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TIER 1 ENVIRONMENTAL IMPACT STATEMENT

Draft Tier 1 Environmental Impact Statement and Preliminary Section 4(f) Evaluation

Section 3.12, Geology, Soils, and Prime and Unique Farmlands

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3.12 Geology, Soils, and Prime and Unique Farmlands

3.12.1 Geology

The geology of the Interstate 11 (I-11) Corridor Study Area (Study Area) can influence design and construction practices as certain geologic features are considered resources while others are considered potential hazards. This section identifies geologic features and conditions within the Study Area and specifically encountered by the Build Corridor Alternatives.

3.12.1.1 Regulatory Setting

No state or federal laws were identified that apply to geologic resources. Geologic resources are subject to regulation based on land ownership and the intended use of the resource. Depending on land ownership and planned resource use, geologic resources may be regulated by various agencies. Potential regulators include federal agencies such as the Bureau of Land Management (BLM), Department of the Interior, Department of Energy, National Park Service (NPS), and National Forest Service (USFS); state agencies such as the Arizona State Land Department (ASLD), Arizona Department of Mines and Mineral Resources, Arizona Department of Environmental Quality, (ADWR); counties; cities; and other local municipalities. The United States Geological Survey (USGS) is a non-regulatory agency under the Department of the Interior responsible for information pertaining to geologic, topographic, and seismic data.

3.12.1.2 Methodology

Geologic resources considered in this analysis include surface geology and surface topography, and selected geologic conditions including depth to bedrock, land subsidence and earth fissures, and active faults and seismicity. The geologic resource information presented is based on readily available geological information and maps collected to develop a description of existing conditions and a comparison of impacts. Information on topography, seismicity, and active faults was obtained from published USGS data. Seismic hazard information for the Study Area was obtained from the online *USGS Earthquake Hazards Program, Quaternary Faults and Folds Database* (USGS 2015) and the *National Seismic Hazard Maps, Simplified Hazard Maps* (USGS 2014). Surface geology, depth to bedrock, and earth fissure information was obtained from published Arizona Geological Survey (AZGS) data (AZGS 2000, 2007, 2017a, 2017b). Land subsidence information was obtained from ADWR.

The geological characteristics of each Corridor Option are characterized in terms of presence or absence (Yes or No) within the 2,000-foot-wide corridor. The effects analysis is qualitative because the identified impacts would occur within the Corridor Option limits regardless of the applicable cross section.

3.12.1.3 Affected Environment

<u>Regional Geology</u>

The Study Area is located within the Basin and Range physiographic province of the southwestern United States (US). The Basin and Range province topography is the result of tectonic extension in the middle and late Cenozoic period (15 to 17 million years before present). It is characterized by a northwest-southeast trending system of rugged mountains with intervening, broad, and extensive alluvial valleys created by high-angle normal faults. Early geologic forces created valleys and mountains; subsequent erosion degraded the mountain ranges and partially filled in the valleys with sediments, creating the present landforms.

Local Geology

Geologic units within the Study Area mostly consist of Quaternary-age (0 to 1.8 million years before present) alluvial deposits along broad alluvial valley floors (AZGS 2000). These deposits include Holocene-age (0 to 11,000 years before present) river alluvium; undivided (non-differentiated) Quaternary-age surficial alluvium and eolian (wind deposited) material; and surficial soils of Holocene-age to Pleistocene-age (11,000 to 1.8 million years before present). The soil deposits are comprised primarily of alluvial mixtures of gravel, sand, and silt in floodplains; river and stream terraces; and alluvial fans bordering the basins. The surficial alluvial soils generally become coarser grained with closer proximity to the bordering mountain ranges.

A total of 12 bedrock units comprise the surface geology of the mountains within and along the boundaries of the Study Area, and include granitic, volcanic, sedimentary, and metamorphic rock units (AZGS 2000). Depth to bedrock below surface alluvial deposits in the intervening valleys ranges from as little as about 400 feet near the mountains at the valley edges, to as much as 11,200 feet near the centers of valley basins (AZGS 2007, 2017b). Shallower bedrock conditions, at depths ranging from zero at bedrock outcrops to 4,800 feet below the existing ground surface, are common near the Study Area near Nogales, Gila Bend, and Wickenburg, respectively, where mountains comprise the dominant landforms.

Additional information about local geology can be found in **Appendix E12**, Geology, Soils, and Prime and Unique Farmland Technical Memorandum.

