chapter 6

SITE DEVELOPMENT PRACTICES
CREATING SUSTAINABLE AND PROFITABLE DEVELOPMENTS

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The preceding chapters describe the key principles that frame the context for achieving sustainable communities. The principles are summarized as follows:

- Use land wisely to minimize development impacts on land, water, energy, and other natural resources and to protect regional natural resources and environments that help sustain urban economies and societies.
- Weave a network of natural spaces throughout the urban and urbanizing fabric of developing communities to conserve valued natural resources and environments and to provide opportunities for human appreciation of and benefit from such features.
- Maintain and expand infrastructure systems cost effectively.
- Promote sustainable forms of economic activity and social interaction and advancement that satisfy the diverse needs and desires of community residents.
- Recognize and value, through modified real estate financing practices, the long-term nature of sustainable real estate investments.

This chapter narrows the focus from communitywide aspects of sustainability to the ways developers can apply the above principles to making decisions about the location, components, design, and community relationships of specific developments.

Human beings have long used ecological principles to design their habitats. The Greeks pioneered passive solar architecture, the Romans and Phoenicians used thermal mass to regulate temperature, and the desert cultures of the Middle East and pre-Columbian western America built structures that achieved natural ventilation and cooling. During the industrial revolution, however, society discarded many of the techniques for working in cooperation with nature. Increasingly, site and building designs depended on technological means to augment or even replace reliance on natural processes. In these circumstances, living and working spaces lost their connection with the surrounding natural environment and even isolated their occupants from nature. Accordingly, site development and building construction came to consume enormous quantities of resources while the activities they set in motion consumed extravagant amounts of energy and disgorged large volumes of waste.

By contrast, the message of sustainable development is that economic growth fueled by increased consumption, especially of nonrenewable resources, cannot continue indefinitely. The challenge for developers is to find ways to adapt to changing expectations for reduced resource consumption. In fact, developers can promote sustainable development by pursuing a real-world process that integrates the built environment with the natural environment and that uses modern technology to enhance traditional development approaches. Yet, an emphasis on sustainable qualities of development need not require developers to sacrifice profitability. Applying the principles of sustainability in imaginative ways can yield competitive advantages in development costs and market acceptance.

This chapter describes site development practices that offer opportunities for meeting sustainability goals while satisfying investment objectives. However, many of the practices represent innovative and therefore potentially more risky approaches than typical designs and forms of development. Developers attempting to introduce unconventional technologies or designs should not expect ready acceptance by lenders, public regulators, or even consumers. Furthermore, developers must be prepared to compete in regional markets where conventional projects generate relatively little resistance. Even so, many sustainable development practices have proven successful in completed and profitable projects. And, as discussed in the next section, it appears that sustainable practices can appeal to many consumers, providing a marketing edge for developments that incorporate such practices.

Throughout the chapter, sustainable practices are described in terms that demonstrate their contribution to sustainable development, compare their advantages and disadvantages in relation to conventional practices, and assess the short- and long-range investment values of such practices for both developers and consumers.

The Market for Sustainable Development

Developers depend for their livelihood on accurately identifying and satisfying consumers' needs and desires. Many have been able to carve out special niche markets that respond to particular forms of development—from seniors' housing and artists' lofts to entertainment complexes and boutique hotels. Among niche markets are groups of consumers who crave features and forms of development that promote sustainability. Such consumers include those who support sustainable development based on personal belief and others who enjoy the distinctive features that characterize sustainable development. They also include a host of consumers whose lifestyle and household needs vary from the norm as well as consumers with a growing awareness of the long-term investment value of sustainable development. John Laswick, the city of Tucson's project manager for Civano, Arizona, a 1,200-acre master-planned community under development according to sustainability principles, says, "We have found that our development has been attracting a substantial market share that appreciates the sustainable features of Civano."[1]

Surveys have found that a sizable share of the consumer market believes in sustainability principles and seeks products that promote sustainability. A 1996 study by American LIVES, Inc., a San Francisco–based market research firm, indicated that about 24 percent of the U.S. population, or about 44 million Americans, can be described as "cultural creatives" who support the ideals of ecological sustainability and value globalism, altruism, spirituality, a social conscience, women's advancement, and optimism. The cultural creatives comprise a market segment previously undefined and untargeted by the real estate industry. Another American LIVES, Inc., study found that 77 percent of Americans support the principles of sustainability.[2] In addition, surveys conducted for the public utility industry by American LIVES showed that 75 percent of respondents would be willing to pay somewhat more for electric power if the sources of that power were cleaner than coal. In fact, one survey found that 71 percent of respondents would pay up to 20 percent more for electricity generated by nonpolluting and renewable energy sources.[3]

Americans are also attracted by historically and architecturally interesting buildings and areas. Many older parts of cities and towns are undergoing revitalization as consumers increasingly appreciate distinctive urban living and working spaces. In places as varied as Portland, Oregon; Peoria, Illinois; and Baltimore, Maryland, old and often vacant industrial and warehouse buildings are being refitted for residences, shops, and offices. Adapting existing buildings for new uses brings life to older sections of cities, effectively recycling and thereby sustaining the built environment.

The traditional community designs of the new urbanism, which respond to many of the principles of sustainable development, have gained the support of governments, environmentalists, and the marketplace. According to a 1994 survey of the Tucson, Arizona, market by Market Perspectives of Sacramento, 83 percent of respondents found great appeal in the concept of traditional neighborhood development. Three-quarters of respondents said they would like to be able to walk to retail and other local destinations, thereby reducing daily automobile trips per household and mitigating traffic impacts on air quality.[4]

A 1998 survey of community preferences by American LIVES found that homebuyers were most interested in features such as smaller parks and green spaces located throughout the community. According to the survey:

> Most of the features buyers want involve making little improvements to the land. Items like natural open space, walking paths, and sidewalks are at the top of the importance list. These were the same items topping the list in 1994 and appeal to all respondents in this study, no matter what type of home they bought or what kind of community they live in.[5]

The evolving marketplace also reflects the widening diversity of households that can neither afford nor need the one-size-fits-all suburban tract house. According to U.S. census statistics, only one-quarter of current households fit the supposed "norm" of two married adults and two children, and in only 13 percent of households does a spouse stay home with the children.[6] Projections show a continuing increase in the share of the U.S. population that lives alone, or as a married couple or unrelated adults, or as a single-adult family with children. In fact, "nonfamily" households, which are defined as persons living alone or with nonrelatives, now account for 31 percent of all households.[7]

The U.S. population is also growing older. The baby boomers born in the 1940s and 1950s are approaching retirement age. Many of them are more attracted by the availability of affordable housing in an interesting neighborhood than by large houses in the suburbs. Young adults and retirees, in particular, appear more willing to trade off expansive lawns and access to regional shopping centers for urban amenities such as proximity to cultural and entertainment activities. In describing this phenomenon, a recent analysis of central-city housing markets quotes William Whyte's classic essay "Are Cities Un-American?":

