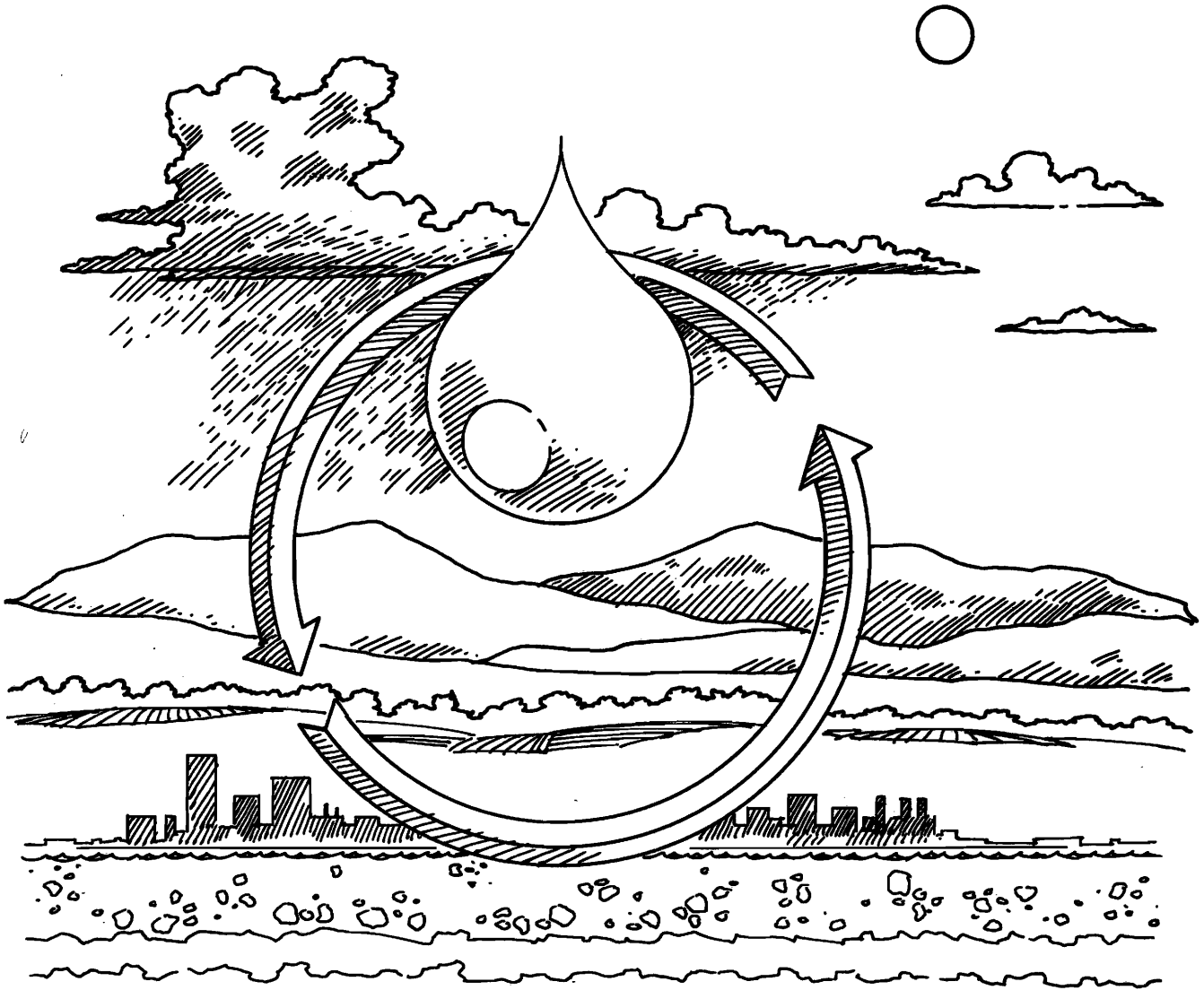
PROTECTING VIRGINIA'S GROUNDWATER:

A Handbook for Local Government Officials



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GLOSSARY

AQUIFER: an underground rock zone or soil layer that contains usable amounts of groundwater

BIODEGRADATION: breakdown or decomposition of substances by the action of microorganisms

DOWNZONING: decreasing density of development allowed on a certain parcel of land; for example, changing the required lot size for a single family home from one unit per acre to one unit per five acres

GROUNDWATER: water under the surface of the earth

HAZARDOUS WASTE SITE: a place where disease-causing agents, poisonous substances, flammable liquids and solids, oxidizing materials, corrosive liquids, and compressed gasses have been dumped, spilled, leaked, or buried

HYDROGEOLOGIC ZONING: determining acceptable land uses or conditions placed on land uses in an area on the basis of impact on groundwater quality or quantity

INFILTRATION: seepage of water through rock cracks and fissures and through soil pores

INORGANIC CHEMICALS: compounds that generally do not contain carbon; usually derived from mineral sources

LEACHATE: liquid that has dripped through dumps or landfills, carrying with it dissolved substances from the waste materials

NONPOINT SOURCE POLLUTION: contaminants contributed by an area, rather than flowing through a discharge pipe. Nonpoint pollution sources include nutrients from animal wastes and fertilizers, sediment, pesticides, airborne materials, and urban runoff.

ORGANIC CHEMICALS: chemical compounds of carbon

OXIDATION: oxygen combining with other elements

OXIDATION-REDUCTION REACTIONS: very common reactions which occur in living and non-living systems. In oxidation, oxygen is added, hydrogen is removed, or electrons (negative particles) are removed. In reduction, oxygen is removed, hydrogen added, or electrons are added. So oxidation and reduction occur together in one reaction. One substance, the oxidizing agent, gains electrons (is reduced) and another, the reducing agent, loses electrons (is oxidized). This is necessary to balance the charges of the reactants. A simple oxidation-reduction reaction that most of us are familiar with is *rusting.* In this reaction iron (Fe_2 as ferrous iron oxide) combines with oxygen (O_2)to form rust (Fe_3 as ferric iron oxide).

PERMEABLE: refers to materials (such as rocks) through which water can move

PERFORMANCE STANDARDS: regulations that specify the environmental goal to be achieved but allow the regulated community to choose the means of reaching that goal

PIECEMEAL ZONING: variances to a comprehensive zoning ordinance enacted by a local governing body to meet changed circumstances. Upzoning and downzoning are types of piecemeal zoning.

RECHARGE: water coming into the groundwater system, such as rain soaking into the ground

SALTWATER INTRUSION: when salty water mixes with fresh groundwater near the seacoast, usually because too much of the fresh water has been pumped out

SATURATED ZONE: the area below the water table where open spaces are filled with water

SINKHOLE: a depression common in limestone areas, where limestone dissolves and the overlying ground collapses

SPRING: groundwater seeping out of the earth where the water table intersects the ground surface

SUBSIDENCE: land collapse due to overwithdrawal of groundwater or to groundwater dissolving out limestone layers which had previously supported the overlying soil

SYNTHETIC ORGANIC CHEMICALS (SOCs): man-made chemical compounds containing carbon and made from either inorganic substances or from organic compounds

TECHNOLOGY-BASED STANDARDS: regulations that detail both the environmental goal (i.e. zero discharge of pollutants) and the means of attaining the goal

UNSATURATED ZONE: the area between the ground surface and water table. Also called "zone of aeration"

UPZONING: increasing density of development or intensity of use on a piece of land such as allowing construction of apartments on land previously zoned for single family residences

WATER TABLE: the top surface of the saturated zone

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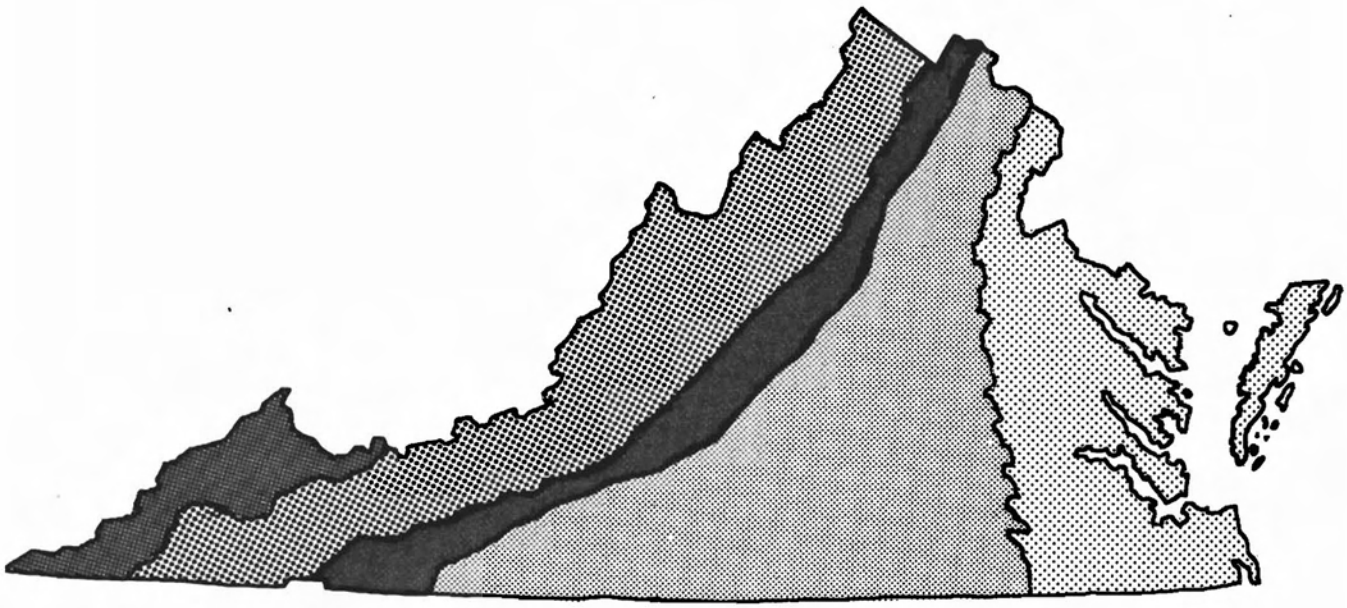
Rec: Low density housing

Supports current pattern

→ Most Devel on central wtr + sewer

Add: BMP's



Virginia's five groundwater regions from west to east are Cumberland Plateau, Valley and Ridge, Blue Ridge, Piedmont and Coastal Plain.

In Virginia, groundwater represents an enormous and relatively untapped reserve of generally good quality water. Both the quantity and quality of this groundwater need protection if this reserve is to remain available for meeting future needs.

INTRODUCTION

Throughout the United States localities are using groundwater to supplement or replace surface water supplies. In Virginia, groundwater represents an enormous and relatively untapped reserve of generally good quality water. This reserve is vitally important if certain sections of the Commonwealth are to continue their economic expansion. In 1980, Virginians withdrew 370 million gallons of groundwater each day for rural (39 percent), public supply (30 percent), industrial (29 percent), irrigation (2 percent), and thermo-electric (1 percent) purposes.[1] Those figures are expected to increase in the future as high construction costs, loss of federal funding, lack of available streamflow and good reservoir sites, and continuing expansion of demand render development of additional surface water supplies impossible or exorbitantly expensive. In particular, rural localities with limited tax bases may find that groundwater is their only choice for meeting domestic, commercial, and industrial needs. Increased reliance on groundwater, however, cannot and will not occur unless the quantity and quality both remain acceptable. Both the quantity and quality of Virginia's groundwater need protection if this reserve is to remain available for meeting future needs.

I. The Role of Local Government

Because human land use activities cause most groundwater pollution, local governments have a special role to play in protecting this resource. The foundation for this special role rests on the responsibility of localities to protect the public health, safety, and welfare; their delegated authority to manage land use practices; and their featured place in EPA's groundwater management strategy. Although groundwater protection is every citizen's responsibility, it is the role of local government to provide the leadership needed to assure the good quality of this vital and vulnerable resource. In order for local governments to assume this responsibility they must understand the extent of their authority and the tools available for protecting their groundwater supplies.

There are many tools that localities can utilize to meet their resource and socio-economic needs. However, few localities have employed them for groundwater protection. Several factors contribute to the lack of effective protection programs: (1) misunderstanding of the resource's importance and vulnerability; (2) lack of information about potential protection tools and techniques; and (3) an actual or perceived lack of delegated authority from the state to develop and implement groundwater protection programs.

This handbook's goal is to provide local officials with the tools to protect their groundwater resources equitably and effectively. The rest of this section discusses groundwater quantity and quality concerns in Virginia, sources of groundwater contamination, and how contamination occurs. Section two looks at the management tools accessible to local governments for protecting the quantity of groundwater available to current and future residents as well as protecting the quality of groundwater from contamination by agricultural use of pesticides and fertilizers, animal feedlots, irrigation, and manure spreading; septic systems; municipal and industrial landfills; underground storage tanks; municipal sewer systems; improper disposal of household hazardous wastes; road de-icing; and industrial liquid waste impoundments. It also describes how localities throughout the country have utilized these tools. The final section presents guidelines for developing a local groundwater protection program.

II. Groundwater Quantity Concerns

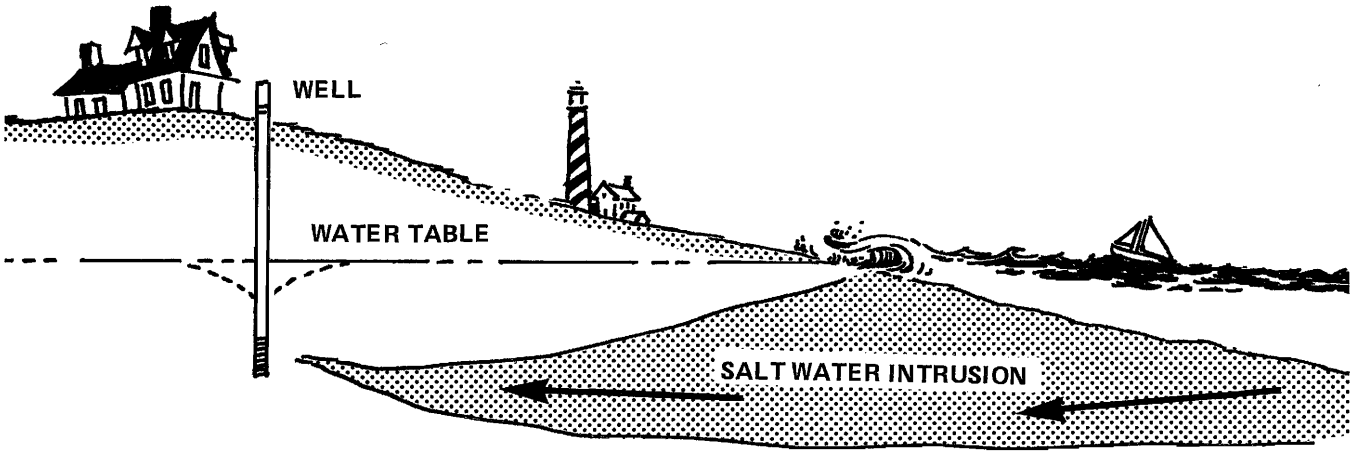
State ordinances exist by which localities may request help in protecting the quantity of their existing and future supplies, but because Virginia's regions are so diverse, localities may have their own distinct groundwater supply problems. Some counties face an inability to locate sufficient reliable sources in scattered areas now being developed,[2] while others deal with a seasonal overabundance which results in structural damage to homes and other buildings.[3] Protection of the quantity of groundwater is vital in those areas of the Commonwealth in which competition between users is an issue, particularly if the competition is between the public's drinking water supply and the needs of water-intensive industries such as paper mills and electric power producers. Because groundwater often is of higher quality (and availability) than surface water, it is frequently industry's choice of water supply.

The amount of water required by industries can be staggering. A DuPont plant in Augusta, for example, averaged daily withdrawals of nearly seven million gallons in 1979; in Isle of Wight, Union Camp withdrew an average, that same year, of over 36 million gallons daily, according to records from the Virginia Water Control Board. More typical are the poultry processing plant in Accomack, whose average withdrawal was nearly 800,000 gallons per day, and the smaller industries which use from a few thousand to a few hundred thousand gallons each day.[4]

Municipalities also may require vast supplies of groundwater. The Town of Chincoteague withdrew over 400,000 gallons of water per day in 1979; Coyner Springs-City of Waynesboro averaged two million gallons per day.[5]

High-yield well fields pumping continuously, as some industries and municipalities require, may lower the water table so much that neighboring, shallower wells may run dry and be damaged as a result. By the mid-

In coastal areas, large withdrawals encourage saltwater intrusion which may ruin the potability of an area's drinking water supply.



1970s, for example, the water table in Franklin had dropped approximately 160 feet (with similar but less extensive drops in Suffolk and Smithfield) as a result of increased industrial and municipal withdrawals. Many shallow wells were damaged when they ran dry.[6]

In coastal areas, such enormous withdrawals encourage possible saltwater intrusion, which may ruin the potability of an area's drinking water supply. Wherever localities have not addressed the issue of the locations of industries and thus the issue of the withdrawal of continuous and vast quantities of groundwater, those localities not designated as groundwater management areas (and thus regulated under withdrawal permits) are powerless to protect their residents' rights to a plentiful groundwater supply.[7]

Of peripheral concern to groundwater quantity issues which must be resolved at a local level are those opposing problems of inadequate and seasonally overabundant supplies. In the Piedmont region of Virginia, groundwater supplies are found in the cracks and fractures of the nonporous rock formations. The location of usable quantities of the resource depends on the extent of the fracturing. Problems with new housing developments have cropped up in Loudoun County recently when wells, even to depths of 500 feet, have been unable to locate sufficient fracture zones to supply these households. The county is considering ordinances requiring developers to locate adequate groundwater sources before building, with the alternative of providing piped-in water from other sources.[8]

In Fairfax County, on the other hand, a seasonally high water table is causing widespread structural damage to homes and other buildings. The county has drafted a groundwater policy emphasizing the identification of groundwater problem areas and their relation to future residential development.[9]

III. Groundwater Quality Concerns

The quality of groundwater is of concern to local officials as well. Examples of almost every type of groundwater contamination have been found in Virginia. In March 1985 IBM, although not acknowledging responsibility, agreed to spend $200,000 to add a carbon filter system to remedy tetrachloroethylene (TCE) contamination of a drinking water system serving 20,000 Prince William County residents. Contamination from a crude oil drilling operation rendered Jonesville's water unpotable in 1984. Berryville had to abandon its public water supply in 1981 because of contamination from nitrates, herbicides, and phenols. A U.S. Environmental Protection Agency (EPA) study showed vanadium, selenium, and arsenic leaking from dumps on Chisman Creek, York County, into local groundwater. Copperas and unreacted titanium ore from an American Cyanamid waste site located in Nelson County caused groundwater contamination and several fish kills. Waste lagoon seepage at a Disston Corporation plant near Danville may have been responsible for groundwater contamination from 1,1,2 trichloroethylene and 1,1,1 trichloroethane in 1977.

There are thirteen sites in Virginia proposed on EPA's Superfund priority list because of groundwater contamination. During 1985, one of four Virginia sites already on the National Priorities List received $1.4 million from EPA. The Matthews Electroplating site in Roanoke County was an automobile bumper plating facility. Groundwater supplies of 30 local families became contaminated with chromium and Superfund money helped build a water line from the City of Salem's water system to the area.[10]

According to the Virginia Water Control Board (VWCB) about 1 percent of groundwater in the state is contaminated, mostly near population centers.[11] Leaking surface impoundments, malfunctioning septic tanks, wood preserving operations, chemical storage and leaking underground storage tanks pose the most severe threats.[12] The number of complaints concerning groundwater contaminated by leaking underground petroleum storage tanks received by the VWCB rose sevenfold between 1979 and 1985. There were about 100 such incidents in 1985. Exxon Corporation paid for an 11,000-foot water line

connecting homes and a beauty shop near Madison whose wells were contaminated by a leaking underground gasoline storage tank. A gas station leak in Pulaski County contaminated several homeowners' wells.[13]

A State Health Department study of shallow wells in central Virginia found bacterial contamination in more than 50 percent of rural household water supplies in 14 counties. Of the systems studied, 70 percent had some water quality problem, most associated with nitrates or bacteria. This study focused on shallow, bored wells and suggested that rural residents who traditionally rely on such wells, run a greater risk of groundwater contamination than non-rural well users. Although 71.6 percent of the Virginians responding to a 1985 Gallup poll sponsored by the Virginia Water Resources Research Center and Region III EPA rated the quality of their drinking water good or excellent, 10.5 percent said they personally knew a Virginian whose well has been contaminated by bacteria and 7 percent said they knew someone with a chemically contaminated well.

IV. Sources and Types of Groundwater Contaminants

Groundwater is a vulnerable resource whose quality is largely determined by how people use land. The U.S. Office of Technology Assessment (OTA) has identified over 200 groundwater contaminants related to land use activities. These contaminants fall into three major categories: (1) bacteria and viruses; (2) nitrates, heavy metals, minerals, and salts; and (3) synthetic organic compounds (SOCs).

Bacteria, viruses, and other microorganisms can enter groundwater from septic systems, manure used as fertilizer, feedlots, and disposal of dead animals in sinkholes. The Centers for Disease Control reported in 1983 that contaminated groundwater accounted for about 60 percent of reported waterborne illnesses in the United States, including giardiasis, dysentery, conjunctivitis, and meningitis.[14]

Nitrates come from human and animal wastes and agricultural and lawn fertilizers. High nitrate concentrations in drinking water can cause a sometimes fatal infant disease, methemoglobinemia (blue baby syndrome), and also can be toxic to some kinds of livestock. Storage and use of road salts can increase chloride levels above acceptable levels. Heavy metals such as cadmium, vanadium, chromium, and lead are toxic and may leach into groundwater from sewer systems, hazardous waste landfills, and hazardous materials use.

A wide variety of common chemical compounds also threatens groundwater. In 1980, there were more than 30,000 chemicals in use and about 1,000 new ones are added each year.[15] Many chemical contaminants had been in use for years[16] before their adverse health effects were discovered. Wood preservatives contain pentachlorophenols salts and heavy metals. Heavy metals and toluene are in paints, varnishes, stains and dyes. Hydrocarbons, benzene and trichloroethylene (TCE) are chemical components of spot removers and dry cleaning fluids.

