Ecological Site Description (Provisional)

Major Land Resource Area 107B

Iowa and Missouri Deep Loess Hills

Deep Loess Upland Prairie

Amorpha canescens/Schizachyrium scoparium – Sporobolus heterolepis

A PROVISIONAL ECOLOGICAL SITE is a conceptual grouping of soil map unit components within a Major Land Resource Area (MLRA) based on the similarities in response to management. Although there may be wide variability in the productivity of the soils grouped into a Provisional Site, the soil vegetation interactions as expressed in the State and Transition Model are similar and the management actions required to achieve objectives, whether maintaining the existing ecological state or managing for an alternative state, are similar. Provisional Sites are likely to be refined into more precise group during the process of meeting the APPROVED ECOLOGICAL SITE DESCRIPTION criteria.

The PROVISIONAL ECOLOGICAL SITE has been developed to meet the standards established in the National Ecological Site Handbook. The information associated with this ecological site does not meet the Approved Ecological Site Description Standard, but it has been through a Quality Control and Quality Assurance process to assure consistency and completeness. Further investigations, reviews and correlations are necessary before it becomes an Approved Ecological Site Description.

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Front cover: Left photo is of leadplant (*Amorpha canescens*) (© Larry Allain, USGS National Wetlands Research Center, USDA-NRCS PLANTS Database); top photo is of little bluestem (*Schizachyrium scoparium*) (© L. Glasscock, 1991, *Southern wetland flora: Field office guide to plant species,* USDA-NRCS PLANTS Database); right photo is of prairie dropseed (*Sporobolus heterolepis*) (© J. Dan Pittillo, USDA-NRCS PLANTS Database).

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General Information

Ecological Site Name

Abiotic: Deep Loess Upland Prairie
Biotic: *Amorpha canescens/Schizachyrium scoparium – Sporobolus heterolepis*
Leadplant/Little Bluestem – Prairie Dropseed

Ecological Site ID: R107BY002MO

Hierarchical Framework Relationships

Major Land Resource Area (MLRA): Iowa and Missouri Deep Loess Hills (107B) (USDA-NRCS 2006)

USFS Subregions: Central Dissected Till Plains Section (251C), Deep Loess Hills (251Ca), Loess Hills (251Cb) Subsections; Nebraska Rolling Hills (251H), Yankton Hills and Valleys (251Ha) Subsection (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Steeply Rolling Loess Prairies (47e), Rolling Loess Prairies (47f), Nebraska/Kansas Loess Hills (47h), Western Loess Hills (47m) (USEPA 2013)

MLRA Notes

The Iowa and Missouri Deep Loess Hills (MLRA 107B) includes the Missouri Alluvial Plain, Loess Hills, Southern Iowa Drift Plain, and Central Dissected Till Plains landform regions (Prior 1991; Nigh and Schroeder 2002). It spans four states (Iowa, 53 percent; Missouri, 32 percent; Nebraska, 12 percent; and Kansas 3 percent), encompassing over 14,000 square miles (Figure 1). The elevation ranges from approximately 1565 feet above sea level (ASL) on the highest ridges to about 600 feet ASL along the Missouri River near Glasgow in central Missouri. Local relief varies from 10 to 20 feet in the major river floodplains, to 50 to 100 feet in the dissected uplands, and loess bluffs of 200 to 300 feet along the Missouri River. Loess deposits cover most of the area, with deposits

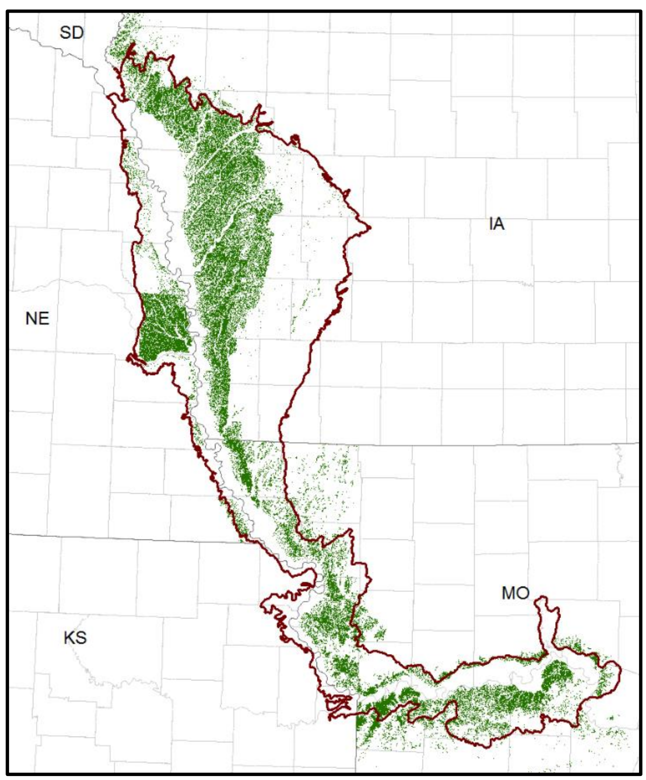

Figure 1. *Location of Deep Loess Upland Prairie ecological site within MLRA 107B.*

reaching a thickness of 65 to 200 feet in the Loess Hills and grading to about 20 feet in the eastern extent of the region. Pre-Illinoian till, deposited more than 500,000 years ago, lies beneath the loess and has experienced extensive erosion and dissection. Pennsylvanian and Cretaceous bedrock, comprised of shale, mudstones, and sandstones, lie beneath the glacial material (USDA-NRCS 2006).

The vegetation in the MLRA has undergone drastic changes over time. Spruce forests dominated the landscape 30,000 to 21,500 years ago. As the last glacial maximum peaked 21,500 to 16,000 years ago, they were replaced with open tundras and parklands. The end of the Pleistocene Epoch saw a warming climate that initially prompted the return of spruce forests, and as the warming continued, spruce trees were replaced by deciduous trees (Baker et al. 1990). Not until approximately 9,000 years ago did the vegetation transition to prairies as climatic conditions continued to warm and subsequently dry. Between 4,000 and 3,000 years ago, oak savannas began intermingling within the prairie landscape. This prairie-oak savanna ecosystem formed the dominant landscapes until the arrival of European settlers (Baker et al. 1992).

Ecological Site Concept

Deep Loess Upland Prairies are generally located within the green areas on the map (Figure 1). They occur on summits and shoulders on slopes less than fifteen percent. Soils are Entisols, Inceptisols, and Mollisols that are well-drained and very deep, formed from leached loess with a strongly acid to moderately alkaline (increased pH) environment. These fine-silty, fertile soils have high soil uniformity resulting in increased nutrient- and water-holding capacity, increased organic matter retention, and good soil aeration that allows deep penetration by plant roots, which generally results in high plant productivity (Catt 2001). Deep Loess Upland Prairies occur upslope from other deep loess ecological sites.

