FAULT HAZARD INVESTIGATION
PROPOSED MORONGO FIRE STATION #1
(APN: 532-060-016)
SWC OF MORONGO ROAD AND SANTIAGO ROAD
RIVERSIDE COUNTY, CALIFORNIA

Prepared For **DLR GROUP**
1650 SPRUCE STREET, SUITE 300
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Prepared By **LEIGHTON CONSULTING, INC.**
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Project Number 13940.001

July 31, 2023

Leighton

Leighton Consulting, Inc.
A Leighton Group Company

July 31, 2023
Project No. 13940.001

DLR Group
1650 Spruce Street, Suite 300
Riverside, California 92507

Attention: Mr. Andy Thompson

Subject: Fault Hazard Investigation
Proposed Morongo Fire Station #1 (APN: 532-060-016)
SWC of Morongo Road and Santiago Road
Riverside County, California

In accordance with our May 30, 2023 proposal, authorized on June 1, 2023, Leighton Consulting, Inc. (Leighton) is pleased to present this geologic fault hazard evaluation report for the proposed Morongo Fire Station #1. Based on the results of our evaluation, the proposed Site is considered to have a low probability of surface fault rupture.

The main geologic concerns associated with this site are potential splays of the active San Gorgonio Pass Fault zone projecting in from the western boundary, or sympathetic to the mapped splay to the north of the site. Please note that this is a fault study report only and does not address the geotechnical aspects of the site.

We appreciate the opportunity to be of additional service. If you have any questions or if we can be of further assistance, please contact us at your convenience.

Respectfully Submitted,
LEIGHTON CONSULTING, INC.

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Distribution: (1) addressee (PDF via email)

TABLE OF CONTENTS

List of Accompanying Figures, Plate and Appendices

1.0 INTRODUCTION

1.1 Site Location and Description

The project site is approximately 4.8-acre vacant property located southwest of the intersection of Morongo Road and Santiago Road within the Morongo Band of Mission Indians property, north of Interstate I-10, Riverside County, California *(see Site Location Map, Figure 1)*. At the time of our investigation, the site had been cleared and grubbed of surface vegetation. The Site is currently undeveloped and slopes moderately to the southerly direction. Access to the site is by existing paved Morongo Road and/or Santiago Road. Based on our review of published geologic hazard maps, an Alquist-Priolo (AP) mapped fault trace is located to the north of the site and the entire site is located within the corresponding mapped AP Fault Zone (see Figure 3).

1.2 Proposed Development

We understand that the proposed development will generally consist of construction of a new fire station building with associated fire apparatus bay, patios, pavements and flatwork. The proposed fire station will be approximately 18,600 square feet and is anticipated to be founded on slab-on-grade supported on conventional continuous and isolated shallow spread footings.

1.3 Purpose and Scope of Work

The purpose of this geologic fault hazard study is to explore subsurface conditions at the site and provide our conclusions regarding the potential for onsite ground rupture. In accordance with our proposal, the scope of this study has included the following tasks:

- **Desktop Review**: We reviewed relevant geologic literature and reports. These documents are referenced at the end of this report.
- **Aerial Imagery:** A detailed review of sequential pairs of aerial photographs (Appendix A) was performed utilizing a stereoscope to further enhance the resolution of these photographs. This effort was aimed at identifying any geomorphic signatures related to faulting, fault splays that cross the site and those currently mapped within the immediate study area. Additionally, we reviewed the Airborne Lidar Swath Mapping (ALSWM) for the area (Bevis and Hudnut, 2005). Lineaments or other geomorphic expressions of fault related structures were not observed within or trending into the site.
- **Fault Trench Exploration**: One exploratory trench was excavated and geologically logged to cover the area of planned fire station facility (see Figure 4). The trench was located to intercept any potential faults trending through the fire station building pad area. The trench was excavated, by a subcontractor, and logged, by an

experienced Certified Engineering Geologist, to evaluate geologic structure and obtain samples for laboratory testing. The log of the fault trench is shown on Plate 1.

- **Geotechnical Laboratory Testing**: Geotechnical laboratory tests were performed on surficial earth material collected during our site exploration to aid in determining relative compaction during trench backfill. Tests performed are included in Appendix A.
- **Report Preparation**: Results of our geologic exploration have been summarized in this report to address the hazard of surface ground rupture.

2.0 FINDINGS

2.1 Regional Geology/Settings

The subject property is located within the San Gorgonio Pass, which is an elongated east-west trending valley between the San Bernardino and San Jacinto mountains. The San Gorgonio Pass delineates the border between the Transverse Ranges and Peninsular Ranges geomorphic provinces. The Peninsular Ranges Province are characterized by northwest trending elongated mountain ranges and valleys, and the Transverse Ranges are a set of mountain ranges the run from the San Bernardino mountains, west to the Santa Ynez mountains in Santa Barbara. Directly east of the San Gorgonio Pass is the start of the low-lying Colorado Desert geomorphic province.

