

1 **3.5 EARTH RESOURCES**
2

3 The following discussion of earth resources is divided into two major topics: geology and soils. The
4 geology section describes the physiography, and mineral and energy resources of McGregor Range. The
5 soils section describes the soils present on McGregor Range and their associated properties. The ROI for
6 earth resources consists of McGregor Range.
7

8 **3.5.1 Geology**
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10 3.5.1.1 Physiography
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12 The McGregor Range is within the Basin and Range Physiographic Province. Extension of the crust
13 throughout the province during the past 30 million years has produced characteristic short, linear
14 mountain ranges separated by intervening valleys (Stewart, 1978). Superimposed along the eastern side
15 of the Basin and Range is a peculiar physiographic feature that extends from west Texas and northern
16 Mexico northward through central New Mexico. This feature, called the Rio Grande Rift Valley, extends
17 northward into the Southern Rocky Mountains physiographic province of southern Colorado and northern
18 New Mexico. From Albuquerque northward, the Rio Grande Rift Valley is a relatively distinct,
19 continuous physiographic feature containing numerous basins. South of Albuquerque, the rift broadens
20 and encompasses several valleys and small, linear mountain ranges. At about the latitude of El Paso,
21 Texas, the Rio Grande Rift Valley turns abruptly to the southeast.
22

23 From south to north, the McGregor Range is comprised of the Hueco Mountains, Otero Mesa, and the
24 Sacramento Mountains. The Hueco Mountains form the western edge of the Diablo Plateau, which
25 extends far into southeast New Mexico and Texas. Otero Mesa is continuous with the Diablo Plateau.
26 North of Otero Mesa the Sacramento Mountains rise steeply. The west side of McGregor Range
27 encompasses a part of the Tularosa Basin which, at 100 miles long and 60 miles wide, is one of the largest
28 valleys in the Rio Grande Rift Valley.
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30 3.5.1.2 Mineral and Energy Resources
31

32 Figure 3.5-1 shows the location of mining districts, quarries, geothermal areas, and exploration holes for
33 oil and gas in and near the McGregor Range. Table 3.5-1 lists, and briefly describes the mining districts
34 in the area.
35

36 The objective of the BLM minerals program under the White Sands RMP as amended by the McGregor
37 Range RMPA, is to provide for the public use of locatable, salable, and leasable minerals on withdrawn
38 public land on McGregor Range consistent with the laws that govern these activities and to minimize
39 environmental damage. Locatable minerals include metallic minerals such as gold, silver, lead, zinc, and
40 copper and nonmetallic minerals such as barite and fluorspar. Salable minerals include industrial
41 minerals and material such as sand, gravel, clay, caliche, stone, and volcanic cinders. Under leasable
42 minerals, oil, gas, and geothermal are the principal activities. The current management policies for
43 mineral and energy resources are described in Section 3.1.2.2, *Nonmilitary Use*.
44

45 Renewal of the land withdrawal for McGregor Range requires that a mineral assessment accompany the
46 withdrawal application. To meet this requirement, a mineral- and energy-resource assessment of
47 McGregor Range was conducted jointly by staff of the New Mexico Bureau of Mines, New Mexico State
48 University, and TRC Mariah Associates, Inc. (U.S. Army, 1998g). The results of this assessment and a
49 review of additional sources are summarized below. Additional material from this study is provided in
50 Appendix C.
51

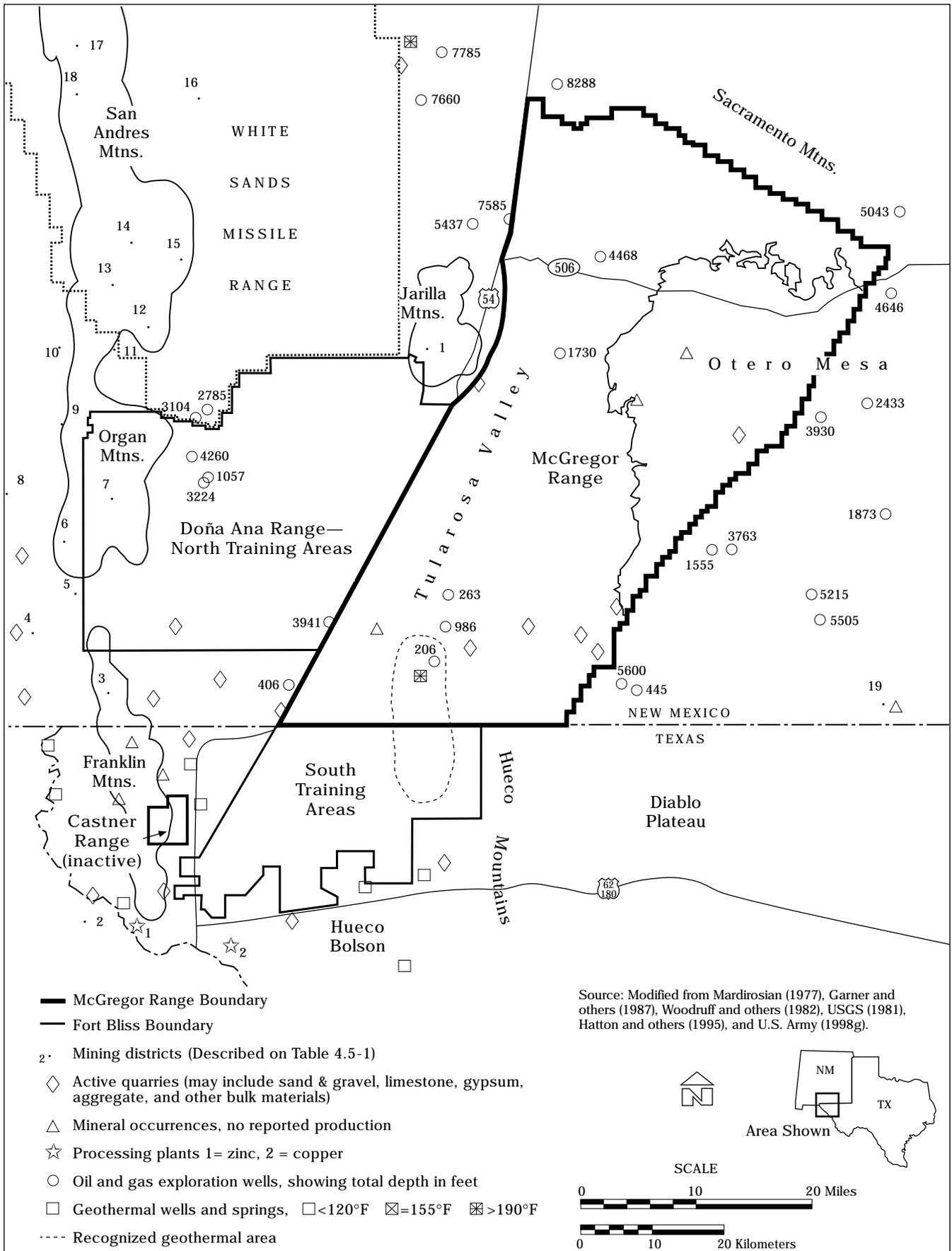


Figure 3.5-1. Mineral and Energy Resources in the McGregor Range Area, Texas and New Mexico.

