

Prairie Establishment & Maintenance Technical Guidance for Solar Projects

Minnesota Department of Natural Resources

May 2016



Introduction

This is a technical guidance document for prairie establishment and management of pollinator-friendly native seed plantings at solar sites. The document provides technical guidance that supports the Minnesota Department of Natural Resources (DNR) Commercial Solar Guidance. The goal of this document is to provide a brief overview of the benefits, establishment, and maintenance guidelines for creating a pollinator-friendly prairie planting at solar sites. It can also be used to develop the Agriculture Impact and Vegetation Management Plans that may be required as part of the Public Utilities Commission Site Permit. Additional references that contain more specific planting and maintenance details are included at the end of the document.

The DNR is available to provide assistance to solar developers throughout project planning, construction, and post-planting maintenance. A general course of action for using this guidance would be for a solar company to read this guidance document, work with a native seed company to develop the native seed mix(es), and provide the mix, planting layout, and maintenance specifications to the DNR for review and comment.

Why Establish Pollinator-Friendly Plantings?

Prairie communities occur in open landscapes with plants that are dominated by a diversity of grass and forb (wildflower) species. Prairie communities vary from site to site due to differences in slope (hills vs. lowlands) and soil types. Prairie seed mixes include a diversity of flowering plants that are both pleasing to the eye, and provide excellent wildlife food and habitat for a variety of species.

Creating a pollinator-friendly prairie planting at solar sites can:

- Provide food and habitat for butterflies, bees, and insects that pollinate flowering forbs and some commercial agricultural crops.
- Provide food, cover, and nesting habitat for some species of mammals, birds, reptiles, and amphibians.
- Significantly reduce wind and surface water erosion.
- Significantly reduce fertilizer, herbicide, and pesticide applications, resulting in improved water quality.
- Increase organic matter and water holding capacity of soils. The result is higher quality soils for farming when the site is decommissioned.
- Improve the aesthetic look of the solar facility.

Seed Mix Cost

Native seed mixes in general cost more than non-native seed mixes. However, the higher seed cost can be offset by the following:

- No fertilizer applications are needed prior to planting.

- Limited use of mulch is necessary, or using erosion control blankets only on the steepest banks and highly erodible areas. Temporary cover of 20 lbs/acre of oats is recommended to stabilize the soil.
- Only a limited amount of fertilizer is used post-planting for sites with very poor soils or limited amounts of soil.
- Watering recently established native seed plantings is not necessary except in years of extreme drought.
- Participating in trading prairie acres as carbon credits may be possible.

Seed Mix Development

Prairie seed mixes can be adapted to include only low-growing species that will not shade the solar panels or cause undue harm to their primary purpose of creating clean, renewable energy. Prairie plantings have both an establishment and a long-term maintenance phase. The establishment phase takes approximately 1-3 years. Long-term maintenance will begin in years 4-5 and continue for the life of the planting. The first year of growth is primarily for root development. In the second and third year of establishment the above ground growth and flowers are more prevalent as the stand matures.

There are many options when developing a native seed mix. The DNR has laid out a framework that solar companies should consider when working with a native seed company to design a native seed mix.

Seed Source

To the extent possible, plant vegetation or sow seeds that are sourced from Minnesota using a high diversity of species. Seeds should first be sourced from areas with similar site conditions that are native to the county or adjacent county where the project is being constructed. Using local seed protects existing native prairies from genetic contamination and the spread of invasive/noxious species. Plants brought from different areas with significantly different climatic conditions may also not produce viable seed. If local seed is not available, follow the seed sourcing sequence in the DNR Seed Collection and Deployment Zones document, which can be found in Appendix A. This guidance document should be provided to the native seed company that is developing the project seed mix.

Seed Specification/Diversity

Diversity, meaning a variety of plant species in one place, is key to a planting's success. The more diverse a planting is, the better chance it has at long-term health and self-sustainability, which translates to lower management costs. Over the years, there will be variations in invasive species pressure, soil conditions, and climate, such as extreme drought or extreme moisture. Having a diversity of plants ensures that more species are able to adapt to these extremes and can therefore respond to changing environmental conditions.

