APPENDIX G:

TRANSMISSION CONSTRAINT ANALYSIS

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The study area for this programmatic environmental impact statement (PEIS), "Programmatic Environmental Impact Statement for Solar Energy Development in Six Southwestern States," is located within the Western Interconnection, the electricity grid overseen by the Western Electricity Coordinating Council that serves the states of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming; part of west Texas; the Canadian provinces of Alberta and British Columbia; and a small portion of northern Mexico in Baja California. The feasibility of developing any electricity-generating project within the Western Interconnection is determined, in part, by whether or not the project can secure access to the transmission grid. The extent and pace of solar energy development in the six-state study area will be affected by the Western Interconnection's existing transmission capacity and future expansions of its system.

As discussed in Section 1.3.6, as part of this PEIS, the U.S. Department of the Interior (DOI) Bureau of Land Management (BLM) considered designating additional electricity transmission corridors on BLM-administered lands to facilitate utility-scale solar energy development. The extent to which the lack of transmission system access could impede solar energy development in the areas that are suitable for utility-scale solar energy development was analyzed to determine whether corridor designation was needed to support solar energy development. Specifically, the analysis identified which areas within the six-state study area are greater than 25 mi (40 km) from an existing transmission line or designated corridor. This transmission analysis only considered the locations of existing transmission lines and designated corridors and did not look at the available capacity on existing lines (i.e., the analysis assumed lines could be upgraded, if needed). Areas exceeding the 25-mi (40-km) threshold were determined to be constrained by the lack of transmission system access, or "transmission constrained," on the basis of the assumption that the process of siting and constructing a transmission line over greater distances could be both cost- and time-prohibitive. Once the constrained areas were identified, the BLM assessed the extent to which lands proposed to be available for right-of-way (ROW) application under the solar energy development program alternative, including the proposed solar energy zones (SEZs), were constrained by the lack of transmission access. For those lands that fell within the constrained areas, the BLM also assessed the conditions contributing to those constraints. On the basis of this analysis, the BLM decided to not include designations of additional transmission corridors on BLM-administered lands in the scope of this PEIS.

This appendix presents general information about the existing transmission grid in the PEIS study area, proposed new transmission lines, and designated corridors. It also presents the results of the transmission constraint analysis, including state-specific maps showing the constrained areas.

G.1 TRANSMISSION ACCESS CONSIDERATIONS

Access to adequate transmission capability directly affects the technical and financial feasibility of solar resource development areas. Several aspects of transmission linkages can influence the economic viability and favorability for potential solar development sites. These aspects fall under the general headings of proximity, capacity, and timing of new transmission and energy development. The sections that follow in this appendix briefly address these aspects of transmission access in the six-state study area.

Proximity to transmission lines is an important factor because costs are typically high for spanning significant distances with new transmission ROWs and new lines. Capacity is important because even if a solar development area is in close proximity to existing lines, adequate capacity must exist on those lines to transmit the solar-generated power to load areas. Timing is important in cases where planned additions of new lines or augmentations of existing lines may provide adequate transmission services for future dates of operation.

The North American Electric Reliability Corporation (NERC) is the primary organization that oversees planning activities of the electric power industry in the United States. In terms of planning efforts and perspectives, NERC's 2009 Long-Term Reliability Assessment (NERC 2009) provides an overview of the 10-year (i.e., 2009 to 2018) needs and plans for transmission systems in the United States. Transmission planning efforts in the west can be summarized as satisfying adequacy requirements as established by NERC guidelines, but with a major new emphasis on coordination between electrical areas within, and adjacent to, the region.

Because of geographic characteristics, load topography, and the way grid systems have evolved, transmission systems in the western United States tend to be characterized by greater "radial" connectivity, like spokes of a wheel, as compared with more "networked" connectivity (higher connectivity between all supply and demand points) that typifies systems in the eastern half of the United States. Networked grids offer reliability advantages over radial systems, and areas in the west are planning additional lines to improve reliability and reduce congestion issues.

A quote from NERC's 2009 Long-Term Reliability Assessment is representative of current objectives in the entire area: "The goal … is to collaborate in the planning, coordination, and implementation of a robust transmission system between Arizona, southern Nevada, Mexico, and southern California that is capable of supporting a competitive, efficient, and seamless west-wide wholesale electricity market while meeting established reliability standards" (NERC 2009). To accomplish this goal, planning efforts are looking to add significant numbers of new transmission links to existing grids.

The following sections provide a brief description of existing systems, current congestion areas, planned new lines, and designated transmission corridors. All of these elements play a role in assessing the implications of existing and planned transmission capabilities on the delivery of solar resources to areas of demand.

G.1.1 Existing Transmission Lines

Figure G-1 illustrates routings for existing transmission lines with ratings of 69 kilovolts (kV) or greater within the PEIS six-state study area. Different line weights indicate line voltages for alternating current (AC) lines in categories of 69 to 230 kV, 230 to 344 kV, 345 to 499 kV, 500 to 734 kV, and direct current (DC) interties (1,000 kV).[1] The total length for all existing lines of 69 kV or higher in the study area is approximately 100,000 circuit miles.

G.1.2 Transmission Congestion

Figure G-2 highlights the existing transmission lines currently encountering constrained flows due to line capacity limits. These constrained lines have little to no excess available capacity to transfer additional electricity above that which they already transfer. As a result, these particular lines offer very limited capabilities for conveying any additional power generation from new electricity-generating sources, such as solar energy projects, to demand areas.

These limitations are not necessarily absolute, in that some incremental power flows can often be achieved. However, time-of-day and seasonal limitations can render any incremental flows less valuable. The times when these constrained lines may be capable of transmitting more power are typically times when demands for power are lower. However, off-peak times when incremental transmission capabilities may be possible over the constrained lines, typically coincide with times that solar generation is not available (e.g., nighttime).

G.1.3 Proposed Transmission Lines

In addition to showing existing lines and the constrained segments, Figure G-2 shows the approximate pathways of new transmission lines currently under construction or proposed in the western United States. While the pathways for existing lines are charted with some degree of accuracy in Figure G-2, the pathways for proposed lines are more notional. In general, the proposed lines are depicted as simple point-to-point connections defined on the basis of the origin and destination endpoints that are associated with the announced plans for each line.

