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FROM THE GROUNDWATER UP: LOCAL LAND USE PLANNING AND AQUIFER PROTECTION

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I. INTRODUCTION

Water is a resource that many people take for granted. The infrastructure of modern industrial society has made possible vast and sophisticated public water supply systems which provide clean fresh water at the turn of a tap. Much of this water is drawn from artificially constructed and managed surface water reservoirs, but much of it also comes from unseen sources below ground. Though groundwater is shielded from sight, it is not always shielded from contamination. Consequently, the pollution of underground water supplies has become a serious policy problem.[1] There is reason to be concerned—about one-half of the population of the United States already depends on groundwater as a primary drinking water supply.[2] Groundwater is important not only for rural areas without public water systems, but also in more densely populated areas, where it is a strategically located source of clean water.[3]

Urban areas, of course, are also more exposed to pollution. Hor-

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1. *See, e.g.*, E. Harrison & M. Dickinson, Protecting Connecticut's Groundwater: A Guide to Groundwater Protection for Local Officials (Connecticut Department of Environmental Protection 1984) [hereinafter DEP]; M. Huffmire, Regulation of Land Use Practices for Areas Surrounding Aquifers—Economic and Legal Implications (Univ. of Conn. Inst. of Water Resources) (n.d.).

2. Burmaster, *The History and Extent of the Groundwater Pollution Problem*, 95 AAAS SELECTED SYMP.: GROUNDWATER POLLUTION: ENVTL. & LEGAL PROBS. 45 (1984) [hereinafter Burmaster]; Dycus, *Development of a National Groundwater Protection Policy*, 11 B.C. ENVTL. AFF. L. REV. 211, 212 (1984) [hereinafter Dycus]; Roberts & Butler, *Information for State Groundwater Quality Policymaking*, 24 NAT. RESOURCES J. 1015 (1984) [hereinafter Roberts & Butler]; Tangley, *Groundwater Contamination: Local Problems Become National Issue*, 34 BIOSCIENCE 142, 144 (1984) [hereinafter Tangley].

3. Josephson, *Restoration of Aquifers*, 17 ENVTL. SCI. & TECH. 347A (1983) [hereinafter Josephson].

ror stories of particular incidents such as Love Canal[4] and the contamination of public wells in Woburn, Massachusetts[5] have captured the public imagination, but these examples are only the tip of the iceberg as pollution from a vast array of sources continues to infiltrate into groundwater.[6] Nationally, less than one percent of the groundwater available for consumption is estimated to be contaminated.[7] However, at the local level, thirty-nine public wells supplying water to thirteen cities in California's San Gabriel Valley have been closed due to contamination from trichloroethylene (TCE).[8] In Atlantic City, New Jersey, seepage from the notorious Price's Pit hazardous waste dump has forced the closing of seven municipal wells which accounted for approximately forty percent of the city's tap water.[9] One-third of the towns sampled in Massachusetts were found to have contaminated wells,[10] and eighty-seven percent of the water samples tested in a recent Connecticut survey were found to contain synthetic organic chemicals.[11]

But despite the ubiquity of the danger, the site-specific nature of groundwater pollution has made it primarily a state and local government responsibility.[12] There is no specific federal groundwater quality statute,[13] and the federal Environmental Protection Agency has shown some reluctance to extend its full regulatory authority to groundwater problems.[14] In any case, because groundwater is diffused beneath the land surface and exists under widely varying local hydrological conditions, sources of pollution are difficult to

4. Tripp & Jaffe, *Preventing Groundwater Pollution: Towards a Coordinated Strategy to Protect Critical Recharge Zones*, 3 HARV. ENVTL. L. REV. 1 (1979) [hereinafter Tripp & Jaffe].

5. DiPerna, *Leukemia Strikes a Small Town*, N.Y. Times, Dec. 2, 1984, §6 (Magazine), at 100.

6. F. DINOVO & M. JAFFE, LOCAL GROUNDWATER PROTECTION, MIDWEST REGION, (American Planning Ass'n 1984)(especially chs. 3 and 4) [hereinafter DINOVO & JAFFE].

7. Josephson, *supra* note 3, at 347A.

8. Burmaster, *supra* note 2, at 52.

9. *Id.*

10. Tangley, *supra* note 2, at 142.

11. Woodhull, *Groundwater Contamination in Connecticut*, 73 J. AM. WATER WORKS A. 188 (1981) [hereinafter Woodhull].

12. Tangley, *supra* note 2, at 148.

13. Dycus, *supra* note 2, at 244; Tripp & Jaffe, *supra* note 4, at 9; Tripp, *Groundwater Protection Strategies: Federal, State and Local Relationships*, 95 AAAS SELECTED SYMP.: GROUNDWATER POLLUTION: ENVTL. & LEGAL PROBS. 131 (1984) [hereinafter Tripp]. A recent proposal by Sen. Dave Durenberger (R-Minn.) would establish an overall nondegradation goal for groundwater resources and a system of state programs and discharge permits modeled on the Clean Water Act. 17 Env't Rep. (BNA) 1708 (Feb. 6, 1987).

14. Tripp & Jaffe, *supra* note 4, at 25.

pinpoint and regulate on a centralized basis. Moreover, once contamination occurs, it is generally irreversible and impossible to clean up.[15] Prevention is the only feasible policy approach to groundwater pollution, and prevention can only be accomplished by regulating potentially threatening land uses above the aquifer. Thus, since land use planning and control is generally a local government prerogative, a strong local role is needed.

Local governments should not treat groundwater protection as a problem, but as an opportunity. In many communities, land use planning and regulation is not guided by any substantive planning theories of land use design. The adoption of a groundwater protection program could redirect and rationalize local land use policy. In this paper it will be argued that aquifer protection should be a basic organizing principle of local land use planning—the foundation upon which other land use decisions are built. The value of the groundwater resource itself is enough to warrant such favored treatment. For this reason, groundwater protection is significant as an introduction to the broader theory of environmental planning.

The need to protect groundwater can provide the impetus for a reorientation of land use policy to accomplish a variety of planning goals, both related and unrelated to groundwater protection. Because groundwater is so important, a land use scheme centered around its protection can justify open space preservation, concentrated development, and restrictions on industrial pollution. And as groundwater is so closely tied to the land in recognizable geological features, an aquifer protection program can establish a structure for land use controls which rationally and ecologically determines where to locate some uses and where not to locate others.

Ultimately, land use regulation through aquifer protection can help local governments develop a comprehensive carrying capacity approach to coordinating economic development and land use with the natural features of the local environment. To elaborate on the theme of aquifer protection, this paper will first describe the nature of groundwater resources, the processes by which they are polluted, and existing regulatory programs. Next, it will explain why and how groundwater protection should be the central concern in land use planning. Finally, the problems and practical effects of the theory will be examined, with a discussion of the techniques and implications of groundwater protection using specific examples

15. Cleary, *Introduction to Groundwater Hydrology*, 95 AAAS SELECTED SYMP.: GROUNDWATER POLLUTION: ENVTL. & LEGAL PROBS. 9, 12 (1984) [hereinafter Cleary].

from Connecticut, a state with a nationally recognized groundwater program.[16] Even if the environmental planning rationale of aquifer protection proves unpersuasive, this discussion is nevertheless useful in demonstrating the effects of groundwater protection on land use planning and in suggesting a greater role for environmental concerns in land use policy.

II. THE NATURE OF THE PROBLEM

A. *The Groundwater Resource*

Though groundwater is often conceptualized as a part of the land, it is intimately connected with surface waters and is an integral part of the hydrological cycle. Unlike an oil or gas formation, groundwater is not a static reservoir, but is constantly moving, flowing downgradient towards discharge points in wells or in surface bodies of water where the water table intersects the surface. Below the water table, in the saturated zone, essentially all porous areas are filled with water; but not every underground formation is capable of yielding usable amounts of water.

Since groundwater is diffused unevenly, only those subterranean formations which can hold significant amounts of water are designated as aquifers. Aquifers can be described as underground reservoirs, even though most of their volume is occupied by sand, gravel, and rock.[17] There are several different types of aquifers. Bedrock aquifers, formed by fissures and pockets in impervious bedrock, do not provide great amounts of water but are important sources of water for rural households.[18] Other aquifers are found in surficial glaciated sediment atop the bedrock. The most productive of these is the stratified drift aquifer, in which the sediments are sorted or stratified by weight, allowing greater quantities of water to flow through and collect in them. In Connecticut, for example, stratified drift aquifers are a major source of public groundwater supplies.[19]

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16. Dycus, *supra* note 2, at 222 n.70; Roberts & Butler, *supra* note 2, at 1033; DEP, *supra* note 1, at 17.

17. Cleary, *supra* note 15, at 13-15; Regional Planning Agency of South Central Connecticut (now South Central Regional Council of Governments), THE NEED FOR GROUND WATER PROTECTION IN SOUTH CENTRAL CONNECTICUT 3-4 (1980)[hereinafter GROUND WATER PROTECTION].

18. GROUND WATER PROTECTION, *supra* note 17, at 3; DEP, *supra* note 1, at 3.

19. Cleary, *supra* note 15, at 15; GROUND WATER PROTECTION, *supra* note 17, at 4; DEP, *supra* note 1, at 3-4. These aquifers are in the class of unconfined or water table aquifers, which flow under the influence of gravity. Confined or artesian aquifers are trapped between

Just as surface reservoirs are replenished by precipitation and runoff from their drainage areas, aquifers are replenished by the percolation of water through their recharge zones. The primary recharge area is the land surface directly above the stratified drift deposit, while the secondary recharge area covers the adjacent till and bedrock. The addition of the tertiary recharge zone comprises the entire recharge area, corresponding to the drainage basin or watershed area of a surface stream.[20] Most stratified drift aquifers and recharge areas can be mapped through geological surveys of soil types and geological features. This type of aquifer may be confined within a small land area, often coinciding with surface streams and watercourses.[21] Aquifers in other areas are less concentrated, with recharge zones extending over a large region.[22]

Though aquifers can be mapped and groundwater movement understood in the abstract, the flow and behavior of individual groundwater formations is often a mystery. Because groundwater is completely hidden from view and moves in three dimensions, groundwater quality evaluation and monitoring is often difficult, and rarely yields enough accurate information to produce a complete picture.[23] Most importantly, groundwater often moves slowly—in inches or feet per day—with very little turbulence or mixing.[24] This hydrological fact is crucial for understanding groundwater pollution. While pollutants discharged into a surface stream tend to disperse and become diluted, pollutants in groundwater tend to move in a discrete, concentrated "plume" of contamination towards a well or surface discharge point.[25] A contaminant plume, though slow-moving and long-lasting, can be difficult to locate. Trying to monitor the progress of groundwater pollution is technically perplexing. "[E]ven a dense network of monitoring

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impermeable strata and are forced up through wells by the pressure of the confined water. *See also* Tangley, *supra* note 2, at 145, fig. 2; DiNovo & Jaffe, *supra* note 6, at 8-14; Roberts & Butler, *supra* note 2, at 1040 n.115.

20. Ground Water Protection, *supra* note 17, at 4.

21. *Id.* at 5-6; Roberts & Butler, *supra* note 2, at 1040 n.115.

22. Roberts & Butler, *supra* note 2, at 1040. *See also* Ballew, *Groundwater Laws: Opportunities for Management and Protection*, 75 J. Am. Water Works A. 280, 281 (1983) [hereinafter Ballew].

23. Cleary, *supra* note 15; Roberts & Butler, *supra* note 2, at 1018-24.

24. Miller, *Protection of Groundwater Quality*, 95 AAAS Selected Symp.: Groundwater Pollution: Envtl. & Legal Probs. 93, 99 (1984) [hereinafter Miller]; Roberts & Butler, *supra* note 2, at 1020.

