APPENDIX 4a

SUBSURFACE SOILS INVESTIGATION
AREAS H AND I SEWER
IMPROVEMENT PROJECT
DESERT HOT SPRINGS, CALIFORNIA

PROJECT NO. 63643.9
JUNE 19, 2020

Prepared for:

TKE Engineering, Inc.
2305 Chicago Avenue
Riverside, California 92507

Attention: Ms. Yesenia Diaz

June 19, 2020

TKE Engineering, Inc.
2305 Chicago Avenue
Riverside, California 92507

Project No. 63643.9

Attention: Ms. Yesenia Diaz

Subject: Subsurface Soils Investigation, Areas H and I Sewer Improvement Project, Desert Hot Springs, California.

Transmitted with this letter is our report entitled Subsurface Soils Investigation, Areas H and I Sewer Improvement Project, Desert Hot Springs, California.

This report was based upon a scope of services generally outlined in our proposal letter dated April 30, 2020 and other written and verbal communications with you.

The native materials should provide adequate support for the proposed water line within the project alignment. Additional geotechnical parameters for pipeline design and construction are provided within the attached report.

LOR Geotechnical Group, Inc.

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INTRODUCTION

During May and June of 2020, a Subsurface Soils Investigation was performed by LOR Geotechnical Group, Inc., for the proposed Areas H and I sewer improvement project, located in the City of Desert Hot Springs, California. The purpose of this investigation was to evaluate the subsurface conditions encountered in our exploratory borings and to provide geotechnical design recommendations for the proposed waterline placement and backfill. The scope of our services included: 1) A subsurface field investigation; 2) Laboratory testing of selected soil samples obtained during the field investigation; 3) Development of geotechnical recommendations for the waterline construction; and, 4) Preparation of this report.

The findings of our investigation, as well as our conclusions and recommendations, are presented in the following sections of this report.

PROJECT CONSIDERATIONS

The project will consist of the construction/installation of approximately 25,000 linear feet of 8-inch sewer pipeline. The project area is generally located south of Desert View Avenue, on the east by Mountain View Road, on the west by Miracle Hill Road, and on the south by approximately one-half mile south of Hacienda Avenue The project will utilize open cut trenching and jack and bore techniques.

The depth to the invert of the pipe will be approximately 8 feet deep in the open cut trench areas and approximately 12 to 15 feet deep under the existing drainage channel between Hidalgo Street and Quinta Way.

The approximate location of the project area within its regional setting is presented on Enclosure A-1, within Appendix A. The approximate location of our exploratory boring, is shown on the enclosed Site Map, Enclosure A-2, within Appendix A.

FIELD INVESTIGATION

Our field exploration program was conducted on May 22 and May 26, 2020 and consisted of drilling 15 exploratory borings with a mobile B-61 drill rig equipped with 8-inch diameter hollow stem augers. The borings were drilled to depths of approximately 12 to 26.4 feet below the existing ground surface. The approximate locations of the borings are presented on the enclosed Site Map, Enclosure A-2, within Appendix A.

Logs of the subsurface conditions encountered in the exploratory borings were created by a geologist from this firm. Relatively undisturbed and bulk samples were obtained within the borings at a maximum depth interval of 5 feet. The thickness of the asphalt concrete pavement, where present, was measured at each location. The condition of the existing pavement in the area of each boring was noted. Observations for each boring are presented on Enclosures B-1 through B-15, along with a detailed description of the field exploration program, within Appendix B.

The relatively undisturbed soil samples and subgrade soil samples were placed in sealed containers and returned to our geotechnical laboratory for further testing and evaluation.

LABORATORY TESTING PROGRAM

Selected soil samples obtained during the field investigation were subjected to laboratory testing to evaluate their physical and engineering properties. Laboratory testing included in-place moisture content and dry density, laboratory compaction characteristics, direct shear, sand equivalent, and soil corrosion. A detailed description of our geotechnical laboratory testing program and our test results are presented within Appendix C.

Corrosion testing and analysis was conducted on select samples by our licensed sub-consultant, HDR, Inc. The results of their testing and analysis are presented in Appendix D.

SUBSURFACE CONDITIONS

Data from our exploratory borings indicates that the project area is underlain by units of silty sand with gravel, poorly graded sand with gravel, and well graded sand with gravel. These units were typically brown to tan in color and dry to damp. Based on our equivalent SPT blow counts and in-place density test data, the native materials below the proposed waterline invert elevations were typically in a medium dense to very dense in-place state.

Groundwater was encountered within two of our exploratory borings. Boring B-8 encountered groundwater as a hot spring at a depth of approximately 7 feet, and Boring B-10 encountered groundwater at a depth of approximately 24 feet.

We reviewed readily available well data from the California Department of Water Resources online water data library. The nearest well to the site is State Well Number 02S05E31H001S, located approximately 0.5 miles (0.84 kilometers) to the west.

Data for this well was available from December 2011 through December of 2019. Groundwater measurements fluctuated from a high of approximately 8 feet in 2011 and a low of approximately 12 feet in 2019.

CONCLUSIONS

The subsurface conditions encountered in our exploratory borings are indicative of the locations explored. It is not to be construed that these conditions are present the same throughout the project alignment.

Recommendations for shoring design are based on the properties of the native material being exposed in excavation walls as obtained during this investigation. The compaction characteristics and shear strength properties of any existing trench backfills is unknown. Typically, excavations exposing trench backfill are considered unstable.

On the basis of our limited field investigation and testing program, it is the opinion of LOR Geotechnical Group, Inc., that placement of the sewer pipeline via jack and bore and open trench replacement, are all feasible from a soil engineering standpoint, provided that the following recommendations are incorporated into design and implemented during construction.

Because of the negligible additional load imposed to the ground by the improvements, the native materials should provide adequate support for the proposed waterline within the project alignment. Details for pipe support are provided in the Preparation of the Pipeline Areas section of this report.

At the time of our investigation groundwater was found at or above the proposed invert elevations in our boring locations, seasonal climatic changes can effect the elevation of the groundwater. Hence, precautions, including localized dewatering and safe slope excavation inclinations, may be necessary especially if the construction of the project takes place following a rainy season.

RECOMMENDATIONS

Dewatering

Groundwater was found in the area of our boring B-8 at or near the proposed invert, groundwater levels may be shallower following periods of heavy rain.

If the construction of the proposed pipeline occurs following a rainy season, groundwater may be a localized nuisance, and it may require dewatering methods. A variety of methods exists for controlling subsurface water. These methods typically utilize barriers, liners, wells, and/or drains. Barriers and liners are typically employed to restrict or reduce the surface flow of water, while wells and drains tend to lower the water table to redirect the water flow. The final solution should be determined by a qualified hydraulic engineer experienced in dewatering methods in similar environments.

Jack and Bore

The proposed jack and bore portion of the project is considered feasible from a geotechnical standpoint provided the recommendations contained within are adhered to. Our data suggests favorable soil conditions to perform such operations are present.

Trench Excavation

Standard trenching equipment should be suitable for the proposed excavation of the sewer pipeline. Trench excavation safety and precautions, including safe slope excavation inclinations, should be implemented and are the responsibility of the contractor.

Following the California Occupational Safety and Health Act (CAL-OSHA) requirements, excavations 5 feet deep and greater should be sloped or shored. All excavations and shoring should conform to CAL-OSHA requirements.

