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WORKSHOP HANDOUT

Restoration Prioritization and Prediction Model

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Ecological Strategies worked closely with the MN Dept. of Natural Resources, and the staff of the five participating counties, as well as with experts listed below, to develop the Restoration Prioritization and Prediction Model.

<u>Ecological Expertise</u>

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- Involved in model design from inception at Great River Greening and provided valuable feedback and input on this iteration as well.

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- Assisted in the creation of Access queries to extract data from the Soil Survey Geographic Database (SSURGO).

<u>GIS Expertise (Modelbuilder)</u>

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- Developing portions of the Prioritization criteria in Modelbuilder, with some material support from his employer, Powel, Inc, a company that develops staking and software for the utility and GIS industries.

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Appendices are provided on a project DVD

Introduction

Purpose
The purpose of this project is to provide a GIS-based model for the five participating Twin Cities metropolitan counties to use as a tool for identifying opportunities for ecological restoration at a landscape-scale in this urbanized landscape. Much of the land cover within the five-county project area has been converted from historic native plant communities to human-disturbed systems. Remnant natural plant communities persist, and their protection remains critical. Significant opportunities also exist for the restoration of other cover types in this landscape. Restoration is defined as “an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability” (Society for Ecological Restoration International, 2004). Restoration within the project area will increase the extent and connectivity of remnant natural areas, and provide ecological benefits such as improved wildlife habitat and reduced soil erosion, while also presenting many opportunities for landowners and other citizens to engage in improving the natural resource base in their own communities. Large-scale restoration will be more possible with landscape-scale planning that provides methods for identifying and prioritizing opportunities, based on the best available information.

The goals of this project are two-fold:

1) to develop prioritization criteria to help categorize restoration sites on a landscape-scale; and
2) to develop a predictive model for identifying suitable natural community type(s) to restore on a given site.

The Restoration Prioritization and Prediction Model (RePP) is designed as a tool that can be tailored to meet site-specific or project-specific goals; it is *not* intended to create a static set of maps for use in restoration planning.

History of this Model
This project is a third application of an approach based on analysis of the systematic land cover mapping data provided by the Minnesota Land Cover Classification System (MLCCS) (Minnesota Department of Natural Resources, 2004) and other environmental spatial data.

The need for a systematic approach for prioritizing restoration opportunities was identified in 2001 by the Big Rivers Partnership (BRP), a team of non-profit and government agencies working in collaboration to restore critical natural areas in the Mississippi and Minnesota River Valleys in the Twin Cities area.

During BRP’s initial planning meetings, it became clear that the partners needed a way to prioritize restoration sites, and to select an appropriate target natural community type for restoration projects. Most potential planting sites no longer support native vegetation;

hence, we suggested that other factors such as characteristics of similar, intact sites and current land use needs could be used to select an appropriate target natural community type. In addition, we recognized that considering landscape-scale patterns when selecting restoration site and natural community type would enable us to increase the ecological contribution of each planting. For example, restoration sites could be targeted that would increase the patch size and connectivity of existing natural areas. The first application of this GIS-based model was developed for the Big Rivers Project area (Lane et al, 2002). That project was supported by funding from the Environment and Natural Resources Trust Fund, as recommended by the Legislative Commission on Minnesota Resources.

In 2003, Ecological Strategies worked in partnership with Great River Greening and the Minnesota DNR to further refine the model, applying it to the historic Maple-Basswood Forest (Lane et al, 2003). That project was funded by a grant from the MN DNR Forestry Division.

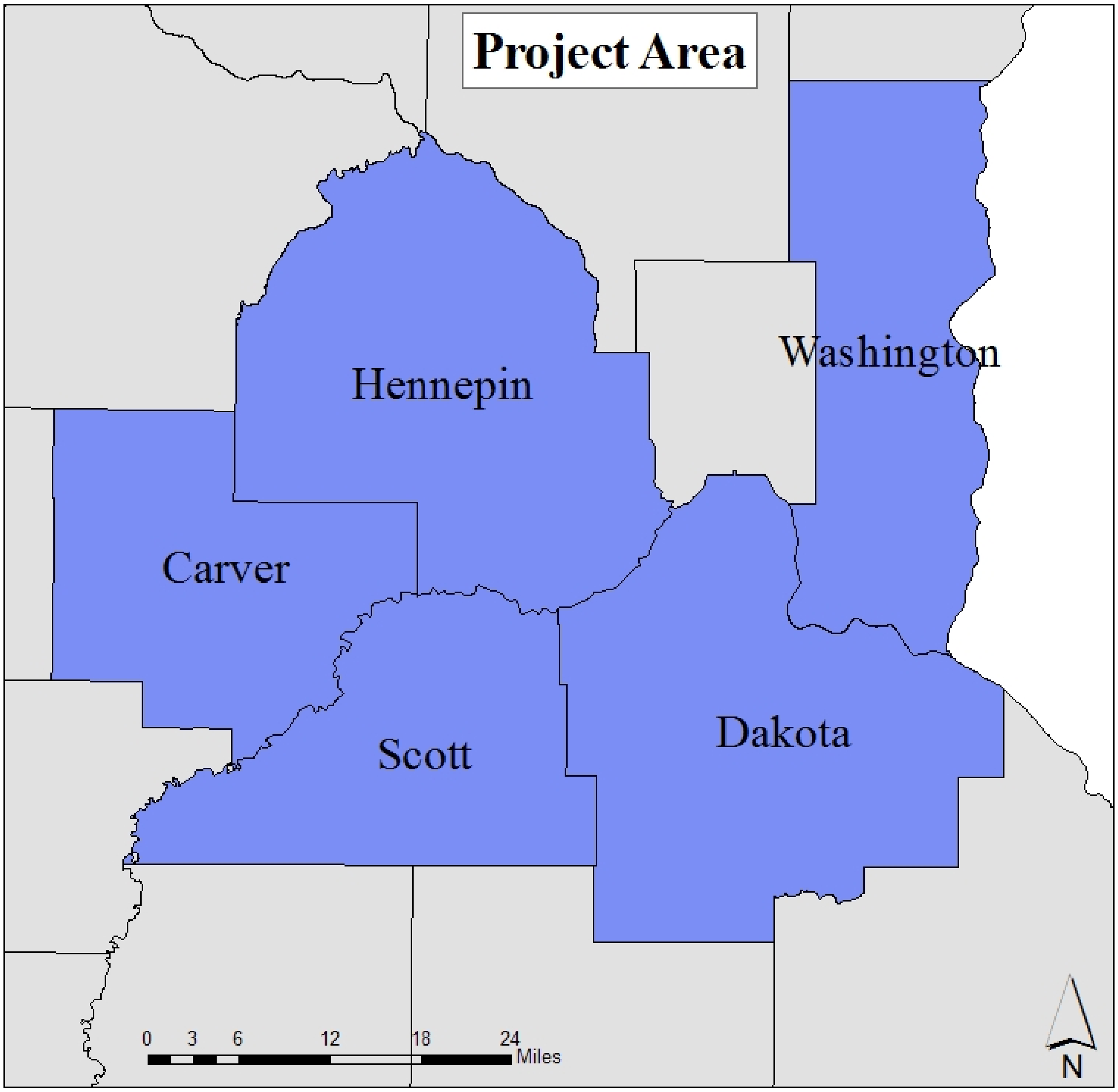
The Restoration Prioritization and Prediction Model
The current project, the Restoration Prioritization and Prediction Model (RePP), is a significant expansion and refinement of the earlier versions of the model. This model applies to five counties of the Twin Cities Metropolitan area: Hennepin, Scott, Carver, Washington, and Dakota Counties (Figure 1). With funding from the Environment and Natural Resources Trust Fund, as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR), the partners were able to obtain additional MLCCS coverage in 2006-2007. Using the same funding source, the RePP model was built using the new MLCCS data, and data previously collected.

The RePP Model analyzes MLCCS and other spatial data in two primary components:

Prioritization: We identify and rank a total of 14 criteria, integrating into these criteria two existing sources of corridors: the Metropolitan Conservation Corridors (MeCC) and the MN DNR's Regionally Significant Natural Areas (RSEA) model, which identifies Corridors and Eco-patches (Minnesota Department of Natural Resources, 2003).

Prediction**:** We use MLCCS and other environmental data to help inform the setting of restoration targets, meaning those plant communities well-suited to be restored on a given site. By building a model based on statistical analyses of environmental variables associated with high-quality native plant communities, we are able to provide predictions for which restoration polygons should be restored to either wetlands or uplands, and which of several upland community types would be the most suitable target communities. These predictions can provide a sense of the potential for wetland/upland restoration and plant community restoration at a landscape scale.

Figure 1. Project Area Map



METHODS

Methods overview

Figure 2 provides a schematic of the components of the RePP Model. Text describing the methods follows, and details of the GIS methods are provided in Appendix A.

1) Polygon coding and selection
    a. Select Restoration Polygons (RPs)
    b. Select Native Plant Communities for analysis (NPCs)
    c. Remaining MLCCS polygons that will not be used for a. or b. (Removed Polygons - EPs)
2) Prioritization component - ranks developed and applied to Restoration Polygons
3) Prediction component - statistical analysis conducted

Results are compiled in a project shapefile and are provided on DVD to the partners and on the MN DNR Data Deli.

Polygon categorization and selection

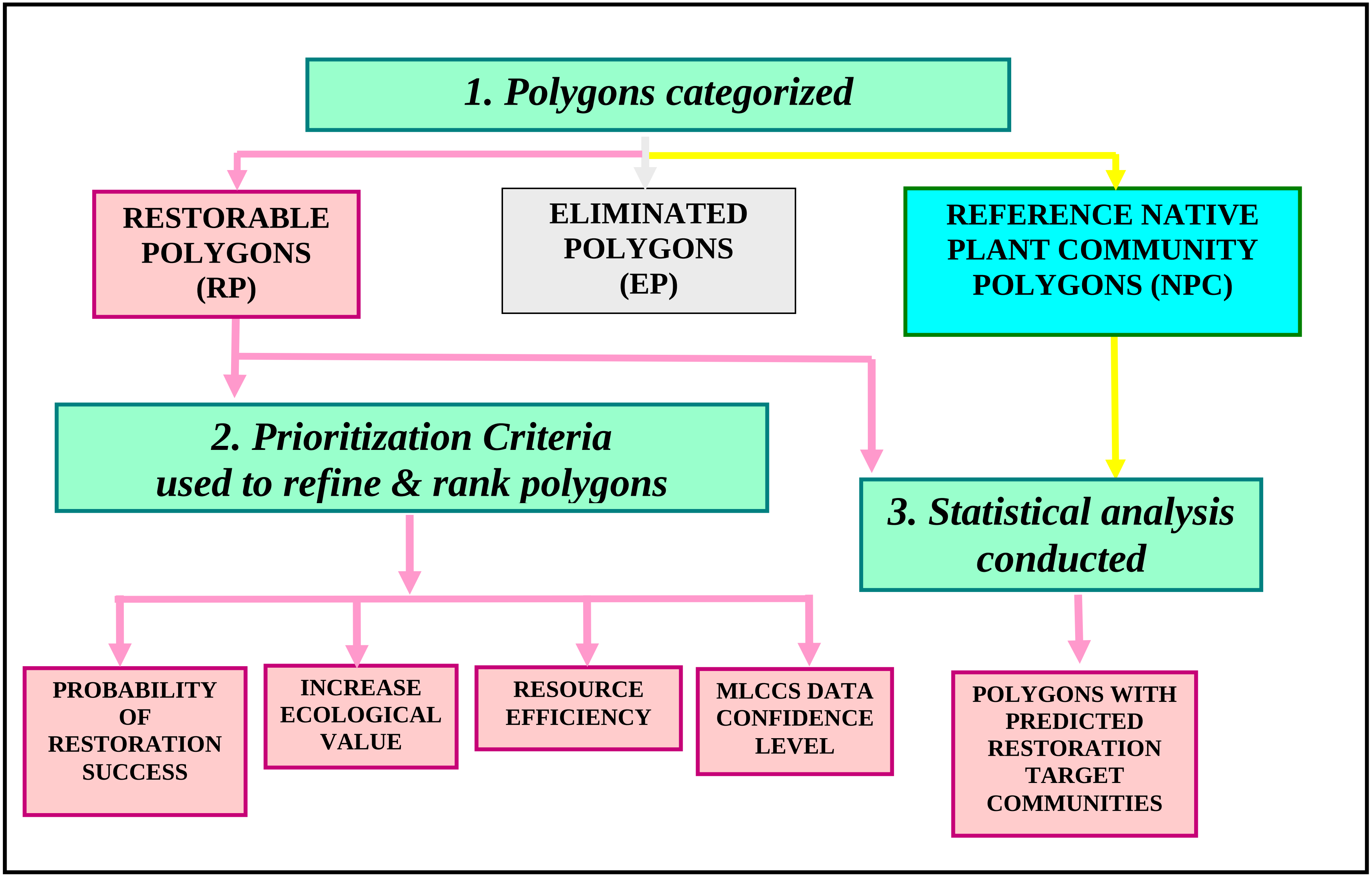
- MLCCS polygons were categorized based on MLCCS code into the following groups (see Appendix B. Project codes):

    - Water/Aquatic – lakes, streams, and other water dominated cover types
    - Eliminated Polygons
    - MLCCS Level – low level mapping
    - NPC + IMP – Native Plant Communities plus impervious
    - NPC – Native Plant Communities
    - RP – Restoration Polygons

Water/Aquatic

Polygons included in the water/aquatic category were those with MLCCS codes in the 90000. The Project Code is: WATER/AQUATIC

Figure 2. Project Schematic



Eliminated Polygons

- All polygons with missing data, or those that were labeled as "Undefined"
- All polygons within 45 meters of a railroad, 45 meters of a high class road, 20 meters from a medium class road, and 10 meters from a low class road. These polygons were removed to ensure all polygons coded as a road or railroad were removed. Text below on criteria related to salt spray and runoff explains the classes as well, as does Appendix A.

MLCCS Level

MLCCS polygons that were not coded to a specific enough level were not included in the Native Plant Community polygon pool for analysis, or in the Restoration Polygon pool. The Project Code is: LEVEL

Native Plant Communities + impervious

Native plant communities with any amount of impervious surface (as indicated by MLCCS code) were not included in the Prediction component. These polygons are recommended for preservation and management, versus restoration. The Project Code is: NPC+ IMP

Native Plant Communities

High quality native plant communities (NPCs) were identified and used in statistical analyses of the Prediction component. The initial pool was subsequently refined and reduced based on the results of the statistical analysis. Details for this process are described in the Prediction component section.

Restoration Polygons

After the other categories were assigned (above, and in Appendix B. Project Codes), the restorable polygons (RPs) pool was further refined by eliminating polygons with the following characteristics:

- All MLCCS Codes in the 10000 group mapped to less than Level 3
- All MLCCS Codes in the 20000 group less than Level 2
- Altered/non-native vegetation in the 30000-60000 groups mapped to less than Level 4 or 5
- Cover types with $\geq$ 11% imperviousness
- All polygons with less than 3500ft^2

After the above process of selection, a total of 78,790 RPs were identified and used in this project. The breakdown of the project polygons into the six categories is provided in Table 1.

Table 1. Polygon Categorization

Category	# Polygons	Acres	% of Total Acreage
WATER/AQUATIC	7,237	96,434	6.39
Eliminated Polygons	63,202	41,9485	27.78
MLCCS Level - Low Mapping Level	251	1,434	0.09
NPC+IMP	472	4,133	0.27
NPC	17,075	151,663	10.05
RP	78,790	836,683	55.42
TOTAL	167,027*	1,509,832	100%

* Value is greater than the original MLCCS layer used for analysis because of processing steps which divided and therefore increased the total number of polygons.

Prioritization Component

Prioritization criteria were identified and developed by our team, in consultation with various experts, and in coordination with our project partners.

Criteria categories

1. Probability of Restoration Success
2. Increase Ecological Value
3. Resource Efficiency
4. MLCCS Data Confidence Level

In Table 2, the GIS attribute table field codes are shown following each criteria name in [brackets]. The first part of the code refers to the Prioritization Criteria category. For example Restoration Success = RS. The second part refers to the specific criteria, such as salt spray/run off = [RS_salt].

Table 2. List of Prioritization Criteria and GIS attribute table field names.

Criteria		**GIS attribute table field heading**
Probability of Restoration Success	Salt spray/run off	RS_SALT
	Invasive species	RS_INVS
	Direct Human Disturbance/Damage	RS_DIST
	Railroad and Utility corridors, and tower sites	RS_UTIL
	Soil compaction/alteration	RS_SOIL
Increase Ecological Value		
	Buffer/Increase the patch size of existing MLCCS NPC	EV_BUFF
	Large patch size	EV_PTCH_PS
	Low perimeter to area ratio	EV_PTCH_PA
	Corridors MeCC RSEA	 EV_C_MeCC EV_C_RSEA
	Reduce erosion, increase infiltration and hydrologic function	EV_HEL
Resource Efficiency		
	Ease of Restoration/Conversion	EF_CONV
	Site slope	EF_SLOPE
MLCCS Data Confidence Level		
	MLCCS mapping	CL_POLY
	County Rank	CL_CTY

Description of prioritization criteria

1. PROBABILITY OF RESTORATION SUCCESS

Restoration is more likely to be successful if the target site is not subjected to influences that inhibit plant growth. Therefore, RPs occurring in areas without known threats and/or stressors will be ranked higher for restoration. Threats and stressors known to occur in the project area, and for which we have data to evaluate, are considered in the following groups:

- Salt spray/run off
- Invasive species
- Direct human disturbance/damage
- Railroad and utility corridors, and tower sites
- Soil compaction/alteration

Salt spray/run off [RS_SALT]

Rationale:
Salt spray and/or run off stresses plant health for many species and may therefore threaten the survival of plantings and/or reduce potential for establishing of a diverse planting.

Methods:

- **Literature review.** Key findings include:
    - Damage to trees can occur up to 150' from salted roads (MN DNR 2001). Highest chloride concentrations occur within 33' (10m) (Lundmark and Olofsson 2007). Salt levels are high as far as 98' (30m) from roads in Ontario (Hofstra et al. 1979). Most salt injury occurs within 60' of road (Sucoff and Johnson (1999).
    - In Colorado, soils along roadsides had significantly higher levels of soil pH, total soluble soil salts measured by electrical conductivity (mmhos/cm), and soil sodium levels (ppm) as compared to soils at a distance from the roadside (Trahan and Peterson 2007).
    - Soil sodium levels have been detected in excess of 67.5ppm at distances greater than 100m from the roadway (Bedunah and Trlica, 1977).
    - "Soils of low topographic position within 150m of the roadway have been found to accumulate significant levels of Na due to the aerial drift of deicing particles, especially within drainage ways and wetland depressions (Iverson, 1984)" in Kelsey and Hootman, (1992).
    - Along Colorado roadways, aerial drift of deicing particles damage roadside vegetation and may have more severe consequences for

plant health than soil uptake of salts. Wind patterns and site topography are important variables salt exposure (Trahan and Peterson 2007).

- "…aerial drift of deicing particles has been documented to occur over extensive distances. Lumis et al. (1973) found vegetation within 40m (131 feet) of the roadbed affected by the aerial drift of suspended salt particulates. Hofstra & Hall (1971) found evidence of salt spray damage up to 120m (394 feet) away from the roadway. Elevated Na and Cl levels in foliage were found in foliage 61m (200 feet) away after one deicing season on a new stretch of highway, while soil sodium increased at distances up to 12m (39 feet), and soil chlorides up to 61m (200 feet) (Langille, 1976). Aerial drift has been documented to occur as far as 500m (1,640 feet) from the roadway (Jones et al., 1992).
- Even trees over 100m (328 feet) from the roadway did not completely escape the influence of deicing applications. The presence of needle surface deposits in off-road trees was detected as far away as 115m (377 feet) (Trahan and Peterson 2007).
- Damage to plants increases as traffic increases from 10,000 to above 80,000 vehicles per day (ADT: average daily traffic) (Trahan and Peterson 2007).

♦ **Road Categorization**.
  - The Metropolitan Council has designated eight road categories in the Metro area, as shown in Table 3**.** (http://www.metrocouncil.org/planning/transportation/TPP/2004/summary_appendices.htm):
  - Based on the above literature review and available data layers, three road classes were designated based on groupings of the Metropolitan Council Road layer, also shown in Table 3.
  - Ranks of threat of salt spray are based on proximity to road and road type. Based on a review of the literature (key points presented above), we used a buffer distance of 60' along low and medium traffic/speed roads, and buffer distances of 300' and 600' for high traffic/speed roads as thresholds for salt spray threats.
  - The buffer distance from each road is based on road type category. Polygon rank is based on where more than 50% of the area of the polygon occurs (either within or outside of the designated buffer distance for that road type).

Table 3. Metropolitan Council Road Categories and Characteristics

FC_NAME	CATEGORY/CLASS	NOTES
Major Collector	Low Traffic Level, Medium Speed (Low Class Road)	Daily Traffic: Urban = 1,000-15,000, Speed = 30-40 mph; Rural = 250-2,500, Speed = 35=45 mph
Minor Collector		
A Minor Augmentor	Medium Traffic Level and Speed (Medium Class Road)	Daily Traffic: Urban = 5,000-30,000; Rural = 1,000-10,000; Speed: Urban = 35-45 mph; Rural = legal limit
A Minor Connector		
A Minor Expander		
A Minor Reliever		
B Minor		
Principal Arterial	High Traffic Level and High Speed	Primary freeway or highway, high traffic volume and speed Daily Traffic: Freeway - Urban = 25,000-200,000, Speed = 45-55 mph; Rural = 5,000-50,000, Speed = 55-65 mph; Other Principal Arterial - Urban = 15,000-100,000, Speed = 40-50mph; Rural = 2,500 - 25,000, Speed = legal limit.

