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June 4, 2009

Mr. Jon Ahlness
Corps of Engineers
St. Paul District
190 East 5th Street
St. Paul, MN 55101

Mr. Erik Carlson
Minnesota Department of Natural Resources
500 Lafayette Road North
St. Paul, MN 55155

**Re: Final Tailings Basin Wetland Mitigation Establishment and Management Plan
U. S. Steel - Keetac Expansion Project
Keewatin, Minnesota**

Dear Mr. Ahlness and Mr. Carlson:

On behalf of U.S. Steel, enclosed is the *Final Tailings Basin Wetland Mitigation Establishment and Management Plan* for the Keetac Mine Expansion Project. The plan was developed as the primary on-site effort to comply with state and federal wetland mitigation requirements for the project. Additional wetland mitigation is planned for the project that will occur off-site by restoring wetlands elsewhere in the project watershed. The off-site plan will be documented in a separate report. This study was conducted in accordance with the Final Scoping Decision Document, Section 6.0, Special Studies or Research – Wetland Mitigation Plan.

The plan has been revised to account for agency comments based on conference calls held on March 9, 2009 and April 1, 2009.

Modifications to the report are focused on Sections 4 through 7, including the following:

1. Wetland impacts have been updated consistent with the *Indirect Wetland Impact Study*,
2. Coniferous swamp has been added as a planned restoration community,
3. The performance standards have been modified to address comments and discussions,
4. Supporting data regarding wetland development on former tailings basins has been added,
5. Tables 1-4 have been modified, and
6. Figures 2-5 have been modified.

For the expansion project, Keetac has developed the attached plan to replace over 75 percent of the projected wetland impacts on-site and prior to the impacts. Keetac is in the third year of establishing 449 acres of mitigation wetlands within inactive areas of their tailings basin following an application and approval for banking excess wetland mitigation credits, as documented in the *2005 Mine and Stockpile Expansion Wetland Replacement and Banking Plan*. In 2008, Keetac identified an additional 191 acres of suitable areas for wetland establishment within other inactive areas of the tailings basin for a total of 640 acres.

A total of 38.2 acres of the 449 acres of mitigation wetlands have been allocated to two past, permitted projects. In addition, approximately 10 acres of the 449 acres of mitigation wetlands are proposed to be removed from banking consideration due to future potential for tailings dam reinforcement. Therefore, with the previous wetland banking approval, the recently identified wetland mitigation areas, and providing compensation for past, permitted projects; a total of 582.3 acres of wetland mitigation are proposed as partial compensation for the 755.2 acres of wetland impacts expected to result from the expansion project.

Please call me at 952-832-2764 or Mike Rhoads of U. S. Steel if you have questions.

Sincerely,



Mark Jacobson
Vice President
Barr Engineering Company

Enclosure

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***Final Tailings Basin Wetland Mitigation
Establishment Plan***

Keetac Expansion Project

***Prepared for
U.S. Steel***

June 2009

Final Tailings Basin Wetland Mitigation Establishment Plan

Keetac Expansion Project

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**Final Tailings Basin Wetland Mitigation
Establishment Plan
Keetac Expansion
U. S. Steel Keetac**

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1.0 Introduction

On behalf of U. S. Steel Keetac (Keetac), Barr Engineering Company (Barr), has prepared this on-site wetland establishment plan (Plan) to provide compensatory wetland mitigation to replace unavoidable wetland impacts associated with Keetac's Expansion Project (Figure 1, Table 1). A total of 755.2 acres of wetland impacts are proposed as a result of the expansion. The compensatory mitigation activities described in this plan include the planned establishment and enhancement of approximately 620.6 acres of wetlands in the inactive areas of the tailings basin at Keetac. The project is located in St. Louis and Itasca Counties, approximately 0.7 miles south of Keewatin, Minnesota (Figures 2 and 3; Tables 2 and 3).

On August 23-24, 2005, Barr Engineering Company field identified and delineated 432.9 acres of wetland mitigation within inactive areas of the tailings basin that Keetac proposed for wetland banking in 2005. Authorization for banking those wetlands was subsequently received in accordance with Section 404 of the Clean Water Act (CWA) and the Minnesota Wetland Conservation Act (WCA). An additional 16.4 acre mitigation wetland (Wetland 12) was identified and delineated on October 9, 2006, and was reported in the 2006 annual monitoring report for a total of 449.3 acres. Those wetland mitigation areas are referred to as the "2005 wetlands." On June 30 through July 2, 2008, Barr completed the third annual wetland mitigation monitoring of the 2005 mitigation wetlands. Results of the 2008 monitoring will be provided in a separate document. On June 30 through July 2, 2008, an additional 190.6 acres of proposed wetland mitigation were field identified and delineated and are described in this report ("2008 mitigation wetlands").

The 2005 mitigation wetlands are continuing to become established within 14 areas (Figure 2) and have a current combined area of 440.0 acres. The existing 2005 wetland mitigation area is approximately 9.3 acres less than reported in the 2006 Annual Monitoring Report, due chiefly to a more detailed field assessment of Wetland 9 in 2008 and refined mapping of Wetland 11. In addition, approximately 10 acres of the mitigation wetlands are expected to be impacted by future tailings dam reinforcement activities, so those areas are proposed to be removed from the mitigation banking process and a total of 430.0 acres of mitigation wetlands are proposed from 2005 (Tables 2 and 3, Figure 2). The 2008 wetlands are becoming established within 19 areas (Figure 3) and have a combined area of 190.6 acres. Compensatory wetland mitigation for impacts resulting from two past, permitted projects at Keetac have utilized 38.2 acres of the 2005 mitigation wetlands including 35.2 acres of impact for the 2005 Mine and Stockpile Expansion and 3.0 acres for the Aromac mine

expansion in 2007. Therefore, the remaining, planned wetland mitigation area in the inactive tailings basin proposed as replacement for unavoidable wetland impacts resulting from the Keetac Expansion Project is 582.3 acres.

The proposed tailings basin wetland establishment plan includes the development and management of wet meadow, shallow marsh, deep marsh, shrub-carr, alder thicket, hardwood swamp, and seasonally flooded wetland plant communities within the created wetlands (Tables 1 and 3, Figures 2 and 3).

Within the 2005 and 2008 wetland mitigation areas; planting, seeding, and management activities are planned within fifteen areas to expedite the establishment of native communities (Figures 4 and 5). These activities are planned for implementation concurrent with development of the expansion project. Keetac is also considering the option of conducting wildlife improvements within and adjacent to the created wetlands (Figure 6).

This document includes discussions of the wetland creation sites, wetland goals, performance standards, vegetation establishment and management activities, and a monitoring plan. This Plan was developed to comply with Wetland Conservation Act rules (Minnesota Rules Chapter 8420) as administered by the Minnesota Department of Natural Resources (MnDNR) – Division of Lands and Minerals, Section 404 of the Clean Water Act as administered by the U.S. Army Corps of Engineers (Corps), and Minnesota Rules 7050.0186 (wetland mitigation) as administered by the Minnesota Pollution Control Agency (MPCA).

Permanent Conservation Easements similar to the example provided in Appendix C will be prepared and recorded to ensure perpetual protection of the wetland creation areas following certification of the wetland mitigation areas by the appropriate regulatory agencies.

2.0 Wetland Mitigation Planning

The wetland mitigation planning efforts for the Keetac Expansion Project have proceeded in accordance with the Wetland Conservation Act wetland replacement siting rules and the Corps guidelines to first replace on-site, within the same watershed, and of the same type as the impacted wetlands to the extent practicable. Additional wetland mitigation that may be required for the project will be planned in accordance with the same guidelines.

3.0 Wetland Impact Summary

Between June and September 2008, wetlands in the vicinity of the Keetac Expansion Project were field delineated and characterized. The expansion is expected to result in unavoidable impacts to 755.2 acres of wetlands during the life of the project. The projected wetland impacts are summarized by wetland type using the Eggers and Reed Classification System on Table 1. Over 80 percent of the impacts are proposed in inundated wetland types including 360.1 acres of shallow, open water wetlands, 156.9 acres of shallow marsh wetlands and 106.0 acres of deep marsh wetlands. Over 210 acres of those wetlands are either incidental or are artificially impounded and therefore, are not the same wetland communities that had naturally developed. Shrub wetlands, including shrub carr and alder thicket communities make up 101.3 acres (13.5 percent) of the projected impacts. Other wetland community types present within the project boundaries include wet meadow (10.4 acres), hardwood swamp (9.5 acres), and seasonally flooded wetlands (4.0 acres). Over 90 percent of the projected wetland impacts are low to moderate quality wetlands encompassing nearly 700 acres.

4.0 Wetland Mitigation Goals

The primary goal of the Plan is to restore moderate to high quality wetland communities (Eggers and Reed, 1997) of the same types as those proposed to be impacted or as were historically present within the expansion project area. While it is not practicable to replace all impacted wetland types with an equivalent area of in-kind wetland due to site limitations, technical feasibility, and other considerations; the goal of the mitigation plan is to replace the wetland types in-kind to the degree practicable in order to replace lost wetland functions and values. A summary of the planned wetland plant communities compared to the projected impacts is provided in Table 4. A total of 236 acres of wetland impacts are replaced in-kind, including all of the wetland types with saturated hydrologic regimes and over 100 acres of shallow deep marsh wetlands. The remaining 513 acres of shallow marsh; deep marsh; and shallow, open water communities are not replaced in-kind. However, since the majority of those wetlands are not natural communities, which were predominantly shrub and forested swamp (based on pre-settlement wetland mapping), the remaining 250 acres of planned shrub and forested mitigation wetlands replace the historic wetland types. Therefore, when considering the natural wetland communities, the proposed tailings basin wetland mitigation replaces nearly 500 acres of the proposed wetland impacts with similar community types. In following wetland mitigation guidelines within the WCA and CWA, 1:1 mitigation is proposed for all wetland impacts to be replaced in-kind, on-site, and ahead of the impacts. The remaining wetland impacts that are proposed to be compensated with wetland communities that differ from the existing wetland types, 1.25:1 compensation is proposed. A separate off-site wetland mitigation plan will be developed to compensate for the proposed wetland impacts that will not be replaced on-site.

Detailed descriptions of the targeted wetland plant communities within the created wetlands are provided in the following sections:

4.1 Seasonally Flooded

A total of 5.1 acres of seasonally flooded wetland is developing in Wetland 11 (Table 2, Figure 2). Seasonally flooded wetlands typically form in shallow depressions that may or may not be located within a floodplain. The seasonally flooded community is targeted for a dominance of annual species with considerable variation depending on climatic conditions and season. The typical species that are expected include: smartweeds, beggarticks, nut-grasses, and wild millet. The seasonally flooded wetland is expected to be inundated for a few weeks or less each year, typically following snowmelt and heavy summer rainfall events.

4.2 Fresh Wet Meadow

A total of 112.5 acres of proposed wet meadow wetland are developing in seven different wetlands within the tailings basin (Tables 2 and 3, Figures 2 and 3). Wet meadows typically form in the transition zone from upland to aquatic systems, often intergrading into sedge meadows and shrub carr. The wet meadow community is targeted for a dominance of native grasses and perennial forbs, although sedges, rushes, ferns, and some shrubs may also be present. Woody plants should only be present as scattered individuals or small groups. The soils are typically saturated close to the surface for much of the growing season with occasional short-term inundation during floods or following snowmelt. Wet meadow mitigation wetlands are proposed in excess of impacts to those wetland types to partially compensate for impacts to wetland communities that have changed from the natural communities due to landscape changes. The compensation of wetland impacts out-of-kind (with different wetland communities than currently present), the proposed replacement ratio is 1.25:1, consistent with WCA and CWA guidelines.

4.3 Shallow Marsh

A total of 84.9 acres of shallow marsh wetland are developing in ten wetlands within the tailings basin (Tables 2 and 3, Figures 2 and 3). Shallow marshes typically form where inundation up to 6 inches in depth is present for long periods of time. The shallow marsh community is targeted for a dominance of primarily native emergent vegetation. Based on natural vegetation establishment observed in the tailings basin, it is expected that cattails (*Typha spp.*), giant reed grass (*Phragmites australis*), and soft-stem bulrush (*Scirpus validus*) will form the dominant species, as they are in most shallow marshes within Minnesota. Some grasses, forbs, and shrubs may develop on suitable micro-sites, but are not expected to be dominant. The shallow marsh creation areas are planned to have hydrology ranging from saturation to the surface with up to 6 inches or more of inundation for much of the growing season.

4.4 Deep Marsh

A total of 27.7 acres of deep marsh wetland are developing in two locations within the tailings basin (Tables 2 and 3, Figures 2 and 3). Deep marshes are typically present adjacent to shallow marshes and/or shallow open water communities with 6 inches to 36 inches of inundation present throughout the growing season. The deep marsh community is targeted for a mix of emergent and submergent vegetation. Based on natural vegetation establishment observed in the tailings basin, it is expected that cattails, giant reed grass, and soft-stem bulrush will form the dominant species. However, submergent vegetation, such as sago pondweed (*Potamogeton pectinatus*) is likely to develop.

4.5 Shrub Carr

A total of 313.7 acres of shrub carr wetland are developing as some component of nearly all of the wetlands within the tailings basin (Tables 2 and 3, Figures 2 and 3). Shrub carr communities are typically saturated close to the surface for much of the growing season with occasional short-term inundation during floods and following snowmelt. The vegetation is expected to be composed of at least 50 percent areal coverage of shrubs, greater than three feet tall, including willows (*Salix* spp.), dogwood (*Cornus* spp.), quaking aspen (*Populus tremuloides*), and balsam poplar (*Populus balsamifera*). The understory vegetation, which is currently developing is expected to be dominated by Canada bluejoint grass (*Calamagrostis canadensis*), horsetail (*Equisetum* spp.), and giant goldenrod (*Solidago gigantea*), along with other scattered forbs. The tree coverage is variable in shrub carr wetlands, typically with less than 25 percent coverage of mature tree species.

4.6 Alder Thicket

A total of 20.6 acres of alder thicket wetland are planned in three wetlands (Tables 2 and 3, Figures 2 and 3). Alder thicket communities are typically saturated close to the surface for much of the growing season with occasional short-term inundation during floods and following snowmelt. The vegetation is expected to be composed of at least 50 percent areal coverage of shrubs, including primarily speckled alder with some willow and dogwood. The understory vegetation is expected to be composed of grasses such as Canada bluejoint grass, horsetail, and giant goldenrod (*Solidago gigantea*), along with other scattered forbs. The tree canopy is expected to be less than 25 percent coverage of mature trees. Soils are anticipated to be saturated at or close to the surface for much of the growing season with occasional short-term, shallow inundation during significant rain events and following snowmelt.

4.7 Hardwood Swamp

A total of 32.9 acres of hardwood swamp wetland are developing in two wetlands within the tailings basin (Tables 2 and 3, Figures 2 and 3). Quaking aspen and balsam poplar- dominated hardwood swamp is the targeted community, but additional tree species such as black ash (*Fraxinus nigra*) and yellow birch (*Betula alleghaniensis*) may be present. A shrub layer is expected, dominated by willows and saplings of the dominant tree species. Herbaceous plants may include various grasses, sedges, ferns, and forbs suited to the tailings basin. Soils are anticipated to be saturated at or close to the surface for much of the growing season with occasional short-term, shallow inundation during significant rain events and following snowmelt.

4.8 Coniferous Swamp

A total of 23.3 acres of coniferous swamp wetland are developing in two wetlands within the tailings basin (Tables 2 and 3, Figures 2 and 3). Tamarack and black spruce are the targeted species, but additional tree species such as balsam fir (*Abies balsamea*) and paper birch (*Betula papyrifera*) may be present. Shrub layer cover is expected, and may be composed of species such as: speckled alder, winterberry, Labrador tea, blueberries, and the various tree species. The groundlayer is expected to be variable, and may include mosses, grasses, sedges, ferns, and forbs. The tall shrub layer coverage is expected to be variable and the tree canopy patchy to interrupted (25 to 75 percent cover). Soils are anticipated to be saturated at or close to the surface for much of the growing season with occasional short-term, shallow inundation during significant rain events and following snowmelt.

5.0 Wetland Mitigation Performance Standards

Performance standards have been developed to determine success within each targeted wetland plant community type that is expected to continue to mature. The performance criteria include measures to evaluate whether or not the hydrology and vegetation meet the plan goals. Should the performance standards not be met during the 10 year monitoring period, a proposal will be submitted to the Corps and the MnDNR Division of Lands and Minerals describing the corrective actions proposed and an implementation schedule. The wildlife improvements Keetac is considering are not expected to be tied to the wetland performance standards, but would improve the overall benefits of the mitigation wetlands in the future.

5.1 General Performance Standards

Several general performance standards apply to all wetland creation areas:

1. More than 50 percent of the vegetation in each wetland shall be facultative (FAC, FAC+) or wetter (FACW, OBL).
2. Invasive and/or non-native vegetation, excluding narrowleaf cattail (*Typha angustifolia*), shall not comprise more than 10 percent cumulative areal coverage within any wetland community at the end of the tenth full growing season for shrub communities; at the end of the tenth full growing season for the hardwood swamp communities; and at the end of the fifth full growing season for all other plant communities. In addition, reed canary grass (*Phalaris arundinacea*), shall not comprise more than 5 percent cumulative areal coverage within any wetland community at the end of the eighth full growing season for shrub communities; at the end of the tenth full growing season for the hardwood swamp communities; and at the end of the fifth full growing season for all other plant communities. Lastly, after 10 years, no buckthorn (*Rhamnus* spp.) or purple loosestrife (*Lythrum salicaria*) will be present within the plant communities.
3. Invasive and non-native vegetation include, but are not limited to the following: reed canary grass (*Phalaris arundinacea*), Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), smooth brome grass (*Bromus inermis*), giant ragweed (*Ambrosia trifida*), common ragweed (*Ambrosia artemisiifolia*), quack grass (*Elytrigia repens*), black locust (*Robinia pseudoacacia*), sweet clovers (*Melilotus alba* and *M. officinalis*), non-native honeysuckles (e.g., *Lonicera x bella*), non-native buckthorns (*Rhamnus cathartica* and *R. frangula*), and salt cedar (*Tamarix ramosissima*). Also included are species listed as non-native on the

MnDNR Minnesota Native Plant List, dated June 25, 2002. Although narrow-leaf cattail is not native to Minnesota, it is common in deep and shallow marshes throughout Minnesota and provides wildlife values similar to the native, broadleaf cattail (Eggers and Reed, 1997). Therefore, in this instance, narrow-leaf cattail shall be considered acceptable. In comparison, hybrid cattail (*Typha x glauca*) is also non-native and common in deep and shallow marshes throughout Minnesota. However, it is not clear if hybrid cattail provides similar wildlife values to narrowleaf.

4. Natural reference wetlands of the community types proposed for mitigation will be identified and monitored for comparing development of the mitigation wetlands.

5.2 Seasonally Flooded Basin

1. The wetland hydrology shall consist of inundation by a few inches to 24 inches of water for a minimum of 15 consecutive days during the growing season under normal to wetter than normal conditions (70 percent of years based on most recent 30-year record of precipitation). Inundation shall be typically absent following the first 6 weeks of the growing season and soil saturation drops below 12 inches from the surface for the majority of the growing season in most years (Table 5).
2. Herbaceous vegetation shall cumulatively comprise at least 80 percent areal cover by the end of the tenth full growing season, except when hindered by seasonal inundation.
3. Shrub and tree vegetation shall comprise less than 50 percent areal cover by the end of the tenth full growing season.
4. The herbaceous layer shall be dominated by at least four species of native, non-invasive grasses, sedges, rushes, forbs, or ferns, except when hindered by inundation.

5.3 Fresh Wet Meadow

1. The wetland hydrology shall consist of saturation at or within 12 inches of the surface for a minimum of 30 consecutive days, or two periods of 15 consecutive days, during the growing season under normal to wetter than normal conditions (70 percent of years based on most recent 30-year record of precipitation). Inundation during the growing season shall not occur except following the 10-year frequency or greater storm/flood event. The depth of inundation shall be 6 inches or less and the duration of any inundation event shall be less than 15 days.

An exception can be made for sites with hummocky microtopography -- hollows between hummocks can have standing water depths of up to 6 inches for extended duration (Table 5).

2. Herbaceous vegetation shall cumulatively comprise at least 50 percent areal cover by the end of the third full growing season.
3. Shrub and tree vegetation shall comprise less than 40 percent areal cover by the end of the tenth full growing season.
4. Total areal vegetative cover shall be more than 80 percent after the tenth full growing season.
5. The herbaceous layer shall be dominated by a minimum of six native, non-invasive species grasses, sedges, rushes, forbs, or ferns shall dominant the wetland by the end of the tenth full growing season.

5.4 Shallow Marsh

1. The wetland hydrology shall consist of saturation to the surface, to inundation by up to 6 inches of water, for a minimum of 60 consecutive days or two periods of 30 consecutive days or four periods of 15 consecutive days, during the growing season under normal to wetter than normal conditions (70 percent of years based on most recent 30-year record of precipitation). During the growing season, inundation by up to 18 inches of water following the 2-year or greater storm/flood event is permissible provided that the duration does not exceed 30 days (e.g., water depth drops from 18 inches to 6 inches within the 30 days) (Table 5).
2. Emergent vegetation shall comprise at least 50 percent areal cover by the end of the fifth full growing season.
3. Shrub and tree vegetation shall comprise less than 20 percent areal cover by the end of the tenth full growing season.
4. The herbaceous layer shall be dominated by at least two native or desirable aquatic species (e.g. bur-reeds, arrowheads, plantain, bulrushes, wild rice, sedges, broad-leaf cattail) after the tenth full growing season unless a community of low diversity, but high integrity (e.g. arrowhead, lake sedge) is present.

5.5 Deep Marsh

1. The wetland hydrology shall consist of inundation by 6 to 36 inches of water throughout the growing season, except in drought years (driest 10 percent of most recent 30-year period of precipitation record) (Table 5).
2. Emergent vegetation shall comprise at least 35 percent areal cover by the end of the fifth full growing season.
3. Submergent, floating, and floating-leaved vegetation shall comprise more than 40 percent areal cover by the end of the fifth full growing season.
4. The herbaceous layer shall be dominated by at least two native or desirable aquatic species (e.g. water-lilies, pondweeds, duckweeds, bur-reeds, arrowheads, plantain, bulrushes, wild rice, sedges, broad-leaf cattail) after the tenth full growing season unless a community of low diversity, but high integrity (e.g. bulrushes, arrowhead, lotus, wild rice) is present.

5.6 Shrub Carr

1. The wetland hydrology shall consist of saturation within 6 inches of the surface, to inundation by up to 6 inches of water, for a minimum of 30 consecutive days or two periods of 15 consecutive days, during the growing season under normal to wetter than normal conditions (70 percent of years based on most recent 30-year record of precipitation). Inundation by more than 6 inches of water during the growing season shall not occur except following the 10-year frequency or greater storm/flood event. Inundation by greater than 6 inches of water shall have a duration of less than 15 days. An exception can be made for sites with hummocky microtopography -- hollows between hummocks can have standing water depths of 6 to 12 inches for extended duration. (Table 5).
2. There shall be at least 300 shrub seedlings/acre or greater than 10 percent areal shrub species coverage, primarily willows, by the end of the third full growing season.
3. Characteristic shrub vegetation (primarily willow) shall comprise more than 40 percent areal cover by the end of the fifth full growing season.
4. Characteristic shrub vegetation (primarily willow) shall comprise more than 60 percent areal cover by the end of the eighth full growing season.

5. Herbaceous vegetation shall form in the understory such that the total areal vegetative cover shall be more than 50 percent by the end of the eighth full growing season.
6. Total areal vegetative cover shall be more than 80 percent by the end of the eighth full growing season.
7. The shrub community shall be dominated by at least two species of native shrubs and the herbaceous community shall be dominated by at least three species of native, non-invasive grasses, sedges, rushes, forbs, or ferns by the end of the tenth full growing season.

5.7 Alder Thicket

1. The wetland hydrology shall consist of saturation within 6 inches of the surface, to inundation by up to 6 inches of water, for a minimum of 30 consecutive days or two periods of 15 consecutive days, during the growing season under normal to wetter than normal conditions (70 percent of years based on most recent 30-year record of precipitation). Inundation by more than 6 inches of water during the growing season shall not occur except following the 10-year frequency or greater storm/flood event. Inundation by greater than 6 inches of water shall have a duration of less than 15 days. An exception can be made for sites with hummocky microtopography -- hollows between hummocks can have standing water depths of 6 to 12 inches for extended duration. (Table 5).
2. There shall be at least 300 shrub seedlings/acre or greater than 10 percent areal shrub coverage, including primarily speckled alder with some willows or dogwood acceptable by the end of the third full growing season.
3. Characteristic shrub vegetation (primarily speckled alder with some willow or dogwood) shall comprise more than 40 percent areal cover by the end of the fifth full growing season.
4. Characteristic shrub vegetation (primarily speckled alder with some willow or dogwood) shall comprise more than 60 percent areal cover by the end of the eighth full growing season.
5. Herbaceous vegetation shall form in the understory such that the total areal vegetative cover shall be more than 50 percent by the end of the eighth full growing season.
6. Total areal vegetative cover shall be more than 80 percent by the end of the eighth full growing season.

7. The shrub community shall be dominated by speckled alder, but may contain other shrub species and the herbaceous community shall be dominated by at least three species of native, non-invasive grasses, sedges, rushes, forbs, or ferns by the end of the tenth full growing season.

5.8 Hardwood Swamp

1. The wetland hydrology shall consist of saturation within 6 inches of the surface, to inundation by up to 6 inches of water, for a minimum of 30 consecutive days or two periods of 15 consecutive days, during the growing season under normal to wetter than normal conditions (70 percent of years based on most recent 30-year record of precipitation). Inundation by more than 6 inches of water during the growing season shall not occur except following the 10-year frequency or greater storm/flood event. Inundation by greater than 6 inches of water shall have a duration of less than 15 days. An exception can be made for sites with hummocky microtopography -- hollows between hummocks can have standing water depths of 6 to 12 inches for extended duration. (Table 5).
2. There will be at least 400 tree seedlings/acre, primarily quaking aspen, balsam poplar, black ash, or willows established by the end of the third full growing season. Some yellow birch may also be present. The cumulative areal cover of willow trees will not exceed 25 percent.
3. The sapling coverage will be at least 40 percent areal coverage at the end of the fifth full growing season including primarily quaking aspen, balsam poplar, black ash, willows, or yellow birch.
4. The herbaceous plant coverage will comprise at least 30 percent areal cover in the open areas, including at least 4 characteristic grass, sedge, fern and/or forb species at the end of the third full growing season.
5. At the end of the fifth full growing season, sapling and shrub density will be at least 400 saplings/acre or at least 50 percent areal coverage.
6. The herbaceous plant coverage will comprise at least 70 percent areal cover in the open areas by the end of the tenth full growing season.
7. At the end of the tenth full growing season, tree density will be at least 100 trees/acre or at least 60 percent areal coverage.

5.9 Coniferous Swamp

1. The wetland hydrology shall consist of saturation within 6 inches of the surface, to inundation by up to 6 inches of water, for a minimum of 30 consecutive days or two periods of 15 consecutive days, during the growing season under normal to wetter than normal conditions (70 percent of years based on most recent 30-year record of precipitation). Inundation by more than 6 inches of water during the growing season shall not occur except following the 10-year frequency or greater storm/flood event. Inundation by greater than 6 inches of water shall have a duration of less than 15 days. An exception can be made for sites with hummocky microtopography -- hollows between hummocks can have standing water depths of 6 to 12 inches for extended duration. (Table 5).
2. There will be at least 400 tree seedlings/acre, primarily tamarack, balsam, and black spruce established by the end of the fifth full growing season.
3. The sapling coverage will be at least 40 percent areal coverage at the end of the fifth full growing season including primarily tamarack, balsam, and black spruce.
4. The herbaceous plant coverage will comprise at least 30 percent areal cover in the open areas, including at least 4 characteristic grass, sedge, fern and/or forb species at the end of the third full growing season.
5. At the end of the fifth full growing season, sapling and shrub density will be at least 400 saplings/acre or at least 50 percent areal coverage.
6. The herbaceous plant coverage will comprise at least 70 percent areal cover in the open areas by the end of the tenth full growing season.
7. At the end of the tenth full growing season, tree density will be at least 100 trees/acre or at least 60 percent areal coverage.

5.10 Optional Upland Buffer- Native Aspen Forest/Woodland

1. Optional upland buffer communities, primarily aspen forest/woodland, composed of primarily native species may be managed so that no more than 10 percent areal cover of exotic or non-native invasive vegetation is present. Reed canary grass, if present, will not exceed 5 percent areal coverage.

2. There will be at least 200 tree seedlings/acre, primarily quaking aspen and balsam poplar, present within non-vegetated areas by the end of the third full growing season.
3. The shrub coverage may be at least 30 percent areal coverage at the end of the fifth full growing season including primarily quaking aspen, balsam poplar, and willows.
4. The herbaceous plant coverage may comprise at least 50 percent areal cover in the open areas, including at least 4 characteristic grass and forb species at the end of the third full growing season.
5. At the end of the fifth full growing season, sapling and shrub density will be at least 400 saplings/acre or at least 50 percent areal coverage.
6. The herbaceous plant coverage may comprise at least 70 percent areal cover in the open areas by the end of the tenth full growing season.
7. At the end of the tenth full growing season, tree density will be at least 100 trees/acre or at least 60 percent areal coverage.

6.0 2008 Wetland Creation Site Description

Approximately 190.6 acres of proposed mitigation wetlands were identified in 2008. Those wetlands are located in the lower, impounded areas of the tailings basin (the description and location of the 2005 mitigation wetlands was published in the 2005 Annual Monitoring Report) (Tables 2 and 3). As a result of the anticipated natural succession and vegetation establishment and management activities; wet meadow, shallow marsh, deep marsh, shrub-carr, alder thicket, hardwood swamp, and coniferous swamp wetland plant communities are planned (Tables 2 and 3, Figure 2).

Soils within the 2008 mitigation wetlands, as well as the 2005 mitigation wetlands, are typically fine tailings with limited nutrients, which in time are expected to have increased organic matter content and to develop hydric soil characteristics, such as mottling and depletions. However, due chiefly to the limited nutrients present within the tailings, the vegetation establishment within the mitigation wetlands, which are typically saturated at or near the surface, is anticipated to be relatively slow.

There is substantial evidence from across the Mesabi Iron Range that sustainable, moderate to high quality wetlands can develop on inactive tailings basins. The Northeast Minnesota Wetland Mitigation Inventory and Mineland Assessment project inventoried wetlands that developed on former minelands across the Mesabi Iron Range over approximately the past 20 to 50 years. A total of 430 wetlands covering over 2,700 acres were identified within former tailings basins within natural ore and taconite mining operations (Barr, 2009). Many of those minelands were not reclaimed following the standards required today and none of them planned for or managed the development of wetlands. Wetland functions and values were assessed in the field within 50 of the 430 tailings basin wetlands (covering nearly 1,100 acres) using the Minnesota Routine Assessment Method for Evaluating Wetland Functions, Version 3.2. Approximately 90 percent of the tailings basin wetland areas assessed, naturally developed moderate to high vegetative diversity including 38 percent with high or exceptional vegetative diversity. In addition, over 70 percent of the assessed wetlands were rated high for having a characteristic hydrologic regime and water quality characteristics. Therefore, with a specific plan and active management, it is expected that the proposed wetland mitigation areas will develop into better quality wetlands than those that have developed naturally with no planning or management.

This conclusion is, in part, substantiated by the continued development of the 2005 mitigation wetlands, which are becoming dominated by an assemblage of primarily native and/or desirable vegetation with stable wetland hydrology. The hydrology in 13 of the 14 mitigation wetlands

identified in 2005 has been monitored for the past three years. Water levels within each of those wetlands have fluctuated by 0.2 ft to 3 ft during that three year period with fluctuations in six of the wetlands of 0.6 ft or less. The vegetation establishment, so far, has been largely due to colonization of volunteer species from adjacent areas. Vegetation colonization within the 2008 mitigation wetlands is expected to improve upon implementation of the establishment and management plan, given a similar amount of time.

7.0 Wetland Establishment Plan

7.1 Wetland Creation Plan

The ultimate objective of this Plan is the development of primarily native vegetation within the 2005 and 2008 mitigation wetlands. The vegetation will be enhanced by seeding a native seed mixture designed for development on tailings, planting shrubs, followed by vegetation management activities.

7.2 Vegetation Establishment and Management

An adaptive management program is proposed to guide the establishment of the wetlands to the targeted conditions. The vegetative management areas for the 2005 and 2008 wetlands are shown on Figures 4 and 5, respectively. The management will be conducted to promote the establishment of characteristic native species that are present in similar plant communities within the general area and adjacent wetlands. The process for vegetation management within the wetlands is designed to aid the proposed plant communities in meeting goals described in Section 4 and the performance objectives described in Section 5 in the most effective manner.

The goal of the Plan is to help ensure that the 2005 and 2008 mitigation wetlands develop into self-sustaining and functioning plant communities to the extent feasible. The proposed wetland communities have been planned in areas that appear to match the desired hydrologic characteristics of each community type.

To aid in tracking the progress of the created wetlands in the past, a reference wetland (a portion of the Mesabi Chief Wetland) was selected (Figures 2 and 3). The reference wetland developed within a tailings basin and includes many of the proposed wetland plant communities. In future monitoring reports, the vegetative species diversity, proportion of vegetative cover, and water levels in the Mesabi Chief Wetland will be characterized and compared to the created wetlands. In addition, natural reference wetlands will be identified and monitored to assist in tracking the development of the mitigation wetlands. It is recognized that the wetland development process cannot be accomplished within a few years, but will take time, and therefore, short-term, interim performance standards (Section 5.0) are proposed.

7.2.1 General Site Preparation

Soil pH within unvegetated portions of the wetland basins will be assessed. Wetland soils which are found to have a pH above 8.2 will be amended with organic matter, preferably peat or sphagnum moss. The organic matter will be incorporated as an admixture to the top twelve inches of soil. Prior to

planting or seeding activities a granular, slow-release fertilizer will be applied to the vegetation management areas (Figures 4 and 5) at a rate of 400 - 500 lbs/ac of 18-46-0, which has proven to be most effective for establishing vegetation on tailings. At locations where seeding alone is proposed, the fertilizer will be incorporated as an admixture to the top six inches of soil. At locations where tree and/or shrub plantings are proposed, the fertilizer will be incorporated as an admixture to the top twelve inches of soil.

7.2.2 Management Activities - All Communities

Several of the 2005 mitigation wetlands have already developed into diverse, sustainable, native wetland communities similar to natural wetlands in the area (Wetlands 1a, 3a, 4a, 6, 8, and 9). Those six wetlands together, encompass approximately 116 acres of the mitigation wetlands. Due to the establishment success in those wetlands thus far, the primary activities planned include invasive species control and monitoring.