The historic pre-European settlement vegetation on this site was dominated by a variety of tallgrass prairie species. Little bluestem (*Schizachyrium scoparium* (Michx.) Nash)[1] is the dominant monocot species, while prairie dropseed (*Sporobolus heterolepis* (A. Gray) A. Gray) is an important indicator species (Steinauer and Rolfsmeier 2010). Other grasses that can occur include big bluestem (*Andropogon gerardii* Vitman), Indiangrass (*Sorghastrum nutans* (L.) Nash), and sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.). Herbaceous species typical of an undisturbed plant community associated with this ecological site include white prairie clover (*Dalea candida* Michx. ex Willd.), Mead's milkweed (*Asclepias meadii* Torr. ex A. Gray), and prairie cinquefoil (*Potentilla arguta* Pursh) (Drobney et al. 2001; Nelson 2010; Ladd and Thomas 2015). Leadplant (*Amorpha canescens* Pursh) is a common shrub that can be found scattered throughout the prairie (Nelson 2010; Steinauer and Rolfsmeier 2010). Fire was the primary disturbance factor that maintained this site, while drought and large mammal grazing were secondary factors (LANDFIRE 2009; Nelson 2010).

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[1] All plant common and scientific names in this document were obtained from the U.S. Department of Agriculture – Natural Resources Conservation Service National PLANTS Database.

Physiographic Features

Deep Loess Upland Prairies occur on summits and shoulders on slopes less than fifteen percent on dissected till plains (Figure 2). This ecological site is unique to the Loess Hills landform situated on elevations ranging from approximately 900 to 1,700 feet ASL. This site does not experience flooding but rather generates runoff to adjacent, downslope ecological sites.

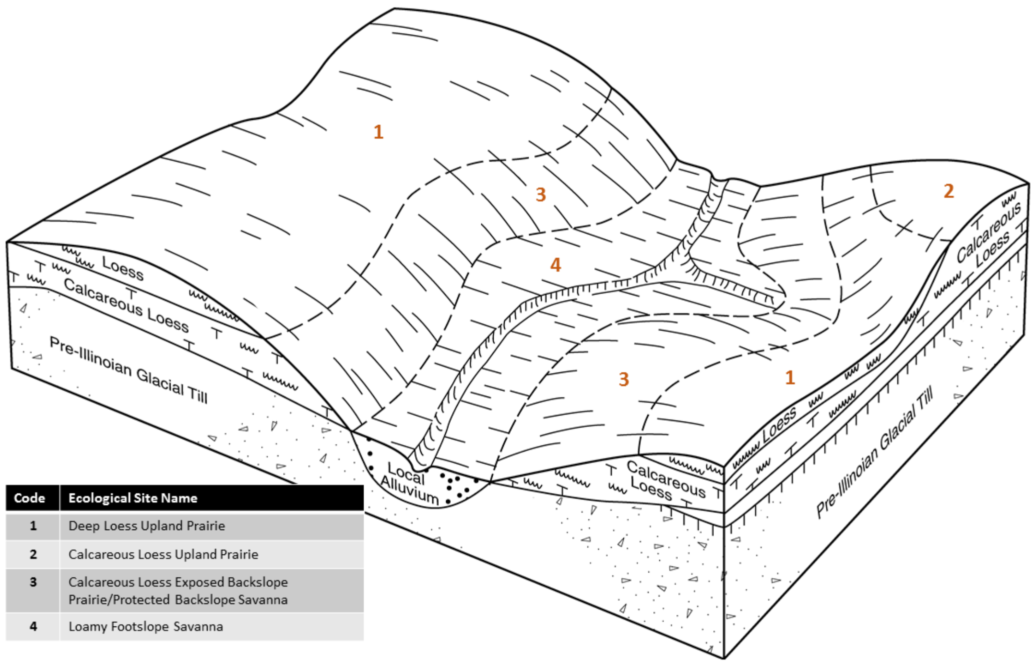


Figure 2. *Representative block diagram of Deep Loess Upland Prairie and associated ecological sites.*

Table 1. *Physiographic features of Deep Loess Upland Prairies.*
(Data and information presented here are based on NRCS integrated plot data and the National Soil Information System.)

	Minimum	Maximum
Elevation (feet)	600	1699
Slope (percent)	0	15
Water Table Depth (inches)	80	80
Flooding		
Frequency	None	None
Duration	None	None
Ponding		
Depth (inches)	None	None
Frequency	None	None
Duration	None	None

Landforms: hillslope, interfluve, ridge
Slope Shape: convex (down slope), convex (across slope)
Hillslope (profile position): summits and shoulders
Aspect: no influence on this site

Climatic Features

The Iowa and Missouri Deep Loess Hills falls into two Köppen-Geiger climate classifications (Peel et al. 2007): hot humid continental climate (Dfa) dominates the majority of the MLRA with small portions in the south falling into the humid subtropical climate (Cfa). In winter, dry, cold air masses periodically shift south from Canada. As these air masses collide with humid air, snowfall and rainfall result. In summer, moist, warm air masses from the Gulf of Mexico migrate north, producing significant frontal or convective rains (Decker 2017). Occasionally, high pressure will stagnate over the region, creating extended droughty periods. These periods of drought have historically occurred on 22-year cycles (Stockton and Meko 1983).

The soil temperature regime of MLRA 107B is classified as mesic, where the mean annual soil temperature is between 46 and 59°F (USDA-NRCS 2006). Temperature and precipitation occur along a north-south gradient, where temperature and precipitation increase the further south you travel. The average freeze-free period of this ecological site is about 175 days, while the frost-free period is about 154 days (Table 2). The majority of the precipitation occurs as rainfall in the form of convective thunderstorms during the growing season. Average annual precipitation is 28 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 38 and 61°F, respectively.

Climate data and analyses are derived from 30-year average gathered from six National Oceanic and Atmospheric Administration (NOAA) weather stations contained within the range of this ecological site (Table 4).

Table 2. *Frost-free and freeze-free days.*
(Data were obtained from NOAA weather stations within the range of this ecological site, using 30-year averages.)

