USDA Natural Resources
Conservation Service

Ecological site R081DY297TX
Gravelly 8-14 PZ

Last updated: 9/19/2023
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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.

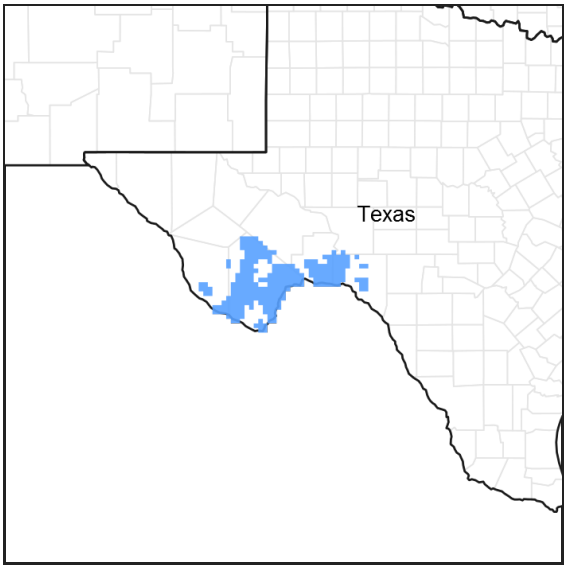


Figure 1. Mapped extent

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): 081D–Southern Edwards Plateau

This area is underlain primarily by limestones in the Austin Chalk, Boquillas Flags, Devil's River, Santa Elena, Buda, and Del Rio Clay Formations of Cretaceous age. Quaternary sand and gravel are in the river valleys.

The 81D is in the hyperthermic thermic zone

Classification relationships

USDA-NRCS Ag Handbook 296

Ecological site concept

The site consists of very shallow to very deep soils that formed in gravelly alluvium derived from limestone bedrock. Soils with restrictive layers such as a petrocalcic horizon will have very slow permeability in these layers. This site is characterized by warm-season bunch grasses, stoloniferous grass, with scattered shrubs and a variety of forbs.

Associated sites

R042AB264TX	**Igneous Hill and Mountain, Hot Desert Shrub** The Gravelly 8-14” PZ will be found below Igneous Hill and Mountain Desert Shrub.
R042AB737TX	**Limestone Hill and Mountain, Hot Desert Shrub** The Gravelly 8-14” PZ does not have the limestone rocks in the surface.
R081DY295TX	**Flagstone Hill 8-14 PZ** The Flagstone Hill site has channers and flagstones on the surface and in the soil profile.
R081DY592TX	**Limestone Hill 8-14 PZ** The Limestone Hill site has cobbles and stones along with the gravels.

Similar sites

R042AC244TX	**Gravelly, Desert Grassland** The Gravelly (DG) is found at higher elevations and slightly more production.

Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) *Larrea tridentata*
Herbaceous	(1) *Bouteloua ramosa*

Physiographic features

The Gravelly Ecological Site consists of soils that are very deep and soils that are very shallow and shallow to a restrictive layer such as a petrocalcic horizon, shale, or tuff parent material. They formed in calcareous loamy materials containing gravel from mixed sources. These soils are on nearly level, hilly uplands fan piedmonts. Slope ranges from 0 to 30 percent. Elevations range from 1100 to 4000 feet.

Table 2. Representative physiographic features

Landforms	(1) Piedmont slope > Inset fan (2) Piedmont slope > Fan remnant (3) Piedmont slope > Alluvial fan (4) Plateau > Ridge
Runoff class	Low to very high
Flooding frequency	None
Ponding frequency	None
Elevation	1,100–4,000 ft
Slope	0–30%
Aspect	Aspect is not a significant factor

Climatic features

The average annual precipitation ranges from 8 to 14 inches. The annual total can vary from two to 21 inches. Most of the precipitation occurs as widely scattered thunderstorms of high intensity and short duration during the summer. Occasional precipitation occurs as light rainfall during the cool season. Negligible amounts of precipitation falls in the form of sleet or snow.

Mean annual air temperature is 70° F. Daytime temperatures exceeding 100° F are common from May through September. Frost-free period ranges from 246 to 256 days. Freeze-free period ranges from 277 to 290 days.