25. Miller, *supra* note 24, at 99; Roberts & Butler, *supra* note 2, at 1020-21; DEP, *supra* note 1, at 5-6, fig. 4.

wells may not suffice to detect problems,"[26] and pollution may therefore remain undetected until a well is already contaminated—and then it is too late.[27]

The slow progress of a pollution plume, in turn, means that most groundwater contamination problems are highly localized.[28] Thus, groundwater quality can vary greatly within just a short distance, since the water downgradient of the plume would not yet be affected.[29] Thus, a portion of an aquifer can be polluted without immediately endangering the remainder. Conversely, once an aquifer is contaminated it will remain so for centuries, "if not for geologic time."[30] Wells in the Connecticut River Valley are still showing traces of the pesticide EDB, which has not been applied in that area for fifteen years.[31] In addition, a program of ambient groundwater quality monitoring, as opposed to testing water quality in existing water supply wells, is rarely undertaken and is tremendously expensive, requiring many well drillings and analyses.[32] The chemical analysis of polluted groundwater is itself expensive and technically limited,[33] and the results often depend on whether the investigator already knows what chemicals he is looking for.[34]

B. *Sources of Pollution*

Analysis of groundwater pollution is complicated by the wide variety of potential types and sources of groundwater pollution. Groundwater is considered purer and better protected than surface water because chemical adsorption and decomposition in overlying layers of soil help degrade many pollutants.[35] However, the same filter of soil and rock that detoxifies some contaminants also protects other pollutants from degradation by dilution, mixing, or exposure to air and sunlight.[36] Thus, some groundwater supplies be-

26. Roberts & Butler, *supra* note 2, at 1020 (citation omitted).

27. *Id.* For a good discussion of groundwater monitoring, see Miller, *supra* note 24, at 105-17.

28. Roberts & Butler, *supra* note 2, at 1020-21.

29. Page, *Toxic Contaminants in Water Supplies and the Implications for Policy*, 4 THE ENVIRONMENTALIST 131, 132-33 (1984) [hereinafter Page].

30. Burmaster, *supra* note 2, at 48.

31. DEP, *supra* note 1, at 11-12.

32. Roberts & Butler, *supra* note 2, at 1019.

33. Page, *supra* note 29, at 132.

34. Tangley, *supra* note 2, at 143-44.

35. Burmaster, *supra* note 2, at 48; Miller, *supra* note 24, at 97.

36. *See, e.g.*, Page, *supra* note 29, at 132-33.

come more polluted than comparable surface water samples.[37] Ultimately, any substance dumped, spilled, leached, dropped, buried, or deposited on the ground can end up in groundwater.[38]

While the sources and components of groundwater contamination are almost infinite,[39] the Connecticut Department of Environmental Protection (DEP) has identified five major categories: synthetic organic chemicals, landfill leachates, salt, biological pollutants, and agricultural wastes.[40]

The most common and notorious pollutants are synthetic organic chemicals, the by-products of our "plastic age."[41] Synthetic organic chemicals are the major component of the nationwide problem of hazardous waste. These chemicals include volatile chlorinated hydrocarbons; petroleum distillates like gasoline, motor oil, and benzene; industrial solvents; and many other common chemicals. Many of these chemicals are considered toxic and are suspected or confirmed carcinogens.[42] They tend to be persistent and are thus more concentrated in groundwater than in surface water,[43] from which they can evaporate.[44] Because much hazardous waste is dumped on or buried in the ground, synthetic organics —which do not break down in groundwater — are often environmentally exposed for the first time in groundwater. These toxic chemicals occur not only in hazardous waste dumps and industrial discharges, but in the everyday operations of many common businesses such as dry cleaners, photo processors, and gas stations.[45] They can enter groundwater through accidental spills or runoff from storage or work areas, as well as from deliberate or negligent dumping.

An especially acute aspect of the synthetic organic pollution problem is the danger posed by underground chemical and fuel storage tanks.[46] Leaking underground storage tanks, or "LUSTs,"

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37. Burmaster, *supra* note 2, at 48.

38. Page, *supra* note 29, at 131.

39. *Id.*

40. DEP, *supra* note 1, at 6-12.

41. GROUND WATER PROTECTION, *supra* note 17, at 1.

42. DINOVO & JAFFE, *supra* note 6, at 18; Harris, *The Health Risk of Toxic Organic Chemicals Found in Groundwater*, 95 AAAS SELECTED SYMP.: GROUNDWATER POLLUTION—ENVTL. & LEGAL PROBS. 63 (1984) [hereinafter Harris]; Page, *supra* note 29, at 131-33; DEP, *supra* note 1, at 7.

43. Burmaster, *supra* note 2, at 51; Page, *supra* note 29, at 132-33.

44. Page, *supra* note 29, at 132-33.

45. DEP, *supra* note 1, at table 1.

46. GROUND WATER PROTECTION, *supra* note 17, at 10; DEP, *supra* note 1, at 8-9; R. Koontz, Legal Options for Municipal Groundwater Protection in Connecticut (Conservation Law Foundation of New England 1983) at 15-16 [hereinafter Koontz].

are currently a hot topic in hazardous waste policy. These tanks, found in gas stations, industries, and homesites, are usually made of bare steel, which corrodes over time[47]—the average life expectancy of a buried steel tank is only fifteen years.[48] Some states have begun to promulgate monitoring and performance standards for LUSTs,[49] and the EPA's *Ground-Water Protection Stategy* calls for "a study to identify the nature, extent, and severity of the [LUST] problem."[50]

Underground fuel tanks, however, are not the only domestic groundwater pollution problem. Synthetic organic chemicals have become so widespread in ordinary commercial products that many households are full of them: household cleaners, stain removers, and solvents; used oil, antifreeze, and other automotive products; lawn fertilizers and pesticides.[51] Serious groundwater pollution problems can arise simply from the aggregation of many small household discharges dumped down the drain or "out back." "TCE, a widely used industrial degreaser, is one of the more common contaminants now known to be present in underground drinking-water supplies. . . . [It] reaches groundwater not only through industrial waste disposal, but also through backyard septic tanks because it is a component of many household cleaning fluids."[52]

The second major source of groundwater contamination, landfill leachate, produces a formidable "chemical soup:"

> Every landfill in the state generates leachate as a result of its operation: smelly, polluted liquid created by precipitation seeping through the refuse. The composition of landfill leachate is highly complex, reflecting the variety of soluble materials in our trash. Heavy metals, numerous organic decomposition products, salts, ammonia, and synthetic organic and inorganic chemicals are typically present. For this large range of contaminants, with both known and unknown human health effects, no satisfactory treatment yet exists.[53]

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47. Tangley, *supra* note 2, at 146.

48. DEP, *supra* note 1, at 9.

49. *Id. See also* R. Andrews, R. Burby, & A. Turner, Hazardous Materials in North Carolina: A Guide for Decisionmakers in Local Government (Center for Urban & Regional Studies, Conservation Foundation of North Carolina, Univ. of N.C. at Chapel Hill 1985) at 47-48 [hereinafter Hazardous Materials in North Carolina].

50. United States EPA, Groundwater Protection Strategy 5 (1984) [hereinafter EPA Strategy].

51. DEP, *supra* note 1, at 12.

52. Tangley, *supra* note 2, at 142.

53. DEP, *supra* note 1, at 9.

Many cases of groundwater contamination are attributable to leachate from landfills.[54] Though all landfills are thought to leak eventually, they at least have the virtue of being a known pollution source, so that any aquifer nearby can be monitored.

A third source of groundwater contamination is salt. In cold weather states where salt is used to de-ice roads, it turns runoff into brine, which corrodes pipes and leaches heavy metals.[55] Road salt runoff has been linked to high sodium levels in nearby groundwater.[56] Salt may also contaminate groundwater as a result of seawater intrusion.[57]

Biological pollutants, generally bacteria and viruses, are another source of contamination to water supplies, and have long been a subject of health regulation. The connection between human wastes and waterborne disease is well known, and can be avoided with a proper septic system (which keeps wells and septic systems a safe distance apart) or by public sewering. Sewers can allow a higher density of development,[58] but are by no means a complete solution to the problem of household groundwater pollution.[59] Even if the sewage were fully treated, household chemicals could still be dumped.

Agricultural activities are a fifth source of groundwater contamination. The use of fertilizers and pesticides, and the accumulated manure of feedlots, have created serious water pollution problems.[60]

C. *Consequences of Pollution*

The pervasiveness of groundwater pollution does not alone es-

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54. Burmaster, *supra* note 2, at 49-55.

55. DEP, *supra* note 1, at 10.

56. GROUND WATER PROTECTION, *supra* note 17, at 12; P. Ryner, Groundwater Management for the Town of Barnstable, Phase One: Issue Identification 11 (Aug. 1984) [hereinafter Ryner].

57. Ballew, *supra* note 22, at 281; Woodhull, *supra* note 11, at 189; Ryner, *supra* note 56, at 11.

58. Development itself has an adverse impact on groundwater quality by removing vegetation that acts as a filter, and by increasing the impervious, or paved, land area. Built-up surfaces increase runoff while accumulating oil, asbestos particles, and other pollutants which are washed into the soil, resulting in a significant source of groundwater contamination. *See, e.g.*, V. NOVOTNY & G. CHESTERS, HANDBOOK OF NONPOINT POLLUTION, SOURCES AND MANAGEMENT 312, 312-47 (1981) [hereinafter NOVOTNY & CHESTERS]; Koontz, *supra* note 46, at 17.

59. Tripp & Jaffe, *supra* note 4, at 43-44 (experience with sewering in Long Island).

60. NOVOTNY & CHESTERS, *supra* note 58, at 426-30; DINOVO & JAFFE, *supra* note 6, at 25-27.

tablish its seriousness. Groundwater contamination is a danger first and foremost because of the health effects of the contaminants. While the disease-causing potential of biological pollutants is well known, "most of the toxic organic chemicals clearly have negative health impacts because humans have evolved without exposure to these synthetic substances and lack defense mechanisms, acclimation capabilities, or excretion pathways to contend with these chemicals."[61]

Since no other organisms or ecosystems have evolved with exposure to toxic chemicals, groundwater pollution can also have severe ecological consequences. The importance of aquifers as a source of public drinking water should not obscure the important ecological function performed by groundwater. Being hydrologically connected with surface water, groundwater helps maintain stream flow and feeds ecologically rich wetlands, bogs, and other water-based ecosystems.[62] Pollution can move with water from surface to ground and back again, so planners will need to take into account the quality of wetlands and streams in the same watershed system as the aquifer. Streamwater quality affects aquifers especially under conditions of induced infiltration, which occurs when a high rate of pumping from a groundwater well creates a cone of depression which causes surface water from streams or lakes to flow into the aquifer.[63] If the aquifer is near the coast, saltwater intrusion from the ocean may occur.[64]

The level of pollution in groundwater, though often relatively high, is absolutely low, and the human health effects of long-term exposure to small doses of toxins are uncertain.[65] However, there is sufficient scientific evidence of carcinogenicity and other harms for federal and state governments to establish drinking water standards to protect public health,[66] and for water utilities to worry about potential legal liability from polluted groundwater.[67] When it is known that groundwater pollutants are likely to have some health effects, the scientific uncertainties counsel a cautious approach. Consequently, stringent drinking water standards will

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61. Page, *supra* note 29, at 133.

62. Burmaster, *supra* note 2, at 49.

63. Ballew, *supra* note 22, at 281.

64. *Id. See also* GROUND WATER PROTECTION, *supra* note 17, at 5.