	Average days
Frost-free period (32.5°F or greater, 90% probability)	154
Freeze-free period (Less than 28.5°F, 90% probability)	175

Table 3. *Monthly and annual precipitation and temperature in the range of Deep Loess Upland Prairie. (Data were obtained from NOAA weather stations within the range of this ecological site, using 30-year averages.)*

	Monthly Moisture (Inches) and Temperature (°F) Distribution				
	----------Precipitation----------			----------Temperature----------	
	Low	Med	High	Average Low	Average High
January	0.3	0.62	0.94	11.8	32.4
February	0.43	0.74	1.09	16.1	37.2
March	0.93	1.71	3.11	26.5	49.7
April	1.86	2.82	4.25	37.9	63.0
May	2.95	4.34	6.21	49.8	73.4
June	2.83	4.37	6.39	59.9	82.4
July	2.47	3.83	5.63	64.3	86.1
August	1.68	3.05	4.64	61.7	84.2
September	1.37	2.81	4.34	51.8	77.4
October	1.16	1.94	3.47	39.2	65.0
November	0.86	1.34	2.29	26.9	48.5
December	0.44	0.80	1.42	15.0	34.3
Annual	-	28.4	-	38.4	61.1

Table 4. *NOAA climate stations used for data analysis, located within the range of this ecological site.*

Climate Station ID	Location (County)	From	To
GLENWOOD 3SW (USC00133290)	Mills, IA 51561	1981	2010
LOGAN (USC00134894)	Harrison, IA 51546	1981	2010
ONAWA 3NW (USC00136243)	Monona, IA 51040	1981	2010
SIDNEY (USC00137669)	Fremont, IA 51652	1981	2010
SIOUX CITY GATEWAY AIRPORT (USW00014943)	Woodbury, IA 51115	1981	2010
TARKIO (USW00014945)	Atchison, MO 64491	1981	2010

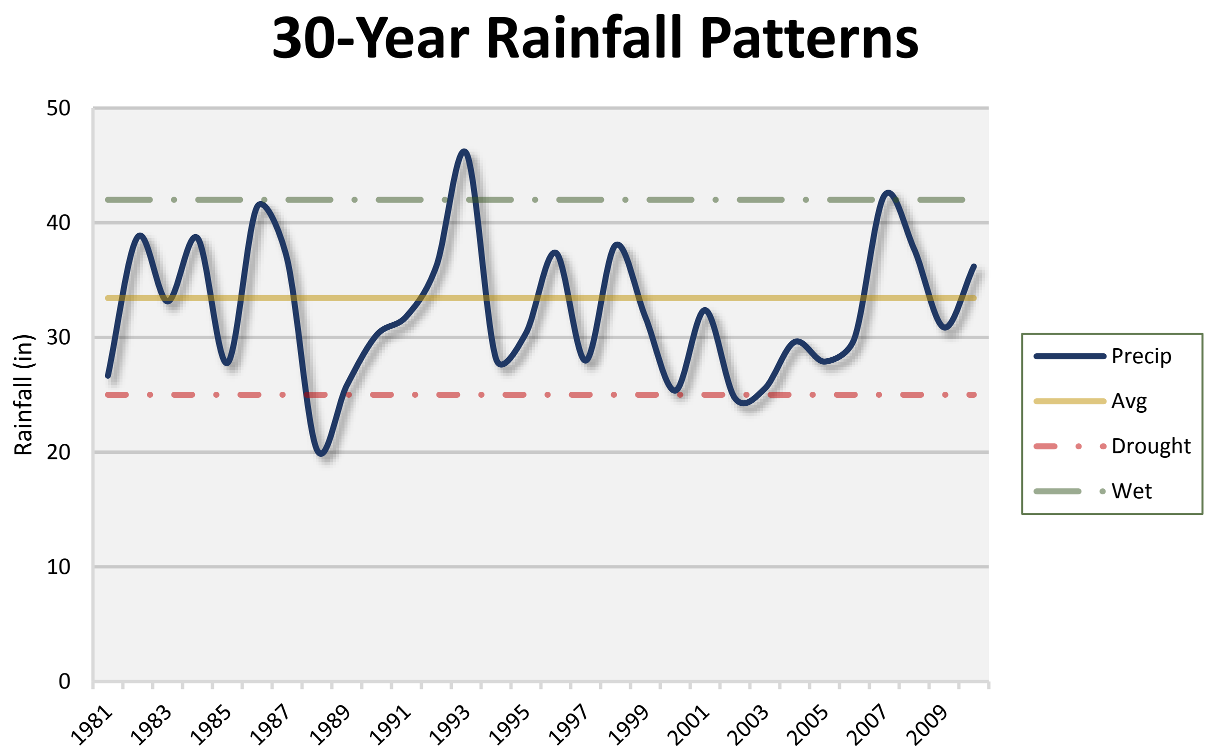


Figure 3. *Deep Loess Upland Prairie 30-year rainfall amounts, 1981-2010.*

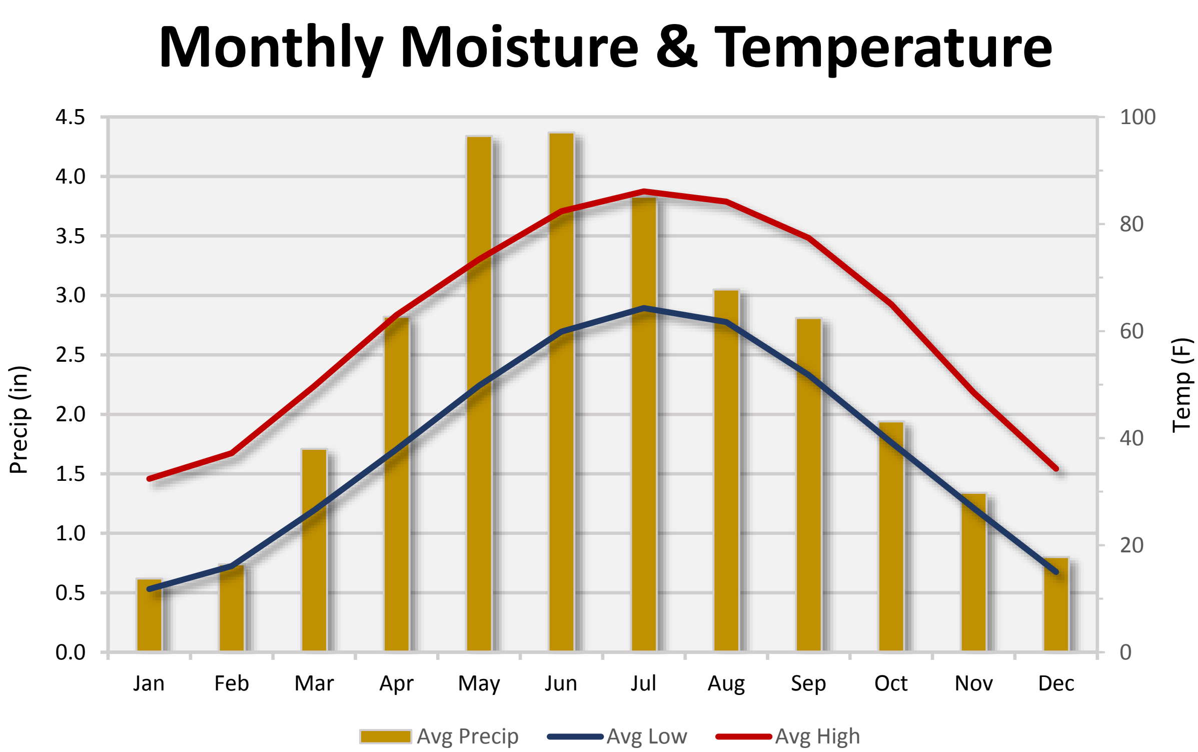


Figure 4. *Deep Loess Upland Prairie average monthly precipitation and temperature, 1981-2010.*