Short-term excavations of 5 feet deep and greater shall conform to Title 8 of the California Code of Regulations, Construction Safety Orders, Section 1504 and 1539 through 1547. Based on our exploratory borings, it appears that Type C soil is the predominant type of soil material on the project and all short-term excavations should be based on this type of soil material. In accordance with Title 8 of the California Code of Regulations, simple slope excavations up to 20 feet in depth made in Type C soil material should have maximum allowable slopes of 1.5 horizontal to 1 vertical. However, due to the relatively dry and granular state of the natural soils, extreme care should be taken in the construction and maintenance of short term excavations within such soils as they tend to be less stable. Deviation from the standard short term slopes are permitted using option 4, Design by a Registered Professional Engineer (Section 1541.1).

It should be stated that depending on the proximity of the pipeline to any other utility trenches, short-term excavations may expose the existing old trench backfill materials.

The compaction characteristics and shear strength properties of the existing trench backfills is unknown. Typically, excavations exposing trench backfill are considered unstable.

The construction and maintenance of short-term excavations is the responsibility of the contractor and should be a consideration of his methods of operation and the actual soil conditions encountered.

Shoring Design Parameters

General: Shoring placed below grade that is restrained against free movement at the top should be designed to resist a lateral earth pressure between active and at rest conditions. For this condition we recommend a lateral earth pressure, trapezoidal distribution of 15H pounds per square foot (psf).

Additional surcharge loads (i.e. equipment, excavation spoil, etc.) placed within a horizontal distance equal to the height of the excavation should be added to the above recommended pressure at a rate of 0.28 times the surcharge load.

In addition, if the excavation walls are composed of any trench backfill materials associated with existing utilities, the in-place density and shear strength properties of the backfills should be investigated to verify the suitability of the preceding shoring parameters.

Any isolated loads (O_P) or line load (Q_L) from adjacent vehicular loading will impose additional burden on the shoring and should be completed as shown on Enclosure E-1, with Appendix E.

Preparation of the Pipeline Areas

Upon excavation of the proposed pipeline areas to the planned line and grade, observations and in-place density testing should be conducted to ensure that no soft/loose materials are present. The materials to be exposed at the bottom of the excavation should be observed to assess if they require stabilization. Stabilization is not anticipated to be required. However, if stabilization is required, consideration should be given to the placement of rock at the bottom of the excavations to achieve a working platform that facilitates the installation of the sewer pipe and placement of bedding and backfill materials. The crushed rock should be sized in accordance with Section 200-1.1 and 1.2 of the Standard Specifications for Public Works Construction “Greenbook”.

To assist in mitigating yielding subgrade conditions, crushed rock materials can be complemented by the placement of continuous sheets of geogrid under the rock.

After placement of the sewer pipe, backfill materials should then be placed around the pipe in accordance with the recommendations given in the Engineered Compacted Fill section of this report.

Engineered Compacted Fill

Based upon laboratory results of preliminary sampling, the majority of the materials encountered and tested resulted in a sand equivalent above 30 and are therefore considered suitable for bedding sand around the pipeline. However, minor amounts of materials were encountered and tested to have a sand equivalent below 30. These materials are not considered suitable as bedding sand around the pipeline. Bedding material should consist of sand, gravel, or crushed aggregate less than 1 inch in diameter and having a sand equivalent of not less than 30 or as specified by the pipe manufacturer.

The site materials are generally suitable for use as trench backfill above the bedding material. However, the majority of the soils to be excavated are dry and will require moisture conditioning to achieve the desired optimum moisture content prior to using as engineered compacted fill. Although not anticipated, rock or similar irreducible material with a maximum dimension greater than 6 inches should not be buried or placed in fills without prior approval by the geotechnical engineer.

Import fill, if required, should be inorganic, non-expansive, granular soils free from rocks or lumps greater than 6 inches in maximum dimension. Sources for import fill should be approved by the geotechnical engineer prior to their use.

Care should be exercised so that the waterline pipe is not damaged or displaced during densification of the backfill. Backfill materials should be free from organic material, trash, debris, and other objectionable materials. Backfill should be mechanically compacted to at least 90 percent relative compaction (ASTM D 1557) at or near optimum moisture content. The upper 12 inches of subgrade materials that are to be paved should be compacted to at least 95 percent relative compaction (ASTM D 1557).

In addition, due to potentially localized high groundwater conditions within the project area, the project civil engineer should verify that the hydrostatic uplift force is balanced by the soil overburden and weight of the pipe in order to ensure that the improvements will not float.

The vertical hydrostatic uplift force, U, due to the water table can be calculated as:

U = ð/4 D^2 $ã_{water}$

where: U = lb/linear ft of pipe
D = OD of pipe, ft
$ã_{water}$ = unit weight of water = 62.4 lb/ft^3

Corrosion Protection

The results from the soil corrosivity testing, analysis, and recommendations completed by HDR, Inc., are presented within Appendix D.

LIMITATIONS

This report contains geotechnical conclusions and recommendations developed solely for use by TKE Engineering, Inc. and their sub-consultants, for the purposes described earlier. It may not contain sufficient information for other uses or the purposes of other parties. The contents should not be extrapolated to other areas or used for other facilities without consulting LOR Geotechnical Group, Inc.

The recommendations are based on interpretations of the subsurface conditions concluded from information gained from subsurface explorations. The interpretations may differ from actual subsurface conditions, which can vary horizontally and vertically across the site. If conditions are encountered during the construction of the project, which differ significantly from those presented in this report, this firm should be notified immediately so we may assess the impact to the recommendations provided. Due to possible subsurface variations, all aspects of field construction addressed in this report should be observed and tested by the project geotechnical consultant.

The report was prepared using generally accepted geotechnical engineering practices under the direction of a state licensed geotechnical engineer. No warranty, expressed or implied, is made as to conclusions and professional advice included in this report. Any persons using this report for bidding or construction purposes should perform such independent investigations as deemed necessary to satisfy themselves as to the surface and subsurface conditions to be encountered and the procedures to be used in the performance of work on this project.

TIME LIMITATIONS

The findings of this report are valid as of this date. Changes in the condition of a property can, however, occur with the passage of time, whether they are due to natural processes or the work of man on this or adjacent properties. In addition, changes in the Standards-of-Practice and/or Governmental Codes may occur. Due to such changes, the findings of this report may be invalidated wholly or in part by changes beyond our control. Therefore, this report should not be relied upon after a significant amount of time without a review by LOR Geotechnical Group, Inc., verifying the suitability of the conclusions and recommendations.

CLOSURE

It has been a pleasure to assist you with this project. We look forward to being of further assistance to you as construction begins. Should conditions be encountered during construction that appear to be different than indicated by this report, please contact this office immediately in order that we might evaluate their effect.

Should you have any questions regarding this report, please do not hesitate to contact this office at your convenience.

Respectfully submitted,
LOR Geotechnical Group, Inc.