65. Harris, *supra* note 42; Page, *supra* note 29, at 133.

66. DINOVO & JAFFE, *supra* note 6, at ch. 5.

67. Selig, *Rights and Liabilities of Water Suppliers Arising from Groundwater Pollution*, 73 J. AM. WATER WORKS A. 186 (1981).

often require a public water supply well to be shut down if even a small amount of contamination is discovered. In one case study, "[l]ess than a gallon per week of material leaked or accidentally discharged from the site was probably responsible for shutting down a one million gallon per day well."[68]

The danger of groundwater pollution is exacerbated by the long-lasting nature of the contamination. Once a pollutant has entered an aquifer the contamination is, for most practical purposes, irreversible. "Natural processes will not degrade or disperse the contaminants and the flushing time may be in the hundreds of years."[69] The difficulties of cleaning up an underground reservoir can be readily imagined. Cleanup techniques include pumping out the aquifer, treating, and recharging the water;[70] drilling additional wells to divert or dilute the contaminant plume;[71] degrading the chemicals by microbial action;[72] and capping the contamination source to reduce runoff.[73] But these techniques are complex, expensive, and must be tailored to the dynamics of each site.[74] "In the last analysis, the cheapest method of ensuring clean groundwater is, and will continue to be, contamination prevention."[75]

D. *Pollution Prevention*

Planning to prevent groundwater pollution involves either controlling specific sources of pollution or keeping potential sources out of recharge areas altogether. But due to the complexities of groundwater hydrology, the causal relationship between individual land uses and the presence of particular pollutants often cannot be specifically traced. Though most pollutants tend to enter an aquifer a short distance from the area of contamination, it is often impossible to determine the exact source of a particular well's contamination or to predict which aquifers are likely to be contaminated from land uses involving toxic chemicals.[76] Studies have shown only vague correlations between groundwater contaminated with toxic chemicals and land use activities using toxic

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68. Miller, *supra* note 24, at 128.
69. Page, *supra* note 29, at 137.
70. Miller, *supra* note 24, at 119; Page, *supra* note 29, at 136.
71. Miller, *supra* note 24, at 118.
72. *Id.* at 118-19.
73. *Id.* at 118.
74. Roberts & Butler, *supra* note 2, at 1022 (citations omitted).
75. Josephson, *supra* note 3, at 350A.
76. Miller, *supra* note 24, at 105-17.

chemicals,[77] but land uses and even urban densities could not explain variations in pollution levels.[78] Aquifers have become generalized waste disposal systems for all of the overlying land uses, and it is impossible to make precise connections between ambient groundwater quality and the "generic human activities" which cause pollution.[79]

There are far too many potential sources of contamination to rely on pollution source control to protect groundwater. Isolated "point-source" discharges such as hazardous waste dumps, industrial injection wells, or storage tanks, are regulated (in theory) by state and federal programs. However, no technological or regulatory means exists to prevent or adequately monitor contamination from "nonpoint" sources such as industrial or urban runoff.[80] Unlike surface water pollution, the greatest volume of groundwater pollution does not arise from deliberate industrial discharges or other point sources but from spills, leakage, and runoff from storage and work areas, and from other "[n]onpoint sources associated with development, such as cars, gas stations, lawn fertilizer, and garden pesticides . . . ."[81] Consequently, it is not even remotely technologically or administratively feasible to identify, license, or regulate every source of potential groundwater pollution in an aquifer recharge area. If preservation of high quality aquifers is to be accomplished, land uses which as a class threaten to contaminate groundwater must be kept out of the recharge zone and relocated to less sensitive areas. "Ideally, this means preservation of the area in its natural vegetated state, but at the very least demands exclusion of land-disposal facilities and hazardous industrial activities, limitation of residential and commercial development to very low densities, and curtailment of road construction."[82]

Only restrictive land use controls are comprehensive enough to encompass all the potential groundwater contamination threats, and only prospective restrictions of threatening land uses can forestall irreversible pollution. But aquifer protection is not an all-or-nothing proposition—there is a range of land use controls beyond leaving the recharge zone in a possibly irretrievable natural state. Though specific land uses may not be able to be correlated with

77. Page, *supra* note 29, at 134-35.
78. *Id.*
79. *Id.* at 134.
80. Tripp & Jaffe, *supra* note 4, at 34.
81. *Id. See also* Roberts & Butler, *supra* note 2, at 1025.
82. Tripp & Jaffe, *supra* note 4, at 34.

specific pollutants in groundwater, land uses which pose greater and lesser threats can be identified with some confidence. Connecticut's DEP has developed a "hierarchy of land uses" for local governments to consider in drafting aquifer protection land use controls, ranging from Category A (highest degree of protection) through Category E (major threat) land uses.[83] Such a classification allows the prohibition and regulation of land uses in recharge zones according to their degree of contamination threat.

III. Theory of Aquifer Protection

> So we can say that terrestrial processes require water and that freshwater processes are indissoluble from the land. It then follows that land management will affect water, water management will affect land processes. We cannot follow the path of every drop of water, but we can select certain identifiable aspects—precipitation and runoff, surface water in streams and rivers, marshes and floodplains, groundwater resources in aquifers and the most critical phase of these—aquifer recharge.[84]

A. *The Need for Government Action*

Water has been sufficiently abundant in most areas of the United States. Thus, providing for an adequate public supply has been a fairly low-level management problem. But groundwater, at least, can no longer be taken for granted. Excessive groundwater withdrawals and depletion for municipal and agricultural use have created a quantity crisis in some areas, while increased discoveries of polluted aquifers in other areas may herald an upcoming quality crisis.[85] To prevent unrestrained private development activities

83. Specifically, the hierarchy of land uses is as follows: Category A, uses providing maximum protection to regionally significant aquifers, includes water utility lands used as water supply areas, designated open space, forest land, and public parks; Category B, uses posing minimal risks, includes field crops and low-density (one dwelling unit per two acres) residential areas; Category C, uses posing slight to moderate risks, includes livestock, orchards, golf courses, and medium-density (one dwelling unit per ½ to two acres) residential areas; Category D, uses posing a substantial risk, includes institutional uses such as schools and hospitals, high-density (more than one dwelling unit per half acre) residential areas, and low-risk commercial uses such as banks and restaurants; and Category E, uses posing a major threat to groundwater, includes retail commercial development, commercial uses which produce non-domestic waste, and industrial uses. The DEP lists mitigating measures for the first four categories of land uses, but recommends prohibition for Category E. DEP, *supra* note 1, at app. 2.

84. I. McHarg, Design With Nature 56 (1969) [hereinafter McHarg].

85. *See, e.g.*, D. Francko & R. Wetzel, To Quench Our Thirst: The Present and Fu-

from forever ruining public groundwater resources, government intervention is necessary. Groundwater pollution must be recognized as a serious policy problem which demands the attention of every level of government. The difficulties of monitoring groundwater movement and quality demonstrate the need for immediate preventive action, since contamination threats are unlikely to be discovered in time to take any remedial measures, if the contamination can be remedied at all.[86] A slow-flushing aquifer is a fixed and finite resource for waste disposal purposes; it can only support a certain amount of the effluvia of economic development before being overwhelmed and rendered unfit for public water supply use.

The importance of potable water as a precondition to development needs no emphasis, for without water for drinking, cooking, cleaning, and agricultural and industrial processes, no human settlement can be supported. Protecting high-quality groundwater may become an even greater priority in the future, in large part because it tends to be cheaper than alternate supplies. The low cost of groundwater is attributable to it being better protected from surface pollution, insulated from evaporation and temperature fluctuation, and often found directly beneath population centers, obviating the need for an expensive pipeline and pumping system to treat and distribute surface water from a distant reservoir. Furthermore, as existing supplies become depleted or polluted, there will be relatively more untapped aquifers near urban areas than potential sites for new surface reservoirs.[87] Aquifer protection may in many cases be the most cost-effective means of providing for future water supplies.[88] However, unless decisions are made soon to protect these aquifers, subsequent or ongoing contamination may foreclose their use. It would be tragic if the water-rich areas of the United States helped create a potable water shortage by failing to protect their irreplaceable groundwater resources. "If we are not successful in planning for abundant uncontaminated water supplies, toxic chemical contamination may cause water scarcity and the wide variation in water treatment and distribution costs to become critical factors in the locational decisions of industries and populations."[89]

TURE STATUS OF FRESHWATER RESOURCES OF THE UNITED STATES (1983).

86. Page, *supra* note 29, at 135-36.

87. *Id.* at 137.

88. *Id. See also* Huffmire, *supra* note 1, at 219-21.

89. Page, *supra* note 29, at 138.

B. Federal Programs

The local and site-specific nature of groundwater and its pollution have led most analysts—even those who favor a strong federal role—to conclude that state and local governments must bear some ultimate responsibility for groundwater protection.[90] Even so, increased federal involvement is seen as likely and desirable at least to the extent of providing funding, technical expertise, and uniform quality standards.[91] Many state and local governments evidently feel they lack the technical expertise, funding, political will, or long-term perspective required for an aquifer protection program.[92] In addition, the lack of uniform federal groundwater quality standards could lead to a competitive advantage in attracting industry and development for states with less stringent groundwater pollution programs.[93] Federal programs could eliminate interstate inconsistencies and help states and localities overcome political obstacles to enacting effective aquifer protection programs.[94]

Partly in response to these problems, the EPA in 1980 promulgated a Proposed Ground Water Protection Strategy, which envisioned a coordinating framework for programs using existing federal statutes. The strategy left EPA with providing aquifer classifications and technical advice, leaving programs and implementation up to the states.[95] The Reagan Administration abandoned this policy and published a Final Ground Water Protection Strategy in August, 1984. The final strategy contemplated assembling existing statutory authority into four major policy areas: building institutions and programs at the state level, studying unaddressed sources of groundwater contamination such as LUSTs and pesticides, adopting guidelines for prioritizing groundwater protection and cleanup (including a three-part groundwater qual-

90. Dycus, *supra* note 2, at 269; Tripp & Jaffe, *supra* note 4, at 35; The National Groundwater Policy Forum, Groundwater: Saving the Unseen Resource, Proposed Conclusions and Recommendations (Nov. 1985) [hereinafter National Groundwater Policy Forum].

91. Dycus, *supra* note 2, at 269; Tripp, *supra* note 13; National Groundwater Policy Forum, *supra* note 90, at 11.

92. Dycus, *supra* note 2, at 221-22; R. Andrews, Local Governments and Ground Water Pollution Control, paper presented at National Symposium on Local Government Options for Ground Water Pollution Control 2, cosponsored by Univ. of Okla. and United States EPA (Jan. 16-17, 1986) (on file, *Journal of Land Use and Environmental Law*).

93. Dycus, *supra* note 2, at 221.

94. *See* Note, *State and Federal Land Use Regulation: An Application to Groundwater and Nonpoint Source Pollution Control*, 95 YALE L.J. 1433 (1986) [hereinafter Note, *Land Use Regulation and Pollution Control*]; National Groundwater Policy Forum, *supra* note 90, at 2.

95. Dycus, *supra* note 2, at 215-17; DINOVO & JAFFE, *supra* note 6, at 52-54.

ity classification system), and strengthening the EPA's in-house arrangements for groundwater policy coordination.[96] Some analysts consider the Reagan strategy to be little different from the Carter Adminstration's, and unlikely to be effective in any case.[97]

Though a comprehensive federal groundwater statute has yet to be enacted, several federal environmental statutes regulate activities affecting groundwater. Perhaps the most important of these is the Federal Water Pollution Control Act (FWPCA),[98] which regulates discharges into surface waters and establishes surface water quality standards. The EPA, however, has refused to extend these requirements to groundwater, even where there is a clear hydrological connection with the surface.[99] Section 208 of the Act, which requires states to plan for areawide waste disposal and control of nonpoint pollution, has been an important stimulus for state groundwater studies and planning, but the 208 program is no longer fully funded.[100]

A related federal statute is the Safe Drinking Water Act (SDWA),[101] which established national drinking water regulations for public water systems.[102] The SDWA also provides for the designation of sole source aquifers, and forbids federal financial assistance for projects which the EPA determines may result in contamination of a sole source aquifer through its recharge zone.[103] The underground injection of waste is also regulated by the Act.[104]

96. EPA STRATEGY, *supra* note 50.

97. Dycus, *supra* note 2, at 217-19; Tangley, *supra* note 2, at 144. The EPA has taken over two years to follow up its strategy with a draft Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy, issued in December, 1986. The draft guidelines specify the procedures to be used for establishing the three classes (Class I, special groundwater; Class II, current or potential sources of drinking water; and Class III, not suitable for drinking water because of natural or man-made contamination), using a site-specific "classification review area" around a "facility" or "activity" affecting groundwater. 17 Env't Rep. (BNA) 1331-32, 1377-1406 (Dec. 12, 1986).

