FINAL

Geotechnical Report

East Indio Employment Corridor Annexation Study

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1 Introduction

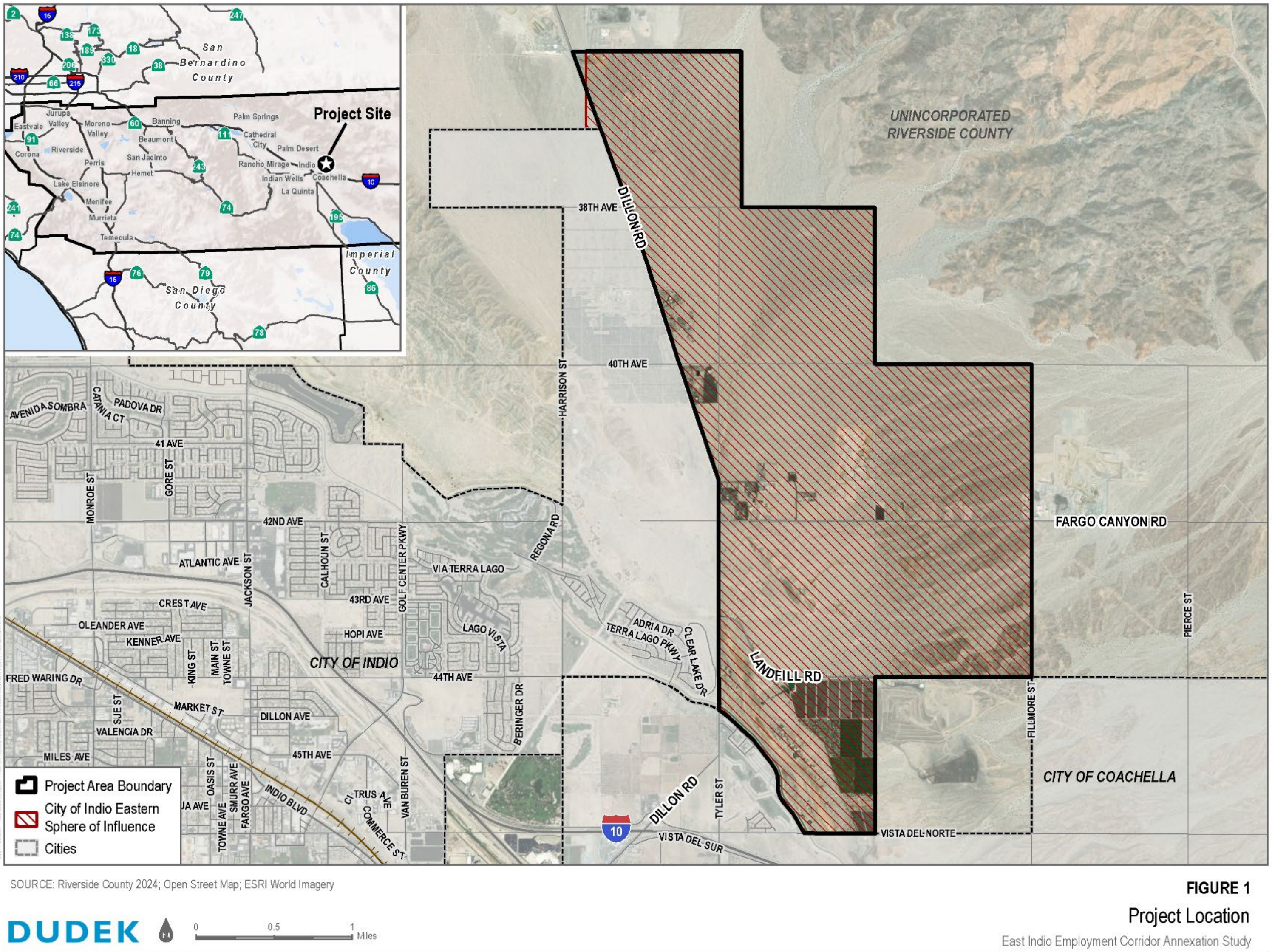
1.1 Project Overview

The East Indio Employment Corridor Annexation Study (Project) is a focused planning study to analyze the potential annexation of approximately 4,609 acres of unincorporated County of Riverside land into the City of Indio's (City) boundary. The Project Area is part of the City's Eastern Sphere of Influence (SOI) that is located adjacent to the City's eastern city boundary and envisioned for potential future annexation per the City's General Plan. The Project Area, as shown in **Figure 1**, is largely passive open space, with a limited amount of existing commercial development and resource extraction. The City envisions this area as a future employment hub with a mix of employment-generating uses, such as a business park with light industrial and logistics, office, retail, in addition to workforce housing and open space, to support job creation and diversification, enhance services, and promote investment in the city. The City's goal for the Project is to identify the portion of the Project Area for annexation through a series of supportive analyses and ongoing outreach and engagement with interested parties, as well as to prepare the required Riverside Local Agency Formation Commission (LAFCO) application to facilitate a request for annexation.

1.2 Purpose of this Report

The purpose of this Geotechnical report is to identify issues and opportunities for potential development within the Project Area as it relates to geology. The following represents geologic and soils conditions as determined from publicly available resources from the United States Geological Survey, the California Geological Survey, and the Natural Resources Conservation Service. No site-specific testing or reporting were conducted or reviewed as part of this baseline assessment. Geotechnical hazards can adversely affect buildings and result in injury or death to occupants if not designed correctly. However, the vast majority of geotechnical hazards can be ameliorated through design measures (e.g., foundation design) and site preparations (e.g., use of engineered fill and compaction of surface soils). Note that this report should be reviewed in concert with other desktop reports, including Land Use and Community Profile, Biological Resources, Cultural Resources, Paleontological Resources, Public Services and Utilities, and Transportation, to understand the full opportunities and constraints to the Project Area.

