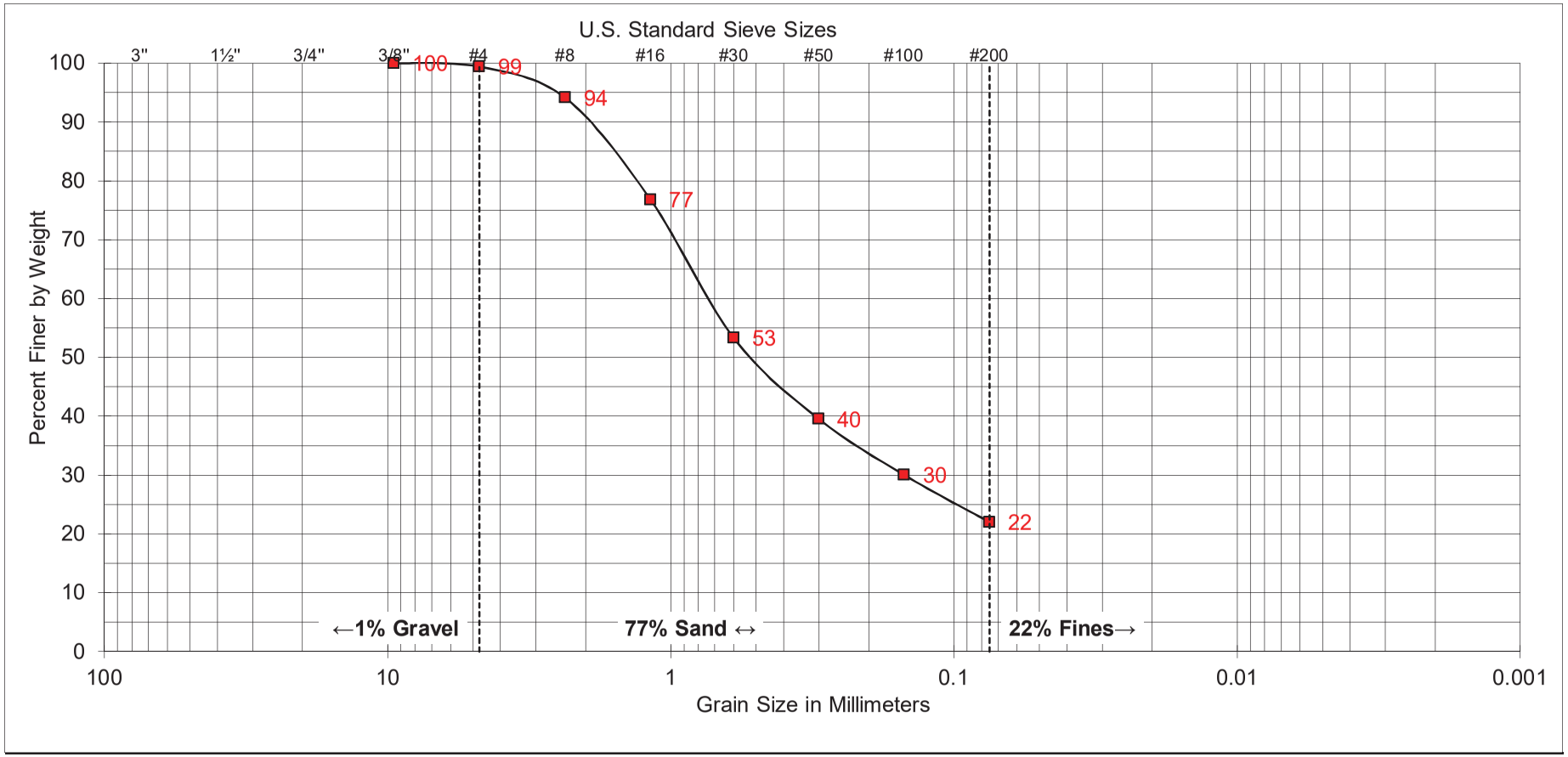
DESCRIPTION: CLAYEY SANDSTONE

ATTERBERG LIMITS	
LIQUID LIMIT:	--
PLASTIC LIMIT:	--
PLASTICITY INDEX:	--

GROUP DELTA

SOIL CLASSIFICATION

Document No. 17-0075
Project No. SD521
FIGURE C-1.4



COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND
GRAVEL		SAND			CLAY

SAMPLE	
BORING NUMBER:	B-2
SAMPLE DEPTH:	50-51.5'

UNIFIED SOIL CLASSIFICATION: SM

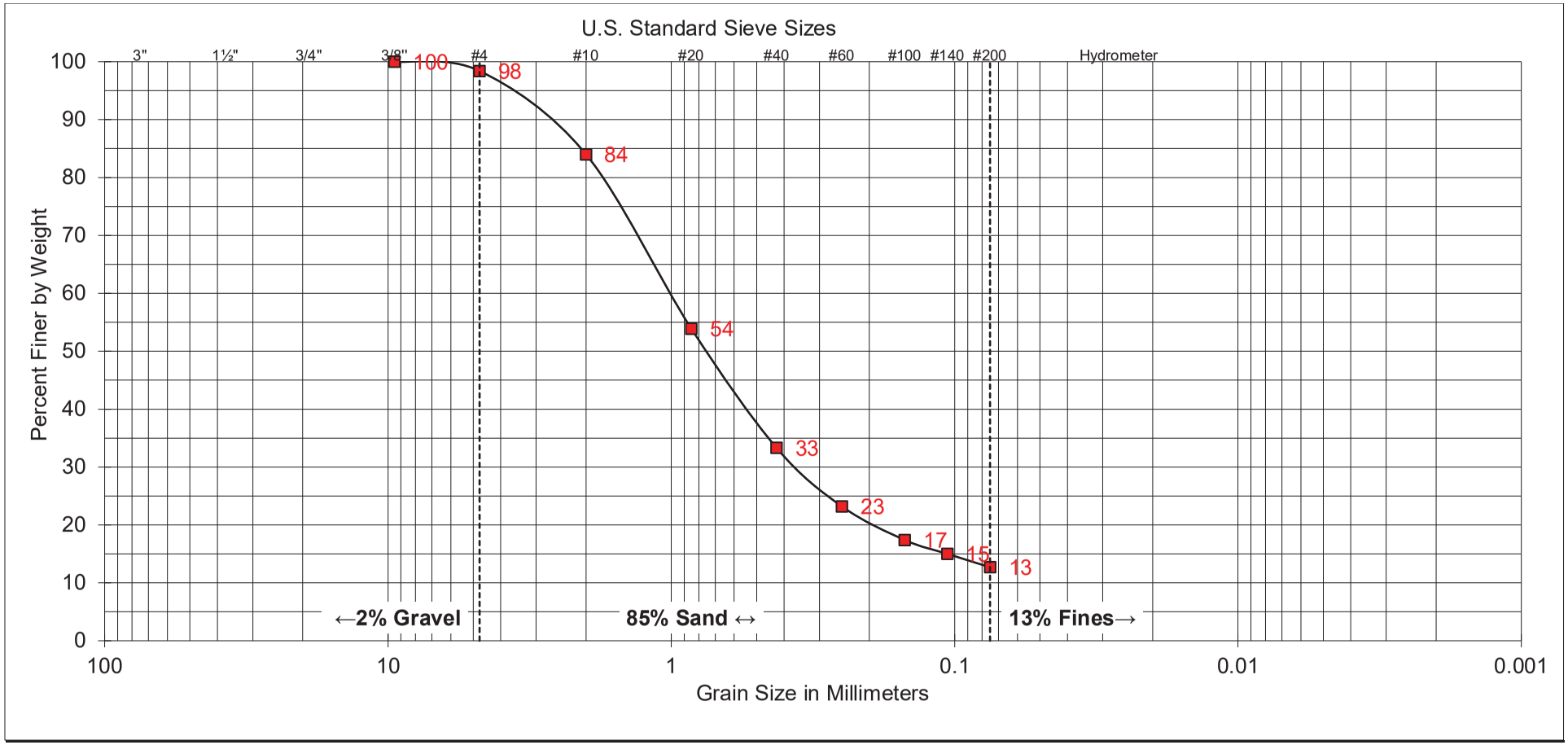
DESCRIPTION: SILTY SANDSTONE

ATTERBERG LIMITS	
LIQUID LIMIT:	--
PLASTIC LIMIT:	--
PLASTICITY INDEX:	--

GROUP DELTA

SOIL CLASSIFICATION

Document No. 17-0075
Project No. SD521
FIGURE C-1.5



COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND
GRAVEL		SAND			CLAY

SAMPLE	
SAMPLE NUMBER:	G-1
SAMPLE DEPTH:	0-1'

UNIFIED SOIL CLASSIFICATION: SM

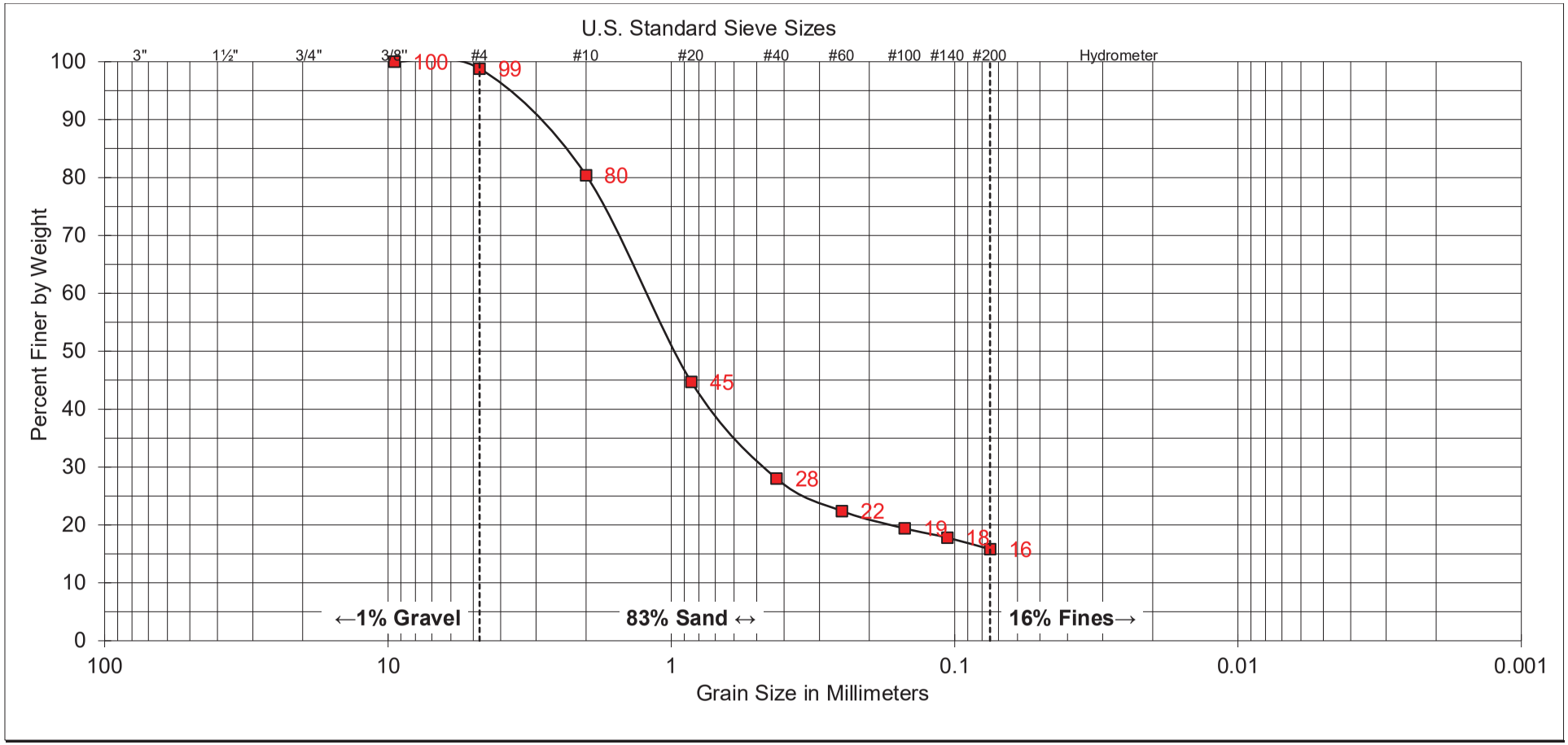
DESCRIPTION: SILTY SAND

ATTERBERG LIMITS	
LIQUID LIMIT:	--
PLASTIC LIMIT:	--
PLASTICITY INDEX:	--

GROUP DELTA

SOIL CLASSIFICATION

Document No. 17-0075
Project No. SD521
FIGURE C-1.6



COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND
GRAVEL		SAND			CLAY

SAMPLE
SAMPLE NUMBER: G-3
SAMPLE DEPTH: 1' - 5'

UNIFIED SOIL CLASSIFICATION: SM

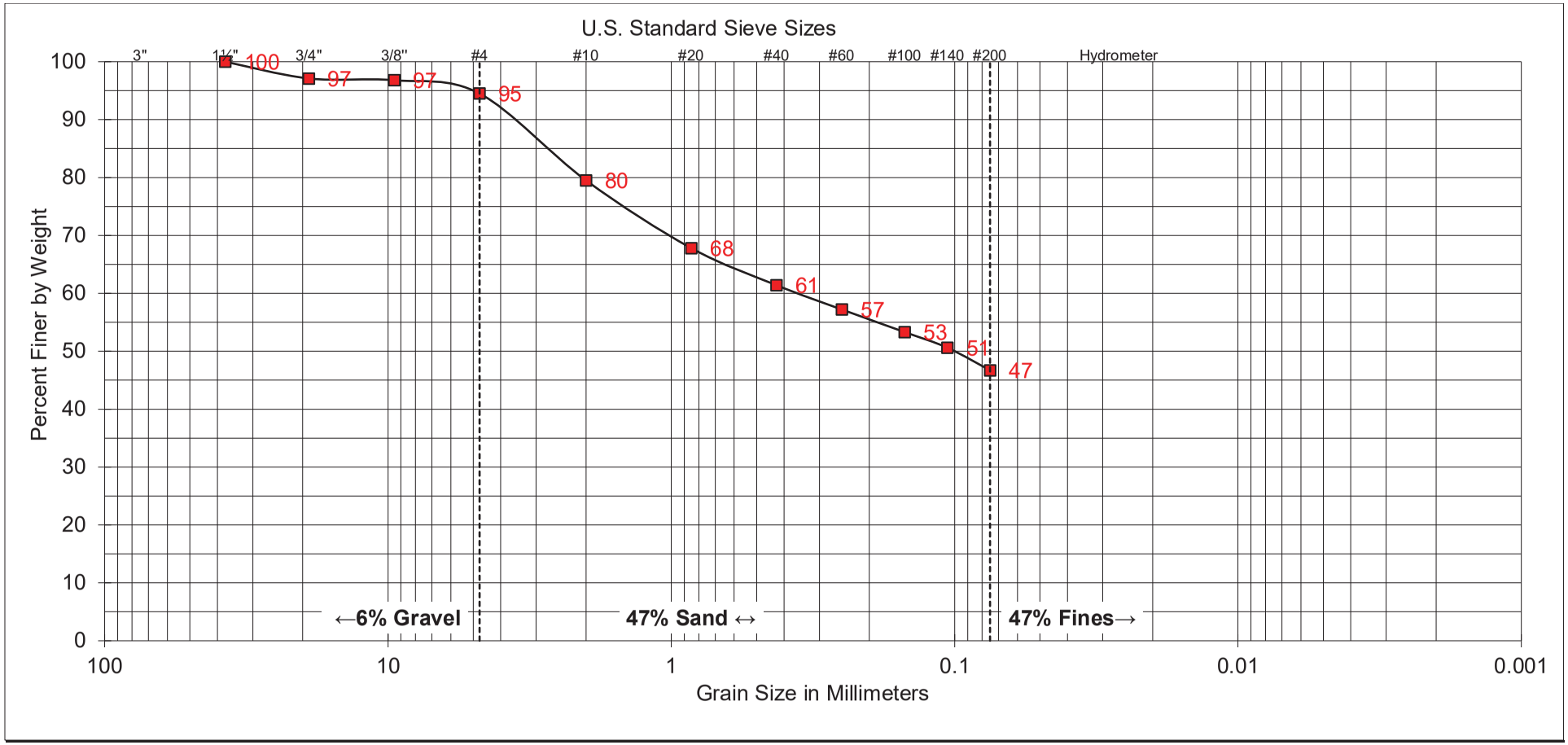
DESCRIPTION: SILTY SAND

ATTERBERG LIMITS	
LIQUID LIMIT:	44
PLASTIC LIMIT:	27
PLASTICITY INDEX:	17

GROUP DELTA

SOIL CLASSIFICATION

Document No. 17-0075
Project No. SD521
FIGURE C-1.7



COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND
GRAVEL		SAND			CLAY

SAMPLE	
SAMPLE NUMBER:	G-5
SAMPLE DEPTH:	0-1'

UNIFIED SOIL CLASSIFICATION: SC

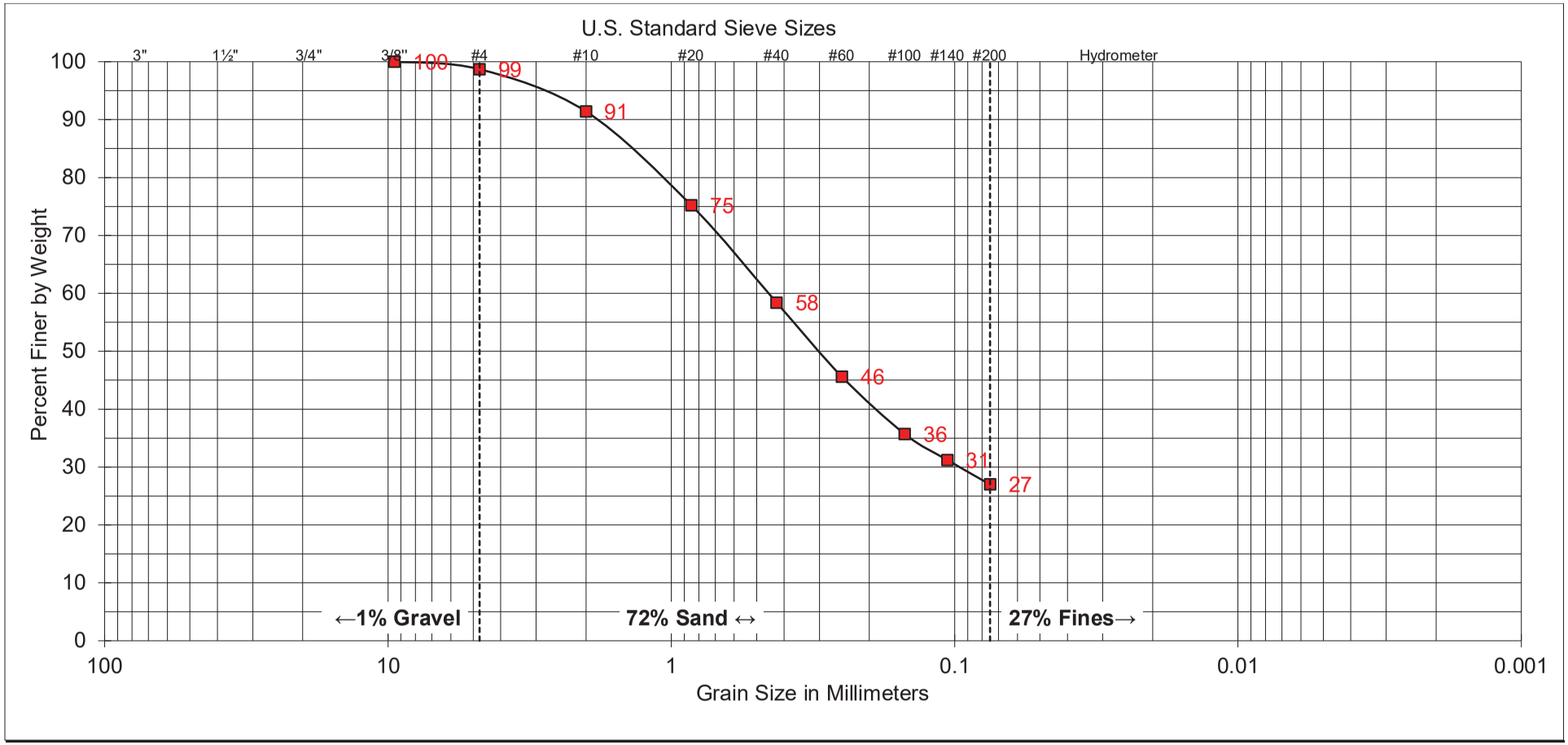
DESCRIPTION: CLAYEY SAND

ATTERBERG LIMITS	
LIQUID LIMIT:	52
PLASTIC LIMIT:	27
PLASTICITY INDEX:	25

GROUP DELTA

SOIL CLASSIFICATION

Document No. 17-0075
Project No. SD521
FIGURE C-1.8



COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND
GRAVEL		SAND			CLAY

SAMPLE
SAMPLE NUMBER: TP-101
SAMPLE DEPTH: 0.5' - 1'

UNIFIED SOIL CLASSIFICATION: SC

DESCRIPTION: CLAYEY SAND

ATTERBERG LIMITS	
LIQUID LIMIT:	--
PLASTIC LIMIT:	--
PLASTICITY INDEX:	--

GROUP DELTA

SOIL CLASSIFICATION

Document No. 17-0075
Project No. SD521
FIGURE C-1.9

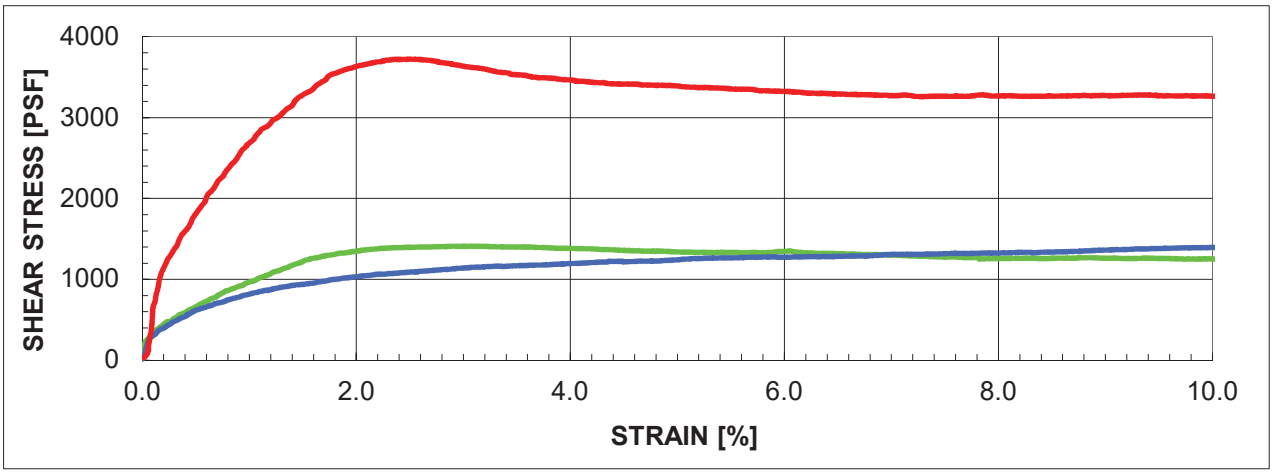
EXPANSION TEST RESULTS
(ASTM D4829)

