USDA Natural Resources Conservation Service

Ecological site R067BY060CO
Limestone Breaks

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General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

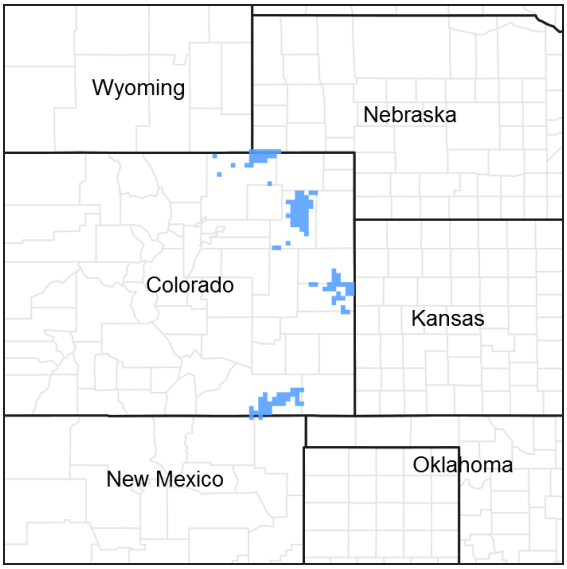


Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 067B–Central High Plains, Southern Part

MLRA 67B occurs in eastern Colorado and consists of rolling plains and river valleys. Some canyonlands occur in the southeast portion. The major rivers are the South Platte and Arkansas which flow from the Rocky Mountains to Nebraska and Kansas. Other rivers in the MLRA include the Cache la Poudre and Republican and associated tributaries. This MLRA is traversed by Interstate 25, 70 and 76; and U.S. Highways 50 and 287. Major land uses include 54 percent rangeland, 35 percent cropland, and 2 percent pasture and hayland. Urban, developed open space, and miscellaneous land occupy approximately 9 percent. Major Cities in this area include Fort Collins, Greeley, Sterling, and Denver. Other cities include Limon, Cheyenne Wells, and Springfield. Land ownership is mostly private. Federal lands include Pawnee and Comanche National Grasslands (U.S. Forest Service), Sand Creek Massacre National Historic Site (National Park Service), and Rocky Mountain Arsenal National Wildlife Refuge (U.S. Fish & Wildlife Service). State Parks include Cherry Creek and Chatfield Reservoirs, and Barr and Jackson Lakes.

This region is periodically affected by severe drought, including the historic “Dust Bowl” of the 1930s. Dust storms may form during drought years in windy periods. Elevations range from 3,400 to 6,000 feet. The Average annual precipitation ranges from 14 to17 inches per year and ranges from 13 inches to over 18 inches, depending upon location. Precipitation occurs mostly during the growing season, often during rapidly developing thunderstorms. Mean annual air temperature (MAAT) is 48 to 52 degrees Fahrenheit. Summer temperatures may exceed 100

degrees Fahrenheit. Winter temperatures may be sub-zero, and snowfall varies from 20 to 40 inches per year. Snow cover frequently melts between snow events.

LRU notes

Land Resource Unit (LRU) A is the northeast portion of MLRA 67B, to an extent of approximately 9 million acres. Most of the LRU is rangeland, and includes the Pawnee National Grassland. Dryland winter wheat/fallow rotations (that may include dryland corn, sunflowers, and sorghum) are grown in most counties. Irrigated cropland is utilized in the South Platte Valley. Small acreage and urban ownership are more concentrated on the Front Range. This LRU is found in portions of Adams, Arapahoe, Elbert, Kit Carson, Larimer, Lincoln, Logan, Washington, and Weld counties. Other counties include Boulder, Cheyenne, Denver, Jefferson, and Yuma. The soil moisture regime is aridic ustic. The mean annual air temperature (MAAT) is 50 degrees Fahrenheit.

LRU B is in the southeast portion of MLRA 67B (2.6 million acres) and includes portions of Baca, Bent, Cheyenne, Kiowa, Las Animas, and Prowers counties. Most of the LRU remains in rangeland and includes the Comanche National Grassland. On the farmed land, a system of dryland winter wheat/fallow rotations (that may include dryland corn, sunflowers, and sorghum) is implemented. Irrigated cropland is found in the Arkansas Valley. The soil moisture regime is aridic ustic and the MAAT is 52 degrees Fahrenheit.

LRU C occurs in portions of Morgan and Weld counties (approximately 1.2 million acres). Most of LRU C is in rangeland. On the farmed land, a system of dryland winter wheat/fallow rotations (that may include dryland corn, sunflowers, and sorghum) is implemented. The soil moisture regime is ustic aridic and the MAAT is 48 degrees Fahrenheit.

Classification relationships

MLRA 67B is in the Colorado Piedmont and Raton Sections of the Great Plains Province (USDA, 2006). The MLRA is further defined by Land Resource Units (LRUs) A, B, and C. Features such as climate, geology, landforms, and key vegetation further refine these concepts and are described in other sections of the Ecological Site Description (ESD). NOTE: To date, these LRUs are DRAFT.

Relationship to Other Hierarchical Classifications:
NRCS Classification Hierarchy: Physiographic Division, Physiographic Province, Physiographic Section, Land Resource Region, Major Land Resource Area, Land Resource Unit (Fenneman, 1946).
USFS Classification Hierarchy: Domain, Division, Province, Section, Subsection,
Land Type Association: Land Type, Land Type Phase (Cleland et al, 1997).

REVISION NOTES:
The Limestone Breaks Ecological Site was developed by an earlier version (2004, revised 2007). This earlier version was based on input from Natural Resources Conservation Service (formerly Soil Conservation Service) and historical information obtained from the Limestone Breaks Range Site descriptions (1975). This ESD meets the Provisional requirements of the National Ecological Site Handbook (NESH). This ESD will continue refinement towards an Approved status according to the NESH.

Ecological site concept

This site is a run-off site on slopes of six percent or greater. The soil surface is within 40 inches of the limestone bedrock.

Associated sites

R067BY002CO	**Loamy Plains** This ecological site is commonly adjacent.
R067BY009CO	**Siltstone Plains** This ecological site is commonly adjacent.
R067BY024CO	**Sandy Plains** This ecological site is commonly adjacent.

