Preliminary Geotechnical and GeoHazards Report

Melon Properties
NEC Melon Road and Ninth Street
Holtville, California

Prepared for:

Melon Properties
c/o DuBose Design Group
1065 State Street
El Centro, CA 92243

Prepared by:

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March 2018

LandMark
Geo-Engineers and Geologists

March 22, 2018

Mr. John Hawk
Melon Properties
c/o DuBose Design Group
1065 State Street
El Centro, CA 92243

Preliminary Geological and Geotechnical Hazard Evaluation
Melon Properties
NEC Melon Road and Ninth Street
Holtville, California
LCI Project No. LE18047

Dear Mr. Hawk:

This preliminary geotechnical report and geologic hazards study is provided for preliminary site evaluation and entitlement for multi-family development of the three (3) vacant lots (APN 045-390-006, 045-390-044, 045-390-065, 045-390-066, and 045-390-067) located at the northeast corner of Melon Road and Ninth Street in northwestern Holtville, California.

Scope of Work

The scope of work consisted of a geologic and geotechnical hazards evaluation of the project site which addresses the following items:

1. General site geology.
2. Site location in relation to mapped earthquake faults and seismic zones.
3. Intensity of ground shaking at the site.
4. Potential for liquefaction, ground failure, and landslides at the site. No drilling was conducted to determine potential for liquefaction settlement or soil analysis.
5. Soil corrosivity.
6. Potential for flooding at the site from manmade facilities (dams, canals, etc.) and from natural storms.
7. Other potential geologic and geotechnical hazards.

Site Description

The project site is located at the northeast corner of northeast corner of Melon Road and Ninth Street in northwestern Holtville, California. The approximately 8-acre project site consists of three vacant parcels (APN 045-390-006, 045-390-044, 045-390-065, 045-390-066, and 045-390-067). The site is L-shaped in plan view and currently undeveloped. The site is bounded on the west by Melon Road, the north by Underwood Road and the south by Ninth Street (Alamo Road). Sporadic weed, burhs and trees cover the site.

Site Geological Conditions

Site Geology: The project site is located in the Imperial Valley portion of the Salton Trough physiographic province. The Salton Trough is a topographic and geologic structural depression resulting from large scale regional faulting. The trough is bounded on the northeast by the San Andreas Fault and Chocolate Mountains and the southwest by the Peninsular Range and faults of the San Jacinto Fault Zone. The Salton Trough represents the northward extension of the Gulf of California, containing both marine and non-marine sediments since the Miocene Epoch. Tectonic activity that formed the trough continues at a high rate as evidenced by deformed young sedimentary deposits and high levels of seismicity. Figure 1 shows the location of the site in relation to regional faults and physiographic features.

The Imperial Valley is directly underlain by lacustrine deposits, which consist of interbedded lenticular and tabular silt, sand, and clay. Based on Unified Soil Classification System, the permeability of these soils is expected to be low to moderate. The Late Pleistocene to Holocene lake deposits are probably less than 100 feet thick and derived from periodic flooding of the Colorado River which intermittently formed a fresh water lake (Lake Cahuilla).

Older deposits consist of Miocene to Pleistocene non-marine and marine sediments deposited during intrusions of the Gulf of California. Basement rock consisting of Mesozoic granite and Paleozoic metamorphic rocks are estimated to exist at depths between 15,000 - 20,000 feet.

Groundwater: The groundwater in the site area is brackish and typically encountered at a depth of between 10 to 15 feet below ground surface in the vicinity of the project site. There is uncertainty in the accuracy of short-term water level measurements, particularly in fine-grained soil.
Groundwater levels may fluctuate with precipitation, irrigation of adjacent properties,

Groundwater levels may fluctuate with precipitation, irrigation of adjacent properties, drainage, and site grading. The groundwater level noted should not be interpreted to represent an accurate or permanent condition.

Geological Hazards

Landsliding: No ancient landslides are shown on geologic maps of the region and no indications of landslides were observed during our site investigation. The hazard of landsliding is unlikely due to the relatively planar topography of the project site.

Volcanic hazards: The site is not located proximal to any known volcanically active area and the risk of volcanic hazards is considered very low.

Tsunamis, seiches, and flooding: The site does not lie near any large bodies of water, so the threat of tsunami, seiches, or other seismically-induced flooding is considered unlikely. The project site is located in FEMA Flood Zone X, an area determined to be outside the 0.2% annual chance floodplain (FIRM Panels 06025C1734C).

Expansive soil: In general, much of the near surface soils within the project site consist of silty clays having a moderate expansion potential. A site specific geotechnical investigation will be required at this site to determine the extent and effect of expansive soils.

Corrosive Soils: The lacustrine site soils (lake bed deposits) are known to be corrosive. Typical remediation for the corrosive soil conditions consists of using concrete mixed with higher cement contents (6 sacks Type V Portland Cement) and low water-cement ratios (0.45 w/c ratio). Additionally, steel post corrosion protection is required, consisting of zinc coatings (galvanizing) or increased structural sections to compensate for metal loss due to corrosion.

Liquefaction/Seismic Settlements: Liquefaction is a potential design consideration because of possible saturated sandy substrata underlying the site. Liquefaction occurs when granular soil below the water table is subjected to vibratory motions, such as produced by earthquakes. With strong ground shaking, an increase in pore water pressure develops as the soil tends to reduce in volume. If the increase in pore water pressure is sufficient to reduce the vertical effective stress (suspending the soil particles in water), the soil strength decreases and the soil behaves as a liquid (similar to quicksand).

Liquefaction can produce excessive settlement, ground rupture, lateral spreading, or failure of shallow bearing foundations. Four conditions are generally required for liquefaction to occur:

    (1)   the soil must be saturated (relatively shallow groundwater);

    (2)   the soil must be loosely packed (low to medium relative density);

    (3)   the soil must be relatively cohesionless (not clayey); and

    (4)   groundshaking of sufficient intensity must occur to function as a trigger mechanism.

All of these conditions may exist to some degree at this site. Liquefaction settlement and ground fissures were not noted in the area of the project site after the April 4, 2010 magnitude 7.2M_w El Mayor-Cucapah Earthquake.

Subsurface exploration and evaluation of the subsurface soils will be required to determine the potential for and magnitude of liquefaction induced settlements at the project site. Ground improvement methods are available to mitigate liquefaction such as deep soil mixing (cement), vibro-compaction, vibro-replacement, geopiers, stone columns, compaction grouting, or deep dynamic compaction. Other means to mitigate liquefaction damage include either a deep foundation system, rigid mat foundations and grade-beam reinforced foundations that can withstand some differential movement or tilting.

Seismic Hazards

The project site is located in the seismically active Imperial Valley of southern California with numerous mapped faults of the San Andreas Fault System traversing the region. The San Andreas Fault System is comprised of the San Andreas, San Jacinto, and Elsinore Fault Zones in southern California. The Imperial fault represents a transition from the more continuous San Andreas fault to a more nearly echelon pattern characteristic of the faults under the Gulf of California (USGS, 1990). We have performed a computer-aided search of known faults or seismic zones that lie within a 37.5 mile (60 kilometer) radius of the project site (Table 1).

A fault map illustrating known active faults relative to the site is presented on Figure 1, *Regional Fault Map*. A legend for the regional fault map is presented on Figure 2. The criterion for fault classification adopted by the California Geological Survey defines Earthquake Fault Zones along active or potentially active faults. An active fault is one that has ruptured during Holocene time (roughly within the last 11,000 years).

A fault that has ruptured during the last 1.8 million years (Quaternary time), but has not been proven by direct evidence to have not moved within Holocene time is considered to be potentially active. A fault that has not moved during both Pleistocene and Holocene time (that is no movement within the last 1.8 million years) is considered to be inactive.

Review of the current Alquist-Priolo Earthquake Fault Zone maps (CGS, 2017) indicates that the nearest mapped Earthquake Fault Zone is the Rico fault located approximately 0.8 miles southwest of the project site and the Imperial fault located approximately 2.9 miles west of the project site.

The Rico fault was first recorded after ground fractures were observed following the 1979 Imperial Valley earthquake. The fractures were discontinuously traced along a one kilometer line. The Rico fault has been interpreted from limited data to be a north-south trending, buried, pre-existing normal fault (down to the west).

Groundshaking. The primary seismic hazard at the project site is the potential for strong groundshaking during earthquakes along the Superstition Hills, Imperial, Cerro Prieto, and Laguna Salada faults (Figure 2).

Site Acceleration: The project site is considered likely to be subjected to moderate to strong ground motion from earthquakes in the region. Ground motions are dependent primarily on the earthquake magnitude and distance to the seismogenic (rupture) zone. Accelerations also are dependent upon attenuation by rock and soil deposits, direction of rupture and type of fault; therefore, ground motions may vary considerably in the same general area.

CBC General Ground Motion Parameters: The 2016 California Building Code (CBC) general ground motion parameters are based on the Risk-Targeted Maximum Considered Earthquake (MCE_R). The U.S. Geological Survey "U.S. Seismic Design Maps Web Application" (USGS, 2018) was used to obtain the site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters. The site soils have been classified as Site Class D (stiff soil profile) based on the estimated site subsurface soil properties in accordance with CBC Section 1613.3.2. Where the soil properties are not known in sufficient detail to determine the site class, Site Class D shall be used (ASCE, 2010).