Influencing Water Features

Deep Loess Upland Prairies are not influenced by wetland or riparian water features. Precipitation is the main source of water for this ecological site. Infiltration is moderate to slow (Hydrologic Groups B and C), and surface runoff is low to medium. Precipitation infiltrates the soil surface and percolates downward through the horizons unimpeded by any restrictive layer. The Dakota bedrock aquifer in the northern region of this ecological site is typically deep and confined, leaving it generally unaffected by recharge. However, there are surficial aquifers in the Pennsylvanian strata in the southern extent of the ecological site that are shallow and allow some recharge (Prior et al. 2003). Surface runoff contributes some water to downslope ecological sites. Evapotranspiration rates occur on a latitudinal gradient, with the northern end of the ecological site receiving a greater number of days with sun and high winds resulting in a higher average evapotranspiration rate compared to the southern end (Visher 1954).

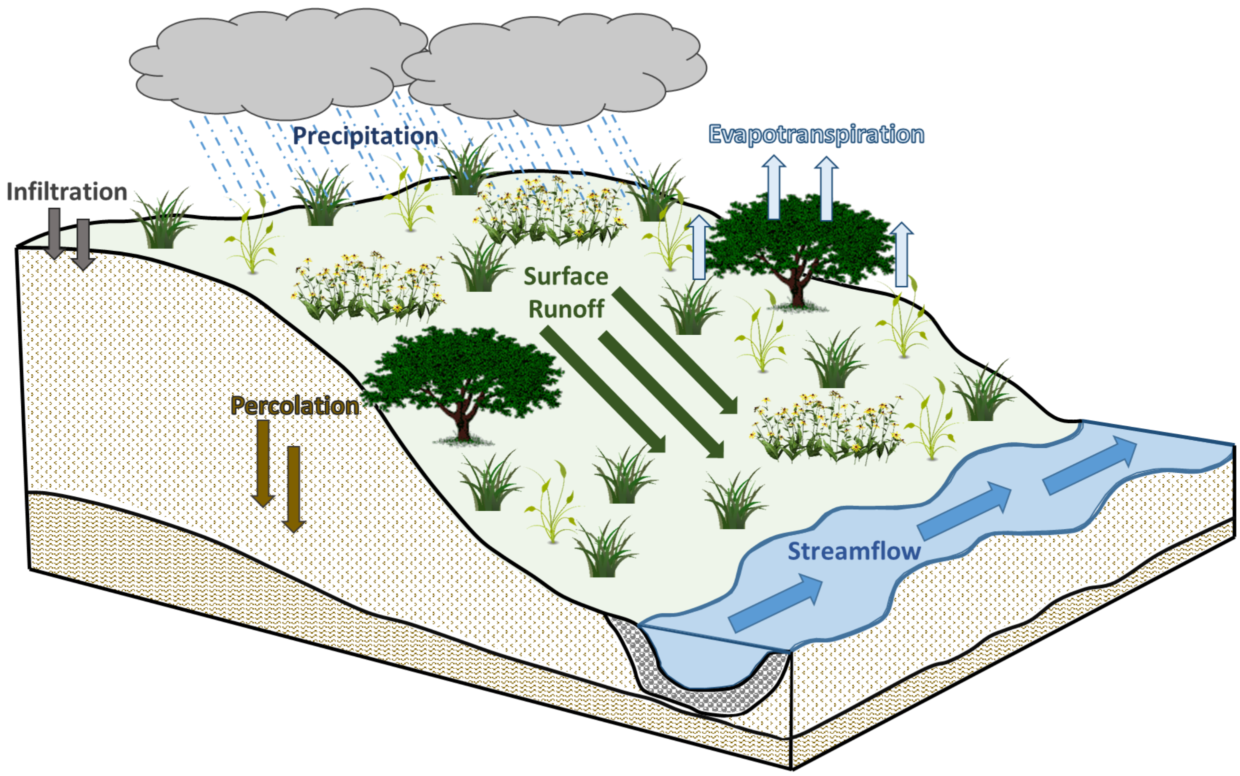


Figure 5. *Hydrologic cycling in Deep Loess Upland Prairie ecological site.*

Representative Soil Features

Soils of Deep Loess Upland Prairies are in the Entisol, Inceptisol, and Mollisol orders, further classified as Aquic Argiudolls, Dystric Eutrudepts, Pachic Hapludolls, Typic Argiudolls, Typic Hapludolls, or Typic Dystrudepts. They were formed under prairie vegetation. The soil series associated with this site includes Arents, Contrary, Deroin, Higginsville, Melia, Monona, Ponca, Sibley, Sibleyville, Strahan, Udarents, Udorthents, and Wakenda. The parent material is loess, and the soils are mostly well-drained and very deep with no coarse fragments. Soil pH classes are strongly acid to moderately alkaline. No rooting restrictions are noted for the soils of this ecological site. Average clay content is between 20 and 30 percent limiting extreme compaction, but erosion from wind and water can be high.

Table 5. *Representative soil features of Deep Loess Upland Prairies.*
(Data and information presented here are based on NRCS integrated plot data and the National Soil Information System.)

	Minimum	**Maximum**
Surface Fragments less than 3” (percent cover)	None	None
Surface Fragments greater than 3” (percent cover)	None	None
Subsurface Fragments less than 3” (percent volume)	None	None
Subsurface Fragments greater than 3” (percent volume)	None	None
Soil Depth (inches)	80	80
Electrical Conductivity (mmhos/cm)	0	2
Sodium Absorption Ratio	0	0
Soil Reaction/pH (1:1 water)	5.1	8.4
Available Water Capacity (inches)	6	9
Calcium Carbonate Equivalent (percent)	0	20
Clay Content (percent)	20	30

Drainage Class: somewhat poorly to well-drained
Permeability Class: moderately slow to moderate
Parent Material – Kind: loess
Parent Material – Origin: loess
Surface Texture: fine-silty
Surface Texture Modifier: none
Subsurface Texture Group: N/A
Soil Series: Arents, Contrary, Deroin, Higginsville, Melia, Monona, Ponca, Sibley, Sibleyville, Strahan, Udarents, Udorthents, Wakenda
Taxonomic Class: Aquic Argiudolls, Dystric Eutrudepts, Pachic Hapludolls, Typic Argiudolls, Typic Hapludolls, Typic Udorthents