The proposed vegetation establishment and maintenance activities anticipated to meet the goals of the plan are listed for the conditions described as appropriate to the 2005 and 2008 wetland development schedule:

1. **Presence of reed canary grass.** Spray grass-selective herbicide (e.g., Intensity®) at label rates in late fall (after desirable native vegetation has senesced) where reed canary grass is present. The purpose of this treatment is to kill reed canary grass while desirable native plants are dormant. This treatment can also be conducted in spring and summer where graminoids are present and desirable. Spraying can be conducted aerially for large areas and areas that are too wet for ground vehicles; by tractor or all-terrain vehicle; or by hand. Recently, other restoration projects have had significant success using this treatment methodology.
2. **Presence of purple loosestrife.** Spray purple loosestrife with a broadleaf herbicide (e.g., Transline) at recommended rates where present within 2005 and 2008 mitigation areas.
3. **Dominance of hybrid cattail.** Spray all monotypic stands with Rodeo® (or other appropriately aquatic labeled glyphosate product) with surfactant. Temperatures must be over 55°F for applications. Ideal conditions are 70°F to 85°F, sunny with no breeze in the fall is preferable.
4. **Presence of Saltcedar (*Tamarix ramosissima*).** Spray actively growing salt cedar with Imazapyr®. Alternatively, large shrubs/trees can be cut, then apply triclopyr (Garlon) to the stumps.

5. **Potential presence of buckthorn.** See Appendix B.
6. **Presence of annual weeds.** Where annual weeds are dominant, mow seeded areas at 6-10 inch height with low ground-pressure mower before seed matures. Mowing also allows light to reach the small native seedlings and reduces competition from weeds and invasive species for water and soil nutrients.
7. **Hydrologic monitoring.** Monitor water levels in mitigation wetlands to determine if target hydrology is present utilizing staff gages where inundation is present or shallow monitoring wells in saturated conditions.
8. **Vegetation characterization.** In July-August of each year, the dominant vegetation present in the mitigation wetland will be characterized. In addition, a meander survey will be conducted within each wetland to determine species diversity. Detailed vegetation monitoring will be conducted in representative sample plots (5 m x 5 m) established in each wetland (center marked with a metal post and surveyed with a GPS unit). Vegetation species will be identified to at least genus level within the sampling plots. The cover class for each species will be record using the following cover classes:

Cover Class	Percent Cover	Description of Cover
0.1	< 0.1%	Rare
0.5	0.1 – <1.0%	Plant is present, but extremely minimal cover
1	1%	Plant is present, but very minimal cover
2	>1-<4%	Plant is present, more than 1% cover
3	4-<9%	Very small group of plants
4	9-<25%	Small group of plants, <25% cover
5	25-<50%	Larger group of plants, <50% cover
6	50-<75%	Larger group of plants, definitely 50% or > cover
7	75-<94%	Nearly complete cover
8	94-100%	Almost entirely or complete cover

Photographs of each wetland and each sampling plot will be captured from established photo monitoring locations.

9. **General weed control.** Continue treatments 1 - 4 annually until reed canary grass, purple loosestrife, buckthorn, and other non-native or invasive species are adequately controlled (see list in Section 5.1).

10. **Site specific treatment.** Spot spray created wetland areas two times annually to control reed canary grass and other perennial non-native or invasive species for up to 8 years in shrub communities, 15 years in swamp communities, and 5 years in other communities following initial vegetation establishment. Extensive treatments may not be needed after a sustainable wetland dominated by characteristic vegetation is established such that the performance standards described in Section 5 are achieved.

11. **Weed control.** Conduct a spring burn in the wet meadow communities after the third growing season to kill weed seed and promote germination of native plants, assuming that there is sufficient fuel for burning and assuming that there are no concerns with fire management due to climate conditions or other considerations.

7.2.3 Seeding/Planting –Wet Meadow, Shrub Carr, and Alder Thicket Communities

Primarily native, wetland vegetation is expected to develop in the majority of the planned wetland mitigation areas due to seed dispersal from nearby wetlands, seeding and planting activities, and vegetation management. Several areas within the 2005 mitigation wetlands and the majority of the 2008 wetlands lack significant vegetative cover. Therefore, to promote more rapid establishment of diverse, native communities, seeding is planned in those areas in 2009 and 2010 (Figures 4 and 5). Approximately 40 acres of relatively barren areas within Wetlands 2a and 4a will be seeded with the native seed mix included in Appendix A at a total rate of 8 lbs/ac followed by the application of 2 tons/ac of clean mulch crimped into the tailings. The seed mix was designed based on recent characterizations of wetland development on reclaimed tailings basins across the Mesabi Iron Range, based on the experience of Keetac with vegetative reclamation on wet tailings, and based on advice from MnDNR reclamation staff. The objective of the seeding is to establish primarily a wet meadow grass cover and understory cover for shrub communities with the potential to develop a diverse forb layer. The development of grass cover on tailings appears to substantially improve nutrient cycling and further vegetation development.

Willow shrubs tend to colonize tailings basin wetlands given enough time, however, speckled alder is not as likely to naturally colonize tailings basin wetlands. Therefore, to promote more rapid establishment of shrub communities, shrub planting and seeding are proposed. Approximately 11 acres of shrub carr (in two locations) will be planted with locally collected dormant cuttings of willow and some dogwood, which will be staked in the fall of 2009 or spring of 2010 at approximately one grouping of 3 stems per 400 square feet. Approximately 13.4 acres of alder

thicket (in two locations) will be seeded with speckled alder seed in the fall of 2009 or spring of 2010. In addition, locally grown speckled alder plants will be planted after seeding at approximately one grouping of 3 plants per 1,000 square feet.

In order to verify the interim performance standards, detailed monitoring will be conducted at the end of the third, fifth, and eighth growing seasons. The monitoring results will be evaluated in the context of the performance standards in Section 5 to evaluate success. Areas that have not met the performance standards will be seeded or planted as follows:

1. **Wet meadow.** Wet meadow areas that do not have adequate wetland vegetation cover or appropriate species established after the fifth growing season will be seeded in the fall of the following growing season with an appropriate seed mix that will be developed after reviewing results of the previous seeding efforts. Seed mixes will be submitted for review and approval prior to seeding.
2. **Shrub carr communities.** Portions of shrub carr wetlands that do not meet the performance standards by the end of the fifth growing season will be planted with locally collected dormant cuttings of willow, which will be staked in the fall or spring at approximately one grouping of 3 stems per 400 square feet.
3. **Alder thicket communities.** Portions of alder thicket wetlands that do not meet the performance standards by the end of the fifth growing season will be planted with locally grown speckled alder plants during the following growing season at approximately one grouping of 3 plants per 1,000 square feet.

7.2.4 Hardwood Swamp

Hardwood swamp communities are developing naturally within three wetland mitigation areas (Wetlands 1a, 6, and 8 - Figure 3 and Table 1). If tree densities do not appear to be on a trajectory to meet the performance standards after the seventh full growing season, bare root or 1 gallon pot size seedlings of balsam poplar, quaking aspen, and black ash will be inter-planted to achieve a stem density that exceeds that of the year 10 performance criteria by 25 percent.

7.2.5 Optional Upland Area Management and Wildlife Enhancement

Vegetation in potential adjacent upland areas (Figure 6) may be managed to promote natural succession of the developing plant communities. Each of the vegetation cover layers – ground, shrub and tree layers – could be managed to promote the ecological integrity and function of

native plant communities. The primary maintenance activity would likely be control of non-native invasive species such as, but not limited to buckthorn, honeysuckle and Canada thistle. Protecting the site from further disturbances and allowing natural colonization and successional processes will maintain ecosystem biodiversity and structure.

Optional Maintenance activities may include:

- Monitoring sites to identify and anticipate problems with invasive species before they reach problem proportions. Particular attention will be paid to edges of the upland sites.
- Removing non-native or invasive plant species or treating them with appropriate herbicides when found; timing/season of treatment will be based upon best practices for control of the species.
- Potential seeding or planting of appropriate native species based on the target communities.

Vegetation management, wildlife enhancement options, and educational opportunities, may also include the following (Figure 6):

- Maintenance of the existing grassland/field bird habitat northwest of the tailings basin.
- Installation of up to 46 eastern bluebird nest boxes northwest of the tailings basin, within the grassland/field community.
- Installation of up to 15 wood duck nesting boxes north and southeast of the tailings basin, within existing prime wood duck habitat (deep marsh surrounded by or contiguous to forest/woodland).
- Installation of 2 osprey nesting platforms northwest of the tailings basin.
- Installation of 4 owl (great gray and great horned owls) nest boxes east of the tailings basin.
- Creation of an interpretive hiking trail east and south of the tailings basin after closure and reclamation.

Appendix D provides details regarding the bird nesting boxes/platforms specifications.

8.0 Wetland Management Schedule

The following schedule represents a plan of the expected activities that may be involved in enhancing the establishment of the mitigation wetlands within the tailings basin. However, with an adaptive management perspective, it should be recognized that the timing of specific establishment and management activities may change as the work progresses. The overall schedule for management activities within the 2005 and 2008 mitigation wetlands is to complete the initial seeding and planting within the next 3 years (through 2011). Management activities will generally follow the schedule provided below.

Many of the mitigation wetlands created to compensate for unavoidable impacts will require regular management to become established as sustainable, functioning wetlands. This is critical in the first three to five years and should be recognized as integral to the wetland mitigation success.

Management will include both controlling non-native and invasive species, creating ideal conditions for the native plants to flourish, and seeding/planting to supplement natural development. Weeds can become established any time that bare ground is present. Some weeds are very aggressive and will out-compete the desirable wetland seedlings. Therefore, weed control and careful monitoring is important during the early stages of the establishment process. As native plants grow and spread over the years, and as thatch slowly builds, the site will become less vulnerable to weed species. Removal of weeds does continue to be important during the first five to ten years to ensure that the native plant communities become established. After final certification of the mitigation wetlands by the appropriate regulatory agencies, Keetac will record a *Permanent Conservation Easement* (Appendix C).

8.1 Year 1 (2010)

1. Spring (May) – late fall (late October) Conduct weekly hydrology monitoring within all mitigation wetlands.
2. Late summer (July-August): Complete detailed vegetation, hydrology, and soils assessment within the created wetlands.
3. Fall (September 1 – 15): Incorporate granular slow-release fertilizer (18-46-0), at a rate of 400 lbs/ac., into the top 6 inches of soil within the proposed 40.5 acre-proposed native seeding locations (Wetlands 2a and 4a, Figure 4) and the proposed 17.8 acre shrub planting areas

(Wetlands 2a and 4b, Figure 4). In October - November 15, at least 2 weeks after fertilization is complete, conduct dormant seeding within the native seeding locations (Wetlands 2a and 4a) (Figure 4), utilizing the seed mixture in Table A-1, Appendix A. In order to help ensure the success of the seeding, the following methodology should be followed:

- A. Prior to starting work, calibrate and adjust seeding equipment to sow seeds at the proper seeding rate. Equipment shall be operated in a manner to insure complete coverage of the entire area to be seeded. Steam clean or thoroughly wash all equipment prior to starting work to prevent contamination from outside seed sources.
 - B. Broadcast seed using two perpendicular passes, broadcasting one half of the seed in each direction.
 - C. Lightly hand rake or drag to cover seed with no more than 1/8 inch of soil.
 - D. Immediately follow seeding with hydromulching or placing weed-free straw mulch.
4. Fall (September 15 – October 15): At least 2 weeks after fertilization is complete, plant willow and dogwood cuttings in clusters of 325 cuttings/ac in Wetlands 2a and 4b (Table A-2, Appendix A).
 5. Winter: Complete monitoring report, including documentation of wetland management activities completed during the year conducted in comparison to the plan and recommended actions for the following year.

8.2 Year 2 (2011)

1. Spring (May) – late fall (late October): Conduct weekly hydrology monitoring.
2. Spring (May 15 – June 1): Incorporate fertilizer (18-46-0), at a rate of 500 lbs/ac., into the top 12 inches of soil within the proposed 11.7 acre alder thicket planting areas in Wetlands 13 and 15, Figure 5) and 12.8 acre shrub planting areas in Wetland 3c (Figure 5).
3. Early summer (June 15 – July 15): At least 2 weeks after fertilization is complete, conduct alder thicket seeding followed by planting of 120 speckled alder plants/ac in Wetlands 13 and 15 (Table A-2, Appendix A).

4. Early summer (June 15 – July 15): At least 2 weeks after fertilization is complete, conduct shrub planting in Wetland 3c with 325 willow and dogwood/ac and seed Wetland 15 with speckled alder (Table A-1, Appendix A).
5. Summer (early July): Mow the 2010, 40.5 acre- native seeding locations (Wetlands 2a and 4a) (Figure 4) at a height of 6 to 10 inches.
6. Summer (July-August): Complete detailed vegetation, hydrology, and soils assessment within created wetlands.
7. Late summer (September 1 – 15): Incorporate fertilizer (18-46-0), at a rate of 400 lbs/ac., into the top 6 inches of soil within the proposed 30.4 acre-proposed native seeding locations in Wetlands 3c and 13 (Figure 5).
8. Fall (October 1 – 15), at least 2 weeks after fertilization is complete, conduct dormant hydroseeding within the native seeding locations (Wetlands 3c and 13), utilizing the seed mixture in Table A-1, Appendix A.
9. Winter: Complete monitoring report, including documentation of wetland management activities completed during the year conducted in comparison to the plan and recommended actions for the following year.

8.3 Year 3 (2012)

1. Spring (May) – late fall (late October): Conduct weekly hydrology monitoring.
2. Summer (early July): Mow the 2011, 40.5 acre native wet meadow seeding locations (Wetlands 2a and 4a, Figure 4) at a height of 6 to 10 inches.
3. Summer (July-August): Complete detailed vegetation, hydrology, and soils assessment within created wetlands.
4. Winter: Complete monitoring report, including documentation of wetland management activities completed during the year conducted in comparison to the plan and recommended actions for the following year.

8.4 Years 4-6

Management activities described for Years 1-3, such as monitoring and reporting, will be continued in Years 4 -6. If tree and shrub development in hardwood swamp, shrub carr, and alder thicket communities are not on target to meet performance standards, seedlings will be planted as described in Sections 7.2.3 and 7.2.4.

In addition, now that the seeded wetland management areas have undergone 1 or 2 growing seasons, they are more likely to survive potential herbicide over-spray. Therefore chemical control of invasives (see Section 7.2.2) may commence:

1. **Summer (July – early August):** Spray mitigation areas where purple loosestrife is present with a broadleaf herbicide (e.g. Transline) at recommended rates.
2. **Early Fall (late September- early October; once desirable native vegetation has senesced):** Utilize grass-selective herbicide at label rates to spray areas where reed canary grass is present.
3. **Fall (October):** Chemically treat buckthorn (Appendix B). Because buckthorn loses its leaves later in the season than native woody plants, herbicide treatment in October may also make buckthorn identification easier.

The monitoring report completed after the fifth growing season will assess whether or not enhanced, wetland communities (with the exception of shrub, alder, and hardwood swamp communities) are in conformance with performance standards such that the 5-year monitoring would be sufficiently complete.

8.5 Years 7-10

Because establishment of shrub, alder, and hardwood swamp communities will take longer to become established, active management and monitoring will be conducted for eight years within shrub communities and ten years in hardwood swamp communities. All of the management and monitoring activities described for Years 4-6 will be continued in Years 7 - 10.

The monitoring report completed after the eighth growing season will assess whether or not enhanced, shrub and alder communities are in conformance with performance standards such that the 8-year monitoring would be sufficiently complete. The monitoring report completed after the tenth

growing season will assess whether or not enhanced, swamp communities are in conformance with performance standards such that the 10-year monitoring would be sufficiently complete.

9.0 Wetland Mitigation Monitoring

Monitoring in wetland mitigation areas will continue for at least five years (eight years for shrub communities and ten years for hardwood swamp communities) beginning in 2006 (year 1) for the 2005 mitigation wetlands and 2009-10 (year 1) for the 2008 mitigation wetlands, to document the progress and condition of the wetland communities at the mitigation sites. For wetlands other than shrub, alder, and swamp communities, monitoring reports will continue to be prepared each year in years 1 through 5. For shrub communities, monitoring reports will be prepared and submitted in years 1, 2, 3, 5, and 8. For swamp communities, monitoring reports will be prepared and submitted in years 1, 2, 3, 5, 8, and 10.

The monitoring report completed after the final growing season will assess whether or not the created wetlands are in conformance with performance standards including a final delineation of the wetland mitigation areas. Future wetland mitigation plans will be submitted for review and approval to address mitigation wetlands that are not in conformance with the performance standards.

Hydrologic parameters will be evaluated in the created wetlands during each year of monitoring. Any significant modifications to the monitoring frequency proposed herein will be described in a revised monitoring plan to be submitted for review and approval prior to implementation. In addition, natural reference wetlands of the same hydrologic regimes and general community types proposed for mitigation will be identified and monitored.

9.1 Hydrologic Monitoring Years 1-2

9.1.1 Shallow Marsh and Deep Marsh Communities

Hydrologic monitoring in these inundated wetland communities will be conducted using staff gages placed within each created wetland. Water elevations will be recorded once per week during the first 10 weeks of the growing season and twice monthly through the remainder of the growing season.

9.1.2 All Other Communities

Hydrologic monitoring in these generally saturated wetland communities will be conducted using shallow wells placed within each created wetland area. Water elevations will be recorded once per week during the first 10 weeks of the growing season and twice monthly through the remainder of the growing season.

9.2 Hydrologic Monitoring Years 3-10

9.2.1 Wet Meadow, Shallow Marsh and Deep Marsh Communities

If during the first 2 years, the detailed hydrology monitoring indicates a stable and consistent hydrologic regime similar to the reference wetlands, water elevations will be recorded monthly throughout the growing season during future monitoring years. In wetlands where water elevation fluctuations differ substantially from the reference wetlands, water elevations will be recorded once per week during the first 10 weeks of the growing season and twice monthly through the remainder of the monitoring.

9.2.2 All Other Communities

If during the first 2 years, the detailed hydrology monitoring indicates a stable and consistent hydrologic regime similar to the reference wetlands, water elevations will be recorded once per week during the first 6 weeks of the growing season and monthly throughout the remainder of the growing season in Years 3-8 for the shrub, alder, and swamp communities.

In wetlands where water elevation fluctuations differ substantially from the reference wetlands, water elevations will be recorded once per week during the first 10 weeks of the growing season and twice monthly through the remainder of the growing season during Years 3-8 for shrub, alder, and swamp communities. Hydrologic monitoring in the swamp communities will continue in years 9 and 10 utilizing shallow wells with water levels recorded approximately once per week for the first 6 weeks of the growing season and monthly thereafter, if sustainable hydrology is not previously documented.

9.3 Vegetation Monitoring

As described in Section 7.2.2 (No. 6), a detailed vegetation survey will be conducted annually (typically July-August) in each wetland mitigation community, as well as the reference wetland communities, to evaluate the success of the created wetlands during the appropriate monitoring period for each community type. A time meander search will randomly sample 20 percent of each wetland restoration community with the exception of the shallow and deep marsh and open water communities. Documentation photographs will also be taken in August from fixed reference points around each restored wetland area.

9.4 Monitoring Report

A monitoring report will be prepared following growing seasons 1, 2, 3, 5, and 8 following restoration for the shrub communities and following growing seasons 1, 3, 5, 8, and 10, for the forested and bog communities. An annual monitoring report will be prepared during the 5-year

monitoring period for all additional communities. The report will describe the status of the wetland mitigation, summarize the results of the vegetative and hydrologic monitoring, and discuss management activities and corrective actions conducted during the previous year, and activities planned for the following year. The report will be submitted to the MnDNR and Corps by January 31st of the following year. The monitoring report will include the following information at a minimum:

- A brief description of the wetland mitigation area, including location, size, vegetative and hydrologic monitoring data, current wetland types and desired wetland types.
- A summary of water level measurements taken to date and a determination whether the hydrology in the wetlands meets the design elevations and wetland hydrology criteria as defined in the performance standards.
- Vegetation survey information, including species and percent areal coverage within each created wetland community and the reference wetlands and a determination of whether the vegetation meets the performance criteria.
- A map of the various plant communities present within the restoration areas will be prepared when distinctly different communities have developed.
- Color photographs of the wetland mitigation areas, reference wetlands, and sample plots taken in July-August of each year at designated photo-reference points
- A summary of management activities and/or corrective actions conducted in the wetlands during the previous year and activities planned for the following year.

10.0 References

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Tables

Table 1
Wetland Impact Summary
by Eggers and Reed Classification
U.S. Steel Keetac
Keewatin, MN
May 26, 2009

Project Area	Circular 39	1	2	3	4	5	6	6	7	Wetland Total	Deepwater	Total
	Eggers and Reed Wetland Classification	Seasonally Flooded	Fresh (Wet) Meadow	Shallow Marsh	Deep Marsh	Shallow, Open Water	Shrub-Carr	Alder Thicket	Hardwood Swamp			
Mine Site	(acres)	5.82	4.10	85.51	53.69	86.74	59.82	0.00	0.00	295.7	10.04	305.7
	% of impact area	2.0%	1.4%	28.9%	18.2%	29.3%	20.2%	0.0%	0.0%	97%		
	# wetlands	2	5	7	1	1	7	0	0	23	1	24
East Stockpile	(acres)	0.00	6.71	93.79	26.82	275.11	26.56	17.82	0.00	446.8	0.00	446.8
	% of impact area	0.0%	1.5%	21.0%	6.0%	61.6%	5.9%	4.0%	0.0%	100%		
	# wetlands	0	3	7	4	4	5	1	0	24		24
South Stockpile	(acres)	0.00	0.00	1.38	0.00	0.00	0.00	0.00	9.53	10.9	0.00	10.9
	% of impact area	0.0%	0.0%	12.6%	0.0%	0.0%	0.0%	0.0%	87.4%	100%		
	# wetlands	0	0	2	0	0	0	0	1	3		3
Tailings Basin	(acres)	0.00	0.00	0.00	1.80	0.00	0.00	0.00	0.00	1.8	0.00	1.8
	% of impact area	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100%		
	# wetlands	0	0	0	1	0	0	0	0	1		1
Total	(acres)	5.8	10.8	180.7	82.3	361.9	86.4	17.8	9.5	755.2	10.0	765.2
	%of impact area	0.8%	1.4%	23.9%	10.9%	47.9%	11.4%	2.4%	1.3%	100%		
	# wetlands	2	8	16	6	5	12	1	1	51	1	52

Table 2
Planned Wetland Plant Communities
U. S. Steel Keetac
Keewatin, MN

Wetland ID	First Year of Identification	Area (acres)	Planned Circular 39 Type	Planned Eggers and Reed Plant Community
Wetland 1a	2005	1.61	3	Shallow Marsh
Wetland 1a	2005	1.38	7	Hardwood Swamp
Wetland 2a	2005	86.21	2	Wet Meadow
Wetland 2a	2005	40.20	3	Shallow Marsh
Wetland 2a	2005	26.04	4	Deep Marsh
Wetland 2a	2005	49.07	6	Shrub-Carr
Wetland 2a	2005	3.19	7	Coniferous Swamp
Wetland 3a	2005	8.36	2	Wet Meadow
Wetland 3a	2005	15.74	6	Shrub-Carr
Wetland 3a	2005	7.84	7	Coniferous Swamp
Wetland 3b	2005	2.69	2	Wet Meadow
Wetland 3b	2005	5.17	6	Shrub-Carr
Wetland 4a	2005	3.32	2	Wet Meadow
Wetland 4a	2005	1.05	6	Shrub-Carr
Wetland 4b	2005	24.38	6	Shrub-Carr
Wetland 5a	2005	0.60	6	Shrub-Carr
Wetland 6	2005	5.53	3	Shallow Marsh
Wetland 6	2005	19.50	6	Shrub-Carr
Wetland 7	2005	7.96	7	Coniferous Swamp
Wetland 8	2005	31.20	7	Hardwood Swamp
Wetland 8	2005	45.76	6	Shrub-Carr
Wetland 9 ¹	2005	6.50	3	Shallow Marsh
Wetland 10	2005	1.11	2	Wet Meadow
Wetland 10	2005	0.57	3	Shallow Marsh
Wetland 11 ²	2005	5.09	1	Seasonally Flooded Basin
Wetland 11 ²	2005	13.47	3	Shallow Marsh
Wetland 12 ³	2005	6.70	2	Wet Meadow
Wetland 12 ³	2005	7.75	3	Shallow Marsh
Wetland 12 ³	2005	1.97	6	Shrub-Carr
Subtotal		430.0		
Wetland 1b	2008	1.67	4	Deep Marsh
Wetland 1b	2008	0.22	6	Shrub-Carr
Wetland 2b	2008	2.25	6	Shrub-Carr
Wetland 3b	2008	3.16	6	Shrub-Carr
Wetland 3c	2008	128.78	6	Shrub-Carr
Wetland 5b	2008	2.09	2	Wet Meadow
Wetland 6a	2008	2.39	6	Shrub-Carr
Wetland 6b	2008	0.63	6	Shrub-Carr
Wetland 6c	2008	0.12	6	Shrub-Carr
Wetland 7a	2008	8.44	6	Alder Thicket
Wetland 7a	2008	1.05	7	Coniferous Swamp
Wetland 8a	2008	4.45	6	Shrub-Carr
Wetland 8a	2008	0.30	7	Hardwood Swamp
Wetland 8a	2008	3.27	7	Coniferous Swamp
Wetland 8b	2008	3.96	6	Shrub-Carr
Wetland 8c	2008	0.53	3	Shallow Marsh
Wetland 9a	2008	0.51	3	Shallow Marsh
Wetland 9b	2008	0.38	3	Shallow Marsh
Wetland 9c	2008	0.14	3	Shallow Marsh
Wetland 9d	2008	4.48	6	Shrub-Carr
Wetland 13	2008	1.99	2	Wet Meadow
Wetland 13	2008	3.88	6	Alder Thicket
Wetland 14	2008	7.69	3	Shallow Marsh
Wetland 15	2008	8.24	6	Alder Thicket
Subtotal		190.6		
Total		620.6		
Allocated for Past Impacts		38.2		
Total Unused Mitigation		582.3		
Reduction in area for		10.0		

¹Area of Wetland 9 reduced by 8.4 acres due to more detailed field delineation in 2008

²Total wetland area reduced by 1.0 acres from 2005 due to refined mapping

³Wetland 12 was first identified and reported during the 2006 annual monitoring

⁴Area of mitigation wetlands 1a, 2a, 3a, and 7 that are expected to be by affected by tailings dam reinforcement have already been removed from the mitigation area shown.

Table 3
Wetland Mitigation Plant Community Areas
U. S. Steel Keetac
Keewatin, MN

Planned Eggers and Reed Plant Community	2005 Mitigation Area (acres)	2008 Mitigation Area (acres)	Total Area (acres)
Seasonally Flooded Basin	5.1	0.0	5.1
Wet Meadow	108.4	4.1	112.5
Shallow Marsh	75.6	9.2	84.9
Deep Marsh	26.0	1.7	27.7
Shrub-Carr	163.3	150.4	313.7
Alder Thicket	0.0	20.6	20.6
Hardwood Swamp	32.6	0.3	32.9
Coniferous Swamp	19.0	4.3	23.3
Total	430.0	190.6	620.6

Table 4
Comparison of Proposed Wetland Impacts and On-Site Tailings Basin Mitigation
U. S. Steel Keetac

Wetland Communities	Total Keetac Tailings Basin Mitigation (ac)	2005 Mine and Stockpile Expansion Impact Area ¹ (ac)	2007 Aromac Expansion Impact Area ² (ac)	Available Tailings Basin Mitigation ³ (ac)	Proposed Keetac Expansion Project Impact Area ⁴ (ac)	In-Kind Mitigation Applied ⁵ (ac)	Mitigation Balance After In-Kind ⁶ (ac)	Remaining Impacts, Not In-Kind ⁷ (ac)	Wetland Impacts Compensated Out-of-Kind at 1.25:1 ⁸ (ac)	Remaining, Uncompensated Impacts ⁹ (ac)
Seasonally Flooded (Type 1)	5.1	0.0	0.0	5.1	5.8	5.1	0.0	0.7	0.0	0.0
Wet Meadow (Type 2)	112.5	12.8	0.7	99.0	10.8	10.8	88.2	0.0	70.5	0.0
Shallow Marsh (Type 3)	84.9	0.0	0.3	84.6	180.7	84.6	0.0	96.1	0.0	0.0
Deep Marsh (Type 4)	27.7	0.0	0.7	27.0	82.3	27.0	0.0	55.3	0.0	0.0
Shallow, Open Water (Type 5)	0.0	0.0	0.0	0.0	361.9	0.0	0.0	361.9	0.0	241.1
Shrub Carr (Type 6)	313.7	16.2	1.4	296.1	86.4	86.4	209.7	0.0	167.8	0.0
Alder Thicket (Type 6)	20.6	0.0	0.0	20.6	17.8	17.8	2.7	0.0	2.2	0.0
Hardwood Swamp (Type 7)	32.9	6.2	0.0	26.7	9.5	9.5	17.1	0.0	13.7	0.0
Coniferous Swamp (Type 7)	23.3	0.0	0.0	23.3	0.0	0.0	23.3	0.0	18.6	0.0
Total	620.6	35.2	3.0	582.3	755.2	241.3	341.1	514.0	272.8	241.1

¹Impacts not compensated by other, previous mitigation measures.

²Compensation was permitted utilizing mitigation wetlands in the tailings basin, and are therefore subtracted from that total.

³This column represents the total, planned wetland mitigation acreage not previously permitted to compensate for past wetland impacts.

⁴Summary of direct and indirect wetland impacts proposed for the Keetac Expansion Project.

⁵In-kind mitigation applied at a 1:1 ratio where the mitigation wetland communities match the impacted wetland communities.

⁶The wetland mitigation acreage remaining after subtracting in-kind wetland compensation at a 1:1 ratio.

⁷Acreage of wetland impacts not proposed to be replaced with the same wetland communities.

⁸Wetland impact acreage compensated out-of-kind (computed by dividing the Mitigation Balance After In-Kind by 1.25), which is applied first to shallow marsh impacts, then deep marsh, and finally, shallow open water impacts.

⁹Wetland impacts that are not proposed to be compensated on-site (a separate, off-site wetland mitigation plan will be developed to compensate for these impacts).

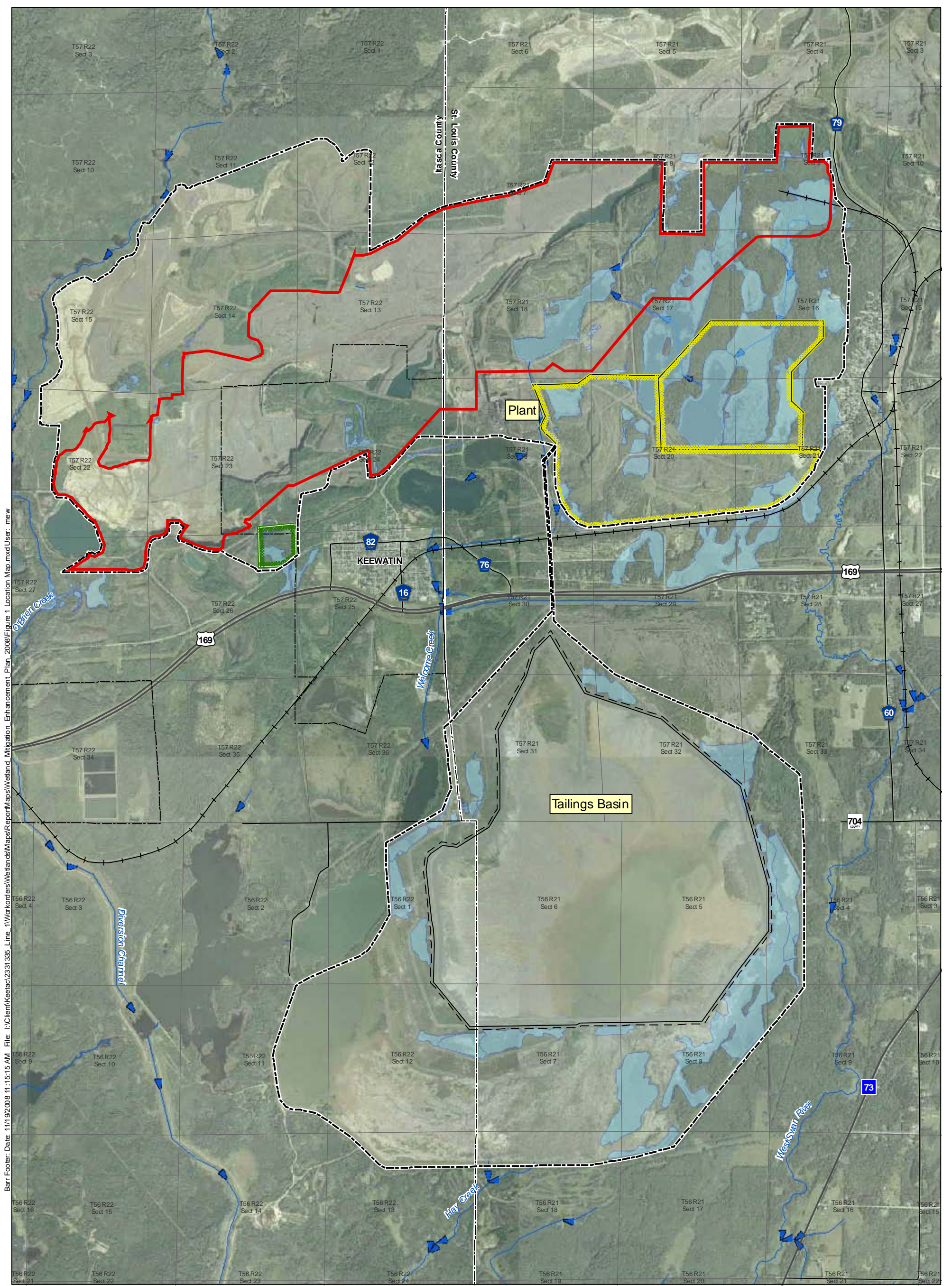
**Table 5
Wetland Mitigation Target Hydrology
Keetac**

Circular 39	Eggers and Reed Wetland Classification	Target Hydrology (inches)	Target Hydroperiod (days)¹	Storm Event Flooding Tolerance (depth in./days)²
1	Seasonally Flooded Basin	0 to 24	> 15	>24/30
2	Fresh (Wet) Meadow	0 to -12	> 30	6/15
3	Shallow Marsh	0 to 6	> 60	N/A
4	Deep Marsh	6 to 36	> 60	N/A
6	Shrub-Carr	6 to -6	> 30	12/15
6	Alder Thicket	6 to -6	> 30	12/15
7	Hardwood Swamp	6 to -6	> 30	12/15

¹Time during the growing season, under normal conditions, in which target hydrology is present

²Water depth tolerance in response to 10-year return period storm event

Figures



Barr Footer: Date: 11/19/2008 11:15:15 AM File: I:\Client\Keetac\2331335_Line_1\Workorders\Wetlands\Maps\Report\Maps\Wetland_Mitigation_Enhancement_Plan_2008\Figure 1 Location Map.mxd>User: new

- Facility Boundary
- Total Final Pit Limit
- East Stockpile Area
- South Stockpile Area
- City Boundary
- County Boundary
- Sections
- Streams
- Waterbodies

