

Ecological site R046XC602MT Dense Clay (DC) RRU 46-C 15-19 PZ

Last updated: 9/07/2023
Accessed: 05/13/2025

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.

MLRA notes

Major Land Resource Area (MLRA): 046X–Northern and Central Rocky Mountain Foothills

Major Land Resource Area (MLRA) 46, Rocky Mountain Foothills, is approximately 11.6 million acres. MLRA 46's extent has changed over recent years and is now primarily located in Montana and Wyoming with limited acres in Utah and Colorado. It spans from the Canadian border south to the Uinta Mountains of Northwest Colorado. MLRA 46 is a transitional MLRA between the plains and mountains of primarily non-forested rangeland. In Montana, 3 Land Resource Units (LRUs) exist based on differences in geology, landscape, soils, water resources, and plant communities. Elevations for this MLRA in Montana vary from a low of 3200 to 6500 feet (975 to 1981 m) however the elevations on the fringes of this MLRA may fall outside of that range in extremely small isolated areas where the boundaries between neighboring MLRAs are not easily defined. Annual precipitation ranges from 8 inches (254 mm) to, in very isolated areas, 42 inches (1083 mm). In general precipitation rarely exceeds 24 inches (610 mm). Frost Free Days are variable from 50 days near the Crazy and Beartooth Mountains to 130 days in the foothills south of the Bear's Paw Mountains of Central Montana. The geology of MLRA 46 is generally Cretaceous and Jurassic marine sediments.

MLRA 46's plant communities are dominated by cool-season bunchgrasses with mixed shrubs. This MLRA is rarely forested; however, ponderosa and limber pine do occupy areas. Portions of this MLRA may have a subdominance of warm-season mid-statured bunchgrasses like little bluestem; however, the general concept of the MLRA does not have a large component of warm-season species. Wyoming big sagebrush, mountain big sagebrush, silver sagebrush, common snowberry, and shrubby cinquefoil tend to be the dominant shrub component. The kind and presences of shrubs tends to be driven by a combination of soils and climate. Due to the variable nature of the Land Resources Units, Climatic subsets will be necessary to describe the ecological sites and the variation of plant communities for this MLRA.

LRU notes

LRU C is generally located in Central Montana. It borders the Little Belt Mountains, Highwood Mountains, Snowy Mountains (Big and Little), Crazy Mountains, and Castle Mountains. Included in this LRU are the foothills of the island mountain groups of the Bear's Paw and Little Rocky Mountains. This LRU borders MLRAs 43B, 52 and 58. LRU C is the second largest of the LRUs located in Montana occupying approximately 2.6 million acres. Cities and towns located in this LRU includes Stanford, Lewistown, Grass Range, and Harlowton. Elevation ranges from 2880 feet (878 m) to 6783 feet (2068 m).

The geology is sedimentary in nature with the majority including the Colorado Shale Formation, Kootenai Formation (mixed sedimentary), Mississippian Formation (carbonatic sedimentary), terrace deposits (alluvium), Tertiary mixed sedimentary. Areas of the Claggett Formation (mudstone), Devonian (carbonatic sedimentary) as well as intrusive and extrusive volcanics (mixed) exist in the foothills of the island mountains. Landforms include hillslopes, drainage ways, fan remnants, valleys, and escarpments.

This LRU is dominated by deep, well drained soils. Soil depth is mixed with 45 percent moderately-deep, 45 percent

very deep, and 10 percent other soil depth. Slopes are most frequently 0 to 15 percent and 15 to 30 percent, while higher sloping areas (30 to 45 percent) exist along the Little Belt and Highwood interfaces. Slightly acid to moderately alkaline soils throughout. Small areas of moderately acid soils exist in places, in particular around Highwoods. Vast differences in soil texture within LRU exist likely due to the variation in parent material.

The climate of this LRU is classic to the MLRA concept. The precipitation falls primarily as rain in the spring however areas may receive high amounts of snowfall (i.e. Lewistown). Precipitation ranges are from 13.7 inches (348 mm) to a rare 37.4 inches (942 mm) with 18 inches as an average. This LRU has an average air temperature of 44 degrees Fahrenheit (6.75 degrees C) with a range of 38 degrees Fahrenheit (3.38 degrees C) to 47.3 degrees Fahrenheit (8.52 degrees C). Frost free days tends to be one of the longest of the Montana LRUs with a range of 70 to 130 days. Soil moisture regime is ustic with a frigid soil temperature regime. Due to the variability in climate of this LRU, climatic subsets will be necessary to accurately describe the ecological processes.