FIGURE 1
Ounces of TCE Required to Contaminate Groundwater at a Level of 50 PPB

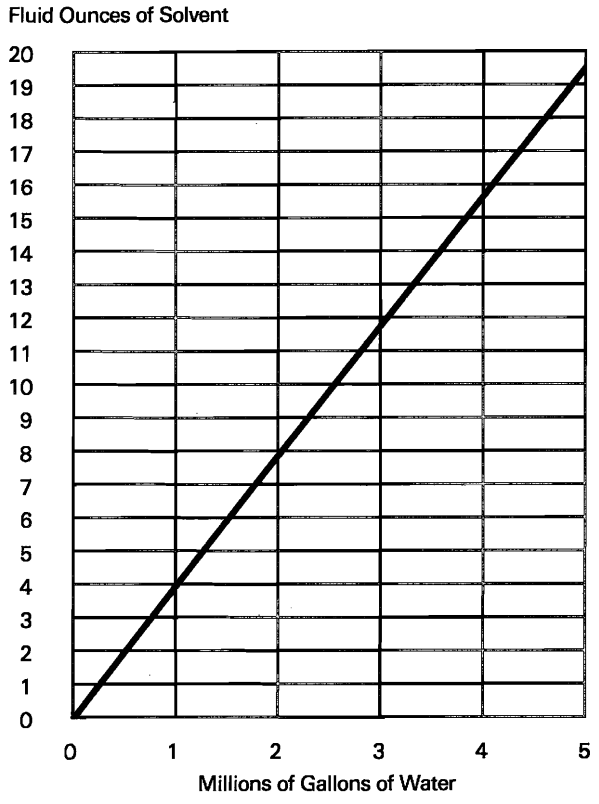
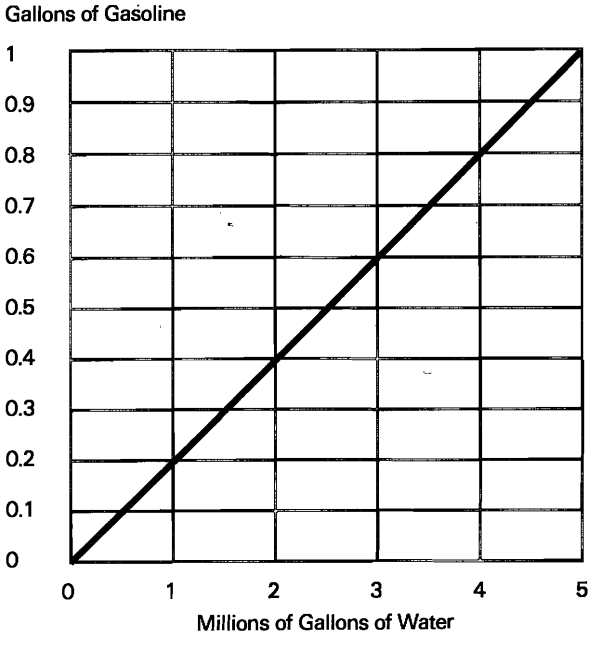


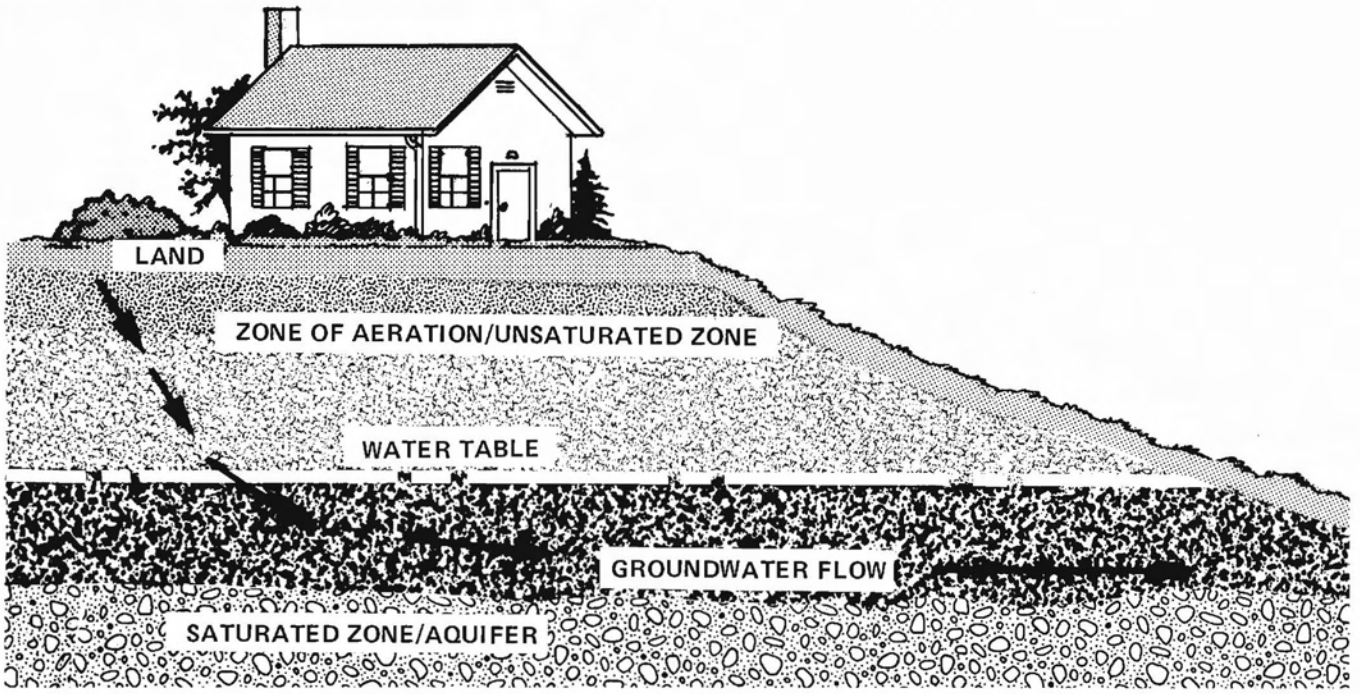
FIGURE 2
Ounces of Benzene from Gasoline to Contaminate at 5 PPB



Source: Lyle S. Raymond, Jr., "Leak and Spill Prevention," (Ithaca, N.Y.: Cooperative Extension, Cornell University), 6-7.

FIGURE 3

How Groundwater Moves Through the Soil



Aldicarb (whose misuse was related to several West Coast illnesses in 1985), ethylene dibromide (EDB), and dibromochloropropane (DBCP) are some of the pesticides that investigators have found in groundwater.[17] All these chemical compounds can be highly toxic, even at low concentrations, and potential health effects include dizziness, nausea, fatigue, liver and kidney damage, recurring infections, skin rashes, spontaneous abortions, and cancer. Thirteen of the 33 synthetic organic chemicals frequently found in groundwater are either known or suspected leukemogens or carcinogens.[18] Appendix A presents some of the toxic compounds found in commonly used products. Figures 1 and 2 demonstrate the relationship between the presence of contaminants and the amount of groundwater pollution. In Figure 1, four ounces of TCE can contaminate one million gallons of water at a level of 50 parts per billion (PPB). This level of contamination is equivalent to 50 cents in $10,000,000. However, even at such extremely small amounts, many organic and inorganic chemicals can be toxic. Figure 2 shows that it takes only 0.2 gallon of gasoline to contaminate one million gallons of groundwater at a level of five parts per billion (5 cents in $10,000,000).

V. How Groundwater Contamination Occurs

Generally, groundwater flows slowly through an aquifer along relatively straight and parallel paths under the force of gravity and in the same direction as the local topography. The most common pattern is for groundwater to move vertically down to the water table and then horizontally through the saturated zone (*Figure 3*). Often it flows at a rate of only inches per day, or feet per year, although rates can be considerably faster in rocks with solution channels[19] as is typical in the Shenandoah Valley of Virginia.

As groundwater travels through the unsaturated and saturated zones, it picks up any water-soluble materials with which it comes into contact and carries them along with it. This process of picking up and transporting soluble substances is called leaching. Some of the leached materials — such as calcium, iron, sodium, and fluorine — occur naturally. Many of groundwater's travelling companions, however, are the contaminants resulting from human land use activities. Once groundwater contamination occurs, it is virtually permanent because filtering or biodegradation, even if possible, requires years.

Remedying groundwater contamination is difficult. Containment and treatment, the two most frequently used remedial technologies, are both expensive and useful only when the size of the contaminated area is small. For example, the costs of cleaning up underground storage tank leaks range from $20,000 to $12 million per leak. Remedying contamination from an "average" chemical landfill can cost $5 million to $10 million per site.

Some groundwater contamination may be remedied by natural processes, depending on the soil, geology and nature of the contaminants. The extent of contamination filtering or breakdown depends on the soil type, the geology and hydrology of the aquifer, and the nature of the contaminant. Contaminants located on the surface or in the subsurface unsaturated zone may be broken down partially. Some soils, such as clay, can filter and trap suspended solids physically like a sponge (absorption) or

chemically hold them onto the surface by adhesion (adsorption). Oxidation, reduction, and biological decay also may reduce contaminant concentrations. The longer the contaminant remains in the unsaturated zone, the greater the opportunity for breakdown of pollutants.

In some areas, however, contaminants can quickly move into the saturated zone. Prime recharge areas — limestone formations, sandy or permeable soils, and aquifers located close to the surface — tend to permit rapid percolation and consequently little chance for dilution. Additionally, synthetic organic compounds resist biodegradation; plants and microorganisms generally cannot break them down at desirable rates. Even when conditions do allow some breakdown of contaminants in the zone of aeration above the water table, natural cleansing decreases once pollutants reach the saturated zone where fewer organisms can survive to carry out biodegradation. Limited dilution capacity means that high concentrations of pollutants remain in the groundwater flow longer.

The higher the level of contamination, the more expensive are remedial measures. The difficulty of predicting the paths pollutants will travel through the aquifer also raises the cost of remedial action. Extensive sampling often is required to detect the pollutant's location and extent, and pollution testing and monitoring are costly. To get adequate data, it is necessary to drill numerous wells, use expensive instrumentation, and regularly repeat measurements. The costs of any remedial measures then must be added to these expenses.

The point cannot be overstated. Once groundwater becomes polluted, it will remain contaminated. Remedial measures are both expensive and generally unable to return the groundwater to potability. The key to making groundwater reserves work for Virginia is protection of the resource, but protection requires local action.

IV. Footnotes

1. *Facts About Virginia's Groundwater.* (Blacksburg: VWRRC, 1984).
2. Telephone conversation with Rob Montgomery, director, Loudoun County Health Department, July 3, 1986.
3. Draft, Fairfax County. Policy for Groundwater, memo, April 29, 1985.
4. *Groundwater 1979: Annual Report to the Governor and the General Assembly on the Groundwater Act of 1973 and Related Matters,* SWCB, Nov. 1979.
5. *Id.*
6. *Id.*
7. Telephone conversation with P.J. Smith, VWCB, July 17, 1986.
8. Sponenberg.
9. See footnote 2.
10. *Water News,* (Vol. 16, No. 5, May 1985), 6.
11. *Water News,* (Vol. 16, No. 9, Sept. 1985), 2.
12. Office of Ground-Water Protection: *Overview of State Ground-Water Program Summaries* (Washington, D.C.: Environmental Protection Agency, 1985) pp. A-4 to A-10. Hereafter cited as EPA 1.
13. *Water News,* (Vol. 16, No. 5, May 1985), 3.
14. Judy Campbell Bird, 1985. *Groundwater Protection: Emerging Issues and Policy Challenges* (Washington, D.C.: Environmental Energy Study Institute), 7.
15. Suzanne M. Kilner. "Groundwater Plan Sidesteps Contamination Woes." *Water Engineering and Management* (March 1984), 27.
16. *Id.,* 27.
17. Frank DiNovo and Martin Jaffe, 1984. *Local Groundwater Protection* (Chicago: American Planning Association), 4.
18. Bird, 8.
19. Torsten Sponenberg and Jacob Kahn, 1984. *A Groundwater Primer for Virginians* (Blacksburg, VWRRC), 4.

Remedying groundwater contamination is difficult. Containment and treatment, the two most frequently used remedial technologies, are both expensive and useful only when the size of the contaminated area is small.

Dillon's Rule means that local governments have only those powers expressly delegated them by the General Assembly.

LOCAL AUTHORITY TO PROTECT GROUNDWATER IN VIRGINIA

Both regulatory and nonregulatory groundwater protection tools are available. However, not all are automatically within the authority of local government in Virginia. This section reviews the statutory authority that might be useful to localities in protecting groundwater, examines available groundwater protection techniques in terms of that authority, and points out the problems facing Virginia's localities as they attempt to protect this valuable and vulnerable resource.

I. The Scope of Local Authority

Traditionally, the scope of local authority in Virginia has been narrow and the General Assembly has had to meet new local needs by enacting new enabling legislation. Several important powers that could be used to protect groundwater have been expressly delegated to state agencies and thus, theoretically, cannot be exercised by localities. The Virginia Department of Health regulates septic systems, has promulgated regulations covering solid waste disposal, and was given a mandate by the 1986 session of the General Assembly to develop well construction standards. Similarly, it is the VWCB's function to impose such water quality regulations as numerical standards and effluent limitations. Regulation of the generation, storage, and disposal of hazardous wastes has been preempted by state agency implementation of the Resource Conservation and Recovery Act and the Comprehensive Emergency Response, Compensation, and Liability Act.

Currently, localities in Virginia can use their fire protection codes[1] to regulate hazardous materials as long as such regulations do not affect the manner of construction or type of building materials used.[2] The City of Alexandria, for example, amended its fire protection code in 1983 to regulate hazards associated with underground petroleum storage tanks.[3] However, the Virginia Water Control Board is developing a statewide program for managing underground storage of hazardous materials that may ultimately supersede local authority.

The groundwater protection options available to Virginia localities are further narrowed by the state's reliance on Dillon's Rule. Dillon's Rule basically states that local governments have only those powers expressly given to them by the state legislature; if a city's charter does not specifically grant a particular power to that city then, according to Dillon's Rule, the city does not have the authority to invoke that power. Through the years, Dillon's Rule has come to be applied to counties and towns as well. Two mechanisms exist for bypassing the hampering effects of Dillon's Rule. First, counties, cities and towns may request specific enabling legislation from the General Assembly. In 1985. for example, Clarke County requested and received enabling legislation authorizing the county to set its own regulations regarding the grouting and casing of water wells. James City County, by request, received the same enabling legislation in 1986.[4]

Second, counties may now apply for charters under the Governmental Charters chapter of the Virginia Code. The act does not of itself grant localities any charter powers, but rather sets the procedure by which they may apply for the charter.[5] A broader range of powers is available to localities under charter government.

Specific authority does exist for Virginia's local governing bodies to construct sewers[6] and develop and implement water conservation programs.[7] Further, local governing bodies in the state do possess important powers that can be used to protect groundwater. Probably the most helpful are eminent domain and the authority to (1) enact zoning and subdivision ordinances, and (2) "prevent the pollution of water and injury to waterworks."[8] These powers theoretically could be used to implement such regulatory techniques as condemnation and purchase of recharge areas, contaminant classifications, BMP programs, erosion control ordinances, facility design requirements, and hydrogeologic or conditional zoning.

II. Regulatory Tools

Regulatory strategies require the performance of actions designed to protect groundwater and/or prohibit or regulate activities which could contaminate groundwater. They include both ordinances and regulations, and do not depend on voluntary cooperation for their implementation. Ordinances are the general or specific policies enacted by local governing bodies. Regulations are the requirements formulated by administrative agencies to implement local ordinances or state laws. The advantages of regulatory strategies are uniformity and inclusiveness of application. However, they are more costly to implement than voluntary strategies and, unless well-explained, are often considered intrusive by citizens.

Regulatory tools available to Virginia localities include (1) zoning; (2) ordinances governing erosion control, site plan review, and subdivision development; (3) mandated implementation of urban Best Management Practices (BMPs); (4) sensitive area identification and protection; (5) contaminant and source classification; and (6) mandatory sewer connections.

In Virginia, zoning is the strongest power available to local governments for use in protecting groundwater.

A. Zoning

Zoning traditionally has been localities' first line of defense against problems generated by land use activities. In Virginia, it is the strongest power available to local governments for use in protecting groundwater. However, decisions of the Virginia Supreme Court have not resulted in clear, consistently applied guidelines for evaluating zoning ordinances. Thus, localities often are unsure whether a proposed ordinance will withstand judicial challenge, particularly if it limits the property owner's development profits. In particular, a recharge zone protection strategy may require severe restrictions on development opportunities with a corresponding loss in potential profits. This approach may be susceptible to legal challenge. As a result, local governments in Virginia have been somewhat hesitant to use the zoning power as a groundwater protection tool.

The General Nature of the Zoning Power. Since the 1926 U.S. Supreme Court decision in *Euclid* v. *Ambler Realty,*[9] the scope of local zoning authority has generally been broadly construed by the courts. Under *Euclid,* zoning ordinances must not be (1) unreasonable, (2) confiscatory, or (3) arbitrary and capricious. Even as refined in *Nectow* v. *City of Cambridge*[10] two years later, courts are to presume the reasonableness of zoning ordinances. The burden of proof is on the ordinance's challengers to demonstrate that the ordinance is "clearly unreasonable, arbitrary or capricious, and that it bears no reasonable or substantial relation to the public health, safety, morals, or general welfare."[11]

Challengers can overcome this presumption of reasonableness by presenting strong evidence of the ordinance's unreasonableness. Then the burden of proof shifts to the locality which must show that the ordinance reasonably serves the public welfare. The courts will continue to uphold local action, however, as long as the question of validity is "fairly debatable."[12] In general, state courts have upheld zoning ordinances enacted under the locality's police power as long as they (1) served the general welfare; (2) were reasonably related to the objectives sought; and (3) did not discriminate among similarly situated landowners.[13] The ultimate judicial test appears to be whether the ordinance represents

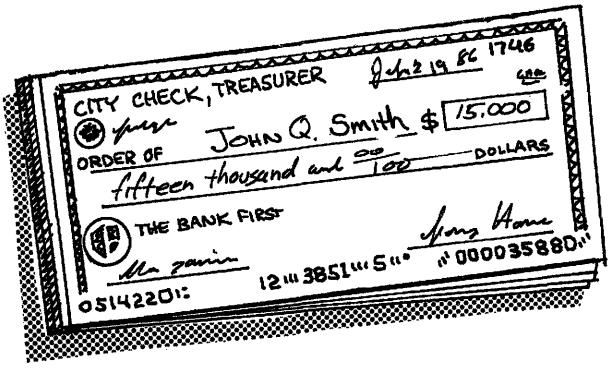
> a fair compromise among the conflicting needs and demands of developers, current residents, potential residents, people of lower income or minority groups, business people, surrounding communities, and the local government.[14]

Good zoning and judicially acceptable zoning both require a local balancing of many interests and factors.

Successful challenges to local zoning ordinances have rested on procedural and substantive grounds. The concern in procedural due process is how the government enacts the ordinance. In Virginia, for example, procedural due process forbids local governing bodies from (1) delegating adoption of a zoning ordinance to the planning commission;[15] (2) failing to submit proposed zoning ordinances to the planning commission for a recommendation; (3) omitting a public hearing; and (4) allowing a more intensive use than advertised.[16]

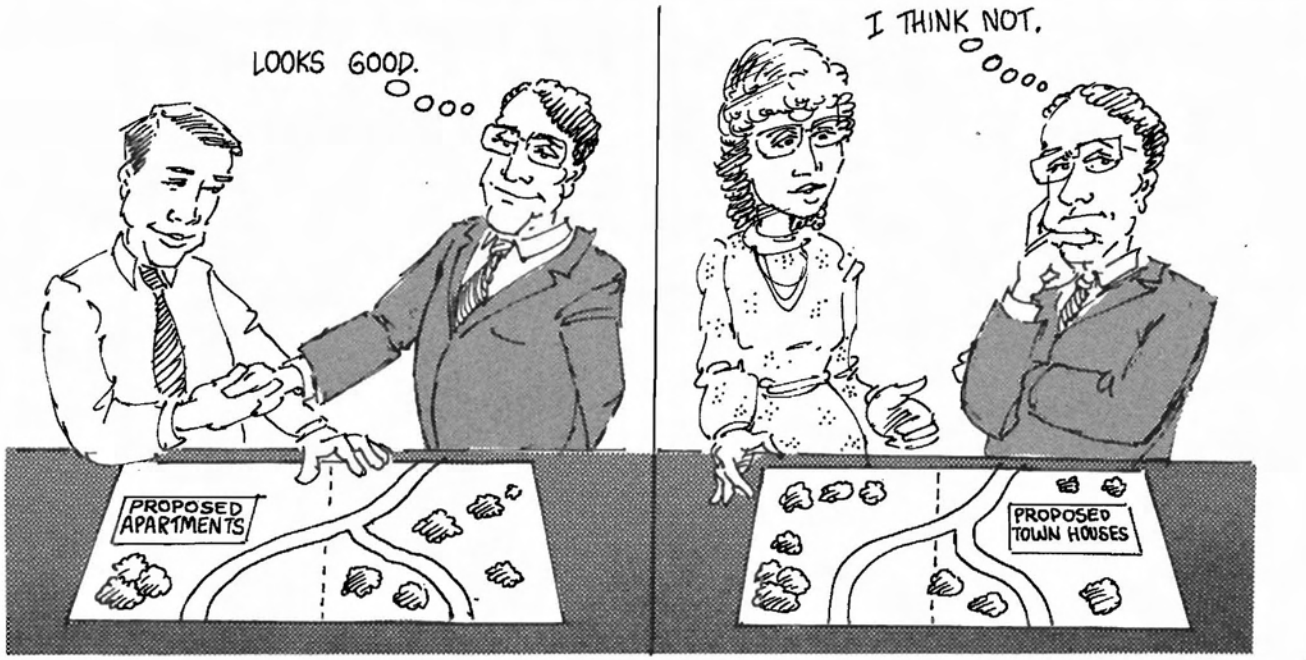
There are three basic substantive challenges to a zoning ordinance: (1) substantive due process; (2) taking; and (3) equal protection. The basis for these challenges is the Fourteenth Amendment to the United States Constitution. Substantive due process is concerned with what the government does, not its procedures. Important substantive due process questions include whether the action is fair and whether the action exceeds the government's regulatory authority.[17] In zoning cases, courts have used substantive due process requirements to examine the relationship between the ordinance's objective and the police power and to assess whether the ordinance is a reasonable means of attaining an appropriate objective. For instance, a zoning ordinance designed to exclude low income families or individuals is not an acceptable exercise of the power to protect the community's health, safety and morals. The objective is constitutionally impermissible. However, an ordinance may be aimed at attaining a constitutionally valid objective and still be invalid under the due process clause. A court may decide that preventing water pollution is a valid objective, but hold that the means of attaining that objective (large-lot zoning, for example) are too restrictive.

The second substantive constitutional challenge to zoning rests on the taking clause which states "nor shall private property be taken for public use, without just compensation." Courts in the United States have never developed a uniform standard for deciding whether a zoning ordinance constitutes a taking of private property without just compensation. Situations in which a taking challenge might arise include temporary moratoria on providing water and sewer service, staged development plans, prohibitions of multi-family units, and mandating large-lot zoning.[18]



A constitutional challenge to zoning rests on the taking clause which states "nor shall private property be taken for public use, without just compensation."

A landowner may charge denial of due process where his request for a downzoning is rejected while that of a similarly situated neighbor is allowed.



Some general guidelines emerge from judicial decisions defining a "taking" which localities should consider when formulating zoning regulations. First, the regulation must leave the landowner with some reasonable use of his or her property.[19] A reasonable use is "an economically profitable use, one to which the land is adapted and one which is not economically unfeasible."[20] In addition, if the ordinance does prohibit a present reasonable use, the restriction cannot be permanent. Third, in keeping with substantive due process, the regulation's objective should be "legitimate,. . .the means be reasonably necessary to the end, and. . .the means not be unduly oppressive on the individual."[21] The objective must be a legitimate exercise of the police power and the means of attaining it must be necessary and not unduly burden an individual's use of his or her property.

A very complex set of tests accompanies the final substantive challenge, the equal protection standard.[22] Basically, however, the Fourteenth Amendment's prohibition of state denial of equal protection of the laws requires that the state treat similar classes or individuals in similar ways. Courts have ruled that racial and sometimes economic discrimination caused by zoning ordinances violates the equal protection clause. A landowner also may charge denial of due process where his request to increase zoning density is rejected while that of his or her similarly situated neighbor is allowed. Equal protection concerns can be especially important in cases involving large-lot zoning to protect sensitive aquifers or recharge areas. In such cases, the zoning agency needs to demonstrate a strong relationship between the lot sizes required and the amount of land needed to protect the locality's groundwater supplies.

The general trend in judicial decisions is toward broad local authority to regulate land uses. In most states, a zoning action designed to protect local water resources will be upheld if three criteria are satisfied. First, the challenger must be unable to show that the ordinance is an invalid exercise of the police power or is a faulty means of attaining groundwater protection (presumably a valid objective of the police power). Second, affected landowners must be left with some practical and profitable use of their land. Finally, the local government must be prepared to demonstrate that the zoning ordinance's primary goal is not to exclude certain groups from the area or to achieve economies in the provision of public services at the expense of such values as social equity or private property rights.[23]

The Zoning Power in Virginia. The Virginia General Assembly has passed enabling legislation authorizing local zoning ordinances.[24] This legislation specifically states eight acceptable zoning objectives which the General Assembly considered directly related to the local police power.[25] One of these objectives is provision of water. In addition, the act requires local governments to consider public service requirements and the conservation of natural resources in "formulating and applying zoning ordinances and districts."[26]

The zoning enabling law also authorizes conditional zoning,[27] site plan ordinances,[28] and variances.[29] Despite these enabling laws, the zoning authority of Virginia's localities is more restricted than might appear from reading either the relevant sections of the Virginia Code or judicial decisions from other states.