From detailed listings in NERC's 2009 Long-Term Reliability Assessment (NERC 2009), plans for new transmission lines represent nearly 150 lines, with planned service dates ranging from 2010 to 2018. Because transmission lines often cross state boundaries, it is difficult to give precise tallies of lines for each state. However, in very general terms, there are approximately 75 new lines proposed for Arizona–New Mexico–Southern Nevada, with expected start-up dates ranging from 2010 to 2018; approximately 35 lines planned for California, with dates of 2010 to 2017; approximately 10 lines planned for Utah for 2010 to 2011; and about 15 proposed lines for Colorado for 2010 to 2013.

[1] Although AC lines with voltages ranging from 735 to 999 kV exist in the United States, there are none in the six-state study area at this time.

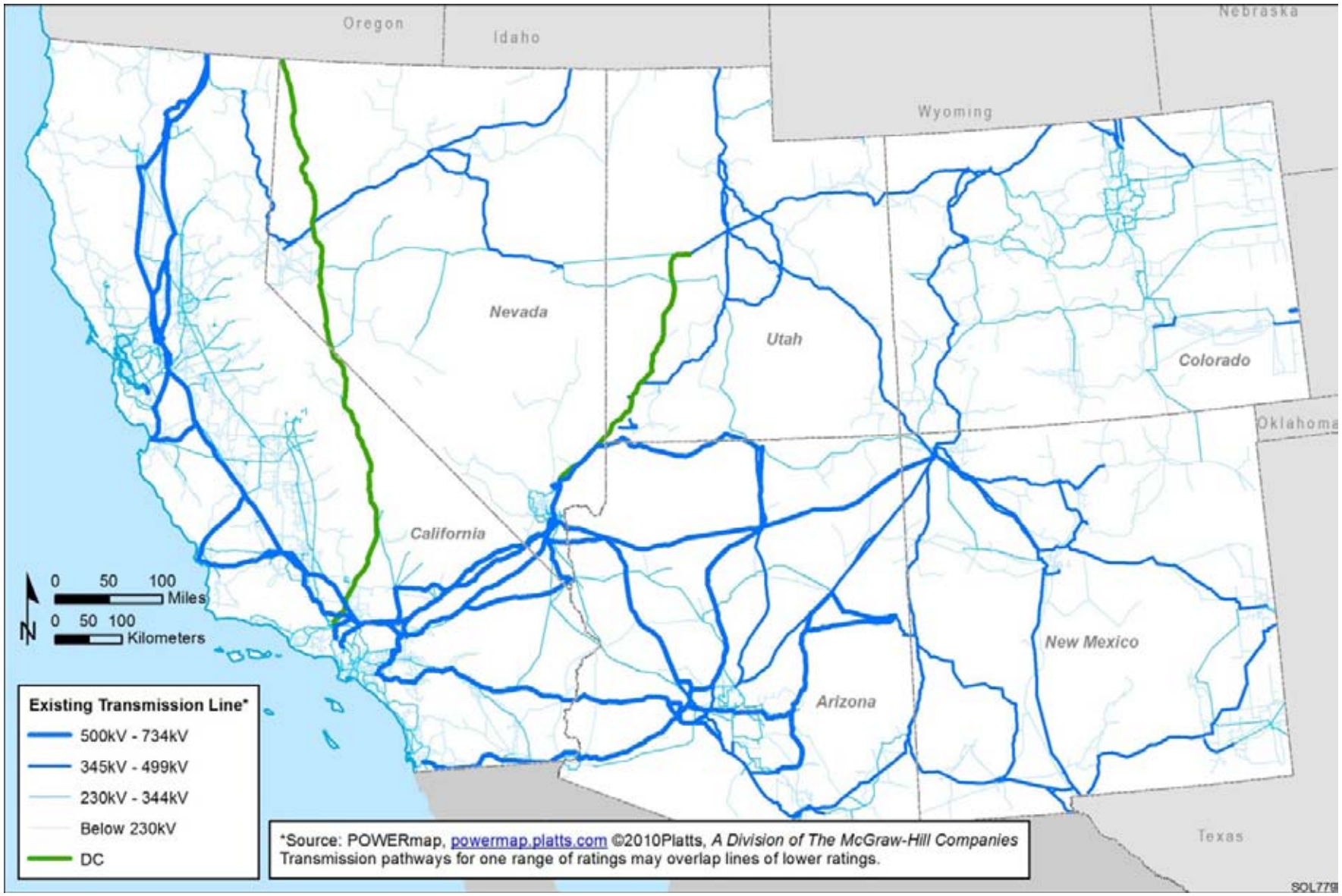

FIGURE G-1 Existing Transmission Lines in the PEIS Study Area with Ratings of 69 kV or Higher