Land Subsidence and Earth Fissures

Land subsidence and earth fissures are identified as geotechnical issues for the Study Area. Land subsidence in the southwestern and western US has occurred as a result of long-term groundwater pumping/withdrawals and groundwater level decline. Associated with this land subsidence, earth fissures and potential earth fissure features have been identified in Arizona since the late 1980s. Earth fissures are tension cracks which form in deep alluvium-filled basins in response to the land subsidence. Earth fissures commonly parallel nearby mountain fronts or buried bedrock highs and often bisect surface drainage features. They can intercept surface flows and create vertical/near-vertical pathways to the subsurface groundwater table. Hazards associated with earth fissures include damage to buildings, roads, flood control structures, dams, impoundments and embankments, canals and channels, and sewer, water, and other utility lines. High surface flow gradients contribute to erosive forces that move sediments along and downward into the fissures, and can create gully features ranging from slightly eroded fissures with occasional small potholes to gullies that are tens of feet wide and tens of feet deep.

Active land subsidence areas occupy portions of the Study Area from near Sahuarita in the South Section and extend to Buckeye in the North Section, and comprise large areas near Green Valley, Sahuarita, Tucson, Eloy, Casa Grande, Gila Bend, and Buckeye/Goodyear (ADWR 2017). Earth fissure study areas containing numerous earth fissures occupy portions of the Study Area from near Marana in the South Section, extending to Buckeye in the North Section, and comprise large areas near Marana, Picacho, Eloy, Casa Grande, Maricopa, and Buckeye/Goodyear (AZGS 2017a).

Active Faults and Seismicity

The *USGS Quaternary Fault and Fold Database* search identified two faults or fault systems in the Study Area. The Santa Rita Fault Zone extends along the east side of the Study Area from just north of Nogales to Sahuarita. The Sand Tank Fault exists a few miles south of the Study Area boundary near Gila Bend. USGS indicated that both faults/fault systems exhibit evidence of deformation within the past 750,000 years, with slip rates of less than 0.2 millimeter/year (0.008 inch/year). No other faults with Quaternary-age deformation were identified within a 40-mile radius of the Study Area.

The Project Team obtained probabilistic earthquake ground motion values of peak ground acceleration (PGA) in bedrock for the Study Area and surrounding regions using the *USGS National Seismic Hazard Maps, Simplified Hazard Maps* (USGS 2014). These values are expressed as a fraction of standard gravity (g) for 2- and 10-percent probabilities of exceedance in 50 years. The mapped PGA values are as follows: 10 percent probability of exceedance in 50 years, with a return period of 475 years, 0.02g to 0.05g; and, 2 percent probability of exceedance in 50 years, with a return period of 2,475 years, 0.06g to 0.14g. These PGA values are for firm rock (rock with shear-wave velocity of 2,500 to 5,000 feet per second in the upper 100 feet of the underlying profile). These values would need to be evaluated and adjusted as appropriate based on the subsurface profile encountered during future geotechnical investigations completed for design of I-11 roadways, bridges, water conveyance and retention facilities, utilities, and other structures.

Maps and additional information about local geology, land subsidence and earth fissures, active faults and seismicity, and section by section features can be found in **Appendix E12**, Geology, Soils, and Prime and Unique Farmland Technical Memorandum.

Build Corridor Alternative Considerations

The Build Corridor Alternatives would encounter surface geology and geologic conditions as described above. Geologic conditions encountered by each Build Corridor Alternative would be generally similar. Some minor differences exist in the total number of land subsidence/earth fissure areas and surface bedrock conditions (mountains) that would be encountered by each Build Corridor Alternative (**Table 3.12-1** [Subsidence, Earth Fissures, and Bedrock: Purple Alternative], **Table 3.12-2** [Subsidence, Earth Fissures, and Bedrock: Green Alternative], and **Table 3.12-3** [Subsidence, Earth Fissures, and Bedrock: Orange Build Corridor Alternative]).

Table 3.12-1 Subsidence, Earth Fissures, and Bedrock: Purple Alternative

	South Section			Central Section					North Section
	A	C*	G	I1	I2	L	N	R	X
Encounters Subsidence Area	No	No	Yes	Yes	Yes	No	Yes	Yes	No
Encounters Earth Fissure Area	No	Yes	Yes	Yes	No	No	No	No	No
Encounters Surface Bedrock	Yes	Yes	No	No	No	No	Yes	No	Yes

* Includes the Sandario Road and Central Arizona Project (CAP) Design Option.
SOURCES: ADWR 2017; AZGS 2007, 2017a.