Figure 1. East Indio Employment Corridor Annexation Study Project Area



1.3 Key Issues and Opportunities

Topic	Description
Issue	
Surface Fault Rupture Hazards	As shown in **Figure 2**, Alquist-Priolo Earthquake Fault Zones intersect portions of the Project Area, especially in the eastern portion of the Project Area. Any structure intended for human occupancy in these areas would require a site-specific fault investigation and report prior to acceptance of a building permit to ensure appropriate setbacks from active fault traces. Completion of a fault investigation involves additional preliminary steps to development that would add both costs and time to develop.
Ground Shaking Hazards	The entire Project Area is in a seismically active area that has a high probability of experiencing a substantive earthquake in the future. Adherence to current seismic design standards contained in existing building code requirements should be effective in minimizing any potential damage or injury.
Liquefaction	The Project Area is located in an area that the City identifies as having a moderate potential for liquefaction. All proposed development within the Project Area would be required to adhere to current building code requirements which include measures to identify and mitigate for any identified liquefaction hazards.
Subsidence	The Project Area is adjacent to an area of identified subsidence due to groundwater withdrawal. Development within the Project Area would increase water demands which could potentially be sourced from groundwater resources that could include the Indio Subbasin. Further analysis would be required, especially for projects subject to Senate Bill 610 which would require preparation of a Water Supply Assessment to ensure that adequate water supplies are available and would not cause or contribute to adverse effects including subsidence.
Opportunity	
New Development	While there are Alquist Priolo Zones (AP Zones) that intersect the Project Area, the existence of these AP Zones does not necessarily preclude development but may affect the ultimate location of any proposed structures as well as add to the cost and time to complete development. Similarly, while the Project Area is identified as having moderate potential for liquefaction, these hazards can be addressed through adherence to building code requirements with various site preparations (e.g., removal of liquefiable materials and replaced with engineered fill or treatment of liquefiable soils to prevent liquefaction) and foundation design.