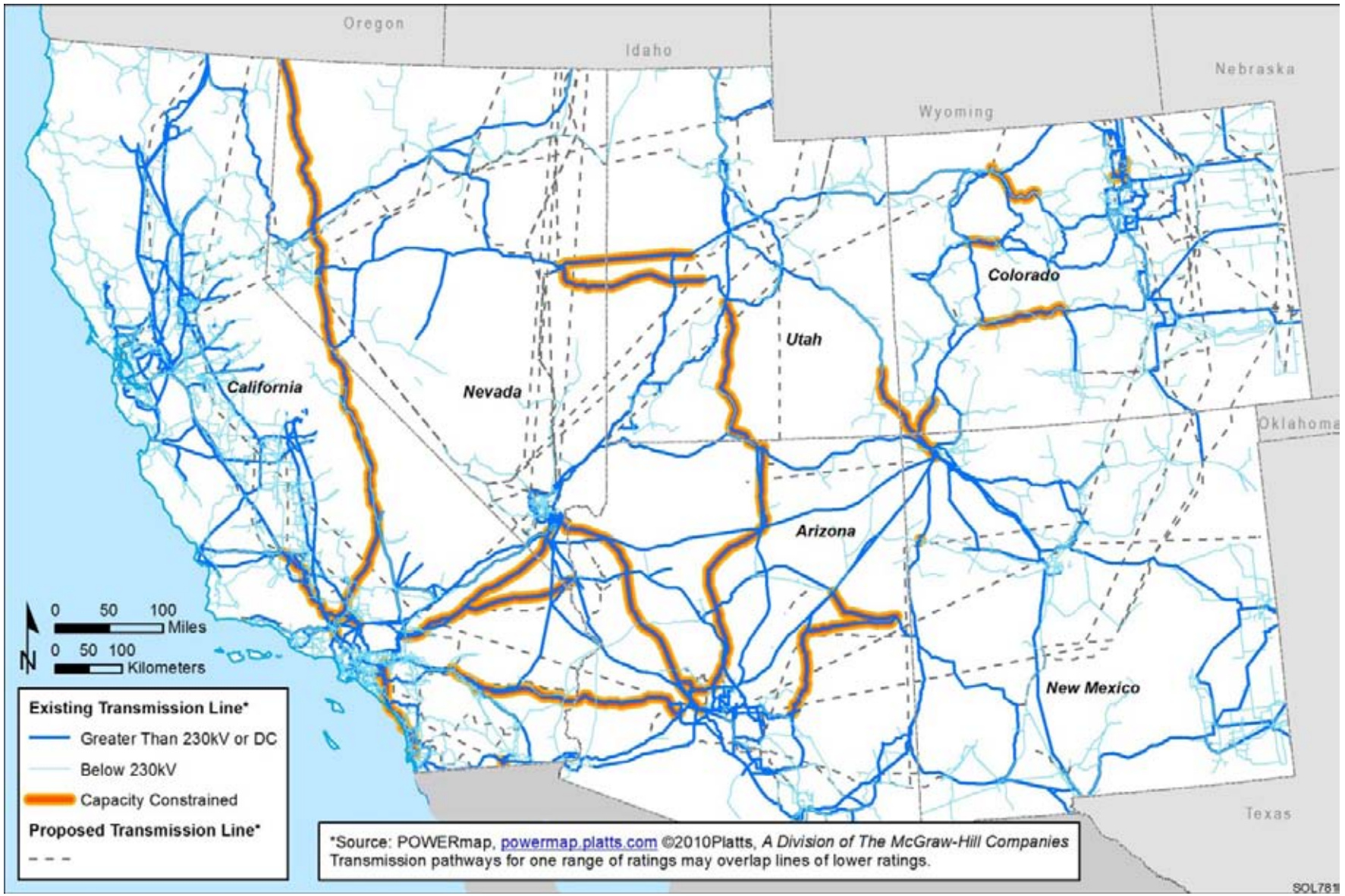

FIGURE G-2 Existing, Constrained, and Proposed New Transmission Lines in the PEIS Study Area with Ratings of 69 kV or Higher

For the Arizona–New Mexico–Southern Nevada area, proposed lines represent a total of more than 3,000 new circuit miles. About 1,400 of these circuit miles are relatively firm planned additions; the other 1,600 are at the "conceptual" stage of planning. The conceptual stage indicates that a project is less advanced in terms of permitting, land acquisition, and other required steps leading up to construction and service. However, conceptual plans represent serious intentions for new transmission capabilities, and these plans are submitted to NERC from each electrical planning region.

For California, proposed lines represent nearly 4,700 circuit miles of additional transmission capabilities. Conceptual planned additions represent approximately 3,300 circuit miles of the total, and about 1,400 circuit miles are more advanced in the planning and implementation process.

Utah is located in an area where 30% of the planned additions are relatively firm, and 70% are at the conceptual stage. Colorado is in a region where virtually all of the planned additions are relatively firm (i.e., almost no additions in "conceptual" category).

Figure G-2 illustrates that there is not a one-to-one correspondence between constrained lines and proposed transmission lines. In some cases, the proposed additions do follow pathways of constrained lines, but in other cases, proposed lines follow new pathways. This observation does not represent an inconsistency, because congestion relief can often be effectively achieved by adding new pathways to the grid. This is especially true for more "radial" systems as typified in the western states. New links lead to a greater level of networked connectivity, and greater flexibility in delivering power from generation sources to various demand areas.

G.1.4 Designated Corridors

Environmental issues and other siting considerations often present barriers to the development of new transmission lines. Some of the key issues and considerations include potential impacts on individual animal and plant species and their habitats, cultural and historic resources, visual resources, and specially designated areas (e.g., parks, monuments, recreation areas). Other siting issues relate to topography, the location of surface water bodies and drainages, land use and ownership, and the location of other infrastructure (e.g., pipelines, roads, and railways).

To proactively address these types of issues and considerations, federal agencies have engaged in comprehensive planning efforts to designate energy transport corridors across federal lands. Such corridors are designated pathways that the agencies have determined to be most appropriate for the location of energy transmission infrastructure, including electricity transmission lines. The corridors are sited specifically to avoid, as much as possible, sensitive resources, land use conflicts, and extreme terrain while maximizing the opportunities to connect energy development areas with demand centers and support development of the existing transmission system. The designation of corridors is expected to streamline reviews and approvals of specific transmission projects crossing federal lands.

Section 368 of the Energy Policy Act of 2005 (Public Law 109-58) required federal agencies to engage in transmission corridor planning (see Section 1.6.2.1). As a result of this mandate, the BLM, U.S. Department of Energy (DOE), U.S. Forest Service (USFS), and U.S. Department of Defense (DoD) prepared a PEIS to evaluate the designation of energy corridors on federal lands in 11 western states, including the six states evaluated in this study (DOE and DOI 2008). The BLM and USFS issued Records of Decision to amend their respective land use plans to designate numerous corridors. In addition to this west-wide initiative, a number of BLM field offices have similarly designated corridors across BLM-administered lands in the study area in local land use plans.

Figure G-3 shows the corridors designated as a result of Section 368 along with BLM locally designated corridors in the six-state study area. For reference, Figure G-3 also shows existing transmission lines, proposed new lines, BLM-administered lands proposed to be available for ROW application, and BLM's proposed SEZs.

G.2 TRANSMISSION CONSTRAINT ANALYSIS FOR BLM-ADMINISTERED LANDS

As discussed previously, BLM's analysis of the extent to which the lack of transmission access could constrain solar energy development on BLM-administered lands proposed to be available for ROW application entailed (1) the identification of lands that were greater than 25 mi (40 km) from an existing transmission line or designated corridor, and (2) for those lands within these constrained areas, the conditions contributing to the constraints. The types of contributing conditions that were evaluated included surrounding land ownership, terrain, and the potential for proposed transmission lines to alleviate the constraints.