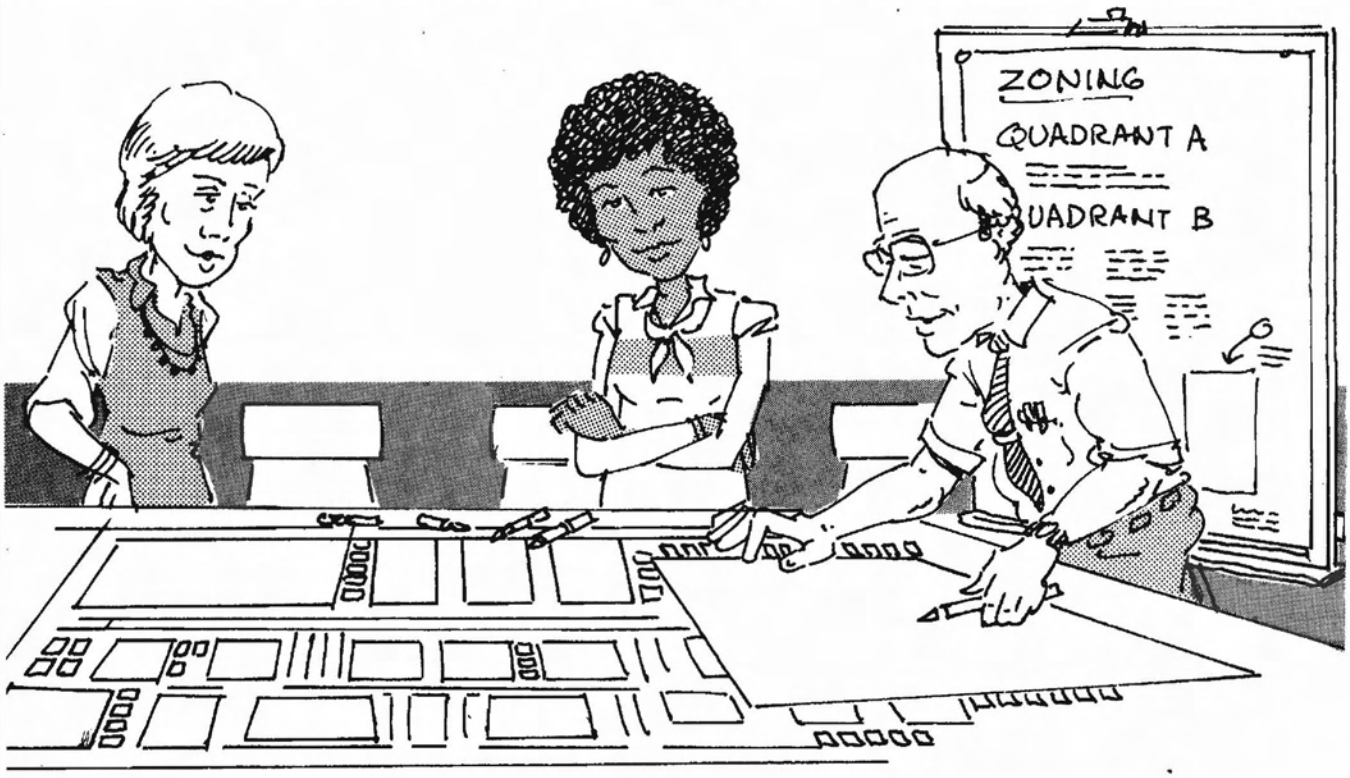
After an initial phase (1910-1950) during which the Virginia Supreme Court's decisions closely paralleled the

general trend in the United States, the court began to move in the direction of severely limiting the exercise of local zoning authority. Between 1955 and 1980, the Virginia Supreme Court consistently relied upon a very narrow reading of the taking test to ensure that "the zoning power would not prevent the developer from developing his land to the most intensive use demanded by the unregulated market."[30] It also has used the equal protection clause to define discriminatory action as "treating physically similar and geographically proximate parcels of land differently, **regardless of the general welfare justification for such differential treatment."**[31] Although Virginia law requires that zoning ordinances be drawn "with reasonable consideration for" the locality's comprehensive plan,[32] the court has often overturned zoning decisions consistent with the comprehensive plan, and has declared that the comprehensive plan is whatever the latest zoning amendment allows.[33] Thus, the trend in Virginia cases between 1955 and 1980 was toward severely undercutting the zoning powers granted localities under the zoning enabling act.[34] As a result some commentators claimed the Virginia Supreme Court had virtually repealed the zoning enabling act.[35]

Since 1980 there appears to be a slight broadening of the Virginia Supreme Court's position. In eleven cases decided between January 1980 and September 1984, the Court seems to distinguish between "stable" and "dynamic" circumstances.[36] In areas where there exists a settled neighborhood and in which the locality has not approved recent rezonings to more intensive land uses, the court has applied the doctrine of broad local power developed prior to 1955. Ten of these cases rest on the idea of zoning as a nuisance-defining and nuisance-abating function set forth in *Euclid* v. *Ambler Realty* and the pre-1955 Virginia cases. Three of the ten cases involved refusal by a locality to rezone property to a more intensive land use.[37] In all three cases, no other similarly situated property owner had applied for and received a rezoning. Five other cases involved restrictions on businesses located in or adjacent to residential neighborhoods.[38] The court upheld the local restrictions each time, generally on the grounds that the locality was protecting an established residential neighborhood.

In the two cases involving dynamic situations — changing neighborhood conditions — the court ruled in favor of the property owner's request for rezoning.[39] Other area property owners whose land was similar physically and proximate geographically had already obtained rezoning in both cases. However, only one decision required the court to overturn local action. In the other, local action was upheld in the face of a third-party complaint. The last case involved the special circumstance of a rezoning request in an historical district.[40] Here, the Virginia Supreme Court upheld a local decision to allow a developer to replace a burned-down church with condominiums in accordance with amendments to the city's zoning ordinance.

Two other recent cases that did not reach the state Supreme Court also point toward a potential easing of judicially imposed restrictions on local zoning authority.



Zoning can be most successfully utilized in a groundwater protection plan to control future development.

Aldre Properties v. *Board of Supervisors* [41] upheld a downzoning by the Fairfax County Board of Supervisors of about 61,000 acres located in the Occoquan basin on the basis of water quality concerns specifically included in the county's comprehensive plan. In the second case, a three judge review panel which screens suits the Virginia Supreme Court has been asked to hear refused to send to the Supreme Court the challenge of a Fauquier County rezoning to lower densities of 10,000 parcels in accordance with its comprehensive plan's growth estimates.[42]

Fewer problems have affected local implementation of conditional zoning, perhaps because of the requirements attached to its use by the General Assembly. The act's purpose is to

> "provide a more flexible and adaptable zoning method to cope with situations found in such zones...whereby a zoning reclassification may be allowed subject to certain conditions. . .,for the protection of the community, that are not generally applicable to land similarly zoned."[43]

To effectively differentiate the process from illegal contract zoning, the conditions must be voluntarily offered by the landowner, not required by the locality.[44] Further, the proposal of conditions must be (1) made in writing, (2) reasonable, (3) in addition to the normal regulations for the zoning district, and (4) part of a request for zoning or an amendment of the zoning map.[45] A series of substantive requirements also must be followed to ensure that the conditions are related to real needs caused by the rezoning request, do not involve cash payments, and conform to the locality's comprehensive plan. Under these circumstances, it is highly unlikely that a court challenge of the zoning decision would occur.

Zoning and Groundwater Protection. Zoning can be most successfully utilized in a groundwater protection plan to control future development. It is particularly effective in strategies to protect sensitive areas. Localities that incorporate zoning into their groundwater protection programs use it to (1) prohibit or require conditional use permits for siting underground storage tanks or industries that use or produce hazardous wastes; (2) impose density or clustering restrictions on subdivision development; (3) require developers to implement stormwater management BMPs and/or certain septic system designs; and (4) implement hydrogeologic or conservation overlay zoning.

Despite the Virginia Supreme Court's generally narrow reading of local zoning authority, it is possible for localities in Virginia to use zoning to protect groundwater. First, the majority of cases reviewed by the state Supreme Court involved piecemeal zoning — local refusal of individual requests for upzonings or local attempts to downzone property. Although the court scrutinized local decisions more strictly than is usual on a national level, in many instances the locality had not prepared a solid justification of its actions to present to the judges. In the two most recent cases discussed, Fairfax and Fauquier counties put together the solid justification needed to meet judicial scrutiny and succeeded.

Second, another large block of decisions focused on the issue of growth management. Rightly or wrongly, growth management plans have become associated with the concept of exclusionary zoning — zoning designed to effectuate racial or economic discrimination. Unless extensively documented, most courts will weaken the presumption of validity usually accorded zoning decisions in cases involving growth management.

Use of some type of sensitive area designation or hydrogeologic overlay zoning would provide substantial evidence in support of decisions requiring downzoning or rejecting requests for intensive development.

Solidly prepared groundwater management plans may overcome the equal protection concerns that piecemeal and growth management zoning seem to raise in the Virginia Supreme Court. The use of some type of sensitive area designation or hydrogeologic overlay zoning would provide substantial evidence in support of decisions requiring downzoning or rejecting requests for more intensive development. Of particular importance in implementing overlay zoning would be (1) accurate knowledge of the aquifer's hydrogeology and (2) inclusion in the locality's comprehensive plan of groundwater protection as a planning goal.

Two other factors that could potentially mitigate court opposition to zoning as a groundwater protection tool are increased local emphasis on (1) conditional zoning in prime recharge or other sensitive areas, and (2) site plan provisions or facility design requirements.[46] Conditional zoning and site plan ordinances provide the locality with more flexibility to accommodate these situations than do blanket rezonings of an entire area. They also can offer localities objective criteria related to an acknowledged state and local priority (groundwater protection) that judges are likely to accept.

Site plan ordinances could be based on contaminant or source classification systems where localities needed protection from a limited number of contaminants or sources. Appendix B provides one example of a site plan ordinance developed by a Virginia expert on local government options for protecting natural resources. Although the Virginia Supreme Court's reaction to such plans cannot be predicted, conditional zoning and site plan ordinances — especially if based on (1) good information about the locality's groundwater; (2) cooperation with such state and federal agencies as the Virginia Water Control Board, Virginia Department of Health, and U.S. Geological Survey; and (3) the local comprehensive plan — seem to rest on a firm statutory foundation. Fairfax, Clarke, and Albemarle counties in Virginia use zoning to protect their water supplies. Albemarle County employs two zoning provisions which serve to protect its groundwater supplies. The first, which falls under the Light Industrial Development section of the county zoning ordinances, restricts groundwater use to 400 gallons per site-acre per day (unless a special permit is granted). The

ordinance encourages heavy industrial users to locate in areas which are less sensitive to groundwater withdrawals.[47] The second Albemarle ordinance affecting groundwater restricts population density in Rural Area (RA) districts by setting the minimum lot size at two acres.

Clarke County's program is discussed in the section on protecting recharge areas.

B. Erosion Control, Site Plan Review, and Subdivision Ordinances

Local governments can and often do require that facilities be built with certain materials, in particular places, and with specific technologies. Localities utilizing this protection tool typically require submittal of a site plan detailing the location, construction, and operation of the activity and plans for preventing groundwater contamination. A site plan review committee then accepts, rejects, or modifies the plan. Facility design requirements, sometimes called site plan ordinances, are particularly useful in protecting against groundwater contamination from (1) municipal and industrial landfills, (2) underground storage tanks, (3) mining operations, and (4) sewage system holding ponds.

Facility design requirements do not strain local budgets because they do not require collection of large amounts of groundwater quality data. They also provide a flexible management tool because requirements can be tailored to the needs of a particular site. However, they do mandate technology-based rather than performance-based standards and thus can be accused of inhibiting development of new pollution control technologies.[48] Further, they regulate only new sources of contamination.[49] In Virginia site plan review ordinances do exist. However, since adoption of the uniform state building code in 1978, there is some question about their legality. A site plan review ordinance must, at the very least, conform to that code.[50]

Erosion control ordinances require specific conservation measures or submission of an individual erosion control plan. Although they can be applied to agricultural activities, most erosion control ordinances focus on subdivision and commercial development. They are particularly useful in regulating earthmoving activities in aquifer recharge zones where the water table may be close to the surface.

The town of Huntington, Long Island, New York, requires a developer to confine runoff to the site during construction and thus reduce site erosion and sedimentation. The ordinance strictly forbids disposal of any runoff onto existing streets and private property.

The Commonwealth of Virginia has an erosion and sediment control law.[51] In pursuance of this law the Division of Soil and Water Conservation has developed an extensive Erosion and Sediment Control Handbook. No grading, building or other permits may be issued unless the applicant submits an approved erosion and sediment control plan.[52] In addition, the law authorizes localities and districts to develop an erosion and sediment control program consistent with the state program.[53]

Local governments can require submittal of a site plan detailing the location, construction, and operation of the activity and plans for preventing groundwater contamination.

Subdivision regulations allow localities to require that developers utilize design standards and engineering practices that will provide maximum protection of the watershed. Localities use them to enforce minimum lot size zoning; reduce stormwater runoff and ensure adequate drainage; regulate on-site waste disposal systems; implement erosion and sediment control plans; and meet public facility needs.[54] Fairfax County's ordinance, for example, requires that developers keep runoff to pre-development levels.

C. Best Management Practices

There are very few examples of states or localities mandating implementation of agricultural Best Management Practices (BMPs) in order to protect surface or groundwater. BMPs are recommended practices for engaging in activities that are likely to cause pollution over a large area. For example, BMPs are available for spraying pesticides and fertilizers, maintaining home septic systems, controlling urban stormwater runoff, spreading salts used to deice roadways, pursuing urban construction, and preventing excessive irrigation.

BMPs can be an effective local tool for protecting groundwater because they offer technical guidelines that

localities often have trouble developing on their own. Moreover, they are cost-effective and flexible, thus enhancing a local government's ability to design a program for its particular needs. Users of BMPs need to be extensively trained in their use and even in mandatory programs their effectiveness depends on voluntary acceptance. BMPs also cannot provide the protection required by aquifer recharge areas.[55] Localities need to remember that BMPs by themselves cannot protect groundwater; they are only one element of a good program.

Barron and Shawano counties in Wisconsin require annual permits for animal waste storage facilities, which also must meet the technical standards of the U.S. Soil Conservation Service.[56] The recently enacted Wisconsin Farmers Fund Program[57] requires such an ordinance in order for a county to be eligible for cost-sharing funds for animal wastewater pollution abatement.[58]

Currently the Commonwealth of Virginia operates a voluntary best management practices program through the VWCB and the Division of Soil and Water Conservation (DSWC). In addition, localities may require adoption of urban best management practices. Subdivision and erosion and sediment control ordinances would be the primary vehicles for requiring implementation of urban BMPs affecting new development. Fairfax County is developing a BMP design manual whose guidelines include: (1) maximizing aerial coverage of on-site drainage area with BMPs (suggested minimum is 70 percent);(2) minimizing on-site impervious area; (3) promoting natural infiltration wherever possible; (4) avoiding placement of structural BMPs in natural stream channels; and (5) delaying BMP construction until all other land disturbing activities are complete.[59]

However, there is no enabling legislation that could be tied to a mandatory agricultural BMP program or to a mandatory urban BMP program governing existing industries, businesses, or subdivisions. Authority for a mandatory agricultural BMP program would have to rest on the locality's general mandate to "prevent the pollution of water and injury to waterworks for which purpose their jurisdiction shall extend to five miles."[60] Although it can be argued that mandatory BMPs are essential to the accomplishment of the "declared objects and purposes of a locality" (police power) and "can be necessarily or fairly implied in...powers expressly granted" (power to protect water supplies),[61] there are no Virginia Court decisions on this issue. Thus, given Virginia's very narrow reading of Dillon's Rule, localities may hesitate to incur the expense of adopting a mandatory BMP program.

D. Sensitive Area Identification and Protection

A sensitive area is one where groundwater can be easily polluted. The three most commonly used approaches for protecting sensitive areas are (1) recharge area protection, (2) development of a groundwater classification system, and (3) critical area designation. Each approach is best suited for accomplishing a different groundwater protection goal.

Recharge Area Protection. Generally, the goal of recharge area or critical aquifer preservation is nondegradation — protection of the groundwater resource at its present (presumably high) quality. Recharge areas are the land surfaces where replenishment of the aquifer takes place. They usually are fairly level areas whose soils and vegetation permit rapid percolation of rainfall into the aquifer. There is little stormwater runoff from recharge areas. The recharge area ultimately is the source of a locality's groundwater supply.

Percolation in recharge areas is generally rapid and water tables often are shallow and contaminants can easily reach the aquifer through the recharge zone.

Because percolation in recharge areas is generally rapid and water tables often are shallow, contaminants can easily reach the aquifer through the recharge zone. If the recharge zone becomes polluted, contamination may eventually reach municipal wells. Thus, the quality of the groundwater in the recharge area is an important factor in determining the quality of the water citizens drink wherever groundwater is the source of supply.

Recharge area protection requires a thorough understanding of the hydrogeology of the recharge area so that its extent and characteristics are known. Important information includes soil properties, slope, gradient, location of potential well sites, elevation, and types of geologic deposits. Recharge area protection schemes focus on preventing pollution within the recharge area through such tools as land use controls, purchase of land, transfer or purchase of development rights, and construction of sewers. In general, recharge area protection is most effective where zones are clearly identified and where extensive development within the recharge zone has not already taken place. Recharge area protection is difficult if the recharge zone is located outside the limits of the locality's political jurisdiction.

New York State's localities have been leaders in utilizing zoning to protect recharge areas. Nassau and Suffolk counties on Long Island, New York, have designated hydrogeologic overlay zones as part of a regional groundwater protection program.

Begun in 1978, hydrogeologic zoning on Long Island started with mapping groundwater flow patterns. First, recharge areas were identified by "evidence of vertical or partially vertical flow."[62] Next, the boundaries between recharge and discharge zones were delineated. Further subdivision of groundwater recharge and discharge zones was done by examining the severity and extent of nitrate contamination "because of its association with most of the human waste disposal practices of concern to Long Island."[63] Analysis of this data led to establishment of three sub-areas within the deepflow recharge zone: (1) grossly contaminated, (2) significantly contaminated, and (3) relatively pristine. Five areas outside the deepflow recharge zone also were characterized. Structural and nonstructural management recommendations for each

zone, based on the realization that the same land use activity can result in different impacts in different hydrogeologic zones, can then be implemented.

Clarke County, Virginia, has added a natural resource conservation overlay district to its zoning ordinance. The designation's purpose is to "prevent the use and development of land in designated water resource recharge areas in a manner tending to affect adversely the quantity and quality of such significant water resources."[64] Development and use of land is allowed in the Natural Resource Conservation (RC) district if the developer can provide satisfactory evidence that the proposed use is compatible with the district's purpose. Any land disturbing activity requires filing an approved erosion and sediment control plan. The ordinance prohibits mining; drilling (except for drinking water wells); sanitary landfills; spreading or spraying of toxic chemicals, hazardous materials or biological materials except applications of pesticides or herbicides in emergencies; underground storage tanks; feedlot operations; and land application of sewage sludge in a RC district. The minimum lot size in such a district is two acres and coverage by all impervious surfaces may not exceed 20 percent.[65]

Crystal Lake, Illinois, created four watershed zoning districts in a 1976 ordinance designed to protect its aquifer recharge area.[66] Since the groundwater primarily feeds a shallow, glacial lake, the community established the four districts based on proximity to the lake to protect the groundwater and the lake. In the Marsh Wetland District adjacent to the lake no development is allowed. The other districts require large lots with high percentages of the lot to remain uncovered by impervious surfaces (i.e., roofs, pavement, sidewalks, etc.).[67] Its recharge area protection scheme utilizes large-lot residential zoning to minimize adverse environmental impacts and to provide services without overcrowding the land; exclusive agricultural zones for non-residential areas as "a direct control of the population level in the watershed;" cluster zoning and planned unit development to concentrate development in the best parts of a site and to minimize disturbance of the land and the possibility of pollution; conditional use zoning and special use permits; special districts; overlay zoning (such as flood plain management districts and aquifer protection zones) and performance zoning (sets minimum standards for quantity, quality, and velocity of runoff instead of specifying acceptable uses).[68]

The federal Safe Drinking Water Act[69] includes another protective tool for recharge areas. It provides for the designation of aquifers as "sole or principal sources" of drinking water. Federal financial assistance is prohibited for projects that would pollute such aquifers.[70] Appendix C outlines several of the key elements of the regulation. As of May 1986, EPA had designated 21 sole source aquifers and sixteen applications are pending. None has been designated in Virginia but Clarke County has applied.

Sole source designation is a useful tool, but localities should not view it as a panacea for their groundwater problems. Perhaps the major utility of such a designation is in creating community awareness of the problem's importance and generating community support for other groundwater protection measures. However, not all projects are prohibited from receiving federal financial assistance and funding decisions are based on the health hazard of the proposed activity.[71]

In June 1986, the Safe Drinking Water Act was amended to include a program authorizing Environmental Protection Agency (EPA) grants to help states develop their own wellhead area protection plans. Congress defined wellhead protection area as the "surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield."

Those states applying for development grants have until 1989 to establish protection plans which will be subject to EPA approval. The states' plans must include such elements as specific duties of state and local agencies and public water systems, identification of the wellhead protection area(s), a list of all potential sources of contamination caused by human activities, descriptions of how the program would function, and contingency plans for alternative drinking water supplies if the original source should become contaminated.

Use of a locality's power of eminent domain sometimes also is suggested as a method for preserving groundwater recharge areas. Eminent domain is discussed in this handbook under the subsection on non-regulatory tools.

Groundwater Classification Systems. Classification systems are usually part of those groundwater protection strategies whose goals are limited degradation or differential protection. A limited degradation policy is one designed to maintain "groundwater quality above a specified standard."[72] A differential protection strategy seeks to preserve the quality of only certain groundwater uses or sources, for example sole source aquifers or groundwater needed to meet present and future drinking water needs. Table 1 provides some examples of state classification systems.

Virginia's classification system, on the other hand, is based on the recognition that natural groundwater quality varies from region to region. The Virginia Water Control Board has defined four physiographic provinces within the state (Coastal Plain, Piedmont and Blue Ridge, Valley and Ridge, and Cumberland Plateau), each of which has distinctive hydrogeologic features that influence the quality of the area's groundwater. For each province, chemical and physical analyses of groundwater samples were evaluated, and standards for pH, ammonia nitrogen, nitrite nitrogen, and nitrate nitrogen were established. However, the majority of groundwater standards, such as those for metals, insecticides, or radioactivity, are applicable statewide.

Virginia's antidegradation policy states that "if the concentration of any constituent in groundwater is less than the limit set forth by groundwater standards, the natural (higher) quality for the constituent shall be maintained; natural quality shall also be maintained for

TABLE 1
Examples of State Classification Systems

State	#Classes (criteria)	Uses
Connecticut	4 classes — (use, quality, land use, flow system, etc)	Drinking water/waste receiving
Florida	4 classes — (quality, flow system, and use	Potable/non-potable
Guam	5 classes — (quality, flow system, and use)	Drinking water/discharge, recharge
Maryland	3 classes — (yield and quality)	Not stated
North Carolina	5 classes — (quality and depth)	Multiple, including cycling wastes
New Jersey	4 classes — (quality and sensitive environmental systems)	Multiple — no waste receiving
New Mexico	3 classes — (use)	Multiple — separate class for agricultural uses
New York	3 classes — (quality)	Multiple, waste receiving
Vermont	2 classes — (use)	Water-supply/other
Virginia	4 classes — (water quality)	Not stated — all reasonable beneficial uses
Wyoming	8 classes — (quality, use, energy, and mineral resources in aquifer)	Multiple including mining, geothermal, etc.

Source: Paula Magnuson; "Ground-Water Classification" in D.M. Vielsen and L. Aller, eds. *Proceedings of the Sixth National Ground-Water Quality Symposium* (Worthington, Ohio: National Water Well Association, 1983), 30.

all constituents, including temperature, not set forth in groundwater standards." In effect, the antidegradation policy prevents the use of standards as an unwitting mechanism by which, theoretically, higher quality groundwater could be abused until it met the lower standards.[73]

Critical Area Designation. This technique is utilized to protect groundwater areas particularly sensitive to quantity or quality problems but which are not necessarily located in a recharge zone. Designation of a groundwater management area is a potential tool for protecting sensitive areas in Virginia. In 1973, the Commonwealth adopted the Groundwater Management Act in an effort to help localities regulate groundwater withdrawals. Counties, cities, and towns may petition the Virginia Water Control Board for designation as a groundwater management area if the locality meets at least one of the following criteria: (1) decline in groundwater levels; (2) substantial interference between the wells of two or more groundwater users; (3) probable overwithdrawal of available supplies; and (4) probable current or future pollution of groundwater supplies.

