Hastings Sand Coulee Scientific and Natural Area, North

ADAPTIVE MANAGEMENT PLAN AND INVENTORY

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Reviewed and approved by:

_____ _____

[Name] **Date**

EXECUTIVE SUMMARY

State Scientific and Natural Areas

Minnesota's Scientific and Natural Areas (SNA) are established by Minnesota Statute 86A.05 (1997) as units of the State Outdoor Recreation System to "protect and perpetuate in an undisturbed state those natural features which possess exceptional scientific or educational value." Nominated areas must satisfy a set of rigorously drawn criteria to qualify for designation. Scientific and Natural Areas serve many purposes. They are places for the quiet appreciation and study of nature and serve as outdoor classrooms for teaching and research in the natural sciences. They are areas against which the effectiveness of resource management techniques employed elsewhere can be evaluated. The more than 150 Scientific and Natural Areas protect over 183,000 acres statewide and are home to a vast array of wildlife – including rare species and Species of Greatest Conservation Need (SGCN) – and the native habitats that support them. Despite their inherent quality, SNAs are facing a growing number of environmental, land use, and management challenges – such as new invasive species threats, lack of natural disturbance, and climate change.

Adaptive Management

Natural areas will decline in quality when not properly managed. Long term preservation of natural areas and their rare features and species requires management of native vegetation, control of invasive species, and providing for appropriate public use. Managers of Minnesota's SNAs are charged with maintaining or improving the habitat condition of these lands. Adaptive management is a systematic process for continually improving management planning, policies and practices by learning the outcomes of operational practices. Assessment and review of the effectiveness of management techniques (fire frequency, time/duration of grazing, invasive species management methods, etc.) will inform future plans and activities and help select the best management techniques.

Management planning is a prerequisite to effective and successful management. This document is part of a planning effort to meet program standards and reporting requirements of various funding sources. It establishes a strategy for stewardship that addresses biological management and monitoring, obligations of ownership, and visitor management.

The goals of the management plan are to improve quality and consistency of management on SNAs and to directly aim that management towards implementation of the State Wildlife Action Plan (SWAP) *Tomorrow's habitat for the Wild and Rare,* 2006, and conservation of SGCNs and key habitats. This management plan specifically addresses goals identified in SWAP as: Goal 1-Stabilize and increase SGCN populations and Goal 2-Improve knowledge about SGCN. The management plan will also lay the basis for adaptive management and monitoring leading to current and ongoing improvements in processes of habitat management and SGCN and rare resource conservation. Native plant community (habitat) classification within this document is based on *A Field Guide to the Native plant Communities of Minnesota – The Easstern Broadleaf Foerest Province*. The plan will directly reflect and support the Adaptive Management Spatial Database (AMSD) function of tracking management and monitoring on SNAs. Additional statutory authorization pertaining to SNAs is included in the Information Sources section.

This plan was prepared by Friends of the Mississippi River Information was based on site visits, historic photos and reports, and an Ecological Evaluation (or Project Evaluations), including Texler, Hannah, April 21, 1985, *Sand Coulee Prairie;* and Texler, Hannah, September 6, 2005, *Hastings Sand Coulee: Preserve Design and Management Needs Summary.*

Protection History: The SNA has been acquired in parcels, starting with the Maher property in 2007. The acquisition history is summarized below.

Private Ownership:

- Maher 76.66 acres
- Murnane 6.75 acres
- Holst 80.15 acres

State Ownership: Wildlife Management Area, 80 acres

City of Hastings Ownership: 25.64 acres (5 acres Drainage Easement)

Protection Status/Action	Date
Nominated for SNA status—Project Proposed	
Project Evaluation	21 April 1985
CAC Recommendation	
Commissioner's Order #192	29 June 2007
New Commissioner's Order #220	22 June 2011
FMR Activity Status:	
Maher property 76.66 ac	07 July 2007
Murnane property 6.75 ac	12 January 2009
Holst property 80.15 ac	10 June 2011
City of Hastings (25.64 ac) deed signed	21 June 2011

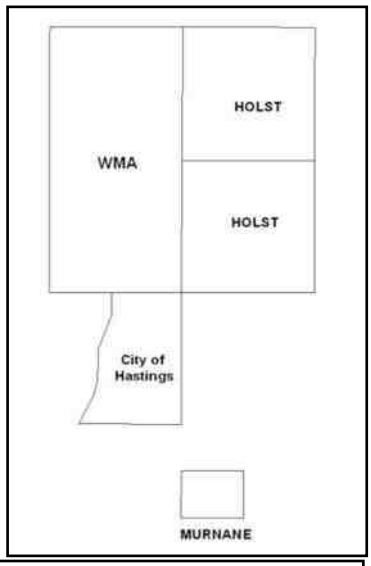

Figure 1. Former parcel ownership

Site Description:

The Hastings Sand Coulee SNA is located in Marshan Township, near the eastern edge of the City of Hastings. It is composed of a South Portion and a North Portion. The South Portion represents the former Maher property, and is located south of Hwy 316, and has a management plan already in place that describes it. The North Portion consists of four formerly distinct properties: 1) the former Murnane property (6.75 ac) located as a disjunct between the South Portion and the rest of the North Portion, 2) the former City of Hastings property (25.64 ac) and drainage easement (5 ac) located in the southern part of the main north parcel, 3) the former state-owned Wildlife Management Area (80 ac) located on the western half of the northern parcel, and 4) the former Holst property (80.15 ac) located on the eastern half of the northern parcel (see Figure 1 and Map 1). This document is the natural resources management plan that addresses the North Portion of the SNA.

Residential developments are located along portions of the western and northern borders of the property. Also directly west of the property is 80 acres belonging to the DNR that was formerly Wildlife Management Area, which is expected to be sold for development. Directly south of the SNA is located privately owned property that is retained as sand-gravel prairie. It has been managed by Friends of the Mississippi River in the past but has no formal protection and state funds for management are no longer available. To the east of the property is primarily agricultural land, with some large-lot residential. Approximately one mile to the northeast of the site lays the floodplain of the Mississippi River.

The bedrock of the region is primarily Prairie du Chien Group, which was formed during the Lower Ordovician about 500 million years ago. With the retreat of the glaciers during the last glaciation event, more than 11,000 years ago, the region was filled with sandy and gravelly outwash, and then the Coulee valley was deeply carved, and deposited with alluvium, by drainage events that followed. Today, the soils of the Coulee valley are predominately sandy loams and those of the steep slopes are loamy sands, both with high permeability, whereas the flatter ridge tops contain slightly more mesic

silt loams.

The vegetation of the site is quite diverse, consisting of multiple fire-dependent plant communities: dry prairie, mesic prairie, oak woodland, and oak forest. The rare **southern dry sand-gravel prairies** are of high quality with good to fair estimated viability, and contain many of the rare plant species found at the site, including Jame's polanisia and Kittentails. It is reasonable to expect that following restoration of additional open open-dunes habitat, that perhaps the rare open-dunes-loving plant species of sea-beach needle grass, clasping milkweed, narrow-leaved pinweed, rhombic-petaled primrose, and clustered broomrape, all found very closeby on privately owned land within one mile to the south, may return to the site. The two most prevalent cover types at the site are **oak woodland-brushland** and **grassland-shrubland,** both communities that have become overgrown with brush over the course of the last century. In areas where more mesic conditions prevail, on north-facing slopes, even though they are steep and sandy, **dry-mesic oak forest** communities occur, where Dutchman's breeches (*Dicentra culcullaria)* and Sprengel's sedge (*Carex sprengellii)* can be found growing under a nearly closed canopy of bur oak-dominated mixed hardwoods. The majority of the area at the Sand Coulee has been degraded by the invasion of exotic vegetation species and the over-abundant growth of brush. Common buckthorn is prevalent in the oak woodlands and smooth brome is dominant in much of the shrubland and grassland communities. Soapwort, or Bouncing Bet (*Saponaria officinalis*), an introduced forb species, has also become established in the grassland and shrubland sites. Eastern red cedar is quite abundant throughout the site, being very dense in woodland-grassland transitions zones. Also, some areas that formerly were more open and savanna-like have become very dense with small trees and shrubs.

It would seem that most of the site had been spared from the plow, except for the mesic, flatter areas on the tops of either west and east side of the Coulee slopes where crops, pasture, and a conifer plantation were found. The presence of many fences scattered throughout the site give evidence of former grazing throughout. Also, several former ATV trails traversed the site, and where they occur, on steep, sandy slopes, erosion and rutting have taken a toll on the landscape. Although ATV impacts have been primarily negative, an unanticipated benefit resulted in that in some areas where the soil was exposed, several individuals of the state-endangered plant species James' Polanisia appeared. Further study on this phenomenon may shed light upon the interaction of disturbance with the expression of this rare species.

A variety of mammals, birds, reptiles, and insects inhabit the site, amongst them are some species of greatest conservation need (SGCN), including loggerhead shrike, blue racer, gopher (bull) snake, regal fritillary, and Ottoe skipper. A focus of this document is to provide a framework for management of the site, elucidating how to preserve, protect, and promote these important species.

Preservation Value:

The purpose of the SNA is to protect rare plant communities and the species they support. The rare dry sand-gravel prairie (southern) and several rare species therein are rare in the Twin Cities Metropolitan Area. SNA status protects the plant communities and species that are threatened by development and loss of habitat.

General Management Considerations

The following is a list of general management considerations for the site:

- Maintenance of dry sand-gravel prairies (UPs13b)
- Reconstruction of dry sand-gravel prairies UPs13b) from Cropland
- Restoration of shrub-grasslands and mesic prairie (UPs23)

- Reconstruction of mesic prairie (UPs23) from conifer plantation and brome-dominated grasslands
- Restoration of southern dry oak savanna (UPs14)
- Maintenance and restoration of southern dry oak woodland (FDs37)
- Restoration or stabilization of ATV-trails on steep, sandy slopes
- Installation of signs at boundaries, especially at the head of unauthorized trails on steep slopes where they enter the site
- Maintenance of interpretive materials and public access such as signs

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INTRODUCTION

This Adaptive Management Plan presents the site analysis and management recommendations for the north unit of the Hastings Sand Coulee Scientific and Natural Area (SNA) in Hastings, MN. The south unit was acquired by the DNR in 2007, in partnership with Friends of the Mississippi River (FMR) and Dakota County. Acquisition of the north unit was completed in 2011 as a joint effort between FMR, the City of Hastings, Dakota County, and the DNR. On-going management of almost all the properties, both before and after protection, has been coordinated by Friends of the Mississippi River, with funding from multiple state and federal sources.

The Hastings Sand Coulee SNA is about 45% overgrown/degraded savanna/oak woodland, 40% overgrown/degraded mesic prairie, and 20% sand-gravel prairie. The remainder is constructed storm water drainage (pond).

The purpose of this plan is to:

• Evaluate the historic and existing condition of vegetation cover on the property

• Identify target native plant communities and restoration goals.

• Identify methods for improving the wildlife habitat value of the property.

• Identify native plant communities

• Identify other features of interest such as rare and sensitive species and Species of Greatest Conservation Need

• Identify management needs and methods for enhancing native plant communities and other features of interest

Specific ecological goals for the property are to:

• Maintain, enhance or restore the native plant communities (desired future condition) and other features of interest

• Provide for interpretation and education opportunities while protecting the native plant communities and features of interest

• Improve wildlife habitat

• Provide connectivity with other natural areas in the landscape.

• Maintain and manage the property to help conserve the local watershed

• Maintain, enhance or restore the ecological functions of the property and of the larger Metro Conservation Corridor/watershed/ecological landscape, etc.

This plan also provides background data on the site ecology, geology and soils, hydrology, historic ecological conditions, its context within the landscape and any known rare features. It provides a detailed evaluation of the site conditions at the time of the survey in May-June, 2011 and uses the combination of information gathered from Geographic Information System data, the Project Evaluation, correspondence and other proposed ecological management and restoration recommendations. A schedule of management tasks is also provided.

BACKGROUND AND SIGNIFICANCE OF THE SITE

Site Summary

Purpose for Site Protection and Designation: to protect the rare dry sand-gravel prairie (southern) and several species that are rare in the Twin Cities Metropolitan Area.

Designation Order Number: #192 June 29, 2007

Superceded by #201 November 2, 2009

Superceded by #220 June 22, 2011

County: Dakota

Legal Description: Marshan, T114N, R17W Sec 2

DNR Quad Code: T18a

Directions to site:

From the Twin Cities:

West Entrance: State Hwy 61 S through the City of Hastings, to Co. Hwy 316 (Red Wing Blvd.). Hwy 316 SE approximately 1.1 miles to Tuttle Drive; Tuttle E then S to chain-link fence and gate on the east side of the road. This is currently the primary entrance to the SNA.

North Entrance: State Hwy 61 S through the City of Hastings, to Co. Hwy 316 (Red Wing Blvd.). Co. Hwy 316 SE approximately 0.3 miles. 31st Street E approximately 1 mile E to Glacier Way. E to the cul-de-sac. Park on the S side of Glacier Way on the N side of the SNA.

Ecological Subsection: Paleozoic Plateau

Size: 185 acres (not including the 77a parcel in T114N R17W SWNE Sec 11)

Permitted Uses and Special Rules: Standard SNA rules apply to this site - hunting, camping, motorized vehicles are not allowed.

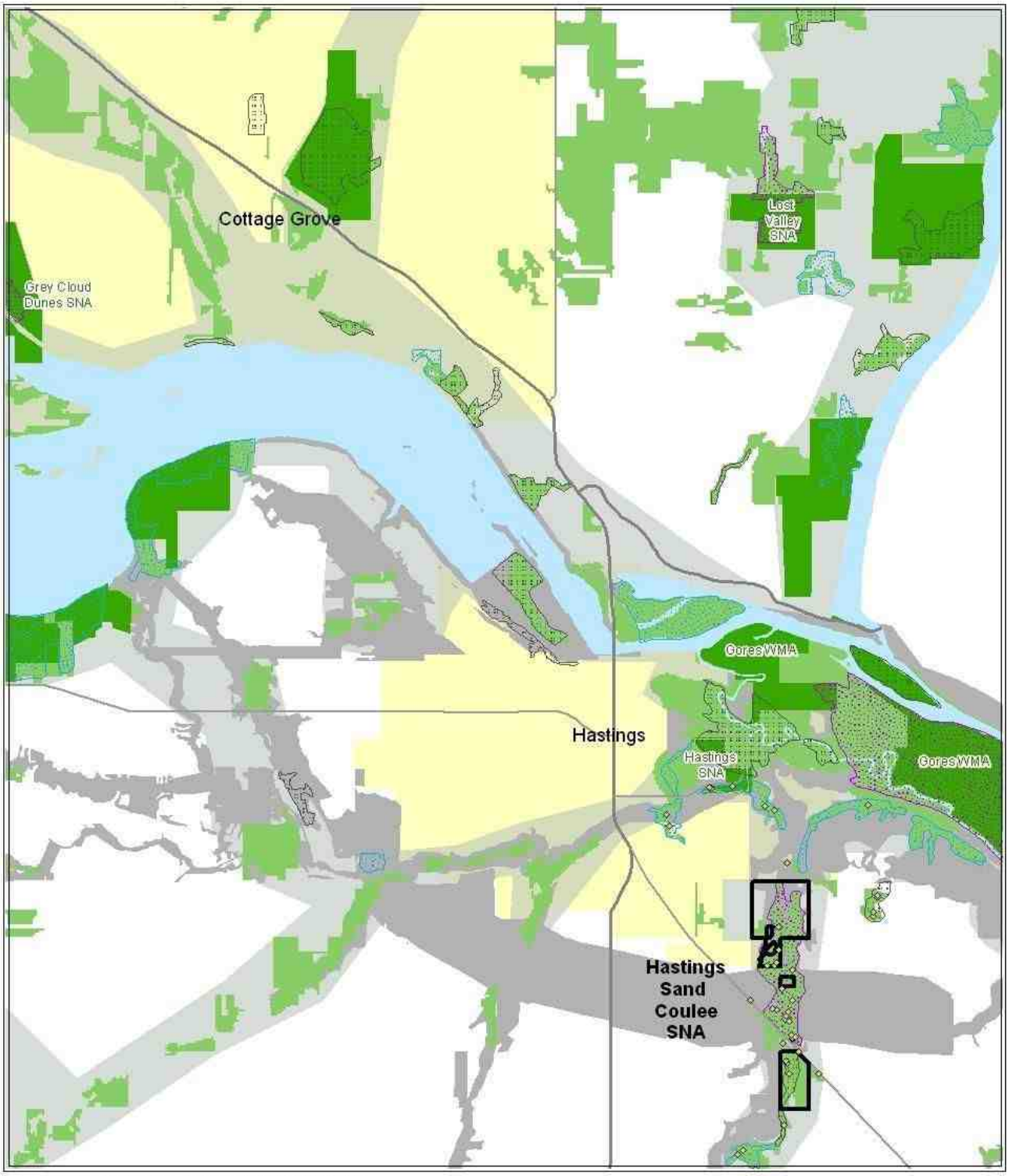
Primary Site Administrator: Region 3 SNA Management Specialist Sr., 1200 Warner Rd, St. Paul, MN 55106; 651-259-5773

Watershed: Lower Mississippi River

Basin: Mississippi River and Lake Pepin

Surface Water Watershed (Level 8): Vermillion River Watershed catchment basin

Map 1. Landscape Context



Ecological Background

Table 1. Known Species of Greatest Conservation Need (SGCN) within Sand Coulee SNA

Scientific Name	Common Name	Source of Information
Birds		
Lanius ludovicianus	Loggerhead Shrike	FMR bird survey 2005-2010
Spiza americana	Dickcissel	FMR bird survey 2005-2010
Sturnella magna	Eastern meadowlark	FMR bird survey 2005-2010
Spizella pusilla	Field sparrow	FMR bird survey 2005-2010
Contopus virens	Eastern wood pewee	FMR bird survey 2005-2010
Ammodramus savannarum	Grasshopper sparrow	FMR bird survey 2005-2010
Pheucticus ludovicianus	Rose-breasted grosbeak	FMR bird survey 2005-2010
Empidonax minimus	Least flycatcher	FMR bird survey 2005-2010
Reptiles		
Coluber constrictor	blue racer	DNR database
Elaphe vulpine	eastern fox snake	FMR 2011
Pituophis catenifer	gopher snake	DNR database
Insects		
Hesperia ottoe	ottoe skipper	DNR database
Speyeria idalia	regal fritillary	DNR database

Element Occurrences:

Key Habitats

Native Plant Communities: UPs13b (dry sand-gravel prairie-S)

This habitat is key to many of the rare species and SGCNs found to inhabit the site. Most of the rare species depend on it, including James' Polanisia, blue racer, bull snake, Ottoe skipper, and regal fritillary. Several rare plant species, namely sea-beach needle grass, clasping milkweed, narrow-leaved pinweed, and rhombic-petaled evening primrose, although not recorded on the SNA-north unit property, have been recorded within one mile to the south, on private property and one on the south unit of the Hasting Sand Coulee SNA. The entire remnant plant community at Hastings Sand Coulee SNA was mistakenly classified on the MCBS data layer as Ups13a, Dry Barrens Prairie (Southern)--it is actually Ups13b, Dry Sand-Gravel Prairie (Southern) (Hannah Texler, pers. com.). Additionally, there are inclusions of areas with scattered trees and shrubs, i.e., savanna and grassland-shrubland. These habitats are key to the rare species kittentails and loggerhead shrike as well as being important to many SGCNs listed in Table 1. Other key habitats include open sand areas for James Polanisia. This has been created in the past by sand or gravel pit excavation, and has been maintained in more recent years by ATV activity in those gravel pits and on the sandy slopes. Future management may need to ensure some disturbance to maintain suitable habitat.

Rare Species & Features

Table 2. Rare Features within One Mile of the SNA (**Map 1**)

FAMILY	SCIENTIFIC NAME	COMMON NAME	State Status	Recorded on SNA
Animals				
Colubridae	*Coluber constrictor*	North American Racer	SPC	X
Colubridae	*Elaphe vulpina*	Western Fox Snake	NON	X
Colubridae	*Pituophis catenifer*	Bull snake or gopher snake	SPC	X
Hesperiidae	*Hesperia ottoe*	Ottoe Skipper	THR	X
Hesperiidae	*Hesperia leonardus pawnee*	Pawnee Skipper	SPC	
Nymphalidae	*Speyeria idalia*	Regal fritillary	SPC	X
Plants				
Araliaceae	*Panax quinquefolius*	American Ginseng	SPC	No, but within 1 mile north of SNA
Asteraceae	*Antennaria parvifolia*	Small-leaved pussytoes	SPC	X - S unit
Asteraceae	*Hieracium longipilum*	Long-bearded Hawkweed	NON	X
Asclepiadaceae	*Asclepias amplexicaulis*	Clasping Milkweed	SPC	No, but within 1 mile south of SNA
Capparaceae	*Cristatella jamesii*	James' Polanisia	END	X
Cistaceae	*Lechea tenuifolia*	Narrow-leaved Pinweed	END	No, but within 1 mile south of SNA
Liliaceae	*Trillium nivale*	Snow Trillium	SPC	No, but within 1 mile north of SNA
Onagraceae	*Oenothera rhombipetala*	Rhombic-petaled Evening Primrose	SPC	No, but within 1 mile south of SNA
Orobanchaceae	*Orobanche fasciculata*	Clustered Broomrape	SPC	No, but within 1 mile south of SNA
Poaceae	*Aristida tuberculosa*	Sea-beach Needlegrass	SPC	No, but within 1 mile south of SNA
Scrophulariaceae	*Besseya bullii*	Kittentails	THR	X
Scrophulariaceae	*Linaria canadensis*	Old Field Toadflax	NON	No, but within 1 mile south of SNA
Natural Communities				
	Dry Barrens Prairie (Southern) Type - Ups13a	Dry Barrens Prairie (Southern)		
	Dry Sand - Gravel Oak Savanna (Southern) Type – Ups14b	Dry Sand - Gravel Oak Savanna (Southern)		
	Dry Sand - Gravel Prairie (Southern) Type – Ups13b	Dry Sand - Gravel Prairie (Southern)		X
	Native Plant Community, Undetermined Class -	Native Plant Community, Undetermined Class		

Relationship to Sites of Biodiversity Significance

The coulee is part of a north-south corridor of natural habitat that connects to the extensive habitat of the

Vermillion River Bottoms (Map 1). This floodplain area contains one of the largest expanses of floodplain native plant communities in southeast Minnesota. These communities include floodplain forest, lowland hardwood forest, mixed emergent marsh, wet meadow, and calcareous fen. This area is one of the top four sites in the state for rare forest birds (Dunevitz 2001). It is also part of the Mississippi Greenway Plan, which creates a connected network of corridors between Rosemount and Ravenna Townships (Map 1). The Hastings SNA, which has significant biodiversity, is within one mile to the north of the Hastings Sand Coulee SNA.

Site Topography, Geology, and Soils

Most of the landscape features in the region were created by glacial activity. In the most recent glacial events, over 10,000 years ago, a series of glacial advances and retreats left deposits of gravel and sand over much of Dakota County, especially the north and mid-sections. In the sand coulee area, those deposits were then overlain with mixed outwash from melt water of the Des Moines Lobe, which deposited sand, loamy sand, and gravel (Hobbs et. al. 1990) (**Map 2**). After the glacial period, water levels in the Mississippi River dropped. Adjacent drainages, such as the Coulee, necessarily adjusted by eroding downward. That erosion created the valley, as the head cut progressively moved upstream until it reached a place of equilibrium, some 3.5 to 4 miles away. The Southern Portion of the SNA (former Maher Property) is located closer to the point of equilibrium, and the Northern Portion is located closer to the point of origin of the valley. Floodplain alluvium sediments are present at the bottom, which were deposited by the stream during modern day flood events.

Today, the most striking characteristic of the site is its topographic relief. In the otherwise nearly level terrain of Marshan Township, the valley of the coulee offers the greatest contour change and is one of the most scenic views in the agricultural landscape. Elevation changes are fairly dramatic, with a 100-foot drop from top to bottom and slopes up to 45 percent. The soils of the Sand Coulee region consist primarily of loamy sands, sandy loams, and gravelly sands.

Hydrology/Watershed

While the coulee seldom holds water in current times, water does flow through the channel and surrounding areas during some spring melt periods (Murnane pers. comm.). The creek flows in a primarily south to north direction, roughly through the center of the site, towards the Vermillion River. Flow has only happened a few times in the last ten or fifteen years, but when they occur, flows can be heavy with water depths on those occasions having often been three feet in areas and as much as six feet (Murnane pers. Comm. 2004).

There are no wetlands on the site, except for the City-constructed storm water pond and two very small wildlife ponds or dugouts (Map 5; GPS point 7, Photo 21). All plant communities are upland - grassland, shrubland, oak woodland, and sand-gravel prairie.

The site is in the Level 8 watershed, Vermilliion River catchment basin.

Historical Background

Historic Vegetation

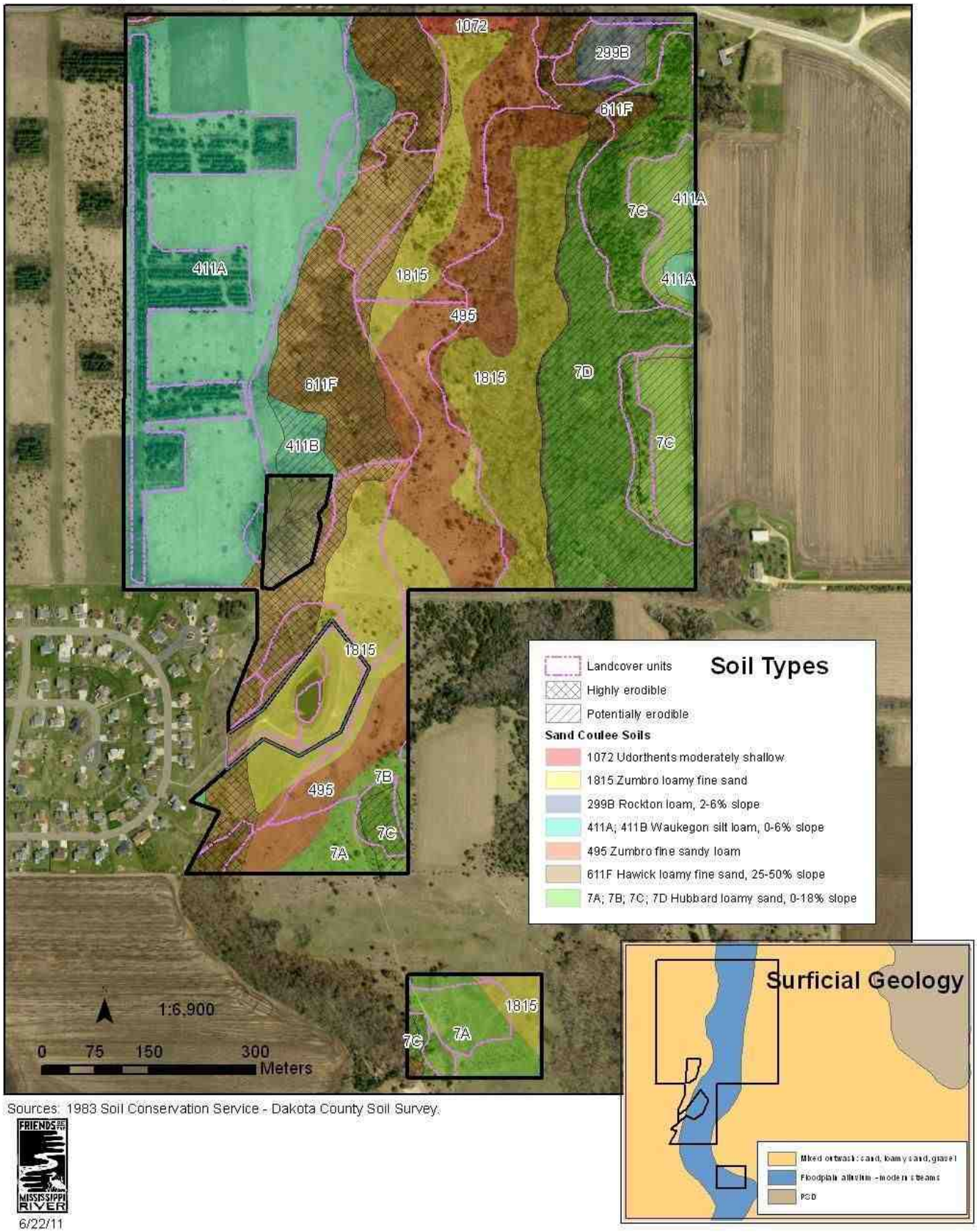
Marcshner's map, which shows land cover conditions at the time of pre-settlement, shows the area that currently occupies the Hastings Sand Coulee-North as having been part of a large land cover unit called "prairie", which extended across most of the central portion of what is today Dakota County (**Map 3**). The

bearing tree data contain no records of tree within the boundary of the site, which is classified as prairie. The few bearing trees recorded near the site were bur oak. The following are the "General Description T114N R17W Dakota County" from the original Public Land Survey notes:

This Twp is level, sandy plain entirely destitute of water except where the Vermilion River crosses the NW corner. The timber is of but little value, being very short and scrubby. The variations I found so irregular that I decided it inexpedient to correct the north and south lines so as to make all the east randoms just 80 chains.

Surveyed Jan 30, 1854 by Thomas Simpson

Map 2. Surficial Geology and Soils



Sources: 1983 Soil Conservation Service - Dakota County Soil Survey.

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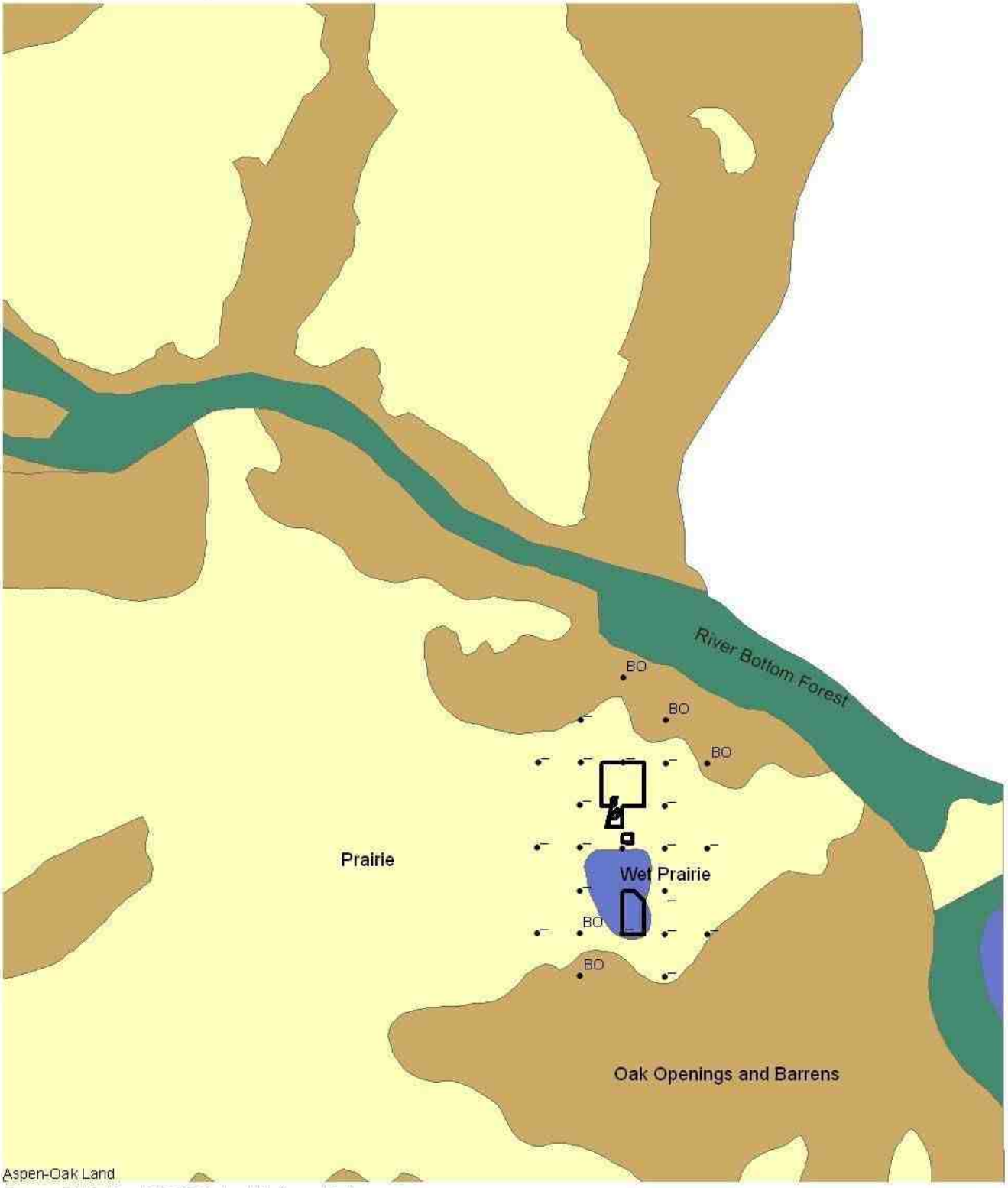
MAP 3. Pre-European Settlement Vegetation



Sources: DNR data deli, DNR Natural Heritage database.

0 0.5 1 2 3 Kilometers

1:100,000

• Bearing trees: "BO" = bur oak, "-" = no trees

Hastings Sand Coulee SNA

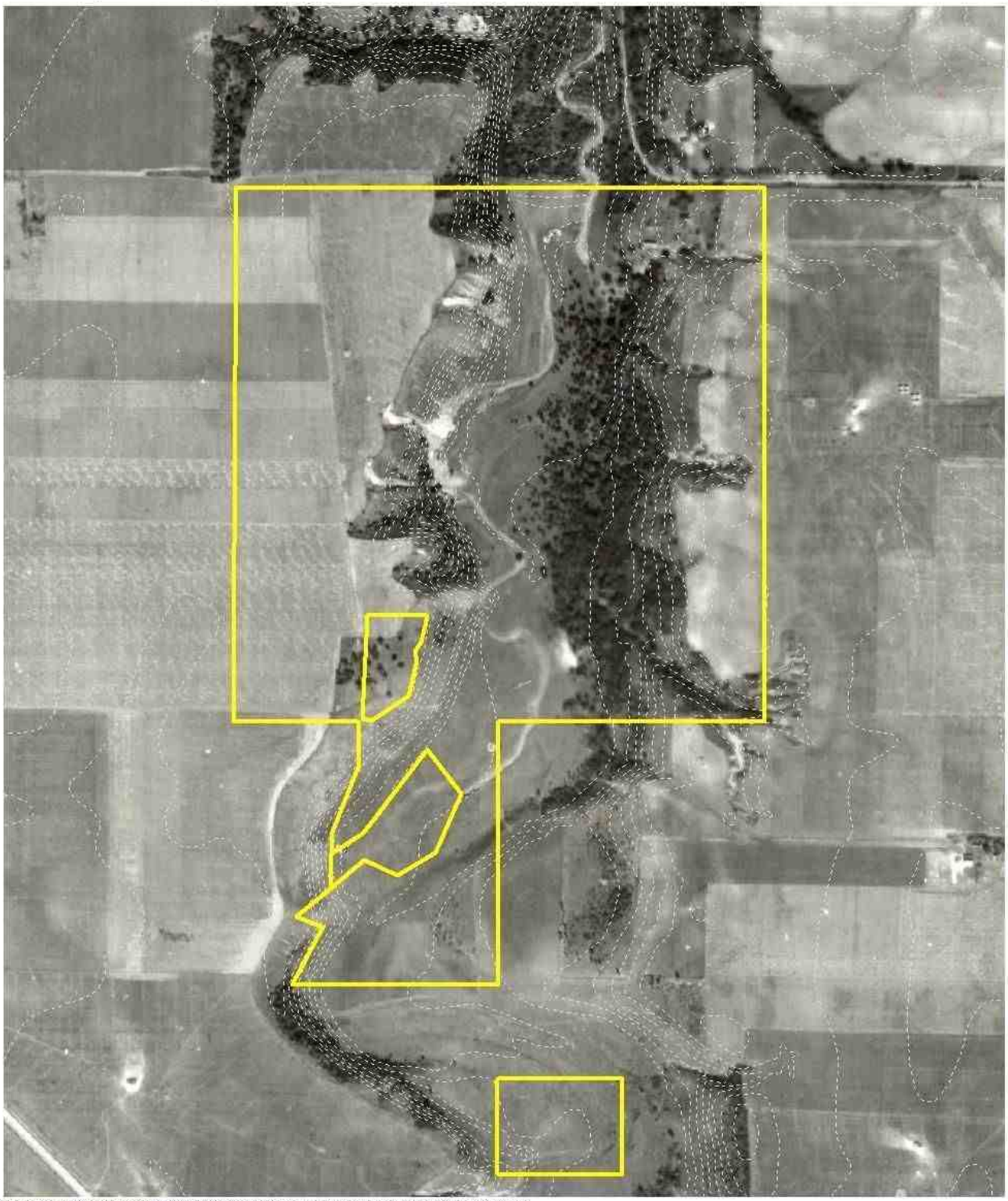
A 1937 aerial photo of the site (**Map 4a**) shows the site to be more open, in terms of woody vegetation density. Locations and extent of trees in forested areas in 1937 were relatively similar to their locations in 2011, except that they have expanded their extent on the edges and become denser in their interiors. In 1937 there were also fewer shrubs in the bottom of the coulee, showing that this area would have been more open like a prairie and less like a grassland-shrubland that it is today. However, not all areas were free of trees, since much of the eastern slope, which is oak woodland today, was populated with trees in 1937. The zones between what would have been prairie on top and woodland on the slopes is an oak savanna transition, with scattered trees amongst primarily prairie. Why trees would have persisted on the dry, sandy, west-facing slopes at the site is a bit of a mystery. Perhaps it can be explained by the frequency, pattern, and occurrence of fire. Since fire would have most likely come from the west or east, traveling across the large, relatively flat, open prairies to the west (and east) of the coulee, it would have met with the steep slopes of the coulee, and probably would not have traveled down these slopes. So, for fire to enter the coulee valley, it would most likely have to have come from the north or south, traveling through the valley itself, which probably would not have been as often as up on the flat plains above.

Sand gravel prairies would have persisted on the southeast-facing slopes on the west side of the site due to the extreme drought conditions that would have prevailed on these steep, sandy-gravelly slopes, since the aspect is southerly enough to keep them very dry, in spite of reduced fire frequency. Conversely, north and northeast-facing slopes resulted in entirely different communities (dry mesic oak forest containing *Dicentra cucullaria* and *Carex sprengelii*), with mesic conditions being more prevalent here. It is possible that fire was not as frequent in the coulee as one might initially expect, and this should be taken into consideration in the management of the site.

Also visible in the 1937 photo is what looks like a trail that traverses the basin of the coulee in roughly a north-south direction, probably paralleling the dry creek bed. In addition, the photo shows the presence of three or four large areas of erosion on the western slopes, presumably caused by runoff from the adjacent agricultural field to the west. In 1937, also, the City of Hastings had not yet expanded to its current limits, and the landscape to the west of the Sand Coulee was not urban-residential, but agricultural fields.

A 1964 aerial photo of the site (see **Map 4b**) shows a progression of the general trend toward expansion of the woody vegetation and an increase in the density of woody vegetation. The eroded areas on the western slope are still present, but appear to be not extending down the slope quite as far as in 1937. Also in 1964, there was some residential housing starting to appear to the west of the Sand Coulee, but it was only along a single road which was approximately one-half mile away, and agricultural fields were adjacent to the site on the west.

MAP 4a. 1937 Aerial Photograph



Sources: University of Minnesota Borchert Map Library, DNR data deli (contours).

0 150 300 Meters

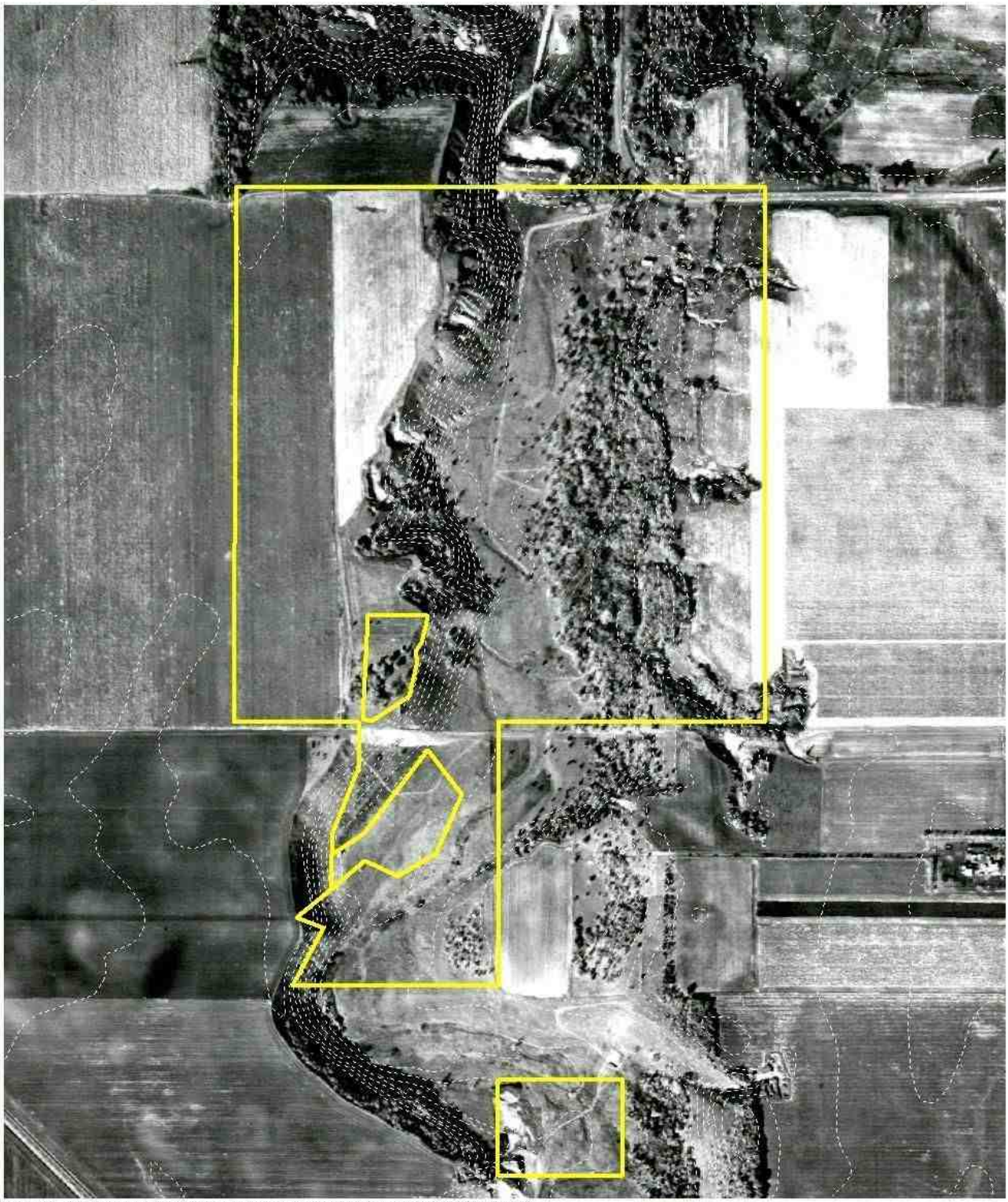
N

1:8,000

Hastings Sand Coulee SNA - North

10-ft contours (dashed white lines)

MAP 4b. 1964 Aerial Photograph



Sources: University of Minnesota Borchert Map Library, DNR data deli (contours).

Hastings Sand Coulee SNA - North

10-ft contours

0 150 300 Meters

N

1:8,000

Historic Land Use

From historic aerial photos and field survey data, it appears that all of the upland areas above the coulee slopes were historically plowed. Runoff from the fields resulted in moderate to severe erosion of the sandy slopes; scars from the large gullies that formed are still present today, though most have revegetated considerably. Two fields on the east side are still cropped, but do not contribute to ravine erosion as they are set back from the top of the ravine. Old barbed wire fences criss-cross the slopes and basin of the coulee, indicating that most or all of the SNA was formerly grazed. The degraded grasslands indicate it was either heavily grazed or that the native prairie was converted to brome grassland for cattle.

A homestead, seen as early as the 1937 aerial, located in the northeast corner of the site was removed in 2011 (**Map 5**, pt 15). There were also remains of some sort of building structure (**Map 5**, pt 33), though it did not appear to be a dwelling.

A portion of the SNA site has also been a wildlife management area for many years and as such was used for hunting. While it was permitted for bow hunting, shotgun cartridges and remains of skeet targets can also be found at the site. A few deer stands were found in eastern woodland. In addition, the site was regularly used for many years by ATV riders. The ATVs used some of the same paths created by agricultural runoff in the past, and further deepened and entrenched the gullies. ATV use is now fairly rare and there is little evidence of recent activity on the slopes.

Within the SNA is a small in-holding for the cemetery from the old state hospital. Located on the bluff top north of the pond it is maintained by a nonprofit organization.

In the center of the SNA is the site of a former sand and gravel quarry. Today the remnants of this quarry are a circular-shaped bare soil zone encompassing roughly 2,000 sq ft. This area resembles a natural "blow-out", and has been extensively used by ATV's, which has kept the site open and relatively free of vegetation. If such radical disturbance is eliminated, this may be optimum habitat for many of the rare plant species—those that require open, shifting sand.

Toward the south end of the SNA is a storm water pond located on the property formerly owned by the City of Hastings. The pond was created in the early 2000's when the housing development was created. It was enhanced with plantings of native emergent plants, but currently appears to be shrinking as it is infiltrating rather than holding water. Wetland plants were installed by Friends of the Mississippi River in partnership with the Hastings High School biology class. FMR and high school classes also installed prairie plants, using local plants grown from seed collected on-site.

Management of the former WMA and other wildlife brush and trees has proceeded for many years under the direction of the DNR. Coniferous trees were planted in the former cropland on the west side for wildlife habitat. A prairie planting was created in the northeast part of the same field. The planted prairie and the native prairie on the west slope were burned periodically. The wooded areas were also managed by the DNR and later by FMR for buckthorn. The woods were also burned at least once in recent years.

The former city property has also been intensively managed by FMR since 2005. Spotted knapweed root weevils (*Cyphocleonus achates*) and seed head weevils (*Larinus minutus)* were released at the site in 2005

and 2006. By 2010 the knapweed was showing clear signs of being reduced. Other management of the area included removal of trees and shrubs from the prairie, management of all wooded areas for exotic brush control, whole site prescribed burns in 2008 and 2010 and burns of the southeast oak woodland in 2005 and 2006.

Priority Features

- Dry Sand-Gravel Prairie (Southern) - Ups13b
- Those plants that are state endangered, threatened, and of special concern: kittentails (*Besseya bullii),* James' polanisia (*Cristatella jamesii).*
- Those plants that were not recorded on the SNA North Unit, but were recorded on the South Unit and on private lands within one mile of the North unit, and are state endangered, threatened, and of special concern, including the following: sea-beach needle grass (*Aristida tuberculosa)*, small-leaved pussytoes (*Antennaria parvifolia*), clasping milkweed (*Asclepias amplexicaulis),* narrow-leaved pinweed (*Lechea tenuifolia),* Rhombic-petaled evening primrose (*Oenothera rhombipetala)*, clustered broomrape (*Orobanche fasciculata)*
- Loggerhead shrike
- Ottoe skipper, regal fritillary
- Blue racer
- Socio-economic features from the Designation Order: Hastings Sand Coulee "is designated as a Public use Unit, open to the public for nature observation and general educational and research activities"
- Public Relations features: talking to neighbors about dumping yard waste, recruiting a site steward, coordinating with Friends of the Mississippi on nature hikes, etc.

SGCN, Rare Features, and Key Habitats

Dry Sand –Gravel Prairie (Southern) Ups13b

The following excerpt describing Southern Dry Prairie and Southern Dry Sand-Gravel Prairie was taken from the *Field Guide to the Native Plant Communities of Minnesota, Eastern Broadleaf Forest Province, 2005:*

"Graminoid-dominated, forb-rich herbaceous communities on coarse-textured, usually gravelly soils on gentle or occasionally steep slopes on outwash and ice-contact deposits. Soils are characterized by mollic epipedons. The community shares many species with Dry Bedrock Bluff Prairie (Southern) and with Dry Hill Prairie (Southern) that are rare in Dry Barrens Prairie (Southern). The xeric conditions and lower soil fertility of Southern Dry Prairie strongly favor species having physiological and morphological adaptations to cope with these stresses. Reduced aboveground biomass, narrow, small, or deeply dissected leaves, and dense hairy vestiture are examples of such adaptations. On dune sands, blowout formation and migration produces dramatic local variation in species composition, from sparse stands of pioneer species in bare, sterile sand, to a relatively dense sod of grasses and forbs on long-stabilized organically enriched sand. As for all prairie classes in Minnesota, recurrent fire is necessary to prevent succession to woodland or forest, although the fire frequency required to maintain dry prairies is lower than form mesic prairies because the xeric conditions and lower fertility of the sites somewhat inhibit tree and shrub invasion. Smooth sumac and eastern red cedar are two of the most aggressive prairie invaders in the absence of fire. The first spreads clonally into prairies from woodland edges, while the second invades from seed dropped by

birds. Once these woody species establish dense stands it is difficult for fire to remove them. Other trees present in nearby woods and forests also can become established in dry prairies unless eliminated by fire. Before Euro-American settlement, grazing and trampling by large ungulates were regular occurrences in dry prairies except probably on steep slopes. The contribution of these disturbances to the composition and structure of the vegetation is not well understood; although it is known that confined grazing by domestic livestock can badly degrade dry prairies. Dry prairies are, however, more resilient than mesic prairies to grazing."

In general, prairie is important because of the 18 million acres of prairie that once covered one-third of the state of Minnesota, less than 1% remains today, and that is generally in scattered, fragmented pieces (DNR website: http://www.dnr.state.mn.us/npc/status.html). Most of the SGCNs found at this SNA (see Table 1, p. 11) rely on prairie habitat to breed and feed. Additionally, the patches of wooded ravines offer habitat for some woodland birds in Table 1 such as eastern wood pewee, least flycatcher and rose-breasted grosbeak.

Rare Features

The rare species have been grouped into the following three habitat types, according to which they prefer:

Habitat 1 = dry, loose, shifting sand as in dunes with sparse vegetation or eroding sandy slopes;
Habitat 2 = native dry-mesic to dry prairie where mid-height grasses, on deep sands, on steep bedrock-controlled slopes, and on slopes and hills in unsorted glacial till;

Habitat 3 = dry oak savanna, open oak woodlands, or less xeric north-facing slopes in prairie habitats.

Habitat Type 1: dry, loose sand in dry sand prairies or prairie openings: in sand savannas, sand prairies, and dunes where vegetation is sparse; sandy or sandy-gravelly deposits associated with eroding slopes and exposed, coarse, fluvial deposits or sandy colluvium.

James' Polanisia *(Cristatella jamesii)*

The following excerpt is from the MN DNR website:

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PDCPP08030

"These northern populations [of the species] appear to be restricted to sandy or sandy-gravelly deposits associated with eroding slopes and exposed, coarse, fluvial deposits or sandy colluvium. At the original collection site, most of the native sand prairie habitat is now degraded or destroyed by off-road vehicles, sand and gravel extraction, pine plantations, and residential development. At the other Dakota County sites, the encroachment of woody plants or more aggressive plants shade out this tiny species.

In Minnesota, C. jamesii occurs on sandy or sandy-gravelly soil in dry, open settings with sand prairie species. The sites are all on post-glacial stream deposits, especially where glacial melt water streams cut into fluvial deposits creating coulees or small valleys. The dry valley walls, sandy aprons of colluvium at the base of valley walls, and local dune-like deposits or blowouts of

sand are all places in which C. jamesii might occur. This species prefers full sunlight, but woody plants and more aggressive plants are now encroaching on many habitat patches. In areas of steeper terrain, it typically occurs on slopes with south- or west-facing exposures. Plants that commonly occur in association with C. jamesii are *Calamovilfa longifolia* (sand reed grass), *Dalea villosa* (silky prairie clover), and *Liatris punctata* (dotted blazing star).