> The people who choose the city, in sum, are of many different kinds, but they have one thing in common: they *like* the city. They like the privacy, they like the specialization, and the hundreds of one-of-the-kind shops; they like the excitement—to some, the sirens at night are music—they like the heterogeneity, the contrasts, the mixture of odd people.[8]

These attractions seem to be borne out by recent trends that show large-city gains in home construction during the 1990s. A Brookings Institution analysis of housing construction patterns concludes that "despite the dominance of suburban home building, large cities experienced rapid gains in new housing construction between 1991 and 1998. The number of new housing permits in large cities more than doubled . . . , growing at a faster rate than that of suburbs and metropolitan areas in general."[9]

In 1999, the National Association of Home Builders (NAHB) conducted a survey of 2,000 randomly selected households and found that most disliked the idea of building higher-density housing in their neighborhoods and that 83 percent would choose to buy a detached home in a suburban area rather than a townhouse in an urban area. However, the other side of the ledger revealed the growing diversity of housing demand: 17 percent would prefer a townhouse in an urban area, and 32 percent would support the building of townhouses in their neighborhoods. (The results do not expressly identify the education and safety concerns that respondents may have reflected in their desires for suburban living styles.)[10]

Another survey by American LIVES, Inc., in 1995 sampled consumers who had shopped for or bought homes in large-scale planned communities. It found that 44 percent approved of a mix of housing for all types and ages of residents in the neighborhood. After analyzing the study results, authors Brooke H. Warrick and Paul Ray determined that over 20 percent favored the close-knit community design advocated by new urbanist designers, including higher densities, foot access to a town center and community gathering places, and the availability of public transit.[11] Results of both the NAHB and American LIVES surveys indicate that a significant market exists for neighborhoods that embody the goals of sustainability.

Niche markets are willing to pay more to live in communities that incorporate aspects of sustainability. Studies published in 1999 that examined purchase prices of new urbanist projects compared with nearby conventional projects in suburban areas found that homes in new urbanist environments were selling for price premiums up to 15 percent and that resale values were higher.[12]

Other surveys indicate that homebuyers are generally willing to pay more for projects where developers or builders stress an environmental theme. A 1997 study by Permar & Ravenel, Inc., showed that price premiums for frontage on lagoons and marshes in coastal golf-oriented developments were as high or higher than frontage on golf courses. Whereas interior lot prices averaged $92,000, lots with lagoon and fairway frontage averaged $101,000; lots with marsh frontage were priced at an average of $225,000 while water-frontage lots averaged $467,000. These types of price increases are typical of resort communities as documented by ULI's *Resort Development Handbook.* Environmental amenities such as cycle and walking trails and wildlife or forest preserves also attract buyers. The developer of High Desert, a 1,000-acre master-planned community in Albuquerque, New Mexico, for example, estimates that the project's location adjacent to the 8,000-acre Cibola National Forest, as well as a landscape design that minimized environmental impacts, dramatically enhanced lot sales and prices. Of the 79 lots listed in the first phase of development, 63 sold at prices 20 to 50 percent higher than the area's average. By 1998, about one-third of the planned 2,250 homes were built, with prices for homes at four to eight units per acre ranging from $160,000 to $650,000.[13]

It appears, therefore, that developers who incorporate sustainable features into their projects can tap consumer markets that heretofore have largely gone ignored. Moreover, as the principles of sustainability become more widely known and appreciated and developers learn to integrate sustainable features into development designs and marketing, we can expect an expanding market for sustainable development.

From Greenfields to Brownfields: A Range of Sustainable Approaches

Although sustainable development is a marketable commodity in general, developers of new projects must still identify specific strategies for applying sustainability principles that will spark the interest of consumers. For example, some professional land planners and designers, conservationists, and engineers have addressed sustainability by reconfiguring conventional designs for suburban "greenfield" developments. Increasingly, their plans for mid- to large-scale developments propose to cluster development within settings that respect the natural assets of a development site. Site designs emphasize conservation and restoration of landscape features (such as native vegetation, wildlife habitats, stream valleys, and terrain attributes) and recognition of natural hydrologic functions (including management of water supply, wastewater collection and treatment, and stormwater). The teachings of Ian McHarg and Randall Arendt, in particular, have inspired many designers to plan suburban and rural developments that function in close partnership with natural features.[14]

Still focusing primarily on reforming suburban development patterns, other designers have proposed a return to models of traditional neighborhood design (TND) and transit-oriented development (TOD)—both of which are combined in new urbanism notions of community development. TND and TOD revive older patterns of close-knit development that use land more conservatively and thereby preserve open space. They cluster a mix of housing types around community and neighborhood centers that enhance opportunities for social interaction and accommodate travel by means other than the automobile. Both TND and TOD respond to concerns for sustainable development but tend to focus primarily on creating livable built environments rather than on conserving natural resources.[15]

More and more developers have been attracted to infill and redevelopment projects in urbanized areas. Typical project areas, which might be termed infields as opposed to greenfields, include central business districts and their environs, business districts in older neighborhoods and suburbs, established residential areas, and former industrial sites. Many developers can point to demonstrated experience in reinventing and retrofitting the existing urban fabric—whether through adaptive use of historic or architecturally distinctive buildings, cleanup and redevelopment of contaminated brownfield sites, or development of vacant or underused sites. By recycling existing buildings and urban sites, making more intensive use of existing infrastructure systems, and revitalizing declining employment centers and neighborhoods, infields development makes important contributions to sustainable development.

All the above approaches to sustainable development are underscored by the smart growth principles championed by many community planners and designers. As observed in chapter 1, smart growth principles are general but seek, first, to direct more development to existing urbanized areas where infrastructure is already in place or can be readily extended and, second, to promote more sustainable forms of suburban development from the standpoints of efficient use of resources, optimization of public and private investments, and community livability. Smart growth advocates envision community development at somewhat higher overall densities than those associated with typical suburban development or with the nature-respecting development patterns espoused by many conservation-minded designers.

Traditional residential design in Prairie Crossing, Grayslake, Illinois.

Here is the conundrum: Advocates of sustainable development are divided on the issue of reconciling conservation of natural areas with compact development. Do we favor limited development within a setting of conserved and restored natural features that generally results in overall low densities, or do we favor higher-density development that is served by urban infrastructure and depends on conservation of extensive open spaces outside urban areas? The first approach—designing resource-sensitive but generally low-density development—appears most appropriate for small, isolated developments in rural areas. In the case of development in growing urban areas, however, the spread-out form of nature-respecting development would only continue to push suburban settlements into the countryside. The second approach assumes that natural resource losses within densely developed urban areas can be mitigated or offset by a combination of improved technologies and resource conservation within the urban setting and by greater protection and restoration of resources outside urban areas. Instead of attempting to balance all the needs of man and nature within individual sites, the second approach seeks a sustainable balance of compact urban development and resource conservation within a region or watershed. It must be observed that neither model takes adequate account of inevitable changes in the form and density of development as urban areas grow larger. And neither model offers a foolproof solution to achieving sustainable community—or project—development.