Pollinator seed mixes should include:

- Seed mixes that have a seeding rate of 30-50 seeds/sq. ft. with forb species making up approximately 40% of the total seeding rate.
- 7 or more native grass/sedge species with at least 2 species of bunchgrass.
- 20 or more native forbs with at least 5 species in each bloom period: Early (April-May), Mid (June-August), and Late (August-October).
- Plant species under panel arrays should have a maximum height of 3 feet.

Grass only seed mixes:

- Seed mixes should have a seeding rate of 30-50 seeds/sq ft.
- 7 or more native grass/sedge species with at least 2 species of bunchgrass.
- Plant species under panel arrays should have a maximum height of 3 feet.

Wetland/ Farmed wetland seed mixes to be used outside of panel areas:

- Work with a native seed company to select the appropriate State Seed Mix or develop a custom seed mix using the State Seed Mix Guidance as a template.

We generally recommend not including tall warm season grasses (big bluestem-*Andropogon gerardii*, Indian grass-*Sorghastrum nutans*, switchgrass-*Panicum virgatum*) in seed mixes at solar sites. The tall warm season grass height and density may interfere with operations or dominate the stand and outcompete the shorter stature species. If tall warm season grasses are used then they should comprise less than 5% of the total seed mix.

* Please note that state-listed species (endangered, threatened, or special concern) seed should not be included in any of the mixes.

Visual Screening

If visual screening is being considered for the project site, native flowering shrubs can be planted around the perimeter to both fulfill this consideration and supplement early-blooming species requirements. Suitable shrubs may include: red-osier dogwood (*Cornus sericea*), gray dogwood (*Cornus racemosa*), pagoda dogwood (*Cornus alternifolia*), American wild plum (*Prunus americana*), chokecherry (*Prunus virginiana*), and New Jersey tea (*Ceanothus americanus*). Shrub selection should be based on site conditions and species native to the county or adjacent county where the project is being constructed.

Visual screening using tree species should follow the shrub selection criteria above. Use of tree species in the open landscapes of Minnesota should be used only when required by a permit or to address adjoining landowner concerns. Companies should not plant invasive tree species. Eastern red cedar (*Juniperus virginiana*), while a native species, should not be selected for solar sites as it competes with prairie vegetation and spreads aggressively.

Planting Layout Recommendations

Appendix B includes a schematic of planting options and an example seed mix. The example seed mixes are short in stature and have some shade tolerance for species planted under the panels. The seed mixes may need to be modified to include species that naturally occur in the geographic area of the project and are suitable for the soil and site conditions.

There are three basic layout options that should work for the majority of solar sites:

- Option 1. Whole site planted with pollinator seed mix (grasses and forbs).
- Option 2. Grass only mix planted underneath solar panels. In between rows and perimeter planted with pollinator mix.
- Option 3. Grass only mix planted underneath and between solar panels. Perimeter planted to a pollinator mix.

Plant species chosen for areas under the panels should have a maximum height of 3' so that they do not interfere with solar operations. Taller species can be used in perimeter pollinator plantings or in between panel rows. Shading of the panels should not be an issue when using some taller species because most of the mass of prairie plants is in the lower portion of the plant, with the majority of the height being in the flower stalk.

Planting Specifications

Planting Method: Drilling, Broadcasting

The DNR recommends that planting occur post-construction of the panels. Attempting to plant after grading and before post and panel installation will result in poor soil to seed contact due to equipment maneuvering. A temporary cover of 20 lbs/acre of oats can be used as erosion control and site stabilization until construction is complete and the prairie seed mixes are planted.

Grasses/sedges should be broadcast seeded in the grass only areas and the pollinator mix (forbs and grasses) drilled into the remaining areas. The key to stand success is to maximize seed to soil contact during planting. If drilling is the planting method, seed drills designed specifically to plant prairie grasses and flowers should be used. If broadcasting is the planting method, native-seed broadcasters (e.g., Vicon seeder) should be used as they are adapted to spread mixes with different sized seeds. For more information about planting methods, please refer to [A Prairie Restoration Handbook for Minnesota Landowners](#) under the 'Planting your Prairie' section'.