Major watersheds within this LRU include Big Spring Creek, Judith River, Swimming Woman Creek, and Musselshell River. These watersheds provide irrigation water for production of small grains and hay. As these watersheds leave the neighboring MLRA 43B, these river systems offer fishing and other recreational opportunities.

Cropland conversion is the largest land conversion within this LRU. Small grains such as wheat and barley are the most common particularly in Judith Basin County. Conversion to recreational property is becoming a more frequent occurrence, particularly near Lewistown.

Ecological site concept

- Site does not receive additional effective moisture
- Soils are natric or have relic natric horizons
- Columnar structure present with abrupt root or water restrictive clay layer present within 4 inches of soil surface

Associated sites

R046XC609MT	Claypan (Cp) RRU 46-C 15-19 PZ Clay Pan site occupies similar landscape position and produces similar plant community and state and transition model. Clay Pan production will be nearly double that of the Dense Clay
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Similar sites

R046XC609MT	Claypan (Cp) RRU 46-C 15-19 PZ Clay Pan site occupies similar landscape position and produces similar plant community and state and transition model. Clay Pan production will be nearly double that of the Dense Clay
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Table 1. Dominant plant species

Tree	Not specified
Shrub	(1) <i>Artemisia tridentata</i> (2) <i>Krascheninnikovia lanata</i>
Herbaceous	(1) <i>Pascopyrum smithii</i> (2) <i>Nassella viridula</i>

Physiographic features

The Dense Clay Ecological site exists on nearly level to gently sloping hills, stream terraces, fan remnants, alluvial fans, fans, and terraces. Slopes average 1 to 8 percent with extremely limited areas of up to 15 percent.

Table 2. Representative physiographic features

Landforms	(1) Foothills > Alluvial fan (2) Foothills > Hill (3) Foothills > Stream terrace (4) Foothills > Fan remnant (5) Foothills > Terrace (6) Foothills > Fan
Runoff class	Medium to very high
Elevation	914–1,402 m
Slope	1–8%
Water table depth	152 cm

Climatic features

The climate of the Dense Clay ecological site falls into Climatic Subset B. The central concept of Climatic Subset B is 15 to 19 inches Relative Effective Annual Precipitation (REAP) and 70 to 110 days frost-free. Calculated averages based on climate stations suggest that this ecological site receives just over 16 inches of precipitation with 81 to 113 frost-free days.

The soil temperature regime for this Dense Clay ecological site is frigid and the soil moisture regime is ustic

Table 3. Representative climatic features

Frost-free period (characteristic range)	77-94 days
Freeze-free period (characteristic range)	110-118 days
Precipitation total (characteristic range)	381-432 mm
Frost-free period (actual range)	49-110 days
Freeze-free period (actual range)	70-126 days
Precipitation total (actual range)	381-483 mm
Frost-free period (average)	81 days
Freeze-free period (average)	113 days
Precipitation total (average)	406 mm

