

# Ecological site F093AY011MN

## Dry Sandy Upland Forest

Last updated: 9/06/2024  
Accessed: 11/23/2024

### 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): 093A–Superior and Rainy Stony and Rocky Till Plains and Moraines

The Superior Stony and Rocky Loamy Plains and Hills, Western Part is located and completely contained in northeastern Minnesota. This area has both the highest and lowest elevations in the state, as well as some of the state’s most rugged topography (Ojakangas and Matsch, 1982). The MLRA was glaciated by numerous advances of the Superior, Rainy, and Des Moines glacial lobes during the Wisconsin glaciation as well as pre-Wisconsin glacial periods. The geomorphic surfaces in this MLRA are geologically very young (i.e., 10,000 to 20,000 years) and dominated by drumlin fields, moraines, small lake plains, outwash plains, and bedrock-controlled uplands (USDA-NRCS, 2022).

There are thousands of lakes scattered throughout the region that were created by these glacial events. Most of these lakes are bedrock-controlled in comparison to adjacent glaciated regions where glacial drift deposits are much thicker and the lakes occur in depressions atop the glacial drift (Ojakangas and Matsch, 1982). In contrast to adjacent MLRAs, the depth to the predominantly crystalline or sandstone bedrock in MLRA 93A is relatively shallow because the most recent glacial events were more erosional than depositional (Ojakangas and Matsch, 1982).

### Classification relationships

Major Land Resource Area (MLRA): Superior Stony and Rocky Loamy Plains and Hills, Western Part (93A)

USFS Subregions: Northern Superior Uplands Section (212L); North Shore Highlands Subsection (212Lb)

Relationship to Other Established Classifications:  
FDn12-Northern Dry-Sand Pine Woodland, Fire-Dependent Forest/Woodland System, Northern Floristic Region, Minnesota Department of Natural Resources

### Ecological site concept

This site is a dry jack pine-red pine woodland and located on outwash plains and moraines. Soils are course textured, well drained to excessively drained, and have a low available water capacity. Historically, fire was a common disturbance that influenced plant community composition. Jack pine, red pine, and balsam fir have frequent occurrence and moderately high cover on this site.

### Associated sites

F093AY012MN	<b>Sandy Upland Forest</b> The Sandy Upland Forest ecological site is located on uplands with soils that are course textured and moderately well drained to somewhat excessively drained. Available water capacity ranges from 2-5 inches.
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Similar sites

F093AY012MN	<b>Sandy Upland Forest</b> The Sandy Upland Forest ecological site is located on uplands with soils that are coarse textured and moderately well drained to somewhat excessively drained. Available water capacity ranges from 2-5 inches.
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Table 1. Dominant plant species

Tree	(1) <i>Pinus banksiana</i> (2) <i>Pinus resinosa</i>
Shrub	(1) <i>Vaccinium angustifolium</i> (2) <i>Amelanchier</i>
Herbaceous	(1) <i>Maianthemum canadense</i> (2) <i>Pteridium aquilinum</i>

Physiographic features

This upland site is located on outwash plains and moraines. No flooding or ponding occurs. The available water capacity ranges from 2-4.5 inches (5 - 11 centimeters) and the vegetation consists of tree species tolerant of dry soil conditions.

Table 2. Representative physiographic features

Landforms	(1) Outwash plain (2) Moraine
Runoff class	Low to high
Flooding frequency	None
Ponding frequency	None
Elevation	305–533 m
Slope	0–60%
Water table depth	203 cm
Aspect	Aspect is not a significant factor

Climatic features

The average annual precipitation is 26-32 inches (66 to 81 centimeters). Measurable climatic variation (due to the lake effect) near some of Lake Superior may alter temperature and precipitation (Hillman & Nielsen, 2023). About 65 percent of the precipitation falls as rain during the growing season (May through September) and about 21 percent falls as snow. The freeze-free period averages about 130 days and ranges from 97 to 150 days (USDA-NRCS, 2022).