Table 4. Ranks: Restoration Success -- Salt spray/runoff

RANK	THREAT/ STRESSOR	DESCRIPTION	
		Low to Moderate Volumes/Speeds	*High Volumes/Speeds*
9	Low	RP located completely outside a 120’ zone from the road with low traffic levels and moderate speeds	RP located completely outside the 600’ zone from the road with high traffic volumes and high speed.
7	Moderate	Less than or equal to 50% of RP located within 60’ – 120’ from the road with low traffic levels and moderate speeds	
5	High	Greater than 50% of RP located within 60’ – 120’ from the road with low traffic levels and moderate speeds	Less than 50% of RP within 300’to 600’ from the road with high traffic volumes and high speed, but within 600’.
3	Very High	51% and greater of RP located completely inside the 60’ zone from the road with low traffic levels and moderate speeds	Greater than or equal to 50% of RP located between 300’ and 600’ of a zone from the road with high traffic volumes and high speed
1	Extremely High		Greater than or equal to 50% of RP located completely within the 300’ zone from the road with high traffic volumes and high speed

Invasive species **[*RS_INVS]***

Rationale:

Presence of noxious weeds or other invasive species will usually present a threat to restoration plantings.

Methods:

- ♦ The application of this criterion to RPs is limited because only some RP (or NPC) polygons have invasive species modifier data included.
- ♦ Rank polygons based on presence and abundance of invasive species based on modifiers in MLCCS codes.

- For RPs where information about invasive species is not known, a conservative approach is taken, and these polygons receive the lowest rank.
- In the shapefile, RS_INVS ranks are shown, but are not included in a polygon's total rank.

Table 5. Ranks: Restoration Success -- Invasive species

RANK	THREAT/STRESSOR	DESCRIPTION
9	Low	RP field checked to level 3 or higher and no record of invasive species on site
3	Moderate	RP field checked to level 1 or 2 and invasive species present but at very low abundance (values 0-2)
1	High	RP field checked to level 1 or 2 and invasive species present at high abundance (values 3-6); Or site not field checked and abundance unknown

Direct Human Disturbance/Damage [RS_DIST]

Rationale:

A high percentage of impervious cover is often associated with salt, sand, snow damage, excess heat, trampling, and other conditions that limit the success of restoration plantings.

Methods:

- Rank polygons based on percent impervious of RP as described by assigned MLCCS code.
- Remove polygons with 11% or greater impervious from the RP pool. MLCCS mapping protocols dictate that any large non-impervious areas be mapped separately, meaning that polygons with 4% or greater impervious tend to be small, or a matrix of houses, etc. – i.e. not conducive to restoration.

Table 6. Ranks: Restoration Success – Direct Human Disturbance/Damage

RANK	THREAT/STRESSOR	DESCRIPTION
9	Low	0% impervious
1	Moderately high	4-10% impervious

Railroad and Utility corridors, and tower sites [RS_UTIL]

Rationale:

Areas associated with *active* utility corridors and sites will be subjected to maintenance practices that may not be compatible with restoration goals. Railroad right-of-ways and areas in the immediate vicinity of cell phone, cable and other towers often have disturbed, compacted and/or polluted soils.

Methods:

- ♦ Rank based on presence and type of utility corridor or crossing.
    - o Right-of-way (ROW)
        - ▪ Railroad right-of-way
    - o Towers and Stations
        - ▪ Cell phone towers
        - ▪ Land mobile stations (commercial and private)
        - ▪ Microwave towers
        - ▪ Pager towers
        - ▪ Radio towers (AM and FM)
        - ▪ TV towers
- ♦ *Note:* an abandoned road ROW GIS data set was obtained, but the data was not recent enough to be included for ranking. When refining RP selection at a local scale, this abandoned ROW layer should be considered and field checked.

Table 7. Ranks: Restoration Success –Railroad and Utility Corridors, and towers

RANK	THREAT/STRESSOR	DESCRIPTION: Distance to ROW
9	Low	RP more than 300' from active ROW
5	Moderate	Less than 50% of RP within 50' – 300' of active ROW
3	Moderately High	Greater than or equal to 50% of RP within 50' – 300' of active ROW
1	High	Greater than or equal to 50% of RP within 0' - 50' of active ROW, or other feature in polygon. Small polygons, i.e. 2 acres or less, contain a tower or station.

Soil compaction/alteration [RS_soil]

Rationale:

♦ Plantings in RPs that contain soils that have been severely altered or disturbed are more likely to suffer from the negative impacts of soil compaction, high pH, soil toxins and other factors. Disturbed soils are defined here as those soils that no longer have the recent historical soil type present and/or have been severely altered. These include: filled areas, landfills, and gravel pits.

Methods:

♦ Rank RP polygons that have disturbed soils based on 1) Soil Survey (SSURGO) database (Natural Resources Conservation Service, 2008) and 2) based on MLCCS code.

1) Using SSURGO soils data, overlay RPs onto soils data and determine what percentage of the RP occurs on disturbed soils. Appendix A provides more details on this step.
2) Table 8 ranks MLCCS codes based on the degree of likely soil degradation. . Landfills and mines are ranked as most disturbed, sand and gravel pits as least disturbed.
3) Rank RP polygons based on MLCCS codes in Table 8.

Table 8. MLCCS code based ranks for disturbance.

MLCCS CODE	DESCRIPTION	DISTURBANCE COVER TYPE
14200	Exposed earth	B
14210	0-10% impervious cover-exposed earth	B
14211	Mines with 0-10% impervious cover	C
14212	Sand and gravel pits with 0-10% impervious cover	A
14213	Landfill with 0-10% impervious cover	C
14214	Other exposed/transitional land with 0-10% impervious cover	B
14220	11-15% impervious cover-exposed earth	B
14221	Mines with 11-25% impervious cover	C
14222	Sand and gravel pits with 11-15% impervious cover	A
14233	Landfill with 11-25% impervious cover	C
14224	Other exposed/transitional land with 11-15% impervious cover	B
14230	26-50% impervious cover-exposed earth	B
14231	Mines with 26-50% impervious cover	C
14232	Sand and gravel pits with 26-50% impervious cover	A
14233	Landfill with 26-50% impervious cover	C
14234	Other exposed/transitional land with 26-50% impervious cover	B

Table 9. Ranks: Restoration Success –Soil Compaction/Alteration

RANK	THREAT/STRESSOR	DESCRIPTION: % disturbed
9	Low	0% of RP on disturbed soils (SSURGO)
7	Moderately Low	Greater than 0%, but less than 4% of RP occurs on disturbed soils (SSURGO)
5	Moderate	Greater than or equal to 4%, but less than 10% of RP occurs on disturbed soils (SSURGO)
3	Moderately High	Greater than or equal to 10%, but less than 25% of RP occurs on disturbed soils (SSURGO); *OR* RP is one of disturbed MLCCS cover type A or B.
1	High	Greater than or equal to 25% of RP occurs on disturbed soils; *OR* RP is one of disturbed MLCCS cover type C.

2. INCREASE ECOLOGICAL VALUE

Opportunities to increase ecological health/value in the project area include:

- Buffer/increase patch size of existing NPCs
- Restore RPs with large size, and with the least edge, to provide habitat for forest interior or grassland species
- Contribute to wildlife habitat or ecological function identified in RSEA Eco-patch model
- Contribute to existing corridors: Metro Conservation Corridors and/or Regionally Significant Ecological Area Corridors and Eco-patches
- Reduce erosion, increase infiltration and hydrologic function

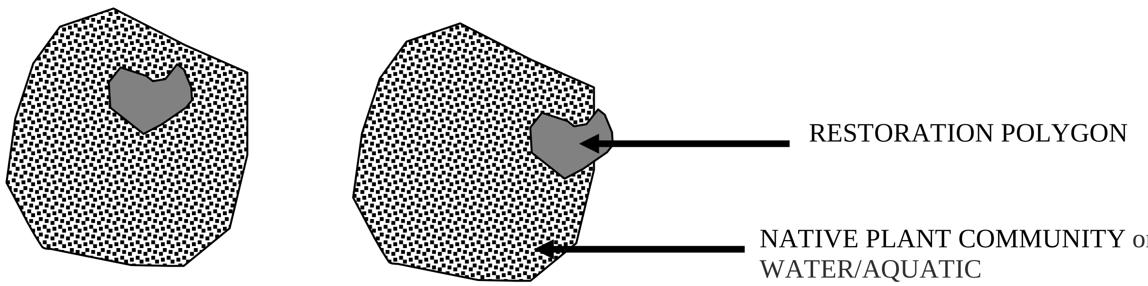
Buffer/Increase the patch size of existing MLCCS NPC [EV_BUFF]

Rationale:
Increasing native plant cover around existing native plant communities (buffering) or restoring gaps within NPCs and water/aquatic features (referred to as WATER/AQUATIC polygons) will help buffer those remnants and associated wildlife species from various stresses associated with non-native and/or disturbed cover types.

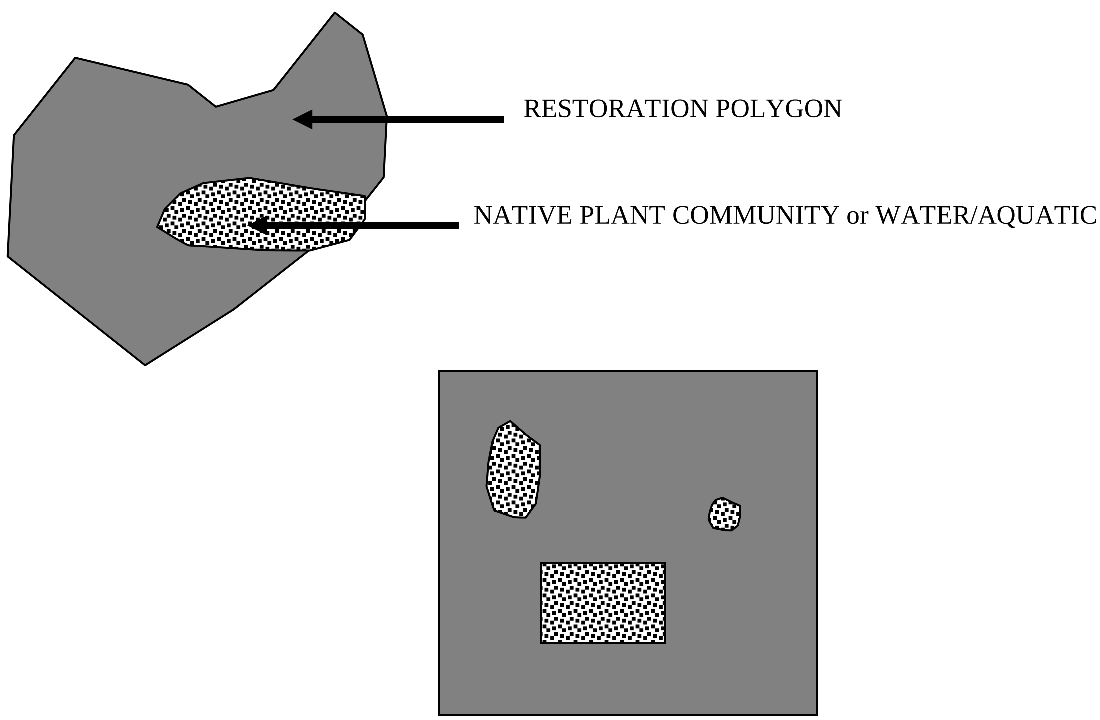
Methods:

- Identify the RPs that are within, adjacent to, or surrounding native plant communities, streams, rivers or lakes (NPC or WATER/AQUATIC).
- RP rank based on three types of relationship as follows (A, B, and C):

Type A- Greater than 75% of RP has a shared perimeter with NPC or WATER/AQUATIC.



Type B – Greater than 75% of NPC or WATER/AQUATIC polygon has a shared perimeter with RP.



Type C – Not A or B, but RP with ≥ 300' shared perimeter with NPC or WATER/AQUATIC

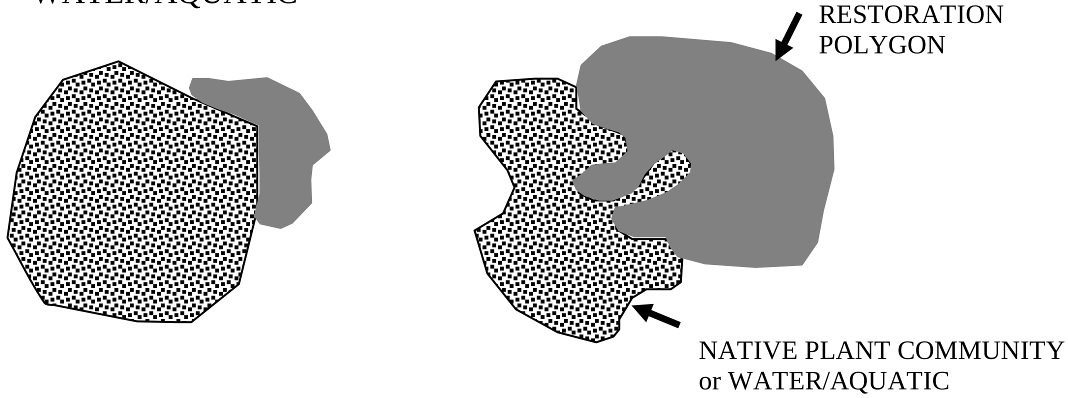


Table 10. Ranks: Increase Ecological Value – Buffer/Patch Size and Adjacency to NPCs or Water/Aquatic Features

RANK	QUALITY	DESCRIPTION: Adjacency
9	High adjacency	Type A
7		Type B
5		Type C, > 800 - 17,000' shared perimeter
3		Type C, ≥ 300 - 800' shared perimeter
1	Low adjacency	RP with less than 300' shared perimeter

Large patch size and low edge

Rationale:
Large patch sizes and low edge area have been shown to be advantageous for many species of plants and animals, especially forest interior species. Large grasslands provide important habitat for nesting birds.

Small patches can also provide important habitat for species such as butterflies or small mammals, but typically when connected to or in close proximity to other habitat patches. Small patches are ranked low here, but are ranked equal to large patches when they occur in RSEA corridor areas.

This criterion has two components: A) patch size and B) patch perimeter/area ratio. Each is applied to uplands and wetlands separately.

A) Patch size [EV_PTCH_PS]

Methods:

- Rank uplands and wetlands separately, as smaller wetlands can provide important ecological services and habitat.
- Rank RPs: HIGH - large area and round shape, LOW - small, irregular shape
- Patch size categories will be based on natural breaks in RP patch size frequency and on ecological principles. Patch size ranks are set up to allow high ranks to be applied to the large agricultural complexes in Dakota and Carver counties, while still resulting in high ranks (for the entire project area) for large patches (>250 acres) in other counties. County staff can easily determine the highest ranking patches based on size for their own county, irrespective of other counties' ranks, by selecting out their own county's RPs from the project area.

UPLANDS – Patch Size

Patch size ranks are based on:

1) Size of RP (acres) in the project area. Restoration polygons are organized by increasing size, then divided into 5 groups with equal numbers of polygons in each group. The size range for each group is shown in Table 11.
2) RSEA forest interior model values. Based on habitat requirements for forest interior indicator species.
3) Grassland bird habitat.

Table 11. Size groups of Upland RPs in the project area.

Numbers of polygons	Range of polygon area in group (acres)
Group 1	0-95
Group 2	96-418
Group 3	419-1,433
Group 4	1,434-3,501
Group 5	3,502-6,217

Table 12. RSEA Forest Interior Model

Rank (higher rank is more valuable habitat)	**Polygon size (acres)**
3	>247
2	>123-247
1	60-123
not included	<60

Grassland bird habitat: Nesting success for grassland bird species has been shown to be higher within larger blocks of grassland habitat. Therefore, Winter et al. (1999) suggest that grassland reserves should be large (>100 ha) if they are to support characteristic prairie avifauna (100 ha = 247 acres.)

Table 13. Ranks: Increase Ecological Value – Patch Size of Uplands

RANK	QUALITY	DESCRIPTION: (acres)
9	Large patch	>500
7		250-499
5		125-249
3		60-124
1	Small patch	<60

WETLANDS & HYDRIC SOILS – Patch Size

Patch ranks are based on:

1) Frequency of RP area in the project
2) RSEA wetland model values

Table 14. Size groups of Wetland RPs in the project area

Numbers of polygons	Range of polygon area in group (acres)
Group 1	.08-9
Group 2	10-33
Group 3	34-98
Group 4	99-301
Group 5	302-999

Table 15. RSEA Wetland Model

Rank	Polygon size (acres)
Not included	<150
Rank = 1	150-300
Rank = 2	>300

Table 16. Ranks: Increase Ecological Value – Patch Size of Wetlands

RANK	QUALITY	DESCRIPTION: (acres)
9	Large patch	>300
7		150-299
5		50-149
3		5-49
1	Small patch	<5

B) Patch perimeter to area ratio [EV_PTCH_PA]

Methods:

- Rank polygons based on RP perimeter to area ratio. I.e. rank = HIGH for RPs with large area and round shape, LOW = small, irregular shape (high ratio of perimeter to area).
- Perimeter/Area ratio (P/A) is the perimeter of a patch divided by its area. A large circle will have a smaller P/A ratio than a large rectangle or convoluted edged polygon. See Fragmentation metric definitions (Elkie, Rempel and Carr 1999).
- The P/A ratios for all RPs, separated into Uplands and Wetlands, were arranged from small to large. Then the polygon P/A values were grouped into 5 classes with equal number of polygons in each class.
- During team member meetings, we discussed adjusting the P/A ratios based on ‘good’ vs. ‘bad’ edge. It was suggested that native plant communities, and possibly other MLCCS cover types, might not present the threat that more built-up cover types do. However, given the species specific nature of what is ‘good’ and ‘bad’ edge, we did not attempt to separate edge types.

Table 17. Ranks: Increase Ecological Value – Perimeter/Area Ratio

RANK	QUALITY	DESCRIPTION: P/A ratio	
		Uplands	***Wetlands***
9	Less edge	0.0008 - 0.017	0.0007- 0.016
7		0.018 - 0.037	0.017- 0.028
5		0.038 - 0.079	0.029 - 0.046
3		0.080 - 0.18	0.047 - 0.082
1	More edge	0.19 - 0.54	0.083 - 0.36

Contribute to Corridors [EV_C_MeCC and EV_C_RSEA]

Rationale:
Restoration projects will have greater ecological value if they occur within identified corridor areas, or within other areas identified as having high ecological value.

Two sources of existing corridors were incorporated:

A. MeCC – Metro Conservation Corridors
B. RSEA – Regionally Significant Ecological Areas

Methods:

Ranks RPs that occur within the MeCC corridors and/or RSEA corridors. These two values can then be summed along with other criteria to create the total RP rank. This method effectively weighs the corridor criteria two times.

Metro Conservation Corridors (MeCC)
The Metro Conservation Corridors (MeCC) grow out of the natural resource analysis work done by the DNR in the late 1990's, documented in the Metro Greenprint publication (http://files.dnr.state.mn.us/assistance/nrplanning/community/greenways/greenprint.pdf).
In 2003 the DNR and the Met Council conducted a follow-up natural resource assessment and created a Regional Significant Ecological Resources data layer (http://deli.dnr.state.mn.us/metadata.html?id=L390002900201). The DNR's regional plant ecologist (Hannah Texler) created the first draft of the MeCC data using the RSEA data and the MCBS data as reference layers, drawing on PRIM (Public Recreation Info Maps) maps or digitizing on screen. The corridors have subsequently been refined by the MeCC partners and ecological experts in each county. The data was digitized between 1:24,000 and 1:10,000, using USGS quad maps and the DNR PRIM maps for location references.

Table 18. Ranks: Increase Ecological Value – MeCC

RANK	VALUE	DESCRIPTION
9	High	Greater than or equal to 50% of the RP polygon area is contained within MeCC corridor
7	Moderate high	Less than 50% of the RP polygon area is contained within MeCC corridor
5	Moderate	RP adjacent or within 100’ (30.5 m) of MeCC corridor
1	Low	RP not adjacent to MeCC corridor

Regionally Significant Ecological Area Corridors and Eco-Patches (RSEA)

- Model links RSEA eco-patches and develops corridors
- Based on model developed by MN DNR. Bart Richardson ran the RSEA model based on the new MLCCS data obtained by the project partners.
- Ecological areas included are:
    - Interior Forest
    - Riparian Forest
    - Grasslands
    - Wetlands
- RPs rank higher if they overlap or are adjacent to RSEA eco-patches or to the corridors linking the eco-patches.

Table 19. Ranks: Increase Ecological Value –RSEA

RANK	VALUE	DESCRIPTION
9	High	Greater than or equal to 50% of the RP polygon area is contained within the RSEA
7	Moderate high	Less than 50% of the RP polygon area is contained within the RSEA
5	Moderate	RP adjacent or within 100’ (30.5 m) of RSEA.
1	Low	RP not adjacent to corridor

Reduce erosion, increase infiltration and hydrologic function [EV_HEL]

Rationale:

Improving vegetative cover to sloped areas with highly erodible soils can reduce erosion, and increase infiltration and other functions.

Methods:

- Prioritize RPs that are on steep slopes and have more erosion-prone soil types. I.e. those ranked as HEL (highly erodible lands) in SSURGO.
- *Note:* This method of ranking will rank polygons in direct contrast to the Resource Efficiency criteria. (I.e. a polygon with a low rank associated with the increased cost of implementing restoration on a steep slope will rank high from the perspective of preventing erosion).
- Rank based on whether current cover type has exposed or protected soils. Included in the exposed/cultivated soils group:

    Agriculture/Horticulture: 24000’s
    Gardens/Vegetables: 13300’s
    Exposed earth: 14200’s

Table 20. Ranks: Increase Ecological Value – Reduce erosion, etc.