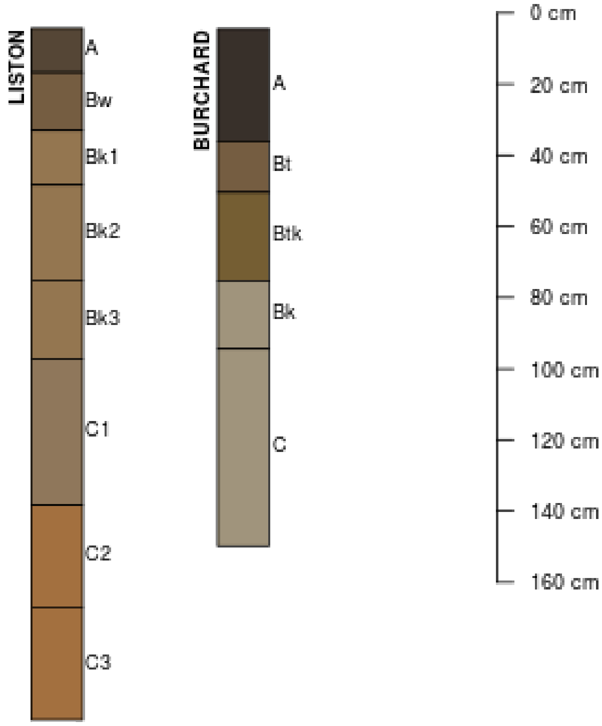


Figure 6. *Profile sketches of soil series associated with Deep Loess Upland Prairies.*

State and Community Phases

The information in this Ecological Site Description, including the state-and-transition model (STM), was developed based on historical data, current field data, professional experience, and a review of the scientific literature. As a result, all possible scenarios or plant species may not be included. Key indicator plant species, disturbances, and ecological processes are described to inform land management decisions.

Ecological Dynamics

Prairie ecosystems are regarded as the most endangered ecosystem in North America where an estimated four percent of the tallgrass prairie habitat remains (Steinauer and Collins 1996). The Loess Hills region of MLRA 107B were once dominated by tall and mixed-grass prairies, extending across more than 90 percent of the area (Rosburg 1994; Farnsworth 2009). However, by the early twenty-first century much of the land had been converted to agriculture, leaving an estimated 20 percent of the region to be classified as “grassland” and another three percent classified as “remnant prairie” (Farnsworth 2009).

Deep Loess Upland Prairies form a vegetative continuum throughout the Loess Hills, where soil moisture serves as the primary influence on community composition (White 1983; White and Glenn-Lewin 1984). This ecological site can occur on nearly any aspect. Species characteristic of this ecological site are sun-loving, fire- and drought-adapted plants.

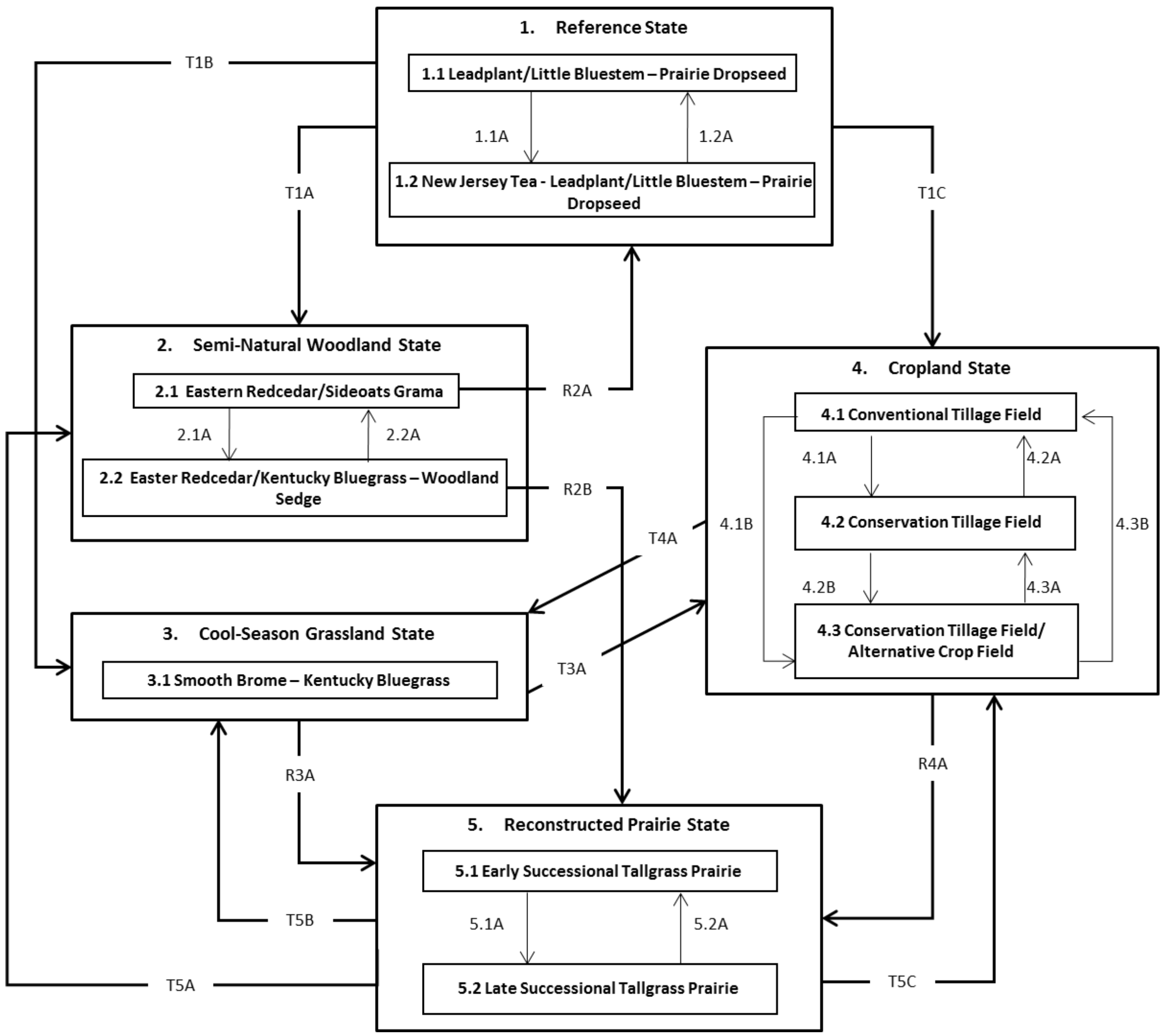
Fire is arguably the most important ecosystem driver for maintaining this ecological site (Vogl 1974; Anderson 1990; Eilers and Roosa 1994). Fire intensity typically consisted of periodic, low-intensity surface fires (Stambaugh et al. 2006; LANDFIRE 2009). Ignition sources included summertime lightning strikes from convective storms and bimodal, human ignitions during the spring and fall seasons. Native Americans regularly set fires to improve sight lines for hunting, driving large game, improving grazing and browsing habitat, agricultural and village clearing, and enhancing vital ethnobotanical plants (Day 1953; Barrett 1980; White 1994). Fire frequency has been estimated to occur on average every 6.6 years in the Loess Hills region (Stambaugh et al. 2006). This continuous disturbance provided critical conditions for perpetuating the native prairie ecosystem.