In their 1999 publication, *Sustainability and Cities,* Newman and Kenworthy discuss how the conflict between the two approaches is playing out among supporters of sustainable development. One camp is guided by the "rural commons" concept, which proclaims that "cities are too big and need to be broken down into little pieces that should be substantially self-sufficient."[16] In other words, the best way to improve the environment and achieve livable cities is to create large lots that would permit local cultivation of food and trees; in addition, most work, recreation, and social interaction would occur locally as well. Cooperative ventures would provide for sharing food production, water and solar power, urban forest management, and the like. Advocates of the rural commons concept abhor density. Newman and Kenworthy, however, point to an important flaw in the self-sufficiency approach: it would maintain dependence on the automobile.

The other camp has adopted the "urban commons" concept, which views the city as a system that should "become more urban, not less, and rebuilt from within."[17] Not only would "urban commons" development reduce today's dependence on the automobile, but it could also foster innovative approaches to "greening the city" with greenways, urban forests, and even some agriculture and linked water/habitat/recreation systems. Newman and Kenworthy nonetheless suggest that the advocates of the urban commons approach seem to ignore the fact that compact, highly interactive, walkable centers of civilization such as central Paris or downtown Portland, Oregon, cannot be created in the absence of concentrations of impervious surfaces, some degree of river channelization, and considerable dependence on piped water supply and wastewater collection. A green infrastructure of trees, open spaces, streams, and ponds, along with protection of rural open spaces, will certainly offset some impacts of urban commons development, but not the full range of impacts.

Newman and Kenworthy observe that the supporters of the two opposing concepts of sustainability are engaged in continuing conflicts about how to make urban areas more ecologically sensitive and sustainable. The plan for the acclaimed Coffee Creek Center development next to Chesterton, Indiana, shown in figure 6-1, demonstrates the interplay of proenvironmental and prourbanist tensions. Designed by ecologically minded William McDonough and developed by the Lake Erie Land Company (a subsidiary of a deep-pockets power utility), the 640-acre Coffee Creek Center will contain 1,200 residences and at least a million square feet of office and retail space. The new urbanist plan combines a modified grid street system with neighborhood greens and a mixed-use town center and employment district. A prominent feature is a 240-acre swath of parkland along the creek, including existing and constructed wetlands, restored prairie lands, and cycle and walking trails. The riparian corridor will handle stormwater runoff and wastewater treatment as well as provide a central open space for recreation.

The proenvironmental/prourbanist tensions relate to the site's locational attributes and design. On the one hand, the site is 50 miles east of Chicago in the Indiana Dunes, giving rise to issues of traffic generation and costs of new infrastructure. On the other hand, the relatively low land costs permit more attention to the protection of natural assets. Conservation of the central, natural corridor locates open space near most residents yet makes the town center less accessible to neighborhoods on the other side of the creek. Another developer concerned with building a walkable community might have placed the town center nearer the creek and added more creek crossings, but Kevin Warren, a project spokesperson, observes, "I don't see sustainability and new urbanism always hand in hand. There clearly are cases where a compromise must be struck."[18]

For developers, sustainability issues such as those outlined above must be resolved in practical ways as projects are concep-

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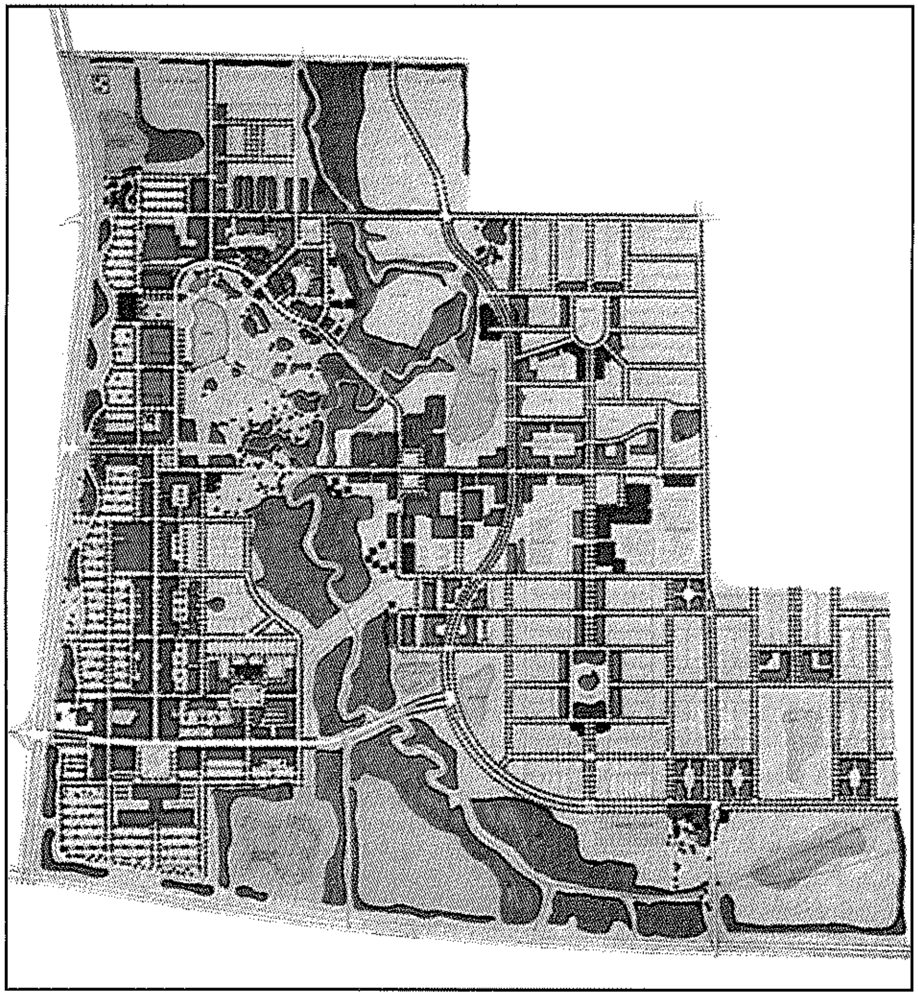
Coffee Creek Center, near Chesterton, Indiana



Designed in new urbanist style as a sustainable development, Coffee Creek Center highlights some of the tradeoffs often required between conservation and development.

tualized. The character of a specific project—its building components, uses, overall density, and intended market—will define the demand for land, infrastructure, and amenities. A site's location in the region and community, its natural features, and the surrounding built or natural environment will suggest opportunities for leveraging site assets while limiting the magnitude of the development. High-density infill developments on small sites, for example, most likely will connect to existing infrastructure systems rather than attempt to meet water, sewer, and drainage needs independently. Infill developments must also be designed to blend compatibly with adjacent development and thus encourage social and economic interactions with the neighborhood and community. Generally, in the case of infill projects, opportunities for restoring the natural landscape will be minimal and even antithetical to the concept of retrofitting development within compact communities. Developers can, however, integrate green building techniques into all their projects by, for example, adopting methods that conserve energy, improve air quality, and reduce impervious surfaces, as demonstrated in many of the examples cited in the next chapter.

