APPENDIX I:

ECOREGIONS OF THE SIX-STATE STUDY AREA AND LAND COVER TYPES OF THE PROPOSED SOLAR ENERGY ZONES

This page intentionally left blank.

APPENDIX I:

ECOREGIONS OF THE SIX-STATE STUDY AREA AND LAND COVER TYPES OF THE PROPOSED SOLAR ENERGY ZONES

I.1 STUDY AREA ECOREGIONS

An ecoregion is defined as an area that has a general similarity of ecosystems and is characterized by the spatial pattern and composition of biotic and abiotic features, including vegetation, wildlife, geology, physiography, climate, soils, land use, and hydrology (EPA 2007a). Ecoregions of the United States as mapped and described by the U.S. Environmental Protection Agency (EPA) are presented here as the basis for describing visual resources and ecosystems at a general level. The Level III ecoregion classification includes 22 ecoregions covering the six-state study area (Figure I-1). Figures I-2 and I-3 show the lands that the U.S. Department of the Interior (DOI) Bureau of Land Management (BLM) is proposing as being available for solar energy development under its solar energy development program and solar energy zone (SEZ) program alternatives, respectively (see Section 2.2.2), in relation to the Level III ecoregions. Ecoregions of each of the six states in the study area, along with lands available under both the solar energy development program alternative and SEZ program alternative, are shown in Figures I-4 through I-9. The ecoregion descriptions presented here were derived primarily from the EPA (2002), except where noted.

I.1.1 Coast Range

The Coast Range ecoregion is located along the coast of California and extends north into Oregon and Washington. Within the six-state study area analyzed in the "Programmatic Environmental Impact Statement for Solar Energy Development in Six Southwestern States" (Solar PEIS), this ecoregion is approximately 3,261,500 acres (13,199 km^2), and the elevation ranges from 0 to 3,947 ft (0 to 1,203 m). The topography of this ecoregion ranges from beaches and low terraces to steeply sloping capes and volcanic slopes. The original dominant types of vegetation were Sitka spruce and coastal redwood forests along the coast, with a mosaic of western red cedar, western hemlock, and seral Douglas-fir in the inland areas. The low Coast Range mountains support highly productive coniferous forests. The area is now widely managed for timber production, and it supports extensive plantations of Douglas-fir. Because of the high precipitation levels, there are numerous streams and rivers. High scenic values attract many recreationists. Logging, wildlife habitat, recreation, rural residential, urban residential, and commercial development are important land uses within the ecoregion. Neither the solar energy development program alternative (development alternative) nor the SEZ program alternative includes this ecoregion.

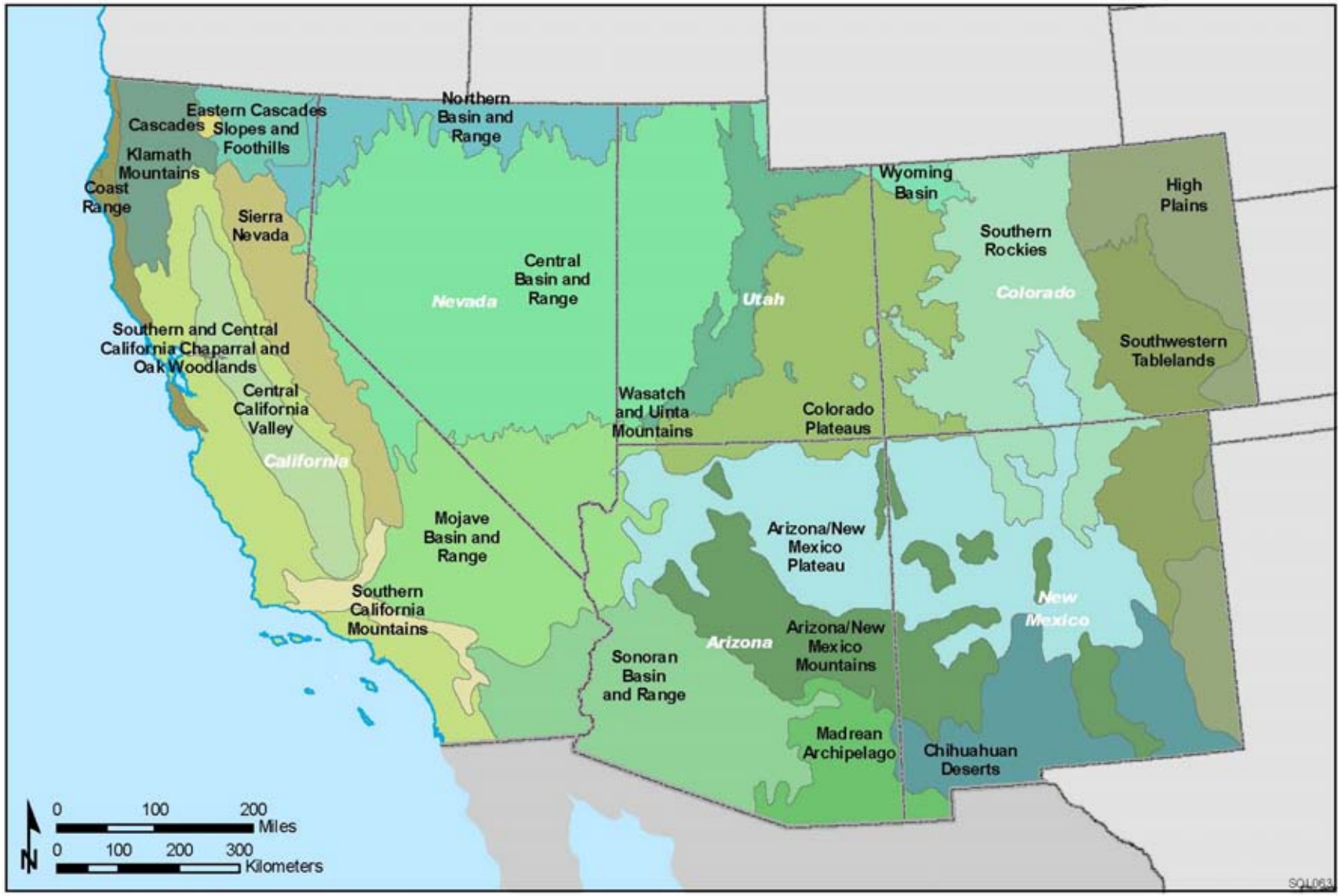

FIGURE I-1 Level III Ecoregions in the Six-State Study Area (Source: EPA 2007b)

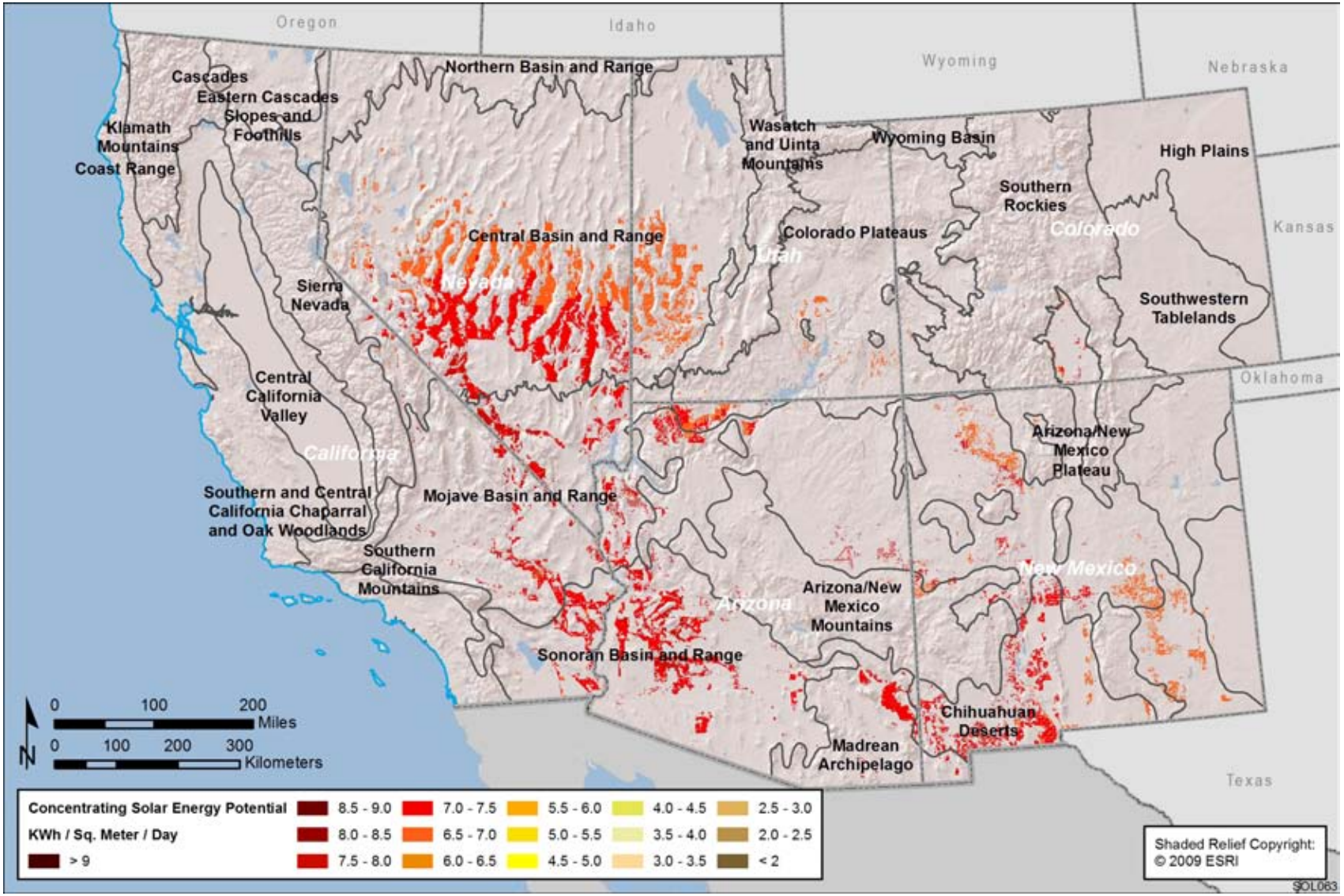

FIGURE I-2 BLM-Administered Lands Proposed To Be Available for Solar Energy Development and Associated Level III Ecoregions (Source: EPA 2007b)

FIGURE I-3 Level III Ecoregions and SEZs (Source: EPA 2007b)

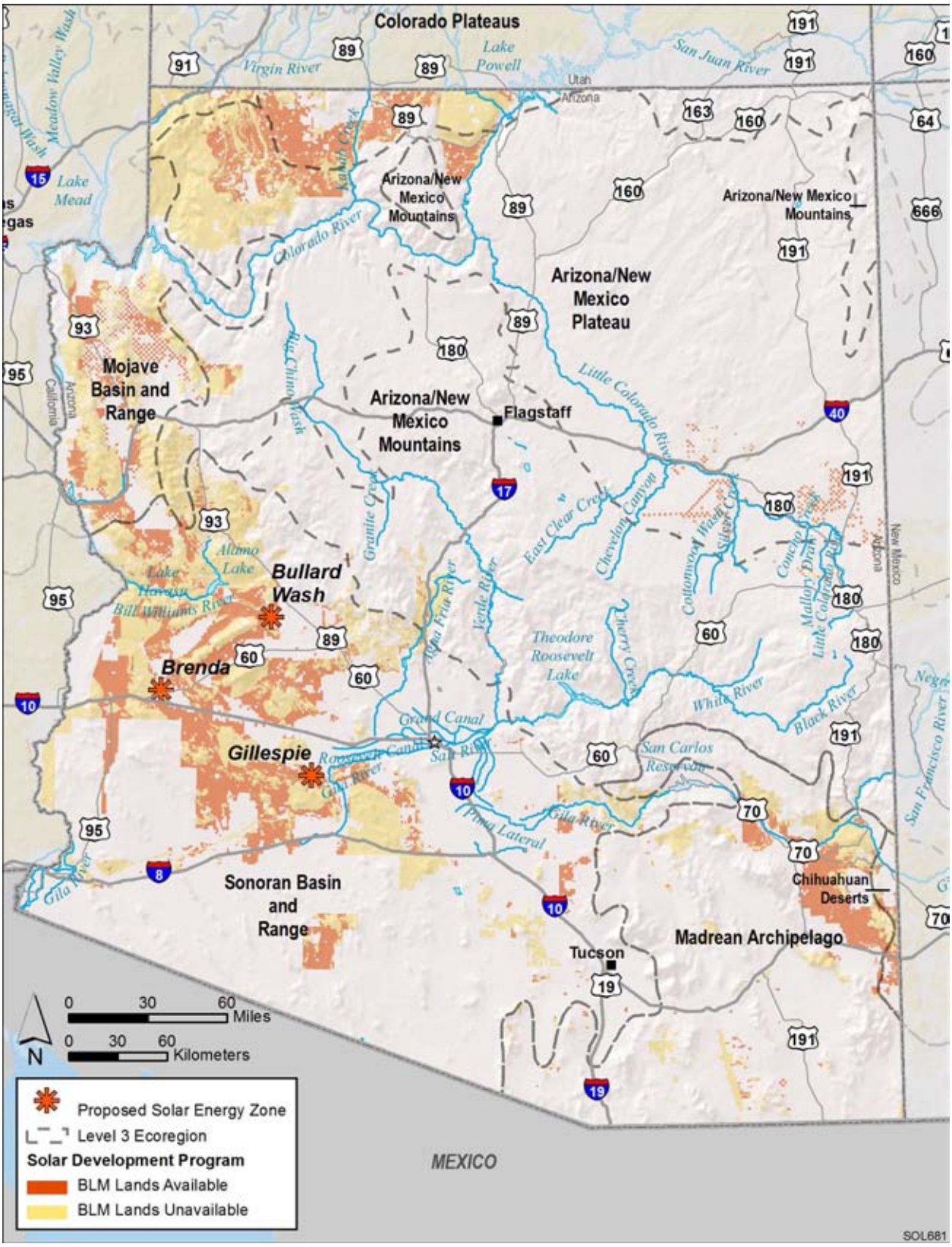

FIGURE I-4 Level III Ecoregions of Arizona and SEZs (Source: EPA 2007b)

FIGURE I-5 Level III Ecoregions of California and SEZs (Source: EPA 2007b)

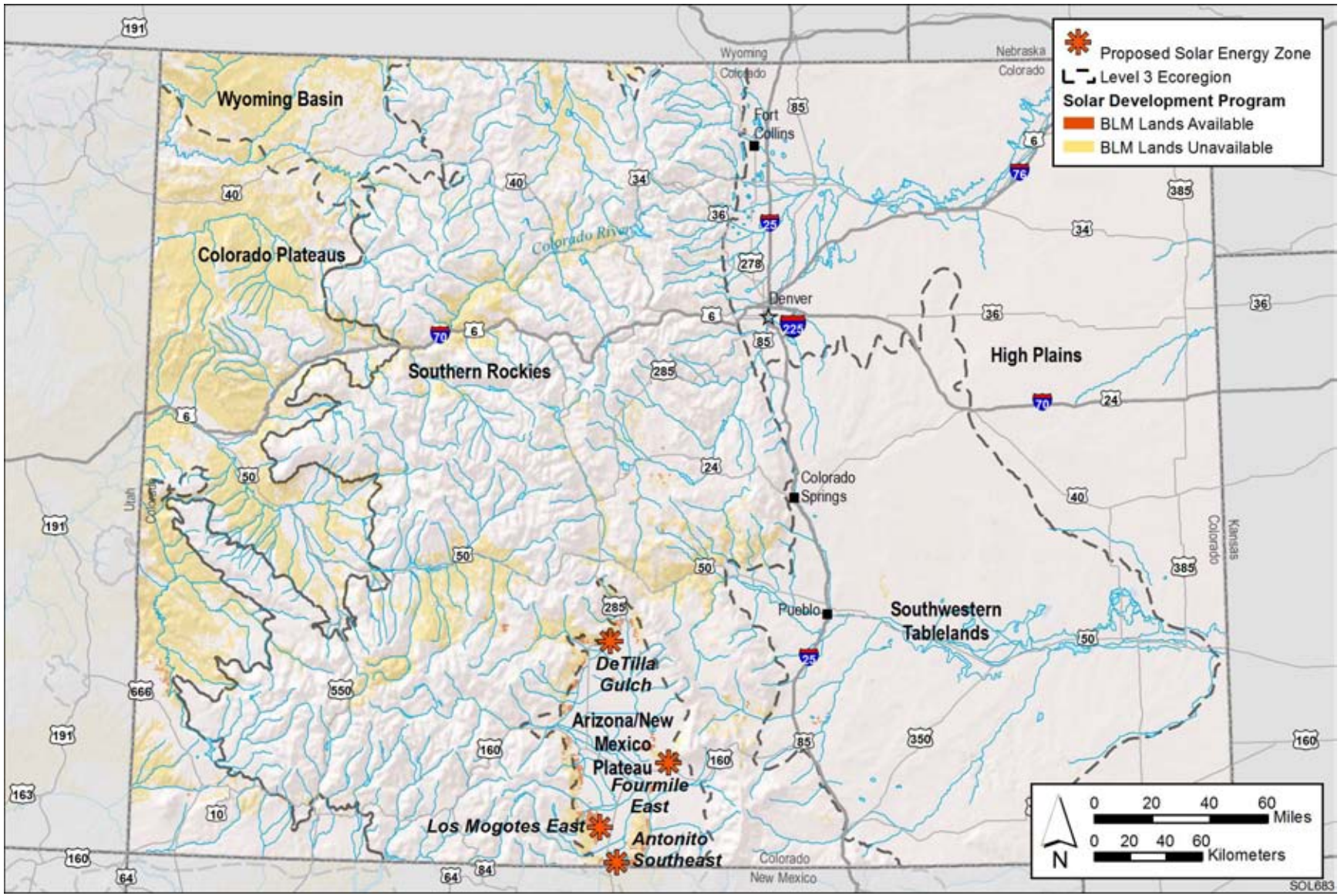

FIGURE I-6 Level III Ecoregions of Colorado and SEZs (Source: EPA 2007b)

