



GEOTECHNICAL ENGINEERING INVESTIGATION REPORT

WATER MAIN REPLACEMENT – TASK ORDER NO. 8 BEECH – MITCHELL – WOLFE – FARR – PARK – JULIAN – HIGH – GRANT - LEXINGTON TURLOCK, CALIFORNIA

BSK PROJECT G18-304-11F

PREPARED FOR:

**AECOM
1360 E. SPRUCE AVENUE, SUITE 101
FRESNO, CALIFORNIA 93720**

SEPTEMBER 18, 2019

**GEOTECHNICAL ENGINEERING INVESTIGATION REPORT
WATER MAIN REPLACEMENT – TASK ORDER NO. 8
BEECH – MITCHELL – WOLFE – FARR –
PARK – JULIAN – HIGH – GRANT - LEXINGTON
TURLOCK, CALIFORNIA**

Prepared for:

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BSK Project: G18-304-11F

September 18, 2019

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TABLE OF CONTENTS

1.0	Introduction	1
1.1	General	1
1.2	Project Description	1
1.3	Purpose and Scope of Services	2
2.0	Field Investigation and Laboratory Testing	2
2.1	Field Exploration	2
2.2	Laboratory Testing	2
3.0	Site Conditions	2
3.1	Site Description	2
3.2	Subsurface Conditions	2
3.3	Groundwater Conditions	3
4.0	Conclusion and Recommendations	3
4.1	General	3
4.2	Site Preparation and Earthwork Construction	4
4.3	Excavation and Trenching	5
4.4	Temporary Shoring	6
4.5	Pipe Bedding and Envelope	6
4.7	Pipe Loading Design Factors	7
4.8	Pavement Design Recommendations	8
4.9	Surface Drainage Control	8
5.0	Plans and Specification Review	8
6.0	Construction Testing and Investigation	9
7.0	Limitation	9



Tables

Table 1: Pipeline Location
Table 2: Pavement Thickness
Table 3: Lateral Earth Pressures for Temporary Shoring
Table 4: Modulus of Subgrade Reaction (E')
Table 5: Pipe Loading Design Factors
Table 6: Conventional Pavement Section Recommendations

Figures

Figure 1: Site Vicinity Map
Figure 2: Overall Site Map
Figure 3: Boring Location Map (Sheets 1 through 9)

Appendices

Appendix A: Field Exploration and Boring Logs
Appendix B: Laboratory Testing



1.0 INTRODUCTION

1.1 General

This report presents the results of our geotechnical engineering investigation for the proposed Task Order Number 8 – Water Main Replacement project to be constructed in Turlock, California as shown on the site vicinity map, Figure 1. The geotechnical engineering investigation was conducted in general accordance with the scope of services outlined in BSK Proposal GF18-17073, dated July 13, 2018, and updated May 2, 2019. The proposed improvements and exploratory borings are shown on Figure 3, Boring Location Map.

In the event that significant changes occur in the design or location of the proposed structure, the conclusions and recommendations presented in this report will not be considered valid unless the changes are reviewed by BSK and the conclusions and recommendations are modified or verified in writing as necessary.

1.2 Project Description

BSK understands that the project will encompass removal of existing and installation of new water mains at various locations in Turlock, California. Pipelines are anticipated to be less than 5 feet deep. Pavement reconstruction may consist of replacement in kind, replacement with overlay, or complete repave. The proposed areas of improvements are presented below:

TABLE 1
Pipeline Locations

Pipeline Location	Estimated Length (ft)	Water Line Number
S. Beech St. South of Columbia St.	320	W-1
Mitchell alleys from Wolfe to Olive	1500	W-2
Farr St. from Main St. to High St.	830	W-3
Park St. from Lexington Avenue to Soderquist Rd.	2800	W-4
Julian St. from Grant Ave. to North Broadway	600	W-5
High St. from South Orange to West Ave.	1550	W-6
Grant Ave. from Florence St to West Main St.	680	W-7
Mitchell from North Palm to Denair	750	W-8

In the event significant changes occur in the design of these planned facilities, our conclusions and recommendations may not be appropriate until the changes are reviewed with BSK Associates (BSK) and pertinent conclusions and recommendations are formulated and provided in writing.



1.3 Purpose and Scope of Services

The purpose of the geotechnical investigation is to assess soil conditions at the project site and provide geotechnical engineering recommendations for use by the project designers. The scope of the investigation included a field exploration, laboratory testing, engineering analysis, and preparation of this report.

2.0 FIELD INVESTIGATION AND LABRATORY TESTING

2.1 Field Exploration

The field exploration, conducted on January 22 and 23 and August 30, 2019 consisted of a site reconnaissance and drilling fourteen (14) exploratory test borings. The test borings were drilled to depths of approximately 10 and 11.5 feet below ground surface (bgs). The test borings were drilled with a truck-mounted drill rig, equipped with 6-inch diameter hollow stem augers and a manually operated hand auger. Cores were drilled through the asphalt pavement using a 6 inch diameter core barrel. The approximate boring locations are presented on Figure 3. Details of the field exploration and the boring logs are provided in Appendix A.

2.2 Laboratory Testing

Laboratory testing of selected soil samples were performed to evaluate in-situ moisture and density, gradation, direct shear, R-Values, and corrosion potential. The in-situ moisture, dry density, and percent passing the No. 200 sieve test results are presented on the boring logs in Appendix A. Descriptions of the laboratory test methods and test results are provided in Appendix B.

3.0 SITE CONDITIONS

3.1 Site Description

The area of the proposed water main replacement was relatively flat through the length of the alignment. The asphalt pavement showed signs of distress including alligator cracking, potholes, and rutting. The street contained sidewalks, curbs and gutters. The general area of improvements included residential housing with landscaping including trees adjacent to the roadway.

3.2 Subsurface Conditions

The near surface soil consisted predominantly of silty sand in the upper 4 to 11.5 feet underlain by layers of silty sand, poorly graded sand, sandy silt, and sandy clay to the maximum depth of exploration (11.5 feet bgs). The relative density of coarse grained soils were loose to very dense while the relative consistency of the fine grained soils were stiff to very stiff. The boring logs in Appendix A provide a more detailed description of the soils encountered in each boring, including the applicable Unified Soil Classification System symbols.



Borings were drilled through existing pavement at all locations. The pavement section thicknesses were measured and are presented in Table 2. R-value testing was completed for near surface (0 to 5 feet bgs) samples. Concrete pavement was encountered in test borings B-2 and B-3. Concrete pavement and underlying base material, if any, was not measured. Test borings at B-2 and B-3 were relocated to landscaping areas and alleys, respectively. Results are presented in Table 2 and in boring logs in Appendix A.

TABLE 2
Pavement Thickness

Test Boring	Approximate Location (Street)	Asphalt ¹ (in)	Aggregate Base ¹ (in)	R - Value
B-1	N Mitchell, 60' SW of Denair	5	0	46
B-2	Wolfe, 180' SW of N Palm	3 ½	NM ²	-
B-3	N Mitchell, 130' SW of N Thor	4 ½	NM ²	-
B-4	Julian, 255' E of Grant	3 ½	5	51
B-5	Park, 70' E of Grant	6 ½	0	-
B-6	Park, 850' E of Grant	8 ½	0	-
B-7	Grant, 70' S of Florence	8	3	-
B-8	Grant, 60' N of W Main	5	3 ½	-
B-9	Farr, 70' N of Columbia	5 ½	0	56
B-10	S Beech, 165' S of Columbia	3	0	-
B-11	High, 70' E of West	6	0	52
B-12	High, 90' E of Marks	2.25	4 ¾	-
B-13	Park, 400' W of Soderquist	2 ½	2 ½	-
B-14	Park, 230' E of West	6	0	51

Notes: 1. NM = not measured
2. Asphalt underlain by PCCP

3.3 Groundwater Conditions

Groundwater was not encountered in the test borings explored at the time of our field exploration. The California Department of Water Resources indicates the depth to regional groundwater is around 40 to 50 feet. However, fluctuations in the groundwater level or the presence of perched groundwater may occur due to variations in rainfall, irrigation, seasonal factors, pumping from wells and other factors that were not evident at the time of our investigation.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 General

Subsurface conditions observed during our field exploration typically present favorable geotechnical engineering characteristics for the structural bearing capacities and lateral restraint available at pipe invert elevations. Undisturbed soils are typically firm and insensitive to settlement under expected loads imposed by the pipe network. Trench sidewalls offer adequate passive resistance capacity and confinement of backfill without significant deformation. From a trench excavation stability aspect,



cohesionless sand deposits occur predominantly below 5 feet. Cemented zones with highly irregular degrees of induration and thickness occur at depths of 8 to 10-feet

Site conditions described above represent only our observations of predominant trends. The boring logs should be reviewed for specific conditions.

4.2 Site Preparation and Earthwork Construction

The following procedures must be implemented during site preparation for the proposed improvements. It should be noted that references to maximum dry density, optimum moisture content, and relative compaction are based on ASTM D1557 (latest test revision) laboratory test procedures.

1. Within the area of the planned improvements, remove existing pavement and debris to expose a clean soil surface. Removed pavement may be used as base material provided it is pulverized and sufficiently blended to meet Caltrans Class 2 aggregate base. Abandoned pipelines to remain in place that are less than 2 inches in diameter must be capped at the cutoff point, while pipelines greater than 2 inches in diameter must be filled with a 1-sack sand-cement slurry.
2. Soil disturbed as a result of demolition and/or undocumented fill deemed to possess inadequate compaction or uniformity, debris, abandoned underground structures must be excavated to expose undisturbed native soil or suitable fill.
3. Engineered fill must consist of non-expansive soil ($EL < 20$), moisture conditioned to at or above optimum moisture, and compacted to 90 percent relative compaction. Excavated soils, free of deleterious substances (organic matter, demolition debris, tree roots, etc.) and with less than 3 percent organic content by weight, may be reused as engineered fill.
4. The upper 12 inches of engineered fill/subgrade soil under pavement sections must be compacted to at least 95 percent of the maximum dry density. Acceptance of engineered fill placement must be based on both moisture content at time of compaction and relative compaction.
5. Imported fill materials must be free of deleterious substances and have less than 3 percent organic content by weight. The project specifications must require the contractor to contact BSK for review of the proposed import fill materials for conformance with these recommendations at least two weeks prior to importing to the site, whether from on-site or off-site borrow areas. Imported fill soils must be non-hazardous and be derived from a single, consistent soil type source conforming to the following criteria:

Maximum Particle Size:	3-inches
Percent Passing #4 Sieve:	65 – 100
Percent Passing #200 Sieve:	20 – 45
Plasticity Index:	less than 12
Expansion Index:	< 20
R-Value	>46



Low Corrosion Potential:

Soluble Sulfates:	< 1,500 mg/kg
Soluble Chlorides:	< 300 mg/kg
Soil Resistivity:	> 2,000 ohm-cm

Grading operations must be scheduled as to avoid working during periods of inclement weather. Should these operations be performed during or shortly following periods of inclement weather, unstable soil conditions may result in the soils exhibiting a "pumping" condition. This condition is caused by excess moisture, in combination with compaction, resulting in saturation and near zero air voids in the soils. If this condition occurs, the affected soils must be over-excavated to the depth at which stable soils are encountered and replaced with suitable soils compacted as engineered fill. Alternatively, the Contractor may proceed with grading operations after utilizing a method to stabilize the soil subgrade, which must be subject to review by BSK prior to implementation.

4.3 Excavation and Trenching

Open Trench excavation depth expected to be up to 5 feet. Soils within these depths comprise granular deposits of silty sand, and sand. These soils are consistent with OSHA Type "C" materials.

Based on dimensionless methods by Janbu, temporary slopes deeper than about 5 feet are stable to about 2:1 (H:V). The presence of sand layers with minimal to low fines content occurs in some borings as shallow as 5 feet. If areas of sand layers are encountered along the alignment, slopes should be laid back.

Temporary excavations for the project construction should be left open for as short a time as possible and should be protected from water runoff. In addition, equipment and/or soil stockpiles must be maintained at least 10 feet away from the top of the excavations. If it becomes necessary to encroach within the setbacks, surcharging effects should be evaluated. Because of variability in soils, BSK must be afforded the opportunity to observe and document sloping and shoring conditions at the time of construction. Slope height, slope inclination, and excavation depths (including utility trench excavations) must in no case exceed those specified in local, state, or federal safety regulations, (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations).



4.4 Temporary Shoring

Where there is insufficient space to layback slopes, temporary shoring will be necessary. Lateral earth pressures for cantilevered or braced shoring supporting level ground are presented in Table 3.

TABLE 3
Lateral Earth Pressures for Temporary Shoring

Parameter	Pressure
Active Pressure	35 psf/ft
Braced Pressure	25H psf
Allowable Passive Pressure	
Solid Sheet piling	240 psf/ft
Isolated Soldier Pile	560 psf/ft

Notes: 1. H is shored height in feet
2. Values for isolated soldier piles already include an increase for arching, no further consideration should be applied.

In areas where the stability of adjoining improvements could be endangered by excavation operations, support systems such as shoring, bracing or underpinning may be required to provide stability and to protect personnel working within the excavation. In areas where traffic is anticipated to encroach within 10 feet of shoring, an additional surcharge of 240 psf should be included. However, in the shoring design, all vehicle loads, equipment, etc. must maintain a minimum distance of 12 inches away from the shoring. Shoring, bracing or underpinning required for the project (if any), should be designed by a professional engineer registered in the State of California.

4.5 Pipe Bedding and Envelope

A minimum thickness of six inches of bedding material or the thickness equivalent to 1/4 the pipe outside diameter whichever is the greater, is recommended for pipe installation. The bedding thickness may be adjusted to achieve the desired bedding angle and corresponding bedding constant. Bedding material must consist of sand with not more than 5 percent passing the #200 Sieve and with 100 percent passing the 3/8-inch Sieve. We recommend that the pipe zone up to the spring line also be backfilled with the bedding materials described above.

The remaining pipe zone up to 12-inches above the top of the pipe must consist of friable granular backfill. Silty sand deposits with 35 percent or less passing the #200 sieve are suitable for backfill.

Sand-cement slurry may be used for envelope backfill (50-200 psi at 28 days).



4.6 Modulus of Soil Reaction E'

Modulus of Soil Reaction E' values for use in the Iowa Formula for estimating the deflection of buried flexible pipes are provided in Table 4. The materials include undisturbed native soils (trench sidewalls), compacted native soil backfill, Class 2 base rock conforming to Caltrans Section 26 of Standard Specifications and sand-cement slurry (50 psi at 7 days).

TABLE 4
Modulus of Subgrade Reaction (E')

Material Designation	Modulus of Subgrade Reaction (E'), psi	Degree of Compaction of Bedding & Envelope (ASTM D1557)
Trench Sidewalls: 0'-5' (SM)(SP)*	2200	-
Compacted Native Soil Backfill	1350	90 percent
Class 2 Base Rock	3400	95 percent
Sand-Cement Slurry	4000	--

Note: * - Derived from standard penetration tests SM: Silty Sand, SP: Sand

The Modulus of Subgrade Reaction is applicable to the determination of initial deflection only. For long-term deflection, a deflection lag factor of 1.25 is recommended for design purposes.

4.7 Pipe Loading Design Factors

Pipe loading design factors listed in Table 5 below are provided for bedding material consisting of:

- 1) Native and imported sand or silty sand soil with less than 35 percent passing the #200 sieve and 100 percent passing the 3/8-inch sieve (SP/SM);
- 2) Class 2 crushed base rock conforming to Caltrans Section 26 of standard specifications;
- 3) Sand-cement slurry with 28-day compressive strength of 50-200 psi.