Table 3.12-2 Subsidence, Earth Fissures, and Bedrock: Green Alternative

	South Section			Central Section						North Section
	A	D*	F	I1	I2	L	M	Q2	R	U
Encounters Subsidence Area	No	No	Yes	Yes	Yes	No	No	Yes	Yes	No
Encounters Earth Fissure Area	No	Yes	Yes	Yes	No	No	No	No	No	No
Encounters Surface Bedrock	Yes	Yes	No	No	No	No	Yes	Yes	No	Yes

* Includes the Sandario Road and CAP Design Option.
SOURCES: ADWR 2017; AZGS 2007, 2017a.

Table 3.12-3 Subsidence, Earth Fissures, and Bedrock: Orange Alternative

	South Section			Central Section					North Section
	A	B	G	H	K	Q1	Q2	Q3	S
Encounters Subsidence Area	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Encounters Earth Fissure Area	No	No	Yes	Yes	No	No	No	No	No
Encounters Surface Bedrock	Yes	No	No	Yes	Yes	Yes	Yes	No	Yes

SOURCES: ADWR 2017; AZGS 2007, 2017a.

3.12.2 Soils

The soil resources within the Study Area can influence design and construction practices because some soils are more suitable for these uses while others can be considered potential constraints. This section identifies soil conditions within the Study Area and specifically encountered by the Corridor Options regarding the suitability for or potential limitation to construction of roads and streets.

3.12.2.1 Regulatory Setting

The US Department of Agriculture's (USDA) Natural Resources Conservation Service (NRCS) identifies, maintains, inventories, and monitors the use and development of soil resources. The NRCS does not have regulatory authority.

3.12.2.2 Methodology

This section evaluates potential effects on soils and summarizes NRCS ratings of encountered soils for construction of roads and streets. The NRCS ratings are based on soil properties that affect the capacity of the soil to support a load without movement and on soil properties that affect excavation and construction costs. These properties include depth to a water table, ponding and flooding, subsidence, linear extensibility (shrink-swell potential), compressibility (inferred by NRCS from the United Soil Classification System classification of the soil), slope, depth to bedrock or a cemented/hard soil layer, hardness of bedrock or a cemented/hard soil layer, and the frequency and size of rock fragments. The effects analysis is qualitative and does not quantify acreage impacts on each soil type.

3.12.2.3 Affected Environment

A total of 162,082 acres of soil are contained within the Study Area. Of the total soil acreage comprising the Build Corridor Alternatives, 34 percent (54,209 acres) are categorized as "Very Limited", 29 percent (47,681 acres) as "Somewhat Limited", and 35 percent (57,304 acres) as "Not Limited". About 2 percent of the soils located within the Study Area are not categorized by the NRCS. Site-specific field investigations would be required to validate these interpretations and confirm soil characteristics.

Soils categorized as "Not limited" possess characteristics very favorable for the specified use, and good performance and low maintenance can be expected. "Somewhat limited" indicates the soil is moderately favorable for the specified use and limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. "Very limited" indicates that the soil has one or more characteristics unfavorable for the specified use. The soil limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures.

This descriptive terminology is taken directly from NRCS Soil Survey, but based on local experience the Project Team has found that these soil limitations do not represent a significant constraint and represent soil conditions that are common to many other transportation projects. The soil limitations have the potential to impact cost and will be addressed and mitigated during design.

Maps and additional information about soils and section by section features can be found in **Appendix E12**, Geology, Soils, and Prime and Unique Farmland Technical Memorandum.

<u>Build Corridor Alternative Considerations</u>

Soil conditions encountered by each Build Corridor Alternative would be generally similar. Minor differences that exist between the Build Corridor Alternatives are summarized in **Table 3.12-4** (Limitations to Construction of Roads and Streets: Purple Alternative), **Table 3.12-5** (Limitations to Construction of Roads and Streets: Green Alternative), and **Table 3.12-6** (Limitations to Construction of Roads and Streets: Orange Alternative).

The Purple Alternative includes the most soils categorized as "very limited" (41 percent). Most of those soils occur in the Options G and I1. The percentages of soils categorized as "very limited" in the Green Alternative and Orange Alternative are 35 and 34 percent, respectively.

Table 3.12-4 Limitations to Construction of Roads and Streets: Purple Alternative

	South Section			Central Section					North Section	Purple Summary
	A	C*	G	I1	I2	L	N	R	X	
% Very Limited	34	48	61	67	56	47	25	11	25	41
Acres Very Limited	2,396	6,790 (6887)	6,707	1,191	2,546	1,722	1,573	474	3,368	26,767 (26,864)
% Somewhat Limited	59	39	23	20	27	7	4	13	28	28
Acres Somewhat Limited	4,139	5,454 (5671)	2,465	335	1,214	267	258	551	3,754	18,437 (18,654)
% Not Limited	6	13	15	12	17	45	68	75	46	31
Acres Not Limited	426	1,902 (1876)	1,612	206	756	1,658	4,220	3,184	6,106	20,070 (20,044)

* CAP Design Option data shown in parenthesis.
SOURCE: NRCS 2017.