R067BY056CO	**Sandstone Breaks** This ecological site is commonly adjacent.
R067BY063CO	**Gravel Breaks** This ecological site is commonly adjacent.

Similar sites

R067BY063CO	**Gravel Breaks** Bedrock is deeper than 40 inches on the Gravel Breaks Ecological Site, and there are greater than 15 percent rock fragments on the soil surface or in the subsoil.
R067BY056CO	**Sandstone Breaks** The Sandstone Breaks Ecological Site overlays sandstone bedrock.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Krascheninnikovia lanata* (2) *Atriplex canescens*
Herbaceous	(1) *Schizachyrium scoparium* (2) *Bouteloua curtipendula*

Physiographic features

This site occurs on ridges, hillslopes, or scarps (or escarpments) on dissected plains or canyonlands. The topography can be rough, broken, and dissected by narrow drainageways or gullies.

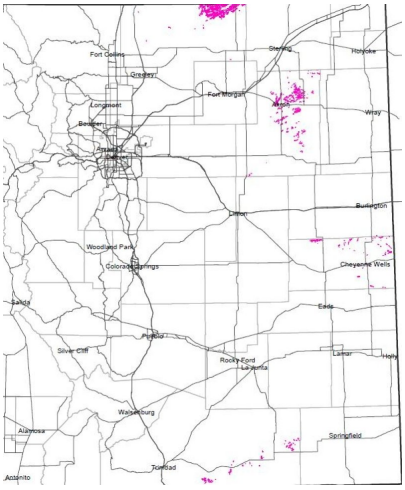


Figure 2. The distribution of the Limestone Breaks site in MLRA 67B.

Table 2. Representative physiographic features

Landforms	(1) Ridge (2) Hillslope (3) Scarp
Runoff class	Medium to high
Flooding frequency	None
Ponding frequency	None
Elevation	1,067–1,676 m
Slope	9–30%
Ponding depth	0 cm
Water table depth	203 cm

Aspect	Aspect is not a significant factor

Climatic features

Average annual precipitation across the MLRA extent is 14 to 17 inches, and ranges from 13 to over 18 inches, depending on location. Precipitation increases from north to south. Mean Annual Air Temperature (MAAT) is 50 degrees Fahrenheit in the northern part and increases to 52 degrees Fahrenheit in the southern part. Portions of Morgan and Weld counties are cooler and drier, the MAAT is 48 degrees Fahrenheit, and average precipitation is 13 to14 inches per year.

Two-thirds of the annual precipitation occurs during the growing season from mid-April to late September. Snowfall averages 30 inches per year, area-wide, but varies by location from 20 to 40 inches per year. Winds are estimated to average 9 miles per hour annually. Daytime winds are generally stronger than at night, and occasional strong storms may bring periods of high winds with gusts to more than 90 mph. High-intensity afternoon thunderstorms may arise. The average length of the freeze-free period (28 degrees Fahrenheit) is 155 days from April 30th to October to 3rd. The average frost-free period (32 degrees Fahrenheit) is 136 days from May 11th to September 24th. July is the hottest month, and December and January are the coldest months. Summer temperatures average 90 degrees Fahrenheit and occasionally exceed 100 degrees Fahrenheit. Summer humidity is low and evaporation is high. Winters are characterized with frequent northerly winds, producing severe cold with temperatures occasionally dropping to -30 degrees Fahrenheit or lower. Blizzard conditions may form quickly. For detailed information, visit the Western Regional Climate Center website:
Western Regional Climate Center Historical Data Western U.S. Climate summaries, NOAA Coop Stations Colorado http://www.wrcc.dri.edu/summary/Climsmco.html.

Table 3. Representative climatic features

Frost-free period (characteristic range)	119-129 days
Freeze-free period (characteristic range)	134-151 days
Precipitation total (characteristic range)	356-432 mm
Frost-free period (actual range)	102-132 days
Freeze-free period (actual range)	126-156 days
Precipitation total (actual range)	356-432 mm
Frost-free period (average)	121 days
Freeze-free period (average)	142 days
Precipitation total (average)	381 mm

Climate stations used

- (1) FT MORGAN [USC00053038], Fort Morgan, CO
- (2) SPRINGFIELD 7 WSW [USC00057866], Springfield, CO
- (3) LIMON WSMO [USW00093010], Limon, CO
- (4) FLAGLER 1S [USC00052932], Flagler, CO
- (5) KIT CARSON [USC00054603], Kit Carson, CO
- (6) BRIGHTON 3 SE [USC00050950], Brighton, CO
- (7) CHEYENNE WELLS [USC00051564], Cheyenne Wells, CO
- (8) BRIGGSDALE [USC00050945], Briggsdale, CO
- (9) BYERS 5 ENE [USC00051179], Byers, CO
- (10) GREELEY UNC [USC00053553], Greeley, CO
- (11) NUNN [USC00056023], Nunn, CO

Influencing water features

There are no water features of the ecological site or adjacent wetland or riparian regimes that influence the vegetation or management of the site.

Soil features

The soils on this site are very shallow to shallow, well to somewhat excessively drained soils that formed from residuum weathered from limestone or very fine grained sandstone. They typically have a moderate to moderately rapid permeability class, but ranges to moderately slow. The available water capacity is very low to low. The soil moisture regime is typically aridic ustic. The soil temperature regime is mesic.

The surface layer of the soils in this site are typically loam, gravelly loam, or channery loam, but may include fine sandy loam, very fine sandy loam, or silt loam. The surface layer ranges from a depth of 3 to 10 inches thick. The subsoil is typically gravelly loam, channery loam, channery sandy loam, or gravelly sandy loam, but may include channery sandy loam, very channery sandy loam, or very channery loamy sand. Soils in this site typically have carbonates at the surface, but some soils may be leached from 0 to 6 inches. These soils are susceptible to erosion by water and wind. The potential for water erosion accelerates with increasing slope. Exposed areas of limestone bedrock are inherent to this site.

Major soil series correlated to this ecological site include: Canyon and Penrose.

Other soil series that have been correlated to this site, but may eventually be re-correlated include: Curabith*.

*Curabith is very deep and lacks contact with bedrock.