98. 33 U.S.C. §§ 1251-1376 (1982 & Supp. III 1985).

99. While it appears that the EPA does have this authority, Tripp & Jaffe, *supra* note 4, at 10-11, it is not explicit. *Id.* at 14. *See also*, Dycus, *supra* note 2, at 238-48; Huffmire, *supra* note 1, at 123-39.

100. Dycus, *supra* note 2, at 245-46. GROUND WATER PROTECTION, *supra* note 17, was a result of Connecticut's 208 program. For a description of the 208 planning process as applied to groundwater problems in the Old Colony area of Massachusetts, see Goldrosen, *The Role of Section 208 Planning in Protecting Drinking Water Sources*, in DRINKING WATER QUALITY ENHANCEMENT THROUGH SOURCE PROTECTION 39 (R. Pojasek ed. 1976).

101. 42 U.S.C. §§ 300f to 300j-10 (1982).

102. 42 U.S.C. § 300g-1 (1982).

103. 42 U.S.C. § 300h-3(e) (1982).

104. 42 U.S.C. § 300h (1982).

Unfortunately, neither the underground injection[105] nor the sole source provision[106] has been vigorously applied to uniformly protect groundwater resources.

The Resource Conservation and Recovery Act (RCRA)[107] is an important federal initiative designed to control solid and hazardous waste disposal. Industrial and municipal wastes are a major source of groundwater pollution, but the effectiveness of RCRA's standards for sanitary landfills and hazardous waste facilities has been questioned.[108] But since the 1984 statutory amendments, small generators of hazardous waste (less than 100 kg./month) will no longer be entirely excluded from the Act's permit regulations,[109] and a new program to regulate underground storage tanks has been added.[110]

C. *The Need for Local Programs*

Though these and other statutes may provide sufficient authority to launch a national groundwater protection policy, the EPA has moved slowly to assert its authority.[111] The lack of federal initiative should encourage a greater role for state and local governments in groundwater protection. But state governments already have responsibility for implementing many federal environmental regulatory programs, and they have their own political and budgetary constraints. Even Connecticut, a relatively wealthy state with a strong groundwater protection program, has conceded that its state environmental agency needs active local government help in attacking groundwater pollution problems:

> The sheer volume of [hazardous waste] facilities and small generators is staggering, and although the Hazardous Materials Management Unit is attempting to minimize the impact, it cannot adequately deal with the problem. Only 10% of the facilities generating hazardous waste were inspected last year; thus, all complaints cannot be handled expeditiously because of the lack of sufficient staff.[112]

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105. DiNovo & Jaffe, *supra* note 6, at 43-46; Dycus, *supra* note 2, at 250-52; Tripp & Jaffe, *supra* note 4, at 16-18.

106. Dycus, *supra* note 2, at 253; Tripp & Jaffe, *supra* note 4, at 16-18.

107. 42 U.S.C. §§ 6901-87 (1982 & Supp. III 1985).

108. Dycus, *supra* note 2, at 254-64; Tripp & Jaffe, *supra* note 4, at 20-22.

109. 42 U.S.C. § 6921(d) (Supp. III 1985) (amending 42 U.S.C. § 6921 (1982)).

110. 42 U.S.C. § 6991 (Supp. III 1985).

111. Dycus, *supra* note 2, at 267; Tripp & Jaffe, *supra* note 4, at 46.

112. DEP, *supra* note 1, app. 1 at 13-14.

Funding and implementation problems aside, there are still major gaps in the coverage of state-federal regulatory programs affecting groundwater pollution.[113] These include policing the many small generators of hazardous waste,[114] the siting and monitoring of hazardous materials users,[115] and enforcing underground storage tank regulations.[116]

Aside from the deficiencies in federal and state groundwater regulation, there are positive reasons why local governments should become involved in aquifer protection. First, groundwater contamination always has concrete, site-specific effects. A community could lose all or most of its public water supplies if a vulnerable aquifer is contaminated. Second, local governments may be the only source of information and inspection capability to monitor and regulate particular wellfields, LUSTs, or small chemical and hazardous materials users. Consequently, if groundwater supplies are to be protected, local governments must take an active part in designing and implementing aquifer protection programs.[117] Finally, municipal governments which cherish local autonomy would be well advised to prevent groundwater contamination from becoming a problem widespread enough to necessitate statewide control of land uses and nonpoint pollution sources.

Localities simply cannot afford to wait for a federal mandate, especially since the design of an effective groundwater protection program is well within the capability of many, if not most, local governments. Though local aquifer protection programs are still rare in a national context,[118] land use planning to protect aquifers is not a new idea but a practical reality. Scientifically, the hydrology of aquifers and groundwater movement, and the prevalence of contaminated groundwater in urban and industrial areas, establish a firm technical basis for controlling recharge zone land uses. Theoretically, environmental planning doctrines explain the signifi-

113. HAZARDOUS MATERIALS IN NORTH CAROLINA, *supra* note 49, at 3-4; Koontz, *supra* note 46, at 8.

114. HAZARDOUS MATERIALS IN NORTH CAROLINA, *supra* note 49, at 5-6; Koontz, *supra* note 46, at 4-5.

115. HAZARDOUS MATERIALS IN NORTH CAROLINA, *supra* note 49, at 9-10; Koontz, *supra* note 46, at 3-4.

116. HAZARDOUS MATERIALS IN NORTH CAROLINA, *supra* note 49, at 8-9; Koontz, *supra* note 46, at 5-6.

117. *See e.g.*, HAZARDOUS MATERIALS IN NORTH CAROLINA, *supra* note 49.

118. M. Jaffe, Local Government Capabilities, paper presented at Symposium, Institutional Capacity for Ground Water Pollution Control 87, cosponsored by Univ. of Okla. and United States EPA (June 20-21, 1985) (on file, *Journal of Land Use and Environmental Law*) [hereinafter Jaffe].

cance of groundwater and the implications of preserving it. Legally, protection of existing or potential public water supplies through land use controls fits squarely within the police power protection of the public health, safety, and welfare.[119] In addition to the twenty-six or more Connecticut towns with aquifer protection controls,[120] local groundwater protection programs are in place or being considered in the New Jersey Pine Barrens;[121] San Antonio, Texas;[122] Dade County, Florida;[123] Long Island, New York;[124] and Cape Cod, Massachusetts;[125] among other places.[126]

D. *Environmental Land Use Theory*

Many local governments, unless prodded by well contamination or by a higher level of government, will probably not have thought much about the need to protect underground water supplies, just as they are unlikely to have based their overall land use regulation on any coherent theory of land planning.[127] Local planning instruments—official comprehensive plans, zoning and subdivision ordinances—are all too likely to reflect existing development patterns, with perhaps a nod to environmental constraints by restricting building in floodplains or areas of steep slopes or unstable soils. Local governments often have a reputation for small-minded, parochial concerns and may be quite unaccustomed to thinking broadly about the relationship of human activity patterns to natural systems. An episode of groundwater contamination would be quite a shock to such a local government, jolting it out of its complacency

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119. Connecticut's zoning enabling act now specifically recognizes this, having been amended in 1985 to read in part: "Zoning regulations . . . SHALL BE MADE WITH REASONABLE CONSIDERATION for the protection of existing and potential public surface and ground drinking water supplies." CONN. GEN. STAT. § 8-2 (1977), *as amended by* 1985 Conn. Pub. Acts 279 (capitals indicate the new language).

120. DEP, *supra* note 1, at 18.

121. Tripp & Jaffe, *supra* note 4, at 38-40.

122. *Id.* at 40-42.

123. *Id.* at 42-43.

124. *Id.* at 43-46.

125. Roberts & Butler, *supra* note 2, at 1030-33.

126. *See, e.g.*, DINOVO & JAFFE, *supra* note 6, at 99-110.

127. Connecticut's Public Acts ch. 85-279 has amended CONN. GEN. STAT. §§ 8-2 and 8-3 (1977) to make the consideration of protecting public surface and groundwater supplies in municipal zoning and plans of development mandatory rather than optional. *See supra* note 119. The Act added teeth to the groundwater protection measure by making the state Commissioner of Health Services a party (with right of appeal) to any municipal proceeding involving public water supplies. In addition, the Commissioner is empowered to issue a cease and desist order to any persons creating "imminent and substantial damage to a public water supply."

and forcing the consideration of stronger medicine than simply redrawing zoning boundaries or drilling a new well. Groundwater pollution is not only an indictment of bad planning; it also offers an opportunity and a compelling justification for reorienting land use regulation on a rational and sustainable ecological basis.

To fully understand the causes of groundwater pollution and the implications of aquifer protection, local governments need a short lesson in environmental planning theory. The environmentalist approach to land use planning found its central expression in Ian McHarg's seminal work, *Design with Nature*.[128] McHarg, a landscape architect, put forth the simple but profound thesis that urban development and land uses should be compatible with the surrounding natural features. Natural processes make civilization possible, and must be treated with respect:

> [I]t appeared reasonable to suggest that nature performed work for man without his investment and that such work did represent a value. It also seemed reasonable to conclude that certain areas and natural processes were inhospitable to man—earthquake areas, hurricane paths, floodplains and the like—and that those should be prohibited or regulated to ensure public safety. This might seem a reasonable and prudent approach, but let us recognize that it is a rare one.[129]

When applied to land use planning, a study of the physiographic characteristics of interacting natural processes should determine which land uses should be located where.

> The basic theme can then be restated, as for every problem, that it is necessary to understand nature as an interacting process that represents a relative value system, and that can be interpreted as proffering opportunities for human use—but also revealing constraints, and even prohibitions to certain of these.[130]

The opportunities and constraints presented by a particular land area should dictate its development:

> Thus we can state as a proposition that certain lands are unsuitable for urbanization and others are intrinsically suitable. . . . [I]f one selects eight natural features, and ranks them in order of

128. McHARG, *supra* note 84.
129. *Id.* at 55.
130. *Id.* at 127.

> value to the operation of natural process [sic], then that group reversed will constitute a gross order of suitability for urbanization. These are: surface water, floodplains, marshes, aquifer recharge areas, aquifers, steep slopes, forests and woodlands, unforested land. . . . [N]atural features can absorb degrees of development—ports, harbors, marinas, water-related and water-using industries must be in riparian land and may occupy floodplains. Surface water, floodplains and marshes may be used for recreation, agriculture and forestry. The aquifer recharge areas may absorb development in a way that does not seriously diminish percolation or pollute groundwater recources.[131]

For McHarg, water is especially important as the basic currency of natural processes. The physiographic boundaries of the hydrological cycle—streams, watersheds, estuaries, and of course, aquifer recharge zones—should be the framework of land use design and the guiding principles for allocation of land use.[132]

McHarg's physiographic determinism has been further refined with the notion of carrying capacity. Carrying capacity is an ecological concept which recognizes that the natural processes of a given ecosystem have a limited capacity to absorb changes in inputs or outputs before being degraded, possibly irreversibly.[133] Applying this insight to land use planning suggests that there is a limit to the amount of urban growth or economic development that a natural (or man-made) system can absorb before breaking down. This limit is signified by numerical thresholds of maximum population or resource use.[134] Just as too many cars can cause a traffic system to grind to a halt, and a demand surge can overload an electric utility, so too can pollution from careless urban development result in undrinkable groundwater. To keep the carrying capacity thresholds from being reached, planners can employ technological fixes (i.e., installing water and sewer systems, pollution source controls, or growth management techniques), regulations, and policies designed to restrict population growth and economic development. Growth management, made notorious by *Construc-*

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131. *Id.* at 154.