Table 3.12-5 Limitations to Construction of Roads and Streets: Green Alternative

	South Section			Central Section						North Section	Green Summary
	A	D*	F	I1	I2	L	M	Q2	R	U	
% Very Limited	34	25 (26)	42	67	56	47	13	48	11	32	34
Acres Very Limited	2,396	3,922 (4,098)	5,228	1,191	2,546	1,722	571	531	474	3,851	22,432 (22,608)
% Somewhat Limited	59	57 (55)	45	20	27	7	10	0	13	26	37
Acres Somewhat Limited	4,139	8,815 (8,687)	5,515	335	1,214	267	445	0	551	3,166	234,447 (24,319)
% Not Limited	6	18	13	12	17	45	77	44	76	42	29 (30)
Acres Not Limited	426	2,834 (2,884)	1,573	206	756	1,658	3,437	483	318 4	5,055	19,612 (19,662)

* CAP Design Option shown in parenthesis.
SOURCE: NRCS 2017.

Table 3.12-6 Limitations to Construction of Roads and Streets: Orange Alternative

	South Section			Central Section					North Section	Orange Summary
	A	B	G	H	K	Q1	Q2	Q3	S	
% Very Limited	34	25	61	39	27	27	48	9	32	34
Acres Very Limited	2,396	3,603	6,707	1,706	2,757	1,027	531	379	3,868	22,974
% Somewhat Limited	59	53	23	7	3	0	0	9	22	26
Acres Somewhat Limited	4,139	7,544	2,465	297	346	0	0	379	2,718	17,888
% Not Limited	6	21	15	52	69	73	44	74	46	39
Acres Not Limited	426	3,047	1,612	2,289	6,928	2,833	483	3,118	5,637	26,373

SOURCE: NRCS 2017.

Dust Storms

Dust storms causing poor visibility are a common hazard in the arid southwestern US and are known to impact the Study Area, such as along the existing Interstate 10 and Interstate 8 corridors and surrounding areas between Tucson and Phoenix, especially between Casa Grande and Marana. Dust storms result from the interaction between meteorological conditions (high winds) and poor surface soil conditions (loose, unstable, and/or disturbed soils). Meteorological conditions related to dust storms include two categories – summertime monsoonal thunderstorms[1] and large scale synoptic weather systems[2] that cross Arizona in the fall, winter and spring.

During the summer monsoon season, thunderstorms tend to cause large-scale dust storms from strong outflow winds that typically reach 40 to 60 miles per hour. These winds can pick up fine grained soil particles creating vast dust storms called haboobs[3], which can be 50 to 100 miles across and extend vertically hundreds to thousands of feet up into the atmosphere (UCAR 2010). Haboobs can be seen on radar due to their size and composition and the public is often warned (NWS 2018).

During the rest of the year (fall, winter, and spring) large scale synoptic weather systems including Pacific Storms and cut-off low pressure systems can cause dust storms as they cross the desert Southwest creating large regions of elevated, gusty winds (Lader et al. 2016).

[1] Monsoon/ Monsoon Thunderstorms are defined as a pattern of pronounced increase in thunderstorms and rainfall over large areas of the southwestern US and northwestern Mexico that typically occur between July and September. The thunderstorms are fueled by daytime heat and a shift in wind patterns where the usual flow and the prevailing winds start to flow from moist ocean areas into dry land areas. The storms typically build up in the late afternoon or early evening.

[2] In meteorology, synoptic weather systems are a weather pattern or system with a horizontal length scale of the order of 1,000 kilometers (about 620 miles) or more; also known as large scale or cyclonic scale weather systems.

[3] Haboobs are intense sandstorms or dust storms caused by strong winds, with sand and/or dust elevated to heights as high as 5,000 feet, resulting in a "wall of dust" along the leading edge. Haboobs are often caused by an atmospheric gravity current, such as thunderstorm outflow and can occur in arid and semiarid regions of the world and sometimes deposit large quantities of sand and/or dust.

