USDA Natural Resources Conservation Service

# Ecological site R052XN172MT
# Dense Clay (DC) 10-14" p.z.

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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.

## MLRA notes

Major Land Resource Area (MLRA): 052X–Brown Glaciated Plains

The Brown Glaciated Plains, MLRA 52, is an expansive and agriculturally and ecologically significant area. It consists of around 14.5 million acres and stretches across 350 miles from east to west, encompassing portions of 15 counties in north-central Montana. This region represents the southwestern limit of the Laurentide Ice Sheet and is considered to be the driest and westernmost area within the vast network of glacially derived prairie pothole landforms of the northern Great Plains. Elevation ranges from 2,000 feet (610 meters) to 4,600 feet (1,400 meters).

Soils are primarily Mollisols, but Entisols, Inceptisols, Alfisols and Vertisols are also common. Till from continental glaciation is the predominant parent material, but alluvium and bedrock are also common. Till deposits are typically less than 50 feet thick, and in some areas glacially deformed bedrock occurs at or near the soil surface (Soller, 2001). Underlying the till is sedimentary bedrock largely consisting of Cretaceous shale, sandstone, and mudstone (Vuke et al., 2007). Bedrock is commonly exposed on hillslopes, particularly along drainageways. Significant alluvial deposits occur along glacial outwash channels and major drainages, including portions of the Missouri, Teton, Marias, Milk, and Frenchman Rivers. Large glacial lakes, particularly in the western half of the MLRA, deposited clayey and silty lacustrine sediments (Fullerton et al., 2013).

Much of the western portion of this MLRA was glaciated towards the end of the Wisconsin age, and the maximum glacial extent occurred approximately 20,000 years ago (Fullerton et al., 2004). The result is a geologically young landscape that is predominantly a level till plain interspersed with lake plains and dominated by soils in the Mollisol and Vertisol orders. These soils are very productive and generally are well suited to dryland farming. Much of this area is aridic-ustic. Crop-fallow dryland wheat farming is the predominant land use. Areas of rangeland typically are on steep hillslopes along drainages.

The rangeland, much of which is native mixed grass prairie, increases in abundance in the eastern half of the MLRA. The Wisconsin-age till in the north-central part of this area typically formed large disintegration moraines with steep slopes and numerous poorly drained potholes. A large portion of Wisconsin-age till occurring on the type of level terrain that would typically be optimal for farming has large amounts of less-suitable sodium-affected Natrustalfs. Significant portions of Blaine, Phillips, and Valley Counties were glaciated approximately 150,000 years ago during the Illinoisan age. Due to erosion and dissection of the landscape, many of these areas have steeper slopes and more exposed bedrock than areas glaciated during the Wisconsin age (Fullerton and Colton, 1986).

While much of the rangeland in the aridic-ustic portion of MLRA 52 is classified as belonging to the “dry grassland” climatic zone, sites in portions of southern MLRA 52 may belong to the “dry shrubland” climatic zone. The dry shrubland zone represents the northernmost extent of the big sagebrush (Artemisia tridentata) steppe on the Great Plains. Because similar soils occur in both southern and northern portions of the MLRA, it is currently hypothesized that climate is the primary driving factor affecting big sagebrush distribution in this area. However, the precise factors are not fully understood at this time.

Sizeable tracts of largely unbroken rangeland in the eastern half of the MLRA and adjacent southern Saskatchewan

are home to the Northern Montana population of greater sage-grouse (Centrocercus urophasianus), and large portions of this area are considered to be a Priority Area for Conservation (PAC) by the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service, 2013). This population is unique among sage grouse populations because many individuals overwinter in the big sagebrush steppe (dry shrubland) in the southern portion of the MLRA and then migrate to the northern portion of the MLRA, which lacks big sagebrush (dry grassland), to live the rest of the year (Smith, 2013).

Areas of the till plain near the Bearpaw and Highwood Mountains as well as the Sweetgrass Hills and Rocky Mountain foothills are at higher elevations, receive higher amounts of precipitation, and have a typic-ustic moisture regime. These areas have significantly more rangeland production than the drier aridic-ustic portions of the MLRA and have enough moisture to produce crops annually rather than just bi-annually, as in the drier areas. Ecological sites in this higher precipitation area are classified as the moist grassland climatic zone.

## Classification relationships

NRCS Soil Geography Hierarchy
• Land Resource Region: Northern Great Plains
• Major Land Resource Area (MLRA): 052 Brown Glaciated Plains
• Climate Zone: Dry Grassland

National Hierarchical Framework of Ecological Units (Cleland et al., 1997; McNab et al., 2007)
• Domain: Dry
• Division: Temperate Steppe
• Province: Great Plains-Palouse Dry Steppe Province 331
• Section: Northwestern Glaciated Plains 331D
• Subsection: Montana Glaciated Plains 331Dh
• Landtype association/Landtype phase: N/A

National Vegetation Classification Standard (Federal Geographic Data Committee, 2008)
• Class: Mesomorphic Shrub and Herb Vegetation Class (2)
• Subclass: Temperate and Boreal Grassland and Shrubland Subclass (2.B)
• Formation: Temperate Grassland, Meadow, and Shrubland Formation (2.B.2)
• Division: Great Plains Grassland and Shrubland Division (2.b.2.Nb)
• Macrogroup: Hesperostipa comata – Pascopyrum smithii – Festuca hallii Grassland Macrogroup (2.B.2.Nb.2)
• Group: Pascopyrum smithii – Hesperostipa comata – Schizachyrium scoparium Mixedgrass Prairie Group (2.B.2.Nb.2.c)
• Alliance: Pascopyrum smithii – Nassella viridula Northwestern Great Plains Herbaceous Alliance
• Association: No existing correlation

EPA Ecoregions
• Level 1: Great Plains (9)
• Level 2: West-Central Semi-Arid Prairies (9.3)
• Level 3: Northwestern Glaciated Plains (42)
• Level 4: North Central Brown Glaciated Plains (42o) & Glaciated Northern Grasslands (42j)

## Ecological site concept

Dense Clay is a moderately extensive ecological site occurring on alluvial landscapes throughout MLRA 52. It occurs on fans, plains, and terraces.

The distinguishing characteristic of this site is that soils contain more than 45 percent clay in the upper 4 inches. Soils in this ecological site are typically very deep (more than 60 inches to bedrock) and derived from clayey glaciolacustrine or outwash deposits. Soil textures in the upper 4 inches are typically clay, or silty clay. The soils commonly have an ochric epipedon and weakly developed underlying horizons. Characteristic vegetation is western wheatgrass (Pascopyrum smithii), prairie Junegrass (Koeleria macrantha), and green needlegrass (Nassella viridula). The principal shrub species on this site is Nuttalls saltbush (Atriplex nuttallii) and winterfat (Krascheninnikovia lanata).