Note: Revisions to soil surveys are on-going. For the most recent updates, visit the Web Soil Survey, the official site for soils information: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.

The attributes listed below represent 0-40 inches in depth or to the first restrictive layer.

Table 4. Representative soil features

Parent material	(1) Residuum–limestone and sandstone
Surface texture	(1) Loam (2) Gravelly loam (3) Channery loam
Drainage class	Somewhat excessively drained to well drained
Permeability class	Moderately slow to moderately rapid
Soil depth	15–51 cm
Surface fragment cover <=3"	0–25%
Surface fragment cover >3"	0–15%
Available water capacity (0-101.6cm)	1.52–10.16 cm
Calcium carbonate equivalent (0-101.6cm)	10–75%
Electrical conductivity (0-101.6cm)	0–4 mmhos/cm
Sodium adsorption ratio (0-101.6cm)	0
Soil reaction (1:1 water) (0-101.6cm)	7.4–9
Subsurface fragment volume <=3" (Depth not specified)	0–35%
Subsurface fragment volume >3" (Depth not specified)	0–35%

Ecological dynamics

The Limestone Breaks Ecological Site is characterized by three states: Reference, Warm-Season Shortgrass, and Increased *Bare Ground*. The Reference State is characterized by warm-season mid- and tallgrasses with a variety of forbs and shrubs. The Warm-season Shortgrass State is characterized by a warm-season short bunchgrass (blue grama) and grass-like (threadleaf sedge). The Increased *Bare Ground* State is characterized by annual grasses and forbs, soapweed yucca (aka small soapweed), and broom snakeweed.

Continuous, heavy grazing without allowing for adequate recovery opportunities between grazing events causes this site to deteriorate. Grasses such as little bluestem, sideoats grama, big bluestem, switchgrass, prairie sandreed, western wheatgrass, and needle and thread decrease in both frequency and production. Blue grama and threadleaf sedge increase. Forbs and shrubs such as purple prairie clover, American vetch, winterfat, and fourwing saltbush decrease. Mid- and tallgrasses are eventually be removed from the plant community. Over the long-term, heavy, continuous grazing results in large amounts of bare ground. Species such as Fendler threeawn, sand dropseed, spiny milkvetch (aka mat loco), creeping nailwort (aka sessile nailwort), soapweed yucca (aka small soapweed), broom snakeweed, and annuals increase or invade the site. Tillage is not recommended on this site due to shallow soils and associated low production potential.

The degree of grazing has a significant impact on the ecological dynamics of the site. This region was historically occupied by large grazing animals, such as bison, elk, pronghorn, and mule deer. Grazing by these large herbivores, along with climatic and seasonal weather fluctuations, had a major influence on the ecological dynamics of the site. Deer and pronghorn are widely distributed throughout the MLRA. Secondary influences of herbivory by species such as prairie dogs and other small rodents, insects, and root-feeding organisms continues to impact the vegetation.

Historically, grazing patterns by herds of large ungulates were driven by water distribution, precipitation events, drought events, and fire. It is believed that grazing periods would have been shorter, followed by longer recovery periods. These large migrating herds impacted the ecological processes of nutrient and hydrologic cycles, by urination, trampling (incorporation of litter into the soil surface), and breaking of surface crust, (which increases water infiltration).

Today, livestock grazing, especially beef cattle has been a major influence on the ecological dynamics of the site. Grazing management, coupled with the effects of annual climatic variations, largely dictates the plant communities for the site.

Recurrent drought has historically impacted the vegetation of this region. Changes in species composition vary depending upon the duration and severity of the drought cycle and prior grazing management. Drought events since 2002 have significantly increased mortality of blue grama and buffalograss in some locales.

This site developed with occasional fire as part of the ecological processes. Historic fire frequency (pre-industrial) is estimated at 10 to14 years (Guyette, 2012), randomly distributed, and started by lightning at various times throughout the growing season. Early human inhabitants also were likely to start fires for various reasons (deliberate or accidental). It is believed that fires were set as a management tool for attracting herds of large migratory herbivores (Stewart, 2002). The impact of fire over the past 100 years has been relatively insignificant due to the human control of wildfires and the lack of acceptance of prescribed fire as a management tool.

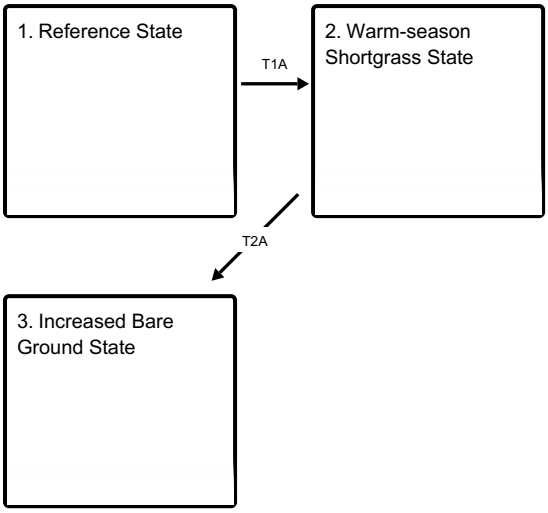
Mechanical treatment consisting of contour pitting, furrowing, terracing, chiseling, and disking has been practiced in the past. It was theorized that the use of this high-input technology would improve production and plant composition on rangeland. These high-cost practices have shown to have no significant long-term benefits on production or plant composition and have only resulted in a permanently rough ground surface. Prescribed grazing that mimics the historic grazing of herds of migratory herbivores, as described earlier, has been shown to result in desired improvements based on management goals for this ecological site.

Eastern Colorado was strongly affected by extended drought conditions in the “Dust Bowl” period of the 1930’s, with recurrent drought cycles in the 1950s and 1970s. Extreme to exceptional drought conditions have re-visited the area from 2002 to 2012, with brief interludes of near normal to normal precipitation years. Long-term effects of these latest drought events have yet to be determined. Growth of native cool-season plants begins about April 1 and continues to mid-June. Native warm-season plants begin growth about May 1 and continue to about August 15.

Regrowth of cool-season plants occurs in September in most years, depending on the availability of moisture.