The average relative humidity in mid-afternoon is about 25 percent. Relative humidity is higher at night, and the average at dawn is about 57 percent. The sun shines 81 percent of the time in summer and 75 percent in winter. The prevailing wind is from the southwest. Average wind speed is highest, around 11 miles per hour, in March and April.

The combination of low rainfall and relative humidity, warm temperatures, and high solar radiation creates a significant moisture deficit. The annual Class-A pan evaporation is approximately 94 inches.

Table 3. Representative climatic features

Frost-free period (characteristic range)	240-280 days
Freeze-free period (characteristic range)	270-300 days
Precipitation total (characteristic range)	8-15 in
Frost-free period (actual range)	240-280 days
Freeze-free period (actual range)	270-300 days
Precipitation total (actual range)	8-15 in
Frost-free period (average)	260 days
Freeze-free period (average)	280 days
Precipitation total (average)	13 in

Climate stations used

- (1) LANGTRY [USC00415048], Comstock, TX
- (2) DRYDEN TERRELL CO AP [USW00003032], Dryden, TX
- (3) PERSIMMON GAP [USC00416959], Big Bend National Park, TX

Influencing water features

None.

Wetland description

N/A

Soil features

The site consists of very shallow to very deep soils that formed in gravelly alluvium derived from limestone bedrock. Soils with restrictive layers such as a petrocalcic horizon will have very slow permeability in these layers. Runoff is low to medium on slopes less than 1 percent and very high on slopes greater than 20 percent.

The associated soil series include Strawhouse and Stillwell.

This soil is classified as “Hyperthermic”, meaning that the Mean Annual Soil Temperature typically measured at 20 inches depth is >72 degrees F based on the summary of a 5-year soil temperature study near La Linda, Texas.

Table 4. Representative soil features

Parent material	(1) Alluvium–limestone
Surface texture	(1) Very gravelly coarse sandy loam (2) Very gravelly sandy loam (3) Very gravelly fine sandy loam (4) Very gravelly loam
Family particle size	(1) Loamy-skeletal
Drainage class	Well drained
Permeability class	Very slow to moderate
Depth to restrictive layer	10–80 in

Soil depth	10–80 in
Surface fragment cover <=3"	42–70%
Surface fragment cover >3"	2–16%
Available water capacity (0-40in)	1–2 in
Calcium carbonate equivalent (0-40in)	35–80%
Electrical conductivity (0-40in)	0–4 mmhos/cm
Sodium adsorption ratio (0-40in)	0–5
Soil reaction (1:1 water) (0-40in)	7.9–8.4
Subsurface fragment volume <=3" (4-40in)	30–60%
Subsurface fragment volume >3" (4-40in)	5–20%

Ecological dynamics

The reference plant community on the Gravelly 8-14” PZ ecological site consists of bunch and stoloniferous grasses along with a variety of perennial forbs and woody shrubs.

Probably the factor that most influenced the historic vegetative composition of the site was extended dry weather. High rainfall events did occur but were episodic. However, insects and grazers such as rodents, deer, and infrequent fire certainly played a part. Bison were not documented in the historical record as being present in any significant amount. A lack of water was probably a contributing factor. The perennial grasses dominating the site could survive the periodic droughts as long as the density of woody plants did not become excessive, and top-removal of the grass plants did not occur too frequently. Overgrazing amplifies the effects of drought.

Early historical records do not always provide information specific to a site but can provide insight as to conditions existing in a general vicinity. Accounts suggest cattle, sheep, and horses were introduced into the southwest from Mexico in the mid-1500s. However, extensive ranching did not begin in the Trans-Pecos region until the 1880s. Early explorers described the vegetation as they traveled over parts of the Trans-Pecos. For instance, Captain John Pope in 1854 described a portion of the Trans-Pecos area as “…destitute of wood and water, except at particular points, but covered with a luxuriant growth of the richest and most nutritious grasses known to this continent…”. Other early travelers describe the scattered springs and water sources that were found in the region. Wagon travel could only be accomplished, along trails that had both water and forage sufficient for overnight stops. Livestock numbers peaked in the late 1880s following the arrival of railroads. Some historical accounts document ranches with stocking rates as high as one animal unit per four acres; however, this was far from sustainable in this environment.