## Associated sites

| | |
|---|---|
| R052XN162MT | **Clayey (Cy) 10-14" p.z.**<br>soils >20 inches in depth, higher production, and no hardpan, different species composition |
| R052XN176MT | **Shallow to Gravel (SwGr) 10-14" p.z.**<br>similar position in landscape, soils with depth restriction that limits available moisture, soils 10-20” deep to sands or loamy sands |
| R052XN179MT | **Shallow Clay (SwC) 10-14" p.z.**<br>similar position in landscape, soils with depth restriction that limits available moisture, soils 10-20” deep to sands or loamy sands |
| R052XN170MT | **Saline Upland (SU) 10-14" p.z.**<br>similar position in landscape, soils with depth restriction that limits available moisture, soils 10-20” deep to sands or loamy sands |

## Similar sites

| | |
|---|---|
| R052XC206MT | **Dense Clay (DC) 10-14" p.z.**<br>same concept, shift in plants and production, different LRU |
| R053AE073MT | **Dense Clay (DC) (Legacy) RRU 53AE**<br>same concept, shift in plants and production, different MLRA |
| R052XN086MT | **Claypan (Cp) 10-14" p.z.**<br>has 2-8” of soil over the hard argillic layer, less bare ground, and higher production |

**Table 1. Dominant plant species**

| | |
|---|---|
| Tree | Not specified |
| Shrub | (1) *Atriplex nuttallii*<br>(2) *Krascheninnikovia lanata* |
| Herbaceous | (1) *Pascopyrum smithii*<br>(2) *Nassella viridula* |

## Physiographic features

This ecological site occurs on nearly level to gently rolling uplands, low terraces and fans. Slopes are usually less than 8%, but can go as high as 12%. Elevations normally vary from 2000 to 4000 feet.

**Table 2. Representative physiographic features**

| | |
|---|---|
| Landforms | (1) Terrace<br>(2) Fan<br>(3) Plain |
| Runoff class | Medium to very high |
| Flooding frequency | None |
| Ponding frequency | None |
| Elevation | 2,000–4,000 ft |
| Slope | 1–8% |
| Aspect | W, NW, N, NE, E, SE, S, SW |

**Table 3. Representative physiographic features (actual ranges)**

| | |
|---|---|
| Runoff class | Not specified |
| Flooding frequency | Not specified |
| Ponding frequency | Not specified |

| | |
|---|---|
| Elevation | 1,875–4,000 ft |
| Slope | 1–12% |

## Climatic features

A semi-arid, temperate climate characterizes the Glaciated Plains. The predominance of cool season species has evolved to take advantage of the precipitation regime that peaks in late spring-early summer (June). Seventy-five percent of the annual precipitation usually falls as steady, soaking, frontal system rains. Summer rains usually come with thunderstorms. Precipitation is the most important factor influencing production (Heitschmidt et al 2005). Severe drought occurs on average in two out of every ten years (Cooper, et al., 2001).

**Table 4. Representative climatic features**

| | |
|---|---|
| Frost-free period (characteristic range) | 85-123 days |
| Freeze-free period (characteristic range) | 116-142 days |
| Precipitation total (characteristic range) | 10-14 in |
| Frost-free period (average) | 94 days |
| Freeze-free period (average) | 125 days |
| Precipitation total (average) | 12 in |