State and transition model

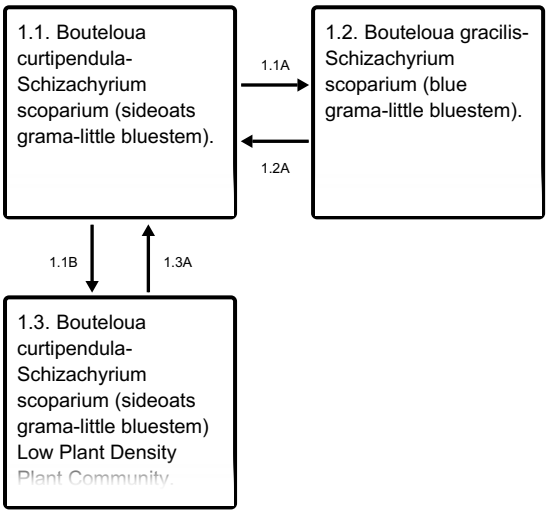
Ecosystem states



T1A - Excessive grazing. Lack of fire.

T2A - Excessive grazing. Lack of fire.

State 1 submodel, plant communities



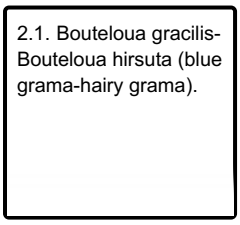
1.1A - Excessive grazing. Lack of fire.

1.1B - Non-use. Lack of fire.

1.2A - Prescribed grazing. Prescribed fire.

1.3A - Prescribed grazing. Prescribed fire.

State 2 submodel, plant communities



State 3 submodel, plant communities

3.1. Salsola-Bassia scoparia/Bromus tectorum-Vulpia octoflora (Russian thistle-burningbush/cheatgrass-sixweeks fescue)

State 1
Reference State

The Reference State is characterized by three distinct plant community phases. The plant communities and various successional stages between them represent the natural range of variability within the Reference State.

Dominant plant species

- oneseed juniper (*Juniperus monosperma*), tree
- winterfat (*Krascheninnikovia lanata*), shrub
- fourwing saltbush (*Atriplex canescens*), shrub
- sideoats grama (*Bouteloua curtipendula*), grass
- little bluestem (*Schizachyrium scoparium*), grass

Community 1.1
Bouteloua curtipendula-Schizachyrium scoparium (sideoats grama-little bluestem).

This plant community is the interpretive plant community. This community evolved with grazing by large herbivores and is suited to grazing by domestic livestock. Historically, fires likely occurred infrequently. This plant community can be found on areas that are grazed and where the grazed plants receive adequate periods of recovery during the growing season. The potential vegetation is about 70 to 80 percent grasses and grass-likes, 10 to 15 percent forbs and 10 to 15 percent woody plants. The principal grasses that dominate this community are little bluestem, sideoats grama, and big bluestem. Secondary grasses are blue grama, switchgrass, western wheatgrass, and needle and thread. Threadleaf sedge and sun sedge are common. Dominant forbs include purple prairie clover, dotted blazing star (dotted gayfeather), spiny milkvetch (mat loco), creeping nailwort (sessile nailwort), and Hood's phlox. Winterfat, fourwing saltbush, skunkbush sumac, wax and golden currant are key shrubs. Trees are occasionally present. One-seed juniper occurs in the southeastern counties. This is a sustainable plant community in terms of soil stability, watershed function, and biological integrity. Litter is properly distributed where vegetative cover is continuous. Some litter movement may occur on steeper slopes. Decadence and natural plant mortality is very low. Community dynamics, nutrient cycle, water cycle, and energy flow are functioning properly. This community is resistant to many disturbances except heavy, continuous grazing, tillage, and development into urban or other uses. Areas having lost all vegetation, such as livestock and vehicle trails are subject to high erosion rates and extreme runoff. Total annual production ranges from 550 to 1,450 pounds of air-dry weight with a Representative Value of 950 pounds.

Dominant plant species

- oneseed juniper (*Juniperus monosperma*), tree
- winterfat (*Krascheninnikovia lanata*), shrub
- fourwing saltbush (*Atriplex canescens*), shrub
- sideoats grama (*Bouteloua curtipendula*), grass
- little bluestem (*Schizachyrium scoparium*), grass

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Grass/Grasslike	415	796	1300
Forb	101	135	163
Shrub/Vine	101	135	163
Tree	–	11	22
Total	**617**	**1077**	**1648**

Figure 10. Plant community growth curve (percent production by month). CO6702, Warm-season dominant, cool-season subdominant; MLRA-67B, upland fine textured soils..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	2	15	45	20	15	3	0	0	0

Community 1.2
Bouteloua gracilis-Schizachyrium scoparium (blue grama-little bluestem).

Blue grama has significantly increased. Little bluestem and sideoats grama are present in reduced amounts. Big bluestem, switchgrass, needle and thread, and western wheatgrass have decreased. Forbs and shrubs that have increased are spiny milkvetch (mat loco), creeping nailwort (sessile nailwort), Hood's phlox, hairy goldenaster, Cuman ragweed (western ragweed), slimflower scurfpea, soapweed yucca, and prairie sagewort (fringed sagebrush). Purple prairie clover, winterfat, fourwing saltbush, currants, and skunkbush sumac have been reduced. Plant frequency, production, and litter levels are lower compared to the Reference Plant Community. Soil erosion may be a concern at this point especially on high travel or impact areas. Some flow paths may be connected and minor rills are evident. Water cycle and nutrient cycle are at risk of becoming impaired due to the reduction of key species. Total annual production ranges from 250 to 800 pounds of air-dry vegetation per acre and averages 500 pounds during a normal year.

Dominant plant species

- oneseed juniper (*Juniperus monosperma*), tree
- winterfat (*Krascheninnikovia lanata*), shrub
- fourwing saltbush (*Atriplex canescens*), shrub
- blue grama (*Bouteloua gracilis*), grass
- little bluestem (*Schizachyrium scoparium*), grass

Figure 11. Plant community growth curve (percent production by month). CO6702, Warm-season dominant, cool-season subdominant; MLRA-67B, upland fine textured soils..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	2	15	45	20	15	3	0	0	0

Community 1.3
Bouteloua curtipendula-Schizachyrium scoparium (sideoats grama-little bluestem) Low Plant Density Plant Community.