Within the San Gorgonio Pass and depicted on Figure 2, the surficial geology generally consists of Holocene to Pleistocene-age alluvial fan deposits, originating from the adjacent ranges. These fan deposits are overlain by recent wash deposits of the San Gorgonio River, which flows from the San Bernardino Mountains west of the San Gorgonio Pass, east through the pass to its confluence with the Whitewater River, which drains to the Salton Sea in the Coachella Valley. The fan deposits in the northern portion of the pass generally consist of sand and gravel of plutonic and gneissic detritus originating from the San Bernardino Mountains to the north.

2.2 Site Geology

As regionally mapped and discussed above, the general site vicinity is underlain by alluvial fan deposits origination from the San Bernardino mountains to the north. Our field exploration indicates that locally the fan deposits are sparsely covered with thin surficial soils as further described below. The observed units are presented on the trench logs and discussed below in order of increasing age.

2.2.1 Surficial Soils

Surficial soils including topsoil should be expected within the site. These soils are expected to be relatively shallow (<1-3 feet), but they may be deeper locally in areas such as depressions, and infilled drainages. The surficial soils generally consist of silty sand with varying amounts of organics and cobbles and boulders.

2.2.2 Alluvial Fan Deposits

The site is situated on a broad alluvial fan associated with Potrero Creek near its confluence with the San Gorgonia River. This fan sequence is presumed to be relatively thick, with the oldest exposed unit in the Pass being the upper Miocene Coachella fanglomerate. The alluvial deposits generally consist of unconsolidated sand, silty sand, gravels, and cobbles. Depositional geologic structures observed within these deposits include cross-bedding, medium to thick planer tabular bedding, and massively bedded units within the channel and young fan deposits. The source of these deposits on the northern portion of the San Gorgonio Pass is mainly due to weathering of the texturally uniform granodioritic and tonalitic rocks of the San Bernardino Mountains.

2.3 Geologic Structure, Faulting and Seismicity

Faulting in the San Gorgonio Pass area is a result of a 20-km wide contractional stepover between the San Bernardino and Coachella Valley segments of the San Andreas fault system. Specifically, within the pass, folds, dextral-reverse, and dextral-normal faults form an east-west belt of active structures. The dominant active structure within the stepover is the San Gorgonio Pass – Garnet Hill faults (Yula and Sieh, 2003). In the vicinity of the site, portions of the fault are obscured by modern fan deposits, however, multiple discontinuous scarps extend southwesterly across remnants of early to mid-Holocene deposits of the Potrero Creek fan (Morton and Matti, 1993). Reports in this area document offset of Holocene sediments along several parallel north dipping faults (Treiman, 1994).

2.4 Faulting and Seismicity

Seismic hazards in Southern California typically include strong ground shaking and fault ground rupture. The subject site is included within a currently recognized Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007). The AP zoned active faults are part of the San Gorgonio Pass Fault Zone, located approximately 300 feet north of the site (See Figure 3).

By definition of the California Geological Survey, an active fault is a fault, which has had surface displacement within Holocene time (about the last 11,700 years). This definition is used in delineating Earthquake Fault Zones as mandated by the Alquist-Priolo Geologic Hazards Zones Act of 1972 and as most recently revised in 2007 (Hart, 2007) as the Alquist-Priolo Earthquake Fault Zoning Act and Earthquake Fault Zones. The intent of this act is to require fault studies on properties located within Earthquake Fault Zones to assure that certain habitable structures are not constructed across the traces of active faults. The California Geologic Survey provides additional update and guidelines in their Revised 2018 Special Publication 42, Earthquake Fault Zones (CGS, 2018).

2.5 Exploratory Trenching

Due to the site being located within an AP Fault Hazard Zone, a field trenching program was performed to evaluate the potential for fault activity within the planned fire station building area. One exploratory trench was excavated across the building area and extended approximately 50 feet beyond the planned structures (see figure 4). The trench was located to intercept any faults trending through the subject site building area. The trench was scraped clean of smeared soils, examined, and logged in detail by a Certified Engineering Geologist from this firm. Our exploratory trenching exposed continuous depositional horizons of likely early Holocene to late Pleistocene aged alluvial fan deposits t. Due to the presence of grussified, primarily Tonalite granitic clasts, an age of late Pleistocene can be placed on the deeper units exposed. Our exploratory trench FT-1 did not display evidence for through going faulting. This trench confirms the absence of active faults in this portion of the site.

A detailed review of vertical, sequential, stereo aerial photograph pairs was also conducted to identify possible geomorphic evidence of faulting. Various photos taken between 1949 and 1999 and a Lidar Survey of the area were reviewed (see references). Our review of the Lidar Survey and aerial photographs and subsequent field observations do not provide geomorphic evidence supporting the existence of Holocene-aged faulting or reveal any photo-lineaments that are typically associated with faulting in this region. The recent (<11,000 years) geologic history of this area reflects that this site is undergoing a regressive, erosional sequence. As observed in the aerial photographs, there are several nearby drainage channels that do not show any horizontal displacement that may be associated with site active faulting.

