Identifying and Quantifying Development Constraints for the Townships of Birchwood, Long Lake, and Madge

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Abstract

Development Constraints Analysis (DCA) was conducted to identify land that remains available to accommodate future development. The analysis was conducted for the Townships of Birchwood, Long Lake, and Madge, in Washburn County, Wisconsin. GIS software, land information, and simple overlay logic was used to identify and quantify development constraints (i.e., land-based features that restrict future development) and land yet available for future development. DCA reveals that 40 percent, or 42,660 acres, of the project area are consumed by development constraints. Sixty percent, or 64,720 acres, are available for future development. This analysis is functional for generalized land planning, and is not meant for site-specific applications, such as plotting a subdivision. Results are rounded to the nearest 10-acre.

Introduction

DCA identifies and quantifies land available to accommodate future development by locating constraints to future development. Development constraints are cultural or natural land features that restrict, limit, or modify the occurrence of future development. For example, surface water is a natural feature that restricts future development. Houses cannot be built atop of navigable waters. County forests also restrict development, but because of management or ownership constraints, not because of physical limitations.

DCA was conducted for the project area, defined by the public land survey one-mile section surrounding the townships of Birchwood, Long Lake, and Madge, and including those townships (see Figure 1). The project area is located within Washburn County, Wisconsin (see Figure 2).

Figure 1: Long Lake Project Extent

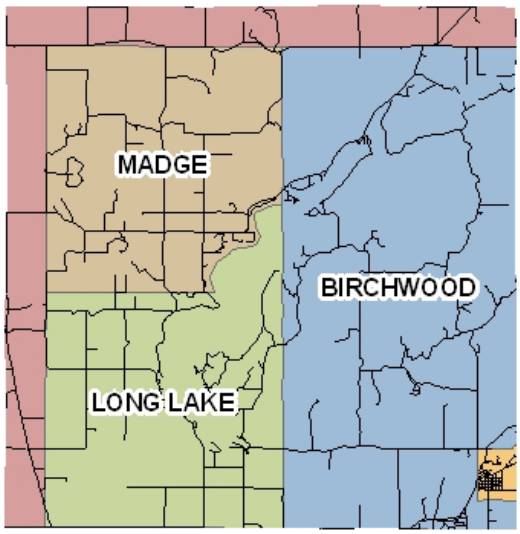
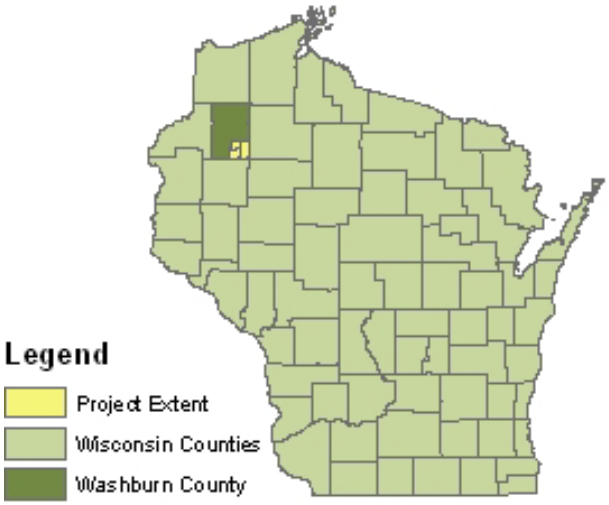


Figure 2: Long Lake Context



Statistics and maps, resulting from this analysis, are meant to guide land use planning and decision-making (see Table 1 and Map, Development Constraints).
They can help:

- Identify the location and extent of natural and cultural features, including ownership patterns.
- Identify the proximity of natural and public lands to areas currently developed or areas with development potential.
- Define areas for management, protection, preservation, or development.

Methods

Step 1: Compile Data

The Northwest Wisconsin Regional Planning Commission (NWRPC) provided data in Washburn County coordinates. Units were defined in feet. The following list defines data used for DCA.

- Surface Water
- Wetlands
- Slopes
- DNR owned land
- County forest owned land
- Industrial forests
- Minor civil divisions
- Public Land Survey
- Land Use (1997)
    - Residential, Commercial, Industrial, Parks and Open space, Government and Institutional, Utilities, and Road right of ways

Land use data created by NWRPC from 1997 orthophotography. All other data from the Wisconsin Department of Natural Resources (WDNR).