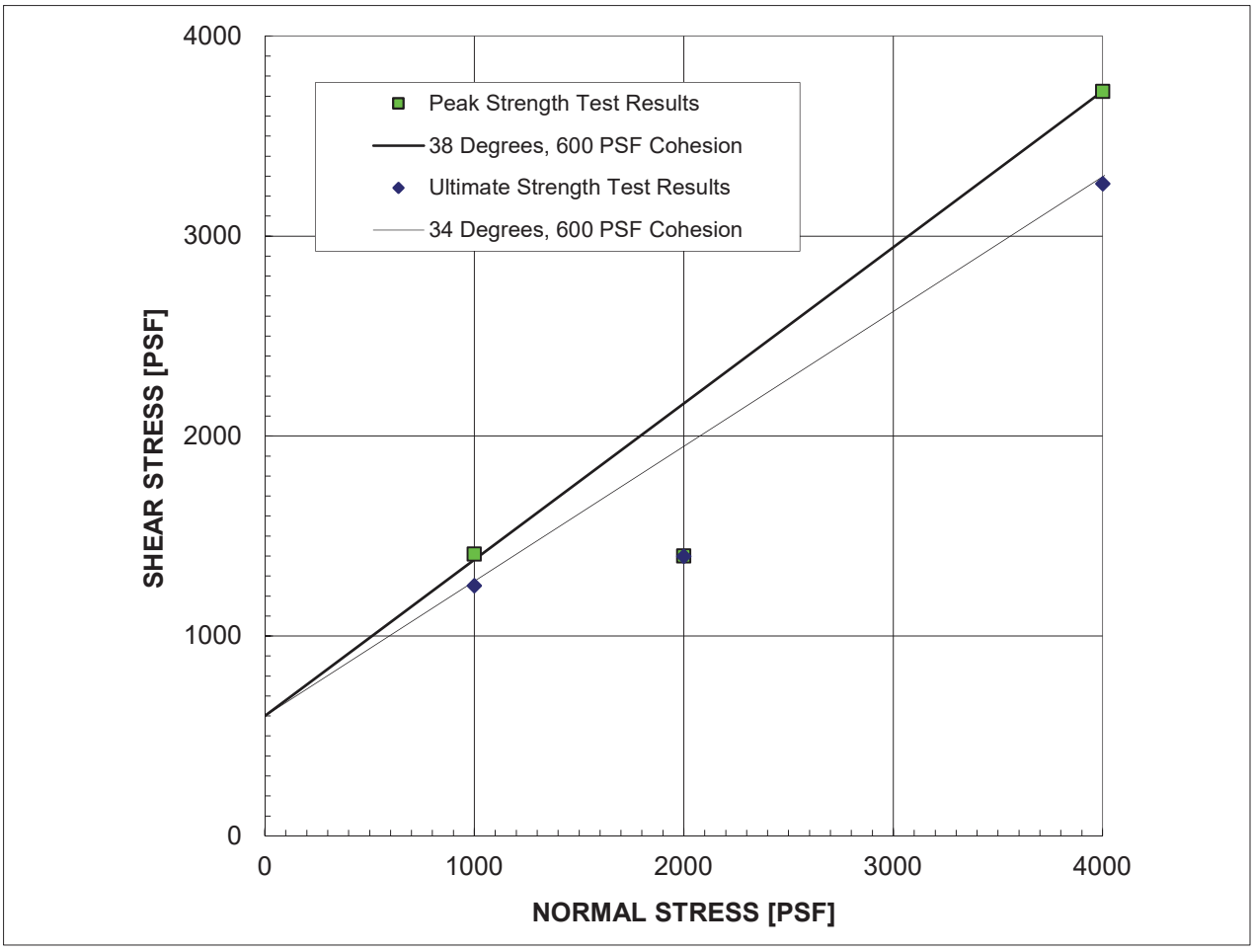
SAMPLE	DESCRIPTION	EXPANSION INDEX
B-1 @ 1' – 5'	**FILL:** Fat CLAY (CH)	118
TP-101 @ 0.5' – 1'	**COLLUVIUM:** CLAYEY SAND (SC)	8
G-1 @ 0' – 1'	**COLLUVIUM:** SILTY SAND (SM)	0
G-5 @ 0' – 1'	**COLLUVIUM:** CLAYEY SAND (SC)	43

EXPANSION INDEX	POTENTIAL EXPANSION
0 to 20	Very low
21 to 50	Low
51 to 90	Medium
91 to 130	High
Above 130	Very High

MAXIMUM DENSITY & OPTIMUM MOISTURE
(ASTM D1557 & D4718)

SAMPLE	DESCRIPTION	MAXIMUM DENSITY [lbs/ft^3]	OPTIMUM MOISTURE [%]
G-3 @ 0' – 1'	CLAYEY SAND (SC)	125.2	8.8





SAMPLE: B-1 @ 10.9' - 11.4'

Description:
Olive gray sandy lean CLAYSTONE (CL)

STRAIN RATE: 0.0007 IN/MIN
(Sample was consolidated and drained)

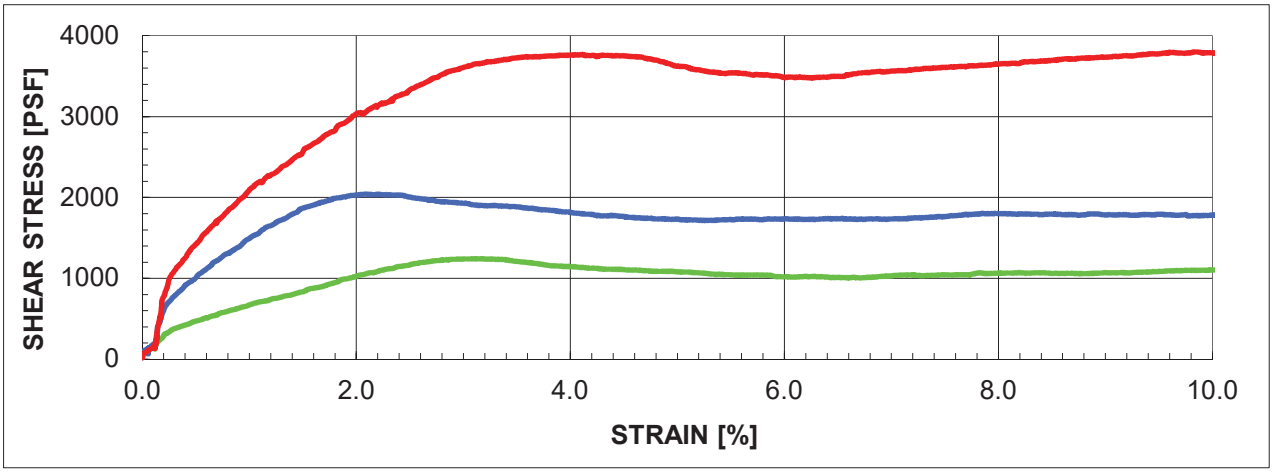
	PEAK	ULTIMATE
ϕ'	38 °	34 °
C'	600 PSF	600 PSF

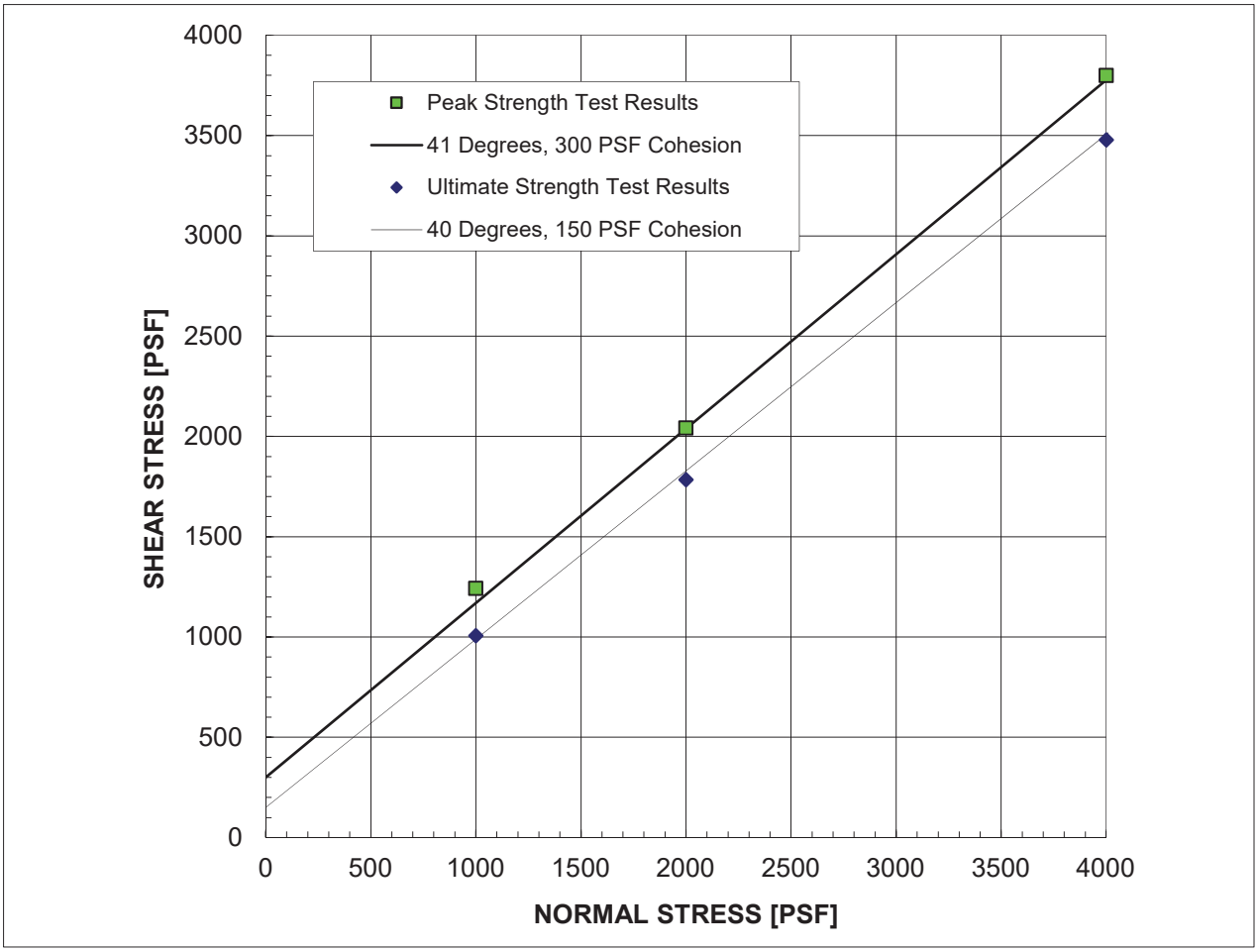
	IN-SITU	AS-TESTED
γ_d	115.4 PCF	115.4 PCF
w_c	11.6 %	17.0 %

GROUP DELTA

DIRECT SHEAR TEST RESULTS

Document No. 17-0075
Project No. SD521
FIGURE C-3





SAMPLE: B-2 @ 15.4' - 15.9'

Description:
Light gray silty SANDSTONE (SM)

STRAIN RATE: 0.0040 IN/MIN
(Sample was consolidated and drained)

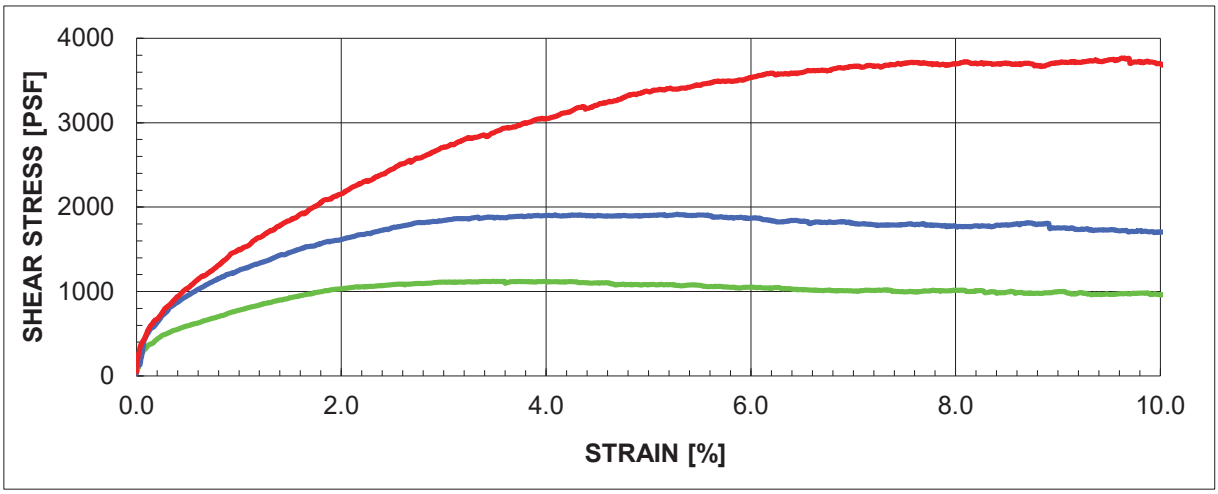
	PEAK	ULTIMATE
ϕ'	41 °	40 °
C'	300 PSF	150 PSF

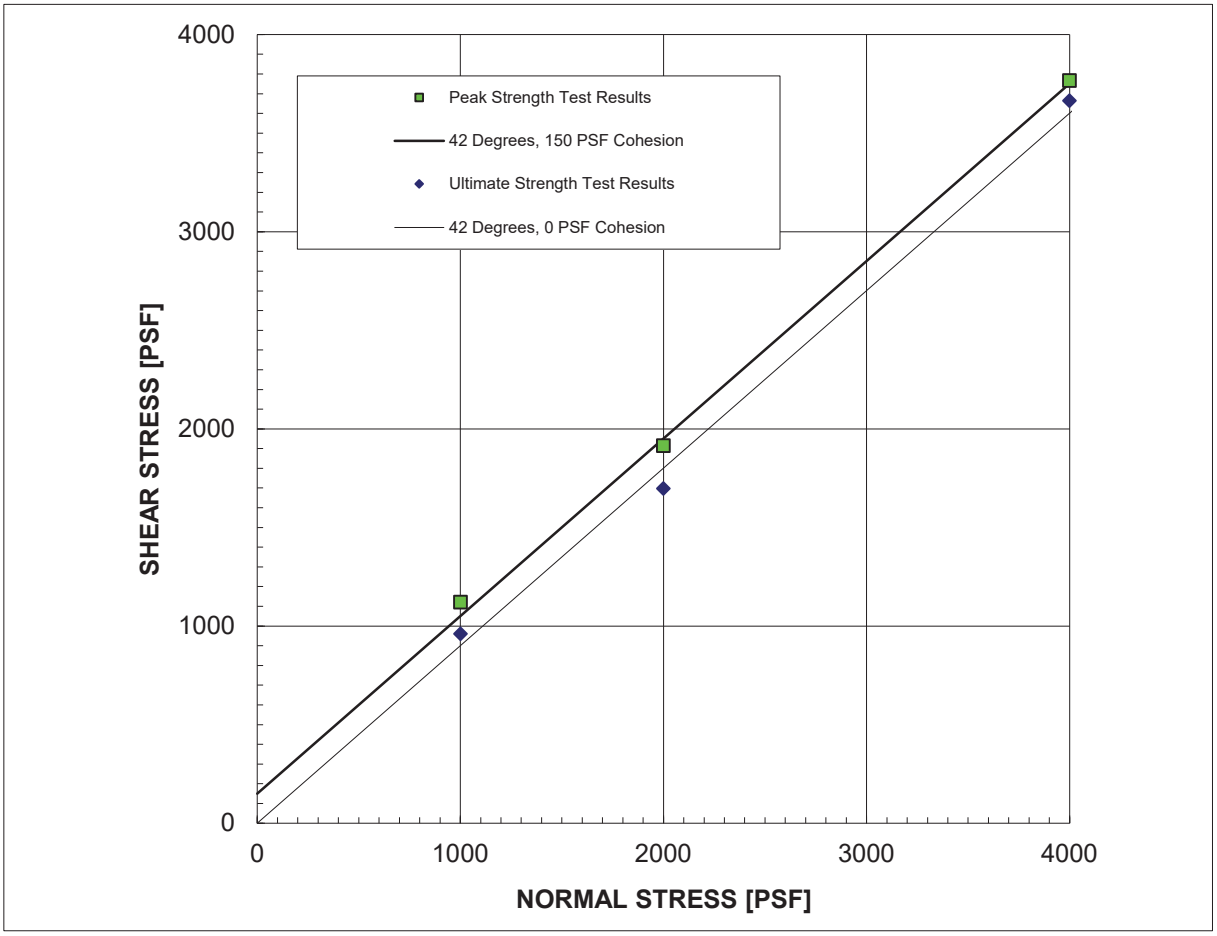
	IN-SITU	AS-TESTED
γ_d	114.6 PCF	114.6 PCF
w_c	7.9 %	17.4 %

GROUP DELTA

DIRECT SHEAR TEST RESULTS

Document No. 17-0075
Project No. SD521
FIGURE C-4





SAMPLE: G-3 @ 0-1'

Description:
Grayish yellow silty sand (SM)

*Remolded to 90% Relative Compaction

STRAIN RATE: 0.0020 IN/MIN

(Sample was consolidated and drained)

	PEAK	ULTIMATE
ϕ'	42 °	42 °
C'	150 PSF	0 PSF

	IN-SITU*	AS-TESTED
γ_d	112.8 PCF	112.8 PCF
w_c	8.7 %	17.5 %

GROUP DELTA

DIRECT SHEAR TEST RESULTS

Project No. SD521

FIGURE C-5

CORROSIVITY TEST RESULTS
(ASTM D516, CTM 643)

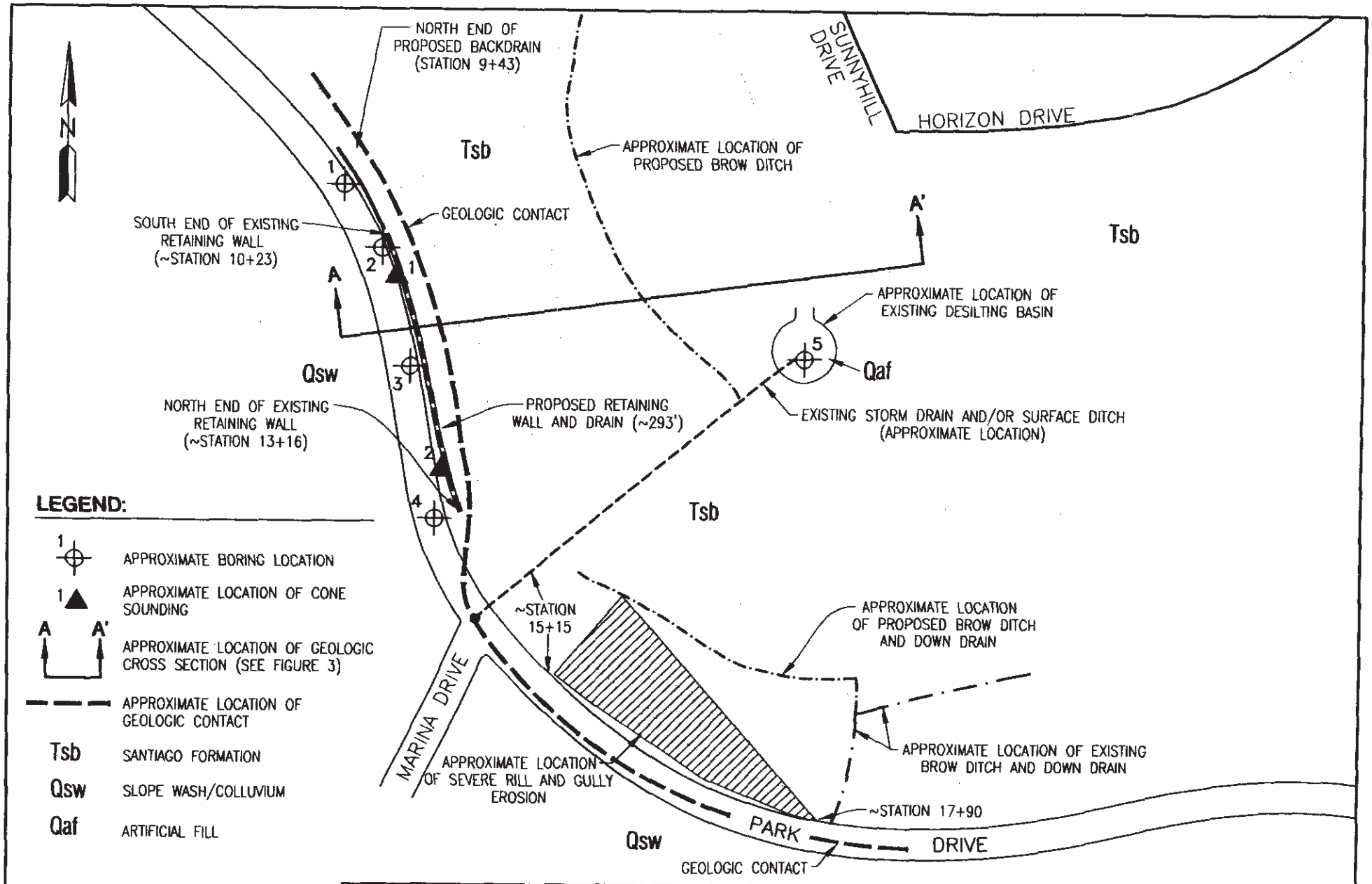
SAMPLE NO.	pH	MINIMUM RESISTIVITY [OHM-CM]	SULFATE CONTENT [%]	CHLORIDE CONTENT [%]
B-1 @ 1' – 5'	8.6	471	0.12	0.01
G-2 @ 0' – 1'	8.3	2,345	0.01	0.01