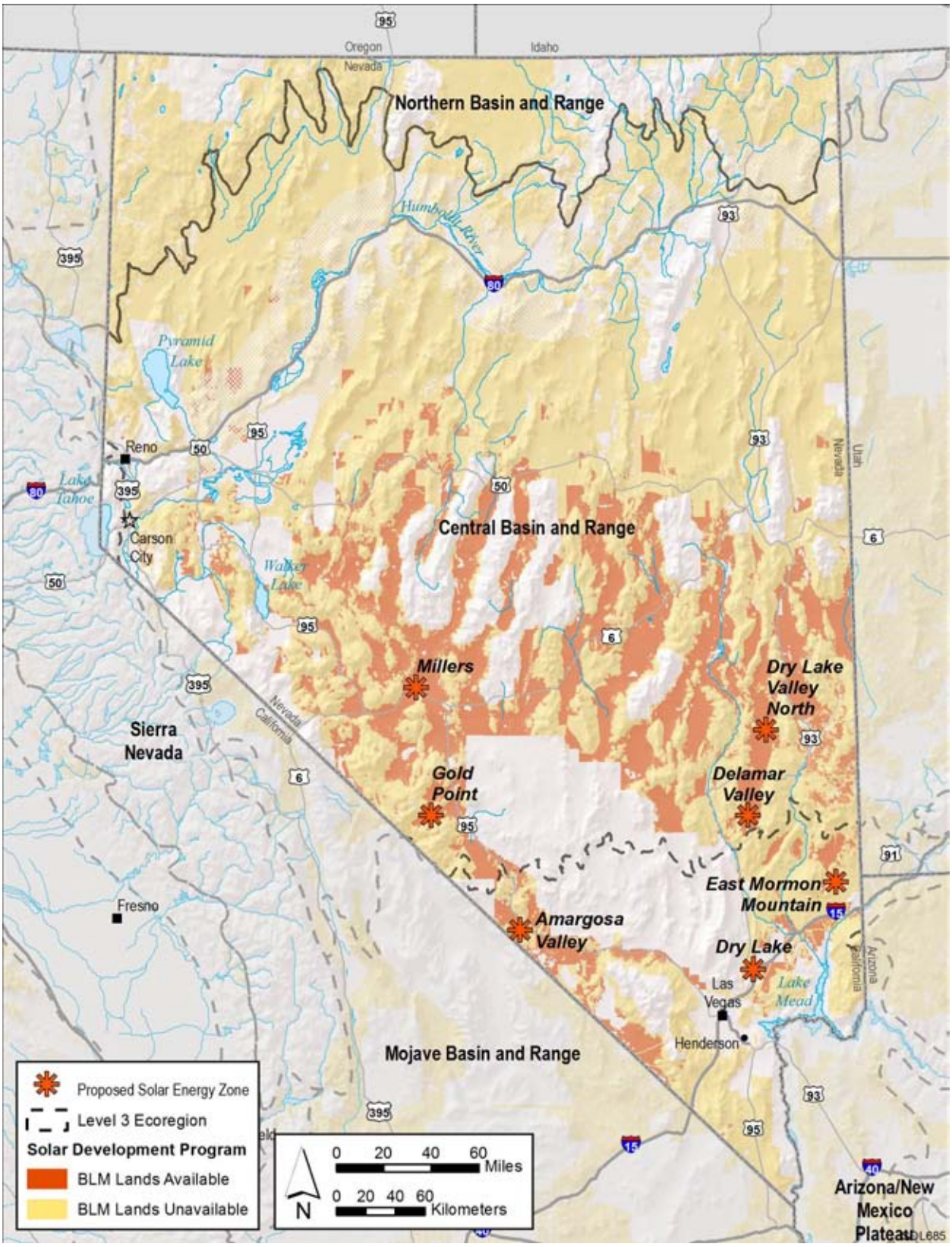

FIGURE I-7 Level III Ecoregions of Nevada and SEZs (Source: EPA 2007b)

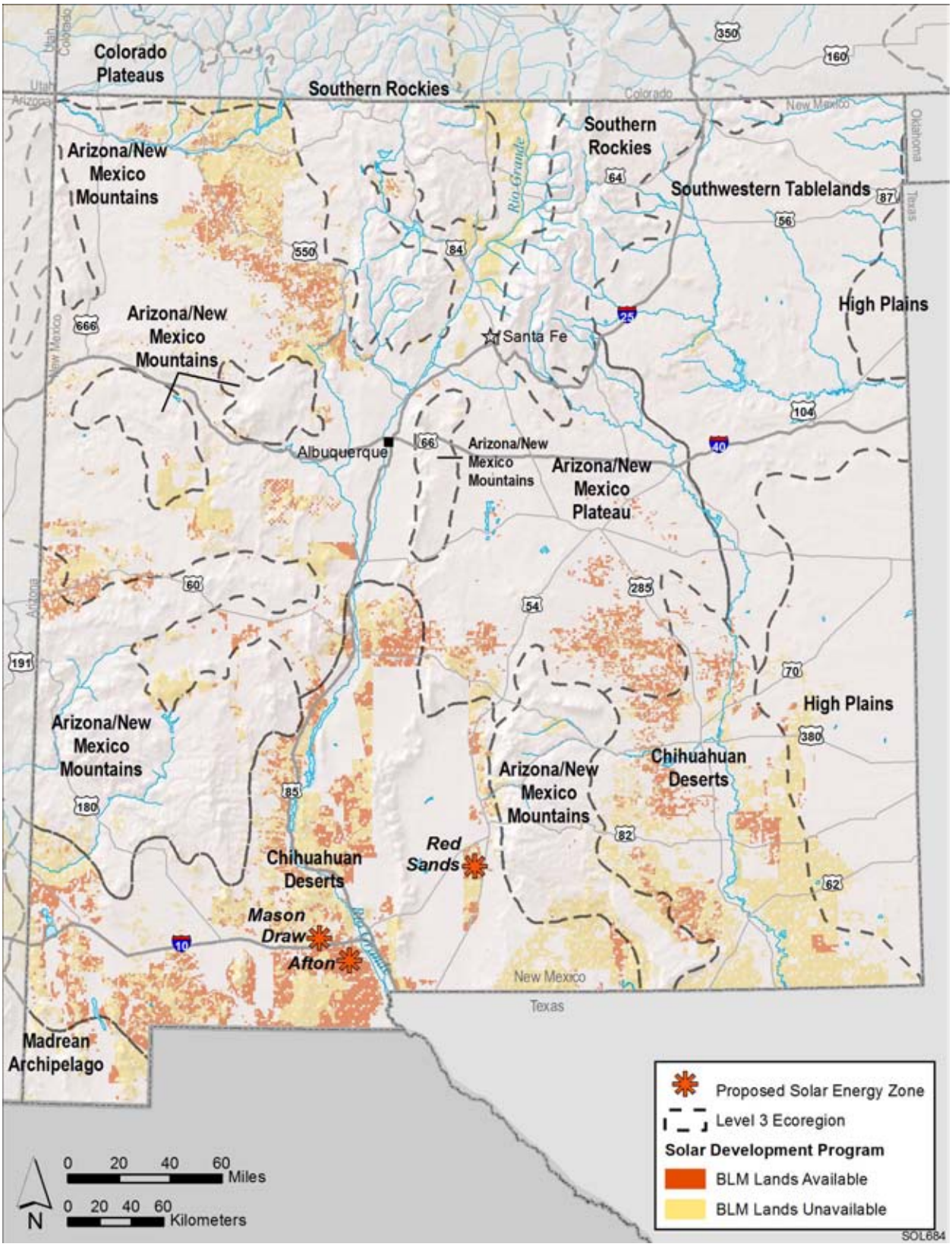

FIGURE I-8 Level III Ecoregions of New Mexico and SEZs (Source: EPA 2007b)

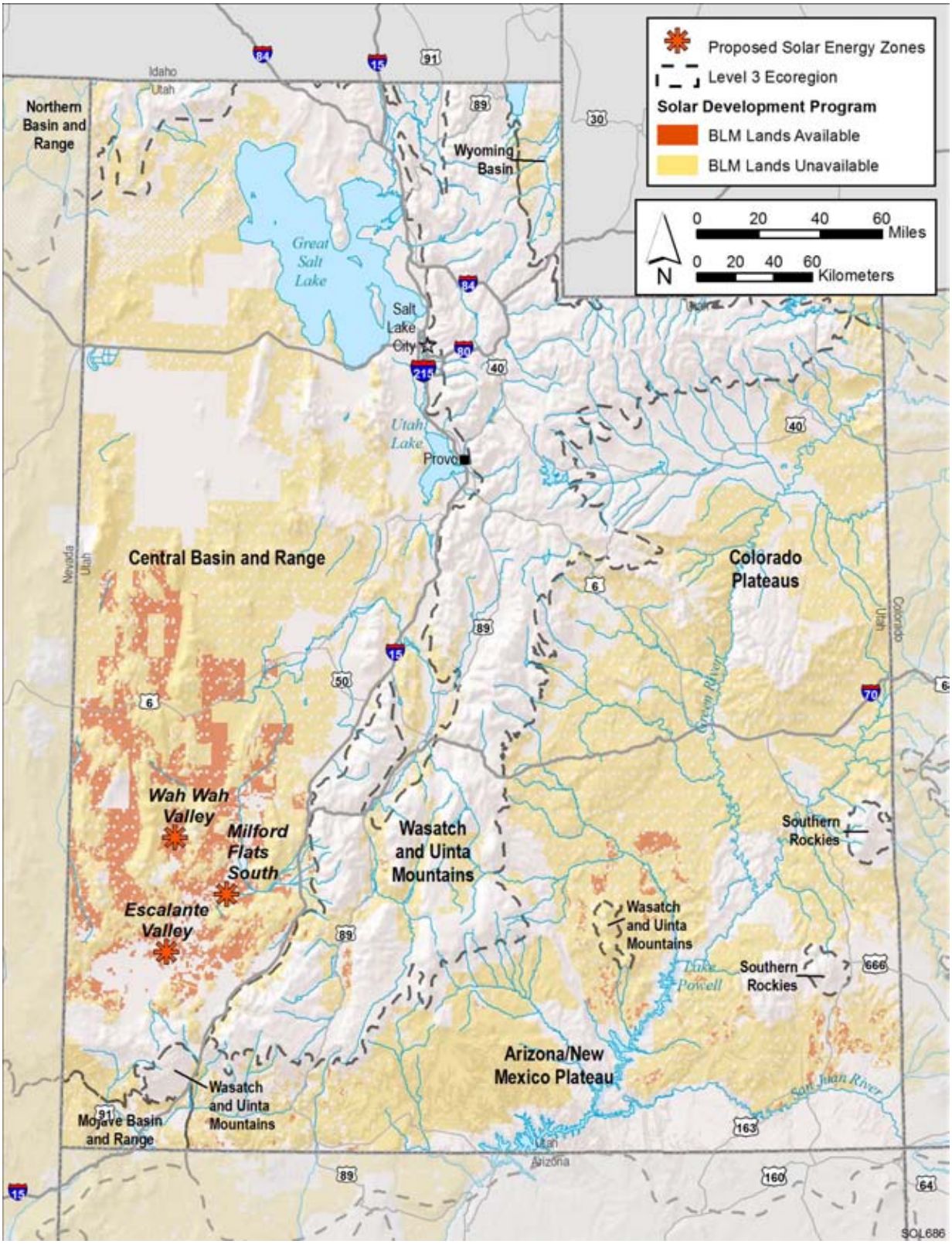

FIGURE I-9 Level II Ecoregions of Utah and SEZs (Source: EPA 2007b)

I.1.2 Cascades

The Cascades ecoregion occurs in California and extends north into Oregon and Washington. Within the six-state study area analyzed in the PEIS, the ecoregion is approximately 365,500 acres (1,479 km^2), and the elevation ranges from 2,989 to 12,747 ft (911 to 3,885 m). This mountainous ecoregion contains steep ridges and river valleys in the west and a high plateau in the east. The landscape includes westerly trending mountain ridges, steeply sloping mountains, and scattered lakes in glacial-rock basins, as well as glaciers and year-round snowfields on the highest peaks. It includes active and dormant volcanoes. The ecoregion's moist, temperate climate supports extensive coniferous forests, with subalpine meadows occurring at high elevations. Timber management and recreation are major land use activities. Neither the development program alternative nor the SEZ program alternative includes this ecoregion.

I.1.3 Sierra Nevada

The Sierra Nevada ecoregion is located almost entirely in California, except for a small portion in west–central Nevada. Within the six-state study area analyzed in the PEIS, the ecoregion is approximately 13,030,000 acres (52,729 km^2), and the elevation ranges from 827 to 13,596 ft (252 to 4,144 m). This deeply dissected ecoregion slopes gently down to the west and drops sharply on the eastern edge. The eastern portion has been strongly glaciated, and it is characterized by high mountain slopes, peaks, ridges, moraines, and lakes. Lower elevations support mostly ponderosa pine in the west and lodgepole pine in the east, with fir and spruce at higher elevations. Alpine conditions exist at the highest elevations. The Sierra Nevada ecoregion is famous for its scenic resources. In addition, its close proximity to San Francisco and other major urban areas leads to high levels of recreational use. Other land uses include logging, wildlife habitat, rangeland, and woodland grazing. The development program alternative includes 71 acres (0.29 km^2) of this ecoregion; the SEZ program alternative does not include this ecoregion.

I.1.4 Southern and Central California Chaparral and Oak Woodlands

The Southern and Central California Chaparral and Oak Woodlands ecoregion is located entirely within California and covers a sizable portion of the state. Within the six-state study area analyzed in the PEIS, the ecoregion is approximately 24,734,900 acres (100,099 km^2), and the elevation ranges from 0 to 7,166 ft (0 to 2,184 m). Open low mountains or foothills compose most of the region, with some irregular plains in the south. The ecoregion exhibits a Mediterranean climate of hot, dry summers and cool, moist winters. It supports mainly chaparral and oak woodlands vegetation. Grasslands occur at some lower elevations, and small stands of pine grow at higher elevations. Much of this region is grazed by domestic livestock; very little land has been cultivated. Numerous urban areas are found within the ecoregion, including Los Angeles, San Francisco, and San Diego. Neither the development program alternative nor the SEZ program alternative includes this ecoregion.

I.1.5 Central California Valley

The Central California Valley ecoregion is located entirely within California. Within the six-state study area analyzed in the PEIS, the ecoregion is approximately 11,368,000 acres (46,006 km^2), and the elevation ranges from 0 to 4,337 ft (0 to 1,322 m). The ecoregion is a flat, intensively farmed plain that has long, hot, dry summers and cool winters. Nearly half of the region is cropland, most of which is irrigated. The region once supported an array of prairies, oak-grass savannas, desert grasslands, riparian woodlots, and wetlands; however, human activities have affected most of the native plant communities (Olson and Cox 2001). Neither the development program alternative nor the SEZ program alternative includes this ecoregion.