132. Several of McHarg's complete land use plans show the influence of aquifers and other hydrological factors. *Id.* at 7-18, 127-52, 175-85.

133. P. Rowe, J. Mixon, B. Smith, J. Blackburn, Jr., G. Callaway, J. Gevirtz, Principles for Local Environmental Management 42-43 (1978).

134. D. Schneider, D. Godschalk, N. Axler, The Carrying Capacity Concept as a Planning Tool (Planning Advisory Service Report No. 338, 1978), reprinted in *Carrying Capacity in Urban Development Planning* (C. Wyman ed.) Univ. of N.C. at Chapel Hill (n.d.); Ryner, *supra* note 56, at 16, 21.

tion Industry Association of Sonoma County v. City of Petaluma[135] and *Golden v. Planning Board of Ramapo*,[136] is now a recognized specialty in the planning field and has developed a substantial literature.[137] Strict limits on overall growth have often been suggested by carrying capacity studies of special areas such as the New Jersey Pinelands[138] and coastal estuaries.[139]

The role of the environment in land use planning was later fully incorporated into a standard text in the planning field, Chapin and Kaiser's URBAN LAND USE PLANNING.[140] In their comprehensive description of the planning process, Chapin and Kaiser discuss the environmental suitability of particular sites for particular land uses, and the environmental impacts of different types of land uses.[141] Moreover, in their chapter on determining the spatial distribution of land uses, the authors recommend beginning the land use design with the allocation of open space—land reserved for natural processes and functions.[142] Open space warrants this priority for several reasons: it is undervalued by the market, certain natural processes are preconditions to other land uses, and environmental degradation can be more cheaply and easily prevented than corrected after pollution occurs. But in the next stage of the land use design process Chapin and Kaiser emphasize that restricting development in open space areas can serve purposes beyond environmental preservation. They suggest that open space serves the following functions: protection of urban investments and people from natural environmental hazards; protection and manage-

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135. 522 F.2d 897 (9th Cir. 1975), *cert. denied*, 424 U.S. 934 (1976) (upholding zoning plan enacted to preserve city's small town character, open space, low population density, and providing for orderly growth, as reasonable exercise of police power).

136. 30 N.Y. 2d 359, 285 N.E.2d 291, 334 N.Y.S.2d 138 (N.Y. 1972) (upholding zoning ordinance providing for "phased growth" where physical and financial resources of community were unable to support substantial population increase).

137. *See, e.g.*, Management and Control of Growth: Issues, Techniques, Problems, Trends (Urban Land Inst., 1975); D. Godschalk, *Responsible Growth Management: Cases and Materials* (1978); *Dilemmas in Growth Management*, 50 J. AM. PLAN. A. 403 (1984).

138. Tripp, *supra* note 13, at 141-43.

139. *See, e.g.*, CARRYING CAPACITY IN URBAN DEVELOPMENT PLANNING (C. Wyman ed.) Univ. of N.C. at Chapel Hill (n.d.); A CARRYING CAPACITY STUDY OF HATTERAS ISLAND (J. Hegenbarth & R. Shaw eds. 1984) Univ. of N.C. at Chapel Hill.

140. F. CHAPIN & E. KAISER, URBAN LAND USE PLANNING (3d ed. 1979) [hereinafter CHAPIN & KAISER].

141. *See id.* at ch. 9.

142. *Id.* at 375-86. Just as McHarg points to the opportunities and constraints afforded by natural processes, Chapin and Kaiser identify open space as the locus of natural processes which either "perform useful functions without man's intervention and without cost" or "pose a hazard to man and property." *Id.* at 376.

ment of natural resources and environmental processes (including hydrological processes such as groundwater recharge areas); protection and management of natural resources for economic production; protection, provision, and enhancement of natural amenities and of outdoor recreational, educational, and cultural opportunities; shaping urban form; and reservation of land for future development.[143]

What, then, does environmental planning have to say about groundwater pollution and aquifer protection? First of all, in McHarg's terms, groundwater is both an opportunity and a constraint for man's activities.[144] The presence of an aquifer in an area is a natural opportunity because a stable source of clean fresh water is a valuable life-support system. Groundwater is a vital input in many residential, industrial, and environmental processes, and the withdrawal of groundwater for use as an input need only be constrained by the capacity of the aquifer and its rate of recharge.

But like all communities, human settlements take resource inputs and convert them into energy or useful products, leaving a residual output of waste. If the wastes exceed the capacity of environmental systems to absorb or reprocess them into future inputs they become pollution. Pollution from human activities can enter the environment through the air, by being spilled, dumped, or drained into surface water, or by being dumped or buried on the land surface, to make its way inevitably into groundwater. Here aquifers perform their second useful service for man—as a waste processing system. Layers of soil and sediment through which wastes leach and percolate help to filter and chemically break down pollutants before they reach the aquifer or the groundwater reaches a surface outlet.[145] This is the basic principle of septic systems, and is constrained by the capacity of the aquifer to process different types and amounts of wastes.

The problem arises when man uses the same aquifer for both purposes—as a drinking fountain and a dump. Since only a small amount of pollution can make an aquifer unfit for drinking water, the carrying capacity of a water supply aquifer to support pollution-causing activities in the recharge zone (i.e., most land uses) is relatively low. At this point the presence of an aquifer becomes a serious constraint on development and land uses because the waste

143. *Id.* at 378-79.
144. *See supra* text accompanying note 130.
145. DiNovo & Jaffe, *supra* note 6, at 19-21.

disposal function precludes the more valuable water supply function. Thus, the rational local government will want to act to protect its groundwater supply. The most effective means to do so, as discussed in the last section, is to employ land use controls to prevent pollution.

E. *A Three-Step Local Program*

Aquifer protection, given the ubiquity of groundwater resources and their importance for both man and the environment, is likely to be the most persuasive argument for adopting the environmental planning perspective on land use regulation. As Chapin and Kaiser suggest, beginning a land use planning system with an environmental perspective can lead to a more rational allocation of land uses and serve a variety of useful purposes not directly related to the preservation of natural processes. Starting from the need to protect groundwater, local governments should construct a new land use regulatory design in three stages: first, identify the significant groundwater resources and the appropriate policy of protection; second, establish the zone of protection and a regulatory strategy; and third, integrate aquifer protection with the full spectrum of local planning and development concerns.

Once local governments decide to undertake an aquifer protection program, they should start from a basic understanding of the resources involved. The first step is to recognize the importance of an adequate supply of clean groundwater to the survival and development of the community. Protection of the significant aquifers should be formally adopted as a central policy of the locality. This means, for example, amending the comprehensive plan to include the prevention of aquifer contamination generally, or the protection of a specific aquifer, as a goal of land use policy. Moreover, the policy objective should be specified as nondegradation of the aquifers which are determined to be important potential or current sources of public water supply. Nondegradation is an appropriate—indeed the only coherent—objective, because a policy based on allowing degradation or waste discharges within certain ambient standards is both impractical and irresponsible. The slippage between ambient groundwater quality monitoring and the control of the multitude of point and nonpoint pollution sources makes such fine tuning of resource uses impossible. In any event, the ambient quality standard approach ignores the fundamental risks surrounding the health and environmental effects of the many pollutants in groundwater.[146]

Possibly the most crucial aspect of this first stage is to delineate the aquifers to which the nondegration policy applies. It is unrealistic to begin by saying that since the entire land surface is underlain by some quantity of water, all land uses which pose any danger of contamination should be banned entirely. "Depending on how broadly 'recharge zone,' 'aquifer,' and 'risky land uses' are defined, such policies could imply the prohibition of most land uses over very substantial areas."[147]

Consequently, the important water supply aquifers must be identified and their recharge zones mapped,[148] perhaps as part of a state groundwater classification system. Geological formations which are below sizable cities or are already contaminated are unlikely to be useful as future water supplies and thus could be designated to serve the waste disposal function—to receive spills and runoff from more intensive development and industrial uses. At first glance, this form of ecological triage—"in effect, to create a sacrifice zone"[149]—seems to go against the environmentalist grain. However, it is more realistic to recognize that with a limited capacity to restrict land uses, governments must set priorities for protection of groundwater.[150] If economic development is allowed some pollution is inevitable. Even under ideal conditions, all industrial and residential runoff, wastes, and other potential contaminants cannot simply be gathered up and carted away to some safe place, nor can they be dumped directly into the air or surface water. Thus, polluting land uses must either be dispersed to dilute potential groundwater contamination, or concentrated in a sacrifice zone where they will do the least amount of harm.

Once the significant aquifers have been identified, classified, and their geological boundaries mapped, the second stage in the protection program is to determine the legal boundaries of protection—to draw the zone of dispersal or concentration. In most cases the zone

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146. Roberts & Butler, *supra* note 2, at 1018-23; Page, *supra* note 29, at 132.

147. Roberts & Butler, *supra* note 2, at 1026 (citations omitted).

148. *Id.* at 1026-28; Tripp & Jaffe, *supra* note 4, at 34; DEP, *supra* note 1, at 20-21.

149. Dycus, *supra* note 2, at 236.

150. Connecticut chose to set priorities for groundwater protection by classifying all groundwater according to use. *See* R. Smith, Institutional Issues Affecting Connecticut's Ground Water Management Program, paper presented at Symposium, Institutional Capacity for Ground Water Pollution Control 67, cosponsored by Univ. of Okla. and United States EPA (June 20-21, 1985) (on file, *Journal of Land Use and Environmental Law*) [hereinafter Smith]; Tripp & Jaffe, *supra* note 4, at 31-32. Connecticut's water quality standards are set out in DEP, *supra* note 1, app. 1 at 2, and table 2.

of protection will correspond to the aquifer recharge zone, which is the critical land-water interface for the hydrological cycle. In some cases, however, local governments might choose to protect an area directly surrounding public water supply wellfields. This strategy, which might be appropriate for aquifers which are ill-defined, spread over broad areas, or located where there is substantial existing development, has been employed in the metropolitan areas of southeastern Florida, among other places.[151] The approach used by Connecticut's DEP is to designate an aquifer protection zone (APZ) comprising the primary and secondary recharge zones (and perhaps the tertiary recharge zone as well, thus covering the entire drainage basin).

With the geological features of the recharge zone incorporated as a legal boundary of special zoning or other regulation, localities can select the appropriate level of protection from among three basic strategies: acquisition, low density zoning, or overlay zoning.

First, if the recharge zone is small or undeveloped, local governments could consider acquiring the fee or development rights, or encouraging such a purchase by a private preservation group or a water utility. Creation of a park, preserve, or forest over the recharge zone is indisputably the safest and most effective means of aquifer protection. This is analogous to the familiar concept of public ownership of restricted-access watershed lands around a surface water reservoir.

The second strategy, downzoning, could be used when purchase and ownership would not be economical. Governments can simply downzone the entire recharge area to prohibit the most threatening industrial and commercial uses and to disperse other commercial and residential uses at low densities.[152] Downzoning would be most effective in rural or undeveloped areas, where landowner opposition might be weaker and the exceptions of nonconforming uses would not swallow the low-density rule.

The third strategy is to treat the APZ as a special overlay zone. Within the overlay district some of the most dangerous uses would be prohibited outright and other proposed uses would be required to obtain a special APZ permit. The permit applicant should bear the burden of demonstrating that the proposed development would minimize danger to groundwater by compliance with designated best management practices and performance standards for such

151. Jaffe, *supra* note 118, at 91; DiNovo & Jaffe, *supra* note 6, at 103-04.
152. DEP, *supra* note 1, at 29; Ground Water Protection, *supra* note 17, at 7.

hazards as underground tanks, hazardous materials storage and use, and runoff and spill controls.