Table 3. Representative climatic features

Frost-free period (characteristic range)	90-109 days
Freeze-free period (characteristic range)	123-143 days
Precipitation total (characteristic range)	660-813 mm
Frost-free period (actual range)	44-114 days
Freeze-free period (actual range)	97-150 days
Precipitation total (actual range)	660-813 mm
Frost-free period (average)	93 days
Freeze-free period (average)	130 days

Precipitation total (average)

737 mm

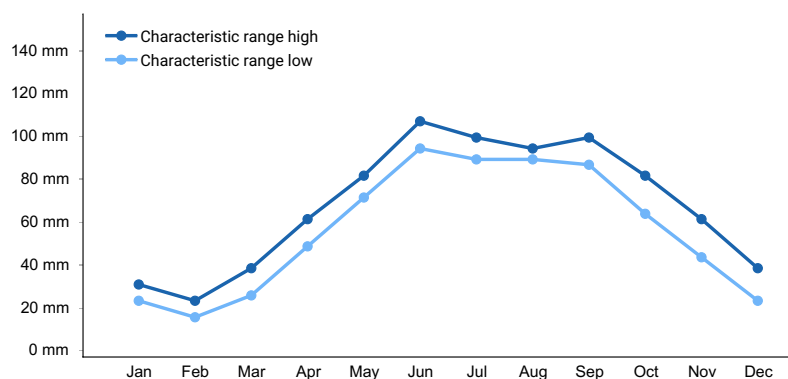


Figure 1. Monthly precipitation range

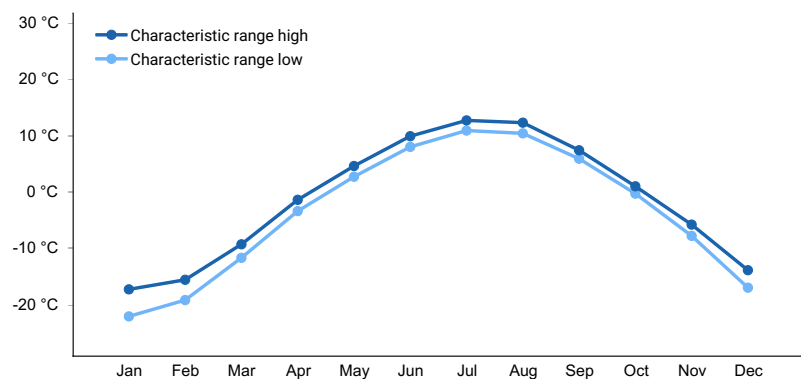


Figure 2. Monthly minimum temperature range

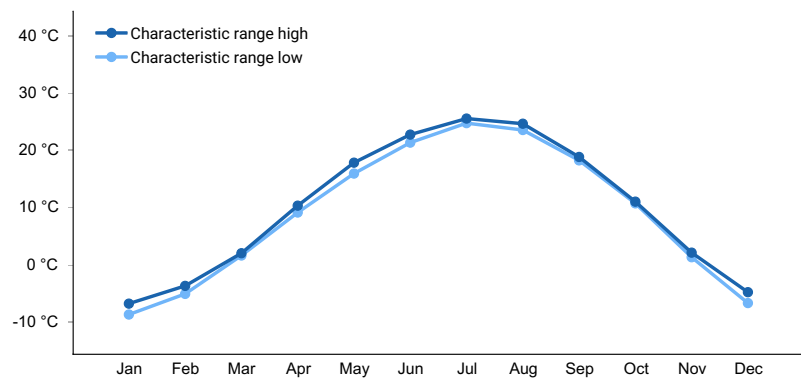


Figure 3. Monthly maximum temperature range

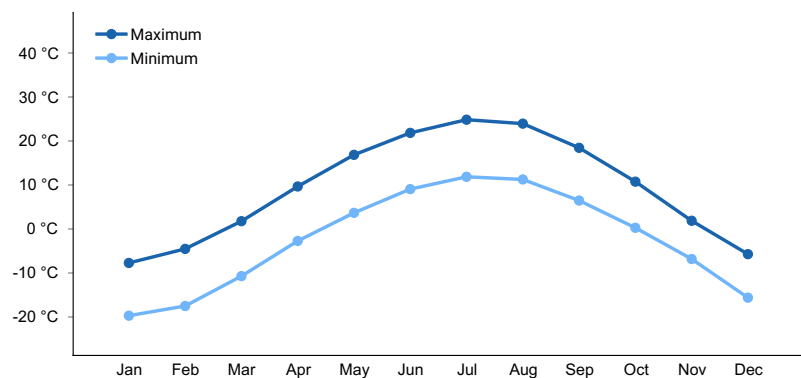


Figure 4. Monthly average minimum and maximum temperature

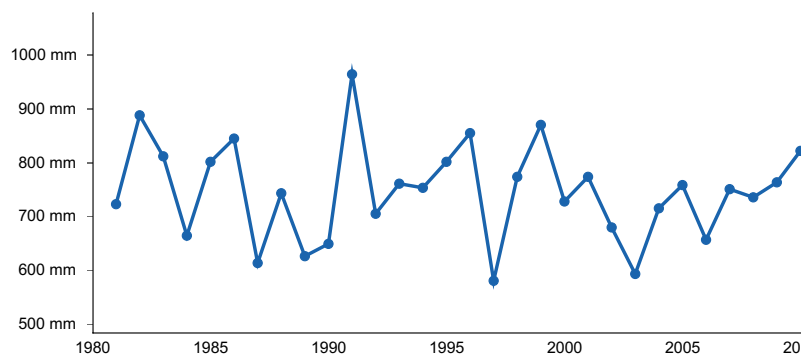


Figure 5. Annual precipitation pattern

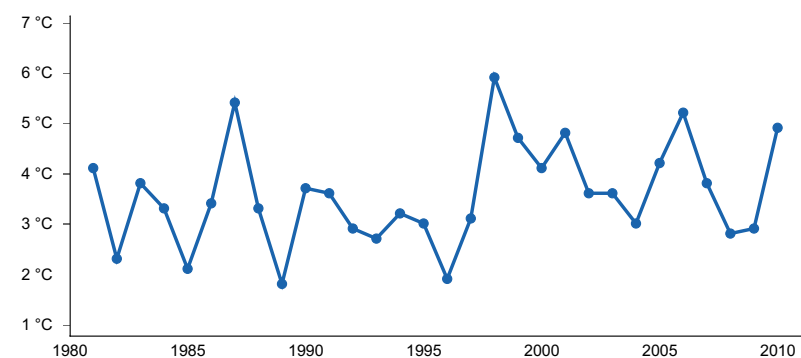


Figure 6. Annual average temperature pattern

### Climate stations used

- (1) GRAND PORTAGE [USC00213296], Grand Portage, MN
- (2) WOLF RIDGE ELC [USC00219134], Finland, MN
- (3) DULUTH [USW00014913], Duluth, MN
- (4) ELY 25E [USC00212555], Ely, MN
- (5) KETTLE FALLS [USC00214306], Voyageurs Natl Park, MN