Grazing by native ungulates is often cited as an important disturbance regime of North American grasslands, with bison (*Bison bison*), prairie elk (*Cervus elaphus*), and white-tailed deer (*Odocoileus virginianus*) serving as the dominant herbivores of the area. However, plant community succession in the Loess Hills region does not necessarily follow this hypothesis. The steep and rugged topography of the Loess Hills has been considered an impediment to grazing by large ungulates such as bison. Any role bison played in the area was most likely relegated to the northwestern extent where the terrain is milder (Dinsmore 1994). Elk and deer are believed to have played a relatively significant role in keeping woody vegetation at bay in the prairies of the Loess Hills (Farnsworth 2009; LANDFIRE 2009).

Drought has also played a role in shaping the prairie ecosystems in the Loess Hills. The periodic episodes of reduced soil moisture in conjunction with the well-drained soils have favored the proliferation of plant species tolerant of such conditions (Stambaugh et al. 2006). In addition, drought can also slow the growth of plants and result in dieback of certain species. When coupled with fire, periods of drought can also greatly delay the recovery of woody vegetation, substantially altering the extent of shrubs and trees (Pyne et al. 1996).

Today, Deep Loess Upland Prairies are limited in their extent, having been converted to pasture or agricultural land. What remnants do exist have been degraded by woody species encroachment and invaded by non-native species (e.g., Kentucky bluegrass (*Poa pratensis* L.), sericea lespedeza (*Lespedeza cuneata* (Dum. Cours.) G. Don), and nodding plumeless thistle (*Carduus nutans* L.)) (Nelson 2010; Steinauer and Rolfsmeier 2010). A return to the historic plant community may not always be possible, but long-term restoration efforts can help to restore some natural diversity and ecological functioning.

R107BY002MO Deep Loess Upland Prairie



Code	Process
T1A, T5A	Fire suppression
T1B, T4A	Brush control, interseeding of non-native cool-season grasses
T1C, T3A, T5C	Agricultural conversion via tillage, seeding, and non-selective herbicide
1.1A	Reduced fire return interval
1.1B	Increased fire return interval
R2A	Historic fire regime re-introduced
4.1A	Less tillage, residue management
4.1B	Less tillage, residue management, and implementation of cover cropping
4.2B	Implementation of cover cropping
4.2A, 4.3B	Intensive tillage, remove residue, and reinitiate monoculture row-cropping
4.3A	Remove cover cropping
R2B, R3A, R4A	Site preparation, native seeding, non-native species control
5.1A	Invasive species control, native seeding, and implementation of natural disturbance regime
5.2A	Drought or improper timing/use of management actions

STATE 1 – REFERENCE STATE

The reference plant community is categorized as a dry-mesic prairie and includes grasses, forbs, and varying components of shrubs. The community phases within the reference state are dependent on a fire frequency of every one to six years. Shorter fire intervals maintain dominance by grasses, while less frequent intervals allow woody vegetation to increase their importance in the plant canopy. Grazing and drought disturbances have less impact in the reference phases, but do contribute to overall species composition, diversity, cover, and productivity.

<u>Community Phase 1.1 Leadplant/Little Bluestem – Prairie Dropseed</u> – Many grass species are present on the site, with little bluestem, big bluestem, and Indiangrass being the dominant ones (Nelson 2010; Steinauer and Rolfsmeier 2010). Prairie dropseed is an important, sometimes co-dominant, species characteristic of sites with higher clay content (Steinauer and Rolfsmeier 2010). Important forbs for this site include rush skeletonplant (*Lygodesmea juncea* (Pursh) D. Don ex Hook.), bastard toadflax (*Comandra umbellata* (L.) Nutt.), white heath aster (*Symphyotrichum ericoides* (L.) G.L. Nesom var. *ericoides*), and prairie blazing star (*Liatris pycnostachya* Michx.). Shrubs, such as leadplant, are scattered throughout the community (Nelson 2010; Steinauer and Rolfsmeier 2010).

> Pathway 1.1A – Natural succession as a result of an average fire return interval of four to six years.

<u>Community Phase 1.2 New Jersey Tea – Leadplant/Little Bluestem – Prairie Dropseed</u> – This reference community phase can occur when fire frequency is reduced to every four to six years (Stambaugh et al. 2006). The native prairie grasses continue to form the dominant herbaceous ground layer, but the reduced fire interval allows woody and suffruticose species to increase shrub cover species across the prairie with canopy coverage ranging from about ten to 30 percent (LANDFIRE 2009). Important shrub species in this phase include New Jersey tea, leadplant, Jersey tea (*Ceanothus herbaceus* Raf.), and prairie rose (*Rosa arkansana* Porter) (Nelson 2010; Steinauer and Rolfsmeier 2010).

> Pathway 1.2A – Natural succession as a result of an average fire return interval of four years or less.
>
> *Transition 1A* – Long-term fire suppression transitions this site to the semi-natural woodland state (2).
>
> *Transition 1B* – Interseeding non-native cool-season grasses and brush control transition this site to the cool-season pasture state (3).
>
> *Transition 1C* – Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

STATE 2 – SEMI-NATURAL WOODLAND STATE

Fire suppression can transition the reference prairie community into a semi-natural woodland state dominated by eastern redcedar (*Juniperus virginiana* L.) (Briggs et al. 2002; Anderson 2003). Eastern redcedar is a species native to the eastern half of North America with a range spanning from Ontario east to Nova Scotia, south across the Great Plains into eastern Texas, and east to the Atlantic coast (Lawson 1990; Lee 1996). It is a long-lived (450+ years), slow-growing, fire-intolerant dioecious conifer and historically was found in areas that were protected from fire (e.g., bluffs, rocky hillsides, sandstone cliffs, granite outcrops, etc.) (Ferguson et al. 1968; Anderson 2003). Today, however, decades of fire suppression have allowed this species to spread and it can now be found occupying sites with highly variable aspects, topography, soils, and formerly stable plant communities (Anderson 2003).

