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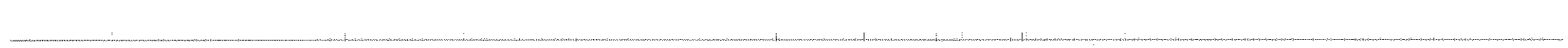

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INTRODUCTION

Groundwater is an important natural resource in Wisconsin. More than 70 percent of the state's drinking water comes from underground sources. In rural areas virtually everyone drinks groundwater. Wisconsin residents also depend on good quality groundwater for dairying, cheese making, brewing, fruit and vegetable processing, and many other activities. A supply of high quality groundwater gives the people of Wisconsin an economic advantage over states with less abundant or poorer quality groundwater.

Unfortunately, the groundwater used by some Wisconsin communities has become contaminated in recent years. Some land-use practices, such as agriculture, industry, and mining, can inadvertently result in groundwater contamination. Contaminants include nitrate from manure, fertilizer, and septic systems; agricultural pesticides; gasoline from leaking underground tanks; industrial solvents from landfills; and even chlorides from road salt. Local governments can help protect groundwater by regulating land use through zoning ordinances, subdivision regulations, and other controls.

Overview

In this publication we describe several local land-use control measures that can be used to protect groundwater. Chapter 1 contains a discussion of the nature of groundwater and its contamination. In chapter 2 we review state and local powers, the 1984 groundwater law, and the role of local government in groundwater protection. Chapter 2 also includes a discussion of the salient features of conventional zoning, flexible zoning devices, and subdivision regulations, and how they can be used for groundwater protection. We also present an analysis of the legal issues that must be considered in a regulatory program. Chapter 3 presents basic approaches for delineating and regulating special management areas for groundwater protection. Each approach is presented in terms of its purpose, information needs and sources, and regulatory options.

Sample groundwater-protection provisions from a Wisconsin community are included in appendix 1. These are merely examples; they should be tailored to the needs of individual communities. Conditions vary too much from locality to locality to suggest a single best approach. There are substantial differences in local problems, soil and hydrogeologic conditions, land use, the technical information available, and staff expertise. These and other factors make it important to develop land-use controls that fit the local situation. The information presented in this publication should make it easier to fashion the most appropriate local regulations.

Groundwater-protection publications

This is one of a series of four reports published by the Wisconsin Geological and Natural History Survey (WGNHS) dealing with actions that local governments can take to protect groundwater.

A Guide to Groundwater Quality Planning and Management for Local Governments (by S.M. Born, D.A. Yanggen, and A. Zaporozec; published as WGNHS Special Report 9) describes the steps involved in preparing a groundwater-management plan, the regulatory and non-regulatory measures available to local government, how local governments can coordinate their efforts with state programs, and informational needs and sources. Special Report 9 is intended for local officials and other people who will be preparing a groundwater-management plan.

Wellhead-Protection Districts in Wisconsin: An Analysis and Test Applications (by S.M. Born, D.A.

Yanggen, A.R. Czecholinski, R.J. Tierney, and R.G. Hennings; published as WGNHS Special Report 10) reviews various methods for delineating wellhead-protection districts, that is, areas supplying water to wells within which special measures are taken to control potentially contaminating activities. The report provides an assessment of wellhead-protection districts in a variety of settings representative of Wisconsin's hydrogeology. Special Report 10 is intended for local technicians and as a guide for local governments in hiring consultants.

This publication, *Groundwater Protection Through Local Land-Use Controls* (published as WGNHS Special Report 11), focuses on how local governments can use zoning and subdivision control powers to regulate the land uses that may contaminate groundwater. Special Report 11 is designed as a guide for local elected officials, planning and zoning officials, and their technical advisors.

Groundwater Quality Regulation: Existing Governmental Authority and Recommended Roles (by D.A. Yanggen and L.L. Amrhein; published as WGNHS Special Report 12) focuses on the roles that local governments in Wisconsin can play in a joint local/state regulatory scheme to protect groundwater quality. Special Report 12 contains a discussion of the division of legal responsibility between state and local governments and an extensive analysis of court cases involving local groundwater-protection regulations. Regulatory techniques to minimize challenges to the validity of local regulations are presented. The publication is intended for persons preparing local regulations and their legal advisors.

In this publication we make numerous references to the three companion publications. We refer to them as *A Guide, Wellhead-Protection Districts,* and *Groundwater Quality Regulation.* Complete references for these and other publications can be found following Chapter 3.

Chapter 1

THE NATURE OF GROUNDWATER CONTAMINATION

The hydrologic cycle

In the past, most water-quality programs concentrated on protecting lakes and streams from contamination; groundwater was taken for granted or largely ignored. Efforts to protect water quality sometimes overlooked the fact that surface water is only one part of the hydrologic cycle; groundwater is also an essential component. Understanding a few basic concepts about groundwater and how it becomes contaminated is the first step toward protecting this resource.

When rain or snow falls on the earth's surface, some runs off into streams and lakes, some evaporates, and some is used by plants. The rest trickles down through the soil and subsurface material. This water eventually reaches a saturated zone, the top of which is called the *water table* (fig. 1). All the water in the saturated zone beneath the water table is groundwater.

The concept of water moving from the land's surface into groundwater is the starting point for thinking about the relationship between land use and groundwater quality. Nearly anything people can dump, spill, or spread on the ground can seep down to groundwater.

Land use and groundwater

Groundwater contamination is not always caused by other people. Most people use the products and benefit from the activities that contribute to groundwater problems. Many of these activities might be considered indispensable in modern

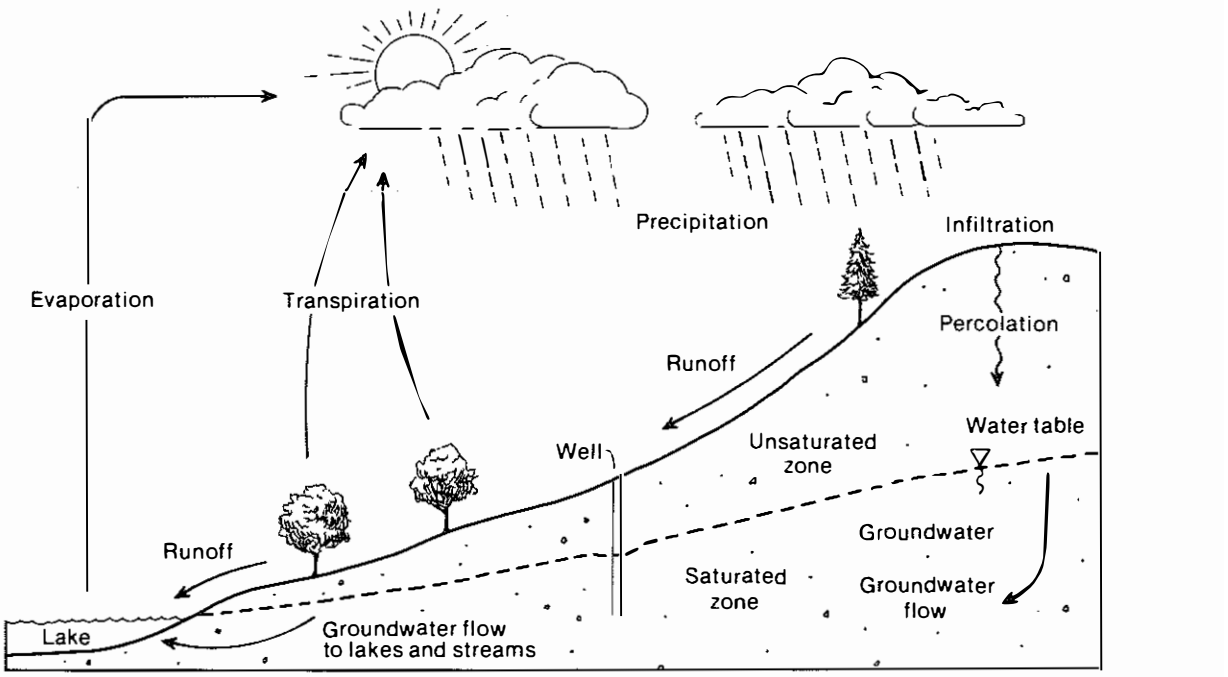


Figure 1. Groundwater and the hydrologic cycle.
Groundwater and surface water are connected: precipitation that trickles down through the ground becomes groundwater; groundwater can return to the surface as springs or as discharge to lakes or streams. From Lippelt (1988).

society. Familiar sources of bacterial and chemical contamination include

- leachate from landfills;
- septic systems;
- septage and sludge disposal;
- hazardous materials storage, handling, and disposal;
- spills of hazardous materials;
- storage and spreading of
  - fertilizers,
  - pesticides, and
  - animal waste;
- industrial waste storage lagoons; and
- petroleum products storage tanks.

Protecting groundwater means modifying or even prohibiting certain activities in areas where contaminants can easily enter groundwater. (For more information about contaminant sources, see *A Guide* and Mercozzi, 1989.)

Soil characteristics

The characteristics of the soil and subsoil within the first few feet of the land surface play an important role in the amount and quality of water seeping down to groundwater. For example, in a rolling area with a rich loam soil, roughly 2 inches of water will seep down to the water table for every inch that runs off to a stream. In a relatively flat area with coarse, sandy soil, 9 inches of water might seep to the water table for every inch that runs off.

Soil and topographic characteristics that allow water to move relatively quickly to the water table can also make groundwater more vulnerable to contamination. Deep soil and soil high in clay or organic matter are generally able to hold water and contaminants and allow for more chemical and biological breakdown. In Wisconsin, areas of coarse, sandy soil and thin soil over fractured bedrock can allow contaminants to enter groundwater without adequate attenuation. Information about soil characteristics such as depth, texture, permeability, organic matter, and pH can be used to assess the potential of soil to attenuate contamination (fig. 2).

Aquifers

A geologic formation that can store and transmit water efficiently is called an *aquifer*. (For a more detailed discussion of Wisconsin's aquifers, see *A Guide* and Mercozzi, 1989.) Wisconsin's geologic formations contain four principal aquifers, which can be connected by fractures or cracks; water and contaminants in one aquifer can move to a deeper, underlying aquifer.

The *sand and gravel aquifer* is the unconsolidated surface material left by retreating glaciers 10,000 and more years ago. Glacial deposits cover all Wisconsin except the unglaciated southwest part of the state. A vast amount of water is stored and transmitted in these porous deposits, which range from a few feet to more than 300 feet thick. Many domestic wells use water from the sand and gravel aquifer, as do many of the irrigation systems for agricultural land because it is closest to the land surface in most of Wisconsin. This aquifer is particularly vulnerable to contamination from land use.

The eastern *dolomite aquifer* occurs in a narrow band in eastern Wisconsin from Door County to the Illinois border. Dolomite, a brittle rock similar to limestone, contains water in countless interconnected cracks and fractures. Where this fractured rock occurs at or near the land surface, there is little or no soil to attenuate contaminants and groundwater can easily be contaminated. Once a contaminant enters the network of fractures, it can move relatively rapidly (tens of feet per day) from the original place of contamination. A layer of less permeable shale serves as a barrier between the eastern dolomite aquifer and underlying rock, which is also an aquifer.

Layers of sandstone and dolomite cover all of the state except the north-central part. The *sandstone aquifer* holds variable but usually plentiful amounts of water. In eastern Wisconsin this aquifer lies below the dolomite and shale deposits; in other areas, it lies below the sand and gravel aquifer or directly below the soil. The sandstone and dolomite deposits form the principal aquifer for the southwest part of the state, where the sand and

gravel aquifer is largely absent. In areas where the sand and gravel aquifer supplies domestic wells, many cities and industries tap the deeper sandstone aquifer to obtain large amounts of water.

The *crystalline bedrock aquifer* consists of a variety of rocks that have a granite-type crystalline structure. These are the basement rocks that underlie the entire state. The cracks and fractures that store and

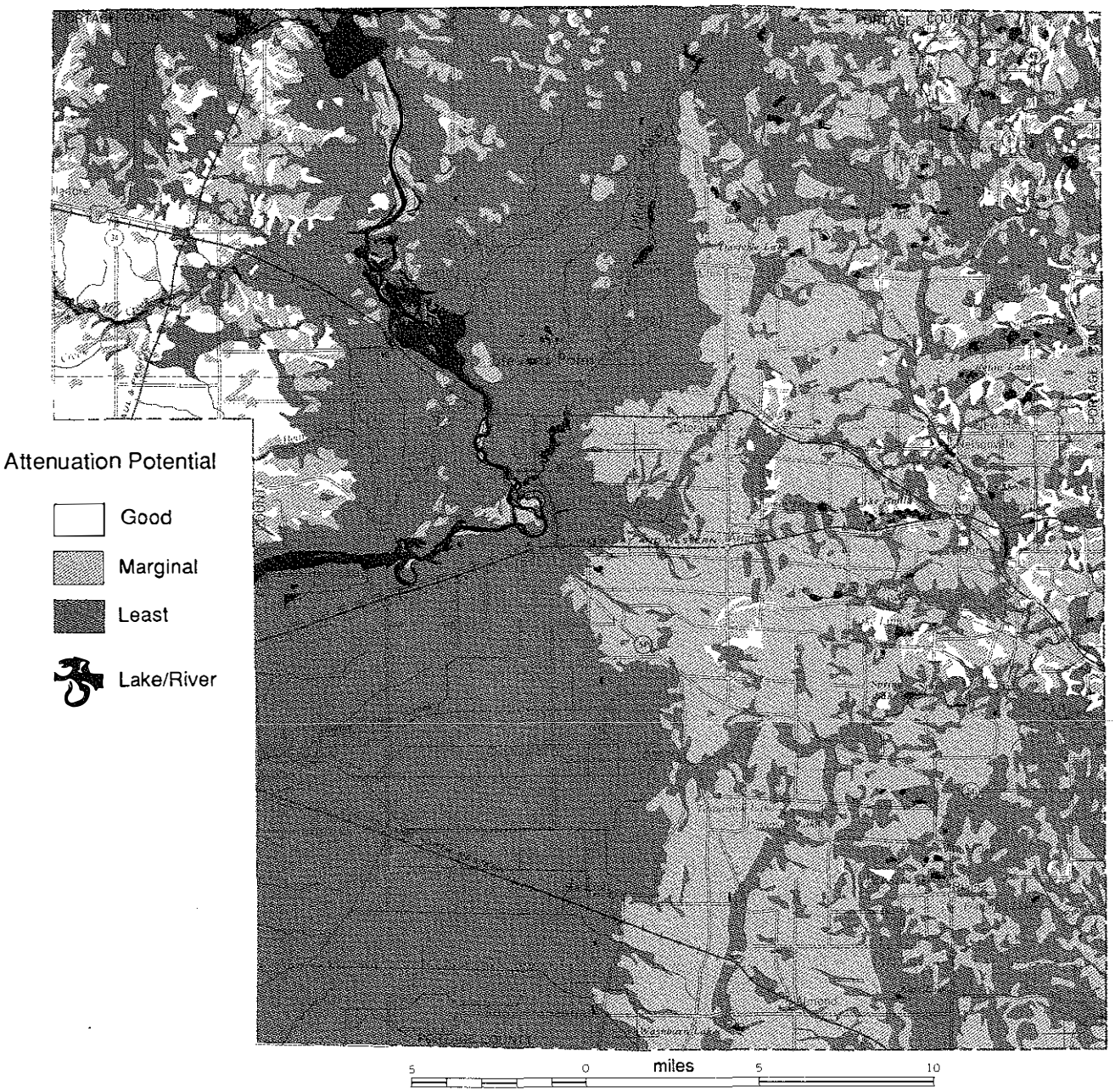


Figure 2. Contamination attenuation potential for Portage County soils.
Vulnerable areas occur where soil and geologic conditions allow rapid percolation of contaminants to groundwater. This map is a compilation of factors that contribute to a soil's ability to attenuate potential contaminants. Similar maps can be prepared in other counties where modern soil surveys have been completed. Adapted from Good and Madison (1987).

transmit water in these rocks occur irregularly. The amount of water available to a well can vary greatly over a small area. Wells in this aquifer can provide an adequate supply of good quality water.

Groundwater movement

Groundwater flows through aquifers from higher to lower elevations. The surface topography gives a general idea of the direction of flow; more precise information is shown by water-table maps (fig. 3). Knowing the direction of groundwater flow is important for land-use decisions. For example, the area downflow from a source of contamination would usually not be a suitable location for a public well.

Groundwater is described as a dynamic *flow system* when it moves from recharge areas to discharge areas. In *recharge areas*, a significant amount of groundwater is added to the aquifer. (Most of the land surface allows at least some recharge, but the extent varies widely.) In *discharge areas*, the groundwater comes back to the surface as seepage or spring-flow into streams, lakes, and wetlands. Typically, groundwater in Wisconsin moves only a few miles from a recharge area to a discharge area. In the vast majority of cases, groundwater stays within the same major surface watershed that controls surface runoff water.

