SOILS OF CHIPPEWA COUNTY AND THEIR ABILITY TO ATTENUATE CONTAMINANTS

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Introduction

Soils usually compose only the upper 2 to 4 feet of unconsolidated materials at the earth's surface. Soils are the basis of agricultural production; they provide the foundation for buildings and roads; and, if properly used, they aid in the treatment and recycling of wastes from homes, from the production of livestock and poultry, and from municipal and industrial sewage treatment plants. Soil characteristics (depth, texture, and permeability) are among the most significant factors that determine the rate and extent of groundwater recharge and the degree of natural protection against contamination. Land characteristics such as slope, vegetation type, and type of rock will, in conjunction with the soil, determine the overall potential of the environment to protect groundwater.

In Chippewa County, soils are formed primarily in till (a poorly sorted mixture of silt, sand, and boulders transported by the glaciers that moved across the land thousands of years ago) or in outwash (sand and gravel carried off the ice by meltwater). When the ice disappeared, silt-sized material called loess was deposited by the wind on top of the till and outwash, usually to depths of about 1 to 3 feet. In parts of the county not covered by glacial materials, loess was deposited directly on top of the sandstone bedrock or interbedded sandstone and shales. Some soils also formed in alluvial deposits (flood plains) and in organic materials (peat and muck). Many factors influence the type of soil that develops in an area: the type of parent material from which the soil formed, relief, climate, natural vegetation, drainage, and time the soil has had to form.

For mapping, classification, and interpretive purposes, soils that have similar physical and chemical characteristics, have formed in a particular kind of parent material, and have a distinctive arrangement of horizons or layers are grouped together as a soil series. A grouping of individual soils based solely on physical and chemical characteristics is required to evaluate the potential of soils for attenuating contaminants. An evaluative system was developed to assess those soil properties that play a role in the attenuation of potential groundwater contaminants resulting from land-use activities.

Capacity of soils to attenuate pollutants

Attenuation is a series of complex processes that are all not clearly understood. It involves holding essential plant nutrients for uptake by agronomic crops, immobilizing metals that might be contained in municipal sewage sludge, or removing bacteria contained in animal or human wastes. The soil is an integral part of the natural protection of groundwater from surface-applied contaminants.

However, the natural purification capacity of the soil, like that of any other natural resource is limited, and sometimes soils that retain contaminants may themselves become contaminated. Cleaning contaminated soil can be as difficult as cleaning contaminated groundwater. The evaluation system presented here must be looked upon as a supplemental planning tool only, as a time- and cost-saving guide for preliminary screening of the county for areas sensitive to the impact of normal land-use activities. This soil-potential map does not replace the need for detailed on-site investigations. It does, however, reduce the number of areas to be studied in detail by identifying the areas of best and least attenuation potential. Local details have been generalized to fit the mapping scale, which cannot accommodate small local variations in soil characteristics.

This system helps evaluate the ability of the soil solum (the A and B horizons) to attenuate potential contaminants resulting from activities above or within the soil zone. The soil-attenuation capacity is considered here only in general terms and is not contaminant-specific. Different contaminants may behave differently–some may be completely eliminated by soil organisms, some may be used by plants, some may be adsorbed on soil particles, and some may eventually pass through the soil solum unchanged.

Physical and chemical characteristics to establish soil ratings

For assessing soil potential for attenuation of contaminants in Chippewa County, seven physical and chemical characteristics were selected for each soil series and were given weighted values (table 1). Values assigned to each characteristic were determined subjectively, with 1 being the poorest and 10 the best attenuation potential. These values were summed, and soils with total point scores within certain ranges were grouped into four soil associations, which, in turn, reflect different attenuation potentials (table 2). Soil associations consist of two or more dissimilar series that occur on the landscape in a regularly repeating pattern.

Information needed for this assessment was taken entirely from the Chippewa County soil survey. All soil series mapped in the county were ranked based on their characteristics in a natural state. Man-induced changes, such as tiling and ditching, may affect the attenuation potential of a particular soil. In those instances where alteration has been extensive, a reassessment may be required. Those areas in Chippewa County where the sandstone or sandstone with interbedded shale is within 5 feet of the land surface are indicated on the map. Even though the rock may be covered with 2 to 4 feet of soil materials with good capacity for contaminant attenuation, the proximity of the bedrock to the surface still limits subsurface and surface land-use activities.

Soil attenuation potential

The acreage of soils in Chippewa County that have the **best** potential for contaminant attenuation is limited. Examples include Sattee soils, which are formed in more than 30 inches of silts over glaciofluvial materials, and Campia soils, which are formed in a similar thickness of silts over glaciolacustrine sands and silts. Otterholt soils develop in 40 to 60 inches of silt over dense glacial till.

Somewhat more widespread are soils that have **good** attenuation capacity. The majority are formed in 15 to 30 inches of silt over glaciofluvial and lacustrine materials (Meridian, Crystal Lake) and till (Freeon, Santiago). Also included are moderately deep silty and loamy materials (20 to 35 in.) over sandstone and interbedded sandstones and shales (Arland, Kert). Spencer and Seaton soils, which are formed in deep silts, are included with this association, although their rankings very nearly place them in the previously discussed "best potential" category. Soils that demonstrate attenuation potential rated as good or best are well suited for a variety of land-use activities, particularly agriculture.