Synoptic systems do not necessarily cause dust storm hazards, but can do so when they encounter a strong dust source. This typically happens in relatively localized areas referred to as dust channels, which are limited in vertical and horizontal extent (widths of about 10 to 100 feet). Synoptic system dust storms are usually too low to the ground to be seen on radar making it difficult to warn the public.

Both monsoonal and synoptic weather systems can create dangerous conditions due to reduced visibility. This happens when these systems encounter soils prone to wind erosion including naturally occurring loose/uncemented, fine-grained alluvial soils, disturbed soil such as abandoned or fallow farmlands or active dirt roads, and soils with poor vegetative cover or lacking cover by urban development. All of these soil conditions can and do vary over time and cannot be expected to remain the same into the future.

3.12.3 Prime and Unique Farmlands

Prime and Unique Farmlands are unique soil resources capable of providing food, feed, fiber, or other specific high-value crops. Conversion of Prime and Unique Farmlands to non-agricultural uses, such as a transportation use, results in the loss of these lands for agricultural purposes. This section describes Prime and Unique Farmlands in the Study Area and identifies potential impacts on these resources associated with each of the Corridor Options.

3.12.3.1 Regulatory Setting

Agricultural lands are subject to regulation by the USDA. The Farmland Protection Policy Act (§4202 (b) Title 7 Chapter 73) (FPPA) directs federal agencies to minimize the extent to which their federal programs contribute to the unnecessary and irreversible conversion of farmland to non-agricultural uses. FPPA was established in 1981 in response to concerns about the declining acreages in the US being actively farmed. Prime farmland and agricultural land are not necessarily the same. The agricultural land use designation is a product of local community planning efforts, while the designation of Prime or Unique Farmland is a product of NRCS criteria. Additionally, farmland subject to FPPA requirements does not have to be currently used for cropland. It can be forestland, pastureland, cropland, or other land, but not surface waterbodies or developed urban land.

3.12.3.2 Methodology

Soils comprising certain chemical and physical properties, in combination with certain current and planned uses, are designated as Prime and Unique Farmlands and farmland of unique importance. The Project Team identified Prime and Unique Farmlands using existing NRCS information and soil maps to develop a description of existing conditions for a comparison of impacts. For this Draft Tier 1 Environmental Impact Statement and Preliminary Section 4(f) Evaluation (Draft Tier 1 EIS), prime farmland and farmland of unique importance are aggregated and are referred together as Prime and Unique Farmlands. No information was gathered on irrigation for the identified acres. Future Tier 2 analysis would identify non-agricultural land use and development to remove those acres from this categorization.

The acreages presented for the referenced farmland classifications include the 2,000-foot-wide corridor for each Corridor Option. The effects analysis is qualitative and does not quantify acreage impacts on each farmland classification.

3.12.3.3 Affected Environment

A total of 162,082 acres of soil are contained within the boundaries of the Corridor Options. These soils were evaluated relative to NRCS categorization as Prime and Unique Farmlands, as discussed above. The percentage of prime and unique farmland was calculated based on NRCS soil surveys data and the 2,000-foot-wide corridor of the Build Corridor Alternative. Of the total soil acreage comprising the Build Corridor Alternative, 44 percent (72,018 acres) are categorized as Prime and Unique Farmlands. About 2 percent of the Corridor Options soils are not categorized by the NRCS.

These acreages include areas that are not irrigated, have been developed since the soil survey data was collected, or will be developed in the future under existing municipal land use plans. Data on areas that have already been developed or are currently planned for future development and areas not under irrigation need to be removed from the Prime and Unique Farmland categorization as part of Tier 2 analysis. Maps and additional information about prime and unique farmland and section by section features can be found in **Appendix E12**, Geology, Soils, and Prime and Unique Farmland Technical Memorandum.

Build Corridor Alternative Considerations

Soil conditions encountered by each end-to-end Alternative would be generally similar. Minor differences that exist between the Build Corridor Alternatives are summarized in **Table 3.12-7** (Prime and Unique Farmlands: Purple Alternative), **Table 3.12-8** (Prime and Unique Farmlands: Green Alternative), and **Table 3.12-9** (Prime and Unique Farmlands: Orange Alternative).

Table 3.12-7 Prime and Unique Farmlands: Purple Alternative

	South Section			Central Section					North Section	Purple Summary
	A	C*	G	I1	I2	L	N	R	X	
% Prime and Unique Farmland	54	35 (32)	94	99	95	26	83	49	8.3	52
Acres of Prime and Unique Farmland	3,775	4,986 (4,531)	10,222	1,754	4,297	938	5,151	2,064	1,102	34,289 (33,834)

* CAP Design Option shown in parenthesis.
SOURCE: NRCS 2017.