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3.0 CONCLUSIONS AND RECOMMENDATIONS

Based on results of this geologic exploration, the proposed fire station site is underlain by a thick sequence of medium dense to dense alluvial fan deposits and located within a currently designated Alquist-Priolo Special Studies Zone. However, based on the results of our subsurface exploration (fault trenching), no fault traces were found to exist within the planned building area.

The completion of our study, the trench was backfilled with native soils compacted by placing in thin loose lifts, moisture conditioned to optimum moisture content and mechanically compacted to at least 90 percent relative compaction, relative to the ASTM D 1557 laboratory maximum density. Results of our field density performed during backfill are presented in Appendix A..

4.0 LIMITATIONS

This report was necessarily based in part upon data obtained from a limited number of observances, site visits, soil samples, tests, analyses, histories of occurrences, spaced subsurface explorations and limited information on historical events and observations. Such information is necessarily incomplete. The nature of many sites is such that differing characteristics can be experienced within small distances and under various climatic conditions. Changes in subsurface conditions can and do occur over time. This report is intended to present known geologic and fault data represented in the referenced reports and as a result of this study. Additional onsite subsurface investigation work may be recommended depending upon future design plan.

Until reviewed and accepted by the reviewing agency of record (if any), this report may be subject to change. Changes may be required as part of the agency review process. Leighton Consulting, Inc. assumes no risk or liability for consequential damages that may arise due to design work progressing before this report is reviewed and accepted by the reviewing agency of record.

This report was prepared for DLR Group based on their needs, directions and requirements at the time of our exploration. This report is not authorized for use by, and is not to be relied upon by any party except DLR Group, and their successors and assigns, with whom Leighton has contracted for the work. Use of or reliance on this report by any other party is at that party's risk. Unauthorized use of or reliance on this report constitutes an agreement to defend and indemnify Leighton from and against any liability which may arise as a result of such use or reliance, regardless of any fault, negligence, or strict liability of Leighton.

R E F E R E N C E S

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Morton, Douglas M., and Matti, Johnathan C., 1993, Geologic map of the Cabazon quadrangle, Riverside County, California: U.S. Geological Survey, 1:24,000.

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Treiman, Jerome A., 1994, The San Gorgonio Pass, Banning and Related Faults, Riverside County, California, California Division of Mines and Geology, Fault Evaluation Report FER-235, dated September 27.

Yule, Doug and Sieh, Kerry, 2003, Complexities of the San Andreas fault near San Gorgonio Pass: Implications for large earthquakes, Journal of Geophysical Research, Vol 108, No. B11, 2548, published 29 November.

Aerial Photographs Used
Continental Aerial Photo, Inc

Flight Date	Photograph No.
06/02/49	14F-80 – 81
05/10/67	2HH-25 - 26
12/15/77	RIV-3, 24-25-22
06/12/90	C83-83-12, 1-2
02/23/99	C133-31-107-108-106

Project: 13940.001	Eng/Geol: SIS/RFR
Scale: 1 " = 2,000 '	Date: July 2023

Reference: © 2023 Microsoft Corporation © 2023 Maxar ©CNES (2023) Distribution Airbus

Author: (btran)