Timing

Growing season plantings should occur from May 1-July 1 when the soil temperature is at least 60 degrees F or higher. Frost seeding should occur after October 15 in the northern half of the state and after November 1st in the southern half of the state, or after soil temperatures fall below 50 degrees F for a consistent period of time, but before soils freeze. Seeding rates may need to be increased by 25% for frost seeding due to lower germination rates and loss of seed that is consumed by wildlife over the winter months.

Planting dates will vary depending on the weather in a particular year and where the planting site is located (e.g., Northern Minnesota vs. Southern Minnesota). Consult with native seed suppliers to determine the best planting dates for that year.

Temporary Cover

A temporary cover should be used with the planting to help suppress weeds and stabilize the soil until the prairie planting becomes established. A temporary cover of 20 lbs/acre of oats is used in the example seed mixes found in Appendix B.

Establishment and Maintenance Specifications

Prairie establishment in the first 2-3 years involves spot-spraying or mowing of invasive weeds. Removal of the invasive weeds will allow for the prairie plantings to become established and help prevent future weed growth.

Spot-Mowing

Spot-mowing involves mowing only in the areas with invasive or noxious plants. Spot-mowing slows the aggressive and fast growing invasive plants and allows the native species to become established. Spot-mowing should be done at a raised height (>5”) in order to target the invasive plants and to not damage the native species, especially during the establishment period. Spot-mowing for control of invasive or noxious weeds can be done every year to ensure planting health—even during establishment years. Care should be taken to avoid repeated mowing, which can cause the planting to fail. A list of noxious/invasive weed species that should be eradicated can be found at the [Minnesota Department of Agriculture’s website](#).

Spot-Spraying

Spot-spraying should target only noxious/invasive weed species. A licensed applicator should be hired to apply the appropriate selective herbicide. Plantings that include both grasses and forbs should not be broadcast-sprayed. [The Midwest Invasive Plant Control Database](#) provides a compilation of control methods for many common invasive plants.

In order to prevent inadvertent spraying of the prairie, it may be advantageous to be placed on the local do not spray list. This will help prevent damage to your prairie planting.

Long-Term Maintenance

Long-term prairie maintenance usually begins in years 4-5 by introducing disturbance into the planting. Prairie habitats thrive on disturbance. Disturbance allows them to renew themselves while also slowing natural succession (keeping the prairie from becoming a forest). Plan on haying/mowing, burning, or spraying to remove any unwanted trees/shrubs that may be present. It is not necessary to use all of these options, just one or two, depending upon the planting's progression and operational concerns. Since burning is most likely not an option at solar sites, introducing a rotation of haying/mowing would be an excellent option. After completing the selected maintenance activity in year 4-5, you will need to repeat this type of maintenance approximately every 2-3 years, depending on tree/shrub encroachment, ratios of grasses to forbs, presence of noxious weeds, and overall planting health.

Haying/mowing should be done at a raised height of 5" or higher in the month of October or when prairie plants have gone dormant. Haying or mowing below 5" in height can damage the long-term health of the planting. Hayed/mowed vegetation should be bagged and removed off site to prevent smothering new growth. Haying/mowing equipment should be cleaned prior to use on site to prevent the spread of non-native and invasive species into the planting.

With any management activity it is very important to establish refugia (undisturbed areas). These areas play an important role in pollinator conservation and allow for the completion of pollinator life cycles. No more than 1/3 of the site should be hayed/mowed each year. The same 1/3 should not be hayed/mowed in consecutive years. If possible, 10% of the site should be set aside as semi-permanent refugia that receives limited haying/mowing on a longer return interval of 15 years. For more information about refugia, consult the [DNR's Pollinator Best Management Practices and Habitat Restoration Guidelines](#).

Prairie Seed Suppliers and Restoration Companies:

The DNR recommends you work with a company(s) that specialize in native seed and installing/maintaining prairie restoration projects. Companies should be selected who are experienced and have a history of successful prairie restoration projects. There are several commercial companies that can be easily found through an internet search. A list of native seed suppliers can be found by visiting the [DNR's Landscaping with Native Plants webpage](#).