If the locality is declared to be a groundwater management area, then any users wishing to begin or increase withdrawals must apply for and receive permits for such withdrawals. There are several notable exemptions from the permitting process, including: (1) any withdrawals of less than 300,000 gallons per month; (2) agricultural and livestock use; and (3) withdrawals for use by a heat pump. In addition, a grandfather clause grants existing users, even those withdrawing over 300,000 gallons per month, the right to continue to withdraw up to the maximum of any date within the previous two years. Thus, extensive withdrawals may continue unchecked.

The permitting process does not exclude large-scale users. If the VWCB determines that large withdrawals will not aggravate existing or potential groundwater quantity problems, then the permit will be granted. Rather, the designation simply gives the area a mechanism for limiting, when deemed necessary, the quantity that may be withdrawn by new users.

Currently, two groundwater management areas exist in Virginia. The first, the Southeastern Virginia Groundwater Management Area, includes the counties of Prince George, Surrey, Sussex, Southampton, and Isle of Wight, and the cities of Suffolk, Portsmouth, Chesapeake, Norfolk, Virginia Beach, and Hopewell. The second, the Eastern Shore Groundwater Management Area, includes Northampton and Accomack counties.

E. Contaminant and Source Classification

Contaminant classification emphasizes control of the most harmful potential pollutants, and source classification focuses on those industries that discharge the largest amounts of or the most serious pollutants. These options are most helpful to states or localities with limited resources or that need an immediate regulatory response to a fairly specific problem because they can target specific regulations at the source or contaminant and only there. However, contaminant and source classifications generally are more "useful for organizing remedial responses once contamination is discovered" than as part of a groundwater protection strategy.[74]

Spokane County, Washington, uses a Critical Materials List (contaminants list) which relates chemicals on this list to chemicals regulated under state and federal hazardous waste regulations. The list of substances fills more than 17 pages. In addition, a Critical Materials Activity List (source list)[75] lists types of businesses found to use, handle or store critical materials. Specific regulations are applied to the critical materials or activities in a particular area.

Sewer systems reduce the amounts of waste received by the land and, thus, also reduce the potential for groundwater contamination.

F. Mandatory Sewer Hookups

Constructing sewers to serve residents who currently use on-site sewage systems reduces the amounts of waste received by the land and, thus, the potential for groundwater contamination. Further, placement of sewer lines in sections of the community at a distance from the groundwater recharge zone will funnel development away from that critical area. However, sewer systems are expensive and federal construction grant funds have been reduced. Many rural and small communities are not able to afford new sewer construction. These are often the very localities that depend most on groundwater for public supplies. In addition, constructing sewers also reduces recharge by not returning water to the aquifer from which it was pumped. The locality also needs to realize that because increased development generally follows sewer system construction lines, it must be prepared to meet increased public service demands (schools, garbage collection, fire protection) in those areas.

III. Nonregulatory Tools

Nonregulatory groundwater protection techniques focus on voluntary actions to promote compliance. They can be important elements of a locality's overall groundwater protection strategy. However, in order for nonregulatory tools to be successfully employed, two conditions must be met. First, a public education program is essential. Citizens must understand the importance and vulnerability of their local groundwater supply or they will not be motivated to undertake the actions necessary to protect it. Second, nonregulatory programs work best when they include some mechanism that makes it "more advantageous to prevent contamination than to continue to pollute."[76] Tax incentives, mortgage guarantees, and loans are some of the usual incentives offered. Methods of curtailing pollution include provision of crop insurance only to farmers practicing integrated pest management or linking crop subsidy payments to the implementation of BMPs.

The most frequently used nonregulatory groundwater protection techniques are (1) encouragement of voluntary BMP implementation; (2) water conservation; (3) purchase of development rights; (4) used oil recycling programs; and (5) household hazardous waste collections.

A. Best Management Practices

Adoption of BMPs is voluntary in most states, including Virginia. Even voluntary BMPs can work well. The Virginia Water Control Board has developed a comprehensive set of BMPs for most land use activities. Its *Best Management Practices Handbook* suggests many ways to minimize pollution from such nonpoint sources as urban areas, agricultural lands, and forests. Their publication, *Know Your Land,* also offers advice to homeowners.[77]

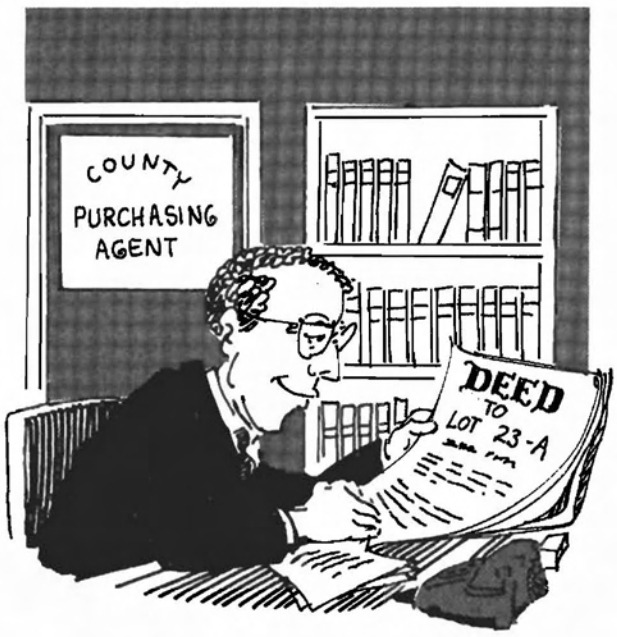
Effective voluntary BMP programs require: (1) community acceptance; (2) understanding of their necessity by those asked to implement them; (3) some type of incentive program; and (4) extensive educational efforts to train citizens in their use. Thus, although voluntary BMP programs do not require extensive regulatory personnel or frameworks, success does require some commitment of local resources.

In Virginia Beach, conservation measures resulted in about a 25 percent reduction in per capita water use.

B. Water Conservation

Water conservation has both regulatory and nonregulatory aspects. Because of its reliance on citizen compliance for success, however, it will be discussed with the nonregulatory tools. Water conservation produces water quality as well as water quantity benefits. Saving water means that less wastewater is treated and discharged. Moreover, water conservation stretches supplies and extends the life of local water supply facilities and individual residential wells and septic systems. Thus, less time and money need to be spent locating new groundwater supplies of sufficient quantity and quality to meet local needs, and local officials' job of balancing groundwater protection and development can be made somewhat easier. Many towns in the Boston Metropolitan Area Planning Council (MAPC) region have implemented local conservation programs; among the most successful have been those in North Reading, Stoughton, and Arlington.[78] In the MAPC area commercial users of water, especially larger users, also have contributed significantly to water conservation. Some private industries and businesses have cut more than 25 percent from their water consumption. Raytheon (at three Boston-area plants), Digital Equipment Corp., Western Electric and General Electric are among the firms that have reduced their wastewater production to save money.[79]

Water conservation programs in Madison, Wisconsin, and Elmhurst, Illinois, saved these communities the cost of drilling new wells. Madison saved $750,000, and Elmhurst saved $400,000.[80] Many communities in California have used conservation measures successfully to cope with serious water shortages: in one of their worst droughts in history "conservation measures reduced water use by as much as 60 percent."[81]



A few localities simply have purchased the land overlying their aquifer recharge zone in order to protect it from contamination.

Since 1978, the building code for the City of Virginia Beach has required that new or remodeled homes install water-saving plumbing fixtures, that car wash installations recycle water, and that public lavatories not have continuous flow or continuous flush toilets and urinals. The city's water management program includes a supply management aspect to conserve water within the production and delivery system and a demand management program that includes the water conservation strategies of pricing, bans on nonessential uses during water supply emergencies, rationing, a water connection moratorium, and public education programs. In the recent past, Virginia Beach has experienced two significant droughts and the conservation measures adopted have resulted in about a 25 percent reduction in per capita use.

C. Fee Simple Purchase

A few localities simply have purchased the land overlying their aquifer recharge zone in order to protect it from contamination. Often such land is utilized for parks, playgrounds or open space. It is possible to exercise eminent domain in making such purchases. This is an important tool, especially where "regulation is either politically or legally unacceptable."[82] However, the costs of acquisition often make fee simple purchase too expensive if a large recharge area or one that already is partially developed are involved.

Local governing bodies in Virginia may provide for and regulate parks, streets, public grounds, etc.,[83] and may purchase or condemn land necessary for "acquiring, locating, establishing, maintaining, operating, extending, or enlarging waterworks..." and preventing "the pollution of water and injury to waterworks."[84] However, property can be condemned for these purposes only after the local government demonstrates its necessity to the court with jurisdiction over the case or the local governing body declares its necessity after a public hearing.[85] In addition, many complications arise in attempts to condemn property located in another locality, and it is very possible a recharge zone may be so located.

There has been sufficient concern over the legal authority of localities to use eminent domain to protect reservoirs and aquifer recharge areas that the State Water Plan Advisory Committee advocated enactment of clarifying legislation to specifically enable condemnation for that purpose. The draft bill, however, has not been considered by the General Assembly. Rivanna Water and Sewer Authority (WSA) used eminent domain in acquiring land for its proposed Buck Mountain Reservoir and has proceeded with fee simple purchase of the reservoir area, a 300-foot wide buffer zone, and restrictive easements beyond the buffer zone. The WSA also declared a two-year building moratorium around the project site while conducting needed geological, hydrological, and archaeological surveys.

D. Purchase of Development Rights (PDR)

With this technique, development potential is considered a property right with a specific monetary value that, like any other property right, can be sold. The general pattern is for the locality to develop a comprehensive plan indicating areas where development will be allowed and those where development will be prohibited or restricted. For example, a community could designate its aquifer recharge zone as a restricted area and then channel public services into the development area. Landowners in the restricted zone still could realize some profit from their land by selling the property's development rights to the locality.

Establishment of PDR programs through which development rights are purchased from local property owners would have to be accomplished within the confines of the eminent domain power. Localities would have to purchase the development rights themselves and then sell them. Few problems probably would arise over selling development rights for a public use or to keep the land from a use that would adversely affect groundwater. However, notice of such a sale would have to be published and a public hearing would have to be held concerning a proposed transfer to a private developer in order to demonstrate that the sale served the public interest and had public support. Even after such a hearing the transfer could be challenged at a later date.[86] The legal foundation for a PDR program that includes sale of rights to private parties, therefore, is far from secure.

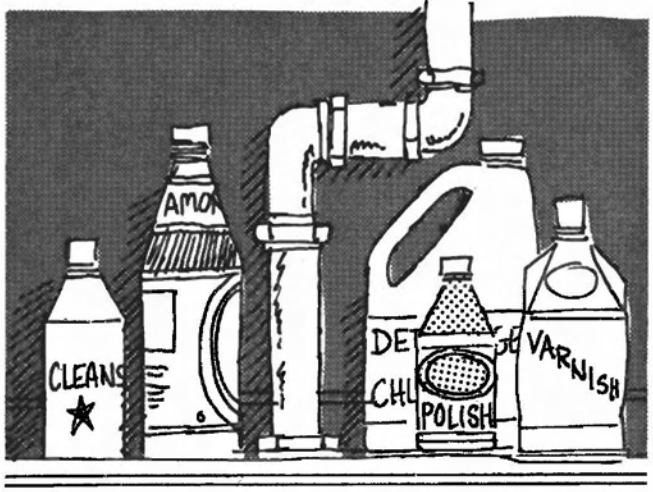
E. Household Hazardous Waste Cleanup Days

There is a variety of contaminants present in common household products (*Appendix A*). Yet disposal of these products is haphazard at best. Homeowners typically pour them out on the ground or down a storm drain or send them to the local landfill with their trash. Even these small amounts can contaminate groundwater.

A number of counties and towns in the Northeast have conducted household hazardous waste cleanup days when citizens bring their unused hazardous products to a central location. A licensed waste hauler then disposes of them for a small fee.[87]

Connecticut's first household hazardous waste collection program, "Chemical Disposal Day," was conducted in 1984 with contributions by local corporations and civic organizations underwriting most of the expense. The household wastes, which included DDT and chlordane, were collected and disposed of by a licensed hazardous waste transporter. The state has a program to assist local communities in developing and holding collection days. The Department of Environmental Protection (DEP) has set standards to ensure the health and safety of residents during a collection event. A community that follows the state guidelines may receive reimbursement from the state. The program provides information and assistance to communities in setting up collection days.

The Cape Cod Planning and Economic Development



A variety of contaminants is present in common household products.

Commission organized the first program in Massachusetts in 1983. With the cooperation of property owners and town managers of 15 towns, seven regional collection sites were selected. Wastes that were collected during the three-day collection program were transported to a solvent recovery facility, shipped to an out-of-state high temperature incinerator, or disposed of in a hazardous waste landfill in New York. Local governments in Massachusetts have given various agencies the lead in promoting collection days and the League of Women Voters has been active in generating support through outreach programs and audiovisual materials distributed to the public.

Broome County, New York, held the first pesticide cleanup days in that state in the spring of 1982, and again in 1983 when three other counties followed its example with their own cleanup days. Major coordination of these cleanup days has come from the county Environmental Management Councils, working with the Bureau of Pesticides of the state Department of Environmental Conservation and the Cooperative Extension Associations. The state Association of Environmental Management Councils began considering regional cleanup days with groups of counties in 1984.

Fairfax County, Virginia, sponsored a cleanup day in October 1985. Its success led the county to plan another for April 1986. In addition, Chesterfield County and the City of Newport News also are planning household hazardous waste cleanup days.

Good planning is essential to the success of household hazardous waste cleanup days. In particular the following issues need to be addressed:[88]

1. Timing of the event(s). Sufficient lead time (at least 4-6 months) must be provided to allow for adequate planning, publicity, etc.
2. Location of collection point(s). Factors to be considered include ownership (whether public or private), familiarity to the public, accessibility, parking space, and availability of cover.

3. Nature of waste to be accepted.
4. Contractual arrangement with licensed hazardous waste transporter.
5. Method of financing. Public funds may be available; however, if these are not forthcoming or are insufficient, grants or contributions may be sought from private businesses and/or civic groups. User fees are another option, but care must be taken to ensure that people are not discouraged from bringing in their waste.
6. Public education and publicity. The public should be kept informed and involved as much as possible from the earliest moment. There is a need to educate the public regarding the nature of the problem and the use of a collection day as a solution. All potentially interested groups and individuals should be encouraged to participate in the planning and operation of the event.
7. Emergency preparedness. There are many risks associated with the collection of household hazardous waste: for example, the inadvertent mixing of different materials — possibly of unknown composition and inadequately contained — could lead to explosions and/or the release of toxic fumes. It is vital that adequate preparation be made to deal with possible incidents of this kind.

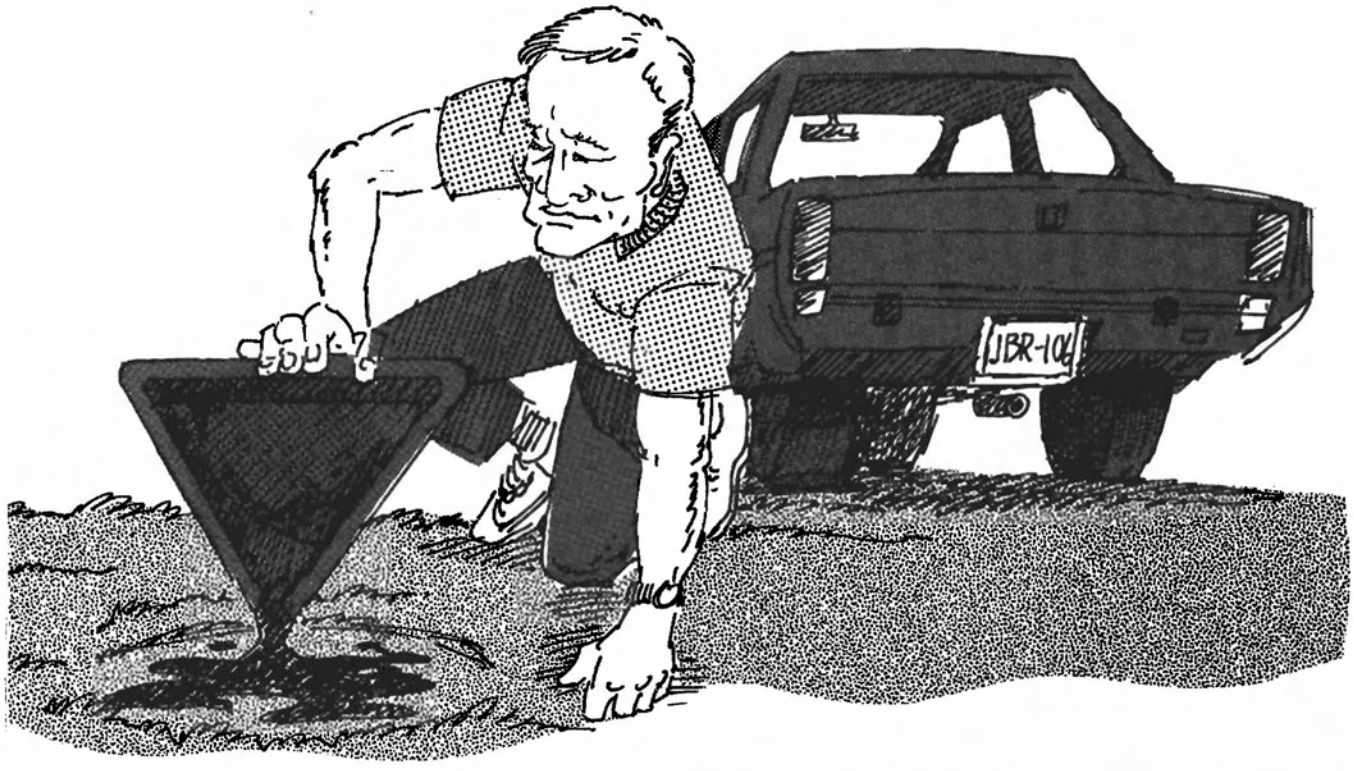
In addition, several legal concerns must be taken into consideration: (1) permit requirements; (2) service contracts; and (3) liability. Appendix D presents the advice of the Hazardous Waste Management Project on the issues.

F. Used Oil Recycling Programs

Citizens often are in the habit of dumping their used motor oil into a sinkhole or vacant lot, or burying it in the backyard. To prevent the groundwater pollution that results from such disposal practices, many localities have established used oil recycling programs. Used oil can be taken to designated service stations or a central location for disposal. The oil is then recycled. Begun in 1982, the Virginia Used Oil Recycling Program is coordinated by the Department of Mines, Minerals, and Energy. In 1986 there were 910 service stations statewide participating as collection centers. A 1984 survey showed that 280,000 gallons of used motor oil are recycled each year.

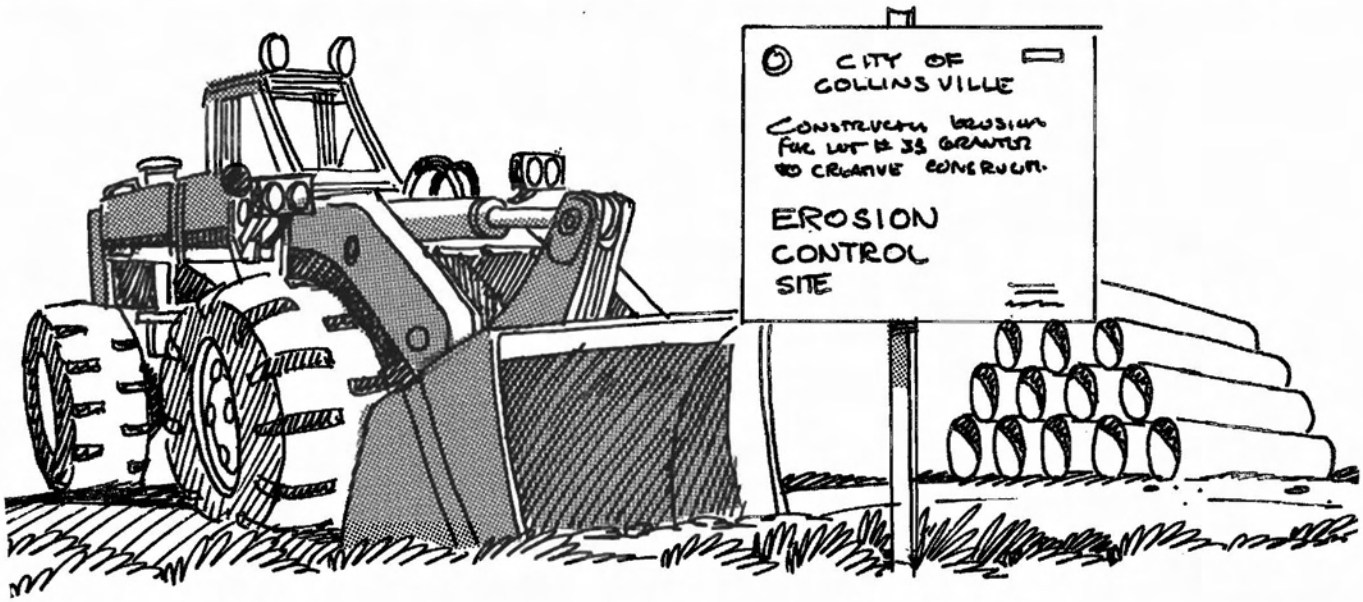
Montgomery County, Virginia, is beginning recycling operations because the county landfill has a limited projected lifespan.[89] A 550-gallon oil tank would take recyclable motor oil and the landfil would recycle colored and clear glass. The county also is considering working with Reynolds Aluminum to recycle metal products.

The Virginia Office of Emergency and Energy Services and Virginia Division of Litter Control have developed good information on recycling oil and other nonhazardous wastes.[90] Although state law prohibits the discharge of oil into or upon the waters and some localities prohibit the disposal of used oil onto land, an estimated 4.4 million gallons of used oil are disposed of improperly each year in Virginia.



Citizens often are in the habit of dumping their used motor oil into a sinkhole or vacant lot, or burying it in the backyard. To prevent the groundwater pollution that results from such disposal practices, used oil can be taken to designated service stations or a central location for disposal. The oil is then recycled.

Erosion control ordinances require specific conservation measures or submission of an individual erosion control plan.



IV. Summary

Each local governing body must choose those groundwater protection methods most applicable to the physical characteristics of its aquifer, its dependence on groundwater, the current quality of its groundwater, and its personnel and financial resources. However, some generalizations can be made about the groundwater protection methods discussed in this section. The most useful local tools for preventing groundwater contamination appear to be (1) recharge area protection; (2) zoning; (3) mandatory and voluntary BMP implementation; (4) erosion control, site-plan review, and subdivision ordinances; (5) household hazardous waste cleanup days; and (6) recycling programs. Appendix E lists sources of information for each of these protection techiques. Sewer construction, fee simple purchase, and purchase of development rights offer good protection but usually are beyond a locality's financial means. Contaminant and source classifications can be unwieldy and do not provide much protection against pollution. Water conservation programs, despite their many virtues, have very limited potential to prevent groundwater pollution.

Some of the most effective methods for preventing groundwater pollution, however, require some land use regulation. Local governments' statutory authority to utilize these tools is not completely secure. This authority would be stronger if the General Assembly specifically authorized (1) groundwater protection as a purpose of zoning; (2) mandatory local BMP programs for watershed protection; (3) groundwater protection as a purpose for site plan ordinances; and (4) use of eminent domain and/or temporary building moratoria to preserve recharge areas/ watersheds.