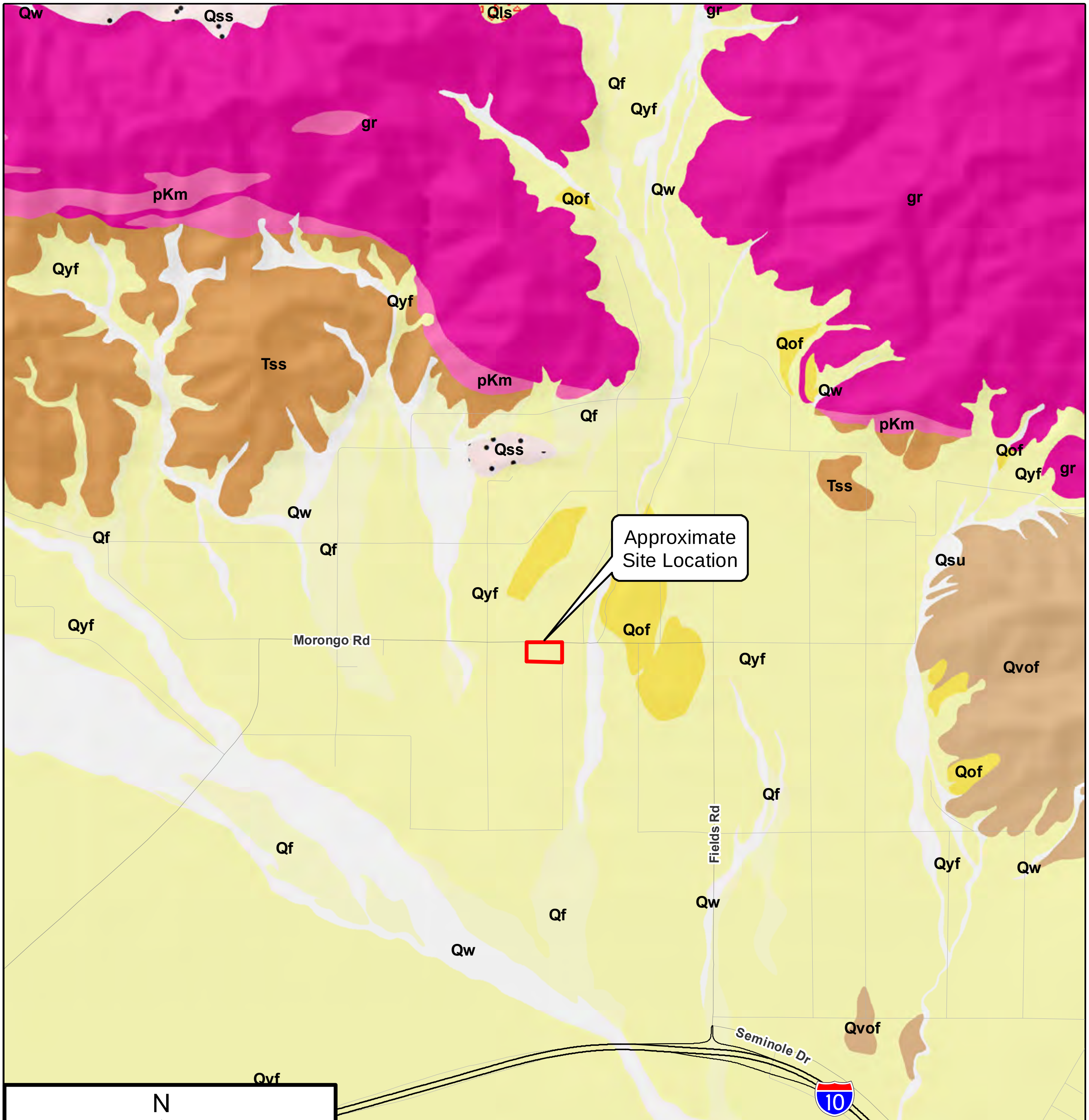
SITE LOCATION MAP

Morongo Fire Station 1
SW Corner of Morongo Rd and Santiago Rd
Banning, California

FIGURE 1

Leighton

Map Saved as J:\Drafting\13940\001\Maps\13940-001_F01_SLM_2023-06-20.mxd on 6/20/2023 2:00:21 PM



LEGEND

- Qf, Alluvial Fan Deposits
- Qyf, Young Alluvial Fan
- Qls, Coarse-grained Tertiary age formations of sedimentary origin
- Qw, Alluvial Valley Deposits
- Qls, Landslide Deposits; may include debris flows and older landslides
- Qss, Coarse-grained formations of Pleistocene age and younger; primarily sandstone and conglomerate
- Qsu, Coarse-grained Tertiary age formations of sedimentary origin
- Qof, Old Alluvial Fan Deposits
- Qvof, Very Old Alluvial Fan Deposits
- Tss, Coarse-grained Tertiary age formations of sedimentary origin
- gr, Granitic and other intrusive crystalline rocks of all ages
- pKm, Cretaceous and Pre-Cretaceous metamorphic formations of sedimentary and volcanic origin

Project: 13940.001	Eng/Geol: SIS/RFR
Scale: 1 " = 2,000 '	Date: July 2023
Reference: Socal CGS Geology 2018	

REGIONAL GEOLOGY MAP

Morongo Fire Station 1
SW Corner of Morongo Rd and Santiago Rd
Banning, California