Please contact the [DNR's Regional Ecologist in your area](#) to receive more information about companies near you or to answer any questions concerning your prairie planting. The DNR appreciates the efforts of all solar companies that install native seed plantings that are favorable to pollinators and other wildlife.

Additional Information:

[A Prairie Restoration Handbook for Minnesota Landowners](#)

[BWSR Native Vegetation Establishment and Enhancement Guidelines](#)

Board of Water and Soil Resources (BWSR) State Seed Mixes

Landscaping with Native plants

Minnesota Wildflowers

Restore your Shore Plant Selector Tool

The Midwest Invasive Plant Control Database

DNR's Pollinator Best Management Practices and Habitat Restoration Guidelines

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Alternative Format Available Upon Request.

Document Citation

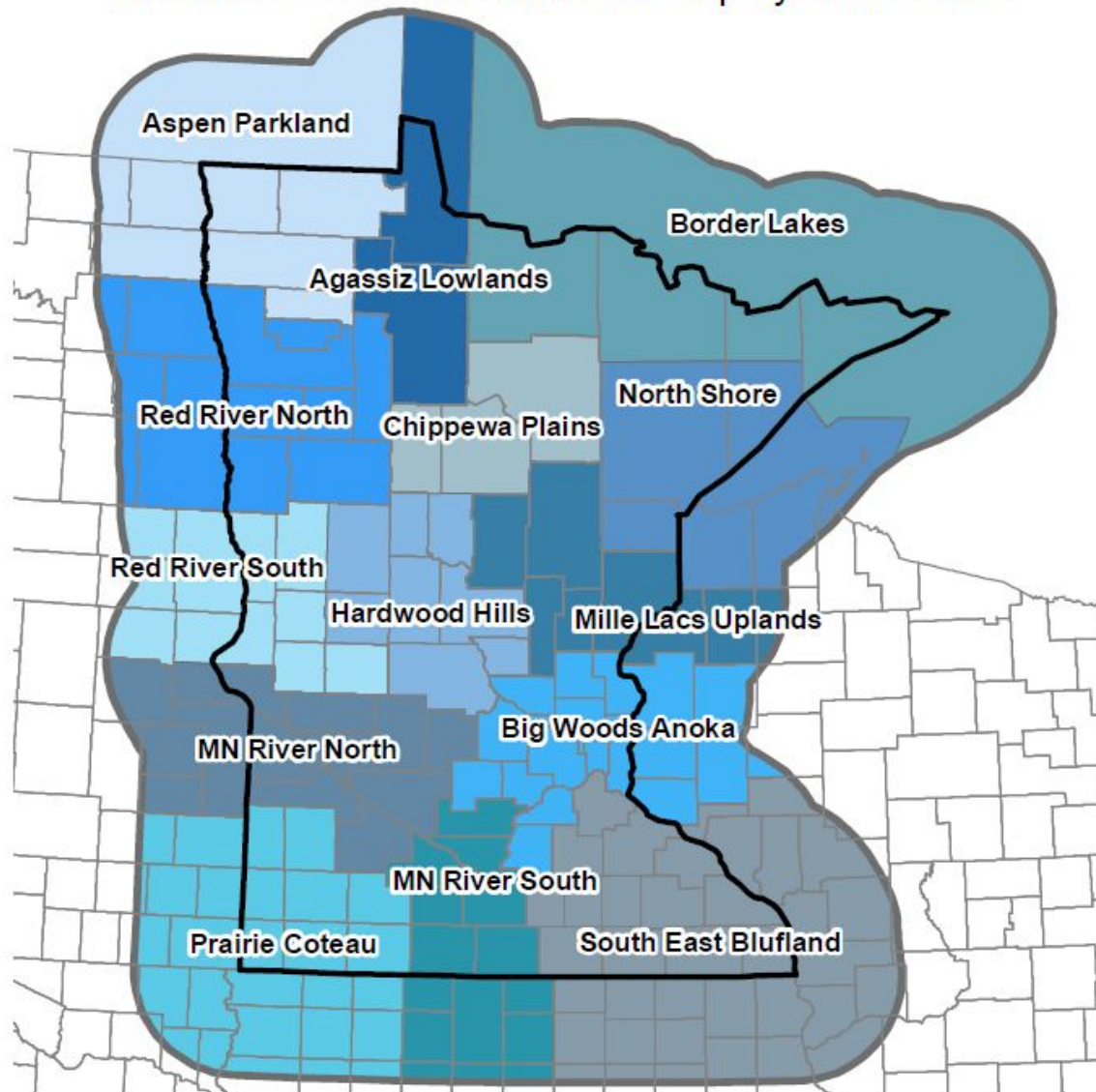
Minnesota Department of Natural Resources Prairie Establishment & Maintenance Technical Guidance for Commercial Solar Projects. 2016. Minnesota Department of Natural Resources. New Ulm, Minnesota, USA. 12pp.