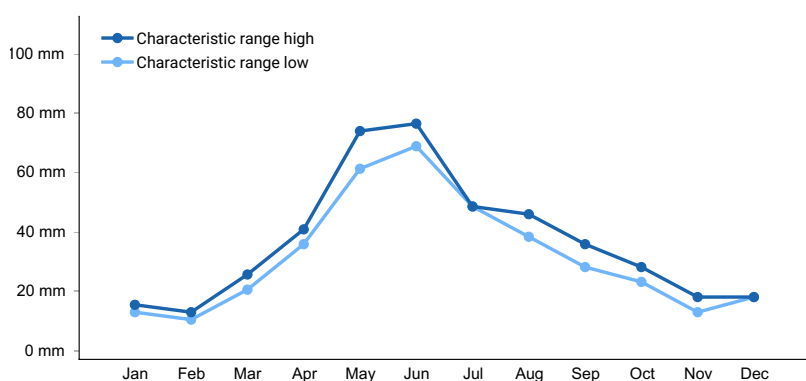


Figure 1. Monthly precipitation range

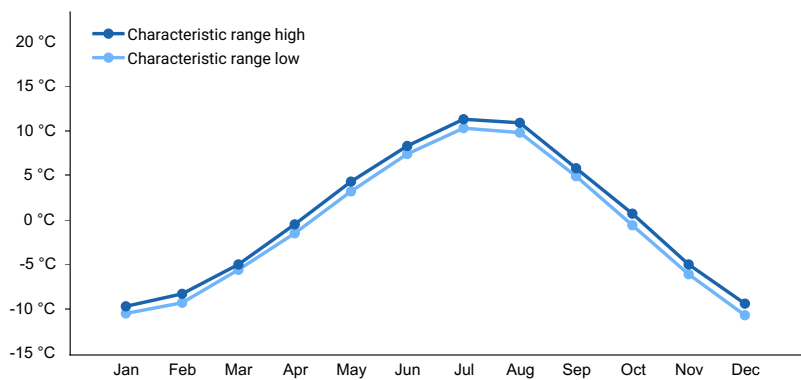


Figure 2. Monthly minimum temperature range

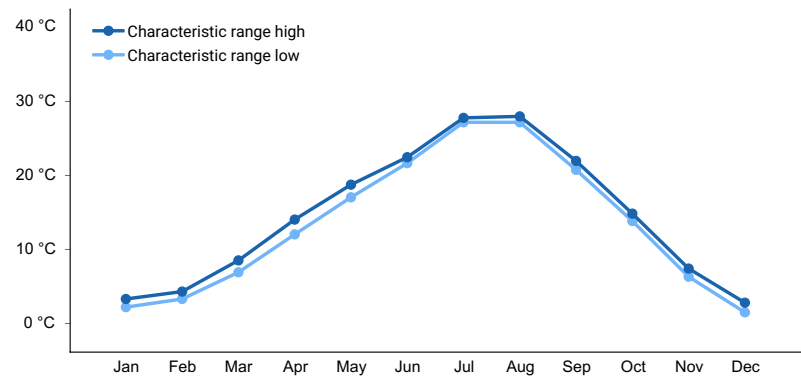


Figure 3. Monthly maximum temperature range

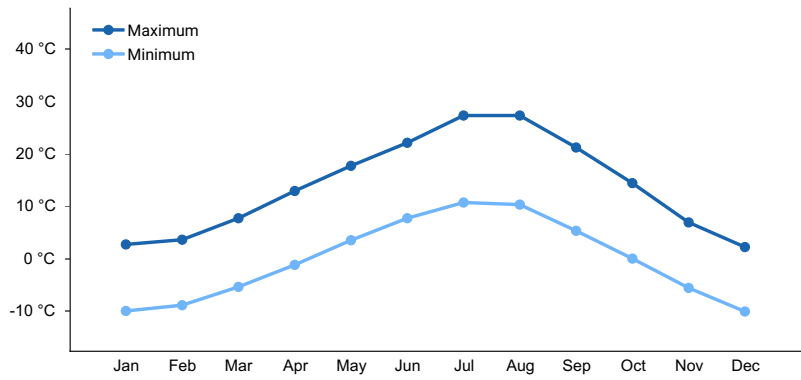


Figure 4. Monthly average minimum and maximum temperature

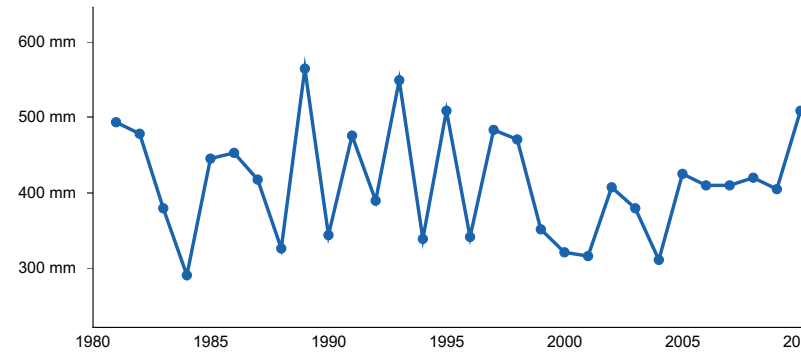


Figure 5. Annual precipitation pattern

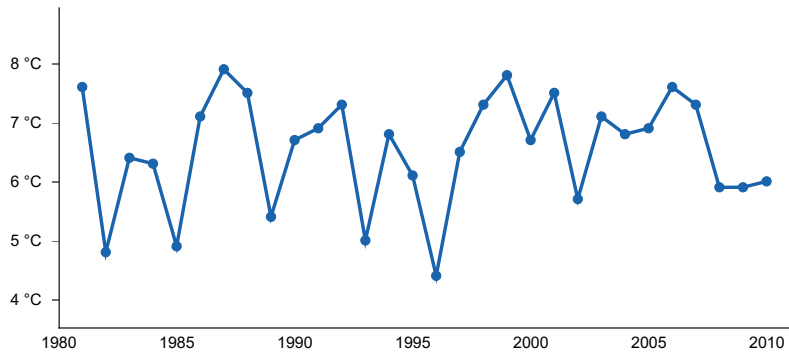


Figure 6. Annual average temperature pattern

Climate stations used

- (1) STANFORD [USC00247864], Stanford, MT
- (2) MOCCASIN EXP STN [USC00245761], Moccasin, MT
- (3) HOBSON [USC00244193], Hobson, MT
- (4) LEWISTOWN MUNI AP [USW00024036], Lewistown, MT
- (5) GRASS RANGE [USC00243727], Grass Range, MT
- (6) JUDITH GAP 13 E [USC00244545], Judith Gap, MT

Influencing water features

No influencing water features

Wetland description

Not present

Soil features

These are moderately deep to very deep non-granular clay soils that are strongly to very strongly alkaline near the surface. These soils typically are very hard to extremely hard when dry and very sticky when wet. They typically have a thin vesicular surface crust, which restricts water permeability. The subsoil is either massive, or has a very strong columnar structure. Permeability and root development are severely limited by the surface crust, hard subsoil, and alkalinity.

Table 4. Representative soil features

Parent material	(1) Alluvium—sedimentary rock
Family particle size	(1) Fine
Drainage class	Moderately well drained to well drained
Permeability class	Slow to very slow
Depth to restrictive layer	0–10 cm
Available water capacity (0-101.6cm)	9.14–12.95 cm
Clay content (0-10.2cm)	25–45%
Soil reaction (1:1 water) (0-101.6cm)	7.6–9

Ecological dynamics

This site developed under Northern Rocky Mountain foothills climatic conditions, which included the natural