FIGURE 2

Leighton

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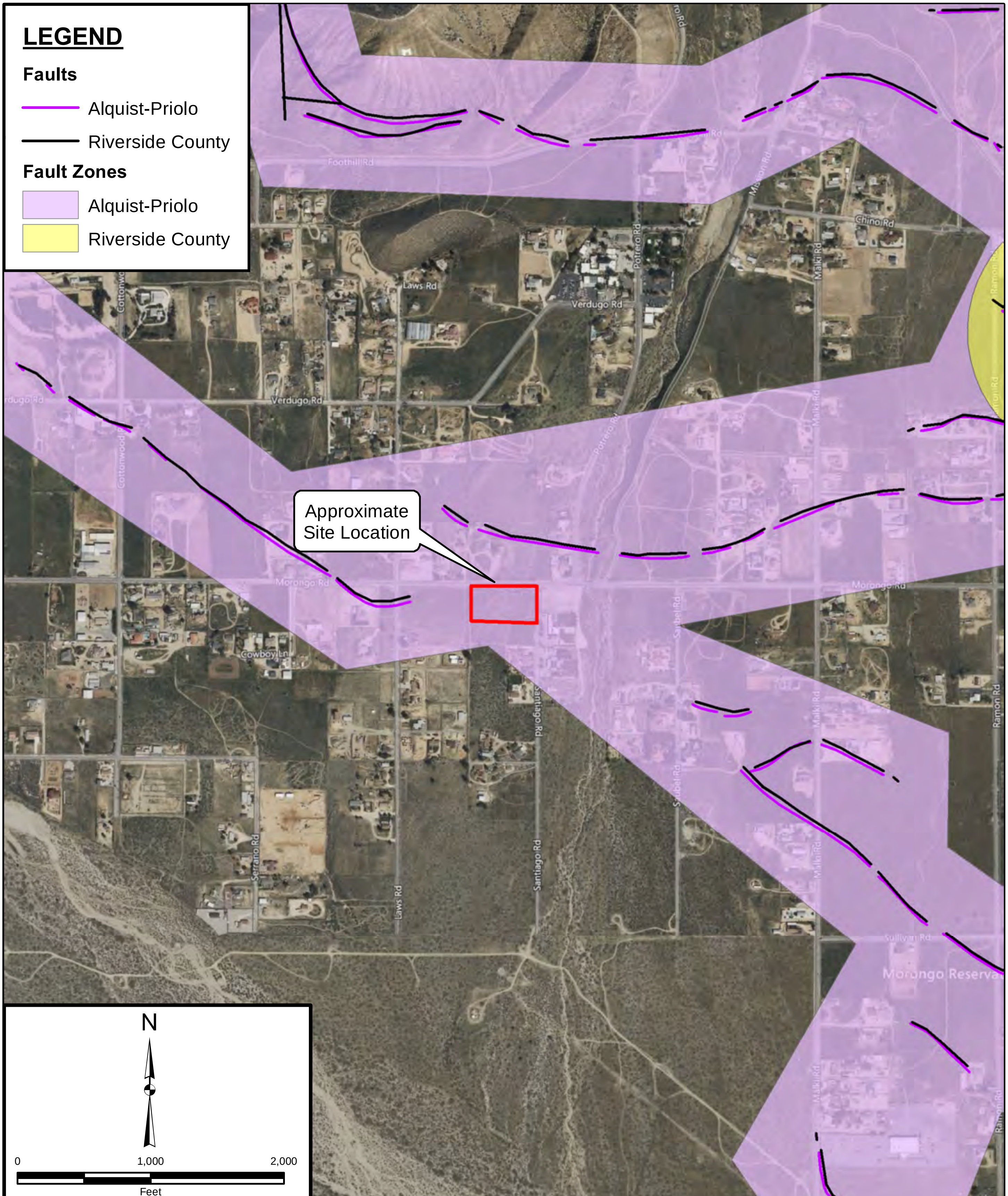

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Scale: 1 " = 1,000 '	Date: July 2023

Reference: © 2023 Microsoft Corporation © 2023 Maxar ©CNES (2023) Distribution Airbus

Author: (btran)