TABLE 5
Pipe Loading Design Factors

Materials Classification	Angle of Internal Friction, Degrees	$K\mu$ (Marston's Formula)	Degree of Compaction ASTM: D1557
(1) SM	32	0.19	90
(2) Class 2 Aggregate Base	45	0.17	95
(3) Cement/Sand Slurry (CLSM)	55	0.14	--

A bulk unit weight of 115 pcf is recommended for compacted soil backfill within the pipe bedding and envelope. For Class 2 aggregate base, a unit weight of 140 pcf is recommended.

In the determination of the load coefficient, $K\mu$, "K" is Rankine's lateral earth pressure ratio and μ is equal to the coefficient of friction.



4.8 Pavement Design Recommendations

Laboratory testing performed on four (4) near surface sample, B-1, B-4, B-9, B-11 and B-14 at 0-5 feet, had measured R-values of 46, 51, 56, 52, and 51, respectively. The laboratory tests were performed in conformance with Caltrans Test Method 301.

The conventional pavement section presented in Table 6 are based upon the California Department of Transportation (CALTRANS) design procedures and a design R-value of 46 and Traffic Indexes of 5.0, 6.0, 7.0, and 8.0.

TABLE 6
CONVENTIONAL PAVEMENT SECTION RECOMMENDATIONS
(DESIGN R-VALUE = 46, 20-YR DESIGN LIFE)

Traffic Index	Conventional Section	
	HMA (feet)	AB (feet)
5.0 or less	0.25	0.35
6.0	0.30	0.35
7.0	0.35	0.40
8.0	0.40	0.55

Notes: HMA: Hot Mix Asphalt

AB: Caltrans Class 2 Aggregate Base (Minimum R-Value = 78)

Hot mix asphalt and Class 2 aggregate base should conform to and be placed in accordance with the latest revision of Caltrans Standard Specifications.

4.9 Surface Drainage Control

Final grading around site improvements must provide for positive and enduring drainage. Ponding of water must not be allowed on or near the improvements/roadways. Saturation of the soils immediately adjacent to or below improvements must not be allowed. Although landscaping is not anticipated, irrigation water must be applied in amounts not exceeding those required to offset evaporation, sustain plant life, and maintain a relatively uniform moisture profile around and below, site improvements. Fill elevations are anticipated to be less than 3 feet above natural grade to achieve positive site drainage.

5.0 PLANS AND SPECIFICATION REVIEW

BSK recommends that it be retained to review the draft plans and specifications for the project, with regard to pavements and earthwork, prior to being finalized and issued for construction bidding.



6.0 CONSTRUCTION TESTING AND INVESTIGATION

Geotechnical testing and observation during construction is a vital extension of this geotechnical investigation. BSK recommends that it be retained for those services. Field review during site preparation allows for evaluation of the exposed soil conditions and confirmation or revision of the assumptions and extrapolations made in formulating the design parameters and recommendations. BSK's observations must be supplemented with periodic compaction tests to establish substantial conformance with these recommendations. BSK must also be called to the site during earthwork operation, in order to assess whether the actual subgrade conditions are compatible with the conditions anticipated during the preparation of this report.

If a firm other than BSK is retained for these services during construction, that firm must notify the owner, project designers, governmental building officials, and BSK that the firm has assumed the responsibility for all phases (i.e., both design and construction) of the project within the purview of the geotechnical engineer. Notification must indicate that the firm has reviewed this report and any subsequent addenda, and that it either agrees with BSK's conclusions and recommendations, or that it will provide independent recommendations.

7.0 LIMITATION

The analyses and recommendations submitted in this report are based upon the data obtained from the test borings performed at the locations shown on Figure 3. The report does not reflect variations, which may occur between or beyond the borings. The nature and extent of such variations may not become evident until additional exploration and testing is performed or construction is initiated. If variations then appear, a re-evaluation of the recommendations of this report will be necessary after performing on-site observations during the excavation period and noting the characteristics of the variations.

The validity of the recommendations contained in this report is also dependent upon an adequate testing and observation program during the construction phase. BSK assumes no responsibility for construction compliance with the design concepts or recommendations unless it has been retained to perform the testing and observation services during construction as described above.

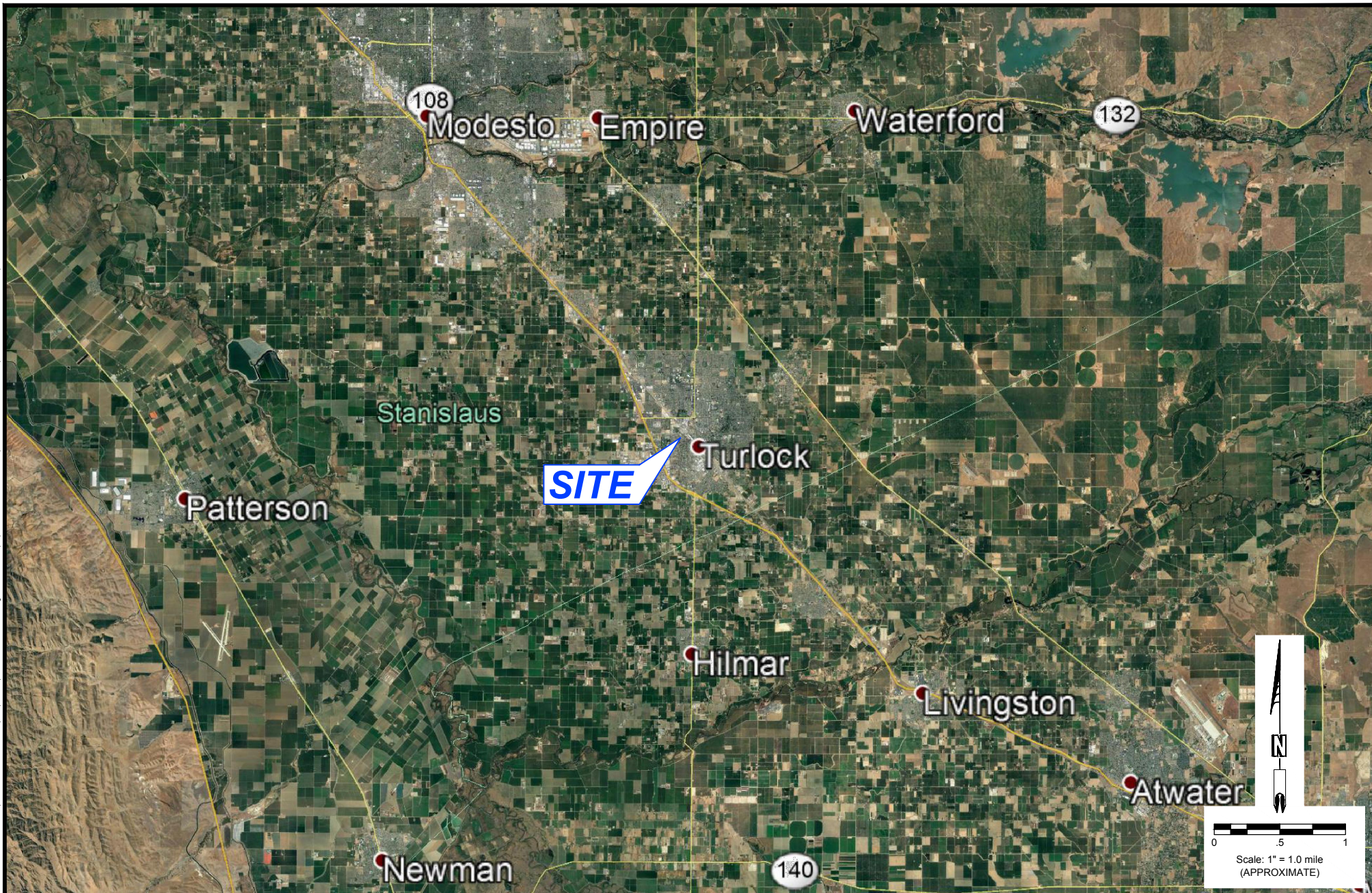
The findings of this report are valid as of the present. However, changes in the conditions of the site can occur with the passage of time, whether caused by natural processes or the work of man, on this property or adjacent property. In addition, changes in applicable or appropriate standards may occur, whether they result from legislation, governmental policy or the broadening of knowledge.

BSK has prepared this report for the exclusive use of the Client and members of the project design team. The report has been prepared in accordance with generally accepted geotechnical engineering practices, which existed in Stanislaus County at the time the report was written. No other warranties either express or implied are made as to the professional advice provided under the terms of BSK's agreement with Client and included in this report.

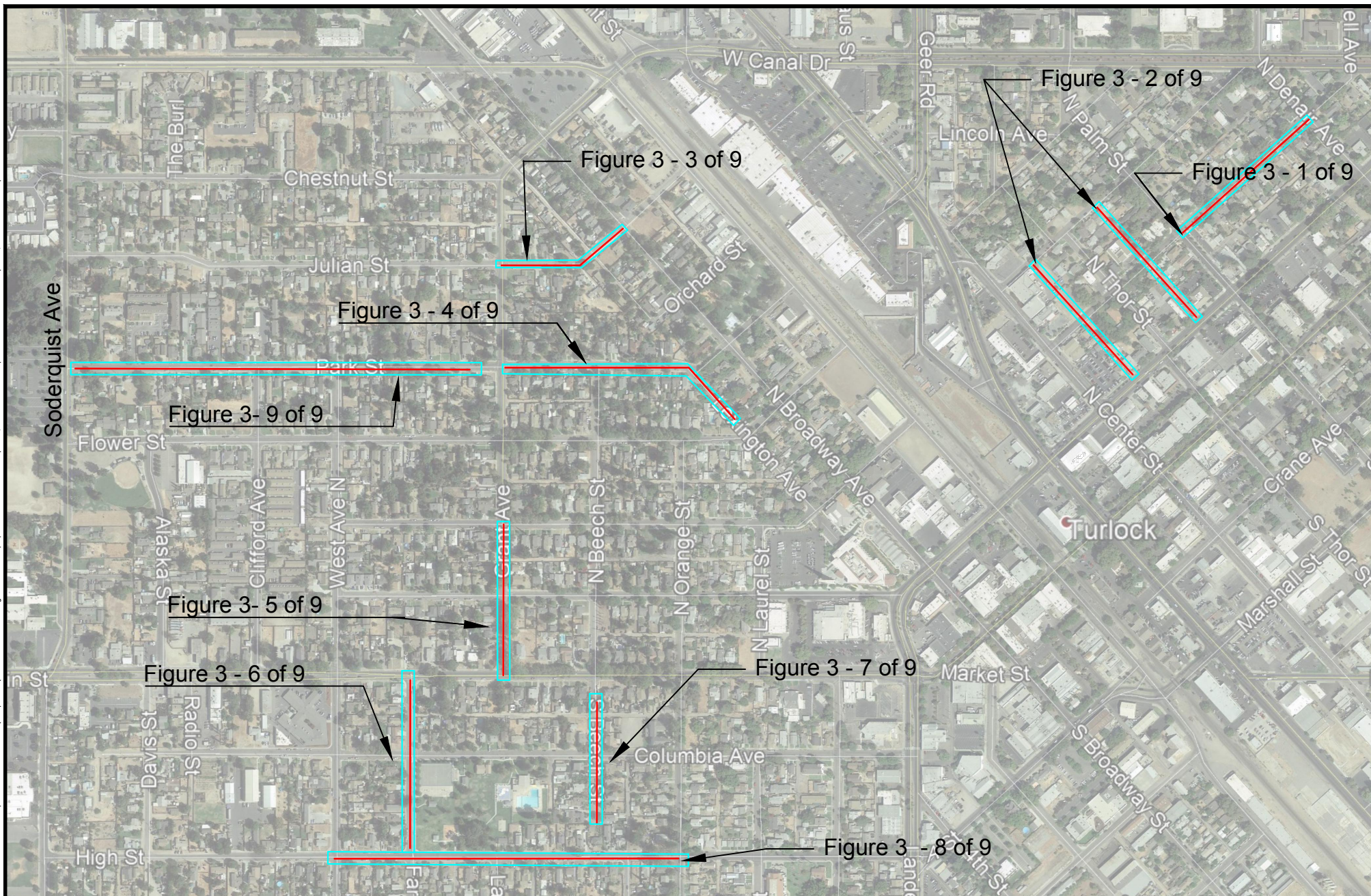


FIGURES

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REFERENCE IMAGE: Google Earth	 550 West Locust Avenue Fresno, California 93650 Tel. (559) 497-2880	SITE VICINITY MAP		FIGURE 1	
		Water Main Replacement - TO 8 Turlock, California		JOB NO. <u>G18-304-11F</u> DATE <u>September 17, 2019</u>	
				DR. BY <u>TG</u> CH. BY <u>NP</u> SCALE AS SHOWN	
				SHEET NO. <u>1</u> OF <u>1</u> SHEETS	



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OVERALL SITE MAP

Water Main Replacement - TO 8
 Turlock, California

FIGURE 2

JOB NO.	G18-304-11F
DATE	September 17, 2019
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OF	1 SHEETS

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LEGEND:



B-1

APPROXIMATE BORING LOCATION



APPROXIMATE WATER LINE
ALIGNMENT

REFERENCE IMAGE: Google Earth

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BORING LOCATION MAP

Water Main Replacement - TO 8
Mitchell Avenues
Turlock, California

FIGURE 3

JOB NO. G18-304-11F

DATE September 17, 2019

DR. BY TG

CH. BY NP

SCALE AS SHOWN

SHEET NO. 1

OF 9 SHEETS



LEGEND:
 APPROXIMATE BORING LOCATION
 APPROXIMATE WATER LINE ALIGNMENT

REFERENCE IMAGE: Google Earth

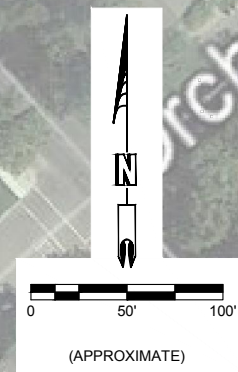
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BORING LOCATION MAP

Water Main Replacement - TO 8
 Thor, Olive, Mitchell, and Wolfe Avenues
 Turlock, California

FIGURE 3

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DATE	September 17, 2019	
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LEGEND:
 APPROXIMATE BORING LOCATION
 B-4
 APPROXIMATE WATER LINE ALIGNMENT

REFERENCE IMAGE: Google Earth

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BORING LOCATION MAP

Water Main Replacement - TO 8
 Julian Street
 Turlock, California

FIGURE 3

JOB NO.	G18-304-11F
DATE	September 17, 2019
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OF	9 SHEETS

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LEGEND:

-  APPROXIMATE BORING LOCATION
-  APPROXIMATE WATER LINE ALIGNMENT

REFERENCE IMAGE: Google Earth

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BORING LOCATION MAP

Water Main Replacement - TO 8
Park Streets and Lexington Avenue
Turlock, California

FIGURE 3

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DATE	September 17, 2019
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OF	9 SHEETS



LEGEND:
 APPROXIMATE BORING LOCATION
 APPROXIMATE WATER LINE ALIGNMENT

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BORING LOCATION MAP

Water Main Replacement - TO 8
 Grant Avenue
 Turlock, California

FIGURE 3

JOB NO.	G18-304-11F
DATE	September 17, 2019
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SHEET NO.	5
SCALE AS SHOWN	OF 9 SHEETS



LEGEND:
 APPROXIMATE BORING LOCATION
 APPROXIMATE WATER LINE ALIGNMENT

REFERENCE IMAGE: Google Earth

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BORING LOCATION MAP

Water Main Replacement - TO 8
 Farr Street
 Turlock, California

FIGURE 3

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SCALE AS SHOWN	
SHEET NO.	6
OF	9 SHEETS