In a *local flow system* it could take only a few weeks or months to move the tens or thousands of feet from a recharge area to a discharge area or well. Most domestic wells are shallow and within local flow systems. In *regional flow systems* water must travel much farther; it might take years to go from recharge to discharge areas or wells (fig. 4).

Implications for groundwater protection

Groundwater problems can remain undetected unless someone suspects a problem and has the water tested; even then, the exact nature, cause, and extent of the problem can be difficult to determine. Once contaminated, groundwater may be virtually impossible to clean up completely.

What does all this mean in terms of what local governments can do to protect groundwater?

- The emphasis of groundwater regulations should be on prevention, not on groundwater treatment or aquifer restoration after contamination has occurred.
- Contaminated groundwater can usually be traced to local sources. Local regulations should play a key role in preventing problems.
- Local regulations to protect groundwater should address the land uses and activities that present a groundwater threat and the physical characteristics that make a site more or less vulnerable to contaminant leaching. Land uses and activities that may contaminate groundwater should be controlled in areas where groundwater is vulnerable.
- The highest priorities of local groundwater programs should be (1) protecting aquifers used to supply local drinking water, and (2) protecting surface areas that serve as principal aquifer recharge areas.

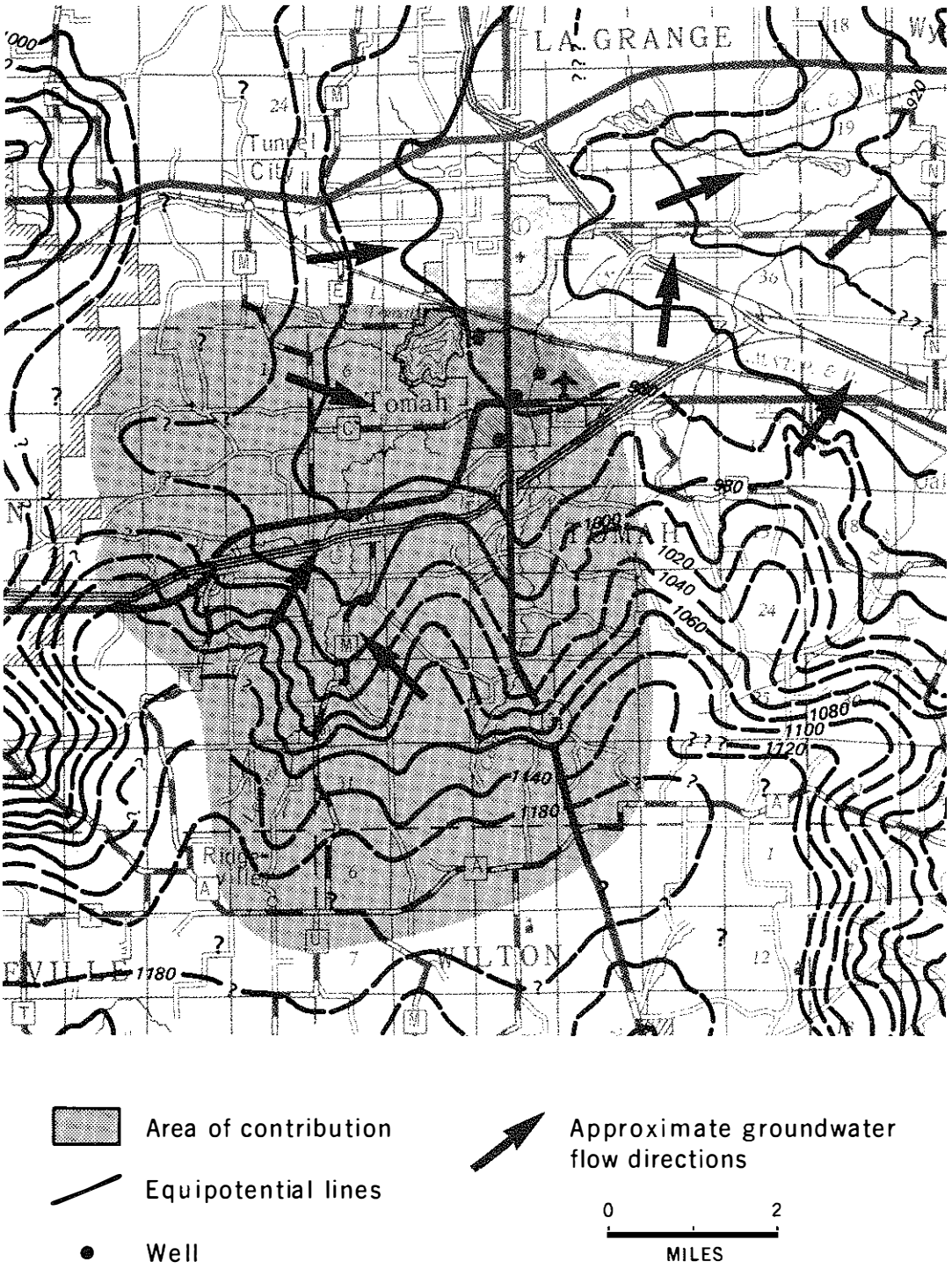


Figure 3. Groundwater flow.

For planning and regulatory purposes, it is important to know the direction of groundwater flow. A general idea can be obtained from surface topography; a more precise idea can be obtained through hydrogeologic studies. This is a water-table map, which is essentially a contour map of the groundwater. Arrows indicate the direction of groundwater flow. Water-table maps are available for some Wisconsin counties from the Wisconsin Geological and Natural History Survey; see appendix 3. From figure III-11 of Wellhead-Protection Districts.

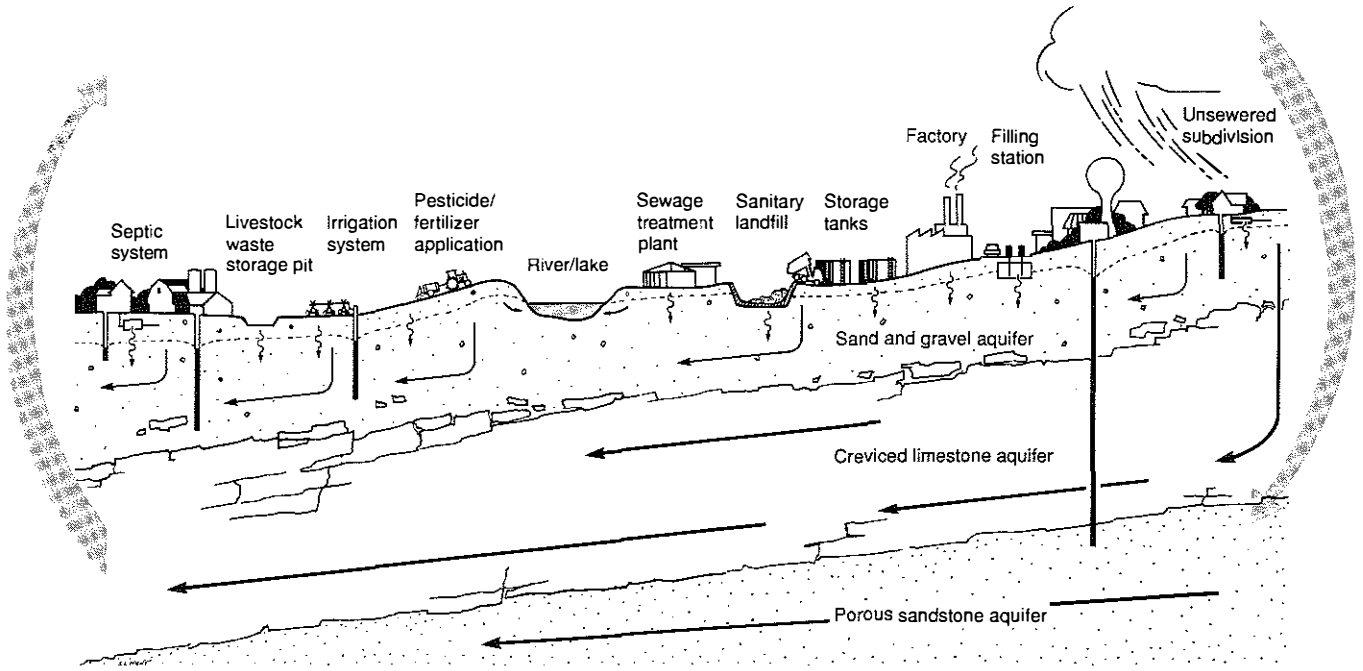


Figure 4. Relationship between land use, contamination, and groundwater flow systems.
Groundwater becomes part of a flow system when it moves from recharge to discharge areas. Contamination in a shallow, local flow system travels a relatively short distance and can move quickly to a discharge point or a well. In a deeper, regional flow system, contamination typically moves a much greater distance and takes a longer time to reach a discharge point or a well.

Chapter 2

STATE AND LOCAL ROLES IN GROUNDWATER PROTECTION

State ground rules for local regulation

Many land uses and activities that affect groundwater are directly and indirectly regulated by federal, state, and local laws. Other activities are only partly regulated or not regulated at all. With groundwater, as with other resources, state and local regulations apply and sometimes overlap, but there are certain rules that typically apply.

In general, the state sets ground rules for local government action. There are different types of local government in Wisconsin, and their powers vary. Rural units of government (towns and counties) are more limited in the exercise of their powers than are incorporated municipalities (cities and villages). A county or town has only those powers that are conferred by statutes or that might be implied from statutes (*Brown County* v. *Dep't of Health & Social Services* [DHSS], 103 Wis. 2d 37, 307 N.W. 2d 247 [1981]). Cities and villages, on the other hand, have constitutional and statutory home-rule powers. This means that cities and villages (that is, incorporated municipalities) possess all powers not denied them by statute or constitution. The powers do not have to be specified; an incorporated municipality can act as long as state statutes do not specifically preempt action.

In short, groundwater is a matter of statewide concern, but a local unit of government can regulate activities to protect groundwater, unless

- state legislation expressly withdraws the power;
- the local ordinance logically conflicts with state legislation;
- the local ordinance defeats the purpose or goes against the spirit of state legislation or state policy; or
- in the case of counties and towns, the power has not been expressly granted or it is impossible to reasonably infer that power.

See *Groundwater Quality Regulation* for a detailed treatment of constitutional and legal considerations in developing local groundwater-protection ordinances.

Statutory sources for local regulation

Two statutory sources that counties might use for groundwater protection are public nuisance laws and sanitary regulations. Under sec. 823.01 Wisconsin Statutes, any person, county, city, village, or town may abate a public nuisance. Rock County, Wisconsin, has adopted an ordinance defining groundwater contamination as a public nuisance. Such an ordinance can be helpful; however, its primary focus is not on preventing contamination, but on abating contamination after it has occurred.

County sanitary regulations [sec. 59.07(51) Wisconsin Statutes] can be used to prevent contamination before it occurs by setting up a permit system to regulate potential contamination sources. Sec. 59.07(51) was formerly the statutory authority for private sewage-system ordinances now adopted under sec. 59.065 Wisconsin Statutes. However, sec. 59.07(51) remains, and its continued existence could be interpreted as authorizing regulation of other potential groundwater contamination sources. The introduction to sec. 59.07 Wisconsin Statutes states that the County Board's powers "shall be broadly and liberally construed and limited only by express language."

Several counties have adopted regulations governing animal-waste storage and disposal under sec. 59.07(51) on the theory that improper animal-waste management can cause groundwater contamination and that this is a legitimate subject of a sanitary code. Other regulations adopted under sec. 59.07(51) could establish a permitting system to control additional sources of potential groundwater contamination before development is allowed. The sanitary ordinance could also define groundwater contamination as a violation of federal or state standards and as a public nuisance that must be halted whenever the violation occurs.

Unlike county zoning, for which a town must approve the county ordinance to come under it, a town is under county sanitary regulations unless the town adopts its own regulations. Sec. 59.07(51) provides that county sanitary regulations do not apply within cities, villages, or towns that may have adopted ordinances or codes concerning the same subject matter.

The regulation of septic-tank systems is covered by sec. 59.065, which authorizes a county to adopt a private sewage-system ordinance that conforms with the state plumbing code. In addition, sec. 145.20(2)(g) authorizes a county to perform other duties regarding private sewage systems that the county considers appropriate. NR 120 of the Wisconsin Administrative Code sets eligibility requirements for cost-sharing under the Wisconsin Fund grants for private sewage-system replacement. Under its terms, each private sewage system constructed after a county enters the program must be inspected once every three years and pumped if necessary. About 50 counties participate in the program. A few counties require mandatory inspection of a system at the time of sale, require full soil testing on all new lots created, and take other steps to help ensure that private sewage systems do not contaminate groundwater.

Wisconsin's groundwater law

Major state groundwater-protection legislation, passed in 1984, established groundwater standards for existing and newly created regulatory programs. The legislation contains a two-tiered system of numerical standards. *Enforcement standards* are specific contaminant levels that cannot legally be exceeded. When an enforcement standard is exceeded, a state agency must prohibit continuation of the activity causing the contamination or enforce other actions to achieve compliance with the standard. *Preventive action limits* (PALs) represent a percentage of the enforcement standards. For example, the enforcement standards for arsenic is 50 parts per million; the PAL is five parts per million. When a PAL is exceeded, state regulatory agencies are required to take action to maintain or lower the contaminant concentrations. PALs must be used to establish design and management standards for facilities (such as landfills) and activities (such as pesticide application).

The groundwater law also created several new state regulatory programs. The Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) now regulates the storage of bulk quantities of fertilizer and pesticides. The Wisconsin Department of Transportation (DOT) regulates the bulk storage of salt and other chlorides used on highways during winter months. The Wisconsin Department of Industry, Labor and Human Relations (DILHR) was directed to take groundwater protection specifically into account in its regulation of the storage of flammable and combustible materials and as part of the state plumbing code. The law also requires that the Wisconsin Department of Natural Resources (DNR), DATCP, DOT, and DILHR comply with the groundwater-protection standards (appendix 2).

The 1984 legislation also established a groundwater-monitoring program that includes a fund to assist with the repair or replacement of contaminated wells and to cover costs of improving contaminated groundwater, guidelines for laboratory certification, a council to coordinate state groundwater activities, and several other programs.

The local role defined in the groundwater law

Given that the state currently regulates many activities that cause groundwater problems and establishes standards for the levels of contaminants in groundwater, what can local governments do? Where do they fit into the regulatory framework? The 1984 groundwater law specifically authorizes three optional local regulatory programs (see table 1): well codes, septage ordinances, and zoning.

Well codes. Counties (but not cities, villages, and towns) are authorized to oversee where private wells are placed, constructed, and serviced. The county well code must conform to the state administrative rules (Chapter NR 145). The DNR may

revoke local authority to enforce well codes and septage ordinances if they are not adequately enforced or not in compliance with the administrative rules. For the first 18 months of the program only well-location permitting is authorized. After this period, the pump installation, well inspection, and well-construction programs are also available for delegation to the county.

Septage ordinances. Municipal sewage systems must, under certain circumstances, accept septage from licensed, private septage disposers to minimize the land disposal of septage. A city, village, town, or county may apply to the DNR to regulate the disposal of septage on land. The local governments applying must submit the details of their proposed regulatory program to the DNR, which evaluates the local administrative capability. The site criteria and disposal procedures must be identical to the DNR rules. If the county adopts a septage ordinance, the cities, villages, and towns cannot.

Zoning. State statutes define the purposes for which local zoning ordinances can be adopted. As a result of the 1984 groundwater law, zoning

Table 1. Summary of local regulations related to groundwater protection. From table 5 of *A Guide*.

		Authority		
Activity	**Regulator**	**Wisconsin Statutes**	**Adm. Code**	**Focus of regulations**
Land use (zoning)	County City & Village Town	59.97 61.35 & 62.23(7) 60.61 & 60.62		Regulation of new land-use locations, special areas and activities, and plans of operations for conditional uses.
Land division (subdivision)	County City & Village Town	236.45		Regulation of new parcel creation.
Septage disposal	County (otherwise) City & Village Town	146.20(5m)	NR 113	Regulation of land spreading of domestic wastewater.
Livestock waste management	County	92.16 59.07(51)	Ag 165	Regulation of earthen collection and storage facilities. Regulation of feeding and holding areas.
Hazardous materials	County City & Village	59.07(51) home rule*		Regulation of storage handling, disposal, and spillage of hazardous materials (types and amounts not covered by state).
Chemical storage tanks	City & Village Town	101.14(2)	IHLR 10	Regulation of periodic tank inspection, testing, approval, and removal as well as record-keeping.
Well construction and abandonment	County (only)	59.067	NR 112 NR 145	Regulation of well construction and/or pump installation, abandonment of unused wells, and location of new facilities.

*Municipal home rule powers—Wisconsin Statutes, sec. 62.11(5) (cities) and sec. 61.34(1) (villages).

ordinances adopted by counties, towns, cities, and villages may now include a statement that one purpose of the ordinance is "to encourage the protection of groundwater resources."

Local land-use controls can take a broader view of groundwater protection than the state regulation of certain contamination sources. Zoning ordinances and subdivision regulations can protect groundwater by

- establishing locations of certain land uses;
- prohibiting uses that cause problems;
- permitting other uses only under certain conditions; and
- limiting the density of development.