Design spectral response acceleration parameters are defined as the earthquake ground motions that are two-thirds (2/3) of the corresponding MCE$_R$ ground motions. Design earthquake ground motion parameters are provided in Table 2. A Risk Category II was determined using CBC Table 1604.5 (Risk Category of Buildings and Other Structures) based on the anticipated occupancy of the potential future structures. The Seismic Design Category is D since the mapped spectral response acceleration parameter at 1 second (S$_1$) is less than 0.75 as shown on Table 2.

The Maximum Considered Earthquake Geometric Mean (MCE$_G$) peak ground acceleration (PGA$_M$) value was determined from the "U.S. Seismic Design Maps Web Application" (USGS, 2018) for liquefaction and seismic settlement analysis in accordance with 2016 CBC Section 1803.5.12 and CGS Note 48 (PGA$_M$ = F$_{PGA}$*PGA). A PGA$_M$ value of 0.59g (50% of gravity) has been determined for this project site. During an earthquake when the ground is shaking, the ground experiences acceleration (a change in the velocity). The peak ground acceleration is the largest increase in velocity recorded at a site during an earthquake.

Surface Rupture: The nearest major mapped Earthquake Fault Zone is the Imperial fault located approximately 2.9 miles east of the project site. Surface fault rupture at the project site is considered to be low.

Other Hazards

Hazardous Materials: The site is not located in proximity to any known hazardous materials (methane gas, tar seeps, hydrogen sulfide gas), and the risk of hazardous materials is considered very low.

Radon 222 Gas: Radon gas is not believed to be a potential hazard at the site. A report titled "California Statewide Radon Survey-Screening Results", dated November 1990 and published by the California State Department of Health Services, notes that Southern California showed a low risk of elevated radon levels, based on 2-day tests conducted from January through April 1990. Some of the reported testing was performed in Imperial County; however, no data was observed as being at or near the project site.

Naturally occurring asbestos: The site is not located in proximity to any known naturally occurring asbestos, and the risk of naturally occurring asbestos is considered very low.

Hydrocollapse: The site is dominantly underlain by clays that are not expected to collapse with the addition of water to the site. The risk of hydrocollapse is considered very low.
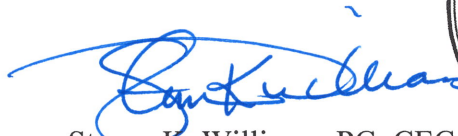
Regional Subsidence: Regional subsidence due to geothermal resource activities has not been documented in the area of the project site; therefore, the risk of regional subsidence is considered low.

Conclusion

This preliminary report was prepared according to the generally accepted *geotechnical engineering standards of practice* that existed in Imperial County at the time the report was prepared. No express or implied warranties are made in connection with our services.

Our research did not reveal conditions that would preclude implementation of the proposed project provided site specific geotechnical investigations are conducted prior to site development to provide geotechnical criteria for the design and construction of this project. We appreciate the opportunity to provide our findings and professional opinions regarding geologic and geotechnical hazards at the site. If you have any questions or comments regarding our findings, please call our office at (760) 370-3000.

Sincerely Yours;
Landmark Consultants, Inc.

Steven K. Williams, PG, CEG
Senior Engineering Geologist

Jeffrey O. Lyon, PE
President

TABLES

Table 2
2016 California Building Code (CBC) and ASCE 7-10 Seismic Parameters
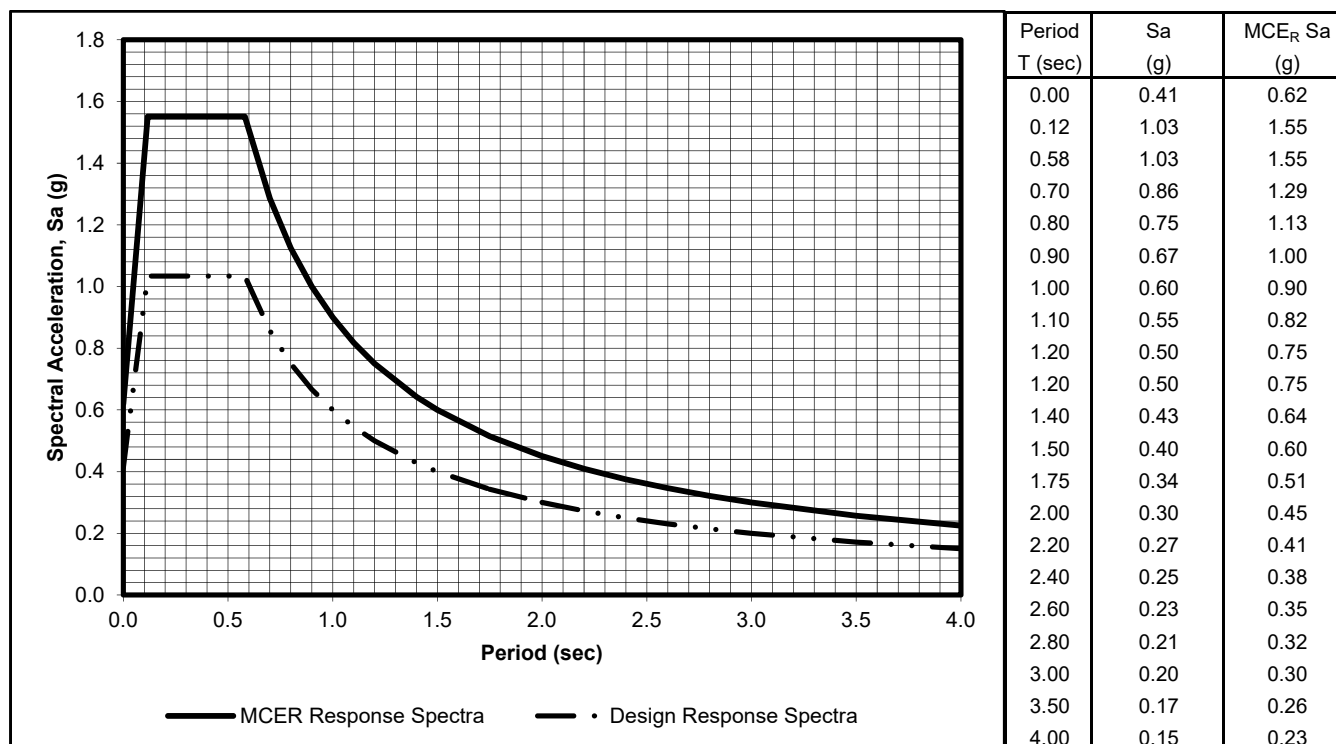
<u>CBC Reference</u>

Soil Site Class:	**D**	Table 20.3-1
Latitude:	32.8189 N	
Longitude:	-115.3879 W	
Risk Category:	II	
Seismic Design Category:	D	

Maximum Considered Earthquake (MCE) Ground Motion

Mapped MCE_R Short Period Spectral Response	S_s	1.551 g	Figure 1613.3.1(1)	
Mapped MCE_R 1 second Spectral Response	S_1	0.600 g	Figure 1613.3.1(2)	
Short Period (0.2 s) Site Coefficient	F_a	1.00	Table 1613.3.3(1)	
Long Period (1.0 s) Site Coefficient	F_v	1.50	Table 1613.3.3(2)	
MCE_R Spectral Response Acceleration Parameter (0.2 s)	S_{MS}	1.551 g	$= F_a * S_s$	Equation 16-37
MCE_R Spectral Response Acceleration Parameter (1.0 s)	S_{M1}	0.900 g	$= F_v * S_1$	Equation 16-38

Design Earthquake Ground Motion

Design Spectral Response Acceleration Parameter (0.2 s)	S_{DS}	1.034 g	$= 2/3 * S_{MS}$	Equation 16-39
Design Spectral Response Acceleration Parameter (1.0 s)	S_{D1}	0.600 g	$= 2/3 * S_{M1}$	Equation 16-40
Risk Coefficient at Short Periods (less than 0.2 s)	C_{RS}	1.063		ASCE Figure 22-17
Risk Coefficient at Long Periods (greater than 1.0 s)	C_{R1}	1.028		ASCE Figure 22-18
	T_L	8.00 sec		ASCE Figure 22-12
	T_O	0.12 sec	$= 0.2 * S_{D1}/S_{DS}$	
	T_S	0.58 sec	$= S_{D1}/S_{DS}$	
Peak Ground Acceleration	PGA_M	0.59 g		ASCE Equation 11.8-1

Period T (sec)	Sa (g)	MCE_R Sa (g)
0.00	0.41	0.62
0.12	1.03	1.55
0.58	1.03	1.55
0.70	0.86	1.29
0.80	0.75	1.13
0.90	0.67	1.00
1.00	0.60	0.90
1.10	0.55	0.82
1.20	0.50	0.75
1.20	0.50	0.75
1.40	0.43	0.64
1.50	0.40	0.60
1.75	0.34	0.51
2.00	0.30	0.45
2.20	0.27	0.41
2.40	0.25	0.38
2.60	0.23	0.35
2.80	0.21	0.32
3.00	0.20	0.30
3.50	0.17	0.26
4.00	0.15	0.23

Table 1
Summary of Characteristics of Closest Known Active Faults

Fault Name	Approximate Distance (miles)	Approximate Distance (km)	Maximum Moment Magnitude (Mw)	Fault Length (km)	Slip Rate (mm/yr)
Rico *	0.8	1.2			
Imperial	2.9	4.7	7	62 ± 6	20 ± 5
Brawley *	5.0	8.0			
Superstition Hills	12.5	20.0	6.6	23 ± 2	4 ± 2
Superstition Mountain	17.9	28.7	6.6	24 ± 2	5 ± 3
Unnamed 2*	19.4	31.0			
Unnamed 1*	21.5	34.4			
Cerro Prieto *	21.9	35.1			
Yuha*	23.2	37.1			
Borrego (Mexico)*	24.0	38.4			
Laguna Salada	25.8	41.2	7	67 ± 7	3.5 ± 1.5
Algodones *	26.0	41.6			
Shell Beds	26.1	41.8			
Yuha Well *	26.4	42.2			
Pescadores (Mexico)*	26.4	42.3			
Cucapah (Mexico)*	26.6	42.6			
Vista de Anza*	29.7	47.6			
Elmore Ranch	30.1	48.1	6.6	29 ± 3	1 ± 0.5
Painted Gorge Wash*	30.4	48.6			
Ocotillo*	34.0	54.4			
Elsinore - Coyote Mountain	37.4	59.8	6.8	39 ± 4	4 ± 2
San Jacinto - Borrego	37.5	60.0	6.6	29 ± 3	4 ± 2

* Note: Faults not included in CGS database.