SULFATE CONTENT [%]	SULFATE EXPOSURE	CEMENT TYPE
0.00 to 0.10	Negligible	-
0.10 to 0.20	Moderate	II, IP(MS), IS(MS)
0.20 to 2.00	Severe	V
Above 2.00	Very Severe	V plus pozzolan

SOIL RESISTIVITY [OHM-CM]	GENERAL DEGREE OF CORROSIVITY TO FERROUS METALS
0 to 1,000	Very Corrosive
1,000 to 2,000	Corrosive
2,000 to 5,000	Moderately Corrosive
5,000 to 10,000	Mildly Corrosive
Above 10,000	Slightly Corrosive

CHLORIDE (Cl) CONTENT [%]	GENERAL DEGREE OF CORROSIVITY TO METALS
0.00 to 0.03	Negligible
0.03 to 0.15	Corrosive
Above 0.15	Severely Corrosive

ATTACHMENT D
PREVIOUS GEOTECHNICAL INVESTIGATIONS



KLEINFELDER
9555 CHESAPEAKE DRIVE, SUITE 101
SAN DIEGO, CALIFORNIA 92123

CHECKED BY: REL	FN: 4659SITE
PROJECT NO. 51-4659-01	DATE: 5/4/98

SITE PLAN AND GEOLOGIC MAP

PARK DRIVE SLOPE / DRAINAGE STUDY
CITY OF CARLSBAD
CARLSBAD, CALIFORNIA

FIGURE
2

PROJECT NO. 51-4659-01

LOG OF BORING LEGEND

SHEET 1 OF 1

DRILLING EQUIPMENT

PROJECT NAME: PARK DRIVE SLOPE STUDY

LOCATION: CARLSBAD, CA

TYPE OF BIT | HAMMER DATA: WT. LBS. DROP INCHES | SURFACE ELEVATION | TOP OF CASING ELEVATION

DATE: STARTED: | COMPLETED: | BACKFILLED:

DRILLING AGENCY | LOGGED BY | SURFACE CONDITIONS

GROUNDWATER ELEVATION _____ DATE _____

DEPTH (FEET)	GEOLOGIC LOG	SOIL DESCRIPTION	U.S.C.S.	WELL DETAILS	BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	NOTES
0									
1									
2		WELL-GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	GW						CONTINUOUS SAMPLER
3									
4		POORLY GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	GP						GRAB SAMPLE
5									
6		SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	GM						CALIFORNIA SAMPLER
7		CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES	GC						
8									MODIFIED CALIFORNIA SAMPLER
9		WELL-GRADED SANDS AND GRAVELLY SANDS, LITTLE OR NO FINES	SW						
10		POORLY GRADED SANDS AND GRAVELLY SANDS, LITTLE OR NO FINES	SP						NO RECOVERY
11									
12		SILTY SANDS, SAND-SILT MIXTURES	SM						PITCHER SAMPLER
13		CLAYEY SANDS, SAND-CLAY MIXTURES	SC						
14									SHELBY TUBE SAMPLER
15		INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS	ML						
16		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	CL						STANDARD PENETRATION SAMPLER
17									
18		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	OL						
19		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDS OR SILTS, ELASTIC SILTS	MH						
20									
21		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	CH						
22		ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY	OH						
23									
24		PEAT, MUCK AND OTHER HIGHLY ORGANIC SOILS	PT						
25									
26									
27		▽ ATD WATER LEVEL AT TIME OF DRILLING							
28		▼ WATER LEVEL MEASURED IN WELL							
29									
30									

BENTONITE
CAVED AREA
CEMENT
CONCRETE
NATURAL BACKFILL
BENTONITE PACKER
SAND BACKFILL
SAND
VOLCLAY GROUT
PIPE
SLOTTED PIPE

REFER TO FIGURE A2 FOR PHYSICAL PROPERTIES CRITERIA FOR ROCK/ FORMATION DESCRIPTIONS.

FN: 4659LOGS

KLEINFELDER

9555 CHESAPEAKE DRIVE, SUITE 101
SAN DIEGO, CALIFORNIA 92123

FIGURE NO. A1

CONSOLIDATION OF SEDIMENTARY ROCKS; usually obtained from unweathered samples. Largely dependent on cementation.

U = unconsolidated
P = poorly consolidated
M = moderately consolidated
W = well consolidated

BEDDING OF SEDIMENTARY ROCKS

Splitting Property	Thickness	Stratification
Massive	Greater than 4.0 ft.	very thick bedded
Blocky	2.0 to 4.0 ft.	thick-bedded
Slabby	0.2 to 2.0 ft.	thin-bedded
Flaggy	0.05 to 0.2 ft.	very thin-bedded
Shaly or platy	0.01 to 0.5 ft.	laminated
Papery	Less than 0.01 ft.	thinly laminated

FRACTURING

Intensity	Size of Pieces in Feet
Very little fractures	Greater than 4.0
Occasionally fractured	1.0 to 4.0
Moderately fractured	0.5 to 1.0
Closely fractured	0.1 to 0.5
Intensely fractured	0.05 to 0.1
Crushed	Less than 0.05

HARDNESS

1. Soft – Reserved for plastic material alone
2. Low hardness – can be gouged deeply or carved easily with a knife blade
3. Moderately hard – can be readily scratched by a knife blade; scratch leaves a heavy trace of dust and is readily visible after the powder has been blown away.
4. Hard – can be scratched with difficulty; scratch produces little powder and is often lainly visible.
5. Very hard – cannot be scratched with knife blade; leaves a metallic streak.

STRENGTH

1. Plastic or very low strength
2. Friable – crumbles easily by rubbing with fingers
3. Weak – An unfractured specimen of such material will crumble under light hammer blows.
4. Moderately strong – Specimen will withstand a few heavy hammer blows before breaking.
5. Strong – Specimen will withstand a few heavy ringing hammer blows and will yield with difficulty only dust and small lying fragments.
6. very strong – Specimen will resist heavy ringing hammer blows and will yield with difficulty only dust and small flying fragments.

WEATHERING – The physical and chemical disintegration and decomposition of rocks and minerals by natural processes such as oxidation, reduction, hydration, solution, carbonation, freezing, and thawing.

D. Deep – Moderate to complete mineral decomposition; extensive disintegration; deep and thorough discoloration; many fractures, all extensively coated or filled with oxides, carbonates, and/or clay or silt.
M. Moderate – Slight change or partial decomposition of minerals,; little disintegration, cementation–little to unaffected, moderate to occasionally intense discoloration, moderately coated fractures.
L. Little – No megascopic decomposition of minerals, little or no effect on normal cementation, slight and intermittent, or localized discoloration, few stains on fracture surfaces.
F. Fresh – Unaffected by weathering agents. No disintegration or discoloration. Fractures usually less numerous than joints.

KLEINFELDER
9555 CHESAPEAKE DRIVE, SUITE 101
SAN DIEGO, CALIFORNIA 92123

CHECKED BY: REL	FN: A2
PROJECT NO. 51-4659-01	DATE: 2/23/98

PHYSICAL PROPERTIES CRITERIA FOR ROCK/FORMATION DESCRIPTIONS

PARK DRIVE SLOPE / DRAINAGE STUDY
CITY OF CARLSBAD
CARLSBAD, CALIFORNIA

FIGURE
A2

PROJECT NO. 51-4659-01	LOG OF BORING 1	SHEET 1 OF 1
DRILLING EQUIPMENT CME 55 (W/AUTOHAMMER)	PROJECT NAME PARK DRIVE SLOPE STUDY	LOCATION STATION 9+72
TYPE OF BIT 8" HSA	HAMMER DATA: WT. 140 LBS. DROP 30 INCHES	SURFACE ELEVATION 12' / TOTAL DEPTH OF HOLE 16.5'
DATE STARTED: 12-5-97	DRILLING AGENCY SCOTT'S DRILLING	GROUNDWATER ELEVATION 9.0' ATD / DATE 12-5-97
DATE COMPLETED: 12-5-97	LOGGED BY GMB	
DATE BACKFILLED: 12-5-97	SURFACE CONDITIONS 6" AC / 6" GRANULAR BASE	

DEPTH (FEET)	SYMBOL	LOG OF MATERIAL	U.S.C.S.	WELL DETAILS	BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	NOTES
0		6" ASPHALT CONCRETE							
1		OLIVE BROWN SILTY SAND, FINE-GRAINED, MOIST	SM						
2		COLLUVIUM:							
3		FINE TO MEDIUM-GRAINED, MOIST	SC		13				
4		MEDIUM DENSE, BROWN CLAYEY SAND,							
5									
6		VERY DENSE, TRACE GRAVEL							
7					54				
8									
9		▽							
10		MEDIUM DENSE							
11		WET CUTTINGS AT 11 FT.			31	14	121		
12									
13									
14									
15		WET							
16					34				
17		BORING STOPPED AT 16.5 FT.							
18		CAVING OBSERVED AT 9 FT.							
19		FREE WATER OBSERVED AT 9 FT.							
20		BOREHOLE BACKFILLED WITH SOIL CUTTINGS AND CAPPED WITH CONCRETE DYED BLACK							
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

KLEINFELDER
9555 CHESAPEAKE DRIVE, SUITE 101
SAN DIEGO, CALIFORNIA 92123

FIGURE NO.: A3

PROJECT NO. 51-4659-01	LOG OF BORING 2	SHEET 1 OF 1
DRILLING EQUIPMENT CME 55 (W/AUTOHAMMER)	PROJECT NAME PARK DRIVE SLOPE STUDY	LOCATION STATION 10+23
TYPE OF BIT 8" HSA	HAMMER DATA: WT. 140 LBS. DROP 30 INCHES	SURFACE ELEVATION 12.5' / TOTAL DEPTH OF HOLE 11.5'
DATE STARTED: 12-5-97	DRILLING AGENCY SCOTT'S DRILLING	GROUNDWATER ELEVATION 3.0' ATD / DATE 12-5-97
DATE COMPLETED: 12-5-97	LOGGED BY GMB	
DATE BACKFILLED: 12-5-97	SURFACE CONDITIONS 10" AC / 5" BASE	

DEPTH (FEET)	SYMBOL	LOG OF MATERIAL	U.S.C.S.	WELL DETAILS	BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	NOTES
0		10" ASPHALT CONCRETE							
1		OLIVE BROWN SILTY SAND, FINE-GRAINED, MOIST	SM						
2									
3		▽ COLLUVIUM:	SC		26				
4		MEDIUM DENSE, BROWN CLAYEY SAND, FINE TO MEDIUM-GRAINED, MOIST							
5									
6		VERY DENSE, MOIST, (OUTSIDE OF SAMPLER WET)			55	12	122		
7									
8									
9									
10									
11					18				
12		BORING STOPPED AT 11.5 FT. NO CAVING OBSERVED FREE WATER OBSERVED AT 3 FT. ATD BOREHOLE BACKFILLED WITH SOIL CUTTINGS AND CAPPED WITH CONCRETE DYED BLACK							
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

KLEINFELDER
9555 CHESAPEAKE DRIVE, SUITE 101
SAN DIEGO, CALIFORNIA 92123

FIGURE NO.: A4

PROJECT NO. 51-4659-01	LOG OF BORING 3	SHEET 1 OF 1
DRILLING EQUIPMENT CME 55 (W/AUTOHAMMER)	PROJECT NAME PARK DRIVE SLOPE STUDY	LOCATION STATION 11+47
TYPE OF BIT 8" HSA	HAMMER DATA: WT. 140 LBS. DROP 30 INCHES	SURFACE ELEVATION 13' / TOTAL DEPTH OF HOLE 11.5'
DATE: STARTED 12-5-97 / COMPLETED 12-5-97 / BACKFILLED 12-5-97	DRILLING AGENCY SCOTT'S DRILLING / LOGGED BY GMB / SURFACE CONDITIONS 6" AC / 6" BASE	GROUNDWATER ELEVATION _____ DATE _____

DEPTH (FEET)	SYMBOL	LOG OF MATERIAL	U.S.C.S.	WELL DETAILS	BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	NOTES
0		6" ASPHALT CONCRETE							
1		OLIVE BROWN SILTY SAND, FINE-GRAINED, MOIST	SM						
2		COLLUVIUM:			42				
3		MEDIUM DENSE, BROWN CLAYEY SAND, FINE TO MEDIUM-GRAINED, MOIST	SC						
4									
5		VERY DENSE							
6					69				
7									
8									
9									
10		HARD, OLIVE SILTY CLAY, DRY MOIST	CL						
11					81	14	118		
12		BORING STOPPED AT 11.5 FT. NO CAVING OBSERVED NO FREE WATER OBSERVED BOREHOLE BACKFILLED WITH SOIL CUTTINGS AND CAPPED WITH CONCRETE DYED BLACK							
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

FN: 4659LOGS

KLEINFELDER

9555 CHESAPEAKE DRIVE, SUITE 101
SAN DIEGO, CALIFORNIA 92123

FIGURE NO.: A5

PROJECT NO. 51-4659-01	LOG OF BORING 4	SHEET 1 OF 1
DRILLING EQUIPMENT CME 55 (W/AUTOHAMMER)	PROJECT NAME PARK DRIVE SLOPE STUDY	LOCATION STATION 13+10
TYPE OF BIT 8" HSA	HAMMER DATA: WT. 140 LBS. DROP 30 INCHES	SURFACE ELEVATION 13' / TOTAL DEPTH OF HOLE 15'
DATE STARTED: 12-5-97	DRILLING AGENCY SCOTT'S DRILLING	GROUNDWATER ELEVATION _____ DATE _____
DATE COMPLETED: 12-5-97	LOGGED BY GMB	
DATE BACKFILLED: 12-5-97	SURFACE CONDITIONS 6" AC / 6" BASE	

DEPTH (FEET)	SYMBOL	LOG OF MATERIAL	U.S.C.S.	WELL DETAILS	BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	NOTES
0		6" ASPHALT CONCRETE							
1		OLIVE BROWN SILTY SAND, FINE TO MEDIUM-GRAINED, MOIST	SM						
2		LIGHT BROWN CLAYEY SAND, FINE-GRAINED, MOIST	SC		24	13	111		
3									
4		COLLUVIUM: BROWN SILTY CLAY, MOIST	CL						
5									
6					26	13	101		
7									
8		GRAVEL LAYER							
9									
10		SANTIAGO FORMATION: LIGHT BROWN SANDSTONE, POORLY TO MODERATELY CONSOLIDATED, MASSIVE, MODERATELY HARD, WEAK, MODERATELY WEATHERED, MOIST			50/5"	12	116		
11									
12		HARD DRILLING							
13									
14		LAYER OF HARD BROWN CLAYSTONE AT BOTTOM, DRY							
15					50/5"				
16		BORING STOPPED AT 15 FT. NO CAVING OBSERVED NO FREE WATER OBSERVED BOREHOLE BACKFILLED WITH SOIL CUTTINGS AND CAPPED WITH CONCRETE DYED BLACK							
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

PROJECT NO. 51-4659-01	LOG OF BORING 5	SHEET 1 OF 2
DRILLING EQUIPMENT CME 55 (W/AUTOHAMMER)	PROJECT NAME PARK DRIVE SLOPE STUDY	LOCATION DESILTING BASIN
TYPE OF BIT 8" HSA	HAMMER DATA: WT. 140 LBS. DROP 30 INCHES	SURFACE ELEVATION 114' / TOTAL DEPTH OF HOLE 50.5'
DATE: STARTED 12-5-97	DRILLING AGENCY SCOTT'S DRILLING	GROUNDWATER ELEVATION ____ DATE ____
DATE: COMPLETED 12-5-97	LOGGED BY GMB	
DATE: BACKFILLED 12-5-97	SURFACE CONDITIONS GRASS / 3" ROOT ZONE	

DEPTH (FEET)	SYMBOL	LOG OF MATERIAL	U.S.C.S.	WELL DETAILS	BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	NOTES
0		ROOT ZONE / CONCRETE							
1-8		SEDIMENTS / FILL: BROWN SILTY SAND, VERY FINE-GRAINED, MOIST	SM						
5-8		VERY DENSE, MOIST, (OUTSIDE OF SAMPLER WET)			50/3"	11	120		
8-30		SANTIAGO FORMATION: BROWN SANDSTONE, FINE-GRAINED, MODERATELY TO WELL CONSOLIDATED, MASSIVE, WEAKLY CEMENTED, MODERATELY HARD, WEAK, FRESH, MOIST			50/2.5"	12	114		
13		WATER ADDED TO COOL AUGERS							
16		MOTTLING WITH RED-BROWN, YELLOW-BROWN, AND OLIVE			50/3"	12	117		
21		LIGHT OLIVE, MODERATELY CEMENTED WITH WELL CEMENTED FRAGMENTS			50/5.5"	11	119		
25		SLIGHTLY MORE CLAYEY							
26					50/3"	11	121		

KLEINFELDER
9555 CHESAPEAKE DRIVE, SUITE 101
SAN DIEGO, CALIFORNIA 92123

FIGURE NO.: A7

PROJECT NO. 51-4659-01	LOG OF BORING 5	SHEET 2 OF 2
DRILLING EQUIPMENT CME 55 (W/AUTOHAMMER)	PROJECT NAME PARK DRIVE SLOPE STUDY	LOCATION DESILTING BASIN
TYPE OF BIT 8" HSA	HAMMER DATA: WT. 140 LBS. DROP 30 INCHES	SURFACE ELEVATION 114'
TOTAL DEPTH OF HOLE 50.5'		

DATE
STARTED: 12-5-97
COMPLETED: 12-5-97
BACKFILLED: 12-5-97

DRILLING AGENCY SCOTT'S DRILLING
LOGGED BY GMB
SURFACE CONDITIONS GRASS / 3" ROOT ZONE

GROUNDWATER ELEVATION _____ DATE _____

DEPTH (FEET)	SYMBOL	LOG OF MATERIAL	U.S.C.S.	WELL DETAILS	BLOW COUNTS	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SAMPLE TYPE	NOTES
30									
31		"HARD, BROWN TO LIGHT OLIVE SILTY CLAYSTONE, MODERATELY CONSOLIDATED, MASSIVE, LOW HARDNESS, WEAK, LITTLE WEATHERING, DRY			50/5"	17	110		
32									
33									
34									
35									
36					59/6"	8	127		
37		"VERY DENSE, DARK OLIVE SILTY FINE-GRAINED SANDSTONE, MODERATELY TO WELL CONSOLIDATED, MASSIVE, MODERATELY HARD, WEAK, FRESH, MOIST							
38									
39									
40					50/				
41		LESS SILT, GRADATION CHANGE FROM FINE-GRAINED TO MEDIUM-GRAINED			3.5"	5	120		
42									
43									
44									
45									
46					60/6"	4	119		
47									
48									
49		"VERY DENSE, OLIVE-GRAY CLAYEY SANDSTONE, MODERATELY TO WELL CONSOLIDATED, MASSIVE, MODERATELY HARD, WEAK, FRESH, MOIST							
50									
51					70/4"	10	123		
52		BORING STOPPED AT 50.5 FT. NO CAVING OBSERVED NO FREE WATER OBSERVED BOREHOLE BACKFILLED WITH SOIL CUTTINGS							
53									
54									
55									
56									
57									
58									
59									
60									

FN: 4659LOGS

KLEINFELDER

9555 CHESAPEAKE DRIVE, SUITE 101
SAN DIEGO, CALIFORNIA 92123

FIGURE NO.: A8

DYNAMIC CONE SOUNDING 1

DATE PERFORMED: 12-05-97
CREW: G. Binger
CONE AREA: 10 SQ. CM
HAMMER WEIGHT: 35 pounds

SURFACE ELEVATION: 13 ft.
WATER ON COMPLETION: 13' 4"
LOCATION: Sta. 10 + 76

DEPTH FT	DEPTH M	BLOWS PER 10 CM	RESISTANCE KG/CM^2	CONE RESISTANCE 0 50 100 150	N'	TESTED CONSISTENCY SAND	SILT	CLAY
-	-	-	-					
4"	0.1	3	13.3	***	3	VERY LOOSE		
8"	0.2	6	26.6	*****	7	LOOSE		
1'	0.3	30	133.2	**********	-	DENSE		
1'4"	0.4	20	88.8	*******	25	MED. DENSE		
1'8"	0.5	38	168.7	**********	-	DENSE		
2'	0.6	30	133.2	**********	-	DENSE		
2'4"	0.7	31	137.6	**********	-	DENSE		
2'8"	0.8	36	159.8	**********	-	DENSE		
3'	0.9	36	159.8	**********	-	DENSE		
3'4"	1.0	38	168.7	**********	-	DENSE		

Notes:
1. A "-" in the N' column indicates an equivalent SPT N' value greater than 25.
2. The soil was classified in the field as a brown silty SAND (SM) to clayey SAND (SC).
3. Standing water level was approximately 4 inches above the existing ground surface.
4. Effective cone refusal was encountered at approximately 3'4".