John P. Leuer, GE 2030
President

AAT:JPL/ss

Distribution: Addressee (4) and via email: ydiaz@tkeengineering.com

REFERENCES

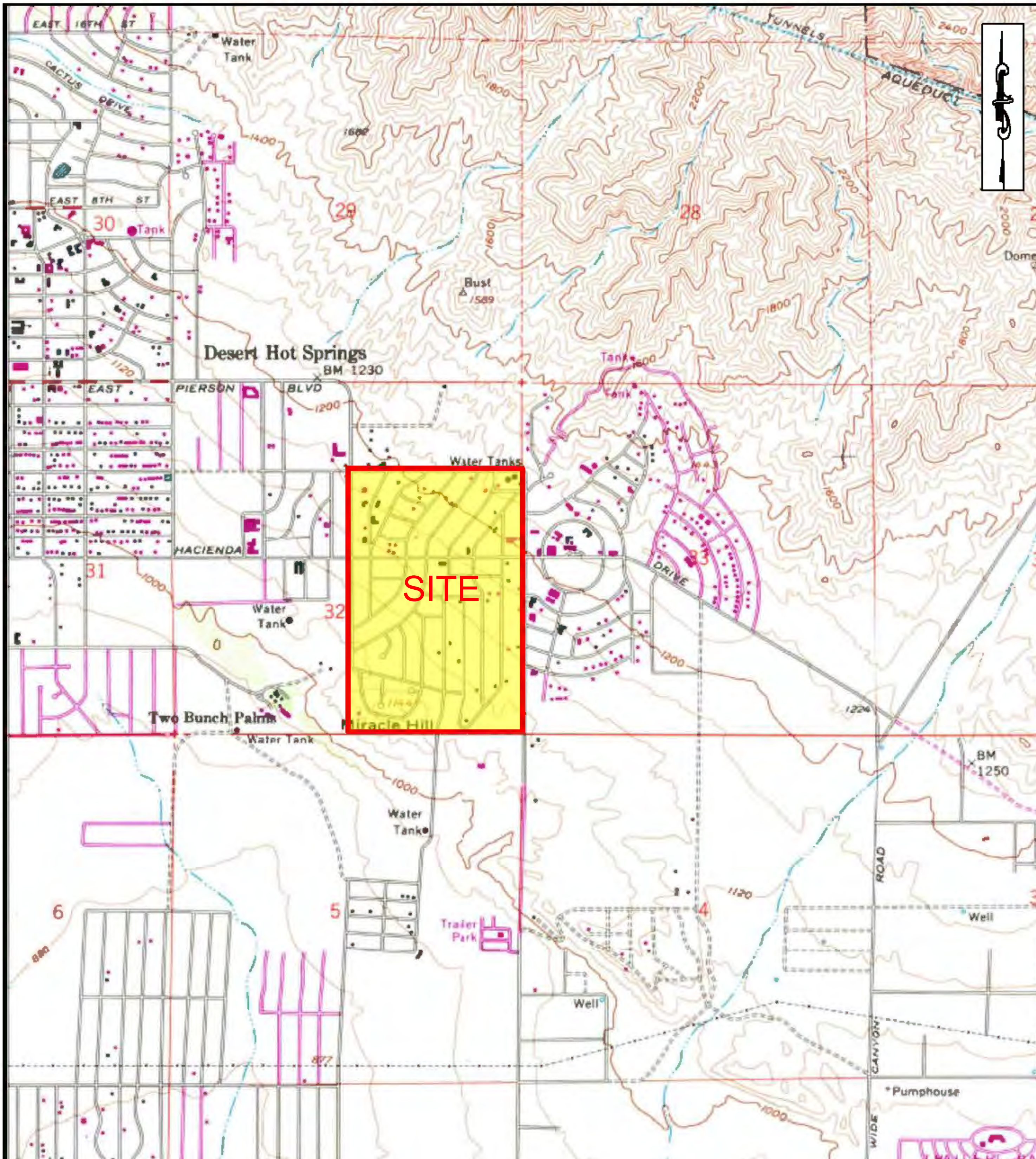
California Building Standards Commission and International Conference of Building Officials, 2019, California Building Code, 2019 Edition.

California Department of Water Resources, 2020, http://www.water.ca.gov/waterdatalibrary/.

Standard Specifications for Public Works Construction "Greenbook" 2018 edition.

APPENDIX A

Index Map and Site Map



INDEX MAP

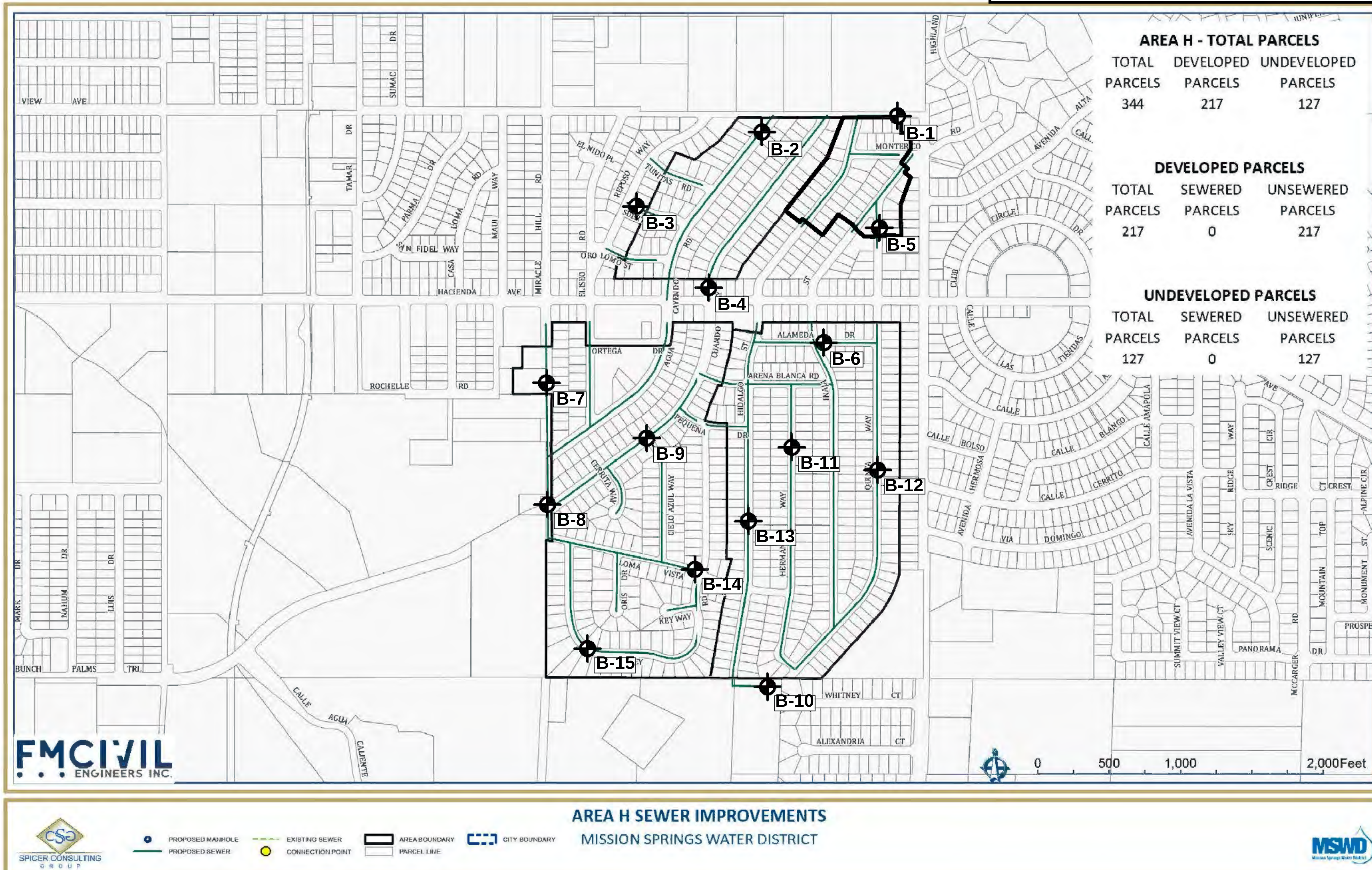
PROJECT:	AREAS H & I SEWER IMPROVEMENTS, DESERT HOT SPRINGS, CALIFORNIA	PROJECT NO:	63643.9
CLIENT:	TKE ENGINEERING INC.	ENCLOSURE:	A-1
LOR Geotechnical Group, Inc.		DATE:	JUNE 2020
		SCALE:	1" ≈ 2000'

Legend

(Locations Approximate)

Map Symbols

B-15 - Exploratory Boring Location



SITE MAP

PROJECT NO: 63643.9

ENCLOSURE: A-2

DATE: JUNE 2020

SCALE: 1" ≈ 700'

PROJECT: AREAS H & I SEWER IMPROVEMENTS, DESERT HOT SPRINGS, CALIFORNIA

CLIENT: TKE ENGINEERING INC.