LEGEND:
 APPROXIMATE BORING LOCATION
 B-10
 APPROXIMATE WATER LINE ALIGNMENT

REFERENCE IMAGE: Google Earth

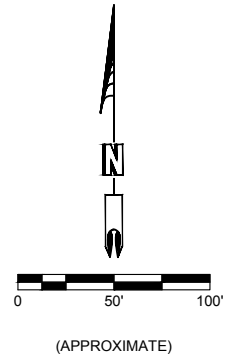
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BORING LOCATION MAP

Water Main Replacement - TO 8
 S Beech
 Turlock, California

FIGURE 3

JOB NO.	G18-304-11F
DATE	September 17, 2019
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SCALE AS SHOWN	
SHEET NO.	7
OF	9 SHEETS



LEGEND:
 APPROXIMATE BORING LOCATION
 APPROXIMATE WATER LINE ALIGNMENT

REFERENCE IMAGE: Google Earth

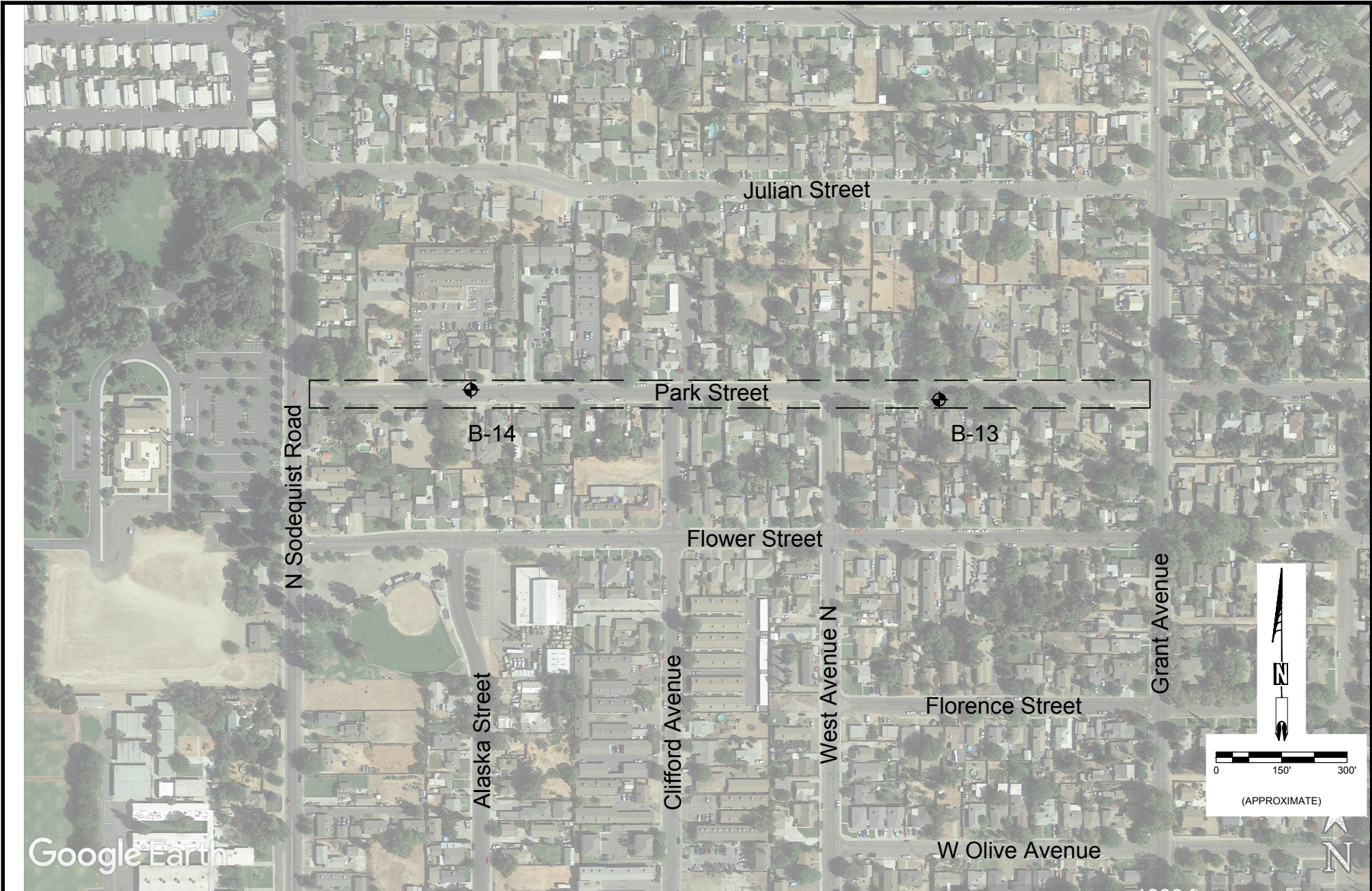
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BORING LOCATION MAP

Water Main Replacement - TO 8
 High Streets
 Turlock, California

FIGURE 3

JOB NO.	G18-304-11F
DATE	September 17, 2019
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CH. BY	NP
SCALE AS SHOWN	
SHEET NO.	8
OF	9 SHEETS



LEGEND:



APPROXIMATE BORING LOCATIONS

B-2



APPROXIMATE WATER LINE
ALIGNMENT

REFERENCE IMAGE: Google Earth

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BORING LOCATION MAP

Water Main Replacement - TO 8
Park Street
Turlock, California

FIGURE 3

JOB NO.	G18-304-11F	
DATE	September 17, 2019	
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APPENDIX A

Field Exploration and Boring Logs



APPENDIX A

Field Exploration

The field exploration was conducted on January 22 and 23 and August 30, 2019, under the oversight of a BSK staff engineer. Fourteen test borings were excavated to a maximum depth of 10 and 11.5 feet below existing ground surface (bgs) within the alignment of the pipeline. The borings were excavated with a Mobile B-61 drill rig, equipped with 6-inch diameter hollow stem augers and a manually-operated hand auger. Cores were completed with a 6-inch diameter diamond core barrel. The approximate locations of the test borings are presented on Figure 3, Boring Location Map.

The soil materials encountered in the test borings were visually classified in the field, and logs were recorded during the drilling and sampling operations. Visual classification of the materials encountered in the test borings was made in general accordance with the Unified Soil Classification System (ASTM D2487). A soil classification chart is presented herein. Borings are presented herein and should be consulted for more details concerning subsurface conditions. Stratification lines were approximated by the Engineer on the basis of observations made at the time of drilling, while the actual boundaries between different soil types may be gradual and soil conditions may vary at other locations.

Subsurface samples were obtained at the successive depths shown on the boring logs by driving samplers which consisted of a 2.5-inch inside diameter (I.D.) California Sampler. The samplers were driven 18-inches using a 140-pound hammer dropped from 30-inches. The number of blows required to drive the last 12-inches was recorded as the blow count (blows/foot) on the boring logs. The relatively undisturbed soil core samples were capped at both ends to preserve the samples at their natural moisture content. Soil samples obtained using the SPT Sampler were placed and sealed in polyethylene bags. At the completion of the field exploration, the test borings were backfilled with soil cuttings and capped with permanent AC patch, as needed.

It should be noted that the use of terms such as “loose”, “medium dense”, “dense” or “very dense” to describe the consistency of a soil is based on sampler blow count and is not necessarily reflective of the in-place density or unit weight of the soils being sampled. The relationship between sampler blow count and consistency is provided in the following Tables A1 and A2 for coarse-grained (sandy and gravelly) soils and fine grained (silty and clayey) soils, respectively.



Table A1: Consistency of Coarse-Grained Soil versus Sampler Blow Count		
Consistency Descriptor	SPT Blow Count (#Blows / Foot)	2.5" I.D. California Sampler Blow Count (#Blows / Foot)
Very Loose	<4	<6
Loose	4 – 10	6 – 15
Medium Dense	10 – 30	15 – 45
Dense	30 – 50	45 – 80
Very Dense	>50	>80

Table A2: Consistency of Fine-Grained Soil versus Sampler Blow Count		
Consistency Descriptor	SPT Blow Count (#Blows / Foot)	2.5" I.D. Cal. Sampler Blow Count
Very Soft	<2	<3
Soft	2 – 4	3 – 6
Medium Stiff	4 – 8	6 – 12
Stiff	8 – 15	12 – 24
Very Stiff	15 – 30	24 – 45
Hard	>30	>45



MAJOR DIVISIONS					TYPICAL NAMES
COARSE GRAINED SOILS More than Half > #200 sieve	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW		WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP		POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 15% FINES	GM		SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			GC		CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS WITH LITTLE OR NO FINES	SW		WELL GRADED SANDS, GRAVELLY SANDS
			SP		POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 15% FINES	SM		SILTY SANDS, POOORLY GRADED SAND-SILT MIXTURES
			SC		CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS More than Half < #200 sieve	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL		ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH		INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH		ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
	HIGHLY ORGANIC SOILS		Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS

-  Modified California
-  Standard Penetration Test (SPT)
-  Split Spoon
-  Pushed Shelby Tube
-  Auger Cuttings
-  Grab Sample
-  Sample Attempt with No Recovery
- CA Chemical Analysis
- CN Consolidation
- CP Compaction
- DS Direct Shear
- PM Permeability
- PP Pocket Penetrometer

- RV R-Value
- SA Sieve Analysis
- SW Swell Test
- TC Cyclic Triaxial
- TX Unconsolidated Undrained Triaxial
- TV Torvane Shear
- UC Unconfined Compression
- (1.2) (Shear Strength, ksf)
- WA Wash Analysis
- (20) (with % Passing No. 200 Sieve)
-  Water Level at Time of Drilling
-  Water Level after Drilling (with date measured)

SOIL CLASSIFICATION CHART AND LOG KEY

ESK
ASSOCIATES



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Project: Water Main Replacement - Turlock

Location: N. Mitchell, 60' SW of N. Palm

Project No.: G18-304-11F

Logged By: J. Schallberger

Checked By: N. Popenoe

Page 1 of 1

Boring: B- 1

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1								SM	Asphalt concrete - 5"	
2			10	106.7	9.2	42		SM	Silty SAND - brown, moist, loose, fine to medium grained	RV = 46
3										
4								CL	Sandy CLAY - brown, moist, very stiff, fine grained sand	
5										
6			40					SM	Silty SAND - brown, moist, medium dense, fine to medium grained	
7										
8										
9										
10										
11			44							
12										
13									Boring terminated at approximately 11.5 feet bgs. Borehole backfilled with soil cuttings and capped with AC cold patch. No groundwater encountered.	
14										
15										
16										
17										
18										
19										

Drilling Contractor: Dave's Drilling
Drilling Method: Hollow Stem Auger
Drilling Equipment: Mobile B-61
Date Started: 1/23/19
Date Completed: 1/23/19

Surface Elevation:
Sample Method: 2.5-inch I.D. modified
Groundwater Depth: Not Encountered
Completion Depth: 11.5 Feet
Borehole Diameter: 6"

* See key sheet for symbols and abbreviations used above.



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Project: Water Main Replacement - Turlock

Page 1 of 1

Location: Wolfe, 180' SW of N. Palm

Project No.: G18-304-11F

Logged By: J. Schallberger

Checked By: N. Popenoe

Boring: B-2

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1									Asphalt concrete - 3.5"	
2									Concrete pavement was encountered below AC, boring was relocated to landscaping area adjacent to roadway. Boring terminated at approximately 3.5 inches bgs. Borehole capped with AC cold patch. No groundwater encountered.	
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										

Drilling Contractor: Dave's Drilling
Drilling Method: Hollow Stem Auger
Drilling Equipment: Mobile B-61
Date Started: 1/23/19
Date Completed: 1/23/19

Surface Elevation:
Sample Method: N/A
Groundwater Depth: Not Encountered
Completion Depth: 3.5"
Borehole Diameter: 6"

* See key sheet for symbols and abbreviations used above.



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Project: Water Main Replacement - Turlock

Page 1 of 1

Location: Wolfe, 180' SW of N. Palm

Project No.: G18-304-11F

Logged By: J. Schallberger

Checked By: N. Popenoe

Boring: B- 2A

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1								SM	Silty SAND - brown, moist, fine to medium grained	
2				103.7	11.7					
3										
4										
5										
6									... weakly cemented	
7										
8										
9										
10										
11									Boring terminated at approximately 10 feet bgs. Borehole backfilled with soil cuttings and capped with AC cold patch. No groundwater encountered.	
12										
13										
14										
15										
16										
17										
18										
19										

Drilling Contractor: BSK Associates
Drilling Method: Hand Auger
Drilling Equipment: N/A
Date Started: 1/23/19
Date Completed: 1/23/19

Surface Elevation:
Sample Method: 2.5-inch I.D. modified
Groundwater Depth: Not Encountered
Completion Depth: 10 Feet
Borehole Diameter: 4"

* See key sheet for symbols and abbreviations used above.



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Project: Water Main Replacement - Turlock

Page 1 of 1

Location: N. Mitchell, 130' SW of N. Thor

Project No.: G18-304-11F

Logged By: J. Schallberger

Checked By: N. Popenoe

Boring: B-3

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1									Asphalt concrete - 4.5"	
2									Concrete pavement was encountered below AC, boring was relocated to alley adjacent to roadway. Boring terminated at approximately 3.5 inches bgs. Borehole capped with AC cold patch. No groundwater encountered.	
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										

Drilling Contractor: Dave's Drilling
Drilling Method: Hollow Stem Auger
Drilling Equipment: Mobile B-61
Date Started: 1/23/19
Date Completed: 1/23/19

Surface Elevation:
Sample Method: N/A
Groundwater Depth: Not Encountered
Completion Depth: 3.5"
Borehole Diameter: 6"

* See key sheet for symbols and abbreviations used above.



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Project: Water Main Replacement - Turlock

Page 1 of 1

Location: N. Mitchell, 130' SW of N. Thor

Project No.: G18-304-11F

Logged By: J. Schallberger

Checked By: N. Popenoe

Boring: B- 3A

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1										
2				108.5	9.7	26				
3										
4										
5										
6				102.5	10.1				... weakly cemented, decrease sand content	
7										
8										
9										
10										
11									Boring terminated at approximately 10 feet bgs. Borehole backfilled with soil cuttings and capped with AC cold patch. No groundwater encountered.	
12										
13										
14										
15										
16										
17										
18										
19										

Drilling Contractor: BSK Associates
Drilling Method: Hand Auger
Drilling Equipment: N/A
Date Started: 1/23/19
Date Completed: 1/23/19

Surface Elevation:
Sample Method: 2.5-inch I.D. modified
Groundwater Depth: Not Encountered
Completion Depth: 10 Feet
Borehole Diameter: 4"

* See key sheet for symbols and abbreviations used above.



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Project: Water Main Replacement - Turlock

Location: Julian, 225' E of Grant

Project No.: G18-304-11F

Logged By: J. Schallberger

Checked By: N. Popenoe

Page 1 of 1

Boring: B- 4

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1								GM	Asphalt concrete - 3.5"	
2								SM	Silty Gravel - brown, moist, loose, fine to coarse grained - 5"	
3			34	113.0	8.9				Silty SAND - brown moist, medium dense, fine to medium grained ... dense	RV = 51
4								ML	Sandy SILT - brown, moist, very stiff, fine grained sand	
5								SP	Poorly Graded SAND - brown, moist, medium dense, fine to medium grained	
6			20							
7										
8										
9								SM	Silty SAND - brown, moist, very dense, fine to medium grained	
10										
11			50/ 5"							
12										
13									Boring terminated at approximately 11.5 feet bgs. Borehole backfilled with soil cuttings and capped with AC cold patch. No groundwater encountered.	
14										
15										
16										
17										
18										
19										

Drilling Contractor: Dave's Drilling
Drilling Method: Hollow Stem Auger
Drilling Equipment: Mobile B-61
Date Started: 1/22/19
Date Completed: 1/22/19

Surface Elevation:
Sample Method: 2.5-inch I.D. modified
Groundwater Depth: Not Encountered
Completion Depth: 11.5 Feet
Borehole Diameter: 6"

* See key sheet for symbols and abbreviations used above.