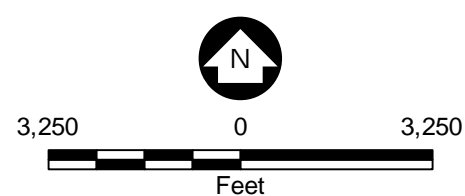
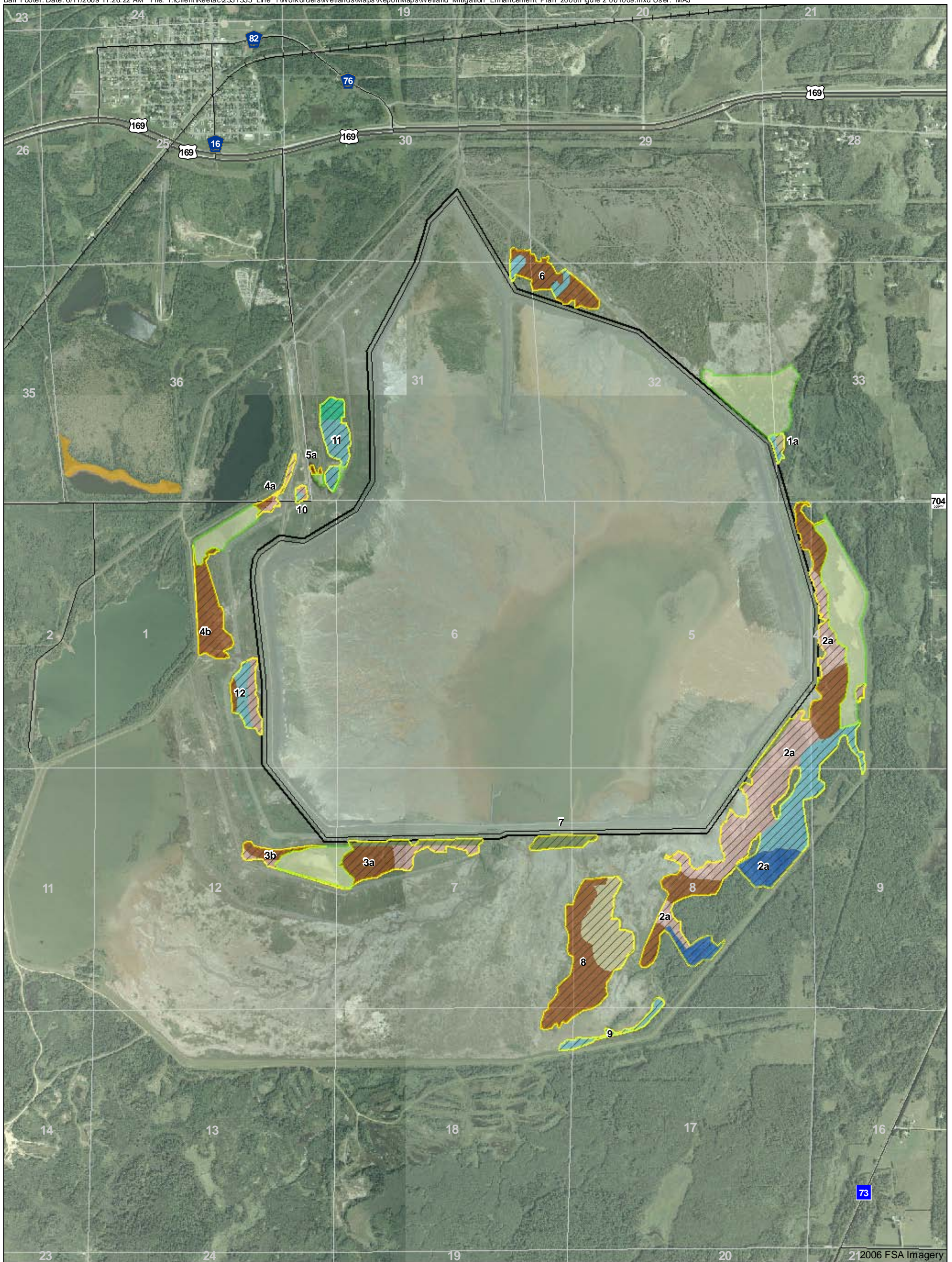


Figure 1
 PROJECT LOCATION
 Keetac Project
 US Steel Corp.
 Keewatin, Minnesota



Legend

Developing Wetland Plant Community

- | | | | |
|--|--------------------|--|-------------------------------|
| | Alder Thicket | | 2005 Wetland Mitigation Areas |
| | Coniferous Swamp | | 2000 Wetland Mitigation Areas |
| | Deep Marsh | | Reference Wetland |
| | Hardwood Swamp | | Section Lines |
| | Seasonally Flooded | | |
| | Shallow Marsh | | |
| | Shrub-Carr | | |
| | Wet Meadow | | |

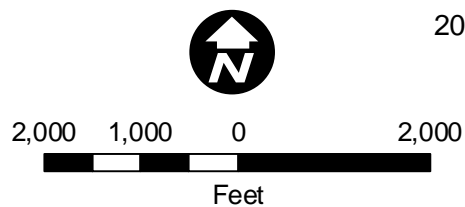
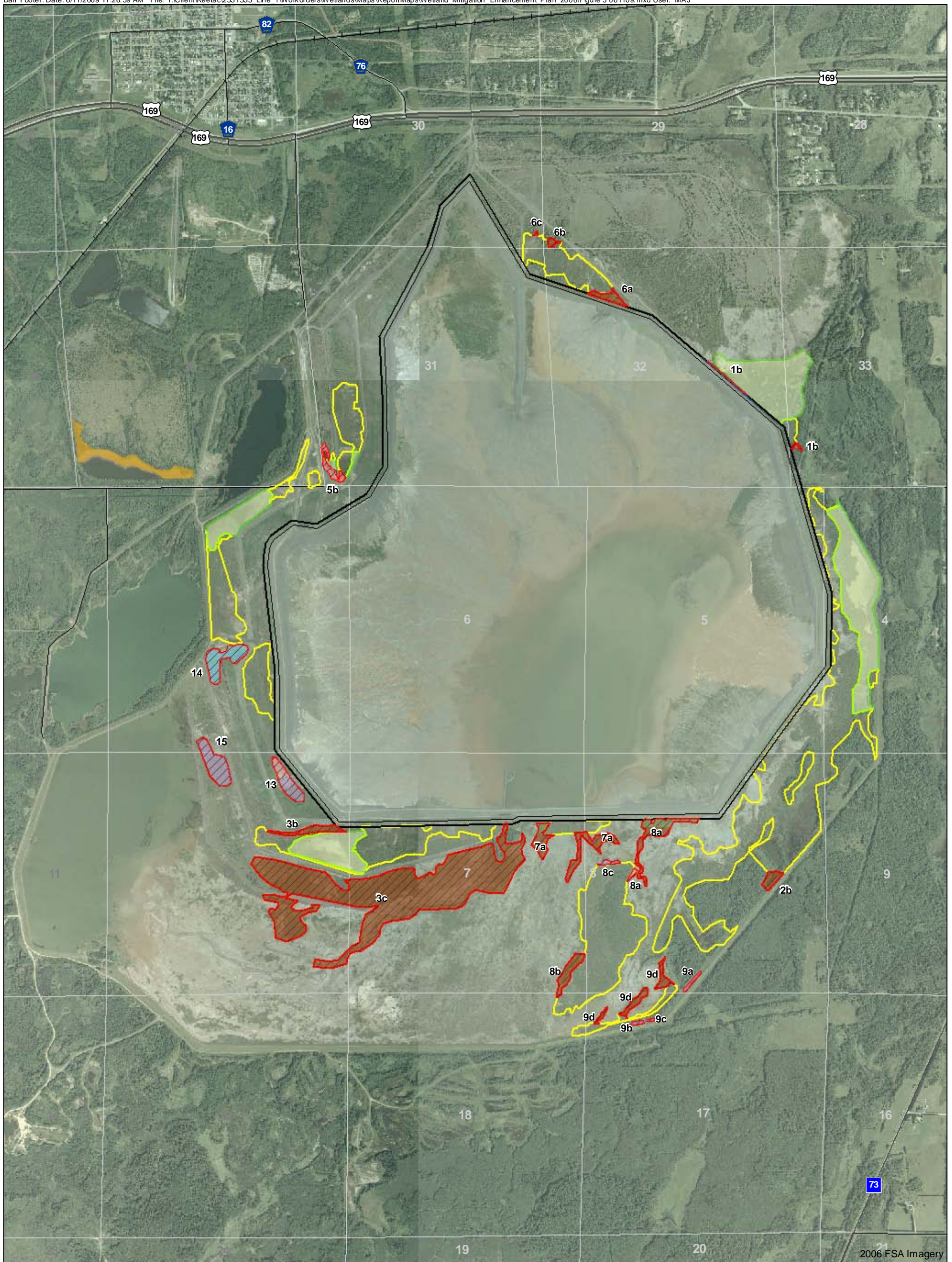


Figure 2

2005 TAILINGS BASIN WETLAND MITIGATION
SITES: PLANNED WETLAND
PLANT COMMUNITIES
Keetac Project
US Steel Corp.
Keewatin, Minnesota



- Developing Wetland Plant Community**
- | | | | |
|--|--------------------|--|-------------------------------|
| | Alder Thicket | | 2008 Wetland Mitigation Areas |
| | Coniferous Swamp | | 2005 Wetland Mitigation Areas |
| | Deep Marsh | | 2000 Wetland Mitigation Sites |
| | Hardwood Swamp | | Reference Wetland |
| | Seasonally Flooded | | Section Lines |
| | Shallow Marsh | | |
| | Shrub-Carr | | |
| | Wet Meadow | | |

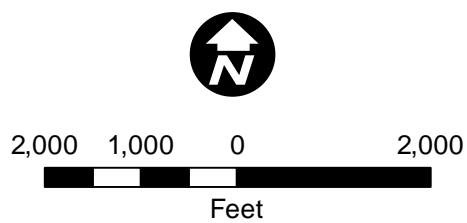
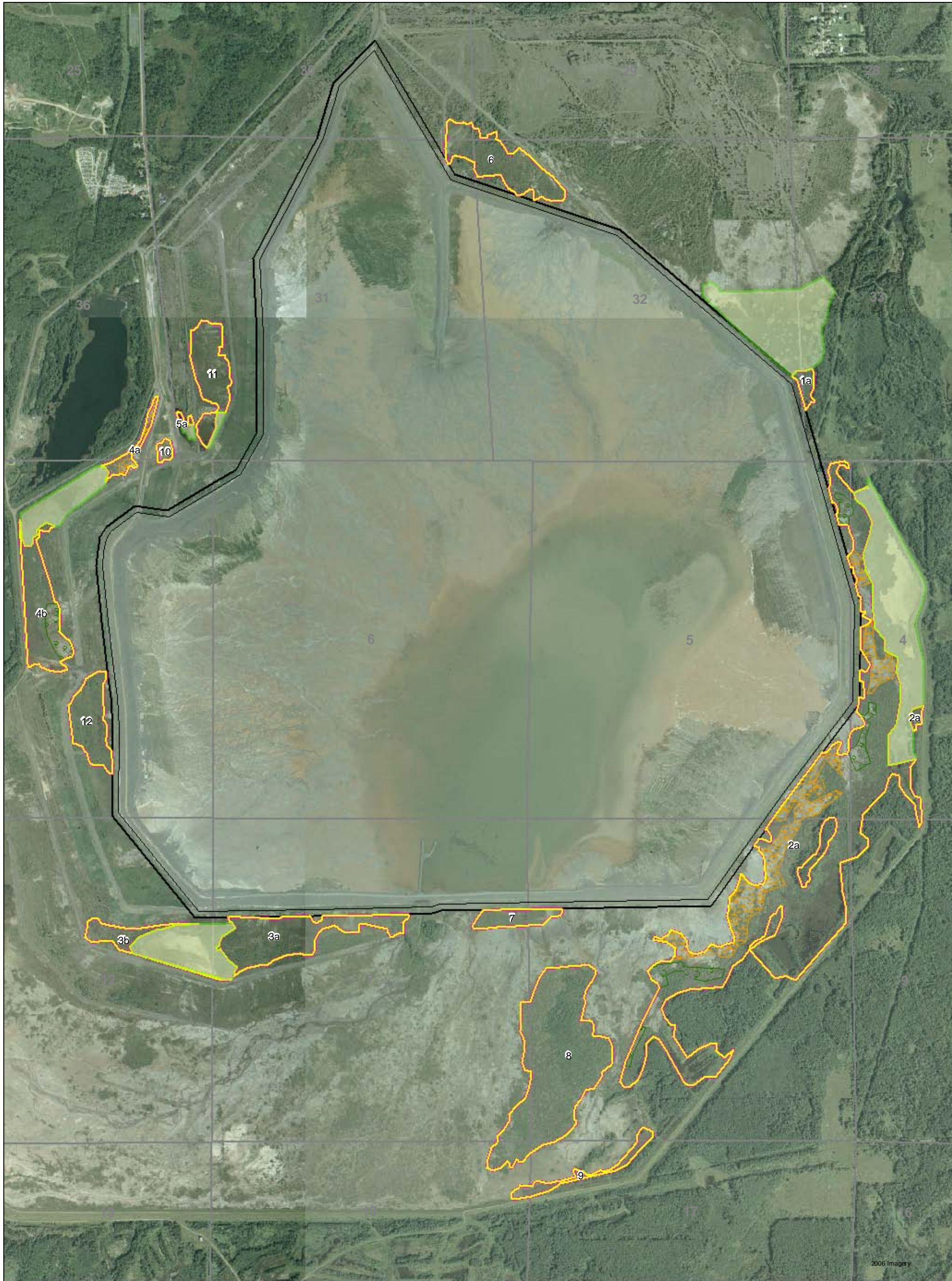


Figure 3
 2008 TAILINGS BASIN WETLAND MITIGATION
 SITES: PLANNED WETLAND PLANT
 COMMUNITIES
 Keetac Project
 US Steel Corp.
 Keewatin, Minnesota



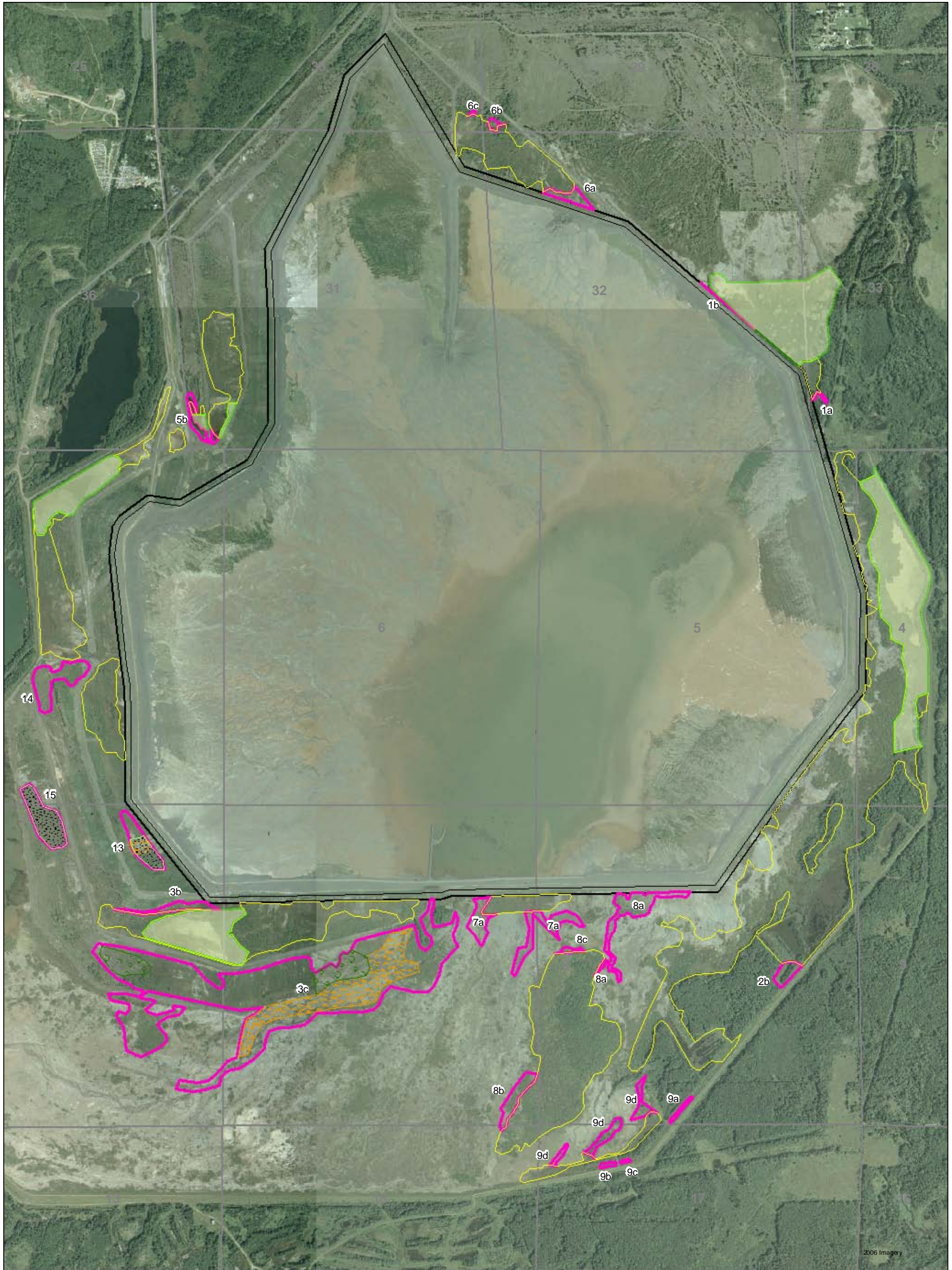
2006 FSA Imagery

-  2005 Wetland Mitigation Areas
-  Existing Wetland Mitigation Sites 2000
-  Existing Wetland Mitigation Sites 2005
-  Proposed 2010 Native Seeding Locations (40.5 ac.)
-  Proposed 2010 Shrub Planting (17.8 ac.)
-  Section Lines



Figure 4

2005 TAILINGS BASIN WETLANDS:
PROPOSED ENHANCEMENT
Keetac Project
US Steel Corp.
Keewatin, Minnesota



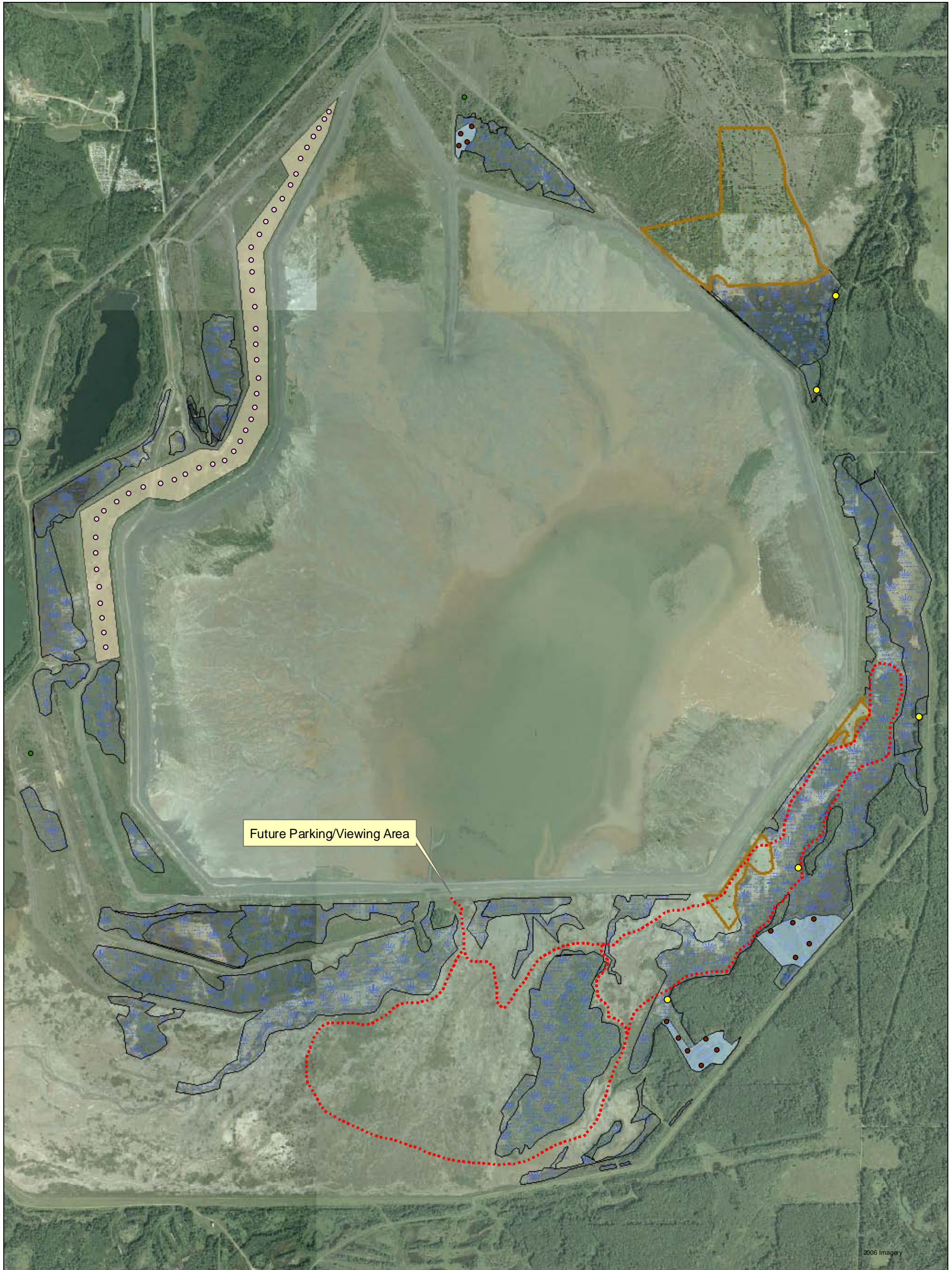
2006 FSA Imagery

- 2008 Wetland Mitigation Areas
- Wetland Mitigation Sites 2000
- Wetland Mitigation Sites 2005
- Proposed 2011 Native Seeding Locations (30.4 ac.)
- Proposed 2011 Speckled Alder Planting (11.7 ac.)
- Proposed 2011 Shrub Planting (12.8 ac.)
- Section Lines



Figure 5

2008 TAILINGS BASIN WETLANDS:
 PROPOSED ENHANCEMENT
 Keetac Project
 US Steel Corp.
 Keewatin, Minnesota



2006 Imagery

2006 FSA Imagery










-  Potential Native Aspen Forest/ Woodland Establishment/Management Area (108.1 ac.)
-  Grassland/Field Bird Habitat
-  Future Bluebird Nest Box (46)
-  Prime Wood Duck Habitat
-  Future Wood Duck Nesting Box (15)
-  Future Osprey Nesting Platform (2)
-  Future Owl Nest Box (4)
-  Future Enterpretive Hiking Trail
-  Created Wetland

Figure 6

POTENTIAL WILDLIFE ENHANCEMENT/
EDUCATION OPPORTUNITY
Keetac Project
US Steel Corp.
Keewatin, Minnesota



Appendices

Appendix A

Proposed Seeding and Planting Species

Table A-1
Wet Meadow Seed Mix
Tailings Basin Wetland Mitigation
U. S. Steel Keetac

Scientific Name	Common Name	Indicator Status	Seeds/ Ounce	Rate (lbs/ac)	% of Mixture
Grasses and Graminoids					
<i>Agrostis gigantea</i>	redtop grass	FACW	312,000	0.80	10.0
<i>Beckmannia syzigachne</i>	American sloughgrass	OBL	50,000	2.40	30.0
<i>Calamagrostis canadensis</i>	bluejoint grass	OBL	280,000	0.20	2.5
<i>Carex vulpinoidea</i>	brown fox sedge	OBL	100,000	0.56	7.0
<i>Glyceria canadensis</i>	rattlesnake mannagrass	OBL	74,000	0.16	2.0
<i>Juncus tenuis</i>	poverty rush	FAC	1,000,000	0.08	1.0
<i>Poa palustris</i>	fowl bluegrass	FACW+	130,000	2.16	27.0
<i>Scirpus cyperinus</i>	woolgrass	OBL	1,700,000	0.24	3.0
<i>Scirpus validus</i>	softstem bulrush	OBL	34,000	0.56	7.0
Forbs					
<i>Aster novae-angliae</i>	New England aster	FACW	60,000	0.040	0.50
<i>Eupatorium maculatum</i>	spotted joepeyweed	FACW-	95,000	0.024	0.30
<i>Eupatorium perfoliatum</i>	common boneset	FACW+	160,000	0.024	0.30
<i>Euthamia graminifolia</i>	flattop goldentop	FACW-	350,000	0.016	0.20
<i>Lycopus americanus</i>	American waterhorehound	OBL	130,000	0.040	0.50
<i>Solidago uliginosa</i>	bog goldenrod	OBL	44,000	0.056	0.7
<i>Iris versicolor</i>	iris blueflag	OBL	1,300	0.640	8.0
Total			840,300	8	100

Table A-2
 Shrub and Tree Planting Summary
 U. S. Steel Keetac

Scientific Name	Common Name	Indicator Status	Plant numbers/ ac.	Size	Tree/ Shrub Density	Method
<i>Alnus rugosa</i>	speckled alder	OBL	TBD	Seed	Final tree/shrub density will be approximately 10 ft. o.c. Placement to be directed by Wetland Scientist or Landscape Architect (~ 800 stems/acre)	Seeding
			120	1 gal pot		Live planting
<i>Salix</i> sp.	willow	FACW	325	cuttings		Staking
<i>Populus balsamifera</i>	balsam poplar	FACW	50	1 gal pot		Live planting
<i>Fraxinus nigra</i>	black ash	FACW+	50	1 gal pot		Live planting

Appendix B

Buckthorn Removal Guidelines

Buckthorn Removal Guidelines

Goal: Aid in the development of native plant communities within created wetlands by controlling and removing non-native invasive species.

Buckthorn belongs to the *Rhamnaceae* family. It is native to Europe and Asia, first appearing in the U.S. in the late 1700s. Buckthorn quickly naturalized in the woodlands of the northeastern states. Today buckthorn flourishes in the understory of Minnesota woodlands and in brushy thickets along roadsides and fields. It has become a major plant pest in natural woodlands and wetlands.

Buckthorn can grow to 15-20 feet and has dark green elliptical or oval leaves. In the fall its leaves without much color change, hanging on late into the season. It starts easily from seed and will tolerate almost any soil condition or location. In partial shade it will outstretch its neighbors toward the light.

Buckthorn removal is recommended for those areas where the native plant community is developing and where there is a high likelihood that the native plant community can be enhanced and restored.

Process

Buckthorn control is a long-term process requiring several steps. Pulling seedlings, cutting and removing mature plants, chemically treating stumps and replanting the site with native species are critical to the long-term success of restoration and enhancement efforts.

Mature plants should be cut and then the stumps chemically treated. A 20%-25% solution of glyphosate (Roundup) with a dye should be used to paint, chemically treat, and mark the stumps.

Recommended chronology of management/enhancement activities

Year one

- Seedlings pulled (September-November)
- Mature trees cut in late fall (October- December)
- Stumps chemically treated within two days of actual cutting
- Removal of brush to a chipping location (or pile on site for burning)

Year two

- Remove seedlings by hand pulling (June-November)
- Follow-up cutting by staff and/or volunteers in late fall (October- December) and chemically stump treat as necessary

Year three and beyond

- Continued monitoring and buckthorn seedling removal

Other removal techniques

Mechanical

- Prescribed fire for seedlings; prescribed burns in early spring and fall annually or biannually to control buckthorns may have to be continued for several years.

Chemical

- Cut-stump treatment with glyphosate; 20%-25% active ingredient cut-stump; or basal bark spray treatment around the stem with 25-50% a.i. triclopyr (Garlon) – consideration of worker safety issues will dictate chemical selection. Glyphosate products registered for wetland/aquatic use should be used within wetlands and are most effective in the fall.
- Fosamine, a non-selective bud inhibitor for woody species, can be applied as a basal bark treatment in the fall at 3% a.i. concentration during the growing season.

Appendix C

Draft Permanent Conservation Easement

_____(Above Space is Reserved for Recording Information)_____

**Minnesota Wetland Conservation Act
Declaration of Restrictions and Covenants for Site Specific Wetland Replacement**

Replacement Wetland Declarant: _____

General Location of Replacement: Sec. _____, Twp. _____, Rge. _____, County of _____

This Declaration of Restrictions and Covenants for Site Specific Wetland Replacement Wetland (Declaration) is made this _____ day of _____, _____ by the undersigned Declarant:

RECITALS

A. The Declarant holds the fee title or perpetual easement on the real property described in Exhibit A, attached hereto.

B. This real property is the site of a Replacement Wetland, as defined in Minnesota Rules 8420.0110, subp. 40. Exhibit B, attached hereto, is a map or survey of the subject Replacement Wetland.

C. The Declarant is seeking approval of (1) a replacement plan under Minnesota Statutes section 103G.222.

D. The Replacement Wetland is subject to the Wetland Conservation Act of 1991, as amended, Minnesota Statutes section 103G.222 et seq., and all other provisions of law that apply to wetlands, except that the exemptions in Minnesota Statutes section 103G.2241 do not apply to the Replacement Wetland, pursuant to Minnesota Rules 8420.0115.

E. The Local Government Unit (LGU) charged with approval of the Replacement Plan is _____, whose address is _____

F. All references in this instrument to Minnesota Statutes and Rules are to the Statutes and Rules currently in effect and as amended or renumbered in the future.

RESTRICTIONS AND COVENANTS

The Declarant makes the following declaration of restrictions and covenants for the Replacement Wetland. These restrictions and covenants shall run with the land, and bind Declarant, and Declarant's heirs, successors, and assigns:

1. The Declarant shall maintain a Replacement Wetland of the size and type specified in the replacement plan approved by the LGU and on file at the offices of the LGU. Declarant shall not make any use of the Replacement Wetland that would adversely affect the functions or values of the wetland as determined by Minnesota Rules 8420.0540, subp. 10, and as specified in the replacement plan.
2. Declarant shall pay the costs of maintenance, repairs, reconstruction, and replacement of the Replacement Wetland, which the LGU or the State of Minnesota through the Minnesota Board of Water and Soil Resources may deem necessary to comply with the specifications for the Replacement Wetland in the approved replacement plan.
3. Declarant grants to the LGU, the State of Minnesota, and the agents and employees of the LGU and the State of Minnesota, reasonable access to the Replacement Wetland for inspection, monitoring, and enforcement purposes. This Declaration grants no access to or entry on the lands described to the general public.
4. Declarant represents that he or she has a fee simple or easement interest in the land on which the Replacement Wetland is or will be located. Declarant represents that he or she has obtained the consent of all other parties who may have an interest in the land on which the Replacement Wetland is or will be located to the creation of the restrictions and covenants herein, and that, all such parties have agreed in writing to subordinate their interests to these restrictions and covenants, pursuant to the attached Consent and Subordination Agreement(s).
5. Declarant shall record or file this Declaration, pay all costs associated with recording or filing, and provide proof of recording or filing to the LGU. If this Declaration is given pursuant to a replacement plan, such proof shall be provided to the LGU before proceeding with construction of the Replacement Wetland.
6. Acknowledge that this Easement shall be unlimited in duration, without being re-recorded. This Easement shall be deemed to be a perpetual conservation easement pursuant to Minn. Stat. ch. 84C.
7. If the replacement plan approved by the LGU and on file at its offices requires the establishment of areas of native vegetative cover, the term "Replacement Wetland" as used in this Declaration shall also include the required areas of permanent vegetative cover, even if such areas are not wetlands. All provisions of this Declaration that apply to the Replacement Wetland shall apply equally to the required areas of native vegetative cover. In addition, the Declarant:

(a) Shall comply with the applicable requirements of Minnesota Rules 8420.0540, subpart 2.D;

(b) Shall, at Declarant's cost, establish and maintain permanent vegetative cover on areas specified in the replacement plan for native vegetative cover, including any necessary planting and replanting thereof, and other conservation practices, in accordance with the replacement plan;

(c) Shall not produce agricultural crops on the areas specified in the replacement plan;

(d) Shall not graze livestock on the areas specified in the replacement plan or;

(e) Shall not place any materials, substances, or other objects, nor erect or construct any type of structure, temporary or permanent, on the areas specified in the replacement plan, except as provided in the replacement plan;

(f) Shall, at Declarant's cost, be responsible for weed control by complying with noxious weed control laws and emergency control of pests necessary to protect the public health on the areas specified in the replacement plan; and

(g) Shall comply with any other requirements or restrictions specified in the replacement plan, including, but not limited to, haying, mowing, timber management or other vegetative alterations that do not enhance or would degrade the ecological functions and values of the replacement site.

8. This Declaration may be modified only by the joint written approval of the LGU and the State of Minnesota through the Minnesota Board of Water and Soil Resources. If the Replacement Wetland has been used to mitigate wetland losses under the Federal Water Pollution Control Act, the U.S. Army Corps of Engineers (or successor agency) must also agree to the modification in writing. Such modification may include the release of land contained in the legal description above, if it is determined that non-wetland areas have been encumbered by this Declaration, unless the approved replacement plan designates these non-wetland areas for establishment of permanent vegetative cover.

9. This Declaration may be enforced, at law or in equity, by the LGU, or by the State of Minnesota. The LGU and the State of Minnesota shall be entitled to recover an award of reasonable attorneys fees from Declarant in any action to enforce this Declaration. The right to enforce the terms of this Declaration is not waived or forfeited by any forbearance or failure to act on the part of the State or LGU. If the subject replacement area is to be used partially or wholly to fulfill permit requirements under the Federal Water Pollution Control Act or a federal farm program, then the provisions of this Declaration that run to the State or the LGU may also be enforced by the United States of America in a court of competent jurisdiction.

10. This Declaration must be recorded and proof of recording submitted to the LGU or other regulatory authority in order to be valid.

Signature of Declarant

Signature of Declarant

STATE OF MINNESOTA)

) ss.

COUNTY OF _____)

This instrument was acknowledged before me on _____ (date) by
_____ (name(s) of person(s)).

(Signature of Notarial Officer)

(Title)

My commission expires: _____

Attachments: [] Exhibit A (legal description)
 [] Exhibit B (map or survey of Replacement Wetland)

This instrument drafted by:

(Above Space is Reserved for Recording Information)

**PERPETUAL CONSERVATION EASEMENT
FOR WETLAND BANK**

Grantor:

Location: within Section , Township , Range , County of

This Perpetual Conservation Easement for Wetland Bank (“Easement”) is made on (date) by the undersigned, hereinafter referred to collectively as the “Grantor”:

RECITALS

A. This Easement is made pursuant to and in furtherance of the Wetland Conservation Act of 1991, as amended, Minn. Stat. §103G.222, *et. seq.* (“WCA”) and the rules implementing WCA, Minn. R. ch. 8420 (“WCA Rules”).

B. This Easement pertains all or part of the real property in _____ County, Minnesota, which is legally described on *Exhibit A* attached hereto and made a part hereof (“Real Property”).

C. The Real Property is the subject of a wetland bank plan pursuant to Minn. R.8420.0740.

D. The Grantors include all of the following (1) all the fee owners of the Real Property and (2) the applicants under the bank plan if different from the fee owners. The term “Grantor” includes all of the Grantors if there is more than one. The Grantors are jointly and severally responsible for complying with the terms of this instrument. This Easement and the duties and restrictions contained in it shall also run with the land.