At the other end of the scale, developers of lower-density suburban or small-town projects, business parks, and large planned communities usually can maintain and restore a site's natural features, particularly its hydrologic properties, and thus provide some needed infrastructure functions (such as storm drainage and wastewater treatment) while creating an attractive and beneficial setting for development.

Midway on the spectrum, we can imagine development of a 200-unit residential subdivision or a neighborhood shopping center that incorporates some elements of high and low levels of density, depending on the character and context of the site and the proposed development. At the mid-level scale of development, for example, some on-site aspects of landscape or hydrologic systems can be conserved while creating land- and energy-saving forms of development. Tolman Creek Shopping Center in Ashland, Oregon, a 94,500-square-foot neighborhood center, preserved existing trees, a stream, and bird habitat; reduced parking by providing bicycle and pedestrian access; and saved $40,000 a year in energy costs through energy-efficient design.

Clearly, the science and art of sustainable development is still evolving. The following section discusses a range of appropriate techniques for sustainable lower-density projects.

Sustainable Systems of Site Development

Potential development sites are often perceived as simply "the ground" upon which construction occurs. However, wise developers and their professional advisers recognize a site's inherent values and features when contemplating a plan for a new project. They begin by analyzing site conditions and aspects of the to-be-built environment that will affect or be affected by the magnitude and character of the proposed development. Frequently, developers conduct the needed analyses by ticking off a mental checklist as they consider how a development idea might fit a potential development site. The following, from ULI's *Real Estate Development: Principles and Process*, describes this process:

> While generating development ideas might often be thought of as unpredictable and intuitive, [the process] is just as frequently methodical and calculated. Developers need to *plan* future projects to keep their firms in business. Successful developers are rigorous in their planning but not so regimented as to lose the creative spark.[19]

Developer James J. Chaffin, Jr., offered the following description of his approach to conceptualizing the Spring Island golf/residential community:

> When I visited the island for the first time . . . , I was awed by its beauty and so frustrated to know that the original developer had approvals to build 5,500 homes on the island, that when the developer couldn't fulfill his options, we decided to grab it.[20]

In moving ahead with Spring Island, Chaffin operated from his "knowledge of the market and gut feeling." He set out to produce a high-quality project that would be sustainable and ecologically sound and provide an example for other developers.

Developers may formulate the overall development concept for a site—sometimes almost instantaneously—but their consultants are usually charged with the task of exploring the technical aspects of site conditions and devising preliminary designs. Consultants should consider all natural and human-made factors as a series of systems that intersect both on the site and with surrounding areas. Figure 6-2 on the next page highlights the natural and human systems that could be guided by sustainable principles.

Clearly, the systems are closely interrelated and cannot be analyzed individually in a vacuum. Moreover, on-site systems connect physically and functionally with systems beyond the site—whether immediately adjacent to the site, across the community at large, or even at the level of watersheds and ecosystems. The significance and interrelationship of systems vary from site to site and location to location. Large, master-planned communities on the outskirts of urban areas demand a comprehensive understanding of interlocking infrastructure systems supportive of the development planned for the site. At the other end of the scale, a small development at the edge of or within an urbanizing area, even with a mix of uses, depends on linkages to existing infrastructure and must be compatible with surrounding development.

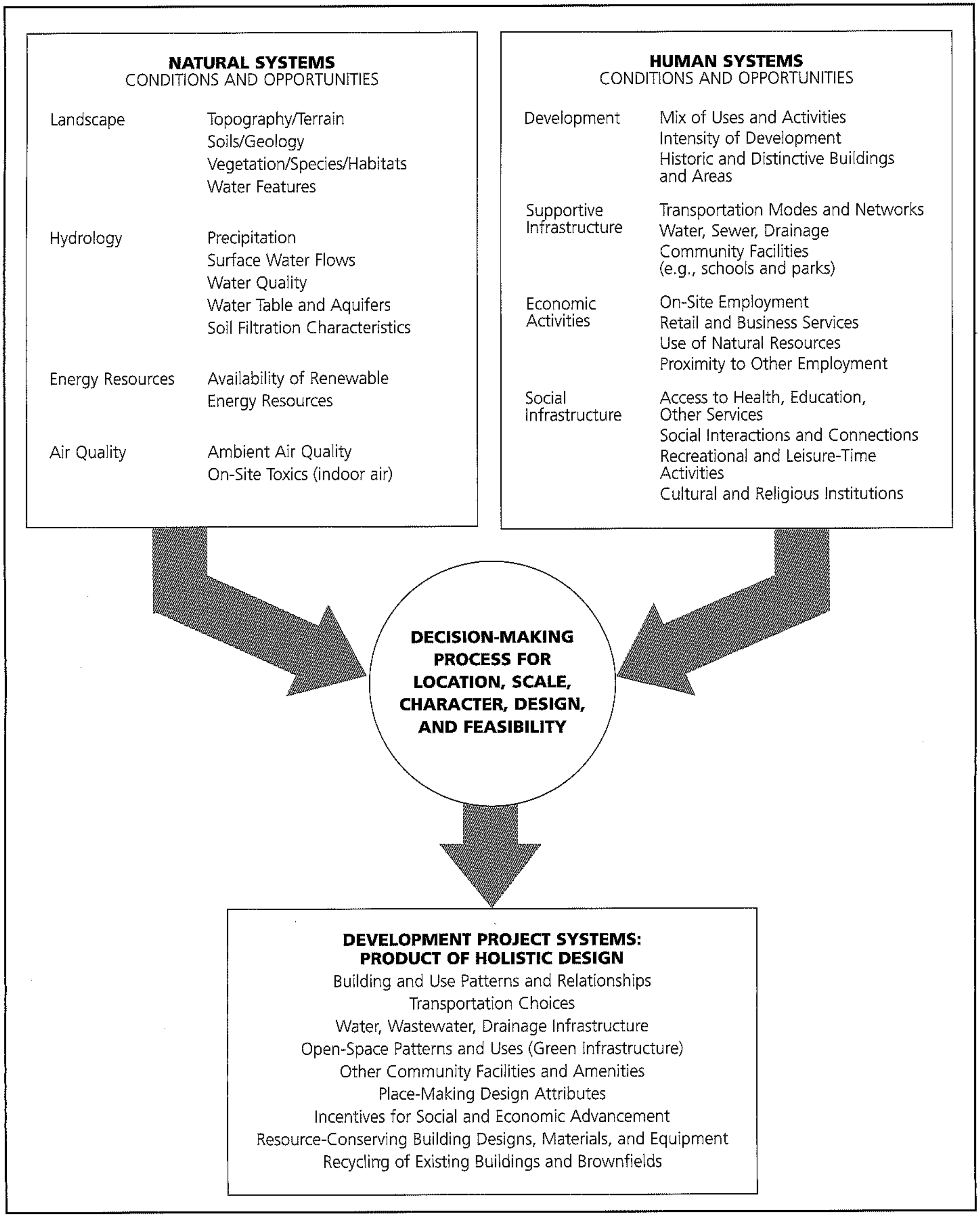
Capturing the various interrelationships and connections is essential to building sustainable developments. An approach sometimes called "whole-systems thinking" or holistic design helps optimize the incorporation of sustainable features into planned developments while maximizing the benefits that make sustainability a worthwhile investment. The key to the approach is defining development and design solutions that, through tradeoffs and multiple benefits, address an array of problems. One such solution is designing narrower streets that reduce stormwater runoff and allow the use of infiltration swales rather than costly storm sewers, thereby creating more space for trees and walkways—amenities attractive to homebuyers.