RANK	VALUE	DESCRIPTION	
		Perennial Cover Types (all remaining polygons)	*Agriculture/Horticulture, Gardens/Vegetables and Exposed Earth*
9	High	Greater than or equal to 75% of polygon classified as HEL	Greater than or equal to 25% of polygon classified as HEL
7	Moderately High	Greater than or equal to 50%, but less than 75% of polygon classified as HEL	Greater than or equal to 10%, but less than 25% polygon classified as HEL
5	Moderate	Greater than or equal to 25%, but less than 50% of polygon classified as HEL	Greater than or equal to 5%, but less than 10% of polygon classified as HEL
3	Moderately Low	Greater than or equal to 10%, but less than 25% of polygon classified as HEL	Less than 5% of polygon classified as HEL
1	Low	Less than 10% of polygon classified as HEL	

3. RESOURCE EFFICIENCY

Rationale:
Some RP types will require fewer resources than other to implement conduct initial restoration efforts and for follow-up management.

Two factors influencing resource efficiency are considered:

1) Ease of conversion
2) Site slope

Ease of Restoration/Conversion [EF_CONV]

Some MLCCS cover types are easier to restore than others, especially when the restoration target is to restore a diverse native plant community. For example, agricultural fields are often relatively free of weeds, and site preparation and weed control costs following planting can be reduced. In contrast, old fields dominated by invasive species will require more site preparation and ongoing weed control.

Methods:

Each MLCCS code in the RP pool was ranked for ease of conversion based on the following factors (see Appendix C. Conversion Ranks for details).

- Impervious cover [IMP]
  - Impervious cover equal or greater than 4% will make restoration efforts more difficult as impervious surfaces will have to be worked around and/or removed. Assumes MLCCS mapping efforts have delineated as a separate polygon all possible areas without impervious surfaces at the minimum mapping size of 1 or 2 acres This means that polygons with greater than 4% impervious cover will have very little natural areas within them. Presence of impervious surfaces also suggest the presence of other human disturbances and degrading factors, such as site grading, vegetation conversion, chemicals, weeds, edge effects, etc.
- Presence of competitive species [INV]
  - Long-grasses (often includes smooth brome),
  - Cattail dominated
  - Boxelder present
  - Weed populations are controlled on most agricultural land and commercial horticultural lands
  - Small scale gardens are likely to be weedy
  - Walnuts are allelopathic
  - Saturated altered/non-native dominated graminoid vegetation is likely to include reed canary grass or other competitive species
- Site history
  - Coniferous tree plantings may have altered soil conditions in ways that conflict with establishing prairie or deciduous forest. Therefore these sites are ranked as more difficult to restore – assuming most restorations are to grassland/forb or deciduous tree dominated NPCs. Sites with mixed coniferous-deciduous are not ranked lower on the basis of coniferous cover. In the case of white pine dominated RPs (21112), this MLCCS code is ranked as easy to convert, with the assumption that the target community is a white pine type NPC. [CONIF]
  - Landfills and mines will typically require grading, capping, chemical treatment/management and/or other significant site preparation prior to planting. Gravel pits will require the least amount of site preparation for restoration, especially when targeting sand-gravel based communities. [DIST]
- Hydrology [HYD]
  - Saturated or Temporarily flooded wetlands will be easier to restore than seasonally flooded, semi-permanently flooded, intermittently flooded, or permanently flooded.
- MLCCS level of mapping [CODE]
  - Where Level 1-3 mapping does not provide sufficient information to rank conversion, a rank on the low end for that MLCCS group is given.

- ♦ Presence of native species [NATSP]
  - Native plant dominated cover types will be easiest to restore.
- ♦ Agriculture/Horticulture cover type [AG/HORT]
  - Agricultural and horticultural crop lands, especially those that have had rigorous weed control, and/or no-till weed control programs, will be easier to restore than weedy cover types such as medium grass.

NOTE:

Restoration to NPC targets on hydric soils can be more difficult to restore if these sites represent drained wetlands. However, there are many hydric soils that are not drained wetlands and present excellent opportunities for restoration to lowland hardwoods, etc. Further modeling work is needed to separate out these two types.

Table 21. Ranks: Resource Efficiency – Ease of Restoration
(See Appendix C. for the specific conversion ranks for each RP type.)

RANK		DESCRIPTION	
		Upland	***Wetland***
5	Less resource required to convert	AG/HORT, NATSP (or no note)	(rank not used for wetlands)
3		IMP, INV, CONIF, DIST, CODE	INV, (or no note)
1	More resources required to convert	(rank not used for uplands)	INV, HYD; CODE

Site slope [EF_SLOPE]

Restoration on steep slopes typically requires more resources because site preparation, planting, weed control and other restoration activities are limited to hand held equipment or other means. On steeper slopes, the use of tractors and other machinery is usually not feasible. Seeding, planting, mulching and weeding on steep slopes is more labor intensive than on less steep or flat areas.

Methods:
Polygons with a flat to 10 degree slope were ranked highest, and steep slopes (50-90 degrees) ranked the lowest).

Table 22. Ranks: Resource Efficiency – Site Slope

RANK		DESCRIPTION
9	Easiest to implement	Flat slope = Less than 10 degrees
5		Greater than or equal to 10 degrees, but less than 25 degrees
3		Greater than or equal to 25 degrees, but less than 50 degrees
1	Most difficult to implement	Steep slope = Greater than or equal to 50 degrees

4. MLCCS DATA CONFIDENCE LEVEL

Rationale:
Where experienced MLCCS mapping staff have collected and mapped the data, restorable polygons are most likely to be delineated and coded properly. This will mean that the criteria and associated rankings applied above will accurately represent the actual on-the-ground condition.

Methods:
We ranked RPs based on the source of the MLCCS data and based on the overall quality of the mapping done by each county.

The primary reason for lower ranks in some counties is that initial MLCCS survey work was done when the MLCCS method of land cover mapping was still being developed. In addition, some of the people conducting the mapping were inexperienced ecologists and/or not familiar with MLCCS mapping protocols. As the MLCCS method has evolved, the DNR has developed protocols and conducted trainings to help improve the confidence in the data.

MLCCS mapping [CL_POLY]

- RPs ranked based on source of MLCCS mapping as determined by Bart Richardson's (MN DNR) experience with data derived from different mapping sources.

Table 23. Ranks: MLCCS Data Confidence Level - Mapping

RANK		DESCRIPTION
9	Good	Experienced and reliable sources
7	Ok to Good	Semi- Experienced and reliable sources
5	Ok	Moderately experienced
1	Poor	Inexperienced sources
1	NA	Source information unavailable

County Rank [CL_CTY]

- RPs ranked based on overall county ranks of MLCCS mapping as determined by Bart Richardson.

Table 24. Ranks: MLCCS Data Confidence Level – County Rank

RANK		DESCRIPTION
9	High	Overall very good quality data, especially for natural communities.
5	Moderately high	Generally good quality data, but might contain a patchwork of high to poor quality for natural communities
1	Low	Overall poor quality data, especially for natural communities

Prediction component

Description of Prediction component

There were 6 primary steps to completing the prediction component of the RePP model. The methods for each of the steps is outlined below, with details for GIS methods provided in Appendix A.

Primary steps

1) Select Native Plant Communities (NPCs) for analysis and develop categories for analysis
2) Identify environmental variables to include
3) Derive environmental variable data for NPCs and Restoration Polygons (RPs)
4) Conduct and apply statistical analyses

1. Select Native Plant Communities (NPC) and Categorize

As described in the Polygon Selection section at the beginning of this Methods section, we categorized MLCCS coded Native Plant Communities (NPCs) for use as reference communities for statistical analysis (further details in Appendix B). After categorizing the NPC pool, we then further refined this set of polygons using the following methods.

SELECT NATIVE PLANT COMMUNITIES

A) Confidence in data source

- Acquired list of ranking of sources from Bart Richardson, DNR
  - Ranked each source based on confidence of data quality and accuracy.
  - Fields:
    1. good = confident of MLCCS classification and polygon delineation
    2. ok = MLCCS classification and polygon delineation correct in the majority of cases
    3. ok to good
    4. poor = MLCCS classification and polygon delineation incorrect in the majority of cases
    5. ?? = unknown
- Refined source further for uplands based on initial statistical results
  - Ranked some sources as excellent and used only those sources

B) Concurrence with Minnesota County Biological Survey (MN CBS) mapped polygons

- For upland NPCs only
- Overlaid MN CBS mapped polygons onto MLCCS data
- Selected MN CBS polygons for analysis where
  - There was 75% or greater shared polygon area; and
  - Native plant community designation was in agreement between MN CBS and MLCCS

CATEGORIZE COMMUNITIES FOR ANALYSIS

Categorization of the communities was in interactive process that occurred through the process of running the statistical analysis. For the first statistical analysis, MLCCS native plant communities were grouped into ecological systems or sub-groups (ECOL_SG), based on available literature (Minnesota Department of Natural Resources, 2005) and expert opinion (Hannah Texler, Jason Husveth, Fred Harris, Doug Mensing)

After running the first set of analyses on the ECOL_SG, we found we needed to modify the groups by eliminating some NPC polygons from the analysis. NPC polygons were eliminated for two main reasons:

- Some MLCCS cover types such as oak forest, oak woodland-brushland, and eastern red cedar woodland, were mapped across too broad of a range of environmental variables to be predicted., and were removed.
- For some NPCs, uncertainty existed about the NPC designation due to the source of MLCCS data. To resolve this, the pool of NPCs polygons was limited to those mapped with 75% or greater overlap with MN CBS polygons and as the same community type

Based on these modifications, we developed three new groupings of native plant communities for further analysis. These three new groups are coded as UNAG_GRP, ALT_ECOL_SG_1, and ALT_ECOL_SG_2. After running these analyses we also eliminated those NPC categories where the number of polygons with confident MLCCS coding was too small to be included in the analysis.

Appendix D. lists the MLCCS codes as they were grouped into the three subgroups for statistical analysis.

2. Identify environmental variables

Environmental variables were selected based on previous applications of the RePP model (Lane et al. 2002, Lane et al. 2003), and conversations with several plant ecologists and soil scientists (see Acknowledgements). Environmental variables used as a starting point for statistical analysis are slope, aspect, shade, and several soil variables, including texture, drainage, pH and others. These are shown in Appendix E.

3. Derive environmental variable data

Environmental variable data were obtained and derived using Access database queries and other GIS methods. The soils data for all five counties was available in SSURGO format. To extract data from the SSURGO data, an Access query was built to derive each environmental variable, and then a single query was built to combine all queries.

Slope, aspect and shade variables were all derived using ARC GIS 9.2, and spatial analyst. Details for how these variables were derived are provided in Appendix A.

4. Conduct and apply statistical analyses

Twenty three variables describing topographic position or soil characteristics were provided as potential predictors to model the presence of 16 ecological subgroups (Appendix E. Environmental Variables). To reduce the number of potential predictors, we removed any categorical variables fully described by continuous variables (e.g. SOIL.TX and SOIL.DRN), variables which contained only zero values (e.g. SOIL.TX.CF, SOIL.TX.R), and variables that were strongly correlated with each other. Pearson correlation analysis was used to identify correlated sets of predictor variables.

Discriminant Analysis (DA) was used to classify ecological subgroups as a function of the reduced set of predictor variables. Because group covariances were not equal (Box-M test comparing homoscedasctic and heteroscedastic models), we used quadratic discriminant analysis to classify the data. Group priors were defined as the total area (AREA) of each sub-group within the data. The predictive performance of the model was assessed by calculating the misclassification rate using the model development data and leave-one-out crossvalidation.

All statistical analyses were conducted using S-PLUS version 6.2.

Variable reduction

Of the original large list of environmental variables in Appendix E., the following six sets of correlated variables were identified:

```
1.  SLOP.RN, SLOP.MN, SLOP.SD
2.  ASPT.MN, SHAD.MN
3.  SOIL.DRN.P, SOIL.DRN.M, SOIL.TX.O, SOIL.AWCS
4.  SOIL.DRN.M, SOIL.DRN.P, SOIL.TX.LMED
5.  SOIL.DRN.E, SOIL.TX.SC, SOIL.PER1
6.  SOIL.TXU.CL, SOIL.TX.LMED
```

From each set we kept the following variables:

```
1. SLOP.MN
2. ASPT.MN
3. SOIL.DRN.P
4. (no variables kept)
5. SOIL.DRN.E
6. SOIL.TXU.CL
```

This left the following 11 variables:

```
SLOP.MN, ASPT.MN, ASPT.DS, SOIL.DRN.P, SOIL.DRN.E,
SOIL.DRN.WE, SOIL.TX.LMC, SOIL.TX.LMF, SOIL.TXU.CL,
SOIL.PER2, SOIL.pH
```

We removed `SOIL.DRN.WE` because the range of values was small and few differences were found between vegetation sub-groups. This left the other 10 variables.

Discriminant analysis

A) Wetland versus upland model

Using the full training dataset of 5248 observations (NPC polygons) we modelled upland and wetland habitat according to the following discriminant functions:

Upland = -46.617 + (0.373xSLOP.MN) – (0.003 x ASPT.MN) + (0.116 x SHAD.MN) + (0.031xSOIL.DRN.P) – (0.019xSOIL.DRN.E) + (0.026xSOIL.TXU.CL) – (0.001xSOIL.TX.LMC) + (0.005xSOIL.TX.LMF) + (0.030xSOIL.PER2) + (3.354xSOIL.pH)

Wetland = -57.251 + (0.403xSLOP.MN) – (0.012xASPT.MN) + 0.405xSHAD.MN) + (0.050xSOIL.DRM.P) + (0.057xSOIL.DRN.E) + (0.036xSOIL.TXU.CL) + (0.029xSOIL.TX.LMC) – (0.017xSOIL.TX.LMF) + (0.011xSOIL.PER2) + (2.360xSOIL.pH)

The statistical analysis produced linear models that could be used to apply the results of the statistical analyses to environmental variables associated with each Restoration Polygon.

Predictions from this model applied to the NPCs accurately identified upland habitat 92% of the time and wetland habitat 68% of the time (Table 1).

Table 25. Crossvalidation summary from DA using wetland and upland polygons.

Observed	Predicted # of NPC polygons		Correctly classified (%)
	Upland	**Wetland**	
Upland	3191	559	85
Wetland	293	1205	80
Classified correctly (%)	92	68	84

B) Modeling upland ecological subgroups

Using a subset of 171 NPC polygons whose ecological subgroups were mapped reliably and consistently in the training data, we tried to model the location of 8 ecological subgroups. One ecological subgroup (FD_WPH) contained too few polygons to model using 6 predictor variables. Two ecological subgroups (OAKF_DRY and UP_BLUF) contained all zero values for several explanatory variables (that were important predictors for other groups). To eliminate this problem, we added a random uniform number (ranging between 0 and 1) to all zero percentages in the affected explanatory variables, but were unable to develop reliable models. Because of these problems we developed a model using only 5 vegetation subgroups (Appendix E):

MH.LH	=	Lowland Hardwood Forest
MH.MB	=	Maple Basswood Forest
MP	=	Mesic Prairie
OAKF.MES	=	Oak Forest - Mesic
UP.SG	=	Upland - Sand-Gravel

MH.LH = -34.76 + (0.16xSHAD.MN) + (0.09xSOIL.DRN.P) + 0.25xSOIL.DRN.E) + (0.61xSOIL.TXU.CL) + (0.03xSOIL.TX.LMC) – (0.14xSOIL.TX.LMF)

MH.MB = -38.92 + (0.19xSHAD.MN) + (0.16xSOIL.DRN.P) + 0.19xSOIL.DRN.E) + (1.07xSOIL.TXU.CL) + (0.10xSOIL.TX.LMC) – (0.21xSOIL.TX.LMF)

MP = -42.69 + (0.23xSHAD.MN) + (0.06xSOIL.DRN.P) + 0.165xSOIL.DRN.E) + (1.15xSOIL.TXU.CL) + (0.10xSOIL.TX.LMC) – (0.13xSOIL.TX.LMF)

OAKF.MES = -24.87 + (0.05xSHAD.MN) + (0.11xSOIL.DRN.P) + 0.10xSOIL.DRN.E) + (0.54xSOIL.TXU.CL) + (0.03xSOIL.TX.LMC) + (0.08xSOIL.TX.LMF)

UP.SG = -31.72 + (0.11xSHAD.MN) + (4.68xSOIL.DRN.P) + 0.35xSOIL.DRN.E) + (0.89xSOIL.TXU.CL) + (0.06xSOIL.TX.LMC) + (2.32xSOIL.TX.LMF)

Predictions from this model accurately identified MH_LH polygons, OAKF_MES polygons and UP_SG polygons 74%, 69% and 60% of the time respectively. Predictions for the MH_MB and MP subgroups were not accurate, with the discriminant functions generally unable to discriminate between MH_MB and MP polygons.

Table 26. Crossvalidation summary from DA using five upland ecological subgroups

	Predicted					
	MH_LH	**MH_MB**	**MP**	**OAKF_MES**	**UP_SG**	**Correctly classified %**
Observed						
MH_LH	14	3	4	4	0	56
MH_MB	0	12	4	7	3	46
MP	4	12	4	3	2	16
OAKF_MES	1	5	1	33	11	65
UP_SG	0	0	0	1	24	96
Classified correctly %	**74**	**36**	**31**	**69**	**60**	

C) Mapping restoration polygons

We applied each of the above models to 78,790 restoration polygons in order to identify (a) upland polygons and (b) ecological subgroups predicted to occur at upland sites. The upland model assigned all upland restoration polygons to one of 5 predicted ecological subgroups (MH_LH, MH_MB, MP, OAKF_MES, and UP_SG). Polygons predicted to contain MH_MB or MP were assigned to an amalgamated vegetation group (MH_MB/MP).

Polygons suitable for restoration of FD_WPH, OAKF_DRY or UP_BLUF were not able to be identified using the upland model because of insufficient polygons for analysis or poor correlations.

RESULTS & APPLICATION

Prioritization Criteria

The shapefile of the results of the prioritization criteria is provided to the partners on an attached DVD.

- The total ranks (sum of all criteria) ranged from 30 to 114.
- Highest ranking polygons had good correlation with the RSEA corridors and Eco_patches
- Data confidence ranks lowered all RP polygon ranks for low ranked counties

Rankings within each criterion are the outcome of this project. However, we recognize that the relative ranking within a criterion, or perhaps more likely, the relative importance of one criterion over another, may differ for various users of the model. We have designed the model to allow flexibility to users who choose to weight the ranks or criteria differently.

As additional MLCCS data is obtained in these five counties, it will be helpful to be able to easily add that data to the model. Steve Bruggeman is converting portions of the Prioritization Criteria into Modelbuilder to automate the application of the model to new MLCCS data, as it becomes available.

Example areas/results

1) Crowhassen Park Reserve area, Hennepin County

- ♦ RPs buffer and expand NPCs
- ♦ Connectivity patterns that can be achieved with restoration or MLCCS RPs is easily seen
- ♦ Highlights importance of restoring some polygons, for example #90824

2) Natural area buffering and linkage

- ♦ Model identifies RPs that will buffer and link NPCs

3) Low priority areas

- ♦ Examples of low ranked RPs

3) Rank considerations

- ♦ Many agricultural fields ranked high because of patch size, may want to downrank patch size or weight RPs the RSEA corridor higher
- ♦ Data confidence a bigger factor in some counties
- ♦ Some on HEL lands

Application

- ♦ Apply at regional, county or subset of county
- ♦ Modifying ranks:
  - Can modify ranks as required based on project goals, funding source, etc.

- Copy the original shape file before modifying ranks
- Document rationale and methods for modifying ranks

Prediction

The shapefile of the results of the prediction component is provided to the partners on an attached DVD.

Example applications

1) **Identify potential sites for target NPC restoration**
   - For example if the project goal is to restore Maple-basswood forest, the areas suited for restoration to this NPC are identified in the results of this Prediction component

2) **Identify reference communities for high priority RPs**
   - Identify high priority RPs to restore for a particular region or project
   - Consult Prediction GIS data to indicate which RPs are predicted to be wetland or uplands
   - For uplands, review which native plant community types/groups has been predicted
   - With modifications, the model can also provides input on areas for potential bluff prairie-savanna restoration
   - With modifications, provides targets for UP bluff prairie-savanna as well

Next steps

- Field check to verify MLCCS mapping where data is not certain
- Review Prioritization Criteria and track modifications needed
- Review Predictions field check
- Update and revise criteria as new information about restoration methods and priorities is available.
- Complete creation of Prioritization Criteria in Modelbuilder to automate the addition of new MLCCS data to the model when those data become available.

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APPENDIX A. GIS METHODS

The following spatial data sources were used for this project:

MLCCS (Minnesota Land Cover Classification System)
Source: http://deli.dnr.state.mn.us/index.html
Metropolitan Council Functional Class Roads layer
Source: MetCouncil DataFinder (http://www.datafinder.org/)
Railroads
Source: MetCouncil DataFinder (http://www.datafinder.org/)
Electrical lines and communication towers
Source: Federal Communications Commission, Land Management Information Center (LMIC) Clearinghouse (http://www.lmic.state.mn.us/chouse/metalong.html#utilities)
Soil Compaction
Source: Soil Survey Geographic (SSURGO) Database, NRCS, Soil Data Mart (http://soildatamart.nrcs.usda.gov/)
Metro Conservation Corridor (MeCC) layer
Source: Bart Richardson, MN DNR
RSEA/Eco Patches and Corridors
Source: Bart Richardson, MN DNR; http://deli.dnr.state.mn.us/index.html
Highly Erodible Land (HEL) layer
Source: Created from HEL tables, NRCS
Slope
Source: derived from 10m DEM (Digital Elevation Model) from Metropolitan Council. DataFinder (http://www.datafinder.org/)

Selection of Restoration Polygons

Polygons were categorized based on MLCCS code, as described in Appendix B.