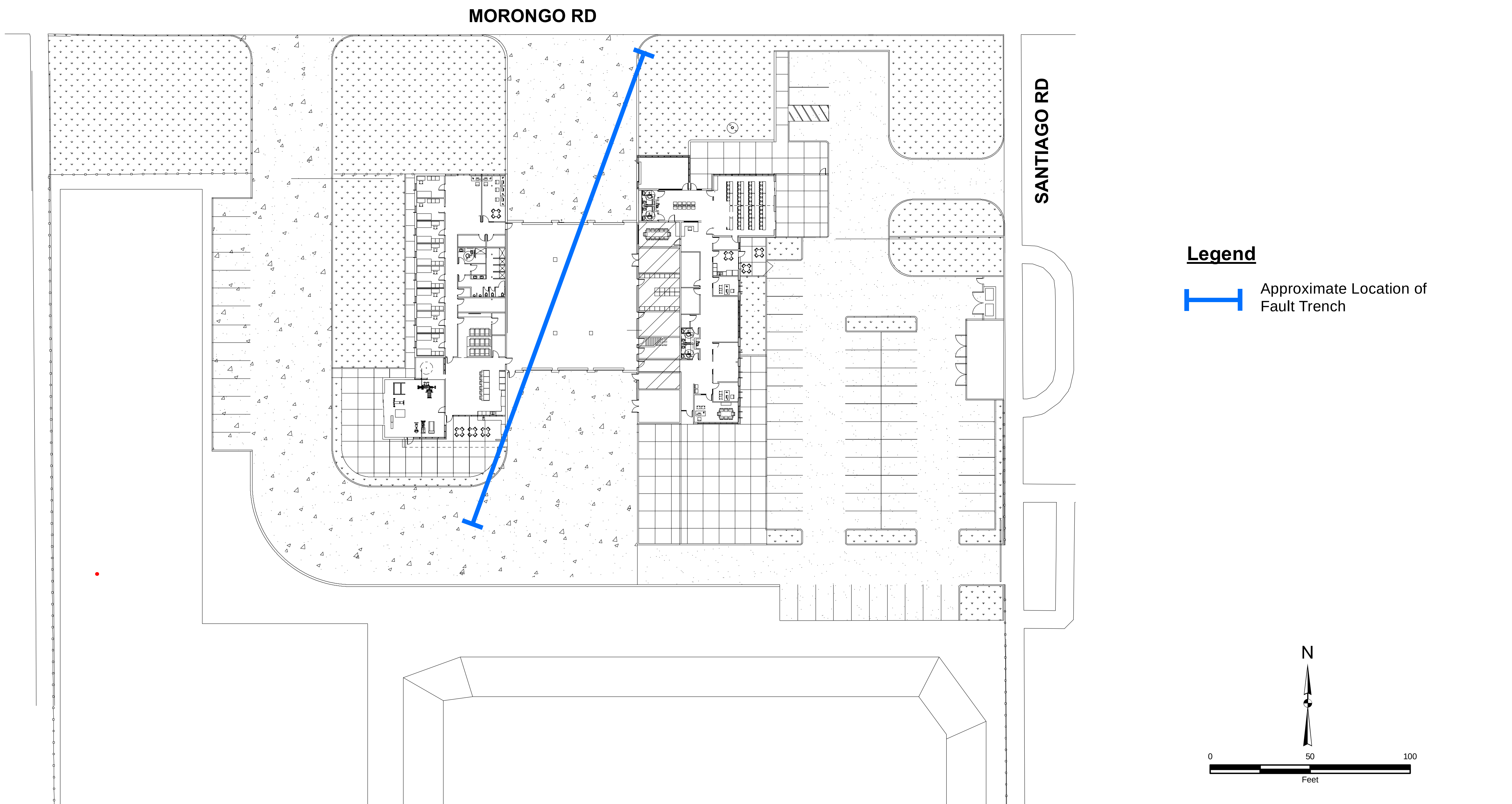
LOCAL FAULT LOCATION MAP

Morongo Fire Station 1
SW Corner of Morongo Rd and Santiago Rd
Banning, California

FIGURE 3

Leighton

Map Saved as J:\Drafting\13940\001\Maps\13940-001_F03_LFLM_2023-06-20.mxd on 6/20/2023 2:43:21 PM



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Scale: 1 " = 50 '	Date: July 2023
Base Map: DLR Group.	
Author: (mmurphy)	

TRENCH LOCATION MAP

Morongo Fire Station 1
SW Corner of Morongo Road and Santiago Road
Banning, California

FIGURE 4

Leighton

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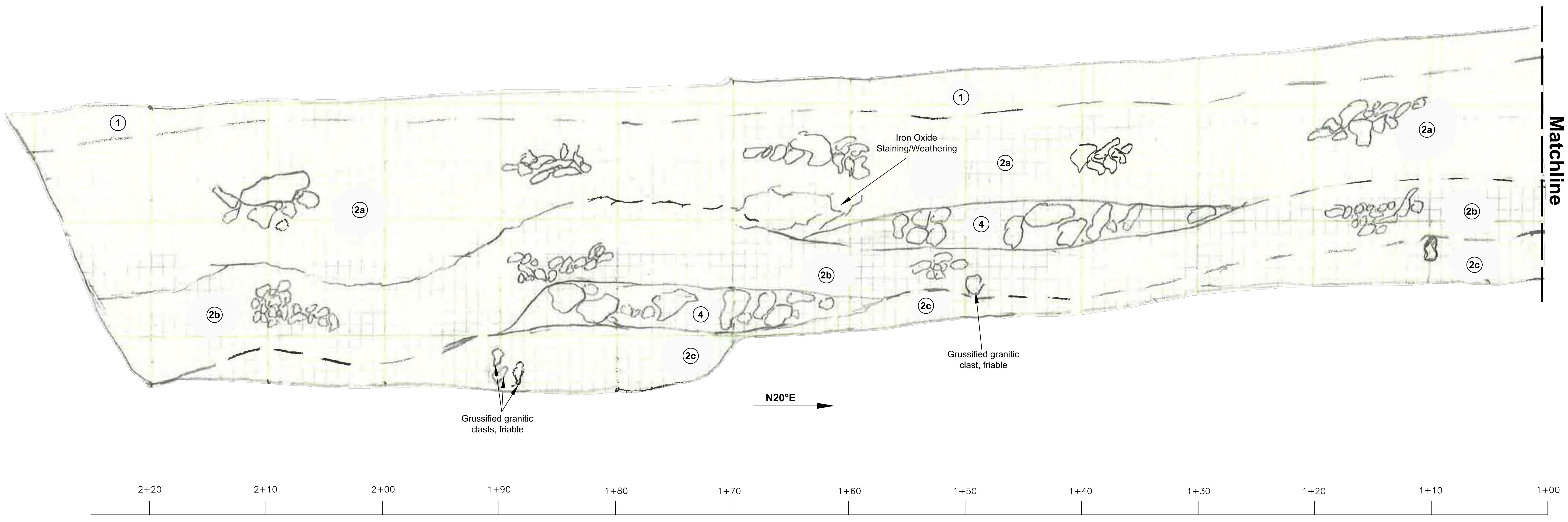
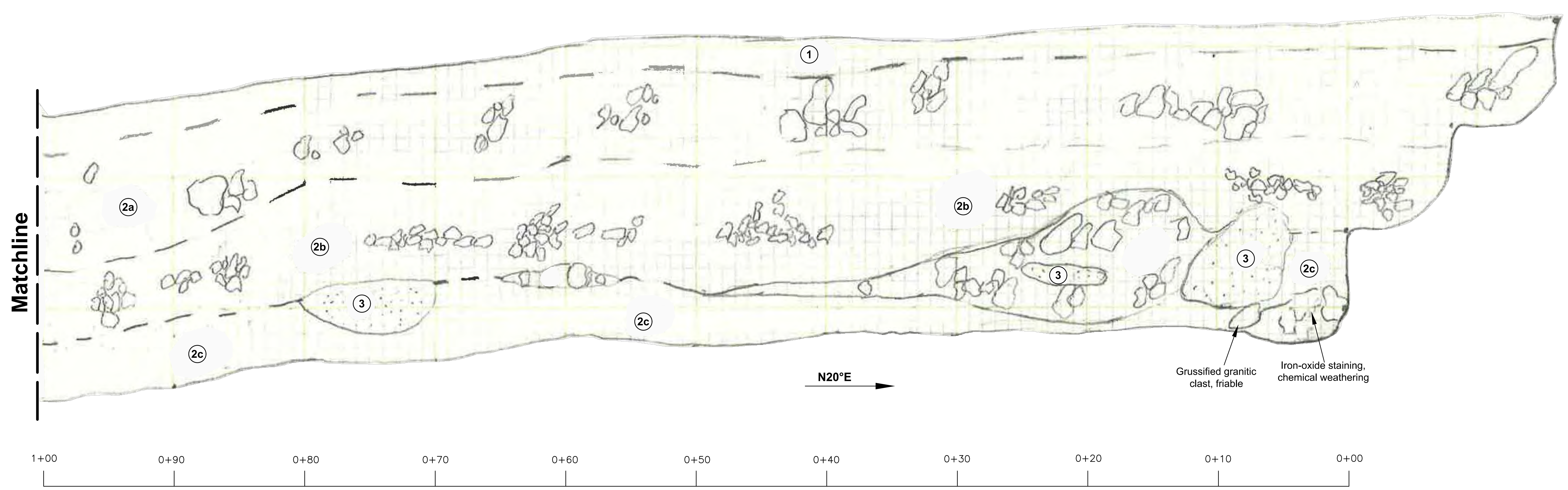
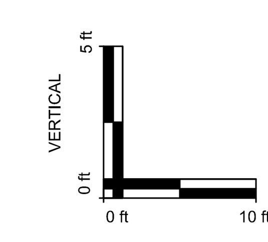