After the APZ strategy is established, the third stage in the groundwater protection program is to integrate aquifer protection with the whole of local land planning and development regulation. The comprehensive plan should be constructed from the groundwater up, since aquifer protection is a primary natural constraint on urban development. Unlike other natural constraints and opportunities, an aquifer's capacity to serve man can be only marginally enhanced by technical means. And an aquifer—unlike buildings, roads, industries, subdivisions, zoning boundaries, and other man-made entities—cannot be moved. Thus, to adopt an aquifer protection program means that urban development must adapt to the aquifer and not vice versa. A certain element of physiographic determinism will have to be imparted to land use policy. For example, local planners should develop a coordinated strategy for channeling intensive growth away from the APZ, perhaps by using tax incentives or transferable development rights, to encourage residential and commercial development to concentrate in a less critical area. As a bonus, development restrictions in the recharge zone could serve several of the open space purposes identified by Chapin and Kaiser. Aquifer protection could also be extended beyond the recharge zone to encompass coordinated waste reduction measures such as regional household and hazardous waste management, resource recovery and recycling, and soil conservation programs.

The process of using aquifer protection to define land use planning points out that the use of an APZ is both a powerful tool and an opportunity to accomplish a variety of planning objectives. An APZ protects an undeniably vital resource and is defined through recognized technical criteria. Thus, it provides a legally convincing justification for open space acquisition and preservation, for encouraging infill development in existing built-up areas, and, ultimately, for limiting overall growth. All these policies, desirable for non-groundwater reasons under environmental planning theory, often come across as being supported by little more than mushy-sounding eco-esthetic rationales, and could benefit from "hard science" support.

However, it is important to recognize that aquifer protection is by no means a no-growth manifesto. Preventing groundwater pollution is more accurately a growth preservation measure, since it seeks to maintain the development opportunity offered by groundwater while avoiding the development constraints associated with its protection. A community can continue to grow and develop so long as it has access to ample potable water supplies, but if its groundwater is polluted by the by-products of growth there will be less water available to satisfy demand. Because of persistent industrial and household pollution threats, Barnstable, Massachusetts, on Cape Code, has become concerned about running out of clean groundwater.[153] Santa Fe, New Mexico has also had to address the issue of a limited amount of groundwater to support projected growth. There, the problem is depletion more than pollution, and the city has adopted a zoning ordinance which explicitly conditions the density of future development on considerations of whether the underlying aquifer should be preserved or "mined" to exhaustion.[154]

These two examples point to the critical importance for land use planning of an aquifer's limited capacity to perform both of its conflicting functions of water supply and waste processing. Groundwater resources are becoming increasing important for public supplies. On the other hand, the effluents and externalities of modern industrial society will not go away, because "there is no 'away'."[155] Technology alone cannot solve the waste disposal problem, for there is simply too much municipal, industrial, and hazardous waste being generated and not enough safe places to put it. Pollution is an inherent by-product of land development, and not just the manageable effluent of a few discrete dumps, pipes, and smokestacks. Consequently, some quantity of pollution will continue to seep or leach into groundwater and endanger aquifers. Environmental planning theory teaches local governments to heed the constraints on urban development that aquifer protection imposes if they would benefit from the development opportunity that clean groundwater offers. The three-stage aquifer protection program suggested here provides a practical method for reorienting land use regulation to secure the benefits of nature.

IV. PROBLEMS AND PRACTICAL IMPLICATIONS

Implementing aquifer protection programs is fraught with problems. Connecticut serves as an example of how to confront

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153. Ryner, *supra* note 56.

154. Wilson, *A Land-Use Policy Based on Water Supply*, 19 WATER RESOURCES BULL. 937 (1983).

155. Dycus, *supra* note 2, at 211 (citation omitted).

these problems. This state, "one of the pioneers in groundwater quality protection, has taken a comprehensive, centralized, and preventive approach to groundwater protection."[156] Under the guidance of the DEP, many of the state's 169 towns began working through the three stages of aquifer protection, even before P.A. 85-279 required them to do so.[157]

A. *Stage I: Gathering Data*

In the first stage, identifying and prioritizing groundwater resources, the Connecticut experience demonstrates that collecting sufficient local technical and hydrological data may not be as great a problem as it might appear. The state's groundwater classification system uses United States Geological Survey topographical maps,[158] which are available in most areas of the country. U.S.G.S. maps were incorporated into studies done by regional planning agencies under grants from the Clean Water Act's 208 program.[159] The Connecticut 208 program produced a series of special maps and regional studies of groundwater pollution and protection problems which encouraged many towns to adopt aquifer protection zoning.[160] State agencies such as the DEP can also serve as sources of maps and natural resources information, as can regional water utilities and university-affiliated research institutes.[161] Local governments may still need to hire a hydrological consultant or survey, but they should look first to the wealth of material already available in most states to help provide the technical basis for groundwater policy.[162]

In addition to hydrological data on groundwater resources, a government undertaking an aquifer protection program will need to know the location and extent of potentially polluting land uses. State governments may also have some data on existing or potential waste dumps or other sources of groundwater pollution,[163] but

156. Roberts & Butler, *supra* note 2, at 1033.

157. J. Murphy, *Protecting Our Groundwater: What Every Community Can Do*, 13 DEP CITIZENS BULL. 10-11 (Jan. 1986) [hereinafter J. Murphy].

158. Roberts & Butler, *supra* note 2, at 1033-34; GROUND WATER PROTECTION, *supra* note 17, at 4.

159. *See, e.g.*, GROUND WATER PROTECTION, *supra* note 17; Jaffe, *supra* note 118, at 88-89.

160. Interview with Shirley Gonzales, Town Planner of Hamden, Conn. (Feb. 27, 1985). For a list of these maps, see GROUND WATER PROTECTION, *supra* note 17, at 15-16.

161. Smith, *supra* note 150, app. D at 84-86 lists maps and other data available.

162. *See, e.g.*, DINOVO & JAFFE, *supra* note 6, at ch. 6; DEP, *supra* note 1, at 23-25.

163. Smith, *supra* note 150, at 73.

local governments are closest to the scene and should perform their own inventory of LUSTs, hazardous materials users, and other potential dangers.[164]

Local governments can organize hydrological and waste source data to establish priorities for protection efforts through a state groundwater classification system. Though somewhat similar to systems in other states, Connecticut's water quality standards (WQS) apparently was a model for the scheme advanced in the EPA's 1980 Proposed Ground Water Protection Strategy,[165] and is the groundwater equivalent of the surface water quality standards required by the FWPCA.[166] Connecticut's groundwater and surface water quality classifications are actually the same basic system,[167] and are determined by surrounding resource uses as well as by existing aquifer quality.[168] The classification system embodies a state goal that all groundwater should ordinarily be brought up to at least class GA, suitable for private wells.[169] Seventy percent of the state's land area is already in class GA,[170] while lands adjacent to existing public water supplies (class GAA) comprise twenty-two percent of the state's land area.[171] Thus, Connecticut's groundwater WQS effectively embodies a nondegradation policy for most of the state's area, and is intended to serve as a guide for developing local aquifer protection programs.[172]

One factor that should not be ignored in local planning is the degree of residents' dependence on bedrock aquifers for private

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164. HAZARDOUS MATERIALS IN NORTH CAROLINA, *supra* note 49, at 19; J. Murphy & J. Cimochowski, *Local Regulation of Hazardous Materials Storage, Step I: Inventory and Assessment*, 13 DEP CITIZENS BULL. 18 (April 1986)[hereinafter Murphy & Cimochowski].

165. Dycus, *supra* note 2, at 222 n.70.

166. *See* Tripp & Jaffe, *supra* note 4 , at 11 n.66. Connecticut's groundwater quality classes are GAA, groundwater used for public and private drinking water supplies without treatment; GA, groundwater used for private drinking water supplies without treatment; GB, groundwater requiring treatment; and GC, groundwater suitable for receiving permitted waste discharges. Each class has a corresponding list of waste discharges compatible with maintaining its quality level. Smith, *supra* note 150, at app. A. The final EPA Ground Water Protection Strategy proposes a somewhat different scheme consisting of Class I, Special Ground Waters (highly vulnerable or an irreplaceable source); Class II, Current and Potential Sources of Drinking Water (existing quality levels to be maintained); and Class III, Ground Water Not a Potential Source of Drinking Water and of Limited Beneficial Use. EPA STRATEGY, *supra* note 50, at 43-48.

167. DEP, *supra* note 1, app. 1 at 1.

168. *Id.* at app. 1 at 1-2.

169. *Id.* at table 2.

170. *Id.*

171. *Id.*

172. *Id.* at app. 1 at 2.

water supply. Most private wells draw upon saturated fissures in bedrock which have a very complex hydrology, making it difficult to monitor possible sources of contamination.[173] Moreover, private wells are rarely tested for even routine bacterial contamination once they are drilled, so that contamination may not even be discovered. If contamination is discovered the homeowner may face a difficult choice between a massive cleanup bill and connection to a public water line, if one is available.[174] While minimum lot sizes and spacing between wells and septic tanks have long been used to protect private wells against biological pollutants, such measures may not be effective against synthetic organic chemical spills and LUSTs. Consequently, planners should consider what additional protections for private wells might be warranted, such as including the areas unserved by private water lines in the APZ, or excluding industrial and commercial uses from such areas. Groundwater-induced development restrictions in non-sewered areas can also dovetail with the common growth management strategy of discouraging development in outlying areas not served by public water and sewer systems.

A sewage system also prevents groundwater recharge from septic tanks, and thus raises the issue of the connection between depletion and pollution, or between groundwater quantity and quality.[175] Depletion has not been as great a danger in the humid states of the East, but in other areas of the country states have historically regulated groundwater use.[176] In conditions of water shortage, depletion and pollution represent two horns of a dilemma. For instance, if contaminated recharge from septic systems, runoff, or injection wells is curtailed by sewering or other means, the aquifer may not receive enough percolated water to balance withdrawals,[177] resulting in water shortages and even land surface subsidence. However, aquifer protection measures will help keep recharge waters uncontaminated, and some regulations—such as zoning to restrict the extent of impervious or built-up area—will

173. *Id.* at 3.

174. Woodhull, *supra* note 11, at 189.

175. Tripp & Jaffe, *supra* note 4, at 35-36.

176. Dycus, *supra* note 2, at 231-32. Connecticut now requires a permit for diversions of ground or surface water, with the permit to address effects on groundwater quality. "This diversion permit process is among the most comprehensive program [sic] of its kind in the country, and is a pioneer program for the water-rich New England states." DEP, *supra* note 1, app. 1 at 17.

177. Tripp & Jaffe, *supra* note 4, at 35.

encourage recharge and dilute pollution.[178]

B. *Stage II: Designing an Ordinance*

The second stage of the aquifer protection process, designing an aquifer protection ordinance, will often be a sensitive political issue requiring the input of many interested parties.[179] There are many considerations unique to each locality which affect the choice of an APZ strategy. Of the three strategies of acquisition, downzoning, and overlay zones, the acquisition of critical recharge areas is clearly the best policy from a groundwater quality standpoint. Water utilities would prefer to have the recharge areas around their wellfields left as protected, vegetated open space in the hands of a single government or institutional owner, so that recharge quality could be most easily maintained.[180] But many local governments, more concerned with the tax rolls and mill rate, will be reluctant to even think about purchasing what might be quite large tracts of land without any direct economic payoff. Moreover, if industrial and commercial land uses (such as those in the DEP's Category E) already exist in the recharge area, acquisition might be prohibitively expensive and possibly futile. On the other hand, if the recharge area is already low-density residential or other Category A or B uses, then acquisition may be unnecessary. Nonetheless, continuing development pressures in most suburban and rural areas and the susceptibility of high-quality aquifers to contamination make purchase of recharge areas a wise public investment, at least for areas surrounding wellfields, if the funds could be found. Local governments could explore the possibilities of private land trusts or easements, or seek state funding. Massachusetts already has a fund to finance purchases of significant recharge areas, and Connecticut is considering a similar program.[181]

Another possibility for acquisition is purchase by the regional water utility, which may present several advantages. Water companies are already experienced in the ownership and management of surface watershed lands and could hold title to aquifer recharge zones in the same manner. Moreover, by financing the purchase of

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178. *Id.* at 36.