V. Footnotes

1. *Va. Code Ann.* sec. 27-63 *et seq.* (1985 Repl. Vol.).
2. *Va. Code Ann.* sec. 27-97 (1986 Supp.).
3. *Water News.* Vol. 15, No. 5, May 1984), 4.
4. Several localities have regulated wells and septic systems without specific authority. The attorney general's office believes these regulations would not be upheld by a court if challenged.
5. *Va. Code Ann.* sec. 15.1-837, 838.
6. *Va. Code Ann.* sec. 15.1-317 *et seq.* (1981 Repl. Vol.).
7. *Va. Code Ann.* sec. 15.1-37.2:1 and 15.1-37.3:4 (1981 Repl. Vol.).
8. *Va. Code Ann.* sec. 15.1-292 (1981 Repl. Vol.).
9. *Euclid* v. *Ambler Realty,* 272 U.S. 365 (1926).
10. *Nectow* v. *City of Cambridge,* 277 U.S. 183 (1928).
11. *Id.,* 187.
12. *Board of Supervisors* v. *Carper,* 107 S.E.2d 128 (1977).
13. David R. Godschalk, David J. Brower, Larry C. McBennett, Barbara A. Vestal, and Daniel C. Herr. 1979. *Constitutional Issues of Growth Management* (Washington, D.C.: Planners Press), 31.
14. *Id.,* 21.
15. *Laird* v. *City of Danville,* 225 Va. 256 (1983).
16. William F. Neely, "Challenging Rezoning in Virginia," 15 *University of Richmond Law Review* 423 (1981), 431.
17. Godschalk, 43.
18. *Id.,* 56.
19. Godschalk, ch. 60.
20. *Id.,* citing *Construction Indus. Ass'n* v. *City of Petaluma,* 522 F.2d 897 (9th Cir. 1975) *cert. denied* 96 S. Ct. 1148 (1976).
21. *Id.,* 60.
22. *Id.,* 82-83.
23. Godschalk, ch. 6.
24. *Va. Code Ann.* sec. 15.1-486 *et seq.* (1981 Repl. Vol. and 1985 Cum. Suppl.).
25. *Va. Code Ann.* sec. 15.1-489 (1985 Cum. Suppl.).
26. *Id.*
27. *Va. Code Ann.* sec. 15.1-491.1 (1982 Repl. Vol.).
28. *Va. Code Ann.* sec. 15.1-491(h) (1985 Repl. Vol.).
29. *Va. Code Ann.* sec. 15.1-491(c) (1985 Repl. Vol.).

30. Lilian R. BeVier and Denis J. Brion. 1981. *Judicial Review of Land Use Decisions in Virginia* (Charlottesville; Institute of Government, University of Virginia), 108.
31. *Id.* (emphasis added). See *Board of Supervisors* v. *Davis,* 200 Va. 316, 106 S.E.2d 152 (1958); *Board of Supervisors* v. *Carper* 200 Va. 653 107 S.E.2d 390 (1959); *Board of Supervisors* v. *Medical Structures, Inc,* 213 Va. 355, 192 S.2d 799 (1972); *Board of Supervisors* v. *Allman,* 215 Va. 434, 211 S.E.2d 48 (1975); *Board of Supervisors* v. *Snell Construction Corp.,* 214 Va. 655, 202 S.E.2d 889 (1974);and *Matthews* v. *Board of Zoning Appeals,* 218 Va. 270; 237 S.E.2d 128 (1977).
32. *Va. Code Ann.* sec. 15.1-490 (1980 Cum. Supp.).
33. *Id.,* 109. See *Wilhelm* v. *Morgan,* 208 Va. 398, 157 S.E.2d 920 (1967).
34. *Va. Code Ann.* sec. 15.1-427 *et seq.* (1980 Cum. Supp.).
35. BeVier and Brion.
36. BeVier, 112.
37. *Board of Supervisors* v. *Jackson,* 269 S.E.2d 381 (1980); *Board of Supervisors of Fairfax County* v. *David L. Pyles,* 224 Va. 629 (1983) and *Board of Supervisors* v. *Lerner,* 221 Va. 30 267 S.E.2d 100 (1980).
38. See *Board of Supervisors* v. *International Funeral Services* 275 S.E.2d 586 (1981); *City of Norfolk* v. *Tiny House,* Inc., 222 Va. 414 (1981); *City of Manassas* v. *Rosson,* 224 Va. 12 (1982); *Fairfax County* v. *Southland Corporation,* 224 Va. 514 (1982); and *Board of Supervisors* v. *Market Inns, Inc.,* 319 S.E.2d 737 (1984).
39. See *Board of Supervisors* v. *Fralin and Waldron, Inc.,* 222 Va. 218 (1981) and *Laird* v. *City of Danville,* 225 Va. 256 (1983).
40. *Bell* v. *City Council,* 224 Va. 490 (1982).
41. *Aldre Properties* v. *Board of Supervisors,* Nineteenth Judicial Circuit of Virginia, Chancery Nos. 78463, 78476, 78550, 78425 (1985).
42. *Costello, et al.* v. *Board of Supervisors of Fauquier County,* Twentieth Judicial Circuit of Virginia, Chancery No. 6021 (1983).
43. *Va. Code Ann.* sec. 15.1-491.1 (1981 Repl. Vol.).
44. Frank O. Brown, Jr., and Susanne L. Shilling, "Conditional Zoning in Virginia" 16 *University of Richmond Law Review* 117 (1982), 133.
45. *Id.*
46. Local site plan ordinances are authorized by *Va. Code Ann.* sec. 15.1-491(h) (1985 Repl. Vol.).
47. Albemarle County Code sec. 27-2.2.10.
48. Timothy Henderson, Jeffrey Trauberman, and Tara Gallagher. 1984. *Groundwater: Strategies for State Action* (Washington, D.C.: Environmental Law Institute), 108.
49. *Id.,* 109.
50. Commonwealth of Virginia, Board of Housing and Community Development, 1984. *Virginia Uniform Statewide Building Code.*
51. *Va. Code Ann.* sec. 21-89 *et seq.* (1985 Repl. Vol).
52. *Va. Code Ann.* sec. 21-89.7 (1985 Repl. Vol.).
53. *Va. Code Ann.* sec. 21-89.5 (1985 Repl. Vol.).
54. Southern Tier Central Regional Planning and Development Board. 1985. *Final Report of the Central and Southern Tier Groundwater Critical Recharge Area Project* (Albany, N. Y. State Department of Environmental Conservation, A-21.
55. Henderson, 111.
56. Juliana Potter. 1984. *Local Ground-Water Protection: A Sampler of Approaches Used by Local Government* (Madison: University of Wisconsin-Extension), 5.
57. *Wis. Stat.* sec. 92.15.
58. Potter, 5.
59. Dept. of Environmental Management. *Preliminary) Design Manual for BMP Facilities* (Fairfax County, Va., 1980
60. *Va. Code Ann.* sec. 15.1-292 (1981 Repl. Vol.).
61. Dillon's Rule as found in *Merriam* v. *Moody's Exec'rs,* 25 Iowa 163 (1868).
62. Edith G. Tanenbaum, "Hydrogeologic Zoning on Long Island," in David M. Nielsen and Linda Aller, eds. *Proceedings of the Sixth National Ground-Water Quality Symposium* (Worthington, Ohio: National Water Works Association, 1983), 58.
63. *Id.,* 60.
64. Clarke County Zoning Ordinance sec. 4-H-1 *et seq.*
65. *Id.,* sec. 4-H-2-a(1),(2).
66. Zoning Ordinance 4.2-5, Watershed Districts.
67. Potter, 2; also see DiNovo, 105.
68. EPA 1, A14 to A27.
69. 42 U.S.C. 3000(f) *et seq.*
70. 42 Fed. Reg. 51620 (1977).
71. Office of Technology Assessment. *Protecting the Nation's Groundwater from Contamination* (Washington, D.C.: Office of Technology Assessment).
72. EPA 1, 12.
73. Section 1.09, Groundwater Standards.
74. Henderson, 78.
75. Spokane County, Washington. *Critical Materials Handbook* sec. 4.16A.200.
76. Bird, 35.
77. Virginia Water Control Board. *Information Bulletin 551: Know Your Land* (Richmond, 1982).
78. Arleen O'Donnell. 1982. *Groundwater Protection: A Guide for Communities* (Boston: Metropolitan Area Planning Council), 44.
79. *Id.,* 45.
80. New England River Basins Commission, 1980. *Before the Well Runs Dry: A Handbook for Designing a Local Water Conservation Plan* (Washington, D.C.: Federal Emergency Management Agency), 6.
81. *Id.*
82. U.S. Environmental Protection Agency. 1977. *Legal and Institutional Approaches to Water Quality Management Planning and Implementation* (Washington, D.C.: EPA), III-26.
83. *Va. Code Ann.* sec. 15.1-14 to 15.1-15 (1981 Repl. Vol.).
84. *Va. Code Ann.* sec. 15.1-292 (1981 Repl. Vol.).
85. *Va. Code Ann.* sec. 15.1-237 (1985 Cum. Suppl.).
86. Telephone conversation with Roy Thorpe, County Attorney, Montgomery County, Virginia, April 16, 1986.
87. Henry Hughes and Lyle Raymond, "Preventing Household Contamination," File No. 85-8(C), August 28, 1985 (Ithaca: Cornell University Center for Environmental Research), 4.
88. This list is from Timothy Herbert, Domenic Forcella and W. David Conn (1986). *Household Hazardous Waste Management in Virginia: A Guide for Local Government* (Blacksburg: Household Hazardous Waste Management Project). The pamphlet provides excellent information to any locality seeking to plan a cleanup day.
89. Phone conversation with Ewell Templeton, director of economic and industrial development, Montgomery County, Virginia, April 4, 1986.
90. See Virginia Division of Litter Control, *Virginia Recycling Guide* for information on how to start a recycling collection center; Virginia Division of Litter Control, *Guide to Household Recycling* and Virginia Office of Emergency and Energy Services. "The Job's Not Finished 'Til the Oil's Recycled."

BMPs are recommended practices for engaging in activities that are likely to cause pollution over a large area. For example, BMPs are available for spraying pesticides and fertilizers, maintaining home septic systems, controlling urban stormwater runoff, spreading salts used to deice roadways, pursuing urban construction, and prevent excessive irrigation.

DEVELOPING A LOCAL PROGRAM FOR GROUNDWATER PROTECTION

The statutory authority of Virginia's local governing bodies will be an important factor in shaping the kinds of groundwater protection devices they may utilize and the overall groundwater protection program they can formulate and implement. Table 3 summarizes the authors' evaluation of local authority in Virginia to protect groundwater supplies. Authority was rated as strong, with the exception of zoning and eminent domain, if specific enabling legislation exists to support implementation of the tool. Zoning was placed in the moderate category because of uncertainties caused by decisions of the Virginia State Supreme Court. There also are some questions concerning the applicability of eminent domain to watershed protection schemes. Hazardous materials ordinances were placed in the moderate category because of the Virginia Water Control Board's work to develop a program for managing underground storage of hazardous materials. Local authority to utilize the tools in the weak category appears even more unsure. Finally, the non-existent category includes those techniques that are either forbidden by the state courts or held by state regulatory agencies.

Virginia's local governing bodies are currently best equipped to handle potential groundwater pollution problems caused by new development in urban and suburban areas. Localities do have authority to enact zoning ordinances, erosion control ordinances, site plan ordinances, and subdivision ordinances as long as they conform to the uniform state building code. However, these tools do not affect agricultural sources. Another area in which local authority appears to need strengthening is prevention of contamination from existing sources. Best management practices are the most effective tools for preventing contamination from existing sources. However, Virginia localities lack the authority to require that agricultural and existing urban sources implement BMPs.

As suggested in the previous section, additional legislation would aid local governments in the state to protect their groundwater resources. There is still a great deal they can accomplish, however, even without such legislation. Virginia's current legal and institutional frameworks make three preconditions essential for successful development of a local groundwater protection program: organization, education, and desire. Desire comes first in a local governing body's commitment to devote time and resources to protecting its drinking water supplies. That commitment then must be translated into community understanding of the importance of groundwater protection and acceptance of the steps needed to protect the resource. An educational program provides important support. Good organization, however, may be the key element. Not only does a well-conceived program express the local governing body's commitment to preventing groundwater contamination, but it also (1) helps ensure efficient utilization of scarce local resources; (2) provides a basis for developing community support; (3) is less susceptible to legal challenge; and (4) has the best chance of actually protecting the groundwater resource.

I. Steps in Developing a Groundwater Protection Program

Although a groundwater protection program must be tailored to meet local needs and conditions, there are some important steps common to all well-organized groundwater protection planning efforts. These steps are designed to fulfill the pre-conditions of organization, education, and desire.

A. Know, Educate and Involve Your Public

Groundwater protection requires a commitment of local resources. The commitment of resources to groundwater protection may require a decrease in the resources available for achieving other local goals. Decisions about how local resources should be allocated involve value choices. If not all goals can be equally accommodated, some method of setting priorities must be used. Many of the tools best able to protect groundwater also require some modification of strongly held political and cultural values concerning the inviolability of private property.

Thus, local officials need to consider citizen values in developing and implementing a groundwater protection program. The best way to incorporate these values is through public participation. One of the first steps a locality considering groundwater protection should take is establishment of a Groundwater Steering Committee. This committee would take the lead in organizing the resource and problem assessments and in investigating program goals and objectives. However, as in any policy-making process, there are certain key points where a wider public should be involved. These are the goal setting and option evaluation stages where better policies and less conflict usually result from utilizing such participation techniques as workshops, seminars, and study group discussions. Public hearings are generally not a good technique for generating real dialogue. Too often misinformation becomes part of the record and, therefore, of the public's knowledge.

In particular, local officials should remember that it is often the way a topic is presented to the public, rather than the topic itself, that generates opposition. With good organization and understanding of public values and potential points of opposition, many sources of resistance can be identified, and often neutralized, in advance. A citizen education program can contribute to lessened resistance by increasing awareness of local dependence on groundwater, the resource's vulnerability, the most likely sources of contamination, the most effective protection techniques, and the economic advantages and disadvantages of protecting, or failing to protect, groundwater.

One of the most important points to remember is that facts do not always speak for themselves. It is necessary to clearly identify the problem and program goals for the public and present citizens with sufficient supporting information so that they can relate suggested programs to public and private needs.[1] The connection between solving the problem and cultural and political values also should be stressed. Effective communication is important in developing citizen understanding and support.

B. Know Your Resource

Localities cannot design effective groundwater protection programs — or ones capable of withstanding legal challenge — without an adequate understanding of the nature, location, and hydrogeology of their groundwater resource. Most essential is understanding the recharge zone for local groundwater supplies and the amount and rate of infiltration required to maintain its yield. Without such data, localities are only guessing at the best approach to providing protection. Table 2 lists information useful in developing a groundwater protection program.

Much of this information can be drawn from existing sources. In Virginia, the Virginia Water Control Board, Soil Conservation Service, Richmond office of the United States Geological Survey, Virginia Department of Health, Division of Soil and Water Conservation, the University of Virginia, and Virginia Tech can provide useful data. The more information the locality begins with, the better. However, not every piece of information in Table 2 is essential and much can be accomplished without spending exorbitant amounts of time and money on gathering data. The purpose of the information is to help local decision makers decide how vulnerable the resource is and what kind of protection it needs. For example, if the recharge area is small then the best strategy may be fee-simple purchase. That strategy would be obviously impractical if the aquifer recharge area is large, contains very permeable (where a pollutant would soak very rapidly through the soil) soils or lies in two localities.[2]

C. Know Your Problems

The first section of this handbook described the major sources of groundwater pollution problems. Prior to developing a groundwater protection plan or program a locality should analyze available information on which potential sources of contamination exist within its political jurisdiction, how large those sources are, and where they are located. This information is helpful in generating public support for groundwater protection and in choosing the most effective groundwater protection tools. Understanding of existing or potential sources of groundwater contamination can be developed by identifying (1) the amount of agricultural land in the jurisdiction and its location in relation to important recharge areas and drinking water wells; (2) the location of local businesses and industries that could produce hazardous or toxic wastes and the amount and type of waste generated; (3) location of road salt storage facilities; and (4) the age of local gas stations and petroleum and/or heating oil suppliers' facilities and their distance from water supply wells or important recharge areas. Thought should be given to prioritizing potential contamination sources in terms of likelihood, potential magnitude and extent, and effects on the most important groundwater supplies once this information is gathered.

TABLE 2
Hydrogeologic Information Needs

Surficial Geology map	distribution and types of major unconsolidated deposits
Bedrock topography map	topographic configuration of bedrock
Water-table map	elevation of water table
Saturated thickness map	most favorable areas for supplies
Groundwater potential map	locations most hydrogeologically favorable for new supplies
Cone of depression	aquifer area where groundwater is drawn directly into the well
Potential well sites	from saturated thickness map, groundwater potential map, and any test drillings
Primary recharge areas	areas where water percolates down into the aquifer
Interrelated surface waters	surface waters and/or wetlands that contribute to aquifer recharge

Source: Arleen O'Donnell, 1982. *Groundwater Protection: A Guide for Communities* (Boston: MAPC), 19-20.

D. Know Your Goals and Objectives

It is not possible to develop a well-organized and effective groundwater protection program without knowing (1) what needs to be protected and (2) the degree of protection required.[3] The information gathered concerning the current quantity and quality of the resource, local dependence on it for drinking water, and potential sources of pollution all contribute to determining local goals. In addition, setting goals and objectives involves knowing the local citizenry's values and priorities. Extensive public input at this stage can help prevent many conflicts later.

E. Know the Tools

Once the locality understands its groundwater resource, the problems facing it, and local objectives for protecting it, then it is time to consider the protection tools discussed in Section 2. Table 4 summarizes the most effective groundwater protection tools for handling each source of pollution identified in Section 1. Utilization of Tables 3 and 4 allows local government officials in Virginia to know which of the most effective techniques fall within their current legal authority. It provides a starting place for localities as they assess the available groundwater protection tools. However, localities should not proceed beyond this point without consulting their attorneys for information related to specific conditions within the political jurisdiction. In addition, Appendix F provides information on model ordinances and some suggestions on how to formulate ordinances that incorporate some of these tools.

In addition, localities may want to consider a recently developed mapping tool called DRASTIC, a standardized system for evaluating groundwater pollution potential. DRASTIC relies on existing information and does not require extensive technical expertise to implement. Its goal is to provide localities with a planning tool for application in areas 100 acres or larger in size that will help them locate aquifers with the greatest pollution potential. Resources then can be targeted to protecting those areas of greatest need and greatest importance to the community. DRASTIC can be used whenever three conditions are met: (1) the pollutant is located on the

TABLE 3
Strength of Local Authority to Implement Groundwater Protection Tools

	Authority			
Tool	Strong	Moderate	Weak	Nonexistent
Classification System				X
Contaminant and Source Classification			X	
Zoning		X		
Numerical Standards				X
Voluntary Agricultural BMPs	X			
Mandatory Urban BMPs (new development)		X		
Voluntary Agricultural BMPs	X			
Mandatory Agricultural BMPs				X
Mandatory Urban BMPs (existing developments)				X
Product Bans				X
Site Plan Ordinances		X		
Effluent Limits				X
Hazardous Materials Ordinances		X		
Subdivision Ordinances	X			
On-site Waste Disposal Ordinances				X
Erosion Control Ordinances	X			
Eminent Domain		X		
TDR			X	
PDR		X		
Household Cleanup Days	X			
Recycling Programs	X			

surface; (2) water flushes the pollutant into the groundwater; and (3) the pollutant has the sarne mobility as water. The states of Maine, Idaho, and Florida and the U.S. EPA's Office of Pesticide Programs and Drinking Water and Office of Groundwater Protection currently are using the system.

F. Know the Relevant Law

Find out what federal and state laws are available to protect local groundwater supplies and use them. Investigate whether local conditions and goals warrant applying for a sole source aquifer designation or participation in the Safe Drinking Water Act's wellhead protection program. Search out current state policies and programs such as the Division of Soil and Water Conservation's cost-share program for BMP implementation and find out how they work in your political jurisdiction. This step can avoid duplication of effort and the unnecessary expenditure of resources. Appendix G summarizes existing federal laws relevant to groundwater. Once Virginia completes its groundwater protection strategy, any local plans should be carefully crafted to complement it.

G. Know Where the Help Is

Appendix C lists sources of information on some important groundwater protection tools and Appendix H summarizes the groundwater-related roles and responsibilities of state agencies. In addition, the Virginia Water Resources Research Center has developed educational materials and programs related to groundwater and can provide leads on information sources. Cooperative Extension agents also have much valuable information. Reliance on these sources first can greatly reduce the cost and work of formulating a groundwater protection program. Even if a consultant's services are required, the more information available in advance, the less those services will cost. Appendix I lists the addresses and phone numbers of potential sources of help in the state.

II. The Best of Times, the Worst of Times

Often faced with increased competition for decreasing resources and citizen demands for progress — continued economic development to broaden the tax base — local governing bodies realistically are concerned that now may be the worst of times to suggest new programs, especially ones requiring regulations. But it also is the best of times to develop a groundwater protection program. The time to protect the resource base needed for future development is now, while the quality of Virginia's groundwater still is good.

Local governments need to recognize one overriding fact. Prevention of contamination is essential to maintenance of adequate drinking and industrial water supplies from groundwater sources. Virginia's legal and institutional framework does present some obstacles to local protection of groundwater. More important obstacles in many cases are local failure to organize, educate and make a commitment to protection of this hidden resource. Currently, Virginia's localities have a unique opportunity to develop protection programs suited to their particular values, needs, and circumstances. However, if they fail to act and manage to hinder action by other governmental levels with complaints about interference with local authority, they must be willing to accept the economic and health consequences. Pollution prevention is the key, but prevention requires local action.

III. FOOTNOTES

1. Donald R. Fessler. 1976. *Facilitating Community Change* (La Jolla, Calif.: University Associates).
2. Charles Thurow, William Toner, and Duncan Erley. 1975. *Performance Controls for Sensitive Lands: A Practical Guide for Local Administrators* (Washington, D.C.: EPA), 147.
3. DiNovo, 95.

TABLE 4

Techniques Most Suitable to Managing Common Groundwater Pollution Sources

Tools	Groundwater Pollution Source										
	Commercial and Industrial Impoundments	Pesticides	Fertilizers	Feedlots	Irrigation	Manure Spreading	Septic Systems	Landfills	Underground Tanks	Road Salts	Household Hazardous Wastes
Sensitive area protection	X			X			X	X	X	X	X
Contaminant and Source Classification	X	X	X	X				X	X		
Zoning	X			X			X			X	
Numerical Standards	X							X	X	X	
Urban BMPs	X									X	
Agricultural BMPs		X	X	X	X	X					
Product Bans							X	X			
Site Plan Ordinances	X								X	X	
Hazardous Materials Ordinances	X								X	X	
On-site Waste Disposal Ordinances							X				
Effluent Limits	X										
TDR	X						X	X	X	X	X
PDR	X						X	X	X	X	X
Household Hazardous Waste Cleanup Days											X
Recycling Programs											X
Sewer Construction							X				

APPENDIX A

Toxic or Hazardous Components of Common Products

Product	Toxic or Hazardous Components
Antifreeze (gasoline or coolant systems)	Methanol, ethylene glycol
Automatic transmission fluid	Petroleum distillates, zylene
Battery acid (electrolyte)	Sulfuric acid
Degreasers for driveways and garages	Petroleum solvents, alcohols, glycol ethers, chlorinated hydrocarbons, toluene, phenols, dichloroperchloroethylene
Engine and radiator flushes	Petroleum solvents, ketones, butanol, glycol ethers
Hydraulic fluid (including brake fluid)	Hydrocarbons, fluorocarbons
Motor oils and waste oils	Hydrocarbons
Gasoline and jet fuel	Hydrocarbons, benzene, toluene, zylene
Diesel fuel, kerosene, #2 heating oil	Hydrocarbons
Other petroleum products: grease, lubes	Hydrocarbons
Rustproofers	Phenols, heavy metals
Carwash detergents	Alkyl benzene sulfonates
Car waxes and polishes	Petroleum distillates, hydrocarbons
asphalt and roofing tar	Hydrocarbons
Paints, varnishes, stains, dyes	Heavy metals, toluene
Paint and laquer thinners	Acetone, benzene, toluene, butyl acetate, methyl ketones
Paint and varnish removers, deglossers	Methylene chloride, toluene, acetone, zylene ethanol, benzene, methanol
Paint brush cleaners	Hydrocarbons, toluene, acetone, methyl ethyl ketones, methanol, glycol ethers
Floor and furniture strippers	Zylene
Metal polishes	Petroleum distillates, petroleum naphtha, isopropanol
Laundry soil and stain removers	Petroleum distillates, tetrachloroethylene
Spot removers and dry cleaning fluids	Hydrocarbons, benzene, trichloroethylene, 1,1,1 trichloroethylene
Other cleaning solvents	Pure strength benzene, acetone
Rock salt (halite)	Sodium concentration
Refrigerants	1,1,2 trichloro-1,2,2 trifluoroethane
Bug and tar removers	Petroleum distillates, zylene
Household cleansers, oven cleaners	Zylenols, glycol ethers, isopropanol
Drain cleaners	1,1,1 trichloroethane
Toilet cleaners	Zylene, sulfonates, chlorinated phenols
Cesspool cleaners	Tetrachloroethylene, dichlorobenzene, methylene chloride
Disinfectants	Cresol, zylenols
Pesticides (insects, weeds, rodents)	Naphthalene, phosphorus, zylene, chloroform, heavy metals, chlorinated hydrocarbons
Photochemicals	Phenols, sodium sulfite, cyanide, silver halide, potassium bromide
Printing ink	Heavy metals, phenol-formaldehyde
Wood preservatives (creosote or salt)	Pentachlorophenols, copper, arsenic, chromium
Swimming pool chlorine	Sodium hypochlorite
Lye or caustic soda	Sodium hydroxide
Jewelry cleaners	Sodium cyanide
Leather dyes	Formic acid
Fertilizers (if stored outdoors)	Arsenic, nitrates, ammonium, sulfuric acid, heavy metals, formaldehyde, phosphoric acid, chlorinated hydrocarbons
PCBs	Chlorinated hydrocarbons
Carbon tetrachloride	Chlorinated hydrocarbons

Source: Scott H. Horsley "Beyond Zoning: Municipal Ordinances to Protect Ground Water," Cape Cod Planning and Economic Development Commission.