KLEINFELDER
9555 CHESAPEAKE DRIVE SUITE 101
SAN DIEGO, CALIFORNIA 92123

PROJECT NO. 51-4659-01
CHECKED BY: CMB DATE: 01-28-98

DYNAMIC CONE SOUNDING LOG

PARK DRIVE SLOPE / DRAINAGE STUDY
CITY OF CARLSBAD
CARLSBAD, CALIFORNIA

FIGURE
A9

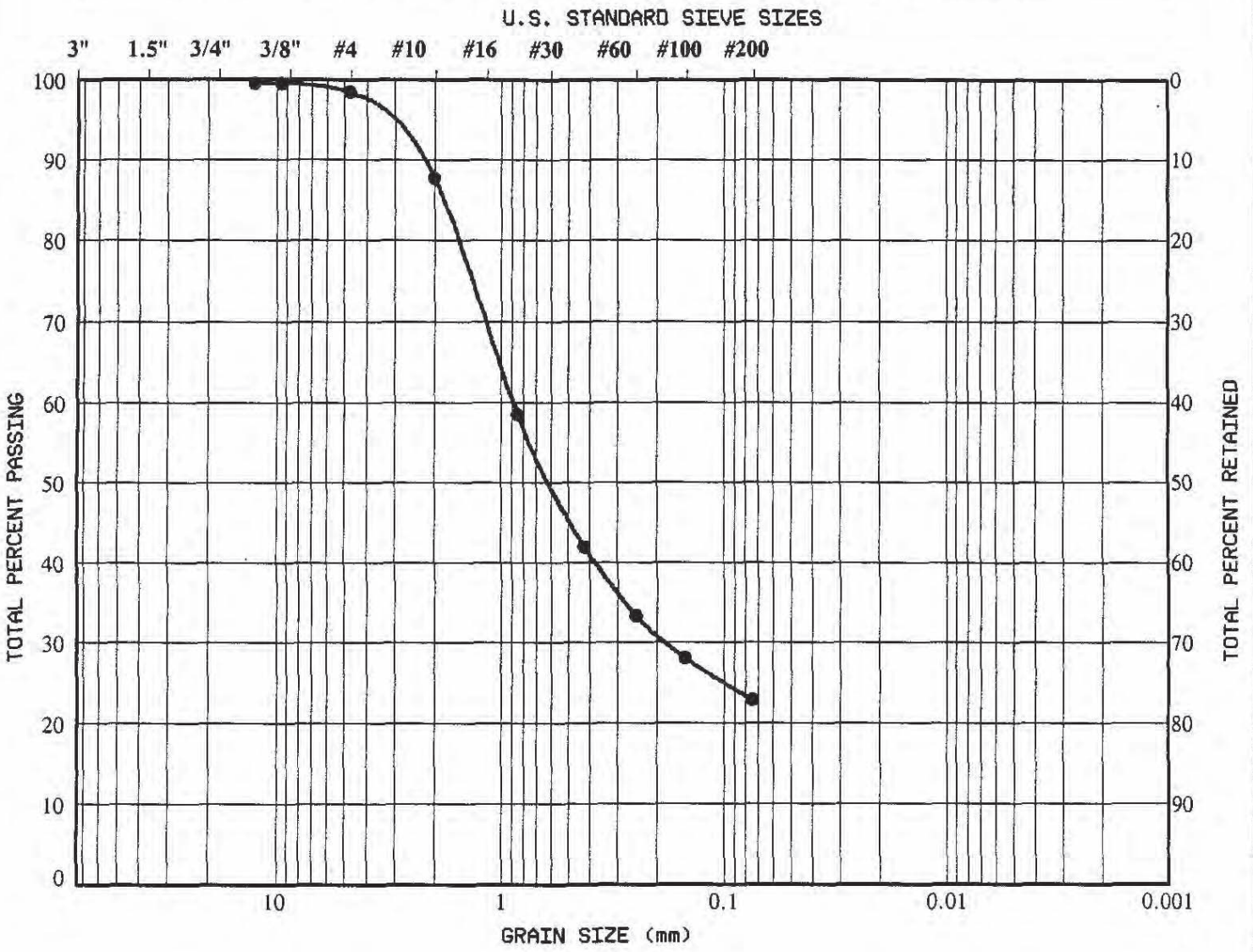
DYNAMIC CONE SOUNDING 2

DATE PERFORMED:	12-05-97	**SURFACE ELEVATION:**	13 ft.
CREW:	G. Binger	**WATER ON COMPLETION:**	13' 4"
CONE AREA:	10 SQ. CM	**LOCATION:**	Sta. 12 + 74
HAMMER WEIGHT:	35 pounds		

DEPTH FT	DEPTH M	BLOWS PER 10 CM	RESISTANCE KG/CM^2	CONE RESISTANCE 0 50 100 150	N'	TESTED CONSISTENCY SAND	SILT	CLAY
-	-	-	-					
4"	0.1	3	13.3	***	3	VERY LOOSE		
8"	0.2	4	17.8	****	5	LOOSE		
1'	0.3	5	22.2	****	6	LOOSE		
1'4"	0.4	6	26.6	*****	7	LOOSE		
1'8"	0.5	7	31.1	******	8	LOOSE		
2'	0.6	7	31.1	******	8	LOOSE		
2'4"	0.7	7	31.1	******	8	LOOSE		
2'8"	0.8	7	31.1	******	8	LOOSE		
3'	0.9	120	532.8	**********	-	VERY DENSE		

Notes:
1. A "-" in the N' column indicates an equivalent SPT N' value greater than 25.
2. The soil was classified in the field as a brown silty SAND (SM) to clayey SAND (SC).
3. Standing water level was approximately 4 inches above the existing ground surface.
4. Effective cone refusal was encountered at approximately 3'4".

SIEVE ANALYSIS	HYDROMETER



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

Symbol	Boring No.	Depth (ft)	Description	Classification
●	3	6.5	Brown clayey SAND	SC

KLEINFELDER

PROJECT NO. 51-4659-01

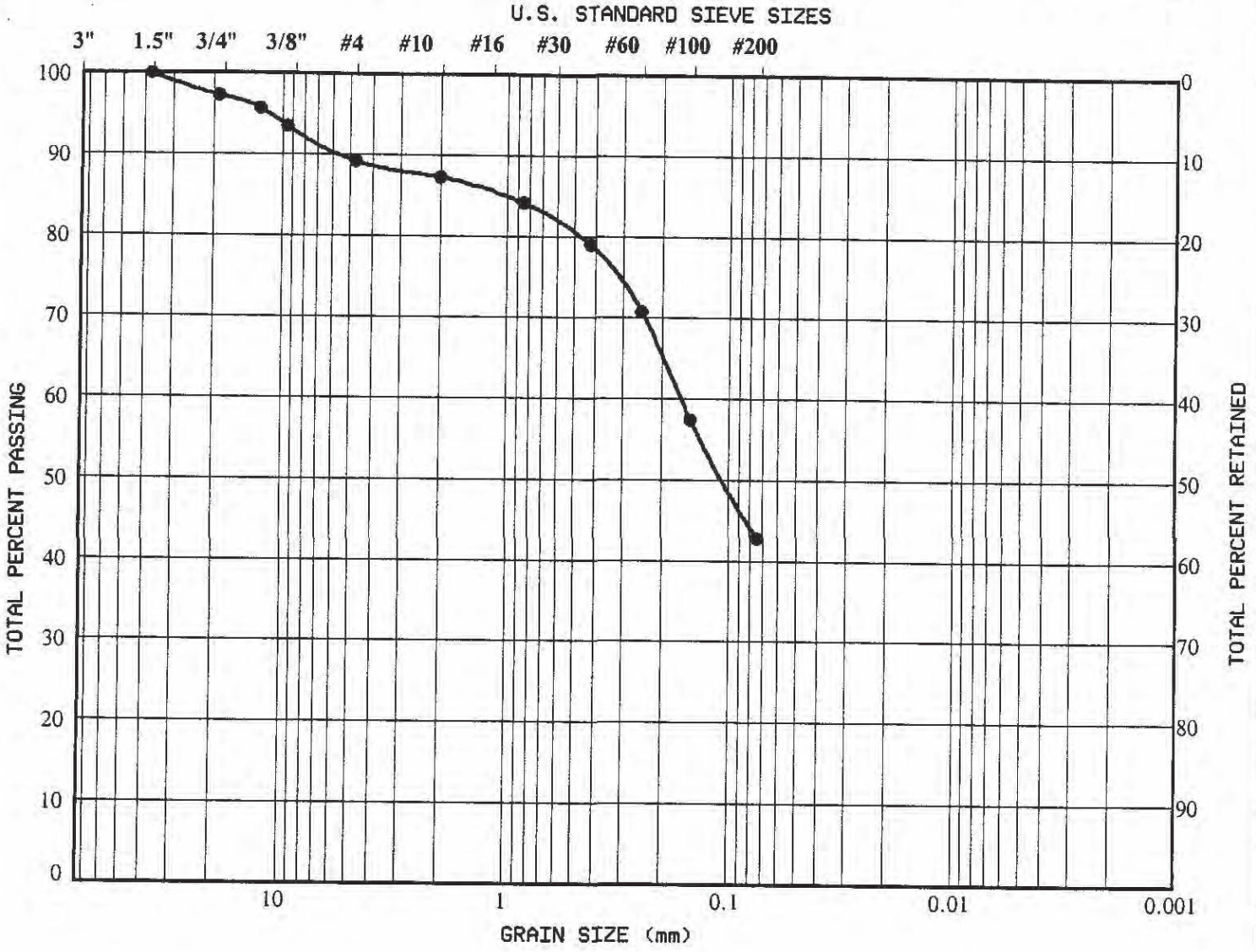
Park Drive Slope/Drainage Study
Carlsbad, California

GRAIN SIZE DISTRIBUTION

FIGURE

B1

SIEVE ANALYSIS	HYDROMETER



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

Symbol	Boring No.	Depth (ft)	Description
●	5	20.5	Light olive SANDSTONE

KLEINFELDER

PROJECT NO. 51-4659-01

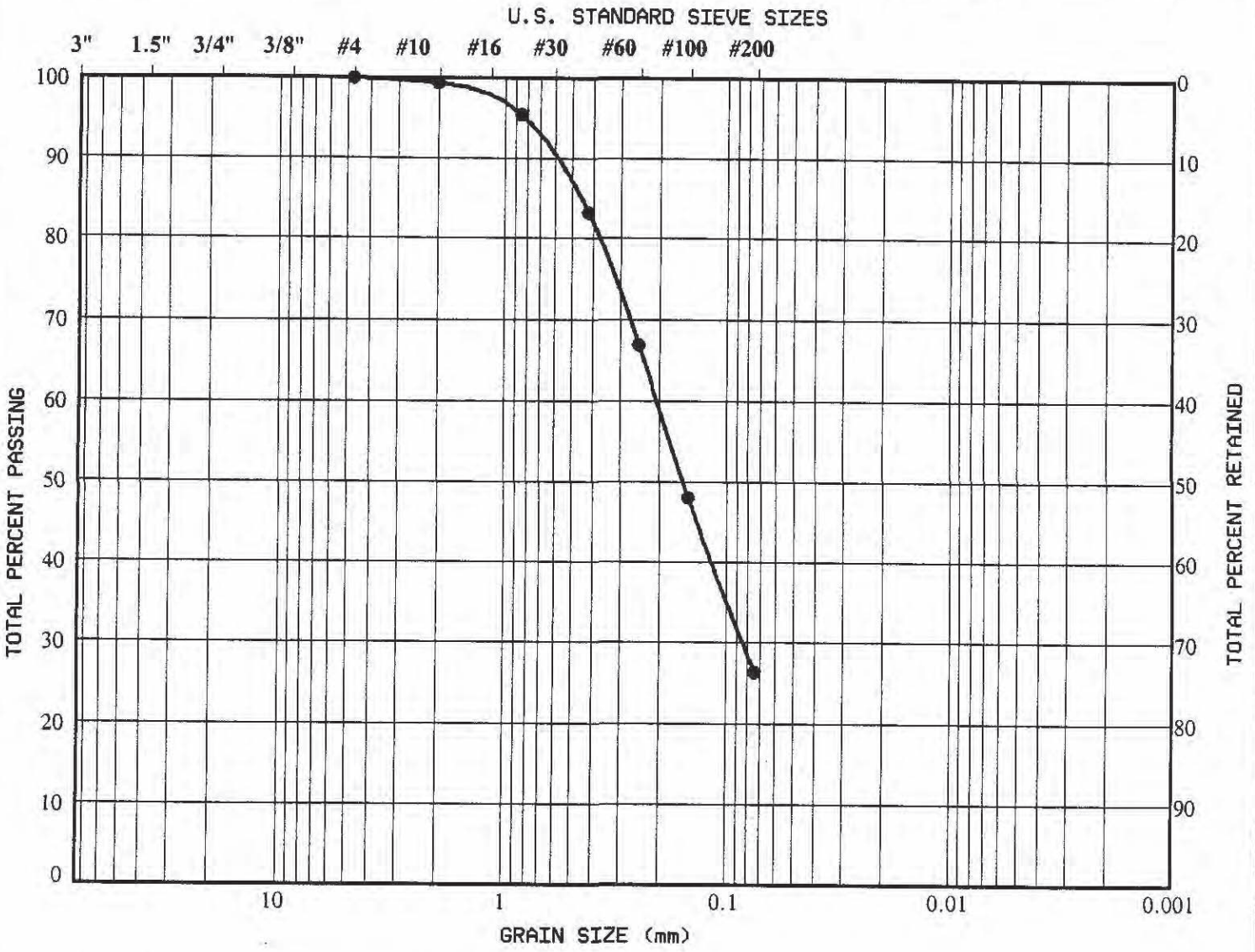
Park Drive Slope/Drainage Study
Carlsbad, California

GRAIN SIZE DISTRIBUTION

FIGURE

B2

SIEVE ANALYSIS	HYDROMETER



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

Symbol	Boring No.	Depth (ft)	Description
●	5	30.5	Light olive SANDSTONE

KLEINFELDER

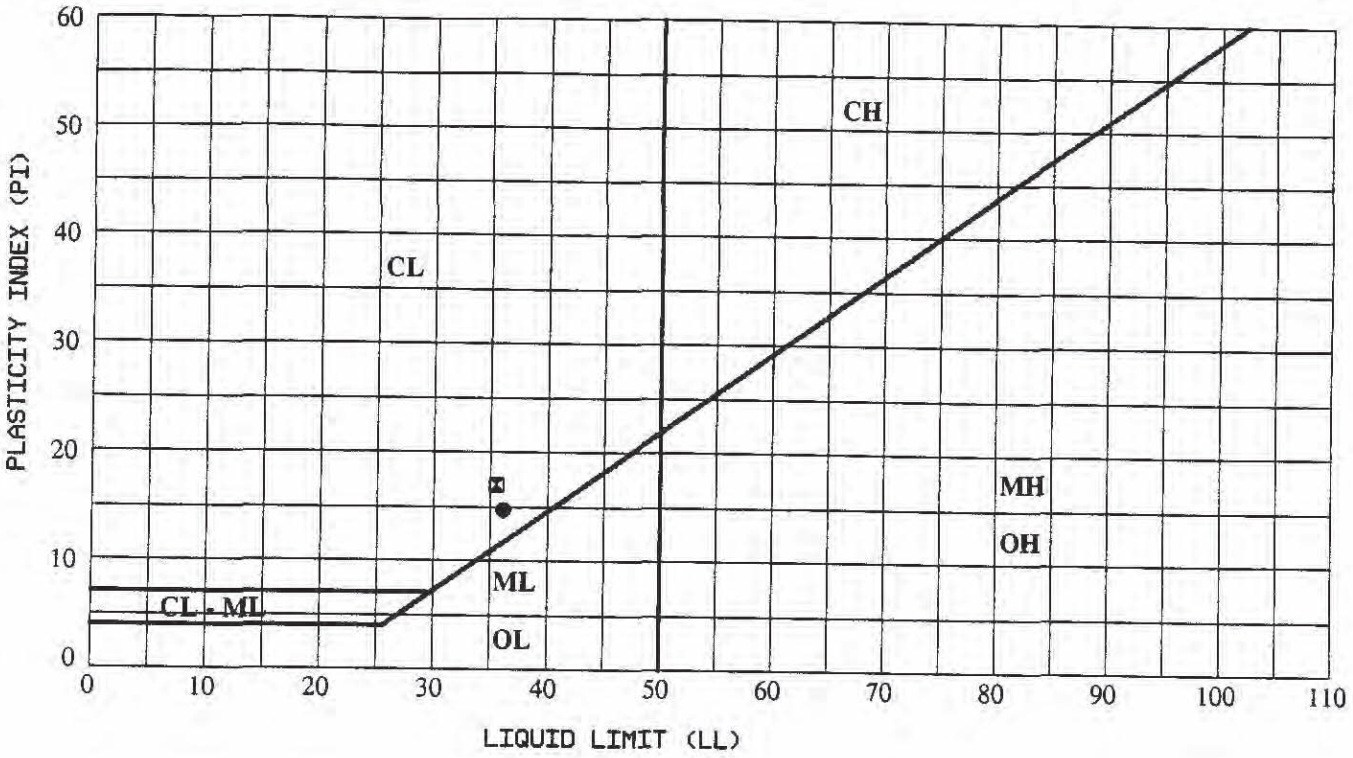
PROJECT NO. 51-4659-01

Park Drive Slope/Drainage Study
Carlsbad, California

GRAIN SIZE DISTRIBUTION

FIGURE

B3



	Boring	Depth (ft)	LL (%)	PL (%)	PI (%)	LI (-)	Description
●	4	6.5	36	21	15		Brown silty CLAY
⊠	5	30.5	36	19	17		Light olive SANDSTONE

LL - Liquid Limit
PL - Plasticity Limit
NP - Nonplastic

PI - Plasticity Index
LI - Liquidity Index

Unified Soil Classification
Fine Grained Soil Groups

	LL < 50
ML	Inorganic clayey silts to very fine sands of slight plasticity
CL	Inorganic clays of low to medium plasticity
OL	Organic silts and organic silty clays of low plasticity

	LL > 50
MH	Inorganic silts and clayey silts of high plasticity
CH	Inorganic clays of high plasticity
OH	Organic clays of medium to high plasticity, organic silts

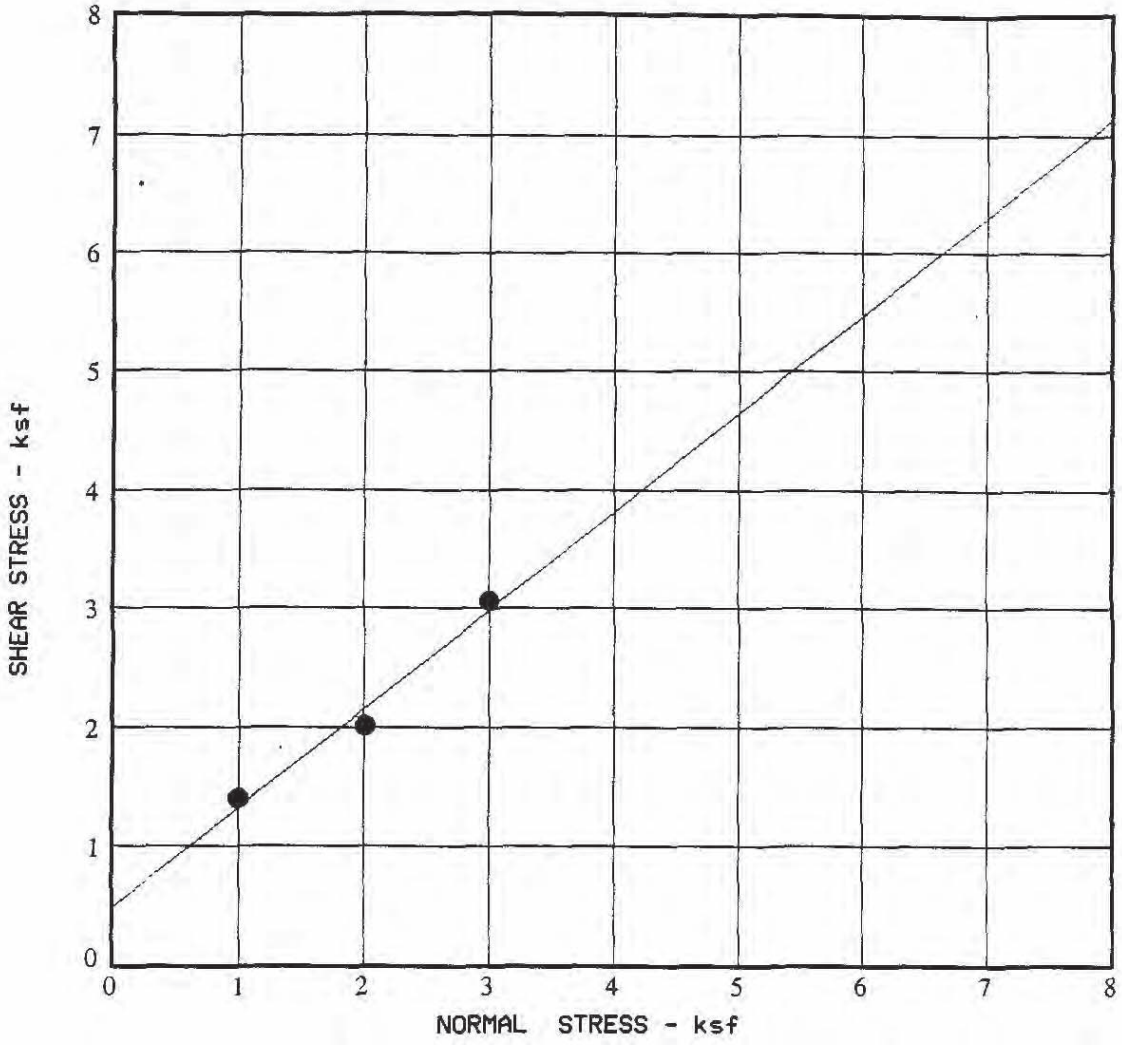
KLEINFELDER

PROJECT NO. 51-4659-01

Park Drive Slope/Drainage Study
Carlsbad, California

PLASTICITY CHART

FIGURE
B4



Dry Density - pcf	118	114	116
Initial Water Content - %	12	12	12
Final Water Content - %	19	18	17
Normal Stress - ksf	1.00	2.00	3.00
Maximum Shear - ksf	1.40	2.01	3.06

Boring No.	4
Depth - ft	11.0
Friction Angle - deg	40
Cohesion - ksf	0.50
Description	Light brown SANDSTONE

KLEINFELDER

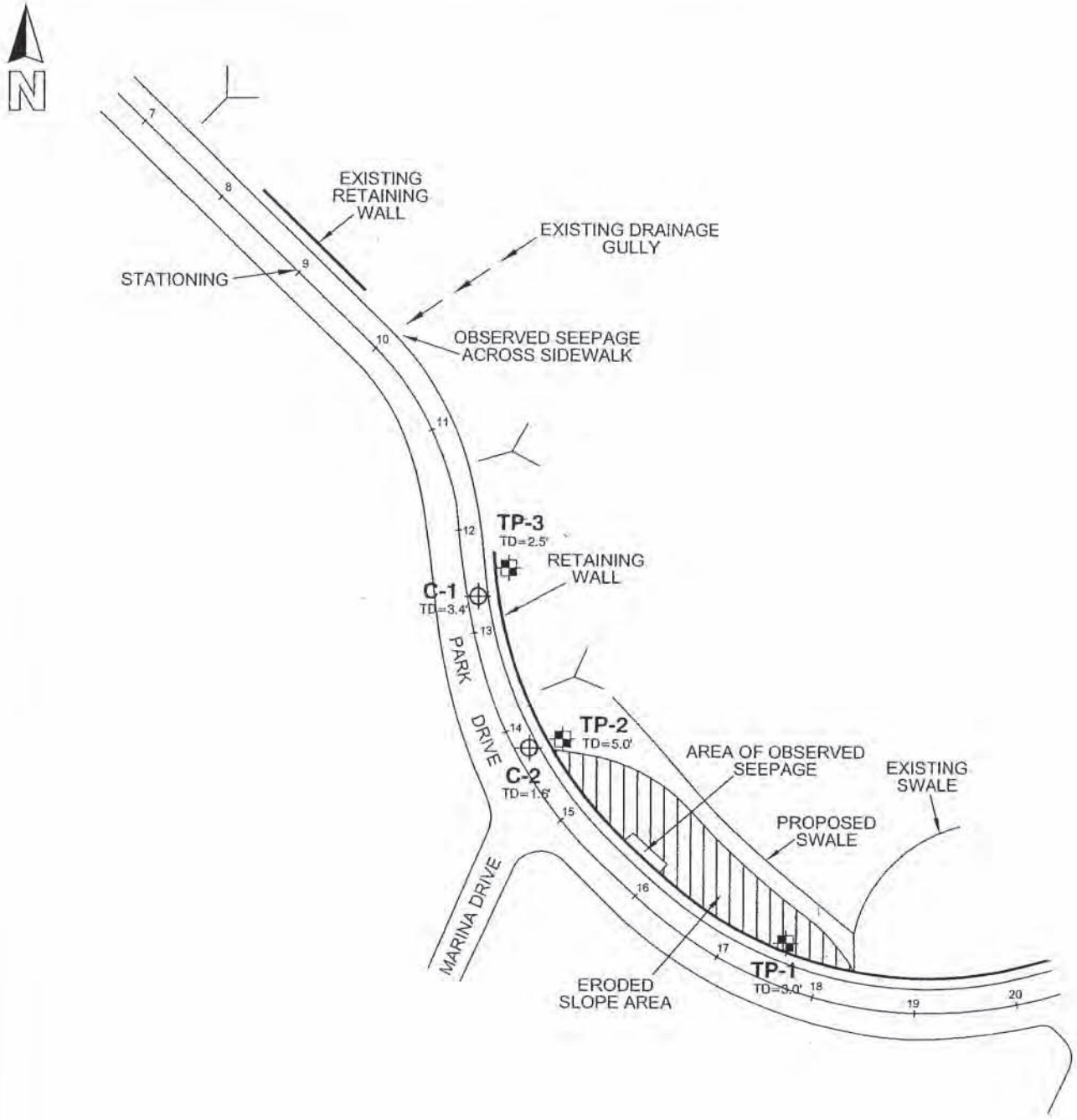
PROJECT NO. 51-4659-01

Park Drive Slope/Drainage Study
Carlsbad, California

DIRECT SHEAR TEST

FIGURE

B5



LEGEND	
TP-3 TD=2.5'	APPROXIMATE LOCATION OF EXPLORATORY TEST PIT TD=TOTAL DEPTH IN FEET
C-2 TD=1.6'	APPROXIMATE LOCATION OF PAVEMENT CORE

APPROXIMATE SCALE

0 150 300 FEET

NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE

Ninyo & Moore		SITE PLAN	FIGURE
PROJECT NO.	DATE	DRAINAGE, RETAINING WALL, AND PAVEMENT IMPROVEMENTS PARK DRIVE AT MARINA DRIVE CARLSBAD, CALIFORNIA	2
106394001	9/08		

APPENDIX A

TEST PIT AND CORE LOGS

Field Procedure for the Collection of Disturbed Samples

Disturbed soil samples were obtained in the field using the following method.