Zoning and subdivision regulations to protect groundwater

Conventional zoning

Zoning developed in an urban context; traditionally, its focus has been to prevent conflicts between incompatible land uses and to prevent overcrowding of land. In subsequent years zoning has taken on an environmental focus through regulation of environmentally sensitive lands such as shorelands, floodplains, and wetlands. Zoning ordinances can require that new land uses be undertaken in a way to protect groundwater quality. Courts have upheld zoning for groundwater protection in cases where the regulations

- prohibited a use that was hazardous to the groundwater;
- made a use conditional because of potential adverse effects;
- delineated areas particularly susceptible to groundwater contamination as special management areas; and
- limited density to protect groundwater.

See *Groundwater Quality Regulation* for more information.

Zoning *use provisions* establish districts in which certain uses are permitted as a matter of right, others are prohibited, and still others are conditionally permitted. Conditional uses (special exceptions) allow flexibility in deciding whether a particular use is appropriate for a specific site. Special flexible zoning techniques such as overlay zoning and cluster zoning (discussed in next section) can also be added to a conventional zoning ordinance to adapt it for groundwater-protection purposes. Zoning *density provisions* include the dimensions of lots and structures, the percentage of lot coverage by structures, and the location of structures on the lot. The basic purpose of dimensional provisions is to provide open space and control density. Regulating the density of development (such as setting large minimum lot sizes for homes that use septic systems) indirectly reduces the amount of potential contaminants that reach groundwater. Maintaining naturally vegetated open space can improve the amount and quality of water that infiltrates into the groundwater.

Flexible zoning

Conditional uses. The conditional-use (special-exception) technique allows individualized treatment of certain land uses according to the terms spelled out in the zoning ordinance. Conditional uses are expressly authorized in the county, town, and city zoning enabling laws.

There is an important difference between permitted and conditional uses. Permitted uses are automatically allowed if they meet the dimensional standards of the zoning district. Conditional uses, however, are not automatically allowed; they have the potential to create special problems or hazards. Instead, a public hearing is held and consideration is given to such relevant factors as

- the specific characteristics of the proposed use (such as the type of materials utilized or the type of wastes produced);
- important features of the proposed site (such as soil, subsurface, and aquifer characteristics);
- the probable effect of permitting that particular use at that specific location (such as likelihood of groundwater contamination); and

- whether adverse effects can be eliminated or substantially mitigated (such as by attaching appropriate conditions to the location, design, or operation of the use).

Overlay zoning. Overlay zoning can add flexibility and precision to land-use controls. Overlay zones can be described in the text of zoning ordinances; they are mapped and administered just as conventional zones are. However, the boundaries of an overlay zone do not coincide with the underlying zoning district but instead follow the location of the natural feature being regulated, such as a hillside prone to erosion, a floodplain, or an important aquifer recharge area. The overlay zone establishes requirements over and above the underlying zoning district. Thus, a groundwater-protection overlay district applied to the basic zoning residential district might impose additional controls (such as reduced density) and special provisions relating to the use, storage, handling, and disposal of hazardous materials. Flexibility is added by making many of the uses in overlay zones conditional. Wisconsin's floodplain regulations are a type of overlay zoning, and the shoreland zoning statute considers shorelands as special, environmentally oriented management areas. Although not central to its decision, the Wisconsin court made the following observation about overlay zones and conditional uses in a zoning case: "[w]here the imposition of conditions on land development is desirable, it might better be done by uniform ordinances providing for special uses, special exceptions and overlaid districts....Conditions imposed in such cases have a sounder legal basis because guidelines for their imposition are spelled out on the ordinance" (State ex rel. *Zupancic* v. *Schimenz*, 46 Wis. 2d 22, 33, 174 N.W. 2d 533, 539 [1970]).

Cluster zoning. Cluster zoning is a regulatory technique that permits development in a pattern that is different from the area requirements of the ordinance. Dwellings may be constructed on lots that do not meet the dimensional standards specified for individual lots. This process allows clustering of dwellings at a higher density over a portion of the site if open space and natural areas are preserved on the remainder. For example, assume a 10-acre site where the zoning required a minimum lot size of 1 acre. If half the site fell within an aquifer recharge area, cluster zoning might allow 10 lots on 5 acres if the remaining 5 acres within the recharge area stayed permanently undeveloped.

To encourage the use of cluster zoning, some local governments allow more housing units per acre than would be allowed under the conventional zoning. Others require that the overall density remain the same, feeling that the cost reductions to the developer resulting from shorter lengths of roads and utilities possible under clustering provide sufficient incentive. Cluster developments may be established as conditional uses, overlay zones, floating zones, or planned-unit developments. A floating zone is described in the zoning text, but it is not mapped. The text describes the conditions that must be met to establish the zone (for example, the size of the tract or density). The district floats until a landowner petitions to have it apply to a particular parcel by amendment of the zoning map, which is then processed as a regular map amendment. According to a prominent zoning treatise, most courts that have had occasion to review the legality of the floating-zone technique have given it either full or at least limited approval (Anderson, Robert M., American Law of Zoning 3d. s. 11.07). The Wisconsin court has not ruled on the issue. Cluster zoning allowed through a floating-zone technique is commonly called a planned-unit development district in Wisconsin zoning ordinances. Cluster zoning provisions should be cross-referenced to the local subdivision ordinance.

Subdivision regulations

Subdivision regulations control the process of dividing larger tracts of land into lots for sale or building. Subdividers are required to prepare plats, detailed maps of the land proposed to be subdivided. The plats must be approved by local regulatory agencies before they can be recorded and the lots sold. Plats can be reviewed to ensure

the physical suitability of the area for a subdivision, sufficiency of water supply and waste-disposal systems, proper stormwater management, control of erosion and sedimentation, the adequacy of the street system, proper dimensions and layout of lots, and adequate open space.

The authority for governmental review of subdivisions is found in Chapter 236 Wisconsin Statutes. A subdivision is defined by sec. 236.02(8) Wisconsin Statutes as the division of land into five or more parcels, each 1.5 acres or less in size, created within a five-year period. These state-defined plats are always subject to review by local approving authorities and one or more state agencies (depending upon the type and location of the plat) before the plat can be recorded by the County Register of Deeds. State agencies do not comprehensively review plats for possible groundwater contamination hazards to potential residents of the proposed subdivision. DILHR reviews unsewered plats to determine whether the soil is generally suitable for the location of private soil-absorption systems. Even this review does not regulate potential contamination from septic systems, which may result if they are located on excessively permeable soils or are not properly maintained.

Towns, cities, and villages can require as a condition of plat approval that a safe water-supply system be installed or a bond be posted to ensure this will take place. The statutory basis for this is sec. 236.13(2)(a) Wisconsin Statutes, which states: "As a further condition of approval, the governing body of the town or municipality within which the subdivision lies may require that the subdivider make and install any public improvements reasonably necessary or that he execute a surety bond to ensure that he will make those improvements within a reasonable time." The Wisconsin court held that a municipality "could require as a condition of its approval of a plat that the subdivider... install...a water system...including water mains and laterals" (*Zastrow* v. *Brown Deer*, 9 Wis. 2d 100, 100 N.W. 2d 359 [1960]).

A local government does not have discretion under Chapter 236 Wisconsin Statutes to reject a plat in the absence of previously adopted standards or guidelines for approval (State ex rel. *Columbia Corp.* v. *Pacific Town* Bd., 92 Wis. 2d 767, 286 N.W. 2d 130 [Wis. Ct. App. 1979]). These standards and guidelines can be part of a locally adopted subdivision ordinance, local master plan, official map, or other ordinance.

Local (county, town, city, and village) subdivision ordinances authorized by sec. 236.45 Wisconsin Statutes may contain specific provisions that make plat approval conditional on the basis of groundwater-protection provisions in the ordinance. Local ordinances may also have a more inclusive definition of what constitutes a subdivision than the state-defined plats. For example, a local subdivision ordinance may define a subdivision as the creation of lots larger than 1.5 acres or divisions into fewer than 5 lots. These locally defined plats are subject to review in that locality and may, at the local government's option, be subject to state agency review. More importantly, the rules set out in local ordinances may be more stringent than statewide rules governing state-defined plats.

Among the stated purposes of local subdivision regulations authorized by sec. 236.45(1) Wisconsin Statutes are to (1) "promote the public health, safety and general welfare;" (2) "facilitate adequate provision for...water [and] sewerage;" and (3) provide "the best possible environment for human habitation." In addition, sec. 236.45(2)(a) authorizes local government to "prohibit the division of land in areas in which such prohibition will carry out the purposes of this section." Thus, groundwater-protection provisions are clearly within the scope and intent of local subdivision regulations.

Local subdivision ordinances vary widely in form and content. Some subdivision ordinances spell out detailed design, construction, and review standards. Other subdivision ordinances contain only relatively general provisions that are then broadly interpreted to determine the specific measures that the local governments will require for the site in question. Many ordinances do not focus upon groundwater protection as a major concern.

More than one set of subdivision regulations may apply to a single tract of land. A plat in a rural area, for example, may be subject to county, town, and municipal regulations if located with the extraterritorial plat-approved jurisdiction of a city or village if the county, town, and municipality each have adopted regulations.

Subdivision regulations where zoning is inadequate

Zoning and subdivision regulations can be complementary tools in accomplishing groundwater protection. A local unit of government can exercise subdivision control in an area where it does not have zoning authority. This can be an important feature where the subdivision regulations contain groundwater-protection provisions but the zoning regulations do not. The following examples illustrate situations in which subdivision regulations may help protect groundwater when the zoning is inadequate.

The first example is an area subject to county zoning that does not contain groundwater-protection regulations. Land within this area could still be subject to groundwater-protection controls contained in the town subdivision regulations or the municipal extraterritorial subdivision controls. Another instance is development that takes place in an unzoned town. Groundwater provisions contained in the county subdivision ordinance would still apply even though the county zoning did not. Although local subdivision regulations typically apply to the division of land for residential purposes, they can be written to apply to industrial and commercial land divisions as well. Condominium development is not subject to state-level plat review but can be reviewed under a local subdivision ordinance if the ordinance specifies that it is intended to apply to condominiums. Because subdivision regulations can set minimum lot sizes, prohibit the division of land in certain areas, and review plats for conformity with local ordinances and local master plans, they can be used to achieve many of the development controls more traditionally accomplished by zoning.

Extraterritorial regulations

The source of potential contamination of a local government's groundwater might be outside the municipal boundaries. Cities and villages in Wisconsin are authorized to adopt extraterritorial subdivision regulations and zoning. Extraterritorial subdivision jurisdiction is defined by sec. 236.02(2) Wisconsin Statutes as "the unincorporated area within 3 miles of the corporate limits of a first, second or third class city or 1.5 miles of a fourth class city or village." When more than one local government has plat-approval authority and their requirements conflict, the plat must comply with the strictest requirements, according to sec. 236.13(4) Wisconsin Statutes. For example, if the city extraterritorial subdivision regulations set a larger minimum lot size than the town or county regulations, the stricter city requirements would prevail. A municipality can control platting outside its boundaries only with respect to that part of the plat lying within its plat-approval jurisdiction; it cannot regulate the part of a plat that may be outside such limits (*Brookhill Dev. Ltd.* v. *City of Waukesha*, 103 Wis. 2d 27, 207 N.W. 2d 242 [1981]).

Extraterritorial zoning is authorized by sec. 62.23(7a) Wisconsin Statutes, which permits cities and villages to zone land outside their municipal borders the same distance as their extraterritorial plat-approval jurisdiction. The municipality may unilaterally adopt zoning that freezes the zoning or uses in the surrounding town for up to two years while a comprehensive zoning plan is being prepared. If the municipality is to make the zoning permanent, it must be approved by a majority vote of a six-member committee composed of three town and three municipal representatives. A Wisconsin court has upheld the validity of a two-year freeze of existing town zoning that prohibited a liquor store, although the town and county subsequently amended the zoning to permit such use (*Walworth County* v. *City of Elkhorn*, 27 Wis. 2d 30, 133 N.W. 2d 257 [1965]). A Wisconsin court has ruled that an interim extraterritorial ordinance allows interim freezes of the existing zoning (that is, if the area is zoned resi-

dential, the city could keep it in that zoning classification for a maximum period of two years even though the town and county wished to rezone it) and interim use freezes if there is no zoning (that is, if the area is unzoned, new development could be prohibited for up to two years) (*Town of Grand Chute* v. *City of Appleton*, 91 Wis. 2d 293,282 N.W. 2d 629 [Wis. Ct. App. 1979]).

Legal considerations

When local government regulates private property, there are certain legal principles that must be considered. If these principles are not taken into account, the regulations may be found legally invalid when challenged in court. A more detailed analysis of the legal underpinning of local groundwater-protection regulations in Wisconsin is found in *Groundwater Quality Regulation.* The brief discussion of these considerations presented here serves as an overview and as background for the following section about fashioning land-use controls to protect groundwater.

Local regulations must protect the public health, safety, and general welfare. Protection of groundwater, especially as a source of drinking water, is in direct furtherance of the public health, which is a particularly important public objective. The regulatory methods must be a reasonable means to achieve these objectives. The groundwater amendment to the state zoning-enabling statutes recognizes that zoning is an appropriate means to accomplish this objective.

There must be a reasonable basis for the classification of uses and land subject to the regulations. Classifying uses on the basis of their threat to groundwater quality and land on the basis of its susceptibility to allow contamination meets this requirement. It could be argued that local groundwater-protection regulations so severely restrict private property that a "taking" has occurred, that is, the landowner is left with no reasonable use of the property. The injury to the landowner must then be balanced against the harm to the public. Courts traditionally consider impairment of the public health an especially serious public harm.

Flexible zoning is another method for ensuring that the stringency of the regulation increases as the potential for public harm increases. Rather than absolutely prohibiting all uses with groundwater contamination potential, it might be preferable to allow certain uses subject to specified conditions. To avoid arbitrary decisions, reasonable standards can be spelled out in the ordinance. This can be done by listing the factors to be considered in reviewing a conditional use. The court has recognized that the conditional use may help avoid a taking. Absolute prohibition of certain contaminating uses may be warranted if it can be shown that an area is particularly vulnerable to contamination (for example, locations near public wells or areas where contaminants would rapidly infiltrate the groundwater).

If the groundwater-protection purposes are clearly articulated in the regulations or in a separate plan, and if there is a factual basis to show that the regulatory provisions are a reasonable means to achieve these goals, then the regulations will likely be found valid. Objective evidence such as detailed soil surveys, studies of subsurface materials, and hydrogeologically defined wellhead-protection areas should be used when possible. An applicant should be allowed to conduct on-site investigations and submit technical evidence to show that conditions in the field differ from the information presented in the technical reports.

Chapter 3

REGULATORY APPROACHES FOR GROUNDWATER PROTECTION

The regulatory approaches that a community can take to protect its groundwater range from the simple to the complex. Some communities might want to develop a comprehensive protection program; others will have neither the problems nor the resources to warrant an extensive program.

The lack of detailed information about the many aspects of groundwater and the technical nature of that information are frequently seen as major hindrances to the development of local groundwater-protection programs. This is not necessarily the case. Despite problems caused by the frequent lack of information and limitations on technical and financial resources at the local level, it is possible in many cases to develop a program to provide a sound basis for land-use controls for protecting groundwater. Because of the nature of groundwater, it is impossible to have all the information desirable for regulatory purposes.

The regulatory approach selected can be based upon the type of information available. If little technical information is available, additional information about the characteristics of the site or the proposed use can be developed on a case-by-case basis at the time the development is proposed through conditional-use procedures.

It is important to keep in mind that each local situation in Wisconsin varies greatly. Information is more readily available in some areas than in others; there are widely different soils and hydrogeologic conditions in different parts of the state; problems differ and so do local perceptions of them; some local governments have staff with more expertise in groundwater matters than other local governments.

Because of this variability, it is impossible to suggest a single best approach to using land-use controls for groundwater protection. In short, a variety of approaches is needed to fit the variety of local situations. Five basic approaches that local governments in Wisconsin could take are presented in this chapter. Other approaches could certainly be devised. The five basic approaches are

- to revise existing land-use control ordinances on the basis of readily obtainable information about groundwater;
- to identify and regulate vulnerable areas where the soils are susceptible to infiltration from contaminants;
- to identify and regulate sensitive areas where contaminants can enter important aquifers;
- to delineate and regulate wellhead-protection areas; and
- to identify and regulate areas of suspected groundwater contamination.

Generally speaking, each successive approach requires more detailed information. In this chapter, we will present each regulatory approach by discussing its purpose, information requirements, and the regulatory options available for implementing the approach.

Approach 1: Revise local ordinances on the basis of readily obtainable information about groundwater

Purpose

The purpose of this approach is to take groundwater protection into account in making day-to-day land-use decisions. Many zoning ordinances were written before people were aware of the many important impacts land use can have on groundwater quality. The central idea here is to make sure that local land-use decisions and ordinances consider groundwater protection as an important factor in development decisions. This can be done by revising regulations to ensure that use classifications in the zoning text and the mapped zoning districts exhibit common sense when looked at

from the point of view of protecting groundwater. Even in situations where there is a lack of technical data, effective actions are possible with this approach.