Soils that have **marginal** attenuation potential consist of those formed in 15 to 40 inches of silt over till (Almena, Magnor, Witter) or outwash (Barronett, Rib) that is either poorly or somewhat poorly drained; those formed in less than 15 inches of silt over till (Amery); and those soils developed in loamy materials over sand and gravel (Scott Lake) or sandstone (Elk Mound). The latter two groups of soil series are naturally better drained but are coarse textured and shallow.

Collectively, the soils in this association illustrate well the basic principles of attenuation. The processes involved depend on water moving through the soil solum at a rate that ensures maximum contact between the percolating water that contains contaminants and the soil particles. Deep (>35 in.), medium- and fine-textured soils are best. Some soils that have marginal attenuation potential are sufficiently deep, but saturated totally or partly for at least a portion of the year. Presence of the saturated zone within the soil solum interrupts the attenuation process and allows contaminants to be introduced into the groundwater.

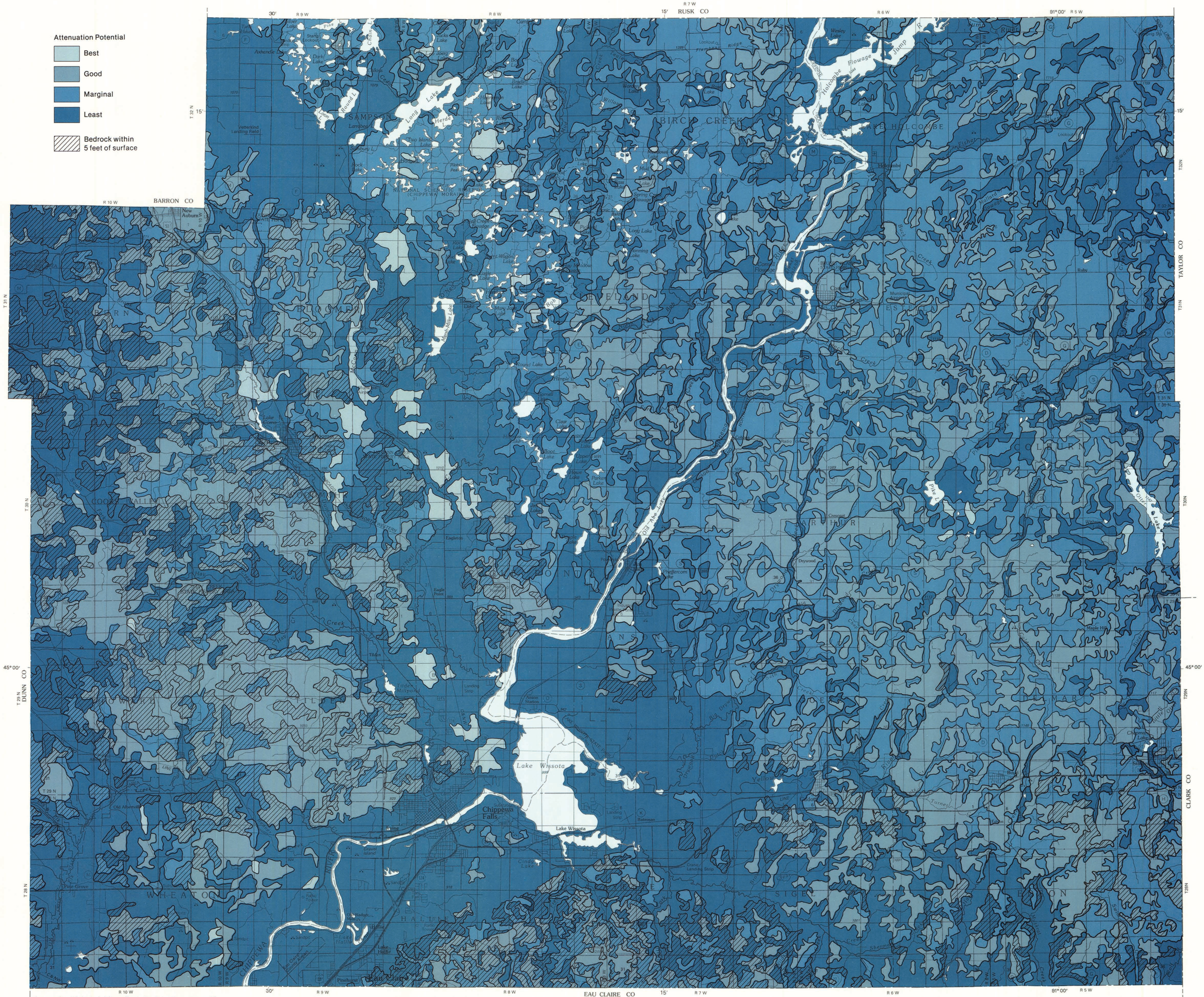
Water moves through coarse-textured materials very rapidly; contact between contaminants and soil particles is minimal and attenuation is reduced. Many soils in this association are shallow and coarse textured and have only a limited ability to reduce surface-applied contaminants.