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Table 3.5-1. Mining Districts in the Vicinity of McGregor Range

<i>Mining District or Mine (see Figure 3.5-3)</i>	<i>Description</i>
#1. Orogrande (Jarilla)	Replacement and skarn deposits of copper, lead, gold, silver, and iron in Pennsylvanian carbonate rocks adjacent to Tertiary intrusive rocks. Also placer deposits. Production estimated between \$1 and \$10 million.
#2. Brickland	Limestone, clay, and shale from Cretaceous rocks for cement. Production less than \$1 million.
#3. N. Franklin Mountains (Copiapo)	Iron from replacement deposits in limestone along shear zones. Lead and fluorspar from veins in dolomite. Gypsum from limestone beds. Production less than \$1 million.
#4. East Vado (active)	Building stone. Production less than \$1 million.
#5. Mesquite	Clay from Pennsylvanian shale. Production less than \$1 million.
#6. Bishop Cap	Fluorspar from veins in limestone. Production less than \$1 million.
#7. White Spar	Barite from veins in limestone. Production less than \$1 million.
#8. Tortugas	Fluorspar from veins and faults in limestone and shale. Production less than \$1 million.
#9. Ruby (or Hayner)	Fluorspar from veins in limestone and shale. Production less than \$1 million.
#10. Organ	Replacement deposits of copper, gold, lead, silver, and zinc in Paleozoic carbonate rocks near Tertiary intrusive rocks. Production estimated between \$1 and \$10 million.
#11. Golden Lily	Fluorspar from veins in Precambrian granite. Production less than \$1 million.
#12. Tennessee	Fluorspar from contact zone between Precambrian granite and dikes. Production less than \$1 million.
#13. Black Mountain	Gold from irregular replacement deposits in dolomite. Production less than \$1 million.
#14. Bear Canyon	Barite and lead from replacement deposits in limestone. Production less than \$1 million.
#15. Stevens	Fluorspar and barite from replacement deposits in limestone. Production less than \$1 million.
#16. Lake Lucero	Sodium compounds and borax from brines in Lake Lucero and surface deposits in nearby alkali flats. Production less than \$1 million.
#17. San Andres	Barite and lead from irregular replacement deposits in limestone. Production less than \$1 million.
#18. Green Crawford	Copper from veins in limestone. Production less than \$1 million.
#19. Cornudas	Nephaline syenite in igneous rocks. A large resource, but no production reported.

2 Sources: Mardirosian, 1977; Garner et al., 1987; U.S. Army, 1998g.

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Metallic Minerals. Five mining districts (or mines) in the vicinity of the McGregor Range have produced metallic minerals (see #1, 3, 10, 13, and 18 on Figure 3.5-1 and Table 3.5-1). None of these districts is currently active (Hatton, et al., 1995). The Orogrande district in the Jarilla Mountains (#1) and the Organ district in the Organ Mountains (#10) have been the largest producers in the area, chiefly copper, gold, lead, silver, zinc, and iron. The value of production at each district was less than \$10 million (Mardirosian, 1977). Small amounts of metallic minerals have also been produced from the Black Mountain district (#13, gold), the Green Crawford district (#18, copper), and the North Franklin Mountains district (#3, iron), all of which are in the Organ and San Andres mountains.

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1 Several areas on McGregor Range have been identified as having some potential for gold, silver, copper,
2 lead, zinc, platinum group, iron, niobium, thorium and rare earths, beryllium, tin, and manganese (Figure
3 3.5-2; [U.S. Army, 1998g]). At most locations the potential is low. The Jarilla Mountains have a
4 moderate potential for deposits of gold, silver, copper, lead, and zinc.

5
6 Industrial Minerals and Materials. Industrial minerals and materials are currently produced from
7 numerous quarries in the vicinity of McGregor Range (Figure 3.5-1). The materials produced are mostly
8 sand, gravel, and limestone. Except for #4 on Figure 3.5-1, none of these quarries are within established
9 or recognized mining districts and are shown on Figure 3.5-1 as “active quarries.” Large amounts of
10 sand, gravel, and building stone are available throughout the Tularosa Basin and Hueco Bolson, as is
11 limestone from Paleozoic rocks in neighboring mountains and mesas.

12
13 Mining districts that have produced industrial minerals and materials are chiefly in the Franklin, Organ,
14 and San Andres mountains (Figure 3.5-1). Materials produced include limestone, clay, and shale for
15 cement; building stone; fluorspar; and barite. The value of the materials produced has been less than \$1
16 million at each district. Only the Vado quarries (#4) are currently active (Hatton et al., 1995). Small
17 amounts of sodium compounds and borax have been produced from a district near White Sands National
18 Monument (#16 on Figure 3.5-1).

19
20 Industrial rocks and minerals occur widely on McGregor Range. Commodities with some potential for
21 development, however, are limited to sand and gravel, limestone, caliche, and gypsum (Figures 3.5-3 and
22 3.5-4; [U.S. Army, 1998g]). The economics of mining these materials depends largely on the costs of
23 transportation. Large amounts of these materials are available in neighboring basins and mountains.

24
25 Energy Resources. The discussion of energy resources for McGregor Range includes geothermal
26 resources, oil and gas resources, and uranium resources.

27
28 **Geothermal.** Geothermal resources of commercial proportion (generally hotter than 194°F and capable
29 of generating commercial amounts of electricity) are most prevalent in areas of crustal instability, high
30 heat-flow, and young igneous rocks (Muffler et al., 1978). In contrast, low-temperature geothermal
31 resources (less than 194°F) occur widely, apparently originating from deep groundwater circulation in
32 regions with normal or higher-than-normal geothermal gradients. Low-temperature resources can be used
33 for such things as space heating, heating domestic water, and desalination.