Information needs and sources

This approach is applicable in situations where there is little available information about soil, geology, and aquifer characteristics. The focus of the approach is on the type of land uses present in the community and how they are regulated in existing zoning and subdivision ordinances. (*A Guide*, p. 18-28, discusses potential sources of contamination and steps that local governments can take to prepare an inventory of those sources.)

Regulatory options

Make groundwater protection a specific goal of the zoning ordinance. Most zoning ordinances contain a statement of purpose or a list of objectives. Prevention of groundwater contamination can be identified as a specific objective of the ordinance to help raise awareness of the relationship between land uses and groundwater quality and to make groundwater quality a specific consideration in zoning decisions.

For example, one Wisconsin village includes the following as part of its statement of purpose: to "prevent and control...pollution of the surface and subsurface waters and further the maintenance of safe and healthful water conditions." A more elaborate statement of purpose, either for the zoning ordinance as a whole or for a groundwater-protection overlay district, could be as follows: "The purpose of this district (or one purpose of this ordinance) is to protect the groundwater resource and its interrelated surface waters from pollution and to prevent contamination of the drinking-water supply within areas delineated as susceptible to contamination because of their soils and hydrogeologic characteristics. Protection of these resources is accomplished by regulating land uses and substances which have been identified as having the potential to contaminate groundwater."

Identify land uses potentially hazardous to groundwater. This involves two steps: (1) inventorying potential sources of contamination within the community; and (2) assessing land uses permitted by right in the local zoning ordinance to identify those uses with potential to contaminate groundwater.

- *Inventory of potential contamination sources.* *A Guide* contains a discussion of a number of potential contamination sources (table 2). For each there is a discussion of the prob lems that might result and sources for obtaining necessary information.
- *Assessing uses-by-right and their permitted location under the zoning ordinance.* In some cases, it might be appropriate to change certain uses that are automatically permitted in the ordinance to conditional uses. For example, a zoning ordinance might allow motor-vehicle repair shops, bulk-fuel storage facilities, and fertilizer-mixing plants as uses-by-right in industrial districts. Each of these land uses has the potential to contaminate groundwater. They could be made conditional by using one of the methods described below. The inven tory of contamination sources can be used as a guide in deciding which uses to prohibit or to make conditional. The location of potential contamination sources or districts in which they are permitted could also be reviewed to eliminate obvious problems, such as an industrial district adjacent to an existing or planned municipal well.

Develop criteria for review of conditional uses. Employing the conditional-use technique means that the ordinance must include standards related to groundwater protection to determine if and under what conditions a particular use will be allowed at a specific site. There are several ways to incorporate standards into a zoning ordinance.

- One approach is to write a very general standard stating that no conditional use will be allowed if it adversely affects groundwa-

Table 2. Activities that may create groundwater quality problems in Wisconsin. From table 2 of *A Guide.*

	Potential contamination sources			
Place of origin	**Municipal**	**Industrial**	**Agricultural**	**Other**
		Waste-related		
At or near the land surface	Sludge and wastewater disposal (N)		Feedlots (P) Manure storage (P) & spreading (N) Whey spreading (N)	Septage disposal (N) Junkyards (P)
Below the land surface	Landfills (P) Wastewater impoundments (P) Seepage cells (P) Sanitary sewers (L)		Manure pits (P) Holding tanks (P)	Septic systems (P)
		Non-waste		
At or near the land surface	Salt piles (P)	Above and on the ground storage of chemicals (P) Stockpiles (P) Tailing piles (P) Spills (P)	Irrigation (N) Fertilizers (N) Pesticides (N) Silage (P)	Highway deicing (L) Lawn fertilizers (N)
Below the land surface		Underground tanks (P) Pipelines (L)		Improperly constructed & abandoned wells (P) Overpumping (induced contamination) (P)

Note: P=point source; N=nonpoint source; L=line source

ter quality. For example, one Wisconsin village ordinance provides: "No activity shall locate, store, discharge...any treated, untreated or inadequately treated materials that might run off, seep, percolate, or wash into surface or subsurface waters so as to pollute, contaminate or harm such waters...." It is up to the local agency reviewing the application for a permit to establish specific criteria or to see that the applicant provides information ensuring that the use will not have a harmful effect on groundwater.

- As a modification of this approach, the ordinance could specifically identify the information that the applicant must provide. For example, a Massachusetts town requires an applicant to submit "a complete list of all chemicals, pesticides, fuels, and other potentially toxic or hazardous materials to be used or stored on the premises...accompanied by a description of measures proposed to protect from vandalism, corrosion, and leakage, and to provide for control of spills." The ordinance also requires analysis of the proposed measures by a registered engineer. One problem with this approach is that local officials might not always have the technical background to properly evaluate the information provided.
- Incorporate standards that already exist for some land uses or facilities into the ordinance, or simply refer to these outside standards. Examples include existing U.S. Soil Conservation Service (SCS) standards for manure-storage facilities or DILHR standards for gasoline-storage tanks. In some cases, it might also be possible to take these existing standards and tailor them to

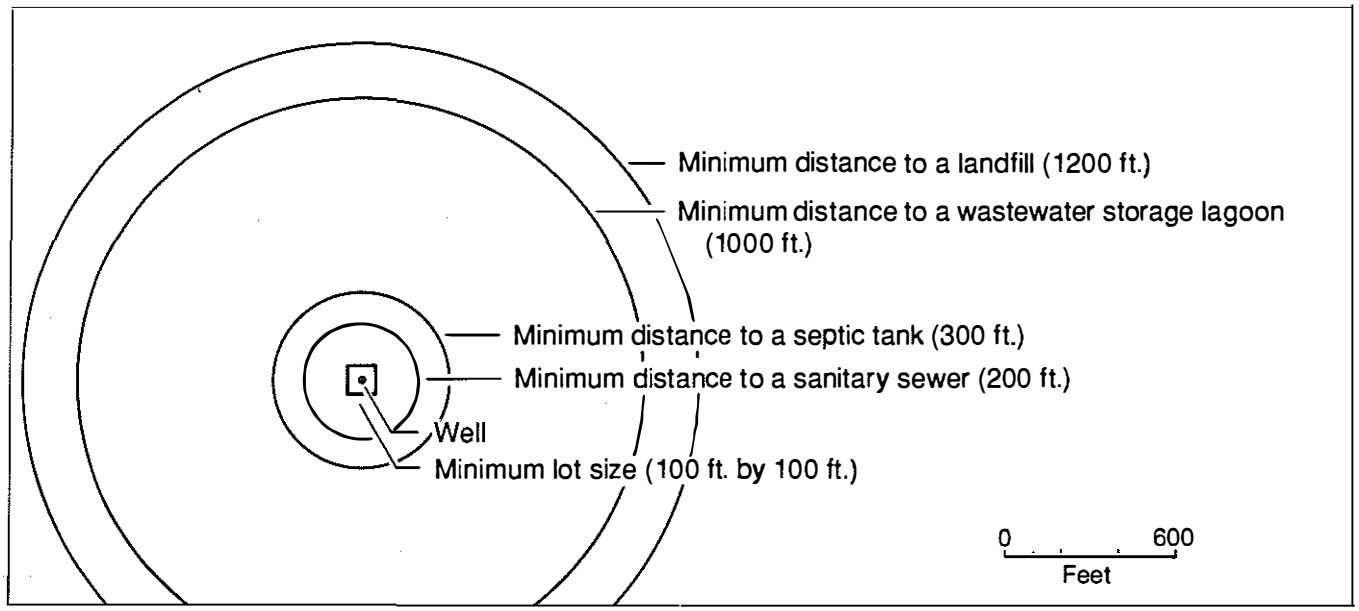


Figure 5. Minimum separating distances for municipal wells.
Under Wisconsin's well code, wells must be separated by a minimum distance from potentially contaminating land uses. Adapted from figure IV-1 of Wellhead Protection Districts.

the local situation. State administrative regulations (NR 111, NR 112) control the location of wells by requiring that they be located minimum distances from potential sources of contamination (fig. 5). The state also regulates certain sources of contamination (such as sanitary landfills), but not all sources (such as storage of hazardous materials), by requiring a minimum separating distance. The zoning ordinance could supplement state regulations by requiring that all potentially contaminating uses be separated from existing wells by specific minimum distances. The uses could be made conditional or prohibited within specified distances of the well. This would help prevent situations similar to those that exist in several Wisconsin communities, where potentially contaminating uses have been developed close to existing wells. In one instance, the immediate neighbor of a municipal well is a bulk-fertilizer and pesticide-storage facility; in another instance, the well is adjacent to an industry producing highly corrosive hazardous substances.

Approach 2: Identify and regulate vulnerable areas

Purpose

The purpose of this approach is to identify the areas where soil, subsoil, and/or bedrock characteristics allow contaminants to move through groundwater relatively quickly, with little attenuation. These are primarily areas of thin soils, coarse and permeable soils, fractured dolomite or granite bedrock, a high water table, or a combination of these factors.

Information needs and sources

To identify areas particularly susceptible to contamination, information is needed about soils, subsoils (including glacial material), bedrock characteristics, and depth to the water table (table 3). A system for evaluating the vulnerability of the

Table 3. Data needed for evaluation of the physical environment. From table 3 of *A Guide.*

Data needed	Source of data
Soil	
Soil map	Soil survey maps 1:20,000 - SCS
Soil material and its properties	Soil interpretation sheets - SCS
surface and subsoil texture	Soil interpretation sheets - SCS
permeability	Soil interpretation sheets - SCS
pH	Soil interpretation sheets - SCS
content of organic matter	Soil interpretation sheets - SCS
Drainage characteristics	Soil interpretation sheets - SCS
Depth of the solum	Soil interpretation sheets - SCS
Soil attenuation capacity	Map 1;100,000 - WGNHS (available only for some counties)
Surficial geology	
Glacial deposits	General map 1:500,000* - WGNHS
Type of material	General description
Permeability	Inferred from general description
Thickness	General map 1:1,000,000*
Bedrock geology	
Geologic map	General map 1;100,000* - WGNHS
Type of material	General description
Permeability	Inferred from general description of rocks
Groundwater	
Depth to bedrock	WGNHS and USGS reports and files (not available for all counties)*
Groundwater elevation	
Slope of the water table	
Direction of groundwater flow	
Components of groundwater flow (recharge and discharge areas)	
Water quality	WGNHS, USGS, and DNR files

*Some counties have maps at scale 1:100,000; a list is available from WGNHS. See also appendix 3.

physical environment to groundwater contamination is discussed in *A Guide* (fig. 6). *A Guide* also presents a method for evaluating the attenuation capacity of soils and subsurface materials. The soil-evaluation model uses the characteristics of each soil series to assess the ability of the soil to attenuate contamination at or near the surface. The subsurface materials evaluation considers the composition and succession of subsurface materials to judge the ability of subsurface materials to attenuate contaminants below the first 5 feet. (Knowledge of the direction and rate of groundwater flow is also important to judge what happens to contaminants once they reach the groundwater flow system.) Detailed soil surveys, well data, and WGNHS reports can be used to prepare local maps designating vulnerable areas.

Detailed soil survey reports. The detailed county soil survey is the most widely available resource inventory, although modern surveys have not been completed for all Wisconsin counties (fig. 7). Detailed information about soil is available from the Soil Conservation Service, County Land Conservation (or Soil and Water Conservation) Department, and County Extension Offices. Interpretation of the detailed soil survey will identify areas where soil characteristics promote infiltration and leaching. In addition, the survey can show "safer" soils, for example, those with low permeability and high clay content. The detailed soil survey maps at a scale of 1:15,840 or 1:20,000 compare favorably in terms of scale and accuracy with many natural resource inventory maps. However, even this scale precludes delineating

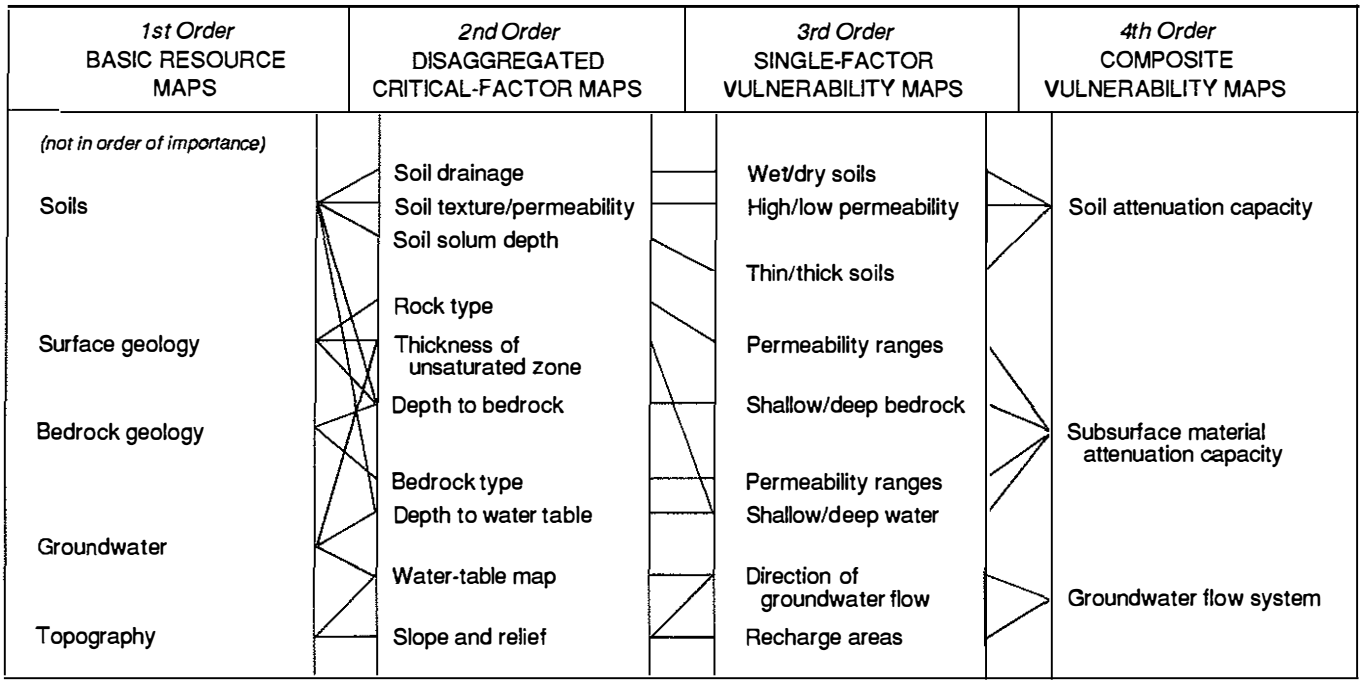


Figure 6. Environmental vulnerability evaluation system.
A composite view of the capacity of wells and subsurface materials to attenuate contaminants can be obtained by using the system presented schematically above. Details on using the system can be found in A Guide *and in the groundwater management study developed for Rock County (Zaporozec, 1985). Adapted from figure 7 of* A Guide.

areas smaller than 2 acres, and enlarging a map does not increase its accuracy. Detailed soil maps are thus most useful for determining the general suitability of soils within areas proposed for development and should be supplemented by on-site investigations to more precisely determine specific conditions. Soil surveys primarily investigate materials within 5 feet of the surface. However, soil scientists can give a reasonable estimate of conditions below 5 feet on the basis of field observation and review of other resource data, including maps of bedrock and surficial geology.

Wisconsin Geological and Natural History Survey publications. A series of reports and maps for 52 counties is available from the WGNHS (appendix 3). These publications describe the geology and discuss the occurrence, movement, availability, and quality of groundwater in the county. The publications may include general maps of soils, bedrock geology, bedrock topography, glacial geology, thickness of unconsolidated materials, areas where the depth to water is less than 10 feet, and the saturated thickness and probable well yields of the various aquifers. Studies underway in other counties will use extensive field investigations to show the water table and shallow aquifer in greater detail. In counties where geologic information is not available at the county level (scale 1:100,000), general information can be obtained from the statewide map of unconsolidated geologic material at a scale of 1:500,000 and the state bedrock map at a scale of 1:250,000 or 1:1,000,000.