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Appendix A: DNR Seed Collection and Deployment Guidance for Seed Selection

MN DNR Seed Collection and Deployment Zones



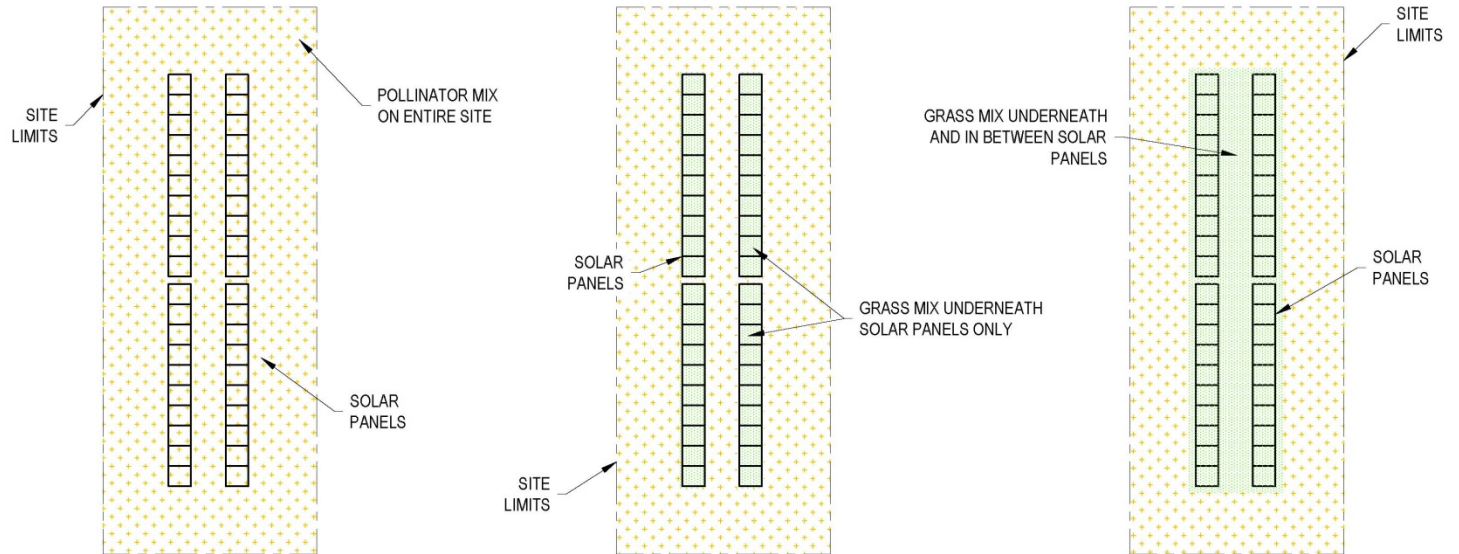
Framework for Selecting Plant Material Sources

1. Collect plant materials from areas with similar site conditions that are within or immediately adjacent to the restoration or reconstruction site or nearby. Nearby is defined by the division and generally is considered to be within the same zone.
2. Obtain plant materials from areas with similar site conditions and within the same Seed Zone.
3. Obtain plant materials from areas with similar site conditions in an adjacent Seed Zone.
4. Obtain plant materials from areas with similar site conditions in a Seed Zone that adjoins one of the adjacent Seed Zones.
5. If suitable seed/plant material can't be found, substitute another species with similar attributes.