Table G-1 lists the amount of acres considered to be constrained by the lack of transmission access in each field or district office, along with the percentage of the total lands proposed to be available for ROW application within that office. Figures G-4 through G-9 show the areas within each state identified as transmission constrained, along with the location of the BLM-administered lands proposed to be available for ROW application, the proposed SEZs, and land ownership. As shown in these figures, some portion of the lands that would be available for ROW application fall within constrained areas in each state, except Colorado. None of the proposed SEZs are located within constrained areas.

The following sections describe the extent of transmission access constraints in each state with respect to the lands proposed to be available for ROW application. In all cases, the BLM determined it did not need to designate additional corridors. A number of reasons factored into these determinations, most of which had some applicability to each of the constrained areas. The reasons for not designating additional corridors to the constrained areas include the following:

- In most instances, except in Utah (see the following discussion), the areas constrained by the lack of transmission access make up a relatively small percentage of the lands proposed to be made available for ROW application.

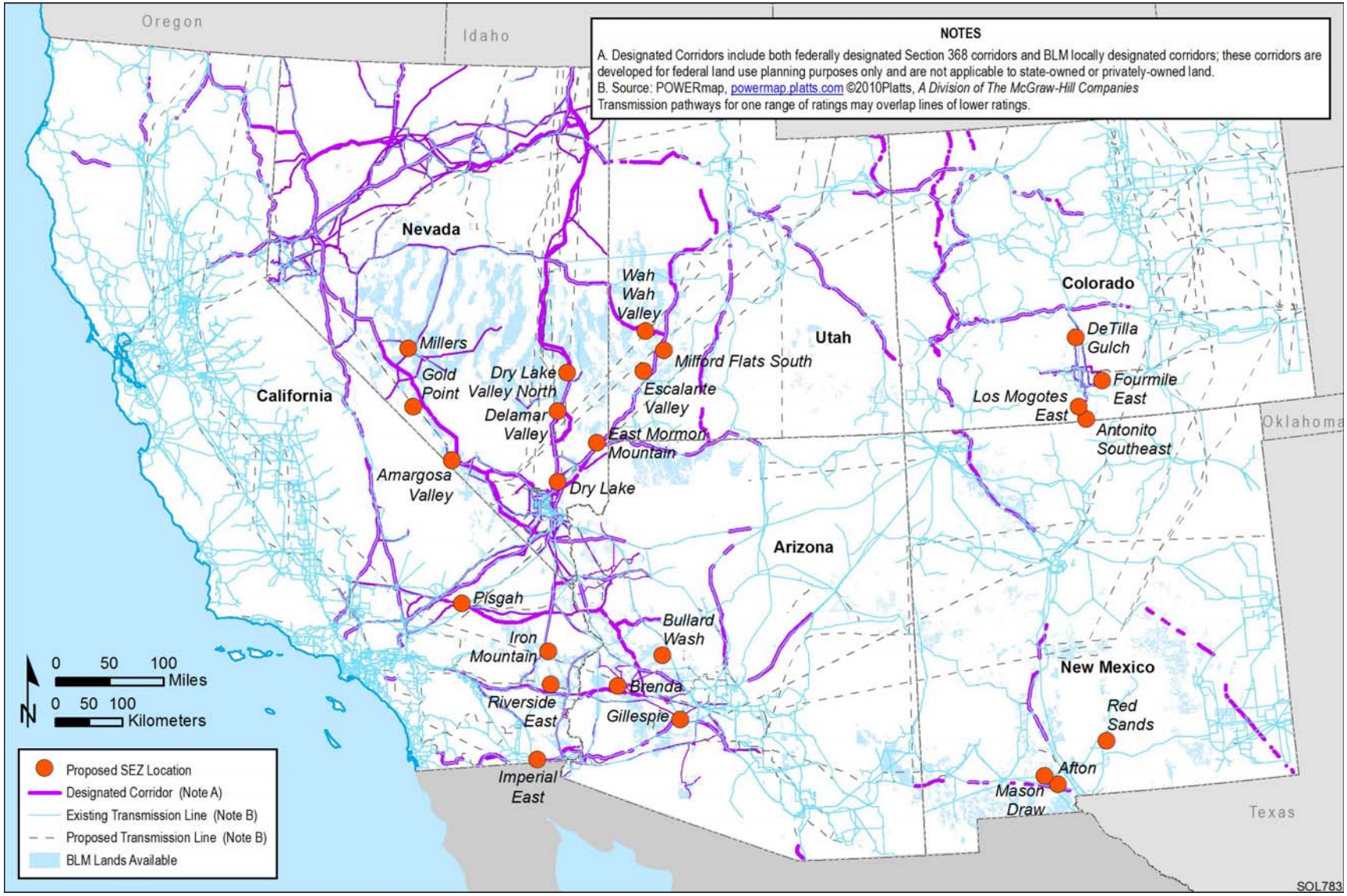

FIGURE G-3 Existing Transmission Lines, Proposed New Lines, and Designated Corridors in Relation to BLM-Administered Lands Proposed To Be Available for ROW Application, Including Proposed SEZs

TABLE G-1 Amount of Lands Available for ROW Application under the Solar Energy Development Program Alternative That Are Constrained by the Lack of Transmission Access[a]

Field/District Office	Total Acres Proposed To Be Available	Acres Constrained by Transmission Access	Percentage Constrained by Transmission Access
Arizona			
Arizona Strip	906,507	99,147	10.94
Hassayampa	338,445	0	
Kingman	625,777	0	
Lake Havasu	536,993	0	
Lower Sonoran	555,328	0	
Safford	709,824	2,127	0.30
Tucson	136,024	0	
Yuma	677,046	0	
Total	4,485,944	101,275	2.26
California			
Bakersfield	337	0	
Barstow	359,871	11,596	3.22
Bishop	95,509	0	
El Central	221,533	0	
Needles	667,447	0	
Palm Springs-South Coast	408,077	0	
Ridgecrest	13,769	0	
Total	1,766,543	11,596	0.66
Colorado			
Columbine	363	0	
Del Norte	9,869	0	
Dolores	9,042	0	
Gunnison	3,124	0	
La Jara	76,831	0	
Royal Gorge	10,755	0	
Saguache	38,088	0	
Total	148,072	0	
Nevada			
Battle Mountain	4,028,449	131,743	3.27
Carson City	863,456	91	0.01
Ely	3,327,761	181,790	5.46
Southern Nevada	789,823	640	
Winnemucca	74,561	0	0.08
Total	9,084,050	314,264	3.46
New Mexico			
Carlsbad	257,828	8,192	3.18
Farmington	364,575	0	
Las Cruces	1,792,899	25,807	1.44

TABLE G-1 (Cont.)