E. WCA is administered by the State of Minnesota through its Board of Water and Soil Resources (“State”).

F. The local government unit (“LGU”) charged under WCA with approval of the subject wetland bank plan (“bank plan”) is . The subject bank plan includes all fully executed forms provided by the State, all supporting maps, engineering plans, drawings, monitoring plan, vegetation establishment plan and management plan and facilities maintenance plan. A complete copy of the bank plan is on file at the LGU. The address of the LGU is .The State is responsible for the acceptance of this Easement.

G. The bank plan requires the restoration or creation of a wetland on the portion of the Real Property designated in Exhibit B attached hereto and made a part hereof (“Bank Area”). The bank plan may also require the establishment of upland buffer within the Bank Area. This Easement pertains to both wetlands and uplands within the Bank Area.

H. The Bank Area is subject to WCA, WCA Rules and all other provisions of law that apply to wetlands, except that the exemptions in Minn. Stat. §103G.2241 and Minn. R. 8420.0122 do not apply to the Bank Area, pursuant to Minn. Stat. §103G.222, subd. 1(h) and Minn. R. 8420.0115.

I. All references in this Easement to Minnesota Statutes and to Minnesota Rules are to the statutes and rules currently in effect and as amended or renumbered in the future.

J. The purposes of this Easement are to maintain and improve the ecological values of the Bank Area through the means identified in the bank plan and to preserve the Bank Area in a natural condition in perpetuity.

IN ADDITION, THE GRANTORS, FOR THEMSELVES, THEIR HEIRS, SUCCESSORS AND ASSIGNS COVENANT THAT THEY:

1. Shall establish and maintain wetlands and upland buffers within the Bank Area as specified in the bank plan approved by the LGU and on file at the offices of the LGU. The wetland and any upland buffer area shall be the size and type specified in the bank plan. Grantor shall not make any use of the Bank Area that would adversely affect any of the functions or values of the area. Those functions and values are identified in Minn. R. 8420.0540, subp. 10, or specified in the approved bank plan.

2. Shall pay the costs of establishment, maintenance, repairs and reconstruction of the wetlands and upland buffers within the Bank Area, which the LGU or the State may deem necessary to comply with the specifications for the Bank Area in the approved bank plan. The Grantor’s obligations under this paragraph include the payment of any lawful taxes or assessments on the Real Property.

3. Shall establish and maintain visible monuments such as signs, numbered fence posts or survey posts at prominent locations along the boundary of the Bank Area in accordance with the approved bank plan. If numbered fence posts are used, Grantor’s Bank Plan must contain a survey or scaled drawing of the property that corresponds to the fence post numbering. Posts must be at least 4 feet high and notably visible on the landscape. If signs are used, such signs must have a surface area of at least one quarter (1/4) square feet, mounted on a fence post at least 4 feet above ground, and minimally contain the words “Boundary of Wetland Bank Area - Subject to Perpetual Conservation

Easement Restrictions – Contact MN Board of Water and Soil Resources or Local Soil and Water Conservation District for Further Information.” Said monuments must be made of non-degradable material and shall be at least four feet in height.

4. Grants to the LGU, the State, and the agents and employees of the LGU and the State, reasonable access to the Bank Area for inspection, monitoring and enforcement purposes. The LGU, the State, and the agents and employees of the State are hereby granted a perpetual ingress and egress easement ("Access Easement") for access to and from the Bank Area. The Access Easement shall be over and across the area ("Access Area") that is specified on Exhibit A attached hereto and made a part hereof or, if not specified on Exhibit A, the most reasonably direct and convenient route between the Bank Area and a public road. If all or any part of the Access Area is owned by a person or entity other than Grantor, then the owner has joined in this Easement for purposes of granting the Access Easement by signing below. The signed written consent and subordination of all other holders of interests in the Access Area has been or will be obtained by Grantor and recorded in the same manner as specified in paragraph 5 below. This Easement grants no access to or entry to the Real Property, the Bank Area, or the Access Area to the general public.

5. Represents that Grantor is (a) the fee owner of the Real Property and (b) the applicant under the replacement plan or bank plan, if different from the fee owner. Grantor represents that all other parties who may have an interest in the Real Property (e.g., mortgagees, contract for deed vendees, holders of easements, etc.) have consented and subordinated their interests to this Easement by signing below. If it is determined at any time that there is any other party who may have an interest in the Real Property that is prior to this Easement, then Grantor shall immediately obtain and record a consent and subordination agreement signed by such other party. Acceptance of this Easement does not release Grantor from the obligation to obtain and record a consent and subordination agreement signed by any party who may have an interest in the Real Property that is prior to this Easement, even if such interest was of record at the time of acceptance.

6. Will record this easement at Grantor's expense in the real property records of the county where the Real Property is located. Said recording shall take place within 30 days of the State's acceptance of this Easement. The Grantor shall provide the original copy of the recorded easement to the State prior to making any credits from this bank available for sale or use.

7. Acknowledge that this Easement shall be unlimited in duration, without being re-recorded. This Easement shall be deemed to be a perpetual conservation easement pursuant to Minn. Stat. ch. 84C.

8. Acknowledge that, unless expressly authorized in writing by the LGU in the approved bank plan, Grantor:

- (a) Shall not produce agricultural crops on the Bank Area, except that this provision does not restrict the harvest of the seeds of native vegetation if only the seed-head is removed in the process of harvest and does not involve the use vehicular, motorized equipment;
- (b) Shall not cut hay, mow vegetation or cut timber on the Bank Area except as allowed or prescribed in the Bank Plan;

- (c) Shall not make any vegetative alterations on the Bank Area that do not enhance or would degrade the ecological functions and values of the Bank Area. Vegetative alterations shall be limited to those listed in the approved bank plan;
- (d) Shall not graze livestock on the Bank Area;
- (e) Shall not place any materials, substances or other objects, nor erect or construct any type of structure, temporary or permanent, on the Bank Area.
- (f) Shall not allow vehicular traffic on the Bank Area except for the purpose of implementing construction or maintenance activities specifically authorized in the bank plan.
- (g) Shall not alter the topography of the Bank Area by any means including plowing, dredging, filling, mining or drilling.
- (h) Shall not modify the hydrology of the Bank Area in any way or by any means including pumping, draining, ditching, diking, impounding or diverting surface or ground water into or out of the Bank Area.

9. Acknowledge that the Grantor is responsible, at Grantor's cost, for weed control by complying with noxious weed control laws and emergency control of pests necessary to protect the public health on the Bank Area.

10. Acknowledge that this Easement may be modified only by the joint written approval of the LGU and the State. If the Bank Area has been used to mitigate wetland losses under the Federal Water Pollution Control Act, the U.S. Army Corps of Engineers (or successor agency) must also agree to the modification in writing.

11. Acknowledge that this Easement may be enforced, at law or in equity, by the LGU or the State. The LGU and the State shall be entitled to recover an award of reasonable attorney's fees from Grantor in any action to enforce this Easement. The right to enforce the terms of this Easement is not waived or forfeited by any forbearance or failure to act on the part of the State or LGU. If the subject Bank Area is to be used partially or wholly to fulfill permit requirements under the Federal Water Pollution Control Act or a federal farm program, then the provisions of this Easement that run to the State or the LGU may also be enforced by the United States of America in a court of competent jurisdiction.

12. Acknowledge that this Easement is not valid, nor can an account for wetland credits be established until the Easement has been accepted by the State, the Grantor has recorded this Easement and the State has received evidence of such recording.

SIGNATURE OF GRANTOR

SIGNATURE OF FEE OWNER(S):

STATE OF MINNESOTA)
) ss.
COUNTY OF _____)

This instrument was acknowledged before me this _____ day of _____, by
(name(s) with marital status).

Notarial Stamp or Seal

Notary Public

**SIGNATURE OF BANK APPLICANT (S),
IF DIFFERENT FROM FEE OWNER:**

STATE OF MINNESOTA)
) ss.
COUNTY OF _____)

This instrument was acknowledged before me this _____ day of _____, by
(name(s) with marital status).

Notarial Stamp or Seal

Notary Public

ACCEPTANCE

The State accepts the foregoing Easement.

MINNESOTA BOARD OF WATER AND SOIL RESOURCES:

By: _____

Its: _____

STATE OF MINNESOTA)
) ss.
COUNTY OF _____)

This instrument was acknowledged before me this _____ day of _____, _____ by _____ (name of person) as _____ (title) of the Board of Water and Soil Resources.

Notary Public

Notarial Stamp or Seal

This instrument was drafted by the Board of Water and Soil Resources
One West Water Street, St. Paul, MN 55107

If there are additional holders of interest the subject real property CHECK HERE and attach their Consent and Subordination agreement [BWSR Form Number: wca-bank-03 (consent).doc].

EXHIBIT A
Legal Description of Real Property

EXHIBIT B

Map or Survey of Bank Area

Appendix D

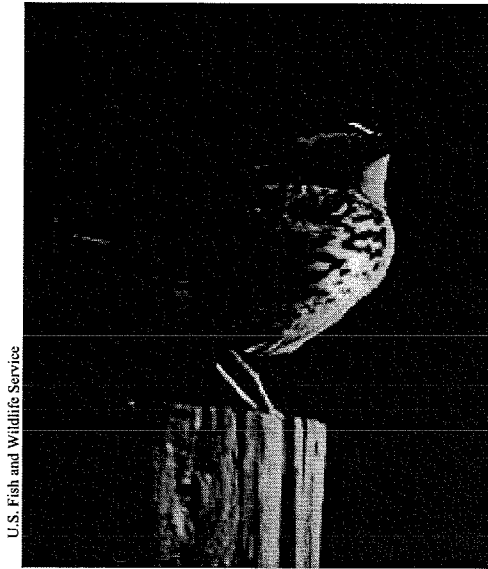
Wildlife Enhancement Information

Grassland Birds

October 1999

Fish and Wildlife Habitat Management Leaflet

Number 8



U.S. Fish and Wildlife Service

Western meadowlark

General Information

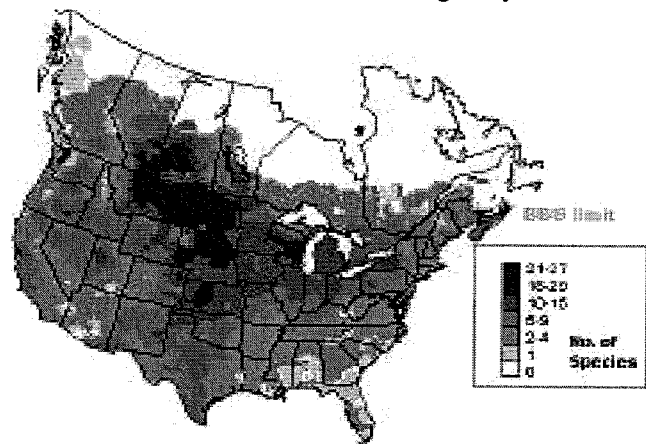
Grassland birds, or those birds that rely on grassland habitats for nesting, are found in each of the 50 United States and worldwide. Various species of waterfowl, raptors, shorebirds, upland gamebirds and songbirds rely on grasslands for nesting and other habitat functions. Historical population fluctuations in grassland-nesting bird species have coincided with changes in land uses and agricultural practices. Many North American grassland-nesting birds species have experienced marked population reductions in recent decades. Continued nationwide declines in some grassland-nesting bird species have increased awareness for the need to preserve, manage, and restore grassland habitat in order to recover and maintain viable grassland-nesting bird populations.

This leaflet is designed to serve as an introduction to the habitat requirements of grassland birds and to assist landowners and managers in developing comprehensive grassland bird management plans for their properties. The success of grassland bird management in a given

area requires that managers consider the present habitat conditions in the area and the surrounding landscape and identify management actions to enhance habitat quality for local grassland birds.

Grasslands of the United States

Native grasslands in the United States have experienced many changes since the arrival of Europeans to North America. There is little doubt that the predominately forested northeastern United States originally contained parcels of open grasslands, including those cleared by native Americans. These grassland areas undoubtedly supported populations of grassland birds. By the 1800s, grasslands were widespread in the northeast due to the forest clearing activity of European settlers to create pastures and hayfields. The establishment of these agricultural grasslands was associated with increases in some grassland bird species populations. In the Midwest and Great Plains regions, settlers found vast expanses of native grassland that had covered much of the landscape. Most of these grasslands were converted to agricultural fields and livestock pastures in the late 1800's and early 1900's as farmsteads and European settlement expanded westward.



Breeding Range of 27 grassland birds. Species include upland sandpiper, long-billed curlew, mountain plover, greater prairie-chicken, sharp-tailed grouse, ring-necked pheasant, northern harrier, ferruginous hawk, common barn-owl, short-eared owl, horned lark, bobolink, eastern meadowlark, western meadowlark, chestnut-collared longspur, McCown's longspur, vesper sparrow, savannah sparrow, Baird's sparrow, grasshopper sparrow, Henslow's sparrow, Le conte's sparrow, Cassin's sparrow, dickcissel, lark bunting, Sprague's pipit, and sedge wren.

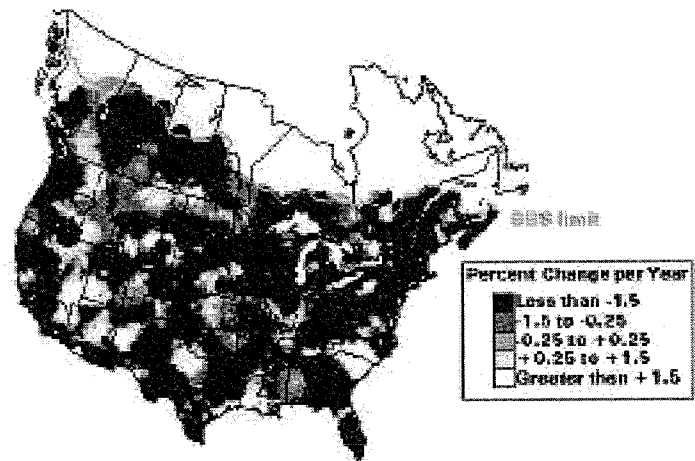
The 1900s also brought major changes to the character of grasslands in both eastern and midwestern/Great Plains regions. Changes in agricultural practices with the advancement of modern machinery and an increasing demand for agricultural products continued to reduce native grassland acreage in the west. Plowing of fields, removal of native grazers (bison), loss of wetlands, implementation of plantation forestry practices, and invasion of woody vegetation resulting from fire suppression have all contributed to significant losses of native grassland habitats. As farms moved westward, many once-large expanses of eastern grasslands became fragmented and began to disappear as idle farmland reverted back to old field and second-growth forest. Development of large farming operations in the Midwest and Great Plains has significantly changed the composition of grasslands; intensively managed crop fields and improved pastures have largely displaced native grasslands on most of the agricultural landscape. In the Midwest, pasture and hayland is also being replaced by more intensively-managed row crops. On the high plains and other areas of the west, a larger percentage of the landscape remains grassland habitat. Many of these rangelands are used extensively for grazing livestock.

Declines in Grassland Bird Populations

Breeding Bird Surveys (BBS) conducted by the Biological Resources Division of the U.S. Geological Survey and volunteers throughout the country reveal that grassland birds, as a group, have declined more than other groups, such as forest and wetland birds. There are many examples of population decline in grassland birds, most notably the extinction of the heath hen from the northeastern United States. Over the 25-year period 1966-1991, New England upland sandpiper and eastern meadowlark populations declined by 84 and 97 percent, respectively. The greater prairie-chicken has experienced an average annual rate of decline of over 10 percent during this same 25-year period. These examples and others illustrate the decline in grassland birds on a continental scale.

The figure at the right illustrates how widespread the decline in grassland birds has been in recent decades. Only 23 percent of the species tracked showed an average annual positive trend in population size, while the remainder either had no change or declined. As the figure illustrates, most areas have experienced long-term declines in grassland bird populations.

While loss of grassland breeding habitat is likely the largest factor contributing to the decline in many grassland bird species, other factors have played a role. Brood parasitism by brown-headed cowbirds, increased use of pesticides and other agricultural chemicals toxic to birds, mortality during migration, and loss of wintering habitats may have contributed to population declines in many species.



Average annual population changes in 28 grassland bird species from 1966 to 1996.

Habitat Requirements

General

Each grassland-nesting bird species has a unique set of habitat requirements. Table 1 illustrates some of the habitat preferences of many grassland-nesting bird species. While there are similarities among many species habitat requirements, habitat management to meet the specific needs of one species may or may not benefit other species. It is beyond the scope of this leaflet to identify detailed habitat requirements for each individual grassland-nesting bird species inhabiting various regions throughout the United States. However, generalizations can be made for the grassland-nesting bird habitat guild, and broad concepts can be addressed and considered in developing habitat management plans for grassland-nesting birds.

Grassland birds are naturally adapted to native grasslands and prairie ecosystems throughout North America. While these communities offer some of the highest quality nesting habitats, they are now extremely rare, especially east of the Great Plains. Fortunately, many grassland birds do not require native vegetation for breeding habitat. "Surrogate grasslands" on agricultural landscapes, in the form of hayfields, small grains, fallow and old fields, pastures, and idled croplands provide most of the important nesting habitats for grassland-nesting birds. Strip habitats such as right-of ways for utility lines, highways, railroads, and secondary roads; and field borders, grassed waterways, filter strips and similar linear habitats maintained in early successional communities provide valuable nesting and foraging habitats as well. On landscapes where intensive row crop agriculture is the dominant land use, these strip habitats are extremely important habitats for grassland birds and other wildlife. Grassland bird assemblages vary with the physical habitat structure, disturbance patterns and other factors. For each species or group of species, these habitats provide protective cover for nesting and brood-rearing activities. Adequate cover of undisturbed grassland is among the greatest factors affecting grassland bird populations, and the continued loss and conversion of grassland breeding and nesting habitat remains the largest threat to the future of many grassland bird species. Preserving and properly managing grassland communities can help maintain and increase local grassland bird populations, as well as populations of other wildlife species that use these habitats.

Food Resources

The foods eaten by grassland birds are as diverse as the types of birds that inhabit grassland ecosystems. While insects are likely the most common food source, a wide variety of plant and animal matter is consumed. The box below lists some of the many food items of grassland birds.

Important grassland-nesting bird food items.

Insects and other invertebrates: grasshoppers, crickets, beetles, dragonflies, caterpillars, ants, katydids, alfalfa weevils, cutworms, wasps, spiders, snails, earthworms, sow bugs, others.

Raptor prey items: mice, gophers, voles, shrews, moles, prairie dogs, rabbits, snakes, lizards, songbirds, others.

Fruits, seeds and cultivated crops: wild berries, seeds of sedges, weed seeds, tame grass seeds, corn, oats, wheat, barley, other small grains

Native grass seeds: big bluestem, little bluestem, switchgrass, Indiangrass, green needlegrass, western wheatgrass, side-oats grama.

Table 1. Habitat preferences of common grassland nesting birds.

Species	Preferred grassland growth form			Avoids woody vegetation ¹
	Short	Med.	Tall	
Upland Sandpiper	X	X		X
Long-billed Curlew	X			
Mountain Plover	X			
Greater Prairie-chicken	X	X		X
Sharp-tailed Grouse	X			
Ring-necked pheasant		X	X	
Northern Harrier			X	X
Ferruginous Hawk	X	X		
Common Barn Owl	X	X	X	X
Short-eared Owl		X		X
Horned Lark	X			X
Sedge Wren			X	
Sprague's Pipit		X		
Bobolink		X		X
Eastern Meadowlark		X		
Western Meadowlark	X			X
Chestnut-collared longspur	X	X		
McCown's longspur	X			
Vesper Sparrow	X			
Savannah Sparrow	X	X		X
Baird's Sparrow		X	X	
Grasshopper Sparrow	X			X
Henslow's Sparrow		X	X	X
Le Conte's sparrow			X	X
Dickcissel		X	X	
Lark Bunting	X	X		

¹ While species marked avoid areas with woody vegetation, most can tolerate some woody vegetation within areas dominated by grassland.

The Importance of Grassland Cover

While all grassland birds rely on herbaceous cover for nesting or foraging, there are many differences in cover requirements among individual species and groups of species. In addition, some species are area-sensitive, requiring large blocks of unbroken grassland habitat for nesting (see minimum habitat area section below). Some species, such as the barn owl, require woody vegetation or other non-grassland structures in which to nest (e.g., tree cavities or nest boxes), while the presence of woody vegetation can be detrimental to other species. Some species require the presence of nearby water or wetlands. Both the vegetation density and growth form – short, medium height, or tall grass – as well as surrounding land use also influences the assemblage of birds that may occur in a given area. In general, where large blocks of undisturbed grassland occur, grassland birds are able to fulfill most courtship, nesting, brood-rearing, feeding, escape, and loafing cover requirements during the nesting season. For many bird species, these habitats provide winter and migration cover as well.



Grasslands in eastern North America provide habitat for grassland-nesting birds within a predominantly forested landscape.

In agricultural landscapes, pastures and crop fields provide cover attractive to many grassland birds. However, in many situations, cultural practices and harvesting operations may destroy nests and adults that attempt to nest in these areas. Although these impacts are unavoidable in many instances, measures discussed in this leaflet can be taken to minimize impacts to nesting birds during field operations.

Landscape Factors

Habitat value for grassland birds is greatly affected by the condition of the landscape in the area and surrounding land uses. Small, isolated parcels of grasslands in landscapes that are heavily wooded have limited potential to support grassland birds. On the other hand, blocks of grassland habitat that occur within landscapes dominated by open grass cover are much more likely to attract and support grassland birds. Interspersion of various types of grassland can maximize habitat quality for some species. However, interspersion of grassland habitat with woody vegetation and other land uses that fragment grassland habitats may be detrimental. Some area-sensitive obligate grassland species (and also some habitat specialists) require large unbroken blocks of grassland habitat with little or no interspersion with other habitat types. For this reason, it is crucial to consider landowner objectives, local landscape features and management potential, and area-wide population goals of target grassland species in the area when planning management actions for grassland birds. Consultation with state and Federal wildlife agencies and review of established grassland bird priorities for the region (e.g., Partners in Flight Bird Conservation Plans – see www.partnersinflight.org) can assist in this process.

The greater the variety of grassland growth forms available and successional growth stages that occur within grassland landscapes, the greater the number of grassland bird species they can support. In addition, the more grassland that is available in an area, particularly in large unbroken blocks, the greater the number of area-sensitive grassland birds the area is able to support.

Area-sensitivity and Minimum Habitat Area

Many “area-sensitive” grassland bird species require a certain amount of habitat to be present, usually in contiguous patches or unbroken blocks, before individuals will use a given site. Estimates of the minimum size of suitable nesting and breeding habitat required to support breeding populations of grassland birds vary greatly among species. Species-specific area requirements may also vary among geographic regions and landscape characteristics. For example, the size of habitat patches needed to attract individuals of a given species may be smaller in landscapes that contain a large amount of grassland and open habitats compared to areas with little grassland habitat.

In order to support an array of grassland-nesting bird species within an area, contiguous grassland blocks of at least 500 acres provide the greatest potential. However, smaller grassland blocks provide viable habitat patches for many grassland bird species. A general rule may be to maximize the size and interconnectedness of grassland habitat patches available, while conducting management actions that maximize the habitat quality within these habitat patches.

Grassland and Rangeland Management for Grassland Birds

Grassland bird habitats in existing grasslands, whether unbroken native prairie, retired farmlands, improved pasture, or other grassland systems, can be maintained and improved through various management actions.

Rotational mowing: Rotational mowing can be used to maintain grassland communities in various stages of growth and vegetation diversity. This management practice is conducted by dividing an area into 15 to 25-foot wide strips (depending on the area's size) that are separated from one another by 50 to 85 feet (see Fig. 1). Wider strips can be established to provide larger habitat blocks as well. A single strip is mowed to a height of four to eight inches either once or twice a year depending on the species of grassland-nesting birds present in the area. Smaller areas can be divided into three strips; mow one strip in early spring (mid-March to mid-April, depending on the region) before grassland birds commence nesting activities, and again in late summer after nesting activities are completed. The following year, the second strip would be mowed in the same months. The third strip would be mowed in year three, and the process begins again in year four. Larger areas evenly divided into six or more strips can be rotationally mown in pairs, so that strip one is worked with strip three, strip two with strip four, strip three with strip six, and so forth. Note: Landowners should work closely with local NRCS field officers, state department of natural resource officers, and other wildlife professionals when planning grassland management to determine mowing dates and techniques that minimize impacts to nesting birds. Knowing the types and habits of species for which an area is managed will also help to determine whether or not residual cover should be provided for nesting birds, and thus whether or not the area should be mowed a second time within the same year in late fall.

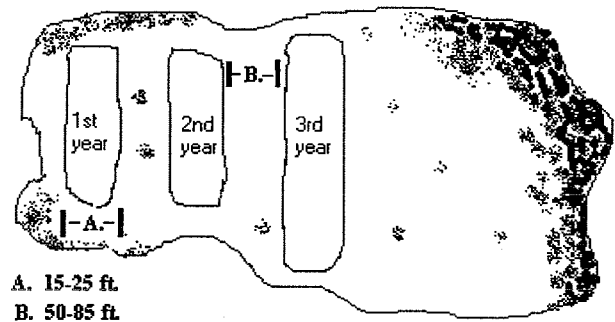


Fig. 1. Rotational mowing configuration to provide various grassland growth forms for grassland birds.

Prescribed grazing: Rotational, deferred, or continuous grazing can be conducted to benefit both forage quality and grassland bird habitat. Grazing by bison in the west was once a natural means of grassland management, and grassland birds may benefit today from controlled livestock grazing in many areas. Depending on the region, grassland composition, and the bird species managed for, grazing types and practices may vary. Rangelands can be maintained in good condition, providing quality forage and suitable grassland bird habitat for many species by one or more of the following measures:

- Provide 30 to 50 days of rest between grazing periods in each paddock .
- Defer grazing in some nesting areas until late in the nesting season.
- Restrict livestock from sensitive nesting areas.
- Graze the entire pasture at a light rate (allowing grass height to be maintained at least 10 inches tall) all summer and put the entire herd on just one half of the pasture during the late season.



- Avoid heavy continuous grazing.
- Rotationally graze cool season grasses in spring and fall and warm season grasses in mid-summer to maximize productivity while minimizing habitat disturbance.

Prescribed burning: Prescribed burning is used to maintain grassland communities in various stages of growth and vegetation diversity similar to rotational mowing and managed grazing. Burning returns valuable nutrients to the soil and maintains grasslands as open habitat, thus preventing conversion of grasslands to wooded communities through invasion or natural plant succession. Most native grasslands benefit from fire. The suppression of natural wildfires in the United States has reduced the quality of many remaining grassland communities. Although beneficial, prescribed burning is a highly regulated technique and should only be conducted in compliance with all state and local laws and with appropriate technical assistance. Agencies and qualified individuals can help develop burn plans and provide necessary tools, equipment, and supervision, and can assist in obtaining required burning permits. Prescribed burns should be conducted on a three- to five-year rotational basis, but shorter rotations may be used to benefit some species. Most prescribed burning should be done in the early spring (March-April, depending on the region), but late-summer and fall burns may also be appropriate in some circumstances. Dividing the burn area into strips or plots is important in order to leave undisturbed nesting habitat adjacent to burned plots. Adequate firebreaks should be planned for prescribed burn areas.

Woody vegetation removal: In areas managed for birds that are intolerant of woody vegetation, grassland management through prescribed burning, mowing and grazing can help maintain grassland habitats. Manual removal of trees and shrubs may be necessary where these practices have not been conducted or where scattered trees and shrubs become established in odd areas. However, some species of grassland birds are benefited by scattered trees, shrubs, and woody fencerows (e.g., loggerhead shrike, Bell's vireo, field sparrow, clay-colored sparrow, and vesper sparrow, as well as savanna birds such as red-headed woodpecker and orchard oriole). In addition, in some areas, birds that use scrub habitats (e.g., yellow-breasted chat, indigo bunting) may be in greater decline than grassland birds, making maintenance of some scrub habitats (non-forest) a priority. Linear woody cover that fragments large blocks of grassland habitat may be more detrimental to grassland birds than scattered patches, due to their use as travel corridors by nest predators. Landowners and managers should carefully consider bird species habitat objectives before proceeding with woody vegetation removal actions.

Cropland Management for Grassland Birds

Hay fields: Ideally, hay mowing activities should be delayed until mid-July or early August to allow grassland birds to complete most nesting activities. However, in many instances this is not feasible for farmers who need to harvest high quality forage. In these circumstances, birds may be drawn to nest in the cover provided by the hay crop only to lose the nest or be killed by hay mowing operations. However, the following measures can be taken to minimize impacts on birds nesting in production hay fields.

- 1) Hay fields should be mowed from the field center outward to provide cover that allows fledgling birds to escape to the edge of the field (see Fig. 2).
- 2) Fields can be broken into sub-units and mowed on a rotational basis to allow for some useable habitat to be available at all times.
- 3) Adult nesting birds and roosting individuals are less likely to flush from cover during the night. Therefore, night mowing should be avoided to prevent adult bird mortality.
- 4) Flushing bars should be mounted on harvesting equipment to minimize bird mortality during mowing operations.

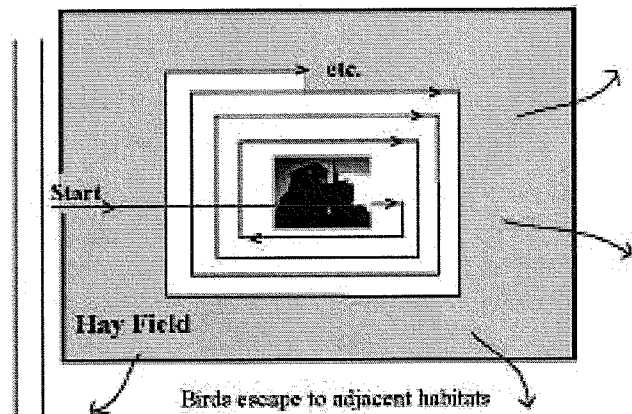


Fig. 2. Hay fields should be mowed from the center outward to allow birds to escape to adjacent habitats.

- 5) Strip cover and similar herbaceous cover should be left undisturbed until well after the nesting season (mid to late August) to allow birds that failed to successfully nest in active hayfields the opportunity to successfully re-nest in these alternative adjacent habitats.

Small grains and row crops: Small grain and row crop fields provide surrogate grassland habitat structure for some grassland birds. While some species nest in conventionally-tilled row crop fields (see Table 2), nest success is generally low due to the frequency of disturbance during the nesting season. Small grain fields, which are typically harvested later in the nesting season, provide more productive nesting habitats for some species. Measures can be taken to improve grassland bird habitat quality in crop fields and to minimize impacts to nesting birds.

- 1) Use no-till practices to provide residual nesting cover and waste grain availability for winter food.
- 2) Minimize the number of equipment passes through conservation tillage practices. Allow 35 to 40 days if possible between equipment passes to allow for complete nesting cycles.
- 3) Use contour buffer strips and strip cropping practices to provide some undisturbed habitat adjacent to crop fields that are disturbed by equipment passes.
- 4) Reduce the use of pesticides and inorganic fertilizers through Integrated Pest Management practices.
- 5) Explore use of alternative crops and cropping practices such as native grass biomass crops and inter-cropping practices.
- 6) Make use of set-aside programs that idle sensitive cropland and establish and maintain high-quality cover consisting of a diversity of native grasses and forbs.

Table 2. Bird species found to nest in conventionally-tilled (T) and no-till (NT) corn and soybean fields¹ (from Best 1986).

Species	Corn		Soybeans	
	T	NT	T	NT
Ring-necked pheasant		x	x	x
Killdeer	x	x		
Mourning dove	x	x	x	x
Horned lark	x		x	
American robin		x		
Common yellowthroat		x		
Bobolink		x		
Eastern meadowlark		x		
Western meadowlark		x		x
Red-winged blackbird	x	x		
Brown-headed cowbird	x	x	x	x
Dickcissel		x	x	
Savannah sparrow		x		
Grasshopper sparrow		x		
Vesper sparrow	x	x	x	x
Field sparrow		x		x

¹ Some NT fields were pastures treated with a burn-down herbicide.

Grassland-nesting Birds Habitat Requirements Summary Table.

Habitat Component	Habitat Requirements
General	<ul style="list-style-type: none"> • Grasslands, crop/grassland/forb-mixed communities, prairies, meadows, hayfields, grazed pastures and rangelands, reverted agricultural fields, idle pastures and old fields, utility and roadway right-of-ways and other strip habitats, coastal grasslands, and other open herbaceous habitats.
Food	<ul style="list-style-type: none"> • Insects and other invertebrates • Fruits, seeds and cultivated crops: wild berries, weed seeds, exotic grass seeds, seeds of sedges, corn, oats, wheat, barley, other small grain crops • Native grasses seeds: big bluestem, little bluestem, switchgrass, Indiangrass, green needlegrass, western wheatgrass, side-oats grama
Interspersion – grassland obligate species	<ul style="list-style-type: none"> • Mixture of short, medium, and tall grass areas in large, unbroken grassland blocks with less than 5% woody vegetation cover. Native grasses provide optimal conditions, but introduced cool season grasses may also provide suitable habitats for many grassland birds.
Interspersion – species requiring woody vegetation	<ul style="list-style-type: none"> • Grassland communities adjacent to woodlands, savannas, wetlands, shrubland, old field communities, overgrown fencerows and shelterbelts. Individual bird species requirements must be considered in determining woody vegetation requirements.
Minimum Habitat Size	<ul style="list-style-type: none"> • Minimum size of suitable nesting and breeding habitat required to support a breeding population of grassland birds varies among species. Depending on species habitat objectives, minimum habitat size may range from as little as 10 acres to as much as 500 acres or more. For grassland bird management, at least 40 acres of grassland should be available unless adjacent to larger grass habitat blocks.

Habitat Inventory and Assessment

Managing habitats for grassland birds relies on assessing the management potential of each area within the surrounding landscape and deciding which species or groups of grassland birds should be targeted. For planning purposes, use the table below to inventory the site to subjectively rate the availability, quality, and potential of grasslands and surrounding habitats, as well as their proximity to one another, based on the above narrative habitat requirement descriptions. Keep in mind that site conditions may provide good habitat conditions for some species and poor habitat for others. For example, habitat quality for species that rely on large unbroken expanses of grassland such as the northern harrier, greater prairie chicken, upland sandpiper, and grasshopper sparrow may be limited in areas with high interspersions with woody habitat types. However, species that tolerate or require some woody vegetation such as the eastern bluebird, loggerhead shrike and field sparrow benefit from high interspersions among grassland and woody habitat types. Therefore, grassland bird community objectives must be considered in determining limiting factors and management objectives for an area.

Habitat Component	Availability/Quality/Potential			
	High	Medium	Low	Absent
Nesting cover:				
Short grass nesting species				
Medium grass height nesting species				
Tall grass nesting species				
Food				
Diversity of surrounding habitat				
Interspersion:				
Large grassland blocks available (circle one)	>250 ac.	25-250 ac.	<25 ac.	
Grassland fragmented by forest/other land uses				

Management Prescriptions

Management treatments should be designed to match the planning area with grassland bird habitat conditions and objectives for the local landscape and address the habitat components that are determined to be limiting habitat potential for the target grassland bird species. For planning purposes, select among the possible action items listed below to raise the quality or availability of each habitat component determined to be limiting. NRCS Conservation Practices and various programs that may provide financial or technical assistance to carry out specific management practices are listed where applicable.