Decades of overgrazing with loss of vegetation and erosion make it a slow process to return to the reference community. In 1944 the southernmost portion of the Trans-Pecos area was set aside as Big Bend National Park. Grazing activities with livestock ceased. For example, in 1944, most of the Gravelly ecological sites accessible to livestock were probably degraded and dominated by woody shrubs. After 60 years of no grazing, the majority of sites have not recovered to the historic plant community which provides insight into the length of time it takes for recovery in this environment.

The large livestock herds brought in during the favorable years, mainly sheep, could not be sustained during the drought. Overgrazing became a major issue as the extended dry weather was a harsh taskmaster to the early stock growers.

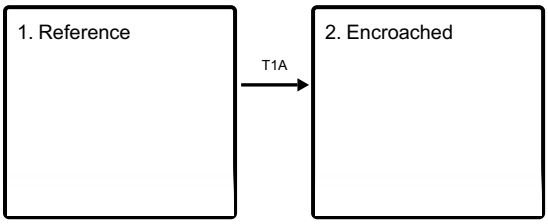
Cattle use on rangeland declines significantly on slopes steeper than 15 percent, however cattle numbers were never very large. Sheep and goats are however able to utilize slopes up to about 45 percent and can negotiate the

surface rock cover better than cattle. It should be noted that abusive grazing by different kinds and classes of livestock will result in different impacts on the site. One effect of the removal of vegetated cover was to expose bare ground to erosion. Another effect was the deterioration of perennial grasses which removed the source of fine fuel to sustain periodic fires. More than likely, fires were not very frequent and when they did occur, the burn pattern was a mosaic governed by terrain and vegetative features.

The following diagram suggests general pathways that the vegetation on this site might follow. There may be other states not shown in the diagram. This information is intended to show what might happen in a given set of circumstances; it does not mean that this would happen the same way in every instance. Local professional guidance should always be sought before pursuing a treatment scenario.

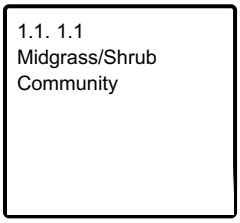
State and transition model

Ecosystem states

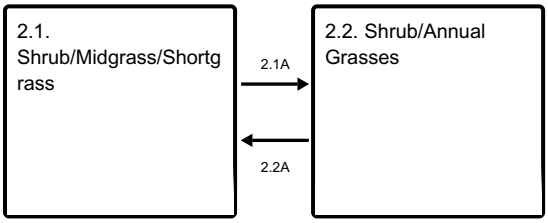


T1A - Prolonged drought coupled with excessive grazing pressure

State 1 submodel, plant communities



State 2 submodel, plant communities



State 1
Reference

The reference state is considered to be representative of the natural range of variation under pre-Euro settlement conditions. It is characterized by a diverse mixture of warm-season grasses and shrubs. Community phase changes are primarily driven by prolonged drought.

Dominant plant species

- Chino grama (*Bouteloua ramosa*), grass
- bush muhly (*Muhlenbergia porteri*), grass
- black grama (*Bouteloua eriopoda*), grass

Community 1.1
1.1 Midgrass/Shrub Community

The Midgrass/Shrub Community (1.1) is the reference plant community for the Gravelly 8-14” PZ Ecological Site. Grasses total approximately 70% of the species composition by air dry weight, while shrubs and forbs account for

25% and 5% respectively. Chino grama dominates the midgrasses along with a diversity of other palatable mid and shortgrasses. Creosotebush is the most common shrub as it thrives in gravelly and calcareous soils. A diversity of subshrubs, succulents, and forbs are also present. The characteristically high surface cover of gravels of the site helps reduce soil erosion. The diversity of plants provides necessary food and cover for native wildlife. Extended dry weather causes an overall decline in grass cover and production and can cause some retrogression. However, the reference community evolved with plants that have drought tolerance. Long term retrogression is triggered primarily by abusive grazing which causes an immediate decrease and eradication of the most palatable plants black grama, sideoats grama, Arizona cottontop, and bush muhly. Resulting from the inherently low production potential of the site, shrub encroachment following grass removal is slow. Annual forbs, grasses, and succulents are the first to increase following a decrease in perennial grass cover Conservation practices such as prescribed grazing can help maintain ecological integrity in the reference community. Stocking rates need to be flexible and adjusted to carrying capacity because of sporadic rainfall.