I.1.6 Southern California Mountains

Within the six-state study area analyzed in the PEIS, this ecoregion is approximately 4,427,900 acres (17,919 km^2), and the elevation ranges from 3 to 10,621 ft (1 to 3,237 m). The Southern California Mountains ecoregion occurs only in California. This ecoregion has a Mediterranean climate of hot, dry summers and cool, moist winters, but because of a higher elevation than adjacent ecoregions, it has slightly cooler temperatures and more moisture. Comparatively dense chaparral and oak woodlands are the predominant vegetation types, along with stands of ponderosa pine. Some grazing occurs, resulting in erosion in some areas. The development program alternative includes 439 acres (1.78 km^2) of this ecoregion; the SEZ program alternative does not include this ecoregion.

I.1.7 Eastern Cascades Slopes and Foothills

The Eastern Cascades Slopes and Foothills ecoregion is located in California and extends north into Oregon and Washington. Within the six-state study area analyzed in the PEIS, the ecoregion is approximately 5,100,000 acres (20,639 km^2), and the elevation ranges from 2,015 to 9,348 ft (614 to 2,849 m). This ecoregion, with a dry continental climate, lies in the rain shadow of the Cascade Mountains and supports open forests of ponderosa pine and some lodgepole pine. Plant communities in this ecoregion are adapted to frequent fires. Landscapes range from marshy basins to steeply sloped mountains and volcanic plateaus. The region also contains forests of white fir, sugar pine, and incense cedar; western juniper woodlands; and sagebrush steppe with low sagebrush, Wyoming big sagebrush, and bunchgrasses (Thorson et al. 2003). Important land uses include timber management, recreation, grazing, rural residential development, orchards, and cropping in valleys. Neither the development program alternative nor the SEZ program alternative includes this ecoregion.

I.1.8 Central Basin and Range

The Central Basin and Range is located in California, Nevada, and Utah. Within the six-state study area analyzed in the PEIS, this ecoregion is approximately 76,238,900 acres (308,529 km^2), and the elevation ranges from 1,106 to 13,439 ft (337 to 4,096 m), but with

large portions between 4,000 and 9,000 ft (1,219 and 2,743 m). This internally drained ecoregion is characterized by a mosaic of xeric basins, scattered mountains, and salt flats. The topography is characterized by alternating basins and northerly trending mountain ranges. Shrub and shrub/grass communities, primarily Great Basin sagebrush and saltbush-greasewood, predominate on valleys, lower slopes, and alluvial fans, while juniper-pinyon woodland, mountain brush, and scattered western spruce-fir forests occur on higher elevation mountain slopes (EPA 2002; Bryce et al. 2003; Woods et al. 2001). Extensive, nearly flat alkaline or saline playas occur in this ecoregion, and tule marshes occur locally, especially along the Great Salt Lake (Bryce et al. 2003; Woods et al. 2001). The region is generally very sparsely populated but has some large urban areas on its periphery, including Carson City and Reno to the west and Salt Lake City to the northeast. Important land uses include rangeland, wildlife habitat, recreation, military reservations, logging, mining, and some irrigated farming. The development program alternative includes 10,274,956 acres (41,581.3 km^2) of this ecoregion; the SEZ program alternative includes 134,215 acres (543.149 km^2).

I.1.9 Mojave Basin and Range

The Mojave Basin and Range ecoregion is located in Arizona, California, Nevada, and Utah. Within the six-state study area analyzed in the PEIS, this ecoregion is approximately 32,024,200 acres (129,598 km^2) in size, and the elevation ranges from –243 ft (–74 m) in Death Valley, California, to 10,909 ft (3,325 m). It has a warm, temperate climate with little precipitation and includes the Mojave Desert and scattered mountains (Holland et al. 2001; EPA 2002). The ecoregion is rich in endemic ephemeral plants. Creosotebush shrubland is the predominant natural vegetation. Mesquite, creosotebush, allscale, brittlebush, desert holly, and sagebrush are dominant species at low elevations (Holland et al. 2001); big sagebrush, blackbrush, Mormon tea, yellowbrush, galleta, Indian ricegrass, cheatgrass, and cholla are dominant at elevations of 3,000 to 5,000 ft (900 to 2,000 m); and pinyon, juniper, and oak woodlots dominate at elevations of 4,000 to 7,000 ft (1,000 to 2,000 m) (Woods et al. 2001; Bryce et al. 2003). The ecoregion includes the urban area of Las Vegas. Important land uses include rangeland, wildlife habitat, urban development, military bases, recreation, gravel operations, some pastureland, and some cropland. The development program alternative includes 2,547,519 acres (10,309.45 km^2) of this ecoregion; the SEZ program alternative includes 84,974 acres (343.88 km^2).

I.1.10 Wyoming Basin

The Wyoming Basin ecoregion occurs in Colorado and Utah, and it extends north into Wyoming, Idaho, and Montana. Within the six-state study area analyzed in the PEIS, the ecoregion is approximately 2,823,200 acres (11,425 km^2), and the elevation ranges from 5,942 to 9,538 ft (1,811 to 2,907 m). This ecoregion is a broad intermountain basin with rolling plains, mesas, terraces, scattered high hills, and low mountains (Chapman et al. 2006; Woods et al. 2001). The dominant vegetation types are arid grasslands and shrublands supporting bunchgrasses and sagebrush. Well-drained alluvial fans and foothills support sagebrush grasslands (Chapman et al. 2006). Wetlands supporting sedges, rushes, cattails,

and marsh grasses occur in poorly drained floodplains, alluvial fans, and terraces (Woods et al. 2001). Important land uses include oil and gas production, coal mining, grazing, and some irrigated farming. Neither the development program alternative nor the SEZ program alternative includes this ecoregion.

I.1.11 Wasatch and Uinta Mountains

The Wasatch and Uinta Mountains ecoregion occurs primarily in Utah and extends into Wyoming and Idaho. Within the six-state study area analyzed in the PEIS, the ecoregion is approximately 10,759,000 acres (43,539 km^2), and the elevation ranges from 3,645 to 12,921 ft (1,111 to 3,938 m). This ecoregion is composed of high mountains with narrow crests and valleys, bordered in some areas by dissected plateaus and open high mountains. Lower elevation semiarid foothills support pinyon-juniper woodlands, mountain mahogany-oak scrub, and maple-oak scrub; middle elevations support Douglas-fir forests, aspen parklands, ponderosa pine, and lodgepole pine; and Engelmann spruce, lodgepole pine, and subalpine fir occur at higher elevations (Woods et al. 2001). Alpine meadows are present above 11,000 ft (3,400 m). Land uses include timber production, seasonal range and livestock grazing, recreation, wildlife habitat, and oil production, with some irrigated farming in mountain valleys. The development program alternative includes 19,551 acres (79.120 km^2) of this ecoregion; the SEZ program alternative does not include this ecoregion.

I.1.12 Colorado Plateaus

The Colorado Plateaus ecoregion is located in Arizona, Colorado, and Utah, with a small portion in New Mexico. Within the six-state study area analyzed in the PEIS, this ecoregion is approximately 32,581,700 acres (131,854 km^2), and the elevation ranges from 3,284 to 10,204 ft (1,001 to 3,110 m). This ecoregion is characterized by a rugged tableland topography, with large basins, ridges, spectacular canyons, and colorful geological formations. The ecoregion is heavily visited for recreational purposes. The higher elevations support extensive pinyon-juniper woodlands. Groundcover in these woodlands is sparse and consists of grama and other grasses, forbs, and shrubs, such as big sagebrush and alderleaf cercocarpus (Primm 2001). Lower areas contain saltbrush-greasewood shrublands, typical of hotter, drier areas. Land uses include livestock, some irrigated farming, recreation, mining, and gas and oil production. The development program alternative includes 1,165,623 acres (4717.112 km^2) of this ecoregion; the SEZ program alternative does not include this ecoregion.

I.1.13 Southern Rockies

The Southern Rockies ecoregion is located in Colorado, New Mexico, and Utah, and extends into Wyoming. Within the six-state study area analyzed in the PEIS, this ecoregion is approximately 31,878,000 acres (129,006 km^2), and the elevation ranges from 5,187 to 13,777 ft (1,581 to 4,199 m). The ecoregion is characterized by high, steep, rugged mountains. Coniferous forest covers much of the region. The lowest elevations are generally grass- or shrub-covered.

Low to middle elevations support a variety of vegetation, including Douglas-fir, ponderosa pine, aspen, and juniper-oak woodlands. Middle to high elevations are predominantly coniferous forest. The highest elevations have alpine characteristics. Important land uses include timber management, recreation, hunting, wildlife habitat, grazing, mining, and oil production. The development program alternative includes 19,327 acres (78.214 km^2) of this ecoregion; the SEZ program alternative does not include this ecoregion

I.1.14 Arizona/New Mexico Plateau

The Arizona/New Mexico Plateau occurs primarily in Arizona, Colorado, and New Mexico, with a small portion in Nevada. Within the six-state study area analyzed in the PEIS, this ecoregion is approximately 45,870,500 acres (185,632 km^2), and the elevation ranges from 2,165 to 11,949 ft (660 to 3,642 m). The ecoregion's landscapes include low mountains, hills, mesas, foothills, irregular plains, alkaline basins, some sand dunes, and wetlands. This ecoregion is a large transitional region between the semiarid grasslands to the east, the drier shrublands and woodlands to the north, and the lower, hotter, less vegetated areas to the west and south. Vegetation communities include shrublands with big sagebrush, rabbitbrush, winterfat, shadscale saltbush, and greasewood; and grasslands of blue grama, western wheatgrass, green needlegrass, and needle-and-thread grass (Chapman et al. 2006). Higher elevations may support pinyon pine and juniper forests. San Luis Lake is fed by regional groundwater and mountain streams. In Colorado, a high water table supports numerous ephemeral lakes, wetlands, springs, and flowing wells (Chapman et al. 2006). The ecoregion includes the urban areas of Santa Fe and Albuquerque. Important land uses include irrigated farming, recreation, rangeland, wildlife habitat, and some natural gas production. The development program alternative includes 2,038,581 acres (8,249.851 km^2) of this ecoregion; the SEZ program alternative includes 21,050 acres (85.186 km^2).

I.1.15 Arizona/New Mexico Mountains

The Arizona/New Mexico Mountains ecoregion occurs in Arizona and New Mexico. Within the six-state study area analyzed in the PEIS, this ecoregion is approximately 26,782,700 acres (108,386 km^2), and the elevation ranges from 1,572 to 11,562 ft (479 to 3,524 m). It is characterized by low-elevation mountains that support vegetation indicative of dry, warm environments. Chaparral is common on lower elevations, while pinyon-juniper and oak woodlands are found on the lower and middle elevations. Open-to-dense ponderosa pine forests predominate at higher elevations, with forests of spruce, fir, and Douglas-fir in a few high-elevation areas. The ecoregion includes the urban area of Flagstaff, Arizona. Important land uses include timber production, livestock grazing, wildlife habitat, military use, and recreation. The development program alternative includes 160,550 acres (649.723 km^2) of this ecoregion; the SEZ program alternative does not include this ecoregion.

I.1.16 Chihuahuan Deserts

The Chihuahuan Deserts ecoregion occurs in Arizona and New Mexico. Within the six-state study area analyzed in the PEIS, this ecoregion is approximately 19,108,000 acres (77,329 km^2), and the elevation ranges from 2,854 to 8,038 ft (870 m to 2,450 m). The broad basins and valleys of this ecoregion are bordered by sloping alluvial fans and terraces. The central and western parts of the region contain isolated mesas and mountains. Arid grassland and shrubland are the predominant vegetation types. The higher mountains, however, support oak-juniper woodlands. Important land uses include grazing, ranching, recreation, wildlife habitat, military reservations, and mining. The development program alternative includes 2,624,166 acres (10,619.63 km^2) of this ecoregion; the SEZ program alternative includes 113,052 acres (457.506 km^2).

I.1.17 High Plains

The High Plains ecoregion occurs in Colorado and New Mexico and extends north into Wyoming. Within the six-state study area analyzed in the PEIS, this ecoregion is approximately 22,586,000 acres (91,404 km^2), and the elevation ranges from 2,979 to 6,992 ft (908 to 2,131 m). This ecoregion consists of smooth to slightly irregular plains. Blue grama-buffalo grass prairies dominate the natural vegetation in this region, which also includes sandsage prairie with sand sagebrush, rabbitbrush, sand bluestem, prairie sandreed, and Indian ricegrass (Chapman et al. 2006). Also occurring are bluestem-grama prairie and wheatgrass-bluestem-needlegrass prairie (Cook et al. 2001). Much of this ecoregion comprises cropland. The ecoregion includes the Denver, Colorado urban area. Other important land uses include grazing, oil and gas production, and gravel mining. The development program alternative includes 18,695 acres (75.656 km^2) of this ecoregion; the SEZ program alternative does not include this ecoregion.

I.1.18 Southwestern Tablelands

The Southwestern Tablelands ecoregion is located in Colorado and New Mexico. Within the six-state study area analyzed in the PEIS, this ecoregion is approximately 21,610,000 acres (87,453 km^2), and the elevation ranges from 3,399 to 8,432 ft (1,036 to 2,570 m). This ecoregion is an elevated tableland that supports subhumid grassland and semiarid rangeland. The natural vegetation in this ecoregion is grama-buffalo grass, with mesquite-buffalo grass also occurring in the southeast portion. Midgrass prairie and open, low shrubs occur along the Canadian River. Juniper-scrub oak-grass savanna occurs on escarpment bluffs (Chapman et al. 2006). This ecoregion includes the urban area of Pueblo, Colorado. Land uses include grazing, dry and irrigated farming, and wildlife habitat, with increasing urban and residential development in some areas. The development program alternative includes 4,741 acres (19.19 km^2) of this ecoregion; the SEZ program alternative does not include this ecoregion.

I.1.19 Klamath Mountains

The Klamath Mountains ecoregion occurs in California and extends north into Oregon. Within the six-state study area analyzed in the PEIS, this ecoregion is approximately 8,131,500 acres (32,907 km^2), and the elevation ranges from 577 to 8,268 ft (176 to 2,520 m). This ecoregion is physically and biologically diverse, with highly dissected, folded mountains; foothills; terraces; and floodplains. The vegetation is a mosaic of conifers and hardwoods. The valleys and foothills support grassland-savanna and grasslands with bunchgrass and wheatgrass, oak woodlands, oak savanna, Douglas-fir, ponderosa pine, madrone, and incense cedar (Thorson et al. 2003). Forests composed of tanoak, Douglas-fir, port orford cedar, and madrone occur on mountain areas. Seasonal ponds occur on mesa tops. Land uses include logging, grazing, crop and tree fruit production, recreation, rural residential development, mining, and some commercial development. Neither the development program alternative nor the SEZ program alternative includes this ecoregion.

I.1.20 Madrean Archipelago

The Madrean Archipelago ecoregion occurs in Arizona and New Mexico. Within the six-state study area analyzed in the PEIS, this ecoregion is approximately 10,342,000 acres (41,851 km^2), and the elevation ranges from 2,129 to 10,250 ft (649 to 3,124 m). It consists of basins and ranges with medium to high local relief. Native vegetation in the basins is mostly grama-tobosa shrub-steppe. Oak-juniper woodland is the dominant vegetation type on the ranges; however, ponderosa pine is predominant at higher elevations. Land uses include livestock grazing, wildlife habitat, and some mining. The development program alternative includes 557,368 acres (2,255.59 km^2) of this ecoregion; the SEZ program alternative does not include this ecoregion.

I.1.21 Northern Basin and Range

The Northern Basin and Range ecoregion occurs in California, Nevada, and Utah, and it extends into Idaho and Oregon. Within the six-state study area analyzed in the PEIS, this ecoregion is approximately 11,323,000 acres (45,824 km^2), and the elevation ranges from 4,200 to 9,961 ft (1,280 to 3,036 m). Landscapes include dissected lava plains, valleys, rocky uplands, rolling hills, alluvial fans, and scattered mountain ranges. Valleys and other mountainless areas support sagebrush steppe or saltbush communities, while juniper woodlands occur on rugged, stony uplands (Bryce et al. 2003; Woods et al. 2001). Some areas of sagebrush steppe support scattered ephemeral pools. Wetland communities of sedges, rushes, and marsh grasses; playas; and lakes also occur in this ecoregion. The dominant species on ranges at lower and middle elevations are Wyoming big sagebrush, black sagebrush, and cool season grasses, such as bluebunch wheatgrass and Idaho fescue. Douglas-fir, subalpine fir, mountain brush, and aspen groves are common at higher elevations, along with black sagebrush or mountain sagebrush, with open grassland on some ridge tops. Livestock grazing, recreation, mining, and wildlife habitat are important land uses, and there is some farming. Neither the development program alternative nor the SEZ program alternative includes this ecoregion.