FIGURES

100 km

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Regional Fault Map

Figure 1
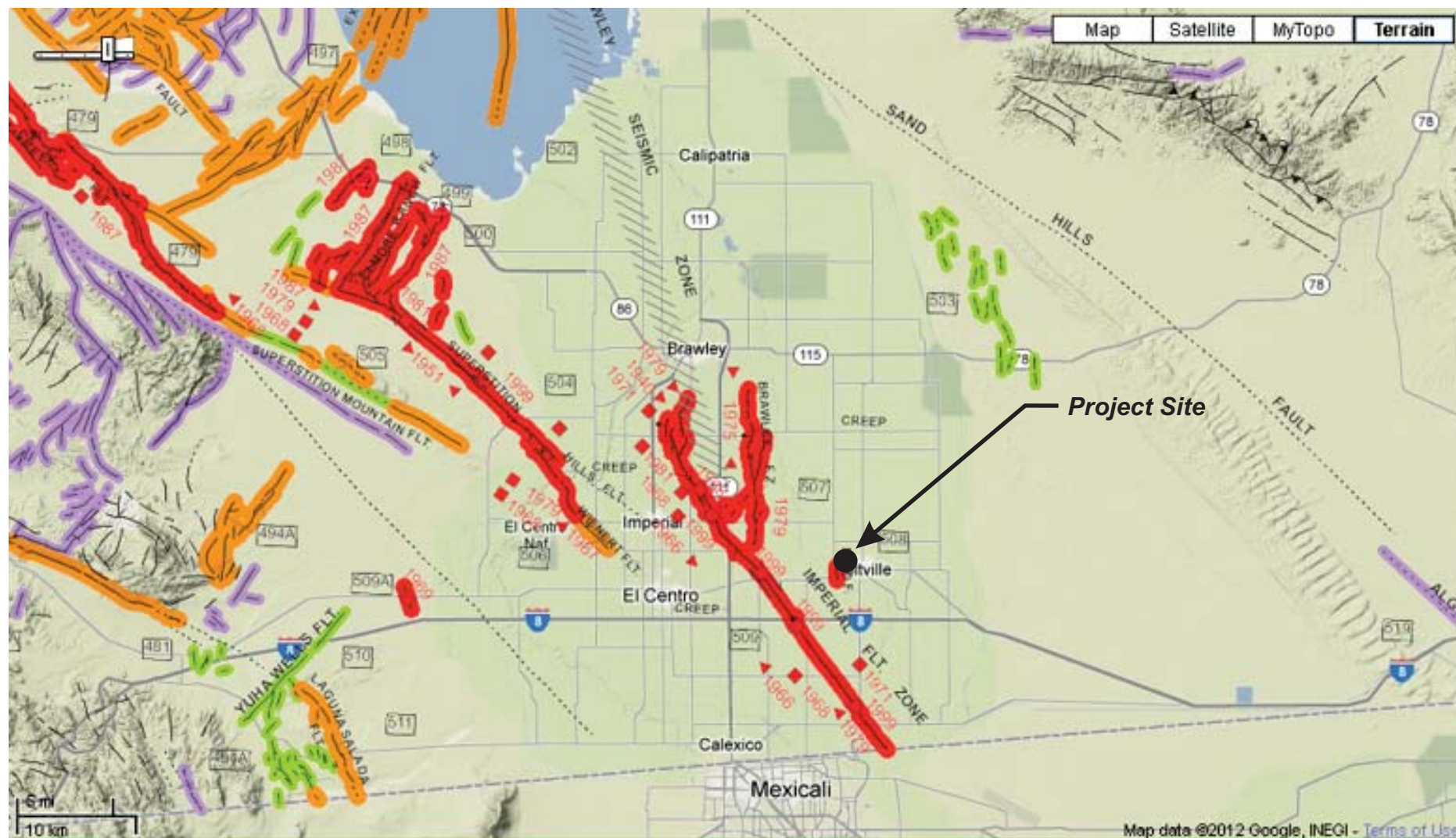
Map Satellite MyTopo **Terrain**

Project Site

Map data ©2012 Google, INEGI - Terms of Use

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Map of Local Faults

Figure 2

EXPLANATION

Fault traces on land are indicated by solid lines where well located, by dashed lines where approximately located or inferred, and by dotted lines where concealed by younger rocks or by lakes or bays. Fault traces are queried where continuation or existence is uncertain. Concealed faults in the Great Valley are based on maps of selected subsurface horizons, so locations shown are approximate and may indicate structural trend only. All offshore faults based on seismic reflection profile records are shown as solid lines where well defined, dashed where inferred, queried where uncertain.

FAULT CLASSIFICATION COLOR CODE
(Indicating Recency of Movement)

Fault along which historic (last 200 years) displacement has occurred and is associated with one or more of the following:

(a) a recorded earthquake with surface rupture. (Also included are some well-defined surface breaks caused by ground shaking during earthquakes, e.g. extensive ground breakage, not on the White Wolf fault, caused by the Arvin-Tehachapi earthquake of 1952). The date of the associated earthquake is indicated. Where repeated surface ruptures on the same fault have occurred, only the date of the latest movement may be indicated, especially if earlier reports are not well documented as to location of ground breaks.

(b) fault creep slippage - slow ground displacement usually without accompanying earthquakes.

(c) displaced survey lines.

A triangle to the right or left of the date indicates termination point of observed surface displacement. Solid red triangle indicates known location of rupture termination point. Open black triangle indicates uncertain or estimated location of rupture termination point.
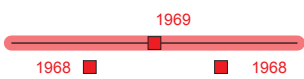
Date bracketed by triangles indicates local fault break.

No triangle by date indicates an intermediate point along fault break.
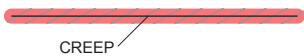
Fault that exhibits fault creep slippage. Hachures indicate linear extent of fault creep. Annotation (creep with leader) indicates representative locations where fault creep has been observed and recorded.

Square on fault indicates where fault creep slippage has occured that has been triggered by an earthquake on some other fault. Date of causative earthquake indicated. Squares to right and left of date indicate terminal points between which triggered creep slippage has occurred (creep either continuous or intermittent between these end points).

Holocene fault displacement (during past 11,700 years) without historic record. Geomorphic evidence for Holocene faulting includes sag ponds, scarps showing little erosion, or the following features in Holocene age deposits: offset stream courses, linear scarps, shutter ridges, and triangular faceted spurs. Recency of faulting offshore is based on the interpreted age of the youngest strata displaced by faulting.

Late Quaternary fault displacement (during past 700,000 years). Geomorphic evidence similar to that described for Holocene faults except features are less distinct. Faulting may be younger, but lack of younger overlying deposits precludes more accurate age classification.

Quaternary fault (age undifferentiated). Most faults of this category show evidence of displacement sometime during the past 1.6 million years; possible exceptions are faults which displace rocks of undifferentiated Plio-Pleistocene age. Unnumbered Quaternary faults were based on Fault Map of California, 1975. See Bulletin 201, Appendix D for source data.

Pre-Quaternary fault (older that 1.6 million years) or fault without recognized Quaternary displacement. Some faults are shown in this category because the source of mapping used was of reconnaissnce nature, or was not done with the object of dating fault displacements. Faults in this category are not necessarily inactive.

ADDITIONAL FAULT SYMBOLS

Bar and ball on downthrown side (relative or apparent).
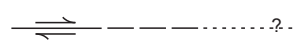
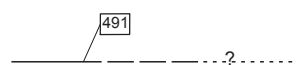Arrows along fault indicate relative or apparent direction of lateral movement.

Arrow on fault indicates direction of dip.

Low angle fault (barbs on upper plate). Fault surface generally dips less than 45° but locally may have been subsequently steepened. On offshore faults, barbs simply indicate a reverse fault regardless of steepness of dip.

OTHER SYMBOLS

Numbers refer to annotations listed in the appendices of the accompanying report. Annotations include fault name, age of fault displacement, and pertinent references including Earthquake Fault Zone maps where a fault has been zoned by the Alquist-Priolo Earthquake Fault Zoning Act. This Act requires the State Geologist to delineate zones to encompass faults with Holocene displacement.

Structural discontinuity (offshore) separating differing Neogene structural domains. May indicate discontinuities between basement rocks.