Well data. Well data can be interpreted by a technician to supplement geologic information. Geologic logs for high-capacity wells (approximately 7,000), which have accompanying rock and soil-profile samples, are available from WGNHS. Well constuctor's reports for low-capacity wells (approximately 400,000) are submitted by well drillers in the course of drilling private wells and

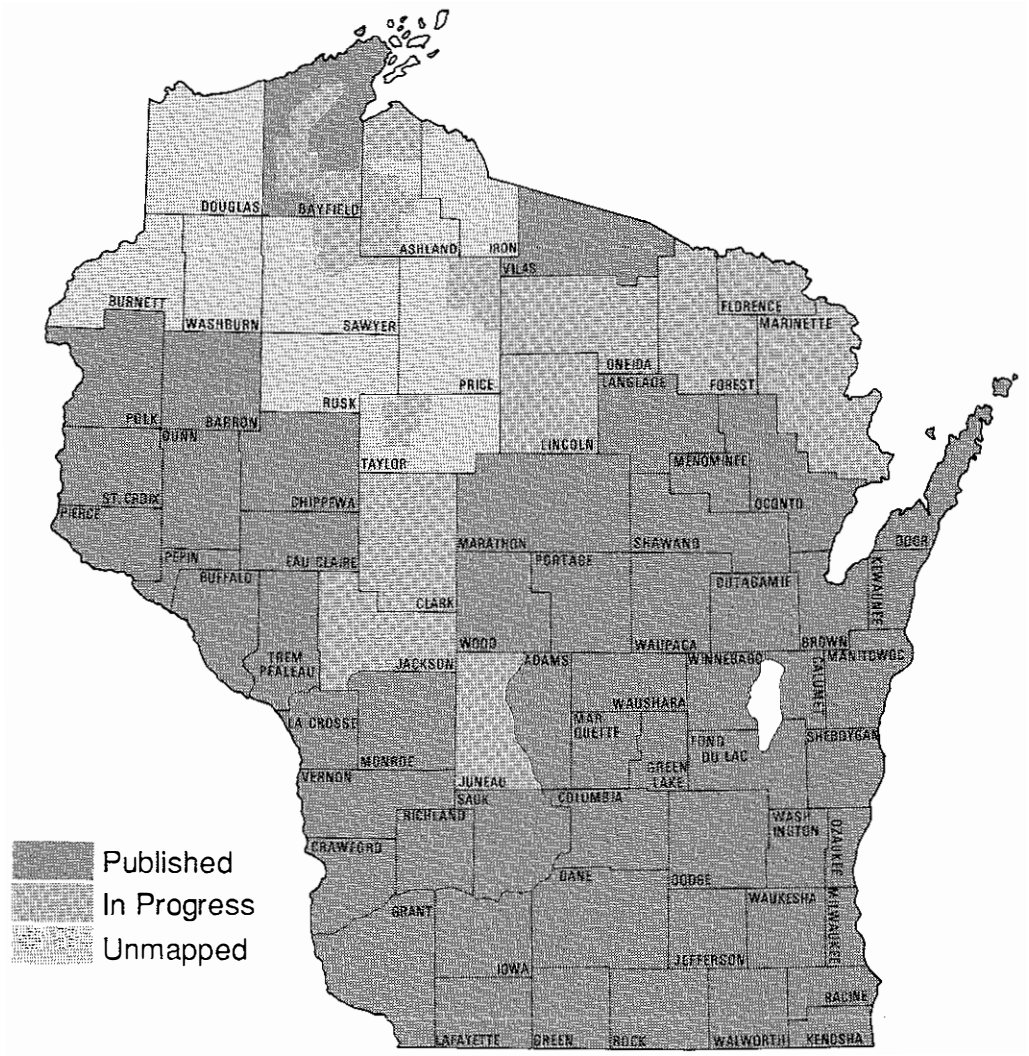


Figure 7. Status of soil surveys in Wisconsin as of August 1, 1990.
Adapted from figure 6 of A Guide.

are available from the DNR district and central offices and the WGNHS. The reports are the driller's description of the location, thickness, and composition of the material encountered. The reports also provide information about the depth to the water table and whether the drinking water was bacteriologically safe at the time of drilling.

The Fox Valley Water Quality Planning Agency used well constructor's reports in a groundwater study for Calumet County. The information allowed the agency staff to plot the general elevations of water within the Silurian aquifer. However, because the well constructor's reports did not record surface elevations to compare to the water-table elevations, the workers could not accurately draw a map showing water-table contours. In some instances, well data can be plotted on topographic maps to provide this information.

Regulatory options

By identifying vulnerable areas and mapping them as zoning overlay districts, communities can target areas needing special consideration for groundwater protection. However, stringent development controls might not be warranted merely because a site is in a vulnerable area. Development in an area designated vulnerable because of highly permeable soil conditions would not substantially affect groundwater quality if the soil was not directly connected to an aquifer. For example, a thick layer of low permeability shale or clay sometimes separates the land surface from an underlying aquifer and reduces the movement of infiltrating water and contaminants to the aquifer.

Designation as a vulnerable area essentially signifies how easily a contaminant might percolate through soil and geologic materials in that area. This approach is used in areas where no detailed information about the characteristics of underlying aquifers is available. Within a vulnerable area overlay zone, potentially contaminating uses could be made conditional uses. When a conditional use is proposed for the overlay zone, prospective developers could then be required to demonstrate that the area is not located over a susceptible aquifer. This might require on-site testing for water quantity and quality. The cost of drilling and the number of holes required depend on the size and complexity of the site. This type of work can be performed by consulting engineers. Where a vulnerable area is located over an aquifer, or if the developer declines to provide the required information, the regulatory provisions for sensitive areas described in the next section could apply.

Approach 3: Identify and regulate sensitive hydrogeologic areas

Purpose

The previous approach can be used to identify areas with potentially rapid movement of contaminants to groundwater, but not to distinguish whether those surface areas are connected to aquifers. The purpose of the next approach is to identify local aquifers and their characteristics and to develop regulatory responses to protect those aquifers. In effect, this step sharpens the delineation of vulnerable areas by adding information about aquifer characteristics.

Information needs and sources

Identifying aquifer characteristics is far more technical than the previous two steps. It requires expertise in hydrogeology to interpret existing information and in most cases will require additional field studies. Relevant information includes

- location and extent of important aquifers;
- aquifer characteristics (confined or unconfined, consolidated or unconsolidated, transmissivity and yield, and presence or absence of fractures and solution features);
- saturated thickness of deposits;
- water quality;
- direction and rate of groundwater movement; and
- major recharge areas.

This information, at varying levels of specificity, is available in the WGNHS county publications noted earlier (appendix 3).

Unlike some states that set standards that vary from aquifer to aquifer, Wisconsin law stipulates that all groundwater is protected by the same groundwater-quality standards. The Wisconsin rules are based in part on a recognition that aquifers can be interconnected (water quality in the shallow sand and gravel aquifer can ultimately affect the underlying sandstone or dolomite aquifer). In some cases, however, shortages of local government staff, time, or money may require that priorities be set in implementing a groundwater-management plan.

The most critical areas for protection, and those that could be given top priority, are obviously those where a particularly vulnerable surface area overlies a high-quality, high-yield aquifer used as

a source of drinking water. An area where soils have a good capability to attenuate contaminants and the site overlays a less productive aquifer should still be protected, but could be given second priority. There are several ways to combine information about aquifers and vulnerable surface areas and produce a hierarchy or ranking of sensitive areas needing protection. The more precise the information about the aquifers to be protected, the more specific the classification of sensitive areas can be.

Regulatory options

By defining a hierarchy of sensitive hydrogeologic areas, it is possible to relate the stringency of development controls to the severity of the threat. Obviously, the most stringent control would be to prohibit uses; less stringent controls would involve making some uses conditional, restricting densities, and imposing site standards designed to protect groundwater.

Prohibit high-risk uses in highly sensitive areas. In towns or counties where there are relatively small, discrete areas that are highly sensitive (such as major aquifer recharge areas), overlay zones could be established and certain potentially contaminating uses (such as sanitary landfills and underground-storage tanks) could be prohibited. In other instances, such as in the central sand plain where very large areas of sandy soils permit rapid infiltration to the aquifer, prohibiting all such uses would be impractical. The regulatory focus could be less on sensitive areas and more on the careful control of land uses through construction standards and monitoring to ensure they do not contaminate groundwater. Potentially hazardous uses could be made conditional in most zones. A qualification of the previous statement must be made in the case of wellhead-protection areas, where zones of varying stringency are typically employed. This is discussed in the following section about wellhead-protection areas.

Make some uses conditional in less sensitive areas. One or more additional overlay zones can be established to classify the somewhat less sensitive areas (such as areas in which the soils have a better capability to attenuate contaminants). In these zones some of the uses that are prohibited in the highly sensitive zone can be allowed as conditional uses. In addition, densities can be varied: higher densities can be allowed in the less sensitive zone. One way to establish residential densities is to base density on estimates of nitrate that would enter the groundwater from unsewered development.

In the Portage County Groundwater Protection Plan, minimum lot sizes were calculated on the basis of the estimated nitrate contribution to the groundwater from the lots in question. The calculations used a mass-balance approach and were made with a computer model developed at Cornell University. Varying permitted loadings of nitrate and lot sizes were recommended within the several wellhead-protection districts. Density controls for certain other uses could be established by adjusting lot size to the type and amount of wastes generated.

Approach 4: Delineate and regulate wellhead-protection areas

Essential groundwater supplies can be protected in many instances by delineation of wellhead-protection zones in which potentially contaminating land uses are controlled.

Purpose

The purpose of this approach is to identify and protect the areas recharging existing and future municipal wells (or existing clusters of private wells). In general, these will be areas where infiltrating water moves directly to a well. In practice, these areas can be defined in several ways.

- The cone of depression, or area within which the groundwater elevation is lowered by the pumping of a well.
- The usually teardrop-shaped recharge area

that is upgradient of the well, within which groundwater finds its way into the well.

- The area within which contaminants will reach the well within a certain time period, such as one year. (This is a way of expressing the previous recharge area in terms of a time dimension.)

Information needs and sources

Identifying these areas depends on data availability, the local hydrogeologic setting, and the level of protection desired by the community. Wellhead-protection zones are most appropriate in aquifers located in a local flow system, such as sand and gravel aquifers that are close to the land surface, are composed of permeable materials, and receive substantial recharge most years. They are not applicable to aquifers in which much of the water that reaches the well may be part of a regional flow system; the water may have traveled substantial distances over a long period of time, with recharge from the immediate area limited to places where the confining layer is thin or fractured. The clearer the delineation of the districts, the stricter the land-use controls that can be justified. In most cases, identification of the areas requires some expertise in hydrogeology and might require pump tests and installation of monitoring wells. (For detailed discussion of defining wellhead-protection areas, see *Wellhead-Protection Districts.*) The following discussion presents the essential elements of a wellhead-protection area.

Cone of depression. When a well is pumped, the groundwater in the vicinity of the well drops or is "depressed" into a cone shape (fig. 8a). This results from a lowering of the original water table in the vicinity of the pumped well. The size and shape of each cone varies depending upon the pumping rate, duration of pumping, shape of the water table, and recharge within the zone of influence of the well. The cone of depression can be estimated from well constuctor's reports (available from the WGNHS) using basic hydrogeologic data and standard calculations. The surface projection of the cone of depression is circular or oval, depending upon the shape of the water table (fig. 8a). This area represents a reasonable first approximation of a protection area. Contaminants entering

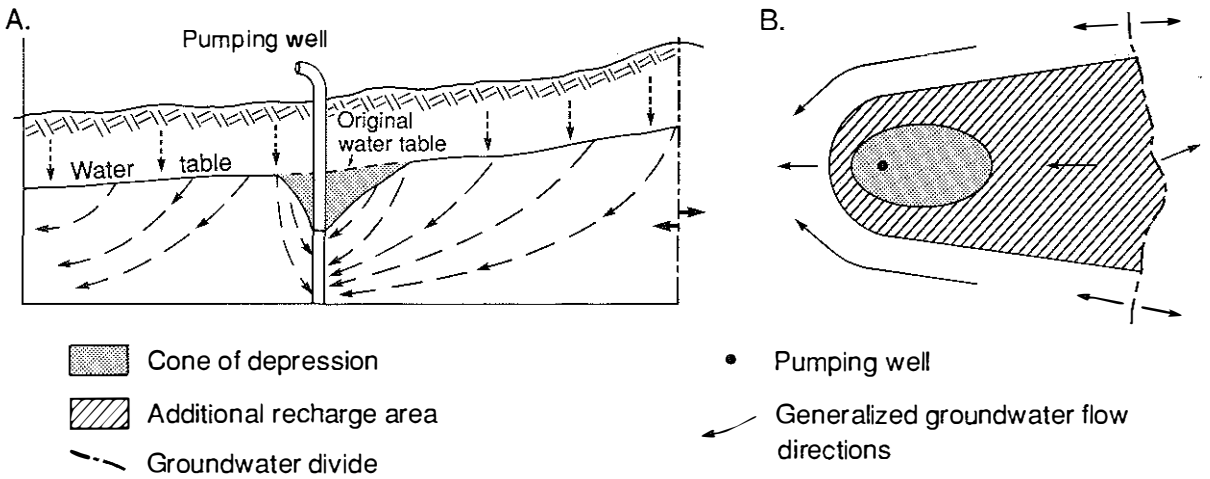


Figure 8. Cone of depression and recharge area.
A: *When a well is pumped, water is drawn to the well from a larger, upgradient recharge area. From figure 9A of* A Guide. B: *Pumping causes groundwater to be drawn down in a cone shape. The surface expression of the cone of depression and recharge area can be defined and should be given high priority in local groundwater-protection programs. From figure II-2 of* Wellhead-Protection Districts.

the ground within this area can be pulled rapidly to wells. Therefore, it is particularly important that this area be protected against contaminating uses.

In large urban areas there may be a series of widely extended cones of depression. It would not be practical to prohibit potentially contaminating uses through such a broad area. Instead, the protection strategy may shift to other management tools such as a municipality-wide ordinance regulating the handling and storage of hazardous materials or requiring appropriate management practices and performance standards through conditional uses under zoning.

Upgradient recharge area. A well's recharge area can be combined with the cone of depression to form a broader protection zone. Groundwater outside and upgradient from the cone of depression will find its way to the well (figs. 8b and 9). These upgradient recharge areas can be estimated using information about water-table elevations, bedrock topography, surficial geology, obvious flow boundaries (such as streams), and other factors. The better the hydrogeologic information available and the more resources a community is willing to commit, the more accurate the delineation of this area will be. However, the upgradient recharge area might be too large for effective measurement or regulation. For example, in part of the central sand plain of Wisconsin, it can extend 10 to 15 miles.

The delineation of appropriate protection zones involves a good deal of judgment. Hydrogeologic factors affecting contaminant attenuation, existing and potential land-use patterns, and the effect of development restrictions on land values are important considerations. The natural boundaries of the well's recharge area might overlap several political and administrative boundaries, thus requiring some adjustment (and compromise) of the protection area (fig. 10).

Hydraulic travel time. Another way to define recharge areas is with estimates of the time it takes various contaminants to reach a well. Contaminants moving through groundwater may become less of a problem the longer the time and travel distance to a well, due to such processes as dispersion, dilution, and chemical breakdown. Protection areas around a well can be defined by relating time to distance. For example, it might take contaminants (such as volatile organic compounds from a landfill) located beyond the cone of depression one year to travel 1,000 feet to a well in a given hydrogeologic setting. Assuming the community wanted a three-year minimum time limit in which to take remedial action, the 3,000 feet could serve as an additional protection area.

Regulatory options

Prohibit development in the area immediately adjacent to the well. This approach could be used to protect existing municipal wells and the known sites of future wells. Where possible, the area immediately adjacent to the well should remain undeveloped. Chapter NR 111 of the Wisconsin Administrative Code requires reservation of a 100-square-foot parcel for construction of a municipal well or a well serving a subdivision. A municipality could control development around a new well by purchasing a substantially larger protection area, or possibly purchasing only the development rights to the area.