Cristatella jamesii is an annual plant and therefore must start growth each year from seed. It is not known how long the seeds remain viable in the soil in these northern locations. Because the species grows in a fairly harsh, dry environment, it is likely to have seeds that remain dormant for a considerable number of years. Plants face a high risk of seed crop failure during years of major drought. They also risk being dislodged and killed by normal, natural erosion on the unstable slopes and sandy places where they occur."

Sea-beach needle grass (*Aristida tuberculosa)* (found on private land within one mile to the south of the Sand Coulee SNA North Unit)

The following excerpt is from the MN DNR website:
http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PMPOA0K160

"Sea-beach needle grass occurs exclusively in dry, loose sand in sand savannas, sand prairies, and dunes where vegetation is sparse. Sandy habitats that are occasionally inundated, such as lakeshores and river floodplains, are not suitable. *Aristida tuberculosa* sometimes occurs in disturbed habitats such as roadsides, foot trails and old fields, but these unstable habitats generally do not support persistent populations of the species.

Aristida tuberculosa is a wind-pollinated annual with a need for open, sparsely vegetated habitats where there is dry, shifting sand. The bent awns seem to be an adaptation for catching in the fur of mammals, thereby dispersing the seeds. However, it also seems likely that wind is involved in the process of dispersion. It has been reported that the awns have hygroscopic properties, which allow the seeds to bury themselves; seeds that do not get buried usually do not germinate, or if they do germinate, the resulting seedlings fail to become established (Collins and Wein 1997).

Native sand savanna habitats typically have a few scattered *Quercus spp.* (oaks) or *Populus tremuloides* (trembling aspen) trees and scattered shrubs such as *Corylus americana* (American hazel). Sometimes these trees and shrubs are in small groves or they may occur as isolated individuals. Either way, most of the habitat will be open and free of woody vegetation thereby allowing the wind to create dunes. Over time, these dunes become bowl shaped with crests and hollows. The hollows, or "blowouts", are the specific habitat where *A. tuberculosa* occurs. It is essential that these dunes be maintained in this natural "active" condition if *A. tuberculosa* is to survive. Under normal conditions, the vegetation in this habitat type is maintained by wildfire and perhaps periodic drought; grazing by bison and elk were probably once also important. These processes keep the dunes from being overgrown by woody vegetation or a dense thatch of herbaceous vegetation, which would eliminate habitat for this rare species. Well-intentioned individuals will sometimes plant non-native pine trees in this sort of habitat thinking they are promoting "conservation". Unfortunately, this has the opposite effect and should be avoided at all costs. Where trees have been planted in the past, they should be carefully removed. The dune habitats should also be protected from off-highway vehicles (OHVs), which easily damage the

fragile soils giving invasive species an opportunity to get a foothold."

Clasping Milkweed (*Asclepias amplexicaulis*) (found on private land within one mile to the south of the Sand Coulee SNA North Unit)

The following excerpt is from the MN DNR website:

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PDASC02020

"Asclepias amplexicaulis occurs exclusively in dry, sandy, sparsely vegetated soil in savannas and upland prairies. It requires full sunlight and minimal competition from other perennials. Like all milkweeds, A. amplexicaulis is a perennial although it is not known how long individuals actually live. The flowers are pollinated by a number of insect species and the seeds are spread great distances by the wind.

Asclepias amplexicaulis is a plant of prairies and open savannas where the trees are few and widely spaced. These conditions developed under a regime of periodic wildfire started by lightning strikes. This favored herbaceous vegetation and discouraged woody vegetation. It is also known that A. amplexicaulis does not compete well with invasive non-native species, especially sod-forming grasses such as *Bromus inermis* (smooth brome). Controlling such invasives may require close monitoring and an ability to respond quickly to newly developing threats."

Narrow-leaved Pinweed (*Lechea tenuifolia)* (found on private land within one mile to the south of the Sand Coulee SNA North Unit)

The following excerpt is from the MN DNR website:

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PDCIS040E0

"In all cases, the habitat was high-quality sand prairie or sand savanna. Maintaining healthy sand prairie and sand savanna habitat requires active management such as prescribed fire to maintain conditions suitable for L. tenuifolia. In Minnesota L. tenuifolia inhabits dry, sandy prairies or openings in sand savannas. Associated species include *Cyperus lupulinus* (slender nut sedge), *Koeleria macrantha* (June grass), and *Solidago nemoralis* (gray goldenrod).

It is a rare event for the tiny flowers of *L. tenuifolia* to open, but it is alleged that they will open in the early morning light of bright days."

Rhombic-petaled evening primrose (*Oenothera rhombipetala)* (found on private land within one mile to the south of the Sand Coulee SNA North Unit)

The following excerpt is from the MN DNR website:

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PDONA0C150

"It appears that the natural habitat of *O. rhombipetala* is dry, sandy prairies and dunes in the east-central and southeast portions of Minnesota. There are some indications that the species can tolerate a certain level of human activity within its habitat. This might include light disturbance to the soil surface caused by vehicles or farm machinery, and possibly light grazing by domestic livestock. It may even find temporary habitat on sandy roadsides and in abandoned fields, although it is unlikely that such habitats can sustain a population of *O. rhombipetala* for very long.

Oenothera rhombipetala is a biennial that lives just two years. The first year it produces only a basal rosette of leaves and a taproot. The second year it produces an erect flowering stem. The flowers open in the evening and are pollinated by a number of night-active insect species including sphinx moths. The flowers are self-incompatible so cross-pollination is required. The dried seed capsules remain on the stem and continue to release seeds for some period of time after the plant has died at the end of its second year. The seeds posses no specialized structure to aid dispersal although they are small enough to be carried short-distances on a strong wind.

The dry prairie habitats of *O. rhombipetala* are extremely vulnerable to the invasion of non-native plant species, especially *Vicia villosa* (hairy vetch), *Euphorbia esula* (leafy spurge), *Centaurea stoebe* (spotted knapweed), *Bromus inermis* (smooth brome), and *Lotus corniculatus* (birdsfoot trefoil). The usual vectors for invasion include livestock, farm machinery, transportation corridors, and erosion. Soil disturbance is generally cited as a serious threat to native species in dry prairies, but it is usually the invasion of non-native species that follows disturbance that causes the loss of sensitive species. Several populations of *O. rhombipetala* from the southwestern metropolitan area have been eliminated or threatened by suburban housing developments situated on sand dunes."

Clustered broomrape (*Orobanche fasciculata)* (found on private land within one mile to the south of the Sand Coulee SNA North Unit)

The following excerpt is from the MN DNR website:

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PDORO04060

"Orobanche fasciculata occurs in prairies and dunes, particularly in excessively drained, loose, sandy or gravelly soil or in thin soil over bedrock. In the Bluff lands, it is often localized in patches of sand immediately down slope from sandstone outcrops. It does not seem to do well where there is a dense sod of rhizomatous grasses, or in soil that has been previously plowed.

Orobanche fasciculata is a non-photosynthetic vascular plant that is parasitic on the roots of other vascular plants. Without its host plant, it cannot produce carbohydrates in sufficient quantity to sustain itself. Species of the genus Artemisia (wormwood) appear to be its preferred host. *Orobanche fasciculata* produces insect-pollinated flowers like autotrophic species, and reproduces exclusively by seeds. The seeds are minute and are shed from dried capsules during the winter. Although all members of the genus *Orobanche* are considered to be annuals (Kuijt 1969), the actual life span of individuals of *O. fasciculata* has not been conclusively determined. However, it does appear that

the species is monocarpic (Reuter 1986), which means that each individual dies after flowering. This may explain, in part, why the number of individuals in established populations is known to fluctuate greatly from year to year (Reuter 1986)."

Habitat 2: Dry prairie: native dry-mesic to dry prairie where mid-height grasses, such as little bluestem (*Schizachyrium scoparium* var. *scoparium*), prairie dropseed (*Sporobolus heterolepis*), and side-oats grama (*Bouteloua curtipendula*) are a major component of the vegetation. This includes prairies on deep sands, on steep bedrock-controlled slopes, and on slopes and hills in unsorted glacial till.

Ottoe skipper (*Hesperia ottoe)*

The following excerpt is from the MN DNR website:

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IILEP65050

"The Ottoe skipper is completely dependent upon the survival of its native prairie and barrens habitat. There is no evidence that reconstructed prairie provides suitable habitat for this species. In addition to protection from destructive activities, prairie requires active management to prevent invasion by trees and eventual succession to woodland, and to suppress non-native invasive species. The principal tool for this purpose is prescribed fire, and this itself poses some threat to the persistence of Ottoe skippers in remnant habitat patches, especially small ones. In most cases, extirpation would not be reversed by recolonization as remnants are too far apart in an inhospitable agricultural landscape. For these reasons, the Ottoe skipper was listed as a threatened species in Minnesota in 1984.

The Ottoe skipper is found in native dry-mesic to dry prairie where mid-height grasses, such as little bluestem (*Schizachyrium scoparium* var. *scoparium*), prairie dropseed (*Sporobolus heterolepis*), and side-oats grama (*Bouteloua curtipendula*) are a major component of the vegetation. This includes prairies on deep sands, on steep bedrock-controlled slopes, and on slopes and hills in unsorted glacial till. Adult skippers will range into low prairie for nectar.

Larvae feed on several grass species in their habitat. Structural properties of the grasses may be more significant than chemical ones; smaller bunch grasses such as little bluestem appear to be more suitable for shelter construction than larger species such as big bluestem (*Andropogon gerardii*) or Indian grass (*Sorghastrum nutans*) or than rhizomatous grasses such as Kentucky bluegrass (*Poa pratensis*) or smooth brome (*Bromus inermis*). Adults are avid seekers of nectar. They visit almost any flowers available, but narrow-leaved purple coneflower is particularly attractive where it occurs (Dana 1991; Swengel and Swengel 1999). Males also visit bare, damp soil for moisture and nutrients."

The primary threat to the Ottoe skipper is habitat destruction, typically from agriculture, aggregate mining, development or wind power. "This skipper is reportedly sensitive to grazing (Lindsey 1942; McCabe 1981; Royer 1988). If not properly managed, long-term grazing can easily degrade prairie and destroy it as skipper habitat. Episodes of heavy grazing may eliminate this skipper even if the prairie is not degraded. Use of herbicides to control weeds or shrubs can eliminate critical nectar sources, and insecticide drift from nearby agricultural fields may kill this skipper. In

some locations in Minnesota the habitat is seriously threatened by shrub and tree invasion. Small, isolated colonies of the Ottoe skipper are at high risk of extirpation resulting from both natural events (such as severe drought or hailstorms) and human caused ones (such as accidental insecticide application), as well as from the vagaries of normal population processes (for example, by chance all adults in one generation are males). Loss of genetic diversity is another possible threat.

Conservation management of prairie remnants inhabited by the Ottoe skipper is an important concern. Immature stages are killed by prairie fire, and small populations are especially at risk of extirpation. Burns when larvae are in buried shelters cause less mortality than burns when larvae or pupae are in surface shelters (Dana 1991). Mortality rate also varies directly with fire intensity (Dana 1991), so factors that influence the latter such as fuel load, fuel moisture content, and ambient temperature, are important to consider in planning burns. Regardless of the timing, prescribed burns will always cause some mortality. Therefore, subdividing a site and burning the units in a rotation that leaves enough larval habitat unburned to assure population survival and recolonization of burned areas between burns is recommended. This may be difficult for small sites. Haying may provide a suitable option in these cases; Swengel (1998) provides evidence that late-summer haying is more favorable for several prairie skippers than rotational burning."

Regal fritillary (*Speyeria idalia)*

The following excerpt is from the MN DNR website:
http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IILEPJ6040

"In Minnesota the regal fritillary is strongly associated with native prairie habitat. Adults are encountered in both upland prairies and in wet prairies, although larval development may be restricted to upland prairie.

The regal fritillary has a single annual generation. Eggs are laid in late summer and hatch after a few weeks. The tiny larvae do not feed after hatching, but hide in the duff and enter dormancy until the following spring, when feeding and growth begin. Larvae complete their growth in June and pupate, with emergence of adults beginning in mid-June and continuing into July. Throughout their adult lives, both sexes feed frequently on floral nectar.

Larvae feed only on violets (*Viola spp.*). In Minnesota, the principal larval host appears to be the prairie bird's-foot violet (*V. palmata* var. *pedatifida*) of upland prairies, but bird's-foot violet (*V. pedata*) is also used in southeastern Minnesota. During the course of its development a larva feeds on several violet plants, consuming only a few leaves of each before moving to a new plant. Violet plants are dispersed in the prairie, and larvae probably have no means of finding plants other than by chance encounter. Thus the density of violets is a critical factor for successful development (Kelly and Debinski 1998).

Adults are rarely encountered away from native prairie remnants, and they appear to have a strong tendency to remain within the boundaries of these (Ries and Debinski 2001). However, adults are frequently observed in remnants too small to produce self-sustaining populations, suggesting that dispersal among remnants is common.

Frequent fire was an integral part of the prairie landscape, and prescribed burning is an important tool in managing the remnants to prevent woody succession and to help control invasive non-natives. However, burns probably cause high mortality in all immature stages of the regal fritillary

(Swengel 1998). Wherever practical, only a fraction of a site should be burned during a butterfly generational cycle, especially in sites that appear to be effectively cut off from immigration. It is unknown whether females will lay eggs in prairie the first growing season after a burn when there is little or no duff; until it is determined that they do, care must be taken to maintain enough unburned habitat through 2 or more successive seasons to maintain an adequate reservoir of butterflies in a site. Haying can be a useful complement to prescribed burning in sites where constraints on burning would make it difficult to achieve management objectives with fire alone. It is not known whether females will lay eggs in a recently mowed prairie. Delaying mowing until most egg laying has occurred would remove this concern, but it creates another, as hay raking could result in significant larval mortality. Haying only part of a site each year is therefore advisable.

How the density of host-plant violets is affected by various prairie-management practices, such as burning, haying, and grazing, is not documented. In more mesic sites, the dense, tall stands of the dominant grasses that result from prescribed burning alone may reduce violet abundance. Light to moderate episodic grazing may stimulate violet reproduction, although heavy, prolonged grazing eliminates the violet. Prairie reconstructions that lack acceptable violets will not support regal fritillary reproduction; research is underway to determine if planting host plants in such reconstructions will create suitable habitat. Adults need plentiful sources of nectar. Intact prairies, with their high plant diversity, typically supply an abundance of good nectar flowers, which is enhanced following dormant-season burns. Grazing and mowing during the butterfly's flight period will reduce flower abundance, perhaps enough to force adults to emigrate from the site. Broadcast application of herbicides to control brush or invasive weeds such as leafy spurge (*Euphorbia esula*), spotted knapweed (*Centaurea maculosa*), and several thistles may also reduce or eliminate both the larval host plants and many of the adult nectar sources."

Habitat Type 3: oak savanna communities: dry prairies and oak woodlands (including dry-mesic oak (maple) woodlands, dry-mesic oak-hickory woodlands, and dry-mesic pine-oak woodlands); or less xeric north-facing slopes in prairie habitats. Soils are most often sandy to gravelly, well-drained soil derived from alluvium or limestone bedrock.

Kittentails (*Besseya bullii)*

The following excerpt is from the MN DNR website:

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PDSCR09030

"*Besseya bullii* is primarily a species of oak savanna communities, though it also occurs in dry prairies and oak woodlands (including dry-mesic oak (maple) woodlands, dry-mesic oak-hickory woodlands, and dry-mesic pine-oak woodlands). Plants show a preference for partial to open light and upper slopes. Some populations exhibit a preference for less xeric north-facing slopes in prairie habitats. Soils are most often sandy to gravelly, well-drained soil derived from alluvium or limestone bedrock.

Wind appears to be a method of seed dispersal, although distance of dispersal is limited. Seeds appear to germinate best within a few months after maturation. Seeds that experienced dormancy had low germination rates, regardless of stratification or hormonal treatments.

Besseya bullii has suffered a significant decline because of habitat loss. Threats to its habitat include gravel mining, limestone quarrying, landfills, residential and industrial development, and succession of oak savannas to forests in the absence of fire. Management techniques should be used to maintain or regain suitable habitat conditions. Active management does not appear to be as necessary at gravel prairie sites due to the xeric conditions and increased erosion. More intensive management may be required at savannas or wooded sites where species vigor is decreased. Management tools may include fire, which may be effective in reducing woody vegetation and encouraging flowering. However, careful timing of prescribed fires is critical. Fire should only be used in early spring before plants appear above ground, usually during late March or early April. Once the plants appear above ground, even 2.5-5.1 cm (1-2 in.), they can be severely damaged by fire. *Besseya bullii* occurs in isolated patches, which makes it conducive to protection from certain types of development, if protection of existing populations is incorporated into the early planning stages of development." Authors note: anecdotal evidence from personal experience suggests that the species thrives even when burned in May. In discussion with colleagues it is suggested that plants may be set back during the burn year, but the following year are more robust, with more seed production.

Loggerhead shrike (*Lanius ludovicianus*)

The following excerpt is from the MN DNR website:

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=ABPBR01030

"The species utilizes open habitat. Since the 1940s, however, some areas have experienced population declines, partly as a result of tree encroachment on grasslands and increasingly intensive row-cropping practices. Loggerhead shrikes live in areas of upland grasslands and sometimes in agricultural areas, where short grass vegetation and perching sites such as hedgerows, shrubs, and small trees are found. They occur in both native and non-native grasslands, including native prairie, pastures, old fields, shelterbelts, farmyards, and cemeteries.

Nests are well hidden in trees or brush and are usually less than 2 m (6.6 ft.) above the ground. Habitat destruction is partly responsible for this species' decline, as loggerhead shrikes require relatively large areas of grassland habitat with scattered shrubs or small trees for nesting. Many of the sites currently used by this species in Minnesota are threatened by rural residential construction. Intensive farming practices often preclude shelterbelts and hedgerows, making the habitat unsuitable for loggerhead shrikes. Additionally, as predators, shrikes are vulnerable to environmental contamination via reduced food supply and ingestion of contaminated prey. In one study, the decrease in loggerhead shrike numbers corresponded to the treatment of grasshoppers with an insecticide (Yosef 1996).

Management efforts should focus on increasing and maintaining suitable grasslands and shelterbelts, brush along fence lines, and scattered trees and shrubs for nest and perch sites. Some loggerhead shrike habitat has become overgrown with trees, particularly red cedar. While red cedar is often an important nest tree for loggerhead shrikes, dry grassland slopes can become so covered by the dense growth of this tree that it becomes unsuitable shrike habitat. Management efforts to control the encroachment of red cedar would benefit this species, as well as many other grassland species."

Blue racer (*Coluber constrictor)*

The following excerpt is from the MN DNR website:

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=ARADB07010

"The North American racer occupies a variety of habitats in the deciduous forest region including forested hillsides, bluff prairies, grasslands, and open woods. Woodland margins and field edges are the preferred summer habitat. During winter months, North American racers hibernate in mammal burrows, caves, rock crevices, gravel banks, stone foundations, and old wells (Ernst and Barbour 1989).

The North American racer emerges from hibernation during late April, remaining near its hibernacula for several days (Oldfield and Moriarty 1994). Breeding usually takes place in May and early June, and 8-21 eggs are laid under rotting logs, stumps, or inside mammal burrows in late June or early July (Fitch 1963; Oldfield and Moriarty 1994). Eggs hatch in 43-65 days, with hatchlings emerging from the nest in late August or early September. The young are about 20-35 cm (8-14 in.) at emergence (Oldfield and Moriarty 1994).

The North American racer is an opportunistic feeder, consuming a wide variety of prey including insects, frogs, toads, lizards, snakes, small rodents, bird eggs, and nestlings. They have large home ranges: home ranges from Kansas have been reported at about 10.5 ha (25.9 ac.) for males, and 9.7 ha (24 ac.) for females (Fitch 1963).

North American racer populations have been drastically reduced in many states due to habitat destruction, pesticide use, and human persecution (Ernst and Barbour 1989). Isolated populations are extremely vulnerable to habitat degradation and loss from intensive agricultural practices and urban sprawl. Young North American racers that feed on invertebrates may be particularly at risk from pesticide use. As members of this species often utilize a large home range, they are also subject to being killed on busy roads. In addition, over-harvest for the pet trade threatens isolated populations."

Relationship to Sites of Biodiversity Significance

Sites of Biodiversity Significance (SBS) are areas with varying levels of native biodiversity that may contain high quality native plant communities, rare plants, rare animals, and/or animal aggregations. A biodiversity significance rank is assigned on the basis of the number of rare species, the quality of the native plant communities, size of the site, and context within the landscape. The Hastings Sand Coulee SNA is part of a north-south corridor of natural habitat that connects to the extensive habitat of the Vermillion River Bottoms. The North Portion of the SNA including the former Murnane property is within the Marshan 11 North SBS ranked Outstanding. The former Maher property (South Portion of SNA) is in the Marshan 11 South SBS ranked Moderate. One mile to the north of this SNA is Hastings SNA which itself occupies parts of a High (Lake Isabelle East) and Moderate (East Part Nininger 35 W) SBS. Adjacent to the south of the North Portion of Hastings Sand Coulee SNA is the extension of the geologic coulee formation. The property is privately owned, but there are several elements of occurrence. There were 37 elements of occurrence within one mile of the SNA, and 8 within the SNA proper (5 in the North Portion and 3 in the South Portion). This SNA is also part of the Mississippi Greenway Plan, which creates a connected network of corridors between Rosemount and Ravenna Townships (**Map 1**).

Following the northerly path of an intermittent stream, the sand coulee occupies a small valley on sandy soils. The basin is primarily sand-gravel prairie, while woodlands have developed on some of the slopes and ravines. The prairie is by far the largest prairie-savanna-oak-woodland remnant (about 185 acres) in the county, and one of very few sand-gravel prairies (totaling about 30 acres). The woodlands were historically oak savanna and dry oak forest. These communities are still somewhat intact, but are degraded in some places with invasive species, especially buckthorn. The open-canopy of the oak savannas is now mostly grown-in with young trees and brush.

The site is considered a SBS, since it meets the criteria requirements for an outstanding biodiversity rank: a concentration S1, S2, or S3 species. At least one species is an S1 or S2; and they occur in a Native Plant Community that was assigned an MCBS condition rank of C or above. The Dry Sand-Gravel Prairie (Southern) was rated S-2 (state imperiled) and ranked BC. The former Murnane property was ranked AB for outstanding. Assignment of these ranks is based on a variety of factors including abundance, distribution, trends, and threats. The UPs13b was also ranked "BC" for "good to fair estimated viability". James' polanisia, a state Endangered plant species rated S1 and G5, was ranked B quality for "good estimated viability" for the existing population. The populations of kittentails, a state Threatened species rated S2 and clustered broomrape (found within one mile south of the SNA), a species of Special Concern rated S3, were not ranked. Sea-beach needle grass (found within one mile south of the SNA), state Special Concern - S3, was given a population rank of BC.

Site Geology and Soils

Geology

The bedrock geology for this site is the Prairie du Chien Group, which was formed during the Lower Ordovician about 500 million years ago (Hobbs, 1990). Prairie du Chien is composed mostly of dolostone, and is highly resistant to erosion. Depth to bedrock varies across the site, being deeper at the bottom of the valley (151-200 feet), and shallower at the ridge tops (51-100 feet). The depth to water table is: 50 to 200 ft. Surficial geology of the site is comprised of two types: 1) mixed outwash from the Des Moines lobe, at the top of the valley and at the ridge tops, and 2) floodplain alluvium from more recent river drainage, at the bottom of the valley. Mixed outwash consists of sand, loamy sand, and gravel; coarser texture near the edge of the lobe. Floodplain alluvium consists of poorly bedded, moderately well sorted sediments deposited by modern streams during flood stage. Some alluvium mapped in small tributaries to the Vermillion River may have accumulated as slackwater sediment related to outwash from the Des Moines lobe.

Sensitivity of the Prairie du Chien to aquifer pollution at the site of the Sand Coulee is rated at "high" (Hobbs, 1990). Estimated travel time for water-borne surface contaminants to reach the aquifer is "weeks to years" (Hobbs, 1990). In general, the thicker the overlying unconsolidated sediment, the better the protection for bedrock aquifers. The type of material is also important, with more permeable materials being less protective than more impermeable materials. The sand and gravel outwash and slopewash/alluvial sediments that overlay the bedrock at the Sand Coulee site are very permeable, and thus do not offer much protection for the aquifer, even though they may be as much as 200 feet thick. Organic deposits may offer some protection, but not enough to change the rating (Hobbs, 1990).

The saturated thickness of the Prairie du Chien aquifer varies from 200 feet at the top of the ridges to less than 150 feet at the bottom of the valley. The general movement of ground water is north, towards the Mississippi River basin. On both the east and west side of the valley are boundaries between water table and confined (artesian) conditions, with the confined condition located in the valley.

Soils

Soils in the Sand Coulee formed as a direct result of glacial deposits and are primarily sandy and gravelly. The dominant soil type is Zumbro loamy fine sand, located along the level areas at the bottom and on the lower slopes (Soil Conservation Service, 1983). Hawick loamy sand, 25 to 50 % slopes, comprise the very steep slopes on the west side of the site, and Hubbard loamy sand, 12 to 18 percent slopes, comprise the steep slopes on the east side of the site. The presence of loam in the Zumbro loamy fine sands and fine sandy loams, located in areas along the bottom, is indicative of floodplain deposits. Waukegan silt loams, 1 to 6 percent slopes, are present at the relatively flat top of the west ridge. Overall, these predominately sandy soils are excessively drained, creating conditions that favor a particular assemblage of plant species adapted to dry, low-nutrient conditions. Soil types are summarized in **Table 3** and illustrated in **Map 2**.

Table 3. Soil Types for the Hastings Sand Coulee, North.

Map Unit Symbol	Map Unit Name	% slope	Family or Higher Taxonomic Class	Parent Material	Acres	Erosion Potential*
411A	Waukegan silt loam	0-1	Fine silty over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls	Glaciofluvial sediments over outwash	52.7	Low
411B	Waukegan silt loam	1-6	Fine silty over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls	Glaciofluvial sediments over outwash	1.7	Medium
1815	Zumbro loamy fine sand		Sandy, mixed, mesic Entic Hapludolls	Outwash	34.2	Low
495	Zumbro fine sandy loam		Sandy, mixed, mesic Entic Hapludolls	Alluvium	25.2	Low
7A	Hubbard loamy sand	0-1	Sandy, mixed, Udorthentic Haploborolls	Outwash	6.7	High
7B	Hubbard loamy sand	1-6	Sandy, mixed, Udorthentic Haploborolls	Outwash	1.2	High
7C	Hubbard loamy sand	6-12	Sandy, mixed, Udorthentic Haploborolls	Outwash	13.8	High
7D	Hubbard loamy sand	12-18	Sandy, mixed, Udorthentic Haploborolls	Outwash	21.2	High
611F	Hawick loamy sand	25-50	Sandy, mixed, mesic Entic Hapludolls	Outwash	28.9	High
299B	Rockton loam	2-6	Fine-loamy, mixed, mesic Typic Argiudolls	Alluvial sediments over bedrock	2.5	Low
1072	Udorthents, moderately shallow		Mixed, mesic Typic Udipsamments	Variable soil material	0.9	NA
Total					**189**	

*Erosion potential is a combination of wind and water erosion, from the Soil Conservation Service.

Waukegan series consists of deep, excessively drained soils on outwash plains and stream terraces. They are moderately permeable in the upper part and rapidly permeable in the lower part.

Zumbro series consists of deep, moderately well drained and well-drained soils on flood plains and drainageways on outwash plains. They are rapidly permeable.

Hubbard series consists of deep, excessively drained soils on outwash plains. They are rapidly permeable.

Hawick series consists of deep, excessively drained soils on stream terraces and outwash plains. They are rapid to very rapidly permeable.

Rockton series consists of moderately deep, well-drained soils on dissected uplands. They are moderately permeable.

Topography

Topography of this site is varied, being very steep on the side slopes (up to 50%) and quite flat at the bottom of the valley and top of the slopes. The elevation ranges from 830 feet above sea level on the upper fields, to 750 feet at the bottom of the coulee. The direction of flow in the basin is from south to north.

The slope and aspect are very important factors in determining what the resultant plant community will be. Slopes with a north component in their aspect are cooler and hold onto more moisture than those with a south component, which are hotter and drier. The combination of aspect, slope, soil type, and fire frequency determine the plant communities at a site.

Erosion

Erosion is a primary concern for the steep, sandy soil on the slopes of the coulee. Evidence of former agricultural runoff as well as ATV and bike trails and walking paths have caused moderate to severe eroded gullies. Many of these areas have revegetated, but any activity in the future should be conducted with awareness and precautions for erosion. When the steep slopes lose their vegetation, especially the root component, for whatever reason, bare soil (sand) can be exposed which has a high potential for erosion. Erosion is generally detrimental, since it causes slope instability.

Some species of plants, however, are adapted to soil disturbance and bare soil areas, especially annual species including James Polanisia and sea beach needlegrass, both rare species. Some amount of erosion is natural and can be beneficial. At this site, most of the erosion has been excessive. If areas on steep slopes "wash out", efforts to re-vegetate them with native plant species could be difficult. Seeding steep slopes is difficult, since seed tends to wash away downhill during large rain events. Also, depending on species recruitment and soil conditions, annual exotic invasive weeds may quickly invade sites where bare soil is exposed, making it hard for native plants to get established.

Hydrology/ watershed

The Level 8 Watershed for Hastings Sand Coulee SNA is the Vermillion River catchment basin. General flow is north to the Vermillion River in Hastings. As stated above, this site is so well drained that it rarely holds water, since most precipitation readily soaks into the permeable sandy-

gravelly soil. Occasionally, during years of high snowfall spring melting will cause sizeable flows through the creek. According to long-time residents, this is a rare event, but when this occurs, the water can be quite high, measuring as much as six feet in depth.

There are several ravines that occur on both the east and west slopes of the site. Some ravines have recently accumulated sediment and debris (both natural and artificial). Although ravines present obstacles for foot-travel, burning, etc., they are natural features of the site and should be protected from accelerated erosion and artificially deposited material should be removed to the greatest extent possible (ravine restored).

There are three artificial ponds or dugouts on the site (Map . One, about one acre in size located in the south portion of the property, is a constructed storm water detention pond for the residential neighborhood to the west. This pond, built around 2000 and maintained by the City of Hastings as part of an easement held by the DNR, could negatively impact the ecosystem within the SNA. It was designed with an outlet on the northeast side to carry overflow into the grassland of the SNA. The pond has apparently never filled to that level, but if the grassland is restored to sand gravel prairie the discharge could introduce contaminants and/or weed species into the area. A secondary concern about the pond is that it appears to be no longer holding water, as it seems to be shrinking over recent years despite higher than normal rainfall. This may be a concern as the site is ranked high sensitivity to pollution of the Prairie du Chein aquifer. Contaminants in the runoff could infiltrate and eventually reach the aquifer. The sandy soils do not provide good filtration. The other two are very small dugouts and may require reconstruction at some point in time to restore the ground level and vegetation.

The basin of the coulee takes drainage from the surrounding watershed from the east, west, and south. To the west lies a relatively narrow fallow field that was formerly Wildlife Management Area. This area probably infiltrates most rainfall, except during very heavy rain events and snowmelt. Agricultural fields to the east drain toward the coulee, and have caused significant ravine erosion in the past. It presently appears that the erosion has stabilized as some edges of these fields have been planted to clover hay (deer feed plot?). Restoration of the fields within the SNA will further buffer the fragile slopes below. South of the SNA lies more sand gravel prairie and woodlands of the coulee, which carries little or no runoff of any consequence. On the bluff tops to the southwest is a residential neighborhood that drains directly into the SNA in large part by way of the storm water pond.

Conditions

The native plant communities, although somewhat degraded, will be protected and restored by conducting ecological management of this site. Likewise, the best method for protection of the rare plant communities (southern dry sand gravel prairie), and all of the rare plant and animal species associated with it, will be to conduct regular, long-term adaptive management practices.

A few highlights regarding existing conditions are:

- Exotic woody species (primarily buckthorn) are abundant on about 80% of the wooded areas.
- Red cedar, sumac and brome dominate on about 40% of the grassland areas.
- Old field (or conifer plantation) exists on 50 acres.

- Newly abandoned cropped field exists on 10 acres.
- Spotted knapweed biocontrol has begun to reduce knapweed on a 2-ac infestation.
- One loggerhead shrike pair has been recorded on the south unit in the last three years.
- Bull snakes were observed on the site multiple times in the last 2 years.
- Fox snake was observed once on the site in the last two months.
- Storm water pond improvements (native plantings) provide habitat for aquatic animals that do not exist elsewhere at the site - invertebrates, amphibians, and birds.
- Former City Property was ranked C by Delaney, 1992
- South of former Murnane property: ranked AB by Thomas Morley, 1992
- Native Plant Community **Dry Sand-Gravel Prairie (southern), UPs13b** (pers. Comm. Hannah Texler).

Existing Vegetation

The following land cover types (**Table 4**), with associated acres, and were determined for the Sand Coulee North. Cover types are based on the Minnesota Land Cover Classification System (MLCCS) though names were altered for brevity and clarification (e.g. brome grassland vs. non-native dominated). Coverage boundaries were also adjusted based on field evaluation and mapped (**Map 5**). Full lists of species found at each cover unit are in **Appendix A**.

Table 4. Existing Cover Types (MLCCS) at the Hastings Sand Coulee SNA, North, 2011.

Code	Cover Class Name	Area (acres)
OW	Oak woodland-brushland	51.8
LGU	Upland brome dominated grassland	36.3
GSH	Grassland – dominated by brome with scattered shrubs	22.9
SGP	Dry Sand-Gravel Prairie	19.2
PC	Planted conifers	14.2
GR	Grassland - brome dominated with native prairie species	13.8
DW	Altered/disturbed woodland	12.7
CROP	Cropland	8.2
OF	Oak forest	3.6
SGT	Short grasses with mixed trees	3.3
DF	Altered/disturbed deciduous forest	0.9
GT	Grassland – dominated by brome with scattered trees	0.9
Pond	Storm water pond	0.7
	TOTAL	188.5

General Description

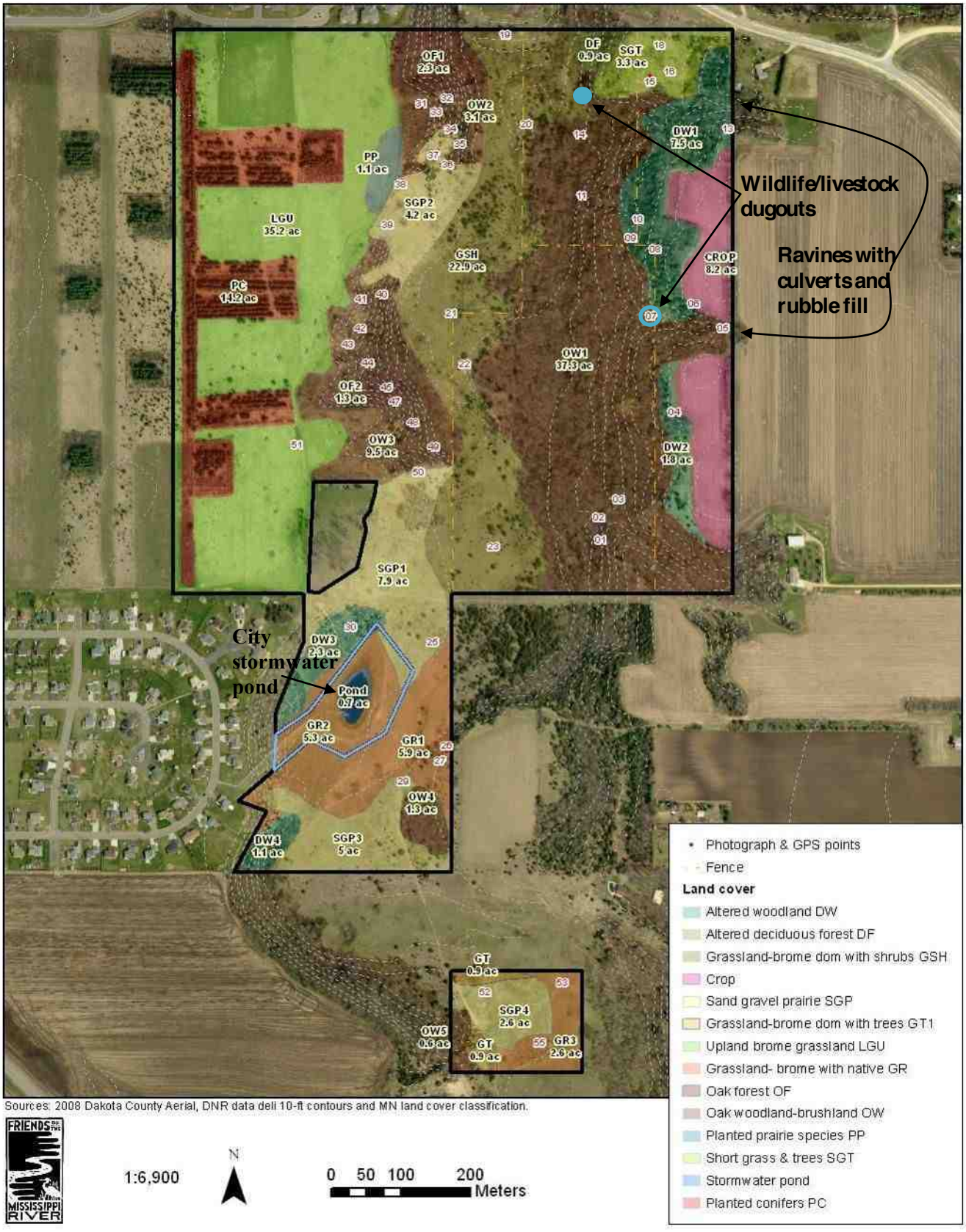
Two primary habitat types exist at the coulee – oak woodland and grassland, including native prairie

remnant and non-native dominated grassland. The oak woodlands have become infested with earth worms and overgrown with woody vegetation, primarily common buckthorn, and Tartarian honeysuckle as well as some eastern red cedar. Buckthorn seedlings are abundant. Buckthorn represents a threat to the native community by crowding native shrubs and groundlayer species, with a resulting loss of species diversity that has already occurred. A corresponding loss of animal diversity has likely also occurred.

The non-native grassland areas, all of which were formerly native prairie, have been altered by grazing and are dominated by smooth brome, smooth sumac, abundant red cedar and some Tartarian honeysuckle, buckthorn and scattered red pine. The smooth sumac, though quite abundant, is short and does not necessarily impede the native species where they occur. The primary threat to the grassland-shrubland community is a mostly continuous layer of sod-forming smooth brome, which competes for space with native forbs and graminoids.

The native grassland remains primarily on the slopes and on the level bottom of the coulee. Its condition ranges from highly disturbed (heavily invaded with brush such as sumac and aspen, infested with spotted knapweed, eroded by human use), through somewhat disturbed along the edges of the bluff top, edges of woody brush invasion, to high quality core areas that have escaped human disturbance and are farther from the invasive trees and brush. This lack of disturbance has also helped withstand invasion of exotic species such as knapweed. The knapweed is thickest south of the storm water pond where excavation activity disturbed or removed the native plant community.

Map 5. Existing Land Cover



The following is a description of the flora of each major land cover types on the site.

Oak Woodland-Brushland (OW).

Acres: 51.8 total. OW-1 = 37.3, OW-2 = 3.1, OW-3 = 9.5, OW-4 = 1.3, OW-5 = 0.6

Current Condition: Oak woodland-brushland; degraded by invasive species.

Description: The oak woodland-brushland was located primarily on the generally west-facing slopes that occur on the east side of the property (of the north unit) and on portions of the generally east-facing to north-east facing slopes that occur on the west side of the property (of the north unit). The slopes are typically approximately 40 degrees. **Canopy tree cover** varied from 25-80% but was generally greater than 50%. Some areas towards the bottoms of the slopes, where the topography was flatter, had sparser tree cover, and there was a transition from the oak woodland to the shrubland unit at the valley bottom. Some of the largest trees in the unit were towards the bottom of the slopes, the largest tree found being a double-stem bur oak that was 24" in diameter. Overall relatively large bur oak (5-20m tall, 10-24" diameter) was the dominant canopy species with small patches of aspen (8-12" diameter), scattered pin oak, eastern red cedar (8-12"), basswood (10-15" diameter) and hackberry (8-12"). Basswood becomes more abundant higher up on the slopes. **Sub-canopy layer** co-dominants were bur oak, quaking aspen, eastern red cedar, and pin oak. Buckthorn, American elm, and hackberry were common, and black cherry and June berry were present. The **shrub layer** was dominated by buckthorn, with Tartarian honeysuckle also abundant in some areas. Chokecherry, raspberry, and gooseberry were common, but native shrubs were generally quite sparse and hazelnut was quite rare. The **ground layer** was not very diverse, and buckthorn seedlings were abundant to dominant. Native species included woodland species in closed canopy areas, such as fragrant bedstraw, Sprengel's sedge, wood anemone, cleavers, sessile leaf bellwort, black snakeroot, as well as more savanna-type species in openings: common yarrow, smooth blue aster, and bergamot. Oddly, there was also a small area at the base of the slope in OW1 where Dutchman's breeches were common. That species occurs on more mesic soils, indicating there is likely some seepage going on. The leaf litter was generally sparse in the OW units, and bare areas covered approximately 20% of the ground area.

In **OW-1**, there were many very old stumps from trees that had been cut. Perhaps this unit was previously logged or selectively logged. In the shrub layer at the bottom of the slope, on the lower edge of this unit, prickly ash was abundant. Going up the slope from the bottom, as the slope levels out and gets flatter, prickly ash diminishes in abundance and buckthorn increases. In the mid to upper slopes, buckthorn becomes dominant and very abundant, especially in areas of very little tree canopy. In this unit a patch (6' x 4') of garlic mustard occurred at the base of the slope, near the large double stem bur oak (Map 5 pt 11), but other than that, garlic mustard was not found. In one single location in the relative center of unit OW-1, on mid-slope, there were a few medium-sized sugar maple (12 inch diameter), but this was an anomaly, since sugar maple were not found anywhere else on the site, and they were not very old, so they were recent inhabitants of the woodland (it does, however, further underscore the long length of time of fire suppression at this site).

In **OW-2**, the canopy trees were somewhat shorter than in OW-1. Bur oak was dominant, but red oak was sub-dominant. Red cedar was dominant in the subcanopy. Buckthorn was abundant, large, and somewhat scattered. There were few small buckthorn or buckthorn seedlings in the ground layer. The ground layer was quite sparse, with moderately thick leaf litter for a dry woods slope.

In **OW-3**, 15-20" diameter bur oak was dominant, and pin oak and red cedar was common, with occasional hackberry. Buckthorn and exotic honeysuckle was moderate to high density, but most was less than 4 feet tall, since this unit was treated in 2009. Regeneration of trees was not prolific, and

mostly comprised of pin oak seedlings, with very few bur oak seedlings. A patch of dead and fallen trees occurred in this unit, probably caused from oak wilt; here the buckthorn was very dense. In addition, an area of old erosion with bare soil occurred here. A small population of Kittentails was also found in a small group mid way up the slope under an 80% oak-green ash canopy (Map 5, pt 47), but a large tree had been cut right next to them, creating a small gap. The ground cover was sparse, with associates including *Arabis sp.,* cleavers, buckthorn, Virginia creeper, lady fern, Tartarian honeysuckle and white snakeroot. The exotic forb soapwort was also found to be quite dense in scattered spots on the lower, flatter portions of this unit.

Figure 1. Dense buckthorn understory with scattered bur canopy.

Target Community: Southern Dry-Mesic Oak (Maple) Forest/Woodland FDs37

The target plant community for all of these units is Southern Dry-Mesic Oak (Maple) Woodland (FDs37). Unit OW2 and parts of OW3 was historically (1937) open prairie. The woodlands have now progressed to a point where a return to prairie would be too destructive, but portions of both units along the edges could be opened more as part of a transition zone. According to the DNR Plant Community Guide (DNR 2006), southern dry oak woodland occurs on undulating sand flats, hummocky moraines, and river bluffs on find sand or sand-gravel soils and often on west or south-facing slopes. Historically, fires were common in this community, and many stands are on sites occupied by brush lands 100 years ago.

Fds37 is a fire-dependent community with a somewhat open canopy cover (50-100%) dominated by bur oak, northern pin oak, northern red oak, white oak, or a combination of these species. Common or occasional canopy species include black cherry, quaking aspen, red maple, paper birch, and green ash. The subcanopy is patchy to interrupted (25-75%) with black cherry, red maple, and bur oak common. The shrub layer is patchy to continuous, typically with American hazelnut, chokecherry, black cherry, prickly ash and gray dogwood. The ground layer is patchy to continuous (25-100%), composed mainly of widespread forest or woodland herbs, including pointed-leaved tick trefoil, Clayton's sweet cicely, hog peanut, Canada mayflower, pale bellwort and wild geranium. Pennsylvania sedge is the most common graminoid.

Upland Brome Grassland (LGU)

Acres: 36.3 total.

Current Condition: Smooth brome grass on upland soils; plowed/cropped, possibly pastured.

Description: The Long grasses on upland soils cover type was located exclusively on the flat, broad ridge-top on the western side of the property, west of the western slope of the Coulee. This cover type was a former agricultural field. Interspersed amongst the Long Grasses cover type are four large rectangular-shaped conifer plantations (see cover type "Planted Conifers"). The **ground layer** was dominated by smooth brome (75-85%), with Canada goldenrod very abundant. Some scattered individual big bluestem plants occurred throughout the cover type. The **shrub layer** was sparse (less than 5%) and consisted primarily of scattered green ash and amur maple, and rarely of sumac, honeysuckle, and red cedar. The canopy/subcanopy layer consisted of scattered individual small trees (3-5m tall, 3-5 inch diameter) primarily green ash and boxelder, with some red pine, with an overall cover of 1-10%. There were several brush piles scattered about the field.

Figure 2. Looking from brome field towards planted spruce.

Target Community: Mesic Prairie (UPs23)

> "Grass-dominated but forb-rich herbaceous communities on somewhat poorly drained to well-drained loam soils mainly formed in unsorted glacial till, sometimes in a thin loess layer over till, and locally in lacustrine sediments and outwash deposits. Communities in this class occur primarily on level to gently rolling sites. Drought stress is irregular in occurrence and usually not severe. Graminoid cover is continuous, with tallgrasses dominant, but several mid-height grasses are also present. Species composition is fairly uniform, although relative abundances shift across the moisture gradient within the community. Forb cover is sparse to patchy, and composition also responds to moisture. A number of species are common across the moisture gradient with others being unique to either end of the gradient. Shrub layer is sparse with low semi-shrubs (e.g., lead plant) generally common. Trees are absent except where fire suppression has allowed invasion by woody species." (Excerpt from Aaseng, et. al., 2005).

Grassland – Dominated by Brome, with scattered Shrubs (GSH)

Acres: 22.9 total. GSH = 22.9

Current Condition: degraded

Description: This unit was located on the flat valley bottom in the middle of the property on Zumbro fine sandy loam, alluvial soils. It is a long, relatively narrow unit that lies roughly north and south in the property. This cover type is dominated by shrubs and grasses/forbs, but with some scattered trees present. The **shrub layer** total cover was 15-50%, and was dominated by relatively short smooth sumac (0.5-1m tall). For the most part, the sumac was spaced enough apart so that other plants could coexist in the same area; that is, the sumac did not choke out or exclude other species from the growing space, as can happen in a more mesic site. Interestingly, many of the sumac plants were browsed at their tips (presumably by deer), which tended to act as a natural pruning mechanism, thus keeping the sumac plants shorter than usual. Also common, but scattered and in patches (especially beneath trees), was buckthorn and Tartarian honeysuckle (0.5-1m tall). Other occasional small shrubs were prairie rose and leadplant. The dominant flora of the **ground layer** was grass, of which the dominant species was the exotic smooth brome, which had formed a relatively continuous-to-patchy sod layer over approximately 50% of the ground. No native grasses were noted, however may have been undetected in the spring survey. The remainder of the ground layer primarily consisted of forbs, of which the most abundant species was the exotic soapwort with a coverage of approximately 25%. The rest of the forbs present were all natives, and included: wormwood, wild bergamot, round-headed bush clover, common strawberry, grey-headed coneflower, smooth aster, pussy toes, prairie violet, and dotted blazing star. The **tree layer** was sparse, with scattered trees covering only about 1-10% of the unit. Canopy tree species present were Siberian elm, Scotch pine (heights ranging from 5-20m, and diameters from 5-10 inches). Only two sub-canopy tree species were present: red cedar (height ranging from 3-6m, with diameters of 2-5 inches) and rarely present was crap apple (height ranging from 3-6m, with diameters of 4-6 inches)

Figure 3. GSH looking NW: brome-dominated grassland with scattered shrubs (red cedar and sumac are obvious in this photo).

Target Community: The grassland areas on sandy loam soils are more mesic than the adjacent sand gravel prairies. Located in the basin of the coulee, these grasslands would have received alluvium from historic water flow and flooding. For that reason, the target plant community would be mesic prairie (UPs23), although probably at the drier end of the gradient. Dominant species would be big bluestem, Indian grass with little bluestem, porcupine grass and side oats grama also important. These areas would essentially have the same species as the adjacent native sand gravel prairie, but in different proportions.

Dry Sand Gravel Prairie (Southern)

Acres: 19.2 total. SGP-1 = 7.4, SGP-2 = 4.2, SGP-3 = 5.0, SGP-4 = 2.6

Current Condition: Sand Gravel Prairie-southern, "BC" for "good to fair estimated viability"

Description: The sand-gravel prairie cover type was broken into four units, punctuated by oak-woodland and grassland units. One of these units was located in the small, disjunct south parcel. The sand-gravel prairies were found on the generally southeast-facing, very steep slopes on the west side of the property, and at the flat bottom of the Coulee valley. These units were underlain by Zumbro loamy fine sand. Generally, somewhat sparse individual to patchy graminoids and forbs dominated the sand-gravel prairies, with bare soil between plants. There were few trees and shrubs (other than low prairie shrubs), although some spots had incursions of red cedar, pin oak, quaking aspen, and smooth sumac. A fire had recently occurred (2010) at the SGP-2 unit, with many aspen being charred. Unit SGP-3, located in the far south end of the main parcel, had been invaded by smooth sumac at the south and west of this unit. In SGP-3, no bare soil was showing; there was a nearly continuous layer of herbaceous cover. The **ground layer** of the sand-gravel prairies was highly diverse and forb-rich. Poison ivy was very abundant, indicative of past grazing. The following is a subset of the native species found in this cover type: hairy pucoon, narrow-leaved pucoon, western spiderwort, muhly sedge, silky prairie clover, Scribner's panic grass, blue-eyed grass, giant foxtail, Carolina anemone, alum root, violet wood sorrel, sky-blue aster, prairie dropseed, prairie rose, switch grass, and June grass. For a complete species list see **Appendix A**. The **shrub layer** was quite diverse, but in areas of woody incursion was dominated by smooth sumac. Some of the other species found in the shrub layer included: leadplant, grey dogwood, red cedar, Tartarian honeysuckle, buckthorn, bur oak, prairie rose, wolfberry, and prickly ash (see appendix A for a complete list). The **canopy and subcanopy layer** was primarily absent, except for some areas of wood incursion from adjacent oak-woodland units, of which red cedar, and pin oak were common; a quaking aspen stand in the center of SGP-2 had trees of 5-7 inch diameter, but the stand did not appear to be spreading, since fire had recently been run through the stand. A few scattered, individual green ash were found throughout the cover type, also. One spot in SGP-2, located in the northern part of the unit and surrounded by the oak-woodland unit to the north, west, and east, showed some human disturbance in the form of a "dig-out", and nearby occurred some very tall red cedar (12-14m high).

Figure 4. SGP4: diverse dry sand-gravel prairie with abundant New Jersey tea.