34
35 The Rio Grande Rift Valley is characterized by crustal instability, moderate to high heat-flow (from 1.5 to
36 more than 2.5 heat-flow units), and warm to hot subsurface waters. The U.S. Army is investigating the
37 potential of a geothermal area at the south end of McGregor Range (Figure 3.5-5). Water temperatures
38 within the 25-mile-long geothermal area range from 176 to 230°F (Henry and Glock, 1981).
39 Temperatures as high as 134°F have been reported from well depths of only 450 feet (Woodruff et al.,
40 1982). Current information indicates that heated water at temperatures between 167 to 185°F exists less
41 than 3,000 feet below the surface; economic use of this resource is currently being evaluated by the U.S.
42 Army (U.S. Army, 1998g). A moderate potential for low-temperature geothermal resources exists along
43 the west side of the range (Figure 3.5-5). Geothermal potential elsewhere on the range is low.

44
45 **Oil and Gas.** The favorability of an area to contain commercial quantities of oil and gas depends on
46 many factors. Important factors include the presence and volume of source rocks; the degree of
47 maturation of the source rocks; the availability of reservoir rocks; and the availability of stratigraphic or
48 structural features to trap the migrating oil and gas. If the severity of post-entrapment tectonic, igneous,
49 and geothermal activity is too intense, the petroleum can vaporize or escape to the atmosphere or
50 hydrosphere along faults and fractures and by fresh-water flushing.

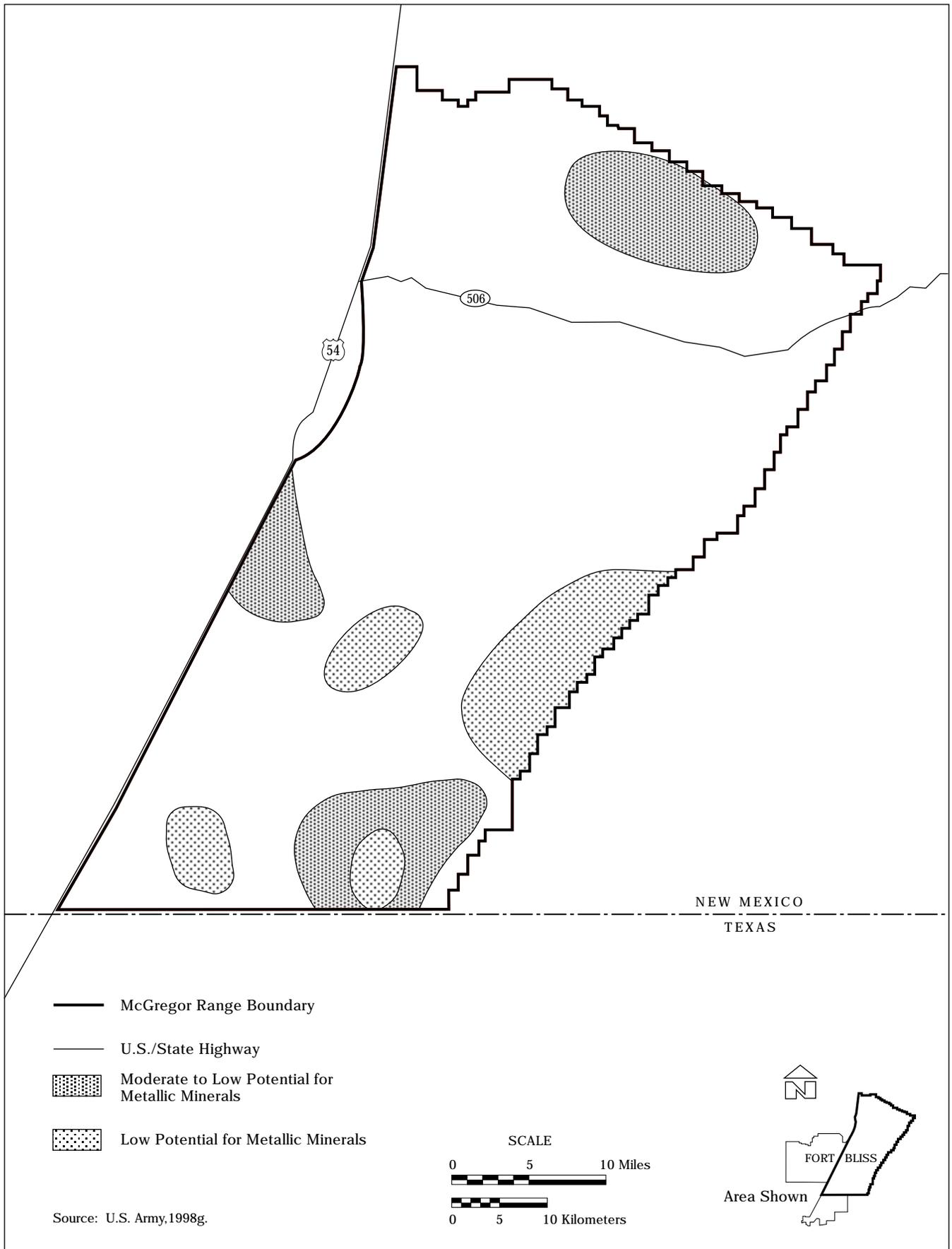


Figure 3.5-2. Areas of Potential for Metallic Minerals on McGregor Range.