I.1.22 Sonoran Basin and Range

The Sonoran Basin and Range ecoregion occurs in Arizona, California, and New Mexico. Within the six-state study area analyzed in the PEIS, this ecoregion is approximately 28,875,100 acres (116,854 km^2), and the elevation ranges from –243 to 6,569 ft (–74 to 2,002 m). This ecoregion includes the Sonoran Desert and scattered low mountains. The climate is slightly hotter than the Mojave Desert to the north. The potential natural vegetation of this arid ecoregion is predominantly creosotebush-bur sage with large areas of palo verde–cactus shrub and giant saguaro cactus. Land uses include grazing, agriculture, mining, and recreation. The development program alternative includes 3,140,682 acres (12,709.9 km^2) of this ecoregion; the SEZ program alternative includes 324,127 acres (1,311.70 km^2).

I.2 LAND COVER TYPES WITHIN THE POTENTIALLY AFFECTED AREAS OF THE PROPOSED SEZS

Land cover types, described and mapped under the Southwest Regional Gap Analysis Project, were used to evaluate plant communities in and near the SEZs. The following land cover descriptions are from USGS (2005).

Agriculture

An aggregated landcover type that includes both Pasture/Hay: areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle, where pasture/hay vegetation accounts for greater than 20 percent of total vegetation, and Cultivated Crops: areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards, where crop vegetation accounts for greater than 20 percent of total vegetation. Includes all land being actively tilled.

Apacherian-Chihuahuan Mesquite Upland Scrub

This ecological system occurs as upland shrublands that are concentrated in the extensive grassland-shrubland transition in foothills and piedmont in the Chihuahuan Desert. It extends into the Sky Island region to the west and the Edwards Plateau to the east. Substrates are typically derived from alluvium, often gravelly without a well-developed argillic or calcic soil horizon that would limit infiltration and storage of winter precipitation in deeper soil layers. *Prosopis* spp. and other deep-rooted shrubs exploit this deep soil moisture that is unavailable to grasses and cacti. Vegetation is typically dominated by *Prosopis glandulosa* or *Prosopis velutina* and succulents. Other desert scrub that may codominate or dominate includes *Acacia neovernicosa, Acacia constricta, Juniperus monosperma,* or *Juniperus coahuilensis*. Grass cover is typically low. During the last century, the area occupied by this system has increased through conversion of desert grasslands as a result of drought, overgrazing by livestock, and/or decreases in fire frequency. It is similar to Chihuahuan Mixed Desert and Thorn Scrub but is generally

found at higher elevations where *Larrea tridentata* and other desert scrub are not codominant. It is also similar to Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub but does not occur on eolian-deposited substrates.

Apacherian-Chihuahuan Piedmont Semi-Desert Grassland and Steppe

This ecological system is a broadly defined desert grassland, mixed shrub-succulent or xeromorphic tree savanna that is typical of the Borderlands of Arizona, New Mexico, and northern Mexico [Apacherian region] but extends west to the Sonoran Desert, north into the Mogollon Rim, and throughout much of the Chihuahuan Desert. It is found on gently sloping bajadas that supported frequent fire throughout the Sky Islands and on mesas and steeper piedmont and foothill slopes in the Chihuahuan Desert. It is characterized by typically diverse perennial grasses. Common grass species include *Bouteloua eriopoda, Bouteloua hirsuta, Bouteloua rothrockii, Bouteloua curtipendula, Bouteloua gracilis, Eragrostis intermedia, Muhlenbergia porteri, Muhlenbergia setifolia, Pleuraphis jamesii, Pleuraphis mutica,* and *Sporobolus airoides*, succulent species of *Agave, Dasylirion*, and *Yucca*, and tall-shrub/short-tree species of *Prosopis* and various oaks (e.g., *Quercus grisea, Quercus emoryi, Quercus arizonica*). Many of the historical desert grassland and savanna areas have been converted, some to Chihuahuan Mesquite Upland Scrub (*Prosopis* spp.-dominated), through intensive grazing and other land uses.

Barren Lands Non-specific

(Rock/Sand/Clay)-Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulation of earthen material. Generally, vegetation accounts for less than 15% of total cover.

Chihuahuan Creosotebush, Mixed Desert and Thorn Scrub

See Chihuahuan Mixed Desert and Thorn Scrub.

Chihuahuan Gypsophilous Grassland and Steppe

This ecological system is restricted to gypsum outcrops or sandy gypsiferous and/or often alkaline soils that occur in basins and slopes in the Chihuahuan Desert. Elevation range is from 1100-2000 m. These typically sparse grasslands, steppes, or dwarf-shrublands are dominated by a variety of gypsophilous plants, many of which are endemic to these habitats. Characteristic species include *Tiquilia hispidissima, Atriplex canescens, Calylophus hartwegii, Ephedra torreyana, Frankenia jamesii, Bouteloua breviseta, Mentzelia perennis, Nama carnosum, Calylophus hartwegii* (= *Oenothera hartwegii*), *Selinocarpus lanceolatus, Sporobolus nealleyi, Sporobolus airoides,* and *Sartwellia flaveriae*. This system does not include the sparsely

vegetated gypsum dunes that are included in North American Warm Desert Active and Stabilized Dune.

Chihuahuan Mixed Desert and Thorn Scrub

This widespread Chihuahuan Desert land cover type is composed of two ecological systems the Chihuahuan Creosotebush Xeric Basin Desert Scrub and the Chihuahuan Mixed Desert and Thorn Scrub. This cover type includes xeric creosotebush basins and plains and the mixed desert scrub in the foothill transition zone above, sometimes extending up to the lower montane woodlands. Vegetation is characterized by *Larrea tridentata* alone or mixed with thornscrub and other desert scrub such as *Agave lechuguilla, Aloysia wrightii, Fouquieria splendens, Dasylirion leiophyllum, Flourensia cernua, Leucophyllum minus, Mimosa aculeaticarpa* var. *biuncifera, Mortonia scabrella* (= *Mortonia sempervirens* ssp. *scabrella*), *Opuntia engelmannii, Parthenium incanum, Prosopis glandulosa,* and *Tiquilia greggii*. Stands of *Acacia constricta, Acacia neovernicosa,* or *Acacia greggii*-dominated thornscrub are included in this system, and limestone substrates appear important for at least these species. Grasses such as *Dasyochloa pulchella, Bouteloua curtipendula, Bouteloua eriopoda, Bouteloua ramosa, Muhlenbergia porteri* and *Pleuraphis mutica* may be common, but generally have lower cover than shrubs.

Chihuahuan Mixed Salt Desert Scrub

This system includes extensive open-canopied shrublands of typically saline basins in the Chihuahuan Desert. Stands often occur on alluvial flats and around playas. Substrates are generally fine-textured, saline soils. Vegetation is typically composed of one or more *Atriplex* species such as *Atriplex canescens, Atriplex obovata*, or *Atriplex polycarpa* along with species of *Allenrolfea, Flourensia, Salicornia, Suaeda*, or other halophytic plants. Graminoid species may include *Sporobolus airoides, Pleuraphis mutica*, or *Distichlis spicata* at varying densities.

Chihuahuan Sandy Plains Semi-Desert Grassland

This ecological system occurs across the Chihuahuan Desert and extends into the southern Great Plains where soils have a high sand content. These dry grasslands or steppe are found on sandy plains and sandstone mesas. The graminoid layer is dominated or codominated by *Achnatherum hymenoides, Bouteloua eriopoda, Bouteloua hirsuta, Hesperostipa neomexicana, Pleuraphis jamesii, Sporobolus cryptandrus, Sporobolus airoides,* or *Sporobolus flexuosus*. Typically, there are found scattered desert shrubs and stem succulents such as *Ephedra torreyana, Ephedra trifurca, Fallugia paradoxa, Prosopis glandulosa, Yucca elata,* and *Yucca torreyi* that are characteristic of the Chihuahuan Desert.

Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub

This ecological system includes the open shrublands of vegetated coppice dunes and sandsheets found in the Chihuahuan Desert. Usually dominated by *Prosopis glandulosa* but includes *Atriplex canescens, Ephedra torreyana, Ephedra trifurca, Poliomintha incana*, and *Rhus microphylla* coppice sand scrub with 10–30% total vegetation cover. *Yucca elata, Gutierrezia sarothrae,* and *Sporobolus flexuosus* are commonly present.

Chihuahuan Succulent Desert Scrub

This ecological system is found in the Chihuahuan Desert on colluvial slopes, upper bajadas, sideslopes, ridges, canyons, hills, and mesas. Sites are hot and dry. Gravel and rock are often abundant on the ground surface. The vegetation is characterized by the relatively high cover of succulent species such as *Agave lechuguilla, Euphorbia antisyphilitica, Fouquieria splendens, Ferocactus* spp*., Opuntia engelmannii, Opuntia imbricata, Opuntia spinosior, Yucca baccata*, and many others. Perennial grass cover is generally low. The abundance of succulents is diagnostic of this desert scrub system, but desert shrubs are usually present. This system does not include desert grasslands or shrub-steppe with a strong cacti component.

Colorado Plateau Mixed Bedrock Canyon and Tableland

The distribution of this ecological system is centered on the Colorado Plateau where it is comprised of barren and sparsely vegetated landscapes (generally <10% plant cover) of steep cliff faces, narrow canyons, and open tablelands of predominantly sedimentary rocks, such as sandstone, shale, and limestone. Some eroding shale layers similar to Inter-Mountain Basins Shale Badland may be interbedded between the harder rocks. The vegetation is characterized by very open tree canopy or scattered trees and shrubs with a sparse herbaceous layer. Common species include *Pinus edulis, Pinus ponderosa, Juniperus* spp*., Cercocarpus intricatus*, and other short-shrub and herbaceous species, utilizing moisture from cracks and pockets where soil accumulates.

Colorado Plateau Mixed Low Sagebrush Shrubland

This ecological system occurs in the Colorado Plateau, Tavaputs Plateau, and Uinta Basin in canyons, gravelly draws, hilltops, and dry flats at elevations generally below 1800 m. Soils are often rocky, shallow, and alkaline. This type extends across northern New Mexico into the southern Great Plains on limestone hills. It includes open shrublands and steppe dominated by *Artemisia nova* or *Artemisia bigelovii* sometimes with *Artemisia tridentata* ssp. *wyomingensis* codominant. Semi-arid grasses such as *Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii,* or *Poa fendleriana* are often present and may form a graminoid layer with over 25% cover.

Colorado Plateau Pinyon-Juniper Woodland

This ecological system occurs in dry mountains and foothills of the Colorado Plateau region including the Western Slope of Colorado to the Wasatch Range, south to the Mogollon Rim, and east into the northwestern corner of New Mexico. It is typically found at lower elevations ranging from 1500–2440 m. These woodlands occur on warm, dry sites on mountain slopes, mesas, plateaus, and ridges. Severe climatic events occurring during the growing season, such as frosts and drought, are thought to limit the distribution of pinyon-juniper woodlands to relatively narrow altitudinal belts on mountainsides. Soils supporting this system vary in texture ranging from stony, cobbly, gravelly, sandy loams to clay loam or clay. *Pinus edulis* and/or *Juniperus osteosperma* dominate the tree canopy. In the southern portion of the Colorado Plateau in northern Arizona and northwestern New Mexico, *Juniperus monosperma* and hybrids of *Juniperus* spp may dominate or codominate the tree canopy. *Juniperus scopulorum* may codominate or replace *Juniperus osteosperma* at higher elevations. Understory layers are variable and may be dominated by shrubs, graminoids, or be absent. Associated species include *Arctostaphylos patula, Artemisia tridentata, Cercocarpus intricatus, Cercocarpus montanus, Coleogyne ramosissima, Purshia stansburiana, Purshia tridentata, Quercus gambelii, Bouteloua gracilis, Pleuraphis jamesii,* or *Poa fendleriana*. This system occurs at higher elevations than Great Basin Pinyon-Juniper Woodland and Colorado Plateau shrubland systems where sympatric.

Developed, Medium–High Intensity

Developed, Medium Intensity: Includes areas with a mixture of constructed materials and vegetation. Impervious surface accounts for 50–79% of the total cover. These areas most commonly include single-family housing units. Developed, High Intensity: Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to 100% of the total cover.

Developed, Open Space–Low Intensity

Open Space: Includes areas with a mixture of some construction materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes. Developed, Low Intensity: Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20–49% of total cover. These areas most commonly include single-family housing units.

This system occurs in mountain ranges of the Great Basin and along the eastern slope of the Sierra Nevada within a broad elevation range from about 1220 m (4000 feet) to over 2135 m (7000 feet). This system often occurs as a mosaic of multiple communities that are tree-dominated with a diverse shrub component. The variety of plant associations connected to this system reflects elevation, stream gradient, floodplain width, and flooding events. Dominant trees may include *Abies concolor, Alnus incana, Betula occidentalis, Populus angustifolia, Populus balsamifera ssp. trichocarpa, Populus fremontii, Salix laevigata, Salix gooddingii,* and *Pseudotsuga menziesii*. Dominant shrubs include *Artemisia cana, Cornus sericea, Salix exigua, Salix lasiolepis, Salix lemmonii,* or *Salix lutea*. Herbaceous layers are often dominated by species of *Carex* and *Juncus*, and perennial grasses and mesic forbs such *Deschampsia caespitosa, Elymus trachycaulus, Glyceria striata, Iris missouriensis, Maianthemum stellatum,* or *Thalictrum fendleri*. Introduced forage species such as *Agrostis stolonifera, Poa pratensis, Phleum pratense*, and the weedy annual *Bromus tectorum* are often present in disturbed stands. These are disturbance-driven systems that require flooding, scour, and deposition for germination and maintenance. Livestock grazing is a major influence in altering structure, composition, and function of the community.

Great Basin Pinyon-Juniper Woodland

This ecological system occurs on dry mountain ranges of the Great Basin region and eastern foothills of the Sierra Nevada. It is typically found at lower elevations ranging from 1600-2600 m. These woodlands occur on warm, dry sites on mountain slopes, mesas, plateaus, and ridges. Severe climatic events occurring during the growing season, such as frosts and drought, are thought to limit the distribution of pinyon-juniper woodlands to relatively narrow altitudinal belts on mountainsides. Woodlands dominated by a mix of *Pinus monophylla* and *Juniperus osteosperma*, pure or nearly pure occurrences of *Pinus monophylla*, or woodlands dominated solely by *Juniperus osteosperma* comprise this system. *Cercocarpus ledifolius* is a common associate. Understory layers are variable. Associated species include shrubs such as *Arctostaphylos patula, Artemisia arbuscula, Artemisia nova, Artemisia tridentata, Cercocarpus ledifolius, Cercocarpus intricatus, Coleogyne ramosissima, Quercus gambelii, Quercus turbinella*, and bunch grasses *Hesperostipa comata, Festuca idahoensis, Pseudoroegneria spicata, Leymus cinereus* (= *Elymus cinereus*), and *Poa fendleriana*. This system occurs at lower elevations than Colorado Plateau Pinyon-Juniper Woodland where sympatric.

Great Basin Xeric Mixed Sagebrush Shrubland

This ecological system occurs in the Great Basin on dry flats and plains, alluvial fans, rolling hills, rocky hillslopes, saddles and ridges at elevations between 1000 and 2600 m. Sites are dry, often exposed to desiccating winds, with typically shallow, rocky, non-saline soils. Shrublands are dominated by Artemisia nova (mid and low elevations), *Artemisia arbuscula* (higher elevation), and may be codominated by *Artemisia tridentata* ssp. *wyomingensis* or *Chrysothamnus viscidiflorus*. Other shrubs that may be present include A*triplex confertifolia, Ephedra* spp., *Ericameria* spp., *Grayia spinosa, Lycium shockleyi, Picrothamnus desertorum, Sarcobatus vermiculatus,* and *Tetradymia* spp. The herbaceous layer is likely sparse and

composed of perennial bunch grasses such as *Achnatherum hymenoides, Achnatherum speciosum, Achnatherum thurberianum, Elymus elymoides,* or *Poa secunda*.

Hay/Pasture, Cultivated Crops

See Agriculture.

Inter-Mountain Basins Active and Stabilized Dune

This ecological system occurs in Intermountain West basins and is composed of unvegetated to moderately vegetated (<10–30% plant cover) active and stabilized dunes and sandsheets. Species occupying these environments are often adapted to shifting, coarse-textured substrates (usually quartz sand) and form patchy or open grasslands, shrublands or steppe composed of *Achnatherum hymenoides, Artemisia filifolia, Artemisia tridentata* ssp*. tridentata, Atriplex canescens, Ephedra* spp*., Coleogyne ramosissima, Ericameria nauseosa, Leymus flavescens, Prunus virginiana, Psoralidium lanceolatum, Purshia tridentata, Sporobolus airoides, Tetradymia tetrameres,* or *Tiquilia* spp.

Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland

This ecological system occurs on montane slopes and plateaus in Utah, western Colorado, northern Arizona, eastern Nevada, southern Idaho and western Wyoming. Elevations range from 1700 to 2800 m. Occurrences are typically on gentle to steep slopes on any aspect but are often found on clay-rich soils in intermontane valleys. Soils are derived from alluvium, colluvium, and residuum from a variety of parent materials but most typically occur on sedimentary rocks. The tree canopy is composed of a mix of deciduous and coniferous species, codominated by *Populus tremuloides* and conifers, including *Pseudotsuga menziesii, Abies concolor, Abies lasiocarpa, Picea engelmannii, Picea pungens, Pinus contorta, Pinus flexilis,* and *Pinus ponderosa*. As the occurrences age, *Populus tremuloides* is slowly reduced until the conifer species become dominant. Common shrubs include *Amelanchier alnifolia, Prunus virginiana, Acer grandidentatum, Symphoricarpos oreophilus, Juniperus communis, Paxistima myrsinites, Rosa woodsii, Spiraea betulifolia, Symphoricarpos albus, or Mahonia repens*. Herbaceous species include *Bromus carinatus, Calamagrostis rubescens, Carex geyeri, Elymus glaucus, Poa* spp*.,* and *Achnatherum, Hesperostipa, Nassella*, and/or *Piptochaetium* spp. (= *Stipa* spp.), *Achillea millefolium, Arnica cordifolia, Asteraceae* spp*., Erigeron* spp*., Galium boreale, Geranium viscosissimum, Lathyrus* spp*., Lupinus argenteus, Mertensia arizonica, Mertensia lanceolata, Maianthemum stellatum, Osmorhiza berteroi* (= *Osmorhiza chilensis*), and *Thalictrum fendleri*. Most occurrences at present represent a late-seral stage of aspen changing to a pure conifer occurrence. Nearly a hundred years of fire suppression and livestock grazing have converted much of the pure aspen occurrences to the present-day aspen-conifer forest and woodland ecological system.

In order to capture important habitat characteristics of an aspen-mixed conifer ecological system for vertebrate habitat modeling, SW ReGAP land cover mappers mapped patches of aspen-mixed conifer stands outside its normal range into the Southern Rocky Mountains. In the Southern Rocky Mountains, this system occurs as small to large patches of aspenmixed conifer woodland that could also be interpreted as seral stands within several Rocky Mountain conifer forest and woodland systems including: Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland, Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland, Rocky Mountain Lodgepole Pine Forest, Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland, Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland, and Rocky Mountain Ponderosa Pine Woodland.

Inter-Mountain Basins Big Sagebrush Shrubland

This ecological system occurs throughout much of the western United States, typically in broad basins between mountain ranges, plains and foothills between 1500 and 2300 m elevation. Soils are typically deep, well-drained, and non-saline. These shrublands are dominated by *Artemisia tridentata* ssp. *tridentata* and/or *Artemisia tridentata* ssp. *wyomingensis*. Scattered *Juniperus* spp., *Sarcobatus vermiculatus,* and *Atriplex* spp. may be present in some stands. *Ericameria nauseosa, Chrysothamnus viscidiflorus, Purshia tridentata,* or *Symphoricarpos oreophilus* may codominate disturbed stands. Perennial herbaceous components typically contribute less than 25% vegetative cover. Common graminoid species include *Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus, Festuca idahoensis, Hesperostipa comata, Leymus cinereus, Pleuraphis jamesii, Pascopyrum smithii, Poa secunda,* or *Pseudoroegneria spicata*.

Inter-Mountain Basins Big Sagebrush Steppe

This widespread matrix-forming ecological system occurs throughout much of the Columbia Plateau and northern Great Basin and Wyoming and is found at slightly higher elevations farther south. Soils are typically deep and non-saline, often with a microphytic crust. This shrub-steppe is dominated by perennial grasses and forbs (>25% cover) with *Artemisia tridentata* ssp. *tridentata, Artemisia tridentata* ssp. *xericensis, Artemisia tridentata* ssp. *wyomingensis, Artemisia tripartita* ssp. *tripartita*, and/or *Purshia tridentata* dominating or codominating the open to moderately dense (10-40% cover) shrub layer. *Atriplex confertifolia, Chrysothamnus viscidiflorus, Ericameria nauseosa, Tetradymia* spp., or *Artemisia frigida* may be common especially in disturbed stands. Associated graminoids include *Achnatherum hymenoides, Calamagrostis montanensis, Elymus lanceolatus* ssp. *lanceolatus, Festuca idahoensis, Festuca campestris, Koeleria macrantha, Poa secunda, and Pseudoroegneria spicata*. Common forbs are *Phlox hoodii, Arenaria* spp., and *Astragalus* spp. Areas with deeper soils more commonly support *Artemisia tridentata* ssp. *tridentata* but have largely been converted for other land uses. The natural fire regime of this ecological system likely maintains a patchy distribution of shrubs, so the general aspect of the vegetation is a grassland. Shrubs may increase following heavy grazing and/or with fire suppression, particularly in moist portions of the northern Columbia Plateau where it forms a landscape mosaic pattern with shallow-soil

scabland shrublands. Where fire frequency has allowed for shifts to a native grassland condition, maintained without significant shrub invasion over a 50- to 70-year interval, the area would be considered Columbia Basin Foothill and Canyon Dry Grassland.

Inter-Mountain Basins Cliff and Canyon

This ecological system is found from foothill to subalpine elevations and includes barren and sparsely vegetated landscapes (generally <10% plant cover) of steep cliff faces, narrow canyons, and smaller rock outcrops of various igneous, sedimentary, and metamorphic bedrock types. Also included is vegetation of unstable scree and talus slopes that typically occurs below cliff faces. Widely scattered trees and shrubs may include *Abies concolor, Pinus edulis, Pinus flexilis, Pinus monophylla, Juniperus* spp., *Artemisia tridentata, Purshia tridentata, Cercocarpus ledifolius, Ephedra* spp*., Holodiscus discolor*, and other species often common in adjacent plant communities.

Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland

See Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland.

Inter-Mountain Basins Greasewood Flat

This ecological system occurs throughout much of the western U.S. in Intermountain basins and extends onto the western Great Plains. It typically occurs near drainages on stream terraces and flats or may form rings around more sparsely vegetated playas. Sites typically have saline soils, a shallow water table and flood intermittently, but remain dry for most growing seasons. The water table remains high enough to maintain vegetation, despite salt accumulations. This system usually occurs as a mosaic of multiple communities, with open to moderately dense shrublands dominated or codominated by *Sarcobatus vermiculatus. Atriplex canescens, Atriplex confertifolia,* or *Krascheninnikovia lanata* may be present to codominant. Occurrences are often surrounded by mixed salt desert scrub. The herbaceous layer, if present, is usually dominated by graminoids. There may be inclusions of *Sporobolus airoides, Distichlis spicata* (where water remains ponded the longest), or *Eleocharis palustris* herbaceous types.

Inter-Mountain Basins Mixed Salt Desert Scrub

This extensive ecological system includes open-canopied shrublands of typically saline basins, alluvial slopes, and plains across the Intermountain western United States. This type also extends in limited distribution into the southern Great Plains. Substrates are often saline and calcareous, medium- to fine-textured, alkaline soils, but include some coarser-textured soils. The vegetation is characterized by a typically open to moderately dense shrubland composed of one or more *Atriplex* species such as *Atriplex confertifolia, Atriplex canescens, Atriplex polycarpa,* or *Atriplex spinifera*. Other shrubs present to codominate may include *Artemisia tridentata* ssp.

wyomingensis, Chrysothamnus viscidiflorus, Ericameria nauseosa, Ephedra nevadensis, Grayia spinosa, Krascheninnikovia lanata, Lycium spp.*, Picrothamnus desertorum,* or *Tetradymia* spp. *Sarcobatus vermiculatus* is generally absent, but if present does not codominate. The herbaceous layer varies from sparse to moderately dense and is dominated by perennial graminoids such as *Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus* ssp. *lanceolatus, Pascopyrum smithii, Pleuraphis jamesii, Pleuraphis rigida, Poa secunda,* or *Sporobolus airoides*. Various forbs are also present.

Inter-Mountain Basins Montane Sagebrush Steppe

This ecological system includes sagebrush communities occurring at montane and subalpine elevations across the western United States from 1000 m in eastern Oregon and Washington to over 3000 m in the southern Rockies. In British Columbia, it occurs between 450 and 1650 m in the southern Fraser Plateau and the Thompson and Okanagan basins. Climate is cool, semi-arid to subhumid. This system primarily occurs on deep-soiled to stony flats, ridges, nearly flat ridgetops, and mountain slopes. In general this system shows an affinity for mild topography, fine soils, and some source of subsurface moisture. It is composed primarily of *Artemisia tridentata* ssp. *vaseyana* (mountain sagebrush) and related taxa such as *Artemisia tridentata* ssp. *spiciformis* (= *Artemisia spiciformis*). *Purshia tridentata* may codominate or even dominate some stands. Other common shrubs include *Symphoricarpos* spp.*, Amelanchier* spp.*, Ericameria nauseosa, Peraphyllum ramosissimum, Ribes cereum,* and *Chrysothamnus viscidiflorus*. Most stands have an abundant perennial herbaceous layer (over 25% cover), but this system also includes *Artemisia tridentata* ssp. *vaseyana* shrublands. Common graminoids include *Festuca arizonica, Festuca idahoensis, Hesperostipa comata, Poa fendleriana, Elymus trachycaulus, Bromus carinatus, Poa secunda, Leucopoa kingii, Deschampsia caespitosa, Calamagrostis rubescens,* and *Pseudoroegneria spicata*. In many areas, frequent wildfires maintain an open herbaceous-rich steppe condition, although at most sites, shrub cover can be unusually high for a steppe system (>40%), with the moisture providing equally high grass and forb cover.

Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland

This ecological system occurs in hills and mountain ranges of the Intermountain basins from the eastern foothills of the Sierra Nevada northeast to the foothills of the Big Horn Mountains. It typically occurs from 600 m to over 2650 m in elevation on rocky outcrops or escarpments and forms small- to large-patch stands in forested areas. Most stands occur as shrublands on ridges and steep rimrock slopes, but it may occur as a small tree in steppe areas. This system includes both woodlands and shrublands dominated by *Cercocarpus ledifolius*. *Artemisia tridentata* ssp. *vaseyana, Purshia tridentata*, with species of *Arctostaphylos, Ribes*, or *Symphoricarpos* are often present. Scattered junipers or pines may also occur. *Cercocarpus ledifolius* is a slow-growing, drought-tolerant species that generally does not resprout after burning and needs the protection from fire that rocky sites provide.

Inter-Mountain Basins Playa

This ecological system is composed of barren and sparsely vegetated playas (generally <10% plant cover) found in the intermountain western United States. Salt crusts are common throughout, with small saltgrass beds in depressions and sparse shrubs around the margins. These systems are intermittently flooded. The water is prevented from percolating through the soil by an impermeable soil subhorizon and is left to evaporate. Soil salinity varies greatly with soil moisture and greatly affects species composition. Characteristic species may include *Allenrolfea occidentalis, Sarcobatus vermiculatus, Grayia spinosa, Puccinellia lemmonii, Leymus cinereus, Distichlis spicata,* and/or *Atriplex* spp.

Inter-Mountain Basins Semi-Desert Grassland

This widespread ecological system occurs throughout the intermountain western United States on dry plains and mesas, at approximately 1450 to 2320 m (4750–7610 feet) elevation. These grasslands occur in lowland and upland areas and may occupy swales, playas, mesatops, plateau parks, alluvial flats, and plains, but sites are typically xeric. Substrates are often well-drained sandy or loamy-textured soils derived from sedimentary parent materials but are quite variable and may include fine-textured soils derived from igneous and metamorphic rocks. When they occur near foothill grasslands they will be at lower elevations. The dominant perennial bunch grasses and shrubs within this system are all very drought-resistant plants. These grasslands are typically dominated or codominated by *Achnatherum hymenoides, Aristida* spp*., Bouteloua gracilis, Hesperostipa comata, Muhlenbergia* spp*.,* or *Pleuraphis jamesii* and may include scattered shrubs and dwarfshrubs of species of *Artemisia, Atriplex, Coleogyne, Ephedra, Gutierrezia,* or *Krascheninnikovia lanata*.

Inter-Mountain Basins Semi-Desert Shrub Steppe

This ecological system occurs throughout the intermountain western United States, typically at lower elevations on alluvial fans and flats with moderate to deep soils. This semi-arid shrub-steppe is typically dominated by graminoids (>25% cover) with an open shrub layer. Characteristic grasses include *Achnatherum hymenoides, Bouteloua gracilis, Distichlis spicata, Hesperostipa comata, Pleuraphis jamesii, Poa secunda,* and *Sporobolus airoides*. The woody layer is often a mixture of shrubs and dwarf-shrubs. Characteristic species include *Atriplex canescens, Artemisia tridentata, Chrysothamnus greenei, Chrysothamnus viscidiflorus, Ephedra* spp*., Ericameria nauseosa, Gutierrezia sarothrae,* and *Krascheninnikovia lanata. Artemisia tridentata* may be present but does not dominate. The general aspect of occurrences may be either open shrubland with patchy grasses or patchy open herbaceous layer. Disturbance may be important in maintaining the woody component. Microphytic crust is very important in some stands.

Inter-Mountain Basins Shale Badland

This widespread ecological system of the intermountain western United States is composed of barren and sparsely vegetated substrates (<10% plant cover) typically derived from marine shales but also includes substrates derived from siltstones and mudstones (clay). Landforms are typically rounded hills and plains that form a rolling topography. The harsh soil properties and high rate of erosion and deposition are driving environmental variables supporting sparse dwarf-shrubs, e.g., *Atriplex corrugata, Atriplex gardneri, Artemisia pedatifida*, and herbaceous vegetation.

Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland

This ecological system extends from the Mojave Desert and Sierra Nevada across the central Great Basin to the central Wasatch and western Uinta mountains. These open woodlands are typically found on high-elevation ridges and rocky slopes above subalpine forests and woodlands. Site are harsh, exposed to desiccating winds with rocky substrates and a short growing season that limit plant growth. Parent materials include dolomitic, limestone, or granitic rocks. Occurrences can be found on all aspects but are more common on southwestern exposures on steep convex slopes and ridges between 2530 and 3600 m (8300–12,000 feet). Stands are strongly dominated by *Pinus flexilis* and/or *Pinus longaeva*. *Pinus monophylla* may be present in lower-elevation stands. If present, shrub and herbaceous layers are generally sparse and composed of xeric shrubs, graminoids, and cushion plants. Associated species may include *Antennaria rosea, Arenaria kingii, Artemisia tridentata, Cercocarpus intricatus, Chamaebatiaria millefolium, Cymopterus cinerarius, Elymus elymoides, Erigeron pygmaeus, Eriogonum ovalifolium, Festuca brachyphylla, Koeleria macrantha, Leptodactylon pungens, Ribes cereum,* or *Ribes montigenum*.

Inter-Mountain West Aspen-Mixed Conifer Forest and Woodland Complex

See Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland.

Introduced Riparian and Wetland Vegetation

See Invasive Southwest Riparian Woodland and Shrubland.

Introduced Upland Vegetation–Annual and Perennial Grassland

See Invasive Annual Grassland and Invasive Perennial Grassland.

Introduced Upland Vegetation–Annual Grassland

See Invasive Annual Grassland.

Introduced Upland Vegetation–Perennial Grassland and Forbland

See Invasive Perennial Grassland and Invasive Perennial Forbland.

Invasive Annual and Biennial Forbland

Areas that are dominated by introduced annual and/or biennial forb species such as: *Halogeton glomeratum, Kochia scoparia, Salsola* spp.

Invasive Annual Grassland

Areas that are dominated by introduced annual grass species such as: *Avena* spp., *Bromus* spp., *Schismus* spp.

Invasive Perennial Forbland

Areas that are dominated by introduced perennial forb species such as: *Circium arvense, C. vulgare, Centaurea* spp*., Euphorbia esula, Isatis tinctora, Lepidium* sp*., Melilotus albus, M. officinalis,* and *Onopordum acanthium*.

Invasive Perennial Grassland

Areas that are dominated by introduced perennial grass species such as: *Agropyron cristatum, Bromus inermis, Eragrostis lehmannianna, Pennisetum* spp*., Poa bulbosa, P. pratensis, Thinopyrum intermedium*.