This plant community developed under many years of non-use and lack of fire. Plant species resemble the Reference Plant Community however, species frequency and production will be reduced. Eventually, litter levels can become high enough to cause stagnation and mortality of various species such as little bluestem, sideoats grama, big bluestem, switchgrass, and blue grama. Bunchgrasses typically develop dead centers and rhizomatous grasses form small communities because of a lack of stimulation by grazing animals. Initially, high surface litter levels minimize erosion. Advanced stages of non-use or lack of fire can result in lower vigor plants, causing an increase in bare areas. These areas are susceptible to water erosion, especially on steeper slopes. Total annual production varies from 250 to 950 pounds of air-dry vegetation per acre.

Dominant plant species

- oneseed juniper (*Juniperus monosperma*), tree
- winterfat (*Krascheninnikovia lanata*), shrub
- fourwing saltbush (*Atriplex canescens*), shrub
- sideoats grama (*Bouteloua curtipendula*), grass
- little bluestem (*Schizachyrium scoparium*), grass

Figure 12. Plant community growth curve (percent production by month). CO6706, Warm-season dominant, cool-season subdominant, excess litter; MLRA-67B; upland fine textured soils..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	2	8	15	35	18	13	7	2	0	0

Pathway 1.1A
Community 1.1 to 1.2

Continuous, heavy grazing without adequate recovery opportunity between grazing events, and lack of fire shift this plant community to the 1.2 Community. Drought accelerates this process. Recurring spring seasonal grazing decreases cool-season plants. Recurring summer grazing decreases warm-season plants.

Pathway 1.1B
Community 1.1 to 1.3

Non-use and lack of fire cause the Reference Plant Community to shift to the 1.3 Community. Plant decadence and standing dead plant material impede energy flow. Water and nutrient cycles are impaired.

Pathway 1.2A
Community 1.2 to 1.1

Grazing that allows for adequate recovery opportunity between grazing events, proper stocking rate, and prescribed fire shifts the 1.2 community back to the Reference Plant Community.

Conservation practices

Prescribed Burning
Prescribed Grazing

Pathway 1.3A
Community 1.3 to 1.1

The return of grazing with adequate recovery periods and normal fire frequency create a community pathway back to the Reference Plant Community. This change can occur in a relatively short time frame with the return of these disturbances.

Conservation practices

Prescribed Burning
Prescribed Grazing

State 2
Warm-season Shortgrass State

A major shift in species composition and plant functional/structural groups has taken place. Nutrient and water cycles have been negatively affected due to the loss of nitrogen fixing forbs and deeper-rooted plants. Soil erosion is a concern. Rills and pedestaled plants with exposed roots are apparent. An ecological threshold has been

crossed. A significant amount of production and diversity has been lost when compared to the Reference State. Significant biotic and edaphic (soil characteristics) changes have negatively impacted energy flow and nutrient and hydrologic cycles. The loss of functional/structural groups such as warm-season tallgrass reduces the biodiversity and productivity of this site.

Dominant plant species

- oneseed juniper (*Juniperus monosperma*), tree
- prairie sagewort (*Artemisia frigida*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- blue grama (*Bouteloua gracilis*), grass
- hairy grama (*Bouteloua hirsuta*), grass

Community 2.1
Bouteloua gracilis-Bouteloua hirsuta (blue grama-hairy grama).

The dominant grass is blue grama. Hairy grama, Fendler threeawn, and threadleaf sedge have increased. Tallgrasses, palatable forbs and shrubs have been removed. Little bluestem and sideoats grama may exist in remnant amounts on steeper slopes. Forbs and shrubs that continue to increase are spiny milkvetch (mat loco), creeping nailwort (sessile nailwort), Hood's phlox, prairie sagewort (fringed sagebrush), and soapweed yucca. Production ranges from 150 to 400 pounds of air-dry vegetation per acre per year and averages approximately 250 pounds during a normal year.

Dominant plant species

- oneseed juniper (*Juniperus monosperma*), tree
- prairie sagewort (*Artemisia frigida*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- blue grama (*Bouteloua gracilis*), grass
- hairy grama (*Bouteloua hirsuta*), grass

Figure 13. Plant community growth curve (percent production by month). CO6707, Warm-season dominant; MLRA-67B; upland fine-textured soils..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	3	20	45	20	10	2	0	0	0

State 3
Increased Bare Ground State

Litter levels have been reduced substantially. Soil erosion hazard has increased due to the increase of bare ground and may be severe on steeper slopes. Biological integrity, watershed function, and soil stability are all impaired. An ecological threshold has been crossed. Erosion and loss of organic matter and carbon reserves are concerns. Nutrient and water cycles and energy flow are impaired.

Dominant plant species

- oneseed juniper (*Juniperus monosperma*), tree
- soapweed yucca (*Yucca glauca*), shrub
- broom snakeweed (*Gutierrezia sarothrae*), shrub
- cheatgrass (*Bromus tectorum*), grass
- sixweeks fescue (*Vulpia octoflora*), grass
- Russian thistle (*Salsola*), other herbaceous
- burningbush (*Bassia scoparia*), other herbaceous

Community 3.1
Salsola-Bassia scoparia/Bromus tectorum-Vulpia octoflora (Russian thistle-burningbush/cheatgrass-sixweeks fescue).

Bare ground has significantly increased. Remnant amounts of blue and hairy grama may exist in localized areas. Soapweed yucca, broom snakeweed, and pricklypear cactus may remain. Annuals increasing or invading are sixweeks fescue, cheatgrass, burningbush, and Russian thistle. Total annual production varies from 50 to 200 pounds of air-dry vegetation per acre.