<u>Community Phase 2.1 Eastern Redcedar/Sideoats Grama</u> – This community phase represents the early stages of eastern redcedar invasion into the prairie. Native grass species that can persist during this stage include big bluestem, little bluestem, sideoats grama, and Scribner's rosette grass (*Dichanthelium oligosanthes* (Schult.) Gould var. *scribnerianum* (Nash) Gould)), however sideoats grama is the only species known to increase its cover during this phase. Candle anemone (*Anemone cylindrica* A. Gray), cutleaf anemone (*Pulsatilla patens* (L.) Mill. ssp. *multifida* (Pritz.) Zamels), and Cuman ragweed (*Ambrosia psilostachya* DC.) comprise the persistent forb component of the plant community (Gehring and Bragg 1992; Rosburg 1994).

> Pathway 2.1A – Fire is removed from the landscape in excess of 20 years.
>
> *Restoration 2A* – Mechanical or chemical control of brush and non-native species and reintroduction of a historic fire regime restore the site back to the reference state (1).

<u>Community Phase 2.2 Eastern Redcedar/Kentucky Bluegrass – Eastern Woodland Sedge</u> – Sites falling into this community phase are strongly dominated by eastern redcedar as a result of over 20 years of fire suppression. As the canopies of the trees increase, light availability is greatly reduced to the ground layer and soil moisture increases, allowing more shade tolerant species, such as Kentucky bluegrass and eastern woodland sedge (*Carex blanda* Dewey), to replace the heliophytic tallgrass prairie species (Gehring and Bragg 1992; Brantley and Young 2010; Pierce and Reich 2010). Over time, the diversity and productivity of the herbaceous understory is greatly reduced (Smith and Stubbendieck 1990; Gehring and Bragg 1992; Rosburg 1994). The continued absence of fire and other disturbances will allow this community to expand its range.

> Pathway 2.2A – Fire is restored to the landscape within 20 years of initial encroachment.
>
> *Restoration 2B* – Site preparation, invasive species control (native and non-native), and seeding native species transition this site to the reconstructed prairie state (5).

STATE 3 – COOL-SEASON PASTURE STATE

The cool-season pasture state occurs when the reference state has been anthropogenically-altered for livestock production. Fire suppression, seeding of non-native cool-season grasses, removal of woody vegetation, periodic cultural treatments, and grazing by domesticated livestock transition and maintain this simplified grassland state (Rosburg 1994; USDA-NRCS 2003). Early settlers seeded such non-native cool-season species as smooth brome (*Bromus inermis* Leyss.) and Kentucky bluegrass in order to help extend the grazing season (Smith 1998). Over time, as lands were continually grazed by large herds of cattle, the non-native species were able to spread and expand across the prairie habitat, reducing the native species diversity.

<u>Community Phase 3.1 Smooth Brome – Kentucky Bluegrass</u> – Species characteristic of this community phase include smooth brome, Kentucky bluegrass, and sweetclovers (*Melilotus* Mill.) (Steinauer and Rolfsmeier 2010). While native grasses may still occur, the non-native species oftentimes occur in higher frequencies across the site. Annuals and biennials are important components of this community phase and are indicative of the disturbed nature of the site (Rosburg 1994).

> *Transition 3A* – Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).
>
> *Restoration 3A* – Site preparation, invasive species control (native and non-native), and seeding native species transition this site to the reconstructed prairie state (5).

STATE 4 – CROPLAND STATE

The Midwest is well-known for its highly-productive agricultural soils, and as a result, much of the MLRA has been converted to cropland, including significant portions of this ecological site. The continuous use of tillage, row-crop planting, and chemicals (i.e., herbicides, fertilizers, etc.) have effectively eliminated the reference community and many of its natural ecological functions in favor of crop production. Corn (*Zea mays* L.) and soybeans (*Glycine max* (L.) Merr.) are the dominant crops for the site. These areas are likely to remain in crop production for the foreseeable future.

<u>Community Phase 4.1 Conventional Tillage Field</u> – Sites in this community phase typically consist of monoculture row-cropping maintained by conventional tillage practices. They are cropped in either continuous corn or corn-soybean rotations. The frequent use of deep tillage, low crop diversity, and bare soil conditions during the non-growing season negatively impact soil health. Under these practices, soil aggregation is reduced or destroyed, soil organic matter is reduced, erosion and runoff are increased, and infiltration is decreased, which can ultimately lead to undesirable changes in the hydrology of the watershed (Tomer et al. 2005).

Pathway 4.1A – Tillage operations are greatly reduced, crop rotation occurs on a regular schedule, and crop residue is allowed to remain on the soil surface.

Pathway 4.1B – Tillage operations are greatly reduced or eliminated, crop rotation is either reduced or eliminated, and crop residue is allowed to remain on the soil surface, and cover crops are implemented to prevent soil erosion.

Community Phase 4.2 Conservation Tillage Field – This community phase is characterized by rotational crop production that utilizes various conservation tillage methods to promote soil health and reduce erosion. Conservation tillage methods include strip-till, ridge-till, vertical-till, or no-till planting systems. Strip-till keeps seedbed preparation to narrow bands less than one-third the width of the row where crop residue and soil consolidation are left undisturbed in-between seedbed areas. Strip-till planting may be completed in the fall and nutrient application either occurs simultaneously or at the time of planting. Ridge-till uses specialized equipment to create ridges in the seedbed and vegetative residue is left on the surface in between the ridges. Weeds are controlled with herbicides and/or cultivation, seedbed ridges are rebuilt during cultivation, and soils are left undisturbed from harvest to planting. Vertical-till systems employ machinery that lightly tills the soil and cuts up crop residue, mixing some of the residue into the top few inches of the soil while leaving a large portion on the surface. No-till management is the most conservative, disturbing soils only at the time of planting and fertilizer application. Compared to conventional tillage system, conservation tillage methods can reduce soil erosion, increase organic matter and water availability, improve water quality, and reduce soil compaction.

Pathway 4.2A – Intensive tillage is utilized and monoculture row-cropping in established.

Pathway 4.2B – Cover crops are implemented to prevent soil erosion.

Community Phase 4.3 Conservation Tillage Field/Alternative Crop Field – This condition applies conservation tillage methods as described above as well as adds cover crop practices. Cover crops typically include nitrogen-fixing species (e.g., legumes), small grains (e.g., rye, wheat, oats), or forage covers (e.g., turnips, radishes, rapeseed). The addition of cover crops not only adds plant diversity but also promotes soil health by reducing soil erosion, limiting nitrogen leaching, suppressing weeds, increasing soil organic matter, and improving the overall soil. In the case of small grain cover crops, surface cover and water infiltration are increased, while forage covers can be used to graze livestock or support local wildlife. Of the three community phases for this state, this phase promotes the greatest soil sustainability and improves ecological functioning within a cropland system.

Pathway 4.3A – Cover crop practices are abandoned.