LOR Geotechnical Group, Inc.

APPENDIX B

Field Investigation Program and Boring Logs

APPENDIX B
FIELD INVESTIGATION

Subsurface Exploration

The site was investigated on May 22 and May 26 of 2020 and consisted of advancing 15 exploratory borings to depths of approximately 12 and 26.42 feet below the existing ground surface. The approximate locations of the borings are shown on Enclosure A-2, within Appendix A.

The boring exploration was conducted using a track mounted Mobile B-61 drill rig equipped with 8-inch diameter hollow stem augers. The soils were continuously logged by our geologist who inspected the site, created detailed logs of the borings, obtained undisturbed, as well as disturbed, soil samples for evaluation and testing, and classified the soils by visual examination in accordance with the Unified Soil Classification System.

Relatively undisturbed samples of the subsoils were obtained within the borings at a maximum interval of 5 feet. The samples were recovered by using a California split barrel sampler of 2.40-inch inside diameter and 3.25-inch outside diameter. The samplers were driven by a 140-pound automatic trip hammer dropped from a height of 30 inches. The number of hammer blows required to drive the sampler into the ground the final 12 inches were recorded and further converted to an equivalent SPT-value. Factors such as efficiency of the automatic trip hammer used during this investigation (80%), inner diameter of the hollow-stem auger (3.75 inches), and rod lengths at the test depth were considered for further computing of equivalent SPT-values corrected for field procedures ($\approx N60$) which are included in the boring logs. The soil samples were retained in brass sample rings of 2.41 inches in diameter and 1.00 inch in height, and placed in sealed plastic containers. Disturbed soil samples were obtained at selected levels within the borings and placed in sealed containers for transport to our geotechnical laboratory.

All samples obtained were taken to our geotechnical laboratory for storage and testing. Detailed logs of the borings and cores are presented on the attached Boring Logs, Enclosures B-1 through B-15. A Boring Log Legend and Soil Classification Chart are presented on Enclosures B-i and B-ii, respectively.

CONSISTENCY OF SOIL

SANDS

SPT BLOWS	CONSISTENCY
0-4	Very Loose
4-10	Loose
10-30	Medium Dense
30-50	Dense
Over 50	Very Dense

COHESIVE SOILS

SPT BLOWS	CONSISTENCY
0-2	Very Soft
2-4	Soft
4-8	Medium
8-15	Stiff
15-30	Very Stiff
30-60	Hard
Over 60	Very Hard

SAMPLE KEY

Symbol | **Description**

INDICATES CALIFORNIA SPLIT SPOON SOIL SAMPLE

INDICATES BULK SAMPLE

INDICATES SAND CONE OR NUCLEAR DENSITY TEST

INDICATES STANDARD PENETRATION TEST (SPT) SOIL SAMPLE

TYPES OF LABORATORY TESTS

1	Atterberg Limits
2	Consolidation
3	Direct Shear (undisturbed or remolded)
4	Expansion Index
5	Hydrometer
6	Organic Content
7	Proctor (4", 6", or Cal216)
8	R-value
9	Sand Equivalent
10	Sieve Analysis
11	Soluble Sulfate Content
12	Swell
13	Wash 200 Sieve

BORING LOG LEGEND

PROJECT:	AREAS H & I SEWER IMPROVEMENTS, DESERT HOT SPRINGS, CA	PROJECT NO.:	63643.9
CLIENT:	TKE ENGINEERING, INC.	ENCLOSURE:	B-i
LOR Geotechnical Group, Inc.		DATE:	JUNE 2020

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	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 SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

PARTICLE SIZE LIMITS

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

12" 3" 3/4" No. 4 No. 10 No. 40 200

(U.S. STANDARD SIEVE SIZE)

SOIL CLASSIFICATION CHART

PROJECT	AREAS H & I SEWER IMPROVEMENTS, DESERT HOT SPRINGS, CA	PROJECT NO.	63643.9
CLIENT:	TKE ENGINEERING, INC.	ENCLOSURE:	B-ii
LOR Geotechnical Group, Inc.		DATE:	JUNE 2020

LOG OF BORING B-1

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0									**@ 0 feet, ASPHALT CONCRETE: 0.33' thick, fair condition.**
									@ 0.33 feet, AGGREGATE BASE, 0.67' thick.
		7						SM	**@ 1 foot, SILTY SAND with GRAVEL, approximately 15% gravel to 1/2", 20% coarse grained sand, 20% medium grained sand, 30% fine grained sand, 15% silty fines, yellow brown, dry.**
5	47	3, 9	1.6		130.0				**@ 5 feet, increase in gravel to 2".**
10	77 for 10"		1.0		117.6			SW	**@ 10 feet, WELL GRADED SAND with GRAVEL, approximately 20% gravel to 3", 20% coarse grained sand, 20% medium grained sand, 35% fine grained sand, 5% silty fines, tan, dry, difficult drilling.**
15	78		2.1		120.0				
									END OF BORING @ 16.5' **No groundwater** **No bedrock**
20									

PROJECT:	**Proposed Sewer Improvements**	PROJECT NUMBER:	**63643.9**
CLIENT:	**TKE Engineering, Inc.**	ELEVATION:	
		DATE DRILLED:	**May 22, 2020**
LOR GEOTECHNICAL GROUP INC.		EQUIPMENT:	**Mobile B-61**
		HOLE DIA.: **8"**	ENCLOSURE: **B-1**

LOG OF BORING B-2

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY *(PCF)*	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0									@ 0 feet, ASPHALT CONCRETE: 0.25' thick, fair condition.
								SM	@ 0.25 feet, SILTY SAND, trace gravel to 1/2", 25% coarse grained sand, 30% medium grained sand, 30% fine grained sand, 15% silty fines, brown, damp.
5	31	9	5.4		120.7				@ 5 feet, slight increase in gravel percentage and size.
								SP SM	@ 7 feet, POORLY GRADED SAND with SILT, approximately 10% coarse grained sand, 35% medium grained sand, 45% fine grained sand, 10% silty fines, tan, dry.
10	73 for 11"		2.2		125.2				@ 10 feet, trace gravel to 1/2", slighlty cemented, white.
15	82 for 9"		6.5		107.3				
									END OF BORING @ 15.75' No groundwater No bedrock
20									

PROJECT:	Proposed Sewer Improvements	PROJECT NUMBER:	63643.9
CLIENT:	TKE Engineering, Inc.	ELEVATION:	
		DATE DRILLED:	May 22, 2020
LOR GEOTECHNICAL GROUP INC.		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-2