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Project: Water Main Replacement - Turlock

Page 1 of 1

Location: Park, 70' E of Grant

Project No.: G18-304-11F

Logged By: J. Schallberger

Checked By: N. Popenoe

Boring: B- 5

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1								SM	Asphalt concrete - 6.5"	
2									Silty SAND - brown, moist, fine to medium grained	
3				106.7	6.3					ø = 33°, C = 0 psf
4										
5										
6				103.6	5.1					
7										
8										
9										
10										
11									Boring terminated at approximately 10 feet bgs. Borehole backfilled with soil cuttings and capped with AC cold patch. No groundwater encountered.	
12										
13										
14										
15										
16										
17										
18										
19										

Drilling Contractor: BSK Associates
Drilling Method: Hand Auger
Drilling Equipment: N/A
Date Started: 1/23/19
Date Completed: 1/23/19

Surface Elevation:
Sample Method: 2.5-inch I.D. modified
Groundwater Depth: Not Encountered
Completion Depth: 10 Feet
Borehole Diameter: 4"

* See key sheet for symbols and abbreviations used above.



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Project: Water Main Replacement - Turlock

Location: Park, 850' E of Grant

Project No.: G18-304-11F

Logged By: J. Schallberger

Checked By: N. Popenoe

Page 1 of 1

Boring: B- 6

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1									Asphalt concrete - 8.5"	
2			8	105.5	5.6			SM	Silty SAND - brown, moist, loose, fine to medium grained	
3										
4										
5										
6			13			40				
7										
8										
9										
10									... light brown, medium dense	
11			28							
12										
13									Boring terminated at approximately 11.5 feet bgs. Borehole backfilled with soil cuttings and capped with AC cold patch. No groundwater encountered.	
14										
15										
16										
17										
18										
19										

Drilling Contractor: Dave's Drilling
Drilling Method: Hollow Stem Auger
Drilling Equipment: Mobile B-61
Date Started: 1/22/19
Date Completed: 1/22/19

Surface Elevation:
Sample Method: 2.5-inch I.D. modified
Groundwater Depth: Not Encountered
Completion Depth: 11.5 Feet
Borehole Diameter: 6"

* See key sheet for symbols and abbreviations used above.



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Project: Water Main Replacement - Turlock

Location: Grant, 70' S of Florence

Project No.: G18-304-11F

Logged By: J. Schallberger

Checked By: N. Popenoe

Page 1 of 1

Boring: B- 7

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1								GM	Asphalt concrete - 8"	
2								SM	Silty GRAVEL - brown, moist, loose, fine to coarse grained - 3"	
3			11	109.7	6.8				Silty SAND - brown, moist, loose, fine to medium grained	
4									... light brown, medium dense	
5										
6			34	109.6	2.4	40				ø = 37°, C = 10 psf
7										
8										
9								SM	Silty SAND - light brown, moist, dense, fine to medium grained, weakly cemented	
10										
11			63							
12										
13									Boring terminated at approximately 11.5 feet bgs. Borehole backfilled with soil cuttings and capped with AC cold patch. No groundwater encountered.	
14										
15										
16										
17										
18										
19										

Drilling Contractor: Dave's Drilling
Drilling Method: Hollow Stem Auger
Drilling Equipment: Mobile B-61
Date Started: 1/22/19
Date Completed: 1/22/19

Surface Elevation:
Sample Method: 2.5-inch I.D. modified
Groundwater Depth: Not Encountered
Completion Depth: 11.5 Feet
Borehole Diameter: 6"

* See key sheet for symbols and abbreviations used above.



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Project: Water Main Replacement - Turlock

Page 1 of 1

Location: Grant, 60' N of W. Main

Project No.: G18-304-11F

Logged By: J. Schallberger

Checked By: N. Popenoe

Boring: B- 8

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1									Asphalt concrete - 5"	
2			15	108.7	5.5			GM SM	Silty GRAVEL - brown, moist, loose, fine to coarse grained - 3.5" Silty SAND - brown, moist, medium dense, fine to medium grained	
3										
4										
5									... light brown, loose	
6			14							
7										
8										
9										
10									... medium dense, fine to coarse grained	
11			34							
12										
13									Boring terminated at approximately 11.5 feet bgs. Borehole backfilled with soil cuttings and capped with AC cold patch. No groundwater encountered.	
14										
15										
16										
17										
18										
19										

Drilling Contractor: Dave's Drilling
Drilling Method: Hollow Stem Auger
Drilling Equipment: Mobile B-61
Date Started: 1/22/19
Date Completed: 1/22/19

Surface Elevation:
Sample Method: 2.5-inch I.D. modified
Groundwater Depth: Not Encountered
Completion Depth: 11.5 Feet
Borehole Diameter: 6"

* See key sheet for symbols and abbreviations used above.



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Project: Water Main Replacement - Turlock

Location: Farr, 70' N of Columbia

Project No.: G18-304-11F

Logged By: J. Schallberger

Checked By: N. Popenoe

Page 1 of 1

Boring: B- 9

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1								SM	Asphalt concrete - 5.5"	RV = 56
2				97.7	14.7	33		ML	Silty SAND - brown, moist, fine to medium grained	
3								SM	Sandy SILT - gray, moist, fine grained sand ... weakly cemented	
4									Silty SAND - gray, moist, fine to medium grained	
5										
6										
7									... light brown	
8										
9										
10										
11									Boring terminated at approximately 10 feet bgs. Borehole backfilled with soil cuttings and capped with AC cold patch. No groundwater encountered.	
12										
13										
14										
15										
16										
17										
18										
19										

Drilling Contractor: BSK Associates
Drilling Method: Hand Auger
Drilling Equipment: N/A
Date Started: 1/23/19
Date Completed: 1/23/19

Surface Elevation:
Sample Method: 2.5-inch I.D. modified
Groundwater Depth: Not Encountered
Completion Depth: 10 Feet
Borehole Diameter: 4"

* See key sheet for symbols and abbreviations used above.



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Project: Water Main Replacement - Turlock

Location: S. Beech, 165' S of Columbia

Project No.: G18-304-11F

Logged By: J. Schallberger

Checked By: N. Popenoe

Page 1 of 1

Boring: B-10

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1								SM	Asphalt concrete - 3" Silty SAND - brown, moist, very dense, fine to medium grained	
2										
3			3"	103.4	13.2				... very moist	
4									... weakly cemented	
5								ML	Sandy SILT - greenish brown, moist, very stiff, fine grained sand, red striations	
6			39							
7								SM	Silty SAND - light brown, moist, medium dense, fine to medium grained	
8										
9										
10										
11			27							
12										
13									Boring terminated at approximately 11.5 feet bgs. Borehole backfilled with soil cuttings and capped with AC cold patch. No groundwater encountered.	
14										
15										
16										
17										
18										
19										

Drilling Contractor: Dave's Drilling
Drilling Method: Hollow Stem Auger
Drilling Equipment: Mobile B-61
Date Started: 1/22/19
Date Completed: 1/22/19

Surface Elevation:
Sample Method: 2.5-inch I.D. modified
Groundwater Depth: Not Encountered
Completion Depth: 11.5 Feet
Borehole Diameter: 6"

* See key sheet for symbols and abbreviations used above.



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Project: Water Main Replacement - Turlock

Page 1 of 1

Location: High, 70' E of West

Project No.: G18-304-11F

Logged By: J. Schallberger

Checked By: N. Popenoe

Boring: B-11

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1								SM	Asphalt concrete - 6"	RV = 52 $\phi = 34^\circ$, C = 10 psf
2									Silty SAND - brown, moist, fine to medium grained	
3				107.9	5.0					
4										
5										
6				101.7	11.4					
7										
8										
9										
10										
11									Boring terminated at approximately 10 feet bgs. Borehole backfilled with soil cuttings and capped with AC cold patch. No groundwater encountered.	
12										
13										
14										
15										
16										
17										
18										
19										

Drilling Contractor: BSK Associates
Drilling Method: Hand Auger
Drilling Equipment: N/A
Date Started: 1/23/19
Date Completed: 1/23/19

Surface Elevation:
Sample Method: 2.5-inch I.D. modified
Groundwater Depth: Not Encountered
Completion Depth: 10 Feet
Borehole Diameter: 4"

* See key sheet for symbols and abbreviations used above.



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Fax: 559-497-2886

Project: Water Main Replacement - Turlock

Location: High, 90' E of Marks

Project No.: G18-304-11F

Logged By: J. Schallberger

Checked By: N. Popenoe

Page 1 of 1

Boring: B-12

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1								GM SM	Asphalt concrete - 2.25" Silty GRAVEL - brown, moist, loose, fine to coarse grained - 4.75"	
2			12	112.9	8.3				Silty SAND - brown, moist, loose, fine to medium grained	
3										
4										
5									... dense, weakly cemented	
6			47							
7										
8										
9										
10										
11			44							
12										
13									Boring terminated at approximately 11.5 feet bgs. Borehole backfilled with soil cuttings and capped with AC cold patch. No groundwater encountered.	
14										
15										
16										
17										
18										
19										

Drilling Contractor: Dave's Drilling
Drilling Method: Hollow Stem Auger
Drilling Equipment: Mobile B-61
Date Started: 1/22/19
Date Completed: 1/22/19

Surface Elevation:
Sample Method: 2.5-inch I.D. modified
Groundwater Depth: Not Encountered
Completion Depth: 11.5 Feet
Borehole Diameter: 6"

* See key sheet for symbols and abbreviations used above.



BSK Associates
550 W. Locust Avenue
Fresno, California 93650
Telephone: (559) 497-2880

Project: Water Main Replacement - Turlock

Location: Various

Project No.: G18-304-11F

Logged By: S. Jue

Checked By: N. Popenoe

Page 1 of 1

Boring: B- 13

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1								SM	Asphalt Concrete - 2.5" Silty Aggregate Base - 2.5" , brown, moist, fine to coarse gravel Silty SAND - brown, moist, fine to medium grained sand	
2										
3				109.7	2.8					
4										
5				119.2	4.5					
6										
7										
8									... reddish orange	
9										
10										
11									Boring terminated at approximately 10 feet bgs. Borehole backfilled with soil cuttings, sand and cold patch. No groundwater encountered.	
12										
13										
14										

Drilling Contractor: BSK Associates
Drilling Method: Hand Auger
Drilling Equipment: 6" diamond core barrel
Date Started: 8/30/19
Date Completed: 8/30/19

Surface Elevation:
Sample Method: 2.5-inch I.D. modified
Groundwater Depth: Not Encountered
Completion Depth: 10 Feet
Borehole Diameter: 4"

* See key sheet for symbols and abbreviations used above.



BSK Associates
550 W. Locust Avenue
Fresno, California 93650
Telephone: (559) 497-2880

Project: Water Main Replacement - Turlock

Location: Various

Project No.: G18-304-11F

Logged By: S. Jue

Checked By: N. Popenoe

Page 1 of 1

Boring: B- 14

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1								SM	Asphalt Concrete - 6"	
2								SM	Silty SAND - brown, moist, fine to medium grained sand	
3						50		CL	CLAY w/Silt - gray, moist	
4				97.9	8.2			SM	Silty SAND - brown, moist, fine to medium grained sand	
5								SM	...	1/4 inch diameter roots found at 6.5 feet bgs
6								SM	...	
7								SM	...	
8								SM	...	
9								SM	...	
10								SM	...	
11								SM	Boring terminated at approximately 10 feet bgs. Borehole backfilled with soil cuttings, sand and cold patch. No groundwater encountered.	
12								SM		
13								SM		
14								SM		

Drilling Contractor: BSK Associates
Drilling Method: Hand Auger
Drilling Equipment: 6" diamond core barrel
Date Started: 8/30/19
Date Completed: 8/30/19

Surface Elevation:
Sample Method: 2.5-inch I.D. modified
Groundwater Depth: Not Encountered
Completion Depth: 10 Feet
Borehole Diameter: 4"

* See key sheet for symbols and abbreviations used above.

APPENDIX B

Laboratory Testing



APPENDIX B

Laboratory Testing

Moisture-Density Tests

The field moisture content, as a percentage of dry weight of the soils, was determined by weighing the samples before and after oven drying in accordance with ASTM D2216. Dry densities, in pounds per cubic foot, were also determined for 2.4-inch core samples in general accordance with ASTM D2937. Test results are presented on the boring logs in Appendix A.

Sieve Analysis Test

Five (5) Sieve Analysis Tests were performed on selected soil samples in the area of planned construction. The tests were performed in general accordance with Test Method ASTM D422. The results of the test are presented on Figures B-1 through B-5.

Direct Shear Test

Five (5) direct shear tests were performed on test specimen trimmed from a selected soil sample. The three-point shear test was performed in general accordance with ASTM D3080, Direct Shear Test for Soil under Consolidated Drained Conditions. The test specimens, each 2.42 inches in diameter and 1 inch in height, were subjected to shear along a plane at mid-height after allowing for pore pressure dissipation. The results of the tests are presented on Figure B-6 through B-10.

R-Value Test

Five (5) R-value tests were performed on selected soil samples. The tests were performed in general conformance with California Department of Transportation's Test Method (CT) 301. The results of the tests are presented on Figures B-11 through B-15.

Corrosion Testing

One minimum resistivity test was completed as per California Test Method 643. The results are presented in Table B-1.