APPENDIX B

Suggestions for Drafting Zoning and Site Plan Ordinances in Virginia

I. Zoning Ordinance

A. District Regulations: No use or activity shall be established or maintained which will, or is likely to, result in violations of the public policy set out in Chapter 3.1 (State Water Control Law) of Title 62.1 (Waters of the State, Ports and Harbors), Section 62.1-44.5. Code of Virginia, as amended. Rationale: Appears duplicative of state law but purpose is to enable locality to require submission of water protection plans as part of site plan review. Otherwise, it could be argued that this requirement is not related to any substantive provision of the zoning ordinance.

B. Site Plan Ordinance Provisions
   1. Every site plan shall include:
      a. A statement of each and every product and/or by-product to be generated on or used on the premises,
      b. A plan for disposition of each product and/or by-product generated or used on the premises.
   2. Applicant shall furnish any and all information requested from state agencies in course of site plan review. (This pertains not only to water but to all state agencies, for example, highway department).
   3. Applicant shall comply with all conditions of site plan approval. (Here, the recommendations of the state agencies will be made conditions of approval by the local Planning Commission and Board of Supervisors).

C. Site Plan Procedure
   1. Upon receipt of application, staff assures it contains all necessary information, including products and by-products to be generated, method of disposal, and hydrological topography of site, if relevant.
   2. If application is complete, it is ready for site plan committee review:
      Planner
      Highway Engineer
      County Engineer
      Water and Sewer Authority
      Soil and Water Conservation District
   3. Then comes referral to state agencies:
      Air Pollution Board
      State Water Control Board
      Health Department
      Division of Mineral Resources
      Council on the Environment
      University of Virginia, Department of Environmental Sciences
      Other appropriate agencies
   4. After input from all state agencies, staff makes report, recommending incorporation of state agencies' recommendations into approval as conditions enforceable by local zoning administrator. This is how the state agencies' expert opinions, which are recommendations from them, acquire the force of law. (Of course, if applicant cannot meet requirements, application is denied). The conditions may include a provision for state and local agency officers to go on the property to monitor compliance with these conditions. From here on, it becomes a matter of enforcement. But at this point, three crucial things have been accomplished. First, the products and by-products to be produced and their capacity to influence the environment, including groundwater, have been identified. Second, the means of preventing damage to the environment, including groundwater, have been identified and put into conditions which have the force of law. Third, through the process of public hearings, citizen awareness has been raised to the point where any violation is likely to be noticed promptly because of citizen vigilance; this process results in raising public consciousness to environmental issues in general, beyond the particular project.

Source: George R. St. John, "Local Options for Groundwater Protection," in J.H. Kahn, ed. *Virginia's Groundwater: Proceedings of a Symposium Sponsored by the Environmental Defense Fund* (Blacksburg: VWRRC, 1984). 63.

APPENDIX C

Important Elements of EPA's Sole Source Aquifer Regulations

A sole or principal source aquifer is defined as one which supplies 50 percent or more of the drinking water for an area. The proposed regulations also specify six factors that must be considered in deciding whether to designate a sole source aquifer:

1. the availability of alternate sources of drinking water;
2. the size of the area and population served by the aquifer;
3. the susceptibility of the aquifer to contamination through the recharge area;
4. the location of the aquifer;
5. the number of public water systems using water from the aquifer, the number of people served by the systems, and the treatment provided by the systems; and
6. such other factors as are deemed relevant.

A significant hazard to public health means any level of a contaminant: a) which causes or may cause the aquifer to exceed any Maximum Contaminant Level set forth in any promulgated National Primary Drinking Water Regulation at any point where the water may otherwise adversely affect human health, or b) which may require a public water system to install additional treatment to prevent such adverse effects.

Federal financial assistance includes any financial benefits provided directly as aid to a project by a department, agency, or instrumentality of the Federal Government in any form, including contracts, grants, and loan guarantees. Actions or programs carried out by the Federal Government itself (e.g., dredging performed by the Army Corps of Engineers) and actions performed for the Federal Government by contractors (e.g., construction of roads on Federal lands) are not included. Federal financial assistance is limited to benefits earmarked for a specific program or action and awarded directly to the program or action.

Source: Office of Technology Assessment, *Protecting the Nation's Groundwater from Contamination* (Washington, D.C.: Office of Technology Assessment), 225.

APPENDIX D

Legal Concerns a Locality Should Address in Planning a Household Hazardous Waste Cleanup Day

1. Permit requirements

Household hazardous waste is exempt from the federal Resource Conservation and Recovery Act and corresponding state legislation in Virginia. Thus, individual consumers are not required to comply with RCRA and equivalent state regulations governing waste generation, transportation, and disposal. However, once waste is collected from individual households, whoever collects and transports the waste (e.g., a private company hired by the locality) does assume responsibility for meeting RCRA requirements as a generator and transporter. It is not necessary to obtain a permit or other form of approval from the federal Environmental Protection Agency in order to hold a collection day, but permission may have to be sought from state or local agencies (depending on the circumstances). Thus, for example, zoning laws and other ordinances should be consulted to assure that there are no conflicts.

2. Service contract

Although it is not required by law, a service contract with a licensed collection company may be desirable in order to increase the likelihood of safe, efficient handling of the waste and to provide some protection for the locality against liability claims. . . . The contract should specify the services, permits, and insurance to be provided by the collection company, the costs of all services, and provisions for the assumption of liability.

3. Liability and liability insurance

A critical question to be addressed in the negotiation of a service contract relates to liability and liability insurance. The locality may want the contracting firm to specify (a) that it will accept liability as both generator and transporter (under RCRA); (b) that it will hold the locality harmless and compensate for any claims that might be brought against the locality, arising out of death, bodily injury, property damage, contamination of the environment, or violation of government laws or regulations which are in any manner connected with the waste accepted at the site on the day of collection; and (c) that it is covered by adequate liability insurance.

However, even if the contracting firm agrees to these specifications, and even though federal and state regulations identify the generator/transporter as the liable party in the event of an accident or spill, a lawsuit involving the locality is always possible. Furthermore, it may be difficult to find a contracting firm that will agree to these specifications in the first place. But, from both humanitarian and legal perspectives, it is apparent that precautionary measures on the part of the locality, including careful preparations for any emergency response, are essential to minimize the risks associated with the collection day.

Source: Timothy Herbert, Dominic Forcella, and David Conn, 1986. *Household Hazardous Waste Management in Virginia: A Guide for Local Governments* (Blacksburg, Hazardous Waste Management Project), 8-9.

APPENDIX E

Information Sources for Selected Groundwater Protection Techniques

This appendix lists a sample of references and contacts that can provide additional information on many of the groundwater protection techniques discussed in section II. The first subhead contains the full citations for the selected published references. Each reference is listed (by author's last name) under the specific groundwater technique on which it provides information in the second subheading. The last subheading contains a list of contacts for selected groundwater protection tools.

I. General References

Central Southern Tier Regional Planning and Development Board. 1985. *Final Report of the Central Southern Tier Groundwater Critical Recharge Area Project.*

"The Chesapeake Bay and You," Virginia Department of Conservation and Historic Resources, Division of Soil and Water Conservation, 203 Governor Street, Suite 206, Richmond, VA 23219-2094 (804)786-2064

Community Groundwater Protection Project. 1984. *An Introduction to Groundwater and Aquifers, Flyer #1; Mapping Aquifers and Recharge Areas, Flyer #3;* and *Local Authority for Groundwater Protection, Flyer #4* (Lincoln: Massachusetts Audubon Society).

DiNovo, Frank, and Martin Jaffe. 1984. *Local Groundwater Protection: Midwest Region* (Chicago: American Planning Association).

Directory of Recycling Collection Centers, Virginia Division of Litter Control, 1215 Washington Bldg., Richmond 23219 (804)786-8679 (Also available from this address: *Virginia Recycling Guide* and *Guide to Household Recycling*

Environmental Protection Agency. 1977. *Legal and Institutional Approaches to Water Quality Management Planning and Implementation* (Washington, D.C.).

Harrison, Ellen, and Mary Ann Dickinson. 1984. *Protecting Connecticut's Groundwater: A Guide to Groundwater Protection for Local Officials* (Hartford: Connecticut Department of Environmental Protection).

Henderson, Timothy, Jeffrey Trauberman, and Tara Gallagher. 1985. *Groundwater: Strategies for State Action* (Washington, D.C.: Environmental Law Institute).

Herbert, Timothy, Domenic Forcella, and David Conn. 1986. *Household Hazardous Waste Management in Virginia: A Guide for Local Governments* (Blacksburg: Hazardous Waste Management Project, College of Architecture and Urban Studies, Virginia Polytechnic Institute and State University).

Hughes, Henry and Lyle Raymond. 1985. "Well Contribution Zones," File No. 85-5(C) (Ithaca: Center for Environmental Research, Cornell University).

Hughes, Henry, and Lyle Raymond. 1985. "Watershed Protection Districts," File No. 85-4(C) (Ithaca: Center for Environmental Research, Cornell University).

Hughes-Davies, Betty Ann. "Pesticide Clean-Up Days," *The Conservationist* (July-August, 1984).

Keeney, Dennis, T.C. Daniel, and Byron Shaw. 1980. *Nitrate in Wisconsin Groundwater: Sources and Concerns* (Madison: University of Wisconsin-Extension).

Kilner, Suzanne. "Groundwater Plan Sidesteps Contamination Woes," *Water Engineering and Management* (March 1984).

Koppelman, Lee, Edith Tannenbaum, and Carole Swick. 1984. *Nonpoint Source Management Handbook* (Hauppauge, N. Y.: Long Island Regional Planning Board).

Land Development for Quality Water, Virginia Division of Soil and Water Conservation, 203 Governor Street, Suite 206, Richmond, VA 23219 (804)786-2064.

The Minnesota Project. 1984. *Model Ordinance for Groundwater Protection* (Preston: Center for Public Policy Study and Community Development, Southeastern Office).

Nielsen, David, and Linda Aller, eds. 1983. *Proceedings of the Sixth National Ground-Water Quality Symposium: State, County, Regional and Municipal Jurisdiction of Ground-Water Protection* (Worthington, Ohio: National Water Well Association).

O'Donnell, Arleen. 1982. *Groundwater Protection: A Guide for Communities* (Boston, Mass.: Metropolitan Area Planning Council).

Porter, Keith, and Steven Pacenka. *Critical Groundwater Areas — A Strategy for Management* (Ithaca: Center for Environmental Research, Cornell University).

Potter, Juliana. 1984. *Local Ground-Water Protection: A Sampler of Approaches Used by Local Governments* (Madison: Geological and Natural History Survey, University of Wisconsin-Extension).

Rural New England, Inc. *Model Ordinances for Groundwater Protection* (79 Sutherland Road #5, Brookline, MA 02146).

Sensible Salting, information packet, The Salt Institute, 206 Washington Street, Alexandria, VA 22314 (703)549-4648.

Thurow, Charles, William Toner, and Duncan Erley. 1975. *Performance Controls for Sensitive Lands: A Practical Guide for Local Administrations* (Environmental Protection Agency document #600/5-75-00).

Tripp, James, and Adam Jaffe, "Preventing Groundwater Pollution: Towards a Coordinated Strategy to Protect Critical Recharge Zones," *Harvard Environmental Law Review.* 3 (1979):1-47.

Virginia Division of Soil & Water Conservation. *Erosion and Sediment Control Handbook* (Richmond).

Virginia Water Control Board. *Bulletin 551: Know Your Land* (Richmond, 1982).

Virginia Water Control Board. *Best Management Practices Handbooks.* Separate volumes are available on: Sources Affecting Groundwater, Agriculture, Forestry, Hydrologic Modifications, Surface Mining, Urban Areas, and Management (Richmond, 1979).

Water Science and Technology Board. 1986. *Ground Water Quality Protection: State and Local Strategies* (Washington, D.C.: National Research Council).

Yanggen, Douglas, and Bruce Webendorfer, (draft, 1984). *Groundwater Protection Through Local Land Use Controls* (Madison: Agricultural Economics Department, University of Wisconsin).

II. Specific References

A. Zoning

Central Southern Tier Regional Planning and Development Board, 1985,A.15-A.19,A.39-A.68.
Community Groundwater Protection Project, 1984, Flyers 1, 3, 4.
DiNovo, 1984, 3-4.
Environmental Protection Agency, 1977, 5-12.
Harrison, 1984, 28-29.
Hughes, 1985, File No. 85-5(C).
Hughes, 1985, File No. 85-4(C).
Kilner, 1984.
Koppelman, 1984, Ch. 1.
Nielsen, 1983, 57-72, 235-275, 287-290.
O'Donnell, 1982, 30-32.
Potter, 1984, 2.
Rural New England, Inc., 13-16.
Suffolk County Sanitary Code, Article 7: Water Pollution Control.
Thurow, 1975, 131-153.
Tripp, 1979, 34-46.
Water Science and Technology Board, 1986, 136-145.
Yanggen, 1984, 14-64.

B. Sensitive Area Protection

Appendix 1
Central Southern Tier, Chapter 3 Community Groundwater Protection Project, Flyer #1, 14
DiNovo, 65-87, 100-143
Environmental Protection Agency, 17-26
Harrison, 20-27, 32-34
Kilner, Metropolitan Area Planning Council, 26-34
National Water Well Association, 38-41, 51-56, 109-171
Central Southern Tier Regional Planning and Development Board, 1985, Chapter 3.
Community Groundwater Protection Project, 1984, Flyer #1.
DiNovo, 1984, 65-87, 100-143.
Environmental Protection Agency, 1977, 17-26.
Harrison, 1984, 27-34.
Kilner, 1984.
Nielsen, 1983, 38-41, 51-56, 109-171.
O'Donnell, 1982, 26-34.
Porter.
Suffolk County Sanitary Code, Article 7: Water Pollution Control.
Thurow, 1975, 121-126, 131-147.
Tripp, 1979, 3-4, 16-24, 34-40.
Yanggen, 1984, 30-31.

C. Best Management Practices

Central Southern Tier Regional Planning and Development Board, 1985, 2/60-2/62, A.23, 2/58-2/59.
Chesapeake Bay and You.
Community Groundwater Protection Project, 1984, Flyer 1.
DiNovo, 1984, 171-175, Appendix B4.
Henderson, 1985, 109-112.
Koppelman, 1984, Ch. 2, 3, 5, and 6.
Land Development for Water Quality.
The Minnesota Project, 1984.
Nielsen, 1983, 85-88.
O'Donnell, 1982, Appendix H.
Potter, 1984, 5.
Virginia Water Control Board, BMP Handbooks.
Water Science and Technology Board, 1986, 117-130.

D. Site Plan Ordinances

Central Southern Tier Regional Planning and Development Board, 1985, 2/55-2/57.
Henderson, 1985, pp. 105-109.
Koppelman, 1984, Chapter 9.
O'Donnell, 1982, Appendix D.

E. Erosion Control and Subdivision Ordinances

Community Groundwater Protection Project, 1985, Flyer 1.
Koppelman, 1984, pp. 79-86, Ordinance sections 5, 6, 8, 9, 11, 19, 20-23.
O'Donnell, 1982, Appendix E.
Potter, 1984, p. 3.
Rural New England, Inc., pp. 17-18.
Thurow, 1975, pp. 134-136.
Yanggen, 1984, pp. 18-24.
Virginia Division of Soil and Water Conservation, 1980.

F. Household Hazardous Waste Clean-up Days

DiNovo, 1984, pp. 136-138.
Herbert, 1986.
Hughes, 1985, File No. 85-8(C).
Hughes-Davies, 1984.

G. Recycling Programs

"The Job's Not Finished 'Til The Oil's Recycled."
"Directory of Recycling Collection Centers."

III. Contacts

A. Zoning

Robert Usherson, Acting Supervisor Metropolitan Planning
Division Dade County Planning Department
111 Northwest First Street, Suite 1220
Miami, FL 33128-1972
(305) 375-2800

Bill Ganek, Director of Planning, City Planning Department
240 Commerce Drive
Crystal Lake, IL 60014
(815) 459-2020

Bob Lee, County Administrator
Clarke County
100 N. Church Street
Berryville, VA 22611
(703) 955-3269

Arthur Kunz, Deputy Director
Suffolk County Department of Planning
H. Lee Dennison Building
Veterans Memorial Highway
Hauppauge, NY 11788
(516) 360-5191

B. Household Hazardous Waste Clean-up Days

Connecticut Department of Environmental Protection
Leslie Lewis, Citizens' Participation Coordinator
Information and Education Unit
State Office Building
Hartford, CT 06106
(203) 566-3489

Cape Cod Planning and Economic Development Commission
Gary Prahm, Hazardous Waste Planner
First District Courthouse
Barnstable, MA 02630

Broome County Environmental Management Council
Claudia Stallman, Senior Environmental Planner
Government Plaza, County Office Building
Box 1766
Binghamton, NY 13902
(607) 772-2116

Florida Department of Environmental Regulation
Amnesty Days, Bureau of Operations
Jeane White, Information Specialist
2600 Blairstone Boulevard
Twin Towers Office Building
Tallahassee, FL 32301
(904) 487-3892

C. Recycling Programs

Ewell "Rocky" Templeton
Economic and Industrial Development
Montgomery County Courthouse
Christiansburg, VA 24073
(703) 382-5732

APPENDIX F
Model Ordinances

This appendix provides some suggestions for drafting zoning ordinances and includes examples of several types of local ordinances discussed in the text. It should be emphasized that the point of including them is to demonstrate concretely the ordinances localities have considered or implemented. No locality should attempt to use these examples without examining closely (1) their applicability to the particular local situation and (2) whether the ordinance's requirements fall within local authority.

Suggestions for Framing an Ordinance

There are five major parts to any ordinance: (1) goals; (2) standards; (3) reporting and recordkeeping requirements; (4) enforcement procedures; and (5) method of appeal. Each of these needs to be written as clearly and simply as possible. It aids clarity to set forth the most general, most important, and most frequently used material at the beginning of each section. Section and subsection headings should summarize the provision's content and, whenever possible, drafters should use charts and/or tables to improve comprehension of the regulation.[1]

Some Sample Ordinances

Following are samples of (1) overlay (hydrogeologic) zoning ordinances; and (2) site-plan review and subdivision rules. Each should be examined in terms of your specific local needs and local authority in Virginia to formulate and implement similar regulations.

[1] Paul Rasmussen. "Drafting Ordinances," in Stuart Merck and Edith N. Netter, eds. 1983. A Planner's Guide to Land Use Law (Chicago: American Planning Association Press).

The first ordinance presented is Clarke County, Virginia's overlay zoning regulation. This ordinance allows establishment of a Natural Resource Conservation Overlay District in the groundwater recharge area for the Clarke County Sanitary Authority's Boyce-Millwood Public Water System and in other areas of the county where groundwater needs special protection.

H. NATURAL RESOURCE CONSERVATION OVERLAY DISTRICT

1. General Intent (4-H-1)

The Natural Resource Conservation District (RC) is designed to apply special regulations to the groundwater recharge area of the Prospect Hills groundwater recharge area of the Prospect Hills Spring, which serves as the source of the Clarke County Sanitary Authority's Boyce-Millwood Public Water System. In addition, one (1) or more of the Districts may also be applied, subject to the provisions of Article 10 of this Ordinance or amendments thereto, to such other areas of Clarke County as may be determined by reasonable scientific investigation and analysis to warrant special protection in the interest of significant public benefit and need. The purpose of the District is to protect those water resources in Clarke County which are necessary to serve adequately and efficiently the public need, health and welfare, to preserve the natural environmental qualities and function of the land to purify water before it reaches such resources, and to prevent the use and development of land in designated water resource recharge areas in a manner tending to affect adversely the quantity and/or quality of such significant water resources or tending to destroy or have a substantially adverse effect on such resources by virtue of pollution of the land and water by foreign substances, including noxious or hazardous biological and/or chemical substances, materials, and/or wastes, whether gas, liquid, or solid.

2. Use Regulations (4-H-2)

a. RC District: (4-H-2-a)

Development and use of land permitted in accordance with the district regulations for the underlying zoning district may be permitted within the RC district, provided the developer presents satisfactory evidence that such use and development is compatible with the general intent and purpose of the Natural Resource Conservation District, as stated in Section 4-H-1, and that such proposed use and development will not have an adverse effect upon the environment. These provisions shall not apply to any uses and structures which otherwise legally existed as of July 20, 1983, provided such existing uses and structures shall be subject to the provisions of Section B-D of this Ordinance, nor shall these provisions apply to ordinary gardening activities in lawn or garden areas which are primarily for home consumption. No person shall engage in any land-disturbing activity within the district in the absence of an approved erosion and sedimentation control plan prepared in accordance with the provisions of the Clarke County Erosion and Sedimentation Control Ordinance. In no event shall the following uses or development of land within the district be permitted: Mining, and/or extraction of natural resources; drilling, other than for private, on-site source of potable water; sanitary land filling, application, depositing, spreading or spraying of any hazardous or toxic chemical and/or biological materials or substances except applications of such pesticides and/or herbicides as may be required under emergency situations and as such applications of pesticides and/or herbicides may be permitted by the Zoning Administrator upon an affirmative recommendation from the Virginia Cooperative Extension Service; underground storage of any chemical or petroleum products for commercial or industrial purposes; storage, disposal, and/or land application of sludge, residue and/or effluent resulting from treatment, storage, disposal or reclamation of sewage and industrial wastes; animal confinement operations (feedlots). Residential use and development of the land within the district may be permitted in accordance with the provisions of the underlying zoning district, except that such residential use and development shall be subject to the following conditions:

(4-H-2-a-(1))
(1) Any lot upon which a new dwelling is to be located, if such dwelling is to be served by an individual subsurface septic system, shall have a minimum lot area of two (2) acres;

(4-H-2-a-(2))
(2) Maximum lot coverage by all impervious surfaces shall not exceed twenty percent (20%);

(4-H-2-a-(3))
(3) On-site individual subsurface septic systems shall be permitted only in accordance with Page Seventeen (17) of the report of Schnabel Engineering and Associates, Contract VB2600, Hydrogeologic and Engineering Study, Prospect Hills Spring, Clarke County, Virginia, dated May 2, 1983, and where applicable, such systems shall be designed, placed and constructed only in accordance with the recommended guidelines for installation thereof set forth in Appendix B of the aforesaid report of Schnabel Engineering Associates (Contract V82600).