Target Community: Dry Sand-Gravel Prairie (southern) UPs13b

Sand gravel prairie is open grassland with interrupted or nearly continuous cover of prairie grasses, scattered forbs, and small areas of exposed ground (Wovcha, Delaney, Nordquist 1995). Vegetation is sparser and shorter than the mesic prairie, with little bluestem, side oats grama, porcupine grass and the sedge *Carex foena* often dominant. Sand reed grass, sand dropseed, western ragwort, and large-flowered penstemon are typical plants found on a sand-gravel prairie that are not common on a bedrock bluff prairie. Sand-gravel prairie occurs on well-drained sandy loams, typically formed on gentle slopes of glacial outwash and stream deposits.

Planted Conifers

Acres: **14.2 total.** PC

Current Condition: Conifer plantation on upland soils; plowed and planted.

Description: This cover type was found on flat, generally level terrain, located on the far western side of the main parcel on Waukegan silt loam, glaciofluvial sediments and outwash. The structure of this cover type consisted of four large rectangle-shaped (roughly 200 m long and 50 m wide) plantations, connected on their west sides along the west property boundary. The plantation consisted of rows of planted white spruce (*Picea glauca).* Interspersed between the rectangles was the LGU (upland brome grassland) cover type. The planted spruce trees were approximately 10-13 m tall and were 8-12 inches in diameter, with 90-100 percent cover. The understory was sparse to absent, and consisted of a few scattered shrubs and trees (Tartarian honeysuckle, buckthorn, green ash, amur maple) forbs (Canada goldenrod, stinging nettle, common plantain), and non-native grasses (smooth brome and Kentucky bluegrass) straining for light in scattered canopy gaps.

Target Community: Mesic prairie, UPs23

Grassland – Brome with Native Prairie Species

Acres: 13.8 total. GR-1 = 5.9, GR-2 = 5.3, and GR-3 = 2.6

Current Condition: Grassland, degraded

Description: Most of this cover type was located in the southern extension of the main unit of the property, surrounding and southwest of the sedimentation pond, with a third unit located in the small southern disjunct parcel. The topography of this cover type was mostly flat, except for some slight slopes along the coulee ravine. The vegetation of unit GR1 was dominated by grasses, with a very few scattered trees and shrubs, except for the east side which contained an incursion of red cedar-dominated forest (which extended eastward, off the property). The west side of the unit was more degraded than the east side, with non-native species being a large component of the vegetation there. There were many gopher mounds at the edge of the red cedar incursion on the shoulder and top of the slope. The south part of the unit grades into the high quality Sand-Gravel Prairie, with the main difference being the presence or absence of bluegrass and smooth brome. Unit GR2 and parts of GR1 were infested with spotted knapweed. Native species were still present, and biocontrol agents were beginning to reduce the stand. In addition, cow vetch was becoming abundant, especially in GR1 near the gated entry.

The **ground layer** was patchy to interrupted to continuous with varying degrees of diversity; some areas were highly diverse and other areas were not very diverse because of abundant Kentucky bluegrass and some smooth brome. Species present in the ground layer were the following: Kentucky bluegrass, smooth brome, big blue stem, rock cress sp., grey-headed coneflower, smooth sumac, little

bluestem, switch grass, stipa, scouring rushes, prairie phlox, blue-eyed grass, prairie coreopsis, smooth aster, prairie violet, and Scribner's panic grass.

A very large patch of kittentails (over 85 individuals) was found on the slope at the southwest portion of the unit, about mid-way up the slope (**Map 5**, pt 26). Associates with the kittentails were the following: rock cress sp., prairie smoke, big blue stem, sky-blue aster, prairie buttercup, bastard toadflax, and prairie coreopsis.

The **shrub layer** was scattered to patchy and dominated by scattered Tartarian honeysuckle, *Rubus* complex, prairie rose, pin oak, and an unknown shrub (looks similar to wolfberry). The **canopy layer** was scattered to patchy, with the greatest density on the southwest slope. The following species were found in this unit: Eastern red cedar (sparse and scattered throughout most of the unit, but common to abundant on the southwest slope—5-15m tall, 5-10 inch diameter, cover 10-50%), bur oak (found rarely on most of the unit, but common and scattered patchy on the southwest slope—5-10m tall, 8-12 inch diameter, cover 10-40%); present but scattered were green ash (5-10m tall, 8-12 inch diameter, cover 5-15%); and present to rare were pin oak (5-10m tall, 8-12 inch diameter, cover 3-5%).

Figure 5. GR2, south of the pond.

Target Community: The target community for GR2 and GR3 is dry Sand Gravel prairie, (UPs13b). Due to the more mesic sandy loam soils of the coulee ravine, unit GR1 would be Southern Mesic Prairie UPs23.

Altered/Disturbed Woodland

Acres: 12.7 total. Units DW-1 = 7.5 and DW-2 = 1.8, DW-3 = 2.3, DW-4 = 1.1

Current Condition: Disturbed woodland, degraded

Description: This cover type was located in basically two general locations: 1) the east side of the main parcel, between the OW-1 and the Cropland unit (CR) and 2) the southwest portion of the main parcel, west and southwest of the pond. This cover type has been altered by the disturbance of the nearby cropland (DW-1 and DW-2) and the nearby housing development (DW-3 and DW-4). Basically, this cover type was overgrown oak woodland or overgrown prairie/savanna that is succeeding to a forested cover type because of a century-and-one-half of fire suppression. DW-1 and DW-2 have medium to large red cedar (4-12 inch diameter) that was dominant in the **canopy layer**, with quaking aspen (2-4 inch diameter) also present. Canopy tree cover was sparse at about 5-10

percent. Canopy layer for DW-3 and DW-4 was sparse, with no large, mature trees. Trees were medium size to small (4 to 10 inches in diameter, 10 to 30 feet tall) and occurred singly or in small groups. Canopy tree species composition for DW-3 and DW-4 consisted of green ash, American elm, bur oak, pin oak, quaking aspen, boxelder, Siberian elm, and eastern red cedar. The total cover of the canopy layer varied from 25-80 percent, with some areas being quite open and others being densely shaded. The **shrub layer** was quite dense throughout, with buckthorn dominant, but also present were Tartarian honeysuckle and patches of smooth sumac, Tartarian honeysuckle, *Rubus spp.*, common buckthorn, pin cherry, American hazel, and American plum. The ground layer was sparse in the denser woods, and thicker and more diverse in the openings. The openings contained the following species: little bluestem, plantain-leaved pussytoes, strawberry, common yarrow, buttercup spp., Kentucky bluegrass, wood anemone, dandelion, smooth blue aster, and a Potentilla species. In the closed, shady areas the ground layer contained the following: sparse leaf litter and dense moss and scattered woodland species similar to those found in the oak-woodland cover type. There were scattered dense patches of Pennsylvania sedge and white rice grass were found in the openings. Coyote scat was observed also

Figure 6. DW1: mixed canopy with dense buckthorn understory.

Target Community: Southern Dry Savanna UPs14

All of the woodland areas were historically (1937) open prairie habitat. Relicts of that state are seen in the occasional prairie plants found in small openings. Restoration to prairie at this point would be too costly and drastic of a change so the suggested plant community for these areas is Southern dry savanna UPs14 at the tops of the slopes, grading into southern dry oak woodland further down the slope. UPs14 is described as follows:

> "Sparsely treed communities with grass-dominated herbaceous ground layers on nearly level to steeply sloping sites with droughty soils. Moderate growing-season moisture deficits occur during most years, and severe moisture deficits are frequent, especially during periodic regional droughts. Trees are open grown, typically small and gnarled. Graminoid cover is patchy to continuous (25-100%) with midheight grasses being most important, although tallgrass species are often important as well, especially where conditions tend toward mesic. Species composition varies with variation in soils and topography and is similar to that of UPs13. Forb cover is sparse to patchy (0-50%). Climbing plants and vines are a minor component. Shrub layer is typically patchy (25-50% cover) and composed of low semi-shrubs and some taller shrubs. Trees occur as scattered individuals or as scattered small clumps.

Trees are usually less than 10m tall and frequently less than 5m with open-grown form, with bur oak most common, but northern pin oak also usually present." (Excerpt from Aaseng, et. al., 2005).

Cropland

Acres: 8.2 total. Unit CROP

Current Condition: Cropland

Description: This cover type was found on flat, generally level terrain, located on the far eastern side of the main parcel, at the top of the slope. Red clover was dominant.

Figure 7. Edge of crop field and DW (in background), to north.

Target Community: Dry Sand-Gravel Prairie, southern UPs13b

Oak Forest

Acres: 3.6 total. OF-1 = 2.3, OF-2 = 3.3

Current Condition: Oak Forest, degraded

Description: The oak forest units were located primarily on the generally north- and northeast-facing slopes on the west side of the Sand Coulee.

OF-1

Canopy cover was 50-75%, with abundant, widely scattered bur oak (6-18 inch diameter), basswood (8 inch diameter) common, and with hackberry, American elm, and pin oak also present. Subcanopy was dominated by basswood, hackberry, and bur oak, with occasional Scotts pines and pin oak present at the flat top of the slope. The shrub layer was dominated by buckthorn, chokecherry was abundant, and American hazelnut was rare. Buckthorn had been cut and treated in 2009 in this unit, with most of the larger individuals having been cut and stacked or scattered throughout the unit, except in the center of the unit, where it was still very dense and dominated the shrub layer. The forb layer was very diverse, in spite of the buckthorn (except in the center where buckthorn was still very dense and had not been treated). Dutchman's breeches and Sprengel's sedge were particularly abundant. Other forbs included star sedge, black snakeroot, Clayton's sweet cicely, false Solomon's

seal, sweet-scented bedstraw, white snakeroot, and false lily of the valley. Bur oak seedlings were present. Small incursions of prairie cropped up throughout this unit. An example of a prairie incursion had the following species: woodland sunflower, pussytoes, blue-eyed grass, and prairie sunflower. Near one of the prairie incursions a patch of approximately 20-30 dead pin oaks, most likely caused by oak wilt, was found. Many Dutchman's breeches plants were still growing in the open ground layer of what used to be a fairly closed canopy understory, prior to the oak wilt gap.

OF-2

This oak forest unit is located on the slopes of a ravine in the center of the OW-3 unit on the west side of the Sand Coulee. With north and northeast facing slopes, the vegetation is different from that of the surrounding oak woodland. Here, the ground layer is dominated by Sprengel's sedge and Dutchman's breeches, as it was in OF-1.

Figure 8. OF1: northeast-facing slope with mixed canopy and rich native ground layer.

Target Community: Southern Dry-Mesic Oak Forest

> "Dry-mesic hardwood forests occurring most often on thin, wind-deposited silt on crests and upper slopes of bedrock bluffs and less often on hummocky stagnation moraines in calcareous, partially sorted drift. Ground layer is patchy to continuous (25-100%). Shrub layer is patchy to interrupted (25-75%). Subcanopy cover is patchy to interrupted (25-75%). Canopy cover is interrupted to continuous (50-100%) with the most common species being northern red oak, white oak, and basswood. "(Excerpt from Aaseng, et. al., 2005).

NOTE: Because of the abundant Dutchman's breeches and Sprengel's sedge, and due to the absence of maples, this community really does not fit neatly into any of the listed native plant communities.

Short Grasses and Mixed Trees

Acres: 3.3 total. SGT

Current Condition: Short non-native grasses and mixed trees, degraded

Description: This unit was also located in the far northeast corner of the main parcel (**Map 5**) This is the location of the former home site, and thus was strongly impacted by human disturbance. This area had an open canopy, with a few scattered, large bur oak (20 inches diameter), and otherwise dominated by small to medium (4-12 inch diameter) boxelder and some scattered American elm. The

subcanopy and shrub layers had a cover of 15-30 percent with abundant red cedar and scattered Tartarian honeysuckle and American elm. The ground layer had 50-75 percent cover and was dominated by smooth brome. Several large patches of daylilies occurred also. A power line and driveway with a gate still exist in the area. Compacted soil could be a concern from the driveway.

Figure 9. Former house site: Kentucky bluegrass dominant in ground layer with scattered green ash and red cedar.

Target Community: Southern Dry Savanna UPs14

Altered/Disturbed Deciduous Forest

Acres: 0.9 total. DF

Current Condition: Disturbed deciduous forest, degraded

Description: This unit was located at the northeast corner of the main parcel, just west of the SGT unit, on a moderate slope that is west facing. It is nearby the former home site, and thus the native plant community has been significantly altered. The **canopy layer** is dominated by a few large (10-20 inch diameter) bur oaks that have markedly open-grown forms with larger, horizontal lower limbs. Subdominant canopy trees present are hackberry (4-14 inch diameter), and medium sized quaking aspen. The **subcanopy** contains scattered elm and red cedar. The **shrub layer** is dense and consists of a relatively even mix of Tartarian honeysuckle, buckthorn, and red cedar, with a combined coverage of about 65%. The **ground layer** has a very thin leaf litter layer, with much bare ground showing. Buckthorn seedlings are dominant in the ground layer, with chokecherry, *Ribes spp.*, false Solomon's seal, Tartarian honeysuckle, white avens, sessile-leaved bellwort, *Viola sororia*, and *Galeum spp.* also being present, but sparse.

Target Community: This unit was historically probably part of the same woodland that covers the slope to the south. The target community is therefore Southern Dry-Mesic Oak (Maple) Woodland FDs37.

Grassland – Dominated by Brome with Scattered Trees

Acres: 0.7 total. GT

Current Condition: Brome grassland with trees, degraded

Description: This unit was located at the northern and southwest parts of the smaller, disjunct parcel to the south of the main parcel (former Murnane property). It is dominated by non-native grasses (smooth brome and Kentucky bluegrass) and contains scattered trees (green ash, red oak, bur oak, boxelder, Scotts pine) and scattered pockets of shrubs (Tartarian honeysuckle, common buckthorn, and American plum). Most of the trees are medium to small sized, but a few are large.

Target Community: Dry Sand-Gravel Prairie, southern UPs13b

Existing Land Use

The current land use of this site is passive recreation, education and research. Presently there exists one former trail located in the bottom of the coulee, running roughly in a north-south direction. There are several other smaller former trails dispersed throughout the site also. There are a few former trails on the steep west slope of the site that have exposed bare soil, are entrenched, and are actively eroding. It appears that illicit ATV and dirt bike activity has caused or at least has contributed to the degradation of these former trails on these steep slopes. Located roughly in the center of the site is a round-shaped area of bare soil ("blow out" area), that also appears to have been caused by ATV activity, but its origin was from a gravel quarry, which has since been kept open and "actively" shifting due to ATV activity.

There are a few ravines located on the site, of which some portions were moderately to severely degraded. The degraded areas were often littered with chunks of concrete, and rubble (possibly a misguided attempt to control eroding slopes). These areas appeared to be actively eroding, with bare soil on the steeper banks having slumped and sloughed away, falling to the bottom of the ravine or dry creek bed. This was especially pronounced on the larger ravines; the smaller ones seemed to be somewhat more stable.

Educational uses exist currently also. Hastings High School field biology class has used the site for education and has also been involved in restoration of a degraded area surrounding the storm water pond.

Existing Animal Impacts

The following animal impacts were present:

- Deer browse
    - Smooth sumac in the shrubland-grassland was browsed ubiquitously, but is not a concern, since this impact is actually not detrimental. Smooth sumac should be controlled in the open areas anyway.
- Deer paths
    - Many deer paths were present, but no erosion problems were detected that could be associated with the paths.
- Castings from earthworms infestation
    - Castings were present. Sheet erosion could be a concern on the steeper slopes

The synergy of the interactions of deer, earthworms and buckthorn creates a larger problem for native plant regeneration than either of these on their own. Earthworms, not native to Minnesota, greatly reduce the duff layer of forests, increase soil compaction, change soil pH and nutrient availability, all of which impairs germination of many species of woodland and forest forbs and allows buckthorn to germinate more readily. Intense browsing of certain favored plant species compounds the problem, resulting in reduced overall diversity of the ground and shrub layers, reduced oak regeneration, and

increased invasions of buckthorn and other exotic plant species. Although the diversity of the ground layer of the oak woodland vegetation unit is still relatively high, deleterious impacts resulting from deer/earthworms/buckthorn interactions are very likely to reduce diversity in the near future.

Erosion

ATV and bike use

Off road vehicle or all terrain vehicle (ATV) use has been somewhat reduced of late, but was formerly very common throughout much of this SNA site, and has lead to the formation of several illicit trails and eroded gullies on the site. There are at least six to eight trails on the steep west slope that have contributed to some rather significant erosion of the hillsides at these trails, due to the steepness of the slope and the sandy texture of the soil. Some of these trails have sort of "healed" over the last couple of years of disuse, but many of them are still very deeply rutted and actively eroding, with exposed bare soil. Repair of these eroding trails will take active management, such as the use of water bars, brush bundles, etc..

Sand Quarry

Located in the center of the SNA at the valley bottom, between OW3 and OW1, but closer to OW1 (**Map 5**, pt 22) is a relatively round formation of open bare soil, that was a former sand and gravel quarry. This site has been used, it appears, quite heavily by ATV's and has been kept open. This site was unique enough to stand out from the rest of the landscape (it can be readily seen on aerial photographs). Decisions on what to do with this area will need to be made.

Factors

Public Support.

There appears to be good general public support for the Hastings Sand Coulee SNA. While it is difficult to accurately gauge public sentiment, the popularity of the interpretive tours and volunteer events point to a supportive citizenry for the conservation efforts associated with this site. Some adjacent neighbors, in the housing to the west, know the site well and have participated in FMR activities.

The City of Hastings has been supportive of FMR's restoration efforts in the Sand Coulee, allowing the organization to conduct these activities on their property and contributing in-kind resources to this effort. Furthermore, when the city recently went through a public process to declare their portion of the Sand Coulee as excess and to sell it to the DNR, no residents appeared to oppose these efforts. The city has sold 25 acres that they owned in the Sand Coulee to the DNR. A number of restoration volunteers live in Hastings. The City still maintains an easement on the pond and the access road.

Likewise, Dakota County has also been very supportive of the conservation efforts in the Sand Coulee. The County Board of Commissioners authorized the establishment of the Hastings Sand Coulee SNA and has contributed significant funds toward the acquisition of land that has been incorporated into the SNA.

Positive Human Activity. Since 2003, Friends of the Mississippi River (FMR) has been reaching out to and assisting residents in the Sand Coulee in protecting and managing the rare natural community found there. FMR has developed several stewardship plans for these landowners and over the last 8 years has assisted them in conducting prescribed burns, woody plant removal & exotic invasive plant

control on their properties. These activities have enhanced the prairie adjoining the SNA and have increased the landowners' awareness and knowledge of this natural community.

The Field Biology class at the Hastings Senior High School, taught by Joe Beattie, has utilized the former City of Hastings property as a learning site and, in conjunction with FMR, has conducted restoration activities around a storm water management pond that the city developed to serve the Tuttle neighborhood. The students have collected prairie seed on site, had it germinated and grown into plugs, and then planted back to the site.

FMR has organized numerous community volunteer and tour events at this site. Volunteers assisted in collecting seed and removing exotic invasive plants. The interpretive tours provided participants with information on the natural history of the natural community and specific plants and animals found at this site.

These public involvement and awareness activities have benefited the SNA and this rare landscape feature by increasing positive human use of the site (bird watching, hiking, restoration), which seems to have reduced the negative activities that have taken place in the Coulee over the years.

Negative Human Activity.

There are several human activities that have negatively impacted the prairie within the Sand Coulee. Human activity in the general area has introduced exotic invasive species to the site. This issue is more thoroughly addressed in the management recommendation section of this document.

Ponding Basin. When the Tuttle neighborhood was developed, the developer and/or the City of Hastings built a storm water management pond to address runoff from the impervious portions of this subdivision. Several acres of native prairie were removed during the pond building process. Soil surrounding the pond was excavated and moved to develop a berm around the catchment basin. This disturbance not only removed the native components of the community but it also served to provide an entry point for exotic invasive plants to take hold.

The pond was developed with an outlet, should the water level exceed its planned capacity. This outlet is located at the northeast corner of the ponding basin. There is no evidence that water has ever flowed from the basin through the outlet. However, the potential does exist for this to happen at some time in the future. Depending on the volume and rate of the water leaving the basin via the outlet, such an event could cause erosion problems on the SNA, downstream from the pond. Furthermore, it should be understood that the storm sewer which channels water into the pond will also continue to serve as a potential source of invasive species from the adjoining Tuttle neighborhood.

Off-Road Vehicles. For many years, the Sand Coulee has been used as a place to ride off-road vehicles. These include motorcycles, dirt bikes, and four-wheeled all terrain vehicles (ATV's). This vehicle use has caused considerable erosion damage to the hillsides and resulted in several trails at this site. Some of the eroded hillside trails are 4 feet or more in depth. Off-road vehicle at the site has diminished over the last couple of years but has not stopped completely.

Adjoining Landowners.

The portion of the Hastings Sand Coulee SNA that is being addressed in this plan adjoins two neighborhoods in the city of Hastings and is essentially surrounded by residential land uses. As such the SNA is highly visible and accessible to neighboring residents. This visibility and accessibility

provide both positive benefits and negative consequences for the SNA.

Neighboring landowners serve as "watchdogs" for the site, reducing unlawful and damaging activates, such as ATV use. On the other hand, some of the adjoining landowners utilize herbicide on their lawns, which could drift onto the SNA, affecting native plants. In addition, there is some evidence that adjoining landowners have and continue to deposit lawn clippings and other vegetation "over the hill" into the Sand Coulee.

Some of the landowners on the western rim of the Coulee have and may continue to cut woody vegetation on the former city property to protect & improve their view of the landscape. It is not known if these shrubs/trees are native or exotic or a combination so it is difficult to make judgments about any negative or positive impacts. However, there is some evidence that this vegetation has been cut in such volume and left in place or stacked that the growth of desirable plants is difficult or impossible. Without an intact and living root system, this slope could be vulnerable to erosion.

The west facing wooded hillside, located just south of the former Holst property, contains a large amount of exotic invasive woody plants. This area will continue to serve as a seed source for these species during and after control measures are undertaken within the woodlands on the SNA. FMR staff has made numerous attempts to contact the landowner (Linkert) with no success. Attempts should continue with the goal of assisting this landowner with controlling these plant species within their woodland.

There are also some active agricultural fields adjoining the Sand Coulee. It is possible that herbicide drift from these fields could have a detrimental impact on the native plans in the Coulee.

Future Dog Park. The Parks and Recreation Director of Hastings has expressed his interest in developing a dog park on the City's property located adjacent to the SNA on its northern boundary. If this dog park is pursued, the DNR should work with the city during the planning stages to ensure that the park complements the SNA and its uses. The dog park could provide an important access point both for the public and for SNA land managers. Because of the topography, management access to the SNA is currently limited.

Fencing.

The portion of the site located at the Northeastern corner of the SNA, the former Holst property, contains fence that was used historically to contain cattle. These fences pose a challenge for accessing the area for management purposes and a threat to visitors to the SNA. They should be removed.

Landscape Context

The site is part of a north-south corridor of natural habitat that connects the extensive habitat of the Vermillion River Bottoms, which is one of the top four sites in the state for rare birds, contains one of the largest expanses of floodplain habitat, is part of the Mississippi Greenway Plan, and is within one mile of the Hastings SNA, which contains significant biodiversity, including a rare plant community (dry sand-gravel prairie, southern UPs13b) and several rare and state-listed plant and animal species. The site's topographic relief is its most striking characteristic, with dramatic elevation changes and nearly 100-foot drops from top to bottom and with steep slopes of 45 percent. Surrounding the site, the landscape consists of a combination of uses including new housing developments (to the east and north), fallow fields (to the west and south) and agricultural fields (to the east), which all have potential impacts on the site. See the Adaptive Management Spatial Database for a summary of factors that may potentially impact the site and associated management responses to these impacts.

Objectives

Public use Provide the public with safe access (e.g. a parking place and walk-in access) to the SNA to observe nature while protecting the natural resources from degradation due to human use or trespass. This SNA is designated as a Public use Unit, open to the public for nature observation and general educational and research activities. This triggers some activities such as: nature hikes, parking, interpretive signs, issuing permits.

Development activities that would come into play to accommodate research, education, and site visitors would be:

- Signing any new acquisitions like the 80a Holst addition on the east
- Constructing parking areas, such as a parking lot on the north end of the site that would improve access there (e.g. off of Glacier Way, or in conjunction with the potential dog park, or off of Co Hwy 91)
- Erecting interpretive signs at all obvious/ well-used entry points (Glacier Way, Tuttle Drive, Co Hwy 91)
- Eliminating the off-road vehicle trail running through the site from north to south

Administrative activities would include public relations:

- Talking to the neighbors about dumping yard waste (especially prevalent from housing on the west)
- Recruiting a site steward
- Planning and notification of neighbors when burning, removing plantations, or carrying out other significant management activities
- Educating of and outreach to neighbors on impacts they can potentially make to the SNA
- Talking to City and neighbors about controlling dogs in the proposed future dog park and on the SNA
- Coordinating with local non-profits for nature hikes, bird counts, management volunteer events

Natural Disturbance Mimic natural disturbance by maintaining and expanding areas of open, loose, shifting sand, which are a habitat requirement of the following priority features: *Aristida tuberculosa, Asclepias amplexicaulis, Cristatella jamesii, Lechea tenuifolia, Oenothera rhombipetala,* and, *Orobanche fasciculate*.

Management activities that would address this objective may include:

- Reduce competition from other plants
- Control exotic invasives, especially hairy vetch, leafy spurge, spotted knapweed, smooth brome, Kentucky bluegrass, bird's foot trefoil—especially smooth brome
- Control woody vegetation encroachment
- Perform controlled burns within strict prescriptions to maintain requirements for rare species, SGCN and expanding native plant communities

Plant community biodiversity and sustainability Provide and improve habitat to promote rare species and support populations of SGCNs. In reconstructions or interseeding, plant vegetation

only of native ecotypes to Minnesota and preferably of the local ecotype using a high diversity of species originating as close to the restoration site as possible and when restoring prairies, protect existing prairies from genetic contamination. At least, 95% of the native prairie is free of woody encroachment and 95% of the oak savanna has a canopy of 25% or less, free of invasive shrub species and supporting a native ground cover on at least 50% of the plant community type, all within 5 years.

Orobanche fasciculate

- Promote and provide adequate abundance of *Artemesia spp.* for parasitism.

Oenothera rhombipetala

- Promote and provide for adequate abundance of night-active pollinators (e.g., sphinx moths)

Besseya bullii

- Promote and provide for suitable habitat conditions
    - Management tools should include fire, which reduces woody vegetation and encourages flowering
    - Fire should only be used in early spring before plants appear above ground, usually during late March or early April. Once the plants appear above ground, even 2.5-5.1 cm (1-2 in.), they can be severely damaged by fire.

Hesperia ottoe

- Promote and provide for an abundance of small bunch grasses for larval feeding and cover
- Promote and provide for a diversity of forbs that produce nectar for feeding adults
- Careful management of prairie remnants, especially fire, which kills immature stages of skipper and can damage small populations
    - Burn when larvae are in buried shelters, not when larvae and pupae are in surface shelters
    - Consider fuel load, fuel moisture content, ambient temperature, relative humidity, since mortality varies with fire intensity
    - Subdivide site and burning the unit in a rotation that leaves refugia for larvae to recolonize burned areas between burns
- Substitute haying for burning, which may be more favorable than rotational burning, depending on the year and the site

Speyeria idalia

- Provide for enough tall duff layer during late summer through fall/winter for larvae to hide in and overwinter in
- Maintain and enhance density and diversity of forbs to provide abundant floral nectar for

feeding adults throughout the entire growing season

  - Conduct dormant season burns
  - Do not graze and mow during butterfly's flight period, which will reduce flower abundance, perhaps enough to force adults to emigrate from the site.

- Promote conditions that provide a high enough density of prairie violets (*Viola palmate* and *V. pedatifida)* for feeding larvae (larvae only feed on violets)
  - Monitor for violet density and distribution
- When burning the site, prevent the high mortality of immature stages of the butterfly.
  - Wherever practical, only a fraction of a site should be burned during a butterfly generational cycle, especially in sites that appear to be effectively cut off from immigration.
  - Take care to maintain enough unburned habitat through two or more successive seasons to maintain an adequate reservoir of butterflies in a site.
  - Haying can be a useful complement to prescribed burning in sites where constraints on burning would make it difficult to achieve management objectives with fire alone.
    - Hay raking could result in significant larval mortality. Haying only part of a site each year is therefore advisable.
  - In more mesic sites, the dense, tall stands of the dominant grasses that result from prescribed burning alone may reduce violet abundance. Light to moderate episodic grazing may stimulate violet reproduction, although heavy, prolonged grazing eliminates the violet. More xeric sites, like the sand gravel prairies, would probably not require this.
- Take care when controlling brush and invasive weeds, such as leafy spurge (*Eurphorbia esula),* spotted knapweed (*Centaurea maculosa*), and several thistles. Broadcast applications of herbicides may also reduce or eliminate both the larval host plants and many of the adult nectar sources."
- Monitor forbs, in particular *Viola spp.,* and track their phenology

Lanius ludovicianus

- Promote and provide conditions for suitable habitat for this bird species.
  - Management efforts should focus on increasing and maintaining suitable grasslands and shelter, brush along fence lines, and scattered trees and shrubs for nest and perch sites.
  - Some loggerhead shrike habitat has become overgrown with trees, particularly red cedar. While red cedar is often an important nest tree for loggerhead shrikes, dry grassland slopes can become so covered by the dense growth of this tree that it becomes unsuitable shrike habitat. Management efforts need to control the encroachment of red cedar while maintaining its structure and density to benefit this species, as well as many other grassland species.
- Protect birds from the detriments of pesticide, since they feed on invertebrates that may carry pesticides, especially insecticides

Coluber constrictor

- Maintain woodland margins and field edges (preferred summer habitat) and provide adequate hibernacula during winter months (mammal burrows, caves, rock crevices, gravel banks, stone foundations, and old wells).
- Provide for rotting logs, stumps, or inside mammal burrows, which are where eggs are laid
- Promote a diverse enough ecosystem that provides for food for this snake species, which includes insects, frogs, toads, lizards, snakes, small rodents, bird eggs, and nestlings.
- Provide adequate space for the large home range of this species; approximately 25 acres (10 ha)
- Protect young North American racers from damage from pesticides, since they feed on invertebrates that may carry pesticides
- Protect them from damage and mortality due to busy roads, since they have a large range they are subject to encountering roads
- Protect from over-harvest by the pet trade

Indicators

- One record of Ottoe Skipper detected annually
- One record of Regal Fritillary detected annually
- The number of blue racer dens detected annually
- One loggerhead shrike and nest detected annually
- The number of rare Dry Sand-Gravel Prairie plant species observed annually
- The amount of site with exotic and woody plant species (particularly the following: common buckthorn, smooth brome, and eastern red cedar) reduced to less than 5 % in 5 years (Table 5).
- Acres dominated by non-native or disturbed communities converted to native plant communities - TOTAL = 128.2 ac:
    - Non-native-dominated grassland (GR) = 36.7 ac
    - Old Field (LGU, PP, CROP) = 44.5 ac
    - Conifer Plantation (PC) = 14.2 ac
    - Disturbed Woodland and Forest (DW, DF) = 32.8 a

Table 5. Invasive Species Summary

Not Native	Scientific name	Common name	Infestation Rating	Past Mgmt Effort	Trend	Perceived Mgmt Need
	Juniperus virginiana	Eastern red cedar	Med	High	Declining	Mod. Sig removal needed in some areas
X	*Lonicera tartarica*	Tartarian honeysuckle	Med	High	Mod decline	Mod-high. Some areas controlled but overall significant removal needed
	Pinus resinosa	Red pine	Low	Low	Decline	Low
X	*Pinus sylvestris*	Scotts pine	Low	High	Declining	Low. Scattered trees or clusters to remove
X	*Rhamnus cathartica*	Common buckthorn	Very High	High	Declining	V high. Some areas controlled but overall VERY intensive removal needed. Long Term.
	Rhus glabra	Smooth sumac	High	Low	Some decline	Mod. Not huge issue, but mowing to reduce in some areas is desirable.
X	*Robinia pseudoacia*	Black locust	Low	Low	Small decline	V. high. Need to remove wherever detected, especially reproducing.
X	*Ulmus pumila*	Siberian elm	Med	Low	Small decline	V. high. Need to remove wherever detected, especially reproducing.
X	*Acer ginnala*	Amur maple	Low	none	None	Mod.
X	*Alliaria petiolata*	Garlic mustard	Low	None	None	V high. Need to address before it expands.
X	*Bromus inermis*	Smooth brome	High	Mod (burn)	Mod decline	Mod. BMPs of prairie should keep in check.
X	*Carduus nutans*	musk thistle	Low	Low	Not known	Low, but regular site eval.
X	*Centaurea maculosa*	spotted knapweed	Med-High	V high	Sig decline	High – continue management efforts (biocontrol, hand pull)
X	*Crepis tectorum*	narrow-leaved hawkweed	Low	None	Not known	Low
X	*Melilotus alba*	White&yellow sweet-clover	Low	Low	Mod decline	Low
X	*Poa pratensis*	Kentucky Bluegrass	High	Mod (burn)	Not known	Mod. BMPs of prairie should keep in check.
X	*Saponaria officinalis*	Soapwort	High	Mod (hand pulling)	Low	High. Need to identify control method.
	Securigura varia	Crown vetch	Low	None	None	Low, but treat regularly when found.
X	*Verbascum thapsus*	common mullein	Med	None	None	Low. Vols could cut.
X	*Vicia cracca*	cow vetch	Med	Low	None	High. Quickly invading pond area

Table 6. Adaptive Management Spatial Database - AMSD - Feature worksheet

A. Project Area Hastings Sand Coulee SNA	**B. Priority Feature -** UPs13b Southern Dry Sand-Gravel Prairie			
C. Condition Variables	**D. Condition Indicators**	**E. Condition Range**	**Unit:**	**I. Objectives**
1. Native Species Dominance	% cover	Excellent = 90-100%, Med = 70-90, Poor < 70%	%	Maintain native species dominance
2. Conservative Spp frequency	frequency	Medium - Excellent in BC rank portion of SNA	% Freq	Maintain high frequencies in high quality areas; increase frequencies in low quality areas
3. Condition Rank	rank	A excellent, B good, C fair, D poor	rank	Use rank guidelines for native plant communities
4. Rare Species				
Ottoe Skippers	sightings	poor - 0, medium - 1 - 2, excellent 3 - 5	number of	Promote and provide for: 1) an abundance of small bunch grasses for larval feeding and cover; 2) a diversity of forbs that produce nectar for feeding adults.
Regal Fritillary	sightings	poor - 0, medium - 1 - 2, excellent 3 - 5	number of	1) Provide for enough tall duff layer during late summer through fall/winter for larvae to hide in and overwinter in; 2) Maintain and enhance density and diversity of forbs to provide abundant floral nectar for feeding adults throughout the entire growing
Rare Plant species, S1, S2, S3 (*Aristida tuberculosa, Asclepias ampilexicaulis, Cristatella jamesii, Lechea tenuifolia, Oenothera rhombipetala, Orobanche fasciculata)*	population size	excellent = 75-100, medium = 30-75, poor = 0-30	number of individuals	Maintain and expand areas of open, loose, shifting sand, which are a habitat requirements for these species
5. Invasive species:	% cover	Poor = 75-100%, Med = 30-75%, Good = 0-30%		
All Invasives	% cover	Good 0 - 30% cover	%	Reduce frequency and abundance
Woody's (*Rhamnus cathartica, Ulmus pumila, Lonicera tatarica, Rhus glabra)*	% cover	Good 0 - 30% cover	%	Reduce frequency and abundance
Graminoids (*Bromus inermis, Poa pratensis)*	% cover	Good 0 - 30% cover	%	Reduce frequency and abundance
Forbs (*Lonicera tatarica, Carduus nutans, Centaurea maculosa, Melilotus alba, Melilotus officinanlis, Saponaria officinalis, Trifloium pratense, Verbascum thapsis, Vicia cracca*)	% cover	Good 0 - 30% cover	%	Reduce frequency and abundance

Table 6. Adaptive Management Spatial Database - AMSD - Feature worksheet (continued)

A. Project Area Hastings Sand Coulee SNA		**B. Priority Feature -** UPs13b Southern Dry Sand-Gravel Prairie		
F. Factor Variables	**G. Factor Indicators**	**H. Factor Range**	**Unit:**	**Objectives**
1. Invasives from outside	From nearby ag fields and residential lots.	Minimal from ag fields--only from the East border of SNA--about 2600 feet long--would affect newly reconstructed Sand gravel prairie on former cropland, but would not affect existing remnant sand gravel prairies. Invasives from residential would affect area	4 ac of sand gravel prairie. 10-20 ac of site in general.	Prevent and monitor invasives on borders with outside properties.
2. Herbicide Drift	Forb dieoffs from cultivated fields and residential lots spraying.	Same as Factor 1).	11 ac of sand gravel prairie. 10-20 ac of site in general.	Prevent and monitor herbicide applications on borders with outside properties.
3. Ponding Basin	Outlet could erode soil. Inlet is potential source of invasive species.	Would not affect remnant sand gravel prairies, but would affect restored ones that occur surrounding the pond. Extent of impact would vary with amount of runoff, but would likely not exceed approximately 10,000 sq. ft.	0.25 ac	Decrease stormwater runoff in Tuttle/South Pine neighborhood
4. Off Road Vehicles	Erosion of hillsides. Rutting.	Six to eight eroded former ATV trails exist on the west slope of the SNA. These "gullies" vary in degree of erosion, but range from approximately 300 to 500 feet long, with an average of 400 feet long.	1) 2400-3200 lineal ft. 2) 15,000-20,000 sq. ft.	Keep road vehicles out of SNA.
5. Adjoining Landowners	Deposit lawn clippings and other heaps of cut vegetation onto the prairie.	Approximately 2000 lineal feet of property borders the residential properties at the southeast end of the SNA, adjacent to the Tuttle neighborhood, where the potential impacts would occur.	1 to 3 ac	Prevent dumping of vegetation and other debrisonto SNA
6. Potential Dog Park	Potential impacts to north end of SNA site: 1) introduction of pets/dogs into SNA, 2) introduction of invasive plant species into SNA.	Approximately 1000 lineal feet that would border the proposed dog park on the north end of the SNA; impacts may be felt in the remnant sand gravel prairies on the north end of the site.	4 ac of sand gravel prairie. 10-100 ac of site in general.	Keep dogs in dog park.

MANAGEMENT RECOMMENDATIONS

Proposed Future Conditions

Please refer to the following tables and map for proposed future conditions, regarding target native plant communities, during the discussion of management recommendations.

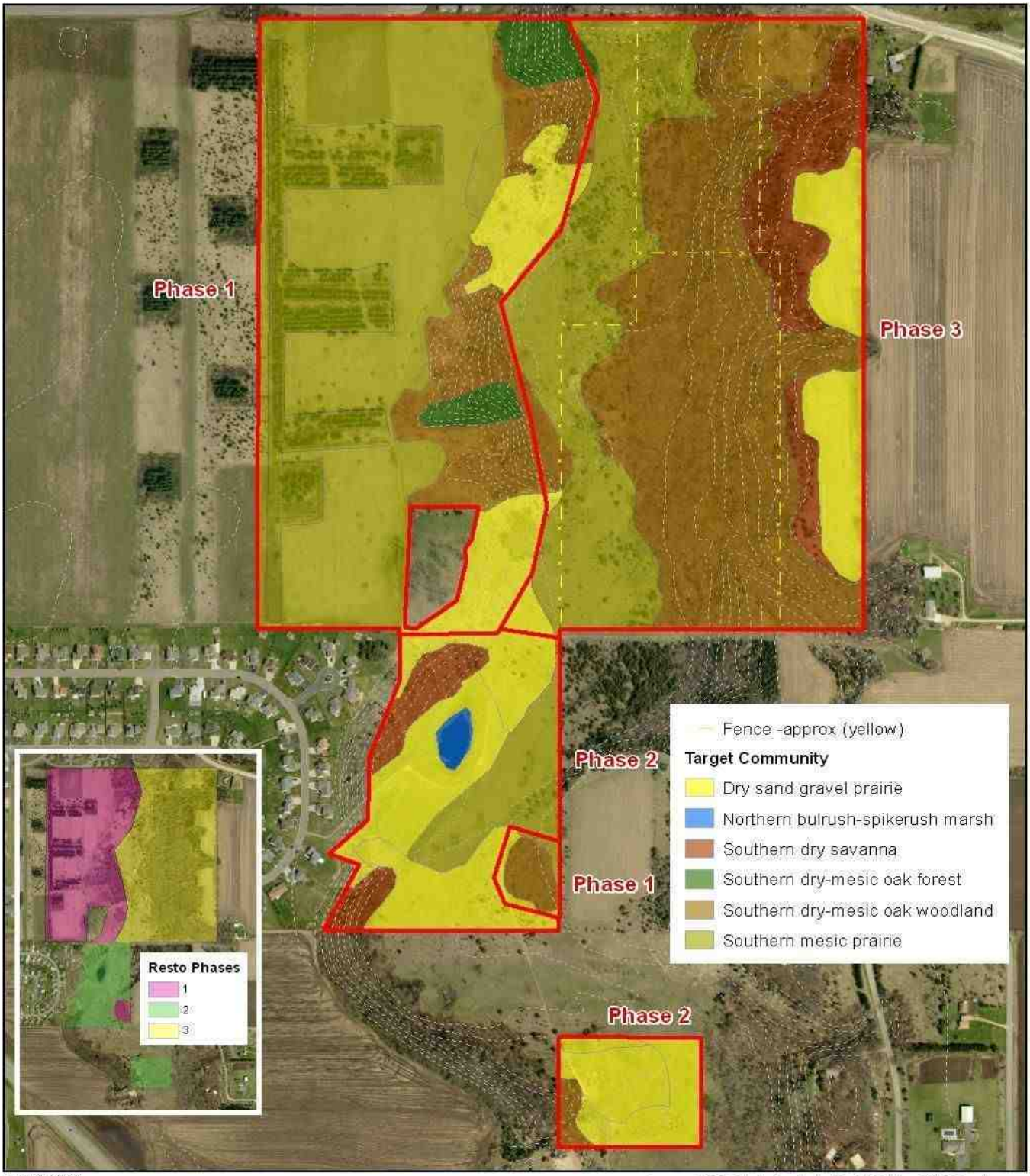
Table 7. Proposed Future Conditions, arranged by Restoration Phase.

Vegetation Un+B4:BM39it Short N	Unit	Existing Acres	Restoration Goal	Resto NPC Code	Resotred Acres	Resto Phase
Upland brome grassland	LGU	35.2	Mesic prairie	UPs23		1
Planted prairie species	PP	1.1	Mesic prairie	UPs23		1
Planted conifers	PC	14.2	Mesic prairie	UPs23		1
Sand gravel prairie	SGP1	7.4	Dry sand gravel prairie	UPs13b		1
Sand gravel prairie	SGP2	4.2	Dry sand gravel prairie	UPs13b		1
Oak forest	OF1	2.3		MHs37 or 38		1
Oak forest	OF2	1.3		MHs37 or 38		1
Oak woodland-brushland	OW2	3.1	Southern dry-mesic oak woodland	FDs37		1
Oak woodland-brushland	OW3	9.5	Southern dry-mesic oak woodland	FDs37		1
Oak woodland-brushland	OW4	1.3	Southern dry-mesic oak woodland	FDs37		1
		79.6			**79.6**	
Grassland-brome with native spp	GR1	5.9	Mesic prairie	UPs23		2
Grassland-brome with native spp	GR2	5.3	Dry sand gravel prairie	UPs13b		2
Grassland-brome with native spp	GR3	2.6	Dry sand gravel prairie	UPs13b		2
Grassland-brome dom with trees	GT	0.9	Dry sand gravel prairie	UPs13b		2
Sand gravel prairie	SGP3	5	Dry sand gravel prairie	UPs13b		2
Sand gravel prairie	SGP4	2.6	Dry sand gravel prairie	UPs13b		2
Altered woodland	DW3	2.3	Southern dry savanna	UPs14		2
Altered woodland	DW4	1.1	Southern dry savanna	UPs14		2
Oak woodland-brushland	OW5	0.6	Southern dry-mesic oak woodland	FDs37		2
Stormwater pond	Pond	0.7	pond	MNr93		2
		27			**27**	
Grassland-brome dom with shrubs	GSH	22.9	Mesic prairie	UPs23		3
Cropland	CROP	8.2	Dry sand gravel prairie	UPs13b		3
Altered woodland	DW1	7.5	Southern dry savanna	UPs14		3
Altered woodland	DW2	1.8	Southern dry savanna	UPs14		3
Short grass, trees	SGT	3.3		MHs37 or 38		3
Altered deciduous forest	DF	0.9	Southern dry-mesic oak woodland	FDs37		3
Oak woodland-brushland	OW1	37.3	Southern dry-mesic oak woodland	FDs37		3
		81.9			**81.9**	

Table 8. Proposed Future Conditions, arranged by Target NPC.

Vegetation Un+B4:BM39it Short Na	Unit	Existing Acres	Restoration Goal	Resto NPC Code	Resotred Acres	Resto Phase
Grassland-brome dom with shrubs	GSH	**22.9**	Mesic prairie	UPs23		3
Upland brome grassland	LGU	35.2	Mesic prairie	UPs23		1
Planted prairie species	PP	1.1	Mesic prairie	UPs23		1
Planted conifers	PC	14.2	Mesic prairie	UPs23		1
		50.5				
Grassland-brome with native spp	GR1	5.9	Mesic prairie	UPs23	**79.3**	2
Grassland-brome with native spp	GR2	5.3	Dry sand gravel prairie	UPs13b		2
Grassland-brome with native spp	GR3	2.6	Dry sand gravel prairie	UPs13b		2
		13.8				
Cropland	CROP	**8.2**	Dry sand gravel prairie	UPs13b		3
Grassland-brome dom with trees	GT	**0.9**	Dry sand gravel prairie	UPs13b		2
Sand gravel prairie	SGP1	7.4	Dry sand gravel prairie	UPs13b		1
Sand gravel prairie	SGP2	4.2	Dry sand gravel prairie	UPs13b		1
Sand gravel prairie	SGP3	5	Dry sand gravel prairie	UPs13b		2
Sand gravel prairie	SGP4	2.6	Dry sand gravel prairie	UPs13b		2
		19.2			**42.1**	
Altered woodland	DW1	7.5	Southern dry savanna	UPs14		3
Altered woodland	DW2	1.8	Southern dry savanna	UPs14		3
Altered woodland	DW3	2.3	Southern dry savanna	UPs14		2
Altered woodland	DW4	1.1	Southern dry savanna	UPs14		2
		31.9			**31.9**	
Oak forest	OF1	2.3		MHs37 or 38		1
Oak forest	OF2	1.3		MHs37 or 38		1
		3.6				
Short grass, trees	SGT	**3.3**		MHs37 or 38		3
					6.9	
Altered deciduous forest	DF	**0.9**	Southern dry-mesic oak woodland	FDs37		3
Oak woodland-brushland	OW1	37.3	Southern dry-mesic oak woodland	FDs37		3
Oak woodland-brushland	OW2	3.1	Southern dry-mesic oak woodland	FDs37		1
Oak woodland-brushland	OW3	9.5	Southern dry-mesic oak woodland	FDs37		1
Oak woodland-brushland	OW4	1.3	Southern dry-mesic oak woodland	FDs37		1
Oak woodland-brushland	OW5	0.6	Southern dry-mesic oak woodland	FDs37		2
		51.8			**52.7**	
Stormwater pond	Pond	**0.7**	pond	MNr93	**0.7**	

MAP 6. Restoration Phases



June 21, 2011

Sources: 2008 Dakota County Aerial, DNR data dell 10-ft contours.

1:6,800

N

0 50 100 200
Meters

Activities – all activities to be carried out will comply with current SNA Operational Directives and approval**.**

Development Activities

Access Improvement

Public access to the site needs to be improved as there is currently no designated entry or parking area. A gated entry at Tuttle Drive was built to provide city engineers access to the storm water pond and was not designed or legally intended for foot traffic. However, it is nevertheless used by the community (an adjacent landowner offers access along his property line) and is the most effective and least impactful way for people to get to the site. Large groups regularly come to the site and could create significant erosion problems if they were to walk down the sandy hillsides. It would be beneficial for the DNR to explore with the city a means for public use of the paved trail. However, the gated entry is very valuable for keeping unauthorized vehicles out of the site, so any additional entry for pedestrians should consist of an opening in the fence.

Another opportunity for access to the site may be at the north end, in the basin of the coulee. The city currently owns the property to the north, which was formerly a shooting range but is currently unused. They may convert it into a dog park and have been receptive to the idea of creating an access point there to the Sand Coulee SNA. In addition, SNA signage is needed all along the perimeter of the site, including a wood-routed site identification sign that is visible to the public at the primary entrance and/or from a public road.

A third access possibility would have to be coordinated with the City and the housing development to the north off of Glacier Way. A parking area could be developed over the curb (would have to be removed) and off the street in the field to be reconstructed.

Site Cleanup

There are several locations were debris or other refuse are located. The two deep ravines on the northeastern part of the property have construction rubble and debris piled in them (GPS point 13,Photos 4; GPS point 5, Photo 20). Some of it was apparently placed for erosion control. The debris should be removed when measures are ready to address the ravine erosion. There is also a small collection of debris on the west slope at GPS 49 and GPS point 50, Photo 30. Wooden posts from some small building, located at GPS point 33, Photo 23 should be removed. Throughout the site there is standing barbed wire fencing that should be removed. Approximate fence locations are shown in Map 5. Dispose of debris according to Department policies.

Signing

All boundaries need adequate boundary and rules signs. Wooded areas must have boundary signs placed a minimum of every 500 feet and open areas every 1000 feet. Access points need interpretive signs and boot brush kiosks as well. Signage should be inspected for repair and replacement needs on an annual basis.

Management Activities (refer to Map 5)

Plant Community Restoration

CROPLAND (Unit CROP 8.2 ac)

Based on the historic aerials photographs and the loamy sand soils, which support sand gravel prairie at other parts of the site, we suggest the most suitable plant community for the croplands is dry sand-gravel prairie (UPs13b). The process for restoring native prairie to the croplands is fairly straightforward, and has been conducted at the south unit of the Sand Coulee SNA. Restoration would begin in the fall. During the growing season the unit can be planted with a Roundup-ready crop. If there is a lot of crop residue after harvest it can be lightly disked. If the residue is moderate there may be no additional site preparation needed after harvest. Seed can be broadcast applied any time after late October to as late as mid-February, however, seed should not be applied if there is more than about 5 inches of snow. Seed would ideally be applied just prior to a snowfall or rain event.

After seeding the management will follow fairly standard establishment practices: mowing two or three times the

first growing season, once in the second season in late May or June, and burned in spring of the third season. Mowing is done when vegetation reaches a height of about 12 inches. It is mowed to a height of about 6 inches with a flail type mower that dumps off the rear to prevent leaving dense piles of mowed material that will kill any native seedlings. Additional management of invasive species may be needed, typically starting the second growing season. Species to watch for include spotted knapweed, leafy spurge, Canada thistle, and bird's foot trefoil. Spot mowing and/or herbiciding are often adequate methods used to combat any invasives.

Once established, the prairie units should be monitored regularly (at least annually) for invasive species and burned periodically, about every 4-6 years. The burn cycle should be coordinated with burning of the other prairie units so that adjacent units are not burned in consecutive years and so that no more than one third of the prairie area is burned in any year.

UPLAND BROME GRASSLAND, PLANTED CONIFERS, PLANTED PRAIRIE (Units LGU, PC, PP; 50.5 ac)

All of these units will be restored to mesic prairie (UPs23). Site preparation will begin with removal of the 14 acres of existing spruce trees. DNR Forestry will determine if the stand is merchantable or not. If not the stand can be used for biofuels. Removal will be followed by stump grinding, and then harrowing to create a seedbed. The next step is to remove the existing grass cover on the 36.3 acres of LGU and PP. The process is: burn or mow, herbicide, burn or mow, herbicide, and seed. Seeding of LGU, PC and PP should take place at the same time. Seed will be harvested from a nearby site, preferably Grey Cloud Dunes SNA or possibly Lost Valley SNA. Seeding should take place in late fall or winter. Follow up management will be three flail mowings the first season, one mowing in spring the second season, and a spring burn the third season. The site will be monitored and controlled for invasive weeds especially starting the second season. Spot mowing and/or herbiciding are often adequate methods used to combat any invasives.