179. *See* DEP, *supra* note 1, at 21-22 for a list of these actors and their functions.

180. Interview with Thomas Chaplik, Southern Connecticut Regional Water Authority (Feb. 20, 1985).

181. DEP, *supra* note 1, at 32-33.

fee title or development rights through charges added to customers' bills, the utility or utilities in the aquifer's watershed region could spread the cost of acquisition more effectively than by taxing local property owners or state residents' incomes, since those who benefit by the protection of groundwater supplies would bear the cost.[182] Even if an aquifer supplies only one or a few towns, utility customers in other communities would still benefit by not having to help pay for the diversion and distribution of alternate water supplies in the event the neighboring aquifer became contaminated. Of course, spreading the cost more widely among a greater number of water users will make the cost to each less burdensome. Finally, if the water utility is investor-owned it may be able to continue paying property taxes, however slight, on the recharge zone area.

The second APZ strategy of downzoning the recharge area may be less of a practical problem in cases where recharge zones are in suburban or rural areas. The DEP recommends a 2-acre per dwelling unit density for Category B lands and ½ to 2 acres for Category C,[183] densities which are not uncommon in suburbia. Downzoning is important not only to disperse the sources of potential contamination, but also because large-lot owners are less likely to disturb the natural vegetation and contours of their property.[184] Vegetation, especially trees (forest recharge is the baseline standard for groundwater quality), is superior in controlling runoff and filtering recharge waters, so that altering the contours and soil covering can have deleterious results.[185] A related ill effect discouraged by large lot zoning is the increased runoff and contamination resulting from paving over the land surface.[186] Paved areas, such as city streets and parking lots, are "hydrologically active" and contribute substantial amounts of oil, salt, asbestos particles, and other pollutants to runoff.[187]

Downzoning may present difficulties where the recharge area is zoned for commercial or industrial uses. From an economic perspective, many stratified drift aquifer recharge zones are in flat,

182. Schenectady County, New York, has established a water user surcharge to finance the acquisition of parcels surrounding public wellfields. DiNovo & Jaffe, *supra* note 6, at 101-02.

183. *See supra* note 83.

184. Tripp & Jaffe, *supra* note 4, at 45.

185. Novotny & Chesters, *supra* note 58, at 424-25; Koontz, *supra* note 46, at 17.

186. Novotny & Chesters, *supra* note 58, at 312-17.

187. *Id.*

low-lying areas eminently suited to development.[188] From a legal perspective, changing the zoning to large-lot residential may risk another of the "seemingly inevitable 'taking' challenges to sensible health and environmental protection measures."[189] Certainly the exclusion of potentially polluting industrial uses from critical recharge areas is a legitimate police power goal, and the DEP has assured Connecticut towns that:

> The State Legislature and the courts have made it clear that any revisions to zoning for the purposes of groundwater protection are indeed valid, provided the approach is a rational one and consistent with the comprehensive plan. Rezoning a parcel of land from industrial to residential will not be considered a "taking" so long as the Board has revised its regulations (including the statement of purpose), and the zoning map, on a rational basis.[190]

In Connecticut, municipal planning and zoning enabling acts have been specifically amended to include a mandate for groundwater protection.[191] While no aquifer protection ordinance has been directly challenged, the state's 1975 legislative moratorium on the sale of certain water company lands was upheld as constitutional.[192]

Apart from the requirements of federal and state programs, which are always helpful in justifying local land use regulations, the key to sustaining the rationality or validity of a particular downzoning will be the soundness of the locality's technical and hydrological basis for distinguishing the aquifer protection area. The availability of alternate locations nearby for industrial uses can also be used to justify local land use regulations. Local governments may have to face difficult choices in weighing competing land uses for industrial development and aquifer protection, and many will decide to allow industrial uses in groundwater recharge zones. The town of Cheshire, Connecticut has made this decision, choosing to rely on industry performance standards and regulation

188. Huffmire, *supra* note 1, at 268-69.

189. Tripp & Jaffe, *supra* note 4, at 46.

190. DEP, *supra* note 1, at 29.

191. *See supra* note 127.

192. Bridgeport Hydraulic Co. v. Council on Water Co. Lands, 453 F. Supp. 942 (D. Conn. 1977). Additionally, in DeMars v. Zoning Comm'n of Bolton, 142 Conn. 580, 115 A.2d 653 (Conn. 1955), the Connecticut Supreme Court upheld a town zoning regulation which anticipated future growth and increased all minimum lot sizes "in order to provide larger areas for sewage disposal, and by so doing to lessen the danger to the residential water supply." *Id.* at 655.

to protect the groundwater beneath an area well-sited and long planned for industrial development, even though the town has already experienced a well contamination episode.[193]

Even if there is no taking suit, an aquifer protection downzoning may also risk encountering another common legal challenge—that of exclusionary zoning. The use of large minimum lot sizes has gained notoriety as a tactic used to exclude low-income housing and other unwanted development from the suburbs.[194] Conceivably, the banner of aquifer protection could be raised to camouflage an intent to exclude; the groundwater pollution problem would become, as New Jersey's *Mount Laurel* case put it, a mere "makeweight to support exclusionary housing measures or preclude growth . . . ."[195]

But an aquifer protection downzoning limited to a defined recharge zone is unlikely to be invented just to ward off industry or low-income housing. If supported by a history of groundwater contamination, extensive technical background, or state law, an aquifer protection program will bear little resemblance of a uniform large-lot zoning in areas unrelated to recharge zones and backed only by vague environmental or quality of life rationales. Nonetheless, the possibility of large-lot zoning serving both purposes should reinforce the need for a sound geological and hydrological foundation for aquifer protection zoning.

In contrast to acquisition and downzoning, which are better suited to undeveloped or sparsely populated areas, the strategy of aquifer protection overlay zones is more flexible and widely applicable. The overlay zone device is certainly more popular in Connecticut, where the DEP's 1983 survey found twenty of twenty-five towns using overlay zones superimposed on existing zoning.[196] The overlay zoning technique, in which certain uses are prohibited,

193. Interview with Thomas Chaplik, *supra* note 180; GROUND WATER PROTECTION, *supra* note 17, at 1. In Barnstable, Massachusetts, for instance, downzoning was considered impracticable because most of the town would have been in the aquifer protection zone. Ryner, *supra* note 56.

194. *See, e.g.*, Southern Burlington County NAACP v. Township of Mount Laurel, 336 A.2d 713 (N.J. 1975).

195. *Id* at 731. For a discussion of how local governments could rationalize exclusionary zoning by groundwater protection, see Note, *Land Use Regulation and Pollution Control*, *supra* note 94. In Hamden, Connecticut, a group of rural residents challenged a subdivision application on aquifer protection grounds, even though there was no evidence of any threat to the Mill River Aquifer and the residents were apparently motivated by a desire to stop the subdivision. Interview with Shirley Gonzales, *supra* note 160; *Residents Seeking Tighter Zone Rules*, New Haven Reg., Dec. 6, 1984, at 38, col. 1.

196. DEP, *supra* note 1, at 18.

others allowed, and others require a special APZ permit, is adaptable to almost any local conditions and can be drafted to provide widely varying degrees of protection.

A model zoning ordinance prepared by the Conservation Law Foundation of New England presents an example of a rigorous form of aquifer protection.[197] Declaring its purpose to "protect and preserve the existing and potential groundwater supply and groundwater recharge areas" pursuant to Connecticut General Statutes, section 8-2,[198] the model ordinance prohibits in primary and secondary recharge zones, inter alia: the storage or disposal of solid or hazardous waste, underground fuel tanks less than 1100 gallons (and thus not subject to the DEP LUST regulations), certain dry wells, certain agricultural practices, and commercial or industrial uses employing or storing hazardous materials, such as dry cleaners, photo processors, fuel storage facilities, gas stations, junkyards, and car washes.[199] Restricted uses—including all commercial and industrial activity, DEP-regulated storage tanks, and topographical alterations rendering more than ten percent of the site surface impermeable—must undergo a site plan review for the purpose of determining that "there will be no groundwater contamination or deleterious induced infiltration into a designated aquifer."[200] The site plan application must also include a report detailing the proposed uses of hazardous materials, disposal of waste, alteration of natural contours, groundwater usage, and mitigating measures.[201]

Towards the other end of the protection scale, though serving as a partial model for the CLF ordinance, is the model zoning ordinance designed by the Connecticut 208 program.[202] The model or-

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197. Koontz, *supra* note 46, at app. A.

198. *Id.* at app. A at 1.

199. *Id.* at app. A at 3-4.

200. *Id.* at app. A at 5-6.

201. *Id.* at app. A at 6.

202. GROUND WATER PROTECTION, *supra* note 17, app. at 4. For other examples *see, e.g.*, Art. VI of the Hamden and § 47 of the Cheshire zoning regulations, similar provisions which fall somewhere between the CLF and 208 models in strictness. Both of these measures have a different list of prohibited uses and a less detailed APZ permit application process, though the applications must address effects on sewers and stormwater runoff. A more restrictive example, though different in form from the CLF model in requiring both APZ permits for ordinary uses and special use permits for more dangerous uses, is a Draft Recommendation by the North Haven Conservation Commission to establish a Groundwater Protection Planning & Zoning Regulation in the Town of North Haven, Conn., Aug. 14, 1984 [hereinafter North Haven Draft Ordinance]. *See also* DINOVO & JAFFE, *supra* note 6, at app. C for other sample ordinances.

dinance requires every land use within the APZ to comply,[203] but contains a shorter list of prohibited uses.[204] Only "large-scale" commercial and industrial uses of hazardous materials are barred,[205] and only underground storage tanks and manure storage areas are under special restriction.[206] While the DEP has cited the 208 model as inadequate, it has abandoned its model ordinance strategy in favor of a municipal planning process, citing the unique needs and administrative capacities of each local government.[207]

Though the permitting and site plan review process may seem an ideal means for selectively reconciling groundwater protection with more intensive development, there are problems of evaluation and enforcement inherent in this approach. Many local government staffs may not possess the technical expertise to properly evaluate site plans or permit applications, or to understand whether proposed performance standards and waste controls are adequate. Smaller communities may be able to borrow the expertise of state environmental agencies and the local water utility by seeking their input in reviewing permit application (both the Cheshire and Hamden ordinances provide for such consultation), but these institutions themselves may be inexpert or too overburdened to keep track of all potential dangers to groundwater in a given aquifer. Most significantly, there is little margin for error in regulating potentially contaminating uses in a recharge zone. There are many land uses which pose possible dangers. Since the greatest volume of contaminants results from an aggregation of small sources, each source must be sufficiently policed because only one accident or accumulation of small leaks can render an aquifer unfit for use.

Consequently, local governments should place a heavy burden on commercial and industrial applicants for APZ permits to demonstrate the reliability of their pollution containment systems and to evaluate the probability and possible results of failure. "This does not posit failure to control pollution, but any plan which does not address 'worst case' scenarios and their results is shortsighted when the resource is truly invaluable."[208] The draft North Haven ordinance properly provides, "In making such determination [that

203. GROUND WATER PROTECTION, *supra* note 17, app. at 5.
204. *Id.* at app. at 6-8.
205. *Id.* at app. at 7.
206. *Id.* at app. at 7-8.
207. J. Murphy, *supra* note 157, at 9-10.
208. DEP, *supra* note 1, app.2 at 2.

groundwater quality will not fall below state or federal standards as a result of the proposed use], the [zoning commission] 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."[209]

Even if the site plan application is thorough and is strictly scrutinized and approved by knowledgeable agencies, there remains the responsibility of enforcing the controls and monitoring compliance with performance standards. Enforcement places additional burdens on the locality, which is unlikely to find much assistance from state government or the water utility in ongoing enforcement efforts. Connecticut's DEP already claims that it is overburdened and is seeking local government aid in enforcing state environmental regulatory programs.[210] Consequently, towns which choose to protect groundwater through an APZ permitting process must pay careful attention to screening applications and enforcing permits. Outright prohibition of potentially dangerous uses is a much simpler, more definite and effective means of protecting groundwater, but it may be feasible only for smaller or more rural localities which can afford to set aside land from commercial or industrial development but cannot afford to police those uses.