Table 3.12-8 Prime and Unique Farmlands: Green Alternative

	South Section			Central Section						North Section	Green Summary
	A	D*	F	I1	I2	L	M	Q2	R	U	
% Prime and Unique Farmland	54	41 (38)	99	99	95	26	17	41	49	8.0	51 (50)
Acres of Prime and Unique Farmland	3,775	6,444 (5,948)	12,268	1,754	4,297	938	752	448	2,064	971	33,711 (33,215)

* CAP Design Option shown in parenthesis.
SOURCE: NRCS 2017.

Table 3.12-9 Prime and Unique Farmlands: Orange Alternative

	South Section			Central Section					North Section	Orange Summary
	A	B	G	H	K	Q1	Q2	Q3	S	
% Prime and Unique Farmland	54	63	94	46	8	11	41	29	11.6	43
Acres of Prime and Unique Farmland	3,775	9006	10,222	1,994	808	408	448	1,233	1422	29,316

SOURCE: NRCS 2017.

The Purple and Green Alternatives have the most Prime and Unique Farmland with 52 and 51 percent, respectively. The Orange Alternative has 43 percent Prime and Unique Farmland.

3.12.4 Environmental Consequences

Based on this Draft Tier 1 EIS analysis, variations in the geologic, soil, and Prime and Unique Farmlands resources exist among the Build Corridor Alternatives to varying degrees.

The Corridor Alternatives share many similarities; however, some distinctions can be made based on this preliminary analysis. This section outlines the potential impacts on geology, soils, and Prime and Unique Farmlands in the 2,000-foot-wide corridor.

3.12.4.1 Geology

Potential effects of the project on surface and near surface geologic resources will be similar for all build alternatives and include:

- Loss of geologic material (rock or soil) through removal,
- Loss of access to surface geologic material as part of the construction process (i.e., covering by pavements or improved right-of-way areas), and
- Cut slope instability.

Excavation and removal of existing geologic materials would be required for construction. This would result in loss of native materials from the environment. Access to surface and near-surface geologic materials would be lost following construction of roadway pavements, bridge and wall structures, and other coverings such as engineered fills and landscape materials. Slopes resulting from excavations and fills would be designed in Tier 2 to mitigate erosion prone or unstable slope conditions. Operation and maintenance of a new or expanded roadway system as the result of a Build Alternative would generally not be expected to affect the geology within the Study Area. Additional details about the specific alternatives and Build Corridor Options are included below.

<u>Purple Alternative</u>

- Options A and G would avoid bedrock and related difficult excavation and cut slope stability issues.
- Option A would avoid land subsidence and earth fissure areas.
- Options I1, I2, L, and R would avoid bedrock and related difficult excavation and cut slope stability issues.
- Options L and N would avoid land subsidence and earth fissure areas.
- Option X would avoid land subsidence and earth fissure areas.

<u>Green Alternative</u>

- Options A and F would avoid bedrock and related difficult excavation and cut slope stability issues.
- Option A would avoid land subsidence and earth fissure areas.
- Options I1, I2, and L would avoid bedrock and related difficult excavation and cut slope stability issues.
- Options L and M would avoid land subsidence and earth fissure areas.
- Option U would avoid land subsidence and earth fissure areas.

<u>Orange Alternative</u>

- Options A and G would avoid bedrock and related difficult excavation and cut slope stability issues.
- Option A would avoid land subsidence and earth fissure areas.
- Option S would avoid land subsidence and earth fissure areas.

3.12.4.2 Soils

Potential effects of I-11 on surface and near surface soil resources are the same for all of the Build Alternatives and include:

- Loss of soil through removal,
- Loss of access to soil by covering,
- Loss of soil by water and wind erosion, and
- Reduced stability by disturbance.

Excavation and removal of native soils would be required for construction of I-11, which would result in loss of these native materials from the environment. Access to surface and near-surface soil resources would be lost following construction of roadway pavements, bridge and wall structures, and other coverings such as engineered fills, erosion protection layers, and landscape materials. Slopes in native materials resulting from excavations and fills would be designed in Tier 2 to mitigate erosion prone or unstable slope conditions. If a Build Corridor Alternative were to be selected, operation and maintenance of a new or expanded roadway generally would not be expected to affect soil resources after the construction period.