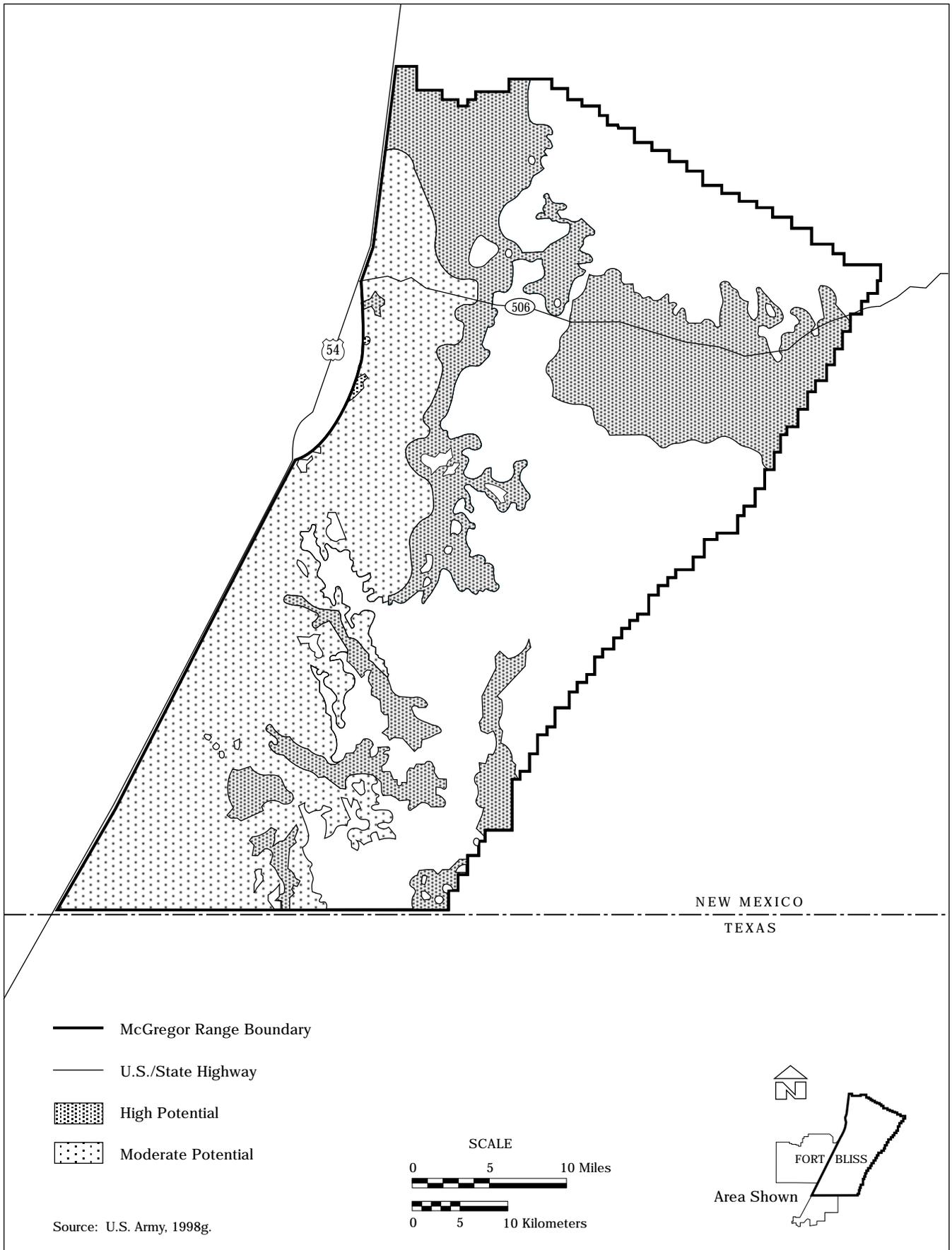


Figure 3.5-3. Resource Potential for Sand and Gravel on McGregor Range.

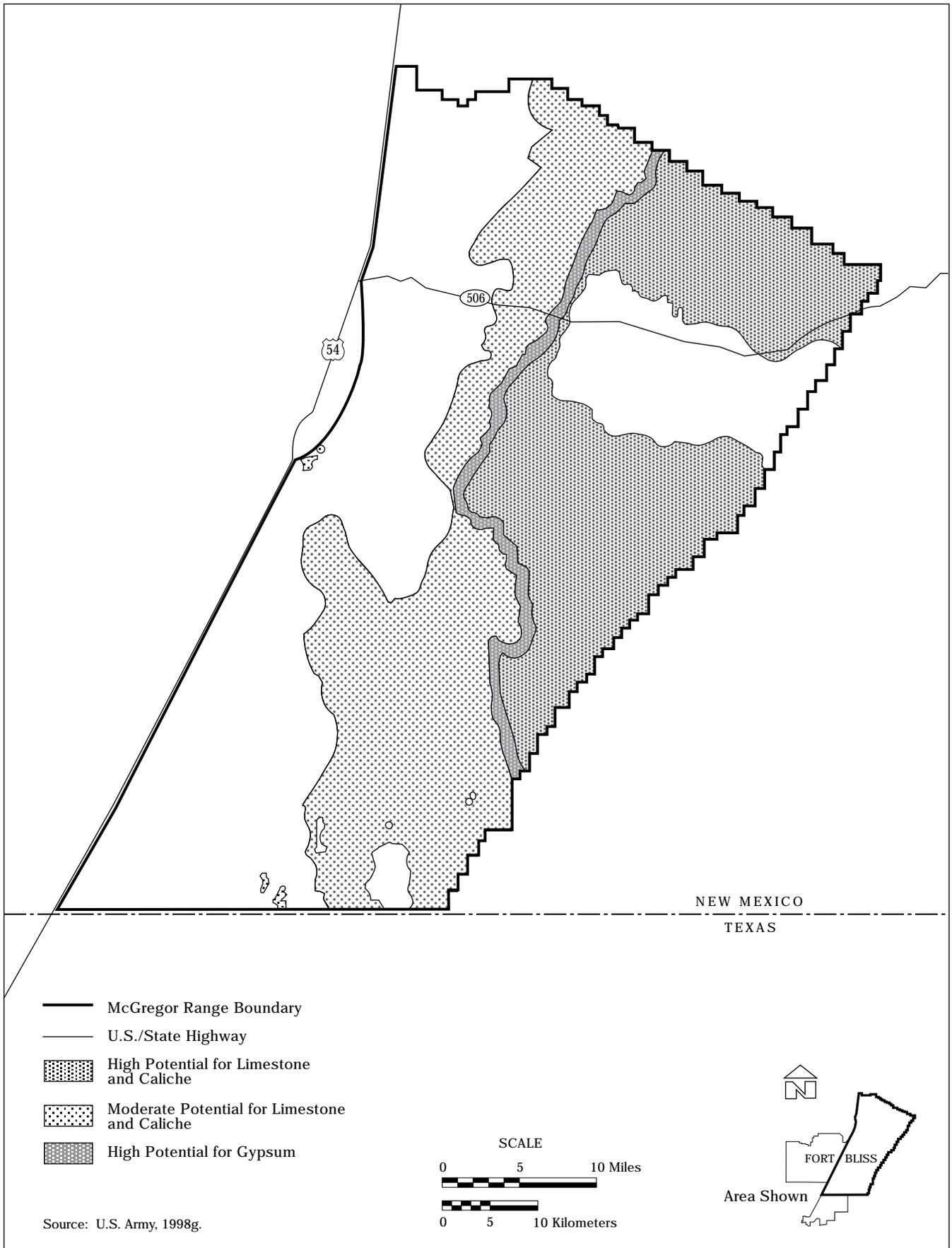
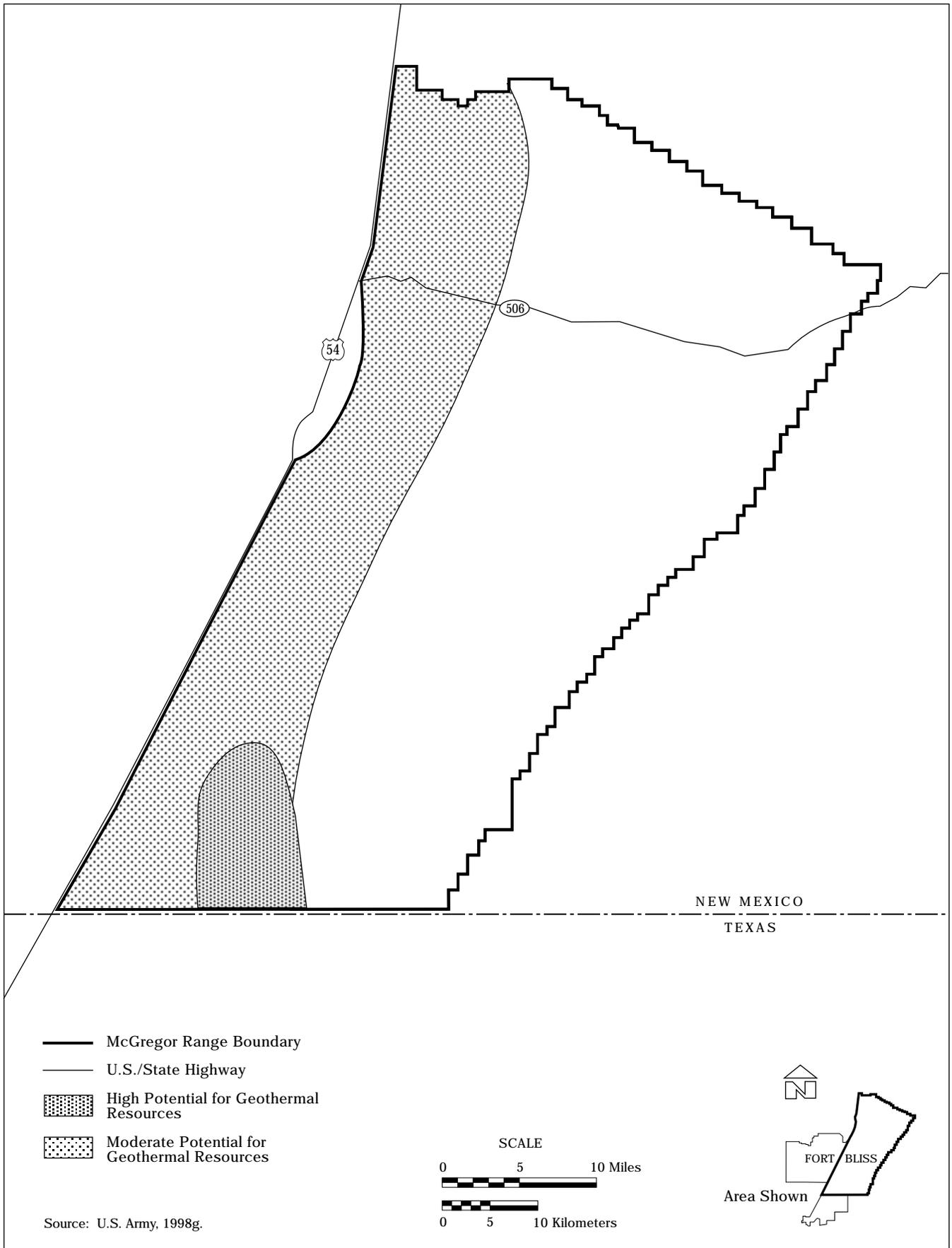