- (6) BRIMSON 2S [USC00210989], Brimson, MN
- (7) KABETOGAMA [USC00214191], Orr, MN

### Influencing water features

This site is not influenced by riparian and wetland features.

### Wetland description

N/A

### Soil features

Representative soil series include Beargrease, Biwabik, Graycalm, Grayling, Rollins, and Shagawa. Soil parent materials include outwash plains and moraines. Soils are well drained to excessively drained and very deep. The soil available water capacity is low and results in plant species that are highly tolerant of dry conditions.

Table 4. Representative soil features

Parent material	(1) Drift (2) Outwash
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Surface texture	(1) Sand (2) Very stony loam (3) Sandy loam (4) Loamy sand (5) Cobbly sandy loam
Drainage class	Well drained to excessively drained
Permeability class	Rapid to very rapid
Depth to restrictive layer	203 cm
Soil depth	203 cm
Surface fragment cover <=3"	0–10%
Surface fragment cover >3"	0–15%
Available water capacity (0-152.4cm)	5.08–11.43 cm
Sodium adsorption ratio (Depth not specified)	0
Soil reaction (1:1 water) (0-101.6cm)	4.5–7.3
Subsurface fragment volume <=3" (Depth not specified)	0–60%
Subsurface fragment volume >3" (Depth not specified)	0–50%