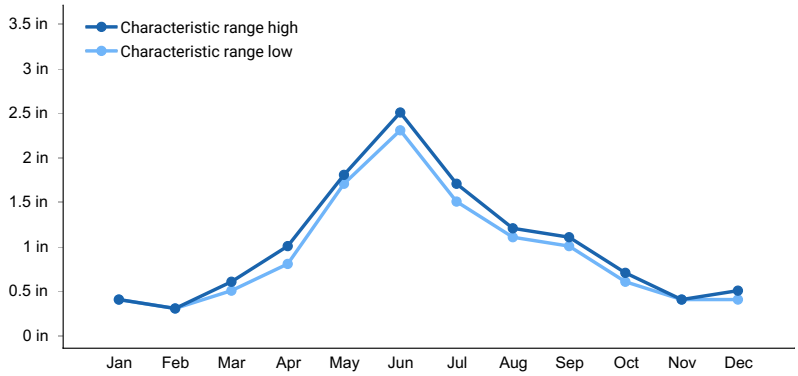



**Figure 1. Monthly precipitation range**

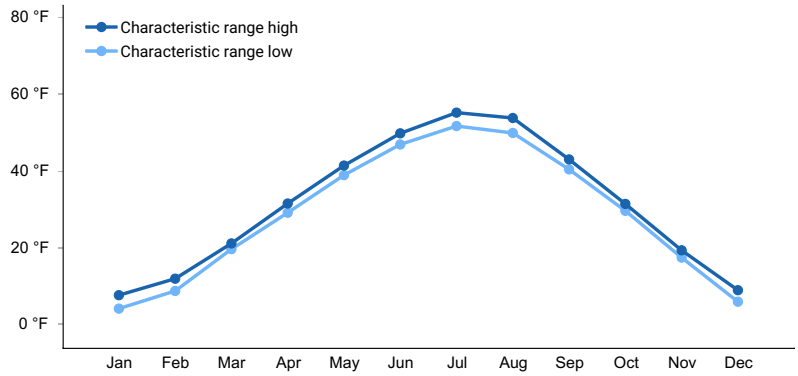



**Figure 2. Monthly minimum temperature range**

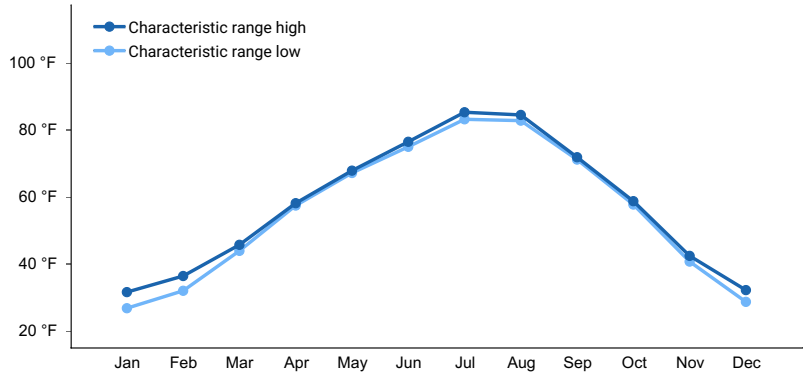



**Figure 3. Monthly maximum temperature range**

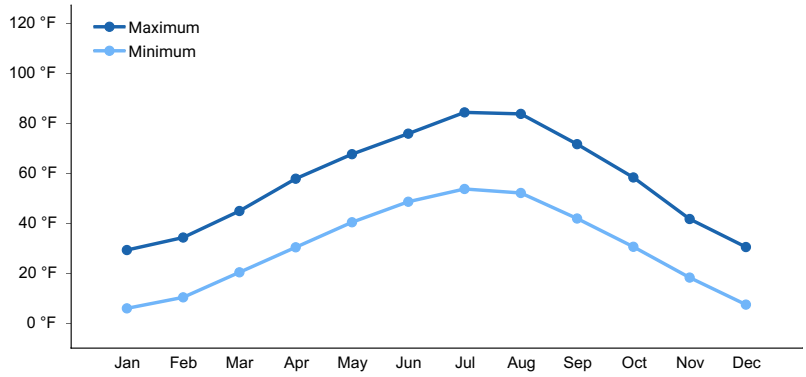



**Figure 4. Monthly average minimum and maximum temperature**

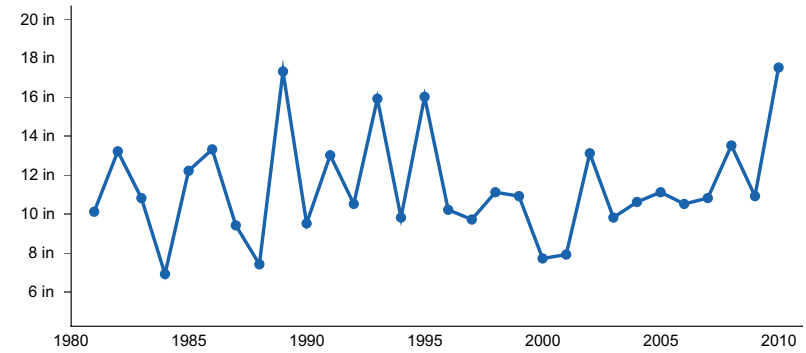



**Figure 5. Annual precipitation pattern**

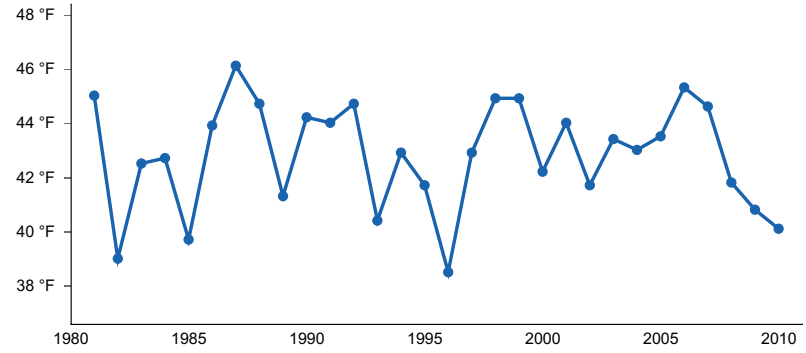



**Figure 6. Annual average temperature pattern**

## Climate stations used

- (1) CHESTER [USC00241692], Chester, MT
- (2) GLASGOW [USW00094008], Glasgow, MT
- (3) HAVRE CITY CO AP [USW00094012], Havre, MT

- (4) SHELBY [USC00247500], Shelby, MT

## Influencing water features

This site is not influenced by water from streams.

## Wetland description

This site is not influenced by water from wetlands.

## Soil features

These deep, well drained soils formed in alluvium. The soils usually contain a two-inch silty clay surface over hardpan. These soils are usually very hard when dry and very sticky when wet. They typically have a high content of sodium (alkali) which causes a dispersed condition and restricts water intake into the soil. Permeability is very slow. Root development is severely restricted by the surface crust, hard subsoil and alkalinity. Soil ph varies from 6.6 - 9.0. This site is characterized by the following soil components: Bowdoin, Absher, Vaeda and Vanda.

**Table 5. Representative soil features**

| | |
|---|---|
| Parent material | (1) Alluvium–sedimentary rock<br>(2) Glaciofluvial deposits |
| Surface texture | (1) Clay<br>(2) Silty clay<br>(3) Silty clay loam |
| Family particle size | (1) Fine<br>(2) Very-fine |
| Drainage class | Moderately well drained to well drained |
| Permeability class | Very slow |
| Soil depth | 20–78 in |
| Surface fragment cover <=3" | 0% |
| Surface fragment cover >3" | 0% |
| Available water capacity (Depth not specified) | 3–5 in |
| Calcium carbonate equivalent (Depth not specified) | 0–10% |
| Electrical conductivity (Depth not specified) | 2–16 mmhos/cm |
| Sodium adsorption ratio (Depth not specified) | 5–25 |
| Soil reaction (1:1 water) (Depth not specified) | 6.1–9 |
| Subsurface fragment volume <=3" (Depth not specified) | 0–10% |
| Subsurface fragment volume >3" (Depth not specified) | 0–5% |

## Ecological dynamics

This site developed through time under the influence of climate, geological materials, fire, plants and animals. In comparison to normal upland range sites, environmental characteristics of this site limit herbage production and subsequent fuel accumulation. Although the role of natural fire is probably less significant in the development of this site, fires may have occurred on a natural interval of 10-12 years (Frost 1998). Research consistently shows that precipitation is the principal factor altering productivity (Heitschmidt et al. 2005). The same authors concluded that

grazing reduces herbage standing crop, whereas its effects on aboveground net primary production varies with timing of grazing and precipitation events, along with the functional and structural composition of the plant community.

The resultant historic climax plant community (HCPC) is the basis for plant community interpretations. The HCPC has been determined by evaluating rangeland relic areas, and other areas protected from excessive disturbance. The HCPC is comprised of a mixture of tall and medium height cool season grasses, forbs and shrubs. About 85% of the annual production is from grasses and sedges, most of which is produced during the cool season. Forbs and shrubs contribute 5 and 10%, respectively, to total annual production. Total vegetative production averages 600 lbs/ac in normal years, 350 lbs/ac in “unfavorable” years, and 900 lbs/ac in “favorable” years.