TABLE B-1

Minimal Resistivity (ohm-cm)
5,420



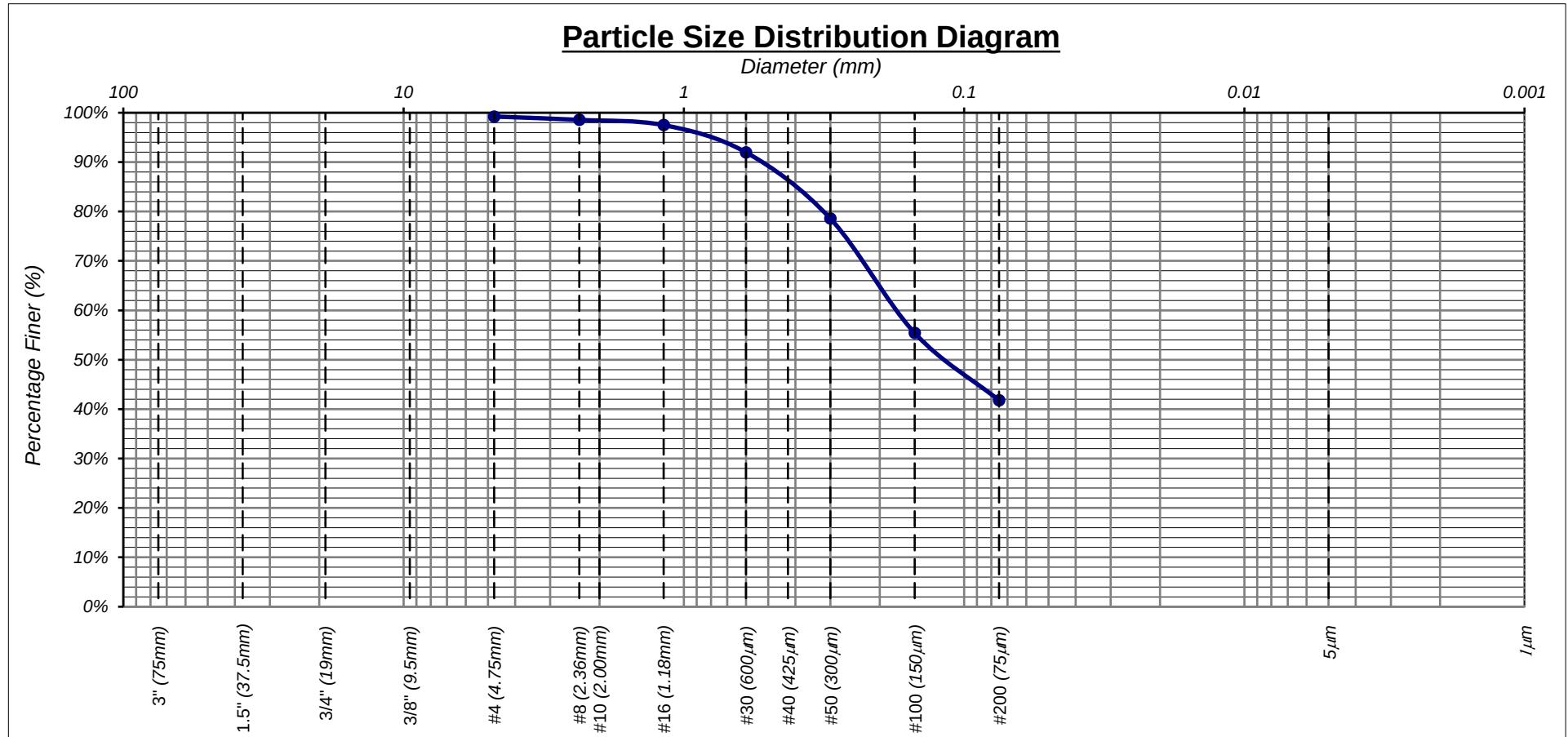


Gradation Analysis Report ASTM D-422 / ASTM C-136

FIGURE B-1

550 W. Locust Ave.
Fresno, CA 93650
Ph: (559) 497-2880
Fax: (559) 497-2886

Project Name:	Water Main Replacement - TO 8	Project Number:	G18-304-11F	Report Date:	2/4/2019
Sample Location:	B-1 @ 0 - 5'	Sample Lab ID:	F19-011	Sample Date:	1/23/2019
Sample Description:	Silty SAND (SM), brown, moist, fine to medium grained			Test Date:	2/3/2019



Clear Square Openings (ASTM C-136)			US Standard Series (ASTM D-422)			Hydrometer Readings (ASTM D-422)
Cobble	Gravel		Sand			Silt (Non-Plastic) to Clay (Plastic)
	Coarse	Fine	Coarse	Medium	Fine	

% Gravel = 1

% Sand = 57

% Fines = 42

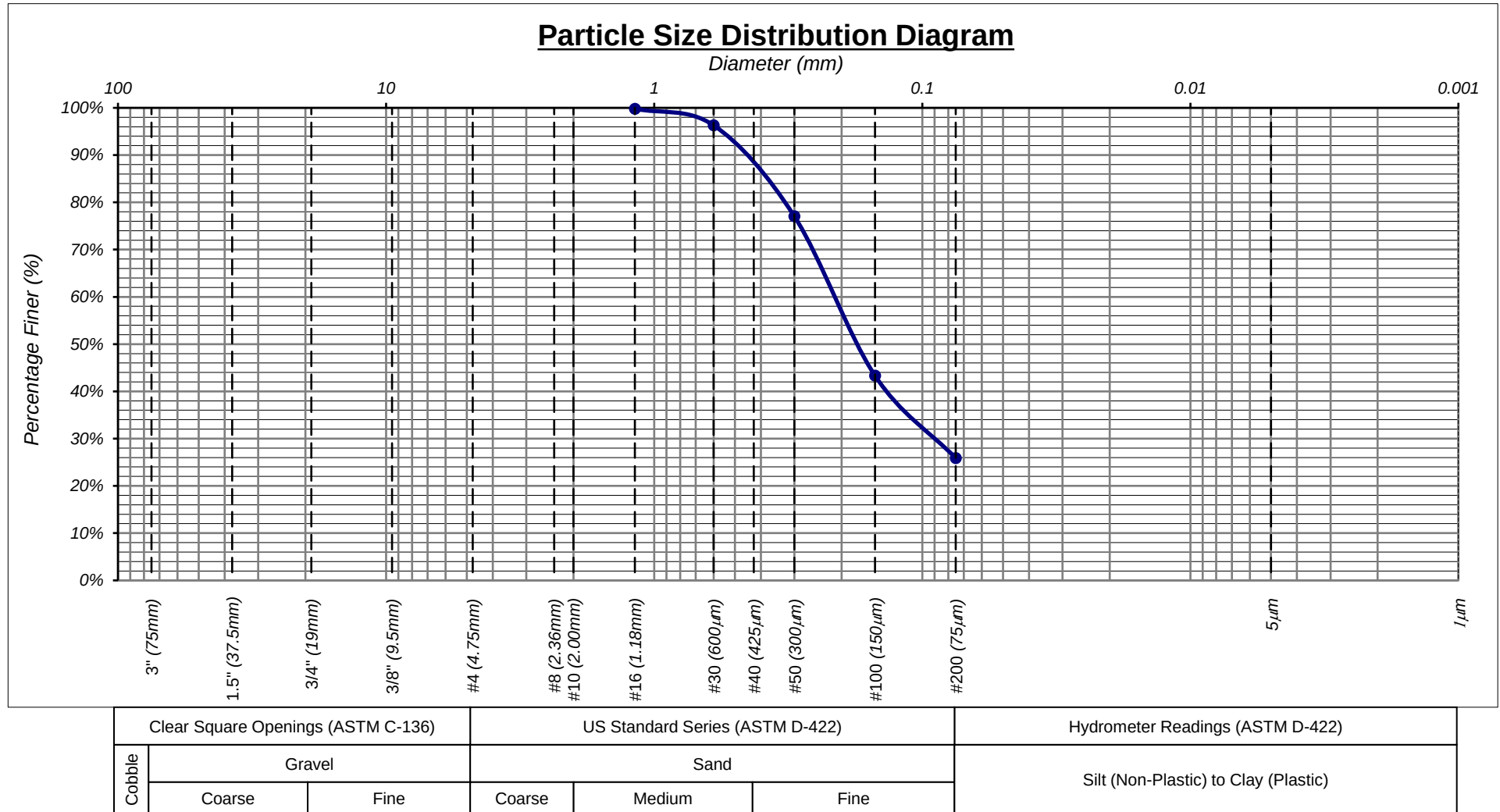


Gradation Analysis Report ASTM D-422 / ASTM C-136

FIGURE B-2

550 W. Locust Ave.
Fresno, CA 93650
Ph: (559) 497-2880
Fax: (559) 497-2886

Project Name:	Water Main Replacement - TO 8	Project Number:	G18-304-11F	Report Date:	2/4/2019
Sample Location:	B-3 @ 0 - 5'	Sample Lab ID:	F19-011	Sample Date:	1/23/2019
Sample Description:	Silty SAND (SM), brown, moist, fine to medium grained			Test Date:	2/3/2019



% Gravel = 0

% Sand = 74

% Fines = 26

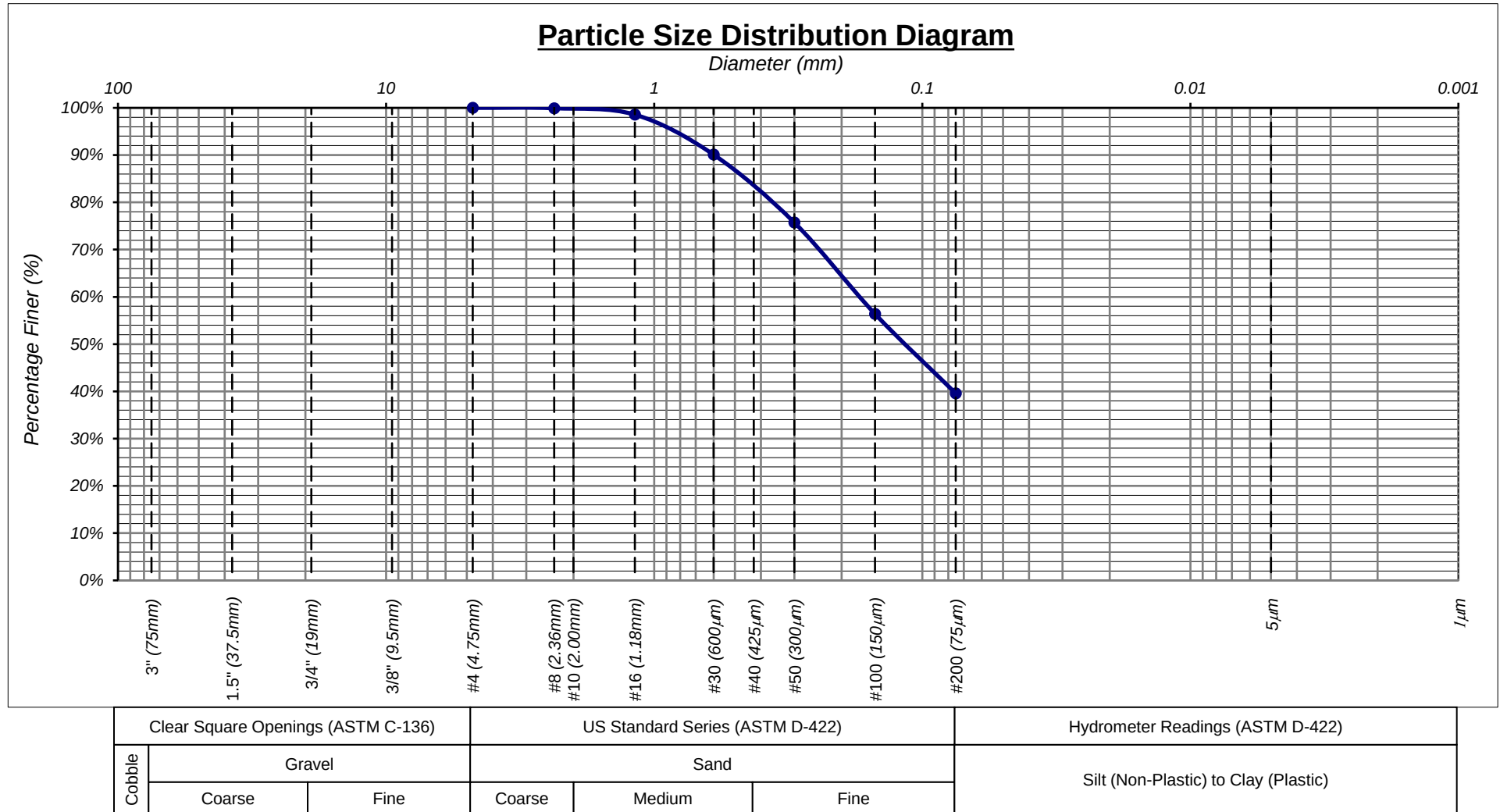


Gradation Analysis Report ASTM D-422 / ASTM C-136

FIGURE B-3

550 W. Locust Ave.
Fresno, CA 93650
Ph: (559) 497-2880
Fax: (559) 497-2886

Project Name:	Water Main Replacement - TO 8	Project Number:	G18-304-11F	Report Date:	2/4/2019
Sample Location:	B-7 @ 6'	Sample Lab ID:	F19-011	Sample Date:	1/23/2019
Sample Description:	Silty SAND (SM), brown, moist, fine to medium grained			Test Date:	2/3/2019



% Gravel = 0

% Sand = 60

% Fines = 40

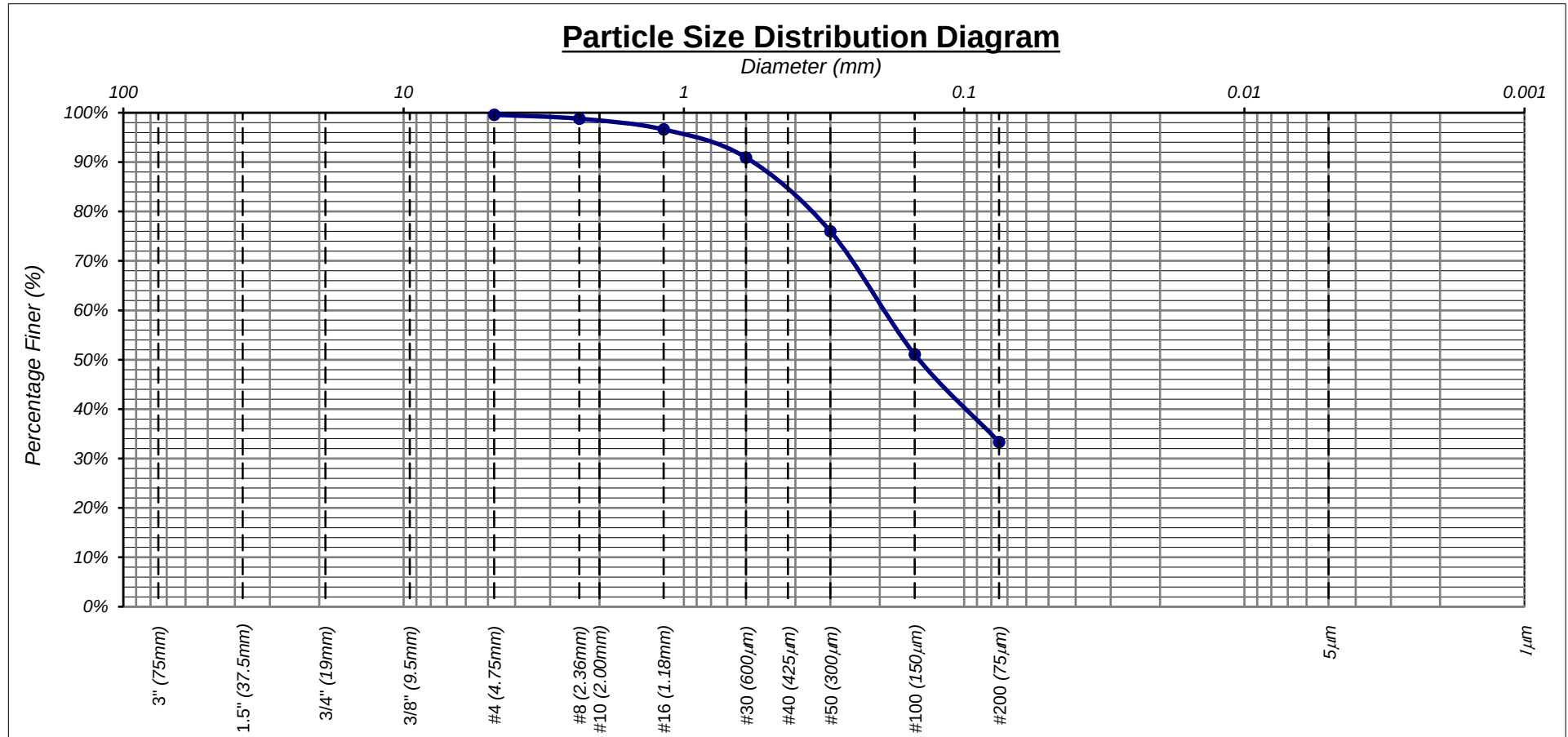


Gradation Analysis Report ASTM D-422 / ASTM C-136

FIGURE B-4

550 W. Locust Ave.
Fresno, CA 93650
Ph: (559) 497-2880
Fax: (559) 497-2886

Project Name:	Water Main Replacement - TO 8	Project Number:	G18-304-11F	Report Date:	2/4/2019
Sample Location:	B-9 @ 0 - 5'	Sample Lab ID:	F19-011	Sample Date:	1/23/2019
Sample Description:	Silty SAND (SM), brown, moist, fine to medium grained			Test Date:	2/3/2019