WOODLAND (Units All DW and OW units (52.4 ac)

Portions of these units have a dense buckthorn cover and very little canopy cover (noted at the south end of OW1 and parts of OW3). These areas will clearly need some seeding once exotic brush is removed. Savanna species can be collected from other parts of the sand coulee and/or from nearby Grey Cloud Dunes SNA or Lost Valley SNA. Seed should be scattered in the openings after a burn is completed. Species for seeding should be a simple mix, focused more on the grasses as well as early successional forbs. A list of savanna species is found in Appendix B.

The OW units generally had a reduced diversity of herbaceous plants and shrub species. Most conspicuously absent from the shrub layer is American hazelnut. Simply removing invasive species and re-introducing fire may stimulate growth and spread of native flora. Several years of management (exotic brush removal and burning) and monitoring will be needed to detect any change. Actions to increase plant diversity will thus depend on monitoring results. Seeding of herbaceous plants could be considered, as well as planting or seeding shrub species.

Prescribed Burn

Fire is a vital management tool and the reintroduction of a natural process required for the ecological health of all the plant communities at this site. In prairie areas, fire reduces cover of woody plants and non-native species, stimulates growth and productivity of native plants, and recycles nutrients. However, fire can also have detrimental effects as it destroys many animals that cannot get out of the way, including insect larvae, eggs and baby birds, snakes, and others. If rare species are present a fire on the whole site could destroy the entire population. For that reason it is important to carefully manage fire so that it does not encompass an entire habitat.

The SNA should be divided into at least three burn units, based on topography, community type and objectives. No burn unit should contain the entirety of any habitat type at the SNA. Burn units were not defined for this SNA, as the burn areas will depend initially on how the management and restoration is implemented. The burn units may not coincide with the restoration phases described below. That is, a burn unit may cross restoration phases.

In order to reduce the effect of hard edges, edges of burn units should not be defined at prairie/woodland borders.

Wherever possible prescribed burns should include both woodland and prairie, at least along the edges. Burns should not be conducted on individual burn units more than once every three years and adjacent units should not be burned in consecutive years.

A burn frequency of 3 to 5 years is typically suitable for long-term management of both the mesic and sand-gravel prairies at the site. The oak woodland areas would typically have a longer burn cycle, about 10 years for mild surface fires, but may require more frequent fire in early years to maintain control of exotic species.

The effectiveness of burns on reaching management objectives should be evaluated by assessing vegetation cover, especially one and two years following the burn. Established long-term monitoring would be beneficial. Detailed burn records included burn conditions and immediate results should be entered and maintained in the specified database.

Specific recommendations for each of the Units shown on **Map 6** are provided below.

Grassland Units GR1, G2, GR3, GT, GSH Smooth brome is well established on large portions of these units, especially in the more mesic loamy soils. Spring burns in successive years will reduce the brome on dry soils but will not likely reduce the coverage on mesic soils. A conservative approach is recommended to avoid use of herbicides: burn in late spring (approximately mid-May) for two consecutive springs. After the second burn, native seed (obtained from on-site) can be broadcast into the unit. Portions of the units that have high sumac coverage can be mowed in summer following the burn and in spring of the third year. Selected areas of sumac should be identified that will NOT be mowed but left for habitat. The full sequence for management is: late spring burn, late summer mow, Year 2: late spring burn, broadcast native seed by early June, late summer mow, Year 3: late spring mow. This will address sumac and brome as well as red cedar seedlings. This sequence should be coordinated to include adjacent units in one of the burns (but probably not both burns).

Grassland and Cropland Units LGU, PP, CR. These prairie restoration units would be burned in spring of the third growing season after being seeded. After that the units will follow the same frequency as other prairie units at the site.

All Woodland units (OW, DF, OF, DW) Prescribed burns will be a critically important tool for managing all OW units, especially for controlling seedling invasive species such buckthorn, honeysuckle, and garlic mustard. As buckthorn is removed, a prescribed burn should be planned for spring of the following year. This will greatly help to reduce the flush of new buckthorn seedlings. A spring burn is likely to be hotter and more effective at targeting buckthorn seedlings as well as garlic mustard seedlings. A fall burn, however, is also very acceptable as the woods are dominated by bur oak, which provide good fall fuels. Unit OW4 was previously burned 10/25/06, 11/15/07, and 5/6/10, with very complete burns each time.

Fire may not carry well in some areas that have poor leaf litter and no grass cover. To help facilitate that, areas that have an open canopy after woody removal can be seeded with oats along with quick-growing native species such as Canada wild rye. The oats will not persist but will provide fuel for fire.

For all OW units except OW4 (which has already been burned several times), burning should be done annually for 2 or 3 years, if feasible, in order to reduce buckthorn seedlings. Following that, frequency may depend on conditions and desired outcomes, but a burn frequency of every 2 to 5 years would be reasonable to reach short-term goals. In the long term, an average fire rotation of 9 years would mimic likely historic trends.

After the initial 2 or 3 years of burning woodlands for buckthorn control, the burn units should be modified to include adjacent prairie units. Specific burn units for the site will need to be determined in the future, after the initial management has been accomplished.

Invasive Species Control

Woody Invasives. Use fire, cutting and follow up treatments to remove woody species encroachment on prairies and prevent establishment of new woody stands. In disturbed areas, species such as honey suckle and buckthorn, which stump sprout profusely, are cut and stump-treated with Garlon, Round-up or other recommended herbicides. On native prairie and steep slopes, woody species are cut in the winter, all slash is removed, and no herbicide is used in order to minimize disturbance (unless otherwise provided in SNA policy). Repeated cutting may be needed in concert with burning in these areas to control invasive species.

Non-native, invasive woody species are prevalent throughout the woodland areas of the SNA, and scattered in the grassland areas. All invasives, primarily common buckthorn and Tartarian honeysuckle, but also Scotch pine and Siberian elm, will be cut and stump-treat (except conifers). See **Appendix C** for details on methodology. Additional details for specific units are provided below.

Woodlands Units—All OW and DW Units. Buckthorn was generally dense or abundant in all OW and DW units, although the coverage varies. Dense cover of red cedar in some areas will also be reduced to facilitate more oak regeneration and/or to create savanna openings. Removal of small green ash, box elder and elm, especially at Units DW3 and DW4, will also steer those units more toward oak savanna.

The total basal area of buckthorn was probably greatest in OW1, where stem size was mostly less than 2 inches. OW2 had larger diameter stems, with more scattered coverage and low coverage of seedlings. OW3 had been cut and treated in 2009 so new growth and resprouts were small diameter, but coverage was dense. Unit OW4 has been managed for several years and has a high coverage of very short multi-stemmed shrubs. All of these conditions may require somewhat different management approaches.

Of the OW units, a priority area for treatment is Unit OW4, because good progress has been made on the buckthorn management, and the investment to achieve control will be relatively low if conducted in the near future. At this unit we recommend mowing the brush in early summer to keep it short, then wick-applying herbicide to the foliage in fall. A wick application will minimize herbicide contact with non-target species. A prescribed burn following herbicide treatment would be beneficial, either the same season or the following. A second wick application will likely be needed in early summer of the following year, then re-assess for future management.

Units OW2 and OW3 are also high priority for treatment because these units have also been managed in recent years. Additional treatment is now needed before the new plants reach maturity. At the time of the survey, new plants and resprouts were still relatively small, but may be of fruiting size in 2011 or 2012. Management should target the larger stem plants that can be cut and stump-treated – typically stems of about 1/2 inch diameter or more can be cut by chainsaw. Application methods should follow the descriptions in Appendix D. Where cut material is very dense, it should be stacked and burned, preferably at the same time it is cut to minimize burn scars. If cut plants are not too dense they can be cut up and dropped on the ground. Debris should be cut small enough so it falls and compacts on itself so that walking through cut debris is not difficult. Management should continue in this unit annually for at least two or three years, each time cutting the stems that are 1/2-inch diameter or more.

Unit OW1 would be lower on the priority list, but should still be addressed as soon as feasible.

A dense canopy of red cedar has over taken some areas, especially noted at OW2 (GPS 478). This particular area of OW2 was historically prairie (1937), and could be restored by red cedar removal followed by seeding and later burning. There is presently little ground cover vegetation in that area. This task would be low priority, but if a biofuels project is underway this area could be included. Species to include for seeding would be Canada wild rye for quick cover, little bluestem, porcupine grass, big bluestem, as well as purple prairie clover, hoary vervain, and yellow coneflower.

Grassland Units GR1 and GSH Both of these units have a higher than desirable cover of trees and shrubs, most of which are native (red cedar, sumac, green ash, aspen). Unit GSH will need the greatest amount of red cedar

removal, but other grassland and prairie areas may need it as well. In Unit GR1, about half the cedar can be removed (as well as the Scotch pine and honeysuckle). Cut juniper can be piled and burned. In addition to red cedar, all non-native shrubs should be cut, treated, stacked and burned.

Herbaceous invasives

A small patch (8x8 feet) of **garlic mustard** was detected in Unit OW1 (GPS pt #14 on map in Map 5) and will become abundant if the site is not managed. Additional survey should be done to detect other populations. Volunteers could be recruited initially to hand pull. The event should be repeated annually. Prescribed burning will help to keep it at bay in the future.

Most invasive herbaceous plants in the grassland and prairie areas are located in disturbed areas. Treatment may include spot application of herbicide, especially after a burn when plants are small. Herbicides should not be used where native plants are nearby. **Spotted knapweed** is very abundant near the pond (GR1 and GR2) and is spreading. Biocontrol first released in 2005 is slowly working. Continued hand pulling may be valuable to slow the spread into new areas. Ultimately the biocontrol insects should reduce it to more scattered plants.

Cow vetch is now increasing, especially where the knapweed is. Hand removal (roots must be dug out) may be feasible in small patches. Anecdotal evidence from Wild River SP is that patches expand for a few years then decline and show up elsewhere. Further research needed on effective control methods, especially where natives exist.

Soapwort is very abundant in the northern part of the site and appears to be increasing. Little information was found regarding control methods or invasibility, but it appears that control is needed. Additional research is needed to determine effective methods. Some areas are brome infested so control will be easier and may be reduced as part of restoration of the brome grassland (GSH). The plant was much less common in established prairie.

Control of **invasive grasses**, primarily smooth brome, quack grass and Kentucky bluegrass, will be accomplished primarily through burning, however, burning many not be adequate for to control brome in the GHS and GR1 units. SNA may decide to apply a grass specific herbicide, after a burn, to reduce brome. Herbicide would be followed by broadcasting native seed.

Hybrid cattail in the pond would be controlled by herbicide as described in Appendix D.

Avoid erosion impacts

Most of the OW units are located on steep slopes with highly erodible soils. It will be important to evaluate the slopes as brush removal progresses and prevent erosion from occurring. One method to prevent erosion would be to bundle the cut brush and lay bundles in staggered fashion across the slope in key areas, but if this may represent a burn hazard due to holdover fuel in future management. An alternative method is to proceed with invasive removal in strips, followed by restoring strips of grass: take out a strip of invasives, then restore grass in that strip, then take out another strip of invasives and restore grass in that strip, etc. Another alternative is to stake mats or use mulch on steep slopes.

Reduce heavy fuels of dead tree stands

While disturbances such as windthrow and disease are natural processes in a wooded area and are an important part of succession as well as habitat for some species, large amounts of standing dead and fallen woody material can be detrimental in the short term to achieving some of the other management goals. In particular, prescribed burning can be unattainable with large amounts of woody debris. There was at least one such area detected in OW3 (GPS 488), possibly due to oak wilt. If feasible, the trees could be removed in winter and used for biofuels. Access may be feasible from the city property at north end of the SNA, or at the northeast corner of the SNA. Machinery should only be used at the site when the ground is well-frozen. If machinery would traverse any prairie area there should also be several inches of snow cover.

After tree removal, the area will be fairly open. Broadcasting native prairie seed grasses from on-site will help to provide ground cover as well as fuel for a future burn. In particular, Canada wild rye would be an excellent species to seed.

Retain some cover of standing and fallen dead trees

Many wildlife species depend on dead wood for food or shelter. The blue racer, for example, may lay eggs under rotting logs. It is important that the prescribed burning methods leave an abundance of both rotting logs and standing dead trees. Provisions should be made in the burn prescriptions to enable some of each to remain, by burning around them or wetting them down or allowing the fire to burn through them and doing mop-up.

SGCN and Other Rare Feature Population Management

Following the standard practices outlined in the Prescribed Burn section will also address most of the management requirements of the rare plant and animal species at the site, as well as the overall plant communities. Additionally, note the following:

Monitor kittentail population Kittentail, found in two areas of GR1, is both aided and harmed by fire. Fire top-kills the plants, preventing seed production for the year, and could eliminate young plants. However fire also stimulates the plants to grow more vigorously the year following a burn (pers. comm. Ellen Fuge). A conservative approach would be to not burn the entire kittentail population in any given year (kittentail is also found at the south end of the coulee on private property). Furthermore, the plants should be monitored, especially before a burn and for two years after. A record of the number of plants and flowering stems would help provide information on long-term trends. GR1 also needs some woody removal, but care should be taken to not remove all of the trees around the eastern kittentail population.

Provide suitable habitat for loggerhead shrikes A precise optimum cover of red cedar needed for shrike habitat is not known, but is speculated that roughly 5-15 percent cover would be adequate, based on known shrike-nesting locations. Unit GSH will need the greatest amount of red cedar removal, but other grassland and prairie areas may need it as well. In Unit GR1, about half the cedar can be removed (as well as the Scotch pine and honeysuckle). Cut juniper can be piled and burned. In addition to red cedar, all non-native shrubs should be cut, treated, stacked and burned. (Note: care should be taken in GR1 to not remove all of the trees around the eastern kittentail population).

Administration Activities

Planning and monitoring are crucial judging the success of management activities and implementations. Planning and monitoring inform management activities, allowing them to adapt and gives them the flexibility to change according to observations and results in the field.

Planning and Monitoring

Planning involves the following activities: animal or plant inventory, invasives inventory, invasives management plan, project plans, burn plans.

Monitoring can consist of simple measures, such as established photograph points to visually record changes. Ideally such methods would be combined with quantitative measures, to record percent coverage of native or non-native species, or to record animal populations. The exact nature of these methods will depend on long-term funding. As funding is typically uncertain, we recommend establishing fairly simple measures that could likely be repeated with minimal funds and adding additional measures if funds are available. Long-term monitoring protocols should be developed for the entire SNA to better evaluate the success of management practices and to facilitate adaptive management.

- Photograph points. Frequency depends on nature of the management. Typically before and after

significant management activities. For the long term it might be every 4-5 years.

- Annual walk through surveys to detect new stands of invasive species, erosion and other ecological changes.
- Vegetation survey plots. Frequency depends on the plant community and objectives.
- Breeding bird surveys – conducted for one or two years (if feasible) prior to management activities. Repeat for one or two after management completed, then repeat every 4 or 5 years. Survey for rare plant and animal species. Repeat every 4 or 5 years.

Monitoring for non-ecological conditions includes:

Trespass - Site boundary and access-ways are monitored and any evidence of illegal trespass, including dumping, hunting, and ATV activity, is reported to the Conservation Officer for enforcement action. Actions are taken to repair damage due to trespass including signage, gates, and erosion.

Public Relations

A management goal is informing and involving cooperators, neighbors, visitors, and volunteers related to management activities on site.

Standard SNA procedures will be followed. Recruit a site steward and train him/her in order to keep in regular contact with SNA staff regarding issues and problems at the site. Individuals previously involved with site management are contacted to collect dates of various activities on site and other data. Field trips will be offered to the public to familiarize them with the site, its features, ecological significance and management activities as time permits.

Notify neighbors of significant management activities such as burning and large-scale tree removal.

Coordination

Other DNR divisions and programs, and other agencies and partners are contacted on issues that pertain to their area of expertise (e.g. Forestry is contacted in regard to set up the cutting of pine; Wildlife is consulted regarding wildlife management issues; Non-game Wildlife is consulted on management issues that may impact rare animals; Minnesota County Biological Survey ecologist is met with on site to identify and discuss rare plant locations and plant community topics; Non-profit partner is consulted on agreement for work they are doing on an SNA; SWCD is consulted regarding funding for projects).

Permits

Permits are required if research is proposed that will destroy or remove anything from an SNA

According to the statute 6136.0400 Subp. 2. Environmental Protection USE OF SCIENTIFIC AND NATURAL AREAS:

> "It is unlawful for any person to destroy, injure, damage, molest, or remove any natural resources within scientific and natural areas, including but not limited to, trees; vegetation; ruins; relics; birds, fish, or other animals; or geological formations, except as provided by a permit or designation order in part 6136.0550, subpart 5 or 6".

Implementation Strategy

The following table summarizes the implementation strategies for the site. Activities are divided into three phases. Strategies are classified based on activity, such as development activities, management activities, and administration activities. Under management activities, it is further divided into reconstruction vs. restoration of native plant

communities, and each target NPC is grouped together, specifically showing implementation steps for each existing cover type unit. Phases are color-coded: pink for Phase I, green for Phase II, and yellow for Phase III. Also, proposed personnel, proposed funding, and estimated priority are listed for each step.

TABLE 9. HASTINGS SAND COULEE, NORTH MANAGEMENT PLAN - IMPLEMENTATION FRAMEWORK.

Refer to Tables 7 & 8, and to Map 6.

Note: As other parcels are acquired, management needs will be added

#	Activity Type	Activity Description	**Phase I** **Year 1-2** (2012-2013)	**Phase II** **Year 3-5** (2014-2016)	**Phase III** **Year 6-10** (2017-2021)	**Ongoing** (every year or as scheduled)	Proposed **Personnel**	Proposed Funding	**Priority**
DEVELOPMENT ACTIVITIES									
1	Survey	Complete boundary survey.	X				DNR survey unit	LCCMR	1
2a	Access	Improve access drive	X				SNA staff or contractor	Bonding	1
2b	Access	Erect gates (at north access, if implemented)	X				SNA staff	Bonding	2
2c	Access	Construct parking lots	X				SNA staff or contractor	Bonding	2
3a	Signs	Erect wood-routed signs	X				SNA staff	Bonding or LCCMR	1
3b	Signs	Erect signs all along the perimeter of the property	X				SNA staff & contractor	LCCMR or bonding	1
3c	Signs	Develop and erect interpretive sign		X			SNA staff & contractor	LCCMR or bonding	1
4	Fence	Repair boundary fence (if needed)				If needed	SNA staff or adj. neighbor	General	1
5	Site Cleanup	Clean up dump sites & erosion control in the two deep ravines on the northeast part of property (GPS pts 5 & 13)		X			SNA staff or contractor	LCCMR or bonding	2
5	Site Cleanup	Remove wooden posts from former small structure & erosion control		X			SNA staff or contractor	LCCMR or bonding	2
5	Site Cleanup	Remove barbed wire fencing from entire site (see Maps 5 & 6) & erosion control		X			SNA staff or contractor	LCCMR or bonding	2

TABLE 9. HASTINGS SAND COULEE, NORTH MANAGEMENT PLAN - IMPLEMENTATION FRAMEWORK (Continued)

Refer to Tables 7 & 8, and to Map 6.

MANAGEMENT ACTIVITIES									
#	**Activity Type**	**Activity Description**	**Phase I** **Year 1-2** (2012-2013)	**Phase II** **Year 3-5** (2014-2016)	**Phase III** **Year 6-10** (2017-2021)	**Ongoing** (every year or as scheduled)	Proposed **Personnel**	Proposed Funding	**Priority**
1	**Plant Com. Reconstruction**								
1.1	Dry sand-gravel prairie (southern) UPs13b			X	X				*1*
1.1.1		**Reconstruct CROP unit to UPs13b, *(See above)***			X See above				*1*
1.1.1a		Plant with Roundup-ready crop.			X		Contractor	LCCMR, LOHC, bonding or partner	*1*
1.1.1b		Harvest crop and lightly disc if necessary.			X		Contractor	LCCMR, LOHC, bonding or partner	*1*
1.1.1c		Collect seed (from Sand Coulee SNA and/or Grey Cloud SNA and/or Lost Valley SNA)			X		SNA staff, partner (volunteers), MCC	LCCMR, LOHC, bonding, partner, donated time	*1*
1.1.1f		Broadcast seed onto sites or seed drill			X		SNA staff or contractor	LCCMR, LOHC, bonding or partner	*1*
1.1.1g		Establishment Mowing			X See above		SNA staff, partner or contractor	LCCMR, LOHC, bonding or partner	*1*
1.1.1h		Prepare burn breaks			X Spr, Yr 3		SNA staff	LCCMR, SWG	*1*

TABLE 9. HASTINGS SAND COULEE, NORTH MANAGEMENT PLAN - IMPLEMENTATION FRAMEWORK (Continued)

Refer to Tables 7 & 8, and to Map 6.

#	Activity Type	Activity Description	Phase I Year 1-2 (2012-2013)	Phase II Year 3-5 (2014-2016)	Phase III Year 6-10 (2017-2021)	Ongoing (every year or as scheduled)	Proposed Personnel	Proposed Funding	Priority
1.1.1i		Conduct Rx burn			X		SNA staff	LCCMR, SWG	*1*
1.1.1j		Control invasives			X	X	SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	*1*
1.1.2		**Reconstruct GT, GR2, & GR3 units to UPs13b *(see above)***		X See above			*See above*	*See above*	*1*
1.1.2a		Remove trees and brush and stump treat.		X			DNR forester, contractor		1
1.1.2b		Prepare burn breaks		X			SNA staff	LCCMR, SWG	1
1.1.2c		Conduct Rx burn on units GT1, GR2, and GR3 in late spring, YR 1		X			SNA staff	LCCMR, SWG	1
		Mow in late summer, YR 1		X					1
1.1.2d		Collect seed (from Sand Coulee SNA and/or Grey Cloud SNA and/or Lost Valley SNA) YR 1		X			SNA staff, partner (volunteers), MCC	LCCMR, LOHC, bonding, partner, donated time	1
		Late spring burn, YR 2		X					1
1.1.2e		Broadcast seed onto sites or seed drill YR 2		X			SNA staff or contractor	LCCMR, LOHC, bonding or partner	1
1.1.2f		Control invasives		X		X	SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	1

TABLE 9. HASTINGS SAND COULEE, NORTH MANAGEMENT PLAN - IMPLEMENTATION FRAMEWORK (Continued)

Refer to Tables 7 & 8, and to Map 6.

#	Activity Type	Activity Description	Phase I Year 1-2 (2012-2013)	Phase II Year 3-5 (2014-2016)	Phase III Year 6-10 (2017-2021)	Ongoing (every year or as scheduled)	Proposed Personnel	Proposed Funding	Priority
1.2	Southern Mesic Prairie (UPs23) reconstr.	**Reconstruct LGU, PC, & PP units to UPs23 (*see above*)**	X See above						2
1.2a		Harvest conifer plantation. Remove trees and brush.	X				DNR forester, contractor	Woody biomass, logger	2
1.2b		Prepare burn breaks	X				SNA staff	LCCMR, SWG	2
1.2c		Conduct Rx burn on LGU, PC, and PP units	X				SNA staff	LCCMR, SWG	2
1.2d		Broadcast apply herbicide to remove brome grass	X				SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	2
1.2e		Burn or mow	X				SNA staff	LCCMR, SWG	2
1.2f		Collect seed (from Sand Coulee SNA and/or Grey Cloud SNA and/or Lost Valley SNA)	X				SNA staff, partner (volunteers), MCC	LCCMR, LOHC, bonding, partner, donated time	2
1.2g		Broadcast seed onto sites or seed drill	X				SNA staff or contractor	LCCMR, LOHC, bonding or partner	2
1.2h		Establishment: 3 mowings 1st season, spring mow 2nd season, spring burn 3rd season.	X				SNA staff, partner or contractor	LCCMR, LOHC, bonding or partner	2
1.2i		Control invasives: spot spray starting 2nd season.	X			X	SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	2

TABLE 9. HASTINGS SAND COULEE, NORTH MANAGEMENT PLAN - IMPLEMENTATION FRAMEWORK (Continued)

Refer to Tables 7 & 8, and to Map 6.

#	Activity Type	Activity Description	Phase I Year 1-2 (2012-2013)	Phase II Year 3-5 (2014-2016)	Phase III Year 6-10 (2017-2021)	Ongoing (every year or as scheduled)	Proposed Personnel	Proposed Funding	Priority
2	**Plant Com Restoration**								
2.1	Southern Dry Savanna (UPs14) restoration	**Restoration of DW1, DW2, DW3 and DW4 units to UPs14**		DW3, DW4	DW1, DW2				2
2.1a		Remove brush		DW3, DW4	DW1, DW2		DNR forester, contractor, or SNA staff	LCCMR, LOHC, bonding or partner	2
2.1b		Prepare burn breaks		DW3, DW4	DW1, DW2		SNA staff	LCCMR, SWG	2
2.1c		Conduct Rx burn		DW3, DW4	DW1, DW2		SNA staff	LCCMR, SWG	2
2.1d		Collect seed		DW3, DW4	DW1, DW2		SNA staff, partner (volunteers), MCC	LCCMR, LOHC, bonding, partner, donated time	2
2.1e		Broadcast seed		DW3, DW4	DW1, DW2		SNA staff or contractor	LCCMR, LOHC, bonding or partner	2
2.1f		Establishment mowings		DW3, DW4	DW1, DW2		SNA staff, partner or contractor	LCCMR, LOHC, bonding or partner	2
2.1g		Control Invasives		X	X	X	SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	2

TABLE 9. HASTINGS SAND COULEE, NORTH MANAGEMENT PLAN - IMPLEMENTATION FRAMEWORK (Continued)

Refer to Tables 7 & 8, and to Map 6.

#	Activity Type	Activity Description	Phase I Year 1-2 (2012-2013)	Phase II Year 3-5 (2014-2016)	Phase III Year 6-10 (2017-2021)	Ongoing (every year or as scheduled)	Proposed Personnel	Proposed Funding	Priority
2.2	Southern Dry-Mesic Oak (Maple) Woodland (FDs37) restoration								
2.2.1		**Restore OW4 to FDs37**	X						1
2.2.1a		Mow brush in early summer, YR 1	X				Contractor or SNA staff	LCCMR, LOHC, bonding or partner	1
2.2.1b		Wick-apply herbicide to foliage in fall YR 1	X				Contractor or SNA staff	LCCMR, LOHC, bonding or partner	1
2.2.1c		Rx burn following wick, in fall YR 1 or Spring YR 2	X				SNA staff	LCCMR, SWG	1
2.2.1d		Second wick apply herbicide to foliage in YR 2	X				Contractor or SNA staff	LCCMR, LOHC, bonding or partner	1
2.2.1e		Re-seed into bare areas	X				SNA staff or contractor	LCCMR, LOHC, bonding or partner	1
2.2.2		**Restore OW1, OW2 & OW3 to FDs37**	X						3
2.2.2a		Cut BT & HS stems greater than 1/2" diameter. In OW2 thin red cedar.	X				SNA staff, MCC, partner or contractor	LCCMR, LOHC, bonding or partner	3
2.2.2b		Stump treat (see Appendix D)	X				Contractor or SNA staff	LCCMR, LOHC, bonding or partner	3

TABLE 9. HASTINGS SAND COULEE, NORTH MANAGEMENT PLAN - IMPLEMENTATION FRAMEWORK (Continued)

Refer to Tables 7 & 8, and to Map 6.

#	Activity Type	Activity Description	Phase I Year 1-2 (2012-2013)	Phase II Year 3-5 (2014-2016)	Phase III Year 6-10 (2017-2021)	Ongoing (every year or as scheduled)	Proposed Personnel	Proposed Funding	Priority
2.2.2c		Stack removed brush and burn piles at same time	X				SNA staff, MCC, partner or contractor	LCCMR, LOHC, bonding or partner	3
2.2.2d		Re-seed into bare areas	X				SNA staff or contractor	LCCMR, LOHC, bonding or partner	3
2.2.3		Rx burn every 2-5 years until woody seedlings are controlled	X	X			SNA staff	LCCMR, SWG	3
2.2.4		Rx burn rotation approx every 9 years, long term	X			X See above	SNA staff	LCCMR, SWG	3
2.2.5		Control invasives: spot spray, hand pull	X			X	SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	3
2.3	Southern Dry-Mesic Oak Forest (MHs37) restoration								
2.3.1		**Restoration of units OF1, OF2 to MHs37**	X See above						2
2.3.1a		Mow brush in early summer, YR 1	X				SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	2
2.3.1b		Wick-apply herbicide to foliage in fall YR 1	X				SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	2
2.3.1c		Rx burn following wick, in fall YR 1 or Spring YR 2	X				SNA staff	LCCMR, SWG	2
2.3.1d		Second wick apply herbicide to foliage in YR 2	X				SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	2
2.3.1e		Cut BT & HS stems greater than 1/2" diameter (YR1).	X				SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	2

TABLE 9. HASTINGS SAND COULEE, NORTH MANAGEMENT PLAN - IMPLEMENTATION FRAMEWORK (Continued)

Refer to Tables 7 & 8, and to Map 6.

#	Activity Type	Activity Description	Phase I Year 1-2 (2012-2013)	Phase II Year 3-5 (2014-2016)	Phase III Year 6-10 (2017-2021)	Ongoing (every year or as scheduled)	Proposed Personnel	Proposed Funding	Priority
2.3.1f		Stump treat YR 1. Only use glyphosate in a very targeted manner to reduce collateral damage to natives (see Appendix D)	X				SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	2
2.3.1g		Stack removed brush and burn piles at same time (YR1)	X				SNA staff, partner or contractor	LCCMR, LOHC, bonding or partner	2
2.3.1h		Re-seed into bare areas (YR 1 and 2)	X				SNA staff, partner or contractor	LCCMR, LOHC, bonding or partner	2
2.3.1i		Rx burn every 2-5 years until woody seedlings are controlled	X				SNA staff	LCCMR, SWG	2
2.3.1j		Rx burn rotation approx every 9 years, long term	X			X	SNA staff	LCCMR, SWG	2
2.3.1k		Control invasives: spot spray, hand pull	X			X	SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	2
2.3.2		**Restoration of SGT unit to MHs37**			X				3
2.3.2a		Remove trees and brush			X		SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	3
2.3.2b		Stump treat elm, buckthorn, exotic honeysuckle, green ash.			X		SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	3
2.3.2c		Subsoil former driveway to reduce soil compaction			X		SNA staff, MCC, partner or contractor	LCCMR, LOHC, bonding or partner	3
2.3.2d		Prepare burn breaks			X		SNA staff	LCCMR, SWG	3

TABLE 9. HASTINGS SAND COULEE, NORTH MANAGEMENT PLAN - IMPLEMENTATION FRAMEWORK (Continued)

Refer to Tables 7 & 8, and to Map 6.

#	Activity Type	Activity Description	Phase I Year 1-2 (2012-2013)	Phase II Year 3-5 (2014-2016)	Phase III Year 6-10 (2017-2021)	Ongoing (every year or as scheduled)	Proposed Personnel	Proposed Funding	Priority
2.3.2e		Conduct Rx burn			X		SNA staff	LCCMR, SWG	3
2.3.2f		Broadcast apply herbicide to remove brome grass and daylilies			X		SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	3
2.3.2g		Burn or mow			X		SNA staff	LCCMR, SWG	3
2.3.2h		Collect seed (from Sand Coulee SNA and/or Grey Cloud SNA and/or Lost Valley SNA)			X		SNA staff, partner or contractor	LCCMR, LOHC, bonding or partner	3
2.3.2i		Broadcast seed onto sites or seed drill			X		SNA staff, partner or contractor	LCCMR, LOHC, bonding or partner	3
2.3.2j		Establishment: 3 mowings 1st season, spring mow 2nd season, spring burn 3rd season.			X		SNA staff, partner or contractor	LCCMR, LOHC, bonding or partner	3
2.3.2k		Control invasives: spot spray starting 2nd season.			X		SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	3
2.4	Southern Mesic Prairie (UPs23) restoration	Restoration of units GSH and GR1 to UPs23			X				3
2.4a		Remove trees and brush. Stump treat with herbicide.			X		SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	3
2.4b		Prepare burn breaks			X		SNA staff	LCCMR, SWG	3
2.4c		Conduct Rx burn on units GT1, GR2, and GR3 in late spring, YR 1			X		SNA staff	LCCMR, SWG	3

TABLE 9. HASTINGS SAND COULEE, NORTH MANAGEMENT PLAN - IMPLEMENTATION FRAMEWORK (Continued)

Refer to Tables 7 & 8, and to Map 6.

#	Activity Type	Activity Description	Phase I Year 1-2 (2012-2013)	Phase II Year 3-5 (2014-2016)	Phase III Year 6-10 (2017-2021)	Ongoing (every year or as scheduled)	Proposed Personnel	Proposed Funding	Priority
2.4d		Mow in late summer, YR 1			X		SNA staff, partner or contractor	LCCMR, LOHC, bonding or partner	3
2.4e		Collect seed (from Sand Coulee SNA and/or Grey Cloud SNA and/or Lost Valley SNA) YR 1			X		SNA staff, partner or	LCCMR, LOHC, bonding or partner	3
2.4f		Late spring burn, YR 2			X		SNA staff	LCCMR, SWG	3
2.4g		Broadcast seed onto sites or seed drill YR 2			X				3
2.4h		Control invasives			X	X	SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	3
2.5	Dry Sand-Gravel Prairie, southern (UPs13b) restoration/maintenance	Restoration/maintenance of SGP1, SGP2, SGP3, & SGP4.							1
2.5a		Rx burn every 3-5 years for long-term mgmt.	SGP1, SGP2	SGP3, SGP4			SNA staff	LCCMR, SWG	1
2.5b		Control invasives by hand-pulling and seed-head collecting as needed	SGP1, SGP2	SGP3, SGP4			SNA staff, MCC, partner or contractor	Invasives, LCCMR, NFWF	1
3	Nat Res Protection								
4	SGCN Pop.								
5	Water Feature								
6	Grazing								

TABLE 9. HASTINGS SAND COULEE, NORTH MANAGEMENT PLAN - IMPLEMENTATION FRAMEWORK (Continued)

Refer to Tables 7 & 8, and to Map 6.

#	Activity Type	Activity Description	Phase I Year 1-2 (2012-2013)	Phase II Year 3-5 (2014-2016)	Phase III Year 6-10 (2017-2021)	Ongoing (every year or as scheduled)	Proposed Personnel	Proposed Funding	Priority
ADMINISTRATION ACTIVITIES									
1a	Plan	Complete invasives inventory	X		Update as needed		Contractor	Invasives	2
1b	Plan	Complete bird inventory	X		Update as needed		Contractor	Federal SWG	2
1c	Plan	Complete Management Plan	Final (by 2011)		Update as needed		SNA staff or contractor	LCCMR or federal SWG	1
1d	Plan	Prepare burn plan & get approval	X	X	X	X	SNA staff	[Same as Rx Burn project $s above]	1
2a	Monitor	Monitor for invasives & other management needs				X	SNA staff & site steward	Invasives, general, donated time	3
2b	Monitor	Monitor restoration site establishment		X	X		SNA staff, partner, contractor	[Same as project $s above]	2
2c	Monitor	Monitor for rules infractions				X	Conservation officer, SNA staff & site steward	General & donated time	2
2d	Monitor	Monitor listed species & selected species in greatest conservation need (SGCN)			X	X	DNR, partners & contractors	SWG, NFWF, other tbd	1
2d.1		Establish transects within NPC's	X	X			DNR, partners & contractors	SWG, NFWF, other tbd	1
		Monitor plant species in transects	X	X	X	X	DNR, partners & contractors	SWG, NFWF, other tbd	1
3a	PR	Identify & establish relations with neighbors & site steward		X		X	SNA staff or partners	General or partner	1
3b	PR	Host guided walking tour		X	X		SNA staff or partners	Partner, other tbd	2

TABLE 9. HASTINGS SAND COULEE, NORTH MANAGEMENT PLAN - IMPLEMENTATION FRAMEWORK (Continued)

Refer to Tables 7 & 8, and to Map 6.

#	**Activity Type**	**Activity Description**	**Phase I** **Year 1-2** (2012-2013)	**Phase II** **Year 3-5** (2014-2016)	**Phase III** **Year 6-10** (2017-2021)	**Ongoing** (every year or as scheduled)	Proposed **Personnel**	Proposed Funding	**Priority**
4	Special Permits	Review & issue permits for entry into sanctuary				X	SNA-Eco staff	General	
5a	Acquisition	Acquire new access easement		X			SNA & LAM staff	Bonding, donation	
5b	Acquisition	Acquire addition to unit		As available	As available		SNA & LAM staff, partners	LCCMR, LOHC, bonding, partner, donation, other	

INFORMATION SOURCES

http://www.dnr.state.mn.us/nr/index.html - Natural Resources Index (includes: Animals, ECS, Forests, Invasive Species, Native Plant Communities, Plants, Rare Species Guide, Rocks & Minerals, Watershed Information, additional fact sheets and information)

http://www.dnr.state.mn.us/npc/status.html - Native Plant Communities Status

Rare Species Information:

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PMPOA0K160

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PDASC02020

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PDCPP08030

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PDCIS040E0

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PDONA0C150

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PDORO04060

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IILEP65050

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IILEPJ6040

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=PDSCR09030

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=ABPBR01030

http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=ARADB07010

Geologic Information:

Geologic Atlas, Dakota County, Minnesota. 1990. Edited by Balaban, N. H., and Hobbs, H. C. University of Minnesota, St. Paul.

Mossler. 1990. *Bedrock Geology*. Atlas C-6, Plate 2.

Hobbs, Howard C., Aronow, Saul, and Patterson, Carrie J. 1990. *Surficial Geology*. Atlas C-6, Plate 3.

Bloomberg, Bruce A., Hobbs, Howard C., Mossler, John H., Patterson, Carrie J. 1990. *Depth to Bedrock and Bedrock Topography.* Atlas C-6, Plate 4.

Palen, Barbara M. 1990. *Quaternary Hydrogeology.* Atlas C-6, Plate 5.

Palen, Barbara M. 1990. *Bedrock Hydrogeology*. Atlas C-6, Plate 6.

Hobbs, Howard C. 1990. *Sensitivity of the Prairie Du Chien-Jordan Aquifer to Pollution*. Atlas C-6, Plate 7.

Mossler, John H. 1990. *Geologic Resources*. Atlas C-6, Plate 9.

Soils Information:

Hundley, Steven J. April 1983. *Soil Survey of Dakota County, Minnesota.* United States Department of Agriculture, Soil Conservation Service in cooperation with the Minnesota Agricultural Experiment Station.

United States Department of Agriculture, Natural Resources Conservation Service, Web Soil Survey, http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Plant Community and Ecological Classification System Information:

Aaseng, Norman, John Almendinger, Robert Dana, Thomas Robert Klein, Michael Lee, Daniel Wovcha. 2005. *Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Forest Province.* Minnesota Department of Natural Resources: Minnesota County Biological Survey (MCBS), Division of Ecological Services, Division of Forestry, and Natural Heritage and Nongame Research Program.

Dunevitz H. and C. Lane. 2004. Species lists for Terrestrial and Palustrine Native Plant Communities in East-Central Minnesota. MN Department of Natural Resources, Great River Greening, Ecological Strategies. St. Paul, MN.

Texler, Hannah. April 21, 1985. *Sand Coulee Prairie*

Texler, Hannah. September 6, 2005. *Hastings Sand Coulee: Preserve Design and Management Needs Summary.*

http://www.dnr.state.mn.us/ecs/index.html - Ecological Classification System

http://www.dnr.state.mn.us/eco/mcbs/biodiversity_guidelines.html - Biodiversity Status

Minnesota DNR. August 7, 2009. Guidelines for Assigning Statewide Biodiversity Significance Ranks to Minnesota County Biological Survey Sites.

Minnesota Department of Natural Resources, 2006. *Tomorrow's Habitat for the Wild and Rare: An Action Plan for Minnesota Wildlife, Comprehensive Wildlife Conservation Strategy.* Division of Ecological Services, Minnesota department of Natural Resources.
http://files.dnr.state.mn.us/assistance/nrplanning/bigpicture/cwcs/chapters_appendix/tomorrows_habitat_toc.pdf

http://www.dnr.state.mn.us/npc/index.html - Native Plant Communities Guides

http://plants.usda.gov - Plant species ranges and nomenclature information

http://wisplants.uwsp.edu/ - Robert W. Freckmann Herbarium, University of Wisconsin - Stevens Point

Invasive Species Information

http://www.dnr.state.mn.us/rsg/index.html - Invasive Species Guide

http://mipn.org/ - Midwest Invasive Plant Network

www.weedcenter.org - Center for Invasive Plant Management

Historic Aerial Photo Sources

U of Minnesota Borchert Library

S-76 Wilson Library

309 19th Ave. South

Minneapolis, MN 55455

(612) 624-4549
FAX: (612) 626-9353
E-mail: mapref@umn.edu
http://map.lib.umn.edu/

SNA Legislation Statutes and Rules

Minnesota Statute 86A.05 (1997)
https://www.revisor.mn.gov/statutes/?id=86A.05

APPENDIX A. Plant Species Recorded

The species recorded at the Hastings Sand Coulee SNA are listed below according to the land cover units shown in Map 5. With the exception of the sand-gravel prairie units, all records were from surveys conducted in May and June 2011 by Friends of the Mississippi River (FMR). The sand gravel species is based on the DNR county biological survey data, with additions made by FMR since 2004.
Relative coverages for all species was generalized for the entire unit, using approximately the same coverage codes as standard releves: **+ = less than 1%, 1 = 1-5%, 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, 5 = 75-100%.**

ALTERED/DISTURBED FOREST (DF)

Not Native	Family	Scientific name	Common name	Cover
	Canopy & Subcanopy			
	Rosaceae	*Amelanchier sp.*	Serviceberry	+
	Ulmaceae	*Celtis occidentalis*	Hackberry	1
	Cupressaceae	*Juniperus virginiana*	Easter redcedar	2
	Salicaceae	*Populus tremuloides*	Quaking aspen	1
	Fagaceae	*Quercus macrocarpa*	Bur oak	2
	Ulmaceae	*Ulmus americana*	American elm	+
	Shrub Layer			
X	Caprifoliaceae	*Lonicera tatarica*	Tartarian honeysuckle	2
	Rosaceae	*Prunus virginiana*	Chokecherry	1
X	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	3
	Rosaceae	*Rubus* complex	Blackberry	1
	Ground Layer			
	Forbs			
	Rubiaceae	*Galium aparine*	Clevers	+
	Rosaceae	*Geum canadense*	White avens	+
	Liliaceae	*Maianthemum racemosum*	False Solomon's seal	+
	Liliaceae	*Uvularia sesselifolia*	Sessile-leaved bellwort	+
	Violaceae	*Viola sororia.*	Common violet	+
	Woody			
X	Caprifoliaceae	*Lonicera tatarica*	Tartarian honeysuckle	+
	Rosaceae	*Prunus virginiana*	Chokecherry	+
X	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	3
	Grossulariaceae	*Ribes cynosbati*	Prickly gooseberry	+

ALTERED/DISTURBED WOODLAND (DW)

Not Native	Family	Scientific name	Common name	Cover
	Canopy & Subcanopy			
	Aceraceae	*Acer negundo*	Boxelder	1
	Oleaceae	*Fraxinus pennsylvanica*	Green ash	1
	Cupressaceae	*Juniperus virginiana*	Easter redcedar	3
X	Caprifoliaceae	*Lonicera tatarica*	Tartarian honeysuckle	1
	Salicaceae	*Populus tremuloides*	Quaking aspen	1
	Facaceae	*Quercus ellipsoidalis*	Northern pin oak	1
	Ulmaceae	*Ulmus americana*	American elm	1
x	Ulmaceae	*Ulmus pumila*	Siberian elm	1
	Shrub Layer			
	Betulaceae	*Corylus americana*	American hazel	+
	Rosaceae	*Prunus americana*	American plum	1
	Rosaceae	*Prunus pensylvanica*	Pin cherry	1

X	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	3
	Anacariaceae	*Rhus glabra*	Smooth sumac	1
x	Ulmaceae	*Ulmus pumila*	Siberian elm	1
	Ground Layer			
	Forbs			
	Asteraceae	*Achillea millefolium*	Common yarrow	+
	Ranunculaceae	*Anemone quinquefolia*	Wood anemone	+
	Asteraceae	*Antennaria plantaginafolia*	Plantained leaved pussytoes	+
	Asteraceae	*Artemesia campestris*	wormwood	+
	Asteraceae	*Aster laevis*	Smooth blue aster	+
	Asteraceae	*Aster oolentangiensis*	Sky-blue aster	+
	Rosaceae	*Fragaria virginiana*	Strawberry	+
	Rubiaceae	*Galium triflorum*	Sweet scented bedstraw	+
	Rosaceae	*Geum* cf. *canadense*	White avens	+
	Saxifrageaceae	*Heuchera richardsonii*	Alumroot	+
	Asteraceae	*Hieracium longipilum*	Long-beard hawkweed	+
	Lamiaceae	*Monarda fistulosa*	Wild bergamot	+
	Lamiaceae	*Monarda fistulosa*	Wild bergamot	+
	Onagraceae	*Oenothera biennis*	evening primrose	+
	Liliaceae	*Polygonatum biflorum*	Solomon's seal	+
	Rosaceae	*Potentilla sp.*	Potentilla	+
	Ranuculaceae	*Ranunculus arbortivis*	Buttercups	+
	Ranunculaceae	*Ranunculus* cf. *abortivus*	Littleleaf buttercup	+
	Asteraceae	*Ratibida pinnata*	Grey-headed coneflower	+
	Apiaceae	*Sanicula marilandica*	Black snakeroot	+
X	Asteraceae	*Taraxacum officianale*	Common dandelion	+
	Liliaceae	*Uvularia sessilifolia*	Sessile-leaved bellwort	+
	Violaceae	*Viola sororia*	Hairy wood violet	+
	Graminoids			
	Poaceae	*Bromus inermis*	Smooth brome	1
	Cyperaceae	*Carex pensylvanica*	Pennsylvania sedge	1
	Poaceae	*Oryzopsis* cf. *pungens*	Rice grass cf. mountain	+
X	Poaceae	*Poa pratensis*	Kentucky bluegrass	1
	Poaceae	*Schizachyrium scoparium*	Little bluestem	+
	Ferns and Allies			
	Equisetaceae	*Equisetum hyemnale*	Scouring rush	+
	Violaceae	*Viola sp.*	Violet	+
	Bryophytes			
	Bryophyta		Moss	1
	Woody			
	Vitaceae	*Parthenocissus quinquefolia*	Virginia creeper	+
	Anacardiaceae	*Toxicodendron radicans*	Poison ivy	1

CROPLAND (CROP)

Not Native	Family	Scientific name	Common name	Cover
X	Fabaceae	*Trifolium pratense*	Red clover	2

DRY SAND-GRAVEL PRAIRIE (SGP)

Relative coverages were not assessed for sand gravel prairie species.