Note: It is important to recognize that boundaries of the Seed Collection and Deployment Zones are not walls which cannot be crossed. If a restoration/reconstruction area is near one of these boundaries, an appropriate choice for restoration materials may be just across the boundary in an adjacent seed zone. This source of materials may actually be more desirable than a more distant source of plant materials from within the same seed zone. This framework recognizes that seed zones are not static; they may be adjusted over time to reflect new information based on research results from climate change and other analyses.

Appendix B: Native Seed Planting Layout Options and Seed Mix Examples for Solar Sites

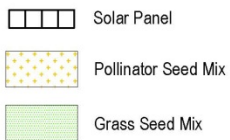
Native Seed Planting Options for Solar Sites



1 Option 1: Whole Site Pollinator Seed Mix
Not to Scale

2 Option 2: Grass Mix Underneath Solar Panels Only
Not to Scale

3 Option 3: Grass Mix Underneath & Between Solar Panels
Not to Scale



Appendix B: Native Seed Planting Layout Options and Seed Mix Examples for Solar Sites

Native Seed Mix Planting Options for Solar Sites: Example <u>Pollinator Mix</u>					
Project: Solar short-stature prairie reconstruction				Bloom Season	
Address: (Lyon County)				Spring	
Date: 2016				Summer	
Soils: Loam, Sandy loam				Fall	
Seeding Rate: 40 seeds per sq ft					
Pollinator Seed Mix (Mesic prairie)	Height	% of Mix	oz/acre	Seeds/sq. ft.	Acres to Seed
<i>Forbs</i>					
<i>Achillea millefolium</i> (yarrow)	1-3'	1.02%	0.10	0.41	1
<i>Allium stellatum</i> (prairie wild onion)	8-18"	1.25%	2.00	0.51	1
<i>Anemone canadensis</i> (Canada anemone)	1-2'	0.46%	1.00	0.18	1
<i>Anemone cylindrical</i> (long-headed thimbleweed)	1-2'	1.48%	1.00	0.60	1
<i>Asclepias syriaca</i> (common milkweed)	2-5'	1.14%	5.00	0.46	1
<i>Asclepias verticillata</i> (whorled milkweed)	1-2'	0.78%	1.25	0.32	1
<i>Astragalus canadensis</i> (Canada milk vetch)	12-40"	1.94%	2.00	0.78	1
<i>Astragalus crassicaulus</i> (ground plum)	1-2'	0.89%	3.00	0.36	1
<i>Dalea candida</i> (white prairie clover)	1-3'	4.33%	4.00	1.74	1
<i>Dalea purpurea</i> (purple prairie clover)	1-3'	5.13%	6.00	2.07	1
<i>Echinacea angustifolia</i> (narrow-leaved purple coneflower)	1-2'	1.60%	4.00	0.64	1
<i>Euthamia graminifolia</i> (grass-leaved goldenrod)	2-4'*	2.00%	0.10	0.80	1
<i>Galium boreale</i> (northern bedstraw)	1-3'	1.00%	0.25	0.40	1
<i>Liatris aspera</i> (rough blazingstar)	1-4'*	0.68%	0.75	0.28	1
<i>Lobelia spicata</i> (pale-spike lobelia)	1-2'	2.57%	0.05	1.03	1
<i>Monarda fistulosa</i> (wild bergamot)	2-4'*	2.00%	0.50	0.80	1
<i>Penstemon grandiflorus</i> (large beardtongue)	12-40"	1.20%	1.50	0.48	1
<i>Phlox pilosa</i> (prairie phlox)	6-24"	0.27%	0.25	0.11	1
<i>Potentilla arguta</i> (prairie cinquefoil)	1-3'	1.31%	0.10	0.53	1
<i>Pycnanthemum virginianum</i> (mountain mint)	1-3'	1.88%	0.15	0.76	1
<i>Ratibida columnifera</i> (upright prairie coneflower)	1-3'	2.39%	1.00	0.96	1
<i>Rudbeckia hirta</i> (black-eyed Susan)	1-3'	3.93%	0.75	1.58	1
<i>Sisyrinchium campestre</i> (prairie blue-eyed grass)	4-16"	1.28%	0.50	0.52	1
<i>Solidago rigida</i> (stiff goldenrod)	1-3'	1.17%	0.50	0.47	1