Prioritization Component

DATA PREPARATION

1. Clip MLCCS layer to study boundary extent
2. Create new columns for each polygon
    a. County Name
    b. Project Code – defined by Lane (see Appendix_Project Code)
    c. Wetland/Upland code– defined by Lane (see Appendix_Project Code)
    d. Disturbance Cover Type Code –defined by Lane (see disturbance criterion)
    e. Source Ranking – defined and provided by Bart Richardson, MN DNR.

f. County Ranking – defined and provided by Bart Richardson, MN DNR, in Table 1.

Table 1. County MLCCS Confidence Level Ranking

COUNTY	CONFIDENCE LEVEL
Carver	Medium
Dakota	Low
Hennepin	High
Scott	Medium
Washington	Medium

3. Remove all polygons that are undefined (C_NUM = 0)
4. Remove all polygons more than 11% of impervious surface (C_NUM = 10000, 11000, 11100, 11110, 11111, 11112, 11113, 11114, 11115, 11116, 11117, 11118, 11119, 11120, 11121, 11122, 11123, 11124, 11125, 11126, 11127, 11128, 11129, 11130, 11131, 11132, 11133, 11134, 11135, 11136, 11137, 11138, 11139, 11140, 11141, 11142, 11143, 11144, 11145, 11146, 11147, 11148, 11149, 11220, 11221, 11222, 11223, 11224, 11225, 11226, 11227, 11228, 11229, 11230, 11231, 11232, 11233, 11234, 11235, 11236, 11237, 11238, 11239, 11240, 11241, 11242, 11243, 11244, 11245, 11246, 11247, 11248, 11249, 11320, 11321, 11322, 11323, 11324, 11330, 11331, 11332, 11333, 11334, 11340, 11341, 11342, 11343, 11344, 12120, 12121, 12122, 12123, 12130, 12131, 12132, 12133, 12140, 12141, 12142, 12143, 12220, 12221, 12222, 12230, 12231, 12232, 12240, 12241, 12242, 13120, 13121, 13122, 13123, 13124, 13125, 13130, 13131, 13132, 13133, 13134, 13135, 13140, 13141, 13142, 13143, 13144, 13145, 13220, 13221, 13222, 13223, 13224, 13230, 13231, 13232, 13233, 13234, 13240, 13241, 13242, 13243, 13244, 13320, 13321, 13322, 13330, 13331, 13332, 13340, 13341, 13342, 14000, 14100, 14110, 14111, 14112, 14113, 14120, 14121, 14122, 14123, 14220, 14221, 14222, 14223, 14224, 14230, 14231, 14232, 14233, 14234)
5. Polygons representing roads and railroads remained in the MLCCS layer after road and building codes were removed during preliminary MLCCS preparations. This is due to variations in each county for coding and digitizing roads. To correct for these inconsistencies, we conducted the following processes:
   a. Buffered the road line layer based on average roads widths for each road class – 45m (high), 20m (medium), and 10m (low). Road class definitions were based on the FC_NAME field from the Metropolitan Council Functional Roads layer (as shown in Table 2 located in the next section of this document):
      i. Low = Major Collector, Minor Collector
      ii. Medium = A Minor Augmentor, A Minor Connector, A Minor Expander, A Minor Reliever, B Minor
      iii. High = Principal Arterial
   b. Buffered the railroad line layer by 45m
   c. These buffered areas were removed from the MLCCS layer prior to the filter process using the Erase tool from ET GeoWizards (http://www.ian-ko.com/). Normally this tool is standard in ArcGIS, but was not available in our licensed version.

6. Create new columns for each polygon
    a. Area
    b. Perimeter
    c. Perimeter/Area Ratio
7. Remove all polygons less than 3500 sq. ft.
8. Create new ID code for each polygon.
9. *NOTE: before, may want to remove all columns except ID and geometry fields to speed process time*

PRIORITIZATION CRITERIA CALCULATIONS

Prioritization criteria are referred to as filters.

1. Salt spray/run off [RS_SALT]

GIS Methods:

- Create road buffer layer
    - Begin with the road buffer layers used in preliminary steps to remove roads
    - Buffer High roads 300' and 600', and Medium/Low roads 60' and 120' (**note: be sure to buffer from the road widths layer used in data preparation steps; DO NOT buffer from the road centerlines)**
    - After dissolve each buffer to create one polygon per layer
    - Be sure that the buffers for High roads overwrites Medium/Low buffers when they intersect
- Prepare to filter roads
    - Select by location all RPs that intersect road buffer - export layer
    - Perform another select by location on new layer for all RPs that intersect high road buffer - export selection
    - Go back to the table, switch selection, and export remaining polygons for medium/low
- Begin coding High polygons
    - Code 1
        - Intersect high buff polys with 300' buffer layer
        - Add area and percent columns – calculate
        - Select all polys > 50%
        - Summarize the FILTERID column and selected ID numbers
        - Use this list to select IDs from original high buff layer
            - Switch selection and export for next steps
    - Code 3, 5
        - Intersect new layer with 600' buffer layer
        - Add area and percent columns – calculate
        - Select all polygons >= 50%
        - Summarize the FILTERID column and selected ID numbers

        - Use this list to select IDs from remaining layer polygon layer – code as 3
        - Inverse polygon selection and code as 5
    - Merge two layers
- Begin coding Medium/Low polygons
    - Code 3
        - Intersect high buff polys with 60’ buffer layer
        - Add area and percent columns – calculate
        - Select all polys >= 50%
        - Summarize the FILTERID column and selected ID numbers
        - Use this list to select IDs from original high buff layer
        - Inverse polygon selection and export for next steps
    - Code 5, 7
        - Intersect new layer with 120’ buffer layer
        - Add area and percent columns – calculate
        - Select all polys >= 50%
        - Summarize the FILTERID column and selected ID numbers
        - Use this list to select IDs from remaining layer polygon layer – code as 5
        - Inverse polygon selection and code as 7
    - Merge two layers
- Merge High and Medium/Low layers created in previous steps
- Join merged table with original RP layer
    - Code all non-coded polygons as 9

Table 2. Metropolitan Council Road Categories and Characteristics

FC_NAME	CATEGORY	NOTES
Major Collector	Low Traffic Level, Medium Speed	Daily Traffic: Urban = 1,000-15,000, Speed = 30-40 mph; Rural = 250-2,500, Speed = 35=45 mph
Minor Collector		
A Minor Augmentor	Medium Traffic Level and Speed	Daily Traffic: Urban = 5,000-30,000; Rural = 1,000-10,000; Speed: Urban = 35-45 mph; Rural = legal limit
A Minor Connector		
A Minor Expander		
A Minor Reliever		
B Minor		

Principal Arterial	High Traffic Level and High Speed	Primary freeway or highway, high traffic volume and speed Daily Traffic: Freeway - Urban = 25,000-200,000, Speed = 45-55 mph; Rural = 5,000-50,000, Speed = 55-65 mph; Other Principal Arterial - Urban = 15,000-100,000, Speed = 40-50mph; Rural = 2,500 - 25,000, Speed = legal limit.

RANKS: [RS_SALT]

RANK	THREAT/STRESSOR	DESCRIPTION	
		Low to Moderate Volumes/Speeds	*High Volumes/Speeds*
9	Low	RP located completely outside a 120’ zone from the road with low traffic levels and moderate speeds	RP located completely outside the 600’ zone from the road with high traffic volumes and high speed.
7	Moderate	Less than or equal to 50% of RP located within 60’ – 120’ from the road with low traffic levels and moderate speeds	
5	High	Greater than 50% of RP located within 60’ – 120’ from the road with low traffic levels and moderate speeds	Less than 50% of RP within 300’to 600’ from the road with high traffic volumes and high speed, but within 600’.
3	Very High	51% and greater of RP located completely inside the 60’ zone from the road with low traffic levels and moderate speeds	Greater than or equal to 50% of RP located between 300’ and 600’ of a zone from the road with high traffic volumes and high speed
1	Extremely High		Greater than or equal to 50% of RP located completely within the 300’ zone from the road with high traffic volumes and high speed

2. Direct Human Disturbance/Damage [RS_DIST]

GIS Methods: TAKE DIRECTLY FROM MLCCS LAYER

RANKS: [RS_DIST]

RANK	THREAT/STRESSOR	DESCRIPTION: % impervious
9	Low	0% impervious
1	Moderately high	4-10% impervious

3. Railroad and Utility corridors, and tower sites [RS_UTIL]

GIS Methods:

- Create utility buffer layer
    - Begin with the railroad buffer layer used in preliminary steps to remove railroads
        - Create buffer layers from railroads at 50' and 300'
    - Take electrical power line layer
        - Create buffer layers from power lines at 50' and 300'
    - Merge layers to create 2 (50' and 300') utility buffer layers
- Code for presence of communication towers
    - Select by location all RP polygons that intersect communication towers layer
    - From this selection, select all polygons less than 2 acres in size
    - Export selection and code those polygons as 1
    - Inverse polygon selection and export for next steps
- Select by location all RP polygons (in the new layer) that intersect the utility buffer layer – export to new layer
- Code polygons within 50' of utilities
    - Intersect RP/utility intersect layer with 50' buffer layer
    - Add area and percent columns – calculate
    - Select all polys > 50%
    - Summarize the FILTERID column and selected ID numbers
    - Use this list to select IDs from original high buff layer – export and code as 1
        - Inverse polygon selection and export for next steps
- Code polygons within 50'-300' of utilities
    - Intersect new layer with 300' buffer layer
    - Add area and percent columns – calculate
    - Select all polys > 50%

- Summarize the FILTERID column and selected ID numbers
    - Use this list to select IDs from remaining layer polygon layer – code as 5
    - Inverse polygon selection and code as 7
- Merge all three layers (towers, 50’, 300’)
- Perform table join with original RP layer and new merged layer
    - Code all remaining uncoded polygons as 9

RANKS*: *[RS_UTIL]

RANK	THREAT/STRESSOR	DESCRIPTION: Distance to ROW
9	Low	RP more than 300’ from active ROW
5	Moderate	Less than 50% of RP within 50’ – 300’ of active ROW
3	Moderately High	Greater than or equal to 50% of RP within 50’ – 300’ of active ROW
1	High	Greater than or equal to 50% of RP within 0’ - 50’ of active ROW, or other feature in polygon. Small polygons, i.e. 2 acres or less, contain a tower or station.

4. Soil compaction/alteration [RS_SOIL]

GIS Methods:

- Code RP polygons which have disturbance cover type codes (Table 3).
    - Select by attribute all polygons which have a disturbed cover type code
    - Export selected polygons and code as 3
    - Inverse polygon selection and export for further analysis
- Create disturbed soils layer from SSURGO database
    - Disturbed soils are considered all soils listed as “Miscellaneous area” and “Taxon above family” in the Component table (under “Type” column)
    - These soils were then joined to the SSURGO GIS layer for analysis
    - Note: In the process of subsetting disturbed soils from the SSURGO data, some of the soils had descriptions that would suggest an undisturbed soil (Aquolls and Histosols, ponded, Beach materials, sandy, Beach materials and muck, Dune land, Water, intermittent, Water, miscellaneous, Sandstone outcrops, Steep land, Hayden-Lester materials, Stony land, Terrace escarpments, and Water). These soils were excluded from the disturbed soil layer.
- Code remaining RPs
    - Intersect remaining RPs with disturbed soils layer
    - Add area and percent columns – calculate
    - Dissolve by FILTERID and sum Percent column
    - Select all polygons based on table ranks outlined below and code accordingly

- Merge the two RP layers created in this process
- Table join new RP layer with original RP layer and export to new layer
    - Code all uncoded polygons as 9

Table 3. MLCCS code based ranks for disturbance.

MLCCS CODE	DESCRIPTION	DISTURBANCE COVER TYPE
14200	Exposed earth	B
14210	0-10% impervious cover-exposed earth	B
14211	Mines with 0-10% impervious cover	C
14212	Sand and gravel pits with 0-10% impervious cover	A
14213	Landfill with 0-10% impervious cover	C
14214	Other exposed/transitional land with 0-10% impervious cover	B
14220	11-15% impervious cover-exposed earth	B
14221	Mines with 11-25% impervious cover	C
14222	Sand and gravel pits with 11-15% impervious cover	A
14233	Landfill with 11-25% impervious cover	C
14224	Other exposed/transitional land with 11-15% impervious cover	B
14230	26-50% impervious cover-exposed earth	B
14231	Mines with 26-50% impervious cover	C
14232	Sand and gravel pits with 26-50% impervious cover	A
14233	Landfill with 26-50% impervious cover	C
14234	Other exposed/transitional land with 26-50% impervious cover	B

RANKS: [RS_SOIL]

RANK	THREAT/STRESSOR	DESCRIPTION: % disturbed
9	Low	0% of RP on disturbed soils (SSURGO)
7	Moderately Low	Greater than 0%, but less than 4% of RP occurs on disturbed soils (SSURGO)
5	Moderate	Greater than or equal to 4%, but less than 10% of RP occurs on disturbed soils (SSURGO)
3	Moderately High	Greater than or equal to 10%, but less than 25% of RP occurs on disturbed soils (SSURGO); *OR* RP is one of disturbed MLCCS cover type A or B.
1	High	Greater than or equal to 25% of RP occurs on disturbed soils; *OR* RP is one of disturbed MLCCS cover type C.

5. Buffer/Increase the patch size of existing MLCCS NPC [EV_BUFF]

GIS Methods:

- Select by Location all RP polygons that have a shared boundary with NPC or WATER/AQUATIC polygons
- Extract RP selection to a new layer for further analysis
- Convert new RP layer and NPC/WATER/AQUATIC layer to a polyline (used ET tools)
- Intersect these two polyline layers
- Calculate segment lengths in intersected layer and percents:
  - PERCRP = (Intersected length / RP perimeter) * 100
  - PERCNPC = (Intersected length / NPCAW perimeter) * 100
- Dissolve layer by FILTERID and sum percent columns and shared length
- Code Type A polygons
  - Select all polygons where PERCRP > 75%
  - Export and code as 9
  - Switch selection and export for next step
- Code Type B polygons
  - Select all polygons where PERCNPC > 75%
  - Export and code as 7
  - Switch selection and export for next step
- Code Type C polygons
  - Select all polygons where shared segment length is >= 800 → code as 5
  - Select all polygons where shared segment length is >= 300 and < 800 → code as 3
- Merge all layers previously created
- Table join new RP layer to original RP
- Export to new layer and code all uncoded polygons as 9

RANKS: [EV_BUFF]

RANK	QUALITY	DESCRIPTION: Adjacency
9	High adjacency	Type A - Greater than 75% of RP has a shared perimeter with NPC or WATER/AQUATIC
7		Type B – Greater than 75% of NPC or WATER/AQUATIC polygon has a shared perimeter with RP
5		Type C – RP has a shared perimeter length with an NPC or WATER/AQUATIC polygon greater than or equal to 800’
3		Type C – RP has a shared perimeter length with an NPC or WATER/AQUATIC polygon greater than or equal to 300’, but less than 800’
1	Low adjacency	RP has a shared perimeter length with an NPC or WATER/AQUATIC polygon less than 300’, or has no shared perimeter

6. Large patch size [EV_PTCH_PS]

GIS Methods: TAKE DIRECTLY FROM MLCCS LAYER

RANKS: *[EV_PTCH_PS]*

RANK	QUALITY	DESCRIPTION: (acres)	
		Uplands	***Wetlands***
9	Large patch	>500	>300
7		250-499	150-299
5		125-249	50-149
3		60-124	5-49
1	Small patch	<60	<5

7. Low Edge [EV_PTCH_PA]

GIS Methods: TAKE DIRECTLY FROM MLCCS LAYER

RANKS: [EV_PTCH_PA]

RANK	QUALITY	DESCRIPTION: P/A ratio	
		Uplands	***Wetlands***
9	Less edge	0.0008 - 0.017	0.0007- 0.016
7		0.018 - 0.037	0.017- 0.028
5		0.038 - 0.079	0.029 - 0.046
3		0.080 - 0.18	0.047 - 0.082
1	More edge	0.19 - 0.54	0.083 - 0.36

8. Contribute to MeCC and RSEA Corridors [EV_C_MeCC and EV_C_RSEA]

GIS Methods (use same methods for each corridor layer):

- Code RP polygons for 7 and 9
  - Intersect RP and corridor layers
  - Add area and percent columns – calculate
  - Add code column
  - Select all polygons >= 50% - code as 9
  - Select all polygons < 50% - code as 7
  - Set layer aside
- Code RP polygons for 1
  - Create 100 ft buffer for each corridor
  - Select by Location all RP polygons completely within buffer
  - Export polygons to new layer
  - Create code column and code all polygons 3

  - Set layer aside
- Merge layers created from the past two processes together
- Join layer to original RP layer, and export to new layer
- Code all uncoded polygons as 1

RANKS (Applied to each RP for each corridor model)

RANK	VALUE	DESCRIPTION
9	High	Greater than or equal to 50% of the RP polygon area is contained within corridor
7	Moderate high	Less than 50% of the RP polygon area is contained within the corridor
5	Moderate	RP adjacent or within 100’ (30.5 m) corridor
1	Low	RP not adjacent to corridor

9. Reduce erosion, increase infiltration and hydrologic function [EV_HEL]

GIS Methods:

- Separate RP layer into two new layers
  - Type 1 = 13300’s, 14200’s, 24000’s
  - Type 2 = all else
- Code for Type 1
  - Intersect Type 1 layer with HEL layer
  - Calculate new area and take percent
  - Dissolve by FILTERID and sum percent
  - Code each polygon according to percents in rank table
  - Set layer aside
- Code for Type 2
  - Use same methodology as used for Type 1
- Merge Type 1 and 2 layers

RANKS*: *[EV_HEL]

RANK	VALUE	DESCRIPTION	
		Perennial Cover Types (all remaining polygons)	*Agriculture/Horticulture, Gardens/Vegetables and Exposed Earth*
9	High	Greater than or equal to 75% of polygon classified as HEL	Greater than or equal to 25% of polygon classified as HEL
7	Moderately High	Greater than or equal to 50%, but less than 75% of polygon classified as HEL	Greater than or equal to 10%, but less than 25% polygon classified as HEL

5	Moderate	Greater than or equal to 25%, but less than 50% of polygon classified as HEL	Greater than or equal to 5%, but less than 10% of polygon classified as HEL
3	Moderately Low	Greater than or equal to 10%, but less than 25% of polygon classified as HEL	Less than 5% of polygon classified as HEL
1	Low	Less than 10% of polygon classified as HEL	

10. Ease of Restoration/Conversion [EF_CONV]

GIS Methods:

- Each MLCC code in the RP pool was ranked for each of conversion based on the following factors
- Use Appendix C. Conversion Ranks to assign codes

RANKS, [EF_CONV] See Appendix C. Conversion Ranks for specific ranks/RP type.

RANK		DESCRIPTION	
		Upland	***Wetland***
5	Less resource required to convert	AG/HORT, NATSP or (no note)	(rank not used for wetlands)
3		IMP, INV, CONIF, DIST, CODE	INV, (or no note)
1	More resources required to convert	(rank not used for uplands)	INV, HYD; CODE

11. Site slope [EF_SLOPE]

GIS Methods:

- Used 10m DEM from MetCouncil website
- Calculated slope using Spatial Analyst
- Calculated mean slope for each RP polygon using Zonal Statistics as Table under Spatial Analyst Tools-Zonal
    - NOTE – this was attempted initially on the entire RP vector layer, but encountered an error message (Grid is missing VAT) each time. Attempted fixes as suggested by ESRI support website, but did not fix problem. I then split the RP dataset in half and function worked. Therefore ran function on each half then merged datasets.
- Joined statistics table to original RP polygon layer
- Added filter code column and assigned code values based on rank table
- NOTE – due to vector/raster conversion issues related to polygon and pixel size, 44 polygons did not have a mean slope assigned. The slopes for these polygons were therefore calculated manually.

*RANKS: **[EF_SLOPE]***

RANK		DESCRIPTION
9	Easiest to implement	Flat slope = Less than 10 degrees
5		Greater than or equal to 10 degrees, but less than 25 degrees
3		Greater than or equal to 25 degrees, but less than 50 degrees
1	Most difficult to implement	Steep slope = Greater than or equal to 50 degrees

12. MLCCS source confidence [CL_POLY]

GIS Methods: TAKE DIRECTLY FROM MLCCS LAYER

RANKS*: *[CL_POLY]

RANK		DESCRIPTION
9	Good	Experienced and reliable sources
7	Ok to Good	Semi- Experienced and reliable sources
5	Ok	Moderately experienced
1	Poor	Inexperienced sources
1	NA	Source information unavailable

*13. **MLCCS county confidence [**CL_CTY**]***

GIS Methods: TAKE DIRECTLY FROM MLCCS LAYER

RANK		DESCRIPTION
9	High	Overall very good quality data, especially for natural communities.
5	Moderately high	Generally good quality data, but might contain a patchwork of high to poor quality for natural communities
1	Low	Overall poor quality data, especially for natural communities

***14. Invasive** species [RS_INVS]*

GIS Methods: TAKE DIRECTLY FROM MLCCS LAYER

***RANKS:** [RS_INVS]*

RANK	THREAT/STRESSOR	DESCRIPTION
9	Low	RP field checked to level 3 or higher and no record of invasive species on site
3	Moderate	RP field checked to level 1 or 2 and invasive species present but at very low abundance (values 0-2)
1	High	RP field checked to level 1 or 2 and invasive species present at high abundance (values 3-6); Or site not field checked and abundance unknown

Prediction component

Derivation of Environmental Variables

PHASE I – MODEL CREATION

1. Obtain data layers
    - MLCCS high quality natural areas – from Bart Richardson, MN DNR.
    - Soils –SSURGO soil database from NRCS.
    - 30m DEM (Digital Elevation Model).