Not Native	Family	Scientific name	Common name
	Trees, shrubs, & vines		
	Fabaceae	*Amorpha canescens*	Leadplant
	Rhamnaceae	*Ceanothus americanus*	New Jersey tea
	Cornaceae	*Cornus racemosa*	Gray dogwood
	Cupressaceae	*Juniperus virginiana*	Red cedar
x	Caprifoliaceae	*Lonicera tartarica*	Tartarian honeysuckle
	Roseaceae	*Prunus pumila*	sand cherry
	Fagaceae	*Quercus macrocarpa*	Bur oak
x	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn
	Anarcardiaceae	*Rhus glabra*	smooth sumac
	Anarcardiaceae	*Rhus rydbergii*	poison ivy
	Roseaceae	*Rosa arkansana*	prairie rose
	Roseaceae	*Rosa blanda*	smooth rose
	Roseaceae	*Rubus occidentalis*	black raspberry
	Salicaceae	*Salix humilus*	Prairie willow
	Caprifoliaceae	*Symphoricarpus occidentalis*	wolfberry
x	Ulmaceae	*Ulmus pumila*	Siberian elm
	Forbs		
	Asteraceae	*Achillea millefolium*	yarrow
	Lamiaceae	*Agastache foeniculum*	Wild anise
	Asteraceae	*Ambrosia psilostachya*	western ragweed
	Primulaceae	*Androsace occidentalis*	western rock jasmine
	Ranunculaceae	*Anemone caroliniana*	Carolina anemone
	Ranunculaceae	*Anemone cylindrica*	thimbleweed
	Asteraceae	*Antennaria neglecta*	Field pussytoes
	Asteraceae	*Antennaria plantaginifolia*	plantain-leaved pussytoes
	Brassicaceae	*Arabis cf hirsuta*	rock cress
	Asteraceae	*Artemisia campestris*	wormwood
	Asteraceae	*Artemisia ludoviciana*	prairie sage
	Asclepiaceae	*Asclepias syriaca*	common milkweed
	Asclepiaceae	*Asclepias viridiflora*	green milkweed
	Asclepiaceae	*Asclepias verticillata*	whorled milkweed
	Asteraceae	*Aster ericoides*	heath aster
	Asteraceae	*Aster oolentengiensis*	sky-blue aster
	Asteraceae	*Aster sericeus*	silky aster
	Fabaceae	*Astragalus canadensis*	Canadian milk-vetch
	Fabaceae	*Astragalus crassicarpus*	Prairie plum/bufflalo bean
	Campanulaceae	*Campanula rotundifolia*	harebell
X	Asteraceae	*Carduus nutans*	musk thistle
X	Asteraceae	*Centaurea maculosa*	spotted knapweed
X	Chenopodiaceae	*Chenopodium album*	lamb's quarters
	Chenopodiaceae	*Chenopodium leptophyllum*	goosefoot
	Asteraceae	*Chrysopsis villosa* (*Heterotheca*)	golden aster
	Asteraceae	*Cirsium discolor*	field thistle
	Santalaceae	*Comandra umbellata*	bastard toadflax
	Asteraceae	*Conyza canadensis*	horseweed
	Asteraceae	*Coreopsis palmata*	prairie coreopsis
	Fumariaceae	*Corydalis aurea*	golden corydalis
x	Asteraceae	*Crepis tectorum*	narrow-leaved hawkweed
	Chenopodiaceae	*Cycloloma atriplicifolium*	winged pigweed

	Fabaceae	*Dalea candidum*	white prairie-clover
	Fabaceae	*Dalea purpureum*	purple prairie-clover
	Fabaceae	*Dalea villosum*	silky prairie-clover
	Ranunculaceae	*Delphinium virescens*	prairie larkspur
	Brassicaceae	*Draba reptans*	Carolina whitlow grass
	Asteraceae	*Erigeron strigosus*	daisy fleabane
	Brassicaceae	*Erysimum cf cheiranthoides*	wormseed mustard
	Euphorbiaceae	*Euphorbia corollata*	flowering spurge
	Euphorbiaceae	*Euphorbia cyathophora*	fire on the mountain
	Euphorbiaceae	*Euphorbia dentata*	toothed spurge
	Euphorbiaceae	*Euphorbia geyeri*	dune spurge
	Linaceae	*Linum sulcatum*	grooved yellow flax
	Amaranthaceae	*Froelichia floridana*	cottonweed
	Gentianaceae	*Gentiana cf puberula*	downy gentian
	Roseaceae	*Geum triflorum*	prairie smoke
	Asteraceae	*Gnaphalium obtusifolium*	fragrant cudweed
	Lamiaceae	*Hedeoma hispida*	rough pennyroyal
	Cistaceae	*Helianthemum bicknellii*	Hoary frostweed
	Asteraceae	*Helianthus rigidus*	stiff sunflower
	Asteraceae	*Heliopsis helianthoides*	early sunflower
	Saxifragaceae	*Heuchera richardsonii*	alum root
	Rubiaceae	*Houstonia longiflolia*	long-leaved houstonia (bluet)
	Asteraceae	*Kuhnia eupatorioides*	false boneset
X	Asteraceae	*Lactuca ludoviciana*	prairie lettuce
	Cistaceae	*Lechea cf stricta*	prairie pinweed
	Brassicaceae	*Lepidium densiflorum*	peppergrass
	Fabaceae	*Lespedeza capitata*	round-headed bushclover
	Asteraceae	*Liatris aspera*	rough blazingstar
	Asteraceae	*Liatris ligulisytlis*	meadow blazingstar
	Asteraceae	*Liatris punctata*	dotted blazingstar
	Linaceae	*Linum sulcatum*	grooved yellow flax
	Orchidaceae	*Liparis cf loeselii*	Loesel's twayblade
	Boraginaceae	*Lithospermum carolinense*	hairy puccoon
	Boraginaceae	*Lithospermum incisum*	narrow-leaved puccoon
	Campanulaceae	*Lobelia spicata*	Pale spiked lobelia
X	Fabaceae	*Melilotus alba*	white sweet-clover
X	Fabaceae	*Melilotus officinalis*	yellow sweet-clover
	Nyctaginaceae	*Mirabilis hirsuta*	hairy umbrella-wort
	Nyctaginaceae	*Mirabilis nyctanginea*	four-o-clock
	Lamiaceae	*Monarda fistulosa*	bergamot
X	Aizoaceae	*Mullogo verticillata*	carpetweed
X	Lamiaceae	*Nepetea cartaria*	catnip
	Onagraceae	*Oenothera biennis*	evening primrose
	Onagraceae	*Oenothera clelandii*	primrose
	Oxalidaceae	*Oxalis violacea*	violet wood-sorrel
	Scrophulariaceae	*Penstemon gracilis*	slender penstemon
	Scrophulariaceae	*Penstemon grandiflora*	large-flowered penstemon
	Polemoniaceae	*Phlox pilosa*	Prairie phlox
	Solanaceae	*Physalis heterophylla*	clammy ground-cherry
	Solanaceae	*Physalis virginiana*	Virginia ground cherry
x	Plantaginaceae	*Plantago purshii*	wooly plantain
	Capparaceae	*Polanisia dodecandra*	clammy weed
	Polygalaceae	*Polygala polygama*	racemed milkwort
	Liliaceae	*Polygonatum biflorum*	Solomon's seal
X	Polygonaceae	*Polygonum convolvulus*	black bindweed
	Polygonaceae	*Polygonum ramosissimum*	bushy knotweed

	Roseaceae	*Potentilla arguta*	tall potentilla
	Roseaceae	*Potentilla norvegica*	rough cinquefoil
	Asteraceae	*Ratibida pinnata*	prairie coneflower
X	Caprifoliaceae	*Saponaria officinalis*	soapwort
	Scrophulariaceae	*Scrophularia lanceolata*	figwort
	Lamiaceae	*Scutellaria parvula*	prairie skullcap
	Selaginellaceae	*Selaginella rupestris*	rock spike-moss
	Asteraceae	*Senecio cf plattensis*	ragwort
	Caryophyllaceae	*Silene antirrhina*	sleepy catchfly
X	Caryophyllaceae	*Silene latifolia*	white campion
X	Caryophyllaceae	*Silene cserei*	bladder campion
	Iridaceae	*Sisyrinchium sp*	Blue-eyed grass
	Liliaceae	*Smilacina racemosa*	false Solomon's seal
	Liliaceae	*Smilacina stellata*	starry false-solomon's seal
	Asteraceae	*Solidago gigantea*	late goldenrod
	Asteraceae	*Solidago missouriensis*	Missouri goldenrod
	Asteraceae	*Solidago nemoralis*	gray goldenrod
	Asteraceae	*Solidago rigida*	stiff goldenrod
	Asteraceae	*Solidago speciosa*	showy goldenrod
	Lamiaceae	*Teucrium canadense*	germander
	Commelinaceae	*Tradescantia occidentalis*	western spiderwort
X	Asteraceae	*Tragopogon dubius*	goat's beard
X	Fabaceae	*Trifolium arvense*	rabbit-foot clover
X	Fabaceae	*Trifolium pratense*	red clover
X	Scrophulariaceae	*Verbascum thapsus*	common mullein
	Verbenaceae	*Verbena stricta*	hoary vervain
x	Fabaceae	*Vicia cracca*	cow vetch
	Violaceae	*Viola pedata*	birds-foot violet
	Violaceae	*Viola pedatifida*	Prairie violet
	Graminoids		
x	Poaceae	Agropyron repens	quack grass
	Poaceae	*Andropogon gerardii*	big bluestem
	Poaceae	*Aristida basimirea*	three awned grass
	Poaceae	*Bouteloua curtipendula*	sideoats grama
	Poaceae	*Bouteloua hirsuta*	hairy grama
X	Poaceae	*Bromus inermis*	smooth brome
	Poaceae	*Calamovilfa longifolia*	sand reedgrass
	Cyperaceae	*Carex muhlenbergii*	muhly sedge
	Cyperaceae	*Carex pennsylvanica*	Pennsylvania sedge
	Poaceae	*Cenchrus longispinus*	sandbur
	Cyperaceae	*Cyperus lupulinus*	nutsedge
X	Cyperaceae	*Cyperus schweinitzii*	nutsedge
x	Poaceae	*Digitaria sp*	crab-grass
	Poaceae	*Elymus canadensis*	Canada wild rye
	Equiseteaceae	*Equisetum laevigatum*	horsetail
	Poaceae	*Eragrostis spectabilis*	purple lovegrass
	Poaceae	*Koeleria macrantha*	junegrass
	Poaceae	*Leptoloma cognatum*	fall witch-grass
	Poaceae	*Panicum linearifolium*	linear leaved panic grass
	Poaceae	*Panicum oligosanthes*	Scribner's panic grass
	Poaceae	*Panicum perlongum*	Long-leaved panic grass
	Poaceae	*Panicum virgatum*	switchgrass
X	Poaceae	*Poa compressa*	Canada bluegrass
x	Poaceae	*Poa pretensis*	Kentucky bluegrass
	Poaceae	*Schizachrium scoparium*	little bluestem

	Poaceae	*Sorghastrum nutans*	Indiangrass
	Poaceae	*Sporobolis heterolepis*	prairie dropseed
	Poaceae	*Sporobolus cryptandrus*	sand dropseed
	Poaceae	*Stipa spartea*	porcupine grass
	Rare Plant species		
SPC	Asteraceae	*Antennaria parvifolia*	small-leaved pussytoes
SPC	Poaceae	*Aristida tuberculosa*	sea-beach needlegrass
SPC	Asclepiaceae	*Asclepias amplexicaulis*	clasping milkweed
T	Scrophulariaceae	*Besseya bullii*	Kittentails
R	Asteraceae	*Hieracium longipilum*	long-bearded hawkweed
E	Cistaceae	*Lechea tenuifolia*	narrow-leaved pinweed
R	Scrophulariaceae	*Linaria canadensis*	old field toadflax
SPC	Onagraceae	*Oenothera rhombipetala*	rhombic-petaled eve primrose
SPC	Orobanchaceae	*Orobanche fasciculata*	clustered broomrape
E	Capparaceae	*Polanisia jamesii*	James's polanisia

E = Endangered, T=Threatened, SPC= Special concern, R= Rare, but no official State status

GRASSLAND—DOMINATED BY BROME WITH SCATTERED SHRUBS (GSH)

Not Native	Family	Scientific name	Common name	Cover
	Canopy and Subcanopy Layer			
	Cupressaceae	*Juniperus virginiana*	Eastern redcedar	1
	Rosaceae	*Malus spp.*	Crabapple	+
	Pinaceae	*Pinus resinosa*	Red pine	+
X	Pinaceae	*Pinus sylvestris*	Scotch pine	+
	Fagaceae	*Quercus macrocarpa*	Bur oak	1
X	Ulmaceae	*Ulmus pumila*	Siberian elm	1
	Shrub Layer			
	Fabaceae	*Amorpha canescens*	Lead plant	+
	Cupressaceae	*Juniperus virginiana*	Eastern redcedar	1
X	Caprifoliaceae	*Lonicera tartarica*	Tartarian honeysuckle	1
X	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	2
	Anarcardiaceae	*Rhus glabra*	Smooth sumac	4
	Rosaceae	*Rosa arkansana*	Prairie rose	+
	Rutaceae	*Zanthoxylum americanum*	Prickly ash	2
	Ground Layer			
	Forbs			
	Asteraceae	*Achillea millefolium*	Common yarrow	1
	Asteraceae	*Antennaria neglecta*	Field pusseytoes	1
	Asteraceae	*Antennaria plantaginifolia*	Plantain-leaved pusseytoes	1
	Asteraceae	*Aster oolentangiensis*	Sky-blue aster	1
	Asteraceae	*Artemisia sp*	Wormwood	1
	Asteraceae	*Cirsium discolor*	Field thistle	1
	Rosaceae	*Fragaria virginiana*	Wild Strawberry	1
	Rosaceae	*Geum triflorum*	Prairie smoke	1
	Asteraceae	*Hieracium longipilum*	Long-beard hawkweed	1
	Fabaceae	*Lespedeza capitata*	Round-headed bushclover	1
	Asteraceae	*Liatris punctata*	Dotted blazingstar	1
	Lamiaceae	*Monarda fistulosa*	Wild bergamot	1
	Asteraceae	*Ratibida pinnata*	Grey-headed coneflower	1
x	Caryophyllaceae	*Saponaria officinalis*	Soapwort	2
	Violaceae	*Viola pedata*	Bird's-foot violet	1
	Violaceae	*Viola pedatifida*	Prairie violet	1
	Graminoids			

	Poaceae	*Andropogon gerardii*	Big bluestem	1
X	Poaceae	*Bromus inermis*	Smooth brome	4

GRASSLAND – DOMINATED BY BROME WITH NATIVE PRAIRIE SPECIES (GR)

Not Native	Family	Scientific name	Common name	Cover
	Trees, shrubs, & vines			
	Aceraceae	*Acer negundo*	Boxelder	+
	Rhamnaceae	*Ceanothus americanus*	New Jersey tea	+
	Oleacea	*Fraxinus pennsylvanica*	Green ash	1
	Cupressaceae	*Juniperus virginiana*	Eastern redcedar	2
X	Caprifoliaceae	*Lonicera tatarica*	Tartarian honeysuckle	1
	Pinaceae	*Pinus resinosa*	Red pine	+
	Rosaceae	*Prunus serotina*	Black cherry	+
	Fagaceae	*Quercus ellipsoidales*	Northern pin oak	+
	Fagaceae	*Quercus macrocarpa*	Bur oak	+
	Anacardiaceae	*Rhus glabra*	Smooth sumac	1
	Rosaceae	*Rosa arkansana*	Prairie rose	+
	Rosaceae	*Rubus* complex	Blackberry	1
	Anacardiaceae	*Toxicodendron radicans*	Poison ivy	1
	Vitaceae	*Vitis riparia*	River bank grape	+
	Forbs			
	Asteraceae	*Achillea millefolium*	Common yarrow	+
	Asteraceae	*Ambrosia psylostachya*	Western ragweed	+
	Asteraceae	*Antennaria plantaginafolia*	Plantain-leaved pusseytoes	+
	Brassicaceae	*Arabis* cf. *hirsuta*	Rockcress	+
	Asteraceae	*Artemesia campestris*	Wormwood	+
	Asteraceae	*Aster oolentangiensis*	Sky-blue aster	+
	Asteraceae	*Aster oolentangiensis*	Sky-blue aster	+
	Scrophulareacea	*Besseya bullii*	Kittentails	+
x	Asteraceae	*Centaurea biebersteinii*	Spotted knapweed	1
	Santalaceae	*Comandra umbellata*	Bastard toadflax	+
	Rosaceae	*Geum triflorum*	Prairie smoke	+
	Asteraceae	*Helianthus sp.*	Sunflower	+
	Saxifragaceae	*Heuchera richardsonii*	Allumroot	+
	Asteraceae	*Hieracium longipilum*	Long-beard hawkweed	+
	Boraginaceae	*Lithospermum carolinense*	Hairy pucoon	+
	Lamiaceae	*Monarda fistulosa*	Wild bergamot	+
	Oxalidaceae	*Oxalis violacea*	Violet woodsorrel	+
	Asteraceae	*Ratibida pinnata*	Grey-headed coneflower	+
	Runnunculaceae	*Runnunculus rhomboideus*	Prairie buttercup	+
	Graminoids			
	Poaceae	*Andropogon gerardii*	Big bluestem	1
x	Poaceae	*Bromus inermis*	Smooth brome	2
	Poaceae	*Dicanthelium oligosanthes*	Scribner's panic grass	1
	Poaceae	*Panicum virgatum*	Switchgrass	1
X	Poaceae	*Poa pratensis*	Kentucky bluegrass	2
	Poaceae	*Schizachyrium scoparium*	Little bluestem	1
	Poaceae	*Stipa spartea*	Porcupine grass	1
	Ferns and Allies			
	Equisetaceae	*Equisetum hyemnale*	Scouring rush	+

OAK FOREST (OF)

Not Native	Family	Scientific name	Common name	Cover
	Canopy & Subcanopy Layer			
	Ulmaceae	*Celtis occidentalis*	Hackberry	1
	Cupressaceae	*Juniperus virginiana*	Eastern redcedar	1
X	Pinaceae	*Pinus sylvestris*	Scotch pine	+
	Tiliaceae	*Tilia americana*	American basswood	2
	Fagaceae	*Quercus ellipsoidalis*	Northern pin oak	1
	Facageae	*Quercus macrocarpa*	Bur oak	3
	Ulmaceae	*Ulmus americana*	American elm	1
	Shrub Layer			
	Cupressaceae	*Juniperus virginiana*	Eastern redcedar	1
X	Caprifoliceae	*Lonicera tatarica*	Tartarian honeysuckle	2
	Rosaceae	*Prunus virginiana*	Chokecherry	1
X	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	3
	Ground Layer			
	Forbs			
	Asteraceae	*Antennaria neglecta*	Field pusseytoes	+
	Fumariaceae	*Dicentra cucullaria*	Dutchman's breeches	3
	Asteraceae	*Eupatorium rugosum*	White snake root	1
	Rubiaceae	*Galium aparine*	Clevers	+
	Rubiaceae	*Galium triflorum*	Sweet-scented bedstraw	1
	Rosaceae	*Geum canadense*	White avens	+
	Asteraceae	*Helianthos sp.*	Sunflower	+
	Asteraceae	*Helianthus cf. strumosus*	Cf. Woodland sunflower	+
	Liliaceae	*Maianthemum canadense*	Maianthemum	+
	Liliaceae	*Maianthemum racemosum*	False Solomon's seal	+
	Apiaceae	*Osmorhiza claytonii*	Clayton's sweet cicely	1
	Liliaceae	*Polygonatum biflorum*	Solomon's seal	+
	Ranunculaceae	*Ranunculus arbortivus*	Small-flowered buttercup	+
	Apiaceae	*Sanicula marilandica*	Black snakeroot	+
	Iridaceae	*Sisyrinchium cf. campestre*	Prairie blue-eyed grass	+
	Asteraceae	*Solidago flexicaulis*	Zig-zag goldenrod	+
X	Asteraceae	*Taxacum officianale*	Dandelion	+
	Runuculaceae	*Thalictrum dioicus*	Early meadow rue	+
	Ranunculaceae	*Thalictrum thalictroides*	Rue anemone	+
	Violaceae	*Viola sororia*	Common blue violet	+
	Graminoids			
	Cyperaceae	*Carex* cf. *radiata*	Star sedge	1
	Cyperaceae	*Carex sprengelii*	Sprengel's sedge	3
	Ferns			
	Dryopteridaceae	*Athyrium filix-femina*	Lady fern	1
	Bryophytes			
			Moss	1
	Trees, shrubs, vines			
	Rosaceae	*Prunus virginiana*	Chokecherry	1
	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	3
	Vitaceae	*Parthenocissus quinquefolia*	Virginia creeper	+
	Caprifoliaceae	*Lonicera tatarica*	Honeysuckle	1

OAK WOODLAND-BRUSHLAND (OW Units)

Not Native	Family	Scientific name	Common name	Cover
	Canopy & Subcanopy			
	Rosaceae	*Amelanchier sp.*	Serviceberry	+
	Ulmaceae	*Celtis occidentalis*	Hackberry	1
	Oleaceae	*Fraxinus pennsylvanica*	Green ash	1
	Cupressaceae	*Juniperus virginiana*	Eastern Red cedar*	1
	Salicaceae	*Populus tremuloides*	Quaking aspen	1
	Rosaceae	*Prunus serotina*	Black cherry	+
	Rosaceae	*Prunus virginiana*	Chokecherry	2
	Fagaceae	*Quercus ellipsoidalis*	Northern pin oak	2
	Fagaceae	*Quercus macrocarpa*	Bur oak	3
	Shrub Layer			
x	Caprifoliaceae	*Lonicera tartarica*	Tartarian honeysuckle	2
	Anarcardiaceae	*Rhus glabra*	Smooth sumac	1
	Saxifragaceae	*Ribes missouriensis*	Missouri gooseberry	+
x	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	4
	Rosaceae	*Rubus complex*	Black raspberry	1
	Tiliaceae	*Tilia americana*	American basswood	1
	Anarcardiaceae	*Toxicodendron radicans*	Poison ivy	1
	Ulmaceae	*Ulmus Americana*	American elm	1
	Vitaceae	*Vitus riparia*	Grapevine	+
	Rutaceae	*Zanthoxylum americanum*	Prickly ash	1
	Ground Layer			
	Forbs			
	Asteraceae	*Achillea millefolium*	Common yarrow	+
x	Brassicaceae	*Alliaria petiolata*	Garlic mustard	+
	Ranunculaceae	*Anemone quinquefolia*	Wood anemone	+
	Asteraceae	*Antennaria neglecta*	Field Pusseytoes	+
	Asteraceae	*Antennaria plantaginifolia*	Plantain-lvd pusseytoes	+
	Asteraceae	*Aster laevis*	Smooth blue aster	+
	Asteraceae	*Aster oolentangiensis*	Sky-blue aster	+
x	Brassicaceae	Cf. *Brassica rapa*	Cf. Field mustard	+
	Scrophulariaceae	*Cf. Scrophularia marilandica*	Cf. Eastern Figwort	+
	Fumariaceae	*Dicentra cucullaria*	Dutchman's breeches	+
	Rosaceae	*Fragaria virginiana*	Wild Strawberry	1
	Rubiaceae	*Galium aparine*	cleavers	1
	Rubiaceae	*Galium triflorum*	Fragrant bedstraw	1
	Rosaceae	*Geum* cf. *canadense*	White avens	1
x	Lamiaceae	*Leonurus cardiaca*	Motherwort	1
	Lamiaceae	*Monarda fistulosa*	Wild bergamot	+
	Onagraceae	*Oenothera biennis*	evening primrose	+
	Apiaceae	*Osmorhiza claytonii*	Sweet cicely	1
	Vitaceae	*Parthenossisus quinquefolia*	Virginia creeper	1
	Liliaceae	*Polygonatum biflorum*	Solomon's seal	+
	Rosaceae	*Potentilla sp.*	Potentilla	+
	Ranunculaceae	*Ranunculus* cf. *abortivus*	Littleleaf buttercup	1
	Apiaceae	*Sanicula marilandica*	Black snakeroot	1
x	Caryophyllaceae	*Saponaria officinalis*	Soapwort	1
	Asteraceae	*Solidago canadensis*	Canada goldenrod	1
	Asteraceae	*Solidago flexicaulis*	Zig-zag goldenrod	1
x	Asteraceae	*Taraxacum officianale*	Common dandelion	1
	Urticaceae	*Urtica dioica*	Stinging nettle	1
	Liliaceae	*Uvularia sessilifolia*	Sessile-leaved bellwort	1

	Violaceae	*Viola sororia*	Hairy wood violet	+
	Violaceae	*Viola sp.*	Violet	1
	Graminoids			
	Cyperaceae	*Carex blanda*	Woodland sedge	1
	Cyperaceae	*Carex pensylvanica*	Pennsylvania sedge	2
	Cyperaceae	*Carex sprengelii*	Sprengel's sedge	1
x	Poaceae	*Poa pratensis*	Kentucky bluegrass	1
	Bryophytes			
			Moss	2
	Ferns and Fern Allies			
	Dryopteridaceae	*Athryreum filix-femini*	Lady fern	+
	Woody			
x	Caprifoliaceae	*Lonicera tartarica*	Tartarian honeysuckle	2
	Vitaceae	*Parthenocissus quinquefolia*	Virginia Creeper	+
	Rosaceae	*Prunus virginiana*	Chokecherry	1
x	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	4
	Rosaceae	*Rhubus* cmx	Blackberry	1
	Grossulariaceae	*Ribes cynosbati*	Prickly gooseberry	+

PLANTED CONIFERS (PC)

Not Native	Family	Scientific name	Common name	Cover
	Canopy			
	Pinaceae	*Picea glauca*	White spruce	5
	Subcanopy and Shrub			
X	Aceraceae	*Acer ginnala*	Amur maple	1
	Oleaceae	*Fraxinus pennsylvanica*	Green ash	+
X	Caprifoliaceae	*Lonicera tatarica*	Tartarian honeysuckle	+
X	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	+
	Ground Layer			
X	Poaceae	*Bromus inermis*	Smooth brome	1
X	Plantaganaceae	*Plantago major*	Common plantain	+
X	Poaceae	*Poa pratensis*	Kentucky bluegrass	+
	Asteraceae	*Solidago Canadensis*	Canada goldenrod	1
	Urticaceae	*Urtica dioica*	Stinging nettle	+

SHORT GRASSES WITH MIXED TREES (SGT)

Not Native	Family	Scientific name	Common name	Cover
	Canopy & Subcanopy			
	Aceraceae	*Acer negundo*	Boxelder	+
	Cupressaceae	*Juniperus virginiana*	Eastern redcedar	2
	Fagaceae	*Quercus macrocarpa*	Bur oak	2
	Ulmaceae	*Ulmus americana*	American elm	1
X	Ulmaceae	*Ulmus pumila*	Siberian elm	1
	Shrub Layer			
	Cupressaceae	*Juniperus virginiana*	Eastern redcedar	2
X	Caprifoliaceae	*Lonicera tatarica*	Tartarian honeysuckle	2
X	Ulmaceae	*Ulmus pumila*	Siberian elm	1
	Ground Layer			
	Forbs and Graminoids			

X	Poaceae	*Bromus inermis*	Smooth brome	3
X	Liliaceae	*Hemerocallis lilioasphodelus*	Yellow daylily	1
X	Poaceae	*Poa pratensis*	Kentucky bluegrass	2
	Asteraceae	*Solidago canadensis*	Canada goldenrod	2
	Woody			
X	Caprifoliaceae	*Lonicera tatarica*	Tartarian honeysuckle	1

STORMWATER POND (POND)

Not Native	Family	Scientific name	Common name	Cover
	Forbs and Graminoids			
	Alismataceae	*Sagittaria latifolia*	Common arrowhead	+
	Cyperaceae	*Schoenoplectus tabernaemontani*	Softstem bulrush	+
x	Typhaceae	*Typha x glauca*	Hybrid cattail	2

UPLAND BROME GRASSLAND (LGU)

Not Native	Family	Scientific name	Common name	Cover
	Canopy & Subcanopy			
	Aceraceae	*Acer negundo*	Boxelder	1
	Oleaceae	*Fraxinus pennsylvanica*	Green ash	2
	Pinaceae	*Pinus resinosa*	Red pine	+
	Shrub Layer			
X	Aceraceae	*Acer ginnala*	Amur maple	1
	Cupressaceae	*Juniperus virginiana*	Eastern Red cedar*	1
X	Caprifoliaceae	*Lonicera tartarica*	Tartarian honeysuckle	1
	Anarcardiaceae	*Rhus glabra*	Smooth sumac	+
	Ground Layer			
	Graminoids			
	Poaceae	*Andropogon gerardii*	Big bluestem	+
X	Poaceae	*Bromus inermis*	Smooth brome	5
	Forbs			
	Asteraceae	*Solidago Canadensis*	Canada goldenrod	1

APPENDIX B. Plant Species for Restoration

The following are species lists suitable for use in restoring each of the plant community types shown in Map 6. The lists are based on the *Species Lists for Terrestrial and Palustrine Native Plant Communities in East-central Minnesota (*Dunevitz and Lane 2004), which were developed from releve data. While many of the species listed are not commercially available, it is possible they could be obtained by harvesting from another site. We included all native species even if they are common and likely establish on their own, such as box elder, not so that they would be intentionally added to a site but so that they are recognized as belonging to the community. There was NO list developed for the sand-gravel prairie, as the suitable species for that will be the same species that exist on the site, as listed in Appendix A. The codes for tables are:

1 See the report for instructions for using these species lists
3 Frequency: Number of releve plots in which species occurs divided by total number of releve plots, multiplied by 100
4 Abundance: Average percent cover of species within the community. It is most appropriate to interpret each value as a cover class similar to those used for original data collection (see text of report for more details)
5 Index of Commonness: Frequency multiplied by Abundance

Southern Mesic Prairie UPs23

Genus	Species	Common Name	[3]Freq	[4]Abund	[5]Index
Shrubs					
Amorpha	*canescens*	Lead-plant	58	10	580
Amorpha	*nana*	Fragrant false indigo	8	1	8
Prunus	*virginiana*	Chokecherry	8	1	8
Rosa	*arkansana*	Prairie rose	8	1	8
Rosa	cmx.	Smooth wild rose	58	3	174
Salix	*humilis*	Prairie willow	8	3	24
Symphoricarpos	cmx.	Snowberry	8	3	24
			25	4	100
Grasses, Rushes and Sedges					
Andropogon	*gerardii*	Big bluestem	100	30	3000
Bromus	*kalmii*	Kalm's brome	25	2	50
Carex	*bicknellii*	Bicknell's sedge	33	6	198
Carex	*muhlenbergii*	Muhlenberg's sedge	8	15	120
Carex	*meadii*	Mead's sedge	17	3	51
Carex	*tenera*	Marsh-straw sedge	17	3	51
Elymus	*wiegandii*	Canada wild rye	25	2	50
Elymus	*trachycaulus*	Slender wheatgrass	8	3	24
Eragrostis	*spectabilis*	Purple lovegrass	8	3	24
Muhlenbergia	*mexicana*	Mexican satin-grass	8	5	40
Panicum	*oligosanthes*	Few-flowered panic grass	33	4	132
Panicum	*virgatum*	Switchgrass	17	4	68
Panicum	*perlongum*	Long-leaved panic grass	8	3	24
Schizachyrium	*scoparium*	Little bluestem	33	13	429
Sorghastrum	*nutans*	Indian grass	100	21	2100
Sporobolus	*heterolepis*	Prairie dropseed	42	13	546
Stipa	*spartea*	Porcupine-grass	33	21	693

Southern Mesic Prairie UPs23 (continued)

Forbs					
Allium	*stellatum*	Prairie wild onion	8	3	24
Allium	*canadense*	Wild garlic	8	1	8
Anemone	*cylindrica*	Long-headed thimbleweed	25	2	50
Anemone	*virginiana*	Virginia thimbleweed	8	3	24
Anemone	*canadensis*	Canada anemone	8	3	24
Antennaria	*spp.*	Pussytoes	17	3	51
Apocynum	*androsaemifolium*	Spreading dogbane	25	3	75
Artemisia	*frigida*	Prairie sagewort	8	3	24
Asclepias	*tuberosa*	Butterfly-weed	25	3	75
Asclepias	*syriaca*	Common milkweed	25	2	50
Aster	*oolentangiensis*	Sky-blue aster	67	7	469
Aster	*ericoides*	Heath aster	58	6	348
Aster	*lanceolatus*	Panicled aster	17	3	51
Aster	*novae-angliae*	New England aster	17	3	51
Aster	*laevis*	Smooth aster	8	3	24
Astragalus	*canadensis*	Canada milk-vetch	8	1	8
Campanula	*rotundifolia*	Harebell	17	3	51
Chrysopsis	*villosa*	Prairie golden aster	8	3	24
Comandra	*umbellata*	Bastard toad-flax	58	3	174
Coreopsis	*palmata*	Stiff tickseed	58	8	464
Dalea	*purpurea*	Purple prairie-clover	50	3	150
Dalea	*candida*	White prairie-clover	50	2	100
Desmodium	*canadense*	Canadian tick-trefoil	25	4	100
Euphorbia	*corollata*	Flowering spurge	8	5	40
Euthamia	*graminifolia*	Grass-leaved goldenrod	8	3	24
Fragaria	*virginiana*	Common strawberry	33	4	132
Galium	*boreale*	Northern bedstraw	42	9	378
Gentiana	*billingtonii*	Closed gentian	17	3	51
Geum	*triflorum*	Prairie smoke	8	1	8
Helenium	*autumnale*	Autumn sneezeweed	8	1	8
Helianthus	*maximiliani*	Maximilian's sunflower	17	20	340
Helianthus	*pauciflorus*	Stiff sunflower	58	5	290
Heliopsis	*helianthoides*	Ox-eye	8	3	24
Heuchera	*richardsonii*	Alum-root	17	2	34
Lathyrus	*venosus*	Veiny pea	17	2	34
Lespedeza	*capitata*	Round-headed bush-clover	42	3	126
Liatris	*aspera*	Rough blazing star	42	3	126
Liatris	*ligulistylis*	Northern plains blazing star	33	3	99
Liatris	*pycnostachya*	Gayfeather	25	2	50
Lilium	*philadelphicum*	Wood lily	17	2	34
Lobelia	*spicata*	Rough-spiked Lobelia	8	3	24
Mirabilis	*hirsuta*	Hairy four-o'clock	8	1	8
Monarda	*fistulosa*	Wild bergamot	50	7	350
Oenothera	*biennis*	Common evening-primrose	25	2	50
Pedicularis	*canadensis*	Wood-betony	17	8	136
Phlox	*pilosa*	Prairie phlox	42	3	126
Physalis	*heterophylla*	Clammy ground-cherry	17	2	34
Polygala	*polygama*	Racemed milkwort	8	3	24
Potentilla	*arguta*	Tall cinquefoil	17	2	34
Pycnanthemum	*virginianum*	Virginia mountain-mint	50	3	150
Ratibida	*pinnata*	Gray-headed coneflower	33	7	231
Rudbeckia	*hirta*	Black-eyed Susan	25	2	50
Sisyrinchium	*campestre*	Field blue-eyed grass	8	1	8
Smilacina	*stellata*	Starry false Solomon's-seal	17	9	153
Smilacina	*racemosa*	False Solomon's-seal	8	3	24
Solidago	*nemoralis*	Gray goldenrod	25	3	75
Solidago	*missouriensis*	Missouri goldenrod	17	4	68
Solidago	*ptarmicoides*	Upland white aster	8	5	40
Solidago	*speciosa*	Showy goldenrod	8	3	24
Thalictrum	*dasycarpum*	Tall meadow-rue	25	4	100
Tradescantia	*bracteata*	Bracted spiderwort	8	1	8
Veronicastrum	*virginicum*	Culver's root	58	3	174
Vicia	*americana*	American vetch	8	1	8
Viola	*pedatifida*	Prairie bird-foot violet	33	3	99
Zizia	*aurea*	Golden alexanders	25	3	75
Artemisia	*campestris*	Tall wormwood	17	4	68

Southern Dry Savanna UPs14

Genus	Species	Common Name	[2]Rarity Status	[3]Freq	[4]Abund	[5]Index
Canopy Trees (>10 m)						
Populus	*tremuloides*	Quaking aspen		11	15	165
Quercus	*ellipsoidalis*	Northern pin oak		22	3	66
Quercus	*macrocarpa*	Bur oak		11	15	165
Understory Trees						
Populus	*tremuloides*	Quaking aspen		33	10	330
Prunus	*serotina*	Black cherry		22	1	22
Quercus	*ellipsoidalis*	Northern pin oak		22	2	44
Quercus	*macrocarpa*	Bur oak		100	9	900
Shrubs						
Amelanchier	cmx.	Juneberry		56	1	56
Cornus	*sericea*	Red-osier dogwood		11	1	11
Corylus	*americana*	American hazelnut		67	7	469
Prunus	*pumila*	Sand cherry		11	3	33
Prunus	*virginiana*	Chokecherry		33	2	66
Rosa	*arkansana*	Prairie rose		89	2	178
Salix	*humilis*	Prairie willow		22	5	110
Symphoricarpos	cmx.	Snowberry		22	3	66
Low Shrubs						
Amorpha	*canescens*	Lead-plant		56	3	168
Artemisia	*frigida*	Prairie sagewort		11	15	165
Forbs						
Allium	*stellatum*	Prairie wild onion		11	3	33
Amphicarpaea	*bracteata*	Hog-peanut		22	21	462
Anaphalis	*margaritacea*	Pearly everlasting		11	3	33
Anemone	*cylindrica*	Long-headed thimbleweed		33	3	99
Anemone	*patens*	Pasque-flower		22	3	66
Antennaria	*spp.*	Pussytoes		89	3	267
Apocynum	*androsaemifolium*	Spreading dogbane		11	5	55
Arabis	*divaricarpa*	Spreading rock-cress		11	1	11
Arabis	*hirsuta*	Hairy rock-cress		33	1	33
Aralia	*nudicaulis*	Wild sarsaparilla		11	1	11
Artemisia	*campestris*	Tall wormwood		11	3	33
Artemisia	*ludoviciana*	Western mugwort		44	7	308
Asclepias	*ovalifolia*	Oval-leaved milkweed		33	2	66
Asclepias	*syriaca*	Common milkweed		56	2	112
Asclepias	*tuberosa*	Butterfly-weed		11	3	33
Aster	*ericoides*	Heath aster		44	2	88
Aster	*oolentangiensis*	Sky-blue aster		56	3	168
Aster	*sericeus*	Silky aster		33	4	132
Campanula	*rotundifolia*	Harebell		56	3	168
Chrysopsis	*villosa*	Prairie golden aster		11	1	11
Comandra	*umbellata*	Bastard toad-flax		11	3	33
Coreopsis	*palmata*	Stiff tickseed		44	4	176
Dalea	*candida*	White prairie-clover		44	3	132
Dalea	*purpurea*	Purple prairie-clover		78	3	234
Delphinium	*carolinianum*	Prairie larkspur		22	1	22
Desmodium	*canadense*	Canadian tick-trefoil		11	1	11
Euphorbia	*corollata*	Flowering spurge		11	3	33
Fragaria	*virginiana*	Common strawberry		11	3	33
Galium	*boreale*	Northern bedstraw		33	8	264
Geranium	*maculatum*	Wild geranium		11	3	33
Geum	*triflorum*	Prairie smoke		44	7	308
Helianthemum	*bicknellii*	Hoary frostweed		89	4	356
Helianthus	*pauciflorus*	Stiff sunflower		33	15	495
Heuchera	*richardsonii*	Alum-root		11	1	11
Lathyrus	*ochroleucus*	Pale vetchling		11	1	11
Lathyrus	*venosus*	Veiny pea		44	2	88
Lechea	*stricta*	Prairie pinweed		67	5	335

Southern Dry Savanna UPs14 (cont'd)

Lespedeza	*capitata*	Round-headed bush-clover		44	2	88
Liatris	*aspera*	Rough blazing star		44	2	88
Lithospermum	*caroliniense*	Hairy puccoon		33	2	66
Monarda	*fistulosa*	Wild bergamot		11	3	33
Oenothera	*biennis*	Common evening-primrose		11	3	33
Pedicularis	*canadensis*	Wood-betony		11	3	33
Penstemon	*gracilis*	Slender beard-tongue		22	3	66
Penstemon	*grandiflorus*	Large-flowered beard-tongue		11	1	11
Phlox	*pilosa*	Prairie phlox		22	2	44
Physalis	*virginiana*	Ground-cherry		100	3	300
Potentilla	*arguta*	Tall cinquefoil		67	2	134
Prenanthes	*racemosa*	Smooth rattlesnake-root		11	1	11
Ranunculus	*rhomboideus*	Prairie buttercup		11	1	11
Rudbeckia	*hirta*	Black-eyed Susan		33	2	66
Scutellaria	*leonardi*	Leonard's skullcap		22	2	44
Silene	*antirrhina*	Sleepy catchfly		11	1	11
Sisyrinchium	*campestre*	Field blue-eyed grass		11	1	11
Smilacina	*stellata*	Starry false Solomon's-seal		44	7	308
Smilax	cmx.	Carrion-flower		22	1	22
Solidago	*gigantea*	Giant goldenrod		11	1	11
Solidago	*missouriensis*	Missouri goldenrod		11	3	33
Solidago	*nemoralis*	Gray goldenrod		44	3	132
Solidago	*rigida*	Stiff goldenrod		11	3	33
Solidago	*speciosa*	Showy goldenrod		22	3	66
Thalictrum	*dasycarpum*	Tall meadow-rue		11	1	11
Viola	*pedatifida*	Prairie bird-foot violet		67	3	201
Grasses, Rushes and Sedges						
Agrostis	*hyemalis*	Rough bent-grass		11	3	33
Andropogon	*gerardii*	Big bluestem		100	10	1000
Aristida	*basiramea*	Base-branched three-awn		11	3	33
Bouteloua	*curtipendula*	Side-oats grama		33	15	495
Bouteloua	*gracilis*	Blue grama		11	3	33
Bouteloua	*hirsuta*	Hairy grama		11	3	33
Bromus	*kalmii*	Kalm's brome		11	5	55
Calamagrostis	*canadensis*	Bluejoint		11	3	33
Calamovilfa	*longifolia*	Sand reed-grass		22	4	88
Carex	*brevior*	Short sedge		11	3	33
Carex	*pensylvanica*	Pennsylvania sedge		44	4	176
Carex	*tenera*	Marsh-straw sedge		11	3	33
Carex	*siccata*	Hay sedge		78	6	468
Cyperus	*lupulinus*	Hop-like cyperus		67	3	201
Elymus	*trachycaulus*	Slender wheatgrass		33	3	99
Koeleria	*pyramidata*	June-grass		67	3	201
Muhlenbergia	*cuspidata*	Plains muhly		11	3	33
Panicum	*lanuginosum*	Hairy panic grass		33	4	132
Panicum	*linearifolium*	Linnear-leaved panic grass		22	2	44
Panicum	*oligosanthes*	Few-flowered panic grass		22	4	88
Panicum	*perlongum*	Long-leaved panic grass		44	3	132
Schizachyrium	*scoparium*	Little bluestem		78	22	1716
Sorghastrum	*nutans*	Indian grass		67	5	335
Sporobolus	*heterolepis*	Prairie dropseed		67	10	670
Stipa	*spartea*	Porcupine-grass		67	26	1742
Ferns and Fern Allies				0	0	0
Equisetum	*laevigatum*	Smooth scouring-rush		33	2	66
Selaginella	*rupestris*	Rock spikemoss		11	1	11

Southern Dry-Mesic Oak (Maple) Woodland FDs37

Genus	Species	Common Name	[3]Freq	[4]Abund	[5]Index
Canopy Trees & understory trees					
Acer	*negundo*	Box elder	5	1	5
Acer	*rubrum*	Red maple	38	11	418
Betula	*papyrifera*	Paper-birch	24	7	168
Carya	*cordiformis*	Bitternut hickory	5	1	5
Fraxinus	*pennsylvanica*	Green ash	10	3	30
Pinus	*strobus*	White pine	10	63	630
Populus	*grandidentata*	Big-toothed aspen	5	38	190
Populus	*tremuloides*	Quaking aspen	19	8	152
Prunus	*serotina*	Black cherry	33	4	132
Quercus	*alba*	White oak	43	26	1118
Quercus	*ellipsoidalis*	Northern pin oak	62	40	2480
Quercus	*macrocarpa*	Bur oak	67	16	1072
Quercus	*rubra*	Northern red oak	48	36	1728
Ulmus	*americana*	American elm	5	1	5
Understory Trees					
Acer	*negundo*	Box elder	33	3	99
Acer	*rubrum*	Red maple	95	16	1520
Betula	*papyrifera*	Paper-birch	10	1	10
Carpinus	*caroliniana*	Blue beech	10	1	10
Carya	*cordiformis*	Bitternut hickory	10	1	10
Celtis	*occidentalis*	Hackberry	10	1	10
Fraxinus	*nigra*	Black ash	19	6	114
Fraxinus	*pennsylvanica*	Green ash	19	12	228
Ostrya	*virginiana*	Ironwood	24	20	480
Pinus	*strobus*	White pine	14	7	98
Populus	*grandidentata*	Big-toothed aspen	10	2	20
Populus	*tremuloides*	Quaking aspen	24	6	144
Prunus	*serotina*	Black cherry	90	13	1170
Quercus	*alba*	White oak	33	5	165
Quercus	*ellipsoidalis*	Northern pin oak	43	10	430
Quercus	*macrocarpa*	Bur oak	48	9	432
Quercus	*rubra*	Northern red oak	38	3	114
Sorbus	*americana*	American mountain-ash	10	1	10
Tilia	*americana*	Basswood	24	2	48
Ulmus	*americana*	American elm	48	3	144
Ulmus	*rubra*	Slippery elm	24	3	72
Shrubs					
Amelanchier	*interior*	Juneberry	48	2	96
Amelanchier	*laevis*	Smooth juneberry	29	4	116
Cornus	*alternifolia*	Pagoda dogwood	19	2	38
Cornus	*rugosa*	Round-leaved dogwood	14	7	98
Cornus	*racemosa*	Gray dogwood	71	10	710
Corylus	*americana*	American hazelnut	90	15	1350
Corylus	*cornuta*	Beaked hazelnut	5	15	75
Crataegus	cmx	Hawthorn	19	2	38
Diervilla	*lonicera*	Bush honeysuckle	43	3	129
Ilex	*verticillata*	Winterberry	29	2	58
Lonicera	*dioica*	Wild Honeysuckle	5	1	5
Prunus	*virginiana*	Chokecherry	95	9	855
Ribes	*cynosbati*	Prickly gooseberry	43	3	129
Ribes	*missouriense*	Missouri gooseberry	19	6	114
Rosa	*arkansana*	Prairie rose	5	3	15
Rosa	*blanda*	Smooth wild rose	24	3	72
Rubus	cm1	Blackberry	57	5	285
Rubus	*occidentalis*	Black raspberry	10	9	90
Rubus	*idaeus*	Red raspberry	52	5	260
Sambucus	*racemosa*	Red-berried Elder	33	7	231
Symphoricarpos	cmx		5	3	15
Toxicodendron	*rydbergii*	Poison ivy	52	3	156
Viburnum	*lentago*	Nannyberry	57	2	114
Viburnum	*rafinesquianum*	Downy arrow-wood	33	5	165

Southern Dry-Mesic Oak (Maple) Woodland FDs37 (cont'd)

Vines					
Celastrus	*scandens*	Climbing bittersweet	19	3	57
Parthenocissus	cmx	Virginia creeper	90	8	720
Smilax	*hispida*	Green-briar	5	1	5
Vitis	*riparia*	Wild grape	71	4	284
Forbs					
Achillea	*millefolium*	Yarrow	5	3	15
Actaea	*rubra*	Red baneberry	10	1	10
Agrimonia	cmx.	Stickweed	10	2	20
Amphicarpaea	*bracteata*	Hog-peanut	86	6	516
Anemone	*quinquefolia*	Wood-anemone	43	3	129
Anemone	*virginiana*	Tall thimbleweed	5	1	5
Apocynum	*androsaemifolium*	Spreading dogbane	24	3	72
Aquilegia	*canadensis*	Columbine	48	3	144
Aralia	*nudicaulis*	Wild sarsaparilla	67	5	335
Aralia	*racemosa*	American spikenard	10	3	30
Arenaria	*lateriflora*	Side-flowering sandwort	10	3	30
Arisaema	*triphyllum*	Jack-in-the-pulpit	14	2	28
Asclepias	*exaltata*	Poke milkweed	14	2	28
Aster	*macrophyllus*	Large-leaved aster	57	9	513
Aster	*ciliolatus*	Lindley's aster	5	3	15
Aster	*lateriflorus*	Side-flowering aster	5	3	15
Aster	*oolentangiensis*	Sky-blue aster	5	3	15
Aster	*sagittifolius*	Tail-leaved aster	19	3	57
Caulophyllum	*thalictroides*	Blue cohosh	5	3	15
Chenopodium	*simplex*	Maple-leaved goosefoot	5	3	15
Circaea	*lutetiana*	Canada enchanter's nightshade	57	6	342
Clintonia	*borealis*	Bluebead lily	10	3	30
Cryptotaenia	*canadensis*	Honewort	10	1	10
Desmodium	*glutinosum*	Pointed-leaved tick-trefoil	86	11	946
Dioscorea	*villosa*	Wild yam	10	2	20
Echinocystis	*lobata*	Wild cucumber	14	2	28
Erechtites	*hieracifolia*	Pilewort	5	1	5
Eupatorium	*rugosum*	Common snakeroot	5	1	5
Fragaria	*virginiana*	Common strawberry	14	4	56
Fragaria	*vesca*	Wood strawberry	10	3	30
Galium	*boreale*	Northern bedstraw	38	3	114
Galium	*triflorum*	Three-flowered bedstraw	43	2	86
Galium	*aparine*	Cleavers	10	4	40
Galium	*concinnum*	Elegant bedstraw	5	3	15
Geranium	*maculatum*	Wild geranium	67	7	469
Geum	*canadense*	White avens	14	2	28
Geum	*triflorum*	Prairie smoke	5	5	25
Hackelia	cmx.	Stickseed	19	3	57
Helianthus	*strumosus*	Rough-leaf sunflower	10	5	50
Helianthus	*hirsutus*	Woodland sunflower	5	3	15
Hepatica	*americana*	Round-lobed hepatica	5	5	25
Heuchera	*richardsonii*	Alum-root	5	1	5
Hieracium	*kalmii*	Hawkweed	5	1	5
Impatiens	cmx	Touch-me-not	10	3	30
Lactuca	*spp.*	Wild lettuce	5	1	5
Lathyrus	*ochroleucus*	Pale vetchling	10	4	40
Lathyrus	*venosus*	Veiny pea	10	1	10
Maianthemum	*canadense*	Canada mayflower	86	5	430
Mitchella	*repens*	Partridge-berry	5	3	15
Osmorhiza	*claytonii*	Clayton's sweet cicely	71	5	355
Osmorhiza	*longistylis*	Anise-root	14	2	28
Phryma	*leptostachya*	Lopseed	57	3	171
Physalis	*heterophylla*	Clammy ground-cherry	5	1	5
Polygonatum	*pubescens*	Hairy Solomon's-seal	19	3	57
Polygonatum	*biflorum*	Giant Solomon's-seal	14	4	56
Prenanthes	*alba*	White rattlesnake-root	14	2	28
Pyrola	*elliptica*	Common pyrola	29	3	87
Pyrola	*secunda*	One-sided pyrola	5	3	15

Southern Dry-Mesic Oak (Maple) Woodland FDs37 (cont'd)

Ranunculus	*abortivus*	Kidney-leaf buttercup	14	3	42
Ranunculus	*recurvatus*	Hooked crowfoot	5	1	5
Rubus	*pubescens*	Dwarf raspberry	19	3	57
Sanguinaria	*canadensis*	Bloodroot	5	3	15
Sanicula	*marilandica*	Mariland black snakeroot	24	2	48
Sanicula	*gregaria*	Gregarious black snakeroot	5	1	5
Smilacina	*racemosa*	Racemose false Solomon's-seal	38	4	152
Smilacina	*stellata*	Starry false Solomon's-seal	24	3	72
Smilax	cmx	Carrion-flower	29	2	58
Solidago	*hispida*	Hairy goldenrod	5	5	25
Solidago	*gigantea*	Giant goldenrod	5	3	15
Solidago	*flexicaulis*	Zig-zag goldenrod	5	1	5
Solidago	*uliginosa*	Bog goldenrod	5	1	5
Streptopus	*roseus*	Rosey twisted-stalk	5	3	15
Thalictrum	*dioicum*	Early meadow-rue	14	3	42
Thalictrum	*dasycarpum*	Tall meadow-rue	5	3	15
Thalictrum	*thalictroides*	Rue-anemone	5	5	25
Trientalis	*borealis*	Starflower	29	4	116
Trillium	*grandiflorum*	Large-flowered trillium	5	3	15
Trillium	*cernuum*	Nodding trillium	5	1	5
Urtica	*dioica*	Stinging nettle	10	3	30
Uvularia	*sessilifolia*	Pale bellwort	71	8	568
Uvularia	*grandiflora*	Yellow bellwort	19	3	57
Veronicastrum	*virginicum*	Culver's root	14	1	14
Viola	cm4	Violet	19	1	19
Zizia	*aurea*	Golden alexanders	5	1	5
Grasses, Rushes and Sedges					
Brachyelytrum	*erectum*	Bearded shorthusk	5	3	15
Carex	*blanda*	Charming sedge	5	1	5
Carex	*deweyana*	Dewey's sedge	5	3	15
Carex	*gracillima*	Graceful sedge	5	3	15
Carex	*peckii*	Peck's sedge	10	4	40
Carex	*pedunculata*	Long-stalked sedge	10	2	20
Carex	*pensylvanica*	Pennsylvania sedge	81	9	729
Carex	*tenera*	Marsh-straw sedge	10	1	10
Carex	*radiata*	Stellate sedge	14	3	42
Danthonia	*spicata*	Poverty grass	5	3	15
Elymus	*hystrix*	Bottlebrush grass	5	1	5
Festuca	*subverticillata*	Nodding fescue	10	3	30
Oryzopsis	*asperifolia*	Moutain rice-grass	33	3	99
Schizachne	*purpurascens*	False melic grass	14	2	28
Ferns and Fern Allies					
Athyrium	*filix-femina*	Lady-fern	76	5	380
Botrychium	*multifidum*	Leathery grapefern	5	1	5
Botrychium	*virginianum*	Rattlesnakefern	24	1	24
Dryopteris	*intermedia*	Fern	19	2	38
Equisetum	*pratense*	Meadow horsetail	5	3	15
Matteuccia	*struthiopteris*	Ostrich-fern	5	38	190
Osmunda	*claytoniana*	Interrupted fern	29	9	261
Pteridium	*aquilinum*	Bracken	62	5	310

Southern Dry-Mesic Oak Forest MHs37

Genus	Species	Common Name	[3]Freq	[4]Abund	[5]Index
Canopy Trees (>10m)					
Acer	*saccharum*	Sugar maple	40	9	360
Acer	*rubrum*	Red maple	20	88	1760
Betula	*papyrifera*	Paper-birch	20	1	20
Carpinus	*caroliniana*	Blue beech	20	3	60
Carya	*cordiformis*	Bitternut hickory	40	3	120
Celtis	*occidentalis*	Hackberry	60	2	120
Ostrya	*virginiana*	Ironwood	40	9	360
Prunus	*serotina*	Black cherry	100	9	900
Quercus	*rubra*	Northern red oak	100	31	3100
Quercus	*alba*	White oak	60	46	2760
Tilia	*americana*	Basswood	40	4	160
Shrubs					
Cornus	*alternifolia*	Pagoda dogwood	100	6	600
Cornus	*racemosa*	Gray dogwood	20	1	20
Corylus	*americana*	American hazelnut	40	9	360
Corylus	*cornuta*	Beaked hazelnut	40	2	80
Prunus	*virginiana*	Chokecherry	60	4	240
Rosa	*blanda*	Smooth wild rose	20	1	20
Sambucus	*racemosa*	Red-berried elder	40	3	120
Symphoricarpos	cmx	Snowberry	20	3	60
Viburnum	*rafinesquianum*	Downy arrow-wood	40	3	120
Viburnum	*lentago*	Nannyberry	20	1	20
Forbs, ferns, graminoids					
Actaea	*rubra*	Red baneberry	60	2	120
Adiantum	*pedatum*	Maidenhair fern	40	3	120
Amphicarpaea	*bracteata*	Hog-peanut	60	4	240
Anemone	*americana*	Round-lobed hepatica	20	3	60
Apocynum	*androsaemifolium*	Spreading dogbane	20	3	60
Aquilegia	*canadensis*	Columbine	20	3	60
Aralia	*nudicaulis*	Wild sarsaparilla	60	6	360
Aralia	*racemosa*	American spikenard	40	2	80
Arisaema	*triphyllum*	Jack-in-the-pulpit	60	4	240
Aster	*sagittifolius*	Tail-leaved aster	20	3	60
Athyrium	*filix-femina*	Lady-fern	100	5	500
Botrychium	*virginianum*	Rattlesnakefern	20	5	100
Carex	*pensylvanica*	Pennsylvania sedge	40	2	80
Caulophyllum	*thalictroides*	Blue cohosh	40	3	120
Circaea	*lutetiana*	Canada enchanter's nightshade	80	8	640
Cryptotaenia	*canadensis*	Honewort	60	3	180
Desmodium	*glutinosum*	Pointed-leaved tick-trefoil	80	18	1440
Dioscorea	*villosa*	Wild yam	20	3	60
Galium	*triflorum*	Three-flowered bedstraw	60	3	180
Geranium	*maculatum*	Wild geranium	100	7	700
Geum	*canadense*	White avens	80	3	240
Hackelia	*spp.*	Stickseed	40	3	120
Hydrophyllum	*virginianum*	Virginia waterleaf	60	4	240
Impatiens	*spp.*	Touch-me-not	40	4	160
Maianthemum	*canadense*	Canada mayflower	60	3	180
Mitella	*diphylla*	Two-leaved miterwort	20	3	60
Osmorhiza	*claytonii*	Clayton's sweet cicely	80	10	800
Osmunda	*claytoniana*	Interrupted fern	40	5	200
Phryma	*leptostachya*	Lopseed	100	6	600
Polygonatum	*pubescens*	Hairy Solomon's-seal	20	3	60
Polygonatum	*biflorum*	Giant Solomon's-seal	40	3	120
Pteridium	*aquilinum*	Bracken	20	5	100
Sanguinaria	*canadensis*	Bloodroot	80	3	240
Sanicula	*marilandica*	Mariland black snakeroot	60	3	180
Smilacina	*racemosa*	false Solomon's-seal	80	3	240
Thalictrum	*dioicum*	Early meadow-rue	100	4	400
Uvularia	*grandiflora*	Yellow bellwort	100	3	300
Uvularia	*sessilifolia*	Pale bellwort	20	3	60
Veronicastrum	*virginicum*	Culver's root	20	3	60
Viola	*Viola sp*	Violet	60	2	120

APPENDIX C. Site photographs and GPS points

Site photographs are shown below in alphabetical order by land cover units. Point numbers correspond to the GPS points shown on Map 5.