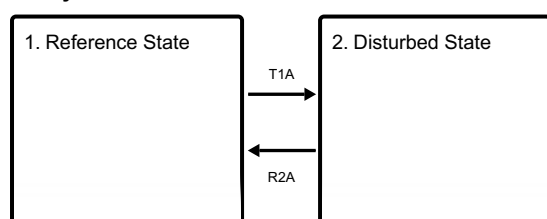
## Ecological dynamics

This site is a dry jack pine-birch woodland. Fire was a historical disturbance that influenced plant species composition. Young woodlands post-fire are dominated by jack pine and paper birch. Mature woodlands are pine dominated with an understory variability dependent upon the fire regime (MN DNR, 2005). Jack pine (*Pinus banksiana*) occurs over a broad range of glacially scoured bedrock and outwash sand plains, with cover ranging from sparse to dense, depending on habitat features. On sand plain habitats, the combination of physiognomy, floristics, and disturbance factors can be used to further distinguish the denser forests with blueberries (*Vaccinium* spp.) and feathermoss (*Pleurozium schreberi*) from more open stands, maintained by a 25 to 50 year fire rotation, where oaks (*Quercus* spp.), little bluestem (*Schizachyrium scoparium*), and other prairie forbs may be common (Faber-Langendoen 2001).

The Dry Sandy Upland Forest ecosite exhibits compositional change during the course of stand maturation. Under the model of succession for this ecological site species achieved dominance by outliving shorter-lived trees as the stand matures. The natural pattern of tree mortality and replacement was the partial loss of trees on a rotation of approximately 50 years. Stand-replacing fire was infrequent with an estimated rotation of 170 years although it is an important driver of many dominant tree species on this site. Stand-replacing windthrow was rare with an estimated rotation of approximately 610 years. Gaps in the canopy also drive the natural succession as species vie for dominance (MN DNR 2022).

## State and transition model

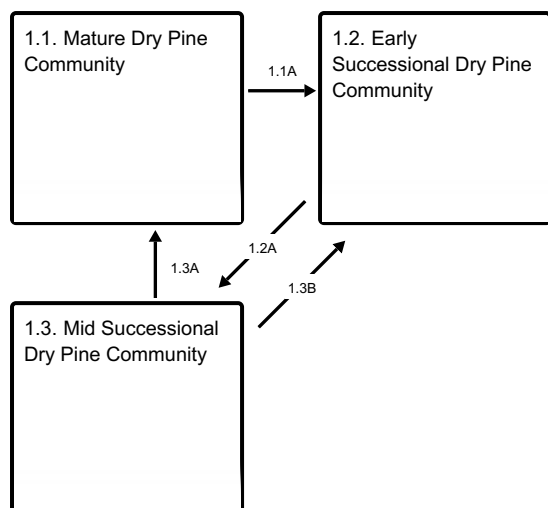
### Ecosystem states



**T1A** - Site is logged and disturbed

**R2A** - Restoration inputs; forest stand management

### State 1 submodel, plant communities



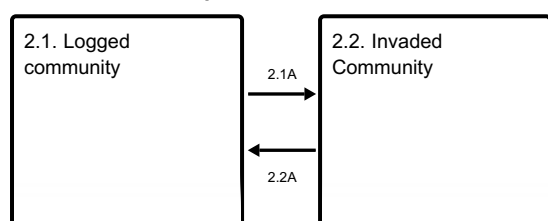
**1.1A** - Severe Disturbance

**1.2A** - Absence of disturbance (55-75 Years)

**1.3A** - No severe disturbance > 75 Years

**1.3B** - Severe site disturbance

### State 2 submodel, plant communities



**2.1A** - Invasive species established

**2.2A** - Eradication of invasive species

## State 1 Reference State

This is a dry jack pine - red pine woodland on coarse textured soils. Sites occur on undulating sandy outwash plains, lake plains, and moraines. Historically, the site was influenced by fire events which occurred approximately every 40-50 years. (MN DNR, 2005).