Topic	Description
	Overall, adherence to regulatory requirements would ensure that any geotechnical hazards present are identified and addressed through site preparations, site design, and location resulting in improvements that can be safely and securely occupied for future proposed land uses. Specifically, the vast majority of geotechnical hazards in the Project Area can be addressed through design measures (e.g., foundation design) and site preparations (e.g., use of engineered fill and compaction of surface soils). These design and site preparation measures are also required by adherence to the California Building Code.

2 Regional Setting

2.1 Geology

The Project Area is located in Coachella Valley which is part of a region heavily influenced by the boundary of two crustal or tectonic plates: the Pacific plate and the North American plate. Movement along these two plate boundaries causes seismic activity such as earthquakes as the Pacific plate slides past the North American plate most prominently expressed by the San Andreas fault system. The San Andreas and related faults generally follow a northwest-southeast trending direction with the San Andreas fault running from the offshore north of the San Francisco area through California and along the eastern boundary of Coachella Valley and east side of the Salton Sea towards Mexico. Coachella Valley forms the northerly part of the Salton Trough (at the lowest point of which is the Salton Sea) which is a structural and topographic depression that is related to complex interactions with the San Andreas Fault system. Offsets along various detachment faults produced Coachella Valley, which progressively grew as the detachment faults moved.

2.2 Groundwater

The Project Area is located within the Coachella Valley-Indio Groundwater Basin (no. 7-021.01) (DWR 2024b). The Coachella Valley Groundwater Basin has been divided into four subbasins as defined in by the California Department of Water Resources (DWR):

- Indio Subbasin (7-21.01)
- Mission Creek Subbasin (7-21.02)
- San Gorgonio Pass Subbasin (7-21.03)
- Desert Hot Springs Subbasin (7-21.04)

The Indio, Mission Creek, and San Gorgonio Pass Subbasins have been designated as medium-priority, and the Desert Hot Springs Subbasin has been designated as very low-priority, by the DWR. The Project Area is located within the Desert Hot Springs Subbasin.

According to data compiled by the California Department of Water Resources (DWR), a well at the nearby Terra Lago Golf Course (State Well No. *05S08E18G001S)*, depth to groundwater ranges from approximately 100 to 130 feet below ground surface (DWR 2025).

2.3 Seismicity

As is the case for all of Southern California, the Project Area is located in a seismically active region with numerous faults that are considered capable of producing substantive seismic events. The California Geological Survey (CGS) (CGS 2018) classifies faults as follows:

- Holocene-active faults, which are faults that have moved during the past approximate 11,700 years. These faults are capable of surface rupture.
- Pre-Holocene faults, which are faults that have not moved in the past 11,700 years. This class of fault may be capable of surface rupture but is not regulated under the Alquist-Priolo Earthquake Fault Zoning Act of 1972, which regulates construction of buildings to be used for human occupancy.
- Age-undetermined faults, which are faults where the recency of fault movement has not been determined.

Holocene-active faults have been responsible for large historical earthquakes in Southern California, including the 1937 San Jacinto (Terwilliger Valley) earthquake (magnitude M 6.0), the 1948 Desert Hot Springs earthquake (moment magnitude (MW) 6.0), the 1992 Joshua Tree Earthquake (magnitude Mw 6.1) and the 1992 Landers earthquake (Mw 7.3), for example (SCEDC 2024). The most prominent Holocene-active faults in the vicinity include the San Andreas, San Jacinto, and Mission Creek faults. Of particular importance to the Project Area, is the San Andreas, strands of which intersect the Project Area as shown in Figure 2.

The Alquist-Priolo Earthquake Fault Zoning Act (AP Act) was enacted to help protect human safety and prevent damage from surface fault rupture by identifying faults at risk of causing surface displacement. Only those faults that have direct evidence of movement within the last 11,700 years, considered to be the most at risk of rupture, are required to be zoned. The AP Act requires the State Geologist to establish earthquake fault zones around the surface traces of active faults and to issue appropriate maps to assist cities and counties in planning, zoning, and building regulation functions. These zones, which generally extend 200 to 500 feet on each side of a known active fault based on location, precision, complexity, or regional significance of the fault, identify areas where potential surface fault rupture along an active fault could prove hazardous and identify where special studies are required to characterize hazards to habitable structures, defined as any structure intended for occupancy for a minimum of 2,000 person hours per year. If a site intended for human occupancy lies within an earthquake fault zone on an official CGS map, a geologic fault rupture investigation which typically includes onsite trenching across areas intended for development, must be performed before issuance of permits to demonstrate that the proposed development is not threatened by surface displacement from the fault.