1. CROP pt4 to north. Cropland and weedy edge.

2. DW1 pt8. Red cedar with open canopy, sumac, grasses.

3. DW1 pt10. Closed red cedar canopy, sparse ground cover.

4. DW1 pt13. Debris in east ravine.

5. GR1 pt 26. Kittentail associates – cedar, sumac, prairie.

6. GR1 pt 27. Overgrowth of non-native and native trees and shrubs to remove at the eastern edge of the unit.

APPENDIX C. Site photographs and GPS points

7. GR3 pt 53. Dominance of sumac and smooth brome.

8. GR3 pt55. Buckthorn and honeysuckle regrowth in area where pines were removed.

9. GSH pt 19. City owned property along north edge of SNA, to west. Non-native grassland, nearby houses.

10. GSH pt 20. View to southwest – abundant cedar and sumac.

11. GSH pt20. Disturbance area- gravel pile and extraction.

12. GSH pt 21. Dominance of sumac and brome. View toward SE.

APPENDIX C. Site photographs and GPS points

13. GSH pt 22. Sand pit and recent ATV activity.

14. LGU pt 51. Toward west. Conifer stand and other trees and shrubs to remove.

15. LGU pt 51. One of about 13 brush piles to be burned.

16. OF1. North slope with Dicentra and other native flora.

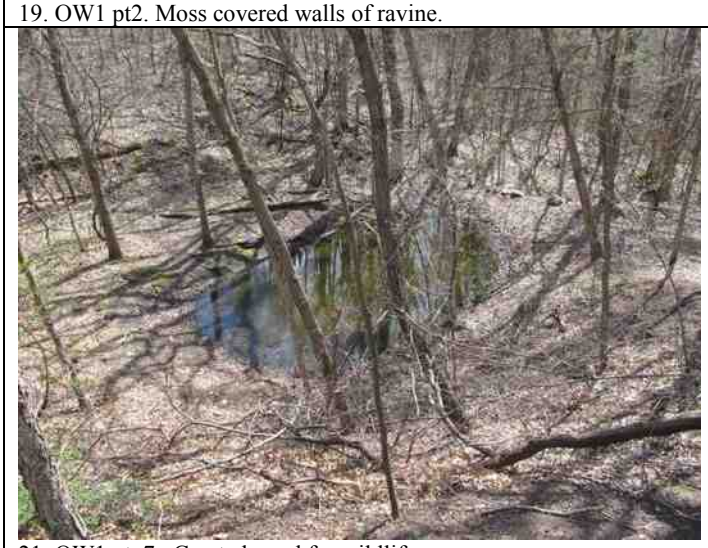
17. OF1. East slope with dense small buckthorn.

18. OW1 pt1. Dense buckthorn with sparse tree canopy.

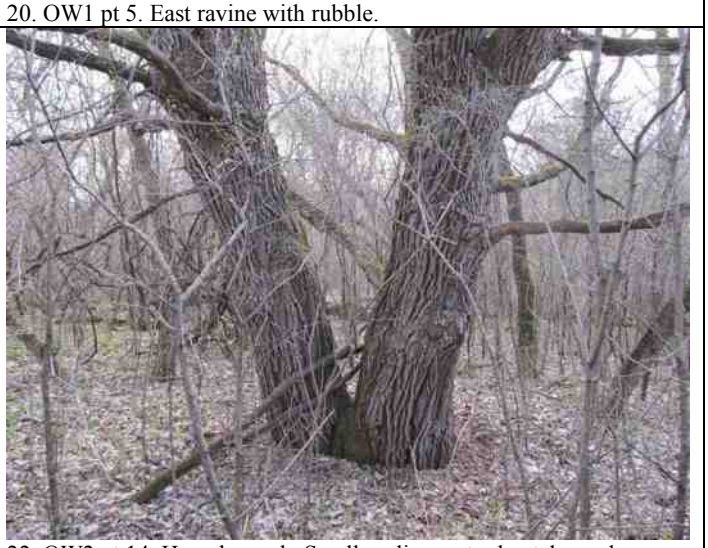
APPENDIX C. Site photographs and GPS points

19. OW1 pt2. Moss covered walls of ravine.

20. OW1 pt 5. East ravine with rubble.



21. OW1 pt. 7. Created pond for wildlife.



22. OW2 pt 14. Huge bur oak. Small garlic mustard patch nearby.

23. OW2 pt 31. Log pile that needs to be burned.

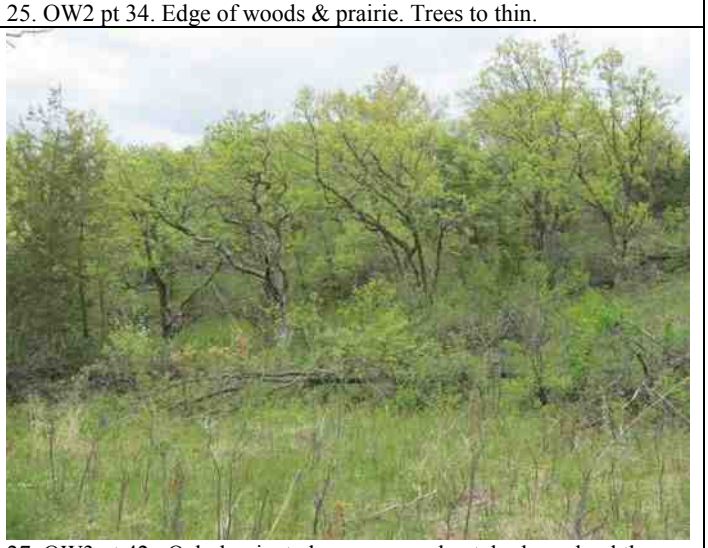
24. OW2 pt 32. Apparent oak wilt area.

APPENDIX C. Site photographs and GPS points

24. OW2 pt 33. Old building posts to be removed.

25. OW2 pt 34. Edge of woods & prairie. Trees to thin.

26. OW2 pt 35. Dense cedar canopy, some buckthorn and honeysuckle.



27. OW3 pt 42. Oak dominated canopy, moderately dense buckthorn.

28. OW3 pt 43. Historic erosion scar (see Map 4a) now healed.

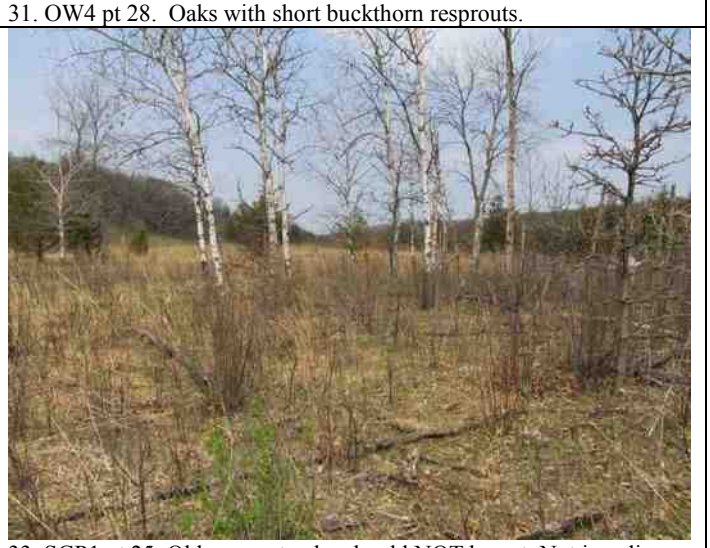
29. OW3 pt 47. Disturbance area and bare soils – need seed after woody removal.

APPENDIX C. Site photographs and GPS points

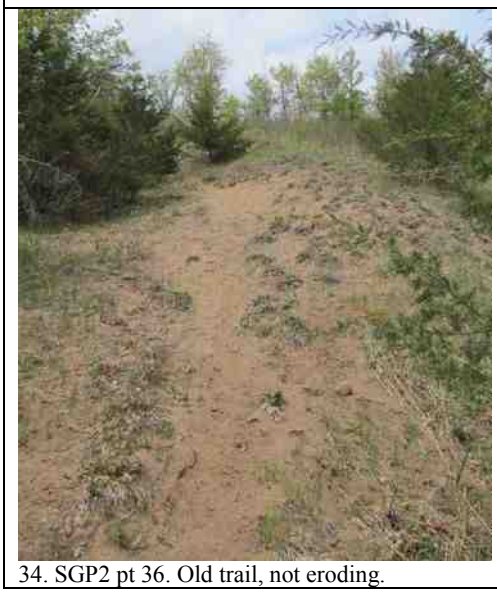
30. OW3 pt50. Some debris near base of slope.

31. OW4 pt 28. Oaks with short buckthorn resprouts.

32. Stormwater Pond - water shrinking and cattail expanding.



33. SGP1 pt 25. Old aspen stand – should NOT be cut. Not invading.



34. SGP2 pt 36. Old trail, not eroding.

35. SGP2 pt 38. Entrenched trail.

36. SGP2 pt 38. Replace damaged signs.


37. SGP2 pt 38. View of coulee toward southeast.


38. SGP2 pt 39. Aspen stand spreading – need to cut and burn.


39. SGP 2 pt 51. Entrenched trail but little use, some reveg occurring.


40. SGP4 NW corner. Remove trees and shrubs in hollow.

41. SGT pt 15. House removal location, toward south.

42. DW3 pt 30. Live fox snake. Dead snake (insert) also found on Glacier Way Rd on north side of SNA.

APPENDIX C. Site photographs and GPS points

Map point	Unit	LAT	LONG	Detail
1	OW1	44.710172	-92.820109	Slope with dense buckthorn, very open canopy (20% cover)
2	OW1	0	0	Coulee ravine walls
3	OW1	44.710694	-92.819793	More oak here (coverage 4), buckthorn still dense.
4	CROP	44.71182	-92.818783	Edge of field toward north.
5	OW1	44.712903	-92.817895	Ravine on east side, with debris
6	CROP	44.713217	-92.818421	Edge of field and DW, to north.
7	OW1	44.713062	-92.819186	Deer pond
8	DW1	44.713924	-92.819108	Red cedar and open canopy
9	DW1			Mixed canopy
10	DW1	44.714312	-92.819431	Dense red cedar stand. N/S fence.
11	OW1	44.71462	-92.820432	Dicentra abundant near base of slope.
13	DW1	44.715476	-92.817793	Debris in NE ravine.
14	OW1	44.715406	-92.82048	Huge bur oak, patch of garlic mustard nearby (6x4 ft)
15	SGT	0	0	House site to south
16	SGT	0	0	House site - Poa, brome, green ash
18	SGT	0	0	House site - daylily patch
19	GSH	0	0	N edge grass
20	GSH	44.715536	-92.82144	Gravel pit area
21	GSH	44.7131	-92.822805	Long-bearded hawkweed.
22	GSH	44.712441	-92.822574	SHG1-gravel pit
23	GSH	44.710093	-92.822047	First Lead plant - start of SG unit. Also liatris
25	SGP1	44.708858	-92.823166	Aspen stand
26	GR1	44.707426	-92.822915	Kittentail - 82 plants
27	GR1	44.707327	-92.823024	East edge brush
29	SGP3	44.707061	-92.823704	Kittentail - 18 plants.
30	DW3	44.709051	-92.824644	View of units to N, S, E, W. Fox snake photographed.
31	OW2	44.715808	-92.823341	log pile
32	OW2	44.715857	-92.82288	Oak wilt, 20-30 dead trees. Remove dead and apple tree, seed with prairie.
33	OW2	44.715697	-92.823068	Posts from an old structure. Remove, regrade, seed with sprengle sedge.
34	OW2	44.71541	-92.822829	Edge of woods and prairie. Need to thin red cedar.
35	OW2	44.715287	-92.822658	Red cedar dense, some buckthorn and honeysuckle
36	SGP2	44.715024	-92.822883	Trail, not eroding. Habitat for annual species.
37	SGP2	44.715143	-92.823136	Trail, not eroding. Habitat for annual species.
38	SGP2	44.71477	-92.823722	Shot up sign.
39	SGP2	44.71425	-92.823961	Aspen stand - girdle large trees, burn to reduce smaller ones (or cut/treat).
40	OW3	44.713346	-92.824063	Bare ground - need to seed after exotic brush removal.
41	OW3	44.713291	-92.824444	Slope somewhat bare - good area for annual species.
42	OW3	44.712915	-92.824462	Oak dominated canopy, shrub layer moderately dense. Photo N to S.
43	OW3	44.7127	-92.824677	Old erosion scar - compare to historic (1937 photo).
44	OW3	44.712466	-92.824323	Disturbance area - open canopy. Possible oak wilt - many fallen trees. Dense buckthorn.
45	OW3	44.712141	-92.823984	Slope with abundant Dicentra, denser canopy (Oak forest rather than woodland).
47	OF2	44.711959	-92.823834	3 kittentail.
48	OW3	44.7117	-92.823509	Slopes bare. If buckthorn removal need seeding
49	OW3	44.711382	-92.823138	Small amount of old trash debris
50	SGP1	44.711056	-92.823406	Trash
51	LGU	44.711409	-92.825615	Brush/wood pile. Photo to SW. Amur maple nearby (saplings).
52	SGP4	44.704335	-92.822222	Depression with gr ash, Rhamnus, Lonicera, boxelder. Clear and seed.
53	GR3	44.704459	-92.820823	Knapweed
55	GR3	44.703682	-92.82114	Conifer removal area, now dense Rhamnus and Lonicera. To SE. Brome and Poa, few natives.

APPENDIX D. Methods for Controlling Invasive Species

Methodologies for control of select species are provided below, including least toxic methods for herbicide use. However, for all exotic species management at the SNA, herbicide will be used only with prior approval from SNA staff, typically in areas that have had prior disturbance and are dominated by non-native species.

Trees and Shrubs

Common Buckthorn, Tartarian Honeysuckle, Siberian Elm, and Black Locust are some of the most common woody species likely to invade native woodlands or prairies in Minnesota. Buckthorn and honeysuckle are European species that escaped urban landscapes and invaded woodlands in many parts of the country. They are exceedingly aggressive and, lacking natural disease and predators, can out-compete native species. Invasions result in a dense, impenetrable brush thicket that reduces native species diversity.

Siberian elm, native to eastern Asia, readily grows, especially in disturbed and low-nutrient soils with low moisture. Seed germination is high and seedlings establish quickly in sparse vegetation. It can invade and dominate disturbed areas in just a few years. Black locust is native to the southeastern United States and the very southeastern corner of Minnesota. It has been planted outside its natural range, and readily invades disturbed areas. It reproduces vigorously by root suckering and can form a monotypic stand.

Chemical Control The most efficient way to remove woody plants that are 1/2 inch or more in diameter is to cut the stems close to the ground and treat the cut stumps with herbicide immediately after they are cut, when the stumps are fresh and the chemicals are most readily absorbed. Failure to treat the stumps will result in resprouting, creating much greater removal difficulty.

In non-freezing temperatures, a glyphosate herbicide such as Roundup can be used for most woody species. It is important to obtain the concentrated formula and dilute it with water to achieve 10% glyphosate concentration. Adding a marker dye can help to make treated stumps more visible. In winter months, an herbicide with the active ingredient triclopyr must be used. Garlon 4 is a common brand name and it must be mixed with a penetrating oil, such as diluent blue. Do not use diesel fuel, as it is much more toxic in the environment and for humans. Herbicide should only be used in distubance area,

Brush removal work can be done at any time of year except during spring sapflow, but late fall is often ideal because buckthorn retains its leaves longer than other species and is more readily identified. Cutting can be accomplished with loppers or handsaws in many cases. Larger shrubs may require brush cutters and chainsaws, used only by properly trained professionals.

For plants in the pea family, such as black locust, an herbicide with the active ingredient clopyralid can be more effective than glyphosate. Common brand names for clopyralid herbicides are Transline, Stinger, and Reclaim. For Scotch pine, red cedar and all other conifers, removal consists of simply cutting the tree and disposing of it. No herbicide is needed as conifers do not resprout.

In the year following initial cutting and stump treatment, there will be a flush of new seedlings as well as resprouting from some of the cut plants. The best way to deal with seedlings is fire. When that is not feasible or not totally effective, herbicide can be applied to the foliage of the plants. Fall is the best time to do this, when desirable native plants are dormant and when the plant is pulling resources from the leaves down into the roots. Roundup (glyphosate), Garlon (triclopyr), and Krenite (active ingredient – fosamine ammonium) are the most commonly used herbicides for foliar application. Krenite prevents bud formation so the plants do not grow in the spring. This herbicide can be effective, but results are highly variable. Glyphoste is non-specific and will kill anything green, while triclopyr targets broadleaf plants and does not harm graminoids. Extreme caution with Garlon should be used, because the surfactants

added that allow it to penetrate bark also seep into the soil and kill many plants within a radius of the treated plant. For this reason, a wick application may be a better application method than broadcast spraying, depending on the groundcover composition .

Undesirable trees and shrubs can also be destroyed without cutting them down. Girdling is a method suitable for small numbers of large trees. Bark is removed in a band around the tree, just to the outside of the wood. If girdled too deeply, the tree will respond by resprouting from the roots. Girdled trees die slowly over the course of one to two years. Girdling should be done in late spring to mid-summer when sap is flowing and the bark easily peels away from the sapwood. Herbicide can also be used in combination with girdling for a more effective treatment.

Basal bark herbicide treatment is another effective control method. A triclopyr herbicide such as 10% Garlon 4, mixed with a penetrating oil, is applied all around the base of the tree or shrub, taking care so that it does not run off. If the herbicide runs off it can kill other plants nearby. More herbicide is needed for effective treatment of plants that are four inches or more in diameter.

All herbicides should be applied by licensed applicators and should not be applied on windy days. Care should be taken to avoid application to other plants.

Mechanical Control Three mechanical methods for woody plant removal are *hand-pulling* (only useful on seedlings and only if few in number), *weed-wrenching* (using a weed wrench tool to pull stems of one to two inches diameter), and *repeated cutting*. Pulling and weed-wrenching can be done any time when the soil is moist and not frozen. In both cases the soil must be shaken off the stems after removal. The disadvantage to both methods is that they are very slow and labor intensive, and create a great deal of soil disturbance, especially weed wrenches. They should not be used on steep slopes or anywhere that desirable native forbs are growing. The soil disturbance also creates opportunities for weed germination. This method is probably best used in areas that have very little cover of desirable native plants or where the invasive shrubs are not very abundant and are fairly small.

Repeated cutting consists of cutting the plants (by hand or with a brush cutter) at critical stages in its growth cycle. Cutting in mid spring (late May) intercepts the flow of nutrients from the roots to the leaves. Cutting in fall (about mid-October) intercepts the flow of nutrients from the leaves to the roots. Depending on the size of the stem, the plants may die within three years, with two cuttings per year. This method is also very labor intensive and costly and depends on a very consistent effort. The success rate varies depending on the size of the plant.

Stems, Seedlings and Resprouts Prescribed burning is the most efficient, cost effective, and least harmful way to control very small seedlings of all woody plants. It also restores an important natural process to fire-dependant natural communities (oak forests, for example). Burning can only be accomplished if adequate fuel (leaf litter) is present and can be done in late fall or early spring, depending site conditions. Disadvantages to burning are that fire coverage is inconsistent over the site and there will be areas that are missed. Fires are typically “cool” in order to be conducted safely, so that even very small stems sometimes survive and resprout. Burning alone may reduce saplings plants, but only if burns are repeated annually for several consecutive years (which will likely also reduce native shrubs). Even then, the level of control is only moderate. Burning is best combined with chemical treatment for greatest effectiveness.

If burning is not feasible, cutting in spring and/or fall can help reduce seedlings of invasive woody plants, but may also be detrimental to desirable plants. Hand-pulling may be a good option for small stands of very small plants, but should be avoided on slopes.

Prickly ash, a native shrub, can become excessively abundant, especially in areas that have been disturbed or grazed. Complete eradication may not be necessary, but management may target reducing the extent of a population. Control will consist primarily of cutting followed by burning.

Disposal The easiest and most cost-effective method to handle large amounts of brush is usually to stack it and burn it in winter. In areas where brush is not dense, it can be cut up into smaller pieces and left on the ground where it will decompose in one to three years. This method is especially useful on slopes to reduce erosion potential. Small brush piles can also be left in the woods as wildlife cover. Where there is an abundance of larger trees, cut trees may be hauled and chipped and used for mulch or as a biofuel. Alternatively, the wood can be cut and used for firewood, if a recipient can be found.

Herbaceous Plants

Spotted knapweed (*Centaurea maculosa*) is one of the most aggressive and well-established invasive species at the coulee. Management of the species has been on-going since 2005, with release of biocontrol insects (root weevils and seedhead weevils), prescribed burning followed by spot treatment (using glyphosate), and hand-pulling of small populations in targeted areas. In 2010 there was clear evidence the biocontrol was taking effect. Continued management of the species should include monitoring to ascertain the continued effectiveness, and targeted hand-pulling. Hand-pulling has been done when the knapweed was found in outlier locations far from the main patch, and where the main population is creeping northward into the high-quality native remnant. The typically recommended herbicide for treating knapweed is a clopyralid. However, this chemical has a long residual in the soil and has not been used at the coulee for that reason. The abundance of native plants at the site warrants a cautious approach, as well as the highly permeable sandy soils.

While spotted knapweed is declining at the coulee, **cow vetch** (*Vicia cracca*) is increasing. This legume sprawls along the tops of other plants, creating a smothering canopy. It is stimulated by fire. There is not much information available on its control, so the information here is based on the experience of FMR and colleagues. Cow vetch is difficult to control with herbicide because the narrow leaves limit effective contact of the chemical. However, Transline has been used with some effectiveness. Hand-pulling is also difficult as the plant tends to break off, leaving a portion of the root in the soil. However, hand-pulling does prevent seed production for that season and is likely to reduce the abundance of the plant to some degree. At this time, we recommend continued attempt to control the plant by these methods. Other colleagues (Dave Crawford, Wild River State Park) have stopped control attempts and found that while the plant was very abundant in some areas each year, it did not persist very long in any location, similar to how sweet clovers behave.

Crown vetch (*Coronilla varia*) and **bird's foot trefoil** (*Lotus corniculata*) patches can be treated with Transline in when plants are small and foliage is lush – typically June. Do not attempt to hand pull as the roots are too dense and the fragments left behind will simply resprout.

A small patch of **leafy spurg**e (*Euphorbia esula*) was found at the south unit of the sand coulee SNA and effectively eradicated with a Transline application. If detected elsewhere, treat immediately. In the event that a large patch became established, biocontrol could be introduced. However, regular site monitoring should prevent that. For more information about control of this species, see the Wisconsin DNR website: http://www.dnr.state.wi.us/invasives/fact/spurge.htm

White and yellow sweet clover (*Melilotus* spp) are aggressive biennial species common to disturbed areas. However, they typically do not persist at a well-established prairie. They increase with fire, but can also be controlled by fire conducted over 2 consecutive years. They were found is low abundance in some of the disturbed areas of the site and edges. Individual plants or small populations can be removed

by hand-pulling or by cutting and bagging the flowering stems. Volunteers could be recruited for this work. In general there is no need to manage specifically for this species at the coulee.

Although not listed on the Minnesota DNR invasive species lists, **soapwort** (*Saponaria officinalis*) is a European species that can be quite problematic especially in sand-gravel dry prairies and mesic prairies. The species is quite abundant in the northern part of the sand coulee, north of the pond. There is little information available about control of this species, so at this time we suggest implementing standard prairie management practices and monitoring this species to assess its response. Hand-pulling (digging out roots) may also be useful in areas where the soapwort is encroaching into native prairie.

In prairie reconstruction areas, **thistles** (Canada (*Cirsium arvense*), musk (*Carduus nutans*), bull (*Cirsium vulgare*)) are best treated by spot application when plants are in the basal rosette stage with an herbicide such a Milestone (an aminopyralid). If plants get to flowering stage the flower should be cut off and the foliage treated. In native plant communities, thistle control methods will depend on the situation. Hand-pulling and repeated cutting may be used.

For small infestations, **Garlic mustard** (*Alliaria petiolata*) should be hand-pulled. Large infestations will need further evaluation to determine appropriate management. Prescribed burning should be employed where ever possible to reduce seedlings. Release of biological control agents may be feasible in the near future.

Graminoids

Many of the non-native, such as **smooth brome** *(Bromus inermis)* and **Kentucky bluegrass** *(Poa pratensis)* cool season grasses can be reduced by late spring prescribed burning. At that time the grasses are growing strong and tillering. The fire sets them back and warms the soil just at the time when native warm season grasses are starting to emerge. The native grasses and forbs thus get a jump-start. As the seasonal temperatures increase the brome is further disadvantaged. Establishing vegetation monitoring plots will help to evaluate changes to the cover of non-native grasses.

To further increase the cover of native grasses and forbs, we recommend broadcasting native seed, harvested from on-site or a nearby site (Lost Valley SNA or Grey Cloud SNA), after a burn. If the native cover is depauperate this will help to bolster it.

In areas where burning does not result in any change to the brome and bluegrass, it may be necessary to apply herbicide. One option is to apply a grass herbicide, such as Poast, to reduce the cover. This herbicide is most effective in spring. The sequence would be: burn in late spring, apply herbicide to regrowth at six inches, if regrowth was dense a second burn may be needed, broadcast a mix of native seed collected from on site – little bluestem, June grass, porcupine grass, and others. Another option is to apply a glyphosate herbicide in late fall, when most native plants are dormant. Then the sequence would be to mow in mid to late September, then apply glyphosate in approximately late October. The challenge is to apply the herbicide when the brome is actively growing but when native plants are dormant.

Hybrid Cattail (*Typha x glauca*) has become established at the stormwater detention pond. Because the pond is quite small and appears to be decreasing, it may not be cost-effective to manage the cattail. However, if control is deemed valuable, one suggested method is to cut the shoots below the water surface two or three times in one growing season before flower production. At this site, however, many plants are likely above the water line and chemical control would also be needed. A wick-application with Rodeo (aquatic formula of glyphosate) when the plants are flowering, followed by cutting and retreating can be very effective. (information from Bugwood Wiki: http://wiki.bugwood.org/Typha_spp.). Adding a non-ionized surfactant to the Rodeo will help it stick to the cattail.

ECOLOGICAL CONTRACTORS

Following is a list of contractors and/or consultants to consider for implementing the management plans. While this is not an exhaustive list, it does include firms with ecologists who are knowledgeable about MN native plant communities and natural resource management. Unless otherwise noted, all firms do prescribed burning. Many other brush removal companies are listed in the yellow pages (under tree care). Additional firm listings can be found on the DNR website: http://www.dnr.state.mn.us/gardens/nativeplants/index.html. Also listed below are firms, compiled by the DNR Biofuels program, that can conduct large scale tree removal services.

Friends of the Mississippi River (FMR) has extensive experience working with landowners to implement natural resource management plans. FMR can assist landowners with obtaining funding for restoration and management projects and providing project management, including contractor negotiations, coordinating restoration and management work, and site monitoring and evaluation.

Applied Ecological Services, Inc.
21938 Mushtown Rd
Prior Lake, MN 55372
952-447-1919
www.appliedeco.com

Bonestroo Natural Resources
2335 West Highway 36
St. Paul, MN 55113
651-604-4812
www.bonestroo.com

Friends of the Mississippi River
360 North Robert St, Suite 400
St. Paul, MN 55101
651-222-2193
(no burning)

Great River Greening
35 West Water St, Suite 201
St. Paul, MN 55107
651-665-9500
www.greatrivergreening.org

Minnesota Native Landscapes, L.L.C.
14088 Highway 95 N.E.
Foley, MN 56329
(320) 968-4222
www.mnnativelandscapes.com

Conservation Corps Minnesota
2715 Upper Afton Road, Suite 100
Maplewood, MN 55119
(651) 209-9900

North American Prairies
111754 Jarvis Ave NW
Annandale, MN 55302
320-274-5316
info@northamericanprairies.com

Prairie Restorations, Inc.
PO Box 305
Cannon Falls, MN 55009
507-663-1091
www.prairieresto.com

TREE REMOVAL SERVICES

Bildeaux Services (MLEP)
21473 Manning Trail N.
Scandia, MN 55073
612-819-9465
bildeauxservices@frontiernet.net

Blue Chip Tree
7700 110th St S
Cottage Grove, MN
Phone: 651-459-5007

Cedar River Horse Logging and Wood Products
51127 130th Street
Lyle, Minnesota 55953
507-438-2164

APPENDIX E. Ecological Contractors

Dennis Dick
Route 2, Box 88A
Wabasha, MN 55981
507-458-5124

Evergreen Energy – service provider to District Energy
Jeff Guillemette
651-747-5798 cell

Johnson Logging, Inc. (MLEP)
7557 360th St. Way
Cannon Falls, MN 55009
507-263-5711
jlogging@msn.com

MN Nice Wood Recovery
320 18th St E
Hastings, MN 55033
651-307-3330

Mike's Tree Service, Inc.
18320 Henna Ave. N.
Forest Lake, MN 55025
651-731-6311

North Central Wildfire LLC (MLEP)
6401 320th St.
Stacy, MN 55079'612-282-4741
newwildfire@frontiernet.net

Rivard Contracting Inc./Central Wood Products (MLEP)
19801 Hwy 65 NE
East Bethel, MN 55011
763-753-7888
Mikerivardcwp@aol.com

Ostvig Tree, Inc.
1161 E. Wayzata Blvd., #311
Wayzata, MN 55391
West Metro: 952-473-0534 or 763-479-4090
East Metro: 651-653-9930
info@ostvigtree.com

S & A Land Clearing, Inc.
(Tree Technology & Recycling)
20370 Enfield Ct. N.
Forest Lake, MN 55025
651-464-8672 ofc

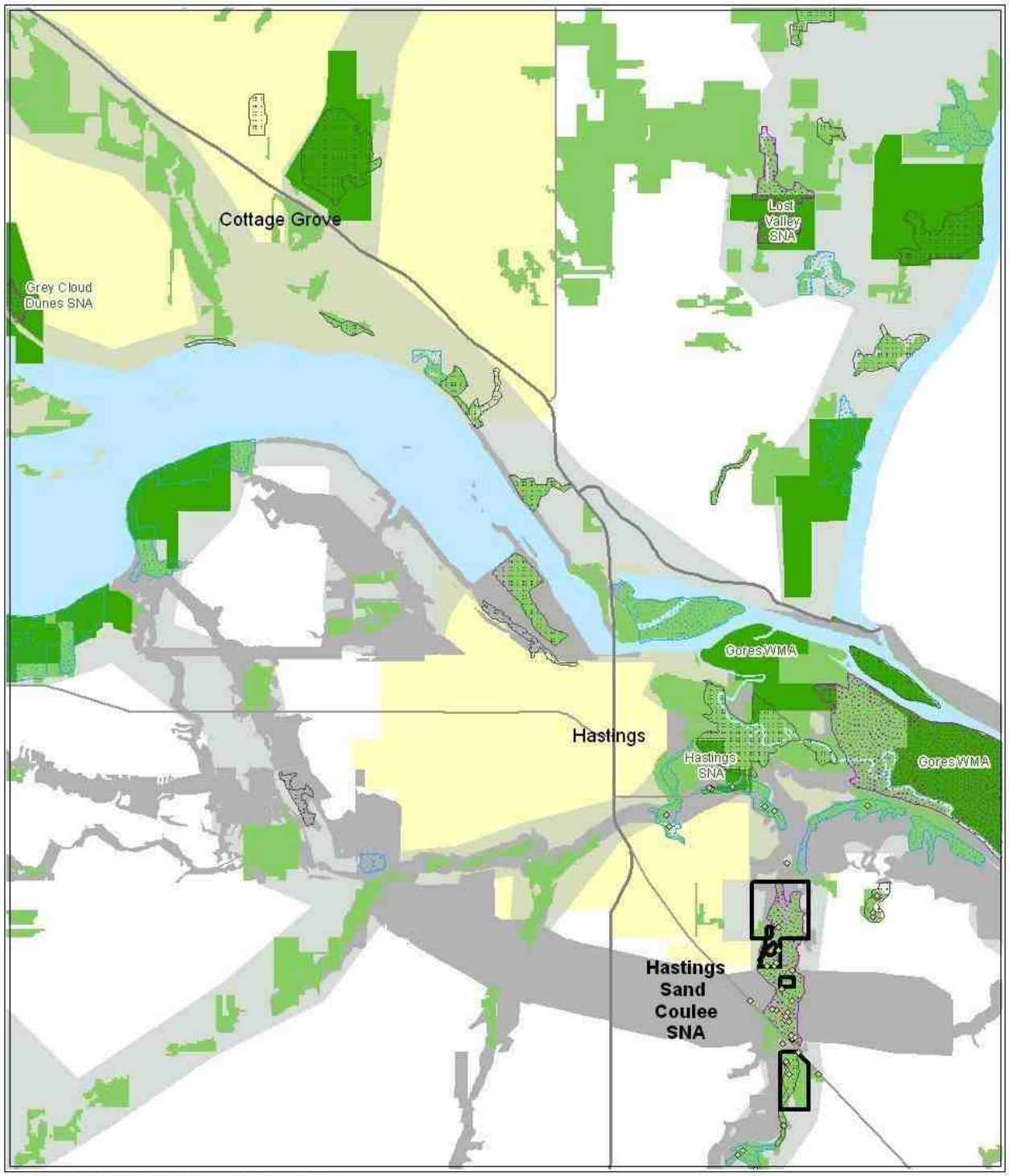
S & S Tree and Horticulture Specialists
405 Hardman Avenue
South St. Paul, MN 55075
651-451-8907

Timonen Harvesting (MLEP)
2738 Fillmore St. NE
Minneapolis, MN 55418
651-208-2967
timonen75@msn.com

Tree People
6945 Skunk Hollow Trail
Cannon Falls, MN 55009
507-263-0794
supertho@rconnect.com

Hastings Sand Coulee SNA (North)
2011 Adaptive Management Plan

Map 1. Landscape Context



Sources: DNR Data Deli, Natural Heritage Database.

FRIENDS of the MISSISSIPPI RIVER

6/22/11

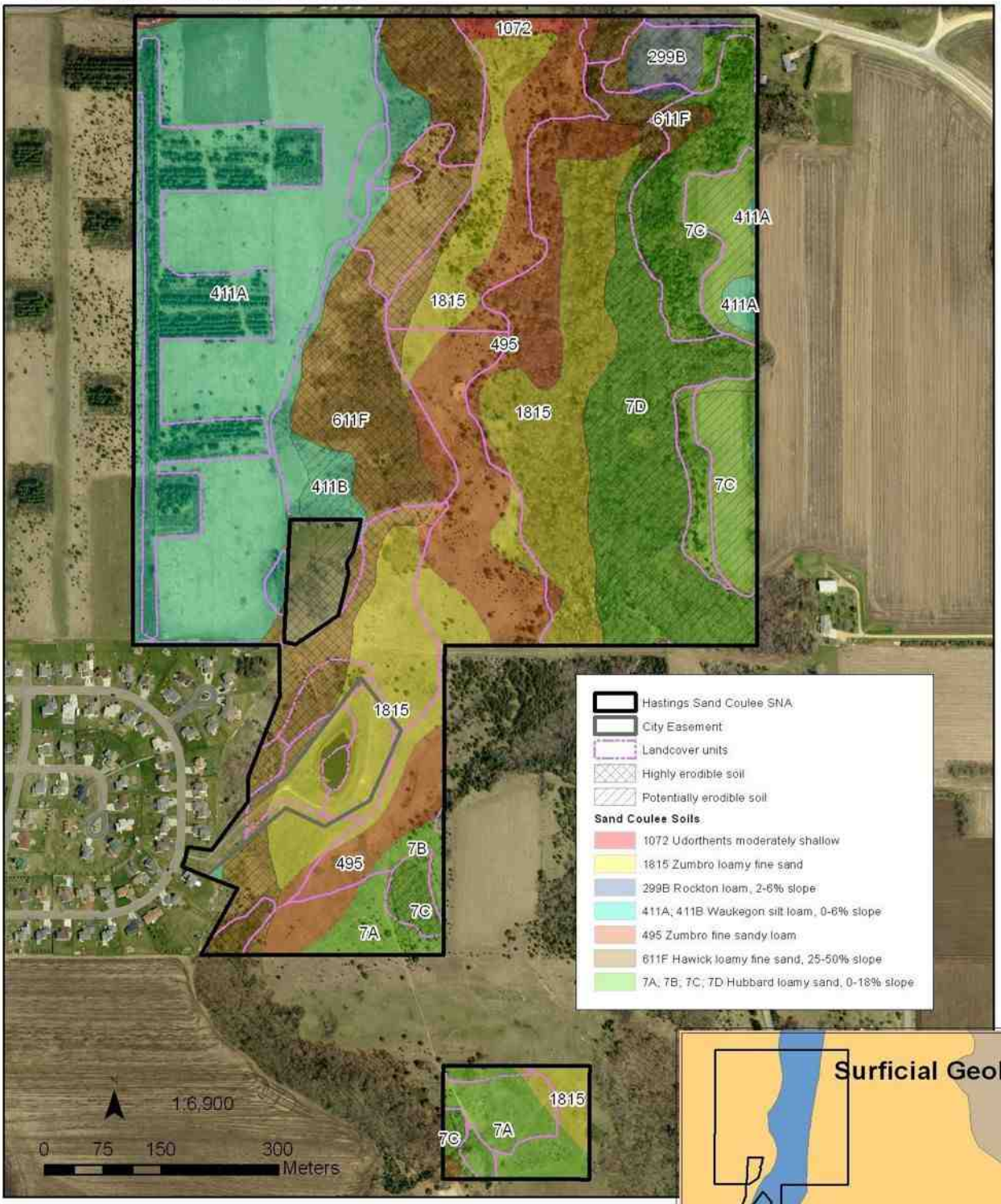
N

0 0.5 1 2 3 Kilometers

- Rare features-1 mile
- MICBS Biological Diversity
  - Outstanding
  - High
  - Moderate
- Parks, WMAs
- Ecologically significant areas (DNR)
- Mississippi Greenway Plan
- Metro Conservation Corridors

Hastings Sand Coulee SNA (North)
2011 Adaptive Management Plan

Map 2. Surficial Geology and Soils



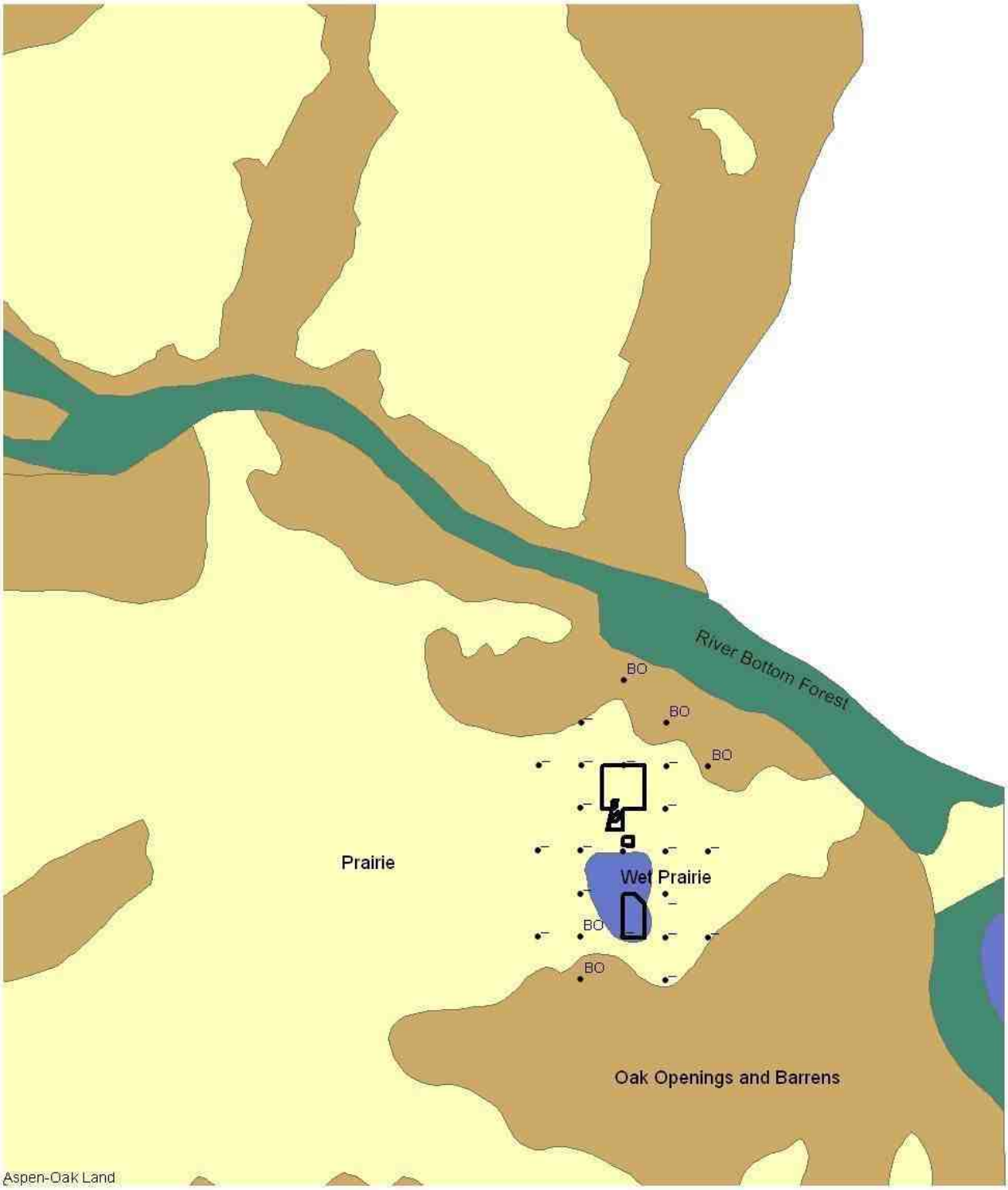
Sources: 1983 Soil Conservation Service - Dakota County Soil Survey.

FRIENDS of the MISSISSIPPI RIVER

6/22/11

Hastings Sand Coulee SNA (North)
2011 Adaptive Management Plan

MAP 3. Pre-European Settlement Vegetation



Sources: DNR data deli, DNR Natural Heritage database.

0 0.5 1 2 3 Kilometers

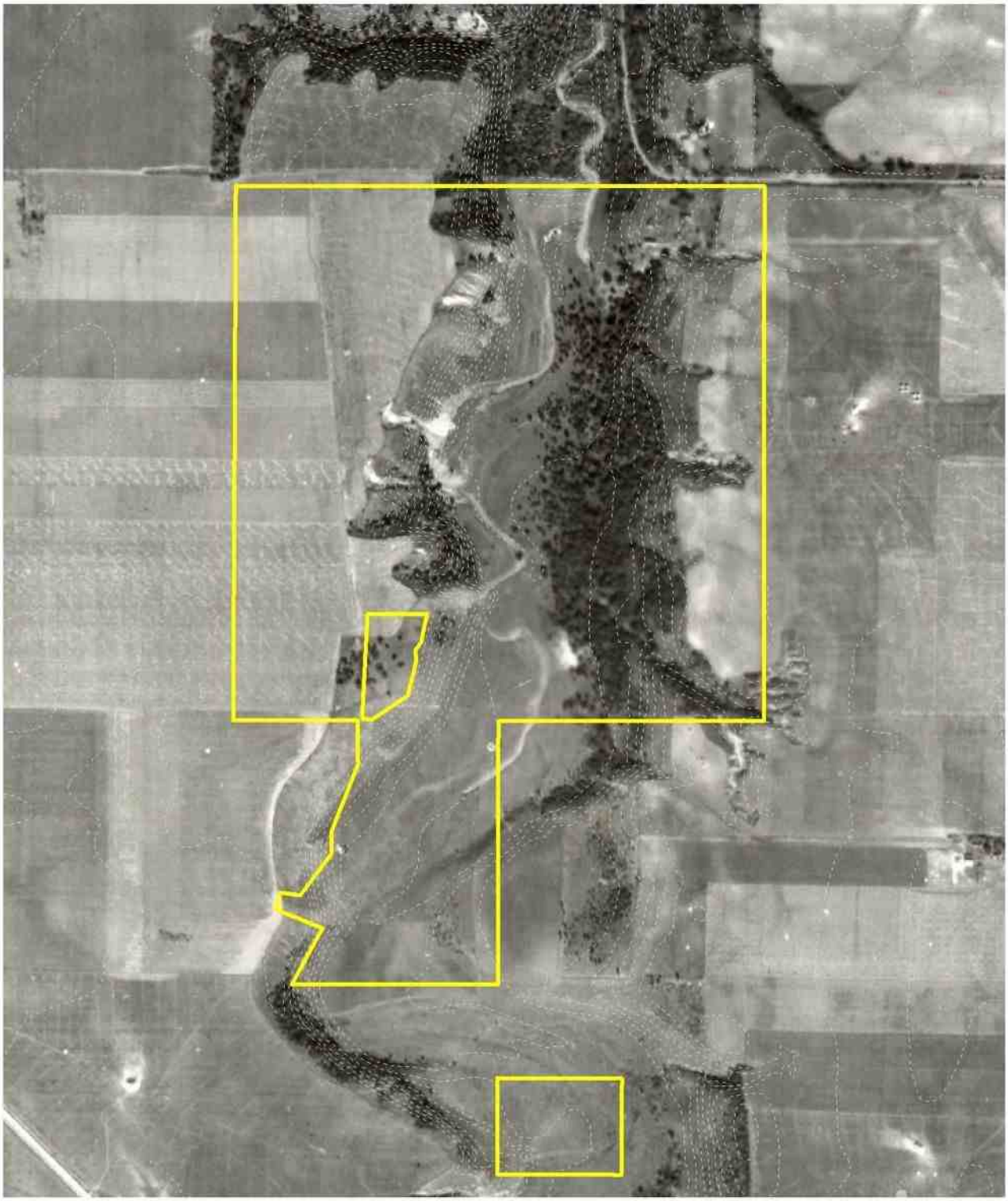
1:100,000

• Bearing trees: "BO" = bur oak, "-" = no trees

Hastings Sand Coulee SNA

Hastings Sand Coulee SNA (North)
2011 Adaptive Management Plan

MAP 4a. 1937 Aerial Photograph



Sources: University of Minnesota Borchert Map Library, DNR data deli (contours).

0 150 300 Meters

N

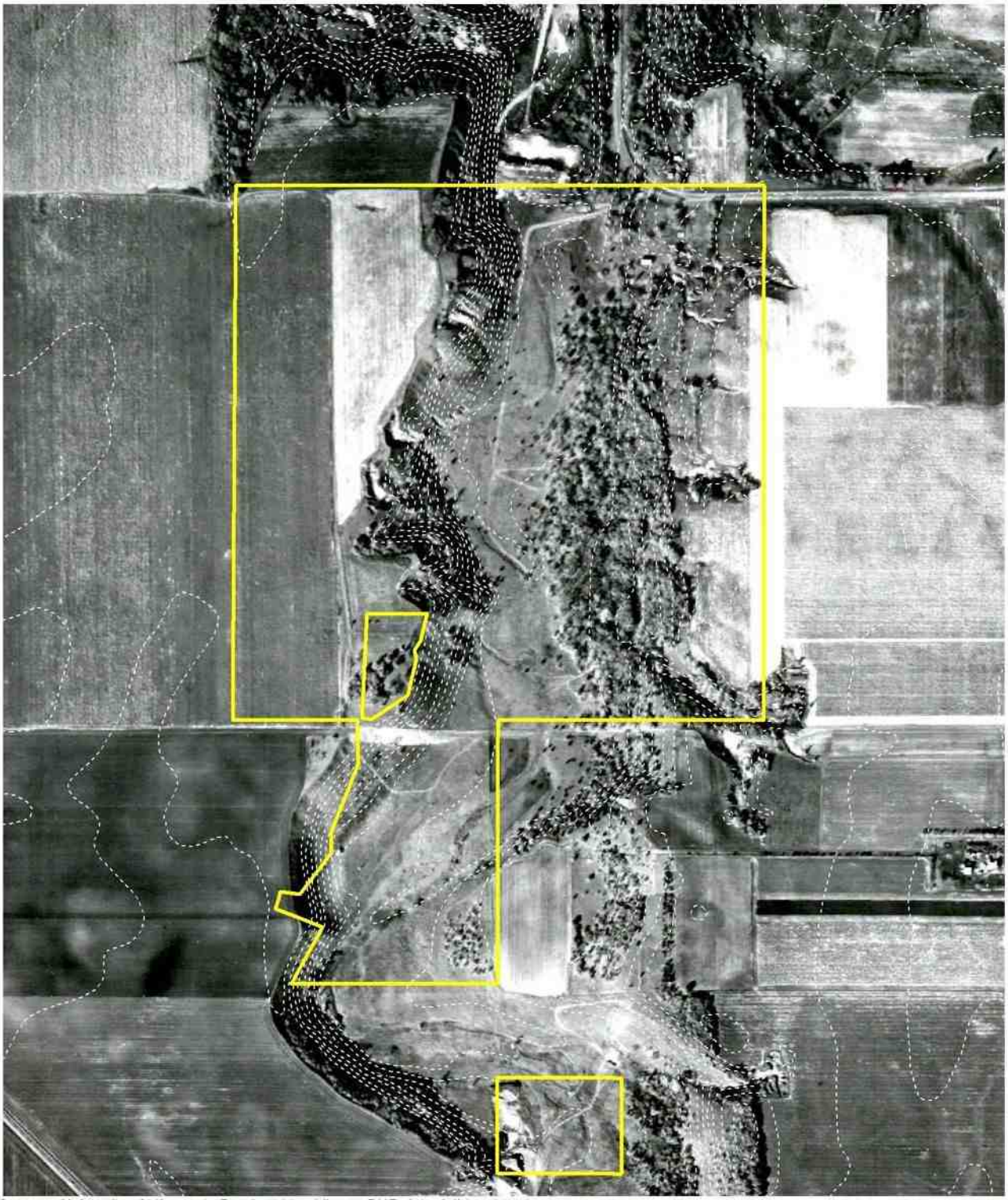
1:8,000

HstgSandCoulee_bndry_new

10-ft contours (dashed white lines)

Hastings Sand Coulee SNA (North)
2011 Adaptive Management Plan

MAP 4b. 1964 Aerial Photograph



Sources: University of Minnesota Borchert Map Library, DNR data deli (contours).