The next model ordinance is an example of an overlay bylaw adopted by a Massachusetts community in 1982. It creates three zones that were derived from a map showing relative groundwater significance. Area 1 includes the area of influence of all existing and proposed municipal wells. The major aquifer and primary recharge zones are in Area 2. Area 3 includes secondary recharge areas. Most intensive land uses are prohibited in Area 1. Fewer restrictions are imposed on Areas 2 and 3.

Aquifer Protection District

1. Purposes — In addition to the purpose of Section 1-A of this bylaw, the purposes of this district are:

   a. To protect, preserve and maintain the existing and potential ground-water supply and ground-water recharge areas within the known aquifers of the town.

   b. To preserve and protect present and potential sources of water supply for the public health and safety.

   c. To conserve the natural resources of the town.

   d. To protect the ground water and ground-water recharge areas of the town from adverse development of land-use practices

2. Special Definitions — The following definitions apply to specialized words or terms associated with this district.

   a. Aquifer — Geologic formation composed of rock or sand and gravel that contains significant amounts of potentially producible potable water.

   b. Area of Influence — The area which experiences drawdown by a pumping well as plotted on a two-dimensional (map) surface, usually ellipsoidal in shape.

   c. Cone-of-depression — A three-dimensional conical concavity produced in a water table by a pumping well.

   d. Glaciofluvial — Pertaining to an unconsolidated geologic deposit which was formed by, or in association with glacial meltwater streams, typically resulting in the deposition of sand and gravel-sized particles.

   e. Glaciolacustrine — Pertaining to an unconsolidated geologic deposit which was formed by, or in association with a glacial lake environment, typically resulting in the deposition of sand, silt and clay-sized particles. References to such deposits within this bylaw refer to the more coarse-grained sediments such as would be associated with a delta.

   f. Ground Water — The subsurface water present in aquifers and recharge areas.

   g. Impervious Surface — Material on the ground that does not allow significant amounts of surface water to penetrate into the soil.

   h. Leachable Wastes — Waste materials including solid wastes, sludge and agricultural wastes that are capable of releasing waterborne contaminants to the surrounding environment.

   i. Mining of Land — The removal of geologic materials such as topsoil, sand and gravel, metallic ores or bedrock.

   j. Process Wastes — Nondomestic, nontoxic, nonhazardous, liquid or solid waste by-products associated with the manufacture or preparation of a product, including but not limited to hardware, dry goods, foodstuffs and printed material.

   k. Recharge Areas — Areas composed of permeable, porous materials that collect precipitation or surface water and transmit it to aquifers.

   l. Sanitary Waste — Wastewater arising from ordinary domestic water use as from toilets, sinks and bathing facilities, and containing such concentrations and types of pollutants as to be considered normal wastes.

   m. Saturated Thickness — The depth of permeabale soil actually saturated with water to the capacity of the soil to contain water under normal conditions of temperature and pressure.

   n. Solid Wastes — Any discarded solid material, putrescible or non-putrescible, consisting of all combustible and non-cumbustible solid material including, but not limited to, garbage and rubbish.

   o. Toxic or Hazardous Materials — Any substance or mixture of such physical, chemical or infectious characteristics as to pose a significant actual or potential hazard to water supplies, or other hazard to human health, if such substance or mixture were discharged to land or waters of this town. Toxic or hazardous materials include, without limitation, organic chemicals, petroleum, heavy metals, radioactive or infectious wastes, acids and alkalines, and include products such as pesticides, herbicides, solvents and thinners. Also refer to Section 1-D of this bylaw.

   p. Wetlands — As defined by M.G.L. Chapter 131, Section 40. Also refer to Section V-1 of this bylaw.

3. Establishment and Delineation of Aquifer Protection District

   For the purpose of this district, there are hereby established within the town certain aquifer protection areas, consisting of aquifers and/or aquifer recharge areas. Aquifers and aquifer recharge areas are determined by standard geologic and hydrologic investigations which may include drilling observation wells, utilizing existing boring data and stratigraphic profiles, conducting seismic surveys or other geophysical techniques, performing pumping tests, water sampling and geologic mapping. The boundaries of this district, exclusive of C.2 which follows, are delineated on maps at a scale of 1 in. = 600 ft. entitled Aquifer Protection District, town of Holliston on file in the office of the inspector of buildings, which maps are hereby made part of this bylaw. These boundaries reflect the best hydrogeologic information available as of the date of the maps. In the event of a discrepancy between the map and the criteria of Areas 1, 2 and 3, which follow, the criteria shall control. The Aquifer Protection District includes the aquifer itself, the land above the aquifer and the aquifer's significant areas of recharge consisting of:

   A. Area 1 — Area of influence of all existing and proposed (confirmed by long-term pump test) municipal wells within the town.

      1. The cones-of-depression and respective areas of influence and recharge generated by the municipal wells after at least five (5) days of continuous pumping at their respective rated capacities.

   B. Area 2 — Major aquifers and primary areas of recharge.

      1. All of the four principal aquifers within the town of Holliston, including: 1) the Hopping Brook Aquifer; 2) the Jar Brook Aquifer; 3) the Lake Winthrop Aquifer; and 4) the Dopping Brook Aquifer as delineated on the town of Holliston Aquifer Protection District maps (scale: 1 in. = 600 ft.).

      2. Any unconsolidated geologic deposit exhibiting an average saturated thickness of 20 ft. or greater and an average of transmissivity of 1,000 ft. squared/day or greater.

C. Area 3 — Secondary recharge areas.

1. All land contiguous to Area 2, above, underlain by glaciofluvial or glaciofluvial/lacustrine deposits in which the direction of ground-water flow is toward Area 2, which precedes.

2. Contiguous wetlands, water bodies, or streams which contribute surface-water flow to Area 2, which precedes.

4. Use Regulations — The Aquifer Protection District shall be considered as overlaying other zoning districts. Any uses permitted in the portions of the districts so overlaid shall be permitted subject to all the provisions of this district. Within the Aquifer Protection District, these regulations shall apply:

A. The following uses are permitted within the Aquifer Protection District subject to 4.B hereafter, provided that all necessary permits, orders or approvals required by local, state or federal law shall have been obtained.

1. Area 1:

a. nonintensive agricultural uses: pasture, light grazing, hay, gardening, nursery, conservation, forestry and harvesting provided that fertilizers, herbicides, pesticides and other leachable materials are not stored outdoors or in any other manner which would permit leakage thereof. Where the application is being made of fertilizers, pesticides, herbicides or other potential contaminants, ground-water quality monitor test wells may be installed and periodically sampled and tested at the town's expense. Test wells shall be located by a professional geologist, hydrologist or engineer trained and experienced in hydrogeology. Sampling will be conducted by an agent of the board of health;

b. necessary public utilities/facilities designed so as to prevent contamination of ground water;

c. residential development of single family dwellings on lots of at least 80,000 sq. ft. in area, such that no more than 5 percent of the building lot is rendered impervious and on-site domestic sewage disposal does not exceed 55 gal/day per 10,000 sq. ft. of lot area;

d. commercial development limited to retail shopping, business or professional office or industrial development limited to storage of nontoxic, nonhazardous materials on lots of at least 80,000 sq. ft. in area such that no more than 20 percent of the building lot is rendered impervious; roof, parking and drive run-off is recharged on-site to the maximum extent practicable with parking and drive runoff discharged to oil/gas trap catch basins with appropriate sumps prior to recharge; and on-site domestic sewage disposal is less than or equal to 55 gal/day per 10,000 sq. ft. of lot area;

e. any other use as permitted in an AR-1 or AR-2 district, subject to 4.B hereafter, with a minimum lot size of 80,000 sq. ft., maximum sewage volumes of 55 gal/day per 10,000 sq. ft. of lot area and maximum impervious cover of 5 percent;

f. structures existing at the effective date of this bylaw may be maintained, repaired or altered, including the addition of accessory buildings or uses, provided that such alteration or addition shall not increase the total amount of impermeable surface on the lot, or the volume of on-site septic disposal by more than 50 percent beyond said amounts and volumes existing at the effective date of this bylaw.

2. Area 2:

a. uses permitted in Area 1, which precedes, and the following uses to the extent permitted in the underlying district;

b. residential development of single family dwellings on lots of at least 40,000 sq. ft. in area, such that no more than 10 percent of the building lot is rendered impervious and on-site sewage disposal is equal to or less than 110 gal/day per 10,000 sq. ft. of lot area;

c. commercial development limited to retail shopping, business or professional office or industrial development limited to storage of nontoxic, nonhazardous materials on lots of at least 40,000 sq. ft. in area such that no more than 40 percent of the building lot is rendered impervious; roof, parking and drive run-off is recharged on-site to the maximum extent practicable with parking and drive run-off discharged to oil/gas trap catch basins with appropriate sumps prior to recharge; and on-site sewage disposal is less than or equal to 100 gal/day per 10,000 sq. ft. of lot area;

d. any other use to the extent permitted in an underlying AR-1 or AR-2 district, subject to 4.B hereafter, with a minimum lot size of 40,000 sq. ft., maximum sewage volumes of 110 gal/day per 10,000 sq. ft. of lot area and maximum impervious cover of 10 percent.

3. Area 3:

a. all uses permitted in Area 2, which precedes, and;

b. uses permitted in the underlying districts, subject to 4.B hereafter, such that run-off waters from constructed impervious surfaces shall be treated and discharged to the ground-water system to the extent practicable. Note: For all uses in Areas 2 and 3, installation of a private water source (i.e., on-site wells) is encouraged. Uses within Area 1 will require tie-in to the municipal water supply system where estimated water requirements exceed 500 gallons per day.

B. The following uses are specifically prohibited:

1. Area 1:

a. disposal by any means of any waste material, solid or liquid, other than domestic sanitary wastes;

b. Outdoor or underground storage or storage otherwise permitting of leakage of leachable, potentially noxious materials including but not limited to chemicals, fertilizers, manure, petroleum products, road salt and deicing compounds;

c. uses which, as part of normal operating or maintenance procedures, would involve the application, transfer, storage or use of toxic or hazardous materials;

d. any use or application of toxic or hazardous materials, even in small application or as accessory to a nonrelated practice;

e. the commercial mining of land.

2. Area 2:

a. disposal of solid wastes other than brush and stumps;

b. the disposal of liquid or leachable wastes other than sanitary domestic wastes or innocuous process wastes;

c. storage of road salt or deicing chemicals;

d. automotive service and repair shops, junk and salvage yards;

e. car washes;

f. dry-cleaning establishments;

g. metal plating or etching;

h. chemical and bacteriological laboratories;

i. any other use which involves as a principal or accessory activity the manufacture, storage, use, transportation or disposal of toxic or hazardous materials.

3. Area 3:

a. disposal of solid wastes other than brush and stumps;

b. storage of road salt or deicing chemicals;

c. any use which involves as a principal activity the manufacture, storage, use, transportation or disposal of toxic or hazardous materials.

C. The following uses are permitted only under the terms of a special permit issued by the Zoning Board of Appeals and subject to 4.B which precedes.

1. Area 1:

a. any use involving the retention of less than 50 percent of lot area in its natural state with no more than minor removal of existing trees and ground vegetation;

b. the mining of land strictly for on-site use, subject to the provisions of Section V-E hereof;

c. expansion of existing nonconforming uses to the extent allowed by paragraph 3 of Section 1-C hereof;

d. uses calling for greater impervious cover than prescribed in Section V-L, 4.A.1.c, provided that plan calls for an on-site method of recharging proposed increases in run-off waters.

2. Area 2:

a. any use involving the retention of less than 30 percent of lot area in its natural state with no more than minor removal of existing trees and ground vegetation, or rendering impervious more than 40 percent of lot area;

b. any use involving on-site disposal of process wastes from operations other than personal hygiene and food for residents, patrons and employees;

c. any use other than a single-family dwelling with a sewage flow, as determined by Title 5 of the State Environmental Code, exceeding 110 gal/day per 10,000 sq. ft. of lot area or exceeding 15,000 gal/day regardless of lot area;

d. expansion of existing or nonconforming uses to the extent allowed by the underlying district. The Board of Appeals shall not grant such approval unless it shall find that such expansion shall not be substantially more detrimental to the water supply than the existing use. In no case shall such permit be issued for a prohibited use under 4.B which precedes.

3. Area 3:

a. expansion of existing or nonconforming uses to the extent allowed by the underlying district. The Board of Appeals shall not grant such approval unless it shall find that such expansion shall not be substantially more detrimental to the water supply than the existing use. In no case shall such permit be issued for a prohibited use under 4.B.

D. Procedures of Issuance of Special Permit

1. Each application for a special permit shall be filed with the town clerk for transmittal to the Zoning Board of Appeals (ZBA) and shall be accompanied by 10 copies of the plan. Such special permit shall be granted if the ZBA determines, in conjunction with other town agencies as specified in Section D.2 which follows, that the intent of this bylaw as well as its specific criteria are met. In making such determination, the ZBA shall give consideration to the simplicity, reliability and feasibility of the control measures proposed and the degree of threat to water quality which would result if the control measures failed. The ZBA shall explain any departures from the recommendations of the other town agencies in its decision.

2. Review by other town agencies. Upon receipt of the special permit application, the town clerk shall transmit one copy each of the board of health, town engineer if any, inspector of buildings, Conservation Commission, Planning Board and water commissioners for their written recommendations. Failure to respond in writing to the clerk of the ZBA within 45 days shall indicate approval by said agencies.

3. The ZBA shall hold a hearing in conformity with the provisions of G.L. Ch. 40A, s.9, within 65 days after the filing of the application with the special permit granting authority and after the review of the aforementioned town bodies. Notice of the public hearing shall be given by publication and posting and by first-class mailings to "parties in interest" as defined in G.L. Ch. 40A, s. 11. The decision of the ZBA and any extension, modification or renewal thereof shall be filed with the special permit-granting authority and town clerk within 90 days following the closing of the public hearing. Failure of the special permit granting to act within 90 days shall be deemed as a granting of the permit. However, no work shall commence until a certification is recorded as required by said s. 11.

4. After notice and public hearing, and after coordinating, clarifying and weighing the comments and recommendations of the board of health, the town engineer if any, inspector of buildings, the Conservation Commission, the Planning Board, and the water commissioner, the ZBA may grant such a special permit provided that it finds that the proposed use:

a. is in harmony with the purpose and intent of this bylaw and will not materially adversely affect the purpose of the Aquifer Protection District;

b. will not, during construction or thereafter, have an adverse environmental impact on any aquifer or recharge area in the town;

c. will not adversely affect an existing or potential water supply, and;

d. is consistent in light of existing and probable future development of surrounding areas.

Source: Walter S. Mulica and Michael A. Beck, "Municipal Ground-Water Supply Protection and Management Techniques in Massachusetts" in David M. Nielsen and Linder Alder, eds. 1983. **Proceedings of the Sixth National Ground-Water Quality Symposium.** (National Water Well Association):291-300.

This model site-plan review ordinance was developed by the Boston Metropolitan Area Planning Council (MAPC). It emphasizes performance standards to protect groundwater and requires a site-plan review of all construction except that involving a single-family or two-family dwelling.

MODEL SITE-PLAN REVIEW BYLAW

A. Purpose

The purpose of site plan review is to ensure that the design and layout of certain developments permitted as of right (or by special permit) will constitute suitable development and will not result in a detriment to the neighborhood or the environment.

In considering a site plan the (Special Permit Granting Authority (SPCA)) shall assure:

a. Protection of adjacent areas against detrimental or offensive uses on the site by provision of adequate surface water drainage, buffers against light, sight, sound, dust, and vibration, and preservation of light and air;

b. convenience and safety of vehicular and pedestrian movement within the site and in relation to adjacent areas;

c. adequacy of the methods of disposal for wastes;

d. protection of environment features on the site and in adjacent areas;

e. adequate protection to prevent pollution of surface waters and groundwater.

B. Projects Requiring Site Plan Review

No building, other than a (single-family or two-family dwelling or building accessory to such dwelling) shall be erected or externally enlarged by more than 10 percent of gross floor area (or, no business or industrial building shall be erected or externally enlarged, and no business or industrial use shall hereafter be established or expanded in ground area) except in conformity with a site plan bearing an endorsement of approval from the (SPA), the (SPA) shall adopt regulations for carrying out its duties under this section.

C. Procedure

1. An applicant for site plan review under this section shall file with the (SPA) _____ copies of each of an application and a site plan. Unless this requirement is waived by the (SPA), the site plan shall be prepared by an engineer, architect, or landscape architect.

2. The site plan shall show all *existing and proposed* buildings, existing and proposed contour elevations, structures, parking spaces, driveway openings, driveways, service areas, facilities for sewage, refuse and other waste disposal and for surface-water drainage, wetlands, surface water, areas subject to the 100-year flood, maximum groundwater elevation, location of aquifers, private or public wells and drinking-water supplies in relation to the site, and landscape features such as fences, walls, planting areas, walks, and lighting, both existing and proposed. The site plan shall also show the relation of the above features to adjacent ways and properties. The site plan shall also show all contiguous land owned by the applicant or by the owner of the property which is the subject of the application.

3. The applicant shall submit such material as may be required regarding measures proposed to prevent pollution of surface or groundwater, soil erosion, increased runoff, and flooding.

4. The applicant shall submit such materials as may be required regarding design features intended to integrate the proposed new development into the existing landscape, to enhance aesthetic assets, and to screen objectionable features from neighbors.

5. The applicant shall submit such material as may be required regarding the projected traffic flow patterns into and upon the site for both vehicles and pedestrians and an estimate of the projected number of motor vehicle trips to and from the site for an average day and for peak hours.

6. The (SPA) shall, within five days of receipt, transmit to the planning board, the building inspector and the conservation commission copies of the application and site plan. The boards receiving these copies shall have up to 40 days to make recommendations to the (SPA).

7. The (SPA) shall hold a public hearing within 45 days of receipt of an application and shall take final action within 90 days from the time of hearing, as provided in G.L. ch. 40a, s 9 and 11, (and in section _____ of this bylaw/ordinance, relating to special permit procedures). Such final action shall consist of either (1) a finding and determination that the proposed project will constitute a suitable development and will not result in detriment to the neighborhood or the environment or (2) a written denial of the application stating the reasons for such denial. Approval may be made subject to conditions, modifications and restrictions as the (SPA) may deem necessary; and any construction, reconstruction, alteration or addition shall be carried on only in conformity to such conditions, modifications or restrictions and in conformity with the application and the site plan.

8. (If the planning board is the special permit authority under this section, it shall, insofar as practical, adopt regulations establishing procedures for submission of a combined plan and application which shall satisfy this section and the board's regulations under the Subdivision Control Act.)

9. Projects reviewed by other town boards are exempt as follows: (Note: any exemptions would be listed here).

D. Criteria for Approval

1. The site plan shall show adequate measures to prevent pollution of surface or groundwater by soil erosion, increased runoff, changes in groundwater level, and flooding.

2. The development design shall be integrated into the existing landscape to enhance aesthetic assets and to screen objectionable features from neighbors.

3. The site plan shall show adequate measures to prevent traffic congestion and dangerous access within the site and onto existing town ways.

4. The site plan shall protect adjacent areas against detrimental or offensive uses on the site by providing adequate surface-water drainage, buffers against light, sound, dust, noise, and vibration.

5. The site plan shall show adequate methods for disposal of wastes.

All site plans complying with this section and which do not tend to impair the health, safety, convenience and welfare of the inhabitants of the town in general shall be approved.

Source: Arleen O'Donnell, 1982. *Groundwater Protection: A Guide for Communities* (Metropolitan Area Planning Council).

This model subdivision ordinance also was developed by the Boston MAPC. However, in contrast with the model site-plan review ordinance, it relies more heavily on technology-based standards.

MODEL SUBDIVISION RULES AND REGULATIONS FOR GROUNDWATER PROTECTION

1. Definitive Subdivision Plan Submission Requirements:

   — proposed system of drainage, including the location of all wetlands, water bodies, streams, open drains and ditches (natural or man-made) and flowage rights, public and private, adjacent to or within the proposed subdivision , in a general manner.

   — zoning classification of all land shown in the plan including overlay zoning such as flood-plain, watershed, or aquifer districts.

   — the board may require soil surveys and/or test pits or borings to suitability of the land for the proposed ways, drainage, and utilities.

   — existing and proposed drainage including drainage areas inside the subdivision, areas outside the subdivision which drain into it, and the route, for all existing and proposed drainage discharging from the subdivision, to the primary receiving water course or other body of water. Calculations shall be figured on the modified soil-cover complex method, unless the board agrees to some other method, using at least 50-year frequency storm data.

   — size and location of existing and proposed water-supply mains and their appurtenances, hydrants, sewer pipes, and their appurtenances and/or sewage disposal systems, storm drains and their appurtenances, and easements pertinent thereto, and curbs and curb dimensions, including data on borings and soil test pits, and methods of carrying water to the nearest watercourse or easements for drainage as needed, whether or not within the subdivision.

   — if surface water drains will discharge onto adjacent existing streets or onto adjacent properties not owned by the applicant, the applicant shall clearly indicate what course the discharge will take, and shall present to the Board evidence from the Town Engineer or the owner of adjacent property that such discharge is satisfactory and permitted by public or private ownership of adjacent street or property.

   — maximum groundwater table elevation and direction of groundwater flow.

   — location of base-flood elevation (100-year frequency storm) if encountered within 100 feet of subdivision.

2. Environmental Analysis

   — any subdivision creating frontage potentially allowing (fifteen) or more lots shall be based on an Environmental Analysis and, in addition, the Board may require for subdivisions of fewer than 30 lots that certain of the following be submitted where such information is necessary to evaluate the plan because of special circumstances of the location or proposal including, but not limited to, proximity to aquifers, surface water supplies, or municipal wells. Environmental analyses shall be prepared by an interdisciplinary team to include a Land Surveyor, Civil Engineer, and Architect or Landscape Architect, unless otherwise agreed to by the planning board. The following documentation is required from an environmental analysis:

   a. The plans shall show the following:

   — the same data as on the definitive plan, reproduced as a clear acetate, or mylar overlay.

   — topography at two-foot contour intervals, with graphic drainage analysis, and indication of the 100-year flood elevation.

   — vegetative cover analysis, including identification of general cover type (wooded, cropland, brush, wetland, etc.), location of all major tree groupings, plus other outstanding trees or other botanical features, important wildlife habitats, and identification of areas not to be disturbed by construction.

   — soil types, based on the most recent U.S. soils study, maximum groundwater level, location and results of soil percolation, or other subsurface tests.

   — for subdivisions located within identified aquifer or recharge areas the environmental analysis shall include an analysis of open and closed drainage system alternatives, examining effects upon the basin water budget and upon the speed of transport of contaminants.

   — location of surface water bodies, wetlands, aquifer or recharge areas for existing or potential drinking water supplies.

   b. A narrative statement also shall be submitted, documenting the following, with references to the above maps as germane:

   — impact upon surface water quality and level.

   — impact upon groundwater quality and level.

   — capability of soils, vegetative cover and proposed erosion control measures to support proposed development without erosion, silting or other instability.

   — relationship to G.L. ch. 131, s. 40.

   c. The report also shall estimate the effect of the project on the town water supply, and proposed water-conservation measures.

   d. The environmental analysis shall include proposed methods of mitigating surface and groundwater impacts, and maximizing recharge.

