SOILS OF ST. CROIX 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.

Glaciers moved across St. Croix County many thousands of years ago, leaving behind characteristic deposits of till (a mixture of sand, silt, clay and boulders) and outwash (primarily sand and gravel). Over time, these older deposits have been altered by a variety of geomorphic processes; some have been completely eroded. The last major ice sheet to invade Wisconsin did not cross the county, but the materials derived from it have strongly influenced the modern landscape and soils.

Ice and meltwaters from that last glacier deposited medium- and coarse-textured materials across the northwestern part of the county. Finer, silt-sized materials that were transported greater distances before being deposited were picked up by the wind and redeposited on the land surface after the meltwaters disappeared. These materials, called loess, can be up to 3 feet thick in St. Croix County.

Many factors influence the type of soil that develops in an area: the parent material from which the soil formed, relief, climate, natural vegetation, drainage and the time that the soil has had to form. The majority of soils in St. Croix County have formed in silty or loamy materials up to 40 inches thick over till or outwash sand and gravel. Some soils have developed in alluvial materials, primarily sand, and in organic materials (muck and peat).

For mapping, classification, and interpretive purposes, soils are grouped into soil series on the basis of similar physical and chemical characteristics, type of parent material, and arrangement of horizons or layers. 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, all of which are not clearly understood. During attenuation, the soil holds essential plant nutrients for uptake by agronomic crops, immobilizes metals that might be contained in municipal sewage sludge, or removes 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 evaluates 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. Contaminants may behave in various ways—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 St. Croix 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 for this assessment was taken entirely from the St. Croix County soil survey. All soil series mapped in the county were ranked on the basis of 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 St. Croix County where either sandstone, limestone, or shale bedrock 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 that have good capacity for contaminant attenuation, the proximity of the bedrock to the land surface still limits subsurface and surface land-use activities.

Soil attenuation potential

Soils in St. Croix County that have the **least** potential for attenuating contaminants are primarily sands like Plainfield, Gotham, Chetek, and Burkhardt. Attenuation depends 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. Water moves through coarse-textured materials very rapidly; contact between contaminants and soil particles is minimal and attenuation is significantly reduced.

Other soils in this association include those found along intermittently and perennially flowing streams where the water table is at or near the land surface for much 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.

Magnor and Skyberg soils are formed in 20 to 40 inches of silts, but their attenuation potential ranks as **marginal** because their natural drainage is poor and the lower parts of their sola are saturated for varying periods of time. Soils like Amery, which form in 30 to 40 inches of coarse-textured materials over sandy loam till, have only marginal ability to attenuate contaminants because of their texture.

If soil coverings are a bit finer and become loams, then soil attenuation potential is **good**, as illustrated by Amery and Sattre soils. As indicated previously, contaminant attenuation depends on maximum contact between percolating water and soil particles. Deep (>35 in.), medium- and fine-textured, well drained soils are best. Soils like Antigo, Santiago, Jewett, Pillot, Freeon, and Vlasaty have formed in 30 to 40 inches of silt over glacial materials, either till or outwash. With the exception of the Freeon and Vlasaty soils, all are well drained and have the **best** potential for contaminant attenuation. A modest reduction in natural soil drainage changes the attenuation ability of Freeon and Vlasaty soils from best to good.

Soils in these two associations that have either good or best potential for contaminant attenuation cover about 65 percent of the land surface in St. Croix County. They are well suited for a wide variety of land-use activities, particularly agriculture. Some acreages of these soils occur on lands with 6 to 12 percent slopes, which suggests that soil erosion may be a problem if they are not carefully managed. Erosion, of course, results in the removal and transport of soil materials. If the finer-textured coverings typical of many soils in the county are lost, their attenuation ability can be significantly reduced. Reduced tillage and other soil conservation methods are effective in reducing this problem.

As the accompanying map shows, soils with good capacity for reducing loadings to the groundwater are well distributed across the county. Areas where bedrock is within 5 feet of the surface are limited to only about 7 percent of the county. If that bedrock is limestone that is fractured or has solution features (karst), land-use activities should be very carefully managed because contaminants will, in these settings, move directly into the groundwater.

Attenuation Potential

- Best
- Good
- Marginal
- Least
- Bedrock within 5 feet of surface

Table 1. Ranking system for evaluating the attenuation potential of soils in St. Croix 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.