Figure 3.5-4. Resource Potential for Limestone, Caliche, and Gypsum on McGregor Range.



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Figure 3.5-5. Areas of Potential for Geothermal Resources on McGregor Range.

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1 The Tularosa Basin contains numerous Paleozoic source and reservoir rocks (King and Harder, 1985).
2 Through 1980, numerous oil and gas exploration wells had been drilled in the McGregor Range area
3 (Figure 3.5-1), but all were dry (USGS, 1981). Foster (1978) lists the wells that had oil and gas shows.
4 The most successful test wells were drilled in 1974 at the northern end of the Tularosa Basin near Three
5 Rivers, where noncommercial volumes of natural gas were recovered from Pennsylvanian and Permian
6 strata (King and Harder, 1985). Most oil and gas shows from the Tularosa Basin have been from
7 Pennsylvanian and Permian rocks, and a few from Mesozoic rocks (Foster, 1978). Testing of pre-
8 Pennsylvanian rocks has been limited and generally unsuccessful. According to the appraisal by King
9 and Harder (1985), the Tularosa Basin contains abundant source rocks, reservoir rocks, and hydrocarbon
10 traps (stratigraphic pinchouts, unconformities, and structural traps).

11
12 The results of exploration drilling on the Otero Mesa-Diablo Plateau have been disappointing (Black,
13 1975; King and Harder, 1985). Silurian and Permian rocks account for most of the shows. Black (1975)
14 suggests that the lower Paleozoic rocks of the Orogrande Basin are adequate source rocks and that fault
15 and stratigraphic traps along the flanks of the late Paleozoic Padernal Uplift are favorable targets.
16 Otherwise, the Otero Mesa-Diablo Plateau is not considered by King and Harder (1985) as a particularly
17 favorable area for hydrocarbons because of a relatively small volume of source rocks, few traps, and late
18 Tertiary uplift and erosion.