Brawley Seismic Zone, a linear zone of seismicity locally up to 10 km wide associated with the releasing step between the Imperial and San Andreas faults.

Geologic Time Scale				Years Before Present (Approx.)	Fault Symbol	Recency of Movement	DESCRIPTION	
							ON LAND	OFFSHORE
Quaternary	Late Quaternary	Holocene	Historic				Displacement during historic time (e.g. San Andreas fault 1906). Includes areas of known fault creep.	
				200				
							Displacement during Holocene time.	Fault offsets seafloor sediments or strata of Holocene age.
				11,700				
		Pleistocene					Faults showing evidence of displacement during late Quaternary time.	Fault cuts strata of Late Pleistocene age.
				700,000				
	Early Quaternary						Undivided Quaternary faults - most faults in this category show evidence of displacement during the last 1,600,000 years; possible exceptions are faults which displace rocks of undifferentiated Plio-Pleistocene age.	Fault cuts strata of Quaternary age.
				1,600,000*				
Pre-Quaternary							Faults without recognized Quaternary displacement or showing evidence of no displacement during Quaternary time. Not necessarily inactive.	Fault cuts strata of Pliocene or older age.
				4.5 billion (Age of Earth)				

* Quaternary now recognized as extending to 2.6 Ma (Walker and Geissman, 2009). Quaternary faults in this map were established using the previous 1.6 Ma criterion.

APPENDIX A

Project Site

HOLTVILLE

Thiesen Road

Road

Underwood

ALAMO ROAD

NINTH STREET

ALAMO ROAD

Wooldridge Rd.

Eighth

HOLTVILLE UN. HI. SCH.
& WEBB CONT.
HI. SCH.

Seventh

Artesia
Ave.

Sixth

SOUTHERN PACIFIC

Road

RAILROAD

Walker Ave.

Myrtle Ave.

Olive

Palm

Pine

FIFTH

HOLT

POOL

F.D.
CITY HALL

Fern

P.O.
Orange

FINLEY ELEM.
SCH. DIST. OFF.

JOSEPH'S
EL. SCH.

SCH.
ST. Street

STREET

HOLTVILLE
JR. HI. SCH.

Mack's
Park

Olive Road

Cedar Road

HOLT ROAD

Orange Road

Ave.

Circle Drive

Fig Ave

Street

Brentwood

Beale

Webb Ave.

Walnut

Figueroa Ave.

Grape

Maple

Chestnut

Slayton Road

Road

Magnolia Rd.

Sequoia Rd.

Road

Canal

Drain

Towland

enos

Tamarack Ave.

Palo Verde Av

Mesquite Ave.

Fifth St.

Melon

ALAMO

INTERURBAN

HOLTON

115

Claybrook

Earl Walker
County Park

Fourth

POLICE STA.

RAILROAD

Holt Park

RIVER

ORCHARD ROAD

Third Street

City Reservoir

WALNUT AVE.

Second St.

First St.

DePaoli

Road

Pear

Pear

115

STREET

115

Ash

Bailey

Canal

Road

S32

LANDMARK
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Project No.: LE18047

Vicinity Map

**Plate
A-1**

E Underwood Rd

Doran Rd

Melon Rd

Project Site

E Alamo Rd

Wooldridge Ave

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Google Earth

N
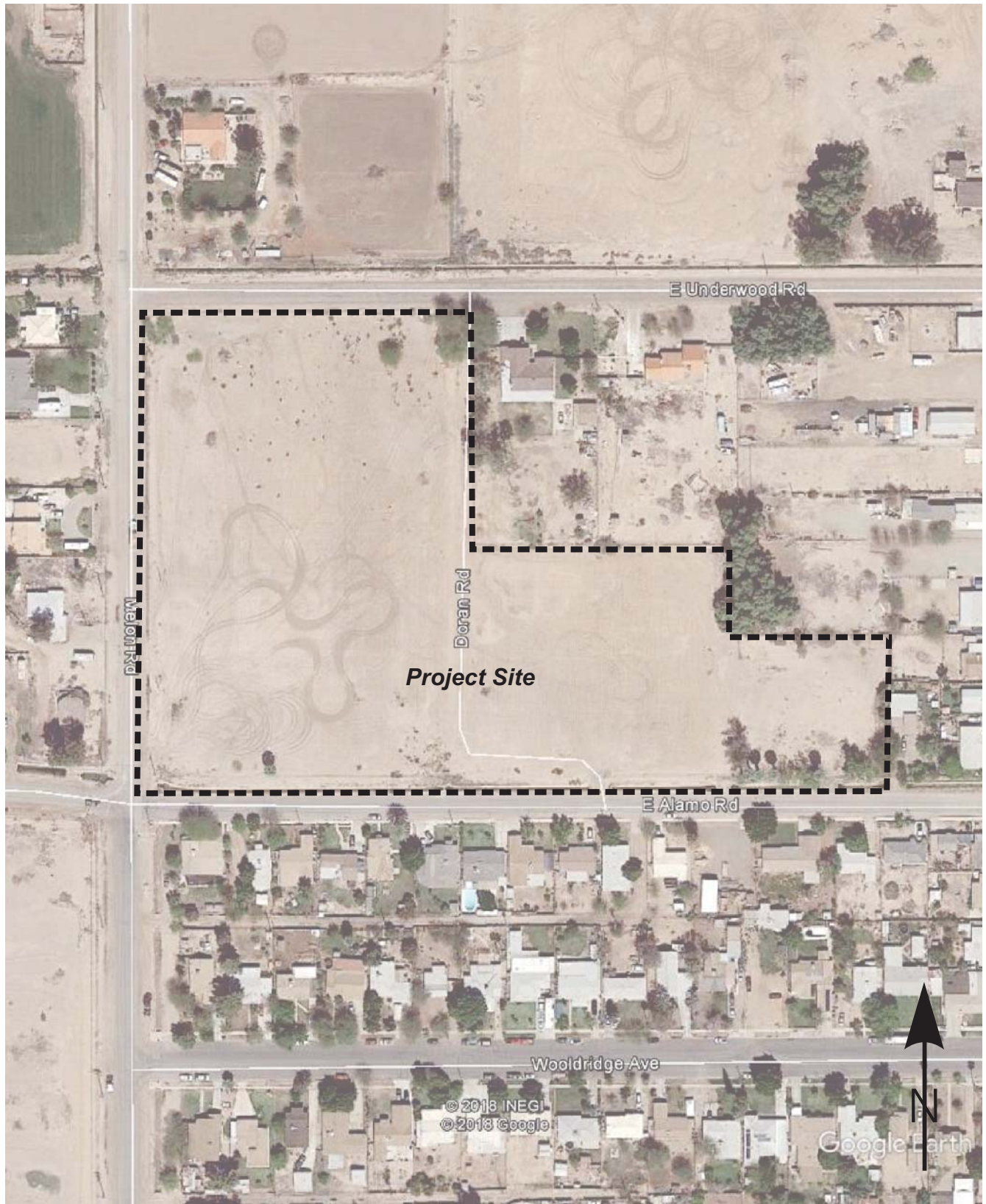
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Project No.: **LE18047**