2. Merge the 5 county data sets for each environmental variable shapefile.

3. Using MLCCS codes, categorize cover types
    - Determine which of the High Quality Natural Community polygons should be included in statistical analysis (Lane).
    - Eliminate all polygons where soil or other data are missing
        - Determine by overlaying soils and MLCCS data
        - Keep grid layer of polygons eliminated
    - Eliminate all polygons where the majority of the polygon has severely disturbed soils, such as Udorthents (based on soil survey)
    - Eliminate all polygons where the data source is ranked as "poor"
    - Eliminate all polygons less than one acre (this is the minimum mapping unit for MLCCS).

4. Generate environmental variables for each MLCCS polygon

<u>Slope</u>

1. Create slope grid from 30m DEM using Spatial Analyst
2. Using the Extract by Mask tool under Spatial Analyst Tools/Extraction, extract from the slope grid the pixels corresponding to the MLCCS polygon layer
3. Because the Slope layer is a floating point pixel type, the layer was converted to a signed integer type
    a. Used the Raster Calculator in Spatial Analyst with the following equation
    b. Int([extracted slope layer] * 1000000)
4. Using the Zonal Statistics as Table tool under Spatial Analyst tools, calculated mean values per polygon
5. Converted mean values back to original format by dividing by 1000000

<u>Aspect</u>

1. Create aspect grid from 30m DEM using Spatial Analyst
2. Using the Extract by Mask tool under Spatial Analyst Tools/Extraction, extract from the reclassified aspect grid the pixels corresponding to the MLCCS polygon layer
3. Using the Reclass tool under Spatial Analyst Tools, recode the aspect grid to 12, 30 degree classes

   a. 1-30 = 15
   b. 30-60 = 45
   c. 60-90 = 75
   d. 90-120 = 105
   e. 120-150 = 135
   f. 150-180 = 165
   g. 180-210 = 195
   h. 210-240 = 225
   i. 240-270 = 255
   j. 270-300 = 285
   k. 300-330 = 315
   l. 330-360 = 345
4. Convert the extracted grid to a polygon layer using Spatial Analyst
5. Intersect this new polygon layer with the MLCCS layer to assign polygon ID values

NOTE: some of the aspect values are zero because the polygon covers flat topology (ex. swamp)

6. Paste this data into Excel spread sheet template to calculate:
   a. Sine and cosine (using circular statistics)
   b. Mean aspect
   c. Aspect dispersion (amount of variation)

<u>Shade</u>

1. Generate shade layer based for August date, 5:00 PM August 21st . For the calculation a project center location was chosen (44.8516 degrees North and 93.6522 degrees West) – source: **http://www.topozone.com** (determine if a new center is needed).
2. The website: http://www.geocities.com/senol_gulgonul/sun/ was used to calculate the Azimuth (264.96) and Altitude (22.14).
3. Using the Extract by Mask tool under Spatial Analyst Tools/Extraction, extract from the reclassified aspect grid the pixels corresponding to the MLCCS polygon layer.
4. Using the Zonal Statistics as Table tool under Spatial Analyst tools, calculated mean values per polygon.

<u>Soils</u>

1. Use Access to query desired soil tabular data from the SURGGO database.
2. Join soil polygon layer to desired soil tabular data using the MUKEY (mapunit key) field.
3. In the MLCCS polygon layer, calculate acreage (to four decimal places) for each individual polygon using Calculate Geometry in the attribute table (if this has not already been done previously).
4. Intersect MLCCS layer with desired soil layer.
5. Calculate area for each new polygon in the intersected layer.
6. Create a new column in the intersected layer, and calculate area percentage using the Field Calculator in the attribute table.

PHASE II – MODEL IMPLEMENTATION

Based on determinations made during Phase I, two models were created - one to delineate uplands from wetlands, and a second to delineate ecological groups from the predicted upland polygons. The models were run on environmental variables calculated using the MLCCS RP layer.

MODEL 1

1. Using the model created in Phase I, environmental variables were generated using the MLCCS RP layer to delineate upland and wetland polygons (Table 4).

Table 4. Model used to delineate upland and wetland polygons

	UPLAND	WETLAND
Intercept	-46.617	-57.251
SLOP. MN	0.373	0.403
ASPT.MN	-0.003	-0.012
SHAD.MN	0.116	0.405
SOIL.DRN.P	0.031	0.050
SOIL.DRN.E	-0.019	0.057
SOIL.TXU.CL	0.026	0.036
SOIL.TX.LMC	-0.001	0.029
SOIL.TX.LMF	0.005	-0.017
SOIL.PER2	0.030	0.011
SOIL. pH	3.354	2.360

a. Slope and Shade
    i. Using the Zonal Statistics as Table tool under Spatial Analyst tools, mean values per polygon were calculated.
    ii. Because of the unique geometric shapes of some RPs, ArcGIS was unable to calculate mean values for these polygons. To find these polygons, the resultant table was joined to main RP layer.
    iii. All un-calculated polygons were exported to a new layer. The same process was used as before, except this time a 10m raster layer was used.
    iv. For the un-calculated polygons that remained, manual calculations were performed using the 30m raster files.

b. Aspect
    i. Create aspect grid from 30m DEM using Spatial Analyst
    ii. Using the Reclass tool under Spatial Analyst Tools, recode the aspect grid to 12, 30 degree classes
        1. 1-30 = 15
        2. 30-60 = 45
        3. 60-90 = 75

            4. 90-120 = 105
            5. 120-150 = 135
            6. 150-180 = 165
            7. 180-210 = 195
            8. 210-240 = 225
            9. 240-270 = 255
            10. 270-300 = 285
            11. 300-330 = 315
            12. 330-360 = 345
      iii. Using the Extract by Mask tool under Spatial Analyst Tools/Extraction, extract from the reclassified aspect grid the pixels corresponding to the MLCCS polygon layer
      iv. Convert the extracted grid to a polygon layer using Spatial Analyst
      v. Intersect this new polygon layer with the MLCCS layer to assign polygon ID values
      vi. Export all un-calculated polygons and perform previous process again, except this time using a 10m raster layer.
      vii. If any un-calculated polygons remain, perform manual calculations using 30m layer.
   c. Soil Variables
      i. Use Access to query desired soil tabular data from the SURGGO database.
      ii. Join soil polygon layer to desired soil tabular data using the MUKEY (mapunit key) field.
      iii. In the MLCCS polygon layer, calculate acreage (to four decimal places) for each individual polygon using Calculate Geometry in the attribute table (if this has not already been done previously).
      iv. Intersect MLCCS layer with desired soil layer
      v. Calculate area for each new polygon in the intersected layer
      vi. Create a new column in the intersected layer, and calculate area percentage using the Field Calculator in the attribute table
2. Environmental variables were applied by the statistician (Jennie Pearce) to the model. Polygon classification (wetland or upland) is based on which variable is greater between the two types.
3. Results were joined to the RP layer.

MODEL 2

1. Using the model created in Phase I, environmental variables were generated using the MLCCS RP layer to delineate upland ecological groups (Table 5).

Table 5: Model delineating upland ecological groups.

	MH.LH	MH.MB	MP	OAKF.MES	UP.SG
Intercept	-34.76	-38.92	-42.69	-24.87	-31.72
SHAD.MN	0.16	0.19	0.23	0.05	0.11
SOIL.DRN.P	0.09	0.16	0.06	0.11	4.68
SOIL.DRN.E	0.25	0.19	0.16	0.10	0.35
SOIL.TXU.CL	0.61	1.07	1.15	0.54	0.89
SOIL.TX..LMC	0.03	0.10	0.10	0.03	0.06
SOIL.TX.LMF	-0.14	-0.21	-0.13	0.08	2.32

2. Environmental variables were calculated using the methods outlined above.
3. Environmental variables were applied by the statistician (Jennie Pearce) to the model. Polygon classification (wetland or upland) is based on which variable is greater between the two types.
4. Results were joined to the RP layer.

Appendix B. Project Codes

C_NUM	C_TEXT	PROJECT CODE	Upland/Wetland
11120	11% to 25% impervious cover with coniferous trees	HIGH IMP	UPLAND
11121	Jack pine (forest or woodland) with 11- 25% impervious cover	HIGH IMP	UPLAND
11122	White/red pine (forest) with 11- 25% impervious cover	HIGH IMP	UPLAND
11123	Spruce-fir (forest) with 11- 25% impervious cover	HIGH IMP	UPLAND
11124	Eastern red cedar (woodland) with 11- 25% impervious cover	HIGH IMP	UPLAND
11125	Northern conifer (woodland) with 11- 25% impervious cover	HIGH IMP	UPLAND
11126	Planted red pine with 11- 25% impervious cover	HIGH IMP	UPLAND
11127	Planted white pine with 11- 25% impervious cover	HIGH IMP	UPLAND
11128	Planted spruce/fir with 11- 25% impervious cover	HIGH IMP	UPLAND
11129	Other planted conifers with 11- 25% impervious cover	HIGH IMP	UPLAND
11130	26% to 50% impervious cover with coniferous trees	HIGH IMP	UPLAND
11131	Jack pine (forest or woodland) with 26-50% impervious cover	HIGH IMP	UPLAND
11132	White/red pine (forest) with 26-50% impervious cover	HIGH IMP	UPLAND
11133	Spruce-fir (forest) with 26-50% impervious cover	HIGH IMP	UPLAND
11134	Eastern red cedar (woodland) with 26-50% impervious cover	HIGH IMP	UPLAND
11135	Northern conifer (woodland) with 26-50% impervious cover	HIGH IMP	UPLAND
11136	Planted red pine with 26-50% impervious cover	HIGH IMP	UPLAND
11137	Planted white pine with 26-50% impervious cover	HIGH IMP	UPLAND
11138	Planted spruce/fir with 26-50% impervious cover	HIGH IMP	UPLAND
11139	Other planted conifers with 26-50% impervious cover	HIGH IMP	UPLAND
11140	51% to 75% impervious cover with coniferous trees	HIGH IMP	UPLAND
11141	Jack pine (forest or woodland) with 51-75% impervious cover	HIGH IMP	UPLAND
11142	White/red pine (forest) with 51-75% impervious cover	HIGH IMP	UPLAND
11143	Spruce-fir (forest) with 51-75% impervious cover	HIGH IMP	UPLAND
11144	Eastern red cedar (woodland) with 51-75% impervious cover	HIGH IMP	UPLAND
11145	Northern conifer (woodland) with 51-75% impervious cover	HIGH IMP	UPLAND
11146	Planted red pine with 51-75% impervious cover	HIGH IMP	UPLAND
11147	Planted white pine with 51-75% impervious cover	HIGH IMP	UPLAND
11148	Planted spruce/fir with 51-75% impervious cover	HIGH IMP	UPLAND
11149	Other planted conifers with 51-75% impervious cover	HIGH IMP	UPLAND
11220	11% to 25% impervious cover with deciduous trees	HIGH IMP	UPLAND
11227	Planted ash with 11- 25% impervious cover	HIGH IMP	UPLAND
11228	Planted oak with 11- 25% impervious cover	HIGH IMP	UPLAND

11229	Other deciduous trees with 11- 25% impervious cover	HIGH IMP	UPLAND	
11230	26% to 50% impervious cover with deciduous trees	HIGH IMP	UPLAND	
11237	Planted ash with 26-50% impervious cover	HIGH IMP	UPLAND	
11238	Planted oak with 26-50% impervious cover	HIGH IMP	UPLAND	
11239	Other deciduous trees with 26-50% impervious cover	HIGH IMP	UPLAND	
11240	51% to 75% impervious cover with deciduous trees	HIGH IMP	UPLAND	
11247	Planted ash with 51-75% impervious cover	HIGH IMP	UPLAND	
11248	Planted oak with 51-75% impervious cover	HIGH IMP	UPLAND	
11249	Other deciduous trees with 51-75% impervious cover	HIGH IMP	UPLAND	
11320	11% to 25% impervious cover with mixed coniferous/deciduous tree	HIGH IMP	UPLAND	
11321	Mixed pine-hardwood (forest) with 11-25% impervious cover	HIGH IMP	UPLAND	
11322	White pine-hardwood (forest) with 11-25% impervious cover	HIGH IMP	UPLAND	
11323	Northern hardwood-conifer (forest) with 11-25% impervious cover	HIGH IMP	UPLAND	
11324	Planted mixed coniferous/deciduous trees with 11-25% impervious c	HIGH IMP	UPLAND	
11330	26% to 50% impervious cover with mixed coniferous/deciduous tree	HIGH IMP	UPLAND	
11331	Mixed pine-hardwood (forest) with 26-50% impervious cover	HIGH IMP	UPLAND	
11332	White pine-hardwood (forest) with 26-50% impervious cover	HIGH IMP	UPLAND	
11333	Northern hardwood-conifer (forest) with 26-50% impervious cover	HIGH IMP	UPLAND	
11334	Planted mixed coniferous/deciduous trees with 26-50% impervious c	HIGH IMP	UPLAND	
11340	51% to 75% impervious cover with mixed coniferous/deciduous tree	HIGH IMP	UPLAND	
11341	Mixed pine-hardwood (forest) with 51-75% impervious cover	HIGH IMP	UPLAND	
11342	White pine-hardwood (forest) with 51-75% impervious cover	HIGH IMP	UPLAND	
11343	Northern hardwood-conifer (forest) with 51-75% impervious cover	HIGH IMP	UPLAND	
11344	Planted mixed coniferous/deciduous trees with 51-75% impervious c	HIGH IMP	UPLAND	
12120	11% to 25% impervious cover with coniferous and/or deciduous shru	HIGH IMP	UPLAND	
12121	Short grasses with planted coniferous and/or deciduous shrubs, 11-2	HIGH IMP	UPLAND	
12122	Long grasses with planted coniferous and/or deciduous shrubs, 11-2	HIGH IMP	UPLAND	
12123	Other coniferous and/or deciduous shrubs, 11-25% impervious cover	HIGH IMP	UPLAND	
12130	26% to 50% impervious cover with coniferous and/or deciduous shru	HIGH IMP	UPLAND	
12131	Short grasses with planted coniferous and/or deciduous shrubs, 26-5	HIGH IMP	UPLAND	
12132	Long grasses with planted coniferous and/or deciduous shrubs, 26-5	HIGH IMP	UPLAND	
12133	Other coniferous and/or deciduous shrubs, 26-50% impervious cover	HIGH IMP	UPLAND	
12140	51% to 75% impervious cover with coniferous and/or deciduous shru	HIGH IMP	UPLAND	
12141	Short grasses with planted coniferous and/or deciduous shrubs, 51-7	HIGH IMP	UPLAND	
12142	Long grasses with planted coniferous and/or deciduous shrubs, 51-7	HIGH IMP	UPLAND	
12143	Other coniferous and/or deciduous shrubs, 51-75% impervious cover	HIGH IMP	UPLAND	

12220	11% to 25% impervious cover with coniferous and/or deciduous shru	HIGH IMP	UPLAND	
12222	Other coniferous and/or deciduous shrubs and trees with11-25% imp	HIGH IMP	UPLAND	
12230	26% to 50% impervious cover with coniferous and/or deciduous shru	HIGH IMP	UPLAND	
12232	Other coniferous and/or deciduous shrubs and trees with 26-50% imp	HIGH IMP	UPLAND	
12240	51% to 75% impervious cover with coniferous and/or deciduous shru	HIGH IMP	UPLAND	
12242	Other coniferous and/or deciduous shrubs and trees with 51-75% imp	HIGH IMP	UPLAND	
13120	11% to 25% impervious cover with perennial grasses and sparse tree	HIGH IMP	UPLAND	
13124	Short grasses and mixed trees with 11-25% impervious cover	HIGH IMP	UPLAND	
13125	Long grasses and mixed trees with 11-25% impervious cover	HIGH IMP	UPLAND	
13130	26% to 50% impervious cover with perennial grasses and sparse tree	HIGH IMP	UPLAND	
13134	Short grasses and mixed trees with 26-50% impervious cover	HIGH IMP	UPLAND	
13135	Long grasses and mixed trees with 26-50% impervious cover	HIGH IMP	UPLAND	
13140	51% to 75% impervious cover with perennial grasses and sparse tree	HIGH IMP	UPLAND	
13144	Short grasses and mixed trees with 51-75% impervious cover	HIGH IMP	UPLAND	
13145	Long grasses and mixed trees with 51-75% impervious cover	HIGH IMP	UPLAND	
13220	11% to 25% impervious cover with perennial grasses	HIGH IMP	UPLAND	
13221	Short grasses with 11-25% impervious cover	HIGH IMP	UPLAND	
13222	Non-native dominated long grasses with 11-25% impervious cover	HIGH IMP	UPLAND	
13230	26% to 50% impervious cover with perennial grasses	HIGH IMP	UPLAND	
13231	Short grasses with 26-50% impervious cover	HIGH IMP	UPLAND	
13232	Non-native dominated long grasses with 26-50% impervious cover	HIGH IMP	UPLAND	
13240	51% to 75% impervious cover with perennial grasses	HIGH IMP	UPLAND	
13241	Short grasses with 51-75% impervious cover	HIGH IMP	UPLAND	
13242	Non-native dominated long grasses with 51-75% impervious cover	HIGH IMP	UPLAND	
13320	11% to 25% impervious cover with cultivated herbaceous vegetation	HIGH IMP	UPLAND	
13321	Vegetables with 11-25% impervious cover	HIGH IMP	UPLAND	
13322	Forbs (flowers) with 11-25% impervious cover	HIGH IMP	UPLAND	
13330	26% to 50% impervious cover with cultivated herbaceous vegetation	HIGH IMP	UPLAND	
13331	Vegetables with 26-50% impervious cover	HIGH IMP	UPLAND	
13332	Forbs (flowers) with 26-50% impervious cover	HIGH IMP	UPLAND	
13340	51% to 75% impervious cover with cultivated herbaceous vegetation	HIGH IMP	UPLAND	
13341	Vegetables with 51-75% impervious cover	HIGH IMP	UPLAND	
13342	Forbs (flowers)with 51-75% impervious cover	HIGH IMP	UPLAND	
14000	Artificial surfaces with less than 25% vegetation cover	HIGH IMP	UPLAND	
14100	Buildings and/or pavement	HIGH IMP	UPLAND	
14110	76% to 90% impervious cover	HIGH IMP	UPLAND	

14111	Buildings with 76-90% impervious cover	HIGH IMP	UPLAND	
14112	Pavement with 76-90% impervious cover	HIGH IMP	UPLAND	
14113	Buildings and pavement with 76-90% impervious cover	HIGH IMP	UPLAND	
14120	91% to 100% impervious cover	HIGH IMP	UPLAND	
14121	Buildings with 91-100% impervious cover	HIGH IMP	UPLAND	
14122	Pavement with 91-100% impervious cover	HIGH IMP	UPLAND	
14123	Buildings and pavement with 91-100% impervious cover	HIGH IMP	UPLAND	
14220	11% to 25% impervious cover-exposed earth	HIGH IMP	UPLAND	
14221	Mines with 11-25% impervious cover	HIGH IMP	UPLAND	
14222	Sand and gravel pits with 11-25% impervious cover	HIGH IMP	UPLAND	
14223	Landfill with 11-25% impervious cover	HIGH IMP	UPLAND	
14224	Other exposed/transitional land with 11-25% impervious cover	HIGH IMP	UPLAND	
14230	26% to 50% impervious cover-exposed earth	HIGH IMP	UPLAND	
14231	Mines with 26-50% impervious cover	HIGH IMP	UPLAND	
14232	Sand and gravel pits with 26-50% impervious cover	HIGH IMP	UPLAND	
14233	Landfill with 26-50% impervious cover	HIGH IMP	UPLAND	
14234	Other exposed/transitional land with 26-50% impervious cover.	HIGH IMP	UPLAND	
10000	Artificial surfaces and associated areas	LEVEL	UPLAND	
11000	Artificial surfaces with trees as the dominant vegetation cover	LEVEL	UPLAND	
20000	Planted or Cultivated Vegetation (greater than 96% vegetation cover)	LEVEL	UPLAND	
30000	Forests	LEVEL	UPLAND	
31000	Coniferous forest	LEVEL	UPLAND	
31100	Upland coniferous forest	LEVEL	UPLAND	
32000	Deciduous forest	LEVEL	UPLAND	
32100	Upland deciduous forest	LEVEL	UPLAND	
32200	Temporaily flooded deciduous forest	LEVEL	WETLAND	
32300	Saturated deciduous forest	LEVEL	WETLAND	
32400	Seasonally flooded deciduous forest	LEVEL	WETLAND	
33000	Mixed coniferous-deciduous forest	LEVEL	UPLAND	
33100	Upland mixed coniferous-deciduous forest	LEVEL	UPLAND	
40000	Woodland	LEVEL	UPLAND	
41000	Coniferous woodland	LEVEL	UPLAND	
41100	Upland coniferous woodland	LEVEL	UPLAND	
42000	Deciduous woodland	LEVEL	UPLAND	
42100	Upland deciduous woodland	LEVEL	UPLAND	
42200	Temporarily flooded deciduous woodland	LEVEL	WETLAND	