influence of large herbivores and occasional fire. The plant community upon which interpretations are primarily based is the Reference Plant Community. This community is described as a reference to understand the original potential of this site, and is not always considered to be the management goal for every acre of rangeland. The following descriptions should enable the landowner or manager to better understand which plant communities occupy their land, and assist with setting goals for vegetation management. It can also be useful to understand the environmental and economic values of each plant community.

This site is considered slightly resilient to disturbance as it has significant soil limitations for plant growth. Changes may occur to the Reference Plant Community due to management actions and climatic conditions. Under continued adverse impacts, a moderate decline in vegetative vigor and composition will occur. Under favorable vegetative management treatments, this site can more readily return to the Reference Plant Community.

Continual adverse impacts to the site over a period of years results in a departure from the Reference Plant Community, with a decrease of the taller, more palatable species such as bluebunch wheatgrass, prairie sandreed, Indian ricegrass, little bluestem, and plains muhly and an increase in sedges, needleandthread, forbs, junipers, and skunkbush sumac. Some of the shrubs (skunkbush sumac) can also be adversely impacted by heavy use, including wildlife. Continued deterioration results in increased amounts of fringed sagewort, and various increaser forbs.

Plants that are not a part of the climax community that are most likely to invade are threeawns, broom snakeweed, annual grasses and forbs. Noxious weeds that are likely to invade are spotted knapweed, dalmation toadflax, sulphur cinquefoil, and leafy spurge.