Legend

1. Residual/Topsoil - Very dark brown, loose, silty SAND with gravel, trace clay, with roots and organics.
2. Alluvial Fan Deposits
   - 2a Siltstone member: olive silty clayey Siltstone to silty Claystone; typically fractured, locally sheared, $CaCO_3$ lining fractures common, locally interbedded with b-Sandstone member.
   - 2b Gray to light brown, dry to slightly moist, well graded, sandy GRAVEL, sub-angular to well rounded, medium gravel to cobble, with fine to coarse sand.
   - 2c Light brown to yellowish brown and grayish brown, sandy GRAVEL, sub-angular to rounded, coarse gravel to boulder, grussified/completely weatheres cobble to boulder-size granitic clasts, iron staining.
3. Alluvial Fan Deposits - Light brown, dry to moist, silty SAND, with gravel, fine to coarse sand.
4. Alluvial Fan Deposits - Gray, dry to slightly moist, sandy GRAVEL, poorly graded, medium sand to fine gravel framework grain, with coarse gravel to cobbles.

Note: Letter identifiers within the profiles are used on the trench logs to discern subsurface sediment layers, and do not infer stratigraphic superposition; but rather, correlate unit descriptions with observed layers. Trenches logged by Engineering Geologist BAA.



FAULT TRENCH	PLATE 1
Morongo Fire Station 1 SW Corner of Morongo Road and Santiago Road Banning, California	Scale: 1" = 5' V 1" = 10' H
	Date: July 2023
Leighton	Proj: 13940.001
	Eng/Geol: SIS/BAA
Base Map:	

APPENDIX A

LABORATORY TEST RESULTS AND DENSITY TEST RESULTS

MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Leighton

Project Name:	DLR Morongo FS 1 Fault Inv	Tested By:	J. Foltz	Date:	06/12/23
Project No.:	13940.001	Input By:	M. Vinet	Date:	06/12/23
Boring No.:	T-1	Depth (ft.):	Stockpile		
Sample No.:	B-1				
Soil Identification:	Silty Gravel with Sand (GM)s, Dark Brown.				

Note: Corrected dry density calculation assumes specific gravity of 2.70 and moisture content of 1.0% for oversize particles

			Scalp Fraction (%)	
Preparation Method:	X	Moist	#3/4	29.3
		Dry		
Compaction Method	X	Mechanical Ram	#3/8	
		Manual Ram	#4	

Rammer Weight (lb.) = 10.0

Height of Drop (in.) = 18.0

Mold Volume (ft³) = 0.07500

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	9967	10152	10253	10230		
Weight of Mold (g)	5482	5482	5482	5482		
Net Weight of Soil (g)	4485	4670	4771	4748		
Wet Weight of Soil + Cont. (g)	1694.8	1617.2	1882.0	1587.2		
Dry Weight of Soil + Cont. (g)	1654.2	1553.9	1776.5	1479.2		
Weight of Container (g)	278.4	278.5	277.7	280.2		
Moisture Content (%)	3.0	5.0	7.0	9.0		
Wet Density (pcf)	131.8	137.3	140.2	139.6		
Dry Density (pcf)	128.1	130.8	131.0	128.0		