42300	Saturated deciduous woodland	LEVEL	WETLAND	
42400	Seasonally flooded deciduous woodland	LEVEL	WETLAND	
43000	Mixed coniferous-deciduous woodland	LEVEL	UPLAND	
43100	Upland mixed coniferous-deciduous woodland	LEVEL	UPLAND	
50000	Shrubland	LEVEL	UPLAND	
51000	Coniferous / evergreen shrubland	LEVEL	UPLAND	
51100	Saturated needle-leaved or microphyllous evergreen	LEVEL	WETLAND	
52000	Deciduous shrubland	LEVEL	UPLAND	
52100	Upland deciduous shrubland	LEVEL	UPLAND	
52200	Temporaily flooded deciduous woodland	LEVEL	WETLAND	
52300	Saturated deciduous shrubland	LEVEL	WETLAND	
52400	Seasonally flooded deciduous shrubland	LEVEL	WETLAND	
52500	Semipermanently flooded deciduous shrubland	LEVEL	WETLAND	
60000	Herbaceous	LEVEL	UPLAND	
61000	Grassland or emergent vegetation	LEVEL	UPLAND	
61100	Tall grassland	LEVEL	UPLAND	
61200	Medium-tall grassland	LEVEL	UPLAND	
61300	Temporarily flooded graminoid vegetation	LEVEL	WETLAND	
61400	Saturated graminoid vegetation	LEVEL	WETLAND	
61500	Seasonally flooded emergent vegetation	LEVEL	WETLAND	
61600	Semipermanently flooded emergent vegetation	LEVEL	WETLAND	
61700	Intermittently exposed emergent vegetation	LEVEL	WETLAND	
61800	Permanently flooded emergent vegetation	LEVEL	WETLAND	
62000	Grassland with sparse tree layer	LEVEL	UPLAND	
62100	Grassland with sparse deciduous trees	LEVEL	UPLAND	
62200	Grassland with sparse conifer or mixed deciduous/coniferous trees	LEVEL	UPLAND	
62300	Temporarily flooded grassland with sparse deciduous trees	LEVEL	WETLAND	
62400	Saturated grassland with sparse deciduous trees	LEVEL	WETLAND	
62500	Seasonally flooded grassland with sparse deciduous trees	LEVEL	WETLAND	
63000	Perennial forb vegetation	LEVEL	UPLAND	
63100	Upland forb vegetation	LEVEL	UPLAND	
63200	Saturated forb vegetation	LEVEL	WETLAND	
64000	Hydromorphic rooted vegetation	LEVEL	WETLAND	
64100	Standing water hydromorphic rooted vegetation	LEVEL	WETLAND	
65000	Annual grasslands or forb vegetation	LEVEL	UPLAND	
65100	Seasonally flooded annual forb vegetation	LEVEL	WETLAND	

70000	Nonvascular vegetation	LEVEL	UPLAND	
71000	Lichen vegetation	LEVEL	UPLAND	
71100	Lichen vegetation with sparse tree layer	LEVEL	UPLAND	
80000	Sparse vegetation	LEVEL	UPLAND	
81000	Consolidated rock (cliffs, bedrock, etc.)	LEVEL	UPLAND	
81100	Cliffs with sparse vegetation	LEVEL	UPLAND	
81200	Level bedrock with sparse vegetation	LEVEL	UPLAND	
82000	Boulder, gravel, cobble, or talus	LEVEL	?	
82100	Lowland or submontane talus / scree slopes	LEVEL	?	
82200	Cobble / gravel beaches and shores	LEVEL	?	
83000	Unconsolidated material (soil, sand, and ash)	LEVEL	WETLAND	
83100	Sand flats	LEVEL	WETLAND	
83200	Temporarily flooded sand flats	LEVEL	WETLAND	
83300	Seasonally / temporarily flooded mud flats	LEVEL	WETLAND	
12000	Artificial surfaces with coniferous and/or deciduous shrub dominant	LEVEL	UPLAND	
13000	Artificial surfaces with herbaceous dominant vegetation (25% to 96%	LEVEL	UPLAND	
0	undefined	NO DATA	na	
31110	Black spruce-feathermoss forest	NPC	UPLAND	
31120	Jack pine forest	NPC	UPLAND	
31121	Jack pine forest jack pine-fir subtype	NPC	UPLAND	
31122	Jack pine forest hazel subtype	NPC	UPLAND	
31123	Jack pine forest jack pine-oak subtype	NPC	UPLAND	
31124	Jack pine forest jack pine-black spruce subtype	NPC	UPLAND	
31125	Jack pine forest blueberry subtype	NPC	UPLAND	
31130	Red pine forest	NPC	UPLAND	
31140	White pine forest	NPC	UPLAND	
31150	Upland white cedar forest	NPC	UPLAND	
31151	Upland white cedar forest wet-mesic subtype	NPC	UPLAND	
31152	Upland white cedar forest mesic subtype	NPC	UPLAND	
31160	Spruce-fir forest	NPC	UPLAND	
31161	Spruce-fir forest white spruce-balsam fir subtype	NPC	UPLAND	
31162	Spruce-fir forest fir-birch subtype	NPC	UPLAND	
31200	Saturated coniferous forest	NPC	WETLAND	
31210	Tamarack swamp	NPC	WETLAND	
31211	Tamarack swamp seepage subtype	NPC	WETLAND	
31212	Tamarack swamp minerotrophic subtype	NPC	WETLAND	

31213	Tamarack swamp sphagnum subtype	NPC	WETLAND	
31220	White cedar swamp	NPC	WETLAND	
31221	White cedar swamp seepage subtype	NPC	WETLAND	
31230	Black spruce swamp	NPC	WETLAND	
31240	Black spruce bog	NPC	WETLAND	
31241	Black spruce bog intermediate subtype	NPC	WETLAND	
31242	Black spruce bog raised subtype	NPC	WETLAND	
32110	Oak forest	NPC	UPLAND	
32111	Oak forest red maple subtype	NPC	UPLAND	
32112	Oak forest mesic subtype	NPC	UPLAND	
32113	Oak forest dry subtype	NPC	UPLAND	
32120	Northern hardwood forest	NPC	UPLAND	
32130	Paper birch forest	NPC	UPLAND	
32131	Paper birch forest northern hardwoods subtype	NPC	UPLAND	
32132	Paper birch forest spruce-fir subtype	NPC	UPLAND	
32140	Aspen-birch forest	NPC	UPLAND	
32141	Aspen-birch forest northern hardwoods subtype	NPC	UPLAND	
32142	Aspen-birch forest spruce-fir subtype	NPC	UPLAND	
32150	Maple-basswood forest	NPC	UPLAND	
32160	Aspen forest	NPC	UPLAND	
32210	Floodplain forest	NPC	WETLAND	
32211	Floodplain forest silver maple subtype	NPC	WETLAND	
32212	Floodplain forest swamp white oak subtype	NPC	WETLAND	
32220	Lowland hardwood forest	NPC	UPLAND	
32230	Aspen forest - temporarily flooded	NPC	WETLAND	
32310	Black ash swamp	NPC	WETLAND	
32311	Black ash swamp seepage subtype	NPC	WETLAND	
32320	Mixed hardwood swamp	NPC	WETLAND	
32321	Mixed hardwood swamp seepage subtype	NPC	WETLAND	
32330	Aspen forest - saturated soils	NPC	WETLAND	
32410	Black ash swamp - seasonally flooded	NPC	WETLAND	
32420	Mixed hardwood swamp - seasonally flooded	NPC	WETLAND	
33110	Mixed pine-hardwood forest	NPC	UPLAND	
33120	Boreal hardwood-conifer forest	NPC	UPLAND	
33130	Northern hardwood-conifer forest	NPC	UPLAND	
33131	Northern hardwood-conifer forest yellow birch-white cedar subtype	NPC	UPLAND	

33140	White pine-hardwood forest	NPC	UPLAND	
33141	White pine-hardwood forest dry subtype	NPC	UPLAND	
33142	White pine-hardwood forest mesic subtype	NPC	UPLAND	
41110	Jack pine woodland	NPC	UPLAND	
41120	Northern conifer woodland	NPC	UPLAND	
41130	Eastern Red Cedar woodland	NPC	UPLAND	
42110	Aspen woodland	NPC	UPLAND	
42120	Oak woodland-brushland	NPC	UPLAND	
51110	Open sphagnum bog	NPC	WETLAND	
51111	Open sphagnum bog intermediate subtype	NPC	WETLAND	
51112	Open sphagnum bog raised subtype	NPC	WETLAND	
51120	Scrub tamarack poor fen	NPC	WETLAND	
52110	Mesic brush-prairie	NPC	UPLAND	
52111	Mesic brush-prairie sand-gravel subtype	NPC	UPLAND	
52120	Native dominated disturbed upland shrubland	NPC	UPLAND	
52210	Native dominated temporarily flooded shrubland	NPC	WETLAND	
52230	Birch bog, spiraea temporarily flooded shrubland	NPC	WETLAND	
52310	Shrub fen	NPC	WETLAND	
52311	Poor fen shrub subtype	NPC	WETLAND	
52312	Rich fen shrub subtype	NPC	WETLAND	
52320	Wet brush-prairie	NPC	WETLAND	
52321	Wet brush-prairie seepage subtype	NPC	WETLAND	
52340	Shrub swamp seepage subtype	NPC	WETLAND	
52350	Alder swamp - saturated soils	NPC	WETLAND	
52360	Willow swamp - saturated soils	NPC	WETLAND	
52370	Wet meadow shrub subtype - saturated soils	NPC	WETLAND	
52380	Birch bog, spiraea shrubland - saturated soils	NPC	WETLAND	
52410	Alder swamp	NPC	WETLAND	
52420	Wet meadow shrub subtype	NPC	WETLAND	
52430	Willow swamp	NPC	WETLAND	
52450	Birch bog, spiraea shrubland - seasonally flooded	NPC	WETLAND	
52510	Wet meadow shrub - semipermanently flooded	NPC	WETLAND	
52520	Willow swamp - semipermanently flooded	NPC	WETLAND	
52530	Birch bog, spiraea shrublan - semipermanently flooded	NPC	WETLAND	
61110	Mesic prairie	NPC	UPLAND	
61111	Mesic prairie carbonate bedrock subtype	NPC	UPLAND	

61112	Mesic prairie crystalline bedrock subtype	NPC	UPLAND	
61210	Dry prairie	NPC	UPLAND	
61211	Dry prairie barrens subtype	NPC	UPLAND	
61212	Dry prairie bedrock bluff subtype	NPC	UPLAND	
61213	Dry prairie sand-gravel subtype	NPC	UPLAND	
61214	Dry prairie hill subtype	NPC	UPLAND	
61310	Wet prairie	NPC	WETLAND	
61311	Wet prairie saline subtype	NPC	WETLAND	
61320	Wet meadow - temporarily flooded soils	NPC	WETLAND	
61410	Wet prairie - saturated soils	NPC	WETLAND	
61411	Wet prairie saline subtype - saturated soils	NPC	WETLAND	
61412	Wet prairie seepage subtype - saturated soils	NPC	WETLAND	
61420	Wet meadow	NPC	WETLAND	
61440	Calcareous seepage fen	NPC	WETLAND	
61441	Calcareous seepage fen boreal subtype	NPC	WETLAND	
61442	Calcareous seepage fen prairie subtype	NPC	WETLAND	
61450	Poor fen	NPC	WETLAND	
61451	Poor fen sedge subtype	NPC	WETLAND	
61452	Poor fen patterned fen subtype	NPC	WETLAND	
61460	Rich fen	NPC	WETLAND	
61461	Rich fen sedge subtype	NPC	WETLAND	
61462	Rich fen floating-mat subtype - saturated soils	NPC	WETLAND	
61463	Rich fen patterned fen subtype	NPC	WETLAND	
61470	Open bog	NPC	WETLAND	
61471	Open sphagnum bog schlenke subtype	NPC	WETLAND	
61472	Graminoid bog	NPC	WETLAND	
61520	Mixed emergent marsh - seasonally flooded	NPC	WETLAND	
61540	Wet meadow - seasonally flooded	NPC	WETLAND	
61620	Mixed emergent marsh	NPC	WETLAND	
61640	Wet meadow - semipermanently flooded	NPC	WETLAND	
61641	Wet meadow floating mat subtype	NPC	WETLAND	
61650	Rich fen floating-mat subtype - semipermanently flooded	NPC	WETLAND	
61720	Mixed emergent marsh - intermittently exposed	NPC	WETLAND	
61740	Rich fen floating-mat subtype - intermittently exposed	NPC	WETLAND	
61820	Mixed emergent marsh - permanently flooded	NPC	WETLAND	
61840	Rich fen floating-mat subtype - permanently flooded	NPC	WETLAND	

62110	Aspen openings	NPC	UPLAND	
62111	Aspen openings sand gravel subtype	NPC	UPLAND	
62120	Dry oak savanna	NPC	UPLAND	
62121	Dry oak savanna hill subtype	NPC	UPLAND	
62122	Dry oak savanna barrens subtype	NPC	UPLAND	
62123	Dry oak savanna sand-gravel subtype	NPC	UPLAND	
62130	Mesic oak savanna	NPC	UPLAND	
62210	Jack pine barrens	NPC	UPLAND	
63110	Talus slope algific subtype	NPC	UPLAND	
63210	Seepage meadow	NPC	WETLAND	
64110	Water lily	NPC	WETLAND	
64111	Water lily open marsh	NPC	WETLAND	
64112	Boreal water lily aquatic wetland	NPC	WETLAND	
64113	Northern water lily aquatic wetland	NPC	WETLAND	
64120	Midwest pondweed submerged aquatic wetland	NPC	WETLAND	
65110	Slender glasswort saline meadow	NPC	WETLAND	
71110	Northern conifer scrubland	NPC	UPLAND	
81110	Open cliff	NPC	UPLAND	
81111	Great Lakes shore basalt/diabase cliff	NPC	?	
81112	Northern (Laurentian) igneous/metamorphic dry cliff	NPC	?	
81113	Midwest dry limestone/dolostone cliff	NPC	UPLAND	
81114	Midwest sandstone dry cliff	NPC	UPLAND	
81115	Midwest sandstone moist cliff	NPC	UPLAND	
81116	Great Lakes shoreline granite/metamorphic cliff	NPC	UPLAND	
81120	Wet cliff	NPC	?	
81121	Maderate cliff	NPC	UPLAND	
81122	Midwest sedimentary dripping cliff	NPC	?	
81130	Rock outcrop / butte	NPC	UPLAND	
81131	Northern (Laurentian) granite/metamorphic rock outcrop	NPC	UPLAND	
81132	Midwest quartzite - granite rock outcrop	NPC	UPLAND	
81210	Open level bedrock	NPC	UPLAND	
81211	Inland lake igneous/metamorphic bedrock shore	NPC	UPLAND	
81212	Great Lakes basalt (conglomerate) bedrock lakeshore	NPC	?	
81213	Great Lakes limestone-dolostone bedrock lakeshore	NPC	?	
81214	Great Lakes sandstone bedrock shore	NPC	WETLAND	
81215	River ledge sandstone pavement	NPC	?	

82110	Lowland talus	NPC	?	
82111	Northern granite/metamorphic talus	NPC	?	
82112	Midwest limestone - dolostone talus	NPC	?	
82113	Northern sandstone talus	NPC	?	
82114	Northern basalt/diabase open talus	NPC	?	
82210	Cobble / gravel shore	NPC	?	
82211	Great Lakes basalt/diabase cobble-gravel lakeshore	NPC	?	
82212	Riverine igneous/metamorphic cobble-gravel shore	NPC	?	
82213	Great Lakes non-alkaline cobble/gravel shore	NPC	?	
82214	Inland lake igneous/metamorphic cobble-gravel shore	NPC	?	
83110	Inland strand beach	NPC	WETLAND	
83111	Inland freshwater strand beach	NPC	WETLAND	
83210	Sand flats temporarily flooded	NPC	WETLAND	
83211	Lacustrine sand flats - bars	NPC	WETLAND	
83212	Riverine sand flats - bars	NPC	WETLAND	
83310	Non-tidal mud flat seasonally / temporarily flooded	NPC	WETLAND	
83311	Lake mud flats	NPC	WETLAND	
83312	River mud flats	NPC	WETLAND	
83313	Saline spring mud flats	NPC	WETLAND	
11111	Jack pine (forest or woodland) with 4-10% impervious cover	NPC+IMP	UPLAND	
11112	White/red pine (forest) with 4-10% impervious cover	NPC+IMP	UPLAND	
11113	Spruce-fir (forest) with 4-10% impervious cover	NPC+IMP	UPLAND	
11114	Eastern red cedar (woodland) with 4-10% impervious cover	NPC+IMP	UPLAND	
11115	Northern conifer (woodland) with 4-10% impervious cover	NPC+IMP	UPLAND	
11211	Oak (forest or woodland) with 4-10% impervious cover	NPC+IMP	UPLAND	
11212	Northern hardwood (forest) with 4-10% impervious cover	NPC+IMP	UPLAND	
11213	Maple-basswood (forest) with 4-10% impervious cover	NPC+IMP	UPLAND	
11214	Boxelder-green ash (forest) with 4-10% impervious cover	NPC+IMP	UPLAND	
11215	Aspen-birch (forest) with 4-10% impervious cover	NPC+IMP	UPLAND	
11216	Aspen (forest, woodland) with 4-10% impervious cover	NPC+IMP	UPLAND	
11221	Oak (forest or woodland) with 11- 25% impervious cover	NPC+IMP	UPLAND	
11222	Northern hardwood (forest) with 11- 25% impervious cover	NPC+IMP	UPLAND	
11223	Maple-basswood (forest) with 11- 25% impervious cover	NPC+IMP	UPLAND	
11224	Boxelder-green ash (forest) with 11- 25% impervious cover	NPC+IMP	UPLAND	
11225	Aspen-birch (forest) with 11- 25% impervious cover	NPC+IMP	UPLAND	
11226	Aspen (forest, woodland) with 11- 25% impervious cover	NPC+IMP	UPLAND	

11231	Oak (forest or woodland) with 26-50% impervious cover	NPC+IMP	UPLAND	
11232	Northern hardwood (forest) with 26-50% impervious cover	NPC+IMP	UPLAND	
11233	Maple-basswood (forest) with 26-50% impervious cover	NPC+IMP	UPLAND	
11234	Boxelder-green ash (forest) with 26-50% impervious cover	NPC+IMP	UPLAND	
11235	Aspen-birch (forest) with 26-50% impervious cover	NPC+IMP	UPLAND	
11236	Aspen (forest, woodland) with 26-50% impervious cover	NPC+IMP	UPLAND	
11241	Oak (forest or woodland) with 51-75% impervious cover	NPC+IMP	UPLAND	
11242	Northern hardwood (forest) with 51-75% impervious cover	NPC+IMP	UPLAND	
11243	Maple-basswood (forest) with 51-75% impervious cover	NPC+IMP	UPLAND	
11244	Boxelder-green ash (forest) with 51-75% impervious cover	NPC+IMP	UPLAND	
11245	Aspen-birch (forest) with 51-75% impervious cover	NPC+IMP	UPLAND	
11246	Aspen (forest, woodland) with 51-75% impervious cover	NPC+IMP	UPLAND	
11311	Mixed pine-hardwood (forest) with 4-10% impervious cover	NPC+IMP	UPLAND	
11312	White pine-hardwood (forest) with 4-10% impervious cover	NPC+IMP	UPLAND	
11313	Northern hardwood-conifer (forest) with 4-10% impervious cover	NPC+IMP	UPLAND	
12211	Oak woodland brushland with 4-10% impervious cover	NPC+IMP	UPLAND	
12221	Oak woodland brushland with11-25% impervious cover	NPC+IMP	UPLAND	
12231	Oak woodland brushland with 26-50% impervious cover	NPC+IMP	UPLAND	
12241	Oak Woodland brushland with 51-75% impervious cover	NPC+IMP	UPLAND	
13111	Jack pine barrens with 4-10% impervious cover	NPC+IMP	UPLAND	
13112	Oak savanna with 4-10% impervious cover	NPC+IMP	UPLAND	
13113	Aspen openings with 4-10% impervious cover	NPC+IMP	UPLAND	
13121	Jack pine barrens with 11-25% impervious cover	NPC+IMP	UPLAND	
13122	Oak savanna with 11-25% impervious cover	NPC+IMP	UPLAND	
13123	Aspen openings with 11-25% impervious cover	NPC+IMP	UPLAND	
13131	Jack pine barrens with 26-50% impervious cover	NPC+IMP	UPLAND	
13132	Oak savanna with 26-50% impervious cover	NPC+IMP	UPLAND	
13133	Aspen openings with 26-50% impervious cover	NPC+IMP	UPLAND	
13141	Jack pine barrens with 51-75% impervious cover	NPC+IMP	UPLAND	
13142	Oak savanna with 51-75% impervious cover	NPC+IMP	UPLAND	
13143	Aspen openings with 51-75% impervious cover	NPC+IMP	UPLAND	
13213	Mesic prairie with 4-10% impervious cover	NPC+IMP	UPLAND	
13214	Dry prairie with 4-10% impervious cover	NPC+IMP	UPLAND	
13223	Mesic prairie with 11-25% impervious cover	NPC+IMP	UPLAND	
13224	Dry prairie with 11-25% impervious cover	NPC+IMP	UPLAND	
13233	Mesic prairie with 26-50% impervious cover	NPC+IMP	UPLAND	