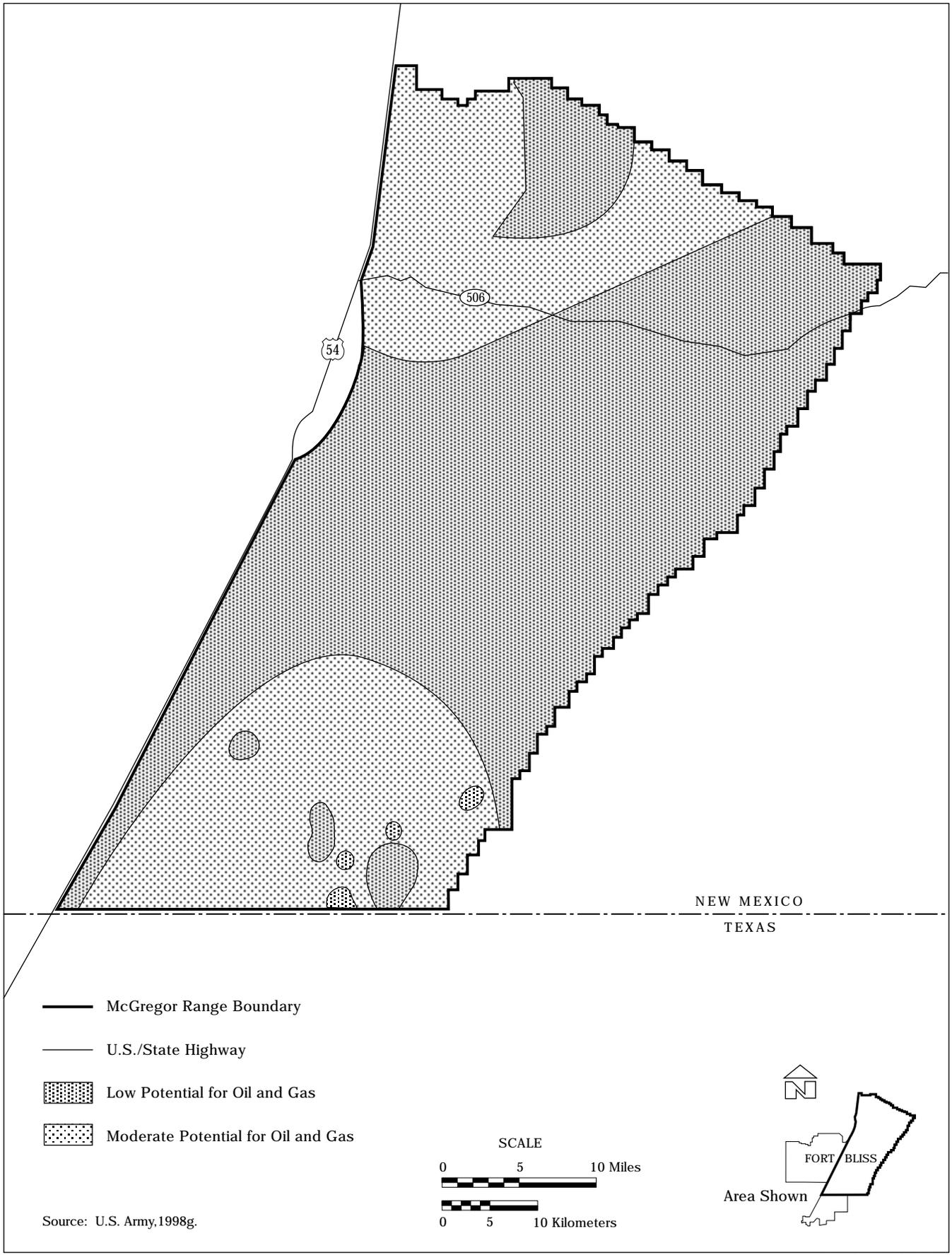
19
20 In addition to the less-than-promising results of drilling to date in the Tularosa Basin, the overall geologic
21 history of south-central New Mexico and west Texas is not particularly favorable for the preservation of
22 moderate to large accumulations of oil and gas. Late Cenozoic crustal extension and high heat-flow
23 during development of the basin and range, and the Rio Grande Rift Valley probably destroyed any
24 moderate- to large-size reservoirs that had survived Early- to Middle-Tertiary igneous activity in the
25 region (Thompson, 1976) (reservoirs with more than 10 million barrels of recoverable oil or 60 billion
26 cubic feet of recoverable gas). If oil and gas resources exist at McGregor Range, they are likely to be
27 small (less than 10 million barrels of recoverable oil or 60 billion cubic feet of recoverable gas). A well
28 drilled recently east of McGregor Range has been determined to be a commercial gas well. This indicates
29 that commercially viable gas resources may exist in the Pennsylvanian rocks on McGregor Range
30 (Jentgen, 1998). This discovery off McGregor Range has prompted oil companies to express interest to
31 the BLM regarding future exploration on McGregor Range (Sanders, 1998), however, there has been no
32 formal request for exploration on McGregor Range. Figure 3.5-6 shows the oil and gas potential of
33 McGregor Range assigned by U.S. Army, (1998g).

34
35 Uranium. The Grants Mineral Belt in northwest New Mexico is the nation's largest producer of uranium
36 (U.S. Department of Energy, 1980). Decreasing demand, however, forced all conventional mines in the
37 state to close in the early 1980s (McLemore and Chenoweth, 1989). Although uranium can occur in a
38 variety of geologic environments, sandstone of Jurassic age has been the most prolific source
39 (Chenoweth, 1976). Jurassic rocks do not occur in south-central New Mexico and west Texas.

40
41 Uranium minerals have been reported from several areas at and near McGregor Range, but uranium
42 deposits are not known to exist on McGregor Range. The potential to develop commercial quantities of
43 uranium at these sites, or elsewhere in the region, is low, considering that highly favorable areas exist
44 elsewhere in New Mexico.

45
46 **3.5.2 Soils**

47
48 Nearly all of McGregor Range is included in the *Otero County, New Mexico Soil Survey* (U.S.
49 Department of Agriculture [USDA], 1981). This survey was conducted and published by the Natural
50 Resources Conservation Service (NRCS) and was mapped at the series, complex, and association
51



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Figure 3.5-6. Oil and Gas Potential on McGregor Range.

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1 levels. An effort is currently underway by the NRCS to resurvey McGregor Range. The purpose of the
2 new survey is to update and refine the current survey, and to map soils that were not previously surveyed.
3 Soils not included in the Otero County survey are found in an unpublished survey conducted by the USFS
4 (Figure 3.5-7).

5
6 The majority of the soils on McGregor Range are classified as either aridisols or entisols, although a few
7 mollisols are found in the area. Aridisols are soils with well-developed pedogenic horizons that
8 developed under conditions of low moisture, and have very little water leaching through the profile
9 (Donahue et al., 1977). Consequently, some of these soils have lime-cemented hardpans (caliche).
10 Entisols are young soils with little or no development of soil horizons located in areas where the soil is
11 actively eroding (slopes) or receiving new deposits of soil materials (alluvial fans, flood plains, and eolian
12 sand dunes). Mollisols occur in the mountains of McGregor Range. They are distinguished by a deep,
13 dark-colored surface horizon, rich in organic matter and saturated with bases.

14
15 Soils on McGregor Range generally consist of sandy, silty, and gravelly loams, and fine sands and silts.
16 The soils are alkaline and calcareous, having developed from the weathering of gypsum, sandstone,
17 limestone, and igneous and metamorphic rocks. Windblown sediments from exposed lakebeds occur
18 widely.

19
20 The soils of McGregor Range can be separated into two general categories based upon the following
21 physiographic positions: valley and basin floors; and mountains, mountain foot slopes, and escarpments.
22 Soils in the valleys and basins are shallow to deep, nearly level to very steep, well-drained to excessively
23 drained soils that formed in alluvium, alluvium modified by wind, and eolian material (USDA, 1981).