### Dominant plant species

- jack pine (*Pinus banksiana*), tree
- red pine (*Pinus resinosa*), tree
- lowbush blueberry (*Vaccinium angustifolium*), shrub
- serviceberry (*Amelanchier*), shrub
- roughleaf ricegrass (*Oryzopsis asperifolia*), grass
- Canada mayflower (*Maianthemum canadense*), other herbaceous

## Community 1.1 Mature Dry Pine Community

This community is characterized by a lack of severe disturbance for over 75 years. The plant community composition is dominated by red pine. Jack pine, white pine, white spruce, and paper birch are also present. (MN DNR, 2005) Surface fires on a rotation of about 50 years could have maintained the mixture of red and jack pine by regenerating patches of jack pine, leaving red pine residuals as seed trees, and killing fire-sensitive balsam fir. Maintenance disturbances allow for continued establishment of red pine to the point where old woodlands may

develop a supercanopy of large-diameter red pines over younger cohorts of jack pine. Surface fires determine the understory composition of this community (MN DNR, 2022).

#### **Dominant plant species**

- red pine (*Pinus resinosa*), tree
- eastern white pine (*Pinus strobus*), tree
- jack pine (*Pinus banksiana*), tree
- lowbush blueberry (*Vaccinium angustifolium*), shrub
- roughleaf ricegrass (*Oryzopsis asperifolia*), grass
- pipsissewa (*Chimaphila umbellata*), other herbaceous
- eastern teaberry (*Gaultheria procumbens*), other herbaceous
- kinnikinnick (*Arctostaphylos uva-ursi*), other herbaceous
- trailing arbutus (*Epigaea repens*), other herbaceous

### **Community 1.2**

#### **Early Successional Dry Pine Community**

This young woodland community is 0-55 years of age and generally dominated by jack pine. Red pine, quaking aspen, paper birch, and white pine are also on site. (MN DNR, 2005) This community happens after fire and rarely windthrow (MN DNR, 2022).

#### **Dominant plant species**

- jack pine (*Pinus banksiana*), tree
- red pine (*Pinus resinosa*), tree
- lowbush blueberry (*Vaccinium angustifolium*), shrub
- serviceberry (*Amelanchier*), shrub
- beaked hazelnut (*Corylus cornuta*), shrub
- northern bush honeysuckle (*Diervilla lonicera*), shrub
- roughleaf ricegrass (*Oryzopsis asperifolia*), grass
- western brackenfern (*Pteridium aquilinum*), other herbaceous
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- pipsissewa (*Chimaphila umbellata*), other herbaceous
- eastern teaberry (*Gaultheria procumbens*), other herbaceous
- kinnikinnick (*Arctostaphylos uva-ursi*), other herbaceous
- trailing arbutus (*Epigaea repens*), other herbaceous

### **Community 1.3**

#### **Mid Successional Dry Pine Community**

The mid successional woodland stage (55-75 years of age) is characterized by a decline in jack pine and an increase in red pine and white pine. (MN DNR, 2005) Some white spruce seedlings may become established during this period (MN DNR, 2022).

#### **Dominant plant species**

- jack pine (*Pinus banksiana*), tree
- red pine (*Pinus resinosa*), tree
- eastern white pine (*Pinus strobus*), tree
- lowbush blueberry (*Vaccinium angustifolium*), shrub
- serviceberry (*Amelanchier*), shrub
- beaked hazelnut (*Corylus cornuta*), shrub
- roughleaf ricegrass (*Oryzopsis asperifolia*), grass
- brackenfern (*Pteridium*), other herbaceous
- western brackenfern (*Pteridium aquilinum*), other herbaceous
- Canada mayflower (*Maianthemum canadense*), other herbaceous
- pipsissewa (*Chimaphila umbellata*), other herbaceous
- eastern teaberry (*Gaultheria procumbens*), other herbaceous

- kinnikinnick (*Arctostaphylos uva-ursi*), other herbaceous
- trailing arbutus (*Epigaea repens*), other herbaceous

### **Pathway 1.1A**

#### **Community 1.1 to 1.2**

A severe disturbance, such as a catastrophic fire, will transition the reference community to an early successional community.

### **Pathway 1.2A**

#### **Community 1.2 to 1.3**

Time and natural plant community growth will transition the site to community 1.3.

### **Pathway 1.3A**

#### **Community 1.3 to 1.1**

Time and natural plant community succession will transition the community to a mature, established wood over 75 years of age.