Site Map

Plate
A-2
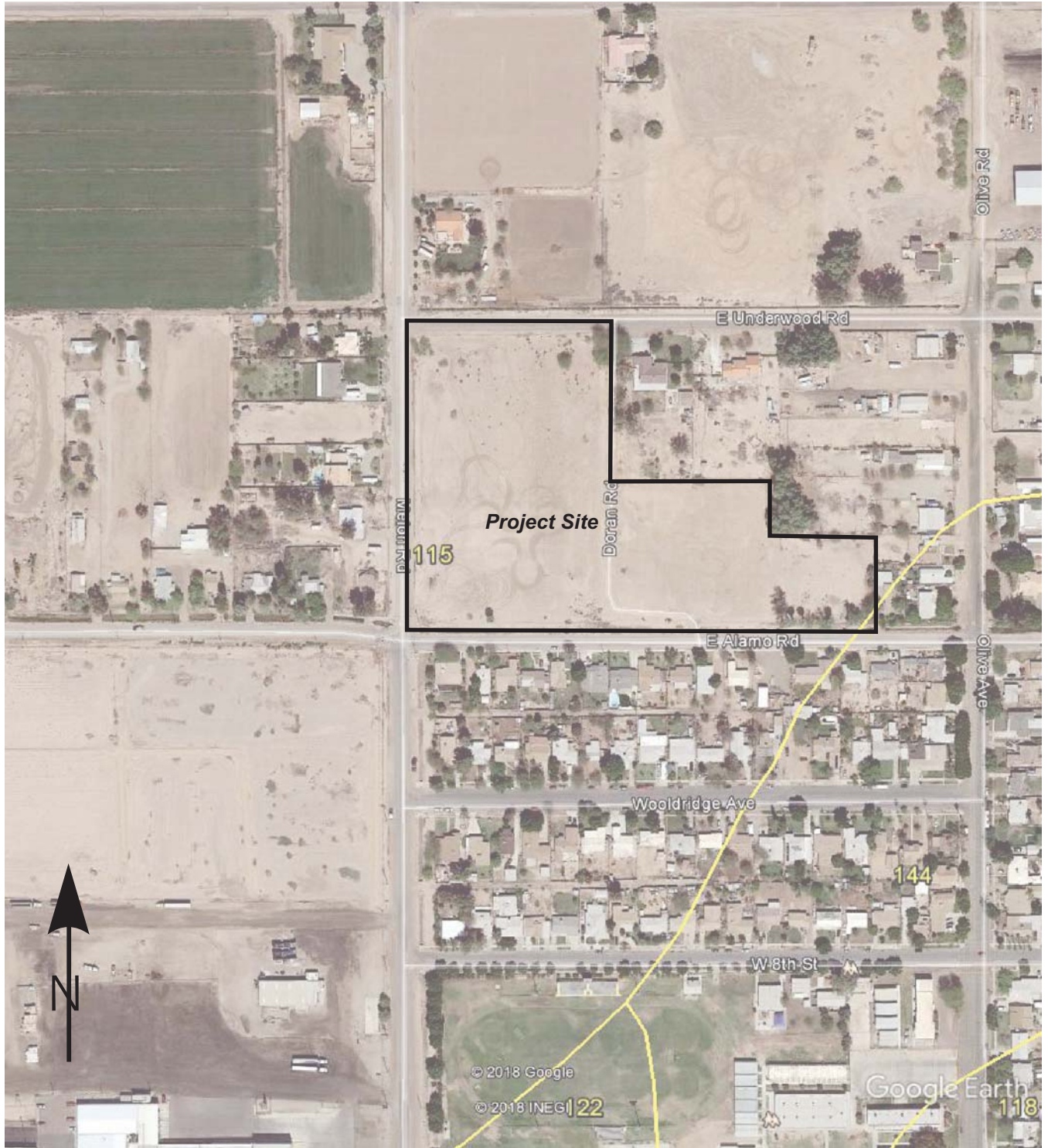
Project Site

E Underwood Rd

E Alamo Rd

Wooldridge Ave

W 8th St

Olive Rd

Olive Ave

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Google Earth

N

Soil Survey of

IMPERIAL COUNTY CALIFORNIA IMPERIAL VALLEY AREA
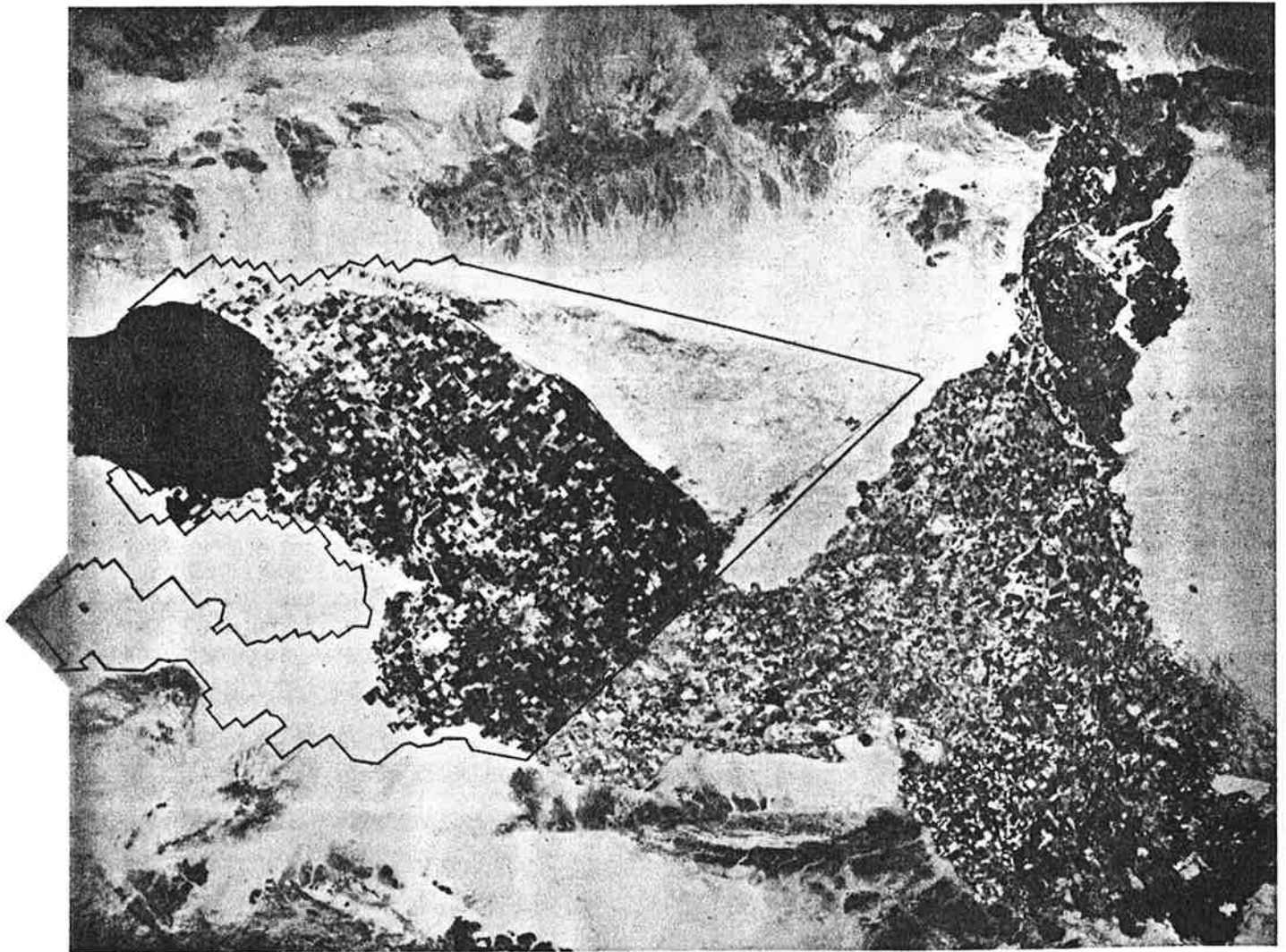
United States Department of Agriculture Soil Conservation Service
in cooperation with
University of California Agricultural Experiment Station
and
Imperial Irrigation District

TABLE 11.--ENGINEERING INDEX PROPERTIES

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
100------------------ Antho	0-13	Loamy fine sand	SM	A-2	0	100	100	75-85	10-30	---	NP
	13-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0	90-100	75-95	50-60	15-40	---	NP
101*: Antho------------	0-8	Loamy fine sand	SM	A-2	0	100	100	75-85	10-30	---	NP
	8-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0	90-100	75-95	50-60	15-40	---	NP
Superstition------	0-6	Fine sand-------	SM	A-2	0	100	95-100	70-85	15-25	---	NP
	6-60	Loamy fine sand, fine sand, sand.	SM	A-2	0	100	95-100	70-85	15-25	---	NP
102*. Badland											
103------------------ Carsitas	0-10	Gravelly sand---	SP, SP-SM	A-1, A-2	0-5	60-90	50-85	30-55	0-10	---	NP
	10-60	Gravelly sand, gravelly coarse sand, sand.	SP, SP-SM	A-1	0-5	60-90	50-85	25-50	0-10	---	NP
104* Fluvaquents											
105------------------ Glenbar	0-13	Clay loam-------	CL	A-6	0	100	100	90-100	70-95	35-45	15-30
	13-60	Clay loam, silty clay loam.	CL	A-6	0	100	100	90-100	70-95	35-45	15-30
106------------------ Glenbar	0-13	Clay loam-------	CL	A-6, A-7	0	100	100	90-100	70-95	35-45	15-25
	13-60	Clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	35-45	15-25
107*------------------ Glenbar	0-13	Loam-----------	ML, CL-ML, CL	A-4	0	100	100	100	70-80	20-30	NP-10
	13-60	Clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	95-100	75-95	35-45	15-30
108------------------ Holtville	0-14	Loam-----------	ML	A-4	0	100	100	85-100	55-95	25-35	NP-10
	14-22	Clay, silty clay	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-35
	22-60	Silt loam, very fine sandy loam.	ML	A-4	0	100	100	95-100	65-85	25-35	NP-10
109------------------ Holtville	0-17	Silty clay------	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-35
	17-24	Clay, silty clay	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-35
	24-35	Silt loam, very fine sandy loam.	ML	A-4	0	100	100	95-100	65-85	25-35	NP-10
	35-60	Loamy very fine sand, loamy fine sand.	SM, ML	A-2, A-4	0	100	100	75-100	20-55	---	NP
110------------------ Holtville	0-17	Silty clay------	CH, CL	A-7	0	100	100	95-100	85-95	40-65	20-35
	17-24	Clay, silty clay	CH, CL	A-7	0	100	100	95-100	85-95	40-65	20-35
	24-35	Silt loam, very fine sandy loam.	ML	A-4	0	100	100	95-100	55-85	25-35	NP-10
	35-60	Loamy very fine sand, loamy fine sand.	SM, ML	A-2, A-4	0	100	100	75-100	20-55	---	NP

See footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
111*:											
Holtville---------	0-10	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-35
	10-22	Clay, silty clay	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-35
	22-60	Silt loam, very fine sandy loam.	ML	A-4	0	100	100	95-100	65-85	25-35	NP-10
Imperial---------	0-12	Silty clay loam	CL	A-7	0	100	100	100	85-95	40-50	10-20
	12-60	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	100	85-95	50-70	25-45
112-------------	0-12	Silty clay------	CH	A-7	0	100	100	100	85-95	50-70	25-45
Imperial	12-60	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	100	85-95	50-70	25-45
113-------------	0-12	Silty clay------	CH	A-7	0	100	100	100	85-95	50-70	25-45
Imperial	12-60	Silty clay, clay, silty clay loam.	CH	A-7	0	100	100	100	85-95	50-70	25-45
114-------------	0-12	Silty clay------	CH	A-7	0	100	100	100	85-95	50-70	25-45
Imperial	12-60	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	100	85-95	50-70	25-45
115*:											
Imperial---------	0-12	Silty clay loam	CL	A-7	0	100	100	100	85-95	40-50	10-20
	12-60	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	100	85-95	50-70	25-45
Glenbar-----------	0-13	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	70-95	35-45	15-25
	13-60	Clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	35-45	15-25
116*:											
Imperial---------	0-13	Silty clay loam	CL	A-7	0	100	100	100	85-95	40-50	10-20
	13-60	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	100	85-95	50-70	25-45
Glenbar-----------	0-13	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	70-95	35-45	15-25
	13-60	Clay loam, silty clay loam.	CL	A-6	0	100	100	90-100	70-95	35-45	15-30
117, 118-----------	0-12	Loam------------	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
Indio	12-72	Stratified loamy very fine sand to silt loam.	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
119*:											
Indio-------------	0-12	Loam------------	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
	12-72	Stratified loamy very fine sand to silt loam.	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
Vint-------------	0-10	Loamy fine sand	SM	A-2	0	95-100	95-100	70-80	25-35	---	NP
	10-60	Loamy sand, loamy fine sand.	SM	A-2	0	95-100	95-100	70-80	20-30	---	NP
120*-------------	0-12	Loam------------	ML, CL-ML	A-4	0	100	95-100	75-85	55-65	20-30	NP-10
Laveen	12-60	Loam, very fine sandy loam.	ML, CL-ML	A-4	0	95-100	85-95	70-80	55-65	15-25	NP-10

See footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

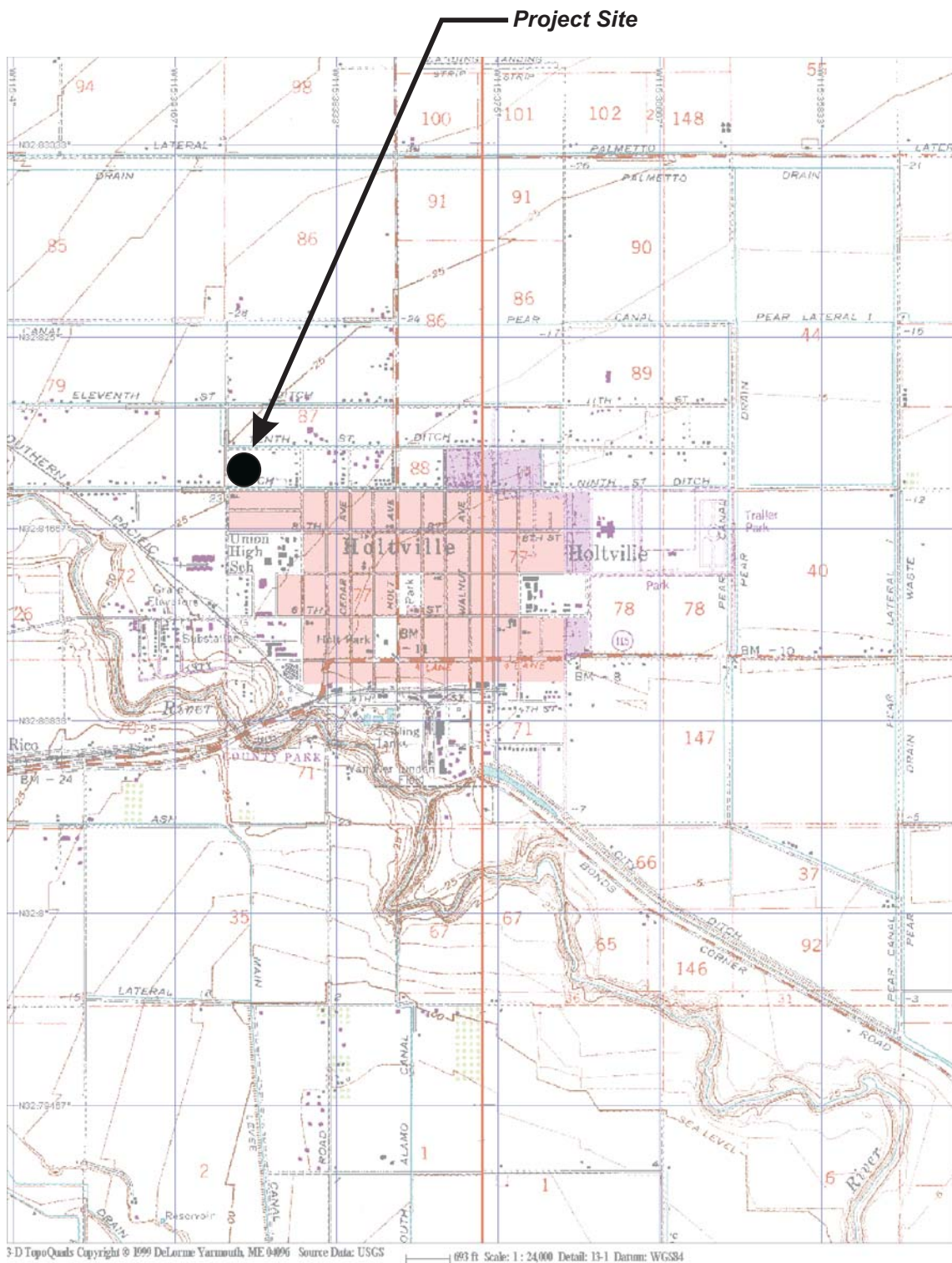| Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
121 Meloland	0-12	Fine sand	SM, SP-SM	A-2, A-3	0	95-100	90-100	75-100	5-30	---	NP
	12-26	Stratified loamy fine sand to silt loam.	ML	A-4	0	100	100	90-100	50-65	25-35	NP-10
	26-71	Clay, silty clay, silty clay loam.	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-40
122 Meloland	0-12	Very fine sandy loam.	ML	A-4	0	95-100	95-100	95-100	55-85	25-35	NP-10
	12-26	Stratified loamy fine sand to silt loam.	ML	A-4	0	100	100	90-100	50-70	25-35	NP-10
	26-71	Clay, silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	85-95	40-65	20-40
123*: Meloland	0-12	Loam	ML	A-4	0	95-100	95-100	95-100	55-85	25-35	NP-10
	12-26	Stratified loamy fine sand to silt loam.	ML	A-4	0	100	100	90-100	50-70	25-35	NP-10
	26-38	Clay, silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	85-95	40-65	20-40
	38-60	Stratified silt loam to loamy fine sand.	SM, ML	A-4	0	100	100	75-100	35-55	25-35	NP-10
Holtville	0-12	Loam	ML	A-4	0	100	100	85-100	55-95	25-35	NP-10
	12-24	Clay, silty clay	CH, CL	A-7	0	100	100	95-100	85-95	40-65	20-35
	24-36	Silt loam, very fine sandy loam.	ML	A-4	0	100	100	95-100	55-85	25-35	NP-10
	36-60	Loamy very fine sand, loamy fine sand.	SM, ML	A-2, A-4	0	100	100	75-100	20-55	---	NP
124, 125 Niland	0-23	Gravelly sand	SM, SP-SM	A-2, A-3	0	90-100	70-95	50-65	5-25	---	NP
	23-60	Silty clay, clay, clay loam.	CL, CH	A-7	0	100	100	85-100	80-95	40-65	20-40
126 Niland	0-23	Fine sand	SM, SP-SM	A-2, A-3	0	90-100	90-100	50-65	5-25	---	NP
	23-60	Silty clay	CL, CH	A-7	0	100	100	85-100	80-95	40-65	20-40
127 Niland	0-23	Loamy fine sand	SM	A-2	0	90-100	90-100	50-65	15-30	---	NP
	23-60	Silty clay	CL, CH	A-7	0	100	100	85-100	80-95	40-65	20-40
128*: Niland	0-23	Gravelly sand	SM, SP-SM	A-2, A-3	0	90-100	70-95	50-65	5-25	---	NP
	23-60	Silty clay, clay, clay loam.	CL, CH	A-7	0	100	100	85-100	80-100	40-65	20-40
Imperial	0-12	Silty clay	CH	A-7	0	100	100	100	85-95	50-70	25-45
	12-60	Silty clay loam, silty clay, clay.	CH	A-7	0	100	100	100	85-95	50-70	25-45
129*: Pits											
130, 131 Rositas	0-27	Sand	SP-SM	A-3, A-1, A-2	0	100	80-100	40-70	5-15	---	NP
	27-60	Sand, fine sand, loamy sand.	SM, SP-SM	A-3, A-2, A-1	0	100	80-100	40-85	5-30	---	NP

See footnote at end of table.