Bulk Samples

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

Field Procedure for the Collection of Relatively Undisturbed Samples

Relatively undisturbed soil samples were obtained in the field using the following method.

The Modified Split-Barrel Drive Sampler

The sampler, with an external diameter of 3.0 inches, was lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with the weight of a hammer. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

Ninyo & Moore

TEST PIT LOG

DRAINAGE, RETAINING WALL, AND PAVEMENT IMPROVEMENTS
PARK DRIVE AT MARINA DRIVE, CARLSBAD CALIFORNIA

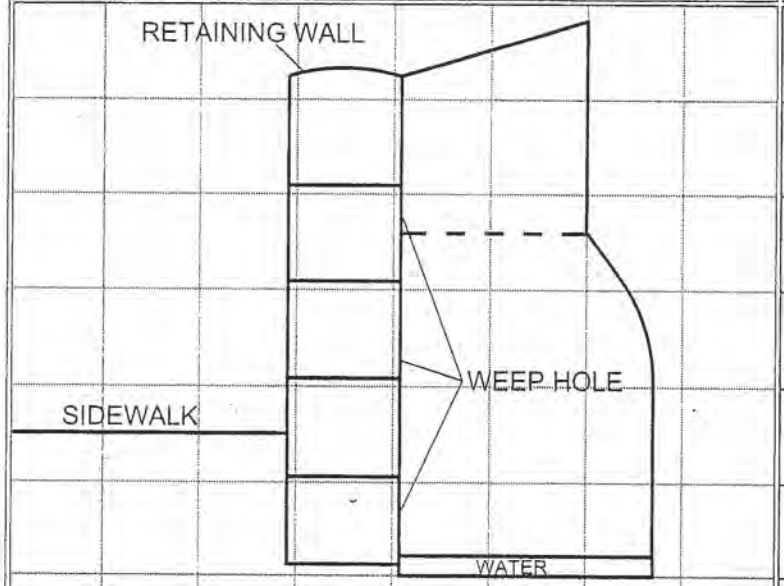
PROJECT NO.	DATE
106394001	9/08

DATE EXCAVATED 8/13/08 TEST PIT NO. TP-1

GROUND ELEVATION 23' ± (MSL) LOGGED BY MJB

METHOD OF EXCAVATION Manual

LOCATION Behind retaining wall, northern end



DEPTH (FEET)	SAMPLES: Bulk	SAMPLES: Driven	SAMPLES: Sand Cone	MOISTURE (%)	DRY DENSITY (PCF)	CLASSIFICATION U.S.C.S.	DESCRIPTION
0						SM	FILL: Light brown to brown, moist, loose to medium dense, silty, fine to medium SAND; little fine to coarse gravel; some roots.
1							Abundant roots.
						GP	White, dark blue, gray, brown, and red mottled, moist, loose, poorly graded GRAVEL.
2							
				▽			(Retaining wall footing at 3 feet.)
3							Total Depth = 3 feet. Groundwater was measured at a depth of approximately 2.8 feet in the test pit during excavation. Backfilled on 8/13/08.
4							
5							
6							

SCALE = 1 in./1 ft.

FIGURE 1

Ninyo & Moore

TEST PIT LOG

DRAINAGE, RETAINING WALL, AND PAVEMENT IMPROVEMENTS
PARK DRIVE AT MARINA DRIVE, CARLSBAD CALIFORNIA

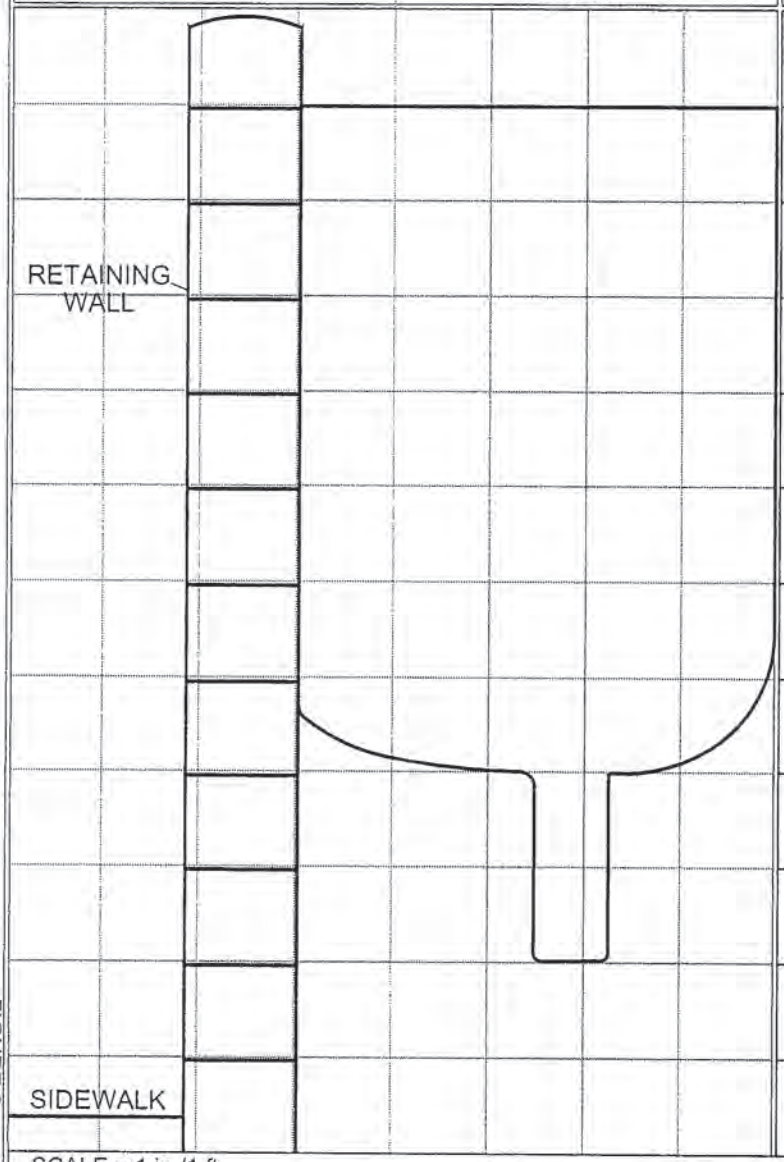
PROJECT NO.	DATE
106394001	9/08

DATE EXCAVATED 8/14/08 TEST PIT NO. TP-2

GROUND ELEVATION 26'± (MSL) LOGGED BY MJB

METHOD OF EXCAVATION Manual

LOCATION Behind retaining wall at Park Drive and Marina Drive



DEPTH (FEET)	SAMPLES: Bulk	SAMPLES: Driven	SAMPLES: Sand Cone	MOISTURE (%)	DRY DENSITY (PCF)	CLASSIFICATION U.S.C.S.	DESCRIPTION
0						SM	FILL: Pale yellowish brown, damp, loose to medium dense, silty, fine to medium SAND; trace clay; little fine to coarse gravel; some roots.
1							
2	■						Abundant roots.
3							Medium dense; clayey; silty; fine to medium sand.
4		■	■				
5		■	■				Total Depth = 5 feet. Groundwater not encountered. Backfilled on 8/14/08.
6							

SCALE = 1 in./1 ft.

FIGURE 2

Ninyo & Moore

TEST PIT LOG

DRAINAGE, RETAINING WALL, AND PAVEMENT IMPROVEMENTS
PARK DRIVE AT MARINA DRIVE, CARLSBAD CALIFORNIA

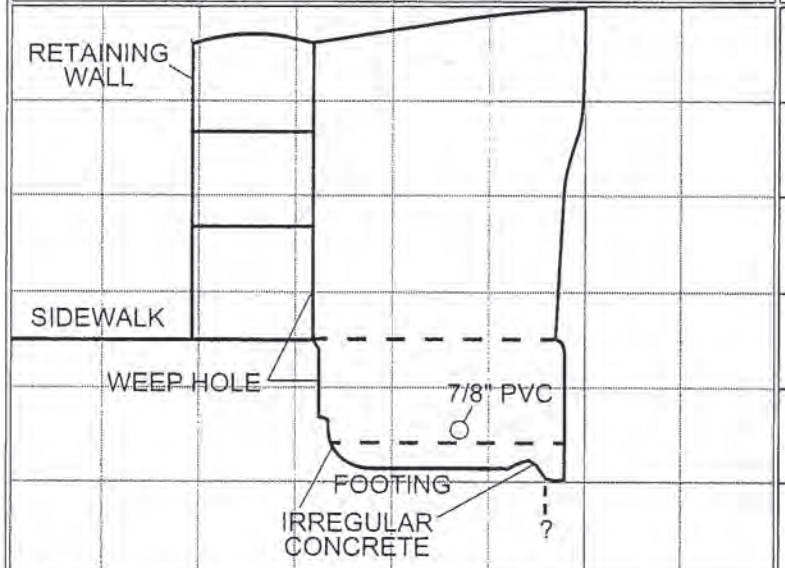
PROJECT NO.	DATE
106394001	9/08

DATE EXCAVATED 8/14/08 TEST PIT NO. TP-3

GROUND ELEVATION 26'± (MSL) LOGGED BY MJB

METHOD OF EXCAVATION Manual

LOCATION Behind retaining wall, southern end



DEPTH (FEET)	SAMPLES: Bulk	SAMPLES: Driven	SAMPLES: Sand Cone	MOISTURE (%)	DRY DENSITY (PCF)	CLASSIFICATION U.S.C.S.	DESCRIPTION
0	■					CL+SM	FILL: Gray to tan, dry to damp, loose to medium dense, silty, fine to medium SAND; contains 1/4-inch to 1/2-inch layers of dark gray, damp, stiff to very stiff CLAY; some roots.
1	■						Dark gray and tan; damp; medium dense; clayey; silty; fine to medium sand.
2	■					GP	Tan and gray, damp, loose, fine sandy, silty, poorly graded, fine GRAVEL.
						SM	Tan and dark gray with iron oxide staining, damp, medium dense, clayey, silty SAND. (Retaining wall footing at 2.5 feet.)
3							Total Depth = 2.5 feet. Groundwater not encountered. Backfilled on 8/14/08.
4							
5							
6							

SCALE = 1 in./1 ft.

FIGURE 3

Ninyo & Moore

CORE LOG

DRAINAGE, RETAINING WALL, AND PAVEMENT IMPROVEMENTS
PARK DRIVE AT MARINA DRIVE, CARLSBAD CALIFORNIA

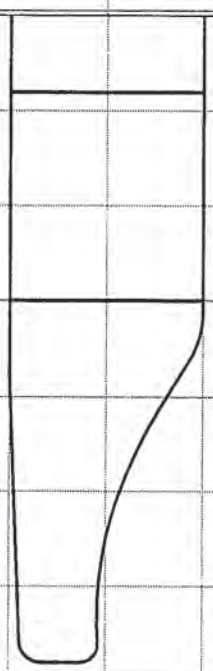
PROJECT NO.	DATE
106394001	9/08

DATE EXCAVATED 8/13/08 TEST PIT NO. C-1

GROUND ELEVATION 20' ± (MSL) LOGGED BY MJB

METHOD OF EXCAVATION 6" Core/Manual

LOCATION Northeast side of Park Drive (northern core)



DEPTH (FEET)	SAMPLES: Bulk	SAMPLES: Driven	SAMPLES: Sand Cone	MOISTURE (%)	DRY DENSITY (PCF)	CLASSIFICATION U.S.C.S.	DESCRIPTION
0							ASHALT CONCRETE: Approximately 5 inches thick.
1						GP+SP	BASE: Dark yellowish and grayish brown, moist to wet, loose, fine to coarse GRAVEL and medium SAND; micaceous; fewer fines in upper 5 inches.
2						ML	FILL: Light brown to brown, damp to moist, loose to medium dense, gravelly, sandy SILT; trace of clay. Light brown to tan; damp; medium dense; clayey silt; trace of sand and gravel.
3							
4							Total Depth = 3.4 feet. Groundwater not encountered. Backfilled and patched with concrete on 8/13/08.
5							
6							

SCALE = 1 in./1 ft.

FIGURE 4

Ninyo & Moore

CORE LOG

DRAINAGE, RETAINING WALL, AND PAVEMENT IMPROVEMENTS
PARK DRIVE AT MARINA DRIVE, CARLSBAD CALIFORNIA

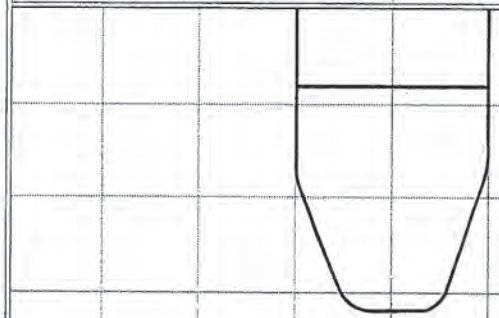
PROJECT NO.	DATE
106394001	9/08

DATE EXCAVATED 8/13/08 TEST PIT NO. C-2

GROUND ELEVATION 20'± (MSL) LOGGED BY MJB

METHOD OF EXCAVATION 6" Core/Manual

LOCATION Northeast side of Park Drive (southern core)



SCALE = 1 in./1 ft.

DEPTH (FEET)	SAMPLES: Bulk	SAMPLES: Driven	SAMPLES: Sand Cone	MOISTURE (%)	DRY DENSITY (PCF)	CLASSIFICATION U.S.C.S.	DESCRIPTION
0							ASHALT CONCRETE: Approximately 4 1/4 inches thick.
1						GP+CL	BASE: Light brown and light grayish brown, wet, loose, fine to coarse GRAVEL and silty, fine to medium sandy CLAY. Refusal on cobble.
2							Total Depth = 1.6 feet. Groundwater not encountered. Backfilled and patched with concrete on 8/13/08.
3							
4							
5							
6							

FIGURE 5

APPENDIX B

LABORATORY TESTING

Classification

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

Gradation Analysis

Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D 422. The grain-size distribution curves are shown on Figures B-1 and B-2. These test results were utilized in evaluating the soil classifications in accordance with the USCS.

Direct Shear Test

A direct shear test was performed on a relatively undisturbed sample in general accordance with ASTM D 3080 to evaluate the shear strength characteristics of selected materials. The sample was inundated during shearing to represent adverse field conditions. The results are shown on Figure B-3.

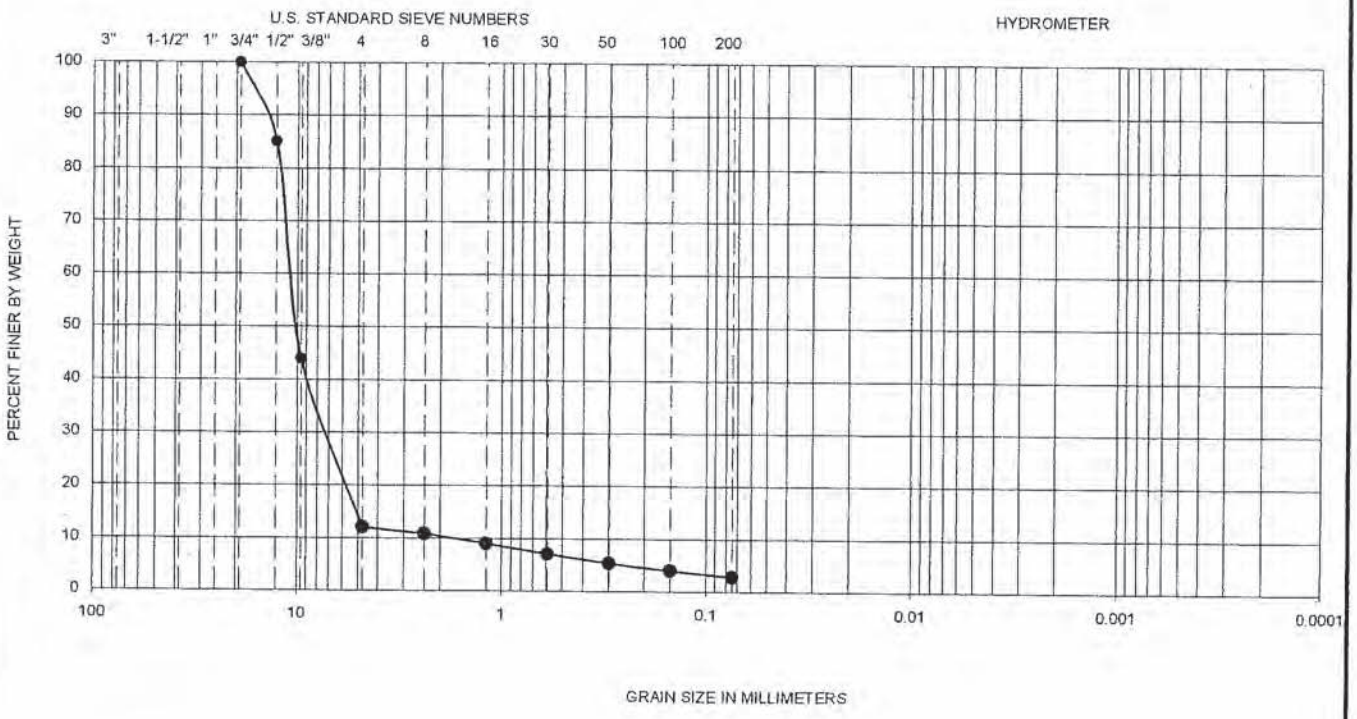
Soil Corrosivity Tests

Soil pH, and resistivity tests were performed on a representative sample in general accordance with CT 643. The soluble sulfate and chloride contents of the selected sample were evaluated in general accordance with CT 417 and CT 422, respectively. The test results are presented on Figure B-4.

R-Value

The resistance value, or R-value, for site soils was evaluated in general accordance with CT 301. A sample was prepared and evaluated for exudation pressure and expansion pressure. The equilibrium R-value is reported as the lesser or more conservative of the two calculated results. The test results are shown on Figure B-5.