Soil conditions across the Study Area, specifically in the dust storm prone-areas are generally similar. Where not developed, they are comprised predominately of exposed alluvial soils with little vegetative cover in active river channels and agricultural lands. Considering this and the variable, widespread meteorological conditions responsible for winds capable of soil disturbance resulting in dust storms, none of the proposed I-11 Corridor Options are expected to be more or less susceptible to dust storms and related hazards associated with low visibility, nor would they be expected provide a safer roadway alternative to avoid dust storms.

3.12.4.3 Prime and Unique Farmlands

Potential impacts of the project on Prime and Unique Farmlands resources are the same for all of the Build Alternatives and include:

- Direct conversion of farmland,
- Cumulative impacts by isolation of remnant parcels, and
- Indirect (secondary) impacts resulting from the acquisition of adjacent land.

Prime and Unique Farmlands occupy portions of all the Build Corridor Alternatives and all action alternatives would directly affect Prime and Unique Farmlands by conversion.

Direct conversion of farmland would occur through construction of the proposed action. Agricultural parcels bisected by the proposed action would result in separated parcels which might become too isolated or too small for continued economic use and/or result in the need to transport equipment using the existing local road network to gain access to opposite sides of the proposed action. Land adjacent to the prosed action is likely to be developed and could result in loss of agricultural land.

During the future Tier 2 analysis, the actual acreage of Prime and Unique Farmlands would be further refined and be dependent on the Tier 2 alternative alignment.

3.12.4.4 No Build Alternative

Under the No Build Alternative, there would be no impact to geologic, soil, or Prime and Unique Farmlands resources from I-11. Urban growth of the metropolitan areas encompassed by the Study Area over the long term is projected to continue and expected to impact geologic, soil, or Prime and Unique Farmlands resources through conversion to residential, commercial, and industrial uses. These are considered indirect and cumulative effect and are further discussed in Section 3.17.

3.12.5 Summary

The impacts associated with geology, soils and prime farmlands are similar for the Build Corridor Alternatives. Each Build Corridor Alternative would encounter geologic features and soils that would impact the design and construction process, but the conditions would be similar. All Build Corridor Alternatives would impact agricultural lands through direct conversion during construction.

As part of the Tier 2 environmental process, field investigations will determine the exact resource characteristics and how to avoid, minimize, and mitigate associated effects during the design process. The key issues are summarized in **Table 3.12-10** (Summary of Potential Impacts on Geology, Soils, and Prime and Unique Farmlands) located at the end of this section.

3.12.6 Potential Mitigation Strategies

Mitigation for specific effects on geology, soils, and Prime and Unique Farmlands would be identified based on the assessment conducted during Tier 2 analysis. Mitigation strategies that could be implemented when setting the specific alignment of I-11 in Tier 2, as well as best management practices to employ during construction activities, are identified below. These are listed separately for each resource.

Geology

- Monitor disturbance and erosion areas during construction and through restoration.
- Avoid steep slopes and known bedrock outcrops.
- Evaluate and design for safe, stable excavated slopes in bedrock.
- Minimize areas of disturbance by using existing roads where possible.
- Avoid known land subsidence areas when feasible.
- Avoid known earth fissures when feasible.
- Appropriate design to avoid or mitigate geotechnical-related construction constraints.
- Design and excavate slopes in accordance with accepted practices and suitable factors of safety.
- Design and place fills in accordance with accepted practices and suitable factors of safety.
- Protect excavation and fill slopes against erosion.
- Design subgrade and foundations in accordance with accepted practices.

Soils

- Monitor potential erosion or settlement areas during construction and through restoration.
- Minimize areas of disturbance by using existing roads where possible.
- Develop and implement dust control and erosion control strategies.

- Stockpile topsoil for use in reclamation.
- Develop and implement a reclamation and revegetation plan.
- Protect excavation and fill slopes against erosion.

Prime and Unique Farmlands

- Formal coordination with NRCS as part of compliance with the FPPA.
- Alignment within or near existing linear transportation features or planned urban areas to avoid agricultural areas.
- Work with local land owners to facilitate swaps and purchases as applicable to avoid fragmented parcels with barriers to equipment access.
- Provide access for farm equipment between divided agricultural parcels, where feasible.
- Implement, during final design, a right-of-way acquisition program in accordance with the Uniform Relocation Assistance and Real Property Acquisition Act of 1970 (Public Law 91 646) and the Uniform Relocation Act Amendments of 1987 (Public Law 100 17).