Field/District Office	Total Acres Proposed To Be Available	Acres Constrained by Transmission Access	Percentage Constrained by Transmission Access
New Mexico (Cont.)			
Rio Puerco	287,054	13,780	4.80
Roswell	722,150	63,887	8.85
Soccoro	633,472	126,112	19.91
Taos	10,346	0	
Total	4,068,324	237,778	5.84
Utah			
Cedar City	804,181	54,817	6.82
Fillmore	928,283	0	
Kanab	23,572	0	
Moab	1,210	0	
Monticello	85,722	16,732	19.52
Richfield	122,646	120,563	98.30
St. George	8,608	0	
Total	2,028,222	192,112	9.47
Total	21,581,154	857,025	3.97

[a] Lands potentially constrained by transmission access include those lands within the lands proposed as being available for ROW application that are greater than 25 mi (40 km) from existing AC transmission lines with a voltage of 69 kV or greater, local transmission corridors described in BLM land use plans, and corridors crossing federal lands designated under Section 368 of the Energy Policy Act. Totals may be off due to rounding. To convert to km^2, multiply acres by 0.00405.

- The constrained areas typically are adjacent to other proposed available lands. Solar energy development on those adjacent lands would result in the development of additional transmission infrastructure in the vicinity of the constrained lands which would, in turn, be likely to alleviate the constraints.

- Proposed transmission lines in the six-state study area, if constructed, would alter the results of the constraint analysis. Many of the constrained areas are located near proposed transmission lines as shown in Figure G-3.

- The constrained areas often are adjacent to, or separated from existing transmission lines, by lands not administered by the BLM. The BLM cannot designate corridors across lands it does not administer.

In Arizona, only 2.26% of the proposed available lands are considered to be constrained by transmission access. As shown in Figure G-4, most of these lands, 99,147 acres (401.2 km^2),

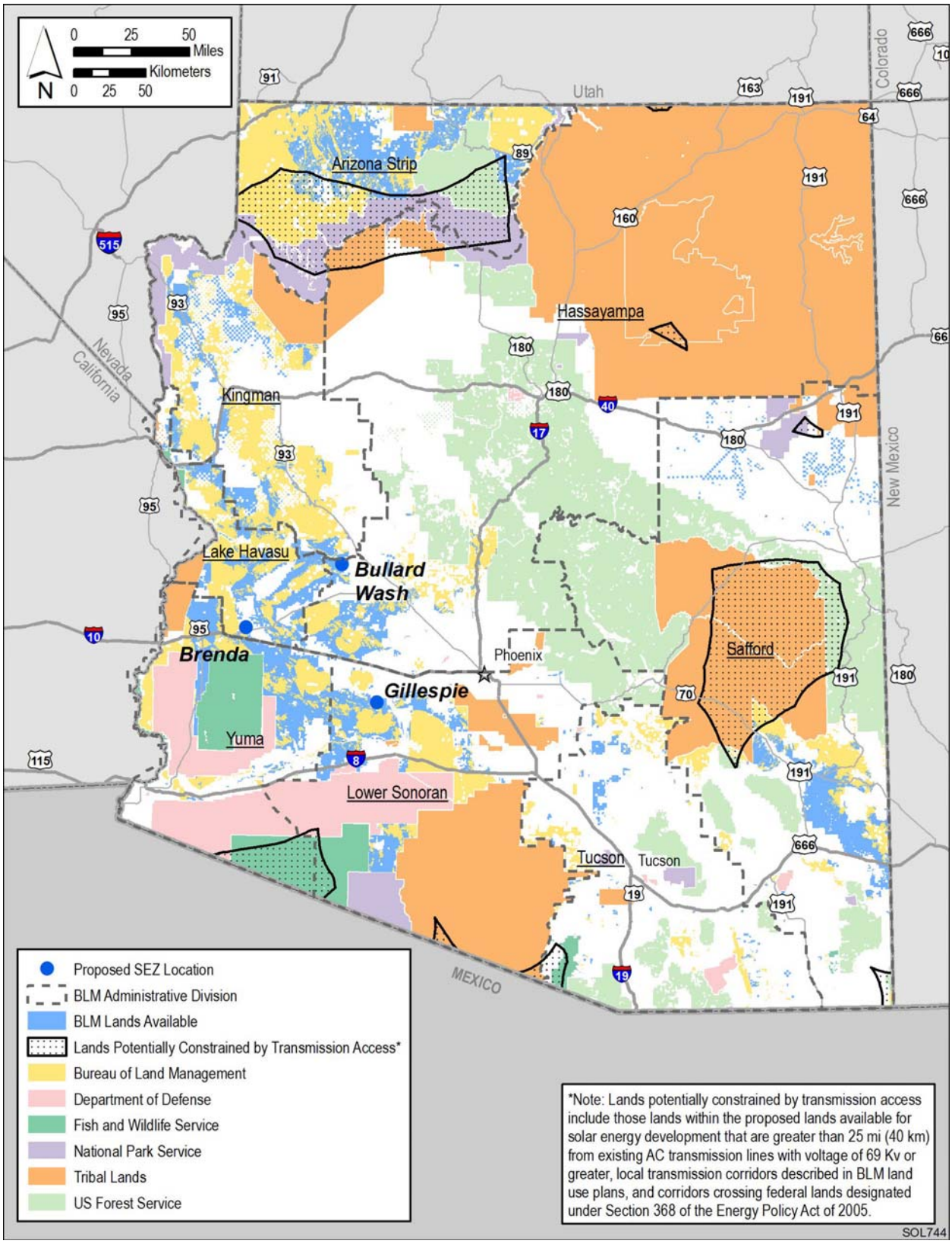

FIGURE G-4 Lands Potentially Constrained by the Lack of Transmission Access in Arizona