Table 5. Annual production by plant type

Plant Type	Low (Lb/Acre)	Representative Value (Lb/Acre)	High (Lb/Acre)
Grass/Grasslike	140	245	350
Shrub/Vine	50	87	125
Forb	10	18	25
Tree	0	0	0
Total	**200**	**350**	**500**

Figure 9. Plant community growth curve (percent production by month). TX4006, Shortgrass Shrub Dominant Community. Shortgrasses with 40% woody canopy of shrubs..

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	2	2	2	8	8	20	25	15	15	1

State 2
Encroached

The Encroached state is characterized by a reduction in warm-season grass diversity, loss of herbaceous cover and increased bare ground. Native shrubs have increased in cover and density and are controlling site resources, including infiltration, runoff, and nutrient cycling.

Dominant plant species

- creosote bush (*Larrea tridentata*), shrub
- Chino grama (*Bouteloua ramosa*), grass

Community 2.1
Shrub/Midgrass/Shortgrass

This plant community is the result of improper grazing (high stocking rates). Extended drought exacerbates the transition from the reference. A compositional and irreversible threshold has been crossed. The vast majority of the most palatable grasses, forbs, and sub-shrubs have been eradicated from the plant community. Although palatable when green, Chino grama increases following the decrease of other midgrasses. It becomes the dominant, and in some places, the only perennial bunchgrass observed. Fluffgrass is an unpalatable shortgrass that increases following disturbance. Some perennial forbs and succulents increase such as dogweed, coldenia, pricklypear, and lechuguilla. Because of the inherently low productivity of the site, shrub encroachment following perennial grass reduction is very slow if at all. Percentage of total plant community by weight is estimated to be 25 percent grass, 60 percent shrubs, and 15 percent forbs.

Resilience management. Climate, soil temperatures and properties, are some of the major factors limiting the restoration of the reference. Continued overgrazing will transition this plant community to a Shrubland/Annual Grasses community (2.2). Prescribed grazing will help maintain the ecologic integrity of the community. Stocking

rates need to be flexible and adjusted to carrying capacity because of sporadic rainfall.

Community 2.2
Shrub/Annual Grasses

Plant community 2.2 is the result of excessive overutilization of plant resources. Annual and shortgrasses dominated the herbaceous layer. Few isolated Chino grama plants can be observed. Succulents and unpalatable perennial forbs increase. Because of the inherently low productivity of the site, shrub encroachment following perennial grass reduction is very slow if at all. The appearance of this community is a very sparse shrubland. Shrubs are scattered and not overlapping. Overall canopy cover is low. Percentage of total plant community by weight is estimated to be 5 percent grass, 80 percent shrubs, and 15 percent forbs.

Resilience management. With several years of prescribed grazing and favorable rainfall, some areas of this plant community have the potential to return to a Shrub mid/shortgrass community (2.1). Some areas within the lowest elevations of the site's range, may not be able to transition back to community 2.1.

Pathway 2.1A
Community 2.1 to 2.2

This plant community shift is the result of improper grazing (high stocking rates). Extended drought exacerbates the transition from the reference.

Pathway 2.2A
Community 2.2 to 2.1

With a prescribed grazing plan that includes rest and recovery periods along with favorable rainfall, the site may shift back to community 2.1.

Transition T1A
State 1 to 2

This transition is the result of improper grazing (high stocking rates). Extended drought exacerbates the transition from the reference.