According to forecasting by UCERF3, a collaborative effort between the U.S. Geological Survey, Southern California Earthquake Center, and CGS, there is a 93% chance of a magnitude 6.7 earthquake or greater occurring in the Southern California region by 2045 (USGS 2015). The southern segment of the San Andreas is considered to have the highest probability of being the source of this earthquake at 19%. The severity of groundshaking that would be caused by a seismic event in the region of the Project Area would depend on a variety of factors including distance to the source, depth, duration of shaking, and characteristics of underlying materials. Based on the proximity to the San Andreas Fault, seismic ground shaking within the Project area could reach levels that could cause substantive damage if not designed appropriately.

2.3.1 Liquefaction and Lateral Spreading

Liquefaction involves a sudden loss in strength of saturated, cohesionless soils that are subject to ground shaking during an earthquake and results in temporary transformation of the soil to behave more like a fluid mass. The densification results in increased pore water pressures if the soils are not sufficiently permeable to dissipate these pressures during, and immediately following, an earthquake. When the pore water pressure is equal to or exceeds the overburden pressure, liquefaction of the affected soil layer occurs. For liquefaction to occur, three conditions are required: (1) ground shaking of sufficient magnitude and duration; (2) a groundwater level at or above the level of susceptible soils during the ground shaking (i.e., generally at depths less than 50 feet); and (3) soils that are susceptible to liquefaction. Similarly, lateral spreading can result in ground cracking and may occur when a site is sloped or near a free-face and there is a sufficiently continuous liquefiable layer on which the overlying soils can move laterally. Ground settlement may occur during seismic shaking of an area. The settlement can be caused by liquefaction of loose granular soils and by compaction of loose, but not necessarily liquefiable, soils.

The Project Area has not been included in regional liquefaction analyses by the California Geological Survey (CGS 2024). However, according to mapping included in the Final EIR for the City's General Plan, the Project area is within an area that is considered to have a moderate potential for liquefaction even though groundwater data from a nearby well at the Terra Lago Golf Course would seem to indicate groundwater depths that are greater than 50 below ground surface (City of Indio 2019 and DWR 2025). Conditions can change over relatively short distances such that the liquefaction hazards could vary within the Project Area and would need to be assessed on a site-by-site basis.

2.3.2 Landslides/Slope Stability

The topography of the Project Area is predominantly flat to very gently sloping, resulting in a very low potential for landslides and slope instability.

2.3.3 Subsidence

Land subsidence is the downward settlement of a large area of land, which can potentially result in surface infrastructure damage. Historical subsidence in California has resulted from several processes, including oil and gas production, groundwater withdrawal, hydrocompaction, and peat oxidation. Subsidence associated with water or gas withdrawal occurs when compressible subsurface deposits are depressurized as a result of removing water or gas and can no longer support the weight of the overlying material. In the case of groundwater withdrawal, subsidence occurs primarily when groundwater withdrawal from confined aquifers results in the depressurization and dewatering of compressible clay layers. Subsidence generally occurs slowly and can continue for a period of several years after pumping has terminated, as water continues to migrate from compressible clay layers. According to mapping compiled by the Department of Water Resources, Coachella Valley from Thousand Palms down to the Salton Sea is within an identified area of subsidence due to groundwater withdrawal (DWR 2024a).