A) *Create surface water file:* Surface water data arrived as two files, a polygon file showing major water bodies, and a line file, showing the outlines of major water bodies and streams. For analysis, the two files were combined into one polygon shapefile. The BUFFER function was used to give the line file area. A 15-foot buffer was applied. The UNION function combined the features of the polygon file and the buffer file into a single surface water shapefile. The result was used for all analyses and statistics.

B) *Create slope file:* ArcMap, spatial analyst and the 30-meter digital elevation model were used to create a slope grid in percent slope. Slopes greater than 20 percent were converted to a shapefile for analysis.

C) *Clip data to project extent:* All data were geographically clipped to the project extent using ArcMap, geo-processing wizard CLIP function.

D) *Calculate acreage:* ArcView 3.3, X-Tools extension was used to update area, perimeter, and acreage of all shapefiles. Acreage defined by X-Tools was used to quantify constraints.

Step 2: Measure Project Extent

This step measured the total acreage in the project extent.

A) *Create project extent file:* Public Land Survey quarter-quarter sections within the project extent were selected and converted to a new shapefile, showing only those quarter-quarter sections within the project extent. The DISSOLVE function was used to create a single attribute. The result was a single attribute, single feature file showing the project extent.

B) *Calculate acreage:* X-Tools was used to calculate area, perimeter, and acres attributes. ArcView 3.3, field statistics was used calculate total acreage. The total acreage of the project extent equals 107,380.

Step 3: Measure Development Constraints

The following natural and cultural features were used as development constraints and their acreage was quantified.

1. Residential
2. Commercial
3. Industrial
4. Gov't/ Institutional
5. Road right of ways
6. Surface water
7. Wetlands
8. Slopes > 20 percent

9. Local parks and open space
10. County forest
11. DNR owned land
12. Industrial forests

A) *Measure acreage of all constraints:* The UNION function was used to compile individual constraints into a single shapefile. Field statistics revealed that 42,660 acres, or 40 percent, of the project extent were covered by development constraints, or are unavailable to development.

B) *Measure individual constraints:* To identify the extent of each individual land-based feature, acreage was calculated for each (see Table 1). The acreage of individual constraints was summed, totaling 58,957 or 16,297 acres more than the total found in Step 3A.

C) *Eliminating Spatial Overlap:* Inconsistency between Step 3A and 3B was a result of spatial overlap among constraints. For example, surface water within the county forest and the county forest itself share the same geographic space. When measuring acreage separately, acreage is counted twice. Step 3A measured acreage only once. Step 3B measured acreage twelve individual times, with twelve possibilities for spatial overlap and double counting.
Overlap was eliminated using the X-tools ERASE function and by prioritizing constraints. Constraints were prioritized by precedence. For example, roads (bridges) cover water, but water likely covers parks, residences, and county forests. Constraints were prioritized as follows:

1 = Highest priority
1. Road right of ways
2. Surface water
3. Slopes
4. Residential, Commercial, Industrial, Gov't/Institutional
5. Wetlands
6. Parks and open space
7. County Forest
8. DNR owned land
9. Industrial forests

The ERASE function eliminated overlap of lower priority layers. For example, surface waters were erased where they overlapped with roads. Slopes were erased that overlapped with roads and surface waters, and so on.

Step 4: Adjusting Road Statistics
Original acreage statistics, showing 13,880 acres of roads, were false. Road acreage was recalculated using X-Tools in ArcView 3.3. The result totaled 1,640 acres. Adjusting road statistics and correcting for spatial overlap, made the sum of individual constraints in Step 3B, equal to the sum of UNION constraints found in Step 3A.

Results

Development constraints were found to total 42,660 acres, or 40 percent of the project extent. 60 percent or 64,720 acres remain available to accommodate new development. The acreage for each individual constraint can be found in Table 1 (see Table 1 and Development Constraints Map).

Table 1: Development Constraints

Development Constraint	Measure Individual Constraints	Constraint, Minus Spatial Overlap	Percent of Total Land
Project Extent	107,380	107,380	100
Residential	1,347.00	830	< 1
Commercial	61.00	40	<1
Industrial	53.00	30	<1
Gov't/ Institutional	35.00	20	<1
Road Right of Ways	13,880.00	1,640	2
Surface Water	11,186.00	11,180	10
Wetlands	9,771.00	7,320	7
Slopes > 20 Percent	1,194.00	1,000	1
Local Parks/ Open Space	1,304.00	630	<1
County Forest	19,436.00	19,290	18
WDNR Land	247.00	440	<1
Industrial Forests	443.00	443	<1
Total Constraints	58,957.00	42,660	40
Remaining Land		64,720	60