Invasive Southwest Riparian Woodland and Shrubland

Areas that are dominated by introduced riparian woody species such as: *Tamarix* spp. and *Elaeagnus angustifolius*.

Madrean Encina

Madrean Encinal occurs on foothills, canyons, bajadas, and plateaus in the Sierra Madre Occidentale and Sierra Madre Orientale in Mexico, extending north into Trans-Pecos Texas, southern New Mexico, and sub-Mogollon Arizona. These woodlands are dominated by Madrean

evergreen oaks along a low-slope transition below Madrean Pine-Oak Forest and Woodland and Madrean Pinyon-Juniper Woodland. Lower elevation stands are typically open woodlands or savannas where they transition into desert grasslands, chaparral or in some cases desertscrub. Common evergreen oak species include *Quercus arizonica, Quercus emoryi, Quercus intricata, Quercus grisea, Quercus oblongifolia, Quercus toumeyi*, and in Mexico, *Quercus chihuahuensis* and *Quercus albocincta*. Madrean pine, Arizona cypress, pinyon, and juniper trees may be present, but do not codominate. Chaparral species such as *Arctostaphylos pungens, Cercocarpus montanus, Purshia* spp.*, Garrya wrightii, Quercus turbinella, Frangula betulifolia* (= *Rhamnus betulifolia*), or *Rhus* spp. may be present but do not dominate. The graminoid layer is usually prominent between trees in grassland or steppe that is dominated by warm-season grasses such as *Aristida* spp., *Bouteloua gracilis, Bouteloua curtipendula, Bouteloua rothrockii, Digitaria californica, Eragrostis intermedia, Hilaria belangeri, Leptochloa dubia, Muhlenbergia* spp.*, Pleuraphis jamesii,* or *Schizachyrium cirratum*, species typical of Chihuahuan Piedmont Semi-Desert Grassland. This system includes seral stands dominated by shrubby Madrean oaks typically with a strong graminoid layer. In transition areas with drier chaparral systems, stands of chaparral are not dominated by Madrean oaks; however, Madrean Encinal may extend down along drainages.

Madrean Juniper Savanna

This Madrean ecological system occurs in lower foothills and plains of southeastern Arizona, southern New Mexico extending into west Texas, and Mexico. These savannas have widely spaced mature juniper trees and moderate to high cover of graminoids (>25% cover). The presence of Madrean *Juniperus* spp. such as *Juniperus coahuilensis, Juniperus pinchotii*, and/or *Juniperus deppeana* is diagnostic. *Juniperus monosperma* may be present in some stands, and *Juniperus deppeana* has a broader range than this Madrean system and extends north into southern stands of Southern Rocky Mountain Juniper Savanna and Woodland. Stands of *Juniperus pinchotii* may be short and resemble a shrubland. Graminoid species are a mix of those found in Western Great Plains Shortgrass Prairie and Chihuahuan Piedmont Semi-Desert Grassland, with *Bouteloua gracilis* and *Pleuraphis jamesii* being most common. In addition, these areas include succulents such as species of *Yucca, Opuntia*, and *Agave*. Juniper savanna expansion into grasslands has been documented in the last century.

Madrean Pinyon-Juniper Woodland

This system occurs on foothills, mountains, and plateaus in the Sierra Madre Occidentale and Sierra Madre Orientale in Mexico, Trans-Pecos Texas, southern New Mexico, and Arizona, generally south of the Mogollon Rim. Substrates are variable, but soils are generally dry and rocky. The presence of *Pinus cembroides, Pinus discolor*, or other Madrean trees and shrubs is diagnostic of this woodland system. *Juniperus coahuilensis, Juniperus deppeana, Juniperus pinchotii, Juniperus monosperma*, and/or *Pinus edulis* may be present to dominant. Madrean oaks such as *Quercus arizonica, Quercus emoryi, Quercus grisea*, or *Quercus mohriana* may be codominant. *Pinus ponderosa* is absent or sparse. If present, understory layers are variable and may be dominated by shrubs or graminoids.

Mogollon Chaparral

This ecological system occurs across central Arizona (Mogollon Rim), western New Mexico, and southern Utah and Nevada. It often dominants along the mid-elevation transition from the Mojave, Sonoran, and northern Chihuahuan deserts into mountains (1000–2200 m). It occurs on foothills, mountain slopes and canyons in drier habitats below the encinal and *Pinus ponderosa* woodlands. Stands are often associated with more xeric and coarse-textured substrates such as limestone, basalt, or alluvium, especially in transition areas with more mesic woodlands. The moderate to dense shrub canopy includes species such as *Quercus turbinella, Quercus toumeyi, Cercocarpus montanus, Canotia holacantha, Ceanothus greggii, Forestiera pubescens* (= *Forestiera neomexicana*), *Garrya wrightii, Juniperus deppeana, Purshia stansburiana, Rhus ovata, Rhus trilobata, and Arctostaphylos pungens* and *Arctostaphylos pringlei* at higher elevations. Most chaparral species are fire-adapted, resprouting vigorously after burning or producing fire-resistant seeds. Stands occurring within montane woodlands are seral and a result of recent fires.

Mojave Mid-Elevation Mixed Desert Scrub

This ecological system represents the extensive desert scrub in the transition zone above *Larrea tridentata – Ambrosia dumosa* desert scrub and below the lower montane woodlands (700–1800 m elevations) that occurs in the eastern and central Mojave Desert. It is also common on lower piedmont slopes in the transition zone into the southern Great Basin. The vegetation in this ecological systems is quite variable. Codominants and diagnostic species include *Coleogyne ramosissima, Eriogonum fasciculatum, Ephedra nevadensis, Grayia spinosa, Menodora spinescens, Nolina* spp.*, Opuntia acanthocarpa, Salazaria mexicana, Viguiera parishii, Yucca brevifolia,* or *Yucca schidigera*. Desert grasses, including *Achnatherum hymenoides, Achnatherum speciosum, Muhlenbergia porteri, Pleuraphis jamesii, Pleuraphis rigida,* or *Poa secunda*, may form an herbaceous layer. Scattered Juniperus osteosperma or desert scrub species may also be present.

North American Arid West Emergent Marsh

This widespread ecological system occurs throughout much of the arid and semi-arid regions of western North America, typically surrounded by savanna, shrub steppe, steppe, or desert vegetation. Natural marshes may occur in depressions in the landscape (ponds, kettle ponds), as fringes around lakes, and along slow-flowing streams and rivers (such riparian marshes are also referred to as sloughs). Marshes are frequently or continually inundated, with water depths up to 2 m. Water levels may be stable, or may fluctuate 1 m or more over the course of the growing season. Water chemistry may include some alkaline or semi-alkaline situations, but the alkalinity is highly variable even within the same complex of wetlands. Marshes have distinctive soils that are typically mineral, but can also accumulate organic material. Soils have characteristics that result from long periods of anaerobic conditions in the soils (e.g., gleyed soils, high organic content, redoximorphic features). The vegetation is characterized by herbaceous plants that are adapted to saturated soil conditions. Common emergent and floating

vegetation includes species of *Scirpus* and/or *Schoenoplectus, Typha, Juncus, Potamogeton, Polygonum, Nuphar*, and *Phalaris*. This system may also include areas of relatively deep water with floating-leaved plants (*Lemna, Potamogeton*, and *Brasenia*) and submergent and floating plants (*Myriophyllum, Ceratophyllum,* and *Elodea*).

North American Warm Desert Active and Stabilized Dune

This ecological system occurs across the warm deserts of North America and is composed of unvegetated to sparsely vegetated (generally <10% plant cover) active dunes and sandsheets derived from quartz or gypsum sands. Common vegetation includes *Ambrosia dumosa, Abronia villosa, Eriogonum deserticola, Larrea tridentata, Pleuraphis rigida, Poliomintha* spp*., Prosopis* spp*., Psorothamnus* spp*., Artemisia filifolia,* and *Rhus microphylla*. Dune "blowouts" and subsequent stabilization through succession are characteristic processes.

North American Warm Desert Bedrock Cliff and Outcrop

This ecological system is found from subalpine to foothill elevations and includes barren and sparsely vegetated landscapes (generally <10% plant cover) of steep cliff faces, narrow canyons, and smaller rock outcrops of various igneous, sedimentary, and metamorphic bedrock types. Also included are unstable scree and talus slopes that typically occur bellow cliff faces. Species present are diverse and may include *Bursera microphylla, Fouquieria splendens, Nolina bigelovii, Opuntia bigelovii*, and other desert species, especially succulents. Lichens are predominant lifeforms in some areas. May include a variety of desert shrublands less than 2 ha (5 acres) in size from adjacent areas.

North American Warm Desert Lower Montane Riparian Woodland and Shrubland

This ecological system occurs in mountain canyons and valleys of southern Arizona, New Mexico, and adjacent Mexico and consists of mid- to low-elevation (1100–1800 m) riparian corridors along perennial and seasonally intermittent streams. The vegetation is a mix of riparian woodlands and shrublands. Dominant trees include *Populus angustifolia*, *Populus deltoides ssp. wislizeni*, *Populus fremontii*, *Platanus wrightii*, *Juglans major*, *Fraxinus velutina*, and *Sapindus saponaria*. Shrub dominants include *Salix exigua*, *Prunus* spp., *Alnus oblongifolia*, and *Baccharis salicifolia*. Vegetation is dependent upon annual or periodic flooding and associated sediment scour and/or annual rise in the water table for growth and reproduction.

North American Warm Desert Pavement

This ecological system occurs throughout much of the warm deserts of North America and is composed of unvegetated to very sparsely vegetated (<2% plant cover) landscapes, typically flat basins where extreme temperature and wind develop ground surfaces of fine to medium gravel coated with "desert varnish." Very low cover of desert scrub species such as

Larrea tridentata or *Eriogonum fasciculatum* is usually present. However, ephemeral herbaceous species may have high cover in response to seasonal precipitation, including *Chorizanthe rigida, Eriogonum inflatum,* and *Geraea canescens*.

North American Warm Desert Playa

This system is composed of barren and sparsely vegetated playas (generally <10% plant cover) found across the warm deserts of North America, extending into the extreme southern end of the San Joaquin Valley in California. Playas form with intermittent flooding, followed by evaporation, leaving behind a saline residue. Salt crusts are common throughout, with small saltgrass beds in depressions and sparse shrubs around the margins. Subsoils often include an impermeable layer of clay or caliche. Large desert playas tend to be defined by vegetation rings formed in response to salinity. Given their common location in wind-swept desert basins, dune fields often form downwind of large playas. In turn, playas associated with dunes often have a deeper water supply. Species may include *Allenrolfea occidentalis, Suaeda* spp*., Distichlis spicata, Eleocharis palustris, Oryzopsis* spp*., Sporobolus* spp*., Tiquilia* spp*., or Atriplex* spp. Ephemeral herbaceous species may have high cover periodically. Adjacent vegetation is typically Sonora-Mojave Desert Mixed Salt Desert Scrub, Chihuahuan Mixed Salt Desert Scrub, Gulf of California Coastal Mixed Salt Desert Scrub, Baja California del Norte Gulf Coast Ocotillo-Limberbush-Creosotebush Desert Scrub, or Chihuahuan Creosotebush Basin Desert Scrub.

North American Warm Desert Riparian Mesquite Bosque

This ecological system consists of low-elevation (<1100 m) riparian corridors along intermittent streams in valleys of southern Arizona and New Mexico, and adjacent Mexico. Dominant trees include *Prosopis glandulosa* and *Prosopis velutina*. Shrub dominants include *Baccharis salicifolia, Pluchea sericea,* and *Salix exigua*. Vegetation, especially the mesquites, tap groundwater below the streambed when surface flows stop. Vegetation is dependent upon annual rise in the water table for growth and reproduction.

North American Warm Desert Riparian Woodland and Shrubland

This ecological system consists of low-elevation (<1200 m) riparian corridors along medium to large perennial streams throughout canyons and the desert valleys of the southwestern United States and adjacent Mexico. The vegetation is a mix of riparian woodlands and shrublands. Dominant trees include *Acer negundo, Fraxinus velutina, Populus fremontii, Salix gooddingii, Salix lasiolepis, Celtis laevigata* var. *reticulata,* and *Juglans major*. Shrub dominants include *Salix geyeriana, Shepherdia argentea,* and *Salix exigua*. Vegetation is dependent upon annual or periodic flooding and associated sediment scour and/or annual rise in the water table for growth and reproduction.

North American Warm Desert Volcanic Rockland

This ecological system occurs across the warm deserts of North America and is restricted to barren and sparsely vegetated (<10% plant cover) volcanic substrates such as basalt lava (malpais) and tuff. Vegetation is variable and includes a variety of species depending on local environmental conditions, e.g., elevation, age and type of substrate. Typically scattered *Larrea tridentata, Atriplex hymenelytra*, or other desert shrubs are present.

North American Warm Desert Wash

This ecological system is restricted to intermittently flooded washes or arroyos that dissect bajadas, mesas, plains, and basin floors throughout the warm deserts of North America. Although often dry, the intermittent fluvial processes define this system, which are often associated with rapid sheet and gully flow. This system occurs as linear or braided strips within desert scrub- or desert grassland-dominated landscapes. The vegetation of desert washes is quite variable ranging from sparse and patchy to moderately dense and typically occurs along the banks, but may occur within the channel. The woody layer is typically intermittent to open and may be dominated by shrubs and small trees such as *Acacia greggii, Brickellia laciniata, Baccharis sarothroides, Chilopsis linearis, Fallugia paradoxa, Hymenoclea salsola, Hymenoclea monogyra, Juglans microcarpa, Prosopis* spp*., Psorothamnus spinosus, Prunus fasciculata, Rhus microphylla, Salazaria mexicana,* or *Sarcobatus vermiculatus*.

Open Water

Areas of open water, generally with less than 25% cover of vegetation or soil.

Recently Chained Pinyon-Juniper Areas

Areas that have recently been chained to remove Pinyon-Juniper and are clearly evident in the imagery (images acquired between 1999–2001).

Recently Logged Areas

Areas that have recently been clear-cut or thinned by 50% or more and are clearly evident in the imagery (images acquired between 1999–2001).

Recently Mined or Quarried

Areas where open pit mining or quarries are visible in the imagery (images acquired between 1999–2001), and are 2 ha or greater in size.

Rocky Mountain Alpine Bedrock and Scree

This ecological system is restricted to the highest elevations of the Rocky Mountains, from Alberta and British Columbia south into New Mexico, west into the highest mountain ranges of the Great Basin. It is composed of barren and sparsely vegetated alpine substrates, typically including both bedrock outcrop and scree slopes, with nonvascular- (lichen) dominated communities. Exposure to desiccating winds, rocky and sometimes unstable substrates, and a short growing season limit plant growth. There can be sparse cover of forbs, grasses, lichens, and low shrubs.

Rocky Mountain Alpine Fell-Field

This ecological system is found discontinuously at alpine elevations throughout the Rocky Mountains, west into the mountainous areas of the Great Basin, and north into the Canadian Rockies. Small areas are represented in the westside of the Okanagan Ecoregion in the eastern Cascades. These are wind-scoured fell-fields that are free of snow in the winter, such as ridgetops and exposed saddles, exposing the plants to severe environmental stress. Soils on these windy unproductive sites are shallow, stony, low in organic matter, and poorly developed; wind deflation often results in a gravelly pavement. Most fell-field plants are cushioned, or matted, frequently succulent, flat to the ground in rosettes and often densely haired and thickly cutinized. Plant cover is 15–50%, while exposed rocks make up the rest. Fell-fields are usually within or adjacent to alpine tundra dry meadows. Common species include *Arenaria capillaris, Carex albonigra, Carex paysonis, Geum rossii, Kobresia myosuroides, Minuartia obtusiloba, Myosotis asiatica, Paronychia pulvinata, Phlox pulvinata, Sibbaldia procumbens,* and *Silene acaulis*.

Rocky Mountain Alpine-Montane Wet Meadow

These are high-elevation communities found throughout the Rocky Mountains and Intermountain regions, dominated by herbaceous species found on wetter sites with very low-velocity surface and subsurface flows. They range in elevation from montane to alpine (1000-3600 m). These types occur as large meadows in montane or subalpine valleys, as narrow strips bordering ponds, lakes, and streams, and along toeslope seeps. They are typically found on flat areas or gentle slopes, but may also occur on sub-irrigated sites with slopes up to 10%. In alpine regions, sites typically are small depressions located below late-melting snow patches or on snowbeds. Soils of this system may be mineral or organic. In either case, soils show typical hydric soil characteristics, including high organic content and/or low chroma and redoximorphic features. This system often occurs as a mosaic of several plant associations, often dominated by graminoids, including *Calamagrostis stricta, Caltha leptosepala, Cardamine cordifolia, Carex illota, Carex microptera, Carex nigricans, Carex scopulorum, Carex utriculata, Carex vernacula, Deschampsia caespitosa, Eleocharis quinqueflora, Juncus drummondii, Phippsia algida, Rorippa alpina, Senecio triangularis, Trifolium parryi,* and *Trollius laxus*. Often alpine dwarf-shrublands, especially those dominated by *Salix*, are immediately adjacent to the wet meadows. Wet meadows are tightly associated with snowmelt and typically not subjected to high disturbance events such as flooding.