Savannah sparrow

Habitat Component	Management options for increasing Habitat quality or availability	Cons. Practices & Assistance Programs
Food	<ul style="list-style-type: none"> Preserve and maintain grassland/forb communities by conducting prescribed burning, rotational mowing, and prescribed grazing (especially during drought) when and where appropriate. Encourage a forb component in grasslands. 	327, 338, 528A, 645, 647 WHIP, EQIP, PFW, CRP
	<ul style="list-style-type: none"> Plant native warm season grasses adapted to the site such as big bluestem, little bluestem, switchgrass, eastern gama, and Indiangrass, and native cool season grasses such as green needlegrass, western wheatgrass, and side-oats grama. 	327, 390, 643, 645, 647 WHIP, EQIP, PFW, CRP
	<ul style="list-style-type: none"> In areas where fragmentation of large grassland blocks is not a concern, preserve overgrown fence-, tree-, and establish hedgerows that provide a diversity of plant and insect life and wild fruits and seeds. 	380, 391, 422, 650 WHIP
	<ul style="list-style-type: none"> Leave waste corn, oats, wheat, barley, rye, sorghum, and other small grain crops on ground after harvest activities. Avoid fall tillage. 	329
	<ul style="list-style-type: none"> Limit herbicide and insecticide use on range- and other grasslands to small areas or use mechanical means so as to reduce reduction of forbs, invertebrates (insects), or mast (seeds) used as food. 	329
Nesting cover	<ul style="list-style-type: none"> Preserve and maintain grassland/forb communities by conducting prescribed burning, rotational mowing, and prescribed grazing (especially during drought) when and where appropriate. Encourage a forb component in grasslands. 	327, 338, 528A, 645, 647 WHIP, EQIP, PFW, CRP
	<ul style="list-style-type: none"> Plant native warm season grasses adapted to the site such as big bluestem, little bluestem, switchgrass, eastern gama, and Indiangrass, and native cool season grasses such as green needlegrass, western wheatgrass, and side-oats grama. 	327, 390, 643, 645, 647 WHIP, EQIP, PFW, CRP
	<ul style="list-style-type: none"> Restore hydrology and vegetation in herbaceous wetlands and establish adjacent grassland buffers 	657 PFW, WRP
	<ul style="list-style-type: none"> Establish field borders, hedgerows, shelterbelts, and other habitat corridors on agricultural land (may harm some area-sensitive species while benefiting other species). This can conflict with management for open grassland species by fragmenting open grassland; the exception may be in row crop-dominated systems. 	380, 386, 390, 391, 422 WHIP, EQIP, PFW, CRP
	<ul style="list-style-type: none"> Conduct haying activities in a manner that minimizes bird mortality and allows for some nesting success where feasible. 	
	<ul style="list-style-type: none"> Reduce herbicide use when application results in loss of nesting and winter cover provided by grasses and forbs. 	
Interspersion & minimum habitat size	<ul style="list-style-type: none"> Combine above prescriptions to increase interspersion of habitat components or amount of suitable grassland bird habitat. Provide large (500 acres if possible), diverse grassland blocks or connect smaller grassland blocks with adjacent grassland areas. 	

NRCS Conservation Practices that may be useful in undertaking the above management actions.

Conservation Practice	Code	Conservation Practice	Code
Conservation Cover	327	Hedgerow Planting	422
Residue Management	329	Prescribed Grazing	528A
Prescribed Burning	338	Restoration of Declining Habitats	643
Windbreak/Shelterbelt Establishment	380	Upland Wildlife Habitat Management	645
Field Border	386	Early Successional Habitat Development	647
Riparian Herbaceous Cover	390	Windbreak/Shelterbelt Renovation	650
Riparian Forest Buffer	391A	Wetland Restoration	657

Available Assistance

Landowners interested in making their individual efforts more valuable to the community can work with WHC and NRCS to involve school, scout, and community groups and their families in habitat projects when possible. On-site education programs demonstrating the necessity of grassland-nesting bird habitat management can greatly increase the value of your individual management project as well. Corporate-owned land should encourage interested employees to become involved. Involving federal, state and non-profit conservation agencies and organizations in the planning and operation of a grassland-nesting bird management plan can greatly improve the project's success. Assistance programs available through various sources are listed below.

Programs that provide technical and financial assistance to develop habitat on private lands.

Program	Land Eligibility	Type of Assistance	Contact
Conservation Reserve Program (CRP)	Highly erodible land, wetland, and certain other lands with cropping history. Stream-side areas in pasture land	50% cost-share for establishing permanent cover and conservation practices, and annual rental payments for land enrolled in 10 to 15-year contracts. Additional financial incentives are available for some practices	NRCS or FSA State or local Office
Environmental Quality Incentives Program (EQIP)	Cropland, range, grazing land & other agricultural land in need of treatment	Up to 75% cost-share for conservation practices in accordance with 5 to 10-year contracts. Incentive payments for certain management practices	NRCS State or local Office
Partners for Fish and Wildlife Program (PFW)	Most degraded fish and/or wildlife habitat	Up to 100% financial and technical assistance to restore wildlife habitat under minimum 10-year cooperative agreements	Local office of the U.S. Fish and Wildlife Service
Waterways for Wildlife	Private land	Technical and program development assistance to coalesce habitat efforts of corporations and private landowners to meet common watershed level goals	Wildlife Habitat Council (301-588-8994)
Wetlands Reserve Program (WRP)	Previously degraded wetland and adjacent upland buffer, with limited amount of natural wetland, and existing or restorable riparian areas.	75% cost-share for wetland restoration under 10-year contracts and 30-year easements, and 100% cost share on restoration under permanent easements. Payments for purchase of 30-year or permanent conservation easements.	NRCS State or local Office
Wildlife at Work	Corporate land	Technical assistance on developing habitat projects into a program that will allow companies to involve employees and the community	Wildlife Habitat Council (301-588-8994)
Wildlife Habitat Incentives Program (WHIP)	High-priority fish and wildlife habitats	Up to 75% cost-share for conservation practices under 5 to 10-year contracts	NRCS State or local Office
State fish and wildlife agencies and private groups such as Pheasants Forever and Prairie Grouse Technical Council may have assistance programs or other useful tools in your state.			State or local contacts

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In cooperation with partners, the mission of the Wildlife Habitat Management Institute is to develop and disseminate scientifically based technical materials that will assist NRCS field staffs and others to promote conservation stewardship of fish and wildlife and deliver sound habitat management principles and practices to America's land users.



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**Wildlife
Habitat Council**

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The Wildlife Habitat Council's mission is to increase the amount of quality wildlife habitat on corporate, private, and public land. WHC engages corporations, public agencies, and private, non-profit organizations on a voluntary basis as one team for the recovery, development, and preservation of wildlife habitat worldwide.



www.wildlifehc.org

We received helpful comments on the draft manuscript from
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Artificial Nesting Structures

January 2001

Fish and Wildlife Habitat Management Leaflet

Number 20

General Information

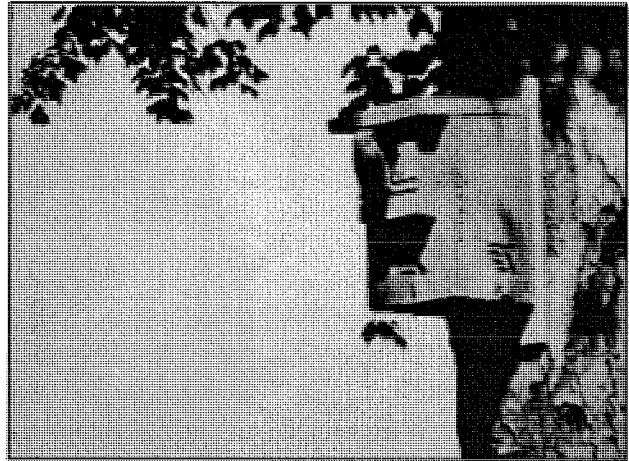
Artificial nesting structures can be used to increase wildlife reproductive success in areas where natural nest sites are unavailable or unsuitable. While artificial nesting structures cannot replace natural nesting habitats, they can increase the number of nesting sites available in an area.

Many types of wildlife use artificial nesting structures, including songbirds, woodpeckers, waterfowl, raptors, squirrels and bats. While structures are generally designed to meet the nesting requirements of certain species, they may also be used by nontarget animals and provide roosting and winter cover for a variety of birds and mammals. Nest boxes, bat houses, nesting platforms or shelves, and nesting baskets, culverts, and cylinders are some of the common types of artificial nesting structures.

The most effective artificial nesting structures are those installed in close proximity to brood-rearing habitat, adequate escape/concealment cover, a reliable source of food and water, and other elements of the habitat of target species. Predators, competitors, and territory sizes for individual species also influence the usefulness of nesting structures. Nest monitoring and maintenance actions can be taken to limit competing or undesirable species, assess reproductive success, and provide an opportunity for landowners and managers to observe wildlife.

Cavity-nesting wildlife

Birds and mammals that nest in tree cavities are likely to use nest boxes. Primary cavity-nesting species, such as members of the woodpecker family, excavate nesting cavities in live or standing dead trees (snags). Sec-



WHC

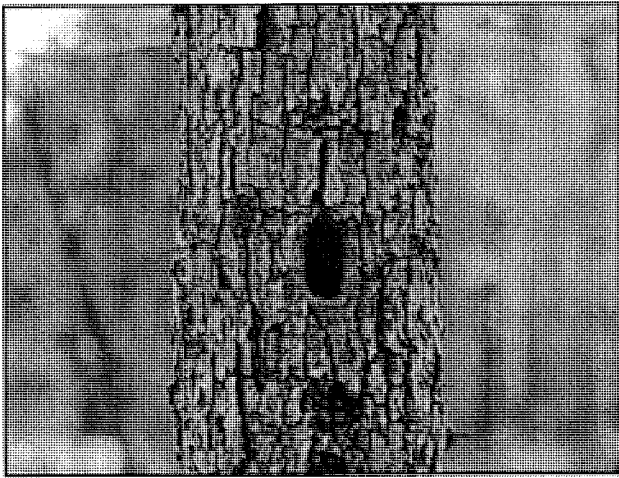
ondary cavity nesters (e.g., some passerine--or perching--birds, owls, waterfowl, and mammals) use cavities abandoned by primary excavators and those formed by fungus, knots, and trees subject to decay. The presence of snags in forested areas is directly related to the quality and quantity of nesting habitat for many cavity-nesting species. Fifty-five species of cavity-nesting birds in North America use snags, and invertebrates inhabiting the dead wood provide a rich food source. Optimal nesting opportunities for cavity-nesting wildlife are typically found on forested tracts that contain 10-12 small (<12-inch diameter at breast height—dbh) and 2-5 large (>12-inch dbh) standing dead trees per acre. Sloughing bark on snags is also used by roosting bats. Table 1 provides a list of North American cavity-nesting birds.

This leaflet is designed as an introduction to the use of artificial nesting structures to enhance wildlife habitats. When incorporated into comprehensive habitat management plans, artificial nesting structures can increase wildlife use in many areas. The success of any management strategy depends on targeting the habitat

Table 1. North American cavity-nesting birds.

Primary (excavator)	Secondary (nonexcavator)	Secondary (nonexcavator)
Northern flicker*	Black-bellied whistling duck*	Violet-green swallow*
Pileated woodpecker*	Wood duck*	Tree swallow*
Red-bellied woodpecker	Common goldeneye*	Purple martin*
Gila woodpecker	Barrow's goldeneye*	Black-capped chickadee*
Red-headed woodpecker	Bufflehead*	Carolina chickadee*
Acorn woodpecker	Hooded merganser*	Boreal chickadee*
Lewis' woodpecker	Common merganser*	Chestnut-backed chickadee*
Yellow-bellied sapsucker	American kestrel*	Mountain chickadee*
Williamson's sapsucker	Barn owl*	Tufted titmouse*
Hairy woodpecker*	Eastern screech owl*	Plain titmouse*
Downy woodpecker	Western screech owl*	Bridled titmouse*
Red-cockaded woodpecker	Whiskered screech owl	White-breasted nuthatch*
Ladder-backed woodpecker	Northern hawk owl	Red-breasted nuthatch*
Nuttall's woodpecker	Barred owl*	Brown-headed nuthatch*
Strickland's woodpecker	Boreal owl*	Pygmy nuthatch
White-headed woodpecker	Northern saw-whet owl*	Brown creeper
Black-backed woodpecker	Spotted owl*	House wren*
Three-toed woodpecker	Flammulated owl*	Winter wren
Golden-fronted woodpecker*	Elf owl	Carolina wren*
Black-capped chickadee*	Ferruginous pygmy owl	Bewick's wren*
	Northern pygmy owl	Eastern bluebird*
	Brown-crested flycatcher*	Western bluebird*
	Great-crested flycatcher*	Mountain bluebird*
	Ash-throated flycatcher*	Prothonotary warbler*

*Species known to use nest boxes.



C. Rewa

Natural cavities provide nesting sites for many species of birds and mammals.

needs of the desired wildlife species, and assessing managed areas to ensure that the required habitat elements are present. Landowners and managers should be familiar with state and federally listed rare, threatened, or endangered plant and animal species to ensure their protection. Involvement of wildlife professionals in the identification of habitat management objectives and actions is encouraged.

Nesting Structure Basics

Besides overall habitat conditions, several factors influence the success of artificial nesting structures. These factors include construction materials used, structure design and placement, installation methods, use of

Site fidelity.—Cavity nesting waterfowl and other birds exhibit site fidelity, where nesting females return to the general area in which they were raised. When nest sites are destroyed by timber harvest, land development, and natural disturbances, returning females are forced to find other nesting cavities. Landowners and managers can supply artificial nesting structures to replace lost nest sites, and should limit the amount of disturbance during the nesting season.

Some cavity-nesting mammals in North America.

Yellow-pine chipmunk	Deer mouse
Northern flying squirrel	Common red-backed vole
Gray squirrel	Yellow-necked field mouse
Fox squirrel	Ermine
Red squirrel	Bats
Bushy-tailed woodrat	Raccoon

predator guards, and monitoring and maintenance performed. Wildlife managers must consider all of these factors to maximize the usefulness of nesting structures. For example, the best-designed structures will be of little use if they are placed in the wrong habitat type or are easily accessed by predators. Likewise, a well-designed structure placed in suitable habitat may not be used if it is not properly attached or is easily detached from its support by wind or storms.

Construction materials

Structures made of wood are relatively inexpensive and easy to build. Wood seems to be the most weather-resistant, insulating material, and most wildlife species prefer wood to metal or plastic structures. For most nest boxes, 3/4-inch rough-cut boards are best used for construction. Since cavity-nesting waterfowl do not carry nesting material to the nest, 3-4 inches of coarse sawdust or wood chips should be placed inside the nest box. Nest boxes intended for use by woodpeckers can be tightly packed with sawdust to resemble decaying woody material. Old nesting material should be removed at the start of each nesting



Monsanto, Pensacola, FL.

Great-crested flycatcher.

season and replaced with fresh materials.

While many artificial nesting structures are designed for cavity-nesters, some provide nesting sites for other wildlife. Nesting platforms, baskets, and cylinders are used by waterfowl, raptors, and other species. If wire mesh is used as nest support material, the weave must be tight enough to prevent eggs and young from falling

Basic Nest Box Characteristics

- ✓ Should be made of wood; cedar (preferred, most weather-resistant), cypress, redwood, or pine.
- ✓ Box should open from the side or top for maintenance and cleaning.
- ✓ Sides of nest box should enclose the floorboard (recessed 1/4 inch) to prevent rain seepage
- ✓ Nails, woodscrews, and hinges should be rust-proof.
- ✓ Entrance hole dimensions should accommodate the desired bird species; hole should not large enough to allow competitors and predators access.
- ✓ A double thick entrance and extended roof to deter predators like squirrels and raccoons.
- ✓ Ventilation holes or slits at the top of both sides, just beneath the roof of the box.
- ✓ Drainage holes (four or five) drilled into the bottom of the nest box to allow for drainage.
- ✓ Songbird nest box should not have a perch, which increase predator access; native songbirds do not use perches.
- ✓ Nest box should not be treated with green-preserved—it is poisonous to birds.
- ✓ Nest box should not be painted on the inside or painted bright, unnatural colors on the outside (may attract predators or exotic species).



WHC

Eastern bluebird.

through the wire. Culverts are typically made of concrete, and some nesting baskets/boxes are made from plastic buckets or open metal tubs. Closed metal boxes are generally not used, since they trap excessive heat which can kill eggs and young and stress adults. Artificial burrows have a solid, plywood top and are buried about six inches underground to prevent trampling by livestock. Milk cartons should not be used as nest boxes.

Structure design

A wide variety of artificial nesting structure designs have been developed over the years to accommodate

cavity-nesting and other wildlife species. Designs range from simple platforms to complex, multi-compartment structures. Some of these designs are more successful than others, and most can be built or acquired from a variety of suppliers. Design schematics for a number of structures are provided throughout this leaflet.

Basic nest box designs can be modified to accommodate various species by altering dimensions or entrance hole sizes. The size of the entrance hole also influences the internal temperature of the box, predator accessibility, and use by competing nontarget species. Table 2 contains recommended nest box dimensions and entrance hole sizes for many cavity-nesting birds.

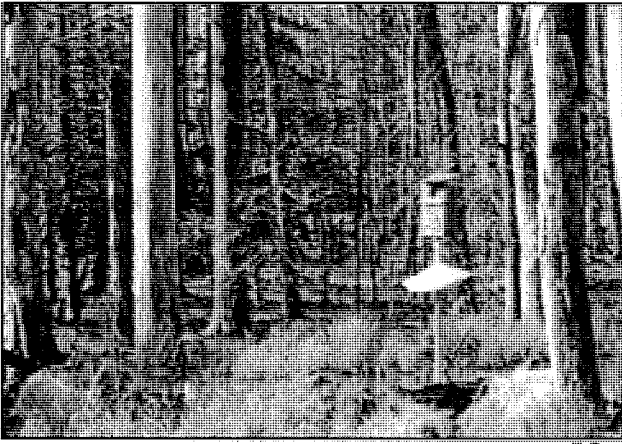


WHC

Wood duck hens may lay eggs in the nests of others (dump nesting) where boxes are positioned in open areas.

Waterfowl.—Nest boxes for waterfowl should be placed in wooded areas close to or directly over water. Wood ducks, mergansers, buffleheads, and goldeneyes are tolerant of other nearby nesting species. Some waterfowl species exhibit a brood parasitism behavior known as dump nesting. Dump nesting occurs when a hen observes another female entering and exiting a nest box and is stimulated to lay her eggs in that nest. This behavior increases when several nest boxes are erected close to each other in highly visible areas. Studies show that hatching success decreases in areas with excessive dump nesting. It may be necessary to put a few nest boxes out in the open *initially* to attract nesting waterfowl. The nest boxes should be moved to more secluded spots along wooded edges close to water the season after nesting is observed. Once a female has successfully nested in a box, she is likely to return in following years.

Cavity-nesting waterfowl do not bring nesting materials to the nest. They use bark, decayed wood fibers, and other debris found in natural cavities and line the nest with down. Therefore, a 3- or 4-inch layer of coarse saw dust or wood chips should be added to boxes as nest building material.



Wood duck nest box placed in wooded wetland setting.

Placement

Habitat requirements of target wildlife species and available habitat greatly influences nesting structure placement. Some species seek secluded nesting sites, while others prefer to nest in more open areas. Species-specific nesting preferences should be considered when deciding where to install nesting structures. Table 3 provides habitat preferences and nest site characteristics for a variety of cavity-nesting birds.

Structures should be made available and ready for occupants before the breeding season begins. Since some bird species begin nest site selection as early as February, most nesting structures should be installed and/or made ready the previous fall or by late January.

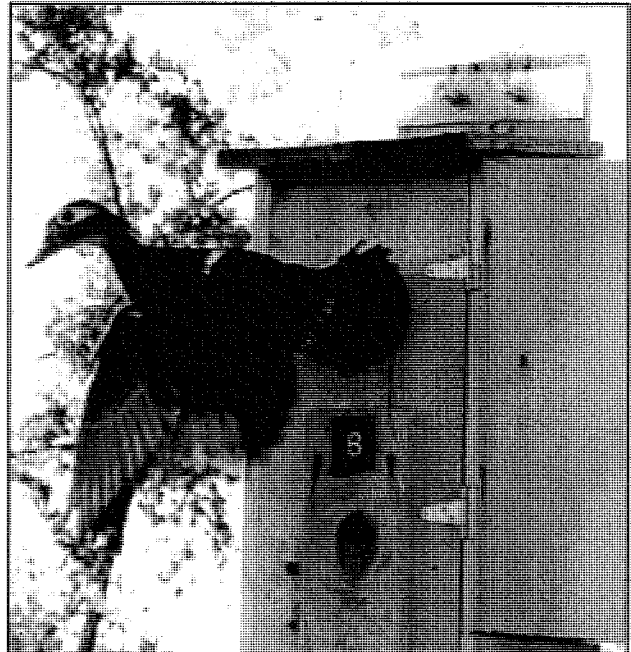
Installation

When installing nest structures, landowners should consider height above the ground, orientation, predator guards, and preferred natural nesting sites. Woodpeckers and bats prefer nest boxes that face east, providing greater morning sun exposure. Most birds and mammals favor entrances that face away from prevailing winds. Landowners and managers should learn which natural habitat conditions are favored by the desired wildlife species. Cavity-nesting waterfowl nest on or near the water, and often prefer nesting structures that face open water and are clear of overhang-

ing branches. Where beavers occur, landowners should avoid attaching nest structures to aspen or other tree species that are preferred beaver food sources.

Nest structures can be attached to poles, posts, or pipes on land or in the water. Nest boxes can also be attached to trees; however, it is hard to install predator guards on tree trunks. Supports should be sturdy enough to keep the structure from swaying or tipping over in high winds. Nest boxes can be attached to 4x4- or 4x6-inch treated wooden posts or trees by inserting a 4- to 6-inch lag bolt through a hole drilled in the back of the box, opposite the entrance hole. A large washer between the head of the lag bolt and the box should be used to secure the box to the support. The bolt should be checked each year and loosened as the tree grows. Wire should not be used to attach nest structures to live trees to avoid damaging the tree.

To ensure stability, the inside diameter of metal support poles should be at least two inches. Hex or carriage bolts can be used to attach structures to steel poles. Nest structures can be installed on or over water when it is iced over or when the water level is low. Nest boxes mounted over water should be four



Solutia, Inc.

Wood ducks readily use nest boxes.

Table 2. Nest box dimensions for some cavity-nesting birds (dimensions in inches).

Species	Floor Area	Cavity depth	Entrance height	Diameter of entrance hole
Wood duck*	8x12	15	9 1/2	3x4 oval
Hooded merganser*	10x12	23	17	4x3 oval
American kestrel	8x8	12-15	9-12	3
Barn owl*	12x40	15	7	6x6
Barred owl*	13x13	22-28	14-18	6-8
Saw-whet owl*	6x6	10-12	8-10	2 1/2
Screech owl*	8x8	12-15	9-12	3
Northern flicker*	7x7	16-18	14-16	2 1/2
Downy woodpecker**	4x4	8-10	6-8	1 1/4
Hairy woodpecker**	6x6	12-15	9-12	1 1/2
Lewis' woodpecker**	7x7	16-18	14-16	2 1/2
Pileated woodpecker**	8x8	16-24	12-20	3x4
Ash-throated flycatcher	6x6	8-10	6-8	2
Great-crested flycatcher	6x6	8-10	6-8	1 3/4
Brown-headed nuthatch***	4x4	8-10	6-8	1 1/4
Pygmy nuthatch***	4x4	8-10	6-8	1 1/4
Red-breasted nuthatch***	4x4	8-10	6-8	1 1/4
White-breasted nuthatch***	4x4	8-10	6-8	1 3/8
Tree swallow	5x5	8	6	1 3/8
Violet-green swallow	5x5	6-8	4-6	1 1/2
Eastern bluebird	5x5	6	10	1 3/8
Mountain bluebird	5x5	8-12	6-10	1 9/16
Western bluebird	5x5	8-12	6-10	1 1/2
Bewick's wren	4x4	6-8	4-6	1 1/2
Carolina wren	4x4	6-8	4-6	1 1/2
House wren	4x4	6-8	4-6	1 1/8
Black-capped chickadee	4x4	9	7	1 1/8
Carolina chickadee	4x4	9	7	1 1/4
Tufted titmouse	4x4	9	7	1 1/4

* put four inches of wood chips or coarse sawdust in bottom of nest box

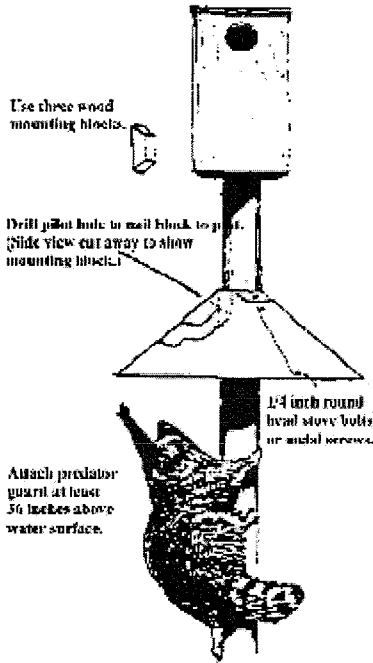
** fill nest box tightly with sawdust, preferred if outer material is bark

*** outer material should be bark

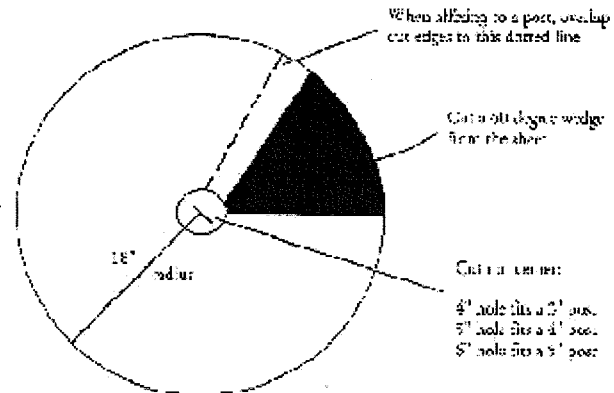
Conical predator guard

Below is a top view layout for cutting a predator guard from a 2-foot x 3-foot sheet of 26-gauge galvanized steel. The first cut is to remove a 45-degree wedge from the sheet. The center hole is then cut.

The side view shows a guard fitted to a nest box post. It was done by overlapping the edges of the 50-degree wedge to the sheet metal flat. Bolts or screws are then used to fix the sheet into a cone. Fasten the guard to the post with supporting brackets. Note: 3-welder mounting blocks can also be placed on the outside of the guard to fasten it to the post. Fasten the blocks to the guard and post with screws. The predator guard should be placed on the post so the bottom of the guard is at least 4 feet from the ground.



Top View



Conical Side View

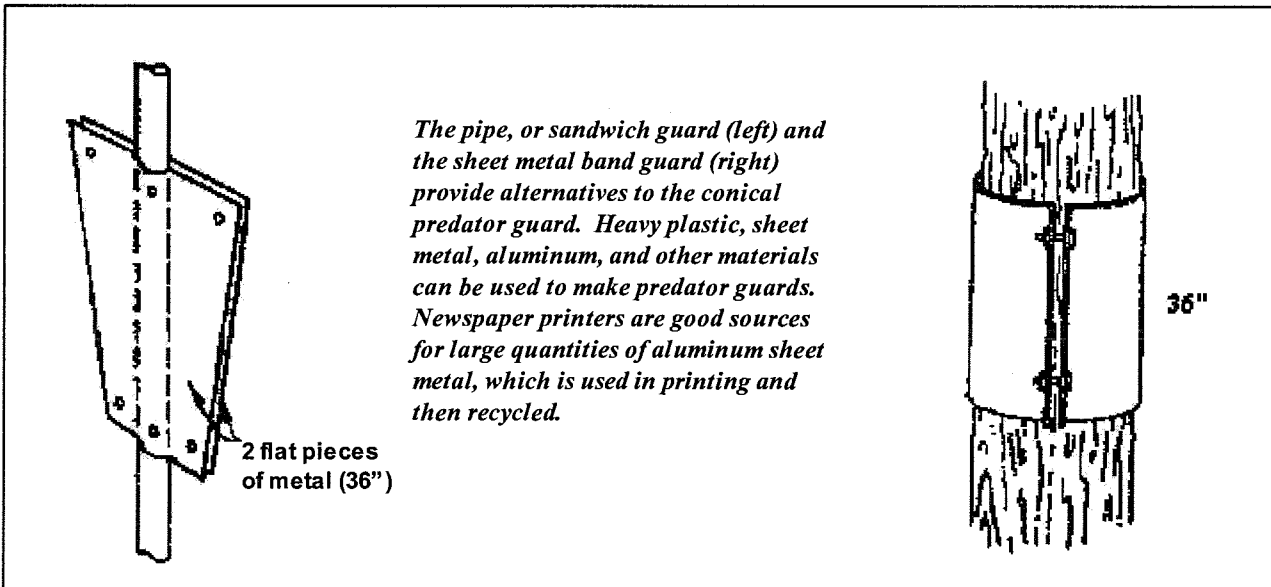
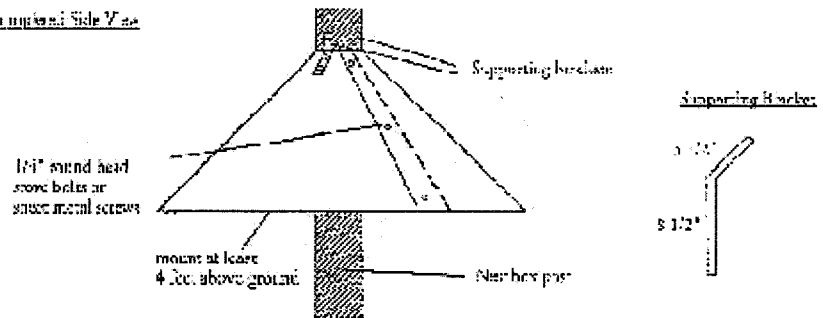


Table 3. Habitat requirements and nest box placement for some cavity-nesting birds.

Species	Nesting habitat and placement tips
Eastern bluebird Mountain bluebird Western bluebird	Open fields, meadows, backyards; old orchards; open rural country with scattered tree cover; place box 3-6 ft. above ground; entrance hole should face open areas, preferring east and north directions; Mountain and Western bluebirds may use some forest edge.
American kestrel	Pastures, fields, and open meadows with grazed or mowed vegetation; place box on solitary trees or posts in open fields or along edge of woodlots 10-30 ft. above ground.
Wood duck	Forested wetlands, swamps, ponds, lakes; place box in deciduous trees 6-30 ft. above ground, 30-100 ft. from nearest water source; space boxes 100 ft. apart.
Hooded merganser Common merganser	Prefer secluded wooded waterways, lakes, faster-moving rivers; place box on tree up to 6-30 ft. above ground, within 30-100 feet of water source.
Common goldeneye Barrow's goldeneye	Forested areas near permanent lakes and rivers and large, mature trees; place box in trees 6-30 ft. above ground, within 30-100 ft. of water source.
Screech owl	Forests, parks, woodland clearings, forest edges, especially in riparian areas; place box 10-30 ft. above ground facing north.
Great crested flycatcher	deciduous or mixed deciduous-coniferous forests and forest edges, woodlands; place box on post or tree at forest edge, 3-20 ft. above ground.
Ash-throated flycatcher	Chaparral, mesquite thickets, savannas, deserts, and open deciduous and riparian woodlands; place box 3-20 ft. above ground.
Northern flicker	Pastures, woodlands, forest edges; place box 6-30 ft. above ground on pole or tree at forest edge or along fence rows.
Tree swallow	Open fields and other open habitats near riparian areas; place box on pole or post 5-15 ft. above ground with entrance hole facing east 30-100 ft. apart.
Violet-green swallow	Open or broken deciduous or mixed deciduous-coniferous forests, forest edge adjacent to open area; place box 9-15 ft. above ground.
White-breasted nuthatch	Deciduous, mixed deciduous-coniferous forests, woodlands, forest edges, with mature stands and decaying trees; place box 3-60 ft. above ground, entrance hole should face away from prevailing wind.
Red-breasted nuthatch	Coniferous, and mixed deciduous-coniferous forests, aspen woodlands, mature stands with decaying trees; place box 5-40 ft. above ground, entrance hole should face away from prevailing wind.
Pygmy nuthatch	Ponderosa, yellow, and Jeffrey pine forests, pinyon-juniper woodlands; place box 6-60 ft. above ground.
Brown-headed nuthatch	Open stands of pines, mixed pine-hardwood woodland; place box 2-10 ft. above ground.
Black-capped chickadee Carolina chickadee	Forests, woodlots, and areas with mature hardwood trees, forest edges, and meadows; area should receive 40-60% sunlight and entrance hole should face away from prevailing wind.
Mountain chickadee	Montane coniferous forests; place box 5-15 ft. above ground, preferably in a snag; entrance hole should face away from prevailing wind.
Chestnut-backed chickadee	Coniferous and mixed deciduous-coniferous forests, usually near riparian areas; place box 2-15 ft. above ground; entrance hole facing away from prevailing wind.
Carolina wren	Open deciduous woodlands (especially with thick underbrush), backyards, parks, gardens with trees or shrubs; place box 0-10 ft. above ground.
Prothonotary warbler	Swampy lowland forests and river bottom woodlands subject to flooding; place box 2-10 ft. above or near water.

to six feet above the water surface to avoid flooding. A slight forward tilt can help drain the structure and keep out precipitation. A post driver can be used to drive wooden or metal posts into the substrate of ponds or wetlands. Utility or fire companies may be able to help landowners raise tall nesting structures, such as raptor and heron platforms.

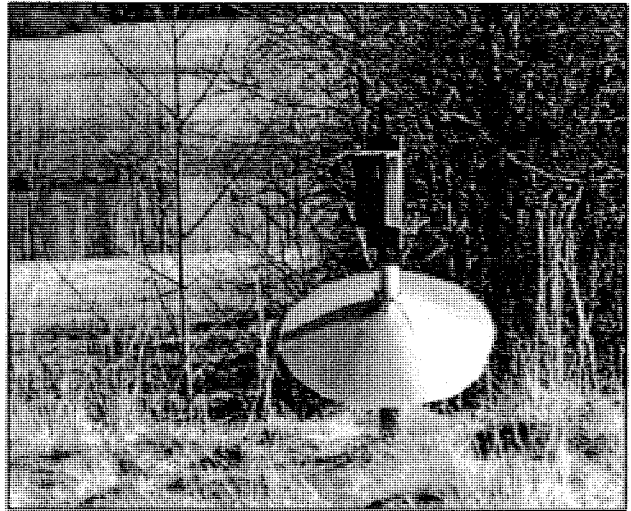
Floating nest platforms are usually held in place by anchor chains, weights, or buoys. They should be anchored at least 25 feet from shore, in water at least 18 inches deep. Floating platforms should be removed before the first major freeze to prevent damage from ice action and fluctuating water levels.

Predator guards

Predators (both native and introduced) can limit the reproductive success of wildlife using natural nest sites and artificial nesting structures. The rough surface of wooden posts and trees makes climbing easy for terrestrial predators such as snakes, raccoons, and domestic cats.