Clear Square Openings (ASTM C-136)			US Standard Series (ASTM D-422)			Hydrometer Readings (ASTM D-422)
Cobble	Gravel		Sand			Silt (Non-Plastic) to Clay (Plastic)
	Coarse	Fine	Coarse	Medium	Fine	

% Gravel = 0

% Sand = 66

% Fines = 33



Gradation Analysis Report ASTM D-422 / ASTM C-136

FIGURE B-5

550 W. Locust Ave.
Fresno, CA 93650
Ph: (559) 497-2880
Fax: (559) 497-2886

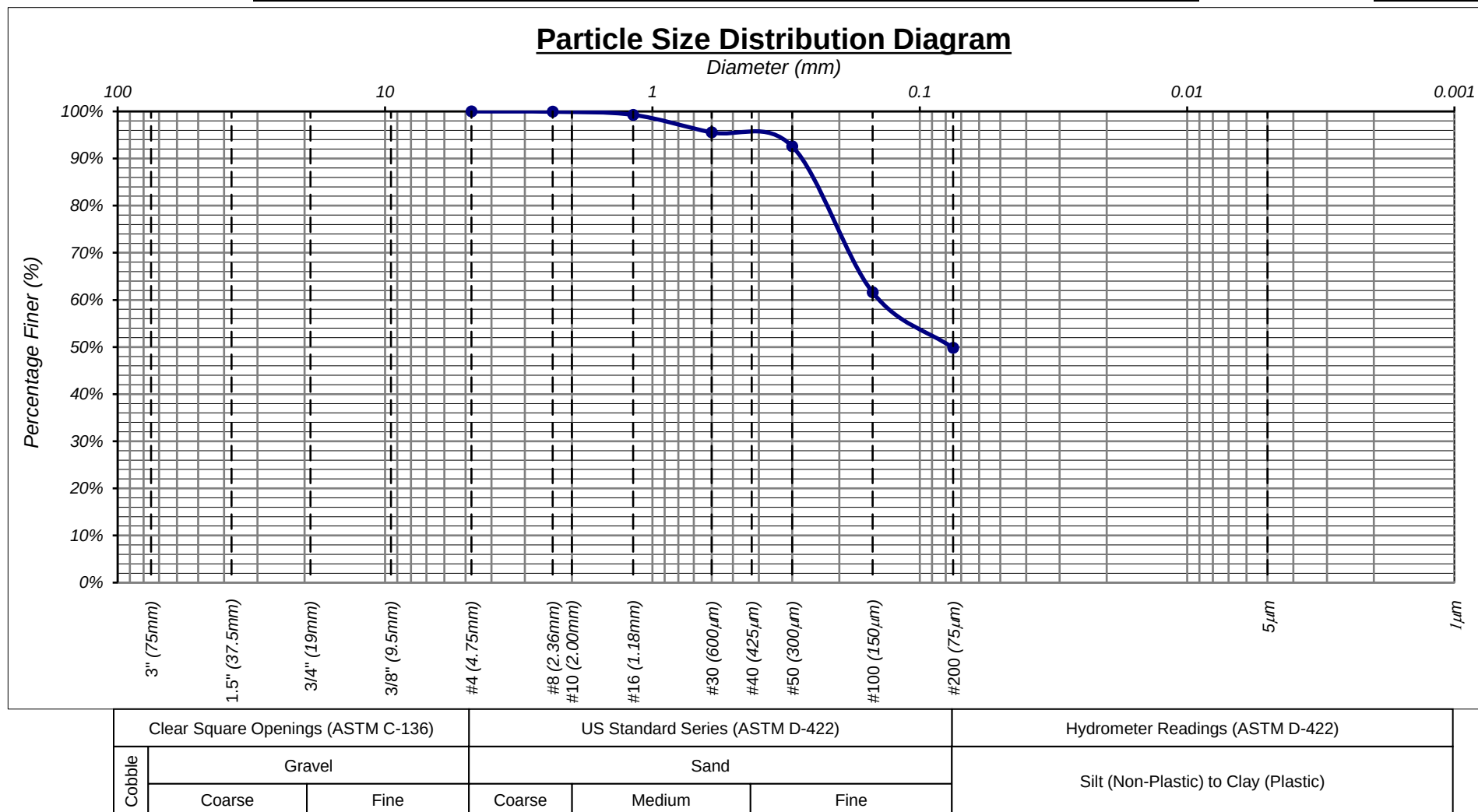
Project Name: Water Main Replacement - TO 8
Sample Location: B - 14 @ 0 - 5'
Sample Description: Silty SAND (SM)

Project Number: G18 - 304 - 11F

Report Date: 9/9/2019

Sample Date: 8/30/2019

Test Date: 9/4/2019



% Gravel = 0

% Sand = 50.2

% Fines = 49.8



Direct Shear Test

ASTM D-3080

FIGURE B-6

550 W. Locust
Fresno, CA 93650
Ph: (559) 497-2880
Fax: (559) 497-2886

Project Name: Water Main Replacement - TO 8

Sampled By: J.S.

Sample Date: 1/23/2019

Tested By: D.M.

Test Date: 2/1/2019

Project Number: G18-304-11F

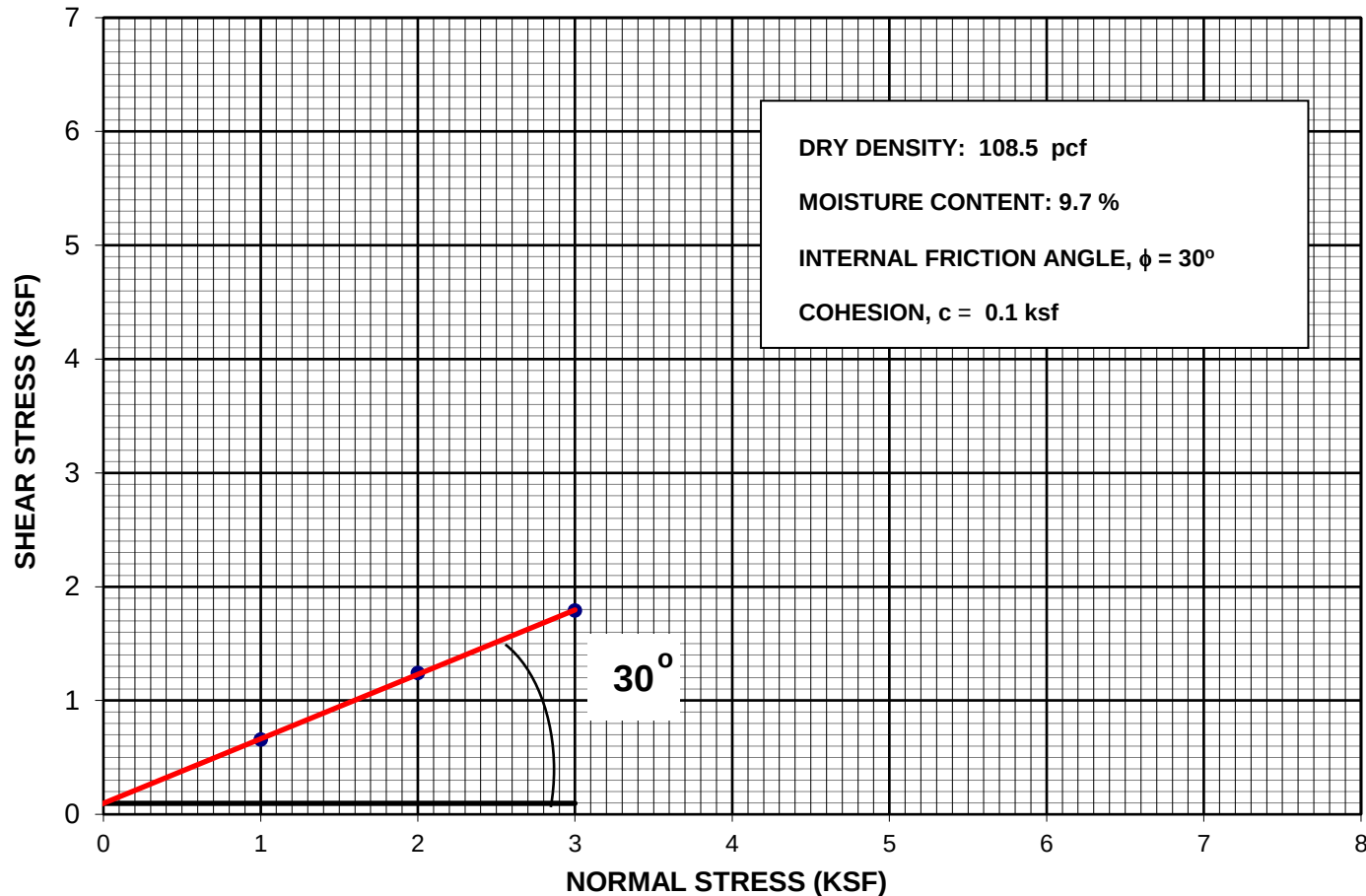
Lab Tracking ID: F19-011

Report Date: 2/12/2019

Sample Location: B-3 @ 1.5'

Sample Description: Silty SAND (SM), brown, moist, fine to medium grained

SHEAR STRENGTH DIAGRAM





Direct Shear Test

ASTM D-3080

FIGURE B-7

550 W. Locust
Fresno, CA 93650
Ph: (559) 497-2880
Fax: (559) 497-2886

Project Name: Water Main Replacement - TO 8

Sampled By: J.Schallberger

Sample Date: 1/23/2019

Project Number: G18-304-11F

Tested By: D.Messfin

Test Date: 2/3/2019

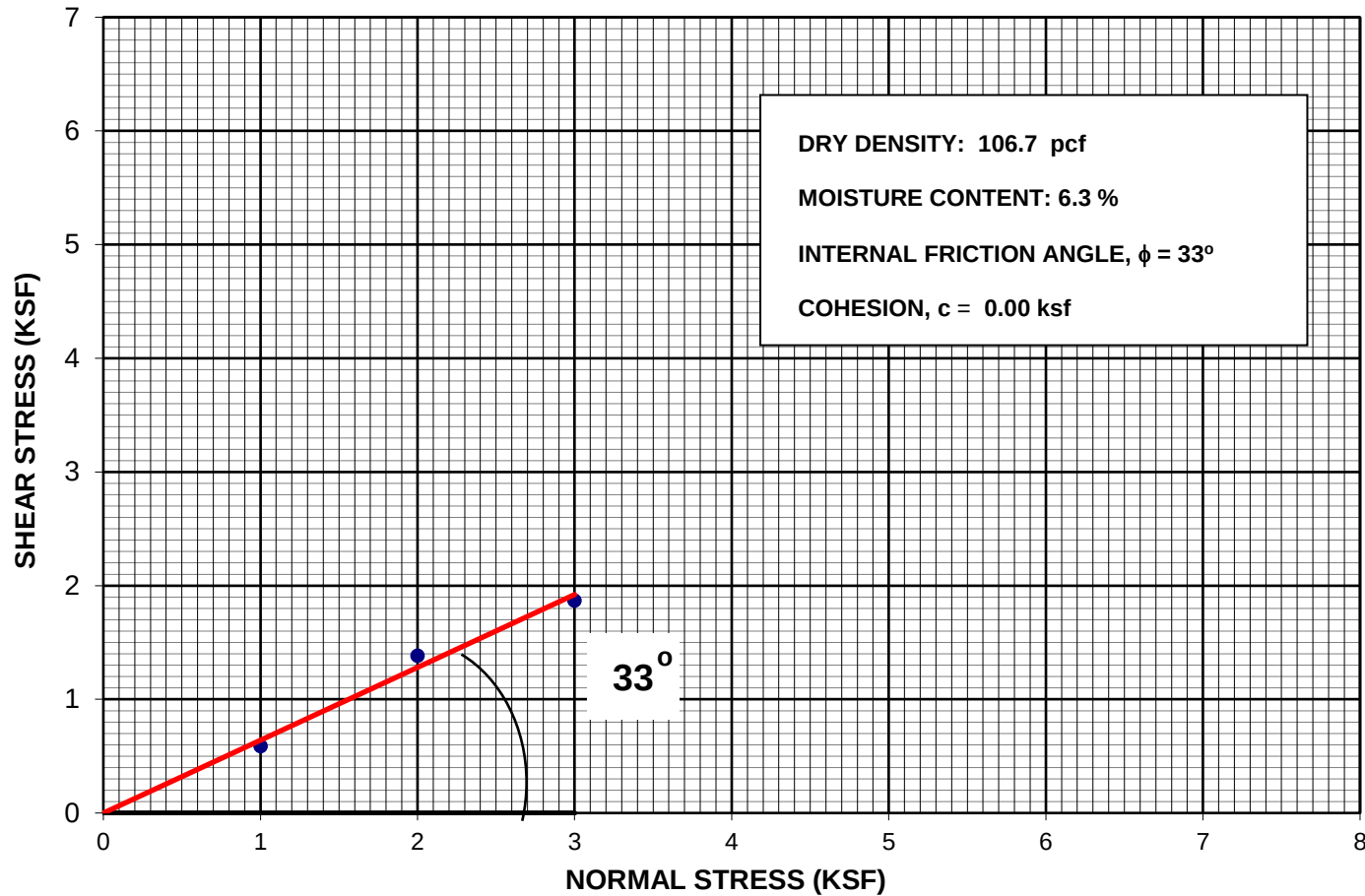
Sample Location: B-5 @2.5'

Lab Tracking ID: F19-011

Report Date: 2/4/2019

Sample Description: Silty SAND (SM), brown, moist, fine to medium grained sand

SHEAR STRENGTH DIAGRAM





Direct Shear Test

ASTM D-3080

FIGURE B-8

550 W. Locust
Fresno, CA 93650
Ph: (559) 497-2880
Fax: (559) 497-2886

Project Name: Water Main Replacement - TO 8

Sampled By: J.S.

Sample Date: 1/23/2019

Tested By: D.M.