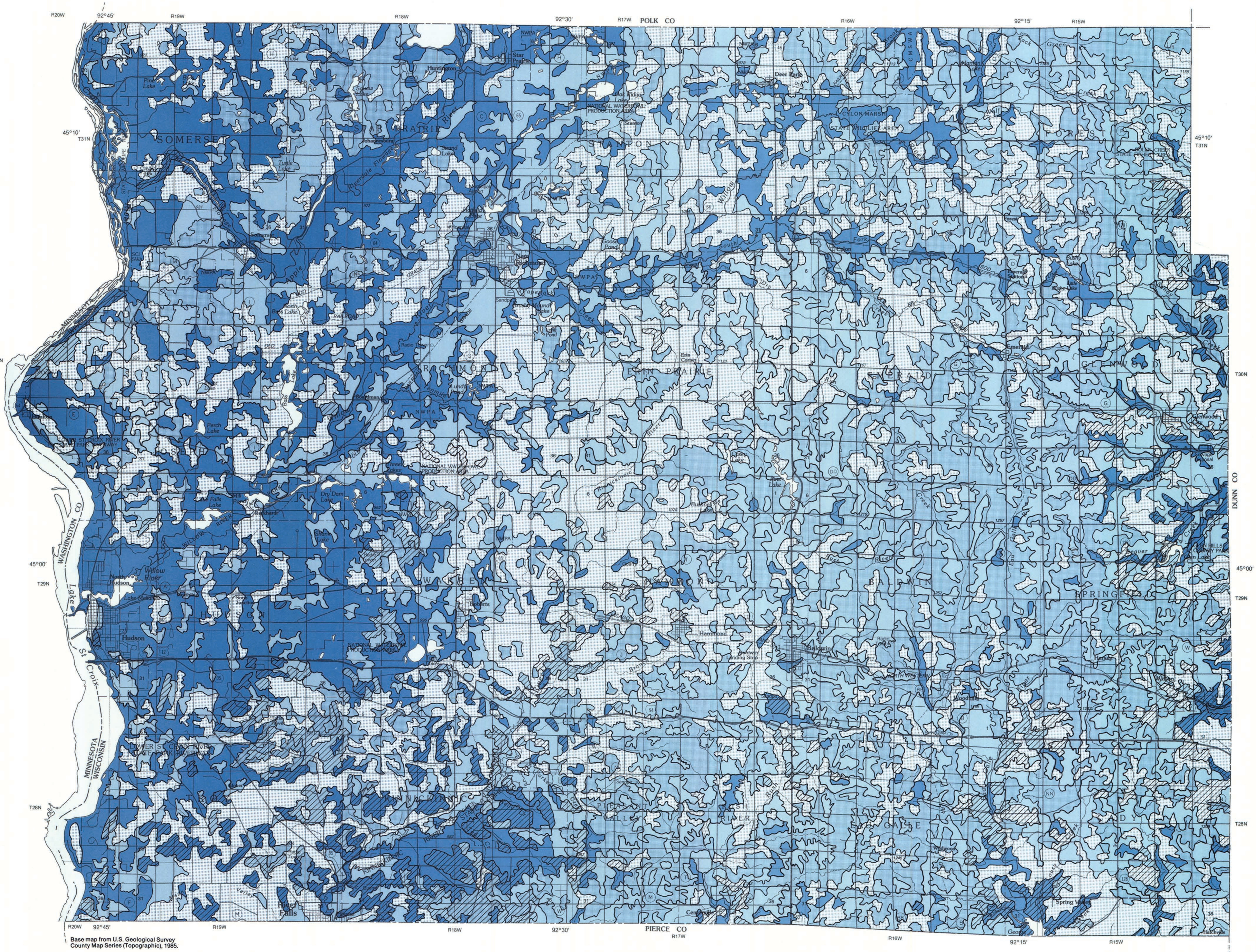
[2] Based on the ordinal, subordinal, or subgroup levels of the soil classification system; soils are assigned a lower number if they are wet or less than 20 inches thick over bedrock; see county soil survey report.

[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 St. Croix County listed by attenuation potential

	Least potential	Marginal potential	Good potential	Best potential
Sum of weighted values	0-30	31-40	41-50	51+
	Boone Burkhardt Burkhardt-Sattre complex Chetek-Onamia (Rosholt)§ complex Cut and fill areas* Dickman Duelm Emmert Fluvaquents* Fluvaquents, wet* Gotham Gravel pits* Hubbard Plainfield Ritchey soils and rock outcrop† Saprists and aquents* Seelyeville Udifluvents*	Adolph Amery sandy loam‡ Amery-Cromwell soils† Auburndale Clyde Derinda variant Floyd Freeon, heavy substratum‡ Halder Lawler Magnor Rib Ritchey Skyberg	Amery loam‡ Arland sandy loam‡ Brill Dakota Dakota-Pillot complex Derinda Freeon Hesch Orion Renova Renova variant Rockton Sattre Vlasaty Whalan	Antigo Arland Huntsville Jewett Nickin Onamia (Rosholt)§ Onamia (Rosholt)§-Antigo complex Otterholt Pillot Port Byron Santiago Santiago-Antigo complex
Acreage	88,150	76,780	141,590	157,510
Percent of total land area	19.0%	16.5%	30.5%	34.0%

*Undifferentiated land type
†Soil association
‡Soil phase
§Modern soil series name



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

SCALE 1:100 000
KILOMETRES
MILES

Map 87-10

Cartography by B.R. Haskins-Grahn

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