Dominant plant species

- oneseed juniper (*Juniperus monosperma*), tree
- broom snakeweed (*Gutierrezia sarothrae*), shrub
- soapweed yucca (*Yucca glauca*), shrub
- cheatgrass (*Bromus tectorum*), grass
- sixweeks fescue (*Vulpia octoflora*), grass
- Russian thistle (*Salsola*), other herbaceous
- burningbush (*Bassia scoparia*), other herbaceous

Figure 14. Plant community growth curve (percent production by month). CO6707, Warm-season dominant; MLRA-67B; upland fine-textured soils..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0	0	0	3	20	45	20	10	2	0	0	0

Transition T1A
State 1 to 2

Heavy, continuous grazing without adequate recovery opportunity between grazing events and lack of fire shift this plant community across an ecological threshold to the Warm-season Shortgrass State. Biotic integrity and hydrologic function are impaired as a result of this transition.

Transition T2A
State 2 to 3

Long-term, heavy, continuous grazing without adequate recovery opportunity between grazing events and lack of fire cause a shift across an ecological threshold to the Increased *Bare Ground* State.

Constraints to recovery. Erosion, loss of organic matter and carbon reserves, and invasion by annual plants are constraints to recovery.

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1				745–852	
	sideoats grama	BOCU	*Bouteloua curtipendula*	160–213	–
	little bluestem	SCSC	*Schizachyrium scoparium*	160–213	–
	big bluestem	ANGE	*Andropogon gerardii*	106–160	–
	switchgrass	PAVI2	*Panicum virgatum*	54–106	–
	Indiangrass	SONU2	*Sorghastrum nutans*	21–75	–
	western wheatgrass	PASM	*Pascopyrum smithii*	33–75	–
	needle and thread	HECOC8	*Hesperostipa comata ssp. comata*	33–75	–
	blue grama	BOGR2	*Bouteloua gracilis*	54–75	–
	green needlegrass	NAVI4	*Nassella viridula*	11–54	–
	Grass, perennial	2GP	*Grass, perennial*	11–54	–

	plains muhly	MUCU3	*Muhlenbergia cuspidata*	11–33	–
	hairy grama	BOHI2	*Bouteloua hirsuta*	11–33	–
	threadleaf sedge	CAFI	*Carex filifolia*	11–33	–
	sun sedge	CAINH2	*Carex inops ssp. heliophila*	11–33	–
	prairie sandreed	CALO	*Calamovilfa longifolia*	0–33	–
	sand bluestem	ANHA	*Andropogon hallii*	0–21	–
	Fendler threeawn	ARPUL	*Aristida purpurea var. longiseta*	0–11	–
	Indian ricegrass	ACHY	*Achnatherum hymenoides*	0–11	–
	squirreltail	ELELE	*Elymus elymoides ssp. elymoides*	0–11	–
	thickspike wheatgrass	ELLAL	*Elymus lanceolatus ssp. lanceolatus*	0–11	–
	prairie Junegrass	KOMA	*Koeleria macrantha*	0–11	–
	buffalograss	BODA2	*Bouteloua dactyloides*	0–11	–
	ring muhly	MUTO2	*Muhlenbergia torreyi*	0–11	–
	sand dropseed	SPCR	*Sporobolus cryptandrus*	0–11	–
	sixweeks fescue	VUOC	*Vulpia octoflora*	0–11	–
	tumblegrass	SCPA	*Schedonnardus paniculatus*	0–11	–
Forb					
2				106–160	
	Forb, perennial	2FP	*Forb, perennial*	11–33	–
	purple prairie clover	DAPUP	*Dalea purpurea var. purpurea*	11–21	–
	dotted blazing star	LIPU	*Liatris punctata*	11–21	–
	rush skeletonplant	LYJU	*Lygodesmia juncea*	0–11	–
	lacy tansyaster	MAPIP4	*Machaeranthera pinnatifida ssp. pinnatifida var. pinnatifida*	0–11	–
	crownleaf evening primrose	OECO2	*Oenothera coronopifolia*	0–11	–
	purple locoweed	OXLA3	*Oxytropis lambertii*	0–11	–
	white locoweed	OXSE	*Oxytropis sericea*	0–11	–
	alpine feverfew	PAAL6	*Parthenium alpinum*	0–11	–
	creeping nailwort	PASE	*Paronychia sessiliflora*	0–11	–
	broadbeard beardtongue	PEAN4	*Penstemon angustifolius*	0–11	–
	beardtongue	PENST	*Penstemon*	0–11	–
	spiny phlox	PHHO	*Phlox hoodii*	0–11	–
	woolly plantain	PLPA2	*Plantago patagonica*	0–11	–
	slimflower scurfpea	PSTE5	*Psoralidium tenuiflorum*	0–11	–
	upright prairie coneflower	RACO3	*Ratibida columnifera*	0–11	–
	scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0–11	–
	desert princesplume	STPIP	*Stanleya pinnata var. pinnata*	0–11	–
	white heath aster	SYER	*Symphyotrichum ericoides*	0–11	–
	stemless four-nerve daisy	TEAC	*Tetraneuris acaulis*	0–11	–
	stiff greenthread	THFI	*Thelesperma filifolium*	0–11	–
	American vetch	VIAM	*Vicia americana*	0–11	–

	winged buckwheat	ERAL4	*Eriogonum alatum*	0–11	–
	sulphur-flower buckwheat	ERUM	*Eriogonum umbellatum*	0–11	–
	hairy false goldenaster	HEVI4	*Heterotheca villosa*	0–11	–
	Cuman ragweed	AMPS	*Ambrosia psilostachya*	0–11	–
	tarragon	ARDR4	*Artemisia dracunculus*	0–11	–
	white sagebrush	ARLU	*Artemisia ludoviciana*	0–11	–
	spiny milkvetch	ASKE	*Astragalus kentrophyta*	0–11	–
	woolly locoweed	ASMO7	*Astragalus mollissimus*	0–11	–
	Mt. Hood pussypaws	CIUM	*Cistanthe umbellata*	0–11	–
	bastard toadflax	COUM	*Comandra umbellata*	0–11	–
	James' cryptantha	CRCIJ	*Cryptantha cinerea var. jamesii*	0–11	–
Shrub/Vine					
3				106–160	
	winterfat	KRLA2	*Krascheninnikovia lanata*	11–54	–
	fourwing saltbush	ATCA2	*Atriplex canescens*	11–33	–
	Shrub (>.5m)	2SHRUB	*Shrub (>.5m)*	11–33	–
	skunkbush sumac	RHTR	*Rhus trilobata*	0–21	–
	golden currant	RIAU	*Ribes aureum*	0–21	–
	wax currant	RICE	*Ribes cereum*	0–21	–
	soapweed yucca	YUGL	*Yucca glauca*	0–11	–
	common hackberry	CEOC	*Celtis occidentalis*	0–11	–
	rubber rabbitbrush	ERNAN5	*Ericameria nauseosa ssp. nauseosa var. nauseosa*	0–11	–
	broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0–11	–
	plains pricklypear	OPPO	*Opuntia polyacantha*	0–11	–
	prairie sagewort	ARFR4	*Artemisia frigida*	0–11	–
Tree					
4	**Tree**			0–11	
	oneseed juniper	JUMO	*Juniperus monosperma*	0–11	–