Soils that have the **least** potential for attenuation include organic soils like Greenwood and Lupton; soils like Burkhardt and Chetek formed in less than 20 inches of loamy materials over sand and gravel; and deep, sandy soils that are poorly or somewhat poorly drained (Menahga, Mahtomedi). Many of these soils are found in flood plains adjacent to perennial or intermittent streams or where natural drainage has been disrupted. They are not well suited for many land-use activities.

As the map shows, many of the soils in the west-central, south-central and southwestern parts of the county have bedrock within 5 feet of the land surface. Uses of these soils are limited except where silt coverings are greater than about 30 inches. A morainal complex marking the end of the southern expansion of the last major ice sheet to invade Chippewa County runs in a northwest-southeast direction through the middle of the county. To the south and west of the moraine is an extensive outwash plain covered with coarse-textured soils that have only marginal attenuation capacity.

Behind this morainal area (the north-central and northeastern part of the county) are soils formed in silty or loamy materials over loamy glacial till. Because the land surface in this area is very young in a geologic sense, drainage patterns have not been established and many of the soils are poorly drained.

The southeastern corner of the county is covered with older glacial till. The landscape is more mature and surface drainage patterns are well developed. Dense till and fine-textured B horizons slow water movement through the soils. These characteristics make use of these soils difficult, but they are well suited for agriculture when they are properly managed.



Base map from U.S. Geological Survey County Map Series (Topographic), 1985.

Table 1. Ranking system for evaluating the attenuation potential of soils in Chippewa County

Physical/chemical characteristics	Classes	Weighted values
Texture[1]—Surface (A) horizon	l, sil, scl, si	9
	c, sic, cl, sicl, sc	8
	lvfs, vfsl, lfs, fsl	4
	s, ls, sl, organic materials, and all textural classes with coarse fragment class modifiers	1
Texture[1]—Subsoil (B) horizon	c, sic, sc, si	10
	scl, l, sil, cl, sicl	7
	lvfs, vfsl, lfs, fsl	4
	s, ls, sl, organic materials, and all textural classes with coarse fragment class modifiers	1
Organic matter content[2]	Mollisols	8
	Alfisols	5
	Entisols; Inceptisols; Spodosols	3
	Histosols; Aquic suborder; and Lithic, Aquollic, and Aquic subgroups	1
pH—Surface (A) horizon	≥6.6	6
	<6.6	4
Depth of soil solum (A + B horizons)	>40 in.	10
	30-40 in.	8
	20-30 in.	3
	<20 in.	1
Permeability[3]—Subsoil (B) horizon	very low	10
	moderate	8
	high	4
	very high	1
Soil drainage class	well drained	10
	well to moderately well drained	7
	moderately well drained	4
	somewhat poorly, poorly, and very poorly drained; excessively well drained	1

[1] Soil textural classes: l = loam, sil = silt loam, scl = sandy clay loam, si = silt, c = clay, sic = silty clay, cl = clay loam, sicl = silty clay loam, sc = sandy clay, lvfs = loamy very fine sand, vfsl = very fine sandy loam, lfs = loamy fine sand, fsl = fine sandy loam, s = sand, ls = loamy sand, sl = sandy loam.

[2] Based on the ordinal, subordinal, or subgroup levels of the soil classification system; soils are assigned a lower number if they are wet or less than 20 inches thick over bedrock; see county soil survey report.

[3] Based on the particle-size class at the family level of the soil classification system, type and grade of structure, and consistency; see county soil survey report.

Table 2. Soil series in Chippewa County listed by attenuation potential

	Least potential		Marginal potential	Good potential	Best potential
Sum of weighted values	0-30		31-40	41-50	51+
	Beseman Boone Billett Burkhardt Chetek Cable Carryville Fall Creek Eleva Elm Lake Fordum Friendship Greenwood Humbird Markey Lupton	Mahtomedi Meehan Menahga Merrillan Moundville Minoqua Newson Plainbo Oesterle Richford Rosholt Seelyeville Udifluvents* Warman variant	Alban Amery Arenzville Auburndale Barronett Comstock Elk Mound Halder Lows Magnor Northfield Orion Plover Poskin Rib Scott Lake Shiffer Vesper Withee	Antigo Arland Brill Crystal Lake Flambeau Freeon Gale Hiles Hixton Kert Loyal Meridian Santiago Spencer Seaton Tell	Campia Hiles variant Otterholt Sattre
Acreage**	261,430		218,900	158,495	10,725
Percent of total land area**	40.2%		33.6%	24.4%	1.6%

*Undifferentiated soils in modern flood plains
**The remaining 1285 acres (0.2%) of the land area contain gravel pits

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Cartography by B.R. Haskins-Grahn

Map 87-3

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SCALE 1:100 000

KILOMETRES

MILES