FIGURE G-5 Lands Potentially Constrained by the Lack of Transmission Access in California

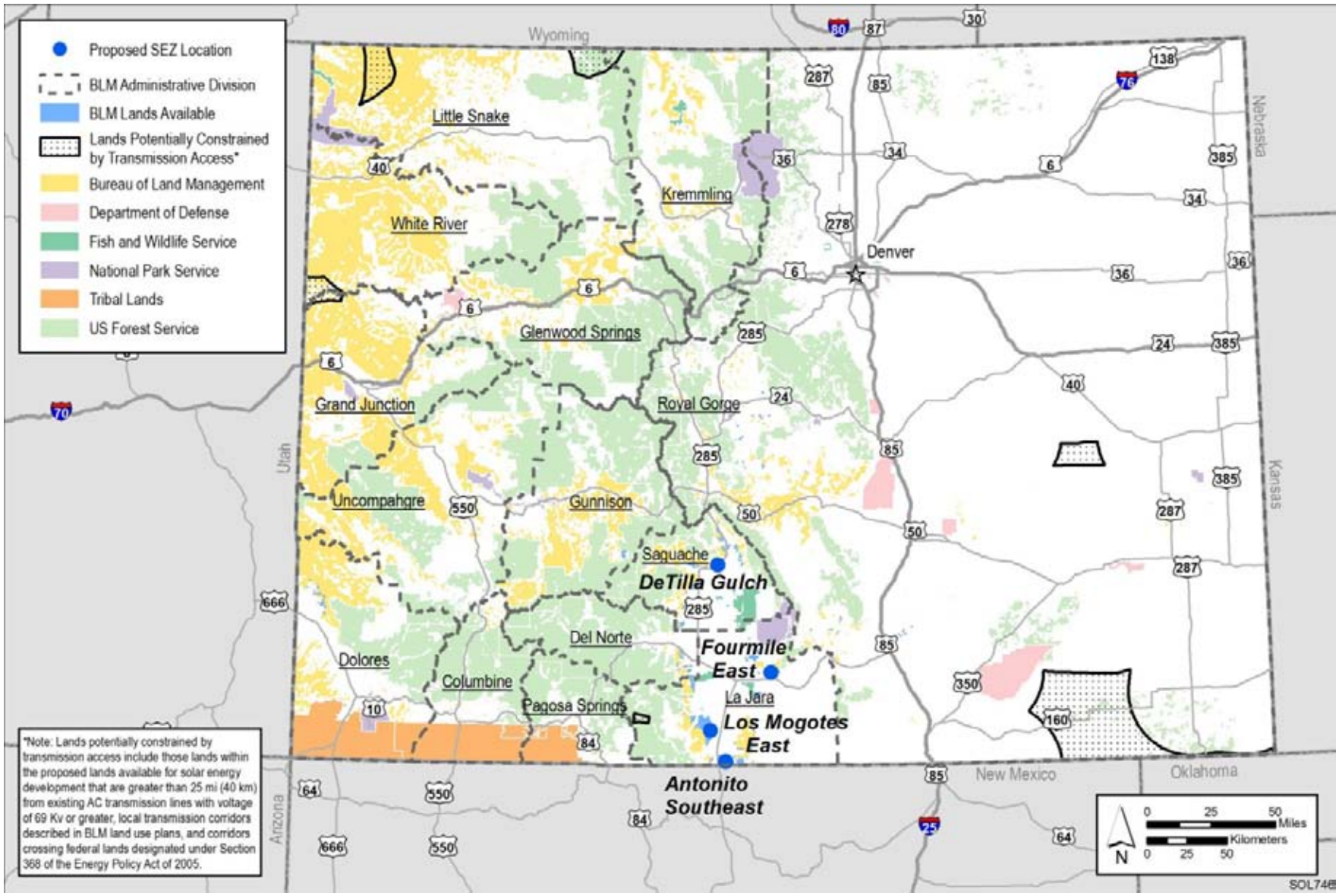

FIGURE G-6 Lands Potentially Constrained by the Lack of Transmission Access in Colorado