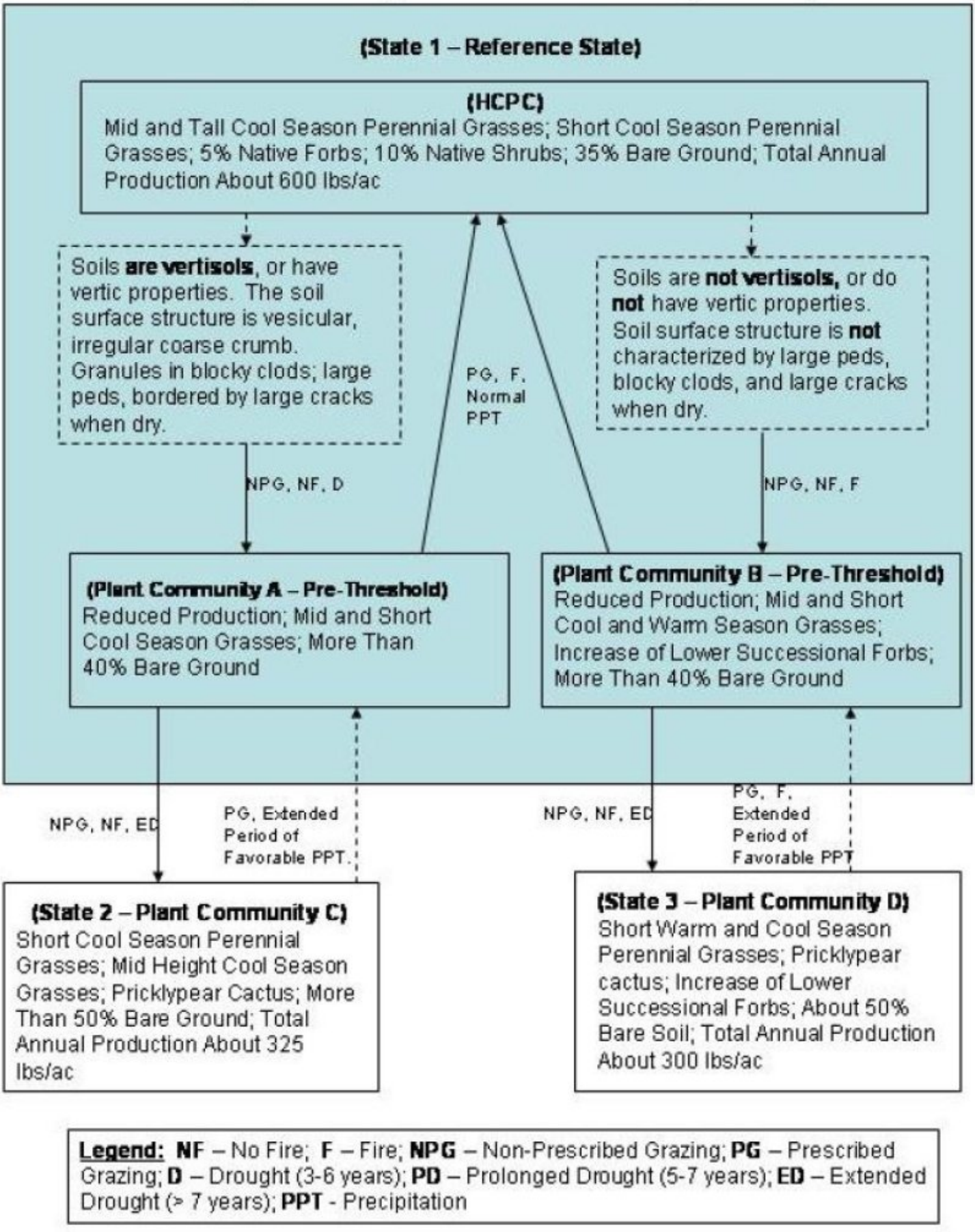
This site is moderately resilient to disturbance because plant growth is limited by soil characteristics. Departures from the HCPC generally result from management actions, drought, and/or a change in the natural fire regime. The site is considered fragile in the sense that vegetative vigor and composition will rapidly decline with continued adverse impacts. With favorable precipitation and/or prescribed grazing treatments the plant community can return to the HCPC. However, succession may be slow. Trends in plant community dynamics, states, transitional pathways, and thresholds have been evaluated and determined through experience and research.

Successional pathways of Dense Clay 10-14” p.z. ecological sites cannot be satisfactorily described using traditional theories of plant succession leading to a single climax community (Briske et al. 2005). As the HCPC regresses to an early seral state, it is theorized that a threshold is crossed somewhere within the mid-seral state. Plant communities occurring below this threshold are in a steady state. Succession back to the HCPC usually does not occur within a reasonable length of time, and/or without a large input of energy.

Three plant communities and the successional pathways that commonly occur within the Reference State (State 1) are shown in the following diagram. In addition, the transitions from Plant Community A (State 1) and from Plant Community B (State 1) to Plant Communities C (State 2) and D (State 3), are also illustrated. Ecological processes are discussed below in the plant community descriptions.

## State and transition model

# Dense Clay 10-14" p.z. RRUs 52XC, 52XN, 53AE




**State 1**
**Reference State**

## Community 1.1
## Historic Climax Plant Community (HCPC) Mid and tall cool-season perennial grasses, short cool-season perennial grasses, 5 percent native forbs, 10 percent native shrubs, 35 percent bare ground, total annual production about 600 lbs/ac

Mid and tall cool-season perennial grasses, short cool-season perennial grasses, 5 percent native forbs, 10 percent native shrubs, 35 percent bare ground, total annual production about 600 lbs/ac Western/thickspike wheatgrasses and green needlegrass are common cool season mid grasses on this ecological site. They account for about 80% of total plant production in the HCPC. Needleandthread, another cool season mid-grass is common and tends to replace the green needlegrass when it is stressed by lack of moisture, grazing pressure, etc. About 5% of the total production is comprised of a mix of cool season short grasses and grasslike plants. These species include sandberg bluegrass, prairie junegrass, needleleaf sedge and threadleaf sedge. American vetch, a cool season nitrogen-fixing legume, is one of the most important members of the forb community. Milk vetches and prairie thermopsis are additional members of the legume family which may occur in the HCPC. Other common forbs include onion, hoods phlox, scarlet globemallow, wooly plantain, and biscuitroot. The latter group contains a mix of warm and cool season species whose relative occurrence on the site is largely influenced by the timing and amount of precipitation. Forbs contribute about 5% of the total annual production. Nuttall saltbush and winterfat are the two most important browse species occurring on the site. While Nuttall saltbush expresses itself during the cool season, winterfat is a warm season plant. Shrubs such as big sagebrush, greasewood, silver sagebrush, pricklypear cactus and fringed sagebrush may also be found in the HCPC. Shrubs normally make up about 10% of the total annual production. Broom snakeweed, annual bromes, and annual forbs are not a part of the HCPC. Their presence indicates possible ecological deterioration, or downward trend. Trend is difficult to interpret because large areas of bare ground between plants are fairly common. Total annual production averages 600 lbs/ac during normal years. However, production declines as the site regresses from the HCPC to lower successional communities. Regression may result from grazing management strategies that do not allow adequate recovery periods between grazing events, drought, and/or the disruption of the normal fire sequence. Following regression from the HCPC, soil structure appears to influence species composition. Surface layers that are vesicular, with large angular peds (blocky clods, etc) appear to limit or restrict the establishment and growth of short grasses (especially blue grama) (White and Lewis 1969). Consequently, the percentage of bare ground increases as the production of green needlegrass and western wheatgrass decline on these soils. In contrast, production of shallow-rooted and/or predominantly lateral-rooted species such as needle and thread, blue grama, sandberg bluegrass, prairie junegrass, hairy goldenaster, and hoods phlox increase when surface soils are more granular, with smaller peds, etc. The large cracks that form between the peds of the heavy soils are theorized to restrict shallow root growth and/or shear the lateral roots that have thin cortices, resulting in a reduction of the short grasses. Regardless of soil shrink/swell realities, winterfat and Nuttall saltbush may also be replaced by broom snakeweed, fringed sagewort, etc on the site. Cheatgrass and Japanese brome may invade the site. As the result of these vegetative changes, there is less litter to protect the soil and less infiltration. Hydrologic cycles are impaired when plant communities are unable to effectively use precipitation. Plant basal cover averages 15%. Litter varies from 40-50%. Consequently, bare ground may range from 35-55%. Thus, infiltration is not optimized and runoff and erosion are not minimized on the Dense Clay 10-14” p.z. ecological site. Runoff and soil erosion normally increase as the HCPC regresses to earlier seral states. (Insert HCPC Plant Community photo) The major plant species composition and production by dry weight are shown for the HCPC in the following table. Total annual production has been derived from several sources, and has been adjusted to represent a typical annual moisture cycle.