3.12.7 Future Tier 2 Analysis

Future Tier 2 analyses would consider project-level effects on geology, soil, and Prime and Unique Farmlands. Additional and more detailed analysis will be needed for the preferred alternative(s) during future Tier 2 project-level National Environmental Policy Act reviews. Such Tier 2 National Environmental Policy Act analysis could be advanced for the following:

- Identify and determine the extent of impacts to specific geology, soils, and prime or unique farmland resources.
- Identify and review regulations related to geologic resources based upon local land ownership and the intended use.
- Evaluate the probabilistic earthquake ground motion values of PGA in bedrock and adjust the design as appropriate based on the subsurface profile encountered during final geotechnical investigations for design of roadways, bridges, water conveyance and retention facilities, utilities, and other structures.
- Collect any additional or refined data (NRCS, USGS, or other sources) on geotechnical conditions that could affect design and performance such as shrink/swell, compression/collapse, and corrosion potential.
- As part of design and geotechnical investigations, determine the amount of ground disturbance anticipated and factors that affect the potential for soils to erode by water and wind, including physical characteristics, slope gradient, vegetative cover, surface roughness, and rainfall or wind intensity.
- Identify the number of irrigated acres for refinement of potential Prime or Unique Farmlands impacts through NRCS completion of the USDA Form AD 1006 (Farmland Conversion Impact Rating form).
- Identify areas of current and planned development that should be removed from Prime and Unique farmland categorization thorough the analysis of local land use and zoning maps.

- Participate in site visits to supplement additional Tier 2 analysis of the areas that may be affected by construction and operation of a selected alternative.
- Site-specific field investigations required during design to validate interpretations and confirm soil characteristics.
- Evaluations for existence and status of mining claims and active mining operations.

Table 3.12-10 Summary of Potential Impacts on Geology, Soils, and Prime and Unique Farmlands

Topics	No Build Alternative	Purple Alternative	Green Alternative	Orange Alternative
Major Resource Features	Unique geology soils and farmland features are found throughout the Build Corridor Alternatives. Some features are considered resources (i.e., soil/rock for construction, farmlands for food production) while others are considered hazards (earth fissures, land subsidence, unstable slopes). The potential hazards are highly likely to influence the design and construction methodologies when the selected alternative advances to the future Tier 2 analysis.			
Land Subsidence Areas	No I-11 impacts identified. Existing conditions and baseline trends would continue. Other projects in the Study Area would be subject to their own evaluation.	Encountered in Options G, I1, I2, N, R.	Encountered in Options F, I1, I2, Q2, R.	Encountered in Options B, G, H, K, Q1, Q2, Q3.
Earth Fissure Areas		Encountered in Options C, G, I1.	Encountered in Options D, F, I1.	Encountered in Options G, H.
Surface Bedrock		Encountered in Options A, C, N, X.	Encountered in Options A, D, M, Q2, U.	Encountered in Options A, H, K, Q1, Q2, S.
Construction of Road and Streets: Very Limited Soils		41% of soils in the corridor identified as Very Limited.	35% of soils in the corridor identified as Very Limited.	34% of soils in the corridor identified as Very Limited.
Construction of Road and Streets: Somewhat Limited Soils		28% of soils in the corridor identified as Somewhat Limited.	38% of soils in the corridor identified as Somewhat Limited.	26% of soils in the corridor identified as Somewhat Limited.
Prime and Unique Farmland Soils		52% of soils identified as potentially Prime and Unique Farmland.	51% of soils identified as potentially Prime and Unique Farmland.	43% of soils identified as potentially Prime and Unique Farmland.
Indirect Effects	No potential indirect effects.	Land development induced by the project could lead to: • Loss of access to geologic material through covering with construction materials. • Improved access to geologic materials (sand and gravel) needed for construction.	Similar to the Purple Alternative, except: • Overall indirect effects would be increased due to the corridor being located in undeveloped areas with limited planned future development and due to greater area of new ground disturbance in the Central Section.	Similar to the Purple Alternative, except: • Potential effects would be less than that of both the Green and Purple Alternatives due to smaller area of new ground disturbance.

Table 3.12-10 Summary of Potential Impacts on Geology, Soils, and Prime and Unique Farmlands (Continued)

Topics	No Build Alternative	Purple Alternative	Green Alternative	Orange Alternative
		• Additional isolation of and remnant prime and unique farmland parcels. • Changes in agricultural land use where land value inflation occurs as a result of land conversion from farmland to developed land.		
Cumulative Effects	Past, present, and reasonably foreseeable projects could: • Drive effects through land conversion to residential, commercial, and industrial uses.	Past, present, and reasonably foreseeable projects could: • Increase incremental effects including the use of geologic resources and soils, loss of those resources through covering, and the loss of farmland potentially accelerated by increasing land value.	Similar to the Purple Alternative.	Similar to the Purple Alternative.

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