24
25 Most of the basin floors are covered by coppice dunes (eolian deposits trapped by mesquite thickets).
26 These soils are found mainly in the Tularosa Basin. The major soil complexes and associations that occur
27 in the valleys and basins include Mimbres-Tome, Nickel-Tencee, and Pintura-Doña Ana. Soils in the
28 valleys and basins are used mainly for grazing, wildlife habitat, and watershed. Military uses include
29 ground-troop training, wheeled and tracked vehicle maneuvering (off-road vehicle maneuvering is limited
30 to TA 8), and missile launching. On-road vehicle training is conducted on the 1,002 miles of roads that
31 cover 2,673 acres of McGregor Range.

32
33 Land surfaces on mountains, mountain foot slopes, and escarpments are either rock outcrops or shallow to
34 deep, well-drained, and nearly level to extremely steep soils that formed in alluvium and colluvium
35 mostly derived from limestone (USDA, 1981). These soils are found mainly in the Sacramento and
36 Hueco mountains, and on Otero Mesa. Major soil units in this category include Ector-Rock outcrop,
37 Lozier-Rock outcrop, and Philder very fine sandy loam. These soils are used mainly for grazing, wildlife
38 habitat, and watershed. In the mountainous areas, military uses are limited because of steep slopes and
39 rough terrain, although some vehicle maneuvering and ground-troop training does occur on these soils.

40
41 Wind and water erosion is currently the most significant process affecting soils on McGregor Range.
42 Soils unprotected by vegetation are susceptible to erosion from wind and water runoff. Gullyng is the
43 most prevalent form of erosion, but sheet and rill erosion from water, and wind erosion are processes that
44 can also significantly affect soil movement.

45
46 The BLM natural units (see Section 3.1.2.2) are considered to have no significant wind erosion:
47 Mountain Foothills, Canyonlands, and Rimlands. The Mesa and Alluvial Fans are subject to moderate
48 erosion rates (20 to 23 tons per acre per year gross erosion), while soil movement in the Bolson is very
49 high (140 tons per acre per year gross erosion). Estimates of water erosion in the co-use area have a rate
50 of sediment yield between 0.3 and 0.5 af per square mile per year throughout the McGregor grazing EIS
51 area (BLM, 1989).

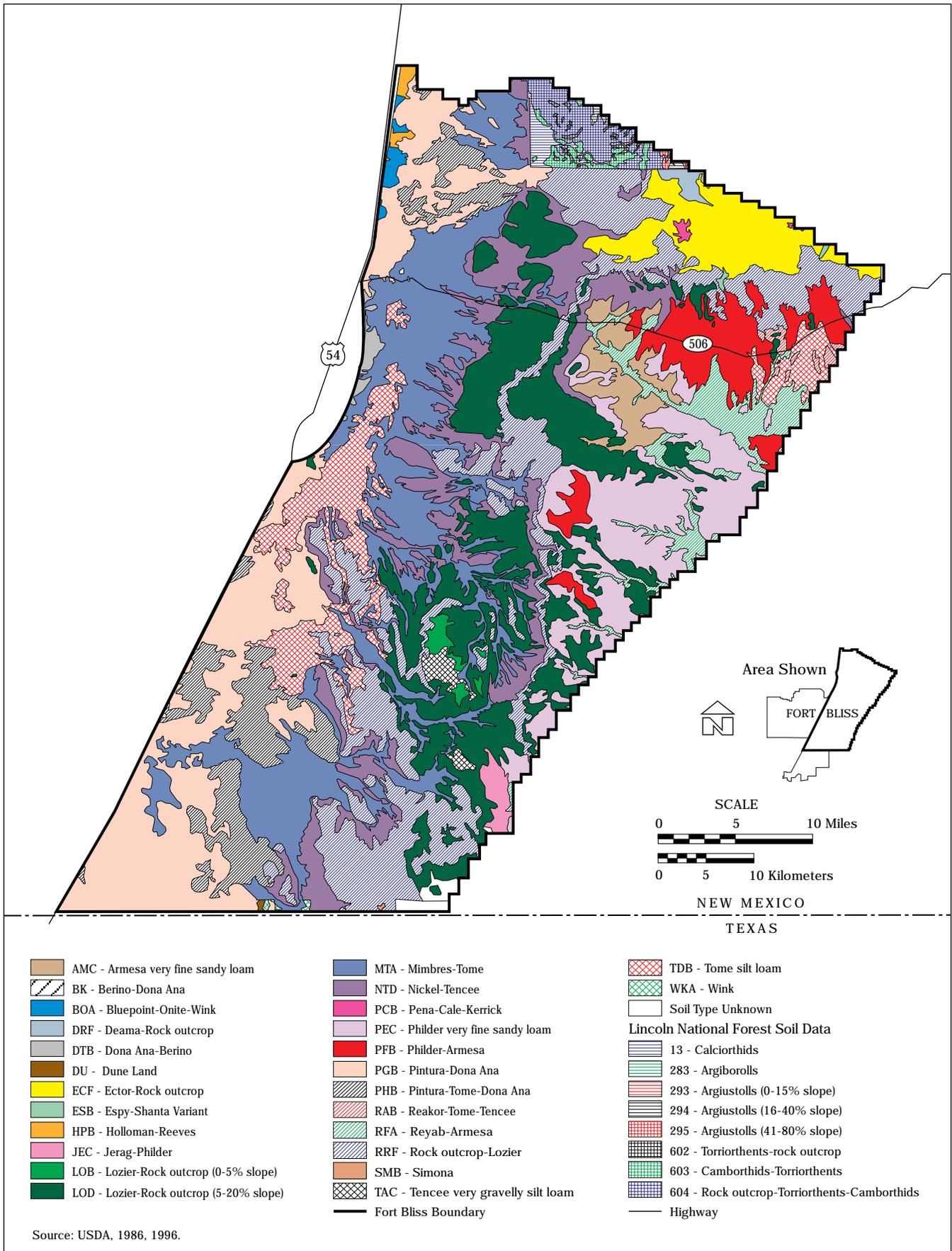


Figure 3.5-7. Distribution of Soil Associations on McGregor Range.

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1 The annual soil loss from wind and water varies primarily according to soil type and vegetative cover.
2 The analysis conducted by the BLM in 1979 described soil loss by natural unit shown by Table 3.5-2.

3
4 **Table 3.5-2. Soil Loss from Wind and Water on McGregor Range**

<i>Natural Unit*</i>	<i>Wind**</i>	<i>Water***</i>
Mountain Foothills	0	0.47
Canyonlands	0	0.32
Mesa	20	0.37
Rimlands	0	0.35
Alluvial Fans	23	0.45
Bolson	140	0.29

5 * See Section 3.1.2.2; ** Tons per acre per year; *** Acre feet per square mile
6 per year.