<i>Solidago speciosa</i> (showy goldenrod)	1-3'	1.35%	0.25	0.55	1
<i>Symphyotrichum ericoides</i> (heath aster)	1-3'	1.14%	0.10	0.46	1
<i>Symphyotrichum laeve</i> (smooth blue aster)	1-3'	1.57%	0.50	0.63	1
<i>Zizia aptera</i> (heart-leaved Alexanders)	1-3'	1.37%	2.00	0.55	1
Total for Forbs				18.57	
<p>*-A maximum height of 4 feet is only expected in sites with rich, moist, and deep soils. Most of the prairie plants will not achieve this maximum height.</p> <p>Native Seed Mix Planting Options for Solar Sites: Example <u>Pollinator Mix</u></p>					
<i>Grasses</i>					
<i>Avena sativa</i> (Oats; Temporary Cover)			20lbs/a c		1.00
<i>Bouteloua curtipendula</i> (side oats grama)	1-2'	8.32%	24.0	3.31	1
<i>Bouteloua gracilis</i> (blue grama)	12"	11.56%	5.0	4.59	1
<i>Carex bicknelli</i> (copper shouldered oval sedge)	1-3'	1.97%	2.0	0.78	1
<i>Carex pensylvanica</i> (Pennsylvania sedge)	8"	1.73%	1.0	0.69	1
<i>Carex brevior</i> (plains oval sedge)	12"	1.68%	1.0	0.67	1
<i>Koeleria macrantha</i> (Junegrass)	2'	11.56%	1.0	4.59	1
<i>Schizachyrium scoparium</i> (little bluestem PLS)	1-3'	10.41%	12.0	4.13	1
<i>Sporobolus heterolepis</i> (prairie dropseed PLS)	2-3'	7.40%	8.0	2.94	1
Total for Grasses				21.69	
Total Seeds/Sq. ft.				40.26	

Appendix B: Native Seed Planting Layout Options and Seed Mix Examples for Solar Sites

<p>Native Seed Mix Planting Options for Solar Sites: Example <u>Grass-only Mix</u> Project: Solar short-stature prairie reconstruction Address: (Lyon County) Date: 2016 Soils: Loam, Sandy loam Seeding Rate: 40 seeds per sq ft</p>					
No-Mow "Turf"	Height	% of Mix	oz/acre	Seeds/ sq ft	Acres to Seed
<i>Grasses</i>					
<i>Avena sativa</i> (Oats; Temporary Cover)			20lbs/ac		1.00
<i>Bouteloua curtipendula</i> (side oats grama)	1-2'	19.00%	56.0	7.71	1.00
<i>Bouteloua gracilis</i> (blue grama)	12"	18.10%	8.0	7.35	1.00
<i>Carex bicknelli</i> (copper shouldered oval sedge)	1-3'	5.77%	6.0	2.34	1.00
<i>Carex pensylvanica</i> (Pennsylvania sedge)	8"	3.39%	2.0	1.38	1.00
<i>Carex brevior</i> (plains oval sedge)	12"	3.28%	2.0	1.33	1.00
<i>Koeleria macrantha</i> (Junegrass)	2'	22.62%	2.0	9.18	1.00
<i>Schizachyrium scoparium</i> (little bluestem PLS)	1-3'	16.97%	20.0	6.89	1.00
<i>Sporobolus heterolepis</i> (prairie dropseed PLS)	2-3'	10.86%	12.0	4.41	1.00
Total Seeds/Sq. ft.				40.59	