HstgSandCoulee_bndry_new

10-ft contours

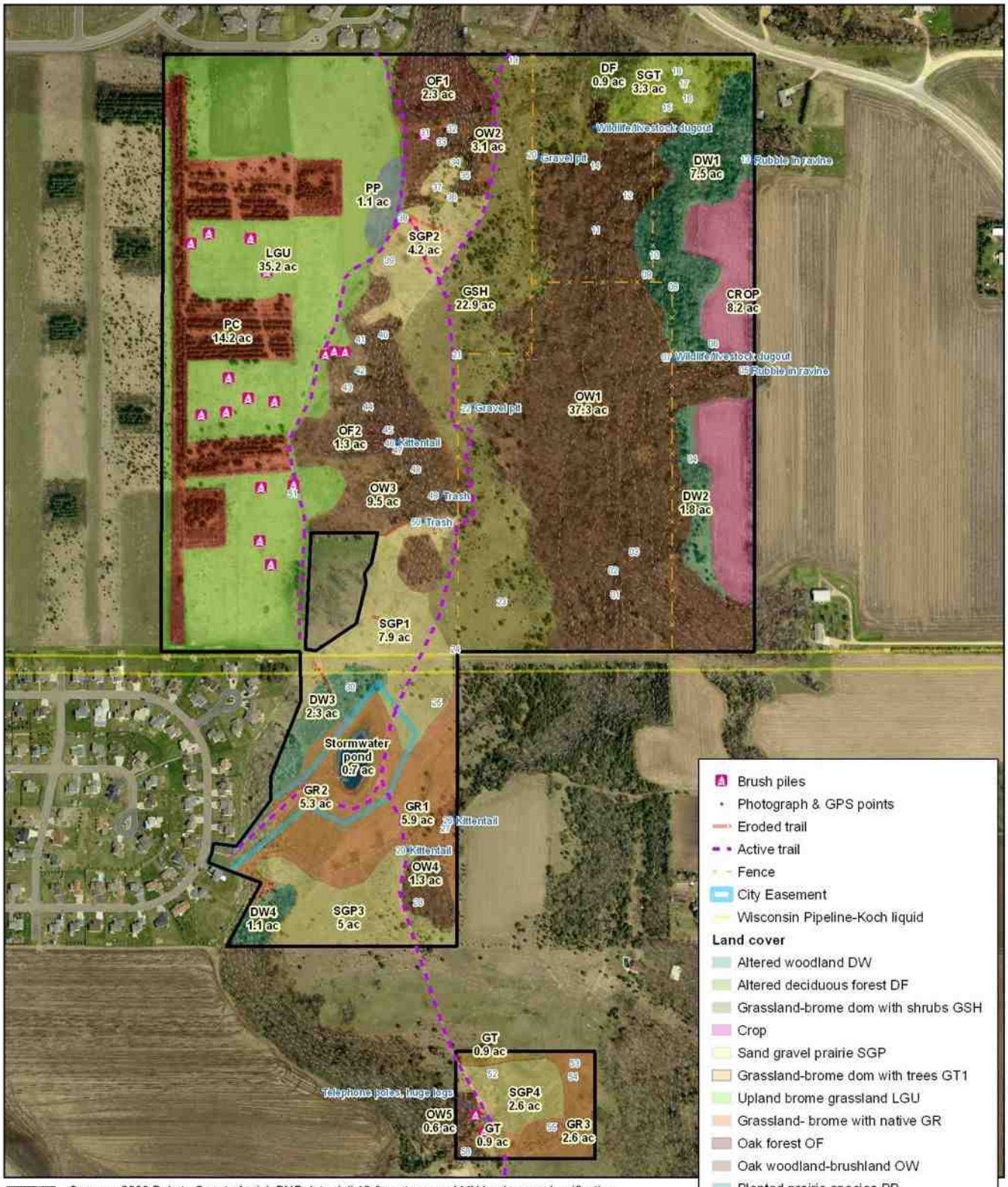
0 150 300 Meters

N

1:8,000

Hastings Sand Coulee SNA (North)
2011 Adaptive Management Plan

Map 5. Existing Land Cover



Sources: 2008 Dakota County Aerial, DNR data deli 10-ft contours and MN land cover classification.

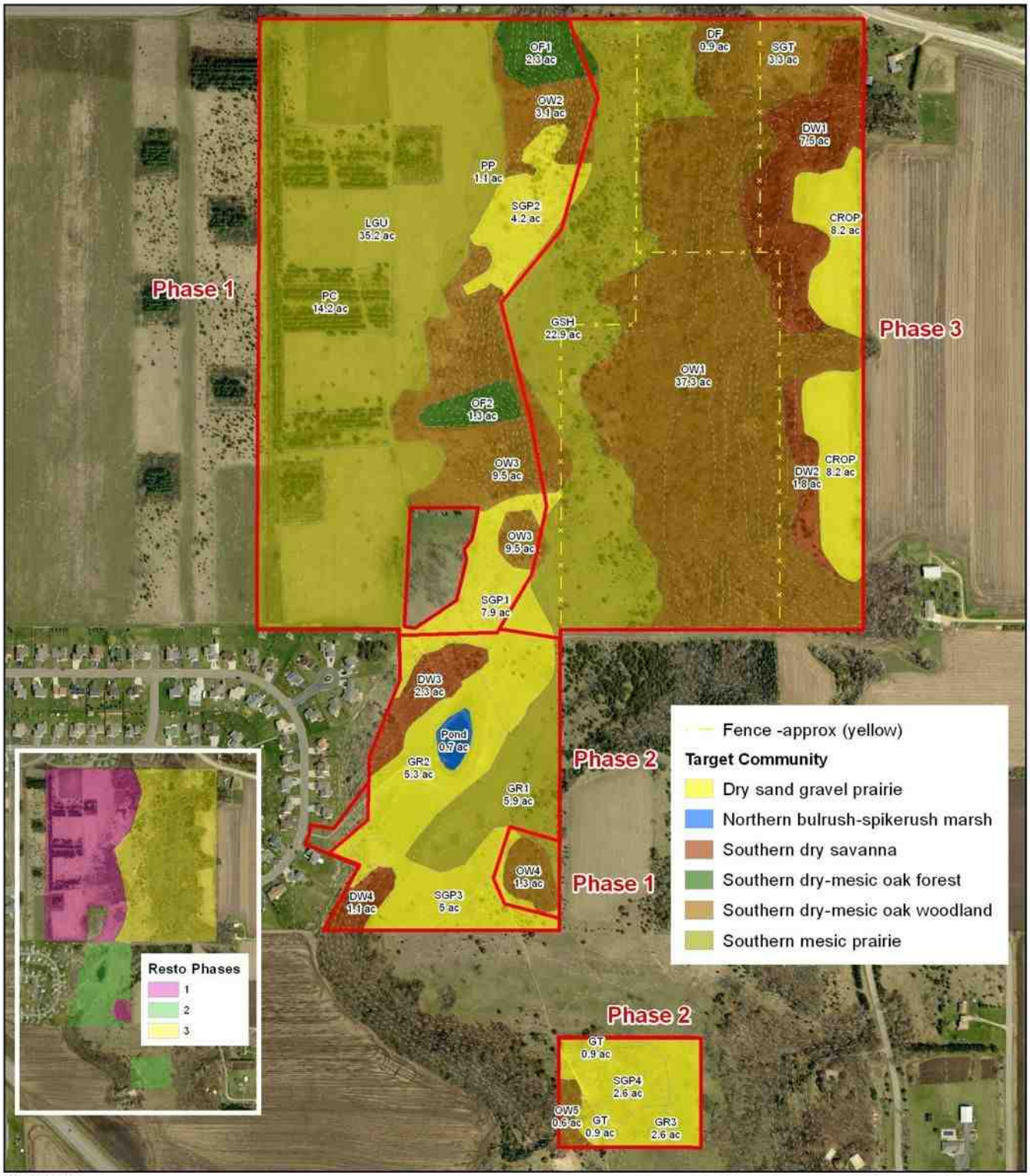
1:6,800

N

0 50 100 200 Meters

Hastings Sand Coulee SNA (North)
2011 Adaptive Management Plan

MAP 6. Restoration Phases



June 21, 2011

Sources: 2008 Dakota County Aerial, DNR data deli 10-ft contours.

1:6,800

N

0 50 100 200
Meters

APPENDIX A. Plant Species Recorded

The species recorded at the Hastings Sand Coulee SNA are listed below according to the land cover units shown in Map 5. With the exception of the sand-gravel prairie units, all records were from surveys conducted in May and June 2011 by Friends of the Mississippi River (FMR). The sand gravel species is based on the DNR county biological survey data, with additions made by FMR since 2004.
Relative coverages for all species was generalized for the entire unit, using approximately the same coverage codes as standard releves: **+ = less than 1%, 1 = 1-5%, 2 = 5-25%, 3 = 25-50%, 4 = 50-75%, 5 = 75-100%.**

ALTERED/DISTURBED FOREST (DF)

Not Native	Family	Scientific name	Common name	Cover
	Canopy & Subcanopy			
	Rosaceae	*Amelanchier sp.*	Serviceberry	+
	Ulmaceae	*Celtis occidentalis*	Hackberry	1
	Cupressaceae	*Juniperus virginiana*	Easter redcedar	2
	Salicaceae	*Populus tremuloides*	Quaking aspen	1
	Fagaceae	*Quercus macrocarpa*	Bur oak	2
	Ulmaceae	*Ulmus americana*	American elm	+
	Shrub Layer			
X	Caprifoliaceae	*Lonicera tatarica*	Tartarian honeysuckle	2
	Rosaceae	*Prunus virginiana*	Chokecherry	1
X	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	3
	Rosaceae	*Rubus* complex	Blackberry	1
	Ground Layer			
	Forbs			
	Rubiaceae	*Galium aparine*	Clevers	+
	Rosaceae	*Geum canadense*	White avens	+
	Liliaceae	*Maianthemum racemosum*	False Solomon's seal	+
	Liliaceae	*Uvularia sesselifolia*	Sessile-leaved bellwort	+
	Violaceae	*Viola sororia.*	Common violet	+
	Woody			
X	Caprifoliaceae	*Lonicera tatarica*	Tartarian honeysuckle	+
	Rosaceae	*Prunus virginiana*	Chokecherry	+
X	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	3
	Grossulariaceae	*Ribes cynosbati*	Prickly gooseberry	+

ALTERED/DISTURBED WOODLAND (DW)

Not Native	Family	Scientific name	Common name	Cover
	Canopy & Subcanopy			
	Aceraceae	*Acer negundo*	Boxelder	1
	Oleaceae	*Fraxinus pennsylvanica*	Green ash	1
	Cupressaceae	*Juniperus virginiana*	Easter redcedar	3
X	Caprifoliaceae	*Lonicera tatarica*	Tartarian honeysuckle	1
	Salicaceae	*Populus tremuloides*	Quaking aspen	1
	Facaceae	*Quercus ellipsoidalis*	Northern pin oak	1
	Ulmaceae	*Ulmus americana*	American elm	1
x	Ulmaceae	*Ulmus pumila*	Siberian elm	1
	Shrub Layer			
	Betulaceae	*Corylus americana*	American hazel	+
	Rosaceae	*Prunus americana*	American plum	1
	Rosaceae	*Prunus pensylvanica*	Pin cherry	1

X	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	3
	Anacariaceae	*Rhus glabra*	Smooth sumac	1
x	Ulmaceae	*Ulmus pumila*	Siberian elm	1
	Ground Layer			
	Forbs			
	Asteraceae	*Achillea millefolium*	Common yarrow	+
	Ranunculaceae	*Anemone quinquefolia*	Wood anemone	+
	Asteraceae	*Antennaria plantaginafolia*	Plantained leaved pussytoes	+
	Asteraceae	*Artemesia campestris*	wormwood	+
	Asteraceae	*Aster laevis*	Smooth blue aster	+
	Asteraceae	*Aster oolentangiensis*	Sky-blue aster	+
	Rosaceae	*Fragaria virginiana*	Strawberry	+
	Rubiaceae	*Galium triflorum*	Sweet scented bedstraw	+
	Rosaceae	*Geum* cf. *canadense*	White avens	+
	Saxifrageaceae	*Heuchera richardsonii*	Alumroot	+
	Asteraceae	*Hieracium longipilum*	Long-beard hawkweed	+
	Lamiaceae	*Monarda fistulosa*	Wild bergamot	+
	Lamiaceae	*Monarda fistulosa*	Wild bergamot	+
	Onagraceae	*Oenothera biennis*	evening primrose	+
	Liliaceae	*Polygonatum biflorum*	Solomon's seal	+
	Rosaceae	*Potentilla sp.*	Potentilla	+
	Ranuculaceae	*Ranunculus arbortivis*	Buttercups	+
	Ranunculaceae	*Ranunculus* cf. *abortivus*	Littleleaf buttercup	+
	Asteraceae	*Ratibida pinnata*	Grey-headed coneflower	+
	Apiaceae	*Sanicula marilandica*	Black snakeroot	+
X	Asteraceae	*Taraxacum officianale*	Common dandelion	+
	Liliaceae	*Uvularia sessilifolia*	Sessile-leaved bellwort	+
	Violaceae	*Viola sororia*	Hairy wood violet	+
	Graminoids			
	Poaceae	*Bromus inermis*	Smooth brome	1
	Cyperaceae	*Carex pensylvanica*	Pennsylvania sedge	1
	Poaceae	*Oryzopsis* cf. *pungens*	Rice grass cf. mountain	+
X	Poaceae	*Poa pratensis*	Kentucky bluegrass	1
	Poaceae	*Schizachyrium scoparium*	Little bluestem	+
	Ferns and Allies			
	Equisetaceae	*Equisetum hyemnale*	Scouring rush	+
	Violaceae	*Viola sp.*	Violet	+
	Bryophytes			
	Bryophyta		Moss	1
	Woody			
	Vitaceae	*Parthenocissus quinquefolia*	Virginia creeper	+
	Anacardiaceae	*Toxicodendron radicans*	Poison ivy	1

CROPLAND (CROP)

Not Native	Family	Scientific name	Common name	Cover
X	Fabaceae	*Trifolium pratense*	Red clover	2

DRY SAND-GRAVEL PRAIRIE (SGP)

Relative coverages were not assessed for sand gravel prairie species.

Not Native	Family	Scientific name	Common name
	Trees, shrubs, & vines		
	Fabaceae	*Amorpha canescens*	Leadplant
	Rhamnaceae	*Ceanothus americanus*	New Jersey tea
	Cornaceae	*Cornus racemosa*	Gray dogwood
	Cupressaceae	*Juniperus virginiana*	Red cedar
x	Caprifoliaceae	*Lonicera tartarica*	Tartarian honeysuckle
	Roseaceae	*Prunus pumila*	sand cherry
	Fagaceae	*Quercus macrocarpa*	Bur oak
x	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn
	Anarcardiaceae	*Rhus glabra*	smooth sumac
	Anarcardiaceae	*Rhus rydbergii*	poison ivy
	Roseaceae	*Rosa arkansana*	prairie rose
	Roseaceae	*Rosa blanda*	smooth rose
	Roseaceae	*Rubus occidentalis*	black raspberry
	Salicaceae	*Salix humilus*	Prairie willow
	Caprifoliaceae	*Symphoricarpus occidentalis*	wolfberry
x	Ulmaceae	*Ulmus pumila*	Siberian elm
	Forbs		
	Asteraceae	*Achillea millefolium*	yarrow
	Lamiaceae	*Agastache foeniculum*	Wild anise
	Asteraceae	*Ambrosia psilostachya*	western ragweed
	Primulaceae	*Androsace occidentalis*	western rock jasmine
	Ranunculaceae	*Anemone caroliniana*	Carolina anemone
	Ranunculaceae	*Anemone cylindrica*	thimbleweed
	Asteraceae	*Antennaria neglecta*	Field pussytoes
	Asteraceae	*Antennaria plantaginifolia*	plantain-leaved pussytoes
	Brassicaceae	*Arabis cf hirsuta*	rock cress
	Asteraceae	*Artemisia campestris*	wormwood
	Asteraceae	*Artemisia ludoviciana*	prairie sage
	Asclepiaceae	*Asclepias syriaca*	common milkweed
	Asclepiaceae	*Asclepias viridiflora*	green milkweed
	Asclepiaceae	*Asclepias verticillata*	whorled milkweed
	Asteraceae	*Aster ericoides*	heath aster
	Asteraceae	*Aster oolentengiensis*	sky-blue aster
	Asteraceae	*Aster sericeus*	silky aster
	Fabaceae	*Astragalus canadensis*	Canadian milk-vetch
	Fabaceae	*Astragalus crassicarpus*	Prairie plum/bufflalo bean
	Campanulaceae	*Campanula rotundifolia*	harebell
X	Asteraceae	*Carduus nutans*	musk thistle
X	Asteraceae	*Centaurea maculosa*	spotted knapweed
X	Chenopodiaceae	*Chenopodium album*	lamb's quarters
	Chenopodiaceae	*Chenopodium leptophyllum*	goosefoot
	Asteraceae	*Chrysopsis villosa* (*Heterotheca*)	golden aster
	Asteraceae	*Cirsium discolor*	field thistle
	Santalaceae	*Comandra umbellata*	bastard toadflax
	Asteraceae	*Conyza canadensis*	horseweed
	Asteraceae	*Coreopsis palmata*	prairie coreopsis
	Fumariaceae	*Corydalis aurea*	golden corydalis
x	Asteraceae	*Crepis tectorum*	narrow-leaved hawkweed
	Chenopodiaceae	*Cycloloma atriplicifolium*	winged pigweed

	Fabaceae	*Dalea candidum*	white prairie-clover
	Fabaceae	*Dalea purpureum*	purple prairie-clover
	Fabaceae	*Dalea villosum*	silky prairie-clover
	Ranunculaceae	*Delphinium virescens*	prairie larkspur
	Brassicaceae	*Draba reptans*	Carolina whitlow grass
	Asteraceae	*Erigeron strigosus*	daisy fleabane
	Brassicaceae	*Erysimum cf cheiranthoides*	wormseed mustard
	Euphorbiaceae	*Euphorbia corollata*	flowering spurge
	Euphorbiaceae	*Euphorbia cyathophora*	fire on the mountain
	Euphorbiaceae	*Euphorbia dentata*	toothed spurge
	Euphorbiaceae	*Euphorbia geyeri*	dune spurge
	Linaceae	*Linum sulcatum*	grooved yellow flax
	Amaranthaceae	*Froelichia floridana*	cottonweed
	Gentianaceae	*Gentiana cf puberula*	downy gentian
	Roseaceae	*Geum triflorum*	prairie smoke
	Asteraceae	*Gnaphalium obtusifolium*	fragrant cudweed
	Lamiaceae	*Hedeoma hispida*	rough pennyroyal
	Cistaceae	*Helianthemum bicknellii*	Hoary frostweed
	Asteraceae	*Helianthus rigidus*	stiff sunflower
	Asteraceae	*Heliopsis helianthoides*	early sunflower
	Saxifragaceae	*Heuchera richardsonii*	alum root
	Rubiaceae	*Houstonia longiflolia*	long-leaved houstonia (bluet)
	Asteraceae	*Kuhnia eupatorioides*	false boneset
X	Asteraceae	*Lactuca ludoviciana*	prairie lettuce
	Cistaceae	*Lechea cf stricta*	prairie pinweed
	Brassicaceae	*Lepidium densiflorum*	peppergrass
	Fabaceae	*Lespedeza capitata*	round-headed bushclover
	Asteraceae	*Liatris aspera*	rough blazingstar
	Asteraceae	*Liatris ligulisytlis*	meadow blazingstar
	Asteraceae	*Liatris punctata*	dotted blazingstar
	Linaceae	*Linum sulcatum*	grooved yellow flax
	Orchidaceae	*Liparis cf loeselii*	Loesel's twayblade
	Boraginaceae	*Lithospermum carolinense*	hairy puccoon
	Boraginaceae	*Lithospermum incisum*	narrow-leaved puccoon
	Campanulaceae	*Lobelia spicata*	Pale spiked lobelia
X	Fabaceae	*Melilotus alba*	white sweet-clover
X	Fabaceae	*Melilotus officinalis*	yellow sweet-clover
	Nyctaginaceae	*Mirabilis hirsuta*	hairy umbrella-wort
	Nyctaginaceae	*Mirabilis nyctanginea*	four-o-clock
	Lamiaceae	*Monarda fistulosa*	bergamot
X	Aizoaceae	*Mullogo verticillata*	carpetweed
X	Lamiaceae	*Nepetea cartaria*	catnip
	Onagraceae	*Oenothera biennis*	evening primrose
	Onagraceae	*Oenothera clelandii*	primrose
	Oxalidaceae	*Oxalis violacea*	violet wood-sorrel
	Scrophulariaceae	*Penstemon gracilis*	slender penstemon
	Scrophulariaceae	*Penstemon grandiflora*	large-flowered penstemon
	Polemoniaceae	*Phlox pilosa*	Prairie phlox
	Solanaceae	*Physalis heterophylla*	clammy ground-cherry
	Solanaceae	*Physalis virginiana*	Virginia ground cherry
x	Plantaginaceae	*Plantago purshii*	wooly plantain
	Capparaceae	*Polanisia dodecandra*	clammy weed
	Polygalaceae	*Polygala polygama*	racemed milkwort
	Liliaceae	*Polygonatum biflorum*	Solomon's seal
X	Polygonaceae	*Polygonum convolvulus*	black bindweed
	Polygonaceae	*Polygonum ramosissimum*	bushy knotweed

	Roseaceae	*Potentilla arguta*	tall potentilla
	Roseaceae	*Potentilla norvegica*	rough cinquefoil
	Asteraceae	*Ratibida pinnata*	prairie coneflower
X	Caprifoliaceae	*Saponaria officinalis*	soapwort
	Scrophulariaceae	*Scrophularia lanceolata*	figwort
	Lamiaceae	*Scutellaria parvula*	prairie skullcap
	Selaginellaceae	*Selaginella rupestris*	rock spike-moss
	Asteraceae	*Senecio cf plattensis*	ragwort
	Caryophyllaceae	*Silene antirrhina*	sleepy catchfly
X	Caryophyllaceae	*Silene latifolia*	white campion
X	Caryophyllaceae	*Silene cserei*	bladder campion
	Iridaceae	*Sisyrinchium sp*	Blue-eyed grass
	Liliaceae	*Smilacina racemosa*	false Solomon's seal
	Liliaceae	*Smilacina stellata*	starry false-solomon's seal
	Asteraceae	*Solidago gigantea*	late goldenrod
	Asteraceae	*Solidago missouriensis*	Missouri goldenrod
	Asteraceae	*Solidago nemoralis*	gray goldenrod
	Asteraceae	*Solidago rigida*	stiff goldenrod
	Asteraceae	*Solidago speciosa*	showy goldenrod
	Lamiaceae	*Teucrium canadense*	germander
	Commelinaceae	*Tradescantia occidentalis*	western spiderwort
X	Asteraceae	*Tragopogon dubius*	goat's beard
X	Fabaceae	*Trifolium arvense*	rabbit-foot clover
X	Fabaceae	*Trifolium pratense*	red clover
X	Scrophulariaceae	*Verbascum thapsus*	common mullein
	Verbenaceae	*Verbena stricta*	hoary vervain
x	Fabaceae	*Vicia cracca*	cow vetch
	Violaceae	*Viola pedata*	birds-foot violet
	Violaceae	*Viola pedatifida*	Prairie violet
	Graminoids		
x	Poaceae	Agropyron repens	quack grass
	Poaceae	*Andropogon gerardii*	big bluestem
	Poaceae	*Aristida basimirea*	three awned grass
	Poaceae	*Bouteloua curtipendula*	sideoats grama
	Poaceae	*Bouteloua hirsuta*	hairy grama
X	Poaceae	*Bromus inermis*	smooth brome
	Poaceae	*Calamovilfa longifolia*	sand reedgrass
	Cyperaceae	*Carex muhlenbergii*	muhly sedge
	Cyperaceae	*Carex pennsylvanica*	Pennsylvania sedge
	Poaceae	*Cenchrus longispinus*	sandbur
	Cyperaceae	*Cyperus lupulinus*	nutsedge
X	Cyperaceae	*Cyperus schweinitzii*	nutsedge
x	Poaceae	*Digitaria sp*	crab-grass
	Poaceae	*Elymus canadensis*	Canada wild rye
	Equiseteaceae	*Equisetum laevigatum*	horsetail
	Poaceae	*Eragrostis spectabilis*	purple lovegrass
	Poaceae	*Koeleria macrantha*	junegrass
	Poaceae	*Leptoloma cognatum*	fall witch-grass
	Poaceae	*Panicum linearifolium*	linear leaved panic grass
	Poaceae	*Panicum oligosanthes*	Scribner's panic grass
	Poaceae	*Panicum perlongum*	Long-leaved panic grass
	Poaceae	*Panicum virgatum*	switchgrass
X	Poaceae	*Poa compressa*	Canada bluegrass
x	Poaceae	*Poa pretensis*	Kentucky bluegrass
	Poaceae	*Schizachrium scoparium*	little bluestem

	Poaceae	*Sorghastrum nutans*	Indiangrass
	Poaceae	*Sporobolis heterolepis*	prairie dropseed
	Poaceae	*Sporobolus cryptandrus*	sand dropseed
	Poaceae	*Stipa spartea*	porcupine grass
	Rare Plant species		
SPC	Asteraceae	*Antennaria parvifolia*	small-leaved pussytoes
SPC	Poaceae	*Aristida tuberculosa*	sea-beach needlegrass
SPC	Asclepiaceae	*Asclepias amplexicaulis*	clasping milkweed
T	Scrophulariaceae	*Besseya bullii*	Kittentails
R	Asteraceae	*Hieracium longipilum*	long-bearded hawkweed
E	Cistaceae	*Lechea tenuifolia*	narrow-leaved pinweed
R	Scrophulariaceae	*Linaria canadensis*	old field toadflax
SPC	Onagraceae	*Oenothera rhombipetala*	rhombic-petaled eve primrose
SPC	Orobanchaceae	*Orobanche fasciculata*	clustered broomrape
E	Capparaceae	*Polanisia jamesii*	James's polanisia

E = Endangered, T=Threatened, SPC= Special concern, R= Rare, but no official State status

GRASSLAND—DOMINATED BY BROME WITH SCATTERED SHRUBS (GSH)

Not Native	Family	Scientific name	Common name	Cover
	Canopy and Subcanopy Layer			
	Cupressaceae	*Juniperus virginiana*	Eastern redcedar	1
	Rosaceae	*Malus spp.*	Crabapple	+
	Pinaceae	*Pinus resinosa*	Red pine	+
X	Pinaceae	*Pinus sylvestris*	Scotch pine	+
	Fagaceae	*Quercus macrocarpa*	Bur oak	1
X	Ulmaceae	*Ulmus pumila*	Siberian elm	1
	Shrub Layer			
	Fabaceae	*Amorpha canescens*	Lead plant	+
	Cupressaceae	*Juniperus virginiana*	Eastern redcedar	1
X	Caprifoliaceae	*Lonicera tartarica*	Tartarian honeysuckle	1
X	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	2
	Anarcardiaceae	*Rhus glabra*	Smooth sumac	4
	Rosaceae	*Rosa arkansana*	Prairie rose	+
	Rutaceae	*Zanthoxylum americanum*	Prickly ash	2
	Ground Layer			
	Forbs			
	Asteraceae	*Achillea millefolium*	Common yarrow	1
	Asteraceae	*Antennaria neglecta*	Field pusseytoes	1
	Asteraceae	*Antennaria plantaginifolia*	Plantain-leaved pusseytoes	1
	Asteraceae	*Aster oolentangiensis*	Sky-blue aster	1
	Asteraceae	*Artemisia sp*	Wormwood	1
	Asteraceae	*Cirsium discolor*	Field thistle	1
	Rosaceae	*Fragaria virginiana*	Wild Strawberry	1
	Rosaceae	*Geum triflorum*	Prairie smoke	1
	Asteraceae	*Hieracium longipilum*	Long-beard hawkweed	1
	Fabaceae	*Lespedeza capitata*	Round-headed bushclover	1
	Asteraceae	*Liatris punctata*	Dotted blazingstar	1
	Lamiaceae	*Monarda fistulosa*	Wild bergamot	1
	Asteraceae	*Ratibida pinnata*	Grey-headed coneflower	1
x	Caryophyllaceae	*Saponaria officinalis*	Soapwort	2
	Violaceae	*Viola pedata*	Bird's-foot violet	1
	Violaceae	*Viola pedatifida*	Prairie violet	1
	Graminoids			

	Poaceae	*Andropogon gerardii*	Big bluestem	1
X	Poaceae	*Bromus inermis*	Smooth brome	4

GRASSLAND – DOMINATED BY BROME WITH NATIVE PRAIRIE SPECIES (GR)

Not Native	Family	Scientific name	Common name	Cover
	Trees, shrubs, & vines			
	Aceraceae	*Acer negundo*	Boxelder	+
	Rhamnaceae	*Ceanothus americanus*	New Jersey tea	+
	Oleacea	*Fraxinus pennsylvanica*	Green ash	1
	Cupressaceae	*Juniperus virginiana*	Eastern redcedar	2
X	Caprifoliaceae	*Lonicera tatarica*	Tartarian honeysuckle	1
	Pinaceae	*Pinus resinosa*	Red pine	+
	Rosaceae	*Prunus serotina*	Black cherry	+
	Fagaceae	*Quercus ellipsoidales*	Northern pin oak	+
	Fagaceae	*Quercus macrocarpa*	Bur oak	+
	Anacardiaceae	*Rhus glabra*	Smooth sumac	1
	Rosaceae	*Rosa arkansana*	Prairie rose	+
	Rosaceae	*Rubus* complex	Blackberry	1
	Anacardiaceae	*Toxicodendron radicans*	Poison ivy	1
	Vitaceae	*Vitis riparia*	River bank grape	+
	Forbs			
	Asteraceae	*Achillea millefolium*	Common yarrow	+
	Asteraceae	*Ambrosia psylostachya*	Western ragweed	+
	Asteraceae	*Antennaria plantaginafolia*	Plantain-leaved pusseytoes	+
	Brassicaceae	*Arabis* cf. *hirsuta*	Rockcress	+
	Asteraceae	*Artemesia campestris*	Wormwood	+
	Asteraceae	*Aster oolentangiensis*	Sky-blue aster	+
	Asteraceae	*Aster oolentangiensis*	Sky-blue aster	+
	Scrophulareacea	*Besseya bullii*	Kittentails	+
x	Asteraceae	*Centaurea biebersteinii*	Spotted knapweed	1
	Santalaceae	*Comandra umbellata*	Bastard toadflax	+
	Rosaceae	*Geum triflorum*	Prairie smoke	+
	Asteraceae	*Helianthus sp.*	Sunflower	+
	Saxifragaceae	*Heuchera richardsonii*	Allumroot	+
	Asteraceae	*Hieracium longipilum*	Long-beard hawkweed	+
	Boraginaceae	*Lithospermum carolinense*	Hairy pucoon	+
	Lamiaceae	*Monarda fistulosa*	Wild bergamot	+
	Oxalidaceae	*Oxalis violacea*	Violet woodsorrel	+
	Asteraceae	*Ratibida pinnata*	Grey-headed coneflower	+
	Runnunculaceae	*Runnunculus rhomboideus*	Prairie buttercup	+
	Graminoids			
	Poaceae	*Andropogon gerardii*	Big bluestem	1
x	Poaceae	*Bromus inermis*	Smooth brome	2
	Poaceae	*Dicanthelium oligosanthes*	Scribner's panic grass	1
	Poaceae	*Panicum virgatum*	Switchgrass	1
X	Poaceae	*Poa pratensis*	Kentucky bluegrass	2
	Poaceae	*Schizachyrium scoparium*	Little bluestem	1
	Poaceae	*Stipa spartea*	Porcupine grass	1
	Ferns and Allies			
	Equisetaceae	*Equisetum hyemnale*	Scouring rush	+

OAK FOREST (OF)

Not Native	Family	Scientific name	Common name	Cover
	Canopy & Subcanopy Layer			
	Ulmaceae	*Celtis occidentalis*	Hackberry	1
	Cupressaceae	*Juniperus virginiana*	Eastern redcedar	1
X	Pinaceae	*Pinus sylvestris*	Scotch pine	+
	Tiliaceae	*Tilia americana*	American basswood	2
	Fagaceae	*Quercus ellipsoidalis*	Northern pin oak	1
	Facageae	*Quercus macrocarpa*	Bur oak	3
	Ulmaceae	*Ulmus americana*	American elm	1
	Shrub Layer			
	Cupressaceae	*Juniperus virginiana*	Eastern redcedar	1
X	Caprifoliceae	*Lonicera tatarica*	Tartarian honeysuckle	2
	Rosaceae	*Prunus virginiana*	Chokecherry	1
X	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	3
	Ground Layer			
	Forbs			
	Asteraceae	*Antennaria neglecta*	Field pusseytoes	+
	Fumariaceae	*Dicentra cucullaria*	Dutchman's breeches	3
	Asteraceae	*Eupatorium rugosum*	White snake root	1
	Rubiaceae	*Galium aparine*	Clevers	+
	Rubiaceae	*Galium triflorum*	Sweet-scented bedstraw	1
	Rosaceae	*Geum canadense*	White avens	+
	Asteraceae	*Helianthos sp.*	Sunflower	+
	Asteraceae	*Helianthus cf. strumosus*	Cf. Woodland sunflower	+
	Liliaceae	*Maianthemum canadense*	Maianthemum	+
	Liliaceae	*Maianthemum racemosum*	False Solomon's seal	+
	Apiaceae	*Osmorhiza claytonii*	Clayton's sweet cicely	1
	Liliaceae	*Polygonatum biflorum*	Solomon's seal	+
	Ranunculaceae	*Ranunculus arbortivus*	Small-flowered buttercup	+
	Apiaceae	*Sanicula marilandica*	Black snakeroot	+
	Iridaceae	*Sisyrinchium cf. campestre*	Prairie blue-eyed grass	+
	Asteraceae	*Solidago flexicaulis*	Zig-zag goldenrod	+
X	Asteraceae	*Taxacum officianale*	Dandelion	+
	Runuculaceae	*Thalictrum dioicus*	Early meadow rue	+
	Ranunculaceae	*Thalictrum thalictroides*	Rue anemone	+
	Violaceae	*Viola sororia*	Common blue violet	+
	Graminoids			
	Cyperaceae	*Carex* cf. *radiata*	Star sedge	1
	Cyperaceae	*Carex sprengelii*	Sprengel's sedge	3
	Ferns			
	Dryopteridaceae	*Athyrium filix-femina*	Lady fern	1
	Bryophytes			
			Moss	1
	Trees, shrubs, vines			
	Rosaceae	*Prunus virginiana*	Chokecherry	1
	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	3
	Vitaceae	*Parthenocissus quinquefolia*	Virginia creeper	+
	Caprifoliaceae	*Lonicera tatarica*	Honeysuckle	1

OAK WOODLAND-BRUSHLAND (OW Units)

Not Native	Family	Scientific name	Common name	Cover
	Canopy & Subcanopy			
	Rosaceae	*Amelanchier sp.*	Serviceberry	+
	Ulmaceae	*Celtis occidentalis*	Hackberry	1
	Oleaceae	*Fraxinus pennsylvanica*	Green ash	1
	Cupressaceae	*Juniperus virginiana*	Eastern Red cedar*	1
	Salicaceae	*Populus tremuloides*	Quaking aspen	1
	Rosaceae	*Prunus serotina*	Black cherry	+
	Rosaceae	*Prunus virginiana*	Chokecherry	2
	Fagaceae	*Quercus ellipsoidalis*	Northern pin oak	2
	Fagaceae	*Quercus macrocarpa*	Bur oak	3
	Shrub Layer			
x	Caprifoliaceae	*Lonicera tartarica*	Tartarian honeysuckle	2
	Anarcardiaceae	*Rhus glabra*	Smooth sumac	1
	Saxifragaceae	*Ribes missouriensis*	Missouri gooseberry	+
x	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	4
	Rosaceae	*Rubus complex*	Black raspberry	1
	Tiliaceae	*Tilia americana*	American basswood	1
	Anarcardiaceae	*Toxicodendron radicans*	Poison ivy	1
	Ulmaceae	*Ulmus Americana*	American elm	1
	Vitaceae	*Vitus riparia*	Grapevine	+
	Rutaceae	*Zanthoxylum americanum*	Prickly ash	1
	Ground Layer			
	Forbs			
	Asteraceae	*Achillea millefolium*	Common yarrow	+
x	Brassicaceae	*Alliaria petiolata*	Garlic mustard	+
	Ranunculaceae	*Anemone quinquefolia*	Wood anemone	+
	Asteraceae	*Antennaria neglecta*	Field Pusseytoes	+
	Asteraceae	*Antennaria plantaginifolia*	Plantain-lvd pusseytoes	+
	Asteraceae	*Aster laevis*	Smooth blue aster	+
	Asteraceae	*Aster oolentangiensis*	Sky-blue aster	+
x	Brassicaceae	Cf. *Brassica rapa*	Cf. Field mustard	+
	Scrophulariaceae	*Cf. Scrophularia marilandica*	Cf. Eastern Figwort	+
	Fumariaceae	*Dicentra cucullaria*	Dutchman's breeches	+
	Rosaceae	*Fragaria virginiana*	Wild Strawberry	1
	Rubiaceae	*Galium aparine*	cleavers	1
	Rubiaceae	*Galium triflorum*	Fragrant bedstraw	1
	Rosaceae	*Geum* cf. *canadense*	White avens	1
x	Lamiaceae	*Leonurus cardiaca*	Motherwort	1
	Lamiaceae	*Monarda fistulosa*	Wild bergamot	+
	Onagraceae	*Oenothera biennis*	evening primrose	+
	Apiaceae	*Osmorhiza claytonii*	Sweet cicely	1
	Vitaceae	*Parthenossisus quinquefolia*	Virginia creeper	1
	Liliaceae	*Polygonatum biflorum*	Solomon's seal	+
	Rosaceae	*Potentilla sp.*	Potentilla	+
	Ranunculaceae	*Ranunculus* cf. *abortivus*	Littleleaf buttercup	1
	Apiaceae	*Sanicula marilandica*	Black snakeroot	1
x	Caryophyllaceae	*Saponaria officinalis*	Soapwort	1
	Asteraceae	*Solidago canadensis*	Canada goldenrod	1
	Asteraceae	*Solidago flexicaulis*	Zig-zag goldenrod	1
x	Asteraceae	*Taraxacum officianale*	Common dandelion	1
	Urticaceae	*Urtica dioica*	Stinging nettle	1
	Liliaceae	*Uvularia sessilifolia*	Sessile-leaved bellwort	1

	Violaceae	*Viola sororia*	Hairy wood violet	+
	Violaceae	*Viola sp.*	Violet	1
	Graminoids			
	Cyperaceae	*Carex blanda*	Woodland sedge	1
	Cyperaceae	*Carex pensylvanica*	Pennsylvania sedge	2
	Cyperaceae	*Carex sprengelii*	Sprengel's sedge	1
x	Poaceae	*Poa pratensis*	Kentucky bluegrass	1
	Bryophytes			
			Moss	2
	Ferns and Fern Allies			
	Dryopteridaceae	*Athryreum filix-femini*	Lady fern	+
	Woody			
x	Caprifoliaceae	*Lonicera tartarica*	Tartarian honeysuckle	2
	Vitaceae	*Parthenocissus quinquefolia*	Virginia Creeper	+
	Rosaceae	*Prunus virginiana*	Chokecherry	1
x	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	4
	Rosaceae	*Rhubus* cmx	Blackberry	1
	Grossulariaceae	*Ribes cynosbati*	Prickly gooseberry	+

PLANTED CONIFERS (PC)

Not Native	Family	Scientific name	Common name	Cover
	Canopy			
	Pinaceae	*Picea glauca*	White spruce	5
	Subcanopy and Shrub			
X	Aceraceae	*Acer ginnala*	Amur maple	1
	Oleaceae	*Fraxinus pennsylvanica*	Green ash	+
X	Caprifoliaceae	*Lonicera tatarica*	Tartarian honeysuckle	+
X	Rhamnaceae	*Rhamnus cathartica*	Common buckthorn	+
	Ground Layer			
X	Poaceae	*Bromus inermis*	Smooth brome	1
X	Plantaganaceae	*Plantago major*	Common plantain	+
X	Poaceae	*Poa pratensis*	Kentucky bluegrass	+
	Asteraceae	*Solidago Canadensis*	Canada goldenrod	1
	Urticaceae	*Urtica dioica*	Stinging nettle	+

SHORT GRASSES WITH MIXED TREES (SGT)

Not Native	Family	Scientific name	Common name	Cover
	Canopy & Subcanopy			
	Aceraceae	*Acer negundo*	Boxelder	+
	Cupressaceae	*Juniperus virginiana*	Eastern redcedar	2
	Fagaceae	*Quercus macrocarpa*	Bur oak	2
	Ulmaceae	*Ulmus americana*	American elm	1
X	Ulmaceae	*Ulmus pumila*	Siberian elm	1
	Shrub Layer			
	Cupressaceae	*Juniperus virginiana*	Eastern redcedar	2
X	Caprifoliaceae	*Lonicera tatarica*	Tartarian honeysuckle	2
X	Ulmaceae	*Ulmus pumila*	Siberian elm	1
	Ground Layer			
	Forbs and Graminoids			

X	Poaceae	*Bromus inermis*	Smooth brome	3
X	Liliaceae	*Hemerocallis lilioasphodelus*	Yellow daylily	1
X	Poaceae	*Poa pratensis*	Kentucky bluegrass	2
	Asteraceae	*Solidago canadensis*	Canada goldenrod	2
	Woody			
X	Caprifoliaceae	*Lonicera tatarica*	Tartarian honeysuckle	1

STORMWATER POND (POND)

Not Native	Family	Scientific name	Common name	Cover
	Forbs and Graminoids			
	Alismataceae	*Sagittaria latifolia*	Common arrowhead	+
	Cyperaceae	*Schoenoplectus tabernaemontani*	Softstem bulrush	+
x	Typhaceae	*Typha x glauca*	Hybrid cattail	2

UPLAND BROME GRASSLAND (LGU)

Not Native	Family	Scientific name	Common name	Cover
	Canopy & Subcanopy			
	Aceraceae	*Acer negundo*	Boxelder	1
	Oleaceae	*Fraxinus pennsylvanica*	Green ash	2
	Pinaceae	*Pinus resinosa*	Red pine	+
	Shrub Layer			
X	Aceraceae	*Acer ginnala*	Amur maple	1
	Cupressaceae	*Juniperus virginiana*	Eastern Red cedar*	1
X	Caprifoliaceae	*Lonicera tartarica*	Tartarian honeysuckle	1
	Anarcardiaceae	*Rhus glabra*	Smooth sumac	+
	Ground Layer			
	Graminoids			
	Poaceae	*Andropogon gerardii*	Big bluestem	+
X	Poaceae	*Bromus inermis*	Smooth brome	5
	Forbs			
	Asteraceae	*Solidago Canadensis*	Canada goldenrod	1

APPENDIX B. Plant Species for Restoration

The following are species lists suitable for use in restoring each of the plant community types shown in Map 6. The lists are based on the *Species Lists for Terrestrial and Palustrine Native Plant Communities in East-central Minnesota (*Dunevitz and Lane 2004), which were developed from releve data. While many of the species listed are not commercially available, it is possible they could be obtained by harvesting from another site. We included all native species even if they are common and likely establish on their own, such as box elder, not so that they would be intentionally added to a site but so that they are recognized as belonging to the community. There was NO list developed for the sand-gravel prairie, as the suitable species for that will be the same species that exist on the site, as listed in Appendix A. The codes for tables are:

1 See the report for instructions for using these species lists
3 Frequency: Number of releve plots in which species occurs divided by total number of releve plots, multiplied by 100
4 Abundance: Average percent cover of species within the community. It is most appropriate to interpret each value as a cover class similar to those used for original data collection (see text of report for more details)
5 Index of Commonness: Frequency multiplied by Abundance

Southern Mesic Prairie UPs23

Genus	Species	Common Name	[3]Freq	[4]Abund	[5]Index
Shrubs					
Amorpha	*canescens*	Lead-plant	58	10	580
Amorpha	*nana*	Fragrant false indigo	8	1	8
Prunus	*virginiana*	Chokecherry	8	1	8
Rosa	*arkansana*	Prairie rose	8	1	8
Rosa	cmx.	Smooth wild rose	58	3	174
Salix	*humilis*	Prairie willow	8	3	24
Symphoricarpos	cmx.	Snowberry	8	3	24
			25	4	100
Grasses, Rushes and Sedges					
Andropogon	*gerardii*	Big bluestem	100	30	3000
Bromus	*kalmii*	Kalm's brome	25	2	50
Carex	*bicknellii*	Bicknell's sedge	33	6	198
Carex	*muhlenbergii*	Muhlenberg's sedge	8	15	120
Carex	*meadii*	Mead's sedge	17	3	51
Carex	*tenera*	Marsh-straw sedge	17	3	51
Elymus	*wiegandii*	Canada wild rye	25	2	50
Elymus	*trachycaulus*	Slender wheatgrass	8	3	24
Eragrostis	*spectabilis*	Purple lovegrass	8	3	24
Muhlenbergia	*mexicana*	Mexican satin-grass	8	5	40
Panicum	*oligosanthes*	Few-flowered panic grass	33	4	132
Panicum	*virgatum*	Switchgrass	17	4	68
Panicum	*perlongum*	Long-leaved panic grass	8	3	24
Schizachyrium	*scoparium*	Little bluestem	33	13	429
Sorghastrum	*nutans*	Indian grass	100	21	2100
Sporobolus	*heterolepis*	Prairie dropseed	42	13	546
Stipa	*spartea*	Porcupine-grass	33	21	693

Southern Mesic Prairie UPs23 (continued)

Forbs					
Allium	*stellatum*	Prairie wild onion	8	3	24
Allium	*canadense*	Wild garlic	8	1	8
Anemone	*cylindrica*	Long-headed thimbleweed	25	2	50
Anemone	*virginiana*	Virginia thimbleweed	8	3	24
Anemone	*canadensis*	Canada anemone	8	3	24
Antennaria	*spp.*	Pussytoes	17	3	51
Apocynum	*androsaemifolium*	Spreading dogbane	25	3	75
Artemisia	*frigida*	Prairie sagewort	8	3	24
Asclepias	*tuberosa*	Butterfly-weed	25	3	75
Asclepias	*syriaca*	Common milkweed	25	2	50
Aster	*oolentangiensis*	Sky-blue aster	67	7	469
Aster	*ericoides*	Heath aster	58	6	348
Aster	*lanceolatus*	Panicled aster	17	3	51
Aster	*novae-angliae*	New England aster	17	3	51
Aster	*laevis*	Smooth aster	8	3	24
Astragalus	*canadensis*	Canada milk-vetch	8	1	8
Campanula	*rotundifolia*	Harebell	17	3	51
Chrysopsis	*villosa*	Prairie golden aster	8	3	24
Comandra	*umbellata*	Bastard toad-flax	58	3	174
Coreopsis	*palmata*	Stiff tickseed	58	8	464
Dalea	*purpurea*	Purple prairie-clover	50	3	150
Dalea	*candida*	White prairie-clover	50	2	100
Desmodium	*canadense*	Canadian tick-trefoil	25	4	100
Euphorbia	*corollata*	Flowering spurge	8	5	40
Euthamia	*graminifolia*	Grass-leaved goldenrod	8	3	24
Fragaria	*virginiana*	Common strawberry	33	4	132
Galium	*boreale*	Northern bedstraw	42	9	378
Gentiana	*billingtonii*	Closed gentian	17	3	51
Geum	*triflorum*	Prairie smoke	8	1	8
Helenium	*autumnale*	Autumn sneezeweed	8	1	8
Helianthus	*maximiliani*	Maximilian's sunflower	17	20	340
Helianthus	*pauciflorus*	Stiff sunflower	58	5	290
Heliopsis	*helianthoides*	Ox-eye	8	3	24
Heuchera	*richardsonii*	Alum-root	17	2	34
Lathyrus	*venosus*	Veiny pea	17	2	34
Lespedeza	*capitata*	Round-headed bush-clover	42	3	126
Liatris	*aspera*	Rough blazing star	42	3	126
Liatris	*ligulistylis*	Northern plains blazing star	33	3	99
Liatris	*pycnostachya*	Gayfeather	25	2	50
Lilium	*philadelphicum*	Wood lily	17	2	34
Lobelia	*spicata*	Rough-spiked Lobelia	8	3	24
Mirabilis	*hirsuta*	Hairy four-o'clock	8	1	8
Monarda	*fistulosa*	Wild bergamot	50	7	350
Oenothera	*biennis*	Common evening-primrose	25	2	50
Pedicularis	*canadensis*	Wood-betony	17	8	136
Phlox	*pilosa*	Prairie phlox	42	3	126
Physalis	*heterophylla*	Clammy ground-cherry	17	2	34
Polygala	*polygama*	Racemed milkwort	8	3	24
Potentilla	*arguta*	Tall cinquefoil	17	2	34
Pycnanthemum	*virginianum*	Virginia mountain-mint	50	3	150
Ratibida	*pinnata*	Gray-headed coneflower	33	7	231
Rudbeckia	*hirta*	Black-eyed Susan	25	2	50
Sisyrinchium	*campestre*	Field blue-eyed grass	8	1	8
Smilacina	*stellata*	Starry false Solomon's-seal	17	9	153
Smilacina	*racemosa*	False Solomon's-seal	8	3	24
Solidago	*nemoralis*	Gray goldenrod	25	3	75
Solidago	*missouriensis*	Missouri goldenrod	17	4	68
Solidago	*ptarmicoides*	Upland white aster	8	5	40
Solidago	*speciosa*	Showy goldenrod	8	3	24
Thalictrum	*dasycarpum*	Tall meadow-rue	25	4	100
Tradescantia	*bracteata*	Bracted spiderwort	8	1	8
Veronicastrum	*virginicum*	Culver's root	58	3	174
Vicia	*americana*	American vetch	8	1	8
Viola	*pedatifida*	Prairie bird-foot violet	33	3	99
Zizia	*aurea*	Golden alexanders	25	3	75
Artemisia	*campestris*	Tall wormwood	17	4	68