Maximum Dry Density (pcf): 131.2

Optimum Moisture Content (%): 6.2

Corrected Dry Density (pcf): 140.5

Corrected Moisture Content (%): 4.5

☐ Procedure A
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

☐ Procedure B
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

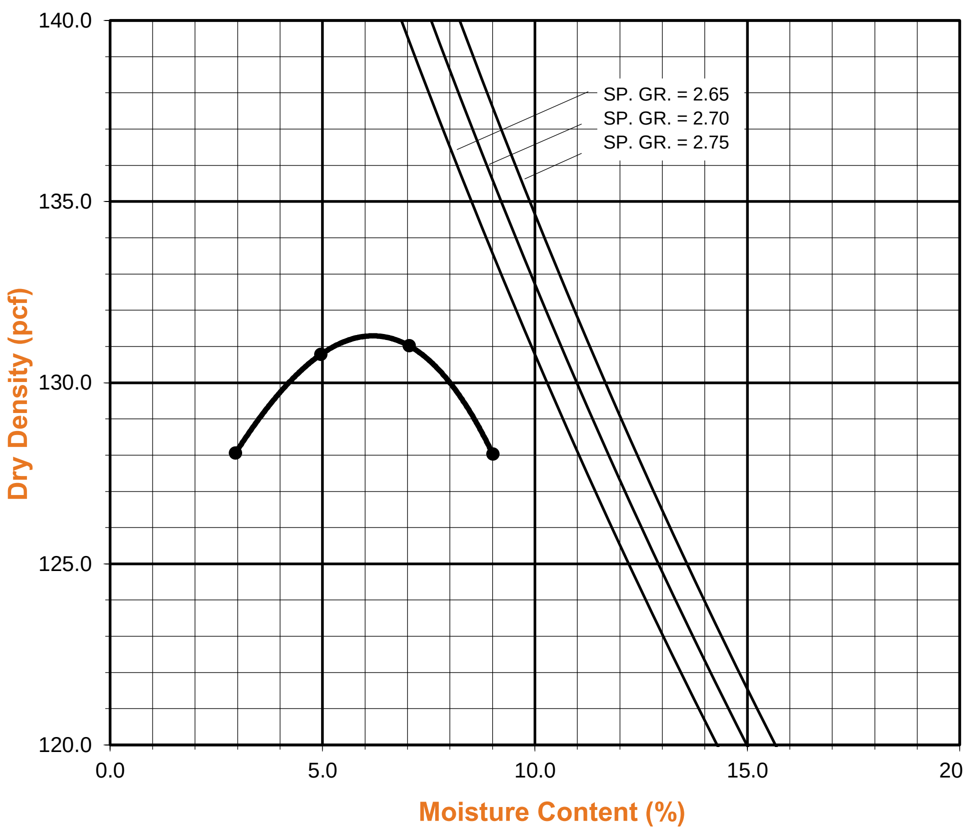
☒ Procedure C
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



SUMMARY OF FIELD DENSITY TESTS

Test #	Retest of	Test Date	Test of	Location	Elev	Soil Type	Dry Density (pcf) Field	Dry Density (pcf) Max	Moisture (%) Field	Moisture (%) Opt	Rel. Comp. (%)
1		6/16/2023	Compacted Fill	Fault Trench Backfill: ~ Sta. 1+25	-9	T-1, B-1	137.2	140.5	6.6	4.5	98
2		6/16/2023	Compacted Fill	Fault Trench Backfill: ~ Sta. 0+65	-8	T-1, B-1	133.6	140.5	5.8	4.5	95
3		6/16/2023	Compacted Fill	Fault Trench Backfill: ~ Sta. 0+15	-8	T-1, B-1	134.9	140.5	6.0	4.5	96
4		6/16/2023	Compacted Fill	Fault Trench Backfill: ~ Sta. 1+55	-6	T-1, B-1	134.4	140.5	4.1	4.5	96
5		6/16/2023	Compacted Fill	Fault Trench Backfill: ~ Sta. 0+45	-6	T-1, B-1	133.6	140.5	5.5	4.5	95
6		6/19/2023	Compacted Fill	Fault Trench Backfill: ~ Sta. 1+85	-4	T-1, B-1	136.1	140.5	3.5	4.5	97
7		6/19/2023	Compacted Fill	Fault Trench Backfill: ~ Sta. 1+15	-3	T-1, B-1	134.0	140.5	6.7	4.5	95
8		6/19/2023	Compacted Fill	Fault Trench Backfill: ~ Sta. 0+44	-2.5	T-1, B-1	133.6	140.5	5.5	4.5	95
9		6/19/2023	Compacted Fill	Fault Trench Backfill: ~ Sta. 0+10	-1	T-1, B-1	138.2	140.5	5.3	4.5	98