7 Source: BLM, 1980.
8

9 Erodibility of soils varies considerably across McGregor Range. Figure 3.5-8 shows the erodibility of
10 soils, as well as the location of steep slopes on the range. In general, soil erodibility is a function of soil
11 type, slope, and vegetative cover. Sandy soils are extremely susceptible to wind erosion; loamy sands are
12 highly erodible and capable of supporting a productive vegetative cover. Soils with large amounts of clay
13 are moderately erodible and capable of supporting vegetation. Loamy soils with less than 35 percent clay
14 are slightly erodible, and stony or gravelly soils and rock outcrops are not generally subject to erosion.
15

16 The majority of steep rocky hills and mountains on McGregor Range have only slight erosion potential
17 (USDA, 1981), although during periods of severe thunderstorm activity, large volumes of runoff can
18 build up rapidly, causing flash floods that can produce large gullies. Soils covered by grasses such as
19 those on Otero Mesa have relatively low amounts of erosion, unless they are disturbed, while areas that
20 are predominantly shrublands (creosotebush and mesquite) have higher rates of erosion (particularly from
21 wind) due to the large amounts of exposed soil between shrubs.
22

23 There are several areas where accelerated erosion is a problem on McGregor Range. Soils in the coppice-
24 dunes area of the Tularosa Basin are subject to wind erosion. Most of the soil movement in this area is
25 localized from dune to dune, but on windy days, blowing dust particles rise to the atmosphere
26 (BLM, 1988b). This process could significantly lower air quality. On training ranges in the Tularosa
27 Basin, roads have been constructed in such a manner that they have become channels for rainwater runoff.
28 This has caused a considerable amount of erosion (BLM, 1988b). A similar problem has occurred on
29 roads leading up to Otero Mesa (USAF, 1998). Grazing by livestock has reduced the vegetative cover
30 and exposed the soil surface to erosion in localized areas on Otero Mesa, such as holding areas, watering
31 points, and mineral licks.
32

33 Qualitative observations during the BLM's 1979 field season indicated that near water facilities, the soil
34 is compacted by livestock over areas as large as 10 acres. On clay soils, the compaction could reduce
35 infiltration capacity by as much as 50 percent. On most other soils, the reduction could be 15 to 30
36 percent. There is no effect on sandy or gravelly soils. Because of the reduced infiltration, soil moisture is
37 reduced in the vicinity of water supplies and the survival potential of seeds may be reduced slightly. In
38 areas away from water, the effects of grazing generally relate to the breaking of soil crusts by trampling
39 (BLM, 1990).
40

41 Soil contamination is not a problem on McGregor Range, although the potential for releases of reportable
42 soil contaminants does exist.
43

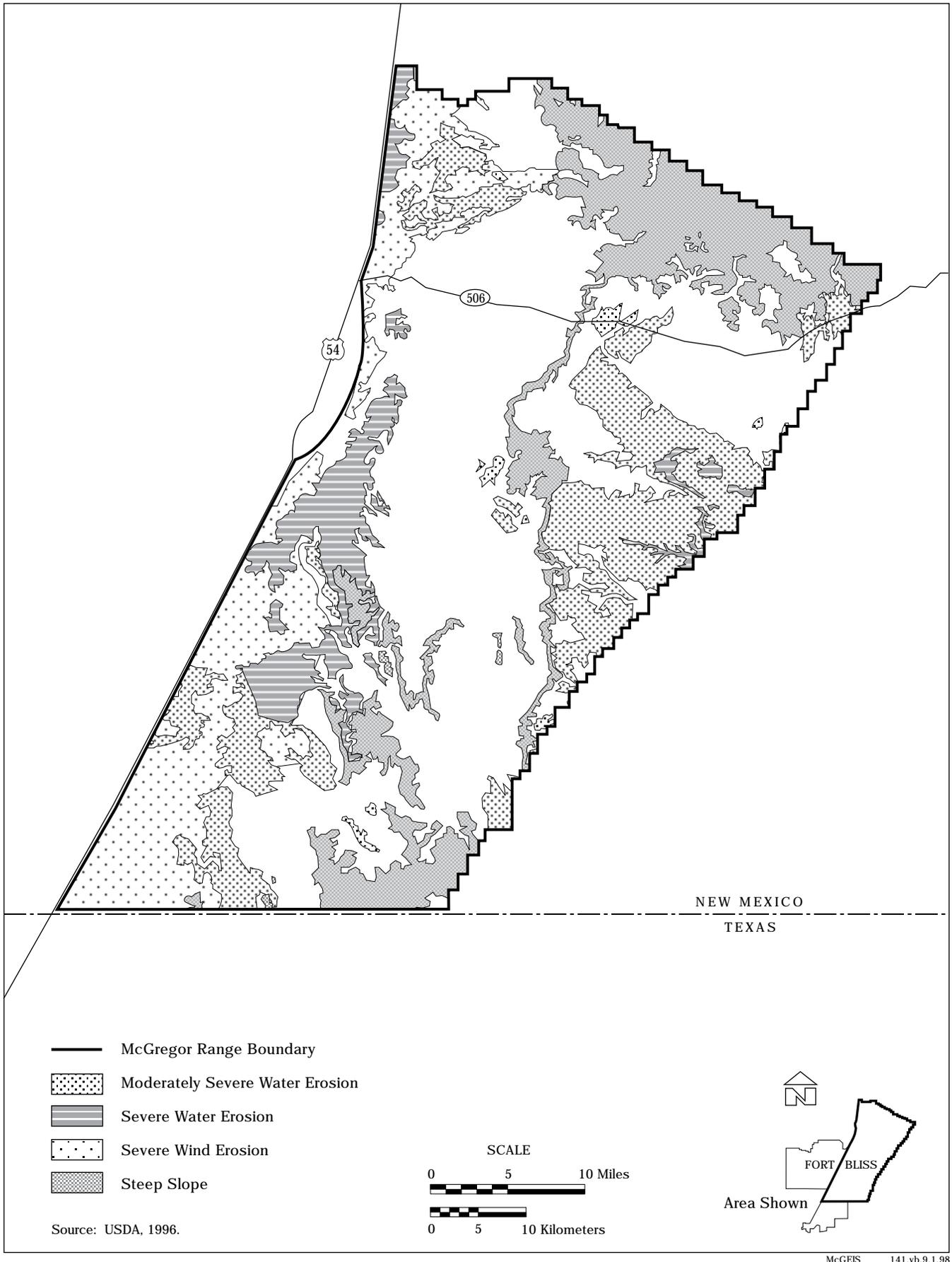


Figure 3.5-8. Steep Slopes and Erodeable Soils Within McGregor Range.