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay



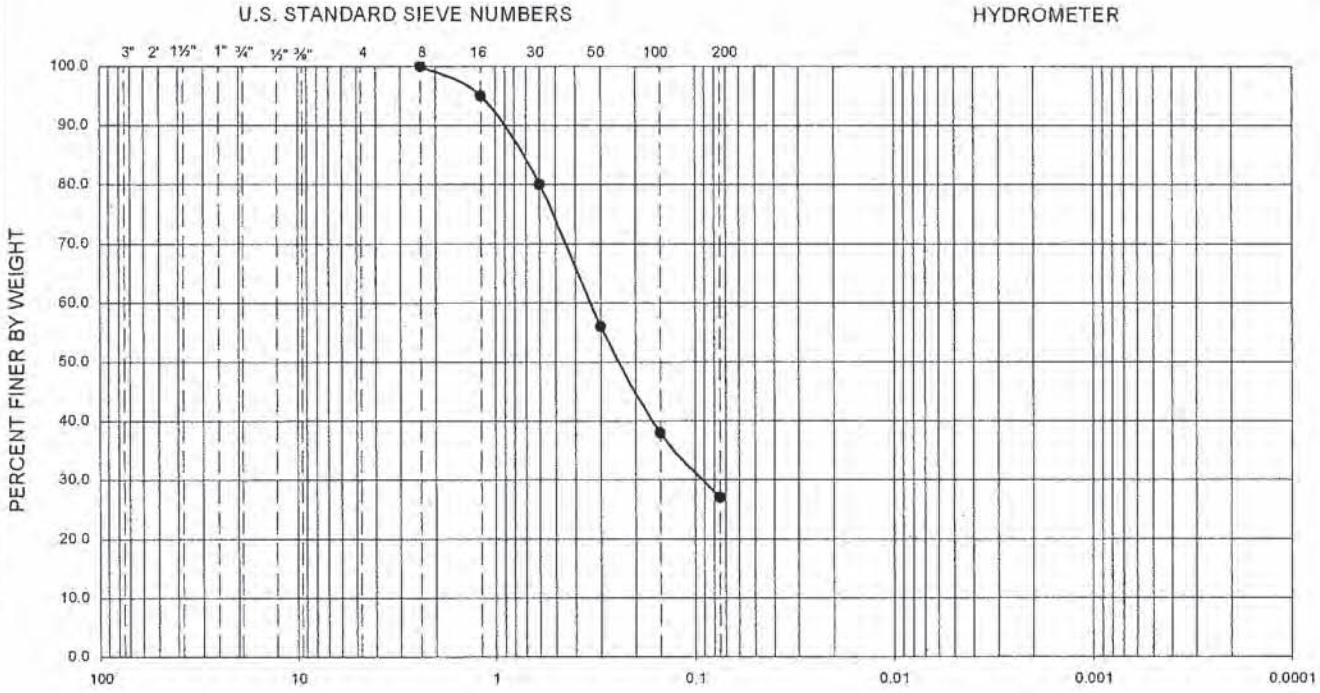
Symbol	Hole No.	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	U.S.C.S
●	TP-1	1.5-2.0	--	--	--	1.80	7.80	10.30	5.7	3.3	3	GP

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422-63 (02)

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	DRAINAGE, RETAINING WALL, AND PAVEMENT IMPROVEMENTS PARK DRIVE AT MARINA DRIVE CARLSBAD, CALIFORNIA	B-1
106394001 / 9/08		

106394001 SIEVE TP-1 @ 1.5-2.0.xls

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

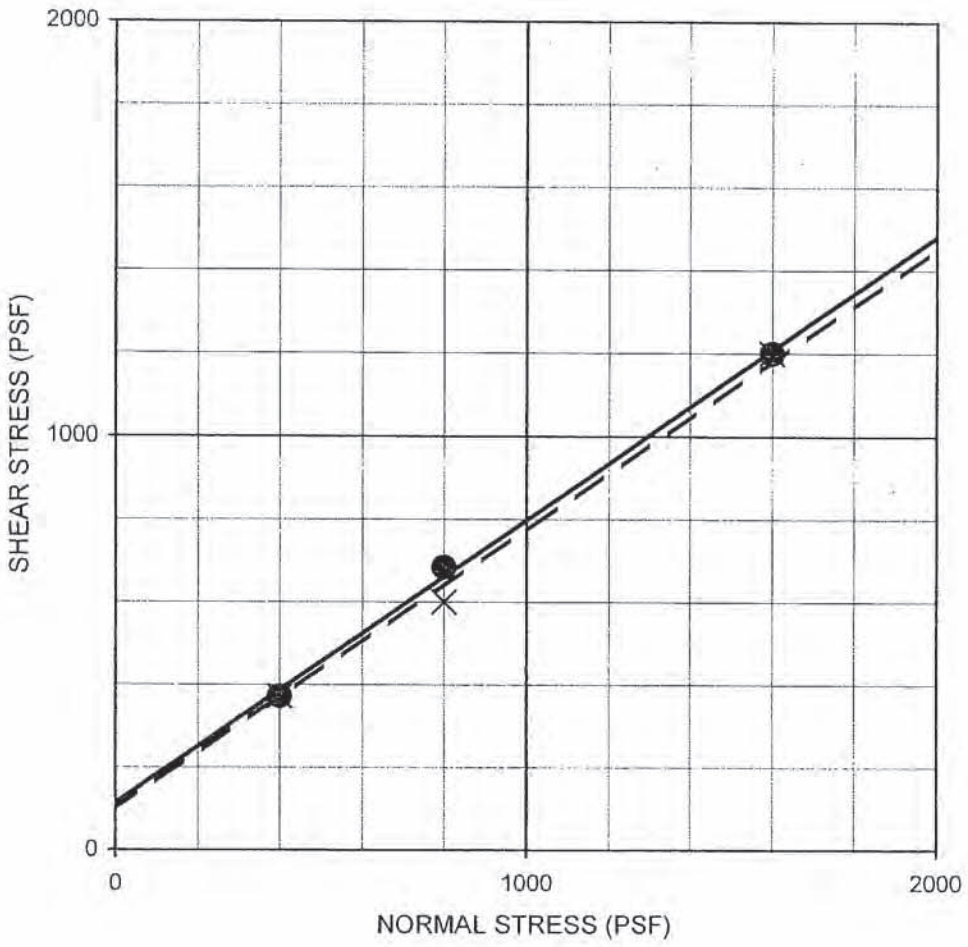


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	TP-3	0.0-0.5	--	--	--	--	--	--	--	--	27	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422-63 (02)

Ninyo & Moore		GRADATION TEST RESULTS	FIGURE
PROJECT NO.	DATE	DRAINAGE, RETAINING WALL, AND PAVEMENTS IMPROVEMENTS PARK DRIVE AT MARINA DRIVE CARLSBAD, CALIFORNIA	B-2
106394001	9/08		

106394001 SIEVE TP-3 @ 0.0-0.5.xls



Description	Symbol	Sample Location	Depth (ft)	Shear Strength	Cohesion, c (psf)	Friction Angle, ϕ (degrees)	Soil Type
Silty SAND	—●—	TP-2	4.0-5.0	Peak	110	34	SM
Silty SAND	- - X - -	TP-2	4.0-5.0	Ultimate	100	34	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080-04

Ninyo & Moore		DIRECT SHEAR TEST RESULTS	FIGURE
PROJECT NO.	DATE	DRAINAGE, RETAINING WALL, AND PAVEMENT IMPROVEMENTS PARK DRIVE AT MARINA DRIVE CARLSBAD, CALIFORNIA	B-3
106394001	9/08		

SAMPLE LOCATION	SAMPLE DEPTH (FT)	pH [1]	RESISTIVITY [1] (Ohm-cm)	SULFATE CONTENT [2]		CHLORIDE CONTENT [3] (ppm)
				(ppm)	(%)	
TP-3	1.0-1.5	7.0	1,210	1620	0.162	165

[1] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 643
[2] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 417
[3] PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 422

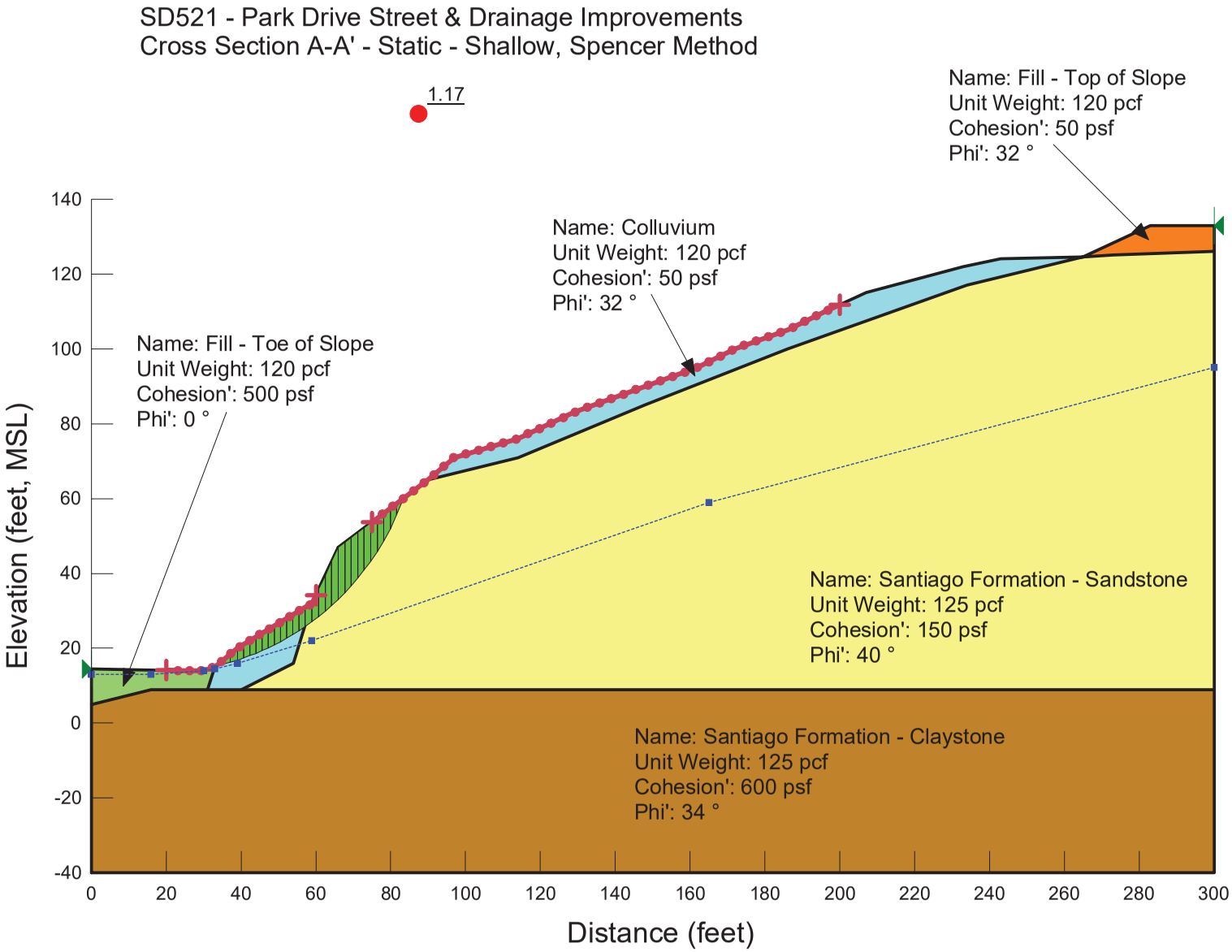
Ninyo & Moore		CORROSIVITY TEST RESULTS	FIGURE
PROJECT NO.	DATE	DRAINAGE, RETAINING WALL, AND PAVEMENT IMPROVEMENTS PARK DRIVE AT MARINA DRIVE CARLSBAD, CALIFORNIA	B-4
106394001	9/08		

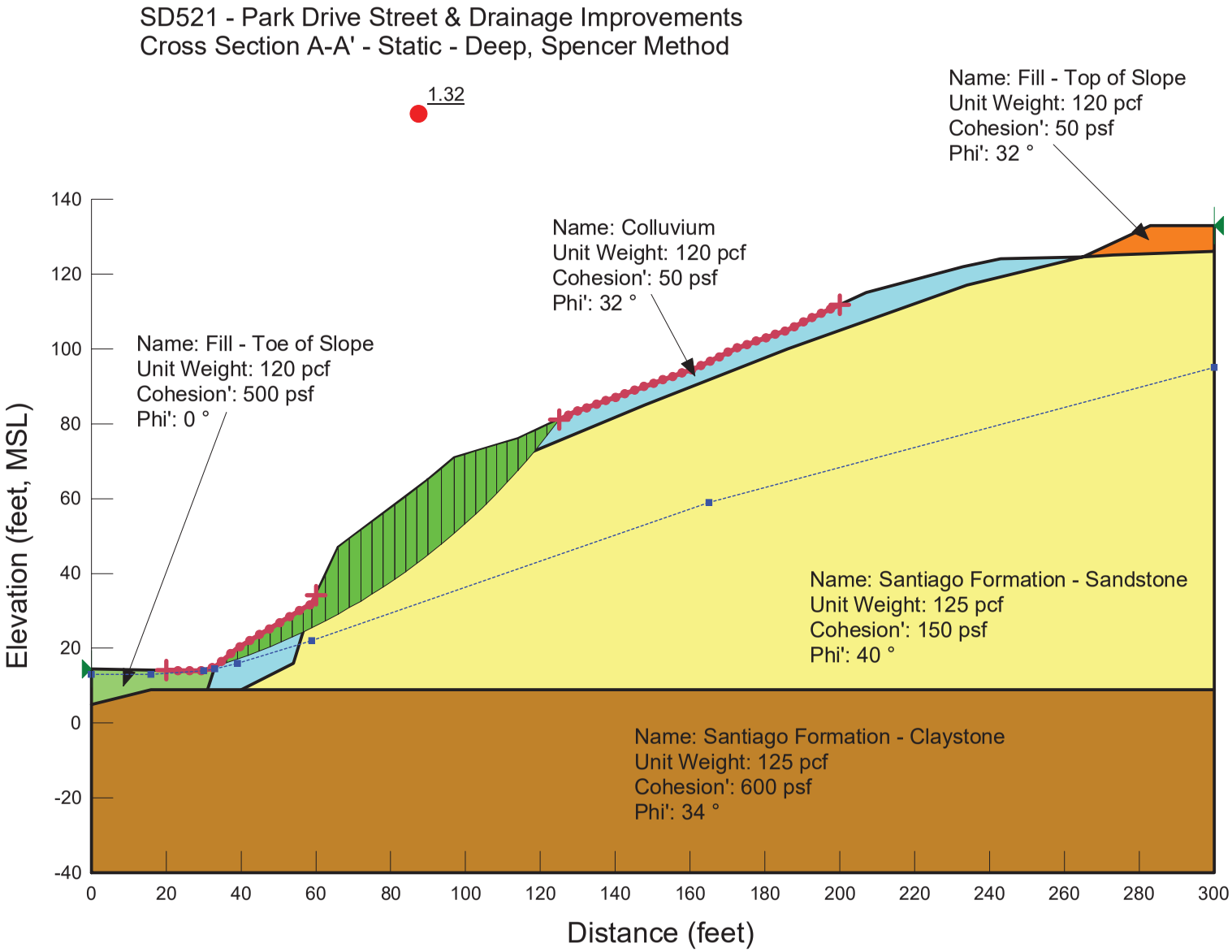
SAMPLE LOCATION	SAMPLE DEPTH (FT)	SOIL TYPE	R-VALUE
C-1	1.5-3.4	ML	16

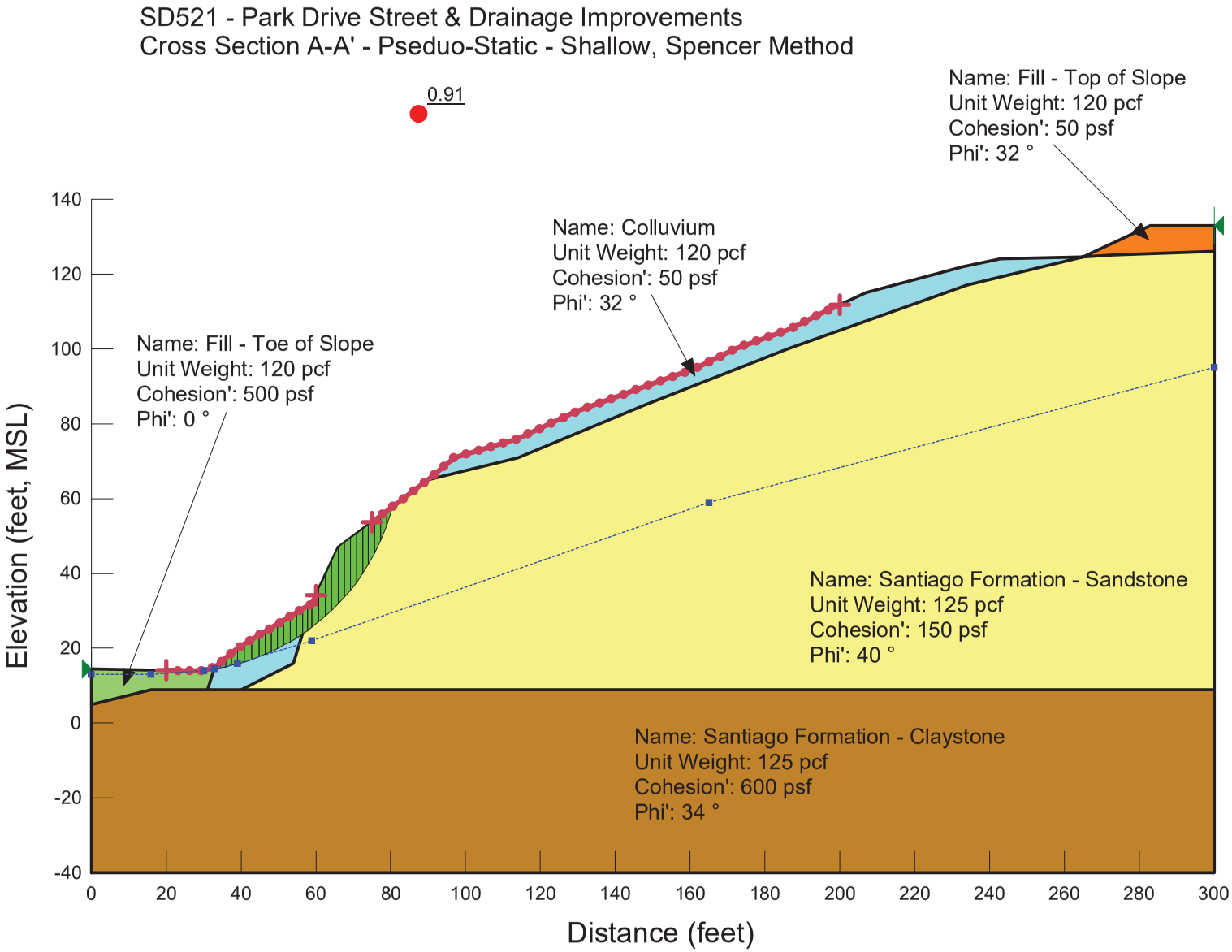
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2844-01/CT 301

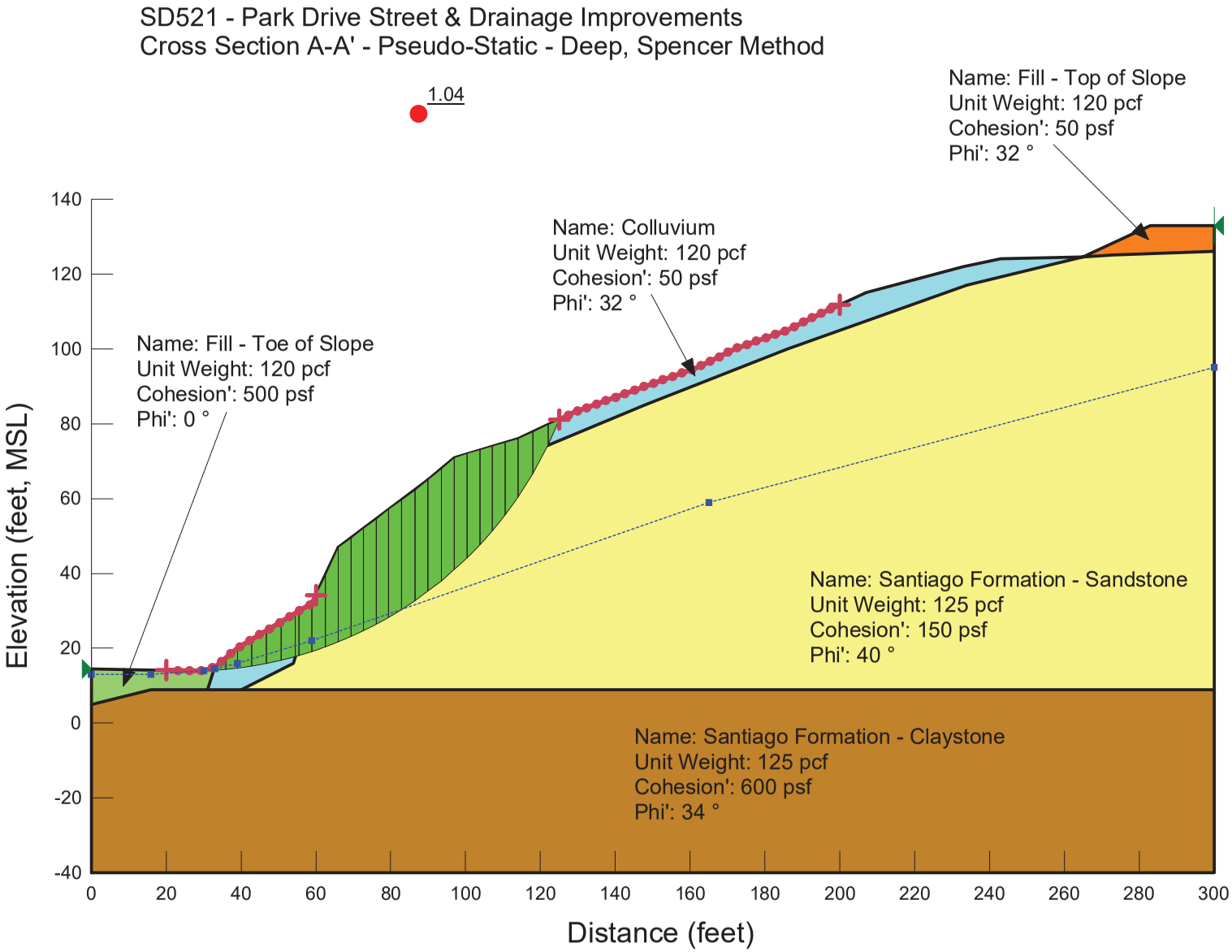
Ninyo & Moore		R-VALUE TEST RESULTS	FIGURE
PROJECT NO.	DATE	DRAINAGE, RETAINING WALL, AND PAVEMENT IMPROVEMENTS PARK DRIVE AT MARINA DRIVE CARLSBAD, CALIFORNIA	B-5
106394001	9/08		

ATTACHMENT E
REPRESENTATIVE SLOPE STABILITY CALCULATIONS


SD521 - Park Drive Street & Drainage Improvements
Cross Section A-A' - Static - Shallow, Spencer Method
1.17
Name: Fill - Top of Slope
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 32 °
Name: Colluvium
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 32 °
Name: Fill - Toe of Slope
Unit Weight: 120 pcf
Cohesion': 500 psf
Phi': 0 °
Name: Santiago Formation - Sandstone
Unit Weight: 125 pcf
Cohesion': 150 psf
Phi': 40 °
Name: Santiago Formation - Claystone
Unit Weight: 125 pcf
Cohesion': 600 psf
Phi': 34 °
Elevation (feet, MSL)
140
120
100
80
60
40
20
0
-20
-40
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
Distance (feet)