C. *Stage III: Implementing the Plan*

Once a community has established an aquifer protection program it should begin the third stage of the process: integrating aquifer protection with other land use and development concerns. The environmental constraints and opportunities in each locality will differ, of course, but the closely associated issue of hazardous waste will inevitably arise in all communities which consider aquifer protection. The most widely mentioned accessories to aquifer protection zoning have been a hazardous materials ordinance and a public education program. Since APZ overlays and downzoning, like all zoning, can only apply to future uses, many communities will need some means of controlling existing uses involving hazardous materials or other potential contaminants, either on a townwide basis or within the aquifer protection zone.[211] Though regulation of hazardous materials use tends to fill a gap in the state and federal regulation of hazardous wastes, there is still the possibilty

209. North Haven Draft Ordinance, *supra* note 202, at 3.
210. DEP, *supra* note 1, app. 1 at 13-14, 19.
211. DEP, *supra* note 1, at 30.

of problems with state or federal preemption of local police power legislation.[212] Nonetheless, the DEP strongly urges that "[a] local hazardous material ordinance should be a component of nearly every local groundwater protection program,"[213] and provides detailed technical guidelines and suggested performance standards for regulating drycleaners, furniture strippers, photo processors, automotive services, machine shops, and metal finishing operations.[214]

It is beyond cavil that the volume of hazardous material in circulation is immense and that state and federal regulatory programs can only cover a small percentage, but it is doubtful whether local governments can pick up the slack entirely on their own. The comprehensive model municipal hazardous materials ordinance drafted by the CLF suggests the magnitude of the practical difficulties.[215] The CLF model would require everyone, including homeowners, who stored twenty-five pounds or fifty gallons of hazardous materials to register and pay a fee with the town, and commercial and industrial users would have to maintain a monthly hazardous materials inventory and meet stringent performance standards.[216]

So long as our economy continues to use and produce hazardous and toxic materials at anything like the current rate, stringent regulations will be necessary to protect the public health. But as the CLF admits concerning its hazardous materials model, "[i]mplementing this ordinance requires significant administrative resources devoted to enforcement."[217] If state and local hazardous materials ordinances are not adequately enforced, the vast numbers of small hazardous materials users and waste generators cannot be expected to comply with burdensome regulations. Indeed, many small commercial and household generators may be ignorant of the need for safe management and disposal of commonplace toxic products, and may have no way of disposing of their wastes safely, even if they wanted to do so.

Since local governments can neither wish nor regulate hazardous

212. Koontz, *supra* note 46, at 10-12 ("[S]tate enabling acts for municipal legislation contain broad authority to protect health by establishing regulatory standards and zoning classifications."); HAZARDOUS MATERIALS IN NORTH CAROLINA, *supra* note 49, at 16 ("Local regulation of hazardous wastes is subjected to certain specific limitations, but is not preempted in general.").

213. DEP, *supra* note 1, at 30, and app. 4.

214. *Id.* at app. 4. *See also* Murphy & Cimochowski, *supra* note 164.

215. Koontz, *supra* note 46, at app. B.

216. *Id.* at app. B at 2-3.

217. *Id.* at 17.

waste out of existence, they should provide small generators with an alternative to dumping down the drain and in the backyard. Exemplary local programs provide for waste oil collection and recycling and municipal collection of small generators' hazardous waste, which is required by law in Florida[218] and is strongly encouraged in Connecticut.[219]

Having accepted the need for groundwater protection, land planners will soon realize the need for regional and statewide coordination of solid and hazardous waste policy,[220] with an ultimate goal of reducing the volume of waste.[221] As the DEP points out, "[t]he very small area classed as GC [suitable for certain waste disposal] means resource conditions will not allow continued reliance on land disposal techniques for our waste stream, and resource recovery alternatives must be developed."[222] One analysis recommends integrated state or regional control of both waste disposal and water supply, so that the external costs of pollution could be internalized into the price of water.[223] Before such a comprehensive solution arrives localities will need help to cope with the garbage crisis. In the absence of active state or federal programs, coordinating roles could be played by state agencies or regional water utilities. The DEP, for instance, has proposed designating regionally significant aquifers, which would impose a stricter regime of state protection upon selected recharge zones.[224] Water utilities, like state government, can perform an important function simply by reviewing and coordinating APZ permit applications in the areas they serve. Because of their technical expertise and concern with water quality, public water utilities could be endowed with additional authority, such as a mandatory review of site plans or even a veto power over APZ permits, to become de facto regional environmental planning agencies. But whatever institutional design is adopted, land use conflicts between aquifer protection and waste production and disposal will necessitate more and more comprehensive regional coordination and planning.

While local government planners and officials are beginning to

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218. Dycus, *supra* note 2, at 260.

219. Katz, *Cleaning up our Waste*, New Haven Journal-Courier, Feb. 11, 1985, at 37, col. 4; Fish, *Hazardous Wastes Education Program: Creating Future Decision-Makers*, 13 DEP CITIZENS BULL. 12-13 (Jan. 1986) [hereinafter Fish].

220. National Groundwater Policy Forum, *supra* note 90, at 2.

221. Dycus, *supra* note 2, at 270.

222. DEP, *supra* note 1, at table 2.

223. Huffmire, *supra* note 1, at 285-86.

224. DEP, *supra* note 1, app. 2 at 9.

realize the environmental interconnections between land use, waste management, hazardous materials use, groundwater supply, and groundwater pollution, this understanding must be conveyed to the public at large. Many local officials are keenly aware of groundwater pollution and waste disposal problems and are willing to take preventive action. But, except in areas which have already experienced contamination, public awareness of groundwater problems seems minimal.[225] Commentators have called for "[a] public information campaign of unprecedented proportions . . . [to] make groundwater contamination a serious moral concern,"[226] both to encourage care in using hazardous materials and to build public understanding and support of groundwater protection measures.[227] The DEP has developed a hazardous waste curriculum to be used in the public schools.[228] It should also be possible to educate adults as to the connections between feared toxic chemicals, common development effluents, and groundwater pollution. People need to be told—for their own sakes and not just to support the schemes of planners—that everyday products such as solvents, pesticides, or gasoline spilled or dumped onto the ground can end up in someone's drinking water:

> Education of citizens and businesses about groundwater protection in general, about local resources and threats to them, and about personal responsibilities for groundwater protection are vital. Not even the best-drafted regulations can control thoughtless dumping or careless handling of small quantities of hazardous materials. People must be made aware of the dangers and of their responsibility to handle such materials with care.[229]

Only when citizens, as well as government, realize how their daily activities depend on natural processes, of which groundwater is only a part—when they begin to see the multitude of land use problems of water supply, surface pollution, hazardous waste, solid waste, and aquifer protection as facets of a single problem—will significant progress be made in addressing any of these individual problems. An understanding of groundwater protection and its central role in land use regulation is a good place to begin adjust-

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225. Jaffe, *supra* note 118, at 87-88.
226. Dycus, *supra* note 2, at 270 (emphasis omitted).
227. *Id. See also* DiNovo & Jaffe, *supra* note 6, at 136-38; DEP, *supra* note 1, at 27; National Groundwater Policy Forum, *supra* note 90, at 2.
228. Fish, *supra* note 219.
229. DEP, *supra* note 1, at 27.

ing human activity to become compatible with the natural environment.

V. Conclusion

Not every community is willing or able to embrace comprehensive land use planning based on environmental planning theory or ecological carrying capacity. But one component of the environment, public water supply aquifers, makes a strong claim for the primary attention of all local governments. In many areas of the country groundwater is or could be a significant source of convenient, clean public water supplies. Yet wherever there is land development, groundwater is in danger of contamination. Aquifers are a fixed geological feature, confining the slow-moving groundwater and making it susceptible to many types of chemical and waste pollution from a wide range of human activities. Because the water cycle moves slowly through aquifers, plumes of pollution are also confined; but once groundwater is contaminated, it will be unusable for a very long time. Consequently, pollution prevention is the key to preserving this important resource. Since each aquifer has only a limited capacity to absorb the spills, runoff, and other contamination that inevitably accompanies land development, control of land uses in the recharge zone is the best means of preventing groundwater pollution. And because the federal government is unable to take the initiative, local governments need to assert their police power to protect the public health.

The legal regime of local land use control has often been severely criticized for its parochialism, its elevation of economic development and tax revenues above non-market public goods, and its neglect of regional and statewide concerns. As a result, some commentators have strongly urged that state governments take over land use planning and regulation for aquifer protection.[230] In view of the ecological interrelationships of groundwater pollution, waste disposal, water supply, and land use, arguments for the broader perspective of state control have an undeniable force. Local governments may well be unwilling to restrict lucrative development to protect a regional groundwater resource if unregulated neighboring areas are able to lure the development away. Thus, state supervision of land use regulation may ultimately be necessary to prevent municipalities from striving for the lowest common

230. Huffmire, *supra* note 1, at 268-70; Note, *Land Use Regulation and Pollution Control*, *supra* note 94.

denominator of groundwater protection. But state control is not an inevitable precondition of effective aquifer protection. Responsible local governments that understand the broader general welfare obligations attached to the privilege of home rule can accomplish much by working cooperatively with the state and with neighboring communities.

Above all, aquifer protection can be a valuable local initiative whether communities wish to avoid or to await state or regional land use controls. The need to prevent groundwater pollution can introduce local governments to McHarg's environmental planning perspective that land uses should conform to the physiographic constraints and opportunities of the environment, and can form the basis for reorienting land use regulations to preserve natural features and processes as suggested by Chapin and Kaiser.

The first stage in the aquifer protection process, identifying critical and endangered aquifers and recharge areas, establishes a solid geological rationale and legal basis for delineating an aquifer protection zone, for restricting land uses within the zone, and for shifting dangerous uses away from the area. Once the zone is incorporated into the local comprehensive plan and zoning map, the threat of groundwater pollution and the importance of aquifer protection can spur the acquisition of open space or low-density zoning of undeveloped recharge areas. In most localities, however, existing development patterns and zoning boundaries will require the aquifer protection program to employ an overlay zone technique, which should rely on prohibition of all questionable commercial and industrial land uses unless the local government is able to invest substantial administrative resources in permit evaluation and enforcement.

Once the APZ boundaries and restrictions are recognized, local governments should reconstruct their development plans and land use regulations on the groundwater protection foundation. Because an aquifer represents both a priceless community resource and a discrete and restricted area of surface land, localities must literally develop around aquifers. In following the pattern set by nature and environmental planning theory, local governments have the opportunity to concentrate industrial development in already urbanized areas; to combine the APZ with existing plans for low-density residential, open space, or recreational uses; and to promote a broader consideration of pollution control, water supply waste management, and development through regional cooperation and public education.

On the other side of the equation, if local governments ignore the need for aquifer protection and continue land development business as usual they risk the loss of their groundwater resources at a time when they may need clean water the most. A polluted aquifer will always be easier to prevent than to correct. Communities do not need to experience a well contamination to realize this; in many localities aquifer protection is already an integral part of local land planning. But if local governments are willing—or compelled—to take a broader, ecological view, an aquifer protection program can represent the beginning of a significant land use reform.