Test Date: 2/5/2019

Project Number: G18-304-11F

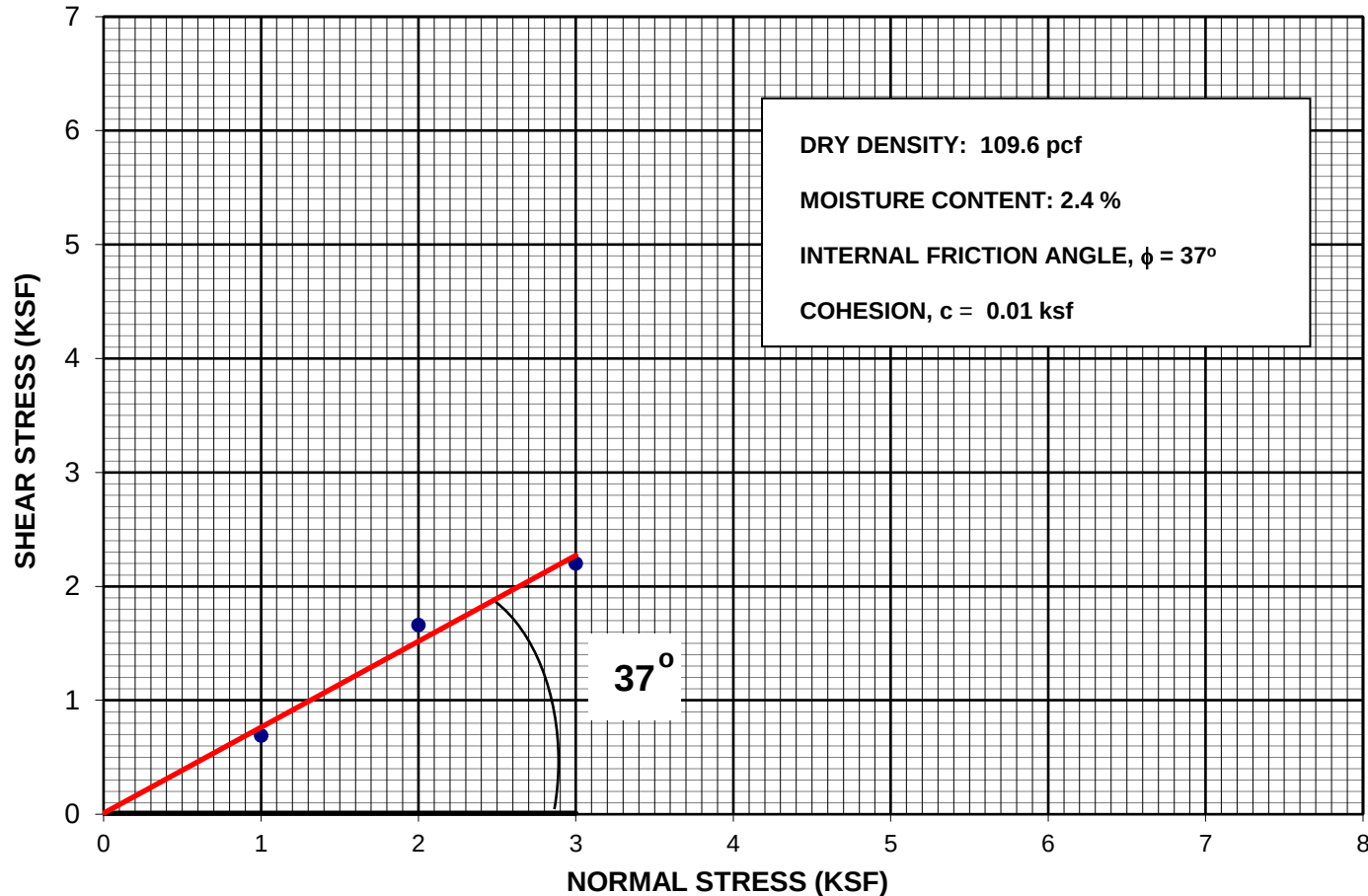
Lab Tracking ID: F19-011

Report Date: 2/11/2019

Sample Location: B-7 @ 6'

Sample Description: Silty SAND (SM), brown, moist, fine to medium grained

SHEAR STRENGTH DIAGRAM





Direct Shear Test

ASTM D-3080

FIGURE B-9

550 W. Locust
Fresno, CA 93650
Ph: (559) 497-2880
Fax: (559) 497-2886

Project Name: Water Main Replacement - TO 8

Sampled By: J.S.

Sample Date: 1/23/2019

Tested By: D.M.

Test Date: 2/5/2019

Project Number: G18-304-11F

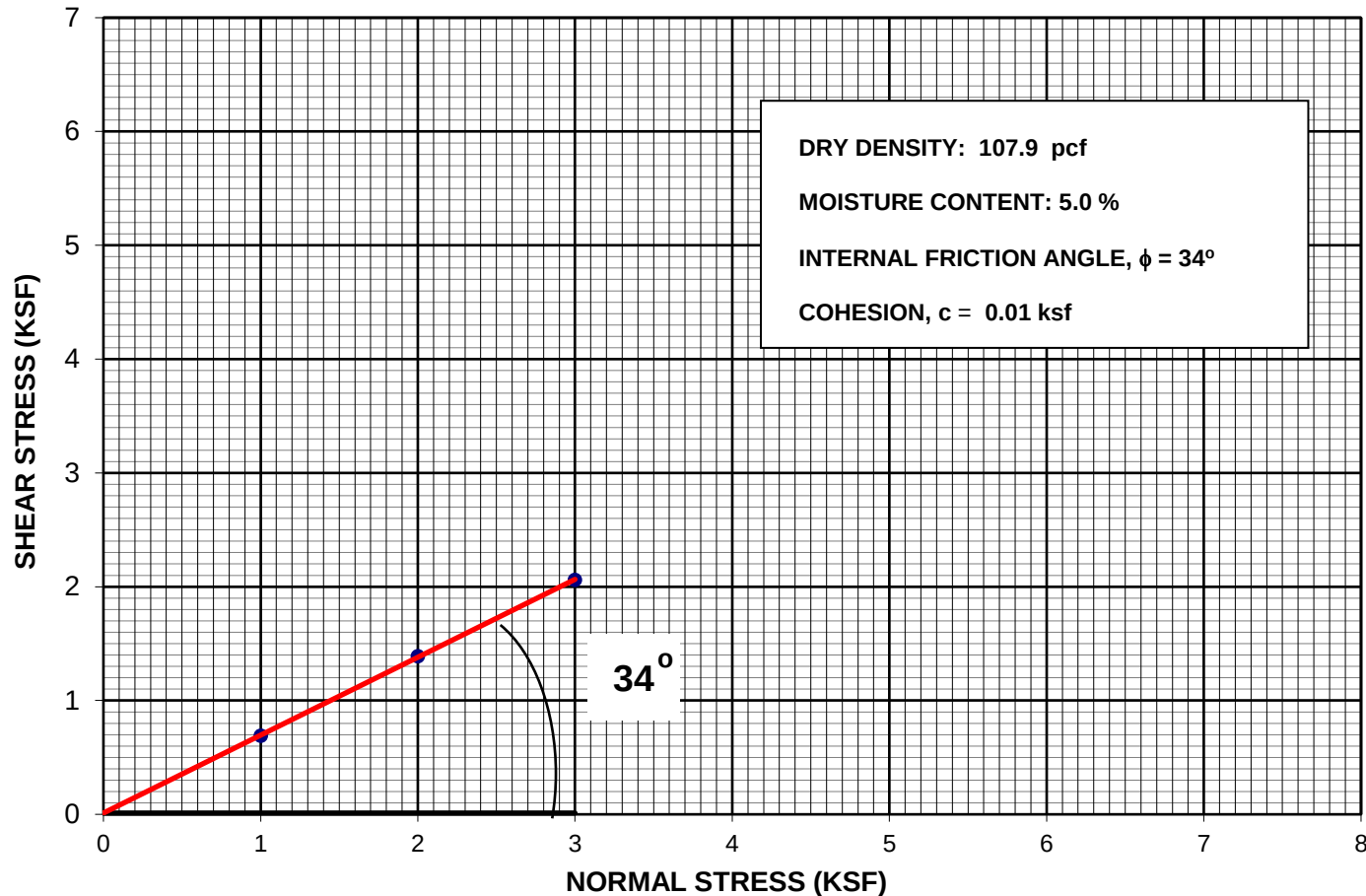
Lab Tracking ID: F19-011

Report Date: 2/11/2019

Sample Location: B-11 @ 2.5'

Sample Description: Silty SAND (SM), brown, moist, fine to medium grained

SHEAR STRENGTH DIAGRAM





Direct Shear Test

ASTM D-3080

FIGURE B-10

550 W. Locust
Fresno, CA 93650
Ph: (559) 497-2880
Fax: (559) 497-2886

Project Name: Water Main Replacement - TO 8

Sampled By: S. Jue

Sample Date: 8/30/2019

Tested By: D.M.

Test Date: 9/5/2019

Project Number: G18-304-11F

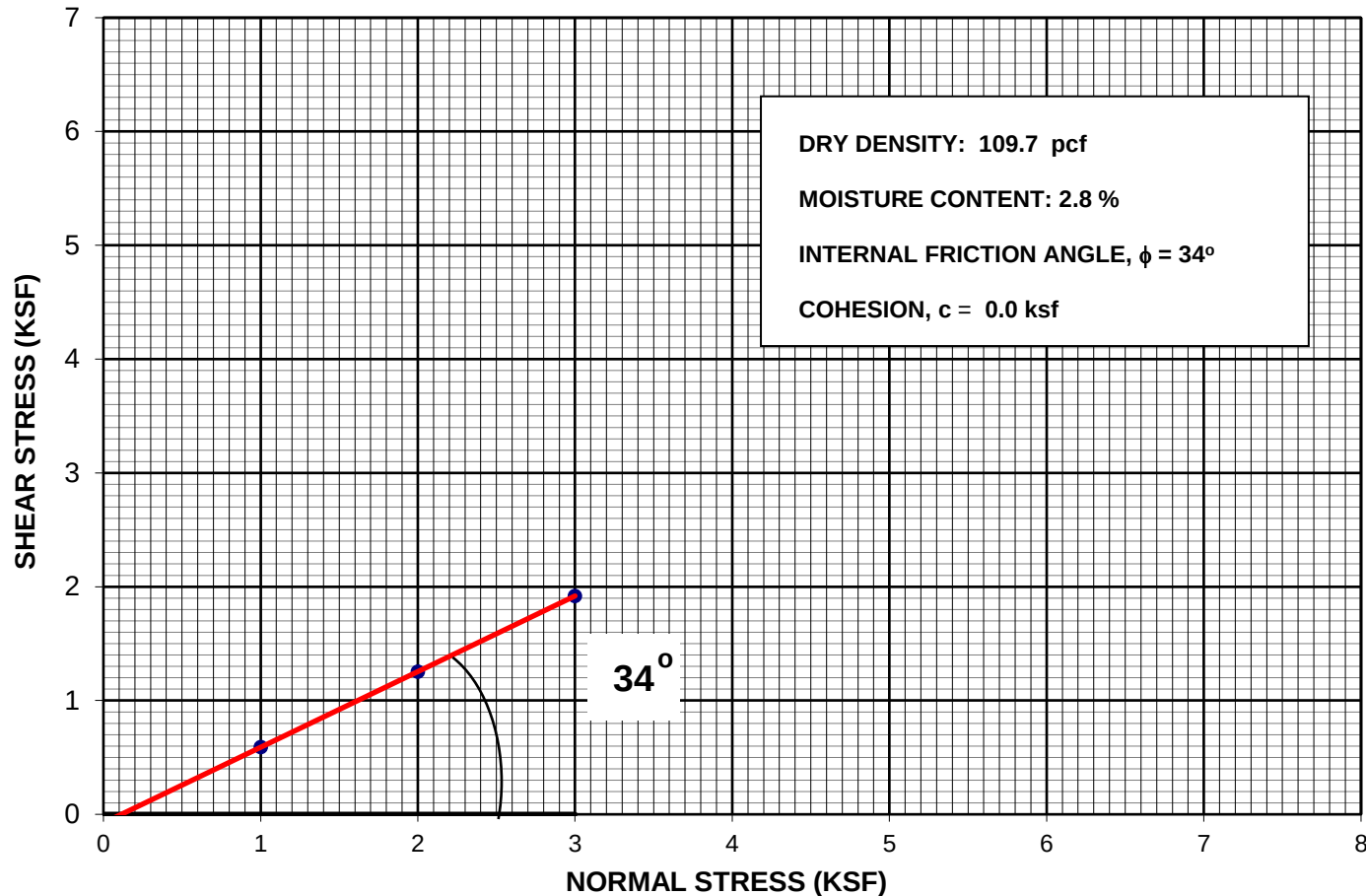
Lab Tracking ID: N/A

Report Date: 9/12/2019

Sample Location: B-13 @ 2'

Sample Description: Silty SAND (SM), brown, moist, fine to medium grained

SHEAR STRENGTH DIAGRAM





R-Value Test

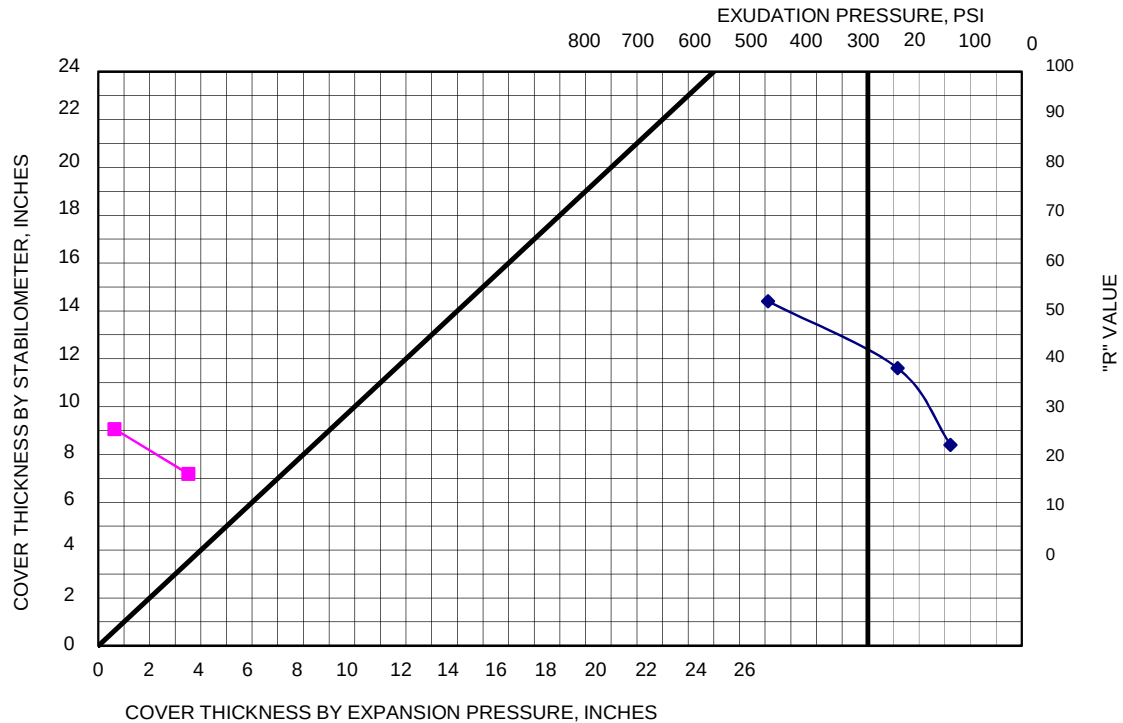
Caltrans Test Method 301

FIGURE B-11

700 22nd St.
Bakersfield, CA 93301
Ph: (661) 327-0670
Fax: (661) 324-4217

Project Name: Water Main Replacement
Project Number: G18-304-11F
Lab Tracking ID: B19-028
Sample Location: B-1 @ 0.0 - 5.0 feet bgs

Sample Date: 1/23/2019
Test Date: 2/5/2019
Report Date: 2/11/2019
Tested By: ILT Remotigue



Sample Description: SM: SILTY SAND; brown; fine to medium; moist.