Strictly control development in the cone of depression. Zone the area of the cone of depression to permit only those uses that would not alter the natural character of the area or adversely affect groundwater. However, zoning must allow some reasonable use of the land to avoid a taking of private property. In some cases, it might be necessary to purchase certain development rights. An alternative might be to zone the land within the cone of depression for residential use served by public sewer and water. This basic zoning district could then be supplemented by an overlay district that would prohibit potentially contaminating activities such as those involving hazardous materials. A third possibility is to use cluster zoning. Where unsewered development is prohibited in wellhead-protection areas, development at a higher density could be permitted if clustered out-

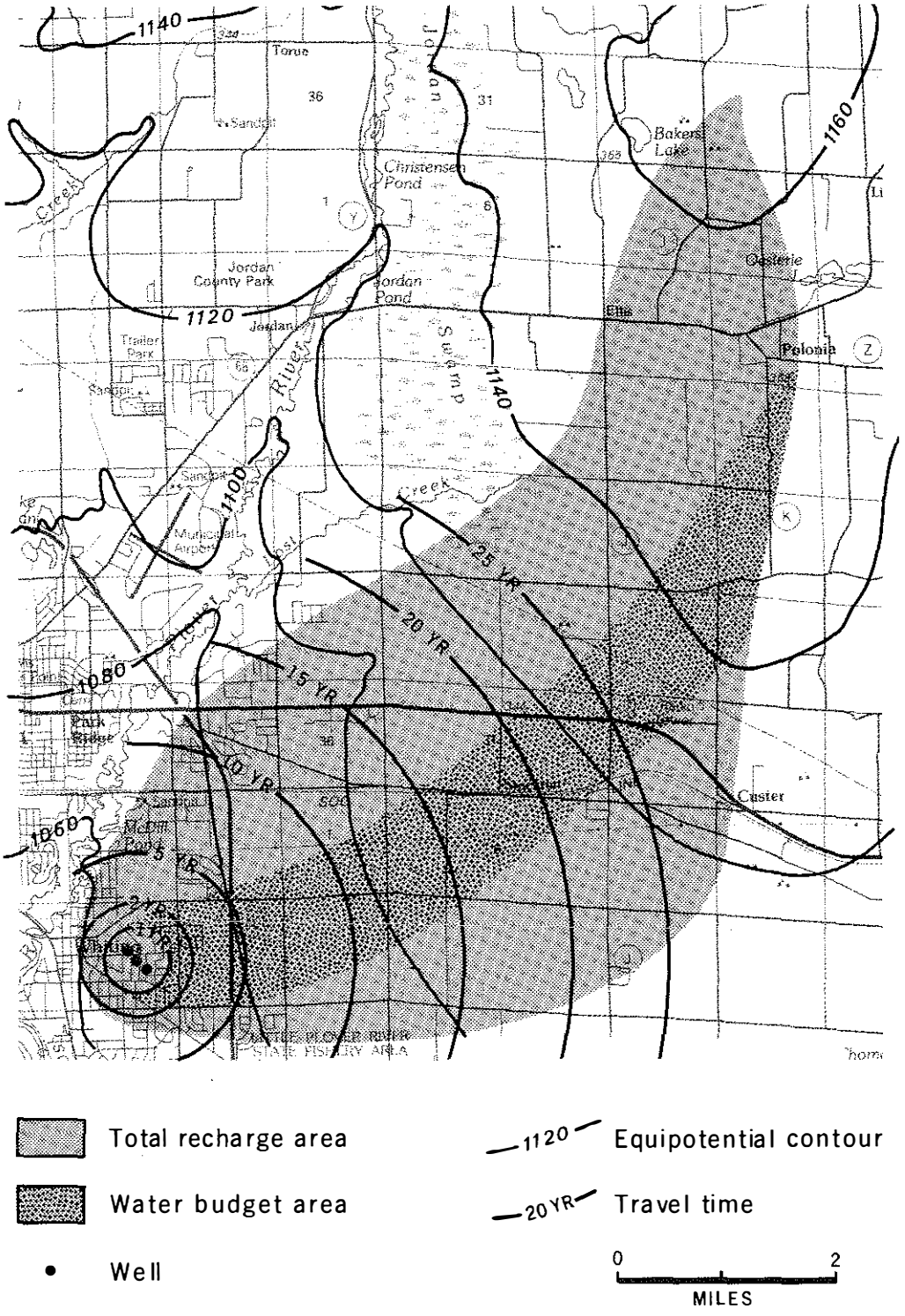


Figure 9. Whiting recharge area.

A water-table map for the village of Whiting in Portage County. The map shows the recharge area for the village well field, the direction of groundwater flow, and travel-time lines showing estimated time recharge water takes to travel to the well. From figure III-3 of Wellhead-Protection Districts.

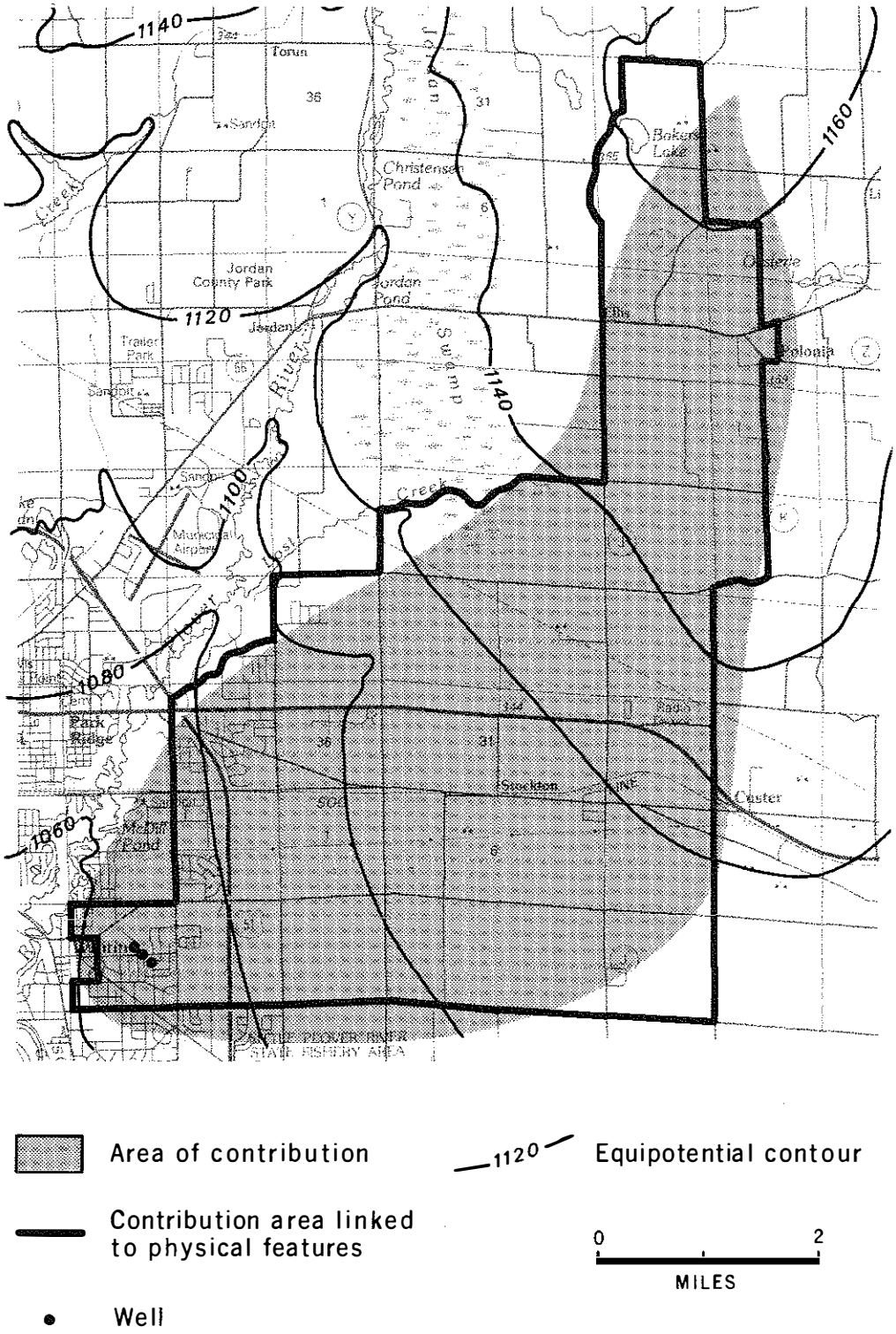


Figure 10. Whiting wellhead-protection district.
The boundaries of the wellhead-protection district do not exactly match the calculated recharge area. Special regulatory districts must consider such factors as development patterns, land values, and political and administrative boundaries in addition to the hydrogeologic boundaries. From figure V-2a of Wellhead-Protection Districts.

side the area. For example, assume that a 50-lot subdivision is proposed in an area where the zoning requires 1 acre per dwelling, and half the proposed subdivision falls within a wellhead-protection overlay zone that prohibits unsewered development. Cluster zoning would permit doubling the density outside the protection zone. This would preserve the 25 acres inside the zone and still allow the landowner to develop 50 lots on the 25 acres outside the zone.

Establish several recharge overlay zones with the most stringent controls in the areas most directly contributing to the well. This approach has been adopted or proposed in several Wisconsin communities with modifications to meet local conditions (appendix 1). Rib Mountain's local government was the first in the state to adopt zoning establishing wellhead-protection areas. The zoning ordinance created a municipal well recharge area overlay district. The purpose of the overlay district is "to protect municipal groundwater resources from certain land-use activities by imposing appropriate restrictions upon lands located within the approximate recharge area of the town's municipal wells."

The overlay district is divided into two zones (fig. 11). Zone A consists of the cone of depression and a surrounding area of sand and gravel soils and subsoils. Within zone A some uses that have a high potential to contaminate groundwater are prohibited, sewered residential uses are permitted, and all other uses are conditional. Zone B consists of the rest of the recharge area, much of which has groundwater or bedrock within 5 feet of the land surface. Underground storage tanks are prohibited and all business or industrial uses are allowed only as conditional uses. The recharge area is relatively small because it is primarily bounded by shallow bedrock on one side and a river on the other. The actual boundaries of the overlay district follow section lines, roads, lots, and other property lines. The zoning configuration and use regulations adopted in Rib Mountain would need to be modified in other communities with different hydrogeologic conditions.

In its groundwater-management plan, Portage County also recommended that high priority be given to wellhead-protection ordinances. However, the use restrictions and the protection areas delineated in the Rib Mountain and Portage County wellhead-protection measures are substantially different, reflecting in large part their different physical settings. Nearly 60 percent of Portage County's population depends upon municipal well fields or private wells concentrated in urban areas. The plan contains an example ordinance (see appendix 1) and an overlay wellhead-protection zoning district in which there are three groundwater-protection district zones (fig. 12): zone A, the well field cone of depression; zone B, the five year time of travel; and zone C, the balance of the recharge area.

Because the sand and gravel aquifer in Portage County is close to the land surface, the wellhead-protection concept works well. Zone A is a circular cone of depression with a radius of 1,500 feet, which was calculated using pump-test data from local wells. Contaminants within this area can move quickly to the pumping well with little dilution or attenuation. Because zone A is subject to the highest contamination threat, its land-use controls are the most restrictive of the three recharge zones. Wildlife areas and natural uses are permitted, sewered residential uses are allowed with certain conditions, and all other uses are prohibited. Zone B is the recharge area within which contaminants will take an estimated five years to reach the pumping well. Land-use controls are somewhat less restrictive than those for zone A because of the longer flow times and greater potential for dilution, dispersion, and breakdown of contaminants. Residential and natural wildlife uses are permitted, certain uses that have a high contamination potential are prohibited, and all other uses are conditional. Zone C is the remainder of the recharge basin that contributes groundwater directly to the well. Land-use controls in zone C are the least restrictive of the wellhead-protection zones. The uses with a high contamination potential that were prohibited in zones A and B are allowed as conditional uses in zone C.

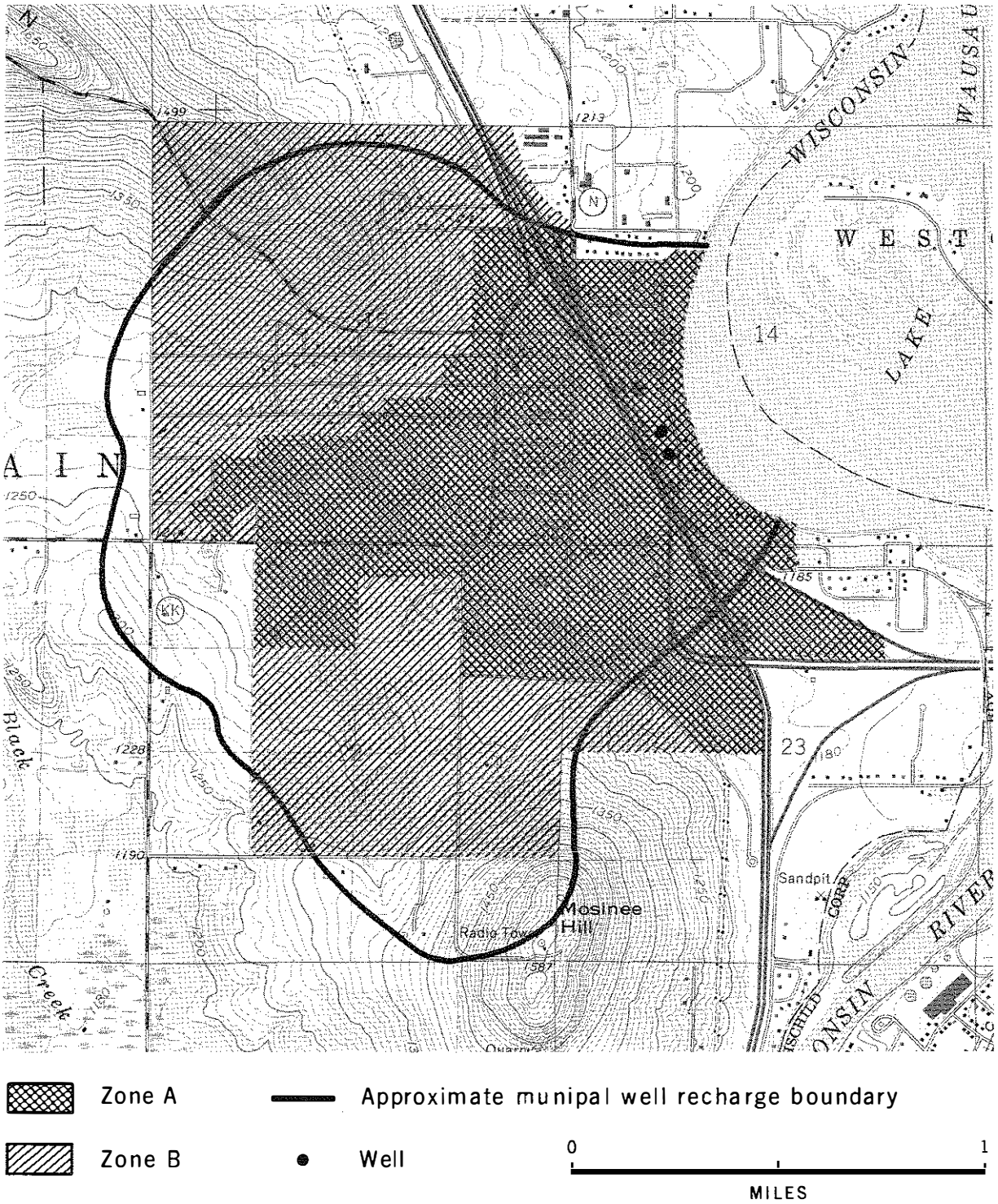


Figure 11. Rib Mountain well recharge overlay district.

The recharge area for Rib Mountain's municipal well was protected by an overlay district divided into two zones. Zone A consists of the cone of depression and a surrounding area of highly permeable soils and subsoils. Zone B consists of the remaining recharge area. (From figure V-1a of Wellhead-Protection Districts.)

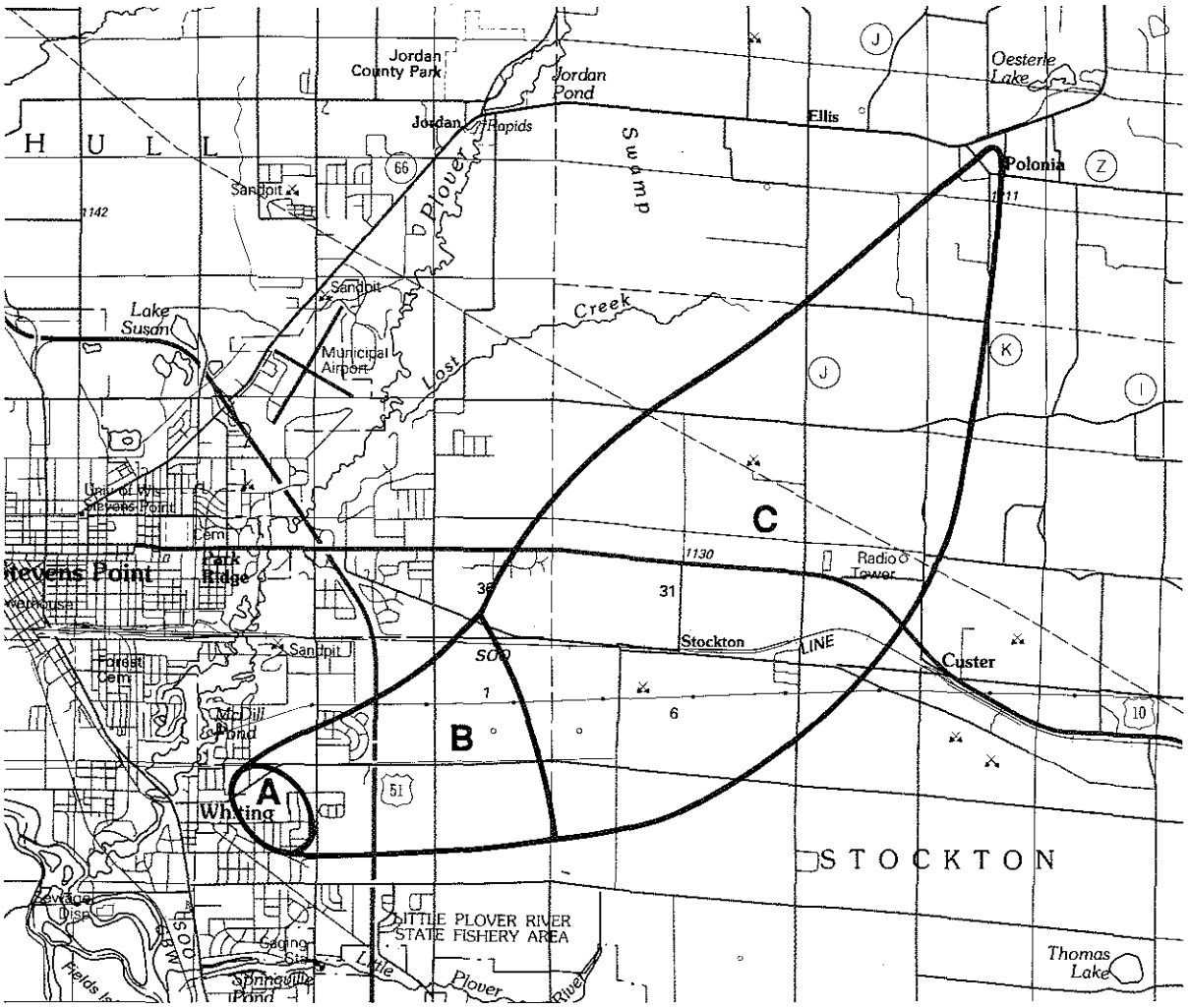


Figure 12. Proposed Portage County wellhead-protection zones.
The Portage County groundwater-management plan recommends wellhead-protection areas with three zones. Zone A is the cone of depression; zone B is the five-year travel time; zone C is the remaining recharge area. This map shows these three zones calculated for the Whiting well field.