LOG OF BORING B-3

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SW	@ 0 feet, ASPHALT CONCRETE: 0.25' thick, fair condition. @ 0.25 feet, WELL GRADED SAND with GRAVEL, approximately 15% gravel to 3/4", 25% coarse grained sand, 25% medium grained sand, 30% fine grained sand, 5% silty fines, tan, dry.
5	25	9	1.9		113.8				
10	36		3.0		126.2			SM	@ 10 feet, SILTY SAND, approxmately 10% gravel to 1/2", 20% coarse grained sand, 25% medium grained sand, 30% fine grained sand, 15% silty fines, brown, damp.
15	71		1.1		128.9			SW	@ 15 feet, WELL GRADED SAND with GRAVEL, approximately 15% gravel to 3/4", 25% coarse grained sand, 25% medium grained sand, 30% fine grained sand, 5% silty fines, tan, dry. END OF BORING @ 16.5' No groundwater No bedrock
20									

PROJECT:	Proposed Sewer Improvements	PROJECT NUMBER:	63643.9
CLIENT:	TKE Engineering, Inc.	ELEVATION:	
		DATE DRILLED:	May 22, 2020
LOR GEOTECHNICAL GROUP INC.		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-3

LOG OF BORING B-4

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0									@ 0 feet, ASPHALT CONCRETE: 0.33' thick, fair condition.
								SW	@ 0.33 feet, WELL GRADED SAND with GRAVEL, approximately 15% gravel to 1/2", 25% coarse grained sand, 25% medium grained sand, 30% fine grained sand, 5% silty fines, brown, dry.
5	30	9	4.4		129.8				
10	80 for 11"	3	2.9		122.2				
15	81 for 11"		1.8		119.7				@ 15 feet, increase in gravel to 1"
									END OF BORING @ 16.42' No groundwater No bedrock
20									

PROJECT:	Proposed Sewer Improvements	PROJECT NUMBER:	63643.9
CLIENT:	TKE Engineering, Inc.	ELEVATION:	
LOR GEOTECHNICAL GROUP INC.		DATE DRILLED:	May 22, 2020
		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-4

LOG OF BORING B-5

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY *(PCF)*	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SW	@ 0 feet, ASPHALT CONCRETE: 0.25' thick, fair condition. @ 0.25 feet, WELL GRADED SAND with GRAVEL, approximately 15% gravel to 3", 20% coarse grained sand, 25% medium grained sand, 30% fine grained sand, 5% silty fines, white, dry.
5	56	9	2.4		126.2				
10	83		2.9		123.4				
15	45		2.3		123.2				
16.5									END OF BORING @ 16.5' No groundwater No bedrock
20									

PROJECT:	**Proposed Sewer Improvements**	PROJECT NUMBER:	**63643.9**
CLIENT:	**TKE Engineering, Inc.**	ELEVATION:	
LOR GEOTECHNICAL GROUP INC.		DATE DRILLED:	**May 22, 2020**
		EQUIPMENT:	**Mobile B-61**
		HOLE DIA.: **8"**	ENCLOSURE: **B-5**

LOG OF BORING B-6

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0									@ 0 feet, ASPHALT CONCRETE: 0.35' thick, fair condition.
								SM	@ 0.35 feet, SILTY SAND, trace gravel to 1/2", approximately 25% coarse grained sand, 30% medium grained sand, 40% fine grained sand, 5% silty fines, brown, dry.
5	19	9	3.2		125.6				
10	80		1.2		123.8			SW	@ 10 feet, WELL GRADED SAND with GRAVEL, approximately 20% gravel to 3/4", 25% coarse grained sand, 25% medium grained sand, 25% fine grained sand, 5% silty fines, brown, dry.
15	68		2.0		128.0				
									END OF BORING @ 16.5' No groundwater No bedrock
20									

PROJECT:	Proposed Sewer Improvements	PROJECT NUMBER:	63643.9
CLIENT:	TKE Engineering, Inc.	ELEVATION:	
		DATE DRILLED:	May 22, 2020
LOR GEOTECHNICAL GROUP INC.		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-6

LOG OF BORING B-7

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0									@ 0 feet, ASPHALT CONCRETE: 0.30' thick, fair condition.
		7						SM	@ 0.30 feet, SILTY SAND, approximately 5% gravel to 1/2", 20% coarse grained sand, 25% medium grained sand, 30% fine grained sand, 20% silty fines, brown, damp.
5	40	9	6.4		129.6				
10	52		2.5		124.0			SW	@ 10 feet, WELL GRADED SAND with GRAVEL, approximately 15% gravel to 1", 25% coarse grained sand, 25% medium grained sand, 30% fine grained sand, 5% silty fines, white, dry.
15	60		2.5		122.6				
									END OF BORING @ 16.5' No groundwater No bedrock
20									

PROJECT:	Proposed Sewer Improvements	PROJECT NUMBER:	63643.9
CLIENT:	TKE Engineering, Inc.	ELEVATION:	
		DATE DRILLED:	May 22, 2020
LOR GEOTECHNICAL GROUP INC.		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-7

LOG OF BORING B-8

TEST DATA								
DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY *(PCF)*	SAMPLE TYPE	U.S.C.S.	DESCRIPTION
0							SW	**@ 0 feet, ASPHALT CONCRETE: 0.15' thick, fair condition.**
								@ 0.15 feet, WELL GRADED SAND with GRAVEL, approximately 25% gravel to 2", 20% coarse grained sand, 25% medium grained sand, 25% fine grained sand, 5% silty fines, brown, dry.
5	**22**	**3, 9**	**10.6**		**121.7**	▮		**@ 5 feet, becomes moist.**
						∇		**@ 7 feet, groundwater (hot).**
10	**81 for 11"**		**8.2**		**129.8**	▮		**@ 10 feet, very difficult to drill, cobbles, wet.**
								END OF BORING @ 12' due to refusal **Groundwater @ 7'** **No bedrock**
15								
20								

PROJECT:	**Proposed Sewer Improvements**	PROJECT NUMBER:	**63643.9**
CLIENT:	**TKE Engineering, Inc.**	ELEVATION:	
LOR GEOTECHNICAL GROUP INC.		DATE DRILLED:	**May 22, 2020**
		EQUIPMENT:	**Mobile B-61**
		HOLE DIA.: **8"**	ENCLOSURE: **B-8**

LOG OF BORING B-9

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0									**@ 0 feet, ASPHALT CONCRETE: 0.25' thick, fair condition.**
								SM	**@ 0.25 feet, SILTY SAND with GRAVEL, approximately 15% gravel to 1", 20% coarse grained sand, 25% medium grained sand, 25% fine grained sand, 15% silty fines, red brown, damp.**
5	**32**	**9**	**1.8**		**127.1**			**SW**	**@ 5 feet, WELL GRADED SAND with GRAVEL, approximately 20% gravel to 1", 20% coarse grained sand, 25% medium grained sand, 25% fine grained sand, 15% silty fines, red brown, damp.**
10	**57**		**3.3**		**125.7**				
15	**63**		**1.7**		**129.9**				
									END OF BORING @ 16.5' **No groundwater** **No bedrock**
20									

PROJECT:	**Proposed Sewer Improvements**	PROJECT NUMBER:	**63643.9**
CLIENT:	**TKE Engineering, Inc.**	ELEVATION:	
		DATE DRILLED:	**May 22, 2020**
LOR GEOTECHNICAL GROUP INC.		EQUIPMENT:	**Mobile B-61**
		HOLE DIA.: **8"**	ENCLOSURE: **B-9**