**Table 6. Annual production by plant type**

| Plant Type | Low (Lb/Acre) | Representative Value (Lb/Acre) | High (Lb/Acre) |
|---|---|---|---|
| Grass/Grasslike | 300 | 510 | 765 |
| Shrub/Vine | 35 | 60 | 90 |
| Forb | 15 | 30 | 45 |
| **Total** | **350** | **600** | **900** |

**Table 7. Ground cover**

| | |
|---|---|
| Tree foliar cover | 0% |
| Shrub/vine/liana foliar cover | 0% |

| | |
|---|---|
| Grass/grasslike foliar cover | 0% |
| Forb foliar cover | 0% |
| Non-vascular plants | 0-1% |
| Biological crusts | 0-1% |
| Litter | 40-50% |
| Surface fragments >0.25" and <=3" | 0-1% |
| Surface fragments >3" | 0-1% |
| Bedrock | 0% |
| Water | 0% |
| Bare ground | 30-40% |

**Table 8. Soil surface cover**

| | |
|---|---|
| Tree basal cover | 0% |
| Shrub/vine/liana basal cover | 1-5% |
| Grass/grasslike basal cover | 9-12% |
| Forb basal cover | 1-2% |
| Non-vascular plants | 0% |
| Biological crusts | 0% |
| Litter | 0% |
| Surface fragments >0.25" and <=3" | 0% |
| Surface fragments >3" | 0% |
| Bedrock | 0% |
| Water | 0% |
| Bare ground | 0% |

**Table 9. Canopy structure (% cover)**

| Height Above Ground (Ft) | Tree | Shrub/Vine | Grass/ Grasslike | Forb |
|---|---|---|---|---|
| <0.5 | – | 0-1% | 0-20% | 0-25% |
| >0.5 <= 1 | – | 0-40% | 0-50% | 0-50% |
| >1 <= 2 | – | 0-50% | 0-25% | 0-25% |
| >2 <= 4.5 | – | 0-10% | 0-5% | – |
| >4.5 <= 13 | – | – | – | – |
| >13 <= 40 | – | – | – | – |
| >40 <= 80 | – | – | – | – |
| >80 <= 120 | – | – | – | – |
| >120 | – | – | – | – |

## Community 1.2
## Plant Community A - Pre-threshold Vertic Reduced production, mid and short cool-season grasses, more than 40 percent bare ground.

Reduced production, mid and short cool-season grasses, more than 40 percent bare ground. Range inventories conducted by NRCS on the Fort Peck and Fort Belknap Reservations indicate similarity indices of 45-64% are indicative of Community A. Non-prescribed grazing and drought reduce plant height and plant litter. Bare ground

increases as the production of HCPC species decline. Surface runoff and soil temperature increases, and infiltration decreases. Production of shallow-rooted short grasses and sedges is limited by the large cracks that form between the peds as the soils dry. Pricklypear cactus is conspicuous in this community. In contrast to the HCPC, total annual production averages about 475 lbs/ac. However, western and thickspike wheatgrasses and green needlegrass still contribute 70% of the annual production. However, they are less vigorous and individual plant growth is reduced from what it is in the HCPC. Production of the short grasses and lower-successional forbs increases slightly to what it was in the HCPC. Although total shrub production did not change, production of silver sagebrush tends to replace production of winterfat and Nuttall saltbush. Plant community A is called a “pre-threshold community”. It is critical that this community be recognized and strategies implemented to prevent further regression. Although this community can improve to the HCPC through successional processes, further disturbance will result in regression to a lower state (State 2). Once Community A regresses to a lower state, normal successional processes are restricted.

### Community 1.3
### Plant Community B - Pre-threshold Non-Vertic Reduced production, mid and short cool- and warm-season grasses, increase of lower successional forbs, more than 40 percent bare ground.

Reduced production, mid and short cool- and warm-season grasses, increase of lower successional forbs, more than 40 percent bare ground. NRCS range inventories indicate that Community B is characterized by similarity indices of 45-64%. The Community is dominated by a mix of medium and short grasses. Blue grama, threadleaf sedge, needle and thread and sandberg bluegrass increased in the community by replacing some of the mid grasses. However, western and thickspike wheatgrass and green needlegrass continued to contribute about 50% of the total annual production (average of 375 lbs/ac.). In comparison to the HCPC, sandberg bluegrass, blue grama, and other short grasses have increased. In addition, sand dropseed and tumblegrass may appear in the community. Warm season forbs increase and replace American vetch and other high-successional forbs. The warm season half-shrub, fringed sagewort, may also increase in this community. Pricklypear cactus and broom snakeweed are conspicuous. In comparison to the HCPC, litter varies from 25-35%. Bare ground increases to 50-60%. Thus, rills, flow patterns and movement of litter deposits are visible. Plant community B is called a “pre-threshold community”. It is critical that this community be recognized and strategies implemented to prevent further regression. Although this community can improve to the HCPC through successional processes, further disturbance will result in regression to a lower state (State 3). Once Community B regresses to a lower state, normal successional processes are restricted.

### Pathway 1.1A
### Community 1.1 to 1.2

Soils are vertisols, or have vertic properties. The soil surface structure is vesicular, irregular, coarse crumb. Granules in blocky clods, large peds, bordered by large cracks when dry. Non-prescribed grazing, no fire, drought (3 to 6 years) Non-prescribed grazing, drought and/or a cessation of the natural fire regime will cause regression from HCPC to Community A. The pathway to Community A occurs on soils with vesicular, irregular, coarse granules, and blocky clods. Large cracks form between the peds (aggregates) as these soils dry. The regression to either Plant Community A may occur within a couple of years.