Whole-systems thinking requires the simultaneous consideration of many economic, design, and regulatory elements at the outset of project conceptualization and planning, not after major decisions have been made. Thinking through the technical options and how they will interact both during and after construction may require more upfront investment in design, but that investment is likely to be repaid in long-term benefits. In retrofitting a 1970s suburban office building, for example, the design team for Continental Offices, Ltd., could not justify upgrading the mechanical systems unless it also upgraded the lighting system and improved the building's energy management devices. Continental's initial costs of retrofit were 8 percent greater than for a conventional renovation, but its energy costs dropped by 81 percent, substantially increasing the building's value. Similarly, many elements of environmentally sensitive design and green building have a higher initial cost than conventional development but frequently offer operational (life-cycle) cost savings that more than offset initial costs.

Sometimes the relationships are not obvious. Borrowing the marketing concept of "loss leaders," developers such as the Grossman Family Properties at Hidden Springs, Idaho, subsidized rents for the village center in order to sell homes more quickly and at higher prices and to cut vehicle trips. The developer further reduced the risk associated with its pioneering project by adding community amenities not offered by the competition.

Finally, incorporating sustainable features into a project can shorten the project approval process, thereby limiting risk and increasing return. Many of the most notable sustainable developments, such as Playa Vista and Prairie Crossing, were originally planned as traditional developments. After running into approval roadblocks at every turn, the communities were redesigned with sustainability principles in mind—protecting and restoring natural features

6-2 Chart of Development Systems



and introducing energy-efficient design. Opponents of conventional development apparently are willing to back sustainable developments that offer superior products and greater conservation of resources.

This chapter focuses on major systems that form the building blocks of sustainable development: landscape, hydrology, the built environment, and economic and social interactions. The next chapter addresses the specific elements of green buildings, including energy, materials, and adaptable use of existing buildings.

Preserving and Restoring the Landscape: Developing Green Infrastructure

Developing a parcel of land—whether farmland, virgin woodland, or a former industrial site—requires a certain amount of disturbance to the landscape and associated water-related systems. In the past, development of greenfield sites sometimes meant a total reshaping of the landscape to meet the perceived needs for building. The result was a huge expense for earthmoving, destruction of the soil mantle, the loss of soil permeability for groundwater recharge, obliteration of topographic features and vegetation, and damage to streams and wildlife habitats. Some land developers refer to the practice of reshaping the landscape as "manufacturing sites"; some environmentalists call it "landscraping." The design of conventional suburban landscapes, for example, often calls for wide, treeless streets and large lawns. Shaping the terrain for such development disrupts existing natural systems while the resultant streets and unshaded lawns raise ambient temperatures as much as ten degrees above those in surrounding natural areas. In addition, the amounts of energy, both fossil fuel and human, used for lawn maintenance are usually much greater than the resources required for landscape management of meadows and woodlands.

Development regulations in many communities now tend to reduce the damage from such practices, but developers can still contribute to sustainability by preserving and even restoring landscape features as an integral part of their developments. After all, the natural terrain, native plant communities, and hydrologic patterns found on a site typically represent the fullest and most efficient use of natural resources. It is usually more expensive to disturb natural systems through extensive grading, drainage piping, and relandscaping with high-maintenance lawns than to acknowledge a site's natural functions and integrate them into a proposed design. For many sites, in fact, land development can be viewed as an opportunity to restore and enhance a site's natural vitality as well as that of the surrounding environmental community. At the same time, natural features command price premiums and result in a more marketable development.

[An excellent source of ideas and guidelines for protecting trees during construction has been prepared by the National Association of Home Builders and the American Forests organization. Entitled *Building Greener Neighborhoods: Trees as Part of the Plan*, it is available from American Forests, P.O. Box 2000, Washington, D.C. 20013 (202-955-4500).]

Developers should also consider that their projects will become part of the regional and local ecosystems within which they are built. Therefore, developers should design their projects to be as least disruptive to such ecosystems as possible. Identifying and understanding the natural systems functioning on a site as fragments or connections to larger systems will lead to design strategies that conserve functioning systems and heal damaged systems.

Landscape elements can be viewed as the "green infrastructure" of a development that is just as important to future occupants as the traditional infrastructure of streets, drainage lines, schools, and so forth. In addition, by integrating natural and cultural resources into site design, developers can preserve and enhance the "uniqueness of place."

An example of the extent to which natural systems can be interwoven with human needs both on and off the site is the development plan for a 280-acre campus in Monroe, Michigan. A religious order wanted to consider an ecologically sound development plan that would sustain the order and promote both spirituality and ecological health. Beyond renovating existing facilities for elder care and creating a sustainability institute, the plan calls for developing agricultural fields into a community-supported agriculture and organic gardening operation intended to supply healthy fruits and vegetables to the order and the surrounding community. The plan also provides for on-site composting of wastes, preservation of existing woodlands, and conversion of many acres of lawn to meadows. A proposed ecovillage would house and train participants in the facility's agricultural and food processing operations. A handicapped-accessible path system would allow elderly residents to tour the preserved open space, meadows, and agricultural fields as a part of their living experience on the campus. Thus, the campus is designed to perpetuate valuable natural features while expanding human use of the site.