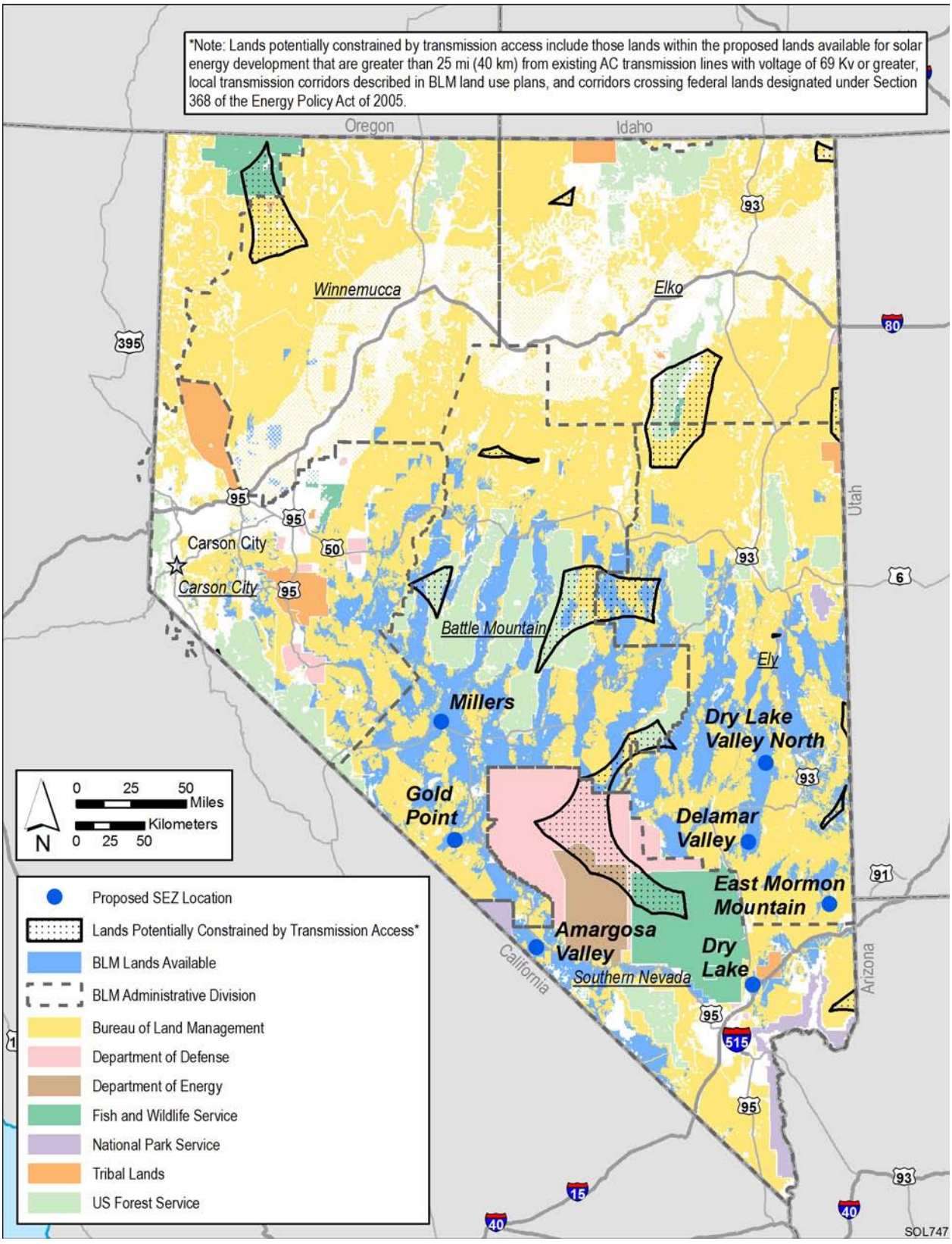

FIGURE G-7 Lands Potentially Constrained by the Lack of Transmission Access in Nevada

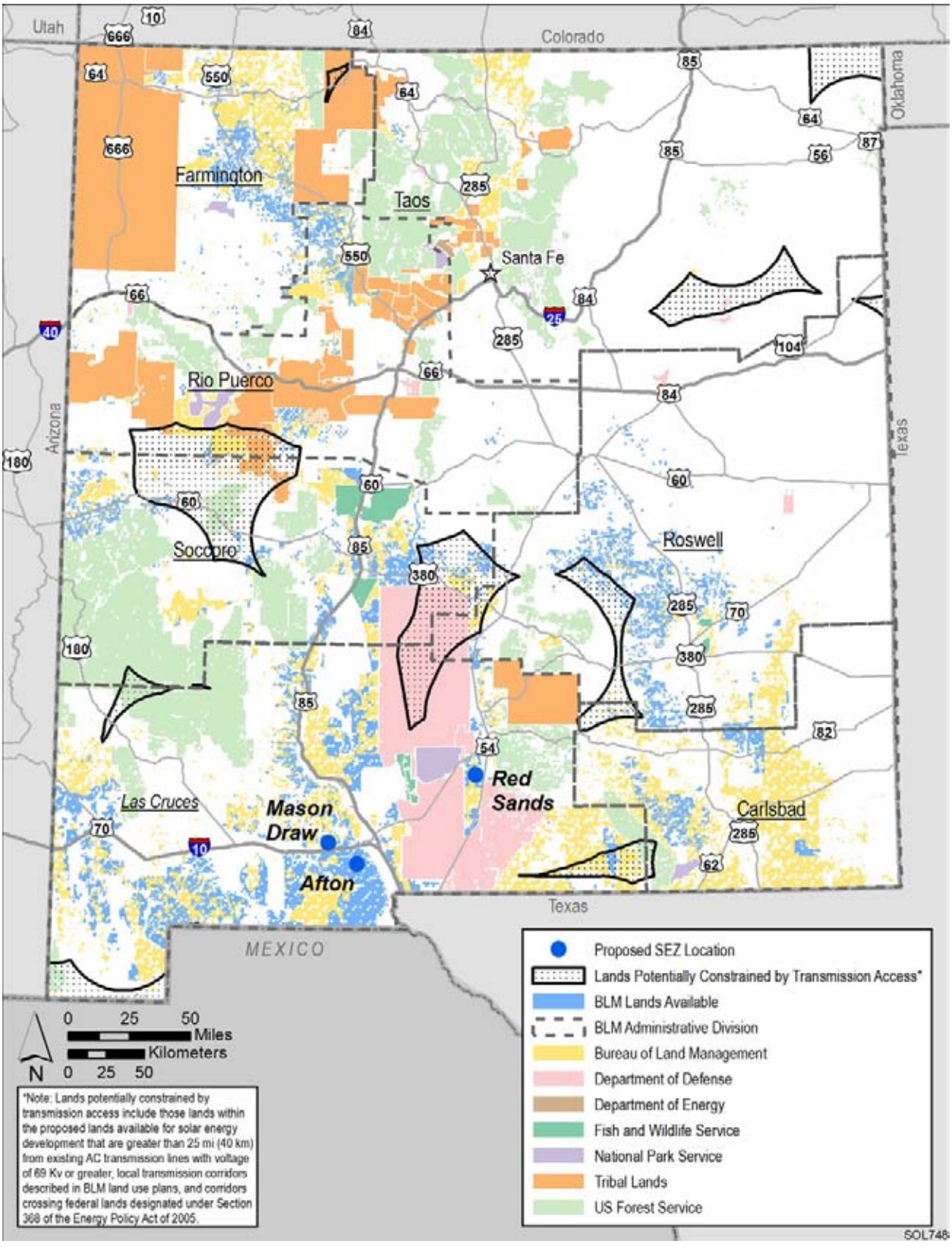

FIGURE G-8 Lands Potentially Constrained by the Lack of Transmission Access in New Mexico