TABLE 11.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification Unified	Classification AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
132, 133, 134, 135- Rositas	0-9	Fine sand-------	SM	A-3, A-2	0	100	80-100	50-80	10-25	---	NP
	9-60	Sand, fine sand, loamy sand.	SM, SP-SM	A-3, A-2, A-1	0	100	80-100	40-85	5-30	---	NP
136-------------- Rositas	0-4	Loamy fine sand	SM	A-1, A-2	0	100	80-100	40-85	10-35	---	NP
	4-60	Sand, fine sand, loamy sand.	SM, SP-SM	A-3, A-2, A-1	0	100	80-100	40-85	5-30	---	NP
137-------------- Rositas	0-12	Silt loam-------	ML	A-4	0	100	100	90-100	70-90	20-30	NP-5
	12-60	Sand, fine sand, loamy sand.	SM, SP-SM	A-3, A-2, A-1	0	100	80-100	40-85	5-30	---	NP
138*: Rositas-----------	0-4	Loamy fine sand	SM	A-1, A-2	0	100	80-100	40-85	10-35	---	NP
	4-60	Sand, fine sand, loamy sand.	SM, SP-SM	A-3, A-2, A-1	0	100	80-100	40-85	5-30	---	NP
Superstition------	0-6	Loamy fine sand	SM	A-2	0	100	95-100	70-85	15-25	---	NP
	6-60	Loamy fine sand, fine sand, sand.	SM	A-2	0	100	95-100	70-85	15-25	---	NP
139-------------- Superstition	0-6	Loamy fine sand	SM	A-2	0	100	95-100	70-85	15-25	---	NP
	6-60	Loamy fine sand, fine sand, sand.	SM	A-2	0	100	95-100	70-85	15-25	---	NP
140*: Torriorthents											
Rock outcrop											
141*: Torriorthents											
Orthids											
142-------------- Vint	0-10	Loamy very fine sand.	SM, ML	A-4	0	100	100	85-95	40-65	15-25	NP-5
	10-60	Loamy fine sand	SM	A-2	0	95-100	95-100	70-80	20-30	---	NP
143-------------- Vint	0-12	Fine sandy loam	ML, CL-ML, SM, SM-SC	A-4	0	100	100	75-85	45-55	15-25	NP-5
	12-60	Loamy sand, loamy fine sand.	SM	A-2	0	95-100	95-100	70-80	20-30	---	NP
144*: Vint--------------	0-10	Very fine sandy loam.	SM, ML	A-4	0	100	100	85-95	40-65	15-25	NP-5
	10-40	Loamy fine sand	SM	A-2	0	95-100	95-100	70-80	20-30	---	NP
	40-60	Silty clay------	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-35
Indio------------	0-12	Very fine sandy loam.	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
	12-40	Stratified loamy very fine sand to silt loam.	ML	A-4	0	95-100	95-100	85-100	75-90	20-30	NP-5
	40-72	Silty clay------	CL, CH	A-7	0	100	100	95-100	85-95	40-65	20-35

* See description of the map unit for composition and behavior characteristics of the map unit.

Project Site

3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096   Source Data: USGS   ⊢——————┤ 693 ft Scale: 1 : 24,000 Detail: 13-1 Datum: WGS84
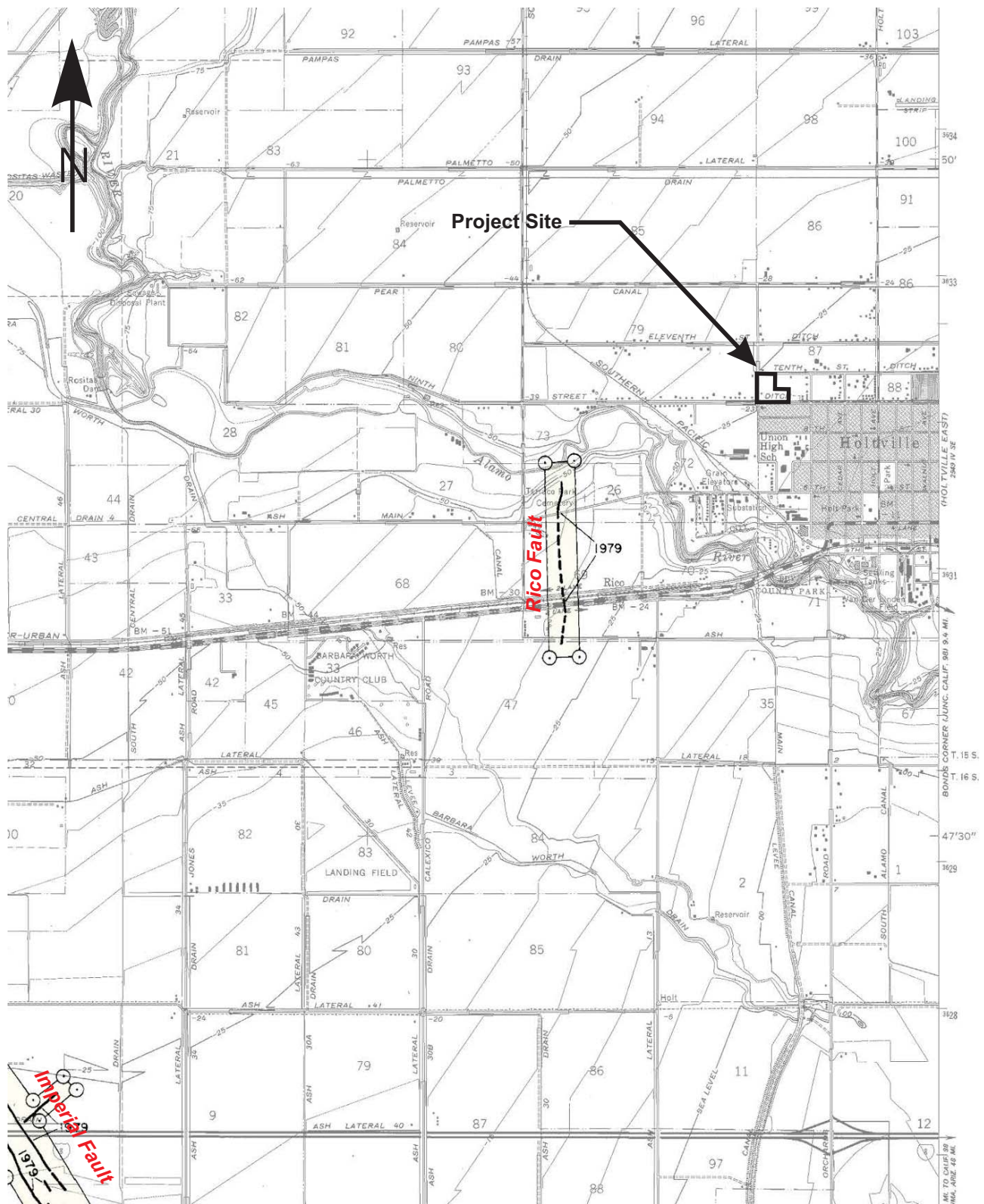
N

Site Coordinates:
Latitude = 32.8189N
Longitude = -115.3879W

LANDMARK
Geo-Engineers and Geologists
Project No.: LE18047
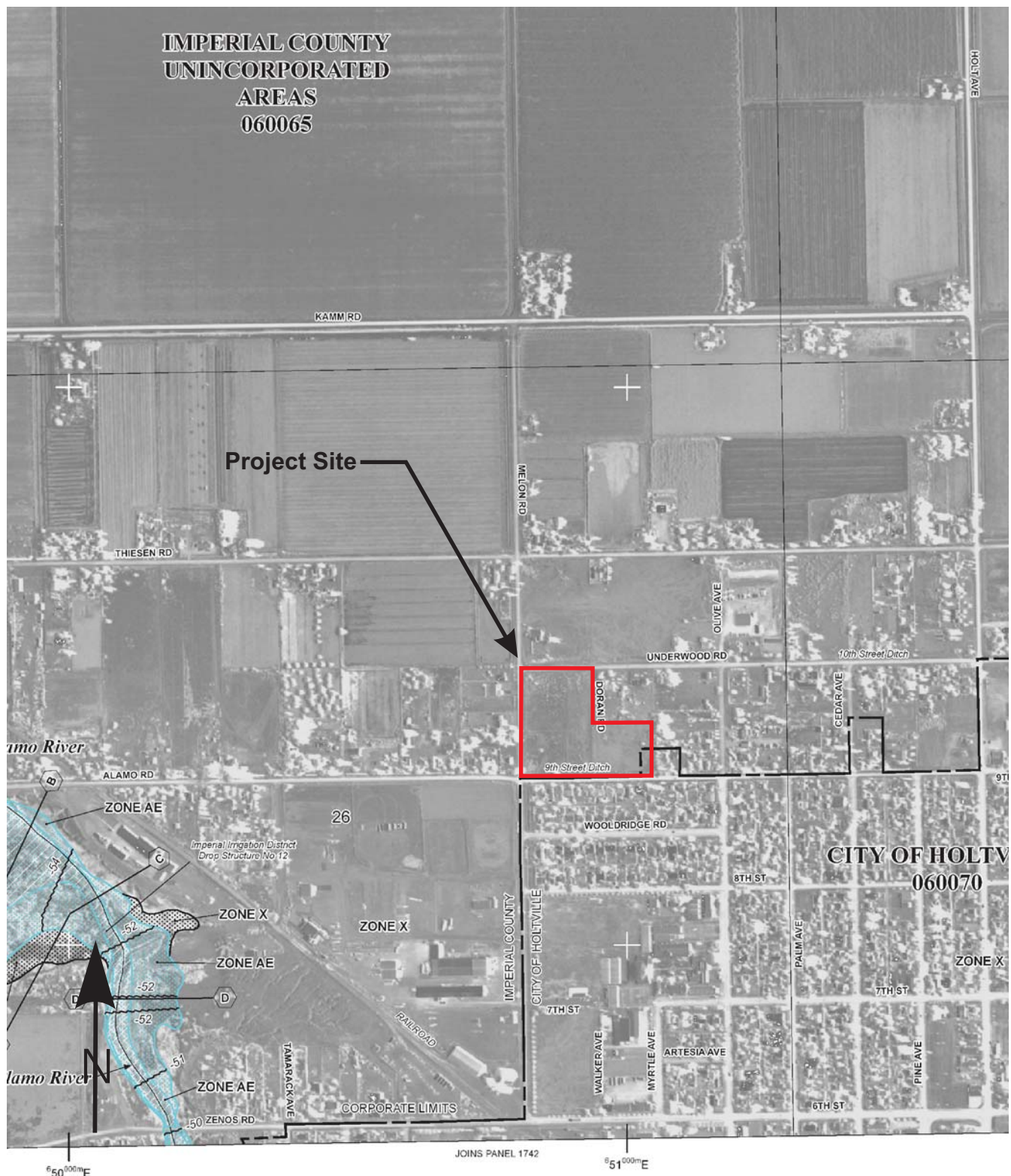
Topographic Map