The Project area itself is outside of this mapped subsidence area, but it is located relatively close to the south of the site. According to the Department of Water Resources, preliminary results from a high-precision GPS survey in September and October of 2015 indicate that much of the basin stopped subsiding since September 2010 (DWR 2024b). The preliminary results also indicate that some areas near Palm Desert, Indian Wells, and La Quinta subsided since 2010, however at reduced rates compared to subsidence rates before 2010 (DWR 2024b). The Desert Hot Springs subbasin, according to DWR, has no documented groundwater extraction induced subsidence (DWR 2024c).

2.3.4 Expansive Soils

Expansive soils are characterized by a tendency to experience volumetric changes (shrink and swell) that correspond to cyclical changes in soil moisture. Repeated shrinking and swelling of the soil can over time lead to stress that eventually damages structures, foundations, pavements, and other associated facilities. Expansive soils owe their characteristics to the presence of swelling clay minerals. The on-site alluvial soils are expected to have a relatively low potential for expansion but can only be confirmed through a required site-specific geotechnical investigation.

3 Constraints

As noted in the previous section, the vast majority of geotechnical hazards can be addressed through design measures (e.g., foundation design) and site preparations (e.g., use of engineered fill and compaction of surface soils). These design and site preparation measures are also required by adherence to the California Building Code.

In addition to building code requirements, development within the Project Area could also be subject to the requirements of the Alquist Priolo Special Studies Zone Act (AP Act), depending on the location of the proposed structure. The AP Act established state policy to identify active faults and determine a boundary zone on either side of a known fault trace, called the Alquist-Priolo Earthquake Fault Zone (AP Zone). The delineated width of an AP Zone is based on the location, precision, complexity, or regional significance of the fault and can be between 200 and 500 feet in width on either side of the fault trace. Fault traces can range from being well defined (depicted on the map as a solid line) or inferred (depicted as a dashed or dotted line) if not well defined. If a proposed structure intended for human occupancy (defined as a building that would be occupied for at least 2,000 hours annually) lies within a designated AP Zone, a geologic fault rupture investigation must be performed to demonstrate that a proposed building site is not threatened by surface displacement from the fault, before development permits may be issued (CGS 2018). The results of a site-specific fault rupture investigation would be able to determine the location of any active fault traces in order to determine if required setbacks (generally 50 feet) for habitable structures would be applicable. Therefore, while there are AP Zones that intersect the Project Area, the existence of these AP Zones does not necessarily preclude development but may affect the ultimate location of any proposed structures as well as add to the cost and time to develop.