### Pathway 1.1B
### Community 1.1 to 1.3

Soils are not vertisols, or do not have vertic properties. Soil surface structure is not characterized by large peds, block clods and large cracks when dry. Non-prescribed grazing, no fire, and fire. Non-prescribed grazing, drought and/or a cessation of the natural fire regime will cause regression from HCPC to Community B. The pathway to Plant Community B occurs on soils with much smaller soil peds. Large cracks between peds are not a normal occurrence on these soils. The regression to either Plant Community B may occur within a couple of years.

### Pathway 1.2A
### Community 1.2 to 1.1

The Dense Clay 10-14” p.z. site is resilient within the Reference State. Normal growing conditions, the

implementation of prescribed grazing, or the re-introduction of the natural fire regime will move Plant Community A to the HCPC. This succession can occur within a couple of years.

### Pathway 1.3A
### Community 1.3 to 1.1

The Dense Clay 10-14” p.z. site is resilient within the Reference State. Normal growing conditions, the implementation of prescribed grazing, or the re-introduction of the natural fire regime will move Plant Community B to the HCPC. This succession can occur within a couple of years.

## State 2
## Degraded Vertic State

### Community 2.1
### Plant Community C Short cool-season perennial grasses, mid-height cool-season grasses, pricklypear cactus, more than 50 percent bare ground, total annual production about 325 lbs/ac.

Short cool-season perennial grasses, mid-height cool-season grasses, pricklypear cactus, more than 50 percent bare ground, total annual production about 325 lbs/ac. Regression of Plant Community A crosses a threshold and results in Plant Community C. This community is a steady state, which is resistant to change. It is characterized by a significant reduction in production of medium-height, cool season grasses. The amount of bare ground increases significantly. The wheatgrasses contributed about 50% of total annual growth. Individual wheatgrass plants produce few seed heads and can be low in vigor. Similarity indices during the NRCS inventories on Fort Peck and Fort Belknap (2001-2004) were less than 35% for this Community. Pricklypear cactus, broom snakeweed and annual bromes are often common in this community. Total annual production averaged 325 lbs/ac, a 20% reduction from Community A. Litter cover averages about 15%. Water flow patterns are numerous and there is moderate active pedestalling. Bare ground is moderately to much higher than expected. Compared to the HCPC, production of tall and medium height grasses has decreased, and bare ground has increased. The ecological processes of energy flow, hydrologic cycle, and nutrient cycle are disrupted.

**Resilience management.** *Successional Pathways Between Communities C and D: Differences in soil structure are largely responsible for the species composition of these two plant communities. Therefore, successional pathways between these communities are unlikely.

## State 3
## Degraded Non-Vertic State

### Community 3.1
### Plant Community D Short warm- and cool-season perennial grasses, pricklypear cactus, increase of lower successional forbs, about 50 percent bare soil, total annual production about 300 lbs/ac.

Short warm- and cool-season perennial grasses, pricklypear cactus, increase of lower successional forbs, about 50 percent bare soil, total annual production about 300 lbs/ac. Regression of Plant Community B ends in Plant Community D. This community is a steady state, which is resistant to change. It is characterized by a mix of warm and cool season short grasses. Blue grama, needleandthread and sandberg bluegrass are the most common plants. Western and thickspike wheatgrasses contribute about 15% to the total annual production. Production of low-successional forbs decreased relative to Community B. Total annual production usually varies from 250-300 lbs/ac during favorable years. The NRCS inventories indicate a few winterfat and Nuttall saltbush plants persist in this community. However, dry weight production of these high-successional shrubs decreased relative to the dry weight production of broom snakeweed, pricklypear cactus and fringed sagewort.

**Resilience management.** *Successional Pathways Between Communities C and D: Differences in soil structure are largely responsible for the species composition of these two plant communities. Therefore, successional pathways between these communities are unlikely.

### Transition T1A
### State 1 to 2

Non-prescribed grazing, no fire, extended drought (greater than 7 years) Plant Communities A and B are much less resistant to disturbance than the HCPC. Lower production, lower vegetative cover, less litter, and increased bare ground increases susceptibility to disturbance, stress etc. Extended drought and non-prescribed grazing are the most common causes of retrogression to State 2.

### Transition T1B
### State 1 to 3

Non-prescribed grazing, no fire, extended drought (greater than 7 years) Plant Communities A and B are much less resistant to disturbance than the HCPC. Lower production, lower vegetative cover, less litter, and increased bare ground increases susceptibility to disturbance, stress etc. Extended drought and non-prescribed grazing are the most common causes of retrogression to State 3.

### Restoration pathway R2A
### State 2 to 1

Prescribed grazing, extended period of favorable precipitation Plant community C is resistant to significant succession. The adverse soil conditions and a theorized inadequate seed bank of high successional species greatly restrict potential for succession to State 1. Although succession usually does not occur within a reasonable length of time, anecdotal evidence indicates succession may occur with the combination of prescribed grazing, the resumption of a normal fire regime, and an extended period of favorable precipitation. Favorable environmental factors may favor succession of Plant Community C to Plant Community A. This possibility is depicted by a dashed arrow in the state and transition diagram. In comparison to “normal” ecological sites (Silty 10-14” p.z., Clayey 10-14” p.z. and Sandy 10-14” p.z.) having soils > 20 inches in depth, the average annual above ground production on this Dense Clay 10-14” p.z. ecological site is 50-60% less. Mechanical treatments and range seeding are not recommended on this site.

### Restoration pathway R3A
### State 3 to 1

Prescribed grazing, fire, extended period of favorable precipitation Plant community D is resistant to significant succession. The adverse soil conditions and a theorized inadequate seed bank of high successional species greatly restrict potential for succession to State 1. Although succession usually does not occur within a reasonable length of time, anecdotal evidence indicates succession may occur with the combination of prescribed grazing, the resumption of a normal fire regime, and an extended period of favorable precipitation. Favorable environmental factors may favor succession of Plant Community D to Plant Community B. This possibility is depicted by a dashed arrow in the state and transition diagram. In comparison to “normal” ecological sites (Silty 10-14” p.z., Clayey 10-14” p.z. and Sandy 10-14” p.z.) having soils > 20 inches in depth, the average annual above ground production on this Dense Clay 10-14” p.z. ecological site is 50-60% less. Mechanical treatments and range seeding are not recommended on this site.