Animal community

WILDLIFE INTERPRETATIONS:

The combination of grasses, forbs, and shrubs found on the ecological site provide habitat for numerous wildlife species. Historic large grazers that influenced these communities were bison, elk, mule deer, and pronghorn. Bison are no longer widely distributed in their historic range. Pronghorn are the most abundant ungulates using this ecological site, followed by mule deer. Domestic grazers share these habitats with wildlife. The grassland communities of eastern Colorado are home to many bird species. Changes in the composition of the plant community when moving from the Reference Community to other communities on this ecological site may result in species shifts in bird species. The occasional spring found on this site provides essential seasonal water needed for reproductive habitat by some reptiles and amphibians. Because of a lack of permanent water, fish are not common.

Reference Plant Community: Little Bluestem, Sideoats Grama, Big Bluestem, and Shrubs:
The grasses, forbs, and shrubs in this plant community provide habitat for reptiles such as prairie rattlesnake and bullsnake. If water is available for breeding, spadefoot toads may be found here. The structural diversity in the plant community on this site provides habitat for Cassin’s and Brewer’s sparrow, lark bunting, and scaled quail.

Ferruginous and Swainson’s hawks are commonly seen on this site. Small mammals such as white-tailed jackrabbit, swift fox, and several species of mice are common in this plant community. Pronghorn is a typical ungulate found in this community.

1.2 Community: Increased Blue Grama, Decreased Sideoats Grama, Decreased Little Bluestem, Decreased Big Bluestem Decreased Shrubs:

All wildlife species found in the Reference Plant Community are expected in this plant community. However, the loss of some of the vegetative structural diversity in this plant community makes it less attractive to the Reference Plant Community species.

1.3 Plant Community;

The wildlife species found here are similar to those in the Reference Plant Community. However, the lower productivity and vegetative structural diversity makes it less attractive to the Reference Plant Community species.

2.1 Community: Blue Grama and Hairy Grama, Remnant Little Bluestem and Sideoats Grama:

As these communities develop into an open landscape the wildlife species shift away from Reference Plant Community species and toward the species that prefer unvegetated areas and short plants. Texas short- lizard, six-lined racerunner, and black-tailed jackrabbit would be expected more frequently here.

Increased *Bare Ground* Plant Community: Soapweed Yucca, Broom Snakeweed, Annuals:

As these communities develop into an open landscape the wildlife species shift away from Reference Plant Community species and toward the species that prefer unvegetated areas and short plants. Texas short- lizard, six-lined racerunner, and horned lark would be expected more frequently here.

GRAZING INTERPRETATIONS:
The following table lists suggested initial stocking rates for an animal unit (1000-pound beef cow) under continuous grazing (yearlong grazing or growing-season-long grazing) based on normal growing conditions. However, continuous grazing is not recommended. These estimates should only be used as preliminary guidelines in the initial stages of the conservation planning process. Often, the existing plant composition does not entirely match any particular plant community described in this ecological site description. Therefore, field inventories are always recommended to document plant composition, total production, and palatable forage production. Carrying capacity estimates that reflect on-site conditions should be calculated using field inventories.

If the following production estimates are used, they should be adjusted based on animal kind or class and on the specific palatability of the forage plants in the various plant community descriptions. Under a properly stocked, properly applied, prescribed grazing management system that provides adequate recovery periods following each grazing event, improved harvest efficiencies eventually result in increased carrying capacity. See USDA-NRCS Colorado Prescribed Grazing Standard and Specification Guide (528).

Reference PC - (950) (0.26)

1.2 PC - (500) (0.14)
2.1 PC - (250) (0.07)

Grazing by domestic livestock is one of the major income-producing industries in the area. Rangelands in this area provide yearlong forage under prescribed grazing for cattle, sheep, horses and other herbivores. During the dormant period, livestock may need supplementation based on reliable forage analysis.

An on-site inventory is required prior to development of a grazing plan.

Hydrological functions

Water is the principal factor limiting forage production on this site. This site is dominated by soils in hydrologic group B, with localized areas in hydrologic group A. Infiltration is moderate to high and runoff potential for this site is moderate depending on soil hydrologic group and ground cover. Areas where ground cover is less than 50 percent have the greatest potential to have reduced infiltration and higher runoff (refer to NRCS Section 4, National Engineering Handbook (USDA–NRCS, 1972–2012) for runoff quantities and hydrologic curves).

Recreational uses

This site provides hunting, hiking, photography, bird watching, and other opportunities. The wide varieties of plants that bloom from spring until fall have an aesthetic value that appeals to visitors.

Wood products

No appreciable wood products are present on the site.

Other products

Site Development and Testing Plan

General Data (MLRA and Revision Notes, Hierarchical Classification, Ecological Site Concept, Physiographic, Climate, and Water Features, and Soils Data):

Updated. All “Required” items complete to Provisional level.

Community Phase Data (Ecological Dynamics, STM, Transition & Recovery Pathways, Reference Plant Community, Species Composition List, Annual Production Table):

Updated. All “Required” items complete to Provisional level.
NOTE: Annual Production Table is from the “Previously Approved” ESD 2004. The Species Composition List is also from the 2004 version, with minor edits. These will need review for future updates at Approved level.

Each Alternative State/Community:

Complete to Provisional level

Supporting Information (Site Interpretations, Assoc. & Similar Sites, Inventory Data References, Agency/State Correlation, References):

Updated. All “Required” items complete to Provisional level.

Livestock Interpretations updated to reflect Total Annual Production revisions in each plant community.