### **Pathway 1.3B**

#### **Community 1.3 to 1.2**

A severe disturbance, such as a major fire event, will transition the community back to an earlier successional stage.

## **State 2**

### **Disturbed State**

Removal of canopy species for timber harvest creates an open canopy and a highly disturbed understory. Shrubs will dominate post logging. A very dense shrub layer can impede tree regeneration. Heavy machinery are a common seed source for non-native species. Human and recreational activities can also lead to seed sources of non-native species being established (MN DNR 2005). The management trend for this ecological site has been to convert stands to red pine plantations whenever possible and a significant portion of its historic range was converted. Logging without conversion has resulted in woodlands dominated by quaking aspen, balsam fir, and paper birch. Managing stands primarily for balsam fir or jack pine increases the risk of windthrow due to the trees not being wind-firm. Managing stands in the absence of surface fire increases the risk of losing jack pine and red pine as a potential crop trees. (MN DNR 2022).

#### **Dominant plant species**

- serviceberry (*Amelanchier*), shrub
- prickly rose (*Rosa acicularis*), shrub
- smooth rose (*Rosa blanda*), shrub
- beaked hazelnut (*Corylus cornuta*), shrub
- prairie willow (*Salix humilis*), shrub
- blueberry (*Vaccinium*), shrub
- poverty oatgrass (*Danthonia spicata*), grass
- ricegrass (*Oryzopsis*), grass

### **Community 2.1**

#### **Logged community**

With the canopy removed, the initial post-logging community will be dominated by shrubs.

#### **Dominant plant species**

- serviceberry (*Amelanchier*), shrub



- prickly rose (*Rosa acicularis*), shrub
- smooth rose (*Rosa blanda*), shrub
- beaked hazelnut (*Corylus cornuta*), shrub
- chokecherry (*Prunus virginiana*), shrub
- prairie willow (*Salix humilis*), shrub
- blueberry (*Vaccinium*), shrub
- poverty oatgrass (*Danthonia spicata*), grass
- ricegrass (*Oryzopsis*), grass

## **Community 2.2**

### **Invaded Community**

This community is identified by the presence of non-native plant species. Heavy machinery and soil disturbance provide an opportunity for invasives to become established. The invasive species on site will depend on the seed source.

#### **Dominant plant species**

- serviceberry (*Amelanchier*), shrub
- blueberry (*Vaccinium*), shrub
- rose (*Rosa*), shrub
- honeysuckle (*Lonicera*), shrub
- common buckthorn (*Rhamnus cathartica*), shrub
- glossy buckthorn (*Frangula alnus*), shrub
- cypress spurge (*Euphorbia cyparissias*), other herbaceous
- knotweed (*Polygonum*), other herbaceous
- common St. Johnswort (*Hypericum perforatum*), other herbaceous

## **Pathway 2.1A**

### **Community 2.1 to 2.2**

Invasive species are introduced to the site and become established.

## **Pathway 2.2A**

### **Community 2.2 to 2.1**

Management inputs will be required to eradicate non-native plant species.

## **Transition T1A**

### **State 1 to 2**

This transition represents the removal of canopy species and severe understory disturbance.

## **Restoration pathway R2A**

### **State 2 to 1**

Restoration inputs, such as timber stand management activities, can transition the Logged State back to State 1.

## **Additional community tables**

### **Inventory data references**

No field plots were established for this project. 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. Future field verification will refine the plant communities described in this project.

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## Contributors

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Approval

Suzanne Mayne-Kinney, 9/06/2024

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)	
Contact for lead author	
Date	09/06/2024
Approved by	Suzanne Mayne-Kinney
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. Number and extent of rills:  

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2. Presence of water flow patterns:  

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3. Number and height of erosional pedestals or terracettes:  

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

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5. Number of gullies and erosion associated with gullies:  

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6. Extent of wind scoured, blowouts and/or depositional areas:  

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7. Amount of litter movement (describe size and distance expected to travel):  

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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):  

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9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**
- 
10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**
- 
11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**
- 
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:
- 
13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**
- 
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):**
- 
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:**
- 
17. **Perennial plant reproductive capability:**
-