LOG OF BORING B-10

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SP SM	@ 0 feet, POORLY GRADED SAND with SILT, approximately 5% coarse grained sand, 15% medium grained sand, 70% fine grained sand, 10% silty fines, gray, dry.
		7						SW	@ 3 feet, WELL GRADED SAND with GRAVEL, approximately 15% gravel to 1", 25% coarse grained sand, 25% medium grained sand, 30% fine grained sand, 5% silty fines, brown, damp.
5	29	9	5.6		125.3				
10	55	3	2.6		122.1				@ 10 feet, slightly coarser grained, dry.
15	43		6.5		118.3				@ 15 feet, gravel to 3".
									@ 19 feet, refusal on cobbles, boring moved 10' east.
20	64		1.9		115.7				
						∇			@ 24 feet, groundwater.
25	89 for 11"		18.8		109.7			SP	@ 25 feet, POORLY GRADED SAND, approximately 5% coarse grained sand, 10% medium grained sand, 80% fine grained sand, 5% silty fines, gray, wet.
									END OF BORING @ 26.42' Groundwater @ 24' No bedrock
30									

PROJECT:	Proposed Sewer Improvements	PROJECT NUMBER:	63643.9
CLIENT:	TKE Engineering, Inc.	ELEVATION:	
		DATE DRILLED:	May 26, 2020
LOR GEOTECHNICAL GROUP INC.		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-10

LOG OF BORING B-11

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0									@ 0 feet, ASPHALT CONCRETE: 0.25' thick, fair condition.
								SP	@ 0.25 feet, POOLY GRADED SAND, trace gravel to 1/2", 5% coarse grained sand, 15% medium grained sand, 75% fine grained sand, 5% silty fines, brown, damp.
5	22	3, 9	2.1		115.7	▮		SW	@ 5 feet, WELL GRADED SAND with GRAVEL, approximately 15% gravel to 2", 25% coarse grained sand, 25% medium grained sand, 30% fine grained sand, 5% silty fines, brown, damp.
10	36		3.5		121.9	▮			@ 10 feet, slight decrease in gravel percentage.
15	53		3.6		123.0	▮			
									END OF BORING @ 16.5' No groundwater No bedrock
20									

PROJECT:	Proposed Sewer Improvements	PROJECT NUMBER:	63643.9
CLIENT:	TKE Engineering, Inc.	ELEVATION:	
		DATE DRILLED:	May 26, 2020
LOR GEOTECHNICAL GROUP INC.		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-11

LOG OF BORING B-12

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY *(PCF)*	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SW	@ 0 feet, ASPHALT CONCRETE: 0.25' thick, fair condition. @ 0.25 feet, WELL GRADED SAND with GRAVEL, approximately 15% gravel to 1.5", 25% coarse grained sand, 25% medium grained sand, 30% fine grained sand, 5% silty fines, gray, dry.
5	27	9	1.9						@ 5 feet, rings disturbed.
10	32		0.2		128.5				
15	57		1.3		122.9				
									END OF BORING @ 16.5' No groundwater No bedrock
20									

PROJECT: Proposed Sewer Improvements	PROJECT NUMBER: 63643.9
CLIENT: TKE Engineering, Inc.	ELEVATION:
LOR GEOTECHNICAL GROUP INC.	DATE DRILLED: May 26, 2020
	EQUIPMENT: Mobile B-61
	HOLE DIA.: 8" ENCLOSURE: B-12

LOG OF BORING B-13

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0								SW	@ 0 feet, ASPHALT CONCRETE: 0.25' thick, fair condition. @ 0.25 feet, WELL GRADED SAND with GRAVEL, approximately 15 gravel to 1", 25% coarse grained sand, 25% medium grained sand, 30% fine grained sand, 5% silty fines, brown, damp.
5	26	9	1.1		113.2	▬			
10	33		2.4		122.8	▬			@ 10 feet, becomes dry.
15	61		4.0		124.4	▬		SM	@ 15 feet, SILTY SAND, approximately 5% gravel to 1", 25% coarse grained sand, 25% medium grained sand, 25% fine grained sand, 20% silty fines, red brown, dry. END OF BORING @ 16' No groundwater No bedrock
20									

PROJECT:	Proposed Sewer Improvements	PROJECT NUMBER:	63643.9
CLIENT:	TKE Engineering, Inc.	ELEVATION:	
LOR GEOTECHNICAL GROUP INC.		DATE DRILLED:	May 26, 2020
		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-13

LOG OF BORING B-14

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	U.S.C.S.	DESCRIPTION
0								@ 0 feet, ASPHALT CONCRETE: 0.33' thick, fair condition.
								@ 0.33 feet, AGGREGATE BASE, 0.5' thick.
							SW	@ 0.83 feet, WELL GRADED SAND with GRAVEL, approximately 15% gravel to 1", 25% coarse grained sand, 25% medium grained sand, 30% fine grained sand, 5% silty fines, brown, dry.
5	71	9	2.2		130.1	▮		
10	80		2.9		115.2	▮		@ 10 feet, slight increase in gravel percentage.
15	77 for 11"		2.5		122.4	▮		
								END OF BORING @ 15.92' No groundwater No bedrock
20								

PROJECT: Proposed Sewer Improvements	PROJECT NUMBER: 63643.9
CLIENT: TKE Engineering, Inc.	ELEVATION:
	DATE DRILLED: May 26, 2020
LOR GEOTECHNICAL GROUP INC.	EQUIPMENT: Mobile B-61
	HOLE DIA.: 8" ENCLOSURE: B-14

LOG OF BORING B-15

DEPTH IN FEET	SPT BLOW COUNTS	LABORATORY TESTS	MOISTURE CONTENT (%)		DRY DENSITY (PCF)	SAMPLE TYPE	LITHOLOGY	U.S.C.S.	DESCRIPTION
0									@ 0 feet, ASPHALT CONCRETE: 0.33' thick, fair condition.
								SP	@ 0.33 feet, POORLY GRADED SAND, approximately 5% coarse grained sand, 15% medium grained sand, 75% fine grained sand, 5% silty fines, gray, dry.
5	36	9	3.5		112.9				
									@ 7 feet, some cobbles, very difficult to drill to 9'.
10	55		0.9		100.5				
									@ 14 feet, some cobbles, rig chatter.
15	46 for 5"								@ 15 feet, no recovery, cobble in tip of sampler.
									END OF BORING @ 15.42'
									No groundwater No bedrock
20									

PROJECT:	Proposed Sewer Improvements	PROJECT NUMBER:	63643.9
CLIENT:	TKE Engineering, Inc.	ELEVATION:	
LOR GEOTECHNICAL GROUP INC.		DATE DRILLED:	May 26, 2020
		EQUIPMENT:	Mobile B-61
		HOLE DIA.: 8"	ENCLOSURE: B-15

APPENDIX C

Laboratory Testing Program and Test Results

APPENDIX C
LABORATORY TESTING

General

Selected soil samples obtained from the borings were tested in our geotechnical laboratory to evaluate their physical and engineering properties. The laboratory testing program performed in conjunction with our investigation included in-place moisture content and dry density, laboratory compaction characteristics, direct shear, and sand equivalent. Descriptions of the laboratory tests are presented in the following paragraphs:

Moisture-Density Tests

The moisture content and dry density information provides an indirect measure of soil consistency for each stratum, and can also provide a correlation between soils on this site. The dry unit weight and field moisture content were determined in accordance with ASTM D 2937 and 2216, respectively, for selected undisturbed samples, and the results are shown on the boring logs, Enclosures B-1 through B-15, within Appendix B, for convenient correlation with the soil profile.