SPECIMEN	A	B	C
EXUDATION PRESSURE, LOAD (lb)	6209	3039.5	1743.1
EXUDATION PRESSURE, PSI	494	242	139
EXPANSION, IN	-	0.0088	0.0016
EXPANSION PRESSURE, PSF	-	3	0
STABILOMETER PH AT 2000 LBS	61	89	110
DISPLACEMENT	3	3.21	3.99
RESISTANCE VALUE "R"	57	38	22
"R" VALUE CORRECTED FOR HEIGHT	52	38	22
% MOISTURE AT TEST	10.6	11.6	12.6
DRY DENSITY AT TEST, PCF	127.8	124.9	121.4
"R" VALUE AT 300 PSI EXUDATION PRESSURE	46		
"R" VALUE BY EXPANSION PRESSURE TI = 4.0, GF=1.50	46		



R-Value Test

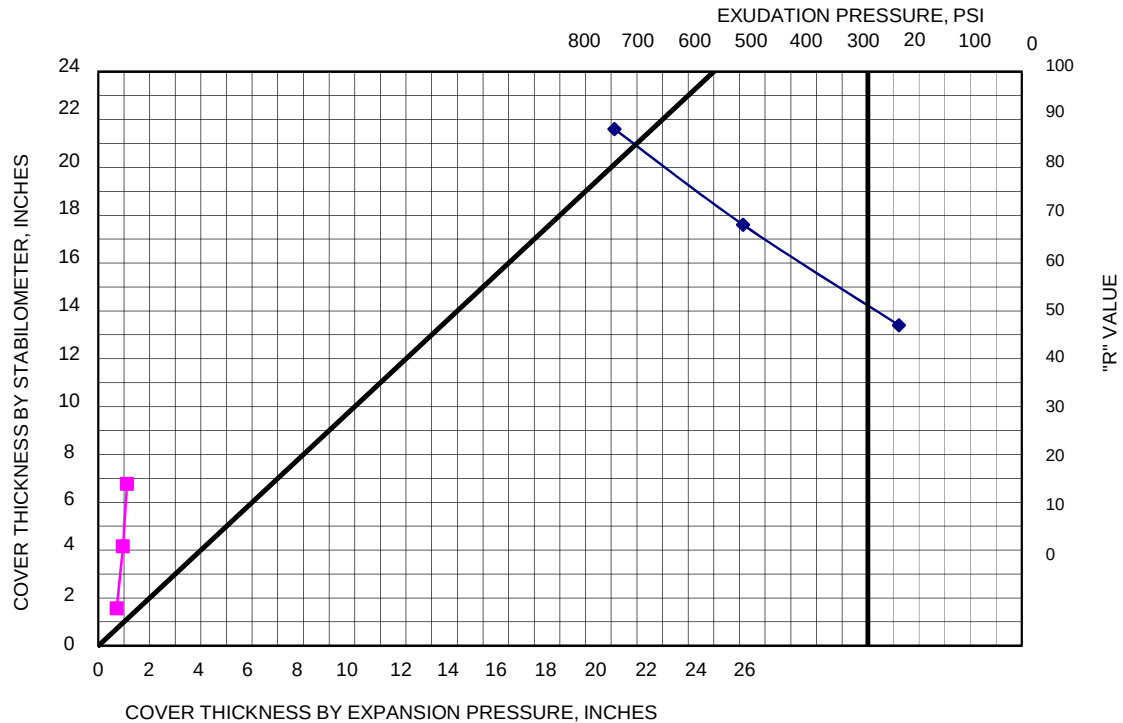
Caltrans Test Method 301

FIGURE B-12

700 22nd St.
Bakersfield, CA 93301
Ph: (661) 327-0670
Fax: (661) 324-4217

Project Name: Water Main Replacement
Project Number: G18-304-11F
Lab Tracking ID: B19-028
Sample Location: B-4 @ 0.0 - 5.0 feet bgs

Sample Date: 1/23/2019
Test Date: 2/6/2019
Report Date: 2/11/2019
Tested By: ILT Remotigue



Sample Description: SM: SILTY SAND; brown; fine to medium; moist.

SPECIMEN	A	B	C
EXUDATION PRESSURE, LOAD (lb)	9975.4	6824.4	3011.1
EXUDATION PRESSURE, PSI	794	543	240
EXPANSION, IN	0.0018	0.0024	0.0028
EXPANSION PRESSURE, PSF	1	1	1
STABILOMETER PH AT 2000 LBS	13	38	69
DISPLACEMENT	3.93	3.85	3.7
RESISTANCE VALUE "R"	88	68	47
"R" VALUE CORRECTED FOR HEIGHT	88	68	47
% MOISTURE AT TEST	7.7	8.7	9.7
DRY DENSITY AT TEST, PCF	131.3	130.8	127.9
"R" VALUE AT 300 PSI EXUDATION PRESSURE	51		
"R" VALUE BY EXPANSION PRESSURE TI = 4.0, GF=1.50	51		



R-Value Test

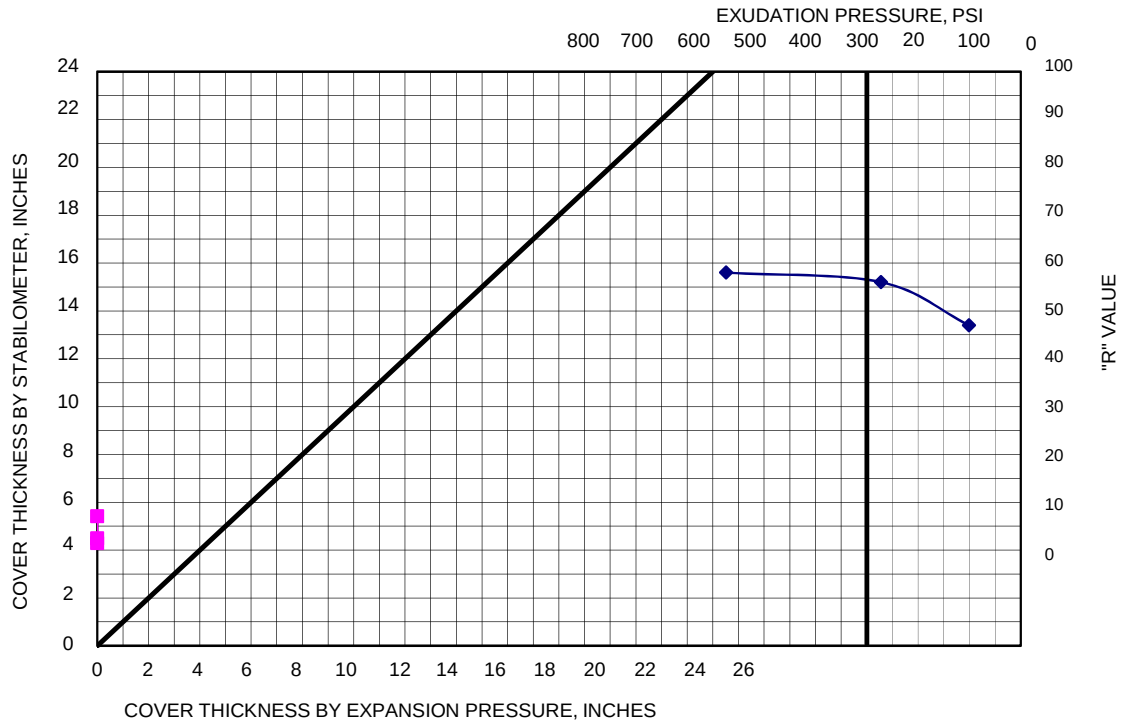
Caltrans Test Method 301

FIGURE B-13

700 22nd St.
Bakersfield, CA 93301
Ph: (661) 327-0670
Fax: (661) 324-4217

Project Name: Water Main Replacement
Project Number: G18-304-11F
Lab Tracking ID: B19-028
Sample Location: B-9 @ 0.0 - 5.0 feet bgs

Sample Date: 1/23/2019
Test Date: 2/6/2019
Report Date: 2/11/2019
Tested By: ILT Remotigue



Sample Description: SM: SILTY SAND; brown; fine to medium; moist.

SPECIMEN	A	B	C
EXUDATION PRESSURE, LOAD (lb)	7214.8	3421.3	1272.6
EXUDATION PRESSURE, PSI	574	272	101
EXPANSION, IN	0.0001	0.0007	0.0117
EXPANSION PRESSURE, PSF	0	0	4
STABILOMETER PH AT 2000 LBS	45	50	58
DISPLACEMENT	4.6	4.3	4.94
RESISTANCE VALUE "R"	58	56	47
"R" VALUE CORRECTED FOR HEIGHT	58	56	47
% MOISTURE AT TEST	11.1	12.1	13.1
DRY DENSITY AT TEST, PCF	116.6	115.3	114.9
"R" VALUE AT 300 PSI EXUDATION PRESSURE	56		
"R" VALUE BY EXPANSION PRESSURE TI = 4.0, GF=1.50	N/A		



R-Value Test

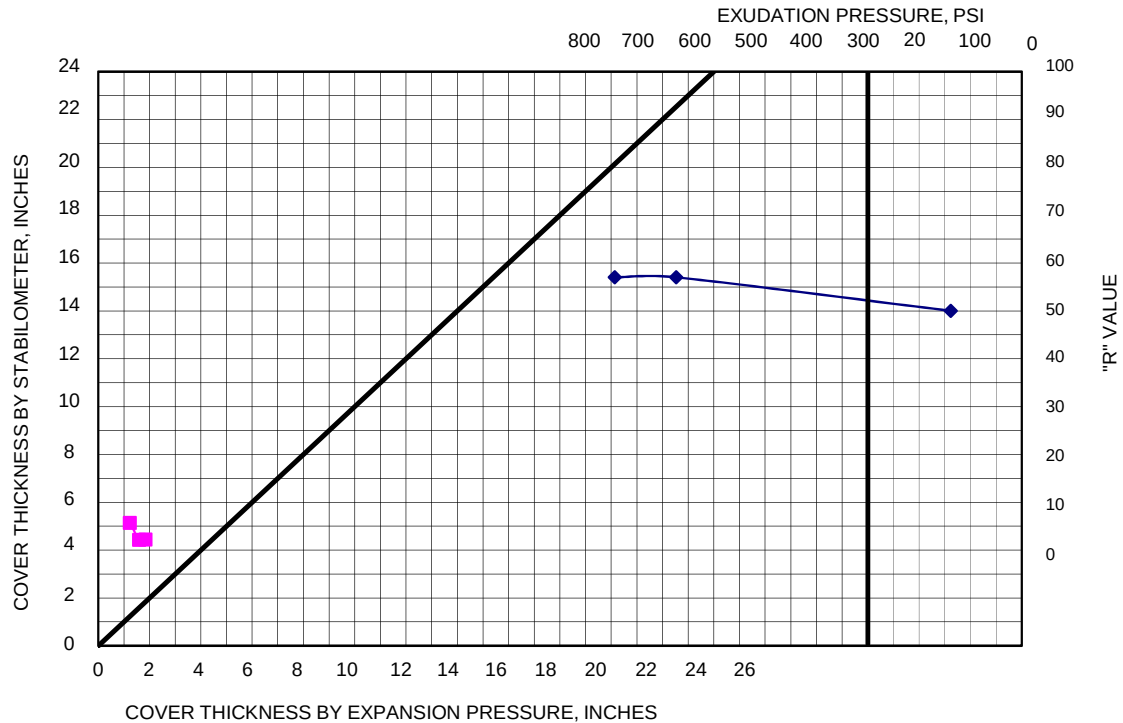
Caltrans Test Method 301

Figure B-14

700 22nd St.
Bakersfield, CA 93301
Ph: (661) 327-0670
Fax: (661) 324-4217

Project Name: Water Main Replacement
Project Number: G18-304-11F
Lab Tracking ID: B19-028
Sample Location: B-11 @ 0.0 - 5.0 feet bgs

Sample Date: 1/23/2019
Test Date: 2/6/2019
Report Date: 2/11/2019
Tested By: ILT Remotique



Sample Description: SM: SILTY SAND; brown; fine to medium; moist.

SPECIMEN	A	B	C
EXUDATION PRESSURE, LOAD (lb)	9965.1	8456.5	1735.8
EXUDATION PRESSURE, PSI	793	673	138
EXPANSION, IN	0.0046	0.004	0.0031
EXPANSION PRESSURE, PSF	1	1	1
STABILOMETER PH AT 2000 LBS	47	49	56
DISPLACEMENT	4.6	4.3	4.67
RESISTANCE VALUE "R"	57	57	50
"R" VALUE CORRECTED FOR HEIGHT	57	57	50
% MOISTURE AT TEST	9.1	9.6	10.1
DRY DENSITY AT TEST, PCF	116.0	117.7	115.1
"R" VALUE AT 300 PSI EXUDATION PRESSURE	52		
"R" VALUE BY EXPANSION PRESSURE TI = 4.0, GF=1.50	52		



R-Value Test

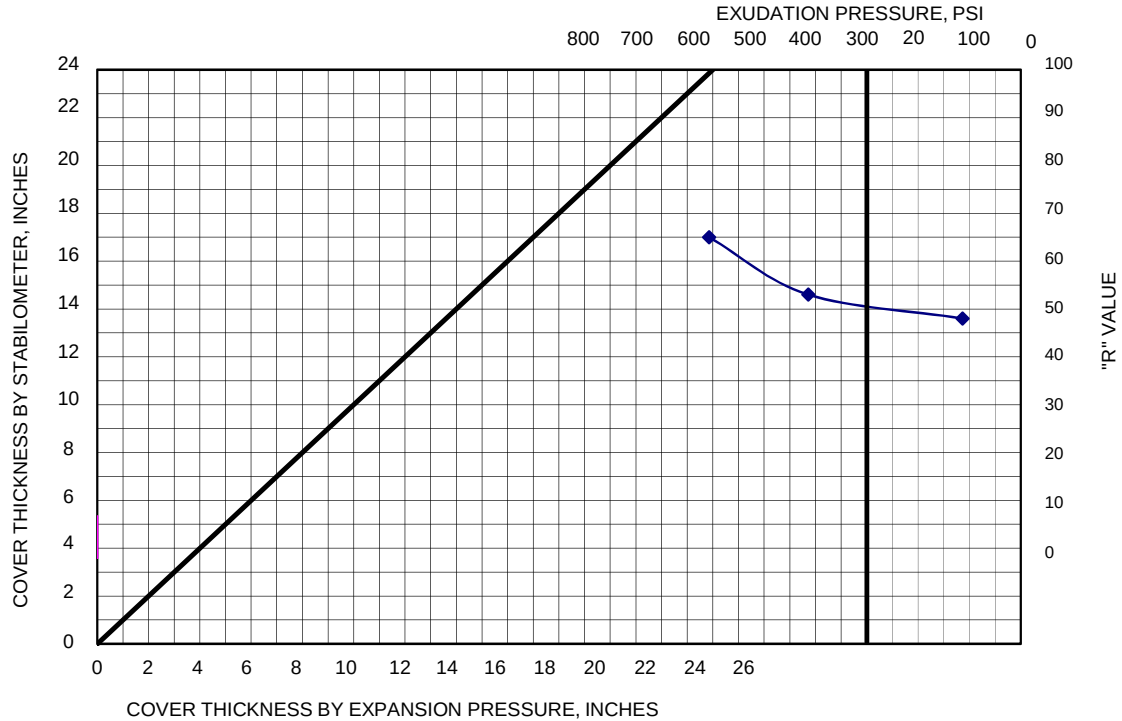
Caltrans Test Method 301

FIGURE B-15

700 22nd St.
Bakersfield, CA 93301
Ph: (661) 327-0670
Fax: (661) 324-4217

Project Name: Water Main Replacement
Project Number: G18-304-11F
Lab Tracking ID: B19-195
Sample Location: B-14 @ 0.0-5.0 feet bgs

Sample Date: 8/30/2019
Test Date: 9/12/2019
Report Date: 9/13/2019
Tested By: ILT Remotigue



Sample Description: SM:SILTY SAND; brown; fine to Medium; moist.

SPECIMEN	A	B	C
EXUDATION PRESSURE, LOAD (lb)	7632.1	5203	1421.9
EXUDATION PRESSURE, PSI	608	414	113
EXPANSION, * 0.0001 IN	-0.003	-0.005	-0.0030
EXPANSION PRESSURE, PSF	0	0	0
STABILOMETER PH AT 2000 LBS	36	46	58
DISPLACEMENT	4.67	5.54	4.78
RESISTANCE VALUE "R"	65	53	48
"R" VALUE CORRECTED FOR HEIGHT	65	53	48
% MOISTURE AT TEST	10.1	11.1	12.1
DRY DENSITY AT TEST, PCF	121.4	116.9	116.2
"R" VALUE AT 300 PSI EXUDATION PRESSURE	51		
"R" VALUE BY EXPANSION PRESSURE TI = 4.0, GF=1.50	N/A		