Artificial nesting structures, especially those close to water, should be fitted with predator guards to reduce the likelihood of nest predation. Heavy plastic, aluminum sheet metal, and other materials can be used to construct predator guards. Newspaper printers are good sources for large quantities of discarded aluminum sheet metal. Metal poles are more difficult to climb, but should at least be covered with repeated applications of axle grease where effective predator guards are difficult to install.

There are three basic types of predator guards: the conical guard, the pipe (sandwich) guard, and sheet metal tree band guard (see illustrations on page 7). Other structures such as coarse wire mesh extending out from around the nest box entrance hole may be used to prevent raccoons and other predators from



C. Rewa

Predator guards help reduce loss of eggs and young to predation.

reaching into the nest box.

In addition to installing predator guards to discourage ground-dwelling predators, overhanging or low branches near nesting structure should be removed to discourage access by arboreal predators.

Monitoring and maintenance

Nesting structures can be monitored throughout the nesting season to track use and nest success, remove undesirable exotic species, and to clean the structure after young are fledged to make it available for late and second nesting attempts. Some birds and mammals tolerate limited levels of human disturbance, such as occasional (once a week or once every ten days) nest checks, but others do not. Nest checks should be completed quickly to minimize stress on parent birds and young. Intrusive monitoring of sensitive species (e.g., ferruginous hawks, ospreys, barn owls) should be limited to prevent nest abandonment.

Parasites cause problems for some nesting birds. To check for blowfly larvae, mites, and other pests, gently lift the nest off the box floor and tap it lightly. After

Woodpeckers.—Many woodpecker species will take advantage of nest boxes if mature trees and snags in which to excavate cavities are not available. Boxes should be tightly packed with sawdust to simulate decaying wood inside snags and dead limbs. Woodpeckers prefer boxes with bark exteriors, placed on the south or east side of trees (to maximize exposure to the sun).



Monsanto, Pensacola, FFL

Monitoring and maintenance can help ensure success of bluebird boxes and other nesting structures.

the pests drop to the box floor, sweep them out of the box. Since birds have a poor sense of smell, adults do not generally abandon nests that have been handled in this manner.

Well-built nesting structures can last 10-15 years if properly maintained. After a brood has left the structure, the old nesting material should be cleaned out to make room for a second clutch. Nest structures should be checked at least once per year before the breeding season starts to remove old nesting materials, mouse nests, insects, and other debris. Place fresh wood chips, shavings, or sawdust in nest boxes, if appropriate. Replacement parts and other repairs can be made to nest structures during annual maintenance checks. Nest monitoring results can be used by local birding organizations and state and federal government agencies to keep track of reproductive success and wildlife population trends.

Competitors

Competition for nest sites is often high among cavity-nesting wildlife species. Birds, small mammals, and insects compete for suitable sites. Deer mice and squirrels often inhabit nest structures during the winter months, and their nests should be removed during annual maintenance inspections if they are not the target species.

House sparrows and European starlings are not na-

tive to North America but thrive in backyard and suburban areas, frequently taking over nest sites used by native songbirds. House sparrows will kill the parents and young of bluebirds, chickadees, house wrens, and other native birds. An entrance hole diameter of less than 1 1/4 inches can preclude house sparrows from using nest boxes, but also excludes some native cavity-nesting birds. European starlings can be excluded by entrance hole diameters of no greater than 1 1/2 inches. Special starling guards are available to protect entrance holes of purple martin houses and other nesting structures.

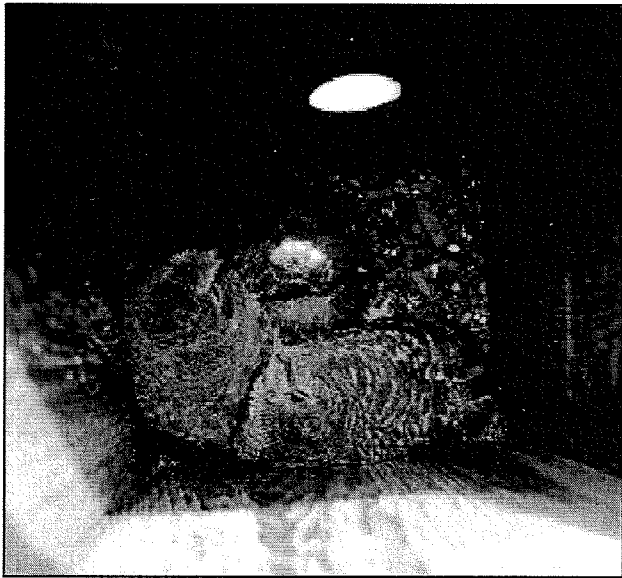
If a house sparrow or starling nest is found during routine nest monitoring, the nest and its contents should be removed. These two introduced species are often persistent nesters and are not protected by federal law. Live trapping and humane destruction may be necessary in areas highly populated by house sparrows and starlings (traps are available at bird specialty stores). Local authorities can help landowners dispose of the birds properly. Frozen birds can be donated for scientific use, and to academic institutions or raptor rehabilitation centers.

Wasps and bees also build nests in bird houses. These insects can be discouraged by soaping the inside top of nest boxes. If insects such as paper wasps establish a nest in a vacant box, a low toxicity insecticide can be sprayed inside the box in the early morning (when the insects are still cold and sluggish) and the



K. Klimkiewicz

Non-native house sparrows aggressively compete for nest sites with native species.



Vulcan, Brooksville, FL

Screech owl young in nest box.

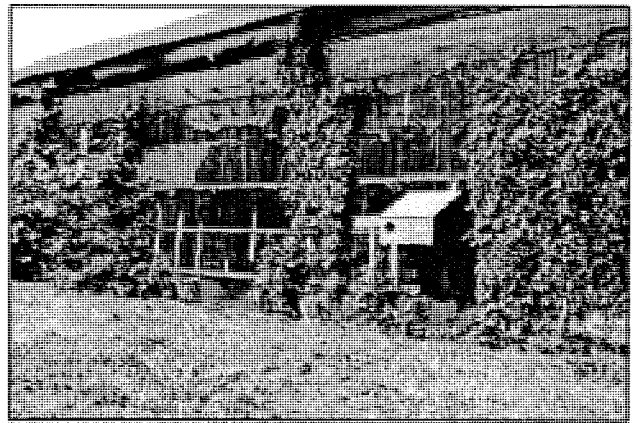
nest can be removed. Annual maintenance and monitoring help detect colonies of wasps and bees.

Types of Artificial Nesting Structures

Nest box

Nest boxes are probably the most common and easily recognized artificial nesting structures used today. Over 50 species of birds including waterfowl, raptors, songbirds, and woodpeckers are known to use nest boxes. A variety of nest box designs are provided throughout this leaflet, and box dimensions for various species are listed in Table 2. Some government and nonprofit organizations may supply nest boxes and/or building materials at no charge or at a reduced rate. Local community groups like scouts and ornithological society chapters can help landowners construct and erect nest boxes.

Like natural nesting cavities, nest boxes should not have perches mounted at the entrance hole. Box construction should limit the amount of light and precipitation that can enter the box. During construction, four 1/4- inch holes should be drilled in the bottom of the nest box for drainage, and ventilation slits should be provided on both sides just under the roof overhang. Hardware cloth attached to the inside front of waterfowl nest boxes serves as exit ladders for ducklings.



C. Rewa

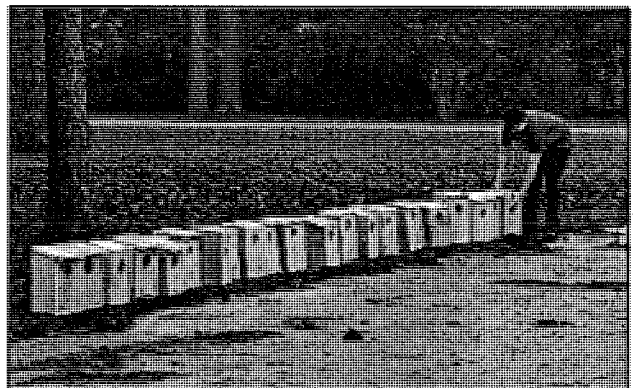
Owl nest boxes can be attached to the side of buildings.

Great Horned Owl and Great Gray Owl Nesting Platforms

Great horned owls and great gray owls do not build their own nests. Both species typically use nests abandoned by red-tailed hawks, goshawks, eagles, and other large raptors. Artificial nesting platforms and cones are also used.

Great horned owls prefer platforms lodged in mature hardwood trees 15 to 50 feet above the ground. Nest sites should be relatively free from human disturbance, and foraging habitat should be available nearby. Platforms in quiet woodlot edges, shelterbelts with mature trees, and windbreaks are examples of suitable nesting sites.

Great gray owls prefer nest sites located in the interior of coniferous forests. Nesting platforms should be placed in mature trees at least 15 feet above the ground.



Monsanto, Pensacola, FL

Owl nest boxes ready for deployment.



Purple Martin Housing Standards

Today, purple martins depend on humans to supply them with suitable nest sites. For more detailed information about purple martins, helpful management tips, and housing specifications and diagrams contact the Purple Martin Conservation Association (PMCA) at the Edinboro University of Pennsylvania at 814-734-4420 or visit the PMCA website at <http://www.purplemartin.org>.

The PMCA has developed a set of biologically-sound housing (for compartment or gourd system) standards for purple martins. Listed below are some purple martin housing basics. These birds have additional housing needs, and PMCA literature addresses those issues.

Housing materials: Although aluminum housing is often preferred for its ease of maintenance and accessibility, untreated wood apartments are also commonly used. Cypress and cedar are recommended, but pine or redwood are also used. The exterior of the apartments should be painted white. The interior should have no treatment, stain, or paint. Wood floors with a rough surface prevent nestlings from developing splayed legs. If the housing is made of plastic, the exterior should be a light color or white. The plastic should be opaque. Translucent plastic overheats quickly, killing the eggs, nestlings, or stressing the incubating parent martin. Gourds are also used as purple martin apartments.

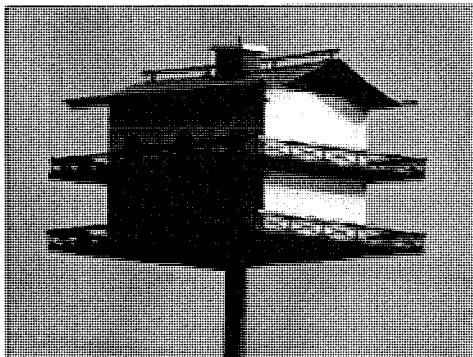
Compartment size: A martin house contains at least four to six compartments, and the minimum size for each compartment is 6x6x6 inches. Larger compartments offer better protection from weather and predators.

Entrance hole: Purple martins use round entrance holes with diameters ranging from 1 3/4 to 2 1/4 inches. Most housing features 2 1/8-inch diameter entrance holes. Door plugs should be used in the winter to close compartments to house sparrows, starlings, and other winter occupants. The entrance hole should be 1 to 1 1/2 inches above the floor of the compartment.

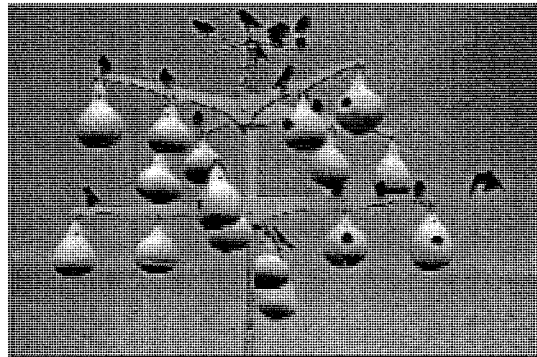
Height and placement of housing: Housing should be erected 12 to 20 feet above the ground on a metal pole or pressure-treated wood post set into the ground with concrete. The house should not sway or tip in high winds. The house should be placed in an open area at least 40 feet away from trees, but within 100 feet of human activity (home, marina, etc.).

Other considerations: Landlords should install a pole predator guard to discourage terrestrial predators. The compartments should have ventilation holes under the roof overhang and drainage holes in the compartment floor. Porch railings are desirable.

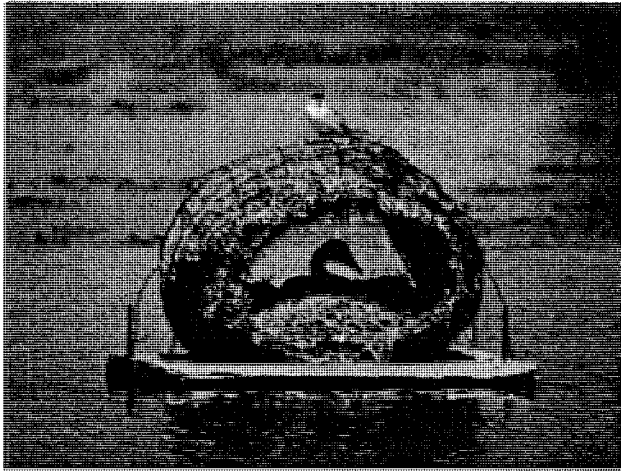
The martin housing must be able to be lowered and raised vertically in order to perform routine maintenance, cleaning, and nest monitoring. Housing on a winch or lanyard system or on a telescoping pole is highly recommended. House sparrows and European starlings frequently take over housing, so the landlord must check for nests, eggs, or occupants on a regular basis. Perches are not recommended since they attract these exotic species.



Aluminum purple martin house. Dave Holmes



Purple martins on gourd housing structure. WHC



Amoco

Many floating platform designs are used to provide suitable waterfowl nesting sites.

Nest Shelf

Nest shelves are used by American robins, eastern phoebes, and barn swallows. Since these species use mud in nest construction, nearby mud puddles or other water sources may enhance the attractiveness of nest shelves. Some birds prefer shelves placed under building overhangs or eaves, adjacent to open areas. Old nesting material should be removed after the breeding season is complete. A design for a typical nest shelf is provided on page 19.

Nesting platform

Ospreys, ferruginous hawks, golden eagles, great horned owls, great gray owls, great blue herons, black-capped night herons, double-crested cormorants, egrets, and occasionally bald eagles have been known to nest on platforms when suitable natural nest sites are limited or unavailable. Sticks are frequently wired to the platform to simulate previous use, which is attractive to these species. Nest platforms can be mounted on a single pole, a solid base such as a tree or tripod, or for species that nest along coastal or inland waterways, marine navigational structures. One nesting platform design is provided on page 24.

Floating platform

Many waterfowl species choose natural nesting sites on islands or along shorelines of lakes, ponds, rivers, and streams. Most waterfowl favor sites sheltered

from prevailing winds, and preferred nesting cover varies with species. Floating platforms offer alternative nesting sites that provide protection from many predators. Floating platforms are used by common loons and Canada geese in areas where water levels fluctuate. Mallards, black ducks, pintails, blue-winged teal, and canvasbacks may also use floating platforms. Aquatic vegetation such as rushes and cattails can be secured to floating platforms in northern lakes to attract nesting loons. Canada geese prefer platforms covered with grass, straw, or hay. Nest material can be wired to the bottom of the platform to prevent it from blowing off. Other waterfowl species and turtles may use floating platforms for loafing. A floating nesting platform design is provided on page 22.

Nesting baskets, cylinders, and culverts

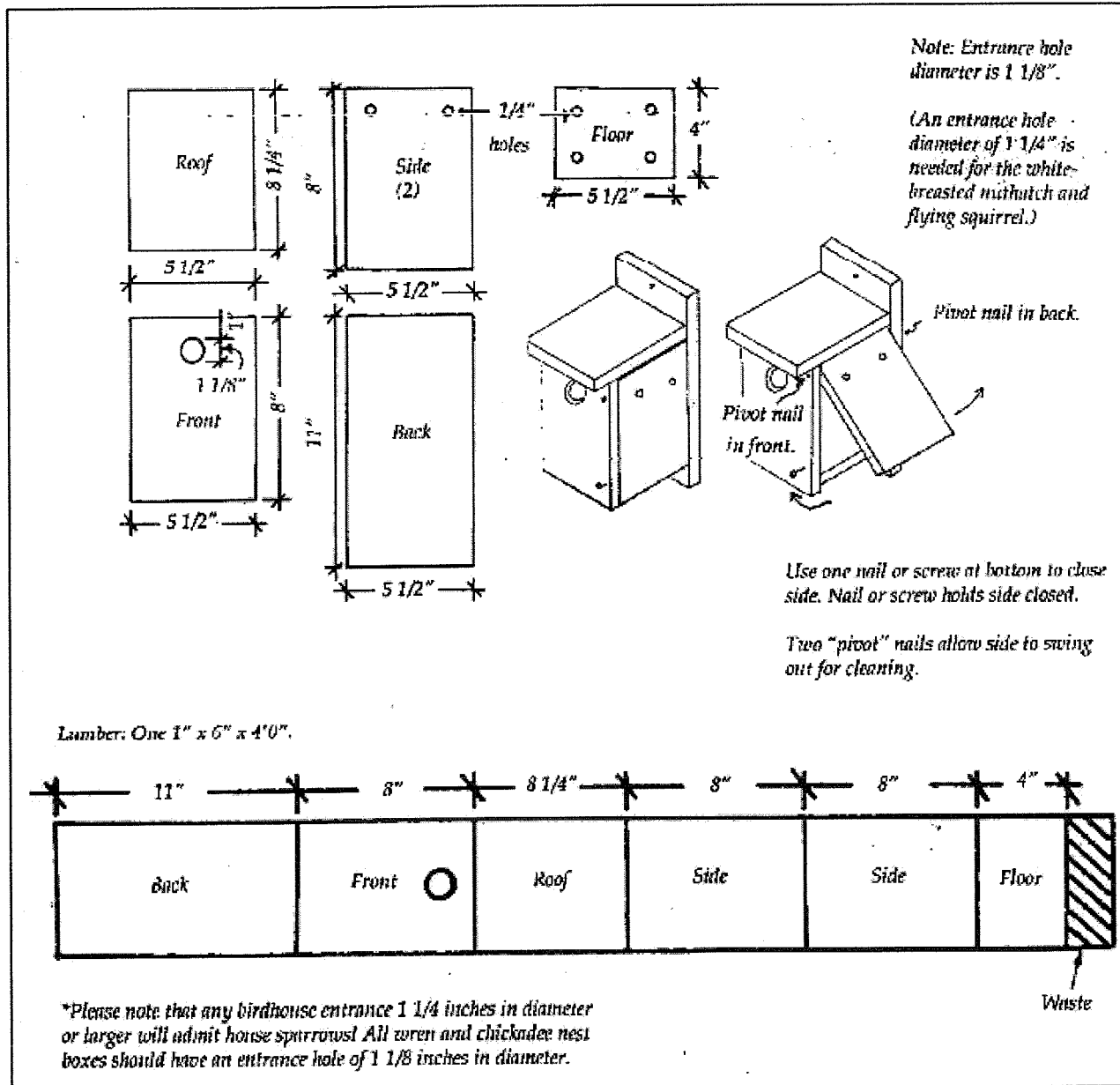
Nesting baskets and tubs (both metal and fiberglass) are used by ducks (primarily mallards) and geese. Mallard nest baskets should be installed over water at least ten feet from the land. Baskets or tubs attached to wood or metal supports should be at least three feet above the surface of the water to prevent flooding. Straw, hay, or grass nesting material should be replaced annually. About ten drainage holes must be punched into the bottom of the tub. A 6x4-inch escape notch should be cut out of the side of the tub to allow goslings and ducklings to exit. The tub may be painted a natural earth tone (brown, gray, or dark green). If the tub is attached to a floating platform, the platform must be anchored to the bottom at opposite



C. Kees

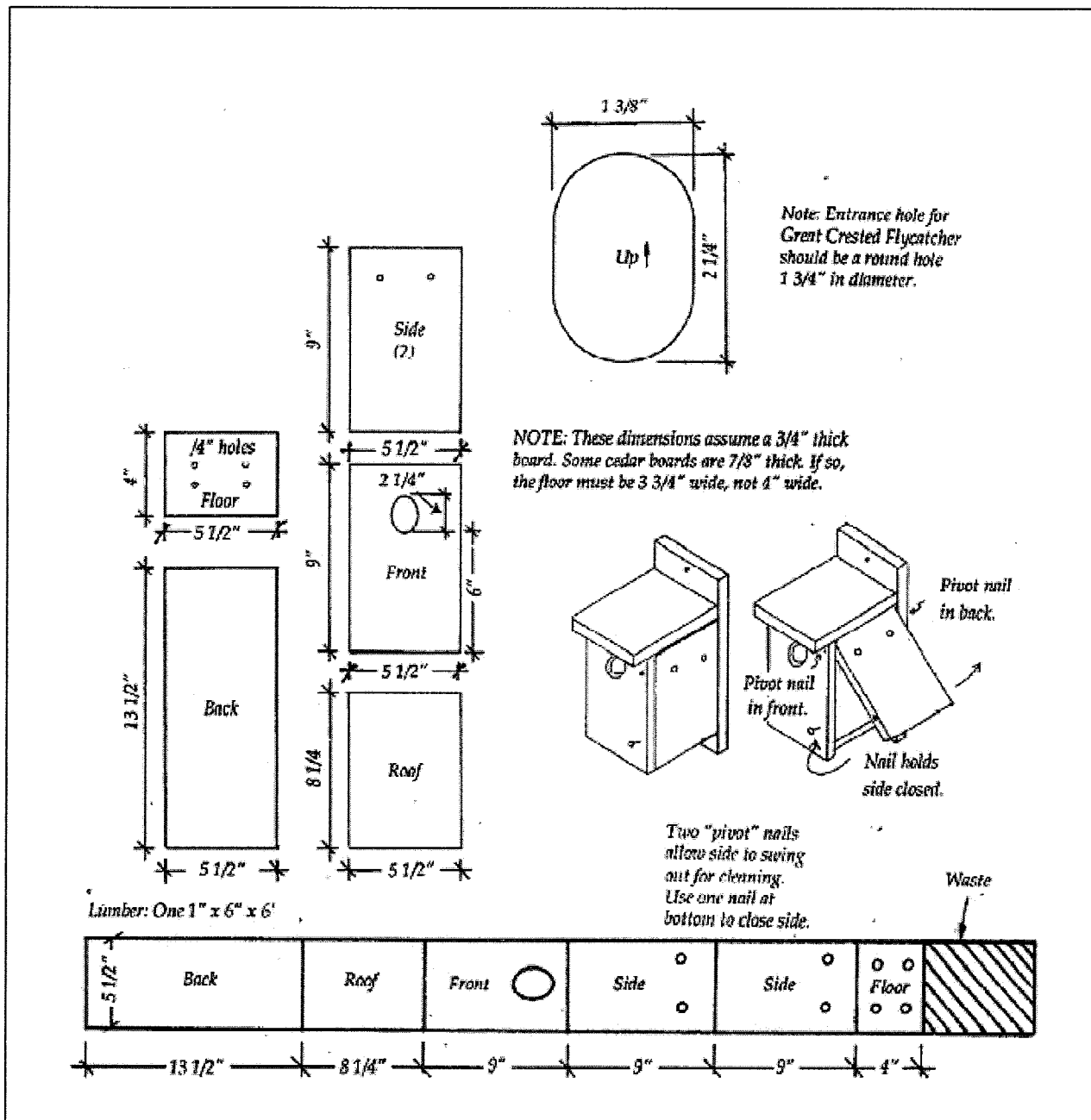
Baskets provide nesting sites attractive to waterfowl.

Nest box diagram for black-capped chickadee, house wren, prothonotary warbler, white-breasted nuthatch, flying squirrel, deer mouse and white-footed mouse.

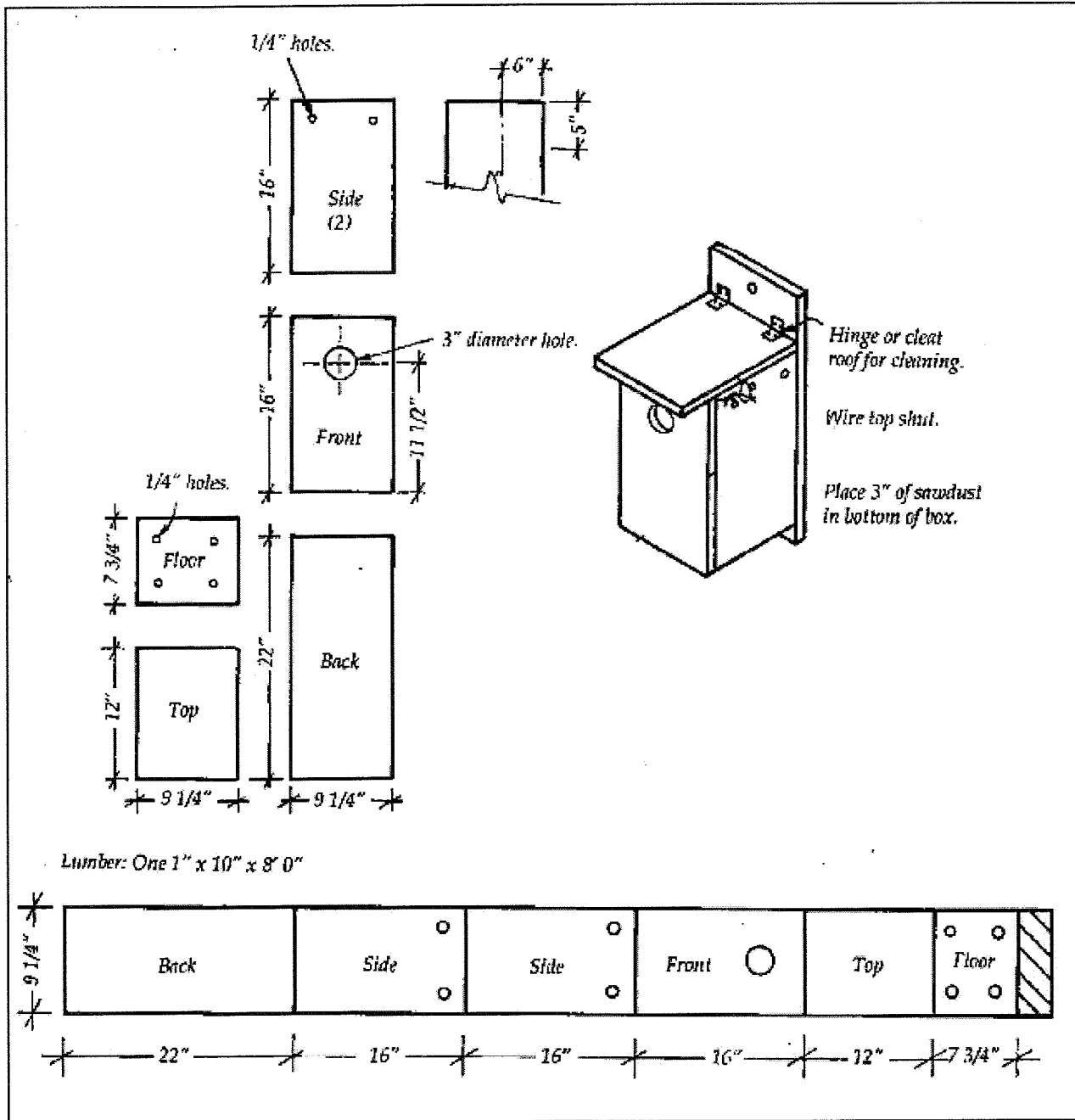


Minnesota Department of Natural Resources

Nest box diagram for eastern bluebird, great-crested flycatcher, and tree swallow.

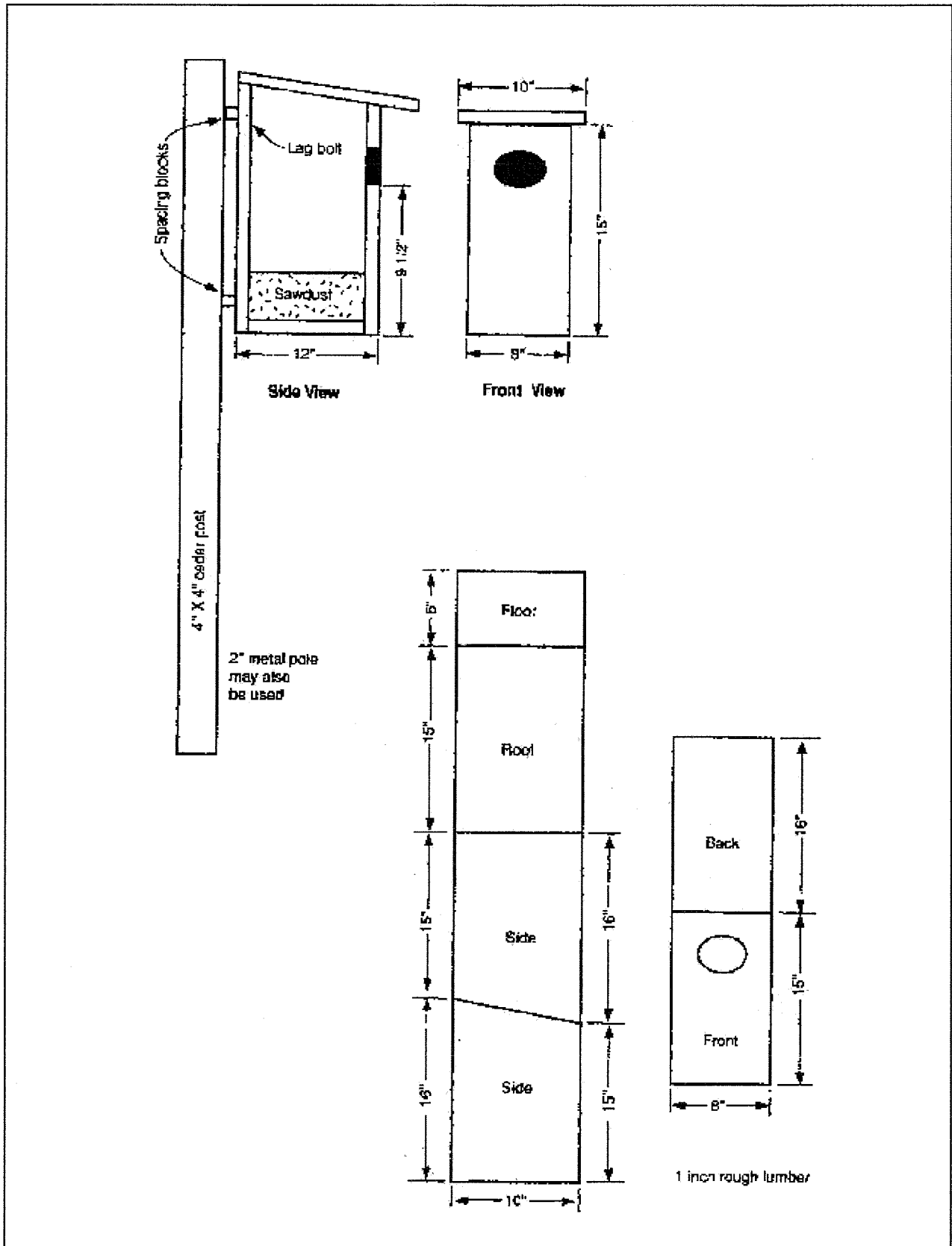


Nest box diagram for American kestrel, boreal owl, northern saw-whet owl, screech owl, fox squirrel, gray squirrel and red squirrel.

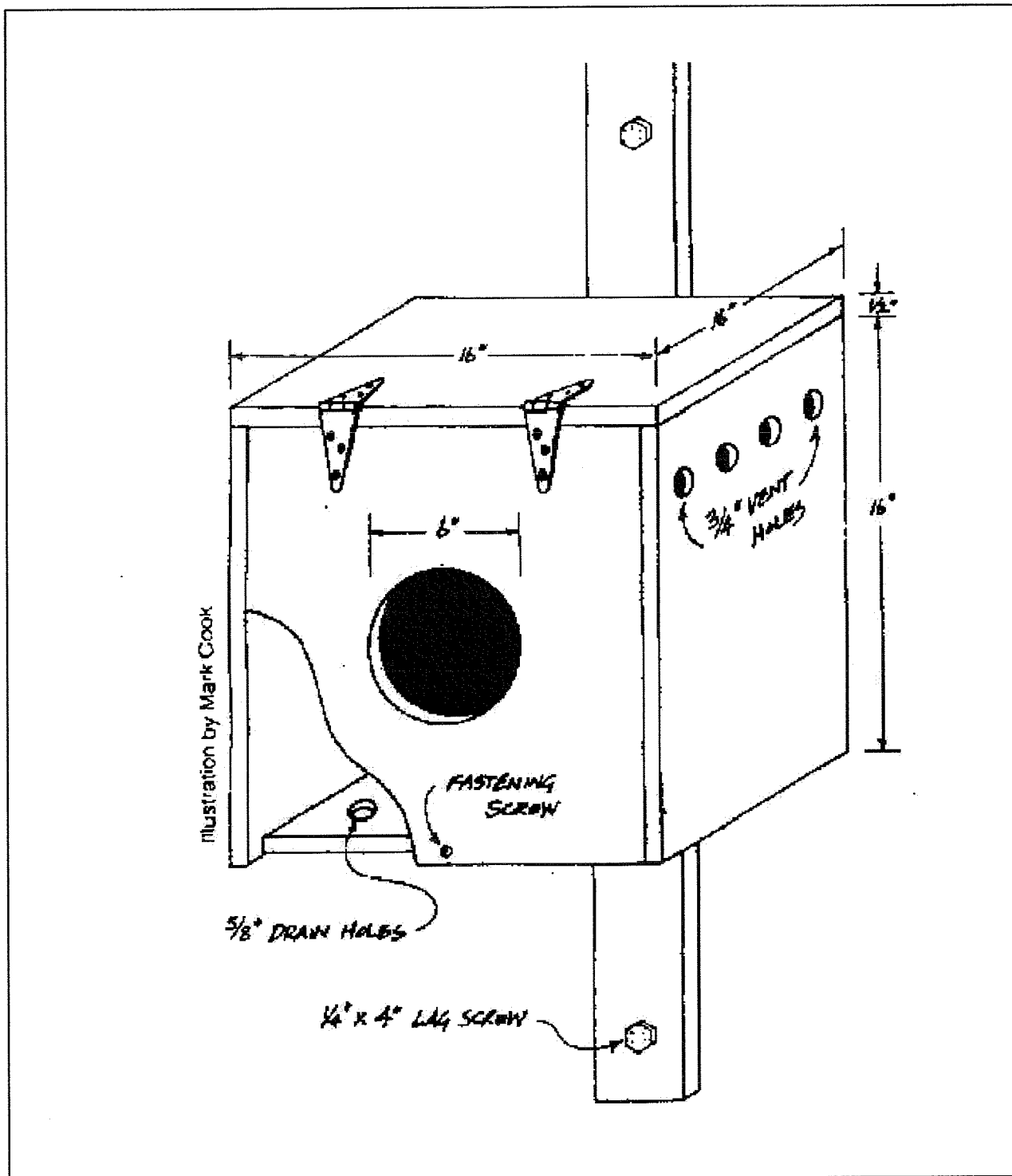


Minnesota Department of Natural Resources

Wood duck nest box diagram.