Southern Dry Savanna UPs14

Genus	Species	Common Name	[2]Rarity Status	[3]Freq	[4]Abund	[5]Index
Canopy Trees (>10 m)						
Populus	*tremuloides*	Quaking aspen		11	15	165
Quercus	*ellipsoidalis*	Northern pin oak		22	3	66
Quercus	*macrocarpa*	Bur oak		11	15	165
Understory Trees						
Populus	*tremuloides*	Quaking aspen		33	10	330
Prunus	*serotina*	Black cherry		22	1	22
Quercus	*ellipsoidalis*	Northern pin oak		22	2	44
Quercus	*macrocarpa*	Bur oak		100	9	900
Shrubs						
Amelanchier	cmx.	Juneberry		56	1	56
Cornus	*sericea*	Red-osier dogwood		11	1	11
Corylus	*americana*	American hazelnut		67	7	469
Prunus	*pumila*	Sand cherry		11	3	33
Prunus	*virginiana*	Chokecherry		33	2	66
Rosa	*arkansana*	Prairie rose		89	2	178
Salix	*humilis*	Prairie willow		22	5	110
Symphoricarpos	cmx.	Snowberry		22	3	66
Low Shrubs						
Amorpha	*canescens*	Lead-plant		56	3	168
Artemisia	*frigida*	Prairie sagewort		11	15	165
Forbs						
Allium	*stellatum*	Prairie wild onion		11	3	33
Amphicarpaea	*bracteata*	Hog-peanut		22	21	462
Anaphalis	*margaritacea*	Pearly everlasting		11	3	33
Anemone	*cylindrica*	Long-headed thimbleweed		33	3	99
Anemone	*patens*	Pasque-flower		22	3	66
Antennaria	*spp.*	Pussytoes		89	3	267
Apocynum	*androsaemifolium*	Spreading dogbane		11	5	55
Arabis	*divaricarpa*	Spreading rock-cress		11	1	11
Arabis	*hirsuta*	Hairy rock-cress		33	1	33
Aralia	*nudicaulis*	Wild sarsaparilla		11	1	11
Artemisia	*campestris*	Tall wormwood		11	3	33
Artemisia	*ludoviciana*	Western mugwort		44	7	308
Asclepias	*ovalifolia*	Oval-leaved milkweed		33	2	66
Asclepias	*syriaca*	Common milkweed		56	2	112
Asclepias	*tuberosa*	Butterfly-weed		11	3	33
Aster	*ericoides*	Heath aster		44	2	88
Aster	*oolentangiensis*	Sky-blue aster		56	3	168
Aster	*sericeus*	Silky aster		33	4	132
Campanula	*rotundifolia*	Harebell		56	3	168
Chrysopsis	*villosa*	Prairie golden aster		11	1	11
Comandra	*umbellata*	Bastard toad-flax		11	3	33
Coreopsis	*palmata*	Stiff tickseed		44	4	176
Dalea	*candida*	White prairie-clover		44	3	132
Dalea	*purpurea*	Purple prairie-clover		78	3	234
Delphinium	*carolinianum*	Prairie larkspur		22	1	22
Desmodium	*canadense*	Canadian tick-trefoil		11	1	11
Euphorbia	*corollata*	Flowering spurge		11	3	33
Fragaria	*virginiana*	Common strawberry		11	3	33
Galium	*boreale*	Northern bedstraw		33	8	264
Geranium	*maculatum*	Wild geranium		11	3	33
Geum	*triflorum*	Prairie smoke		44	7	308
Helianthemum	*bicknellii*	Hoary frostweed		89	4	356
Helianthus	*pauciflorus*	Stiff sunflower		33	15	495
Heuchera	*richardsonii*	Alum-root		11	1	11
Lathyrus	*ochroleucus*	Pale vetchling		11	1	11
Lathyrus	*venosus*	Veiny pea		44	2	88
Lechea	*stricta*	Prairie pinweed		67	5	335

Southern Dry Savanna UPs14 (cont'd)

Lespedeza	*capitata*	Round-headed bush-clover		44	2	88
Liatris	*aspera*	Rough blazing star		44	2	88
Lithospermum	*caroliniense*	Hairy puccoon		33	2	66
Monarda	*fistulosa*	Wild bergamot		11	3	33
Oenothera	*biennis*	Common evening-primrose		11	3	33
Pedicularis	*canadensis*	Wood-betony		11	3	33
Penstemon	*gracilis*	Slender beard-tongue		22	3	66
Penstemon	*grandiflorus*	Large-flowered beard-tongue		11	1	11
Phlox	*pilosa*	Prairie phlox		22	2	44
Physalis	*virginiana*	Ground-cherry		100	3	300
Potentilla	*arguta*	Tall cinquefoil		67	2	134
Prenanthes	*racemosa*	Smooth rattlesnake-root		11	1	11
Ranunculus	*rhomboideus*	Prairie buttercup		11	1	11
Rudbeckia	*hirta*	Black-eyed Susan		33	2	66
Scutellaria	*leonardi*	Leonard's skullcap		22	2	44
Silene	*antirrhina*	Sleepy catchfly		11	1	11
Sisyrinchium	*campestre*	Field blue-eyed grass		11	1	11
Smilacina	*stellata*	Starry false Solomon's-seal		44	7	308
Smilax	cmx.	Carrion-flower		22	1	22
Solidago	*gigantea*	Giant goldenrod		11	1	11
Solidago	*missouriensis*	Missouri goldenrod		11	3	33
Solidago	*nemoralis*	Gray goldenrod		44	3	132
Solidago	*rigida*	Stiff goldenrod		11	3	33
Solidago	*speciosa*	Showy goldenrod		22	3	66
Thalictrum	*dasycarpum*	Tall meadow-rue		11	1	11
Viola	*pedatifida*	Prairie bird-foot violet		67	3	201
Grasses, Rushes and Sedges						
Agrostis	*hyemalis*	Rough bent-grass		11	3	33
Andropogon	*gerardii*	Big bluestem		100	10	1000
Aristida	*basiramea*	Base-branched three-awn		11	3	33
Bouteloua	*curtipendula*	Side-oats grama		33	15	495
Bouteloua	*gracilis*	Blue grama		11	3	33
Bouteloua	*hirsuta*	Hairy grama		11	3	33
Bromus	*kalmii*	Kalm's brome		11	5	55
Calamagrostis	*canadensis*	Bluejoint		11	3	33
Calamovilfa	*longifolia*	Sand reed-grass		22	4	88
Carex	*brevior*	Short sedge		11	3	33
Carex	*pensylvanica*	Pennsylvania sedge		44	4	176
Carex	*tenera*	Marsh-straw sedge		11	3	33
Carex	*siccata*	Hay sedge		78	6	468
Cyperus	*lupulinus*	Hop-like cyperus		67	3	201
Elymus	*trachycaulus*	Slender wheatgrass		33	3	99
Koeleria	*pyramidata*	June-grass		67	3	201
Muhlenbergia	*cuspidata*	Plains muhly		11	3	33
Panicum	*lanuginosum*	Hairy panic grass		33	4	132
Panicum	*linearifolium*	Linnear-leaved panic grass		22	2	44
Panicum	*oligosanthes*	Few-flowered panic grass		22	4	88
Panicum	*perlongum*	Long-leaved panic grass		44	3	132
Schizachyrium	*scoparium*	Little bluestem		78	22	1716
Sorghastrum	*nutans*	Indian grass		67	5	335
Sporobolus	*heterolepis*	Prairie dropseed		67	10	670
Stipa	*spartea*	Porcupine-grass		67	26	1742
Ferns and Fern Allies				0	0	0
Equisetum	*laevigatum*	Smooth scouring-rush		33	2	66
Selaginella	*rupestris*	Rock spikemoss		11	1	11

Southern Dry-Mesic Oak (Maple) Woodland FDs37

Genus	Species	Common Name	[3]Freq	[4]Abund	[5]Index
Canopy Trees & understory trees					
Acer	*negundo*	Box elder	5	1	5
Acer	*rubrum*	Red maple	38	11	418
Betula	*papyrifera*	Paper-birch	24	7	168
Carya	*cordiformis*	Bitternut hickory	5	1	5
Fraxinus	*pennsylvanica*	Green ash	10	3	30
Pinus	*strobus*	White pine	10	63	630
Populus	*grandidentata*	Big-toothed aspen	5	38	190
Populus	*tremuloides*	Quaking aspen	19	8	152
Prunus	*serotina*	Black cherry	33	4	132
Quercus	*alba*	White oak	43	26	1118
Quercus	*ellipsoidalis*	Northern pin oak	62	40	2480
Quercus	*macrocarpa*	Bur oak	67	16	1072
Quercus	*rubra*	Northern red oak	48	36	1728
Ulmus	*americana*	American elm	5	1	5
Understory Trees					
Acer	*negundo*	Box elder	33	3	99
Acer	*rubrum*	Red maple	95	16	1520
Betula	*papyrifera*	Paper-birch	10	1	10
Carpinus	*caroliniana*	Blue beech	10	1	10
Carya	*cordiformis*	Bitternut hickory	10	1	10
Celtis	*occidentalis*	Hackberry	10	1	10
Fraxinus	*nigra*	Black ash	19	6	114
Fraxinus	*pennsylvanica*	Green ash	19	12	228
Ostrya	*virginiana*	Ironwood	24	20	480
Pinus	*strobus*	White pine	14	7	98
Populus	*grandidentata*	Big-toothed aspen	10	2	20
Populus	*tremuloides*	Quaking aspen	24	6	144
Prunus	*serotina*	Black cherry	90	13	1170
Quercus	*alba*	White oak	33	5	165
Quercus	*ellipsoidalis*	Northern pin oak	43	10	430
Quercus	*macrocarpa*	Bur oak	48	9	432
Quercus	*rubra*	Northern red oak	38	3	114
Sorbus	*americana*	American mountain-ash	10	1	10
Tilia	*americana*	Basswood	24	2	48
Ulmus	*americana*	American elm	48	3	144
Ulmus	*rubra*	Slippery elm	24	3	72
Shrubs					
Amelanchier	*interior*	Juneberry	48	2	96
Amelanchier	*laevis*	Smooth juneberry	29	4	116
Cornus	*alternifolia*	Pagoda dogwood	19	2	38
Cornus	*rugosa*	Round-leaved dogwood	14	7	98
Cornus	*racemosa*	Gray dogwood	71	10	710
Corylus	*americana*	American hazelnut	90	15	1350
Corylus	*cornuta*	Beaked hazelnut	5	15	75
Crataegus	cmx	Hawthorn	19	2	38
Diervilla	*lonicera*	Bush honeysuckle	43	3	129
Ilex	*verticillata*	Winterberry	29	2	58
Lonicera	*dioica*	Wild Honeysuckle	5	1	5
Prunus	*virginiana*	Chokecherry	95	9	855
Ribes	*cynosbati*	Prickly gooseberry	43	3	129
Ribes	*missouriense*	Missouri gooseberry	19	6	114
Rosa	*arkansana*	Prairie rose	5	3	15
Rosa	*blanda*	Smooth wild rose	24	3	72
Rubus	cm1	Blackberry	57	5	285
Rubus	*occidentalis*	Black raspberry	10	9	90
Rubus	*idaeus*	Red raspberry	52	5	260
Sambucus	*racemosa*	Red-berried Elder	33	7	231
Symphoricarpos	cmx		5	3	15
Toxicodendron	*rydbergii*	Poison ivy	52	3	156
Viburnum	*lentago*	Nannyberry	57	2	114
Viburnum	*rafinesquianum*	Downy arrow-wood	33	5	165

Southern Dry-Mesic Oak (Maple) Woodland FDs37 (cont'd)

Vines					
Celastrus	*scandens*	Climbing bittersweet	19	3	57
Parthenocissus	cmx	Virginia creeper	90	8	720
Smilax	*hispida*	Green-briar	5	1	5
Vitis	*riparia*	Wild grape	71	4	284
Forbs					
Achillea	*millefolium*	Yarrow	5	3	15
Actaea	*rubra*	Red baneberry	10	1	10
Agrimonia	cmx.	Stickweed	10	2	20
Amphicarpaea	*bracteata*	Hog-peanut	86	6	516
Anemone	*quinquefolia*	Wood-anemone	43	3	129
Anemone	*virginiana*	Tall thimbleweed	5	1	5
Apocynum	*androsaemifolium*	Spreading dogbane	24	3	72
Aquilegia	*canadensis*	Columbine	48	3	144
Aralia	*nudicaulis*	Wild sarsaparilla	67	5	335
Aralia	*racemosa*	American spikenard	10	3	30
Arenaria	*lateriflora*	Side-flowering sandwort	10	3	30
Arisaema	*triphyllum*	Jack-in-the-pulpit	14	2	28
Asclepias	*exaltata*	Poke milkweed	14	2	28
Aster	*macrophyllus*	Large-leaved aster	57	9	513
Aster	*ciliolatus*	Lindley's aster	5	3	15
Aster	*lateriflorus*	Side-flowering aster	5	3	15
Aster	*oolentangiensis*	Sky-blue aster	5	3	15
Aster	*sagittifolius*	Tail-leaved aster	19	3	57
Caulophyllum	*thalictroides*	Blue cohosh	5	3	15
Chenopodium	*simplex*	Maple-leaved goosefoot	5	3	15
Circaea	*lutetiana*	Canada enchanter's nightshade	57	6	342
Clintonia	*borealis*	Bluebead lily	10	3	30
Cryptotaenia	*canadensis*	Honewort	10	1	10
Desmodium	*glutinosum*	Pointed-leaved tick-trefoil	86	11	946
Dioscorea	*villosa*	Wild yam	10	2	20
Echinocystis	*lobata*	Wild cucumber	14	2	28
Erechtites	*hieracifolia*	Pilewort	5	1	5
Eupatorium	*rugosum*	Common snakeroot	5	1	5
Fragaria	*virginiana*	Common strawberry	14	4	56
Fragaria	*vesca*	Wood strawberry	10	3	30
Galium	*boreale*	Northern bedstraw	38	3	114
Galium	*triflorum*	Three-flowered bedstraw	43	2	86
Galium	*aparine*	Cleavers	10	4	40
Galium	*concinnum*	Elegant bedstraw	5	3	15
Geranium	*maculatum*	Wild geranium	67	7	469
Geum	*canadense*	White avens	14	2	28
Geum	*triflorum*	Prairie smoke	5	5	25
Hackelia	cmx.	Stickseed	19	3	57
Helianthus	*strumosus*	Rough-leaf sunflower	10	5	50
Helianthus	*hirsutus*	Woodland sunflower	5	3	15
Hepatica	*americana*	Round-lobed hepatica	5	5	25
Heuchera	*richardsonii*	Alum-root	5	1	5
Hieracium	*kalmii*	Hawkweed	5	1	5
Impatiens	cmx	Touch-me-not	10	3	30
Lactuca	*spp.*	Wild lettuce	5	1	5
Lathyrus	*ochroleucus*	Pale vetchling	10	4	40
Lathyrus	*venosus*	Veiny pea	10	1	10
Maianthemum	*canadense*	Canada mayflower	86	5	430
Mitchella	*repens*	Partridge-berry	5	3	15
Osmorhiza	*claytonii*	Clayton's sweet cicely	71	5	355
Osmorhiza	*longistylis*	Anise-root	14	2	28
Phryma	*leptostachya*	Lopseed	57	3	171
Physalis	*heterophylla*	Clammy ground-cherry	5	1	5
Polygonatum	*pubescens*	Hairy Solomon's-seal	19	3	57
Polygonatum	*biflorum*	Giant Solomon's-seal	14	4	56
Prenanthes	*alba*	White rattlesnake-root	14	2	28
Pyrola	*elliptica*	Common pyrola	29	3	87
Pyrola	*secunda*	One-sided pyrola	5	3	15

Southern Dry-Mesic Oak (Maple) Woodland FDs37 (cont'd)

Ranunculus	*abortivus*	Kidney-leaf buttercup	14	3	42
Ranunculus	*recurvatus*	Hooked crowfoot	5	1	5
Rubus	*pubescens*	Dwarf raspberry	19	3	57
Sanguinaria	*canadensis*	Bloodroot	5	3	15
Sanicula	*marilandica*	Mariland black snakeroot	24	2	48
Sanicula	*gregaria*	Gregarious black snakeroot	5	1	5
Smilacina	*racemosa*	Racemose false Solomon's-seal	38	4	152
Smilacina	*stellata*	Starry false Solomon's-seal	24	3	72
Smilax	cmx	Carrion-flower	29	2	58
Solidago	*hispida*	Hairy goldenrod	5	5	25
Solidago	*gigantea*	Giant goldenrod	5	3	15
Solidago	*flexicaulis*	Zig-zag goldenrod	5	1	5
Solidago	*uliginosa*	Bog goldenrod	5	1	5
Streptopus	*roseus*	Rosey twisted-stalk	5	3	15
Thalictrum	*dioicum*	Early meadow-rue	14	3	42
Thalictrum	*dasycarpum*	Tall meadow-rue	5	3	15
Thalictrum	*thalictroides*	Rue-anemone	5	5	25
Trientalis	*borealis*	Starflower	29	4	116
Trillium	*grandiflorum*	Large-flowered trillium	5	3	15
Trillium	*cernuum*	Nodding trillium	5	1	5
Urtica	*dioica*	Stinging nettle	10	3	30
Uvularia	*sessilifolia*	Pale bellwort	71	8	568
Uvularia	*grandiflora*	Yellow bellwort	19	3	57
Veronicastrum	*virginicum*	Culver's root	14	1	14
Viola	cm4	Violet	19	1	19
Zizia	*aurea*	Golden alexanders	5	1	5
Grasses, Rushes and Sedges					
Brachyelytrum	*erectum*	Bearded shorthusk	5	3	15
Carex	*blanda*	Charming sedge	5	1	5
Carex	*deweyana*	Dewey's sedge	5	3	15
Carex	*gracillima*	Graceful sedge	5	3	15
Carex	*peckii*	Peck's sedge	10	4	40
Carex	*pedunculata*	Long-stalked sedge	10	2	20
Carex	*pensylvanica*	Pennsylvania sedge	81	9	729
Carex	*tenera*	Marsh-straw sedge	10	1	10
Carex	*radiata*	Stellate sedge	14	3	42
Danthonia	*spicata*	Poverty grass	5	3	15
Elymus	*hystrix*	Bottlebrush grass	5	1	5
Festuca	*subverticillata*	Nodding fescue	10	3	30
Oryzopsis	*asperifolia*	Moutain rice-grass	33	3	99
Schizachne	*purpurascens*	False melic grass	14	2	28
Ferns and Fern Allies					
Athyrium	*filix-femina*	Lady-fern	76	5	380
Botrychium	*multifidum*	Leathery grapefern	5	1	5
Botrychium	*virginianum*	Rattlesnakefern	24	1	24
Dryopteris	*intermedia*	Fern	19	2	38
Equisetum	*pratense*	Meadow horsetail	5	3	15
Matteuccia	*struthiopteris*	Ostrich-fern	5	38	190
Osmunda	*claytoniana*	Interrupted fern	29	9	261
Pteridium	*aquilinum*	Bracken	62	5	310

Southern Dry-Mesic Oak Forest MHs37

Genus	Species	Common Name	[3]Freq	[4]Abund	[5]Index
Canopy Trees (>10m)					
Acer	*saccharum*	Sugar maple	40	9	360
Acer	*rubrum*	Red maple	20	88	1760
Betula	*papyrifera*	Paper-birch	20	1	20
Carpinus	*caroliniana*	Blue beech	20	3	60
Carya	*cordiformis*	Bitternut hickory	40	3	120
Celtis	*occidentalis*	Hackberry	60	2	120
Ostrya	*virginiana*	Ironwood	40	9	360
Prunus	*serotina*	Black cherry	100	9	900
Quercus	*rubra*	Northern red oak	100	31	3100
Quercus	*alba*	White oak	60	46	2760
Tilia	*americana*	Basswood	40	4	160
Shrubs					
Cornus	*alternifolia*	Pagoda dogwood	100	6	600
Cornus	*racemosa*	Gray dogwood	20	1	20
Corylus	*americana*	American hazelnut	40	9	360
Corylus	*cornuta*	Beaked hazelnut	40	2	80
Prunus	*virginiana*	Chokecherry	60	4	240
Rosa	*blanda*	Smooth wild rose	20	1	20
Sambucus	*racemosa*	Red-berried elder	40	3	120
Symphoricarpos	cmx	Snowberry	20	3	60
Viburnum	*rafinesquianum*	Downy arrow-wood	40	3	120
Viburnum	*lentago*	Nannyberry	20	1	20
Forbs, ferns, graminoids					
Actaea	*rubra*	Red baneberry	60	2	120
Adiantum	*pedatum*	Maidenhair fern	40	3	120
Amphicarpaea	*bracteata*	Hog-peanut	60	4	240
Anemone	*americana*	Round-lobed hepatica	20	3	60
Apocynum	*androsaemifolium*	Spreading dogbane	20	3	60
Aquilegia	*canadensis*	Columbine	20	3	60
Aralia	*nudicaulis*	Wild sarsaparilla	60	6	360
Aralia	*racemosa*	American spikenard	40	2	80
Arisaema	*triphyllum*	Jack-in-the-pulpit	60	4	240
Aster	*sagittifolius*	Tail-leaved aster	20	3	60
Athyrium	*filix-femina*	Lady-fern	100	5	500
Botrychium	*virginianum*	Rattlesnakefern	20	5	100
Carex	*pensylvanica*	Pennsylvania sedge	40	2	80
Caulophyllum	*thalictroides*	Blue cohosh	40	3	120
Circaea	*lutetiana*	Canada enchanter's nightshade	80	8	640
Cryptotaenia	*canadensis*	Honewort	60	3	180
Desmodium	*glutinosum*	Pointed-leaved tick-trefoil	80	18	1440
Dioscorea	*villosa*	Wild yam	20	3	60
Galium	*triflorum*	Three-flowered bedstraw	60	3	180
Geranium	*maculatum*	Wild geranium	100	7	700
Geum	*canadense*	White avens	80	3	240
Hackelia	*spp.*	Stickseed	40	3	120
Hydrophyllum	*virginianum*	Virginia waterleaf	60	4	240
Impatiens	*spp.*	Touch-me-not	40	4	160
Maianthemum	*canadense*	Canada mayflower	60	3	180
Mitella	*diphylla*	Two-leaved miterwort	20	3	60
Osmorhiza	*claytonii*	Clayton's sweet cicely	80	10	800
Osmunda	*claytoniana*	Interrupted fern	40	5	200
Phryma	*leptostachya*	Lopseed	100	6	600
Polygonatum	*pubescens*	Hairy Solomon's-seal	20	3	60
Polygonatum	*biflorum*	Giant Solomon's-seal	40	3	120
Pteridium	*aquilinum*	Bracken	20	5	100
Sanguinaria	*canadensis*	Bloodroot	80	3	240
Sanicula	*marilandica*	Mariland black snakeroot	60	3	180
Smilacina	*racemosa*	false Solomon's-seal	80	3	240
Thalictrum	*dioicum*	Early meadow-rue	100	4	400
Uvularia	*grandiflora*	Yellow bellwort	100	3	300
Uvularia	*sessilifolia*	Pale bellwort	20	3	60
Veronicastrum	*virginicum*	Culver's root	20	3	60
Viola	*Viola sp*	Violet	60	2	120

APPENDIX C. Site photographs and GPS points

Site photographs are shown below in alphabetical order by land cover units. Point numbers correspond to the GPS points shown on Map 5.

1. CROP pt4 to north. Cropland and weedy edge.

2. DW1 pt8. Red cedar with open canopy, sumac, grasses.

3. DW1 pt10. Closed red cedar canopy, sparse ground cover.

4. DW1 pt13. Debris in east ravine.

5. GR1 pt 26. Kittentail associates – cedar, sumac, prairie.

6. GR1 pt 27. Overgrowth of non-native and native trees and shrubs to remove at the eastern edge of the unit.

APPENDIX C. Site photographs and GPS points

7. GR3 pt 53. Dominance of sumac and smooth brome.

8. GR3 pt55. Buckthorn and honeysuckle regrowth in area where pines were removed.

9. GSH pt 19. City owned property along north edge of SNA, to west. Non-native grassland, nearby houses.

10. GSH pt 20. View to southwest – abundant cedar and sumac.

11. GSH pt20. Disturbance area- gravel pile and extraction.

12. GSH pt 21. Dominance of sumac and brome. View toward SE.

APPENDIX C. Site photographs and GPS points

13. GSH pt 22. Sand pit and recent ATV activity.

14. LGU pt 51. Toward west. Conifer stand and other trees and shrubs to remove.

15. LGU pt 51. One of about 13 brush piles to be burned.

16. OF1. North slope with Dicentra and other native flora.

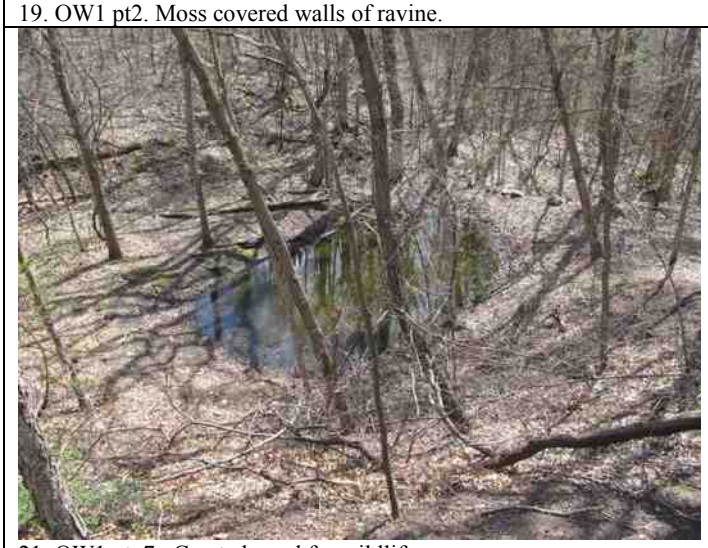
17. OF1. East slope with dense small buckthorn.

18. OW1 pt1. Dense buckthorn with sparse tree canopy.

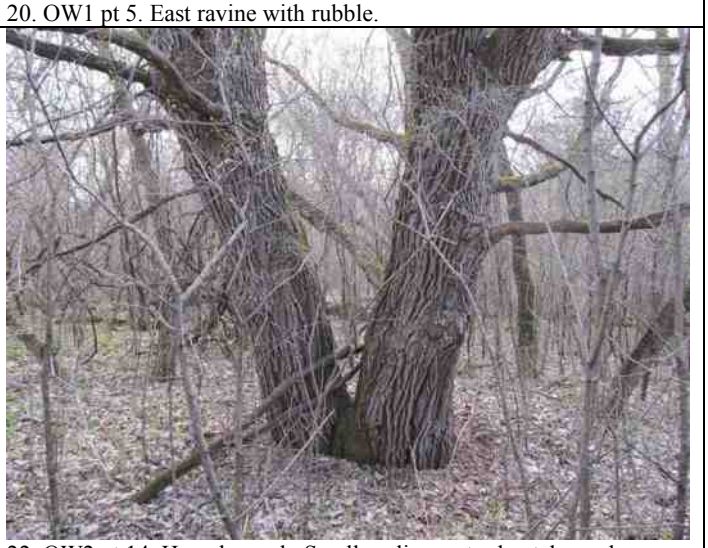
APPENDIX C. Site photographs and GPS points

19. OW1 pt2. Moss covered walls of ravine.

20. OW1 pt 5. East ravine with rubble.



21. OW1 pt. 7. Created pond for wildlife.



22. OW2 pt 14. Huge bur oak. Small garlic mustard patch nearby.

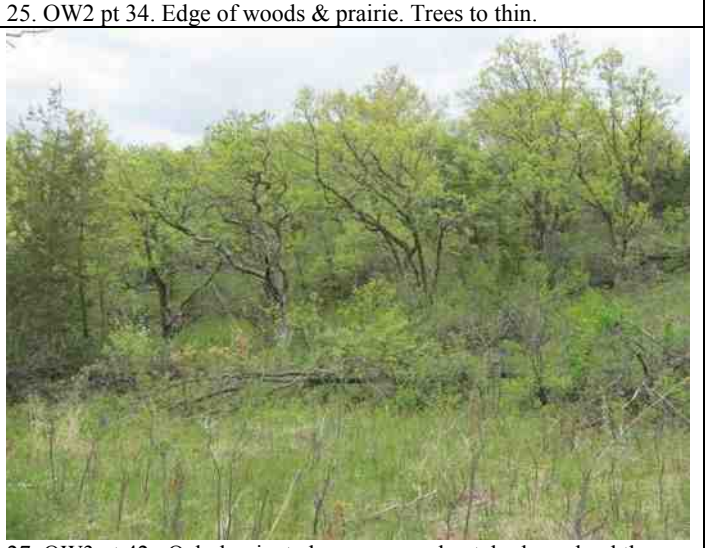
23. OW2 pt 31. Log pile that needs to be burned.

24. OW2 pt 32. Apparent oak wilt area.

24. OW2 pt 33. Old building posts to be removed.

25. OW2 pt 34. Edge of woods & prairie. Trees to thin.

26. OW2 pt 35. Dense cedar canopy, some buckthorn and honeysuckle.



27. OW3 pt 42. Oak dominated canopy, moderately dense buckthorn.

28. OW3 pt 43. Historic erosion scar (see Map 4a) now healed.

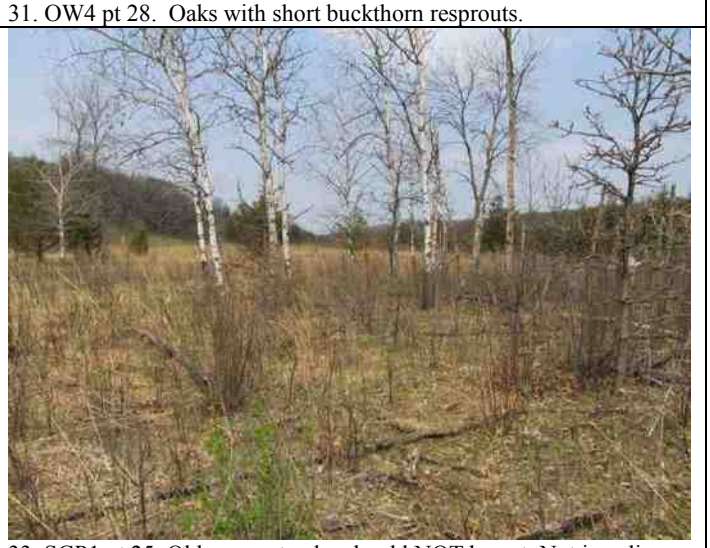
29. OW3 pt 47. Disturbance area and bare soils – need seed after woody removal.

APPENDIX C. Site photographs and GPS points

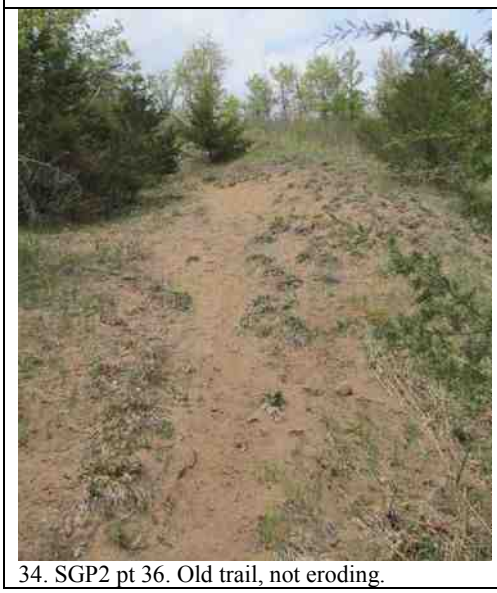
30. OW3 pt50. Some debris near base of slope.

31. OW4 pt 28. Oaks with short buckthorn resprouts.

32. Stormwater Pond - water shrinking and cattail expanding.



33. SGP1 pt 25. Old aspen stand – should NOT be cut. Not invading.



34. SGP2 pt 36. Old trail, not eroding.

35. SGP2 pt 38. Entrenched trail.

36. SGP2 pt 38. Replace damaged signs.


37. SGP2 pt 38. View of coulee toward southeast.


38. SGP2 pt 39. Aspen stand spreading – need to cut and burn.


39. SGP 2 pt 51. Entrenched trail but little use, some reveg occurring.


40. SGP4 NW corner. Remove trees and shrubs in hollow.

41. SGT pt 15. House removal location, toward south.

42. DW3 pt 30. Live fox snake. Dead snake (insert) also found on Glacier Way Rd on north side of SNA.

APPENDIX C. Site photographs and GPS points

Map point	Unit	LAT	LONG	Detail
1	OW1	44.710172	-92.820109	Slope with dense buckthorn, very open canopy (20% cover)
2	OW1	0	0	Coulee ravine walls
3	OW1	44.710694	-92.819793	More oak here (coverage 4), buckthorn still dense.
4	CROP	44.71182	-92.818783	Edge of field toward north.
5	OW1	44.712903	-92.817895	Ravine on east side, with debris
6	CROP	44.713217	-92.818421	Edge of field and DW, to north.
7	OW1	44.713062	-92.819186	Deer pond
8	DW1	44.713924	-92.819108	Red cedar and open canopy
9	DW1			Mixed canopy
10	DW1	44.714312	-92.819431	Dense red cedar stand. N/S fence.
11	OW1	44.71462	-92.820432	Dicentra abundant near base of slope.
13	DW1	44.715476	-92.817793	Debris in NE ravine.
14	OW1	44.715406	-92.82048	Huge bur oak, patch of garlic mustard nearby (6x4 ft)
15	SGT	0	0	House site to south
16	SGT	0	0	House site - Poa, brome, green ash
18	SGT	0	0	House site - daylily patch
19	GSH	0	0	N edge grass
20	GSH	44.715536	-92.82144	Gravel pit area
21	GSH	44.7131	-92.822805	Long-bearded hawkweed.
22	GSH	44.712441	-92.822574	SHG1-gravel pit
23	GSH	44.710093	-92.822047	First Lead plant - start of SG unit. Also liatris
25	SGP1	44.708858	-92.823166	Aspen stand
26	GR1	44.707426	-92.822915	Kittentail - 82 plants
27	GR1	44.707327	-92.823024	East edge brush
29	SGP3	44.707061	-92.823704	Kittentail - 18 plants.
30	DW3	44.709051	-92.824644	View of units to N, S, E, W. Fox snake photographed.
31	OW2	44.715808	-92.823341	log pile
32	OW2	44.715857	-92.82288	Oak wilt, 20-30 dead trees. Remove dead and apple tree, seed with prairie.
33	OW2	44.715697	-92.823068	Posts from an old structure. Remove, regrade, seed with sprengle sedge.
34	OW2	44.71541	-92.822829	Edge of woods and prairie. Need to thin red cedar.
35	OW2	44.715287	-92.822658	Red cedar dense, some buckthorn and honeysuckle
36	SGP2	44.715024	-92.822883	Trail, not eroding. Habitat for annual species.
37	SGP2	44.715143	-92.823136	Trail, not eroding. Habitat for annual species.
38	SGP2	44.71477	-92.823722	Shot up sign.
39	SGP2	44.71425	-92.823961	Aspen stand - girdle large trees, burn to reduce smaller ones (or cut/treat).
40	OW3	44.713346	-92.824063	Bare ground - need to seed after exotic brush removal.
41	OW3	44.713291	-92.824444	Slope somewhat bare - good area for annual species.
42	OW3	44.712915	-92.824462	Oak dominated canopy, shrub layer moderately dense. Photo N to S.
43	OW3	44.7127	-92.824677	Old erosion scar - compare to historic (1937 photo).
44	OW3	44.712466	-92.824323	Disturbance area - open canopy. Possible oak wilt - many fallen trees. Dense buckthorn.
45	OW3	44.712141	-92.823984	Slope with abundant Dicentra, denser canopy (Oak forest rather than woodland).
47	OF2	44.711959	-92.823834	3 kittentail.
48	OW3	44.7117	-92.823509	Slopes bare. If buckthorn removal need seeding
49	OW3	44.711382	-92.823138	Small amount of old trash debris
50	SGP1	44.711056	-92.823406	Trash
51	LGU	44.711409	-92.825615	Brush/wood pile. Photo to SW. Amur maple nearby (saplings).
52	SGP4	44.704335	-92.822222	Depression with gr ash, Rhamnus, Lonicera, boxelder. Clear and seed.
53	GR3	44.704459	-92.820823	Knapweed
55	GR3	44.703682	-92.82114	Conifer removal area, now dense Rhamnus and Lonicera. To SE. Brome and Poa, few natives.

APPENDIX D. Methods for Controlling Invasive Species

Methodologies for control of select species are provided below, including least toxic methods for herbicide use. However, for all exotic species management at the SNA, herbicide will be used only with prior approval from SNA staff, typically in areas that have had prior disturbance and are dominated by non-native species.

Trees and Shrubs

Common Buckthorn, Tartarian Honeysuckle, Siberian Elm, and Black Locust are some of the most common woody species likely to invade native woodlands or prairies in Minnesota. Buckthorn and honeysuckle are European species that escaped urban landscapes and invaded woodlands in many parts of the country. They are exceedingly aggressive and, lacking natural disease and predators, can out-compete native species. Invasions result in a dense, impenetrable brush thicket that reduces native species diversity.

Siberian elm, native to eastern Asia, readily grows, especially in disturbed and low-nutrient soils with low moisture. Seed germination is high and seedlings establish quickly in sparse vegetation. It can invade and dominate disturbed areas in just a few years. Black locust is native to the southeastern United States and the very southeastern corner of Minnesota. It has been planted outside its natural range, and readily invades disturbed areas. It reproduces vigorously by root suckering and can form a monotypic stand.

Chemical Control The most efficient way to remove woody plants that are 1/2 inch or more in diameter is to cut the stems close to the ground and treat the cut stumps with herbicide immediately after they are cut, when the stumps are fresh and the chemicals are most readily absorbed. Failure to treat the stumps will result in resprouting, creating much greater removal difficulty.

In non-freezing temperatures, a glyphosate herbicide such as Roundup can be used for most woody species. It is important to obtain the concentrated formula and dilute it with water to achieve 10% glyphosate concentration. Adding a marker dye can help to make treated stumps more visible. In winter months, an herbicide with the active ingredient triclopyr must be used. Garlon 4 is a common brand name and it must be mixed with a penetrating oil, such as diluent blue. Do not use diesel fuel, as it is much more toxic in the environment and for humans. Herbicide should only be used in distubance area,

Brush removal work can be done at any time of year except during spring sapflow, but late fall is often ideal because buckthorn retains its leaves longer than other species and is more readily identified. Cutting can be accomplished with loppers or handsaws in many cases. Larger shrubs may require brush cutters and chainsaws, used only by properly trained professionals.

For plants in the pea family, such as black locust, an herbicide with the active ingredient clopyralid can be more effective than glyphosate. Common brand names for clopyralid herbicides are Transline, Stinger, and Reclaim. For Scotch pine, red cedar and all other conifers, removal consists of simply cutting the tree and disposing of it. No herbicide is needed as conifers do not resprout.

In the year following initial cutting and stump treatment, there will be a flush of new seedlings as well as resprouting from some of the cut plants. The best way to deal with seedlings is fire. When that is not feasible or not totally effective, herbicide can be applied to the foliage of the plants. Fall is the best time to do this, when desirable native plants are dormant and when the plant is pulling resources from the leaves down into the roots. Roundup (glyphosate), Garlon (triclopyr), and Krenite (active ingredient – fosamine ammonium) are the most commonly used herbicides for foliar application. Krenite prevents bud formation so the plants do not grow in the spring. This herbicide can be effective, but results are highly variable. Glyphoste is non-specific and will kill anything green, while triclopyr targets broadleaf plants and does not harm graminoids. Extreme caution with Garlon should be used, because the surfactants

added that allow it to penetrate bark also seep into the soil and kill many plants within a radius of the treated plant. For this reason, a wick application may be a better application method than broadcast spraying, depending on the groundcover composition .

Undesirable trees and shrubs can also be destroyed without cutting them down. Girdling is a method suitable for small numbers of large trees. Bark is removed in a band around the tree, just to the outside of the wood. If girdled too deeply, the tree will respond by resprouting from the roots. Girdled trees die slowly over the course of one to two years. Girdling should be done in late spring to mid-summer when sap is flowing and the bark easily peels away from the sapwood. Herbicide can also be used in combination with girdling for a more effective treatment.

Basal bark herbicide treatment is another effective control method. A triclopyr herbicide such as 10% Garlon 4, mixed with a penetrating oil, is applied all around the base of the tree or shrub, taking care so that it does not run off. If the herbicide runs off it can kill other plants nearby. More herbicide is needed for effective treatment of plants that are four inches or more in diameter.

All herbicides should be applied by licensed applicators and should not be applied on windy days. Care should be taken to avoid application to other plants.

Mechanical Control Three mechanical methods for woody plant removal are *hand-pulling* (only useful on seedlings and only if few in number), *weed-wrenching* (using a weed wrench tool to pull stems of one to two inches diameter), and *repeated cutting*. Pulling and weed-wrenching can be done any time when the soil is moist and not frozen. In both cases the soil must be shaken off the stems after removal. The disadvantage to both methods is that they are very slow and labor intensive, and create a great deal of soil disturbance, especially weed wrenches. They should not be used on steep slopes or anywhere that desirable native forbs are growing. The soil disturbance also creates opportunities for weed germination. This method is probably best used in areas that have very little cover of desirable native plants or where the invasive shrubs are not very abundant and are fairly small.

Repeated cutting consists of cutting the plants (by hand or with a brush cutter) at critical stages in its growth cycle. Cutting in mid spring (late May) intercepts the flow of nutrients from the roots to the leaves. Cutting in fall (about mid-October) intercepts the flow of nutrients from the leaves to the roots. Depending on the size of the stem, the plants may die within three years, with two cuttings per year. This method is also very labor intensive and costly and depends on a very consistent effort. The success rate varies depending on the size of the plant.

Stems, Seedlings and Resprouts Prescribed burning is the most efficient, cost effective, and least harmful way to control very small seedlings of all woody plants. It also restores an important natural process to fire-dependant natural communities (oak forests, for example). Burning can only be accomplished if adequate fuel (leaf litter) is present and can be done in late fall or early spring, depending site conditions. Disadvantages to burning are that fire coverage is inconsistent over the site and there will be areas that are missed. Fires are typically “cool” in order to be conducted safely, so that even very small stems sometimes survive and resprout. Burning alone may reduce saplings plants, but only if burns are repeated annually for several consecutive years (which will likely also reduce native shrubs). Even then, the level of control is only moderate. Burning is best combined with chemical treatment for greatest effectiveness.

If burning is not feasible, cutting in spring and/or fall can help reduce seedlings of invasive woody plants, but may also be detrimental to desirable plants. Hand-pulling may be a good option for small stands of very small plants, but should be avoided on slopes.

Prickly ash, a native shrub, can become excessively abundant, especially in areas that have been disturbed or grazed. Complete eradication may not be necessary, but management may target reducing the extent of a population. Control will consist primarily of cutting followed by burning.

Disposal The easiest and most cost-effective method to handle large amounts of brush is usually to stack it and burn it in winter. In areas where brush is not dense, it can be cut up into smaller pieces and left on the ground where it will decompose in one to three years. This method is especially useful on slopes to reduce erosion potential. Small brush piles can also be left in the woods as wildlife cover. Where there is an abundance of larger trees, cut trees may be hauled and chipped and used for mulch or as a biofuel. Alternatively, the wood can be cut and used for firewood, if a recipient can be found.

Herbaceous Plants

Spotted knapweed (*Centaurea maculosa*) is one of the most aggressive and well-established invasive species at the coulee. Management of the species has been on-going since 2005, with release of biocontrol insects (root weevils and seedhead weevils), prescribed burning followed by spot treatment (using glyphosate), and hand-pulling of small populations in targeted areas. In 2010 there was clear evidence the biocontrol was taking effect. Continued management of the species should include monitoring to ascertain the continued effectiveness, and targeted hand-pulling. Hand-pulling has been done when the knapweed was found in outlier locations far from the main patch, and where the main population is creeping northward into the high-quality native remnant. The typically recommended herbicide for treating knapweed is a clopyralid. However, this chemical has a long residual in the soil and has not been used at the coulee for that reason. The abundance of native plants at the site warrants a cautious approach, as well as the highly permeable sandy soils.

While spotted knapweed is declining at the coulee, **cow vetch** (*Vicia cracca*) is increasing. This legume sprawls along the tops of other plants, creating a smothering canopy. It is stimulated by fire. There is not much information available on its control, so the information here is based on the experience of FMR and colleagues. Cow vetch is difficult to control with herbicide because the narrow leaves limit effective contact of the chemical. However, Transline has been used with some effectiveness. Hand-pulling is also difficult as the plant tends to break off, leaving a portion of the root in the soil. However, hand-pulling does prevent seed production for that season and is likely to reduce the abundance of the plant to some degree. At this time, we recommend continued attempt to control the plant by these methods. Other colleagues (Dave Crawford, Wild River State Park) have stopped control attempts and found that while the plant was very abundant in some areas each year, it did not persist very long in any location, similar to how sweet clovers behave.

Crown vetch (*Coronilla varia*) and **bird's foot trefoil** (*Lotus corniculata*) patches can be treated with Transline in when plants are small and foliage is lush – typically June. Do not attempt to hand pull as the roots are too dense and the fragments left behind will simply resprout.

A small patch of **leafy spurg**e (*Euphorbia esula*) was found at the south unit of the sand coulee SNA and effectively eradicated with a Transline application. If detected elsewhere, treat immediately. In the event that a large patch became established, biocontrol could be introduced. However, regular site monitoring should prevent that. For more information about control of this species, see the Wisconsin DNR website: http://www.dnr.state.wi.us/invasives/fact/spurge.htm

White and yellow sweet clover (*Melilotus* spp) are aggressive biennial species common to disturbed areas. However, they typically do not persist at a well-established prairie. They increase with fire, but can also be controlled by fire conducted over 2 consecutive years. They were found is low abundance in some of the disturbed areas of the site and edges. Individual plants or small populations can be removed

by hand-pulling or by cutting and bagging the flowering stems. Volunteers could be recruited for this work. In general there is no need to manage specifically for this species at the coulee.

Although not listed on the Minnesota DNR invasive species lists, **soapwort** (*Saponaria officinalis*) is a European species that can be quite problematic especially in sand-gravel dry prairies and mesic prairies. The species is quite abundant in the northern part of the sand coulee, north of the pond. There is little information available about control of this species, so at this time we suggest implementing standard prairie management practices and monitoring this species to assess its response. Hand-pulling (digging out roots) may also be useful in areas where the soapwort is encroaching into native prairie.

In prairie reconstruction areas, **thistles** (Canada (*Cirsium arvense*), musk (*Carduus nutans*), bull (*Cirsium vulgare*)) are best treated by spot application when plants are in the basal rosette stage with an herbicide such a Milestone (an aminopyralid). If plants get to flowering stage the flower should be cut off and the foliage treated. In native plant communities, thistle control methods will depend on the situation. Hand-pulling and repeated cutting may be used.

For small infestations, **Garlic mustard** (*Alliaria petiolata*) should be hand-pulled. Large infestations will need further evaluation to determine appropriate management. Prescribed burning should be employed where ever possible to reduce seedlings. Release of biological control agents may be feasible in the near future.

Graminoids

Many of the non-native, such as **smooth brome** *(Bromus inermis)* and **Kentucky bluegrass** *(Poa pratensis)* cool season grasses can be reduced by late spring prescribed burning. At that time the grasses are growing strong and tillering. The fire sets them back and warms the soil just at the time when native warm season grasses are starting to emerge. The native grasses and forbs thus get a jump-start. As the seasonal temperatures increase the brome is further disadvantaged. Establishing vegetation monitoring plots will help to evaluate changes to the cover of non-native grasses.

To further increase the cover of native grasses and forbs, we recommend broadcasting native seed, harvested from on-site or a nearby site (Lost Valley SNA or Grey Cloud SNA), after a burn. If the native cover is depauperate this will help to bolster it.

In areas where burning does not result in any change to the brome and bluegrass, it may be necessary to apply herbicide. One option is to apply a grass herbicide, such as Poast, to reduce the cover. This herbicide is most effective in spring. The sequence would be: burn in late spring, apply herbicide to regrowth at six inches, if regrowth was dense a second burn may be needed, broadcast a mix of native seed collected from on site – little bluestem, June grass, porcupine grass, and others. Another option is to apply a glyphosate herbicide in late fall, when most native plants are dormant. Then the sequence would be to mow in mid to late September, then apply glyphosate in approximately late October. The challenge is to apply the herbicide when the brome is actively growing but when native plants are dormant.

Hybrid Cattail (*Typha x glauca*) has become established at the stormwater detention pond. Because the pond is quite small and appears to be decreasing, it may not be cost-effective to manage the cattail. However, if control is deemed valuable, one suggested method is to cut the shoots below the water surface two or three times in one growing season before flower production. At this site, however, many plants are likely above the water line and chemical control would also be needed. A wick-application with Rodeo (aquatic formula of glyphosate) when the plants are flowering, followed by cutting and retreating can be very effective. (information from Bugwood Wiki: http://wiki.bugwood.org/Typha_spp.). Adding a non-ionized surfactant to the Rodeo will help it stick to the cattail.

ECOLOGICAL CONTRACTORS

Following is a list of contractors and/or consultants to consider for implementing the management plans. While this is not an exhaustive list, it does include firms with ecologists who are knowledgeable about MN native plant communities and natural resource management. Unless otherwise noted, all firms do prescribed burning. Many other brush removal companies are listed in the yellow pages (under tree care). Additional firm listings can be found on the DNR website: http://www.dnr.state.mn.us/gardens/nativeplants/index.html. Also listed below are firms, compiled by the DNR Biofuels program, that can conduct large scale tree removal services.

Friends of the Mississippi River (FMR) has extensive experience working with landowners to implement natural resource management plans. FMR can assist landowners with obtaining funding for restoration and management projects and providing project management, including contractor negotiations, coordinating restoration and management work, and site monitoring and evaluation.

Applied Ecological Services, Inc.
21938 Mushtown Rd
Prior Lake, MN 55372
952-447-1919
www.appliedeco.com

Bonestroo Natural Resources
2335 West Highway 36
St. Paul, MN 55113
651-604-4812
www.bonestroo.com

Friends of the Mississippi River
360 North Robert St, Suite 400
St. Paul, MN 55101
651-222-2193
(no burning)

Great River Greening
35 West Water St, Suite 201
St. Paul, MN 55107
651-665-9500
www.greatrivergreening.org

Minnesota Native Landscapes, L.L.C.
14088 Highway 95 N.E.
Foley, MN 56329
(320) 968-4222
www.mnnativelandscapes.com

Conservation Corps Minnesota
2715 Upper Afton Road, Suite 100
Maplewood, MN 55119
(651) 209-9900

North American Prairies
111754 Jarvis Ave NW
Annandale, MN 55302
320-274-5316
info@northamericanprairies.com

Prairie Restorations, Inc.
PO Box 305
Cannon Falls, MN 55009
507-663-1091
www.prairieresto.com

TREE REMOVAL SERVICES

Bildeaux Services (MLEP)
21473 Manning Trail N.
Scandia, MN 55073
612-819-9465
bildeauxservices@frontiernet.net

Blue Chip Tree
7700 110th St S
Cottage Grove, MN
Phone: 651-459-5007

Cedar River Horse Logging and Wood Products
51127 130th Street
Lyle, Minnesota 55953
507-438-2164

APPENDIX E. Ecological Contractors

Dennis Dick
Route 2, Box 88A
Wabasha, MN 55981
507-458-5124

Evergreen Energy – service provider to District Energy
Jeff Guillemette
651-747-5798 cell

Johnson Logging, Inc. (MLEP)
7557 360th St. Way
Cannon Falls, MN 55009
507-263-5711
jlogging@msn.com

MN Nice Wood Recovery
320 18th St E
Hastings, MN 55033
651-307-3330

Mike's Tree Service, Inc.
18320 Henna Ave. N.
Forest Lake, MN 55025
651-731-6311

North Central Wildfire LLC (MLEP)
6401 320th St.
Stacy, MN 55079'612-282-4741
newwildfire@frontiernet.net

Rivard Contracting Inc./Central Wood Products (MLEP)
19801 Hwy 65 NE
East Bethel, MN 55011
763-753-7888
Mikerivardcwp@aol.com

Ostvig Tree, Inc.
1161 E. Wayzata Blvd., #311
Wayzata, MN 55391
West Metro: 952-473-0534 or 763-479-4090
East Metro: 651-653-9930
info@ostvigtree.com

S & A Land Clearing, Inc.
(Tree Technology & Recycling)
20370 Enfield Ct. N.
Forest Lake, MN 55025
651-464-8672 ofc

S & S Tree and Horticulture Specialists
405 Hardman Avenue
South St. Paul, MN 55075
651-451-8907

Timonen Harvesting (MLEP)
2738 Fillmore St. NE
Minneapolis, MN 55418
651-208-2967
timonen75@msn.com

Tree People
6945 Skunk Hollow Trail
Cannon Falls, MN 55009
507-263-0794
supertho@rconnect.com