The physical aspect of this site is that of a very sparse grassland and shrubland that is typically dominated by cool season grasses and shrubs. Approximately 80 to 85 percent of the annual production is from grasses and sedges, 1 to 5 percent from forbs, and 5 to 10 percent is from shrubs and half-shrubs. The canopy cover of shrubs is 5 to 10 percent.

This is the interpretive plant community and is considered to be the Reference Plant Community for this site. This plant community contains a diversity of tall and medium height, cool season grasses (western or thickspike wheatgrass, green needlegrass, and bluebunch wheatgrass), and short grasses (blue grama, Sandberg bluegrass). There are numerous forbs that occur in smaller percentages. Shrubs and half-shrubs such as Nuttall's saltbush and winterfat are common. Wyoming big sagebrush is also often a common component of this community.

This plant community is well adapted to the Rocky Mountain Foothills climatic conditions. The diversity in plant species and presence of tall, deep-rooted perennial grasses allows for drought tolerance. Plants on this site have strong, healthy root systems that allow production to increase significantly with favorable moisture conditions. Abundant plant litter is available for soil building and moisture retention. Plant litter is properly distributed with very little movement off-site and natural plant mortality is very low. This plant community provides for soil stability and a functioning hydrologic cycle.

Plant Community 2: Medium and Short Grasses and Sedges/ Shrubs and Half-shrubs: This community occurs due to minor climate shifts or slight variations in soils and/or topography or disturbance, including non-prescribed grazing. Dominants include Wyoming big sagebrush and western/thickspike wheatgrass, Sandberg bluegrass and blue grama. The medium and tall grasses such as green needlegrass and bluebunch wheatgrass will still be present, sometimes in relatively large amounts. The desirable shrubs/half-shrubs such as Nuttall's saltbush and winterfat will be somewhat less prevalent. Palatable and nutritious forbs will begin to be replaced by less desirable and more aggressive species such as scarlet globemallow.

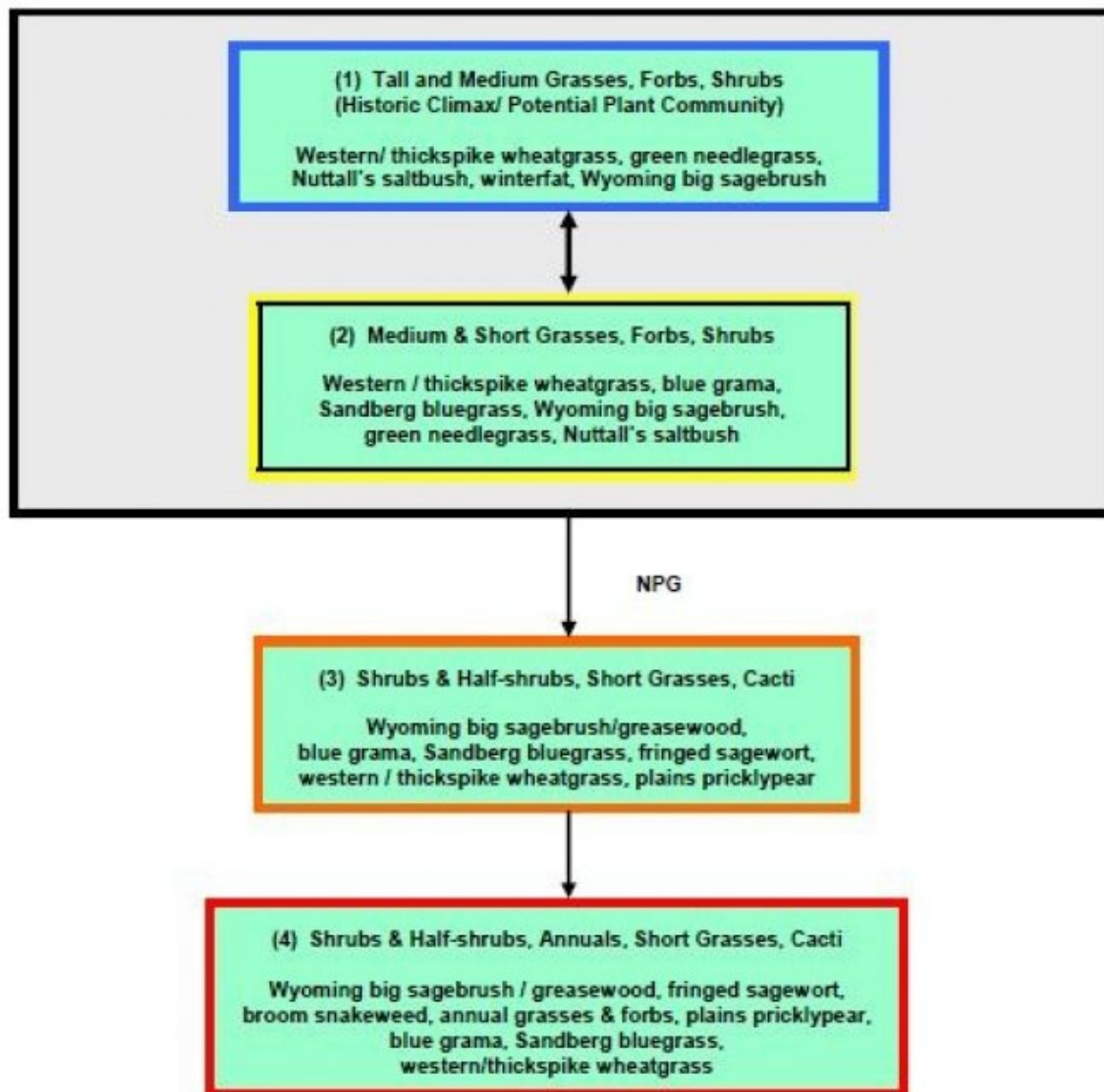
Grass biomass production and litter become reduced on Community 2 as the taller grasses become less prevalent, increasing evaporation and reducing moisture retention. Additional open space in the community can result in undesirable invader species. These plant communities provide for moderate soil stability.