## Additional community tables

**Table 10. Community 1.1 plant community composition**

| Group | Common Name | Symbol | Scientific Name | Annual Production (Lb/Acre) | Foliar Cover (%) |
|---|---|---|---|---|---|
| **Grass/Grasslike** | | | | | |
| 1 | **Rhizomatous Wheatgrass** | | | 240–360 | |
| | western wheatgrass | PASM | *Pascopyrum smithii* | 120–180 | – |
| | tufted wheatgrass | ELMA7 | *Elymus macrourus* | 120–180 | – |
| 2 | **Cool-season Grasses** | | | 120–270 | |
| | green needlegrass | NAVI4 | *Nassella viridula* | 90–180 | – |
| | needle and thread | HECO26 | *Hesperostipa comata* | 30–90 | – |
| 3 | **Warm-season Grasses** | | | 30–90 | |
| | plains muhly | MUCU3 | *Muhlenbergia cuspidata* | 30–90 | – |
| 4 | **Miscellaneous Grasses** | | | 0–60 | |
| | blue grama | BOGR2 | *Bouteloua gracilis* | 0–30 | – |
| | sand dropseed | SPCR | *Sporobolus cryptandrus* | 0–30 | – |
| | plains reedgrass | CAMO | *Calamagrostis montanensis* | 0–30 | – |
| | threadleaf sedge | CAFI | *Carex filifolia* | 0–30 | – |
| | Sandberg bluegrass | POSE | *Poa secunda* | 0–30 | – |
| | prairie Junegrass | KOMA | *Koeleria macrantha* | 0–30 | – |
| | squirreltail | ELEL5 | *Elymus elymoides* | 0–30 | – |
| | Grass, native | 2GN | *Grass, native* | 0–30 | – |
| **Forb** | | | | | |
| 5 | **Dominant Forbs** | | | 6–30 | |
| | American vetch | VIAM | *Vicia americana* | 6–30 | – |
| | milkvetch | ASTRA | *Astragalus* | 6–30 | – |
| 6 | **Miscellaneous Forbs** | | | 5–25 | |
| | scarlet globemallow | SPCO | *Sphaeralcea coccinea* | 0–30 | – |
| | aster | ASTER | *Aster* | 0–30 | – |
| | prairie thermopsis | THRH | *Thermopsis rhombifolia* | 0–30 | – |
| | pussytoes | ANTEN | *Antennaria* | 0–30 | – |
| | bastard toadflax | COUM | *Comandra umbellata* | 0–30 | – |
| | beardtongue | PENST | *Penstemon* | 0–30 | – |
| | spiny phlox | PHHO | *Phlox hoodii* | 0–30 | – |
| | Forb, native | 2FN | *Forb, native* | 0–30 | – |
| **Shrub/Vine** | | | | | |
| 7 | **Dominant Shrubs** | | | 12–90 | |
| | Nuttall's saltbush | ATNU2 | *Atriplex nuttallii* | 6–60 | – |
| | winterfat | KRLA2 | *Krascheninnikovia lanata* | 6–60 | – |
| 8 | **Miscellaneous Shrubs** | | | 0–60 | |
| | big sagebrush | ARTR2 | *Artemisia tridentata* | 0–60 | – |
| | silver sagebrush | ARCA13 | *Artemisia cana* | 0–60 | – |
| | prairie sagewort | ARFR4 | *Artemisia frigida* | 0–60 | – |
| | Shrub (>.5m) | 2SHRUB | *Shrub (>.5m)* | 0–60 | – |
| | plains pricklypear | OPPO | *Opuntia polyacantha* | 0–1 | – |

## Animal community

Livestock Management
The Dense Clay 10-14” p.z. ecological site is suited for livestock grazing. However, prescribed grazing management is needed. Forage production is limited by a hardpan and excessive sodium. Species composition is susceptible to heavy stocking and season long grazing. The cool season medium height grasses are generally selectively grazed, giving the short grasses a competitive advantage on soils with low shrink/swell potential. Grazing during early spring may result in soil compaction. Any additional factors reducing infiltration and increasing runoff on this site is a management concern. Shorter grazing periods, adequate periods of non-use following grazing to facilitate plant regrowth and an accumulation of litter are recommended.
The Dense Clay 10-14” p.z. ecological site that has large peds (aggregates) in the surface soil does not have a significant component of short grass species. The blocky clods and large cracks are not conducive for the growth of shallow-, lateral-rooted short grasses. In contrast, the soils without the large peds do have a short grass component as the site transitions from HCPC to other plant communities. The short grasses usually increase with grazing and decrease with adequate plant rest and recovery periods found in prescribed grazing management systems. However, succession in direct response to a change in grazing pressure is not guaranteed in the Northern Great Plains.
Sampling four-year old ungrazed exclosures and grazed areas with 35% utilization, Vogel and Van Dyne (1966) found essentially the same basal cover of grasses, sedges, forbs, litter and bare soil on protected and grazed sites. They concluded that four years was too short of a time for cover to change significantly. Hofmann and Ries (1989) observed similar results following a four-year study in North Dakota. Even after 41 years of exclosure, changes in species composition can be relatively small when the site is in the dry, low production portion of northern mixed prairie (Brand and Goetz, 1986). They concluded that site characteristics limited the development of potential vegetation with the exclusion of grazing, but the potential impacts of prescribed grazing on succession were not discussed. This ecological site is not as productive as the sites evaluated by Vogel and Van Dyne, Hofmann and Ries, or by Brand and Goetz. Therefore, range managers should recognize the environmental limitations of this site. While a prescribed grazing system is always a good recommendation, seeding and/or mechanical treatment are not recommended.

Wildlife Interpretations
The HCPC associated with the Dense Clay 10-14” p.z. ecological site provides diverse and valuable wildlife habitat. This site often occurs as a mosaic with other ecological sites, thus creating “ecotones” that serve as magnets for many species of wildlife. Antelope and mule deer prefer grazing this site because of the Nuttall saltbush and winterfat, which are high in protein and palatable year-round. However, the landscape does not provide adequate thermal and escape cover. The lack of species diversity limits the value of the site for many species of wildlife. The bare ground and lack of litter also limits the potential of the site for upland birds and for ground nesting birds.
The Dense Clay 10-14” p.z. ecological site becomes less valuable for deer and antelope when plant diversity declines with regression. For example, the disappearance of either the tall warm season grass or cool season grasses would shorten the length of the “green forage” season and reduce the standing residual height. The increase of blue grama, clubmoss, hoods phlox etc. is also associated with the loss of palatable forbs. These changes tend to adversely impact foraging opportunities for deer, antelope, upland birds, etc. Although Communities C and D have very little value for most wildlife species because of insufficient vegetative structural diversity, residual grass carry-over and litter cover, their habitat is critical for such species as the upland plover.

Plant Preferences by Animal Kind
Refer to NRCS Field Office Technical Guide, Section IIE, General Information, for tables displaying plant preferences by livestock and wildlife.

## Hydrological functions

Water is the main factor limiting vegetative production on this site. Soil components in this ecological site are normally classed into Hydrologic Group D. These soils have a medium to very high runoff potential, with hydrologic runoff curves of 89 to 80. Field investigations are needed to adjust the curves when plant communities deteriorate from the HCPC. Areas where ground cover is less than 50% have the greatest potential to have reduced infiltration and higher runoff.