To accommodate the continued functioning of natural features during and after construction, an inventory of site features allows developers and their consultants to become familiar with a site's natural assets and understand their interrelationships. The process advanced by Ian McHarg in the 1960s synthesizes scientific information and mapped overlays of site features to determine areas in need of conservation and protection.[21]

Design professionals have widely adopted McHarg's system as a starting point in the development process for identifying and understanding natural features.

Designers of large-scale planned communities have been employing McHarg's approach for decades—conducting site analyses of natural resources and features, designating sensitive areas for conservation, and identifying features that can add to the attractiveness of a proposed development. To be most sustainable, the functional areas of a proposed development—buildings, roads, and parking—should be adapted to the given landscape patterns. In other words, the "green infrastructure" system becomes part of the overall infrastructure of site development.

The Woodlands master-planned community outside Houston is a notable example that directly involved McHarg himself. The comprehensive ecological inventory of the 25,000-acre site included scientific examinations of the site's geology, subsurface and surface hydrology, limnology, soils, plant ecology, wildlife, and climatology. The inventory revealed that a high percent of the site's soils were poorly drained and that local streams experienced low base flows and high peak flows, resulting in extensive and shallow floodplains. Once the design team understood that conventional development patterns would reduce groundwater recharge, generate land subsidence from lowered water tables, and increase downstream flooding, it focused the site planning effort on both protecting permeable soils to reduce runoff and erosion and protecting natural vegetation and wildlife habitats. The general plan for the Woodlands therefore preserved stream corridors and other ecologically valuable areas, called for the construction of major roads on ridge lines away from drainage areas, clustered higher-density development on impermeable soils near roads, and used minor residential streets as berms to impede water flow over excessively permeable soils.

Elaborate studies also determined degrees of permissible site clearing and coverage for each soil type to maintain the water balance. For the pilot development phase, grassed and planted trenches, swales, and berms collected runoff and encouraged groundwater recharge. As development has proceeded (10,000 acres have been developed), wetlands mitigation efforts have established natural reserves of uplands, natural wetlands, and constructed wetlands. In his recently published autobiography *A Quest for Life*, McHarg identifies the plan for the Woodlands as one of his "proudest accomplishments."[22]

Even small subdivisions can benefit from a landscape evaluation that defines sensitive areas in need of special treatment as well as natural qualities that can add interest to the future residential setting. Except for the occasional large parcel, infill sites are less likely to retain significant natural features, and/or the density of proposed development may limit opportunities for conservation of open lands. Even on these sites, however, some landscape qualities (terrain, stands of trees, surface water drainage ways, and so forth), small parks, or other "special places" can be accommodated within the development.

The following guidelines suggest an approach to sustainable landscape design for both large and small sites:

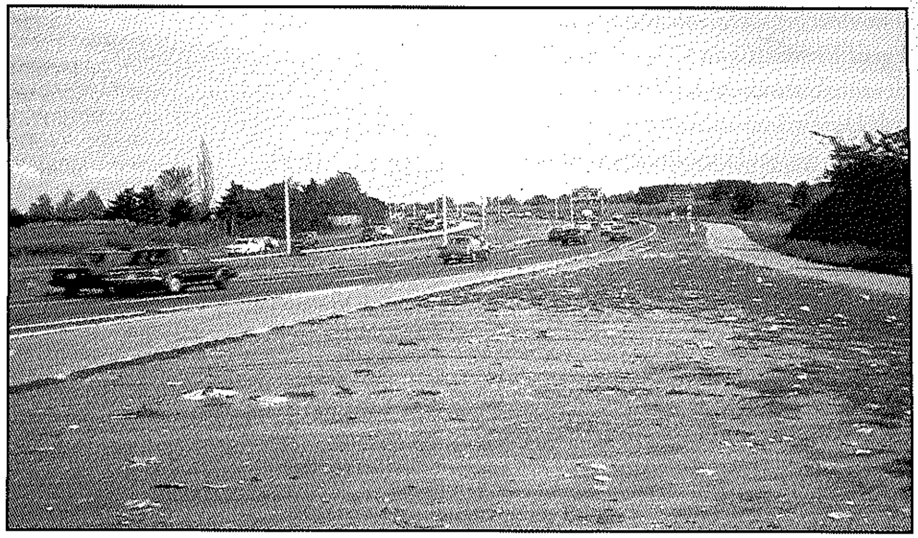
- Respect the existing natural landforms and landscape features; understand the historic and current ecosystem, its natural processes, and the stresses that adjacent development place on it.
- To the degree possible, take advantage of a site's natural assets by preserving the existing landforms and vegetation that define its natural structure and character.
- Create landscapes that can be sustained as a permanent, ongoing natural environment, plan to restore the site's landscape character and vegetative palette, and use native plant species that require as little water and maintenance as possible for those portions of the site that will remain undeveloped or be designed as natural open space.
- Refrain from breaking up or promoting intrusion into contiguous expanses of sensitive habitats and wildlife movement corridors, especially those of threatened or endangered species.
- Avoid construction in washes and other watercourses.
- Ensure that landscape improvements enhance the daily life of residents and workers; landscapes should define spaces, create places for varied activities, and reinforce the expression of relationships between buildings and landforms.

Reinventing the landscape. In many cases, landscape-sensitive designs for development can connect fragments of and/or restore natural site systems. Reconnecting landscape fragments establishes networks both within and beyond the site by taking advantage of the natural succession of landscapes and plant communities. For example, restoring the drainage network on a site and allowing swales and stream corridors to reestablish woody vegetation along their length can reconnect forested fragments along watercourses to adjacent woodlands. Introducing meadow buffers along hedgerows or woodland edges also provides habitat areas for wildlife and allows woodland vegetation to expand over time. On disturbed sites, establishing meadows instead of lawns can foster a higher level of natural diversity and can lend itself to more economical management.

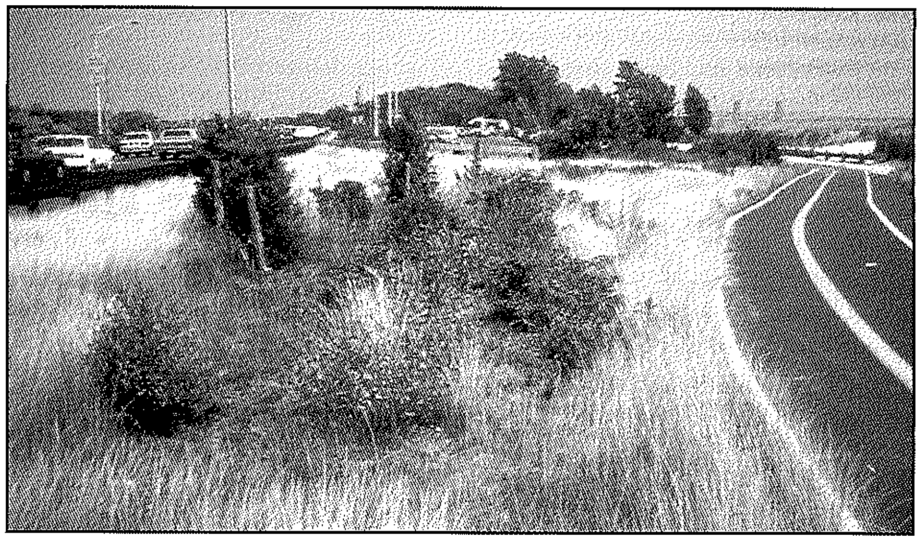
The primary maintenance task in managing natural vegetation is to limit the proliferation of exotic, or nonnative, invasive vegetation. Japanese bamboo, kudzu, Japanese honeysuckle, and the Norway maple are examples of invasive plants that can overwhelm native plant communities.