Plant Community 3: Shrubs/ Short Grasses/ Half-shrubs/ Cacti: This is a disturbance-induced community, with dominants including Wyoming big sagebrush, or greasewood in some situations. Short grasses such as Sandberg bluegrass and blue grama become more prevalent. Mid-seral species such as western or thickspike wheatgrass will still be relatively abundant. The taller grasses (bluebunch wheatgrass and green needlegrass) will still be present, but in much smaller amounts. Palatable forbs will be mostly absent. Fringed sagewort and plains pricklypear will tend to become more abundant.

Plant Community 4: Shrubs & Half-Shrubs/ Annuals/ Cacti/ Short Grasses: If heavy disturbance continues, plant community 3 can deteriorate to one primarily composed of Wyoming big sagebrush / greasewood, fringed sagewort, and broom snakeweed, short grasses (Sandberg bluegrass, blue grama), annual grasses (cheatgrass or Japanese brome, sixweeks fescue), annual forbs (pepperweed, fanweed), and plains pricklypear. There will still be some of the mid-seral species such as western or thickspike wheatgrass present. The taller grasses will occur only rarely, often underneath the shrub canopy or mixed in with the cactus. Palatable forbs will be mostly absent. Weedy forbs (e.g., kochia) are likely to invade.

Plant Communities 3 and 4 are much less productive than Plant Communities 1 or 2, and have lost many of the attributes of a healthy rangeland. The loss of deep perennial root systems reduces total available moisture for plant growth. Reduction of plant litter will result in higher surface soil temperatures and increased evaporation losses. Annual species are often aggressive and competitive with seedlings of perennial plants. This community can respond positively to improved grazing management but it will take additional inputs to move it towards a community similar in production and composition to that of Plant Community 1 or 2. The landscape features often associated with this ecological site as well as the sodic nature of the soils severely limits the use of most common structural improvement practices.

State and transition model



Smaller boxes within a larger box indicate that these communities will normally shift among themselves with slight variations in precipitation and other disturbances. Moving outside the larger box indicates the community has crossed a threshold (heavier line) and will require intensive treatment to return to Community 1 or 2. Dotted lines indicate a reduced probability for success. Yellow boxes indicate caution that the community may be in danger of crossing a threshold. Orange boxes represent communities that have crossed over thresholds from the HCPC and may be difficult to restore with grazing management alone. Red boxes represent communities that have severely shifted away from the HCPC and probably cannot be restored without mechanical inputs.