## Recreational uses

This site provides hunting opportunities for upland game species. Photographers are able to capture the beauty of big bare areas with huge cracks, and the blossoms of pricklypear cactus.

## Wood products

This site has no significant value for wood products.

## Other information

This ecological site is not highly resistant to disturbances. Species diversity is adversely affected by season long continuous grazing and by heavy stocking. Medium height grasses are replaced by short grasses. The number of structural/functional groups is reduced with regression from the HCPC. The amount of solar energy that is captured and converted to carbohydrates for plant growth is reduced in States 2 and 3. A reduction in total vegetative growth results in less potential vegetation that can be transformed into litter. Litter reductions result in less infiltration, and more runoff and soil erosion.

## Inventory data references

Data Source Number of Records Sample Period State County
SCS-Range-417 2 1991, 1992 MT Phillips
ECS-1
Modified Double Sampling* 30 2001-1004 MT Blaine, Phillips, Valley
Daniels, Roosevelt
*The range inventories on Fort Peck and Belknap Reservations mapped thousands of acres of the Dense Clay range site. The inventory data indicated significant production of needleandthread and blue grama. The actual occurrence of these species on the Dense Clay 10-14” p.z. site needs to be verified in the field. It is suggested that the field review examine the relationship between the current and past mapping and classification of soils into the Dense Clay, Clay Pan and the former Panspots range sites.
USDA-SCS-MT 1981 Technical Range Site Description

## Other references

Brand, M.D. and H. Goetz. 1986. Vegetation of exclosures in Southwestern North Dakota. J. Range Manage. 39:434-437.
Briske, D. D., S. D. Fuhlendorf, and F. E. Smeins, 2005. State-and-transition models, thresholds, and rangeland health: a synthesis of ecological concepts and perspectives.
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Frost, C. C. 1998. Presettlement fire frequency regimes of the United States: a first approximation. Pages 70-81. in Teresa L. Pruden and Leonard A. Brennan (eds.). Fire in ecosystem management: shifting paradigm from suppression to prescription. Tall Timbers Fire Ecology Conference Proceedings. No. 20. Tall Timbers Research Station, Tallahassee, FL.
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Hofmann, L. and R.E. Ries. 1989. Animal performance and plant production from continuously grazed cool-season reclaimed and native pastures. J. Range Manage. 42:248-251.
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White, E. M., and J. K. Lewis. 1969. Ecological effect of a clay soil’s structure on some native grass roots. J. Range Manage. 22:401-404.

## Contributors

Kirt Walstad

## Approval

Kirt Walstad, 1/24/2024

## Acknowledgments

Site Description Revisions
The 2005 Dense Clay 10-14” p.z. ecological site description replaces earlier dated versions of the Dense Clay 10-14” p.z. and Panspots 10-14” p.z. descriptions in Rangeland Resource Unit 52XN. This 2005 revision incorporates the State and Transition Model theory, additional data on site productivity, and an improved understanding of many rangeland health indicators.
Site Description Approval
This ecological site description is approved with the understanding that it is no more than another step in our continual effort to update the NRCS technical guide. In order to facilitate the process, NRCS field personnel are encouraged to forward existing information and/or new data that can be used to improve the utility of this site description. Please forward the information and data to the State Rangeland Management Specialist.
Authors Date Approval Date
Dr. John Lacey 02/28/2005 Loretta J. Metz 03/19/2005
Maxine Rasmussen, Area RMS, Glasgow, MT
Jon Siddoway, Area RMS, Great Falls, MT
Rick Bandy, Area RSS, Great Falls, MT
Greg Snell, Area RSS, Glasgow, MT

## 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) | Siddoway/Bandy |
| Contact for lead author | Great Falls Area Office, Great Falls, MT<br><br>Reference site used? No |
| Date | 04/19/2005 |
| Approved by | Kirt Walstad |
| Approval date | |
| Composition (Indicators 10 and 12) based on | Annual Production |

## Indicators

1. **Number and extent of rills:** Slopes are between 0 – 12% and bare ground will be 40-50%, so past and current rill activity is expected on this site after rain storms or following melting of adequate snow depths within a short time period.

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2. **Presence of water flow patterns:** Because the soil surface is not well covered and slopes greater than zero are common on this site there will be evidence of water flow patterns. Sodium content in these soils restricts water intake into the soil.

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3. **Number and height of erosional pedestals or terracettes:** Where there is adequate slope and unsheltered distance, pedestals and terracettes will be shallower towards the top of the slope and deeper towards the bottom of the slope.

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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 will be 40 – 50% across this site.

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5. **Number of gullies and erosion associated with gullies:** Past gully erosion may be evident on this site. Active gullies should not be present.

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6. **Extent of wind scoured, blowouts and/or depositional areas:** These areas will be rare on this site.

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7. **Amount of litter movement (describe size and distance expected to travel):** Litter movement may move over extensive distances relative to other sites due to the presence of larger areas of bare ground. Size of the litter would reflect the more common plant tissue (leaves & reproductive culms) in the reference state – mainly western wheatgrass and green needlegrass.

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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 of 3 or 4 under plant canopies; areas of bare soil on this site will have values between 1 and 3.

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):** Soil surface structure is platy; A horizon depth is less than 1".

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10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:** Even with the dominance of taller, deeper-rooted bunchgrasses infiltration on this site is restricted due to the presence of sodium in the soil, and runoff will be more common on this site with more moderate storm events.

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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):** Will not be present generally, but there may be areas that have "healed" from former bison trails and wallows as well as from more current livestock trailing, which will have a compaction layer below the soil surface. The A or E horizon will have vesicular crusting which inhibits germination.

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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:

    Sub-dominant:

    Other:

    Additional: Cool season, rhizomatous grasses (Western wheatgrass,) > cool season, taller bunchgrasses (Green needlegrass) >> cool season short grasses (Prairie junegrass) > shrubs > perennial forbs = warm season shortgrass (Blue grama).

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):** Will be low for all functional groups in a given year. Prolonged droughts which last more than 3 years may show increases in mortality and decadence for all plant groups.

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):** 600 - 1100 #/acre. This would be the expected production for the reference state during adequate moisture years. 900 pounds would be the expected production in a 12 inch precipitation zone.

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:** Blue grama, Japanese brome, a variety of annual or biennial weedy forbs, fringed sagewort, broom snakeweed, prickly pear cactus, cheatgrass.

17. **Perennial plant reproductive capability:** Due to the soil restrictions on this site, seed production can be unpredictable. Bunchgrasses will generally produce seeds in good moisture years, however the cool season rhizomatous grasses may not necessarily produce seed even with adequate moisture.