13234	Dry prairie with 26-50% impervious cover	NPC+IMP	UPLAND	
13243	Mesic prairie with 51-75% impervious cover	NPC+IMP	UPLAND	
13244	Dry prairie with 51-75% impervious cover	NPC+IMP	UPLAND	
11100	Artificial surfaces with coniferous trees	RP	UPLAND	
11110	4% to 10% impervious cover with coniferous trees	RP	UPLAND	
11116	Planted red pine with 4-10% impervious cover	RP	UPLAND	
11117	Planted white pine with 4-10% impervious cover	RP	UPLAND	
11118	Planted spruce/fir with 4-10% impervious cover	RP	UPLAND	
11119	Other planted conifers with 4-10% impervious cover	RP	UPLAND	
11200	Artificial surfaces with deciduous tree cover	RP	UPLAND	
11210	4% to 10% impervious cover with deciduous trees	RP	UPLAND	
11217	Planted ash with 4-10% impervious cover	RP	UPLAND	
11218	Planted oak with 4-10% impervious cover	RP	UPLAND	
11219	Other deciduous trees with 4-10% impervious cover	RP	UPLAND	
11300	Artificial surfaces with mixed coniferous and deciduous tree cover	RP	UPLAND	
11310	4% to 10% impervious cover with mixed coniferous/deciduous trees	RP	UPLAND	
11314	Planted mixed coniferous/deciduous trees with 4-10% impervious co	RP	UPLAND	
12100	Artificial surfaces with coniferous and/or deciduous shrubs	RP	UPLAND	
12110	4% to 10% impervious cover with coniferous and/or deciduous shrub	RP	UPLAND	
12111	Short grasses with planted coniferous and/or deciduous shrubs, 4-10%	RP	UPLAND	
12112	Long grasses with planted coniferous and/or deciduous shrubs, 4-10%	RP	UPLAND	
12113	Other coniferous and/or deciduous shrubs with 4-10% impervious co	RP	UPLAND	
12200	Artificial surfaces with coniferous and/or deciduous shrubs with spar	RP	UPLAND	
12210	4% to 10% impervious cover with coniferous and/or deciduous shrub	RP	UPLAND	
12212	Other coniferous and/or deciduous shrubs and trees with 4-10% impe	RP	UPLAND	
13100	Artificial surfaces with perennial grasses with sparse trees	RP	UPLAND	
13110	4% to 10% impervious cover with perennial grasses and sparse trees	RP	UPLAND	
13114	Short grasses and mixed trees with 4-10% impervious cover	RP	UPLAND	
13115	Long grasses and mixed trees with 4-10% impervious cover	RP	UPLAND	
13200	Artificial surfaces with perennial grasses	RP	UPLAND	
13210	4% to 10% impervious cover with perennial grasses	RP	UPLAND	
13211	Short grasses with 4-10% impervious cover	RP	UPLAND	
13212	Non-native dominated long grasses with 4-10% impervious cover	RP	UPLAND	
13300	Artificial surfaces with cultivated herbaceous vegetation (Gardens)	RP	UPLAND	
13310	4% to 10% impervious cover with cultivated herbaceous vegetation	RP	UPLAND	
13311	Vegetables with 4-10% impervious cover	RP	UPLAND	

13312	Forbs (flowers) with 4-10% impervious cover	RP	UPLAND	
14200	Exposed earth	RP	UPLAND	
14210	0% to 10% impervious cover-exposed earth	RP	UPLAND	
14211	Mines with 0-10% impervious cover	RP	UPLAND	
14212	Sand and gravel pits with 0-10% impervious cover	RP	UPLAND	
14213	Landfill with 0-10% impervious cover	RP	UPLAND	
14214	Other exposed/transitional land with 0-10% impervious cover	RP	UPLAND	
21000	Planted, maintained or cultivated tree vegetation	RP	UPLAND	
24229	All other close grown cropland on hydric soils	RP	WETLAND	
22220	Artificially flooded or saturated soils	RP	WETLAND	
24230	Artificially flooded or saturated soils - close grown cropland	RP	WETLAND	
24224	Barley on hydric soils	RP	WETLAND	
24121	Beans (all types except soybeans) on hydric soils	RP	WETLAND	
24122	Corn on hydric soils	RP	WETLAND	
24227	Fallow hydric soils	RP	WETLAND	
24228	Hayfield on hydric soils	RP	WETLAND	
24220	Hydric soils - close grown cropland	RP	WETLAND	
24120	Hydric soils - row cropland	RP	WETLAND	
23320	Hydric soils with planted grasses and forbs	RP	WETLAND	
23220	Hydric soils with planted or maintained grasses	RP	WETLAND	
23120	Hydric soils with planted or maintained grasses and sparse tree cover	RP	WETLAND	
22120	Hydric soils with planted, maintained or cultivated coniferous shrubs	RP	WETLAND	
21320	Hydric soils with planted, maintained or cultivated mixed coniferous	RP	WETLAND	
22320	Hydric soils with planted, maintained or cultivated mixed coniferous	RP	WETLAND	
23122	Long grasses with sparse tree cover on hydric soils	RP	WETLAND	
24226	Not planted on hydric soils	RP	WETLAND	
24222	Oats on hydric soils	RP	WETLAND	
24126	Potato on hydric soils	RP	WETLAND	
24127	Pumpkins on hydric soils	RP	WETLAND	
24223	Rice on hydric soils	RP	WETLAND	
23321	Short grasses and forbs on hydric soils	RP	WETLAND	
23221	Short grasses on hydric soils	RP	WETLAND	
23121	Short grasses with sparse tree cover on hydric soils	RP	WETLAND	
24225	Sod on hydric soils	RP	WETLAND	
24123	Sorghum on hydric soils	RP	WETLAND	
24124	Soybeans on hydric soils	RP	WETLAND	

24125	Sugar beets on hydric soils	RP	WETLAND	
24128	Sunflowers on hydric soils	RP	WETLAND	
24221	Wheat on hydric soils	RP	WETLAND	
24218	All other close grown cropland on upland soils	RP	UPLAND	
24213	Barley	RP	UPLAND	
24111	Beans (all types except soybeans)	RP	UPLAND	
22211	Blackberry	RP	UPLAND	
22212	Blueberry	RP	UPLAND	
24200	Close grown or solid seeded cropland	RP	UPLAND	
21114	Coniferous trees on upland soils	RP	UPLAND	
24112	Corn	RP	UPLAND	
22221	Cranberry	RP	UPLAND	
24000	Cultivated herbaceous vegetation	RP	UPLAND	
21213	Deciduous trees on upland soils	RP	UPLAND	
24216	Fallow	RP	UPLAND	
21211	Fruit trees (apple, cherry, plum, etc) on upland soils	RP	UPLAND	
22213	Grape	RP	UPLAND	
24217	Hayfield	RP	UPLAND	
23322	Long grasses and forbs on hydric soils	RP	WETLAND	
23312	Long grasses and forbs on upland soils	RP	UPLAND	
23222	Long grasses on hydric soils	RP	WETLAND	
23212	Long grasses on upland soils	RP	UPLAND	
23112	Long grasses with sparse tree cover on upland soils	RP	UPLAND	
24215	Not planted	RP	UPLAND	
24212	Oats	RP	UPLAND	
22216	Other shrub/vine vegetation	RP	UPLAND	
24119	Other vegetable and truck crops	RP	UPLAND	
24129	Other vegetable and truck crops on hydric soils	RP	WETLAND	
23200	Planted or maintained grasses	RP	UPLAND	
23300	Planted or maintained grasses and forbs	RP	UPLAND	
23100	Planted or maintained grasses with sparse tree cover	RP	UPLAND	
23000	Planted or maintained herbaceous vegetation	RP	UPLAND	
22100	Planted, maintained or cultivated coniferous shrubs	RP	UPLAND	
21100	Planted, maintained or cultivated coniferous trees	RP	UPLAND	
22200	Planted, maintained or cultivated deciduous shrub/vine vegetation	RP	UPLAND	
21200	Planted, maintained or cultivated deciduous trees	RP	UPLAND	

21300	Planted, maintained or cultivated mixed coniferous and deciduous tre	RP	UPLAND	
22300	Planted, maintained or cultivated mixed coniferous-deciduous shrub/	RP	UPLAND	
22000	Planted, maintained or cultivated shrub and/or vine vegetation	RP	UPLAND	
24116	Potato	RP	UPLAND	
24117	Pumpkins	RP	UPLAND	
22214	Raspberry-black	RP	UPLAND	
22215	Raspberry-red	RP	UPLAND	
21113	Red pine trees on upland soils	RP	UPLAND	
24231	Rice	RP	UPLAND	
24100	Row cropland	RP	UPLAND	
23311	Short grasses and forbs on upland soils	RP	UPLAND	
23211	Short grasses on upland soils	RP	UPLAND	
23111	Short grasses with sparse tree cover on upland soils	RP	UPLAND	
24214	Sod	RP	UPLAND	
24113	Sorghum	RP	UPLAND	
24114	Soybeans	RP	UPLAND	
21111	Spruce/fir trees on upland soils	RP	UPLAND	
24115	Sugar beets	RP	UPLAND	
24118	Sunflowers	RP	UPLAND	
24210	Upland soils - close grown cropland	RP	UPLAND	
24110	Upland soils - cropland	RP	UPLAND	
23210	Upland soils with planted or maintained grasses	RP	UPLAND	
23310	Upland soils with planted or maintained grasses and forbs	RP	UPLAND	
23110	Upland soils with planted or maintained grasses and sparse tree cove	RP	UPLAND	
22110	Upland soils with planted, maintained or cultivated coniferous shrub	RP	UPLAND	
22210	Upland soils with planted, maintained or cultivated deciduous shrub/	RP	UPLAND	
21210	Upland soils with planted, maintained or cultivated deciduous trees	RP	UPLAND	
21310	Upland soils with planted, maintained or cultivated mixed coniferous	RP	UPLAND	
22310	Upland soils with planted, maintained or cultivated mixed coniferous	RP	UPLAND	
21110	Upland soils with planted, maintained, or cultivated coniferous trees	RP	UPLAND	
21212	Walnut trees on upland soils	RP	UPLAND	
24211	Wheat	RP	UPLAND	
21112	White pine trees on upland soils	RP	UPLAND	
32170	Altered/non-native deciduous forest	RP	UPLAND	
32240	Altered/non-native temporarily flooded deciduous forest	RP	WETLAND	
32340	Altered/non-native saturated soils deciduous forest	RP	WETLAND	

32430	Altered/non-native seasonally flooded deciduous forest	RP	WETLAND	
42130	Altered/non-native deciduous woodland	RP	UPLAND	
42210	Altered/non-native deciduous woodland - temporarily flooded	RP	WETLAND	
42310	Altered/non-native deciduous woodland - saturated	RP	WETLAND	
42410	Altered/non-native deciduous woodland - seasonally flooded	RP	WETLAND	
43110	Altered/non-native mixed woodland	RP	UPLAND	
52130	Altered/non-native dominated upland shrubland	RP	UPLAND	
52220	Altered/non-native dominated temporarily flooded shrubland	RP	WETLAND	
52330	Altered/non-native dominated saturated shrubland	RP	WETLAND	
52440	Altered/non-native dominated seasonally flooded shrubland	RP	WETLAND	
52540	Altered/non-native dominated semipermanently flooded shrubland	RP	WETLAND	
61120	Tall grass altered/non-native dominated grassland	RP	UPLAND	
61220	Medium-tall grass altered/non-native dominated grassland	RP	UPLAND	
61330	Temporarily flooded altered/non-native dominated grassland	RP	WETLAND	
61340	Cattail marsh - temporarily flooded	RP	WETLAND	
61430	Cattail marsh - saturated soils	RP	WETLAND	
61480	Saturated altered/non-native dominated graminoid vegetation	RP	WETLAND	
61510	Cattail marsh - seasonally flooded	RP	WETLAND	
61530	Seasonally flooded altered/non-native dominated emergent vegetatio	RP	WETLAND	
61610	Cattail marsh - semipermanently flooded	RP	WETLAND	
61630	Semipermanently flooded altered/non-native dominated vegetation	RP	WETLAND	
61710	Cattail marsh - intermittently exposed	RP	WETLAND	
61730	Intermittently exposed altered/non-native dominated vegetation	RP	WETLAND	
61810	Cattail marsh - permanently flooded	RP	WETLAND	
61830	Permanently flooded altered/non-native dominated vegetation	RP	WETLAND	
62140	Grassland with sparse deciduous trees - altered/non-native dominated	RP	UPLAND	
62220	Grassland with sparse conifer or mixed deciduous/coniferous trees -	RP	UPLAND	
62310	Altered/non-native grassland with sparse deciduous trees - temporari	RP	WETLAND	
62410	Altered/non-native grassland with sparse deciduous trees - saturated	RP	WETLAND	
62510	Altered/non-native grassland with sparse deciduous trees - seasonally	RP	WETLAND	
90000	Water	WATER/AQUATIC		
91000	River (riverine)	WATER/AQUATIC		
91100	Slow moving linear open water habitat	WATER/AQUATIC		
91200	Fast moving linear open water habitat	WATER/AQUATIC		
92000	Lake (lacustrine)	WATER/AQUATIC		
92100	Limnetic open water	WATER/AQUATIC		

92200	Semipermanently flooded littoral aquatic bed	WATER/AQUATIC		
92210	Floating algae - semipermanently flooded littoral aquatic bed	WATER/AQUATIC		
92220	Floating vascular vegetation - semipermanently flooded littoral aqua	WATER/AQUATIC		
92300	Intermittently exposed littoral aquatic bed	WATER/AQUATIC		
92310	Floating algae - intermittently exposed littoral aquatic bed	WATER/AQUATIC		
92320	Floating vascular vegetation - intermittently exposed littoral aquatic	WATER/AQUATIC		
92400	Permanently flooded littoral aquatic bed	WATER/AQUATIC		
92410	Floating algae - permanently flooded littoral aquatic bed	WATER/AQUATIC		
92420	Floating vascular vegetation - permanently flooded littoral aquatic b	WATER/AQUATIC		
92500	Littoral open water	WATER/AQUATIC		
93000	Wetland-open water (palustrine)	WATER/AQUATIC		
93100	Intermittently exposed aquatic bed	WATER/AQUATIC		
93110	Floating algae - intermittently exposed aquatic bed	WATER/AQUATIC		
93120	Floating vascular vegetation - intermittently exposed aquatic bed	WATER/AQUATIC		
93200	Permanently flooded aquatic bed	WATER/AQUATIC		
93210	Floating algae	WATER/AQUATIC		
93220	Floating vascular vegetation	WATER/AQUATIC		
93300	Palustrine open water	WATER/AQUATIC		

Appendix C. Conversion Ranks						
C_NUM	**C_TEXT**	**# polys in project**	**PROJECT CODE**	**UPLAND/ WETLAND**	**CONV. RANK**	**NOTES**
11100	Artificial surfaces with coniferous trees		RP	UP	3	IMP, CONIF
11110	4% to 10% impervious cover with coniferous trees	24	RP	UP	3	IMP, CONIF
11114	Eastern red cedar (woodland) with 4-10% impervious cover	1	RP	UP	3	IMP, CONIF
11116	Planted red pine with 4-10% impervious cover	11	RP	UP	3	IMP, CONIF
11119	Other planted conifers with 4-10% impervious cover	9	RP	UP	3	IMP, CONIF
11217	Planted ash with 4-10% impervious cover	2	RP	UP	3	IMP
11219	Other deciduous trees with 4-10% impervious cover	47	RP	UP	3	IMP
11310	4% to 10% impervious cover with mixed coniferous/deciduous trees	79	RP	UP	3	IMP
11314	Planted mixed coniferous/deciduous trees with 4-10% impervious cover	156	RP	UP	3	IMP
12110	4% to 10% impervious cover with coniferous and/or deciduous shrubs	10	RP	UP	3	IMP
12111	Short grasses with planted coniferous and/or deciduous shrubs, 4-10% impervious cover	8	RP	UP	3	IMP
12112	Long grasses with planted coniferous and/or deciduous shrubs, 4-10% impervious cover	5	RP	UP	3	IMP

12212	Other coniferous and/or deciduous shrubs and trees with 4-10% impervious cover	10	RP	UP	3	IMP
13110	4% to 10% impervious cover with perennial grasses and sparse trees	313	RP	UP	3	IMP
13114	Short grasses and mixed trees with 4-10% impervious cover	2175	RP	UP	3	IMP
13115	Long grasses and mixed trees with 4-10% impervious cover	351	RP	UP	3	IMP
13210	4% to 10% impervious cover with perennial grasses	150	RP	UP	3	IMP
13211	Short grasses with 4-10% impervious cover	946	RP	UP	3	IMP
13212	Non-native dominated long grasses with 4-10% impervious cover	422	RP	UP	3	IMP, INV
13310	4% to 10% impervious cover with cultivated herbaceous vegetation	2	RP	UP	3	IMP
13311	Vegetables with 4-10% impervious cover	2	RP	UP	3	IMP
13312	Forbs (flowers) with 4-10% impervious cover	1	RP	UP	3	IMP
14200	Exposed earth	11	RP	UP	3	CODE, DIST
14210	0% to 10% impervious cover-exposed earth	71	RP	UP	3	DIST
14211	Mines with 0-10% impervious cover	6	RP	UP	3	DIST
14213	Landfill with 0-10% impervious cover	5	RP	UP	3	DIST
14214	Other exposed/transitional land with 0-10% impervious cover	498	RP	UP	3	DIST
21000	Planted, maintained or cultivated tree vegetation	2	RP	UP	3	CODE
21100	Planted, maintained or cultivated coniferous trees	25	RP	UP	3	CODE

21110	Upland soils with planted, maintained, or cultivated coniferous trees	950	RP	UP	3	CODE
21111	Spruce/fir trees on upland soils	49	RP	UP	3	CONIF
21113	Red pine trees on upland soils	218	RP	UP	3	CONIF
21114	Coniferous trees on upland soils	420	RP	UP	3	CONIF
21212	Walnut trees on upland soils	4	RP	UP	3	INV - allelopathic
21300	Planted, maintained or cultivated mixed coniferous and deciduous trees	5	RP	UP	3	AG/HORT
21310	Upland soils with planted, maintained or cultivated mixed coniferous/deciduous trees	559	RP	UP	3	AG/HORT
21320	Hydric soils with planted, maintained or cultivated mixed coniferous/deciduous trees	22	RP	UP	5	
22110	Upland soils with planted, maintained or cultivated coniferous shrubs	9	RP	UP	3	AG/HORT
23100	Planted or maintained grasses with sparse tree cover	19	RP	UP	3	CODE
23110	Upland soils with planted or maintained grasses and sparse tree cover	562	RP	UP	3	CODE
23112	Long grasses with sparse tree cover on upland soils	1070	RP	UP	3	INV
23120	Hydric soils with planted or maintained grasses and sparse tree cover	96	RP	UP	5	
23121	Short grasses with sparse tree cover on hydric soils	146	RP	UP	5	
23122	Long grasses with sparse tree cover on hydric soils	65	RP	UP	3	INV
23200	Planted or maintained grasses	54	RP	UP	3	CODE
23210	Upland soils with planted or maintained grasses	999	RP	UP	3	CODE
23212	Long grasses on upland soils	2775	RP	UP	3	INV

23220	Hydric soils with planted or maintained grasses	260	RP	UP	3	HYD
23221	Short grasses on hydric soils	505	RP	UP	5	
23222	Long grasses on hydric soils	223	RP	UP	3	INV
23300	Planted or maintained grasses and forbs	10	RP	UP	3	CODE
23310	Upland soils with planted or maintained grasses and forbs	49	RP	UP	3	CODE
23312	Long grasses and forbs on upland soils	99	RP	UP	3	INV
23320	Hydric soils with planted grasses and forbs	5	RP	UP	5	
23321	Short grasses and forbs on hydric soils	56	RP	UP	5	
23322	Long grasses and forbs on hydric soils	22	RP	UP	3	INV, HYD
24120	Hydric soils - row cropland	674	RP	UP	5	AG/HORT
24122	Corn on hydric soils	325	RP	UP	5	AG/HORT
24124	Soybeans on hydric soils	185	RP	UP	5	AG/HORT
24127	Pumpkins on hydric soils	1	RP	UP	5	AG/HORT
24128	Sunflowers on hydric soils	1	RP	UP	5	AG/HORT
24129	Other vegetable and truck crops on hydric soils	2	RP	UP	5	AG/HORT
24220	Hydric soils - close grown cropland	127	RP	UP	5	AG/HORT
24221	Wheat on hydric soils	3	RP	UP	5	AG/HORT
24223	Rice on hydric soils	1	RP	UP	5	AG/HORT
24224	Barley on hydric soils	1	RP	UP	5	AG/HORT
24225	Sod on hydric soils	22	RP	UP	5	AG/HORT
24226	Not planted on hydric soils	29	RP	UP	5	AG/HORT
24227	Fallow hydric soils	39	RP	UP	5	AG/HORT
24228	Hayfield on hydric soils	212	RP	UP	5	AG/HORT
24229	All other close grown cropland on hydric soils	6	RP	UP	5	AG/HORT
61120	Tall grass altered/non-native dominated grassland	147	RP	UP	3	INV

61220	Medium-tall grass altered/non-native dominated grassland	5190	RP	UP	3	INV
62140	Grassland with sparse deciduous trees - altered/non-native dominated vegetation	4514	RP	UP	3	INV,CODE
62220	Grassland with sparse conifer or mixed deciduous/coniferous trees - altered/non-native dominated	1195	RP	UP	3	INV,CODE
14212	Sand and gravel pits with 0-10% impervious cover	93	RP	UP	5	DIST
21112	White pine trees on upland soils	23	RP	UP	5	NATSP, Assumes white pine dominated NPC target
21200	Planted, maintained or cultivated deciduous trees	14	RP	UP	3	CODE
21210	Upland soils with planted, maintained or cultivated deciduous trees	187	RP	UP	5	AG/HORT
21211	Fruit trees (apple, cherry, plum, etc) on upland soils	45	RP	UP	5	AG/HORT
21213	Deciduous trees on upland soils	247	RP	UP	5	AG/HORT
22000	Planted, maintained or cultivated shrub and/or vine vegetation	4	RP	UP	5	AG/HORT
22200	Planted, maintained or cultivated deciduous shrub/vine vegetation	3	RP	UP	5	AG/HORT
22210	Upland soils with planted, maintained or cultivated deciduous shrub/vine vegetation	11	RP	UP	5	AG/HORT
22213	Grape	2	RP	UP	5	AG/HORT
22215	Raspberry-red	3	RP	UP	5	AG/HORT
22216	Other shrub/vine vegetation	3	RP	UP	5	AG/HORT