In his new book, *The Nature of Reston,* developer/photographer Charles Veatch demonstrates how this approach succeeded in the new town of Reston, Virginia, which was planned in the 1960s but is still developing. Reston's planners clustered development to preserve natural areas but also created lakes and streams, reforested pasturelands, and built woodland trails. Residents of Reston have extended the surrounding intact elements of nature into their gardens, restoring and enhancing native vegetation. Today, Reston's natural environment is a robust example of Virginia's natural landscapes. Says Veatch, "Reston's principles [can] be followed on a smaller scale by other enlightened developers and builders who will go to the effort of setting houses into existing hills instead of grading the land flat, keeping and protecting mature trees, and planting natural landscapes that then give homeowners a framework for their own naturalistic gardens."[23]

In several developments of recent vintage, developers have carefully removed and stored trees for later replanting. The Civano project in Tucson, Arizona, for example, salvaged 3,000 cactus and other plants that were used in landscaping completed sites.[24]



Before restoring landscape features. Decrepit parkway edges and old cycle paths along a heavily traveled highway in Brooklyn, New York. Compaction, dumping, and neglect were damaging adjacent shoreline habitats.



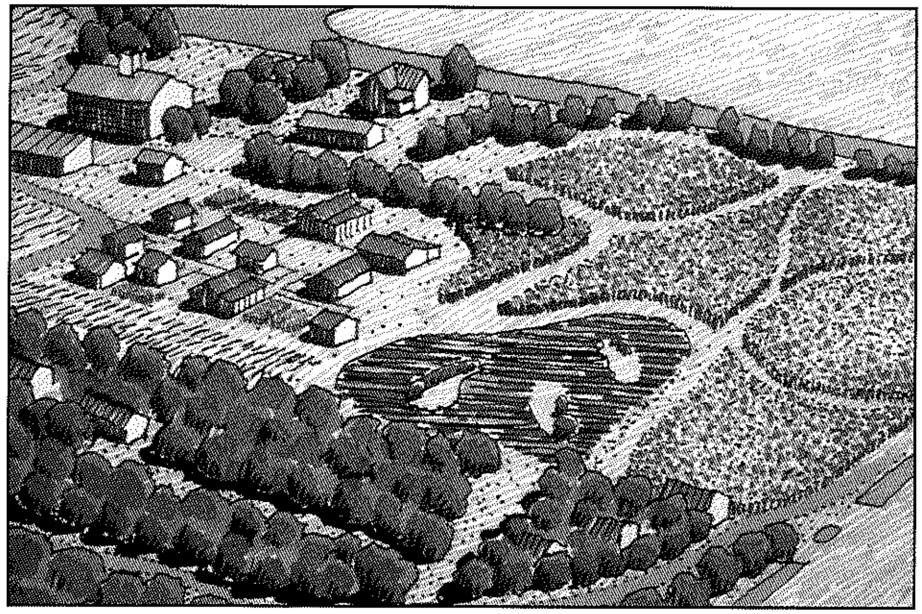
After restoring landscape features. Six miles of parkway, with a new protective guard rail, was planted back into shoreline meadows and incorporates a renovated cycle path. [Landscape Architects: Andropogon Associates, Ltd.; Project Director: Rolf Sauer.]

If clearance, landfills, roads, and other activities have already disturbed portions of a site, it is often advisable to develop those areas first rather than further disturb the site's natural systems. Even sites that have been extensively disturbed, however, may evidence a few remaining fragments of natural landscape. To develop a better understanding of how the site functioned before it was disturbed, design professionals might be able to deduce the profile of the original landscape by analyzing the remaining landscape of adjacent sites or undertaking a historical review based on old photographs or surveys of the site. In some cases, regrading can restore the original topography (assuming no extensive landfills injurious to plant growth), and existing drainage pipes can be removed to reintroduce surface water flow and infiltration. Restored landform and drainage can create a better foundation for reestablishing a sustainable natural system of plant communities.

The development underway on Tryon Farm in Michigan City, Indiana, demonstrates how landscape features can be restored to foster a more sustainable natural environment and, at the same time, provide a beneficial setting for new homeowners. Developer/designer Tom Forman of Chicago Associates proposed to develop an environmentally sensitive residential project on a dairy farm in the urbanizing suburban area of Michigan City, which is the terminus for the electric interurban trains that run into Chicago and South Bend.

Forman began with a landscape analysis that not only identified existing features but also probed historical records to determine earlier landscapes disturbed by the century-old farm. The site evaluation revealed 30-foot-high dunes thick with oak, maple, pine, and beech trees, some over six feet in circumference. It also identified wetlands and former prairie areas. Forman organized the residential development plan around these features, renewing the wetlands to function as wastewater treatment areas, restoring the prairie habitat for migratory birds and ground animals, retaining major wooded areas, and setting aside pastures for continued farming—120 acres in total. The plan also calls for restoration of the century-old farmhouse and construction of 150 houses, lofts, and cabins in eight clusters occupying about 160 acres. As of early 2000, of the 18 units in the first phase, 14 sold quickly and work has begun on a second phase.

The developer leveraged benefits from the conserved farmland by entering into a barter agreement with an adjoining horse stable—free pastures for free rides—while the croplands planted with alfalfa and sorghum are maintained by the grandson of the dairy farmer in return for crop profits. The developer also struck a bargain with the U.S. Fish and Wildlife Service to underwrite most of the costs of restoring three wetlands in exchange for cooperating in the mitigation program. In addition, Michigan City is helping to fund the restoration of two wetlands in order to solve mitigation problems associated with other sites.[25]



Tryon Farm at Michigan City, Indiana. The development of Tryon Farm features clusters of housing among farmlands, woodlands, and restored prairie, plus use of constructed wetlands for wastewater treatment.