Laboratory Compaction

Selected soil samples were tested in the laboratory to determine compaction characteristics using the ASTM D 1557 compaction test method. The results are presented in the following table:

LABORATORY COMPACTION				
Boring Number	**Sample Depth (ft)**	**Material Description (U.S.C.S.)**	**Maximum Dry Density (psf)**	**Optimum Moisture Content (percent)**
B-1	2-5	(SM) Silty Sand with Gravel	138.5	7.0
B-7	1-4	(SM) Silty Sand	139.0	6.0
B-10	3-6	(SW) Well Graded Sand with Gravel	137.0	5.0

Direct Shear Tests

Shear tests are performed with a direct shear machine at a constant rate-of-strain (usually 0.04 inches/minute). The machine is designed to test a sample partially extruded from a sample ring in single shear. Samples are tested at varying normal loads in order to evaluate the shear strength parameters, angle of internal friction and cohesion in accordance with ASTM D 3080. Samples are tested in a relatively undisturbed state and soaked, to represent the worst case conditions expected in the field. The results of the direct shear tests are presented in the following table:

DIRECT SHEAR TEST				
Boring Number	**Sample Depth (ft)**	**Material Description (U.S.C.S.)**	**Apparent Cohesion (psf)**	**Angle of Internal Friction (degrees)**
B-1	5	(SM) Silty Sand with Gravel	300	41
B-4	10	(SW) Well Graded Sand with Gravel	400	37
B-8	5	(SW) Well Graded Sand with Gravel	0	43
B-10	15	(SW) Well Graded Sand with Gravel	650	32
B-11	5	(SW) Well Graded Sand with Gravel	0	41

Sand Equivalent

The sand equivalent of selected subgrade soils were evaluated using the California Sand Equivalent Test Method, Caltrans Number 217. The results of the sand equivalent tests are presented on the table below and on Enclosure C-1:

SAND EQUIVALENT TEST			
Boring Number	**Sample Depth (ft)**	**Material Description (U.S.C.S.)**	**S.E.**
B-1	5	(SM) Silty Sand with Gravel	31
B-2	5	(SM) Silty Sand	22
B-3	5	(SW) Well Graded Sand with Gravel	61
B-4	5	(SW) Well Graded Sand with Gravel	21
B-05	5	(SW) Well Graded Sand with Gravel	31

Boring Number	Sample Depth (ft)	Material Description (U.S.C.S.)	S.E.
B-6	5	(SM) Silty Sand	33
B-7	5	(SM) Silty Sand	17
B-8	5	(SW) Well Graded Sand with Gravel	47
B-9	5	(SW) Well Graded Sand with Gravel	51
B-10	5	(SW) Well Graded Sand with Gravel	34
B-11	5	(SW) Well Graded Sand with Gravel	60
B-12	5	(SW) Well Graded Sand with Gravel	61
B-13	5	(SW) Well Graded Sand with Gravel	60
B-14	5	(SW) Well Graded Sand with Gravel	67
B-15	5	(SP) Poorly Graded Sand	30

APPENDIX D

HDR Test Results

June 18, 2020 via email: atardie@lorgeo.com

LOR GEOTECHNICAL GROUP, INC.
6121 Quail Valley Court
Riverside, CA 92507

Attention: Mr. Andrew Tardie

Re: Soil Corrosivity Study
Areas H & I
Desert Hot Springs, CA
HDR #20-0318SCS, Lor #63643.9

Introduction

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

The proposed project consists of the installation of a 12-inch vitrified clay sewer pipe. The location of the new sewer pipe is outlined in the attached Site Map in Desert Hot Springs, California, and the water table is reportedly seven feet deep.

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

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

Laboratory Soil Corrosivity Tests

The electrical resistivity of each sample was measured in a soil box per ASTM G187 in its as-received condition and again after saturation with distilled water. Resistivities are at about their lowest value when the soil is saturated. The pH of the saturated samples was measured per ASTM G51. A 5:1 water:soil extract from each sample was chemically analyzed for the major soluble salts commonly found in soil per ASTM D4327, ASTM D6919, and Standard Method 2320-B[1]. Laboratory test results are shown in the attached Table 1.

Soil Corrosivity

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

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

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

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

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

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

Electrical resistivities were in the mildly and moderately corrosive categories with as-received moisture. When saturated, the resistivities were in the moderately corrosive category. Some of the resistivities dropped considerably with added moisture because the samples were dry as-received.

Soil pH values varied from 7.7 to 8.3. This range is mildly to moderately alkaline.[3] These values do not particularly increase soil corrosivity.

The soluble salt content of the samples was low. Chloride and sulfate were found at low concentrations.

The nitrate concentration in the sample from B-3 was high enough to be aggressive to copper. Ammonium was not detected.

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

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

Similitude Analysis

HDR has completed a soil corrosion similitude analysis to assess the efficacy of installing the proposed steel casing exposed to project site soil conditions and to calculate a corrosion loss for the casing. The casing will be installed utilizing jack and bore techniques.

HDR understands that a design life of 50 years is desired. A safety factor of two was applied to all corrosion rates presented in this report.

It is assumed that the steel casing will not come into contact with concrete. The pH differential created by the casing in partial contact with both soil and concrete would significantly increase the corrosion rate of the pile near the concrete/soil boundary that is not accounted for in this analysis.

---

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

Corrosion rates of metals in soils depend on construction details, soil moisture, etc., in addition to soil corrosivity, and are, therefore, difficult to predict. Data for corrosion of metals in a variety of soils was compiled by Melvin Romanoff of the National Bureau of Standards in a Circular 579 entitled Underground Corrosion. The basic methodology was to identify the representative soil characteristics most likely to be encountered at the project site and then use the data presented in Circular 579 to calculate the corrosion rates based upon the similitude between the soils documented and the soils anticipated at the site.

Based on the laboratory analysis (see attached Table 1) completed on the soil samples, Soil 12 listed in Table 6 of Romanoff's Circular 579 was selected as the soil of similar composition and corrosivity levels to the project site.

Corrosion Loss for Steel Exposed to Soils

Based on Soil 12, an average single-side uniform corrosion rate of approximately 0.96 mpy was estimated for bare steel exposed to site soils. Over the 50-year design life of the bare steel casing, this equates to a corrosion loss of 48 mils (0.048 inches).

Other Considerations

Uniform corrosion is not the only type of corrosion that can occur on buried metals. Localized corrosion in the form of pitting can also occur. The pitting corrosion rate for this soil type was estimated to be approximately 9.8 mpy. This could result in average pit depths of 490 mils (0.490 inches) of the steel casing. However, pitting and/or perforation of a steel casing are not catastrophic since pitting is a highly localized phenomenon, which would not significantly reduce the mass, weight, or structural capacity of the steel casing.

Corrosion Control Recommendations

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

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

Steel Casing Pipe

1. The casing should be designed per NACE SP0200.
2. It is assumed all casing pipe segments will be welded. In this case no further action is necessary to maintain electrical continuity of the casing.
3. Install test stations at each end of the casing to facilitate corrosion monitoring and the application of cathodic protection. Each wire should be independently welded or pin-brazed to the casing pipe.
4. Prevent contact between the casing pipe and concrete and/or reinforcing steel, with such items as plastic sleeves, rubber seals, or 20 mil plastic tape.
5. Provide electrical isolation between metallic appurtenances and the steel casing.
6. Seal the casing ends with end seals to prevent the ingress of soil.
7. Do not coat the casing.
8. Include a corrosion allowance of 0.96 mpy in the design of the casing, or apply cathodic protection to the steel casing as per NACE SP0169.