NOTE: Not all species present in the community are listed in this table. Species listed are representative of the plant functional groups that occur in the community.

PG = Prescribed Grazing: Use of a planned grazing strategy to balance animal forage demand with available forage resources. Timing, duration, and frequency of grazing are controlled and some type of grazing rotation is applied to allow for plant recovery following grazing.

NPG = Non-Prescribed Grazing: Grazing which has taken place that does not control the factors as listed above, or animal forage demand is higher than the available forage supply.

Fire: Prescribed fire or non-prescribed wildfire.

Matted: >50% cover

Animal community

Livestock Grazing Interpretations: Managed livestock grazing is suitable on this site as it has the potential to produce a limited amount of high quality forage. Grazing must be managed carefully on this site to be sure livestock drift onto the better, more productive, and more accessible sites is not excessive. Management objectives should include maintenance or improvement of the native plant community. Livestock accessibility is a significant limitation with this ecological site.

Using shorter grazing periods and providing for adequate re-growth after grazing are recommended for plant maintenance, health, and recovery. Continual non prescribed grazing of this site can be detrimental and will alter the plant composition and production over time. The result will be plant communities that resemble numbers 3 and 4, depending on how long this grazing management is used as well as other circumstances such as weather conditions and fire frequency.

Whenever Plant Community 2 (medium and short grasses) occurs, grazing management strategies that will prevent further degradation need to be implemented. This community is still stable, productive, and healthy provided it receives proper management. It will respond fairly quickly to improved grazing management, including increased growing season rest of key forage plants. Grazing management alone can usually move this back towards the potential / historic climax community.

Plant community 3 is the result of long-term, heavy, continuous grazing and/or annual, early spring seasonal grazing. Repeated heavy early spring grazing, especially during stem elongation (generally mid May through mid June), can also have detrimental affects on the taller, key forage species. Repeated spring grazing depletes stored carbohydrates, resulting in weakening and eventual death of the cool season tall and medium grasses. This plant community can occur throughout the pasture, on spot grazed areas, and around water sources where season-long grazing patterns occur.

It becomes critical at this point to implement a grazing strategy that will restore the stability and health of the site. Additional growing season rest, often combined with facilitating practices (e.g., water developments, fencing), is usually necessary for re-establishment of the desired native species and to restore the stability and health of the site.

Plant Community 4 has a high percentage of aggressive, less-desirable species. It has lost most of the attributes of a healthy rangeland. Grazing management alone is seldom able to restore the site to one that resembles the HCPC once this plant community has become established. Seeding and/or mechanical treatment on this site is not feasible.

Hydrological functions

The runoff potential for this site is very high depending on slope and ground cover/health. Runoff curve numbers generally range from 84 to 93. The soils associated with this ecological site are generally in Hydrologic Soil Group D. The infiltration rates for these soils will normally be very slow.

The hydrologic condition of this site has a significant affect on runoff. The hydrologic condition considers the effects of cover, including litter, and management on infiltration. Good hydrologic condition indicates that the site usually has a lower runoff potential. Plant cover and litter helps retain soil moisture for use by the plants. Maintaining a healthy stand of perennial native vegetation with deep root systems will optimize the amount of precipitation that is received, help maintain or increase infiltration rates and reduce runoff.

For arid and semi-arid rangelands, good hydrologic conditions exist if cover (grass, litter, and brush canopy) is greater than 70%. Fair conditions exist when cover is between 30 and 70%, and poor conditions exist when cover is less than 30%.

Sites in high similarity to the HCPC/PPC (Plant Communities 1 & 2) generally have enough plant cover and litter to optimize infiltration, minimize runoff and erosion, and have a good hydrologic condition. Erosion is minor for sites in high similarity. Rills and gullies should not be present. Water flow patterns, if present, will be barely observable. Plant pedestals are essentially non-existent. Plant litter remains in place and is not moved by erosion. Soil surfaces should not be compacted or crusted.

Sites in low similarity (Plant Communities 3 and 4) are generally considered to be in less than good hydrologic condition as the majority of plant cover is from shallow rooted species.

Recreational uses

This site provides some recreational opportunities for hiking, horseback riding, big game and upland bird hunting. The forbs have flowers that appeal to photographers. This site provides valuable open space and visual aesthetics.