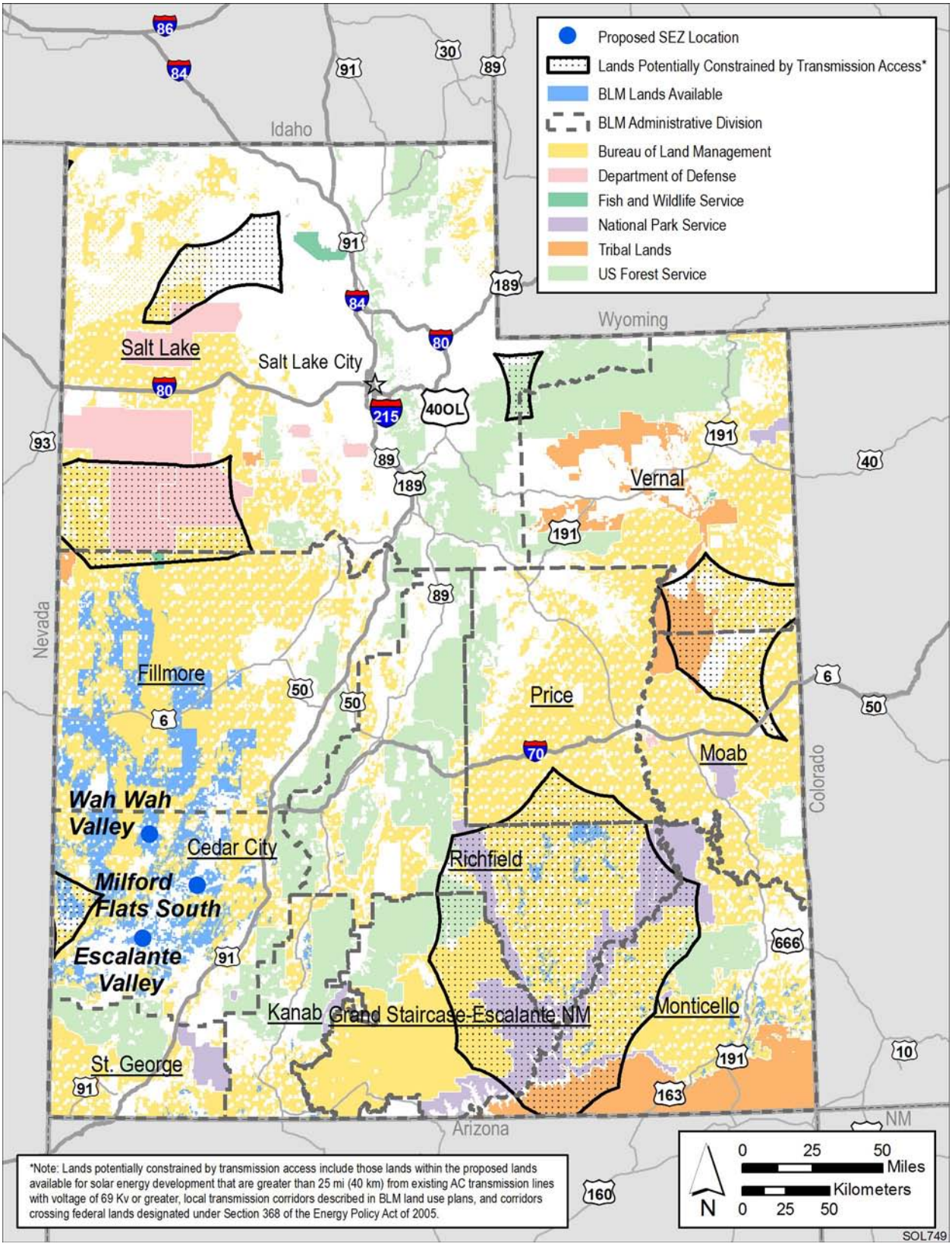

FIGURE G-9 Lands Potentially Constrained by the Lack of Transmission Access in Utah

are located in the Arizona Strip Field Office. Some of these constrained lands are located adjacent to or to the north of Grand Canyon National Park and the Lake Mead National Recreation Area. Smaller portions of constrained available lands are located in the Arizona Strip Field Office in an area situated between the Kaibab National Forest and the Navajo Indian Reservation and in the Safford Field Office.

In California, less than 1% of the proposed available lands are considered to be constrained by the lack of transmission access. As shown in Figure G-5, all of these lands, 11,596 acres (46.9 km^2), are located in the Barstow Field Office, adjacent to Death Valley National Park. These lands compose just over 3% of the proposed available lands in this field office.

In Colorado, none of the BLM-administered lands proposed to be available for ROW application are considered to be constrained by the lack of transmission access (Figure G-6).

In Nevada, at the state level, just over 3% of the proposed available lands are considered to be constrained by the lack of transmission access. As shown in Figure G-7, most of the lands that are constrained, are located in the Battle Mountain District Office (131,743 acres [553.1 km^2]) and the Ely District Office (181,790 acres [735.7 km^2]). Most of these lands are located near the Humboldt National Forest in an area of the state where the basin and range topography may limit transmission line construction.

In New Mexico, at the state level, less than 6% of the proposed available lands are considered to be constrained by the lack of transmission access. As shown in Figure G-8, the constrained lands are spread across many of the New Mexico field offices. The majority of these lands, 126,112 acres (510.4 km^2), are located in the Soccoro Field Office, and they compose almost 20% of the proposed available lands in that office. A number of new transmission lines have been proposed in New Mexico and, if constructed, they would reduce many of these transmission constraints (see Figure G-3).

Utah has the highest percentage of constrained lands. Statewide, more than 9% of the proposed available lands are constrained, with 120,563 acres (487.9 km^2) constrained in the Richfield Field Office, equal to more than 98% of the proposed available lands and 16,732 acres (67.7 km^2) in the Monticello Field Office, equal to almost 20% of the proposed available lands. As shown in Figure G-9, most of these lands are located in the general vicinity of Canyonlands National Park, Capitol Reef National Park, and the Glen Canyon National Recreation Area. This high density of park land is likely to impede transmission development in this area. The lack of proposed transmission lines in this region, as shown in Figure G-3, may be related to the presence of park lands.

G.3 REFERENCES

Note to Reader: This list of references identifies Web pages and associated URLs where reference data were obtained for the analyses presented in this PEIS. It is likely that at the time of publication of this PEIS, some of these Web pages may no longer be available or their URL addresses may have changed. The original information has been retained and is available through the Public Information Docket for this PEIS.

DOE and DOI (U.S. Department of Energy and U.S. Department of the Interior), 2008, *West-Wide Energy Corridor Programmatic Environmental Impact Statement, Designation of Energy Corridors on Federal Land in the 11 Western States,* DOE/EIS-0386, Final, Nov. Available at http://corridoreis.anl.gov/eis/guide/index.cfm.

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