Pathway 4.3B – Intensive tillage is utilized, cover crops practices are abandoned, monoculture row-cropping is established, and crop rotation is reduced or eliminated.

Transition 4A – Non-selective herbicide and seeding of non-native cool-season grasses transitions the site to the cool-season pasture state (3).

Restoration 4A – Site preparation, invasive species control (native and non-native), and seeding native species transition this site to the reconstructed prairie state (5).

STATE 5 – RECONSTRUCTED PRAIRIE STATE

Prairie reconstructions have become an important tool for repairing natural ecological functioning and providing habitat protection for numerous grassland-dependent species. The historic plant community of the tallgrass prairie was extremely diverse and complex, and prairie replication is not considered to be possible once the native vegetation has been altered by post-European settlement land uses. Therefore ecological restoration should aim to aid the recovery of degraded, damaged, or destroyed ecosystems. A successful restoration will have the ability to structurally and functionally sustain itself, demonstrate resilience to the natural ranges of stress and disturbance, and create and maintain positive biotic and abiotic interactions (SER 2002). The reconstructed prairie state is the result of a long-term commitment involving a multi-step, adaptive management process. Diverse, species-rich seed mixes are important to utilize as they allow the site to undergo successional stages that exhibit changing composition and dominance over time (Smith et al. 2010). On-going management via prescribed fire and/or light grazing will help the site progress from an early successional community dominated by annuals and some weeds to a later seral stage composed of native perennial grasses, forbs, and shrubs. Establishing a prescribed fire regimen that mimics natural disturbance patterns can increase native species cover and diversity while reducing cover of non-native forbs and grasses. Light grazing alone can help promote species richness, while grazing accompanied with fire can control the encroachment of woody vegetation (Brudvig et al. 2007).

<u>Community Phase 5.1 Early Successional Tallgrass Prairie</u> – This community phase represents the early community assembly from prairie reconstruction and is highly dependent on the seed mix utilized and the timing and priority of planting operations. The seed mix should look to include a diverse mix of native cool-season and warm-season annual and perennial grasses and forbs typical of the reference state. Cool-season annuals can help to provide litter that promotes cool, moist soil conditions to the benefit of the other species in the seed mix. The first season following site preparation and seeding will typically result in annuals and other volunteer species forming the vegetative cover. Control of non-native species, particularly perennial species, is crucial at this point in order to ensure they do not establish before the native vegetation (Martin and Wilsey 2012). After the first season, native warm-season grasses should begin to become more prominent on the landscape and over time close the canopy.

Pathway 5.1A – Selective herbicides are used to control non-native species, and prescribed fire and/or light grazing help to increase the native species diversity and control woody vegetation.

<u>Community Phase 5.2 Late Successional Tallgrass Prairie</u> – Appropriately timed disturbance regimes (e.g., prescribed fire) applied to the early successional community phase can help increase the beta diversity, pushing the site into a late successional community phase over time. While prairie

communities are dominated by grasses, these species can suppress forb establishment and reduce overall diversity and ecological functioning (Martin and Wilsey 2006; Williams et al. 2007). Reducing accumulated plant litter from such tallgrasses as big bluestem and yellow Indiangrass allows more light and nutrients to become available for forb recruitment, allowing for greater ecosystem complexity (Wilsey 2008).

Pathway 5.2B – Restoration experiences a decrease in native species diversity from drought or improper timing of management actions (e.g., reduced fire frequency, use of non-selective herbicides).

Transition 5A – Active management of the restored prairie is ceased and woody encroachment transitions this site to the semi-natural woodland state (2).

Transition 5B – Land is converted to the cool-season pasture state through the use of non-selective herbicide and seeding of non-native cool-season grasses (3).

Transition 5C – Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

Supporting Information

Relationship to Other Established Classifications

Biophysical Setting (LANDFIRE 2009); the reference community of this ecological site is most similar to:

Central Tallgrass Prairie (4214210)

Ecological Systems (National Vegetation Classification System, Nature Serve 2015): the reference community of this ecological site is most similar to:

Central Tallgrass Prairie (CES205.683)

Eilers and Roosa (1994): the reference community of this ecological site is most similar to:

Loess Hills

Iowa Department of Natural Resources (INAI *nd*): the reference community of this ecological site is most similar to:

Western Dry-Mesic Prairie

Missouri Natural Heritage Program (Nelson 2010): the reference community of this ecological site is most similar to:

Dry-Mesic Loess/Glacial Till Prairie

Nebraska Game and Parks Commission (Steinauer and Rolfsmeier 2010): the reference community of this ecological site is most similar to:

Upland Tall-Grass Prairie

Plant Associations (National Vegetation Classification System, Nature Serve 2015): the reference community of this ecological site is most similar to:

Andropogon gerardii – Sorghastrum nutans – Hesperostipa spartea Loess Hills Herbaceous Vegetation (CEGL002025)

Associated Ecological Sites

Ecological Site Name	Site ID	Narrative
Deep Loess Exposed Backslope Savanna	R107BY003MO	Loess soils on slopes greater than 15 percent with south and west aspects, including Knox, Menfro, Marshall, Monona, and Udarents

Deep Loess Protected Backslope Woodland	R107BY004MO	Loess soils on slopes greater than 15 percent with north and east aspects, including Knox, Menfro, and Udarents

Similar Ecological Sites

Ecological Site Name	Site ID	Narrative
Calcareous Loess Upland Prairie	R107BY012MO	Calcareous Loess Upland Prairies are similar in landscape position but parent material is calcareous loess, and average clay content is lower
Calcareous Loess Exposed Backslope Prairie	R107BY006MO	Calcareous Loess Exposed Backslope Prairies only occur on south and west aspects, parent material is calcareous loess, and average clay content is lower
Calcareous Till Upland Prairie	R107BY027IA	Calcareous Till Upland Prairies are similar in landscape position but parent material is till, average clay content is higher, and soils have a significant component of calcium carbonate at or near the surface
Loess Upland Prairie	R107BY007MO	Loess Upland Prairies are similar in landscape position but average clay content is higher

Ecological Site Correlation Issues and Questions

- Reference and alternative states within the state-and-transition model are not yet well-documented or supported and will require additional field sampling for refinement.

Inventory Data References

No field plots were available for this site. A review of the scientific literature and professional experience were used to approximate the plant communities for this provisional ecological site. Information for the state-and-transition model was obtained from the same sources. All community phases are considered provisional based on these plots and the sources identified in ecological site description.

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Future work, as described in the Project Plan, to validate the information in this Provisional Ecological Site Description is needed. This will include field activities to collect low and medium intensity sampling, soil correlations, and analysis of that data. Annual field reviews should be done by soil scientists and vegetation specialists. A final field review, peer review, quality control, and quality assurance reviews of the ESD will be needed to produce the final document.

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