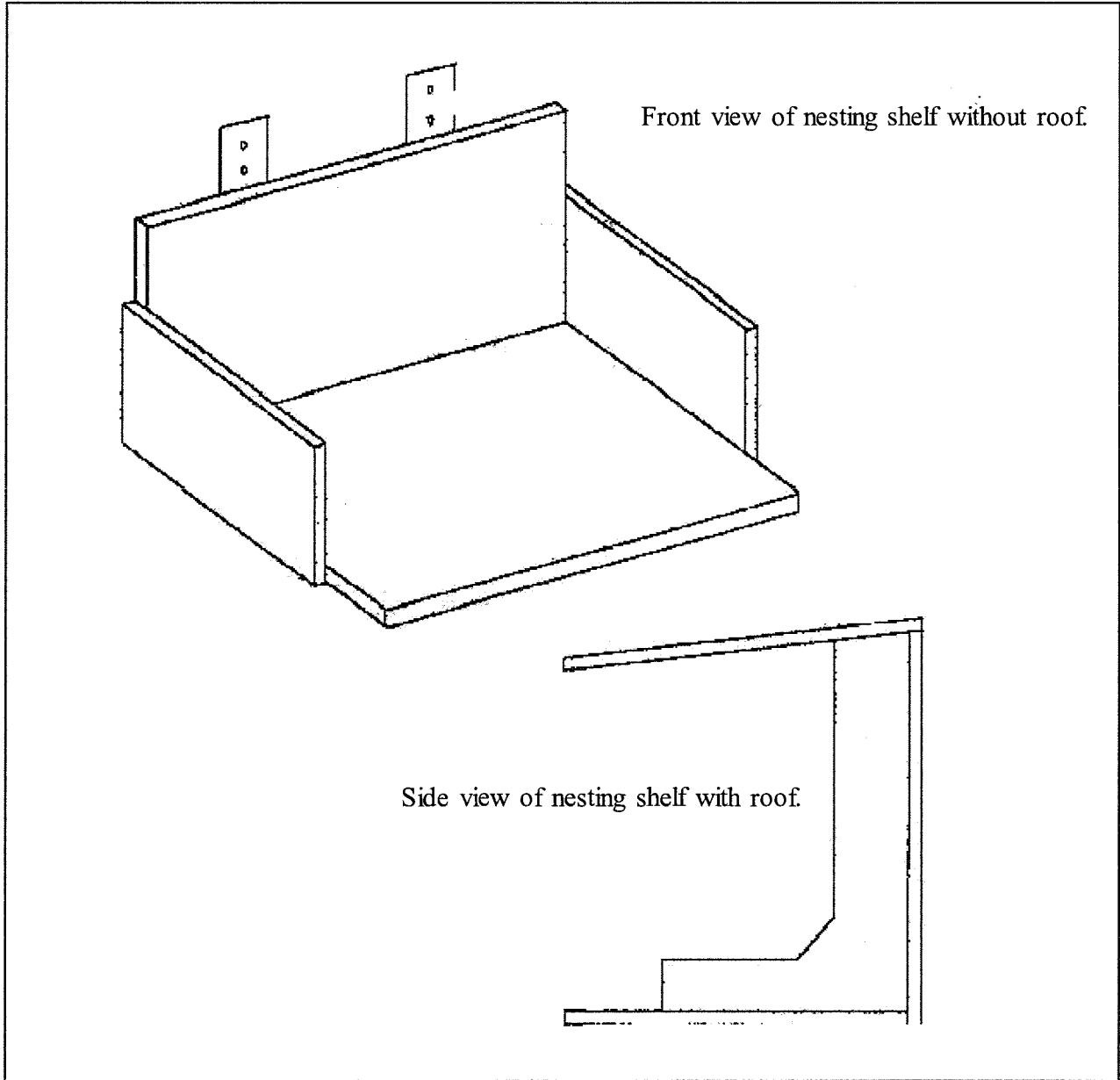


One type of barn owl nest box.



A barn owl nest box based on design in T. Hoffman, *Using Barn Owls for Rodent Control* (see on-line references). The 24-inch cube requires 1 1/2 sheets of 1/2-inch plywood.

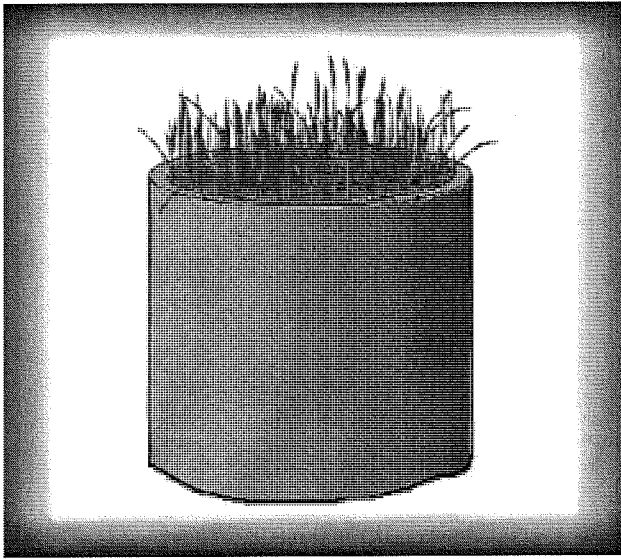
Nesting shelf diagrams for American robin, eastern phoebe, and barn swallow.



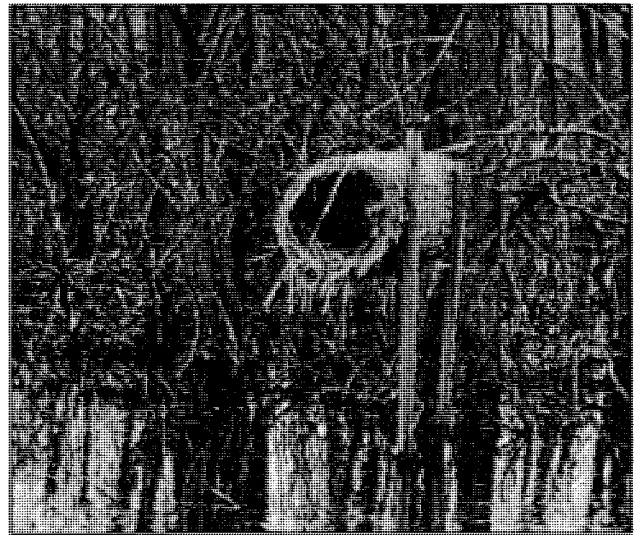
Nesting shelf dimensions and mounting height.

Bird species	Floor dimensions (in.)	Front height (in.)	Mounting height (ft.)
American robin	6x8	8	6 to 15
Eastern phoebe	6x6	6	8 to 12
Barn swallow	6x6	6	8 to 12

Place shelf on side of building with vertical or horizontal brackets.



Concrete waterfowl nesting culvert.



C. Rewa

Waterfowl nesting cylinder, or "hen house."

ends in two to four feet of water. Floating structures and nesting baskets should be installed in areas where view of other similar structures is obstructed.

Hen houses, or nesting cylinders, are suitable nest sites for waterfowl species that favor overhead nesting cover. The house is basically a 3-ft. long cylinder made of rolled fencing wire and hay, dried grass or other vegetation. Cylinders can be mounted on wooden boards attached to poles protruding from the water. Pipes or poles supporting the hen house should extend at least three feet above the surface of the water to prevent flooding.

Basic designs for nesting baskets and cylinders are provided on page 21.

Concrete culverts can be used to make suitable nesting structures for some ducks and geese. To construct a nesting structure, the culvert is be set on end

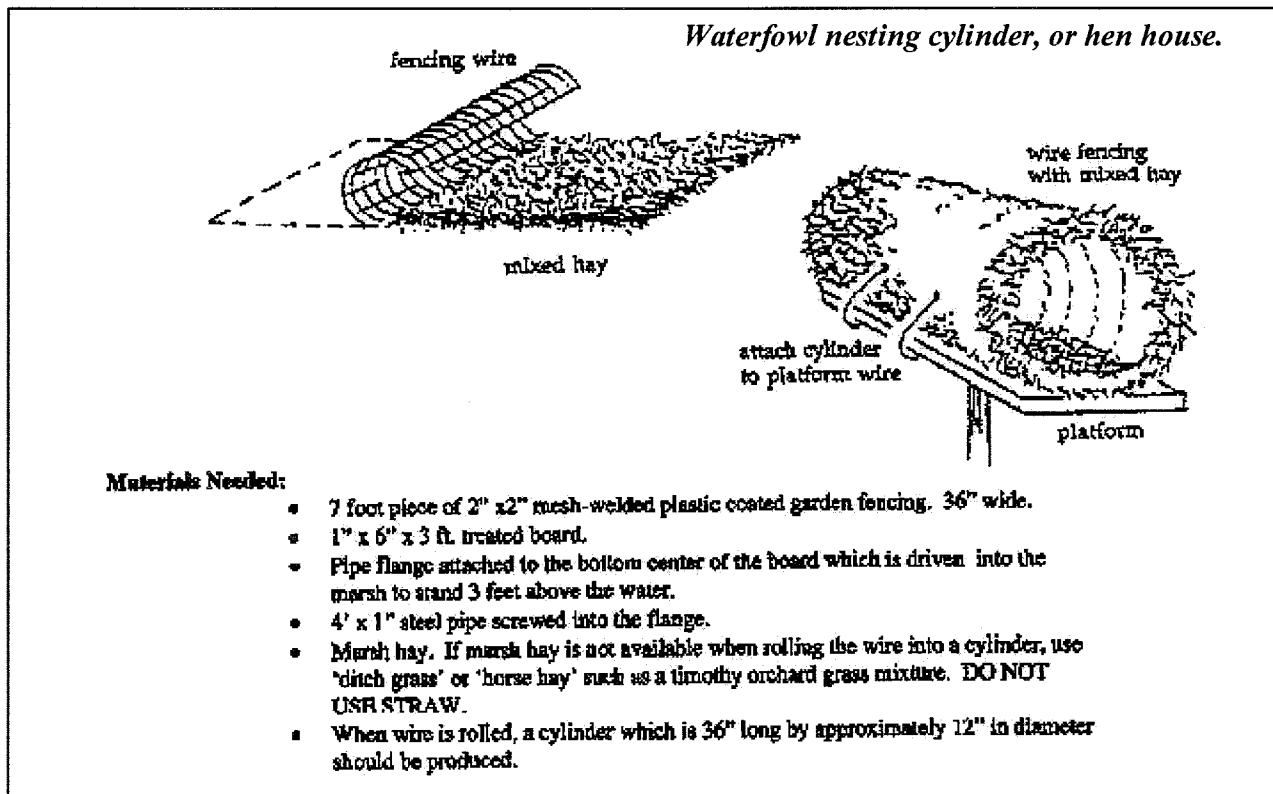
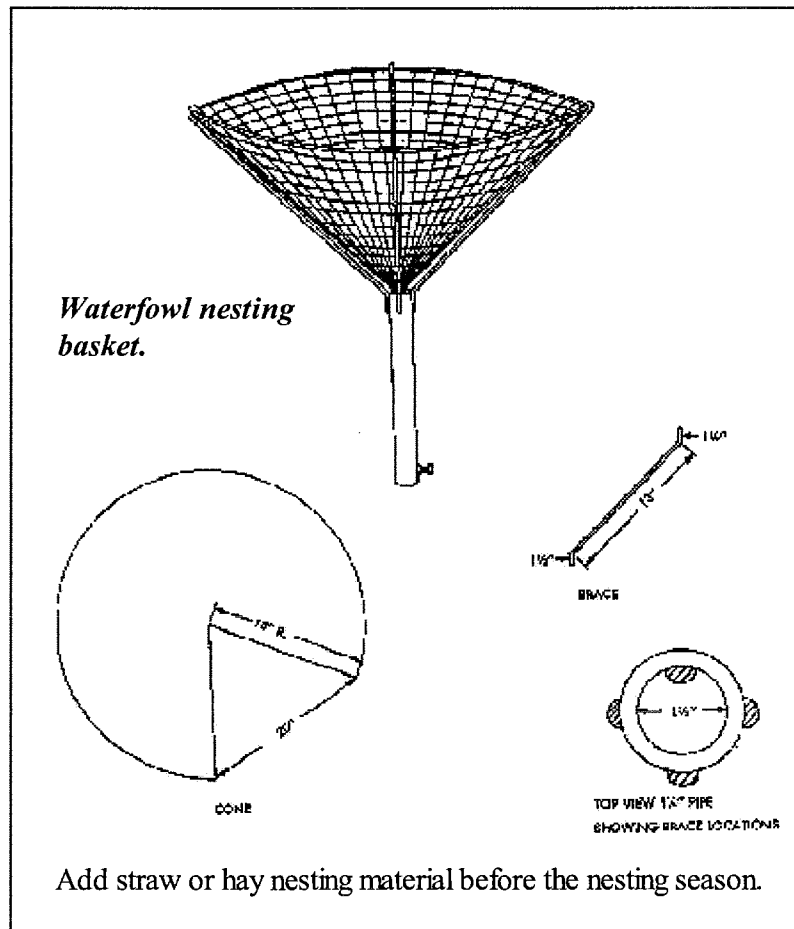
and filled with soil. Vegetation preferred by the target species should be planted in the top layer of soil. Culverts require little annual maintenance and are usually installed in about 18 inches of water along shorelines of lakes, ponds, and wetlands. The culvert should extend far enough above the water to prevent flooding or easy predator access. It may take one or two years before there is adequate vegetation cover to attract nesting waterfowl.

Bat box

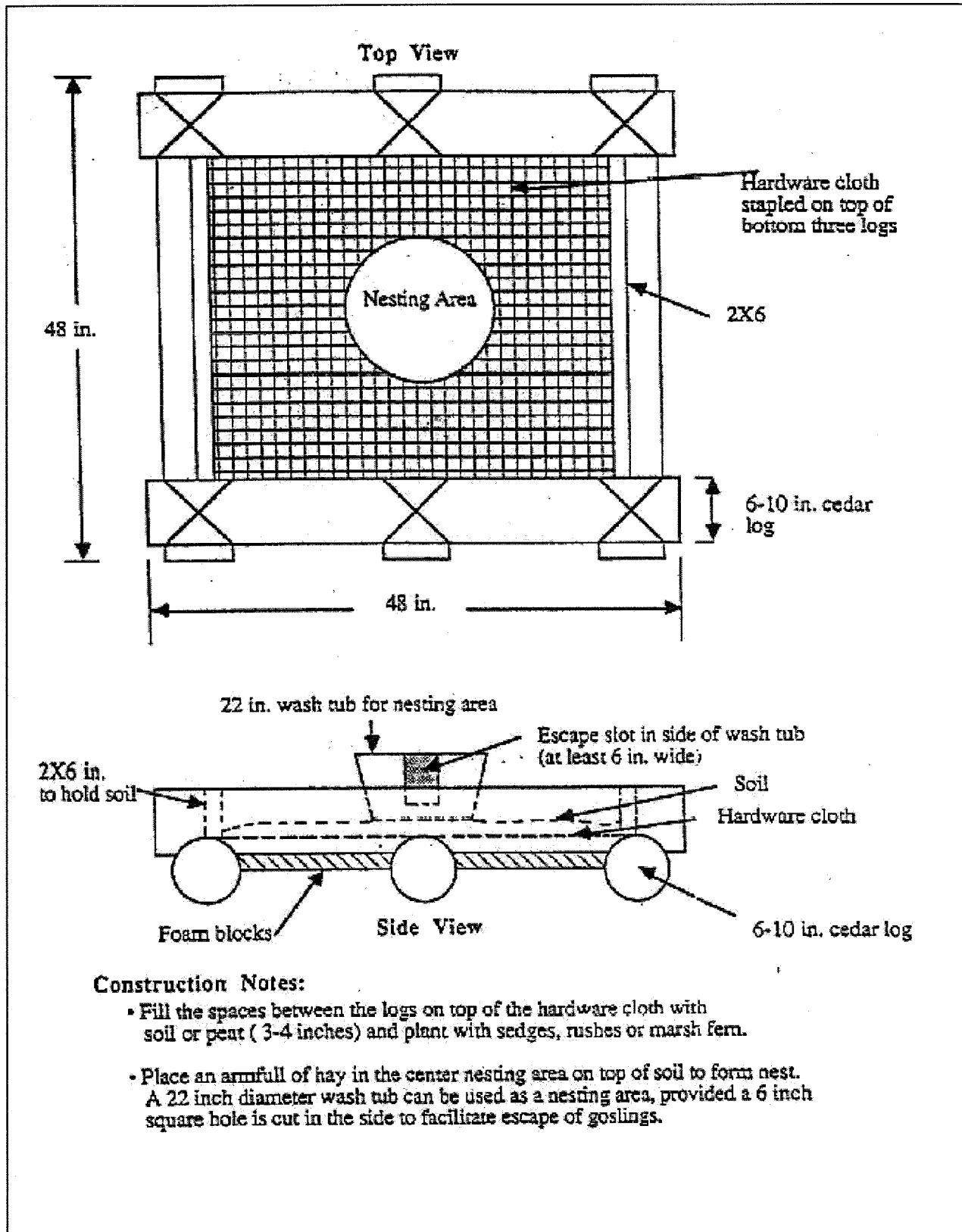
Forty percent of bat species in the United States are rapidly declining or endangered because of habitat loss and destruction of roosts and hibernacula. Bats are nocturnal mammals that depend on roosts in natural tree cavities, caves, hollow trees and sloughing tree bark, and man-made structures such as attics, mines, and bridges. Daytime roosts are used for migrating

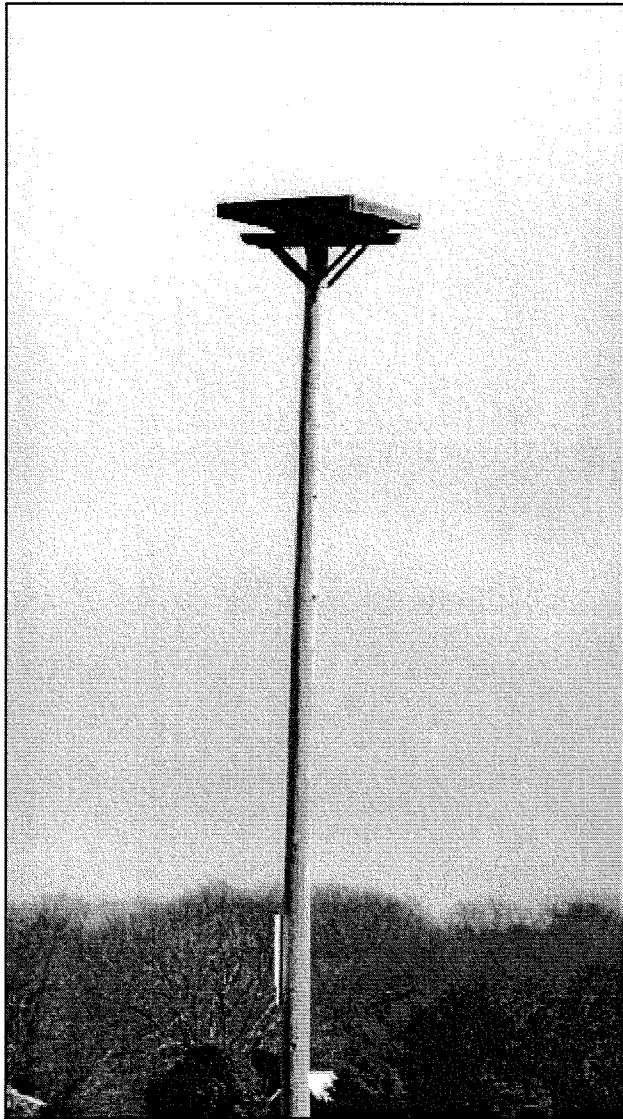


C. Rewa



Floating platform diagram for common loon, Canada goose, and other waterfowl.





Osprey nesting platform.

C. Rewa

and bachelor colonies, as well as summer maternity (or nursery) colonies. Artificial roosting structures, referred to as bat houses or bat boxes, can serve as effective roosts and nursery areas. Pairing two or more bat houses back-to-back or on the same building provides a variety of temperatures for different roosting needs. Pivot-pole systems are the easiest method to raise or lower single or paired boxes for maintenance.

Diagrams for building bat houses are provided on page 26 and 27. For additional information on bat biology, conservation, and research, see Fish and Wildlife Habitat Management Leaflet No. 5, *Bats*, or go to Bat Conservation International's website at www.batcon.org.

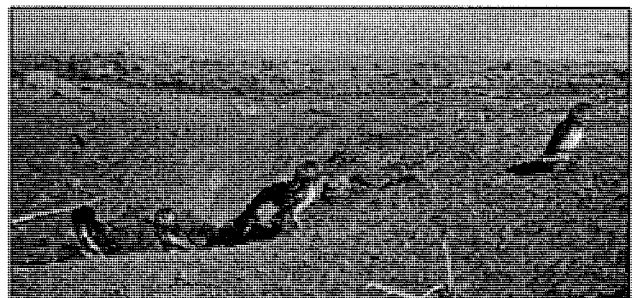
Osprey Nesting Platforms

Ospreys need nesting platforms placed over or close to a good quality water source that supports an abundant fish, the main component of the osprey diet. Platforms should be placed in areas free from human activity such as along secluded wetlands and river segments. Platforms should rise above the elevation of surrounding vegetation and landscape features. Osprey platforms should be located at least 1,000 feet apart and away from nests and perches of other large raptors. Pressure treated wood posts should be at least 25 feet tall. Some sticks should be placed on the platform to simulate previous use by ospreys.

Artificial burrows

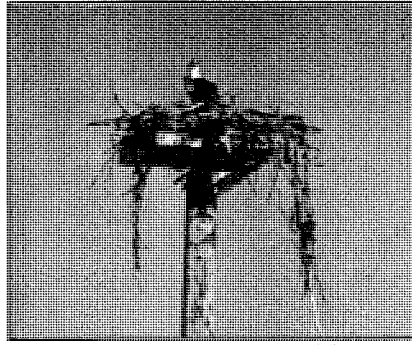
Artificial burrows are used by a variety of ground-dwelling animals. Most artificial burrows are built of plywood and buried at least six inches below the ground surface. For a more natural appearance, a small mound of soil should be built up around the entrance hole to simulate natural excavation by some other animal. Artificial burrows are generally constructed of wood. Plastic tubing at least eight inches in diameter can also be used. The burrow should be placed on a relatively high, well-drained location and checked annually for repairs.

Burrowing owl.—Short grass prairies with good visibility are the preferred habitats of burrowing owls. Ungrazed mixed grass prairies are also used for nesting. The owls inhabit burrows abandoned by ground squirrels, prairie dogs, foxes, coyotes, and badgers. Since much of the burrowing owl's natural habitat has been lost to farming and ranching, artificial nesting burrows can help stabilize declining populations.



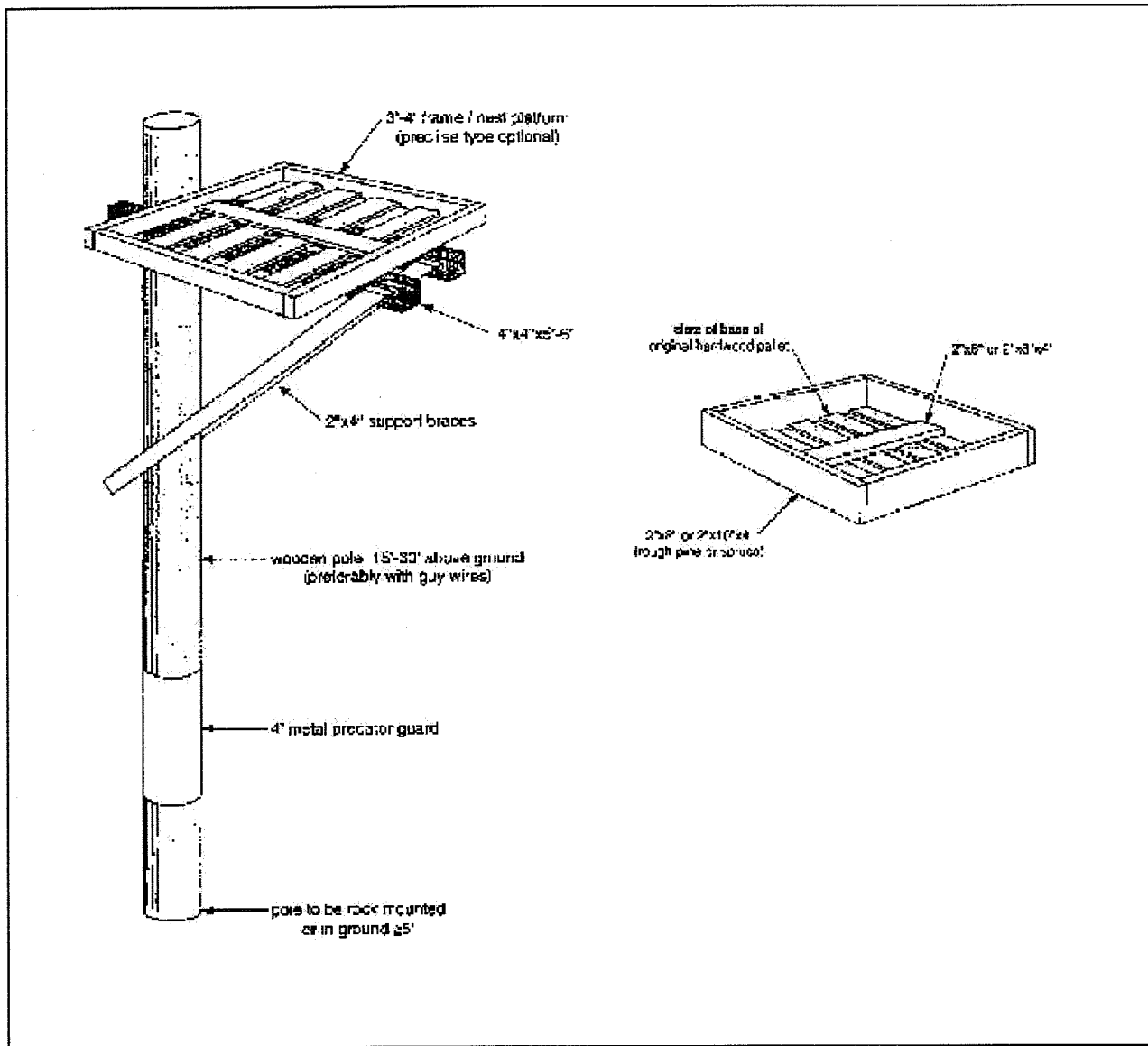
Burrowing owls.

U.S. Fish and Wildlife Service



Unimin-Emmett

Osprey nesting platform diagram.





Bat Conservation International

Bat Box Placement

Install bat houses two to six weeks before spring or before bats are evicted from an attic, barn, etc. Bat boxes should be installed on a 4x4- or 4x6- inch pressure-treated wooden post or a metal pole with an inside diameter greater than two inches (for stability). Boxes should be installed in open woodlots, old orchards, farmlands, or backyards within one-quarter mile of a lake, pond, stream, or wetland.

Bat houses placed on poles, under building overhangs or on the side of buildings are occupied more successfully than those boxes mounted on trees. The bottom of the house should be 12 to 15 feet above the ground and located in ample sunlight. Northern and eastern bat boxes should receive at least eight hours of direct sunlight per day and face south or southeast for the maximum amount of solar radiation. Warmer climates should receive six or more hours of direct sunlight and face east or southeast. In the hottest climates, four or five hours is acceptable.

Basics of Bat House Design

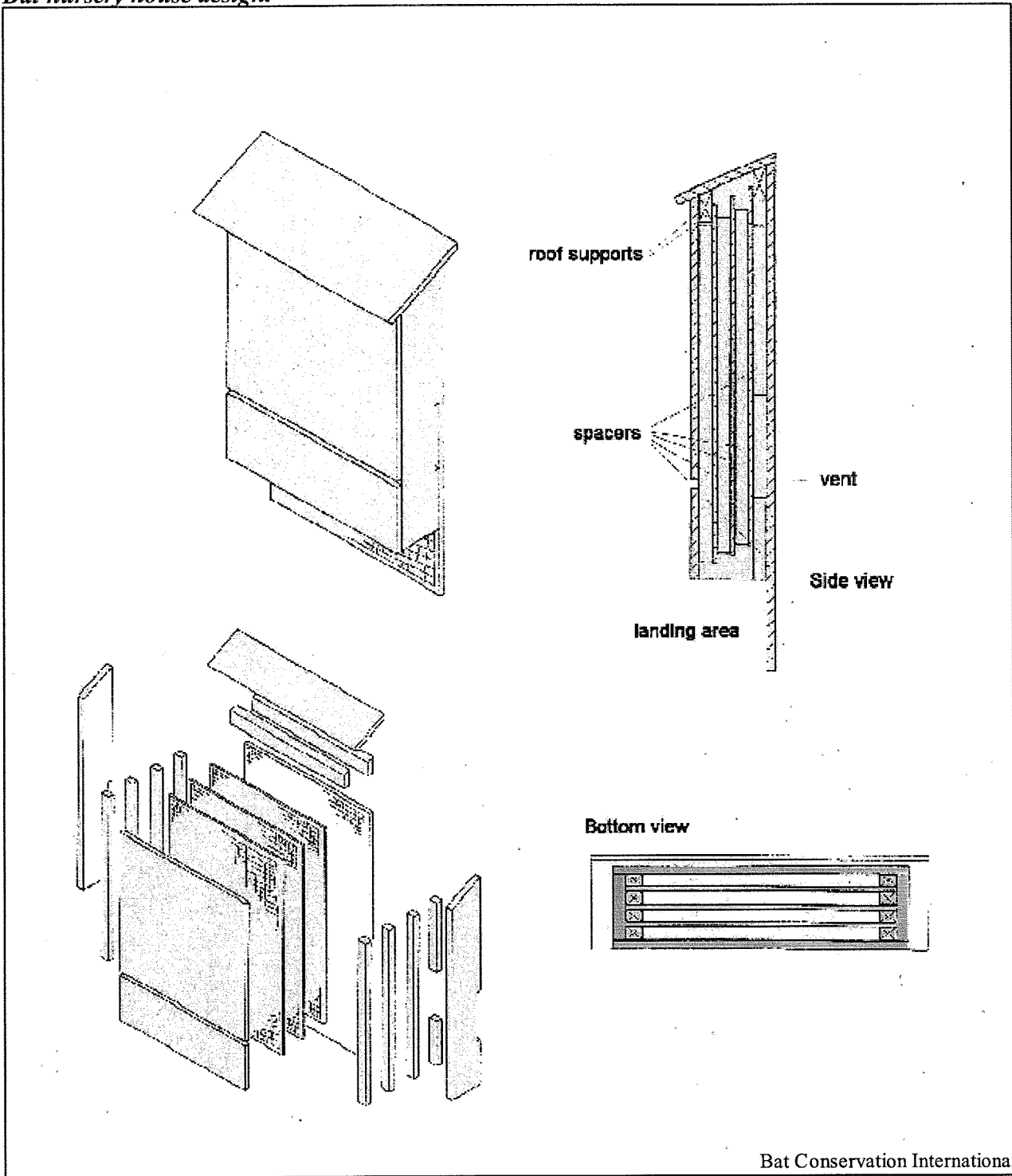
Most bat houses, or bat boxes, are made of wood. Typically exterior-grade plywood that has not been pressure-treated is used. Listed below are some basic guidelines for building bat boxes. For more detailed information, contact Bat Conservation International (BCI) or visit their website at <http://www.batcon.org>.

- ❖ Internal roosting partitions should be properly spaced, 3/4 to 1 inch apart for bat species in the U.S., to conserve heat.
- ❖ Internal roosting partitions should be roughened with a saw or chisel to create footholds for bats. Use 1/8- to 1/4-inch plastic mesh as a substitute.
- ❖ For boxes in regions where average July temperatures exceed 85 degrees Fahrenheit, include vents six inches from the bottom of the box. Front vents should be as long as the box is wide; side vents should be 6x1/2 inch.
- ❖ A partial bottom can be added to boxes in colder, northern climates to increase the internal temperature of the box. The bottom should be angled at 45 degrees or greater to allow guano to fall out of the box. Attach the bottom with rust-proof hinges and secure with a hook-and-eye latch for easy maintenance.
- ❖ Apply three layers of a dark colored exterior paint to the outside of the bat house; dark brown or black for boxes in the north and east, medium to light brown for boxes in the south and southwest. An aluminum roof may need to be installed (for shade) over boxes in regions with high summer temperatures.
- ❖ All exterior surfaces should be caulked and sealed to prevent heat loss from inside the box and prevent precipitation from leaking into the box.
- ❖ Perform routine, annual maintenance on the bat box such as caulking, painting, and general repairs.



Bat Conservation International

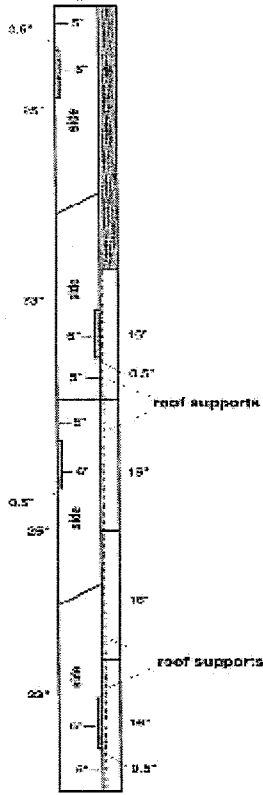
Bat nursery house design.



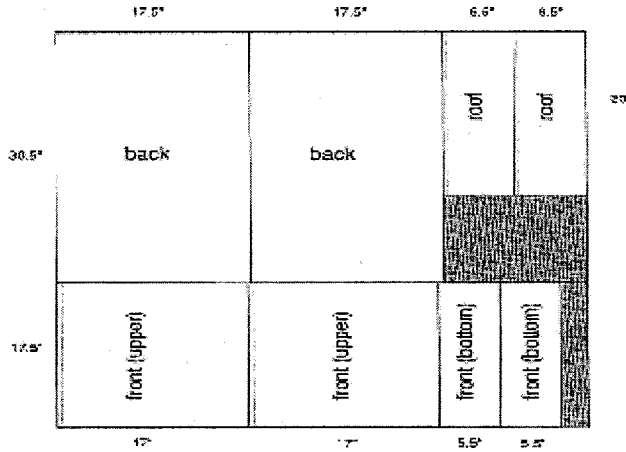
Bat Conservation International

1. Measure and mark all wood as per cutting diagrams on page 27. Cut out all parts.
2. Cut six pieces of netting 14"x21". Staple to partitions.
3. Screw back to sides, caulking first. Be sure top angles match.
4. Cut a piece of netting 16"x30" and staple to inside surface of back. Be sure netting lies flat and does not pucker.
5. Construct house as per drawings above. Place spacers on partitions, screw top front piece to sides, then screw bottom front piece to sides to create a 1/2" vent between the two pieces. Attach supports, attach roof.
6. Caulk between roof and sides, sides and front pieces, and sides and back pieces to seal the nursery house tight.

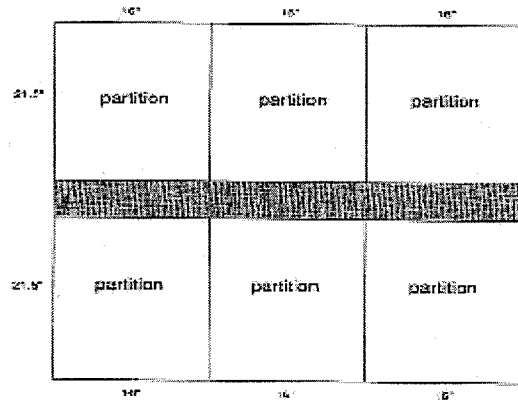
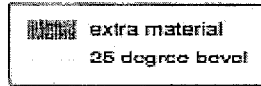
Bat nursery house sawing diagrams.