Caution should be used during wet weather periods.

Wood products

none

Inventory data references

Information presented was derived from NRCS inventory data, National Resources Inventory (NRI) data, literature, field observations, and personal contacts with range-trained personnel (i.e., used professional opinion of agency specialists, observations of land managers, and outside scientists).

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Contributors

Grant Petersen

Approval

Kirt Walstad, 9/07/2023

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)	G. Petersen
Contact for lead author	grant.petersen@usda.gov
Date	08/04/2020
Approved by	Kirt Walstad
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:** Rills are expected after rainfall events and rapid snowmelt due to high bare ground percentage.

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2. **Presence of water flow patterns:** Water flow patterns are common on this site due to high bare ground and very slow infiltration rate.

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3. **Number and height of erosional pedestals or terracettes:** Pedestals and terracettes will exist on steeper slopes (greater than 5 percent). Height is less than 1 inch.
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4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):** Bare ground is 45-50%. It consists of randomly scattered patches.
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5. **Number of gullies and erosion associated with gullies:** Healed gullies may exist as a result of catastrophic rainfall events however current, active gully erosion will not be present.
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6. **Extent of wind scoured, blowouts and/or depositional areas:** Wind scoured, or depositional areas are not evident in the reference condition.
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7. **Amount of litter movement (describe size and distance expected to travel):** Due to the high amount of bare ground and potential connectivity between these bare patches, litter movement is expected to be high. Litter is primarily small leaves and stems travelling up to 10 feet.
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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):** The average soil stability rating is 3-4 under plant canopies and 1-3 in plant interspaces. Surface crusting may exist as a result of the high sodium content. The A horizon is less than 1 inch thick.
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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil Structure at the surface is platy to weak, fine subangular blocky. A Horizon will be less than 1 inch thick with color, when wet, typically ranging in Value of 6 or less and Chroma of 3 or less.
Local geology may affect color, it is important to reference the Official Series Description (OSD) for characteristic range.
<https://soilseries.sc.egov.usda.gov/osdname.aspx>
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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Infiltration of the Dense Clay ecological site is very slow but is well drained. Infiltration is restricted due to high clay and sodium content of the soil. An even distribution of rhizomatous grasses (35-45%), mid stature bunchgrasses (30-40%), cool season shortgrasses (10-15%) along with forbs (3-5%), shrubs (5-10%) and warm season shortgrasses (1-3%)
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11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):** A compaction layer is not present in the reference condition. Soil profile may contain an abrupt transition to an Argillic horizon which can be misinterpreted as compaction, however, the soil structure will be fine to medium subangular blocky, where a compaction layer will be platy or structureless (massive).
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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: rhizomatous grasses (western wheatgrass) ≥ mid-statured, cool season, perennial bunchgrasses (green needlegrass, bluebunch wheatgrass)

Sub-dominant: cool season shortgrasses/grasslikes (Sandberg bluegrass, Junegrass) ≥ shrubs > forbs > warm season shortgrasses

Other:

Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Mortality in herbaceous species is not evident. Species with bunch growth forms may have some natural mortality in centers is 3% or less.
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14. **Average percent litter cover (%) and depth (in):** Total litter cover ranges from 25-35%. Most litter is irregularly distributed on the soil surface and is not at a measurable depth.
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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):** Average annual production is 800 pounds per acre (896.7 kilograms per hectare).

Low: 500lbs/ac (560.4kg/ha)

High: 1050lbs/ac (1176.9kg/ha).

Production varies based on effective precipitation and natural variability of soil properties for this ecological site.

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:** Potential invasive (including noxious) species (native and non-native). Invasive species on this ecological site include (but not limited to) annual brome spp., spotted knapweed, crested wheatgrass, pale alyssum, field pennycress (fanweed)
- Native species such as broom snakeweed, Sandberg's bluegrass, blue grama, pricklypear cactus, greasewood, etc. when their populations are significant enough to affect ecological function, indicate site condition departure.
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17. **Perennial plant reproductive capability:** In the reference condition, all plants are vigorous enough for reproduction either by seed or rhizomes in order to balance natural mortality with species recruitment.
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