SD521 - Park Drive Street & Drainage Improvements
Cross Section A-A' - Static - Deep, Spencer Method
1.32
Name: Fill - Top of Slope
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 32 °
Name: Colluvium
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 32 °
Name: Fill - Toe of Slope
Unit Weight: 120 pcf
Cohesion': 500 psf
Phi': 0 °
Name: Santiago Formation - Sandstone
Unit Weight: 125 pcf
Cohesion': 150 psf
Phi': 40 °
Name: Santiago Formation - Claystone
Unit Weight: 125 pcf
Cohesion': 600 psf
Phi': 34 °
Elevation (feet, MSL)
140
120
100
80
60
40
20
0
-20
-40
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
Distance (feet)


SD521 - Park Drive Street & Drainage Improvements
Cross Section A-A' - Pseduo-Static - Shallow, Spencer Method
0.91
Name: Fill - Top of Slope
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 32 °
Name: Colluvium
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 32 °
Name: Fill - Toe of Slope
Unit Weight: 120 pcf
Cohesion': 500 psf
Phi': 0 °
Name: Santiago Formation - Sandstone
Unit Weight: 125 pcf
Cohesion': 150 psf
Phi': 40 °
Name: Santiago Formation - Claystone
Unit Weight: 125 pcf
Cohesion': 600 psf
Phi': 34 °
Elevation (feet, MSL)
140
120
100
80
60
40
20
0
-20
-40
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
Distance (feet)


SD521 - Park Drive Street & Drainage Improvements
Cross Section A-A' - Pseudo-Static - Deep, Spencer Method
1.04
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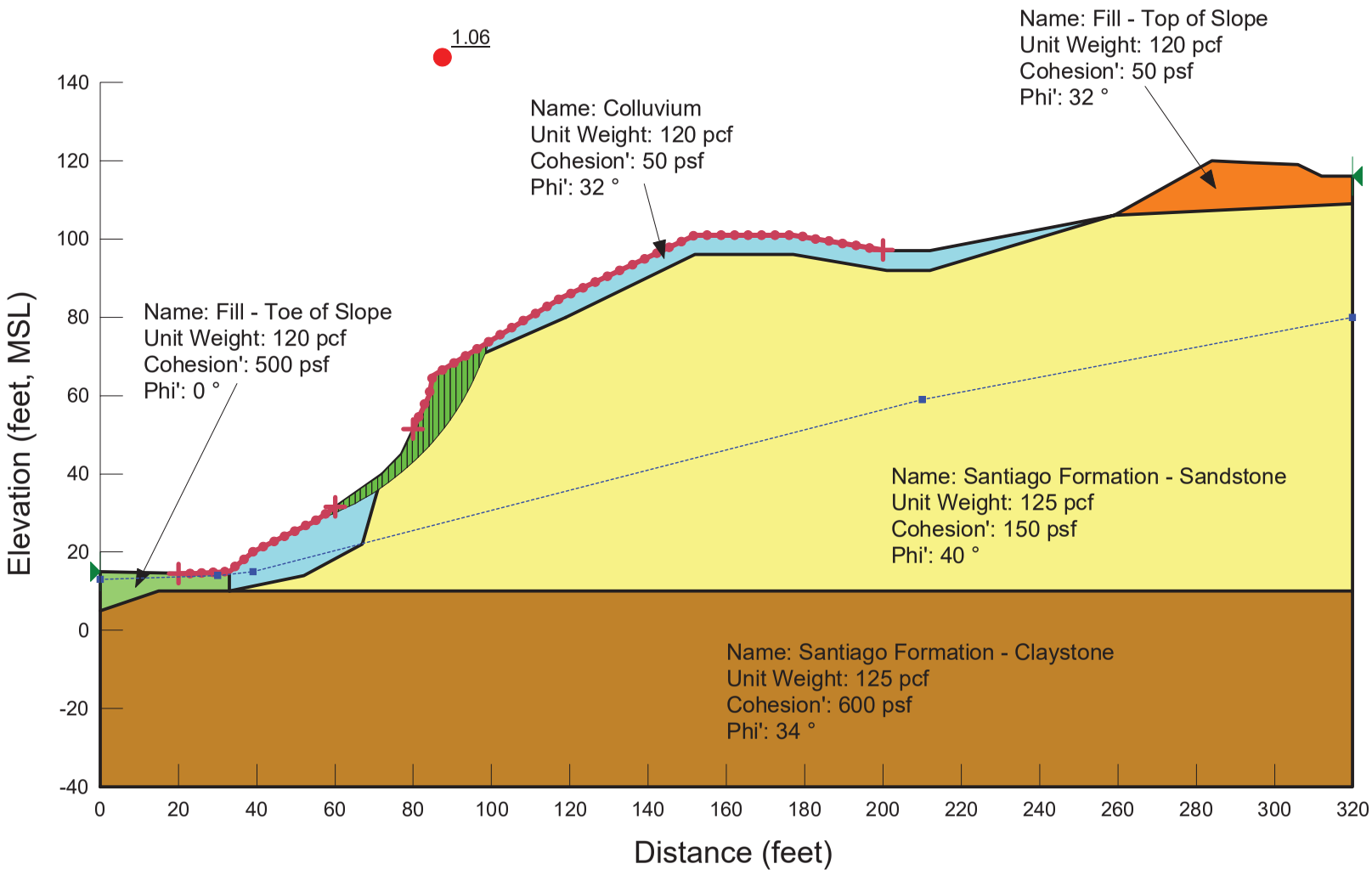
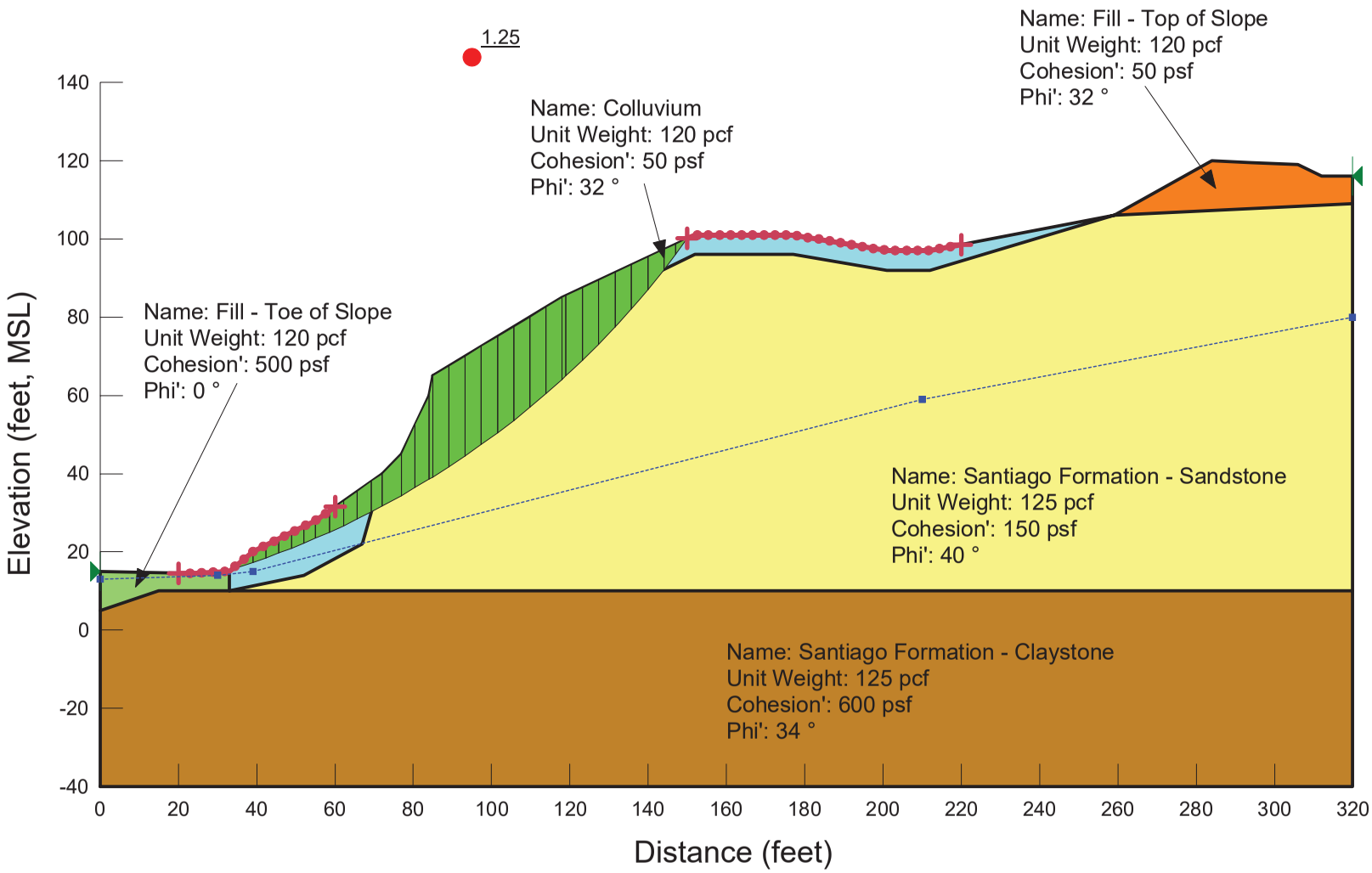
Cohesion': 50 psf
Phi': 32 °
Name: Colluvium
Unit Weight: 120 pcf
Cohesion': 50 psf
Phi': 32 °
Name: Fill - Toe of Slope
Unit Weight: 120 pcf
Cohesion': 500 psf
Phi': 0 °
Name: Santiago Formation - Sandstone
Unit Weight: 125 pcf
Cohesion': 150 psf
Phi': 40 °
Name: Santiago Formation - Claystone
Unit Weight: 125 pcf
Cohesion': 600 psf
Phi': 34 °
Elevation (feet, MSL)
140
120
100
80
60
40
20
0
-20
-40
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
Distance (feet)

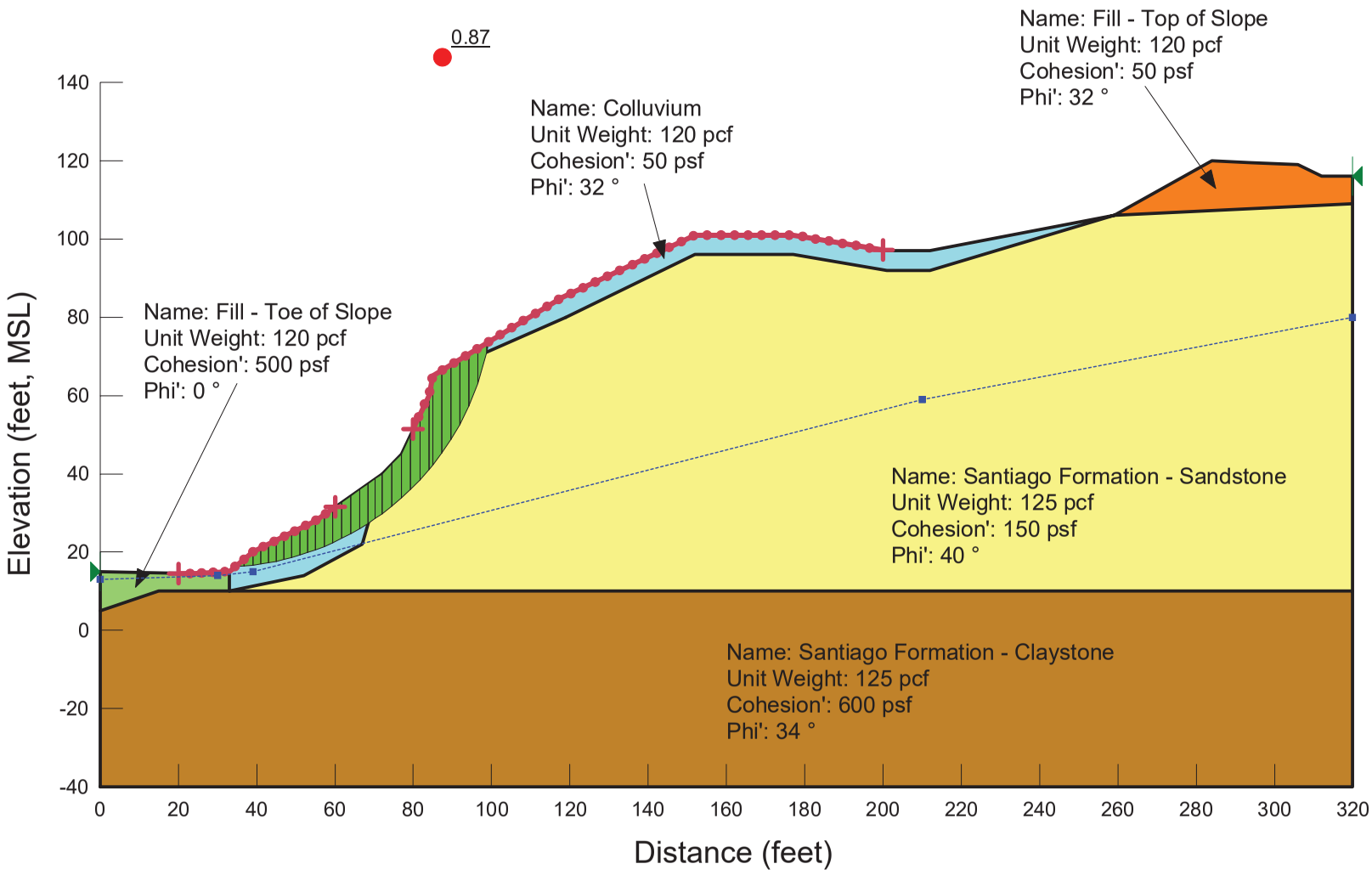
SD521 - Park Drive Street & Drainage Improvements
Cross Section B-B' - Static - Shallow, Spencer Method



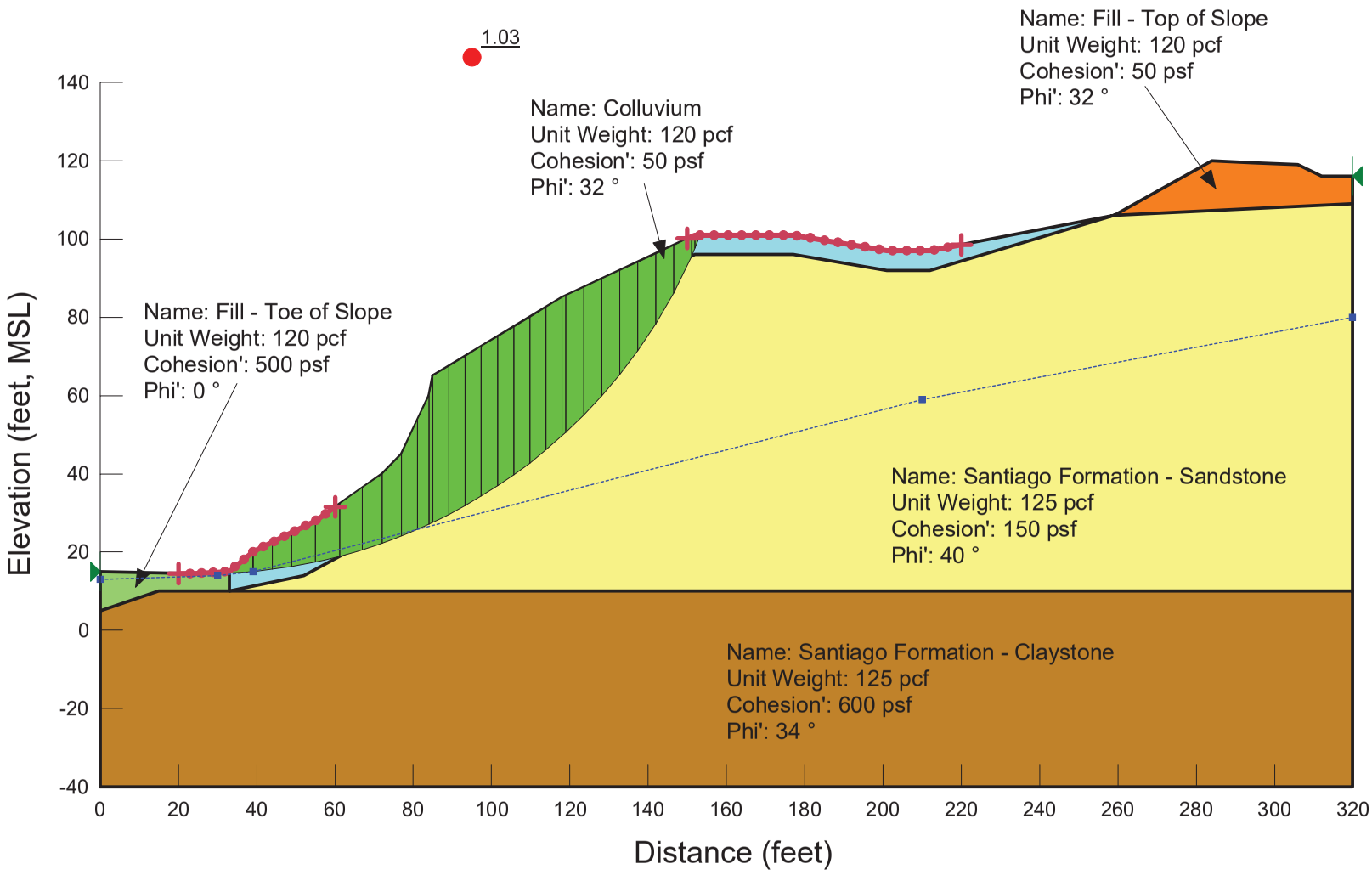
SD521 - Park Drive Street & Drainage Improvements
Cross Section B-B' - Static - Deep, Spencer Method



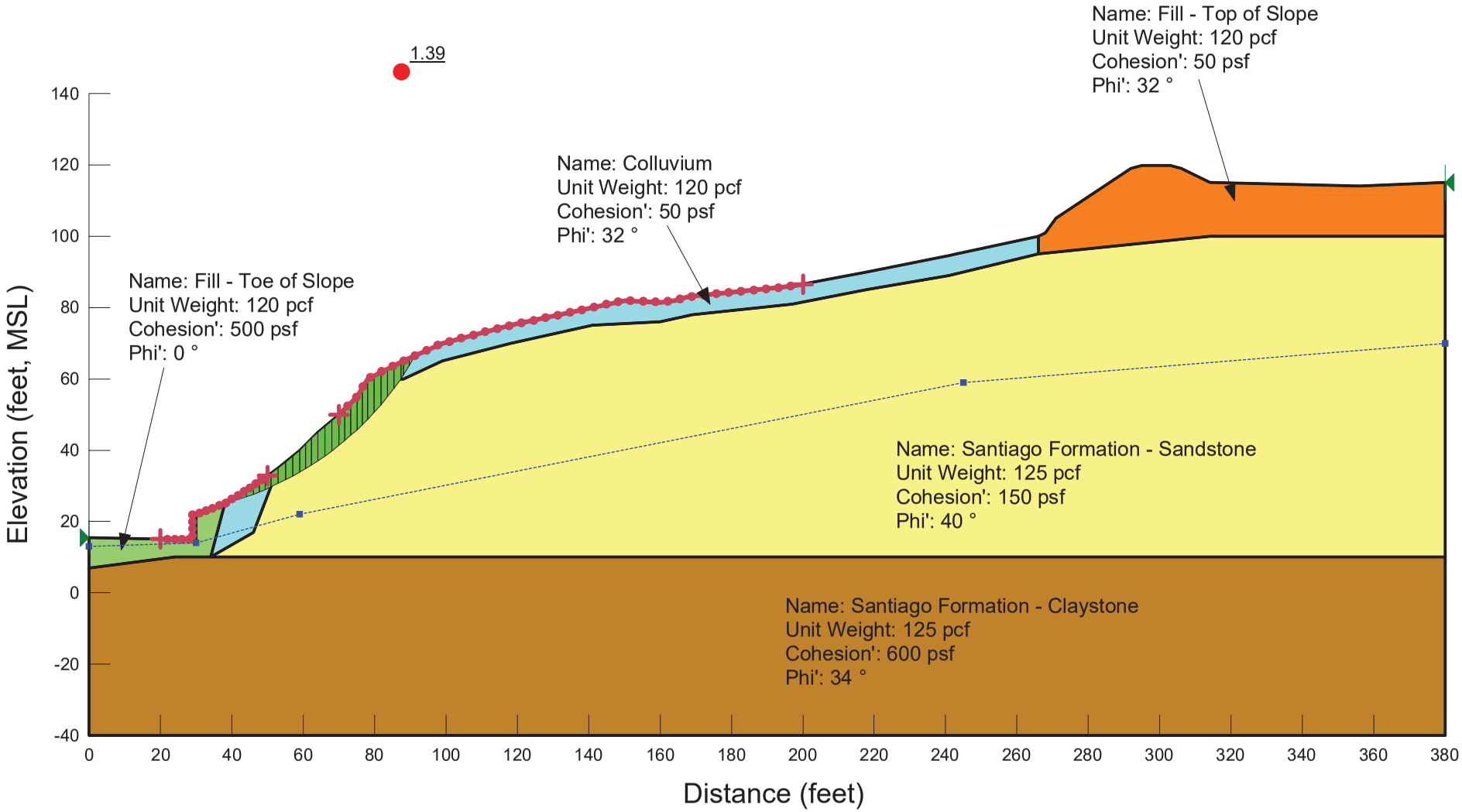
SD521 - Park Drive Street & Drainage Improvements
Cross Section B-B' - Pseudo-Static - Shallow, Spencer Method