**Plate
A-4**

Project Site

Rico Fault

1979

Imperial Fault

1979

Holtville

LandMark
Geo-Engineers and Geologists

Project No.: LE18047

A-P Earthquake Fault Zone Map

Plate
A-5

IMPERIAL COUNTY
UNINCORPORATED
AREAS
060065

KAMM RD

HOLT AVE

MELON RD

Project Site

THIESEN RD

OLIVE AVE

UNDERWOOD RD

10th Street Ditch

CEDAR AVE

DORAN D

amo River

9th Street Ditch

ALAMO RD

ZONE AE

26

WOOLDRIDGE RD

CITY OF HOLTV
060070

Imperial Irrigation District
Drop Structure No 12

8TH ST

ZONE X

ZONE X

ZONE X

ZONE AE

PALM AVE

7TH ST

-52

D

D

IMPERIAL COUNTY

CITY OF HOLTVILLE

ZONE X

-52

RAILROAD

7TH ST

PINE AVE

N

lamo River

ZONE AE

TAMARACK AVE

WALKER AVE

MYRTLE AVE

ARTESIA AVE

6TH ST

-50 ZENOS RD

CORPORATE LIMITS

JOINS PANEL 1742

$^650^{000m}E$

$^651^{000m}E$

LandMark		
LAND**M**ARK		**Plate**
Geo-Engineers and Geologists	**FEMA Flood Zone Map**	**A-6**
Project No.: LE18047		

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A — No Base Flood Elevations determined.

ZONE AE — Base Flood Elevations determined.

ZONE AH — Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO — Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR — Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 — Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V — Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE — Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

———————— 1% annual chance floodplain boundary

———————— 0.2% annual chance floodplain boundary

———————— Floodway boundary

— — — — — Zone D boundary

•••••••••••••••• CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

∼∼∼ 513 ∼∼∼ Base Flood Elevation line and value; elevation in feet*

(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

Ⓐ———Ⓐ Cross section line

㉓— — —㉓ Transect line

87°07'45", 32°22'30" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere

²⁴76^{000m}N 1000-meter Universal Transverse Mercator grid values, zone 11N

600000 FT 5000-foot grid ticks: California State Plane coordinate system, zone VI (FIPSZONE 0406), Lambert Conformal Conic projection
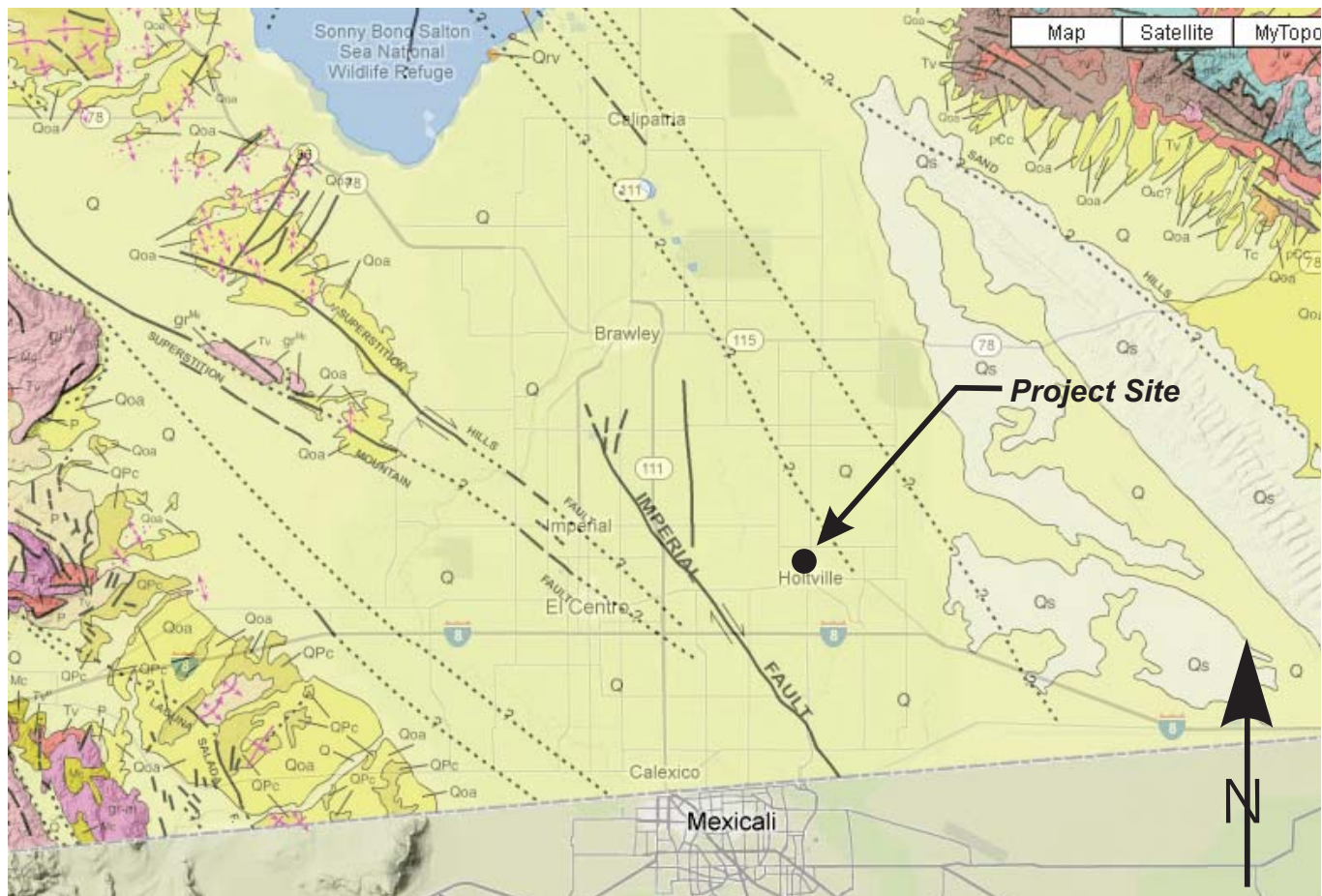
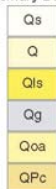DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel)
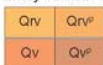
● M1.5 River Mile

Project Site

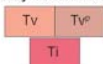GEOLOGIC LEGEND

Quaternary Deposits
Qs
Q
Qls
Qg
Qoa
QPc

Quaternary Volcanic Rocks
Qrv | Qrvᵖ
Qv | Qvᵖ

Tertiary Sedimentary Rocks
Tc
P
M | Mc
Oₑ | Oₑc
E | Ec
Ep

Tertiary Volcanic Rocks
Tv | Tvᵖ
Ti

Tertiary Plutonic Rocks
grᵗⁱ

Mesozoic Sedimentary and Metasedimentary Rocks
TK
K
Ku
Kl
KJf | KJfₘ | KJfₛ
J
T̄R
sch
ls
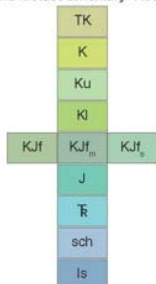
Mesozoic Mixed Rocks
gr-m

Mesozoic Metavolcanic Rocks
MₑV
mv

Mesozoic Plutonic Rocks
grᵐˢ
um
gb
gr
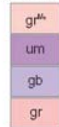
Paleozoic Sedimentary and Metasedimentary Rocks
Pz
Pm
C
D
SO
c̄
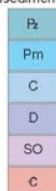
Paleozoic Mixed Rocks
m

Paleozoic Metavolcanic Rocks
Pzv

Paleozoic Plutonic Rocks
grᵖ

Pre-Cambrian Rocks
pC
pCc
grᵖᶜ

SYMBOLS

Geologic boundary

Fault traces - solid where well located, dashed where approximately located or inferred, dotted where concealed, and queried where continuation or existence is uncertain. Ball and bar on downthrown side (relative or apparent). Arrows indicate direction of lateral movement (relative or apparent).

Thrust fault (barbs on upper plate).

Regional strike and dip of stratified rocks.

Regional strike and dip of stratified rocks (overturned).

Anticlinal fold.

Synclinal fold.

Monoclinal fold.

Site Location
Lat N32.8189   Long: W-115.3879

LandMark
Geo-Engineers and Geologists

Project No.: LE18047

Regional Geologic Map

Plate A-7

APPENDIX B

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