Wildlife interpretations, general narrative, and individual plant communities updated to the Provisional level. Hydrology, Recreational Uses, Wood Products, Other Products, Plant Preferences table, and Rangeland Health Reference Sheet carried over from previously “Approved” ESD 2004.

Reference Sheet

The Reference Sheet was previously approved in 2007.
It will be updated at the next “Approved” level.

“Future work, as described in a project plan, to validate the information in this provisional ecological site description is needed. This will include field activities to collect low and medium intensity sampling, soil correlations, and analysis of that data. Annual field reviews should be done by soil scientists and vegetation specialists. A final field review, peer review, quality control, and quality assurance reviews of the ESD will be needed to produce the final document.” (NI 430_306 ESI and ESD, April, 2015).

Other information

Relationship to Other Hierarchical Classifications:

NRCS Classification Hierarchy:
Physiographic Divisions of the United States (Fenneman, 1946): Physiographic DivisionPhysiographic ProvincePhysiographic SectionLand Resource RegionMajor Land Resource Area (MLRA)Land Resource Unit (LRU).
USFS Classification Hierarchy:
National Hierarchical Framework of Ecological Units (Cleland et al, 181-200):
DomainDivisionProvinceSectionSubsectionLandtype AssociationLandtypeLandtype Phase.

Inventory data references

NRI: references to Natural Resource Inventory data
Information presented here has been derived from data collection on private and federal lands using:
• Double Sampling (clipped 2 of 5 plots)*
• Rangeland Health (Pellant et al., 2005)
• Soil Stability (Pellant et al., 2005)
• Line Point Intercept : Foliar canopy, basal cover (Forb, Graminoid, Shrub, subshrub, Lichen, Moss, Rock fragments, bare ground, % Litter) (Herrick et al., 2005)
• Soil pedon descriptions collected on site (Schoeneberger et al., 2012)

*NRCS double-sampling method, CO NRCS Similarity Index Worksheet 528(1).
Additional reconnaissance data collection using numerous ocular estimates and other inventory data; NRCS clipping data for USDA program support; Field observations from experienced range trained personnel. Specific data information is contained in individual landowner/user case files and other files located in county NRCS field offices.

Those involved in developing the 2004 site description include: Harvey Sprock, Rangeland Management Specialist, CO-NRCS; Ben Berlinger, Rangeland Management Specialist, CO-NRCS; James Borchert, Soil Scientist, CO-NRCS; Terri Skadeland, Biologist, CO-NRCS.

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Data collection for this ecological site was done in conjunction with the progressive soil surveys within the 67B Central High Plains (Southern Part) of Colorado. It has been mapped and correlated with soils in the following soil surveys: Adams County, Arapahoe County, Baca County, Bent County, Boulder County, Cheyenne County, El Paso County Area, Elbert County, Eastern Part, Kiowa County, Kit Carson County, Larimer County Area, Las Animas County Area, Lincoln County, Logan County, Morgan County, Prowers County, Washington County, Weld County, Northern Part, and Weld County, Southern Part.

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	Harvey Sprock, Ben Berlinger, Daniel Nosal
Contact for lead author	Harvey Sprock, Area Rangeland Management Specialist, Greeley, CO
Date	01/13/2005
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** None to minor. Rills are associated with steeper slopes.

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2. **Presence of water flow patterns:** None to minimal on gentle slopes (< 15 percent). Flow paths should be broken, irregular in appearance. As slope and limestone outcrops increase, flow paths become more apparent and may be connected.

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3. **Number and height of erosional pedestals or terracettes:** None to slight on gentle slopes. Expect some evidence of pedestalled plants when slopes exceed 15 percent.

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** 5 percent or less bare ground, with bare patches generally less than 3 inches. Extended drought may increase bare ground 5 to10 percent. Exposed limestone is inherent to the site and would be considered rock outcrop.

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5. **Number of gullies and erosion associated with gullies:** None on gentle slopes. Gullies may be present on steeper slopes or limestone outcrop.

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6. **Extent of wind scoured, blowouts and/or depositional areas:** None to minor. Steep exposed areas may have small areas of wind souring.

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7. **Amount of litter movement (describe size and distance expected to travel):** Litter movement is associated with water flow patterns and may move as much as 1 to 3 feet down slope during severe precipitation events, especially on steeper slopes.

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8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):** Stability class rating is anticipated to be 3 to 4 in interspaces at soil surface.

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Average SOM ranges from 1 to 3 percent. Soils are typically shallow and well drained. A-horizon ranges from 0 to 7 inches in depth with a grayish brown color. Surface texture is typically loam. Structure is weak medium granular. Caliche (limestone) fragments found on surface.

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Raindrop impact is reduced by the diverse grass, forb, shrub functional/structural groups and root structure. This slows overland flow and provides increased time for infiltration to occur. Extended drought, wildfire or both may reduce basal density, canopy cover, and litter amounts (primarily from tall, warm-season bunch and rhizomatous grasses), resulting in decreased infiltration and increased runoff on steep slopes following intense rainfall events.

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** None

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant: Warm-season mid bunchgrass >/=

    Sub-dominant: Warm-season tall bunchgrass > cool-season bunchgrass/grasslikes > shrubs >/= warm-season short bunchgrass = warm-season forbs > cool-season mid rhizomatous grasses >

    Other: Leguminous forbs > cool-season forbs

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** None to slight. Expect slight mortality and decadence during and following extended drought.

14. **Average percent litter cover (%) and depth (in):** 30 to 45 percent litter cover at 0.25 inch depth on gentle slopes and 5 to 15 percent on steeper areas and exposed limestone.

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 550 lbs./ac. low precip years; 950 lbs./ac. average precip years; 1450 lbs./ac. high precip years. After extended drought or the first growing season following wildfire, production may be significantly reduced by 200-400 lbs./ac.

16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not**

invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site: Invasive plants should not occur in the reference plant community. Cheatgrass, Russian thistle, burningbush, other non-native annuals may invade following extended drought or fire assuming a seed source is available.

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17. **Perennial plant reproductive capability:** The only limitations are weather-related, wildfire, natural disease, and insects that may temporarily reduce reproductive capability.