Approach 5: Identify and regulate areas of suspected contamination

Purpose

The purpose of this approach is to ensure a safe water supply in areas where contamination is suspected. The object is to restrict development proposed in areas downflow from a suspected groundwater contamination source unless the developer can ensure an adequate supply of safe water.

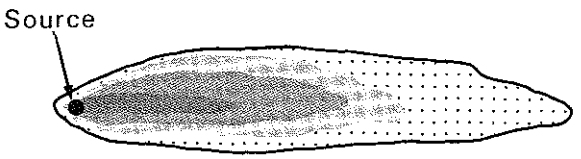
Information needs and sources

Information requirements can vary substantially, depending on the nature of the problem. One situation would be a development proposed downflow from an obvious potential contamination source such as a landfill. The basic informa-

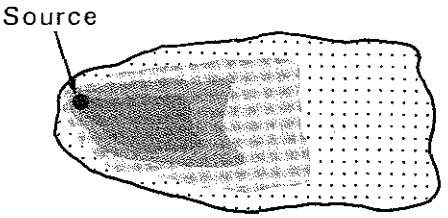
tion needed would be direction of groundwater flow, the nature of the contaminants, and the shape of the contamination plume. Information about the general direction of groundwater flow can be obtained from the WGNHS water-table maps available for some counties (see appendix 3). In other cases, it might be possible to gain a rough picture of groundwater flow from surface information (such as topography) and the presence of springs and surface water. However, it will usually be necessary to conduct a hydrogeologic investigation of the area. Information about the nature of the contaminants and the shape of the contamination plume is typically more difficult to obtain, as discussed below.

A second situation would be development proposed for an area where well-water quality has been a problem, but the source of contamination has not been identified. Well-water test results and hydrogeologic investigation would be needed to describe the source and extent of the problem.

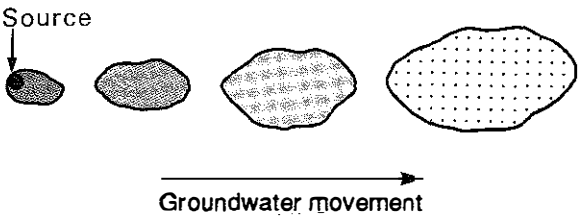
A third situation would be a new development proposed for an area where a plume of contamination from a known source might affect wells in the development. The basic information needs would be delineating the contamination plume and predicting where it will travel and at what concentrations. It is usually difficult and expensive to generate this information. Identification of areas likely to be affected by a plume of contamination depends on an assessment of the groundwater flow system, aquifer characteristics, and the contaminant itself. Different contaminants have different breakdown rates, different patterns of dispersion and dilution, and represent different hazards (fig. 13). Estimating the path of a plume of contamination through the groundwater system can be complicated by aquifer characteristics such as clay or rock lenses, the influence of pumping wells, changes in groundwater flow caused by drought, and other factors. Models of different levels of complexity have been developed for predicting contaminant transport, adsorption, dispersion, and decay. The difficulty of obtaining information about plume identification and management puts it beyond the scope of most local groundwater efforts and would require the services of a specialized consulting firm.



A. Continuous source, rapid flow



B. Continuous source, slow flow
(Contaminant is less concentrated at the margins and increases toward the source.)



C. One-time source
(A slug of contamination moves with groundwater and expands with a lower concentration.)

Figure 13. Contamination plumes.
Contaminants in groundwater can travel along flow lines. The shape and size of these plumes depend on local geology, groundwater flow, type and concentration of the contaminant, and the source (continuous or one-time event). Generally, the concentration of contaminants in groundwater tends to be reduced with time and distance traveled. From figure 26 of Zaporozec, 1985.

Regulatory options

Several related regulatory measures could be used in zoning and subdivision regulations to secure a safe water supply. First, all uses requiring a water

supply could be made conditional to determine more details about the contamination at the proposed site and the appropriate remedial measures. Second, monitoring wells could be required between the suspected contamination source and existing or proposed drinking-water wells. Water-quality monitoring could then be instituted on a systematic basis to make sure that contamination was not endangering the wells.

Long-term performance bonding could be required to ensure funds for the monitoring program. Third, if the first two approaches are impractical or the water is known to be contaminated, land uses requiring an on-site drinking-water supply could be prohibited. Finally, requiring connection to a safe, public drinking-water supply could be required; this might be the preferable, long-term alternative.

SUMMARY AND CONCLUSIONS

Local zoning and subdivision controls can regulate land use to minimize groundwater contamination. Different substances, activities, and land uses vary in their potential to contaminate groundwater. These potential sources of contamination can be identified and regulated. Land areas likewise vary in terms of their susceptibility to contamination. Maps can be prepared by classifying the vulnerability of various areas on the basis of an evaluation of the attenuation capacity of the soils and subsurface materials and the direction and rate of groundwater flow.

Zoning and subdivision controls are the primary responsibility of local government; most local governments already regulate land use with these tools. Adding groundwater-protection provisions to land-use controls takes advantage of an existing framework for administration, inspection, and enforcement. The primary disadvantage of land-use controls is that they usually apply only to new uses and not to existing land uses, which typically are allowed to continue as nonconforming uses. Thus, land-use controls have a greater potential impact in relatively undeveloped areas.

Although the specific provisions of zoning ordinances and subdivision regulations will vary with local circumstances, a basic regulatory approach might include

- prohibiting certain uses that have a potential to seriously contaminate groundwater;
- making other uses conditional and requiring detailed information about the proposed use, plan of operations, and physical characteristics of the site;
- setting conditions that these uses must meet in the form of design standards, performance standards, and operational controls;
- limiting density by specifying minimum lot size, percentage of lot coverage, and minimum separating distances; and
- using overlay districts to designate special management areas such as wellhead-protection areas, sensitive areas, and areas of suspected contamination.

There are several other basic regulatory methods available to protect groundwater quality. Groundwater-quality standards that specify the maximum concentration of contaminants allowed in groundwater are a state, not a local, responsibility. Source-oriented controls are another method. They focus on controlling potential sources of contamination through permit and licensing programs, facility design requirements, and required management practices. In Wisconsin, source-oriented controls are set primarily at the state level. For some source controls there are specific provisions that allow local government to share in the *administration* of the state regulation about private wells, land spreading of septage, and to a more limited extent, underground storage tanks. It may be possible in other instances for local government to adopt local regulations that *supplement* state controls for pesticides, underground storage tanks, and hazardous substances. The state and local roles are discussed in more detail in *A Guide* and a legal analysis of the respective state and local powers can be found in *Groundwater Quality Protection*.

Local administration of state regulations or adoption of local regulations to supplement state-level source controls requires close coordination between the state and local regulatory agencies. Coordination between local units may be similarly essential. For example, the recharge area of a well may extend beyond the municipality's regulatory jurisdiction, making cooperation with the county necessary for proper protection.

In conclusion, it is important to note that although this publication focuses on land-use regulations, non-regulatory measures may be of equal importance. Education and information, waste reduction and recycling methods, voluntary best management practices, and local governments' management powers are discussed in *A Guide*. Reviewing that publication would be helpful before embarking on a program of land-use controls to protect groundwater quality.

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APPENDIX 1
Wellhead-protection ordinance

This appendix includes possible language for a groundwater-protection overlay district developed by the Portage County Planning Department (1987) for incorporation into the Portage County Zoning Ordinance. It illustrates one local government's approach to wellhead protection. It is not intended to be a model elsewhere without careful consideration of local conditions.

Groundwater protection overlay district
6.7.1. Purpose

The County Board of Portage County recognizes that the people of Portage County depend exclusively on groundwater for a safe drinking water supply and that certain land uses in the Portage County environmental setting can seriously degrade water quality. Therefore, the designated best use of the unconfined groundwater of Portage County is for public and private water supply and it is the policy of the County to maintain its groundwater resources as near to the natural condition of purity as reasonably possible for the safeguarding of the public health, safety, and welfare.

The purpose of the Groundwater Protection Overlay District is to protect key groundwater recharge areas by imposing appropriate land-use restrictions in these areas. Wisconsin Act 410, 1983, specifically includes groundwater protection among the purposes for which local zoning power may be exercised. The restrictions included herein are in addition to those of the underlying zoning districts or any other provisions of the zoning or other County ordinance.

6.7.2. Designation of municipal or private well field groundwater protection zones

The boundaries for the groundwater recharge protection zones for the Groundwater Protection Overlay District are as shown on the map "Groundwater Protection Districts for Portage County Well Fields" dated _____. [See fig. A1 for examples of proposed wellhead-protection zones for Whiting well field.]

Said map is hereby adopted by reference becoming a part of this ordinance as if the map were fully described herein. The groundwater recharge basins for the designated well fields are divided into three zones reflecting the potential for land-use activities to adversely impact the well fields and the subsequent scope of land-use restrictions needed.

6.7.3. Zone A — Groundwater protection overlay district

(A) Intent. Zone A is the immediate area around the well field, commonly known as the cone of depression, in which groundwater elevations are lowered by pumping. This area is subject to the highest contaminant threat, and therefore, the land use restrictions are the most severe of the recharge zones.

(B) Uses. The following uses are permitted:
- (1) Parks/playgrounds.
- (2) Archery ranges.
- (3) Boat landings.
- (4) Other natural uses —
  - wildlife areas
  - wild crops
  - non-motor trails (bike, skiing, nature, fitness)
  - hunting/fishing/trapping.

(C) Special Exception Uses. The following uses are permitted upon proper application as provided in this ordi-

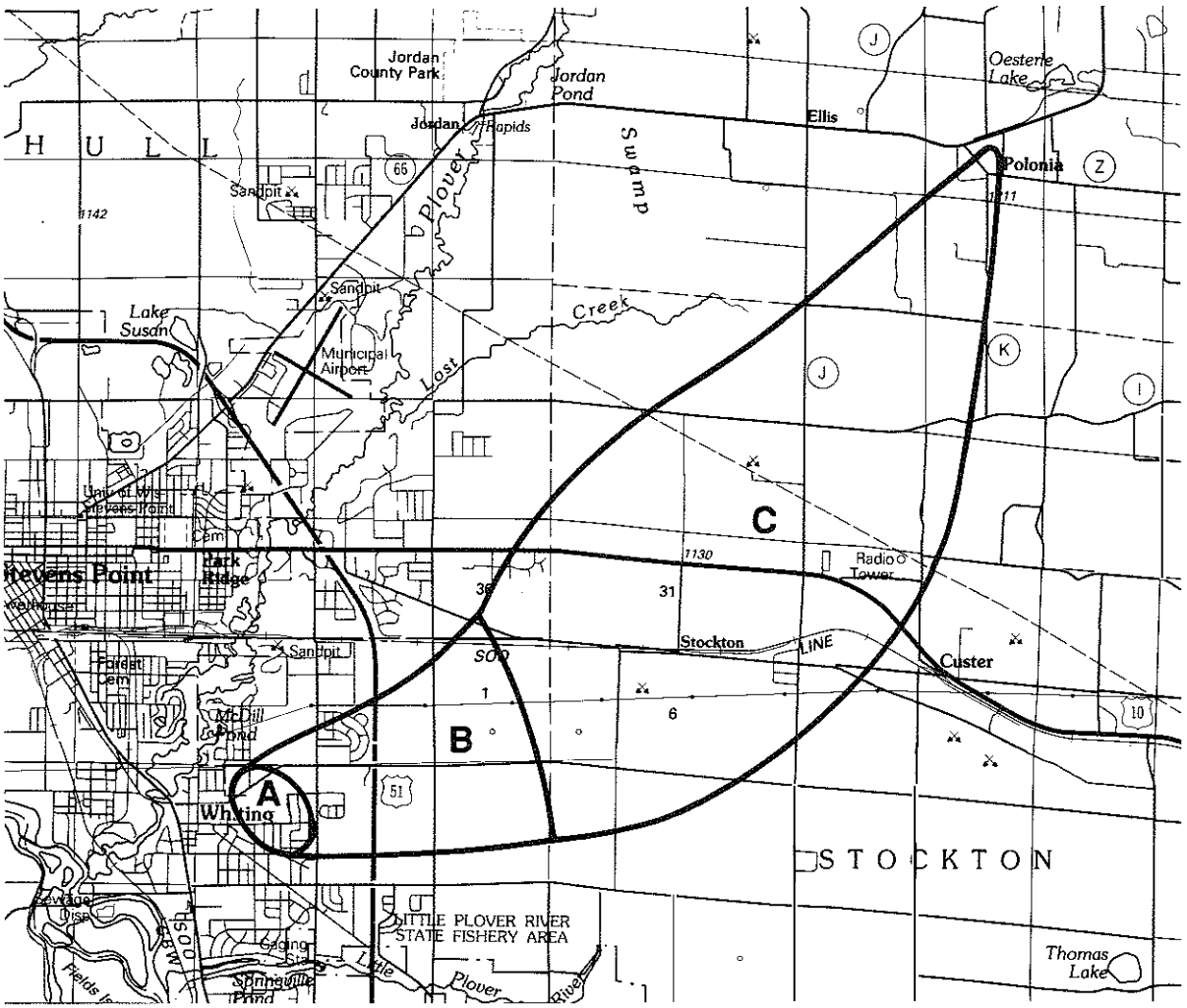


Figure A1. Proposed Portage County wellhead-protection zones for Whiting well field.
Zone A is the cone of depression; zone B is the five-year travel time; zone C is the remaining recharge area.

nance, particularly items (a) and (b) of Subparagraph 6.6.2(A)(3), only after such use shall have been approved in writing by the Board of Adjustment, after public hearing. Such approval shall be consistent with the general purpose and intent of this ordinance and shall be based upon evidence as may be presented at such public hearing, tending to show the desirability of specific uses from the standpoint of the public interest because of such factors as (without limitation because of enumeration) groundwater pollution, smoke, dust, noxious or toxic gases and odors, noise, glare, vibration, operation of heavy machinery, heavy vehicular traffic, increased traffic on the streets and other safety and health factors; such uses shall meet the specific conditions attached below and such other conditions as the Board of Adjustment deems necessary in furthering the purpose of this ordinance.

(1) Residential.
(2) Forestry plantations.
(3) Fishery production facility.
(4) Campgrounds.

(D) Prohibited Uses. The following uses are expressly prohibited in this zone:
(1) All uses not permitted or special exception in this section.

(E) Performance Standards. The following standards apply to all uses in Zone A of the Groundwater Protection Overlay District.
(1) On-site sanitary system with any type of discharge—Prohibited. Municipal sewer required.
(2) Underground tanks—Prohibited.
(3) Natural vegetation not treated with fertilizers and pesticides—A minimum of 85% of lot must be retained in natural vegetation.
(4) Lot size—2 acres per residential unit with municipal sewer. Multiple family units and cluster developments may increase density by 50% if restrictive covenant maintains natural vegetation requirement.
(5) Pesticide/fertilizer storage and use (including septage and sludge landspreading)—Prohibited except for normal home use and by special case-by-case review.
(6) Animal waste facility or landspreading—Prohibited.
(7) Stormwater and drain discharge—Direct subsurface drainage prohibited. Discharge of hazardous materials prohibited. All surface runoff and drain construction must provide a means for collection or containment in the event of a hazardous materials spill.
(8) Salt storage—Prohibited.
(9) Hazardous/toxic materials storage and use—Prohibited except for normal home use.
(10) Hazardous/toxic wastes—On-site treatment, transfer, or disposal prohibited.

6.7.4. Zone B — Groundwater protection overlay district

(A) Intent. Zone B is the recharge area upgradient of Zone A to the point where it is estimated that groundwater and contaminants will take 5 years to reach the pumping well(s). This is an intermediate zone and land use measures are slightly less restrictive than Zone A because of the longer flow times and greater contaminant dilution and attenuation potential.