22300	Planted, maintained or cultivated mixed coniferous-deciduous shrub/vine vegetation	1	RP	UP	5	AG/HORT
22310	Upland soils with planted, maintained or cultivated mixed coniferous-deciduous shrub/vine	9	RP	UP	5	AG/HORT
22320	Hydric soils with planted, maintained or cultivated mixed coniferous-deciduous shrub/vine	2	RP	UP	3	HYD
23111	Short grasses with sparse tree cover on upland soils	3610	RP	UP	5	
23211	Short grasses on upland soils	4490	RP	UP	5	
23311	Short grasses and forbs on upland soils	121	RP	UP	5	
24000	Cultivated herbaceous vegetation	1205	RP	UP	5	AG/HORT
24100	Row cropland	1485	RP	UP	5	AG/HORT
24110	Upland soils - cropland	2573	RP	UP	5	AG/HORT
24111	Beans (all types except soybeans)	3	RP	UP	5	AG/HORT
24112	Corn	1333	RP	UP	5	AG/HORT
24114	Soybeans	678	RP	UP	5	AG/HORT
24117	Pumpkins	13	RP	UP	5	AG/HORT
24118	Sunflowers	4	RP	UP	5	AG/HORT
24119	Other vegetable and truck crops	30	RP	UP	5	AG/HORT
24200	Close grown or solid seeded cropland	91	RP	UP	5	AG/HORT
24210	Upland soils - close grown cropland	557	RP	UP	5	AG/HORT
24211	Wheat	27	RP	UP	5	AG/HORT
24212	Oats	16	RP	UP	5	AG/HORT
24213	Barley	2	RP	UP	5	AG/HORT
24214	Sod	14	RP	UP	5	AG/HORT
24215	Not planted	58	RP	UP	5	AG/HORT
24216	Fallow	120	RP	UP	5	AG/HORT
24217	Hayfield	1317	RP	UP	5	AG/HORT

24218	All other close grown cropland on upland soils	100	RP	UP	5	AG/HORT
32170	Altered/non-native deciduous forest	4681	RP	UP	3	INV
42130	Altered/non-native deciduous woodland	4157	RP	UP	3	INV
43110	Altered/non-native mixed woodland	423	RP	UP	3	INV
52130	Altered/non-native dominated upland shrubland	257	RP	UP	3	INV
32430	Altered/non-native seasonally flooded deciduous forest	54	RP	WT	1	INV, HYD
42410	Altered/non-native deciduous woodland - seasonally flooded	27	RP	WT	1	INV, HYD
52440	Altered/non-native dominated seasonally flooded shrubland	294	RP	WT	1	INV, HYD
52540	Altered/non-native dominated semipermanently flooded shrubland	7	RP	WT	1	INV, HYD
61480	Saturated altered/non-native dominated graminoid vegetation	2498	RP	WT	1	INV,CODE
61510	Cattail marsh - seasonally flooded	791	RP	WT	1	INV, HYD
61530	Seasonally flooded altered/non-native dominated emergent vegetation	3541	RP	WT	1	INV, HYD
62510	Altered/non-native grassland with sparse deciduous trees - seasonally flooded	90	RP	WT	1	HYD
32240	Altered/non-native temporarily flooded deciduous forest	445	RP	WT	3	INV
32340	Altered/non-native saturated soils deciduous forest	117	RP	WT	3	INV
42210	Altered/non-native deciduous woodland - temporarily flooded	263	RP	WT	3	INV
42310	Altered/non-native deciduous woodland - saturated	72	RP	WT	3	INV

52220	Altered/non-native dominated temporarily flooded shrubland	96	RP	WT	3	INV
52330	Altered/non-native dominated saturated shrubland	127	RP	WT	3	INV
61330	Temporarily flooded altered/non-native dominated grassland	2192	RP	WT	3	INV
61610	Cattail marsh - semipermanently flooded	920	RP	WT	1	INV, HYD
61630	Semipermanently flooded altered/non-native dominated vegetation	857	RP	WT	1	INV, HYD
61710	Cattail marsh - intermittently exposed	119	RP	WT	1	INV, HYD
61730	Intermittently exposed altered/non-native dominated vegetation	178	RP	WT	1	INV, HYD
61810	Cattail marsh - permanently flooded	53	RP	WT	1	INV, HYD
61830	Permanently flooded altered/non-native dominated vegetation	69	RP	WT	1	INV, HYD
62310	Altered/non-native grassland with sparse deciduous trees - temporarily flooded	634	RP	WT	3	INV
62410	Altered/non-native grassland with sparse deciduous trees - saturated soils	493	RP	WT	3	INV
61340	Cattail marsh - temporarily flooded	11	RP	WT	3	INV
61430	Cattail marsh - saturated soils	187	RP	WT	3	INV

RP RANKS ** See text explanation*

Factors lowering ranks

IMP	$\geq$ 4% impervious cover
INV	Invasive/competetive species likely to be present and abundanct
CONIF	Coniferous species cover type - soil likely to be altered
DIST	Severely disturbed cover types
HYD	Hydrologic regime wetter than Saturated or Temporarily flooded
CODE	MLCCS mapping not done to a sufficient level of detail

Factors raising ranks

NATSP	Native species present
AG/HORT	Land cover is agricultural or horticultural

Appendix D. Native Plant Community Categories for Analysis

MLCCS CODE (C_NUM)	MLCCS DESCRIPTION (C_TEXT)	WETLAND/ UPLAND GROUPS	ECOL_SG	UNAG_GRP	ALT_ECOL_SG_1	ALT_ECOL_SG_2
31140	White pine forest	UPLAND	FD	X	X	X
32110	Oak forest	UPLAND	OAKF	X	X	X
32111	Oak forest red maple subtype	UPLAND	OAKF	X	X	X
32112	Oak forest mesic subtype	UPLAND	OAKF	OAKF_MES	MES	MH_2
32113	Oak forest dry subtype	UPLAND	OAKF	OAKF_DRY	DRY	DRY
32120	Northern hardwood forest	UPLAND	MH	X	X	X
32141	Aspen-birch forest northern hardwoods subtype	UPLAND	MH	X	X	X
32150	Maple-basswood forest	UPLAND	MH	MH_MB	MH	MH_2
32160	Aspen forest	UPLAND	MH	X	X	X
32220	Lowland hardwood forest	UPLAND	MH	MH_LH	MH	MH_2
33140	White pine-hardwood forest	UPLAND	FD	FD_WPH	FD	MH_2
41130	Eastern Red Cedar woodland	UPLAND	UP	X	X	X
42120	Oak woodland-brushland	UPLAND	OWB	X	X	X
61110	Mesic prairie	UPLAND	MUP	MP	MES	MH_2
61210	Dry prairie	UPLAND	UP	X	X	X
61211	Dry prairie barrens subtype	UPLAND	UP	X	X	X
61212	Dry prairie bedrock bluff subtype	UPLAND	UP	UP_BLUF	DRY	DRY
61213	Dry prairie sand-gravel subtype	UPLAND	UP	UP_SG	DRY	DRY
61214	Dry prairie hill subtype	UPLAND	UP	X	X	X
62120	Dry oak savanna	UPLAND	UP	X	X	X
62121	Dry oak savanna hill subtype	UPLAND	UP	X	X	X
62123	Dry oak savanna sand-gravel subtype	UPLAND	UP	UP_SG	DRY	DRY
31210	Tamarack swamp	WETLAND	FP			
31211	Tamarack swamp seepage subtype	WETLAND	FP			
31212	Tamarack swamp minerotrophic subtype	WETLAND	FP			
31213	Tamarack swamp sphagnum subtype	WETLAND	FP			
32210	Floodplain forest	WETLAND	FF			
32211	Floodplain forest silver maple subtype	WETLAND	FF			
32230	Aspen forest - temporaily flooded	WETLAND	WF			
32310	Black ash swamp	WETLAND	WF			
32311	Black ash swamp seepage subtype	WETLAND	WF			
32320	Mixed hardwood swamp	WETLAND	WF			
32321	Mixed hardwood swamp seepage subtype	WETLAND	WF			
32330	Aspen forest - saturated soils	WETLAND	WF			
32410	Black ash swamp - seasonally flooded	WETLAND	WF			
32420	Mixed hardwood swamp - seasonally flooded	WETLAND	WF			
51120	Scrub tamarack poor fen	WETLAND	PAW			

52311	Poor fen shrub subtype	WETLAND	PAW			
52312	Rich fen shrub subtype	WETLAND	RAW			
52340	Shrub swamp seepage subtype	WETLAND	RAW			
52350	Alder swamp - saturated soils	WETLAND	FP			
52370	Wet meadow shrub subtype - saturated soils	WETLAND	WM			
52380	Birch bog, spiraea shrubland - saturated soils	WETLAND	RAW			
52410	Alder swamp	WETLAND	FP			
52420	Wet meadow shrub subtype	WETLAND	WM			
52530	Birch bog, spiraea shrublan - semipermanently flooded	WETLAND	RAW			
61310	Wet prairie	WETLAND	WPF			
61320	Wet meadow - temporarily flooded soils	WETLAND	WM			
61410	Wet prairie - saturated soils	WETLAND	WPF			
61420	Wet meadow	WETLAND	WM			
61440	Calcareous seepage fen	WETLAND	RCF			
61442	Calcareous seepage fen - prairie subtype	WETLAND	RCF			
61450	Poor fen	WETLAND	PAW			
61451	Poor fen sedge subtype	WETLAND	PAW			
61460	Rich fen	WETLAND	RAW			
61461	Rich fen sedge subtype	WETLAND	RAW			
61462	Rich fen floating-mat subtype - saturated soils	WETLAND	RAW			
61520	Mixed emergent marsh - seasonally flooded	WETLAND	MR-M			
61540	Wet meadow - seasonally flooded	WETLAND	WM			
61620	Mixed emergent marsh	WETLAND	MR-M			
61640	Wet meadow - semipermanently flooded	WETLAND	WM			
61641	Wet meadow floating mat subtype	WETLAND	WM			
61650	Rich fen floating-mat subtype - semipermanently flooded	WETLAND	RAW			
61720	Mixed emergent marsh - intermittently exposed	WETLAND	MR-W			
61740	Rich fen floating-mat subtype - intermittently exposed	WETLAND	RAW			
61820	Mixed emergent marsh - permanently flooded	WETLAND	MR-W			
63210	Seepage meadow	WETLAND	RCF			

Appendix E. Environmental Variables

FIELD NAME	DESCRIPTION	VARIABLE TYPE
ID	Unique ID for each polygon	numerical
AREA	ft2	numerical
PERIMETER	ft2	numerical
ACRES		numerical
C_NUM	MLCCS code	numerical
C_TEXT	description of MLCCS code	categorical
SOURCE	person or organization collecting the data	string
SOURCERANK	rank based on person or organization collecting the data	categorical - good, ok\good, ok, poor
P_CODE	LCMR project code (HQNPC, POTREST,DISTURBED, etc.)	categorical
	UPLAND/WETLAND - ECOLOGICAL SYSTEM/GROUP -	
WET_UPL	Wetland, Fluvial forest, Upland *OR* Wetland and Upland	categorical
ECOL_SG	**Ecological system or Group.** Systems based on MN DNR Eastern Broadleaf Forest Analysis, Groups created by project team for analysis	categorical
	SLOPE - ASPECT - SHADE	
SLOP_RN	**Slope.** Range per MLCCS polygon	continuous
SLOP_MN	**Slope.** Mean per MLCCS polygon	continuous
SLOP_SD	**Slope.** Standard deviation per MLCCS polygon	continuous
ASPT_MN	**Aspect.** Mean per MLCCS polygon	continuous
ASPT_DS	**Aspect.** Dispersion per MLCCS polygon	continuous
SHAD_MN	**Shade.** Mean per MLCCS polygon	continuous
	SOIL	
	Drainage categories for analysis:	
	P = Poorly drained (somewhat poorly, poorly, or very poorly drained) M - well drained (well or moderately well drained) E - excessively drained (excessively or somewhat excessively drained) WE = when components are equal % of well drained and excessively drained	
SOIL_DRN_P	**Soil drainage.** percent of MLCCS polygon with poorly drained soils	continuous
SOIL_DRN_M	**Soil drainage.** percent of MLCCS polygon with well drained soils	continuous
SOIL_DRN_E	**Soil drainage.** percent of MLCCS polygon with excessively drained soils	continuous
SOIL_DRN_WE	**Soil drainage.** percent of MLCCS polygon with equal % of well drained and excessively drained soils	continuous
SOIL_TX_ CF	**Clay Fine.** Percent of each Map Unit that is in the clay fine texture class (above)	continuous

SOIL_TX_ LMC	**Loam - Moderately Coarse.** Percent of each Map Unit that is in the loam-moderately coarse texture class (above)	continuous
SOIL_TX_LMED	**Loam-Medium.** Percent of each Map Unit that is in the loam-medium texture class (above)	continuous
SOIL_TX_LMF	**Loam-Moderately Fine.** Percent of each Map Unit that is in the loam-moderately fine texture class (above)	continuous
SOIL_TX_O	**Organic matter.** Percent of each Map Unit that is in the organic matter texture class (above)	continuous
SOIL_TX_R	**Rock.** Percent of each Map Unit that is in the rock texture class (above)	continuous
SOIL_TX_SC	**Sand-Coarse.** Percent of each Map Unit that is in the sand-coarseloam texture class (above)	continuous
SOIL_TXU_CL	**Clay**. Dominant % clay per Map Unit, upper horizon	continuous
SOIL_PER1	**KSAT.** 0 to 282 um/sec. Upper depth 0-60	continuous
SOIL_PER2	**KSAT**. 0 to 282 um/sec. Lower depth 61+	continuous
SOIL_pH	**pH.** 0-14, average pH in upper horizons/soil layer 0 to 30 cm deep (values range from approx 5 - 8 in project area)	continuous
SOIL_AWCS	**Available water capacity and available water storage**. 0-150 cm depth. Available water storage, the volume of water that the soil to a depth of 150 cm, can store that is is available to plants. It is reported as the weighted average of all components in the map unit, and is expressed a scentimeters of water. AWS is calculated from available water capacity, estimated at the difference between the water contents and 1/10 or 1/3 bar and 15 bars tension.	continuous
SOIL_LCC	**Land capability class.** Broadest category in the land capability classification system for soils. This column displays the dominant capability class under non-irrigated condition, for the map unit based on composition percentage of all components in the map unit. Values: 1-8 and not rated	categorical/continuous

Restoration Prioritization and Prediction Model (RePP)

This project was funded by the Minnesota Environment and Natural Resources Trust Fund,
as recommended by the Legislative-Citizen Commission on Minnesota Resources

SUMMARY:

In 2008, Ecological Strategies worked with 5 Twin Cities metropolitan counties (Hennepin, Carver, Dakota, Scott and Washington) and the MN Dept of Natural Resources to give planners and communities a tool for informing decisions about locations of ecological restoration opportunities and what restoration should happen there. The RePP Model, a GIS-based tool, identifies potential restoration sites and: 1) prioritizes these based on an explicit set of criteria and 2) uses statistical analysis of environmental variables associated with high quality natural areas to help identify target communities for potential restoration sites. The RePP Model uses GIS datasets including Minnesota Land Cover Classification (MLCCS), soils, topography, and other spatial data. The model was initially developed and applied in two smaller project areas and refined for this larger application.

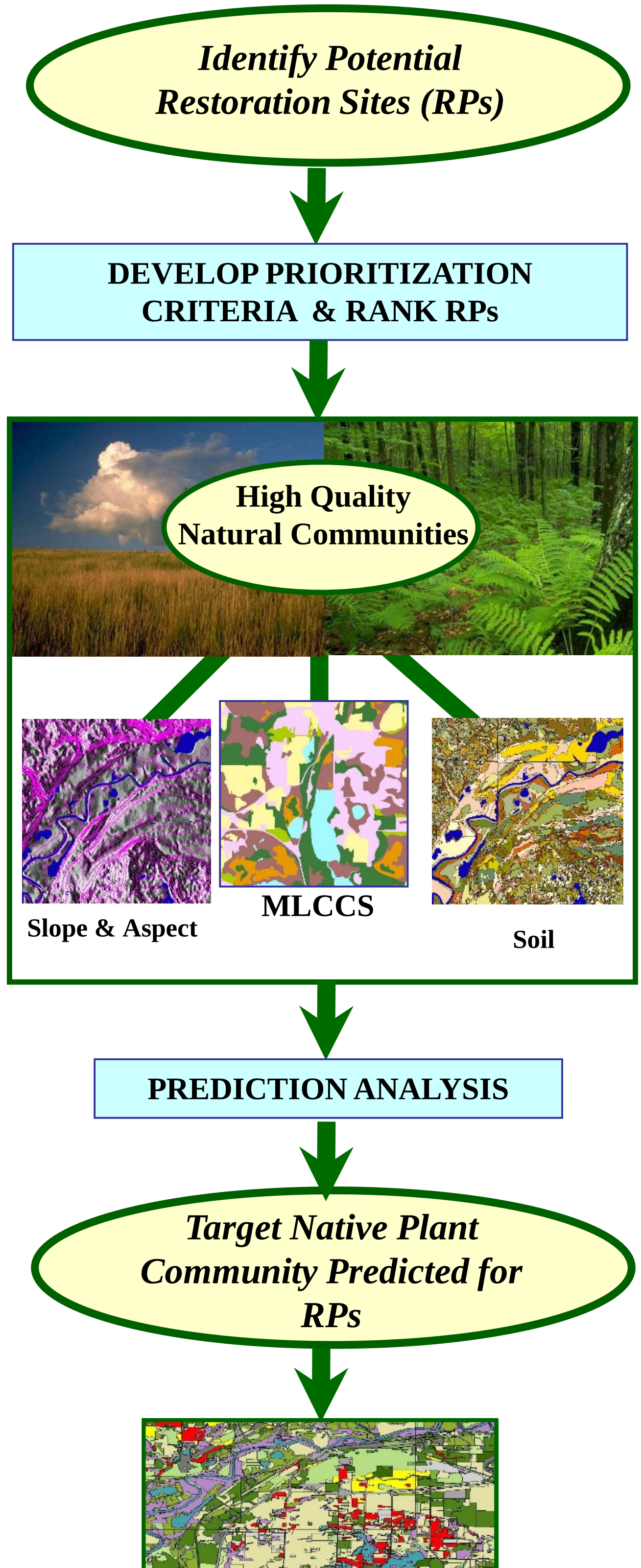
INTRODUCTION:

One of the primary goals of natural resources preservation is to protect, buffer and connect existing natural areas. In most cases, buffering and connectivity will be achieved only by restoring natural communities in areas where they have been eliminated. However, it is difficult to determine which lands best serve these functions, especially when working over large areas. To help address this issue we created a GIS-based tool to identify high priority restoration sites.

METHODS:

Identify restorable sites

Potential Restorable sites (RPs) were all MLCCS polygons that were not native plant communities, or were unsuitable for restoration because of high levels of impervious cover or disturbance.

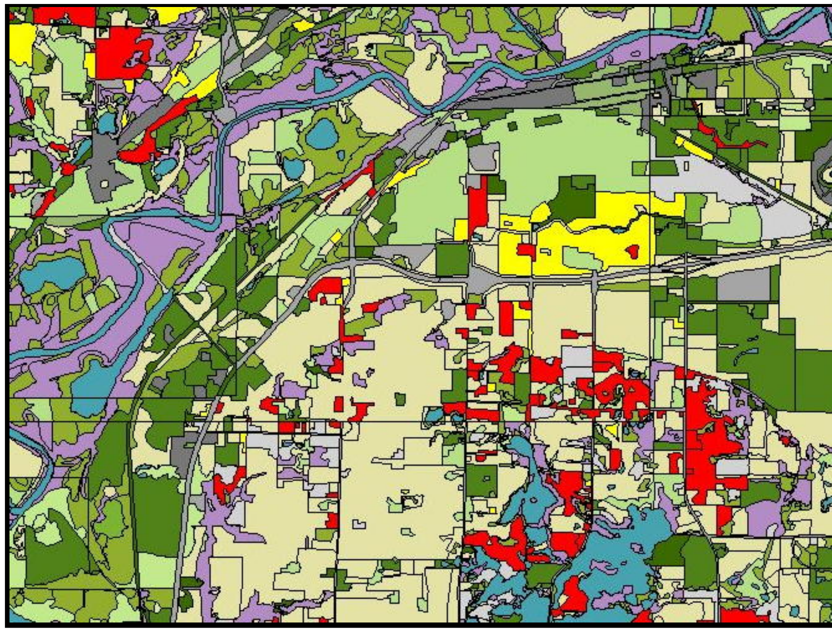


Restoration Prioritization and Prediction Model (RePP)

Restoration Sites Prioritized

Legend

- Rank = 1 high priority
- Rank = 2 medium priority
- Rank = 3 low priority
- Forest
- Prairie & old field
- Floodplain forest
- Lakes & Rivers
- Roads & Impervious



[1]Map created to give a general idea of how restoration sites might be prioritized.

METHODS continued:

Prioritization Criteria

Prioritization Criteria were developed to rank RPs based on a literature review and the input of local experts. The ranks were designed to be flexible so that the ranking criteria can be weighted differently, depending on the specific goals of the government agency or community.

Prediction Analysis

MLCCS, slope, aspect and soil features associated with existing high quality natural communities were analyzed statistically to identify potential restoration sites in the project area. These analyses were then applied to predict target communities for restoration on restorable sites.

PRODUCTS:

The primary product of the application of the tool is a GIS-based database and shapefile (or map) identifying restoration sites and their priority rankings. The tool also provides guidance on what plant community should be restored on the restoration sites, based on the statistical analyses. The shapefile and workshop handout materials are available at:

ftp://ftp.dnr.state.mn.us/pub/gisftp/barichar/restoration_model/

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