Rocky Mountain Aspen Forest and Woodland

This widespread ecological system is more common in the southern and central Rocky Mountains, but occurs throughout much of the western United States and north into Canada, in the montane and subalpine zones. Elevations generally range from 1525 to 3050 m (5000-10,000 feet), but occurrences can be found at lower elevations in some regions. Distribution of this ecological system is primarily limited by adequate soil moisture required to meet its high evapotranspiration demand, and secondarily is limited by the length of the growing season or low temperatures. These are upland forests and woodlands dominated by *Populus tremuloides* without a significant conifer component (<25% relative tree cover). The understory structure may be complex with multiple shrub and herbaceous layers, or simple with just an herbaceous layer. The herbaceous layer may be dense or sparse, dominated by graminoids or forbs. Associated shrub species include *Symphoricarpos* spp*., Rubus parviflorus, Amelanchier alnifolia,* and *Arctostaphylos uva-ursi*. Occurrences of this system originate and are maintained by stand-replacing disturbances such as avalanches, crown fire, insect outbreak, disease and windthrow, or clearcutting by man or beaver, within the matrix of conifer forests.

Rocky Mountain Bigtooth Maple Ravine Woodland

This ecological system occurs in cool ravines, and on toeslopes and slump benches associated with riparian areas in the northern and central Wasatch Range and Tavaputs Plateau extending into southern Idaho, as well as in scattered localities in southwestern Utah, central Arizona and New Mexico, and the Trans-Pecos of Texas. Substrates are typically rocky colluvial or alluvial soils with favorable soil moisture. These woodlands are dominated by *Acer grandidentatum* but may include mixed stands codominated by *Quercus gambelii* or with scattered conifers. Some stands may include *Acer negundo* or *Populus tremuloides* as minor components. It also occurs on steeper, north-facing slopes at higher elevations, often adjacent to Rocky Mountain Gambel Oak-Mixed Montane Shrubland or Rocky Mountain Aspen Forest and Woodland.

Rocky Mountain Cliff and Canyon and Massive Bedrock

This ecological system of barren and sparsely vegetated landscapes (generally <10% plant cover) is found from foothill to subalpine elevations on steep cliff faces, narrow canyons, and smaller rock outcrops of various igneous, sedimentary, and metamorphic bedrock types. It is located throughout the Rocky Mountains and northeastern Cascade Ranges in North America. Also included are unstable scree and talus slopes that typically occur below cliff faces. There may be small patches of dense vegetation, but it typically includes scattered trees and/or shrubs. Characteristic trees includes species from the surrounding landscape, such as *Pseudotsuga menziesii, Pinus ponderosa, Pinus flexilis, Populus tremuloides, Abies concolor, Abies lasiocarpa,* or *Pinus edulis* and *Juniperus* spp. at lower elevations. There may be scattered shrubs present, such as species of *Holodiscus, Ribes, Physocarpus, Rosa, Juniperus,* and *Jamesia americana, Mahonia repens, Rhus trilobata,* or *Amelanchier alnifolia*. Soil development is limited, as is herbaceous cover.

Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland

This is a highly variable ecological system of the montane zone of the Rocky Mountains. It occurs throughout the southern Rockies, north and west into Utah, Nevada, western Wyoming, and Idaho. These are mixed-conifer forests occurring on all aspects at elevations ranging from 1200 to 3300 m. Rainfall averages less than 75 cm per year (40–60 cm) with summer "monsoons" during the growing season contributing substantial moisture. The composition and structure of overstory is dependent upon the temperature and moisture relationships of the site, and the successional status of the occurrence. *Pseudotsuga menziesii* and *Abies concolor* are most frequent, but *Pinus ponderosa* may be present to codominant. *Pinus flexilis* is common in Nevada. *Pseudotsuga menziesii* forests occupy drier sites, and *Pinus ponderosa* is a common codominant. *Abies concolor*-dominated forests occupy cooler sites, such as upper slopes at higher elevations, canyon sideslopes, ridgetops, and north- and east-facing slopes which burn somewhat infrequently. *Picea pungens* is most often found in cool, moist locations, often occurring as smaller patches within a matrix of other associations. As many as seven conifers can be found growing in the same occurrence, and there are a number of cold-deciduous shrub and graminoid species common, including *Arctostaphylos uva-ursi, Mahonia repens, Paxistima myrsinites, Symphoricarpos oreophilus, Jamesia americana, Quercus gambelii,* and *Festuca arizonica*. This system was undoubtedly characterized by a mixed severity fire regime in its "natural condition," characterized by a high degree of variability in lethality and return interval.

Rocky Mountain Dry Tundra

This widespread ecological system occurs above upper treeline throughout the Rocky Mountain cordillera, including alpine areas of ranges in Utah and Nevada, and isolated alpine sites in the northeastern Cascades. It is found on gentle to moderate slopes, flat ridges, valleys, and basins, where the soil has become relatively stabilized and the water supply is more or less constant. Vegetation in these areas is controlled by snow retention, wind desiccation, permafrost, and a short growing season. This system is characterized by a dense cover of low-growing, perennial graminoids and forbs. Rhizomatous, sod-forming sedges are the dominant graminoids, and prostrate and mat-forming plants with thick rootstocks or taproots characterize the forbs. Dominant species include *Artemisia arctica, Carex elynoides, Carex siccata, Carex scirpoidea, Carex nardina, Carex rupestris, Deschampsia caespitosa, Festuca brachyphylla, Festuca idahoensis, Geum rossii, Kobresia myosuroides, Phlox pulvinata,* and *Trifolium dasyphyllum*. Although alpine tundra dry meadow is the matrix of the alpine zone, it typically intermingles with alpine bedrock and scree, ice field, fell-field, alpine dwarfshrubland, and alpine/subalpine wet meadow systems.

Rocky Mountain Gambel Oak-Mixed Montane Shrubland

This ecological system occurs in the mountains, plateaus, and foothills in the southern Rocky Mountains and Colorado Plateau including the Uinta and Wasatch ranges and the Mogollon Rim. These shrublands are most commonly found along dry foothills, lower mountain slopes, and at the edge of the western Great Plains from approximately 2000 to 2900 m in

elevation, and are often situated above pinyon-juniper woodlands. Substrates are variable and include soil types ranging from calcareous, heavy, fine-grained loams to sandy loams, gravelly loams, clay loams, deep alluvial sand, or coarse gravel. The vegetation is typically dominated by *Quercus gambelii* alone or codominant with *Amelanchier alnifolia, Amelanchier utahensis, Artemisia tridentata, Cercocarpus montanus, Prunus virginiana, Purshia stansburiana, Purshia tridentata, Robinia neomexicana, Symphoricarpos oreophilus,* or *Symphoricarpos rotundifolius*. There may be inclusions of other mesic montane shrublands with Quercus gambelii absent or as a relatively minor component. This ecological system intergrades with the lower montane-foothills shrubland system and shares many of the same site characteristics. Density and cover of *Quercus gambelii* and *Amelanchier* spp. often increase after fire.

Rocky Mountain Lodgepole Pine Forest

This system is widespread in upper montane to subalpine elevations of the Rocky Mountains, Intermountain region, and north into the Canadian Rockies. These are subalpine forests where the dominance of *Pinus contorta* is related to fire history and topo-edaphic conditions. Following stand-replacing fires, *Pinus contorta* will rapidly colonize and develop into dense, even-aged stands. Most forests in this ecological system are early- to mid-successional forests which developed following fires. Some *Pinus contorta* forests will persist on sites that are too extreme for other conifers to establish. These include excessively well-drained pumice deposits, glacial till and alluvium on valley floors where there is cold air accumulation, warm and droughty shallow soils over fractured quartzite bedrock, and shallow moisture-deficient soils with a significant component of volcanic ash. Soils supporting these forests are typically well-drained, gravelly, coarse-textured, acidic, and rarely formed from calcareous parent materials. These forests are dominated by *Pinus contorta* with shrub, grass, or barren understories. Sometimes there are intermingled mixed conifer/*Populus tremuloides* stands with the latter occurring with inclusions of deeper, typically fine-textured soils. The shrub stratum may be conspicuous to absent; common species include *Arctostaphylos uva-ursi, Ceanothus velutinus, Linnaea borealis, Mahonia repens, Purshia tridentata, Spiraea betulifolia, Spiraea douglasii, Shepherdia canadensis, Vaccinium caespitosum, Vaccinium scoparium, Vaccinium membranaceum, Symphoricarpos albus,* and *Ribes* spp. In southern interior British Columbia, this system is usually an open lodgepole pine forest found extensively between 500 and 1600 m elevation in the Columbia range. In the Interior Cedar Hemlock and Interior Douglas-fir zones, *Tsuga heterophylla* or *Pseudotsuga menziesii* may present.

Rocky Mountain Lower Montane-Foothill Shrubland

This ecological system is found in the foothills, canyon slopes, and lower mountains of the Rocky Mountains and on outcrops and canyon slopes in the western Great Plains. It ranges from southern New Mexico extending north into Wyoming, and west into the Intermountain region. These shrublands occur between 1500–2900 m elevations and are usually associated with exposed sites, rocky substrates, and dry conditions, which limit tree growth. It is common where *Quercus gambelii* is absent such as the northern Colorado Front Range and in drier foothills and prairie hills. This system is generally drier than Rocky Mountain Gambel Oak-Mixed Montane

Shrubland, but may include mesic montane shrublands where *Quercus gambelii* does not occur. Scattered trees or inclusions of grassland patches or steppe may be present, but the vegetation is typically dominated by a variety of shrubs including *Amelanchier utahensis, Cercocarpus montanus, Purshia tridentata, Rhus trilobata, Ribes cereum, Symphoricarpos oreophilus,* or *Yucca glauca*. In northeastern Wyoming and north into adjacent Montana, *Cercocarpus ledifolius*, usually with *Artemisia tridentata*, is the common dominant shrub. Grasses are represented as species of *Muhlenbergia, Bouteloua, Hesperostipa*, and *Pseudoroegneria spicata*. Fires play an important role in this system as the dominant shrubs usually have a severe dieback, although some plants will stump sprout. *Cercocarpus montanus* requires a disturbance such as fire to reproduce, either by seed sprout or root crown sprouting. Fire suppression may have allowed an invasion of trees into some of these shrublands, but in many cases sites are too xeric for tree growth.

Rocky Mountain Lower Montane Riparian Woodland and Shrubland

This system is found throughout the Rocky Mountain and Colorado Plateau regions within a broad elevation range from approximately 900 to 2800 m. This system often occurs as a mosaic of multiple communities that are tree-dominated with a diverse shrub component. This system is dependent on a natural hydrologic regime, especially annual to episodic flooding. Occurrences are found within the flood zone of rivers, on islands, sand or cobble bars, and immediate streambanks. They can form large, wide occurrences on mid-channel islands in larger rivers or narrow bands on small, rocky canyon tributaries and well-drained benches. It is also typically found in backwater channels and other perennially wet but less scoured sites, such as floodplains swales and irrigation ditches. Dominant trees may include *Acer negundo, Populus angustifolia, Populus balsamifera, Populus deltoides, Populus fremontii, Pseudotsuga menziesii, Picea pungens, Salix amygdaloides,* or *Juniperus scopulorum*. Dominant shrubs include *Acer glabrum, Alnus incana, Betula occidentalis, Cornus sericea, Crataegus rivularis, Forestiera pubescens, Prunus virginiana, Rhus trilobata, Salix monticola, Salix drummondiana, Salix exigua, Salix irrorata, Salix lucida, Shepherdia argentea,* or *Symphoricarpos* spp. Exotic trees of *Elaeagnus angustifolia* and *Tamarix* spp. are common in some stands. Generally, the upland vegetation surrounding this riparian system is different and ranges from grasslands to forests.

Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland

These are mixed-conifer forests of the Rocky Mountains west into the ranges of the Great Basin, occurring predominantly in cool ravines and on north-facing slopes. Elevations range from 1200 to 3300 m. Occurrences of this system are found on cooler and more mesic sites than Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland. Such sites include lower and middle slopes of ravines, along stream terraces, moist, concave topographic positions and north- and east-facing slopes which burn somewhat infrequently. *Pseudotsuga menziesii* and *Abies concolor* are most common canopy dominants, but *Picea engelmannii, Picea pungens*, or *Pinus ponderosa* may be present. This system includes mixed conifer/*Populus tremuloides* stands. A number of cold-deciduous shrub species can occur, including *Acer glabrum, Acer grandidentatum, Alnus incana, Betula occidentalis, Cornus sericea, Jamesia americana,*

Physocarpus malvaceus, Robinia neomexicana, Vaccinium membranaceum, and *Vaccinium myrtillus*. Herbaceous species include *Bromus ciliatus, Carex geyeri, Carex rossii, Carex siccata, Muhlenbergia virescens, Pseudoroegneria spicata, Erigeron eximius, Fragaria virginiana, Luzula parviflora, Osmorhiza berteroi, Packera cardamine, Thalictrum occidentale,* and *Thalictrum fendleri*. Naturally occurring fires are of variable return intervals, and mostly light, erratic, and infrequent due to the cool, moist conditions.

Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland

Engelmann spruce and subalpine fir forests comprise a substantial part of the subalpine forests of the Cascades and Rocky Mountains from southern British Columbia east into Alberta, south into New Mexico and the Intermountain region. They are the matrix forests of the subalpine zone, with elevations ranging from 1275 m in its northern distribution to 3355 m in the south (4100–11,000 feet). They often represent the highest elevation forests in an area. Sites within this system are cold year-round, and precipitation is predominantly in the form of snow, which may persist until late summer. Snowpacks are deep and late-lying, and summers are cool. Frost is possible almost all summer and may be common in restricted topographic basins and benches. Despite their wide distribution, the tree canopy characteristics are remarkably similar, with *Picea engelmannii* and *Abies lasiocarpa* dominating either mixed or alone. *Pseudotsuga menziesii* may persist in occurrences of this system for long periods without regeneration. *Pinus contorta* is common in many occurrences, and patches of pure *Pinus contorta* are not uncommon, as well as mixed conifer/*Populus tremuloides* stands. In some areas, such as Wyoming, *Picea engelmannii*-dominated forests are on limestone or dolomite, while nearby codominated spruce-fir forests are on granitic or volcanic rocks. Xeric species may include *Juniperus communis, Linnaea borealis, Mahonia repens,* or *Vaccinium scoparium*. More northern occurrences often have taller, more mesic shrub and herbaceous species, such as *Empetrum nigrum, Rhododendron albiflorum,* and *Vaccinium membranaceum*. Disturbance includes occasional blow-down, insect outbreaks and stand-replacing fire.

Rocky Mountain Subalpine Mesic Meadow

This Rocky Mountain ecological system is restricted to sites in the subalpine zone where finely textured soils, snow deposition, or wind-swept dry conditions limit tree establishment. It is found typically above 3000 m in elevation in the southern part of its range and above 1500 m in the northern part. These upland communities occur on gentle to moderate-gradient slopes. The soils are typically seasonally moist to saturated in the spring, but if so will dry out later in the growing season. These sites are not as wet as those found in Rocky Mountain Alpine-Montane Wet Meadow. Vegetation is typically forb-rich, with forbs contributing more to overall herbaceous cover than graminoids. Important taxa include *Erigeron* spp., *Asteraceae* spp., *Mertensia* spp., *Penstemon* spp., *Campanula* spp., *Lupinus* spp., *Solidago* spp., *Ligusticum* spp., *Thalictrum occidentale, Valeriana sitchensis, Balsamorhiza sagittata, Wyethia* spp., *Deschampsia caespitosa, Koeleria macrantha*, and *Dasiphora fruticosa*. Burrowing mammals can increase the forb diversity.

Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland

This is a high-elevation system of the Rocky Mountains, dominated by *Picea engelmannii* and *Abies lasiocarpa*. It extends eastward into the northeastern Olympic Mountains and the northeastern side of Mount Rainier in Washington. Occurrences are typically found in locations with cold-air drainage or ponding, or where snowpacks linger late into the summer, such as north-facing slopes and high-elevation ravines. They can extend down in elevation below the subalpine zone in places where cold-air ponding occurs; northerly and easterly aspects predominate. These forests are found on gentle to very steep mountain slopes, high-elevation ridgetops and upper slopes, plateau-like surfaces, basins, alluvial terraces, well-drained benches, and inactive stream terraces. In the Olympics and northern Cascades, the climate is more maritime than typical for this system, but due to the lower snowfall in these rainshadow areas, summer drought may be more significant than snowpack in limiting tree regeneration in burned areas. *Picea engelmannii* is rare in these areas. Mesic understory shrubs include *Menziesia ferruginea, Vaccinium membranaceum, Rhododendron albiflorum, Amelanchier alnifolia, Rubus parviflorus, Ledum glandulosum, Phyllodoce empetriformis,* and *Salix* spp. Herbaceous species include *Actaea rubra, Maianthemum stellatum, Cornus canadensis, Erigeron eximius, Gymnocarpium dryopteris, Rubus pedatus, Saxifraga bronchialis, Tiarella* spp*., Lupinus arcticus* ssp*. subalpinus, Valeriana sitchensis,* and *graminoids Luzula glabrata* var*. hitchcockii* or *Calamagrostis canadensis*. Disturbances include occasional blow-down, insect outbreaks and stand-replacing fire.

Rocky Mountain Subalpine–Montane Limber-Bristlecone Pine Woodland

This ecological system occurs throughout the Rocky Mountains on dry, rocky ridges and slopes near upper treeline above the matrix spruce-fir forest. It extends down to the lower montane in the central and northern Rocky Mountains and northeastern Great Basin mountains where dominated by *Pinus flexilis*, particularly along the Front Range north into Canada. Sites are harsh, exposed to desiccating winds, with rocky substrates and a short growing season that limit plant growth. Higher-elevation occurrences are found well into the subalpine-alpine transition on wind-blasted, mostly westfacing slopes and exposed ridges. Calcareous substrates are important for Pinus flexilis-dominated communities in the northern Rocky Mountains and possibly elsewhere. The open tree canopy is often patchy and is strongly dominated by *Pinus flexilis* or *Pinus aristata* with the latter restricted to southern Colorado, northern New Mexico and the San Francisco Mountains in Arizona. In the northern Rockies and northern Great Basin, *Pinus albicaulis* is found in some occurrences. Other trees such as *Juniperus* spp., *Pinus contorta, Pinus ponderosa,* or *Pseudotsuga menziesii* are occasionally present. *Arctostaphylos uva-ursi, Cercocarpus ledifolius, Juniperus communis, Mahonia repens, Purshia tridentata, Ribes montigenum,* or *Vaccinium* spp. may form an open shrub layer in some stands. The herbaceous layer, if present, is generally sparse and composed of xeric graminoids, such as *Calamagrostis purpurascens, Festuca arizonica, Festuca idahoensis, Festuca thurberi,* or *Pseudoroegneria spicata*, or more alpine plants.

Rocky Mountain Subalpine-Montane Riparian Shrubland

This system is found throughout the Rocky Mountain cordillera from New Mexico north into Montana, and also occurs in mountainous areas of the Intermountain region and Colorado Plateau. These are montane to subalpine riparian shrublands occurring as narrow bands of shrubs lining streambanks and alluvial terraces in narrow to wide, low-gradient valley bottoms and floodplains with sinuous stream channels. Generally it is found at higher elevations, but can be found anywhere from 1700–3475 m. Occurrences can also be found around seeps, fens, and isolated springs on hillslopes away from valley bottoms. Many of the plant associations found within this system are associated with beaver activity. This system often occurs as a mosaic of multiple communities that are shrub- and herb-dominated and includes above-treeline, willow-dominated, snowmelt-fed basins that feed into streams. The dominant shrubs reflect the large elevational gradient and include *Alnus incana, Betula nana, Betula occidentalis, Cornus sericea, Salix bebbiana, Salix boothii, Salix brachycarpa, Salix drummondiana, Salix eriocephala, Salix geyeriana, Salix monticola, Salix planifolia,* and *Salix wolfii*. Generally the upland vegetation surrounding these riparian systems are of either conifer or aspen forests.

Rocky Mountain Subalpine-Montane Riparian Woodland

This riparian woodland system is comprised of seasonally flooded forests and woodlands found at montane to subalpine elevations of the Rocky Mountain cordillera, from southern New Mexico north into Montana, and west into the Intermountain region and the Colorado Plateau. It occurs throughout the interior of British Columbia and the eastern slopes of the Cascade Mountains. This system contains the conifer and aspen woodlands that line montane streams. These are communities tolerant of periodic flooding and high water tables. Snowmelt moisture in this system may create shallow water tables or seeps for a portion of the growing season. Stands typically occur at elevations between 1500 and 3300 m (4920–10,830 feet), farther north elevation ranges between 900 and 2000 m. This is confined to specific riparian environments occurring on floodplains or terraces of rivers and streams, in V-shaped, narrow valleys and canyons (where there is cold-air drainage). Less frequently, occurrences are found in moderate-wide valley bottoms on large floodplains along broad, meandering rivers, and on pond or lake margins. Dominant tree species vary across the latitudinal range, although it usually includes *Abies lasiocarpa* and/or *Picea engelmannii*; other important species include *Pseudotsuga menziesii, Picea pungens, Picea engelmannii X glauca, Populus tremuloides*, and *Juniperus scopulorum*. Other trees possibly present but not usually dominant include *Alnus incana, Abies concolor, Abies grandis, Pinus contorta, Populus angustifolia, Populus balsamifera* ssp. *trichocarpa*, and *Juniperus osteosperma*.

Sonora-Mojave Creosotebush-White Bursage Desert Scrub

This ecological system forms the vegetation matrix in broad valleys, lower bajadas, plains and low hills in the Mojave and lower Sonoran deserts. This desert scrub is characterized by a sparse to moderately dense layer (2–50% cover) of xeromorphic microphyllous and broad-leaved shrubs. *Larrea tridentata* and *Ambrosia dumosa* are typically dominants, but many

different shrubs, dwarf-shrubs, and cacti may codominate or form typically sparse understories. Associated species may include *Atriplex canescens, Atriplex hymenelytra, Encelia farinosa, Ephedra nevadensis, Fouquieria splendens, Lycium andersonii,* and *Opuntia basilaris*. The herbaceous layer is typically sparse, but may be seasonally abundant with ephemerals. Herbaceous species such as *Chamaesyce* spp., *Eriogonum inflatum, Dasyochloa pulchella, Aristida* spp., *Cryptantha* spp., *Nama* spp., and *Phacelia* spp. are common.

Sonora-Mojave Mixed Salt Desert Scrub

This system includes extensive open-canopied shrublands of typically saline basins in the Mojave and Sonoran deserts. Stands often occur around playas. Substrates are generally fine-textured, saline soils. Vegetation is typically composed of one or more *Atriplex* species such as *Atriplex canescens* or *Atriplex polycarpa* along with other species of *Atriplex*. Species of *Allenrolfea, Salicornia, Suaeda*, or other halophytic plants are often present to codominant. Graminoid species may include *Sporobolus airoides* or *Distichlis spicata* at varying densities.

Sonoran Mid-Elevation Desert Scrub

This transitional desert scrub system occurs along the northern edge of the Sonoran Desert in an elevational band along the lower slopes of the Mogollon Rim/Central Highlands region between 750 and 1300 m. Stands occur in the Bradshaw, Hualapai, and Superstition mountains, among other desert ranges, and are found above Sonoran Paloverde-Mixed Cacti Desert Scrub and below Mogollon Chaparral. Sites range from a narrow strip on steep slopes to very broad areas such as the Verde Valley. Climate is too dry for chaparral species to be abundant, and freezing temperatures during winter are too frequent and prolonged for many of the frost-sensitive species that are characteristic of Sonoran Paloverde-Mixed Cacti Desert Scrub, such as *Carnegia gigantea, Parkinsonia microphylla, Prosopis* spp*., Olneya tesota, Ferocactus* sp*.,* and *Opuntia bigelovii*. Substrates are generally rocky soils derived from parent materials such as limestone, granitic rocks or rhyolite. The vegetation is typically composed of an open shrub layer of *Larrea tridentata, Ericameria linearifolia,* or *Eriogonum fasciculatum* with taller shrub such as *Canotia holacantha* (limestone or granite) or *Simmondsia chinensis* (rhyolite). The herbaceous layer is generally sparse.

Sonoran Paloverde-Mixed Cacti Desert Scrub

This ecological system occurs on hillsides, mesas, and upper bajadas in southern Arizona and extreme southeastern California. The vegetation is characterized by a diagnostic sparse, emergent tree layer of *Carnegia gigantea* (3–16 m tall) and/or a sparse to moderately dense canopy codominated by xeromorphic deciduous and evergreen tall shrubs *Parkinsonia microphylla* and *Larrea tridentata* with *Prosopis* sp., *Olneya tesota*, and *Fouquieria splendens* less prominent. Other common shrubs and dwarf-shrubs include *Acacia greggii, Ambrosia deltoidea, Ambrosia dumosa* (in drier sites), *Calliandra eriophylla, Jatropha cardiophylla, Krameria erecta, Lycium* spp*., Menodora scabra, Simmondsia chinensis*, and many cacti

including *Ferocactus* spp., *Echinocereus* spp., and *Opuntia* spp. (both cholla and prickly pear). The sparse herbaceous layer is composed of perennial grasses and forbs with annuals seasonally present and occasionally abundant. On slopes, plants are often distributed in patches around rock outcrops where suitable habitat is present.

Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland

See Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland

Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland

See Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland.

Southern Rocky Mountain Montane-Subalpine Grassland

This Rocky Mountain ecological system typically occurs between 2200 and 3000 m on flat to rolling plains and parks or on lower sideslopes that are dry, but it may extend up to 3350 m on warm aspects. Soils resemble prairie soils in that the A horizon is dark brown, relatively high in organic matter, slightly acid, and usually well-drained. An occurrence usually consists of a mosaic of two or three plant associations with one of the following dominant bunch grasses: *Danthonia intermedia, Danthonia parryi, Festuca idahoensis, Festuca arizonica, Festuca thurberi, Muhlenbergia filiculmis,* or *Pseudoroegneria spicata*. The subdominants include *Muhlenbergia montana, Bouteloua gracilis,* and *Poa secunda*. These large-patch grasslands are intermixed with matrix stands of spruce-fir, lodgepole, ponderosa pine, and aspen forests. In limited circumstances (e.g., South Park in Colorado), they form the "matrix" of high-elevation plateaus.

Southern Rocky Mountain Pinyon-Juniper Woodland

This southern Rocky Mountain ecological system occurs on dry mountains and foothills in southern Colorado east of the Continental Divide, in mountains and plateaus of north-central New Mexico, and extends out onto limestone breaks in the southeastern Great Plains. These woodlands occur on warm, dry sites on mountain slopes, mesas, plateaus, and ridges. Severe climatic events occurring during the growing season, such as frosts and drought, are thought to limit the distribution of pinyon-juniper woodlands to relatively narrow altitudinal belts on mountainsides. Soils supporting this system vary in texture ranging from stony, cobbly, gravelly sandy loams to clay loam or clay. *Pinus edulis* and/or *Juniperus monosperma* dominate the tree canopy. *Juniperus scopulorum* may codominate or replace *Juniperus monosperma* at higher elevations. Stands with *Juniperus osteosperma* are representative the Colorado Plateau and are not included in this system. In southern transitional areas between Madrean Pinyon-Juniper Woodland and Southern Rocky Mountain Pinyon-Juniper Woodland in central New Mexico,

Juniperus deppeana becomes common. Understory layers are variable and may be dominated by shrubs, graminoids, or be absent. Associated species are more typical of southern Rocky Mountains than the Colorado Plateau and include *Artemisia bigelovii, Cercocarpus montanus, Quercus gambelii, Achnatherum scribneri, Bouteloua gracilis, Festuca arizonica,* or *Pleuraphis jamesii*.

Southern Rocky Mountain Ponderosa Pine Woodland

This very widespread ecological system is most common throughout the cordillera of the Rocky Mountains, from the Greater Yellowstone region south. It is also found in the Colorado Plateau region, west into scattered locations in the Great Basin, and in the Black Hills of South Dakota and Wyoming. These woodlands occur at the lower treeline/ecotone between grassland or shrubland and more mesic coniferous forests typically in warm, dry, exposed sites. Elevations range from less than 1900 m in northern Wyoming to 2800 m in the New Mexico mountains. Occurrences are found on all slopes and aspects; however, moderately steep to very steep slopes or ridgetops are most common. This ecological system generally occurs on igneous, metamorphic, and sedimentary material derived soils, with characteristic features of good aeration and drainage, coarse textures, circumneutral to slightly acid pH, an abundance of mineral material, rockiness, and periods of drought during the growing season. Northern Rocky Mountain Ponderosa Pine Woodland in the eastern Cascades, Okanagan and northern Rockies regions receives winter and spring rains, and thus has a greater spring "green-up" than the drier woodlands in the central Rockies. *Pinus ponderosa* (primarily var. *scopulorum* and var. *brachyptera*) is the predominant conifer; *Pseudotsuga menziesii, Pinus edulis,* and *Juniperus* spp. may be present in the tree canopy. The understory is usually shrubby, with *Artemisia nova, Artemisia tridentata, Arctostaphylos patula, Arctostaphylos uva-ursi, Cercocarpus montanus, Purshia stansburiana, Purshia tridentata, Quercus gambelii, Symphoricarpos oreophilus, Prunus virginiana, Amelanchier alnifolia,* and *Rosa* spp. common species. *Pseudoroegneria spicata* and species of *Hesperostipa, Achnatherum, Festuca, Muhlenbergia,* and *Bouteloua* are some of the common grasses. Mixed fire regimes and ground fires of variable return intervals maintain these woodlands, depending on climate, degree of soil development, and understory density.

Undifferentiated Barren Land

(Rock/Sand/Clay)–Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulation of earthen material. Generally, vegetation accounts for less than 15% of total cover.

I.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.

Bryce, S.A., et al., 2003, *Ecoregions of Nevada*, color poster with map, descriptive text, summary tables, and photographs, U.S. Geological Survey, Reston, Va.

Chapman, S.S., et al., 2006, *Ecoregions of Colorado*, color poster with map, descriptive text, summary tables, and photographs, U.S. Geological Survey, Reston, Va.

Cook, T., et al., 2001, *Western Short Grasslands (NA0815)*, World Wildlife Fund. Available at http://www.worldwildlife.org/wildworld/profiles/terrestrial/na/na0815_full.html. Accessed Oct. 17, 2008.

EPA (U.S. Environmental Protection Agency), 2002, *Primary Distinguishing Characteristics of Level III Ecoregions of the Continental United States*, Draft. Available at http://www.epa.gov/wed/ecoregions/us/useco_desc.doc. Accessed Oct. 2, 2008.

EPA, 2007a, *Level III Ecoregions*, map, Western Ecology Division, Corvalis, Ore. Available at http://www.epa.gov/wed/pages/ecoregions/level_iii.htm. Accessed Oct. 2, 2008.

EPA, 2007b, *Level III Ecoregions*, map, Western Ecology Division, Corvalis, Ore. Available at http://www.epa.gov/wed/pages/ecoregions/images/useco_key.jpg. Accessed Oct. 2, 2008.

Holland, B., et al., 2001, *Mojave Desert (NA1308)*, World Wildlife Fund. Available at http://www.worldwildlife.org/wildworld/profiles/terrestrial/na/na1308_full.html. Accessed Oct. 17, 2008.

Olson, D., and R. Cox, 2001, *California Central Valley Grasslands (NA0801)*, World Wildlife Fund. Available at http://www.worldwildlife.org/wildworld/profiles/terrestrial/na/na0801_full.html. Accessed Oct. 2, 2008.

Primm, S., 2001, *Colorado Plateau Shrublands (NA1304)*, World Wildlife Fund. Available at http://www.worldwildlife.org/wildworld/profiles/terrestrial/na/na1304_full.html. Accessed Oct. 17, 2008.

Thorson, T.D., et al., 2003, *Ecoregions of Oregon*, color poster with map, descriptive text, summary tables, and photographs, U.S. Geological Survey, Reston, Va.

U.S. Geological Survey (USGS), 2005**,** *National Gap Analysis Program, Southwest Regional GAP Analysis Project—Land Cover Descriptions,* RS/GIS Laboratory, College of Natural Resources, Utah State University. Available at http://earth.gis.usu.edu/swgap/legend_desc.html. Accessed Jan. 22, 2010.

Woods, A.J., et al., 2001, *Ecoregions of Utah*, color poster with map, descriptive text, summary tables, and photographs, U.S. Geological Survey, Reston, Va.

This page intentionally left blank.