(B) Uses. The following uses are permitted:
(1) Residential.
(2) Parks/playgrounds.
(3) Shooting ranges.
(4) Boat landings.
(5) Campgrounds.
(6) Natural uses —
wildlife areas
wild crops
non-motor trails (bike, skiing, nature, fitness)
hunting/fishing/trapping.

(C) Special Exception Uses. The following uses are permitted upon proper application as provided in this ordinance, particularly items (a) and (b) of Subparagraph 6.6.2(A)(3), only after such use shall have been approved in writing by the Board of Adjustment, after public hearing. Such approval shall be consistent with the general purpose and intent of this ordinance and shall be based upon evidence as may be presented at such public hearing, tending to show the desirability of specific uses from the standpoint of the public interest because of such factors as (without limitation because of enumeration) groundwater pollution,

smoke, dust, noxious or toxic gases and odors, noise, glare, vibration, operation of heavy machinery, heavy vehicular traffic, increased traffic on the streets and other safety and health factors; such uses shall be required to conform with the plan approved by the Board of Adjustment and shall meet the specific conditions attached below and such other conditions as the Board of Adjustment deems necessary in furthering the purpose of this ordinance.

(1) All uses not permitted or prohibited in this section.

(D) Prohibited Uses. The following uses are expressly prohibited in this zone:

(1) Landfills.
(2) Feedlots.
(3) Wastewater treatment facilities.
(4) Junkyards.
(5) Gas stations/garages.
(6) Toxic/hazardous waste facilities.
(7) Radioactive waste facilities.
(8) Bulk fertilizer/pesticide facilities.
(9) Asphalt products manufacturing.
(10) Chemical manufacture/storage/sale.
(11) Dry cleaning facilities.
(12) Electroplating facilities.
(13) Exterminating shops.
(14) Paint/coating manufacturing.
(15) Printing/publishing facilities.
(16) All uses requiring use or storage of hazardous or toxic materials.

(E) Performance Standards. The following standards apply to all uses in Zone B of the Groundwater Protection Overlay District.

(1) On-site sanitary system with any type of discharge—For residential use: One system per 5 acres; for other uses: 75 gal per acre per day.
(2) Underground tanks—Tanks less than 500 gal are prohibited; other tank installations require monitoring wells, overflow prevention, corrosion-resistant construction, monthly reports and inspections, and spill/leak contingency plan.
(3) Natural vegetation not treated with fertilizers and pesticides—A minimum of 80% of lots with on-site sewage disposal must be retained in natural vegetation. A minimum of 60% of lots with municipal sewer must be retained in natural vegetation.
(4) Lot size for residential uses—1 acre per unit with municipal sewer, or 5 acres with on-site sewage disposal. Multiple family and cluster developments may increase density by 50% if restrictive covenant maintains natural vegetation requirement in sewered areas or increases area of natural vegetation by 10% over minimum requirement in unsewered areas.
(5) Lot size for other uses—1 acre minimum subject to (1) above.
(6) Pesticide/fertilizer storage and use (including septage and sludge landspreading)—Prohibited except for normal home use or where an agricultural best-management practices plan approved by the county Land Conservation Department guides usage.
(7) Animal waste facility or landspreading—Waste facilities must be permitted under the Portage County Animal Waste Management Ordinance. A best-management practices plan must be approved by the County Land Conservation Department for landspreading.
(8) Stormwater and drain discharge—Direct subsurface drainage prohibited. Discharge of hazardous materials prohibited. All surface runoff and drain construction must provide a means for collection or containment in the event of a hazardous materials spill.
(9) Salt storage—Prohibited.
(10) Hazardous/toxic materials storage and use—Prohibited except for normal home use (also see 6 above).
(11) Hazardous/toxic wastes—On-site treatment, transfer, or disposal prohibited.

6.7.5. Zone C — Groundwater protection overlay district

(A) Intent. Zone C is the remainder of the recharge basin upgradient of Zone B, and includes surface water basins that may contribute to well recharge. Management measures are the least restrictive of the recharge zones.

(B) Uses. The following uses are permitted uses:
(1) All uses not prohibited or special exception in this section.

(C) Special Exception Uses. The following uses are permitted upon proper application as provided in this ordinance, particularly items (a) and (b) of Subparagraph 6.6.2(A)(3), only after such use shall have been approved in writing by the Board of Adjustment, after public hearing. Such approval shall be consistent with the general purpose and intent of this ordinance and shall be based upon evidence as may be presented at such public hearing, tending to show the desirability of specific uses from the standpoint of the public interest because of such factors as (without limitation because of enumeration) groundwater pollution, smoke, dust, noxious or toxic gases and odors, noise, glare, vibration, operation of heavy machinery, heavy vehicular traffic, increased traffic on the streets and other safety and health factors; such uses shall be required to conform with the plan approved by the Board of Adjustment and shall meet the specific conditions attached below and such other conditions as the Board of Adjustment deems necessary in furthering the purpose of this ordinance.

(1) Landfills.
(2) Feedlots.
(3) Wastewater treatment facilities.
(4) Junkyards.
(5) Gas stations/garages.
(6) Bulk fertilizer/pesticide facilities.
(7) Asphalt products manufacture.
(8) Chemical manufacture/storage/sale.
(9) Dry cleaning facilities.
(10) Electroplating facilities.
(11) Exterminating shops.
(12) Paint/coatings manufacturing.
(13) Printing/publishing facilities.
(14) Septage/sludge landspreading.
(15) Animal waste facilities.
(16) Spray wastewater facilities.

(D) Prohibited Uses. The following uses are prohibited in this zone:
(1) Toxic waste facilities.
(2) Radioactive waste facilities.

(E) Performance Standards. The following standards apply to all uses in Zone C of the Groundwater Protection Overlay District.
(1) On-site sanitary system with any type of discharge—For residential use: one system per 2 acres; for other uses: 200 gal per acre per day.
(2) Underground tanks—Tank installations require overflow prevention, corrosion resistant construction, monthly reports and inspections, and spill/leak contingency plan.
(3) Natural vegetation not treated with fertilizers and pesticides-
A minimum of 65% of all lots must be retained in natural vegetation.
(4) Lot size for residential—2 acres per unit with on-site sewage disposal. Multiple family and cluster developments may increase density by 50% if restrictive covenant increases area of natural vegetation by 10% over minimum requirement.
(5) Lot size for other uses—1 acre minimum subject to (1) above.
(6) Pesticide/fertilizer storage and use (including septage and sludge landspreading)-Bulk storage facilities must include groundwater monitoring and reporting as determined by the County Community Human Services Department. Agricultural best-management practices strongly encouraged.
(7) Animal waste facility or landspreading—Waste facilities must be permitted under the Portage County Animal Waste Management Ordinance. Agricultural best management practices for landspreading strongly encouraged.
(8) Stormwater and drain discharge—Direct subsurface drainage prohibited except for special case-by-case review and approval with groundwater monitoring. Discharge of hazardous materials prohibited.
(9) Salt storage—Groundwater monitoring required as determined by the County Community Human Services Department.
(10) Hazardous/toxic materials storage and use—Site plan review required, including description of all materials, operational practices to prevent groundwater contamination, contingency plan for accidental

discharges, and a proposed disposal plan for anticipated wastes. Best-management practices encouraged.

(11) Hazardous/toxic wastes--On-site treatment, transfer, or disposal prohibited.

Addition to Section 6.6.3(B) Boundaries of Districts:

The boundaries of the Groundwater Protection Overlay District shall be as shown on the map "Groundwater Protection Districts for Portage County Well Fields," dated _____. Boundary determinations for specific properties shall be made by the Zoning Administrator by scaling distances from this map. Appeals to this determination shall be made to the Board of Adjustment as provided in Section 6.6.5(C), and shall be supported with appropriate technical documentation as determined by the Board of Adjustment. Such documentation shall generally be a hydrogeologic study by a qualified professional that indicates the property in question is out of the designated groundwater recharge area or should be classified in a different recharge area zone.

Additions to Section 6.6.10 Definitions:

Aquifer—A saturated permeable geologic formation that contains and will yield significant quantities of water.

Recharge area—The total area relative to a point of groundwater use in which water falling on or discharging to the ground may move via ground or surface waters to that point of use.

Cone of depression—A roughly conical concavity (or dimple) in the water table (unconfined aquifer) around a pumping well.

Hazardous/toxic substance—Any substance which is ignitable, corrosive, acute hazardous, reactive, EPA toxic, or toxic as defined in the State Code NR 181.

APPENDIX 2
Summary of state regulatory controls of contamination sources

Activity	Regulator	Code	Focus of regulations
Waste disposal			
Municipal and industrial landfills	DNR	NR 180* NR 185*	Licensing of all sites; standards for location, design, operation, construction, monitoring, and abandonment.
Environmental response and repair	DNR	NR550	DNR maintains an inventory of sites that might pollute and hazard ranking list of the sites; sets procedures for emergency response and repair.
Municipal and industrial wastewater	DNR	NR 110 NR 206* NR214	DNR regulates through WPDES permit process. NR 110 governs municipal sewage lagoons; NR 206 land disposal of municipal wastewater; and NR 214 land disposal of industrial wastewater.
Sanitary sewers	DILHR DNR	ILHR 82 NR 110	DILHR regulates laterals. DNR regulates interceptors and collectors.
Private wastewater systems	DILHR	ILHR 83 ILHR 85	DILHR regulates siting, design, installation, and inspection of systems and licensing of installers and evaluators. State inspection system (vs. local) is required for large-scale systems.
	DNR	NR 113*	DNR can prohibit tanks in areas where they cause a water quality problem.
Municipal sludge disposal	DNR	NR 110 NR 204	NR 110 requires approval of land for sludge disposal; NR 204 regulates land spreading of sludge.
Septage and holding tank waste disposal	DNR	NR 113* NR 206*	DNR licenses persons for holding-tank maintenance and waste disposal and regulates land spreading of domestic wastewater.
Agriculture			
Animal waste management	DATCP	AG 165	Sets requirements for county animal-waste management plan, including ordinances establishing minimum standards for earthen manure-storage facilities; provides cost-sharing for farmers involved in animal-waste management program.
	DNR	NR 112 NR 243 NR 120	DNR regulations for livestock feeding operations include well location distances, runoff structures, use of WPDES permits, design standards, and storage requirements. NR 120 provides cost-sharing through the Nonpoint Source Pollution Abatement Program.
Fertilizer bulk storage	DATCP	Ag 162	Contains standards for storage containers and appurtenances, loading areas, secondary

*Currently being updated or revised

Summary of state regulatory controls of contamination sources (continued)

Activity	Regulator	Code	Focus of regulations
			containment, and abandoned containers; the emphasis is on liquid fertilizer.
Pesticide storage, transportation, and use	DATCP	Ag 29	Rules require good handling practices and prohibit entry of pesticides into the groundwater above an enforcement standard; also has aldicarb restrictions and groundwater sampling requirements.
	DATCP	Ag 163	Standards and requirements parallel those of fertilizer bulk storage.
	DNR	NR 80	DNR can prohibit use of pesticide; Pesticide Review Board review is required.
Regulation of agricultural chemicals	DATCP	Ag 161	Establishes standards for groundwater test reporting and the regulatory and enforcement actions to prevent and control groundwater pollution from agricultural activities.
Hazardous materials and waste			
Hazardous waste	DNR	NR 181*	Establishes criteria for identifying the characteristics of hazardous waste and management regulations for their treatment, storage, and disposal.
Engine waste oil	DNR	NR 183	Requirements for location, design, and operation of facilities.
PCBs	DNR	NR 157	Establishes procedures for collection, storage, transport, and disposal of PCBs and products containing PCBs.
Chemical storage tanks	DILHR	ILHR 10*	Leak detection program, plan review, tank inspection and approval, design and construction standards, and record-keeping.
Spills	DNR	NR 158	Contingency plan required for emergency response to hazardous substances, DNR has authority to request remedial action.
Abandoned containers	DNR	NR 551	Establishes criteria and procedures for developing contingency plans to respond to abandoned containers of hazardous substances.
Other activities			
Well construction and abandonment	DNR	NR 112 NR 111	DNR licenses well drillers and pump installers, specifies well design and construction, sets minimum separating distances between wells and potential pollution sources, and requires proper abandonment of all wells.

*Currently being updated or revised

Summary of state regulatory controls of contamination sources (continued)

Activity	Regulator	Code	Focus of regulations
	DNR	NR 145	DNR can authorize counties to administer NR 112 at one of four delegation levels.
Well compensation	DNR	NR 123	DNR provides partial reimbursement for replacing contaminated wells.
Drinking water standards	DNR	NR 109	DNR sets drinking water standards and public water supply monitoring requirements.
Groundwater standards	DNR	NR 140	Sets up a two-tiered system of numerical standards for contaminating substances enforced by DNR, and establishes groundwater quality standards for harmful substances.
Highway salt storage	DOT	TRANS 277	Provides for DOT response when the prevention action limit for chloride has been exceeded at a storage facility and sets requirements for remedial action.

APPENDIX 3

Wisconsin Geological and Natural History Survey resource inventory information (as of August 1, 1990)

	Maps										Reports
	Soils (scale 1:100,000)	Geology (scale 1:100,000)			Groundwater (various scales)				Water quality (various scales)		IC Information Circular MP Misc. Paper SR Special Report WSP Water-Supply Paper
County	Attenuation potential	Surface	Bedrock	Depth to bedrock	Potential aquifer yield	Depth to water	Water table	Piezom. surface	NO_3-N	Other	
Adams	■	■			■		■				MP 81-1; IC59
Ashland											
Barron	■	■		■	■	■	■		■	■	MP 86-1; IC 55
Bayfield											
Brown		■			■			■			IC 48; IC 57
Buffalo	+										
Burnett	+										
Calumet											
Chippewa	■			■	■		■		■	■	MP 87-2
Clark				❐			■		■	■	+
Columbia							■				IC37
Crawford											
Dane		■	❐					■			WSP 1779-U
Dodge							■				IC44
Door											WSP 2047
Douglas											
Dunn	■			■	■		■		■	■	MP 87-1
Eau Claire	■		❐	+			❐		+	+	+
Florence		■									IC51
Fond du Lac			❐					■			WSP 1604
Forest		■					❐				IC 61
Grant			❐								
Green											
Green Lake											
Iowa			+								
Iron											
Jackson					■		■				MP 81-1
Jefferson							■		❐		IC33
Juneau		■	■		■		■				MP 81-1; IC66
Kenosha*	+	❐	+	+			■	+	+	+	WSP 1878
Kewaunee											
La Crosse		❐	❐								
Lafayette			+								
Langlade	■	■					■				IC58
Lincoln											
Manitowoc											
Marathon	❐	■	■		■		■				MP 81-1; IC 45; IC 65
Marinette											
Marquette					■		■				MP 81-1
Menominee											

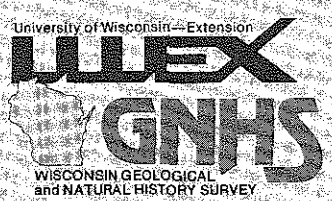
■ published
❐ in progress
\+ planned

* work coordinated with Southeastern Wisconsin Regional Planning Commission

	Maps										Reports
	Soils (scale 1:100,000)	Geology (scale 1:100,000)			Groundwater (various scales)				Water quality (various scales)		IC Information Circular MP Misc. Paper SR Special Report WSP Water-Supply Paper
	Attenuation potential	Surface	Bedrock	Depth to bedrock	Potential aquifer yield	Depth to water	Water table	Piezom. surface	NO_3-N	Other	
County											
Milwaukee*	+			+			■	+	+	+	WSP 1229
Monroe					■		■				MP 81-1
Oconto											
Oneida											
Outagamie								■			WSP 1421
Ozaukee*	+	❐	+	+			■	+	+	+	IC38
Pepin	■		+	+			+		+	+	+
Pierce	■		❐	❐			■		■	■	❐
Polk	■	❐		+			❐		❐	❐	+
Portage	■	■	■		■		■				WSP 1796; IC 56; MP 81-1
Price											
Racine*	+	❐	+	+			■	+	+	+	WSP 1878
Richland											
Rock	■			■		■		■			WSP 1619-X; SR 8; IC41
Rusk											
St. Croix	■		❐	❐			■		■	■	IC 32, ❐
Sauk		■	■								
Sawyer	+										
Shawano											
Sheboygan											
Taylor		❐									
Trempealeau	+										
Vernon											
Vilas		■					❐				IC 50; MP 89-1
Walworth*	+	+	+	+			■	+	+	+	IC34
Washburn											
Washington*	+	❐	+	+			■	+	+	+	IC38
Waukesha*	+	❐	+	+			■	+	+		IC29
Waupaca					■		■				WSP 1669-U; MP 81-1
Waushara					■		■				WSP 1809-B; MP 81-1
Winnebago								■			WSP 1814
Wood	■	■	■		■		■				MP81-1;IC 60

■ published
❐ in progress
\+ planned

* work coordinated with Southeastern Wisconsin Regional Planning Commission



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