Plastic and Vitrified Clay Pipe

1. No special corrosion control measures are required for plastic and vitrified clay piping placed underground.
2. Protect all metallic fittings and valves with wax tape per AWWA C217, or with epoxy and appropriately sized cathodic protection per NACE SP0169.

Metallic Appurtenances

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

Concrete Structures and Pipe

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

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

3. Due to the high ground water table encountered at this site, cyclical or continual wetting may be an issue. Any contact between concrete structures and ground water should be prevented.

    a. For structures that extend below the water table, contact can be prevented with an impermeable waterproofing system. Options include a membrane such as Grace PrePrufe® products, a liquid applied barrier coating, or a waterproofing admixture such as Xypex® Admix. Visqueen, similar rolled barriers, or bentonite-based membranes are not viable waterproofing systems for corrosion protection.

    b. For structures above the water table, contact can be prevented with a gravel capillary break under the concrete and a vapor retarding membrane. Note that per ASTM E1643, "vapor retarders are not intended to provide a waterproofing function." [8] Alternatively, an impermeable waterproofing system may be used.

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

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

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

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

[8] ASTM E1643-11 (2017): Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs. ASTM International, 2017.

Closure

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

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

Please call if you have any questions.

Respectfully Submitted,
HDR Engineering, Inc.

James T. Keegan

Amy Omae, PE

Enc: Table 1
Site Map

20-0318SCS SCS Final.docx

Table 1 - Laboratory Tests on Soil Samples

Lor Geotechnical Group, Inc.
Areas H & I
Your #63643.9, HDR Lab #20-0318SCS
8-Jun-20

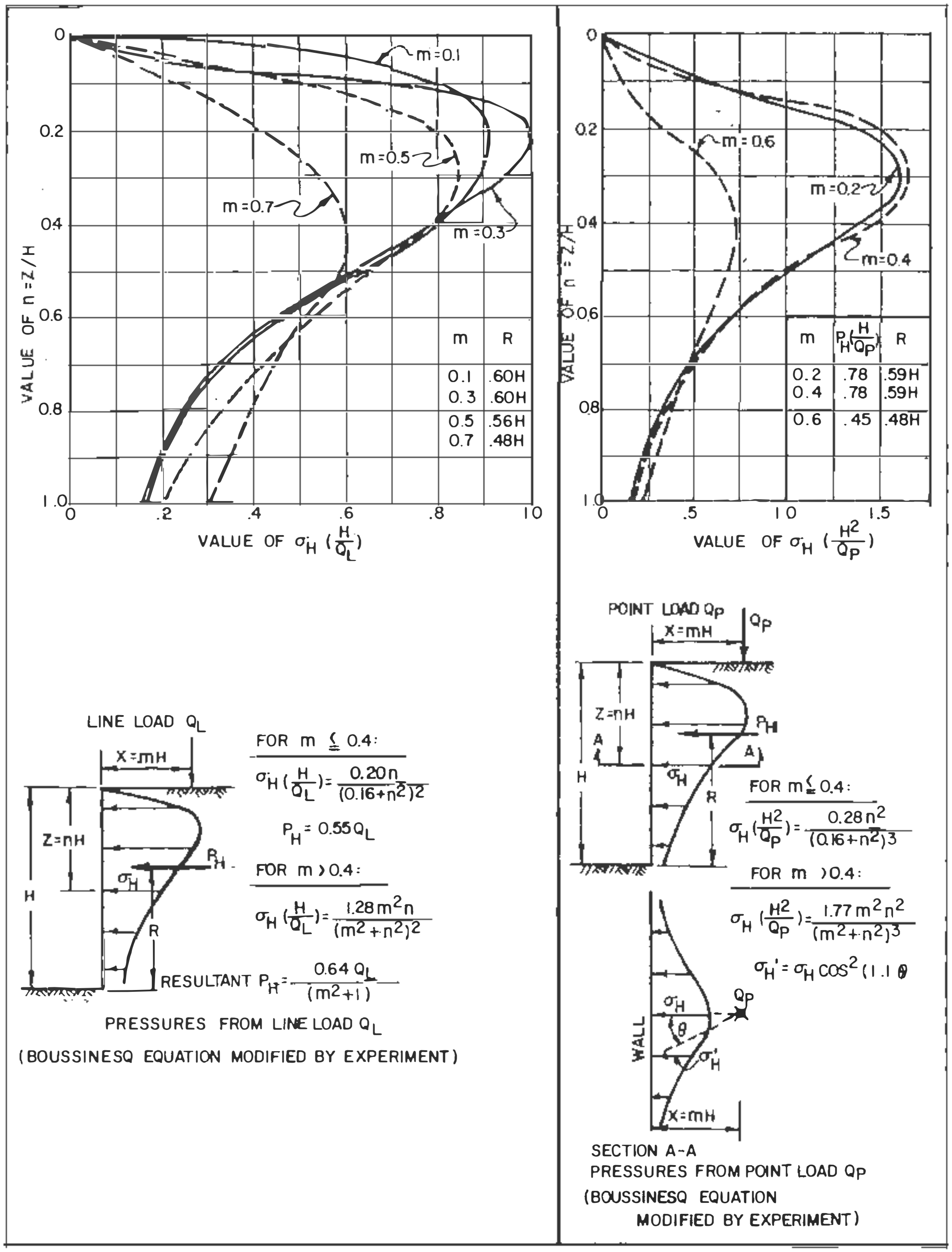
Sample ID			B-3 @ 5'	B-6 @ 5'	B-8 @ 5'	B-10 @ 25'	B-13 @ 5'
Resistivity		**Units**					
as-received		ohm-cm	56,000	28,000	8,000	6,000	92,000
saturated		ohm-cm	4,000	4,800	4,800	5,600	6,800
pH			7.7	8.0	8.3	8.0	8.1
Electrical Conductivity		mS/cm	0.10	0.10	0.09	0.04	0.07
Chemical Analyses							
Cations							
calcium	Ca^{2+}	mg/kg	87	80	24	26	44
magnesium	Mg^{2+}	mg/kg	4.2	2.6	1.4	1.8	2.6
sodium	Na^{1+}	mg/kg	22	69	97	42	43
potassium	K^{1+}	mg/kg	12	7.3	9.1	6.6	9.5
Anions							
carbonate	CO_3^{2-}	mg/kg	26	51	42	ND	45
bicarbonate	HCO_3^{1-}	mg/kg	49	137	34	134	40
fluoride	F^{1-}	mg/kg	1.0	0.8	9.7	3.9	0.9
chloride	Cl^{1-}	mg/kg	45	4.6	12	6.4	13
sulfate	SO_4^{2-}	mg/kg	14	64	61	21	29
phosphate	PO_4^{3-}	mg/kg	ND	ND	ND	ND	ND
Other Tests							
ammonium	NH_4^{1+}	mg/kg	ND	ND	ND	ND	ND
nitrate	NO_3^{1-}	mg/kg	91	18	10	6.0	8.2
sulfide	S^{2-}	qual	na	na	na	na	na
Redox		mV	na	na	na	na	na

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

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

APPENDIX E

Shoring Diagram Design



SHORING DIAGRAM DESIGN

PROJECT: AREAS H & I SEWER IMPROVEMENTS, DESERT HOT SPRINGS, CALIFORNIA	**PROJECT NO.: 63643.9**
CLIENT: TKE ENGINEERING, INC.	**ENCLOSURE: E-1**
LOR Geotechnical Group, Inc.	**DATE: JUNE 20120**