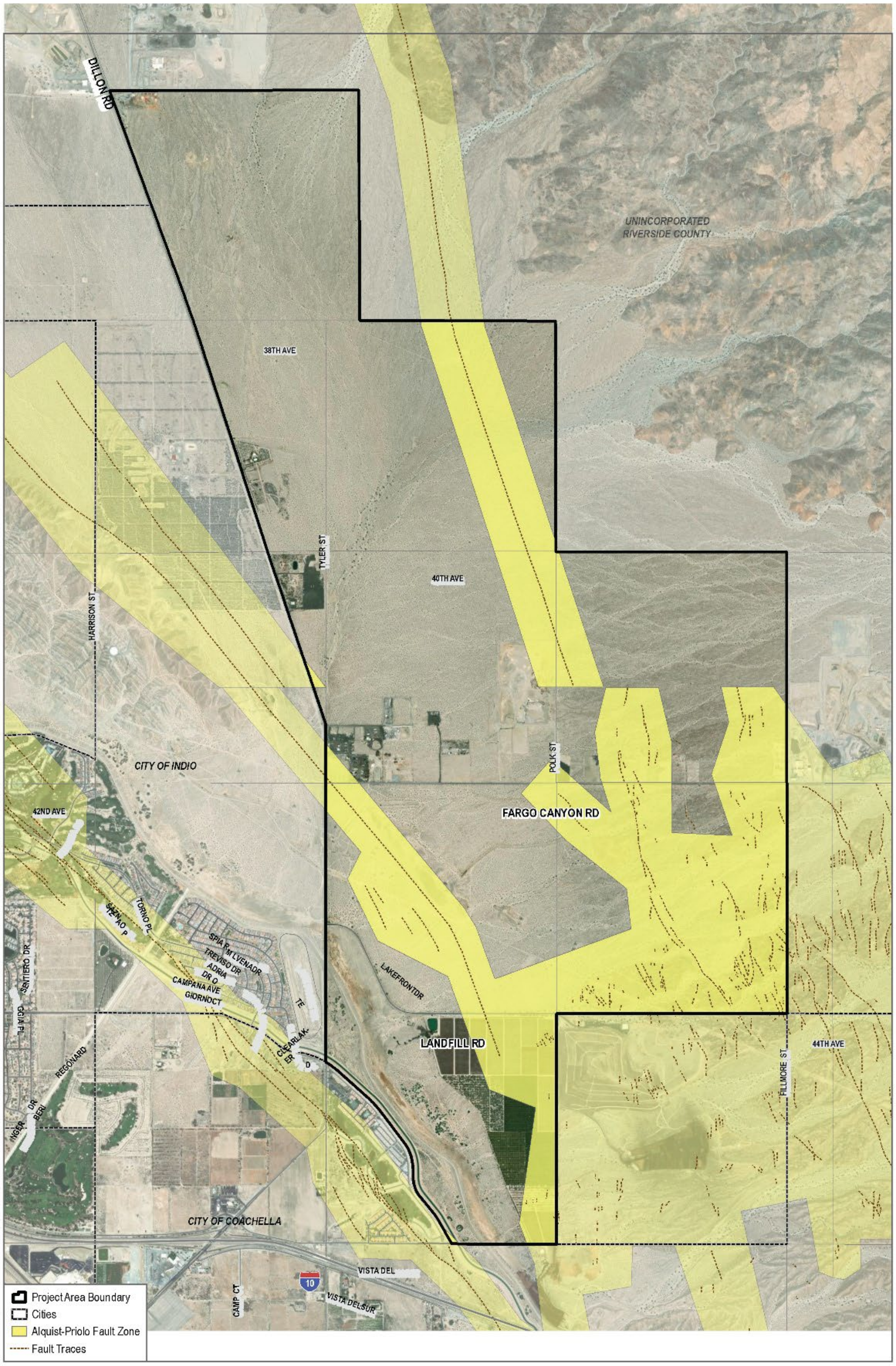
Also noted above is the characterization of the Project Area being located in an area identified as having a moderate potential for liquefaction. However, liquefaction hazards are typically site-specific and entirely dependent on underlying conditions including soil types and moisture content which can vary from site to site. Even so, the presence of liquefiable materials does not preclude development, and these hazards can be addressed through adherence to building code requirements with various site preparations (e.g., removal of liquefiable materials and replaced with engineered fill) and foundation design.

The Project Area is adjacent to an area of identified by DWR as having observed subsidence due to groundwater withdrawal. This area largely coincides with the boundaries of the Coachella Valley – Indio Groundwater Subbasin which is considered a medium priority basin by DWR in accordance with the Sustainable Groundwater Management Act. While the Project Area is located within the Desert Hot Springs Subbasin, development within the Project Area would increase water demands which could potentially be sourced from groundwater resources that could include the Indio Subbasin. Further analysis would be required, especially for projects subject to Senate Bill 610 which would require preparation of a Water Supply Assessment to ensure that adequate water supplies are available and would not cause or contribute to adverse effects including subsidence.

4 Opportunities

New development in the Project Area would be required to comply with the federal, state, regional, and local regulatory requirements which would include the California Building Code along with any local amendments as well as the AP Act, as discussed in the previous section. Adherence to these existing requirements would ensure that any geotechnical hazards present are identified and addressed through site preparations, site design, and location resulting in improvements that can be safely and securely occupied for future proposed land uses.

Figure 2. Alquist-Priolo Fault Zone



SOURCE: CA Department of Conservation; Riverside County 2024; Open Street Map; ESRI World Imagery

DUDEK 0 1,000 2,000 Feet

FIGURE 2
Alquist-Priolo Fault Zone
East Indio Employment Corridor Annexation Study

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