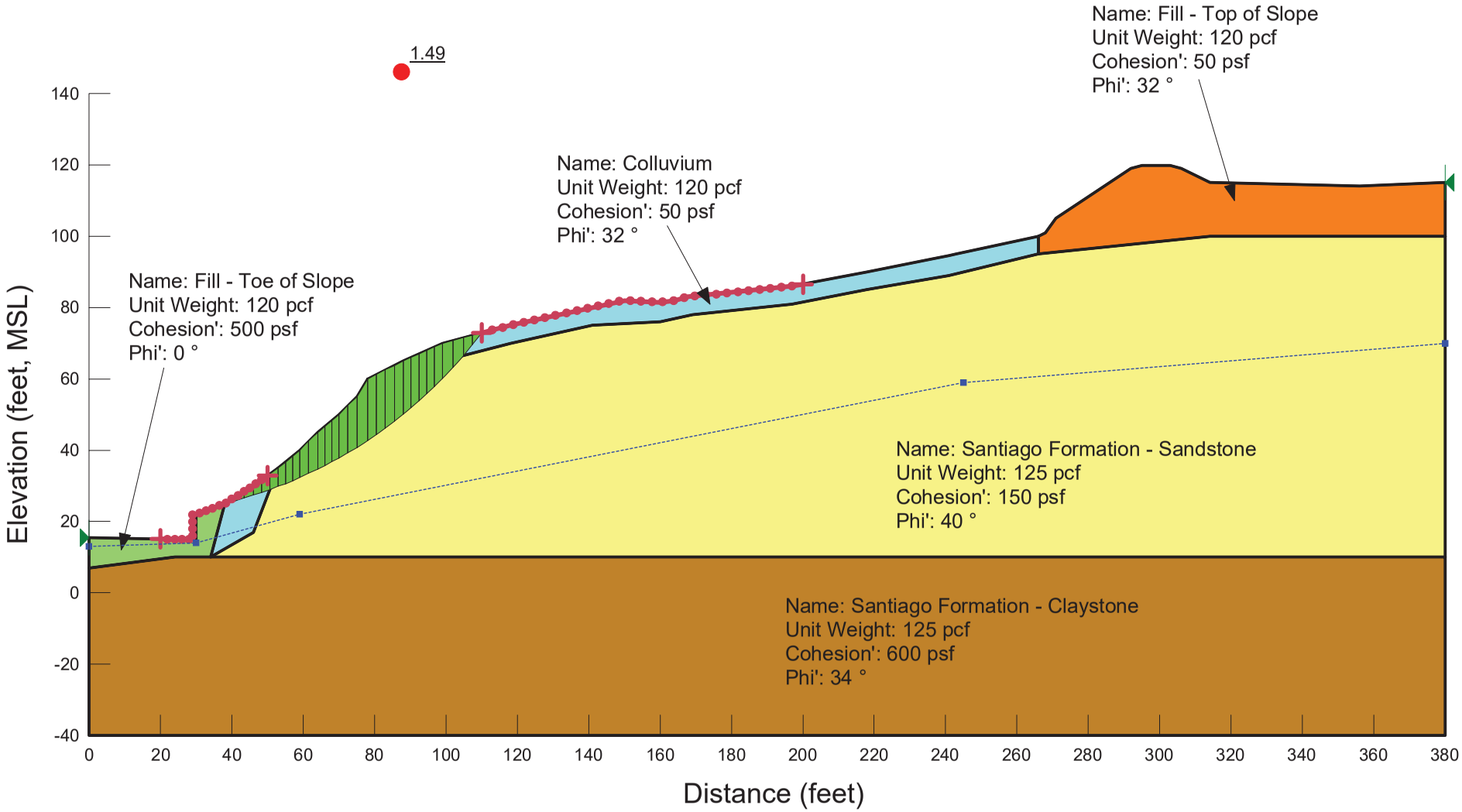
SD521 - Park Drive Street & Drainage Improvements
Cross Section B-B' - Pseudo-Static - Deep, Spencer Method



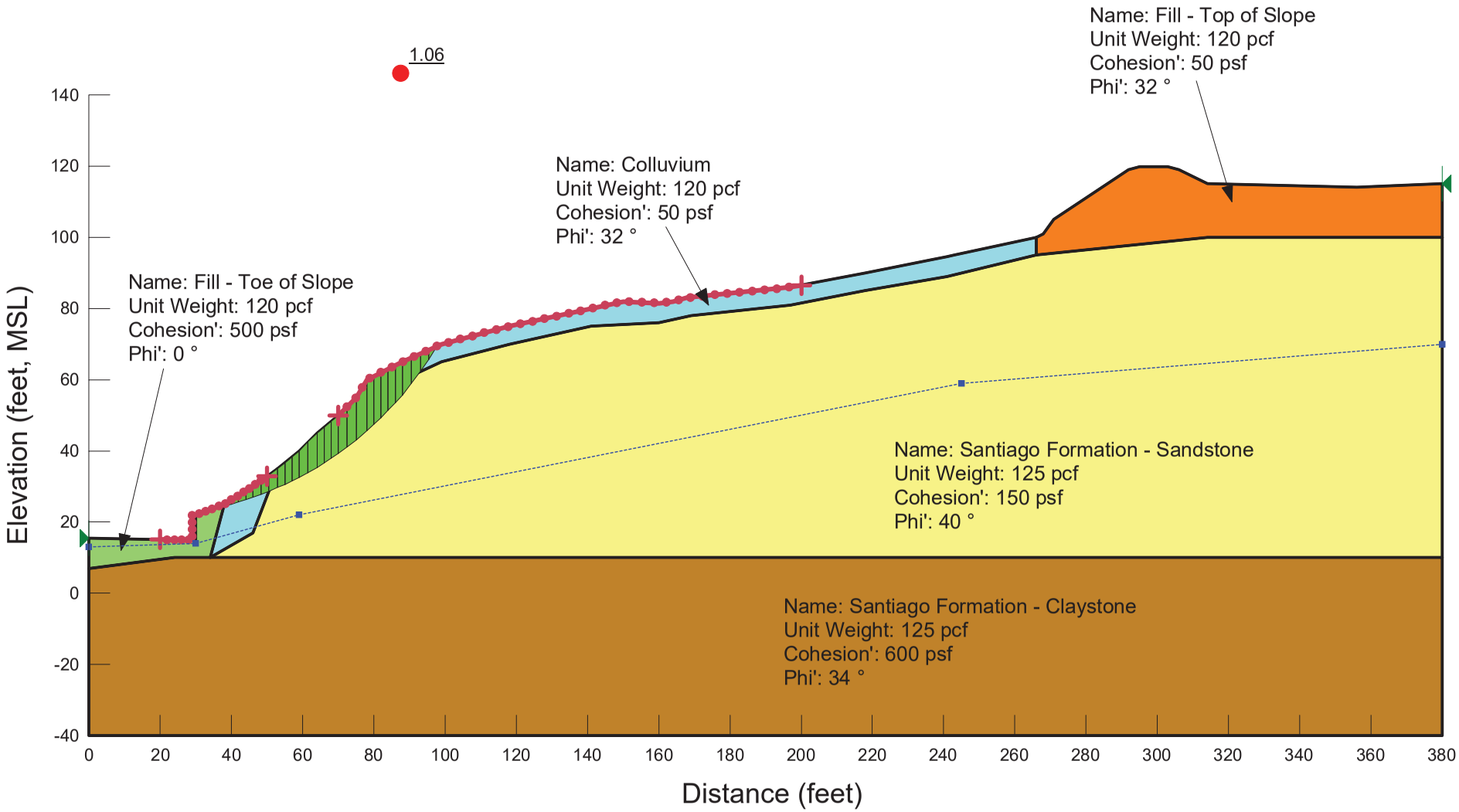
SD521 - Park Drive Street & Drainage Improvements
Cross Section C-C' - Static - Shallow, Spencer Method



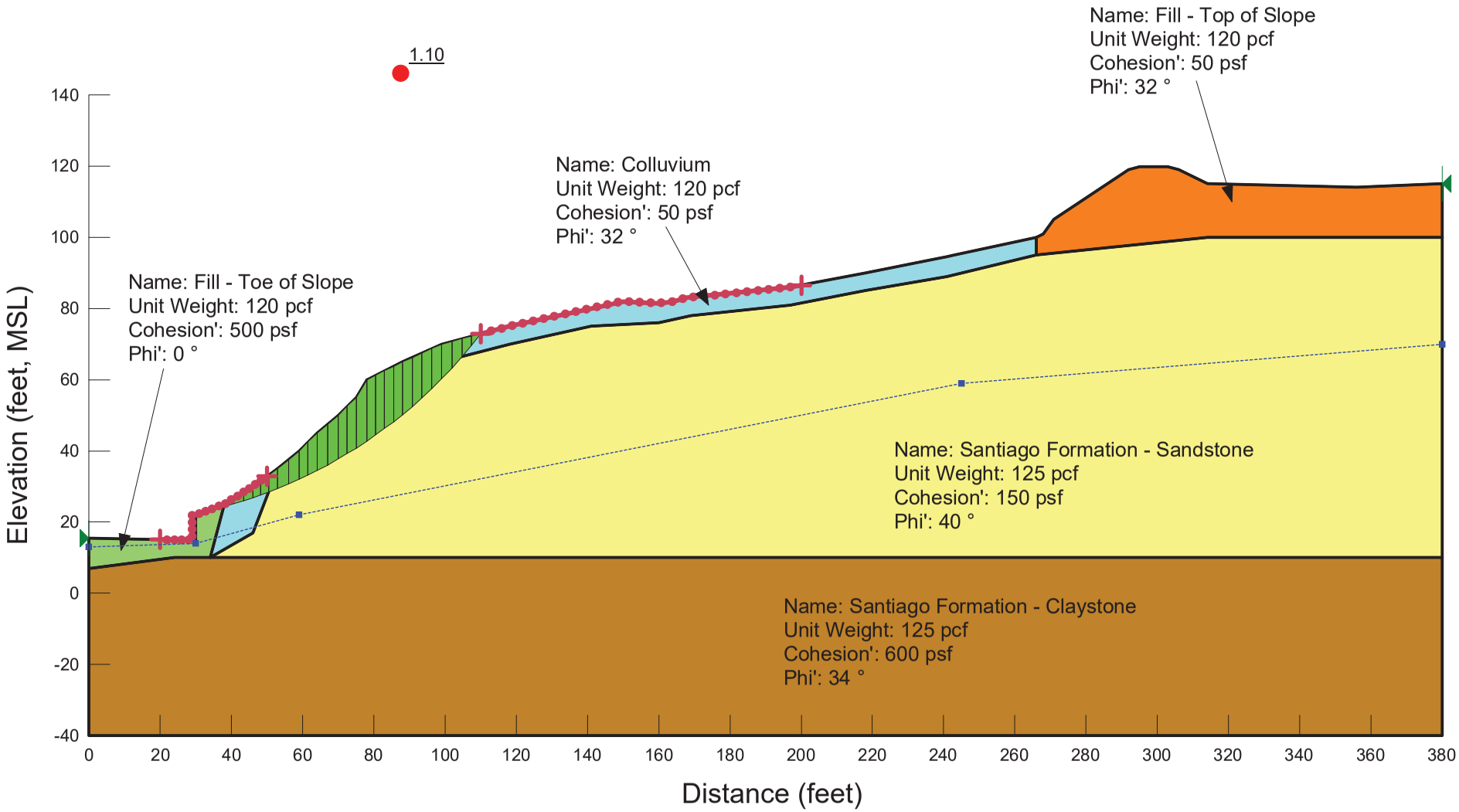
SD521 - Park Drive Street & Drainage Improvements
Cross Section C-C' - Static - Deep, Spencer Method



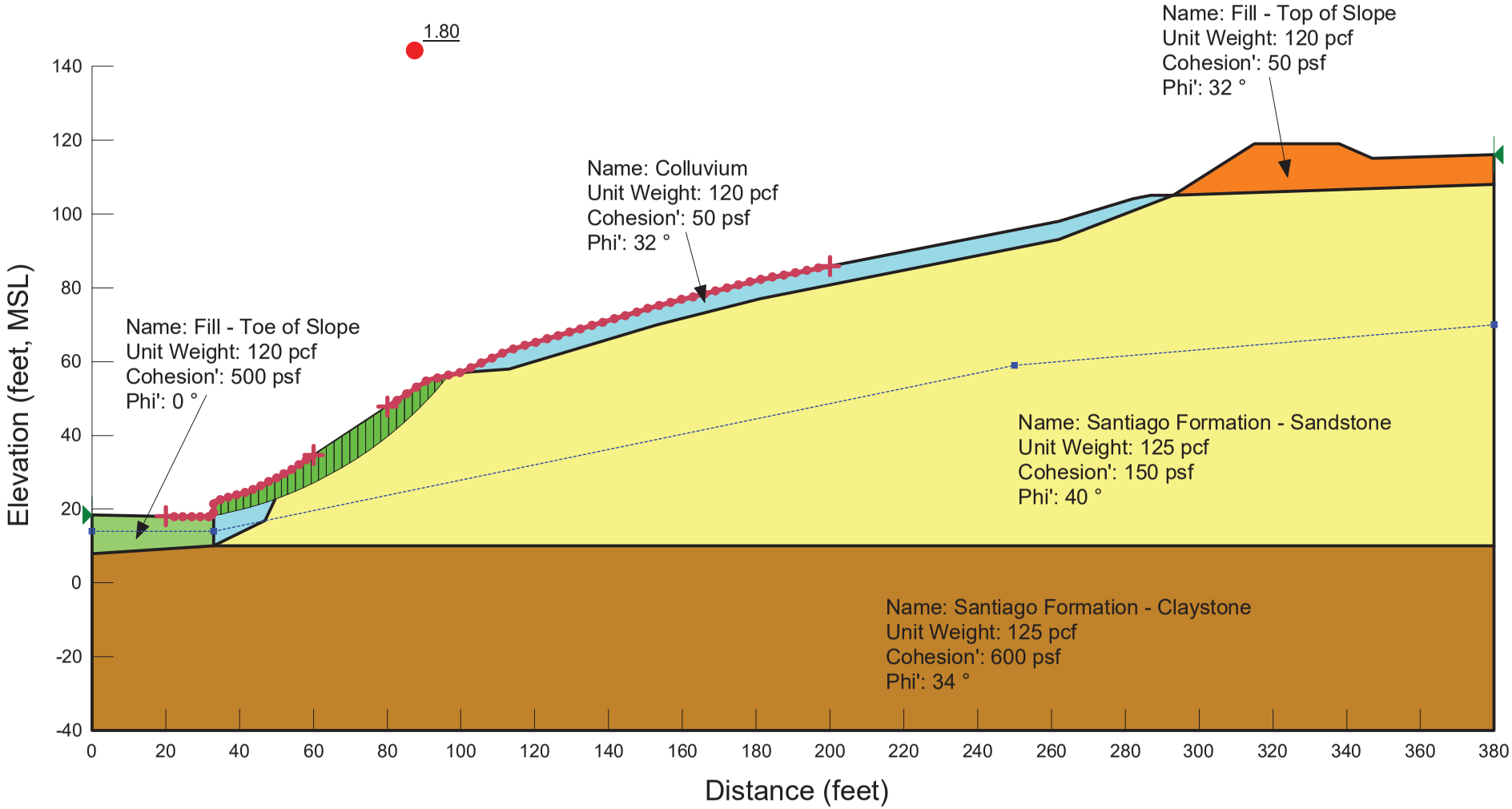
SD521 - Park Drive Street & Drainage Improvements
Cross Section C-C' - Pseudo-Static - Shallow, Spencer Method



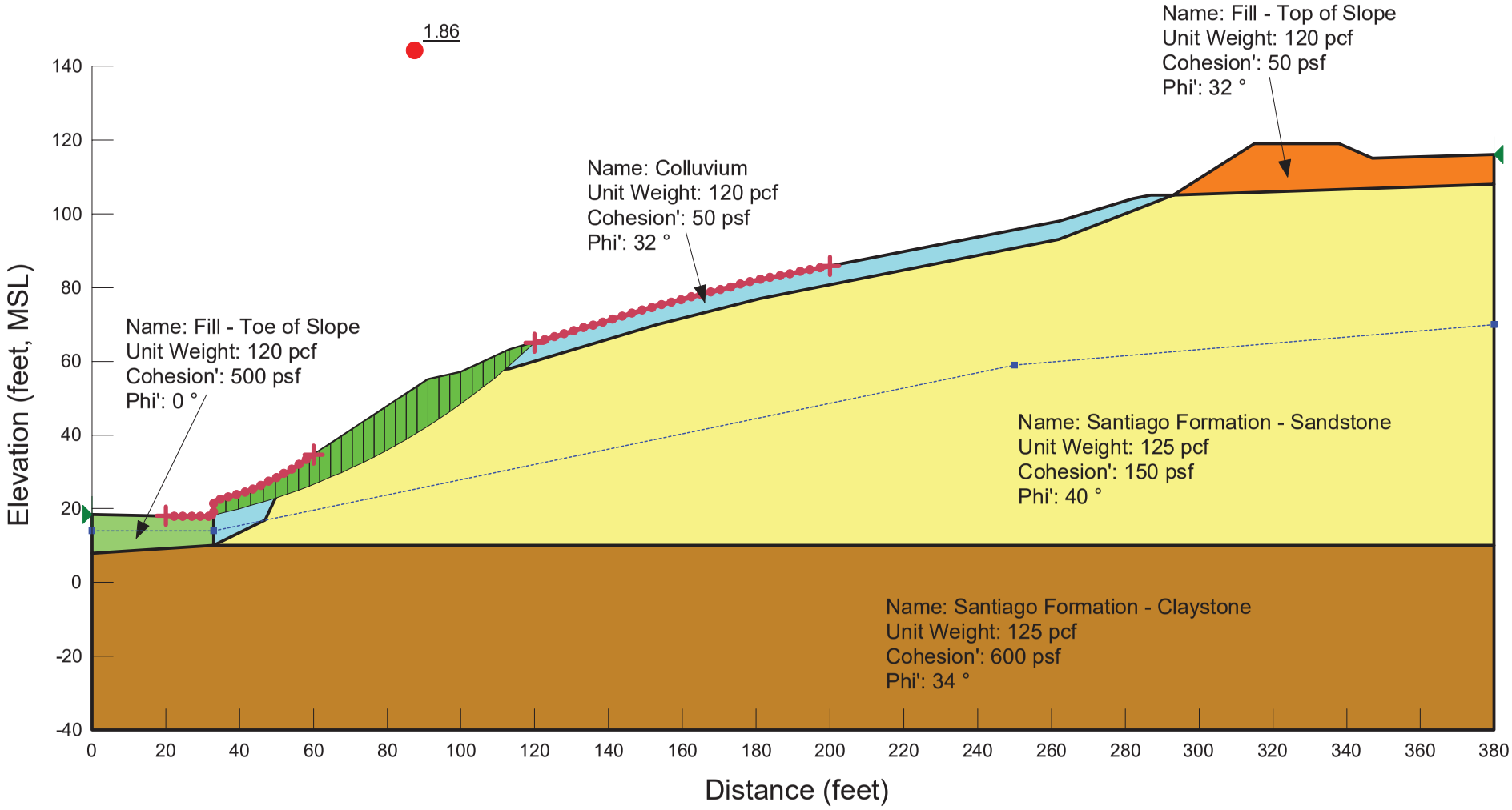
SD521 - Park Drive Street & Drainage Improvements
Cross Section C-C' - Pseudo-Static - Deep, Spencer Method



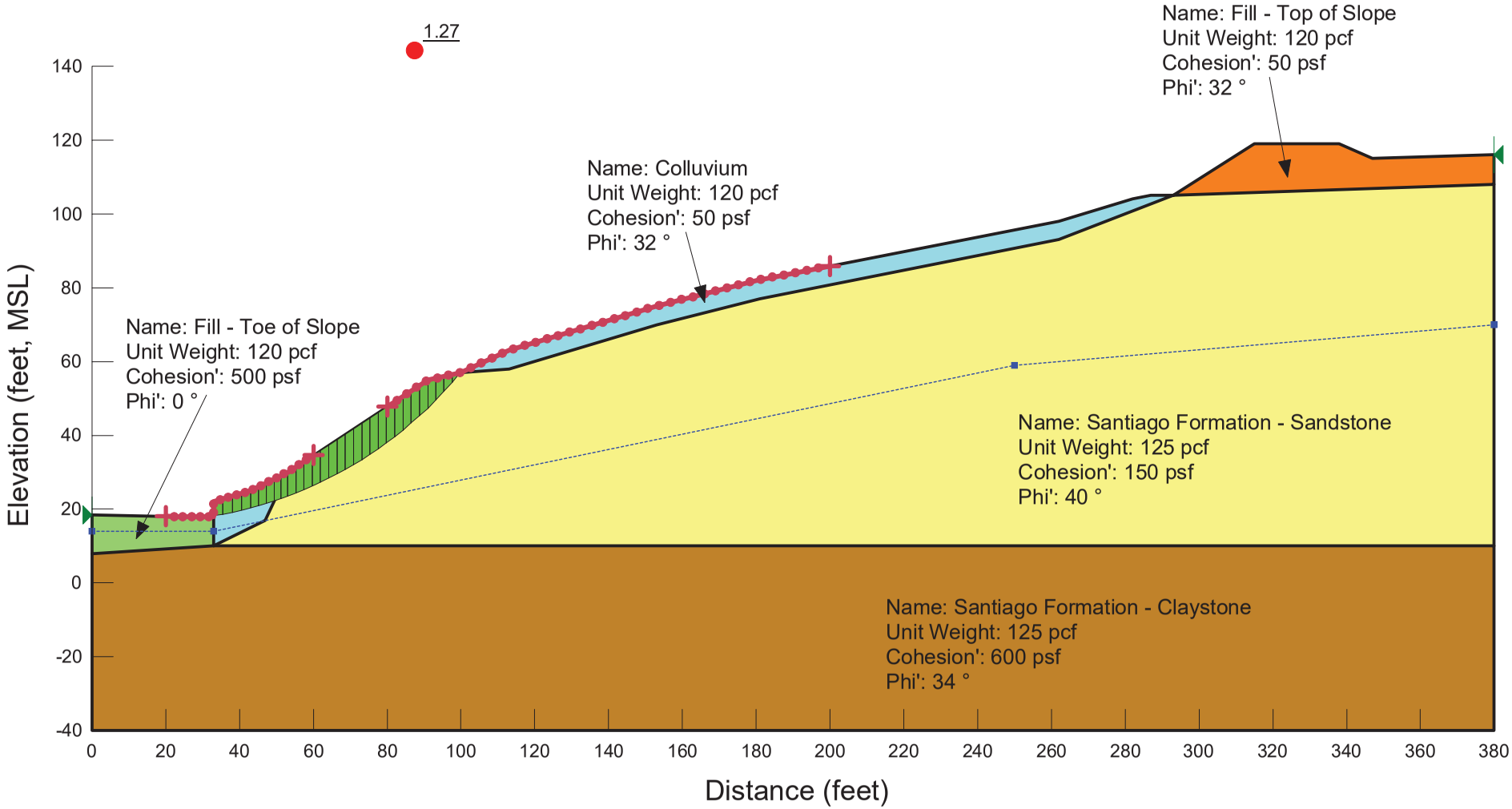
SD521 - Park Drive Street & Drainage Improvements
Cross Section D-D' - Static - Shallow, Spencer Method



SD521 - Park Drive Street & Drainage Improvements
Cross Section D-D' - Static - Deep, Spencer Method



SD521 - Park Drive Street & Drainage Improvements
Cross Section D-D' - Pseudo-Static - Shallow, Spencer Method



SD521 - Park Drive Street & Drainage Improvements
Cross Section D-D' - Pseudo-Static - Deep, Spencer Method