3. Design Standards

   a. Design and construction shall reduce, to the extent possible, the following:

   — encroachment within any wetland or floodplain,

   — volume of cut and fill,

   — area over which existing vegetation will be disturbed, especially if within 200 feet of a river, wetland or waterbody or in areas having a slope of more than 15 percent,

   — number of trees removed having a diameter over 12" dbh,

   — extent of waterways altered or relocated, and

   — dimensions of paved areas (including streets) except as necessary to safety and convenience, especially in aquifer/recharge areas.

b. Design shall maximize, to the extent possible, maintenance within the subdivision of runoff and vegetative cover equivalent to conditions before development.

c. Easements: Where a subdivision is traversed by a water course, drainage way, channel or stream, the board shall require a storm water easement or drainage right-of-way of adequate width and proper side slope as determined by the town engineer to conform substantially to the lines of such water course, drainage way, channel or stream, and to provide access for construction or other necessary purposes. In no case shall the width be less than twenty (20) feet or the side slopes be steeper than three (3) horizontal or one (1) vertical.

d. Pollution control devices: Within aquifer or recharge areas, provisions for contaminant removal shall be made employing detention basins with subsurface drains or perforated risers, oil and grit separator catchbasins, or other appropriate devices. Sanitary sewer pipes shall be reinforced with sealed joints.

e. Curbing: Curb and gutter may be eliminated along certain roadways, when drainage is provided in swales which are designed to reduce the rate of runoff, restore and/or supply needed water to vegetation in the street right-of-way.

f. Trees: Street trees of nursery stock shall be planted on each side of the street in a subdivision, except where the definitive plan shows trees along the ways which are healthy and adequate, which shall be retained. Street trees shall be located outside the right-of-way or at the discretion of the board within the unpaved portion of the right-of-way approximately at forty foot (40') intervals; shall be at least twelve feet (12') in height; two inches (2") in caliper measured four feet (4') above the approved grade (dbh); shall be planted each in at least one-half (1/2) cubic yard of topsoil, unless otherwise required by the tree warden and/or town engineer; and be not closer than five (5') nor more than twenty feet (20') from said right-of-way line unless otherwise approved by the board. Trees shall be properly planted, wrapped and guyed to insure their survival. The developer will be liable for all trees so planted as to their erectness and good health after planting and until the release of all guarantees.

Except as otherwise provided, all cut bankings shall be planted with a low growing shrub or vine and wood chipped to a minimum depth of six inches (6") or seeded with a deep-rooted perennial grass to prevent erosion.

Other landscaping along ways may be required by the board.

g. Road Salt: The board may limit the use of deicing chemicals on ways located over aquifer and recharge areas for existing or potential drinking-water supplies or where runoff may affect drinking water reservoirs or wells.

h. Protection of Natural Features: All natural features, such as trees, wooded areas, water courses, scenic points, historic spots, shall be preserved as much as possible. Any clearance, backfilling, cutting, thinning or other disturbance to trees twelve inches (12") or over in diameter measured four feet (4') above finished ground level, located within the minimum front setback distance shall be prohibited unless deemed both proper by the board and not in conflict or contradiction to the intent of Section 3(c). Any such proposed clearance shall be shown on the plan and written reasons therefore may be requested by the board. Tree wells or retaining walls should be installed when and as requested by the town engineer for suitable grading around trees. Tree wells or retaining walls shall be of such design to meet the standards as set fourth in the Tree Experts Manual or some similar publication.

i. Open Space: The board may require the plan to show a park or parks, suitably located for playground or recreation purposes or for providing light and air. The park or parks shall not be unreasonable in area in relation to the land being subdivided and to the prospective uses of such land and shall be at least equal to one (1) acre of land for each twenty (20) single family dwelling units or fraction thereof shown on the plan. For all non-residential subdivisons, the park shall be equal to three (3) times the floor area of all other dwelling units, and ten (10) percent of the land area. The board may, by appropriate endorsement on the plan, require that no building be erected upon such park or parks without its approval for a period of three (3) years. Each area reserved for such purpose shall be of suitable area, dimensions, topography, and natural character for the purpose of a park and/or playground. The area or areas shall be so located as to serve adequately all parts of the subdivision as approved by the board. The board may require that the area or areas reserved shall be located and laid out so as to be used in conjunction with similar areas of adjoining subdivision or of probable subdivisions.

j. Sediment Control: In order to reduce erosion accompanying the installation of ways, utilities and drainage, and the resultant pollution of streams, wetlands and natural drainage areas, the applicant shall submit a sediment control plan, including control methods such as berms, dikes, detention ponds, mulching, and temporary sodding.

k. Drainage: Storm drains, culverts, and related facilities shall be designed to permit the unimpeded flow of all natural water courses, to ensure adequate drainage at all low points along streets, to control erosion and to intercept storm-water runoff along streets at intervals reasonably related to the extent and grade of the area being drained. To the maximum extent feasible, storm water shall be recharged rather than piped to surface water. Peak stream flows and runoff at the boundaries of the development in a 100-year frequency storm shall be no higher following development than prior to development in aquifer-recharge areas and no more than five percent higher in other areas.

l. Lot Drainage: Lots shall be prepared and graded consistent with drainage into the subdivision and in such a manner that development of one shall not cause detrimental drainage on another or on areas outside the subdivision, to the extent permitted by law. If provision is necessary to carry drainage to or across a lot, an easement or drainage right-of-way of a minimum width of twenty feet (20') and proper side slopes shall be provided.

m. Design Method: Design shall be based upon the modified soil cover complex method and ULI Residential Storm Water Management, 1975, and Guidelines for Soil and Water Conservation in Urbanizing Areas of Massachusetts (SCS USDA 1975), unless alternative methods or sources are approved by the planning board. Water velocities in pipes and gutters shall be between two (2) and ten (10) feet per second, and not more than five (5) feet per second on ground surfaces. Where the water table is not too high and where the soil is reasonably permeable, drainage may feature swales, detention ponds and multi-use areas, as described in the following section, "Methods for Controlling Peak Discharges from Urbanizing Areas" (SCS Guidelines) and described more fully in "Water Resources Protection Measures in Land Development" — A Handbook of the University of Delaware Water Resources Center, Newark, DE, Dec. 1974 (prepared for the Office of Water Resources Research, U.S. DOI). Open drainage systems as described in this publication may be required for recharging groundwater provided that runoff is not seriously polluted.

Source: Arleen O'Donnell, 1982. Groundwater Protection: A Guide for Communities (Metropolitan Area Planning Council).

APPENDIX G

Summary of Selected Federal Laws Affecting Groundwater

by Stephen Goldstein

(1) SAFE DRINKING WATER ACT OF 1974 (PL 93-523, 42 U.S.C.A. Secs. 300f-300j-10), AMENDED VARIOUSLY IN 1976, 1977, 1979, 1980 AND MOST RECENTLY IN 1986 (signed into law June 19, 1986.)

The Safe Drinking Water Act of 1972, as amended, aims to protect water quality at the tap, whether it comes from groundwater or elsewhere. The law requires the EPA to set primary (health-based) and secondary (welfare-based) groundwater quality standards for all drinking water supplies nationwide. Primary standards deal with Maximum Contaminant Levels (MCLs) for substances found in groundwater. The EPA adopted interim primary standards for coliform bacteria, cloudiness, inorganic chemicals and a few organic chemicals in December 1975, and MCLs for such contaminants as radioactive elements, heavy metals and nitrates, and/or organic pesticides and trihalomethanes for only community water supplies with fewer than 10,000 customers. By 1984, the EPA had established no MCLs for such groundwater contaminants as trichloroethylene, chloroform, PCBs and DDT.[1] However, it had "established MCLs for nine heavy metals, coliform bacteria, six pesticides, trihalomethanes. . ., turbidity, and radiation. EPA has also promulgated secondary drinking water standards for twelve contaminants such as chloride, color, forming agents, odor, sulfate and solids."

The standards apply to "public water systems," which supply water regularly to at least 15 connections or to at least 25 persons for at least 60 days per year, including most industrial or commercial sites supplying water to employees, customers or both. The law exempts a site that only stores or distributes water, obtains its water from a regulated water supply, sells no water, and does not carry people in interstate commerce. Variances and exceptions from the primary drinking water standards are available to public water supply systems unable to meet an MCL despite their best technological attempts. Cost or the condition of a raw water supply may earn a variance with an indefinite deadline for compliance.[2]

The SDWA's Underground Injection Control (UIC) program, whose regulations were adopted in 1980 and amended in 1981 and 1982, aims "to prevent groundwater contamination by the underground disposal of wastes via wells."[3] The law "requires the EPA to publish both a list of states where underground injection control (UIC) programs would be necessary to prevent endangerment of drinking water and to propose regulations for approval of state UIC programs. EPA listed all states as requiring UIC programs and states were supposed to submit their applications by the end of January 1981."[4] Virginia has not applied for primacy under this section.

The SDWA also allows the EPA to designate a "sole-source aquifer," to protect an area whose sole source of drinking water would create a significant public health hazard if contaminated. The EPA had designated 21 sole-source aquifers nationwide as of May 1986 and was considering 16 additional applications, including one from Clarke County, Virginia[5]

The latest version of the SDWA allocates $164.4 million annually through 1991; the FY 1986 (ending Sept. 30) appropriation was $91 million. The bill (S 124) that President Reagan signed on June 16 instructs the U.S. Environmental Protection Agency to set standards for 83 contaminants of drinking water within three years. These contaminants include benzene, polychlorinated biphenyls (PCBs) and cyanide. The 1986 amendments to the SDWA also require the EPA to create a new federal groundwater protection program aimed at protecting wellhead areas (the areas surrounding public drinking water supply wells).

(2) COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT OF 1980 (CERCLA, also known as the "Superfund Law"), 42 U.S.C.A. 9601-9657 (PL 96-510), amended in 1982 (PL 97-216 and PL 97-272), in 1983 (PL 98-45) and most recently in 1985 (PL 99-160)

CERCLA, or the "Superfund Law" (nicknamed for one of its major provisions), "created the first comprehensive federal law responses to releases of hazardous substances to the environment."[6]

The law called for a national inventory of inactive hazardous waste sites and establishment of a program for appropriate environmental response action "to protect public health and the environment from the dangers posed by such sites." The law also authorized the administrator of the U.S. Environmental Protection Agency to act in an emergency to help contain such sites, and it holds liable for the cleanup of a site any identifiable parties.[7]

Usually "the owner or operator of a vessel or facility from which there is a release to the environment" is responsible for cleaning up a discharge, but generators of hazardous waste or the transporters of the waste shipped to a site also may be held responsible. If the responsible parties do not voluntarily clean up the discharge, the EPA may order them to do so or may use federal funds to clean up the discharge and then seek recovery from the responsible parties." The two funds to pay for cleanups, the Hazardous Substance Response Trust Fund (Subtitle B) and the Post-Closure Liability Fund (Subtitle C), were scheduled for congressional reauthorization.[8]

The CERCLA initially established a $600-million, four-year Hazardous Waste Response Fund (the "Superfund"), derived equally from fees charged to the chemical and petroleum industries and federal appropriations.[9] The fund grew to $1.6 billion. In late June 1986, a Congressional conference committee was still deliberating changes in the CERCLA focusing on ways to refinance the CERCLA for another five years for $8.5 billion.[10]

An EPA study in 1979 estimated 30,000 to 50,000 inactive and uncontrolled hazardous waste sites existed in the United States and that 1,200 to 2,000 presented a serious risk to public health. Congress also noted growing public opposition to new hazardous waste sites and foresaw the possibility future sites may have to be on federal or state lands. The EPA also estimated 77.1 billion pounds of hazardous waste was produced each year, but only 10 percent was disposed of in an environmentally safe manner.[11]

"The blueprint for cleanup and remedial action is the National Contingency Plan (NCP), which had been developed originally under Section 311 of the Clean Water Act." CERCLA Section 105 expanded this plan to include discharges into the air and onto the land from land-based sites, not only discharges into navigable waters.

Hall[12] summarizes most of the eight subparts of the NCP. Among them, Subpart B outlines the responsibilities of federal, state and local departments and agencies and the private sector; Subpart D requires a regional contingency plan for each federal region; Subpart E refers to the oil spill response provisions implementing the Clean Water Act; and Subpart F relates to responses to the release of "hazardous substances," as defined by the statute.[13]

EPA has reached agreements on settlements and consent degrees "with a number of private potentially responsible parties" that facilitate cleanups of hazardous sites with private funds. For example, 109 companies of 289 identified as potentially responsible helped pay for cleaning up the Chem-Dyne waste site at Hamilton, Ohio, in August 1982, and more than 200 hazardous waste generators settled with the government on the cleanup of the Enviro-Chem site in Zionsville, Ind. In the latter case, the government sued a few generators who did not agree to the settlement.[14]

CERCLA allows states to set up their own "Superfund" laws to impose additional liability for hazardous waste cleanups, except that it blocks additional compensation under any state law or other federal law for the same claim satisfied under CERCLA. States may impose additional liabilities beyond CERCLA, however.

According to Hall, "Virtually all states have some kind of hazardous waste management and cleanup laws. Most, for examples, have adopted statutes which are similar to the Resource Conservation and Recovery Act (RCRA) in order to obtain interim authorization or final authorization to manage that regulatory program. (M)any states have response and cleanup authorities which are similar in nature and purpose to the federal Superfund law."

(3) RESOURCE CONSERVATION AND RECOVERY ACT OF 1976 42 U.S.C.A. Secs. 6901 et seq' (PL 94-580: Oct. 21, 1976, amended in 1978, 1980, 1982, 1983, 1984, and most recently by PL 99-160, Nov. 25, 1985).

"RCRA is basically a regulatory statute, designed to provide cradle to grave management of hazardous waste by imposing management requirements on generators and transporters of hazardous materials and upon owners and operators of treatment, storage and disposal facilities. It does not address what has come to be recognized as the equally serious problem of abandoned and inactive sites." The "Superfund" law, the Comprehensive Environmental Response, Compensation and Liability Act of 1980[15] deals with those sites.[16]

Subtitle C is considered to be the most significant of its nine subtitles.[17] Including Sections 3001 to 3019, it covers the RCRA Hazardous Waste Management Program. Subtitle D, Sections 4001-4010, covers non-hazardous waste. By 1988, Subtitle D, governing state and regional solid waste plans, will require the states to manage the program, or the U.S. Environmental Protection Agency will do it.[18]

Objectives of RCRA include a prohibition of open dumping on land and requiring existing open dumps to be converted into sites that do not threaten the environment or human health; and the creation of a federal-state partnership to carry out Subtitle C.[19]

"Under Subchapter C of RCRA, generators and transporters of hazardous waste, as well as owners and operators of hazardous waste treatment, storage and disposal facilities are subject to regulations designed to identify, track and ensure the proper handling and final disposition of hazardous wastes. In addition, subtitle I, added in November 1984, requires EPA to develop regulatory requirements for owners and operators of underground storage tanks containing petroleum products and certain other substances by May 1987. These regulations must include (1) corrosion-resistant tanks whenever new or replacement tanks are installed, (2) maintenance of a leak detection system; (3) methods for reporting releases; (4) requirements for taking and reporting corrective actions; and (5) tank closure requirements.

(4) CLEAN WATER ACT OF 1977, AMENDING THE FEDERAL WATER POLLUTION CONTROL ACT OF 1972 BY REPLACING IT, and amended variously thereafter, most recently by PL 99-88 IN 1985.

Congress responded to a need to regulate water pollution by enacting The Federal Water Pollution Control Act of 1972. The Clean Water Act of 1977 significantly changed the earlier law and replaced it in more than just a title. The five major parts of the law include: "(1) a permit program, (2) a system of minimum national effluent standards for each industry, (3) water quality standards, (4) provisions for special problems such as toxic chemicals and oil spills, and (5) a construction grant program for publicly owned treatment works (POTWs)."[20]

Congressional amendments in 1977 addressed toxic pollution more effectively and responded to issues of definition and policy raised by court rulings and EPA decisions. Amendments in 1978 dealt with spills of hazardous substances, and amendments in 1980 and 1981 revised portions of the construction grant program for POTWs.[21]

Section 101 of the Clean Water Act of 1977, "Declaration of Goals and Policy," articulates the law's objective "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." These goals include (1) eliminating "the discharge of pollutants into the navigable waters . . . by 1985;" an interim goal of water quality, "wherever attainable" by July 1, 1983, that protects and sustains fish, shellfish and wildlife and "recreation in and on the water;" (2) prohibiting "the discharge of toxic pollutants in toxic amounts;" (3) providing federal financial help to build "publicly owned waste treatment works;" (4) developing and implementing planning processes for area management of waste treatment to control pollution sources in each state adequately; and (5) making a national effort in major research and the development of the technology to eliminate the discharge of pollutants into the navigable waters and the oceans.

The policy emphasized, however,[22] that each state retains jurisdiction over the quantities of water within its jurisdiction and that federal agencies will cooperate with state and local agencies on "comprehensive solutions to prevent, reduce and eliminate pollution" consistent with the management of water resources.

"The principal mechanism for achievement of the goals and objectives propounded originally by the 1972 Act is a system for imposing effluent limitations on, or otherwise preventing, discharge of 'pollutants' into any 'waters of the United States' from any 'point source.'" The National Pollutant Discharge Elimination System (NPDES) requires the disclosure of the amounts and nature of discharges, authorizes the U.S. Environmental Protection Agency to specify the limits on such discharges, requires dischargers to monitor and report how well they comply or fail to comply with these limits, and authorizes the EPA and citizens to force dischargers to comply with the limits.

5) THE TOXIC SUBSTANCES CONTROL ACT OF 1976, 15 U.S.C. Sections 2601-2829, authorizes the EPA to control the manufacture, use and disposal of toxic pollutants, indirectly protecting groundwater by allowing the EPA "to control and even prohibit manufacture, use, storage, distribution or disposal of a substance if it may present an unreasonable risk."[23]

"The primary purpose of the act is to assure that chemical substances and mixtures do not present an unreasonable risk of injury to health or the environment."[24] The TSCA and the Federal Insecticide, Fungicide and Rodenticide Act (see below) "require that manufacturers register these chemicals, submit periodic reports, and meet labeling and packaging standards for toxic substances."[25]

6) THE FEDERAL INSECTICIDE, FUNGICIDE AND RODENTICIDE ACT (Federal Environmental Pesticide Control Act of 1972, as amended in 1975, 1978 and 1980 as 7 U.S.C. 135-135K) manages pesticide use and disposal and gives the EPA "broad powers to regulate pesticides and . . . to review the environmental effects associated with a pesticide. . . ."

Two other laws that relate to groundwater protection: The Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. Section 1201, authorizes the U.S. Department of the Interior "to prevent the contamination of groundwater that could result from strip mining. . . . Areas especially susceptible to drinking water contamination from a mining operation can be designated unsuitable for mining."[26]

The National Environmental Policy Act of 1969, 42 U.S.C. Section 437l, declares as national policy for all federal agencies "to encourage productive and enjoyable harmony between people and the environment and the promotion of efforts to prevent or eliminate damage to the environment" and atmosphere.[27] The National Environmental Policy Act can help identify and prevent groundwater contamination by requiring evaluation and study of all federal actions "for their potential adverse effects on the environment, including groundwater."[28]

1. Timothy Henderson, Jeffrey Trauberman, and Tara Gallagher, 1984. *Groundwater: Strategies for State Action*, Environmental Law Institute, Washington, D.C., second printing January 1985, 36-7; Frank DiNovo and Martin Jaffe, 1984. *Local Groundwater Protection, Midwest Region,* American Planning Association, Chicago, 43.
2. Jeffrey C. Miller, "Safe Drinking Water Act," Chapter 5 in J. Gordon Arbuckle, et al., *Environmental Law Handbook,* Eighth Edition, 1985 (Rockville, Md.: Government Institutes, Inc.) 200.
3. *Id.,* 201
4. Wendy Gordon, 1984. *A Citizen's Handbook on Groundwater Protection,* National Resources Council, Inc., 44.
5. Miller, 205.
6. Office of Technology Assessment. *Protecting the Nation's Groundwater from Contamination* (Washington, D.C.; Office of Technology Assessment).
7. Ridgway M. Hall, Jr., and Nancy S. Bryson, Comprehensive Environmental Response, Compensation and Liability Act (Superfund), Chapter 7 in J. Gordon Arbuckle, et al., *Environmental Law Handbook,* Eighth Edition, 1985, 109.
8. *U.S.C. Congressional and Administrative News,* 1980, Vol. 5, 6119.
9. *Environmental Statutes,* 1986 Edition, 654-58, Hall, 110, 130-37.
10. *U.S.C. Congressional and Administrative News,* 1980, Vol. 5, 6119.
11. *Environment Reporter,* May 23, 1986, 84.
12. *U.S.C. Congressional and Administrative News,* 1980, Vol. 5, 6120, 6123-24.
13. Hall, 117-18.
14. CERCLA, Sec. 101(14).
15. Hall, 130.
16. CERCLA; 42 U.S.C.A. Sec. 9601 *et seq.*, PL 96-510.
17. Hall, 61.
18. *Id,* 62.
19. Clay Erving, technical director, Governmental Refuse Collection & Disposal Association, at Radford, Va., seminar, June 26, 1986.
20. See Sec. 1003 for these and other objectives.
21. J. Gordon Arbuckle and Timothy Vanderver, Jr. *Environmental Law Handbook* eighth edition (Rockville, Md.: Government Institutes, Inc., 1985).
22. *Id.,* 267-68.
23. Sec. 101(g).
24. Gordon, 48.
25. *Protecting the Nation's Groundwater from Contamination,* Congress of the United States, Office of Technology Assessment, October 1984, 70, 75.
26. DiNovo, 41.
27. Gordon, 48.
28. *Protecting the Nation's Groundwater from Contamination,* 68; for a summary of major federal laws related to the protection of groundwater quality, see Table 11, 66-71.
29. Gordon, 48.

APPENDIX H

State Agency Groundwater Responsibilities

A. State Health Department
1. onsite sewage disposal regulation
2. solid and hazardous waste regulation (RCRA and CERCLA)
3. public water supply regulation
4. water well construction standards
5. municipal sludge disposal regulation

B. Virginia Water Control Board
1. statewide groundwater resource management (specifically NPDES permits/no-discharge certificates)
2. groundwater monitoring
3. data collection and management
4. groundwater research/modeling

C. Department of Mines, Minerals and Energy
1. geologic mapping
2. mine regulation
3. gas and oil well regulation

D. Council on the Environment
1. interagency environmental coordination (including environmental impact statement review)

E. Department of Conservation and Historic Resources, Division of Soil and Water Conservation
1. agricultural and urban nonpoint source pollution control
2. soils mapping

F. Department of Housing and Community Development
1. land use planning assistance to localities

G. Department of Agriculture
1. regulation of pesticide and herbicide applicators

H. Cooperative Extension Service
1. pollution education programs
2. agricultural groundwater withdrawal data collection

Source: Gerald Seeley. Virginia Water Control Board, Richmond, (1986).

APPENDIX I

Sources of Help for Developing Local Groundwater Protection Plans

Virginia Water Control Board
Groundwater Programs
Gerard Seeley
2111 N. Hamilton Street
Richmond, VA 23230
(SCATS) 327-6304

Dept. of Mines, Minerals and Energy
Robert Milici, State Geologist
Natural Resources Building
McCormick Road
Charlottesville, VA 22903
(SCATS) 257-6308

Dept. of Housing and Community Development
Div. of Housing and Community Services
Curtis McIver
205 N. Fourth Street Office Building
Richmond, VA 23219-1747
(804) 786-7891

Virginia Cooperative Extension Service
Agriculture and Natural Resources Program
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061
(703) 961-6707

Soil Conservation Service
400 N. Eighth Street
Room 9201
Richmond, VA 23240-9999
(804) 771-2461

Virginia Association of Counties
Old City Hall
Tenth and Broad Streets
Richmond, VA 23219
(804) 788-6652

U.S. Environmental Protection Agency
Region III Groundwater Office
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-9800

Department of Health
Division of Water Programs
Eric H. Bartsch
James Madison Building
109 Governor Street
Richmond, VA23219
(804) 786-1760

Division of Soil and Water Conservation
203 Governor Street, Suite 206
Richmond, VA 3219
(804) 86-3998

Department of Agriculture
Product and Industry Regulation Division
Washington Building
Capitol Square
Richmond, VA 23219
(804)786-3523

Virginia Water Resources Research Center
Kathryn P. Sevebeck, Education Director
617 N. Main Street
Blacksburg, VA 24060
(703) 961-5624

U.S. Geological Survey
3600 W. Broad Street
Richmond, VA 23220
(804) 771-2427

Virginia Municipal League
James Campbell
700 Travelers Building
Richmond, VA 23219
(804) 643-0264

VIRGINIA WATER RESOURCES RESEARCH CENTER
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
BLACKSBURG, VIRGINIA