1" x 6" x 8' sheeting

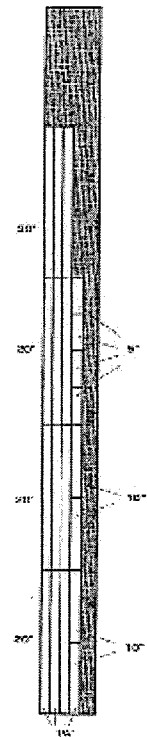


4' x 4' x 1/2" plywood



4' x 4' x 1/4" plywood

spacers:
5" spacers = back bottom
10" spacers = back top
20" spacers = front



1" x 6" x 8' sheeting

Bat Box Monitoring

Bat boxes should be checked at least twice a month in the summer with a flashlight in daylight hours to count adult bats and young. Boxes should be checked at least once during the fall and once during the winter to check for migrating and overwintering bats. Bats are sensitive to excessive human disturbance. For large colonies, count the bats as they emerge from the box at dusk.

To determine if a box contains a nursery colony (late May through June), check the box 45 minutes after sundown after the adults have left to feed. The young are pink and flightless and cling to the insides of the box.

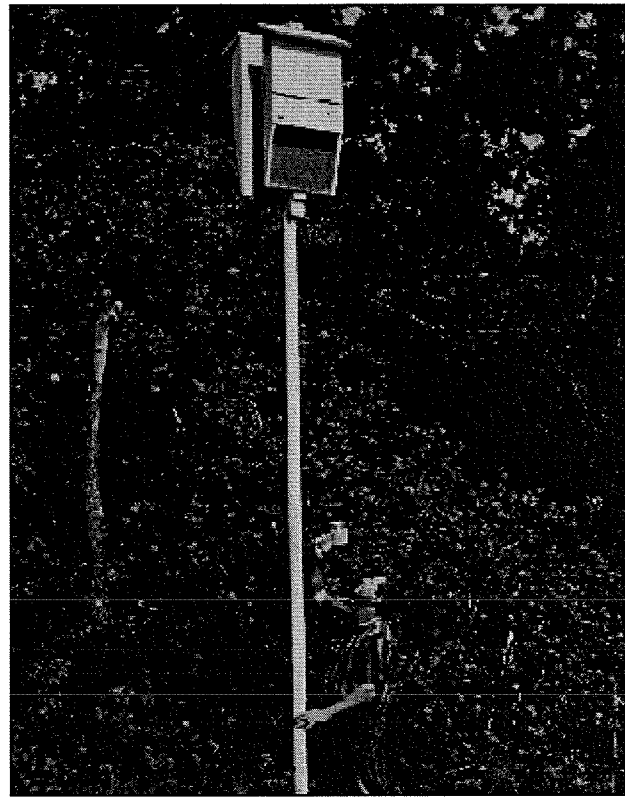
Landowner Assistance

There are a variety of private and public organizations that provide technical and/or financial assistance to landowners and managers that want to enhance existing wildlife habitats by erecting artificial nesting structures. Local chapters of ornithological societies, such as local Audubon chapters or birding clubs, can help landowners construct and install the appropriate nesting structures. State wildlife agencies can also help landowners identify wildlife needs and assess available habitat. Local hardware stores, home improvement stores, lumberyards, or pipe manufacturers may be willing to donate materials needed to construct a large quantity of nesting structures. Boy Scout and Girl Scout troops may wish to help land managers build and install artificial nesting structures. Local utility companies may also be willing to assist landowners erect raptor and heron platforms or other tall, hard to install nest structures.

There are numerous groups and organizations that supply information about the biology of specific species, as well as detailed instructions for building nesting structures to attract the desired species.

Conclusion

Artificial nesting structures are not meant to replace suitable habitat, but rather to enhance existing habitat



Bat Conservation International

Monitoring bat boxes during daylight hours minimizes disturbance to roosting bats.

and increase the nesting success of a particular species. Basic habitat management techniques for improving habitat for a variety of wildlife species and groups are provided in other habitat management leaflets in this series. These leaflets contain information about specific species that use artificial nesting structures, such as the wood duck (*No. 1*), eastern bluebird, (*No. 2*), and American kestrel, (*No. 3*). These leaflets are available at www.ms.nrcs.usda.gov/whmi and at www.wildlifehc.org.

Landowners and managers must be patient when attempting to attract wildlife to artificial nesting structures. It can take a year or two for the desired species to take notice of new nesting structures. Human activities that disturb nesting activities should be restricted in the vicinity of structures during the breeding season.

Quality of construction is important. The type of materials used, entrance hole dimensions (if applicable), attachments, and predator guards contribute to the ef-

Groups and organizations that design artificial nesting structures for specific wildlife species.

Group name	Contact information	Website address
Bat Conservation International (BCI)	P.O. Box 162603 Austin, Texas 78716-2603 tel: 512-327-9721 fax: 512-327-9724	www.batcon.org
Purple Martin Conservation Association (PMCA)	Edinboro University of Pennsylvania Edinboro, Pennsylvania 16444 tel: 814-734-4420	www.purplemartin.org
North American Bluebird Society (NABS)	P.O. Box 74 Darlington, Wisconsin 53530-0074	www.nabluebirdsociety.org
The Eagle Institute	P.O. Box 182 Barryville, New York 12719 tel: 914-557-6162	www.eagleinstitute.org
National Audubon Society	700 Broadway New York, New York tel: 212-979-3000 fax: 212-979-3188	www.audubon.org

fectiveness and longevity of the structure and the reproductive success of the targeted wildlife species. By considering the biology and habitat requirements of the desired species, landowners and managers can maximize the benefits of using artificial nesting structures for wildlife.

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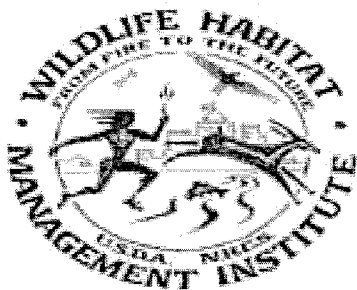
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Wildlife Habitat Management Institute

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Madison, Mississippi 39110
(601) 607-3131

In cooperation with partners, the mission of the Wildlife Habitat Management Institute is to develop and disseminate scientifically based technical materials that will assist NRCS field staffs and others to promote conservation stewardship of fish and wildlife, and deliver sound habitat management principles and practices to America's land users.



www.whmi.nrcs.usda.gov

Wildlife Habitat Council

8737 Colesville Road, Suite 800
Silver Spring, Maryland 20910
(301) 588-8994

The mission of the Wildlife Habitat Council is to increase the amount of quality wildlife habitat on corporate, private, and public land. WHC engages corporations, public agencies, and private, non-profit organizations on a voluntary basis as one team for the recovery, development, and preservation of wildlife habitat worldwide.



www.wildlifehc.org

Primary author: Holly L. May, Wildlife Habitat Council. Reviewers: Sheryl Ducummon, Bat Conservation International; Rob Pauline, Wildlife Habitat Council; Charlie Rewa, NRCS Wildlife Habitat Management Institute; and Tina Phillips, Cornell Laboratory of Ornithology.

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Wood Duck

(*Aix sponsa*)

Fish and Wildlife Habitat Management Leaflet



General Information

The wood duck is considered by many bird watchers to be North America's most colorful waterfowl species. Its scientific name, *Aix sponsa*, translates into "waterbird in bridal dress." Today the wood duck is one of the most common waterfowl species breeding in the United States. However, this was not always the case. Writings from the early 19th century indicate that wood ducks were in abundant supply and very popular for their tasty meat and bright decorative feathers. By the late 1880's, unregulated hunting and destruction of

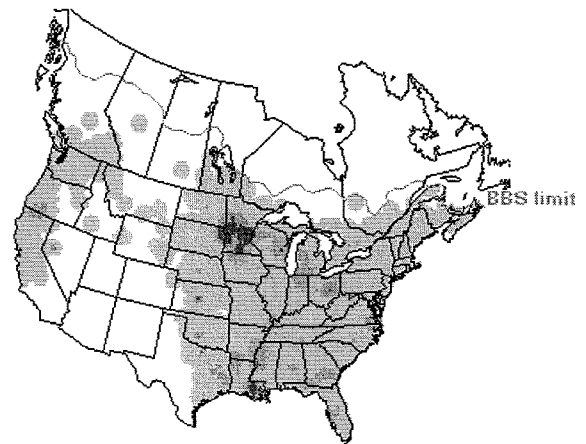
woodland and wetland habitat had caused the wood duck population to decline to alarmingly low levels. By the beginning of the 20th century, wood ducks had virtually disappeared from much of their former range.

In response to the Migratory Bird Treaty established in 1916 and enactment of the Federal Migratory Bird Treaty Act in 1918, wood duck populations began to slowly recover. By ending unregulated hunting and taking measures to protect remaining habitat, wood duck populations began to rebound in the 1920's. The development of the artificial nesting box in the 1930's gave an additional boost to wood duck production. Wood ducks eagerly accepted boxes as suitable nesting sites, and over the following fifty years, conservation groups and individuals helped increase numbers of wood ducks by preserving habitat and erecting nest boxes. The combination of hunting restrictions and habitat conservation and management measures enabled wood duck populations to rebound enough to support conservative hunting in the 1940's. The story of the wood duck is an example of how active wildlife management techniques can have a tremendous effect on the overall success of an individual species.

This pamphlet is designed to serve as an introduction to the habitat requirements of the wood duck and to assist in the development of a comprehensive wood duck management plan. The success of any individual species management plan depends on targeting the specific needs of the species and analyzing the designated habitat areas as a whole to ensure that all habitat requirements are present. This guide also provides recommendations for monitoring the program to ensure successes are documented and problems are addressed before they impact the success of the overall management plan.

Range

The wood ducks' range extends on the east coast from Nova Scotia west to the north central U.S. and south to Florida and the Gulf of Mexico. Birds nesting in New England winter in the Atlantic states from the Carolinas southward. Midwestern wood ducks winter in the area extending from Georgia west to Texas. On the west coast, the wood ducks' range extends from British Columbia



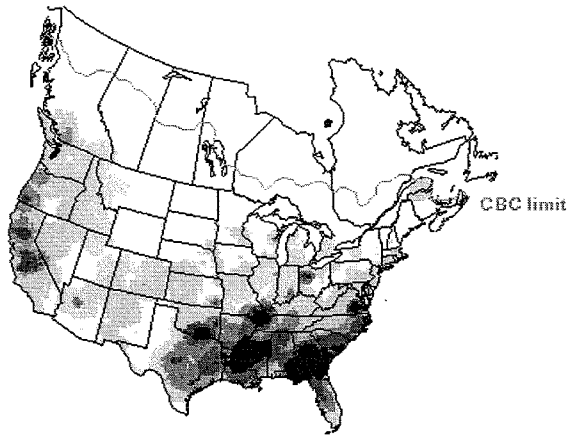
Breeding Range

south to the Mexican border. Upper west coast wood ducks will winter in southern California and the Mexican Pacific coast. Southern breeding wood ducks are year-round residents. Fall migration generally begins in October and extends into November. Spring migration occurs during March and April. Wood ducks migrate either in pairs or in small flocks. Wood ducks respond well to habitat protection and restoration activities, and breeding pairs are increasing use of suitable habitat outside traditional breeding areas.

Habitat Requirements

General

Wood ducks nest in woodland areas along lakes, rivers, and vegetated wetland areas. During the winter months, wood ducks inhabit bottomland hardwood wetlands, beaver ponds and flowages, river oxbows, meanders and backwaters, and other inland freshwater forested wetland areas. Habitat areas chosen by wood ducks are commonly used by other waterfowl species such as black ducks, hooded mergansers, and ring-necked ducks. High-quality wood duck habitat is intricately linked to preservation and management of old growth timber along river corridors and availability of nesting sites. Although wood duck populations have recovered,



Winter Range

the largest threat to their future is the continued loss of habitat. By protecting and restoring floodplain timber, river oxbows and meanders, and other freshwater wetland and riparian habitats, landowners can assist in the continued success of wood ducks and other migratory waterfowl species that rely on similar habitats.

Food

Food for young birds and adults differs dramatically. The early diet of ducklings consists largely of insects, aquatic invertebrates, small fish, and other high-protein animal material. After six weeks of age, the young switch to plant foods until their diet consists of approximately 90 percent vegetative material, primarily aquatic plants such as algae, watermeal, watershield, sago pondweed, and duckweed. Adult wood ducks feed on a variety of nuts and fruits, aquatic plants and seeds, and aquatic insects and other invertebrates. Insects and aquatic invertebrates are particularly important food items of adult hens during egg laying in spring. Acorns and other forest mast are important fall and winter foods. While acorns are the primary winter foods, the seeds of bald cypress, hickory, sweet gum, buttonbush, arrow-arum, bur-reed, and wild rice are also common winter foods. Wood ducks feed primarily in shallow water areas, but will also forage on the forest floor for seeds, acorns, and nuts.

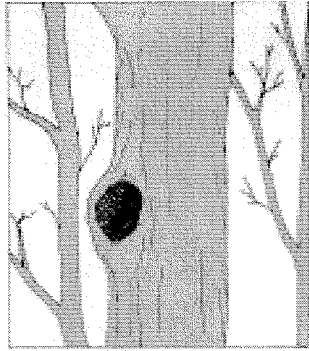
Important wood duck food plants. The following species are known to be important food items in the diet of wood ducks. Those species in bold print are of particular value for their usefulness as a winter food source.

oak (acorns)	hickory (nuts)	elm	bald cypress	beech (nuts)	sweet gum	bulrush
ash	button bush	maple	blackgum	bur-reed	rice cutgrass	pondweed
arrow-arum	wild rice	sedge	smartweeds	barnyard grass	nightshade	watershield
cowlily	beggarticks	duckweed	grape	St. John's-wort	panic grasses	waterlily

These species may be used to enhance vegetation which already exists in and around woodland areas and aquatic habitats. Adding these species to those currently existing will enhance food availability for wood ducks.

Cover — Nesting

Wood ducks nest in natural tree cavities and in some cases, those excavated and abandoned by woodpeckers. Nesting boxes are also readily accepted for nesting. Nesting pairs typically select cavities in deciduous woodland areas in close proximity to rivers, wetlands, and other suitable aquatic habitats used for brood rearing. Cavities located 30 feet or more above the ground are preferred, but the height can vary from near ground level to 65 feet. Suitable natural cavity dimensions typically have an entrance hole diameter of at least 4 inches, an inside diameter of approximately 6 to 8 inches, and a depth of at least 24 inches. Optimal nesting habitat contains up to five suitable cavities per acre in close proximity to brood-rearing habitat; however, since most natural cavities are not suitable for use by nesting wood ducks, these conditions frequently require that 50 or 60 natural cavities per acre exist. This illustrates the utility of providing suitable artificial nesting boxes to augment the availability of natural cavities.



Nest Box Design. — Nest boxes should be constructed of a weather-resistant wood; cedar or cypress is often recommended. The wood can be painted, stained, or treated, but only on the outside surface. The entrance hole should have a 4-inch diameter or be an oval that is 3 inches high and 4 inches wide. Numerous nest box designs have been used with success; fig. 1 provides one example. A 3-inch wide strip of $\frac{1}{4}$ -inch mesh hardware cloth should be securely fastened to the inside of the box under the entrance to function as a ladder for the hen and newly hatched ducklings. The cut edges of this cloth should be folded back before insertion to avoid injury to the ducklings. Another method of assisting the ducklings in their climb from the nest to the entrance hole is to roughen up the wood surface under the hole with a chisel. A 3-inch layer of coarse sawdust should be placed at the bottom of the box to serve as nesting material and to help prevent the eggs from rolling around. The lid or one side of the box should be removable to facilitate monitoring and cleaning. All wood duck boxes should be fitted with a galvanized sheet metal predator guard (see fig. 2). The predator guard should be placed 6 to 12 inches below the bottom of the box.

Nest Box Installation. — Wood ducks are highly secretive in selecting nest sites to minimize impacts of nest predators and competition from other wood ducks. Therefore, it is important to locate individual nest boxes in relatively secluded areas within timber stands where natural cavities would occur naturally. Nest boxes can be placed either on land or over the water. If located over the water, they should be placed at least 4 feet above the high water level and the entrance hole should face the open water rather than the shoreline. Because of ease of access by predators, installation of nest boxes directly on trees should be avoided. Nest boxes placed on land should be located from 30 to 150 feet away from the shoreline. Boxes placed directly on the shoreline appear to be more likely frequented by nest predators. Since the hen must lead her ducklings to water soon after they hatch, the area between the nest box and the water's edge should be free of any major obstacles such as roads or fencing. Nest boxes placed on poles over water are generally more easy to monitor than those placed in trees. Regardless of whether the box is placed over the water or land, the entrance should be clear of obstructions to provide easy access for the ducks.

In order to maximize nest box use while minimizing nest dumping (see sidebar below), it is generally recommended that nest boxes should be placed at least 600 feet apart and should not be visible to one another. When placing nest boxes in isolated locations, consider ease of access for monitoring purposes.

Cover — Brood Rearing

Wood duck broods require shallow water for foraging on invertebrates and aquatic plants that contain some protective cover from predators. A ratio of 50 to 75 percent cover to 25 to 50 percent open water is preferred as brood-rearing (and breeding) habitat. Cover may be provided by trees or shrubs overhanging the water, flooded woody vegetation and debris, and herbaceous emergent vegetation. Ideal shrub cover is

provided by mature shrubs that provide a dense canopy about two feet above the water surface. Button bush is an important shrub species in a large portion of the wood duck's range due to its brushy growth form, providing brood cover, and its prolific seed production, used heavily by foraging adults. Reliance on permanent, deeper water bodies for brood habitat should be avoided to minimize duckling mortality from aquatic predators such as snapping turtles and large fish.

Adult molting cover requirements are generally met by suitable brood-rearing habitat. Permanent water, cover, and food are the key elements of molting habitat.

Cover — Winter

In areas where wood ducks winter, areas similar to brood rearing habitat provide adequate winter cover. Bottomland hardwood wetlands and quiet river backwaters and streams with an abundance of partially submerged downed timber, shrubs, and woody debris are favored. Winter-persistent herbaceous emergent vegetation that has a shrubby-like life form (e.g., cattail, soft rush, bulrush, bur-reed, etc.) may also provide adequate winter cover. Security provided by overhead woody cover is the key element of good wood duck roosting habitat.



Water

Water requirements for wood ducks are assumed to be met where suitable brood-rearing and wintering habitat exist.

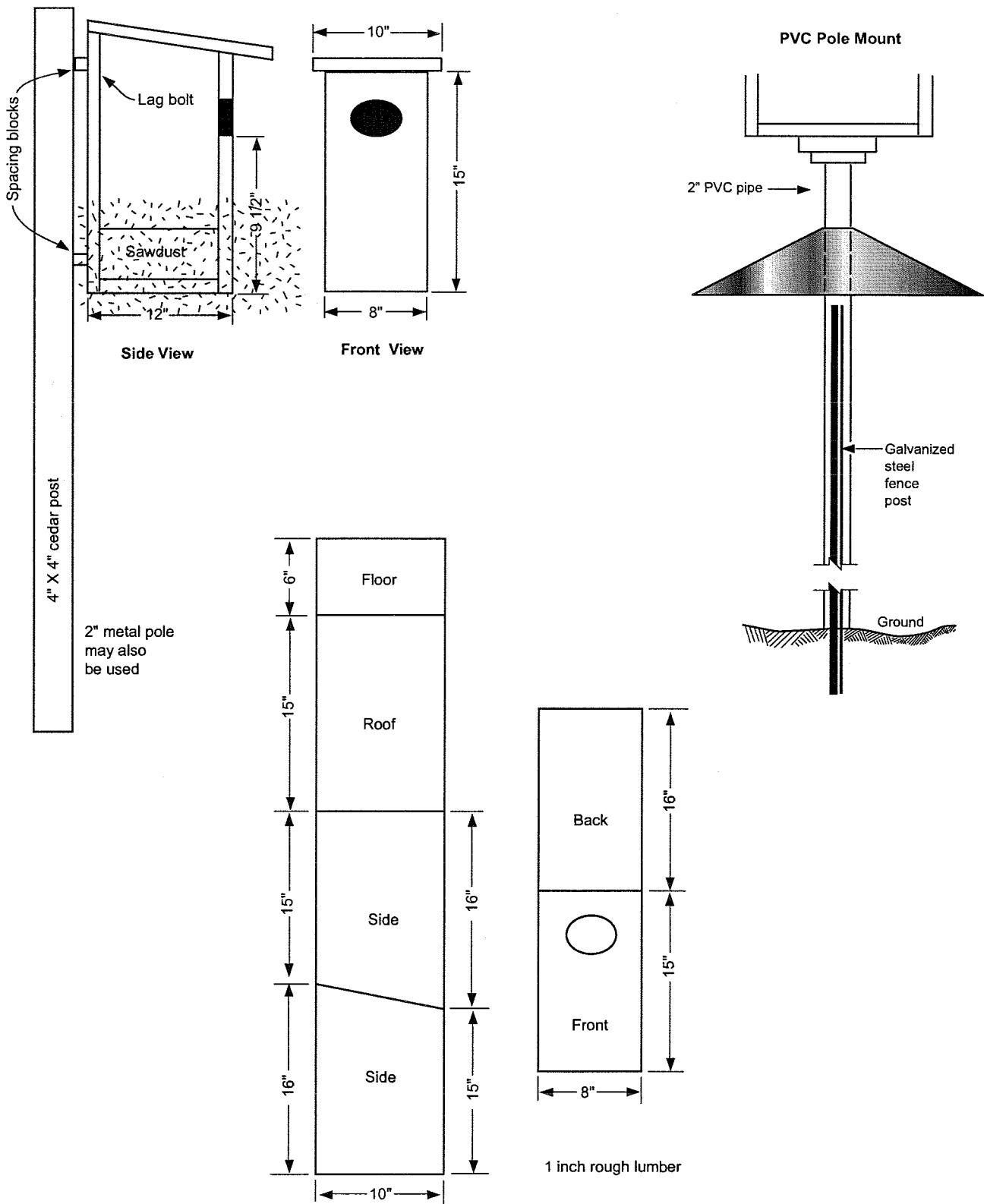
Interspersion of Habitat Components

In order for successful wood duck reproduction and survival to occur, all the habitat components must be available in relative proximity to one another. Since wood ducks are highly mobile during winter, the most critical aspect of habitat interspersion, or the mix of different habitat types, is the proximity of suitable brood-rearing habitat to nesting habitat in the spring. The highest-quality nesting habitat is of little use if the nearest brood-rearing habitat is more than a mile distant. Likewise, the best brood-rearing habitat will not support wood duck broods if there is no nesting habitat in the vicinity. In southern areas where wood ducks are year-round residents, the best habitats consist of a complex of forested wetland habitats that include live forest, green-tree reservoirs, rivers, oxbows, riparian corridors, beaver ponds, shrub-scrub and robust emergent herbaceous wetlands.

Minimum Habitat Area

Since wood ducks are able to nest at some distance from brood-rearing habitat, no reasonable estimate of minimum nesting habitat size exists. In addition, no good estimates for minimum wintering habitat area are available due to the high mobility of wintering birds. However, at least 10 acres of wetland or other aquatic habitat in a contiguous unit, or in isolated parcels separated by no more than 100 feet of upland, is needed in close proximity to nesting habitat to support brood rearing. Lands outside the immediate planning area should be considered when making the determination of minimum habitat area for wood duck reproduction.

Fig. 1. Wood duck nesting box design



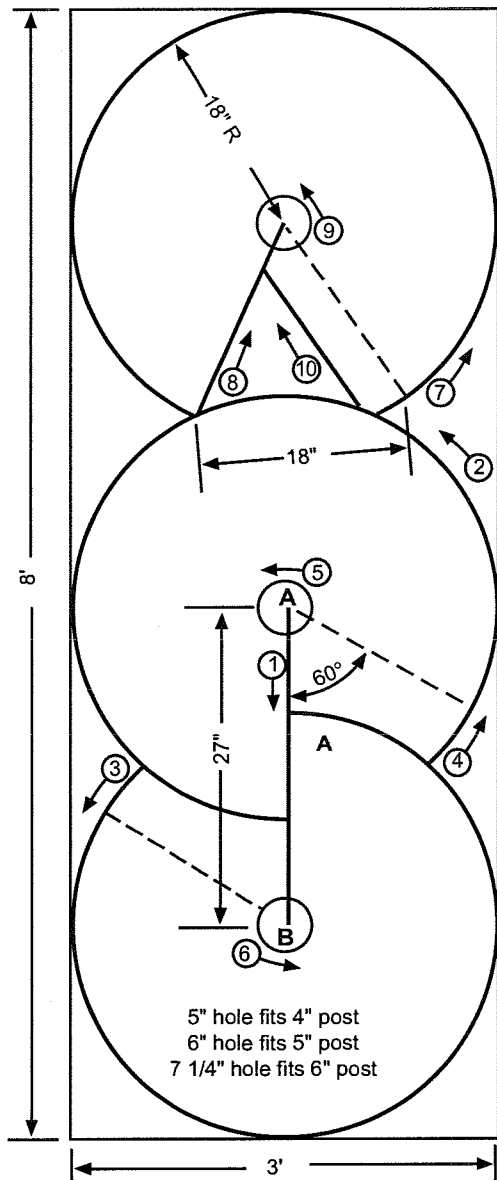
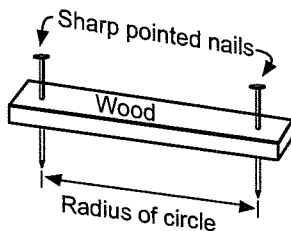


Fig. 2. Standard cone-shaped predator guard.

At left is a layout for cutting three predator guards from a 3 ft x 8 ft sheet of 26-gauge galvanized metal. When installing the guard, overlap the cut edge to the dotted line. To facilitate cutting, follow the sequence of numbers. Make circular cuts in counterclockwise direction. To make initial cut on line A-B, make a slot at A with a wood chisel, use tinsnips, and wear leather gloves.



Home made compass for scribing metal

Use 3 wooden mounting blocks

Drill pilot hole for nailing block to post

Side view cut away to show mounting block

Nail guard in place

1/4" round head stove bolts or metal screws

36" minimum above water

To minimize access to nest boxes by predators, metal predator guards should be installed on all wood duck box support posts.

Dump-Nests. — While the normal brood size for wood ducks is 10 to 15, nests have been found to contain 30 eggs or more. These extra eggs are the result of “egg dumping” or intraspecific brood parasitism. Egg dumping occurs as a result of several factors, including nest predation and lack of available nest sites. Dumping occurs when a female wood duck, frequently a first-year breeder, follows another hen to hidden or scarce nest sites during the egg-laying period. The visiting bird is stimulated to lay eggs in the nest of the other hen. In the wild, this impulse is kept in check because wood ducks normally nest in isolated locations. Artificial nesting structures are often mistakenly erected close together and in highly visible locations, such as the center of a pond. This creates a situation where egg dumping is common, and overall reproductive success plummets. A hen whose nest is dumped with too many eggs may abandon it; the result is a huge amount of wasted reproductive effort. In a natural scenario, approximately 80 percent of eggs hatch. But where egg dumping is out of control, hatch rates may drop to as low as 10 percent. Because of this, it is critical to locate nest boxes in isolated locations as described above. If wood ducks are very rare in the area, it may be necessary to place boxes in open areas initially to encourage use, and then moving them to more secretive locations as the population increases.

Wood Duck Habitat Requirements Summary Table.

Habitat Component	Habitat Requirements
Food — Young	<ul style="list-style-type: none"> Insects, aquatic invertebrates, small fish, and other high-protein animal material. Aquatic plants such as algae, watermeal, watershield, sago pondweed, and duckweed.
Food — Adult	<ul style="list-style-type: none"> Seeds of oaks, bald cypress, hickory, sweet gum, beech, button bush, arrow-aram, bur-reed, wild rice, and other mast-producing plants. Aquatic insects and other invertebrates. Aquatic plants and seeds.
Nesting Cover	<ul style="list-style-type: none"> Natural tree cavities or artificial nesting boxes in deciduous woodlands in close proximity to rivers, wetlands, and other suitable aquatic habitats used for brood rearing.
Brood-Rearing Cover	<ul style="list-style-type: none"> Shallow water for foraging on invertebrates and aquatic plants that contain some protective cover from predators. A ratio of 50 to 75 percent cover to 25 to 50 percent open water is preferred.
Winter Cover	<ul style="list-style-type: none"> Bottomland hardwood wetlands with an abundance of partially submerged downed timber, shrubs, and woody debris.
Water	<ul style="list-style-type: none"> Water requirements are met where wetlands suitable as brood-rearing and wintering habitat exist.
Interspersion	<ul style="list-style-type: none"> Prefer a complex of forested wetland habitats that include live forest, green-tree reservoirs, rivers, oxbows, riparian corridors, beaver ponds, shrub-scrub and robust emergent herbaceous wetlands.
Minimum Habitat Size	<ul style="list-style-type: none"> At least 10 acres of wetland or other aquatic habitat should be available in a contiguous unit or in isolated parcels separated by no more than 100 feet of upland in close proximity to nesting habitat.

Limiting Factors

For planning purposes, inventory the site to determine the availability of each of the basic habitat components, based on the above narrative habitat requirement descriptions. Habitat components that are absent or rated low are limiting the value of the habitat for wood ducks.

Habitat Component	Availability/Quality			
	High	Medium	Low	Absent
Food				
Nesting cover				
Brood-rearing cover				
Winter cover (may not be applicable if wood ducks do not winter in the area)				
Water				
Interspersion of habitat components				
Minimum habitat size				

Management Prescriptions

Management treatments should address the habitat components that are determined to be limiting wood duck habitat potential. For planning purposes, select among the possible action items listed below to raise the quality or availability of each habitat component determined to be limiting. A list of programs that may provide financial or technical assistance to carry out specific management practices is provided.

Habitat Component	Management options for increasing habitat quality or availability	Assistance Programs
Food	• Plant, preserve and encourage trees shrubs and herbaceous food plants (see plant species list Insert).	WHIP, EQIP, WRP, PFW, CRP
	• Restore hydrology on previously drained forested wetland.	WRP, PFW, EWP
	• Restore hydrology and vegetation on previously drained and cropped wetland.	WRP, CRP, PFW
	• Establish shallow water areas and artificial wetlands.	WRP, CRP, PFW
	• Provide winter water on cropland and woodland.	WHIP
Nesting cover	• Install artificial nesting boxes over and near wetland areas.	WHIP, WRP, PFW
	• Preserve old growth timber, especially large, live hardwood trees in and adjacent to wetlands conducive to natural cavities.	WRP
Brood-rearing cover	• Restore hydrology on previously drained forested wetland.	WRP, PFW, EWP
	• Restore hydrology and vegetation on previously drained and cropped wetland.	WRP, CRP, PFW, EWP
	• Establish woody riparian vegetation along streams.	CRP, WRP, EQIP, PFW, WHIP
Winter cover	• Restore hydrology to previously drained forested wetland.	WRP, PFW, EWP
	• Restore hydrology and vegetation to previously drained and cropped or grazed wetland.	WRP, CRP, PFW
	• Provide winter water on cropland and woodland.	WHIP
Water	• Restore or establish bottomland hardwood or emergent herbaceous wetland.	WRP, CRP, PFW
Interspersion and minimum habitat size	• Combine above prescriptions to increase interspersion of habitat components or size of habitat blocks available.	WRP, CRP, PFW, EQIP, EWP

For landowners interested in making their individual efforts more valuable to the community, they can work with WHC and NRCS to involve school and scout groups and their families in habitat projects. A wood duck management project is an easy way to provide fun hands on learning opportunities, especially for children. If the land is corporate owned, encourage interested employees to become involved. Involve students or scouts in building and monitoring nest boxes. The educational benefits can greatly increase the value of your individual wood duck management project.

Nest Box Monitoring. — Before nesting boxes are erected, a maintenance and monitoring plan to ensure the success of the program should be developed. Old nests and those of invasive species such as European starlings must be cleaned out regularly if the boxes are to be used more than once during a nesting season. The monitoring program should ensure that boxes are monitored at least once before the beginning of the nesting season, and should be checked at least once a month during the nesting season if multiple use of nest boxes per nesting season is desired. Boxes should remain out during the winter to provide winter cover sites for screech owls and other resident birds. For Wildlife Habitat Council member organizations, the monitoring program may enroll in WHC's *Nest Monitoring Program*, useful in WHC's *Corporate Wildlife Habitat Certification Program*. Enrollment can be accomplished by contacting the WHC Nest Monitoring Program Coordinator at (301) 588-8994.

Programs that provide technical and financial assistance to develop fish and wildlife habitat on private lands.

Program	Land Eligibility	Type of Assistance	Contact
Conservation Reserve Program (CRP)	Highly erodible land, wetland, and certain other lands with cropping history. Stream-side areas in pasture land.	50% cost-share for establishing permanent cover and conservation practices, and annual rental payments for land enrolled in 10 to 15-year contracts. Additional financial incentives are available for some practices.	NRCS or FSA State or County Office
Emergency Watershed Program (EWP) Floodplain Easements	Flood-damaged croplands.	Up to 100% cost-share for floodplain wetland restoration and payments for purchase of conservation easements.	NRCS State or County Office
Environmental Quality Incentives Program (EQIP)	Cropland, range, grazing land & other agricultural land in need of treatment.	Up to 75% cost-share for conservation practices in accordance with 5 to 10-year contracts. Incentive payments for certain management practices.	NRCS State or County Office
Partners for Fish and Wildlife Program (PFW)	Most degraded fish and/or wildlife habitat.	Up to 100% financial and technical assistance to restore wildlife habitat under minimum 10-year cooperative agreements.	Local office of the U.S. Fish and Wildlife Service
Waterways for Wildlife	Private land	Technical and program development assistance to coalesce habitat efforts of corporations and private landowners to meet common watershed level goals.	Wildlife Habitat Council (301-588-8994)
Wetlands Reserve Program (WRP)	Previously degraded wetland and adjacent upland buffer, with limited amount of natural wetland, and existing or restorable riparian areas.	75% cost share for wetland restoration under 10-year contracts, and 30-year easements, and 100% cost-share on restoration under permanent easements. Payments for purchase of 30-year or permanent conservation easements.	NRCS State or County Office
Wildlife at Work	Corporate land.	Technical assistance on developing habitat projects into a program that will allow companies to involve employees and the community	Wildlife Habitat Council (301-588-8994)
Wildlife Habitat Incentives Program (WHIP)	High-priority fish and wildlife habitats.	Up to 75% cost-share for conservation practices under 5 to 10-year contracts.	NRCS State or County Office
State Fish and Wildlife Agencies and private groups such as state waterfowl associations, Ducks Unlimited, Pheasants Forever, and others may have assistance programs in your state.			State or local contacts

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The Wildlife Habitat Council's mission is to increase the amount of quality wildlife habitat on corporate, private, and public land. WHC engages corporations, public agencies, and private, non-profit organizations on a voluntary basis as one team for the recovery, development, and preservation of wildlife habitat worldwide.

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In cooperation with partners, the mission of the Wildlife Habitat Management Institute is to develop and disseminate scientifically based technical materials that will assist NRCS field staffs and others to promote conservation stewardship of fish and wildlife and deliver sound habitat management principles and practices to America's land users.

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