Additional community tables

Table 6. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Lb/Acre)	Foliar Cover (%)
Grass/Grasslike					
1	**Mid/Shortgrasses**			100–250	
	Chino grama	BORA4	*Bouteloua ramosa*	60–150	–
	bush muhly	MUPO2	*Muhlenbergia porteri*	20–50	–
	black grama	BOER4	*Bouteloua eriopoda*	20–50	–
2	**Mid/Shortgrasses**			30–75	
	threeawn	ARIST	*Aristida*	10–25	–
	fall witchgrass	DICO6	*Digitaria cognata*	10–25	–
	slim tridens	TRMU	*Tridens muticus*	10–25	–
	sideoats grama	BOCU	*Bouteloua curtipendula*	0–5	–
	Arizona cottontop	DICA8	*Digitaria californica*	0–5	–
3	**Shortgrasses**			10–25	
	nineawn pappusgrass	ENDE	*Enneapogon desvauxii*	4–10	–
	hairy woollygrass	ERPI5	*Erioneuron pilosum*	2–5	–
	red grama	BOTR2	*Bouteloua trifida*	2–5	–

	red grama	BOTR2	*Bouteloua trifida*	2–5	–
	low woollygrass	DAPU7	*Dasyochloa pulchella*	2–5	–
Shrub/Vine					
4	**Shrubs**			40–100	
	creosote bush	LATR2	*Larrea tridentata*	20–50	–
	Texas barometer bush	LEFR3	*Leucophyllum frutescens*	4–10	–
	mariola	PAIN2	*Parthenium incanum*	4–10	–
	resinbush	VIST	*Viguiera stenoloba*	4–10	–
	Texas lignum-vitae	GUAN	*Guaiacum angustifolium*	4–10	–
	Grass, annual	2GA	*Grass, annual*	0–6	–
	whitethorn acacia	ACCO2	*Acacia constricta*	2–5	–
	jointfir	EPHED	*Ephedra*	2–5	–
	ocotillo	FOSP2	*Fouquieria splendens*	2–5	–
	littleleaf ratany	KRER	*Krameria erecta*	2–5	–
5	**Fibrous/Succulents**			10–25	
	lechuguilla	AGLE	*Agave lechuguilla*	2–5	–
	Christmas cactus	CYLE8	*Cylindropuntia leptocaulis*	2–5	–
	Texas sotol	DATE3	*Dasylirion texanum*	2–5	–
	candelilla	EUAN3	*Euphorbia antisyphilitica*	2–5	–
	leatherstem	JADI	*Jatropha dioica*	0–5	–
	pricklypear	OPUNT	*Opuntia*	2–5	–
	yucca	YUCCA	*Yucca*	2–5	–
Forb					
6	**Perennial**			10–20	
	woody crinklemat	TICAC	*Tiquilia canescens var. canescens*	4–10	–
	featherplume	DAFO	*Dalea formosa*	2–5	–
	littleleaf ratany	KRER	*Krameria erecta*	2–5	–
	Forb, perennial	2FP	*Forb, perennial*	1–3	–
	croton	CROTO	*Croton*	1–3	–
	lacy tansyaster	MAPI	*Machaeranthera pinnatifida*	1–3	–
	menodora	MENOD	*Menodora*	1–3	–
	woolly paperflower	PSTA	*Psilostrophe tagetina*	1–3	–
	globemallow	SPHAE	*Sphaeralcea*	1–3	–
	pricklyleaf dogweed	THAC	*Thymophylla acerosa*	1–3	–
	woody crinklemat	TICAC	*Tiquilia canescens var. canescens*	1–3	–
	vervain	VERBE	*Verbena*	1–3	–
7	**Annual**			0–5	
	Forb, annual	2FA	*Forb, annual*	0–3	–
	bladderpod	LESQU	*Lesquerella*	0–2	–

Animal community

The historic Midgrass/Shrub Community (1.1) was part of the habitat for mule deer, songbirds, birds of prey, small mammals, and predators such as coyote, bobcat, and mountain lion. As the site changes through the Midgrass/Shrub Community (1.1) toward the Creosotebush Shrubland Community (2.1), it becomes less suitable to many animal species due to the increase in bare ground and erosion and subsequent lack of food and cover.

Many species of wildlife utilize this site for at least a portion of their habitat needs. It is also important to balance wildlife populations with carrying capacity. Mule deer need high protein forbs and browse. They generally eat a wide variety of browse and forbs and small amounts of grass. Quail and dove prefer a combination of low shrubs, bunch grass, bare ground, and forbs. Game bird species such as mourning and white wing dove and scaled quail can be present on the site. Smaller mammals present include rodents, jackrabbits, cottontail rabbits, raccoons, and skunks. Mammalian predators like coyote, bobcat, and mountain lion can potentially be found at the site. Numerous species of snakes and lizards are native to the site.

Non-game species of birds found on this site include songbirds and birds of prey. Habitat on this site that provides a large diversity of grasses, forbs, and shrubs will support a variety and abundance of songbirds. Birds of prey are important to keep the numbers of rodents, rabbits, and snakes in balance.

Cattle find the best forage in the Midgrasses/Shrub Community (1.1). As this site reaches the Creosotebush Shrubland Community (2.1), it becomes difficult to find enough forage to thrive. An assessment of vegetation is needed to determine the site's current carrying capacity in order to avoid overgrazing. Carrying capacity in the Trans-Pecos will vary greatly from year to year depending on the episodic precipitation.

Plant Preference by Animal:
These preferences are somewhat general in nature as the preference for a plant is dependent upon animals grazing experience, time of year, availability of choices, and total forage supply.

Hydrological functions

The Gravelly 8-14" PZ site is a well-drained, very shallow to very deep gravelly upland. Its soils are moderately slow to moderately rapidly permeable. Under historic climax condition the vegetation intercepted and utilized much of the incoming rainfall. There was runoff during torrential rains due to the limited water holding capacity of the soil. The presence of rocks enhances the effectiveness of rainfall, especially small rainfall events, by concentrating it on a smaller surface area. When the site changes from grassland to shrub community there is a structural change resulting in faster runoff that carries soil particles away. Less of the rainfall is intercepted and infiltrates into the soil.

Recreational uses

The Gravelly 8-14" PZ site is suited for many outdoor recreational uses including hunting, hiking, and bird watching. Its rugged beauty and topography make it a unique site and colorful forbs can be found on or near the site throughout the spring and summer.

Other references

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Approval

Bryan Christensen, 9/19/2023

Acknowledgments

Site Development and Testing Plan:

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, medium and high 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. Annual reviews of the Project Plan are to be conducted by the Ecological Site Technical Team.

The following individuals assisted with the development of this site description:

Mr. Charles Anderson –Rangeland Management Specialist- NRCS; San Angelo, Texas
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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.

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Date	12/05/2011
Approved by	Bryan Christensen
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** None

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2. **Presence of water flow patterns:** None, except following high intesity storms, when short (less than 1 m) and discontinuous flow patterns may appear. Flow patterns in drainages are linear and continuous.

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3. **Number and height of erosional pedestals or terracettes:** None

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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** 2-5% bare ground

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5. **Number of gullies and erosion associated with gullies:** None

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6. **Extent of wind scoured, blowouts and/or depositional areas:** None

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7. **Amount of litter movement (describe size and distance expected to travel):** In drainages, there can be significant amounts of litter moved long distances. On most of the site, minimal and short distance (<5ft) of litter movement associated with high intense rainfall.

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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):** Soil stability values usually ranging from 4-6 under vegetation and 2-3 in the interspaces

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** 1-2 inche thick, pale brown surface horizon with a moderate medium granular structure. Data from Stillwell soil series description

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** A high canopy cover of midgrass bunch and stoliniferous grasses will help minimize runoff and maximize infiltration. Grasses should comprise approximately 60% of total plant compostion by weight. Shrubs will comprise about 30% by weight.

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: Mid bunchgrass (Chino grama)

    Sub-dominant: mid stoloniferous grasses > mid/tall shrubs

    Other: Subshrubs = fibrous/succulents > perennial forbs > annual forbs and grasses

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** All grasses will show some mortality and decadence in addition to annual forbs. Mid/tall perennial shrubs will show some mortality or decadence only after prolonged and severe droughts. Subshrubs will be less resistant to severe droughts than mid/tall perennial shrubs.

14. **Average percent litter cover (%) and depth (in):**

15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** 200-500 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:** Dry climate prevents non-native species to encroach on this site. Creosotebush will increase some but will still remain in a widely spaced pattern that is characteristic of desert climates.

17. **Perennial plant reproductive capability:** All species should be capable of reproducing.