Respecting the Hydrologic Cycle to Achieve Sustainable Development

Water is one of the resources essential to sustaining all life and, through its interaction with geology, soils, topography, vegetation, and wildlife, is a major ingredient in achieving sustainable development on every parcel of land. Managing water supply, wastewater disposal, and stormwater drainage are therefore primary and interlocking concerns in land development. Over the past century, in particular, developers have tended to address hydrology needs by contriving technological solutions that serve immediate needs but too often generate unwanted long-term impacts on the natural resource base. Many environmental problems such as floods, erosion, landslides, aquifer depletion, and even loss of biodiversity and climatic change can be traced to our tendency to use technology as substitutes for, instead of working with, natural hydrologic systems.

Water enters a development site as rainfall and through surface and groundwater flows. Some evaporates or transpires through the vegetation it feeds. Some infiltrates the soil to join subsurface flows and to recharge the water table before flowing out through wetlands, streams, and rivers. The constancy of these cycles of flow keeps the earth green and alive.

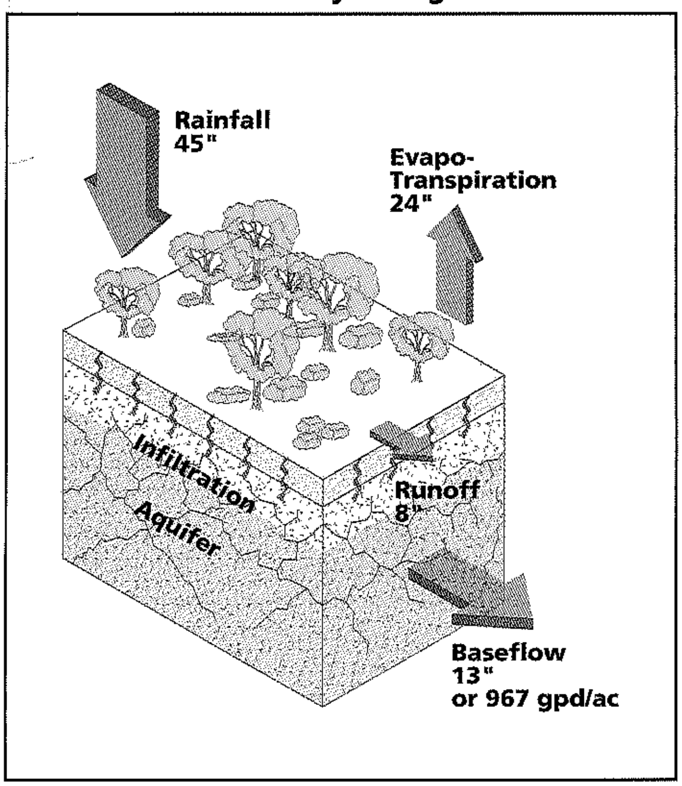
Land development too often ignores and interferes with the hydrologic cycle, most significantly by regrading the topography, removing ground cover, building impervious surfaces, and creating inhospitable landscapes that deflect water flow off instead of into the land. Runoff from construction sites, roadways, and parking lots carries sediments, greases, and oils while water draining from manicured lawnscapes conveys excess fertilizers and pesticides. Typically, pipes intercept runoff and carry it away from a development site and dump it into detention basins and/or streams. Stormwater discharged into waterways during storms raises and drops water levels precipitously, scouring banks and generating widespread erosion and flooding. The reduced infiltration of water into the soil and groundwater lowers the water table and starves vegetation of needed nutrients. Detention ponds typically hold water for too short a time to have any significant impact on the consequences of runoff.

Reconfiguring dysfunctional hydrologic cycles to reintroduce natural systems to the development process is a chief objective for conservation-minded landscape architects and engineers. In fact, science-based experience has demonstrated workable alternatives to conventional pipe-dependent approaches. Those approaches not only get the hydrologic job done in ways that prevent unwanted consequences but also add value to a development. Even on small sites and infield sites dependent on pipe systems, developers can adopt measures that significantly reduce impacts on areawide hydrology.

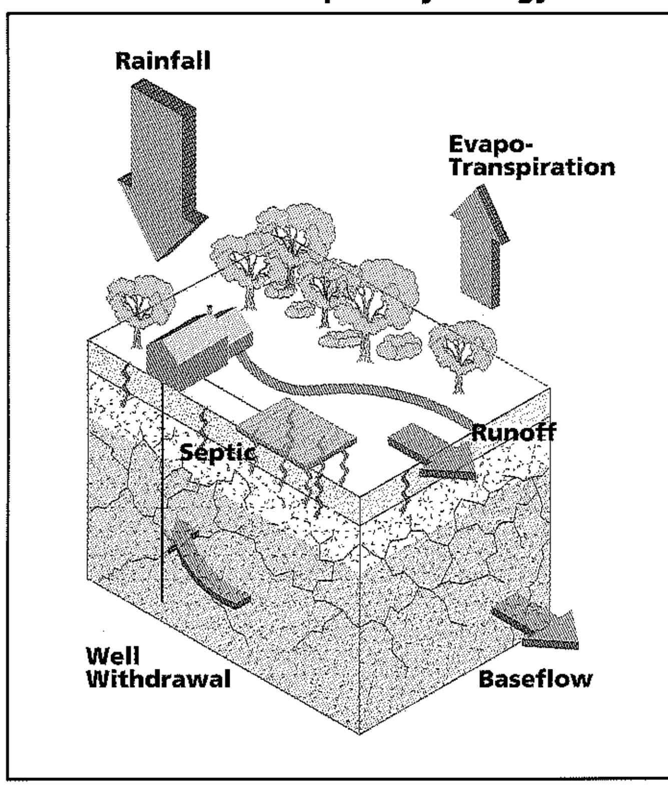
Natural and Disrupted Hydrologic Cycles. The pursuit of a sustainable land resource requires a clear understanding of the natural water cycle and how it functions on undeveloped land (see figures 6-3 and 6-4). Whatever the climatic conditions or amount of rainfall in a given physiographic region, much of the annual precipitation returns immediately to the atmosphere as evaporation or as transpiration from vegetative systems. Where woodlands exist, they are the most significant hydrologic feature on the landscape; the role played by woodlands in the terrestrial ecosystem can be appreciated if trees are pictured as a water pump that operates when the weather is wet or dry. The pump mechanism accounts for about half of annual rainfall. A relatively small fraction of annual rainfall runs off from the land surface under natural conditions, and more than twice as much soaks into the soil mantle to become the base flow of groundwater.

The rate at which rainfall percolates into the soil is controlled by the physical composition, thickness, and topologic form of the soil mantle. In most areas, soil is the result of thousands of years of weathering of the underlying bedrock. Rainfall drains slowly through the upper layer of the earth by the force of gravity until it reaches the zone of saturation called the water table. In the layer of subsurface soil and weathered bedrock, which is defined as an aquifer, the water moves slowly downgradient as seeps, springs, or streams toward surface discharge points. A few days after a rainfall, a small stream flowing in a valley is made up entirely of groundwater discharge. This process is essential to

6-3 **Natural Hydrologic Flow**



6-4 **Disrupted Hydrology**



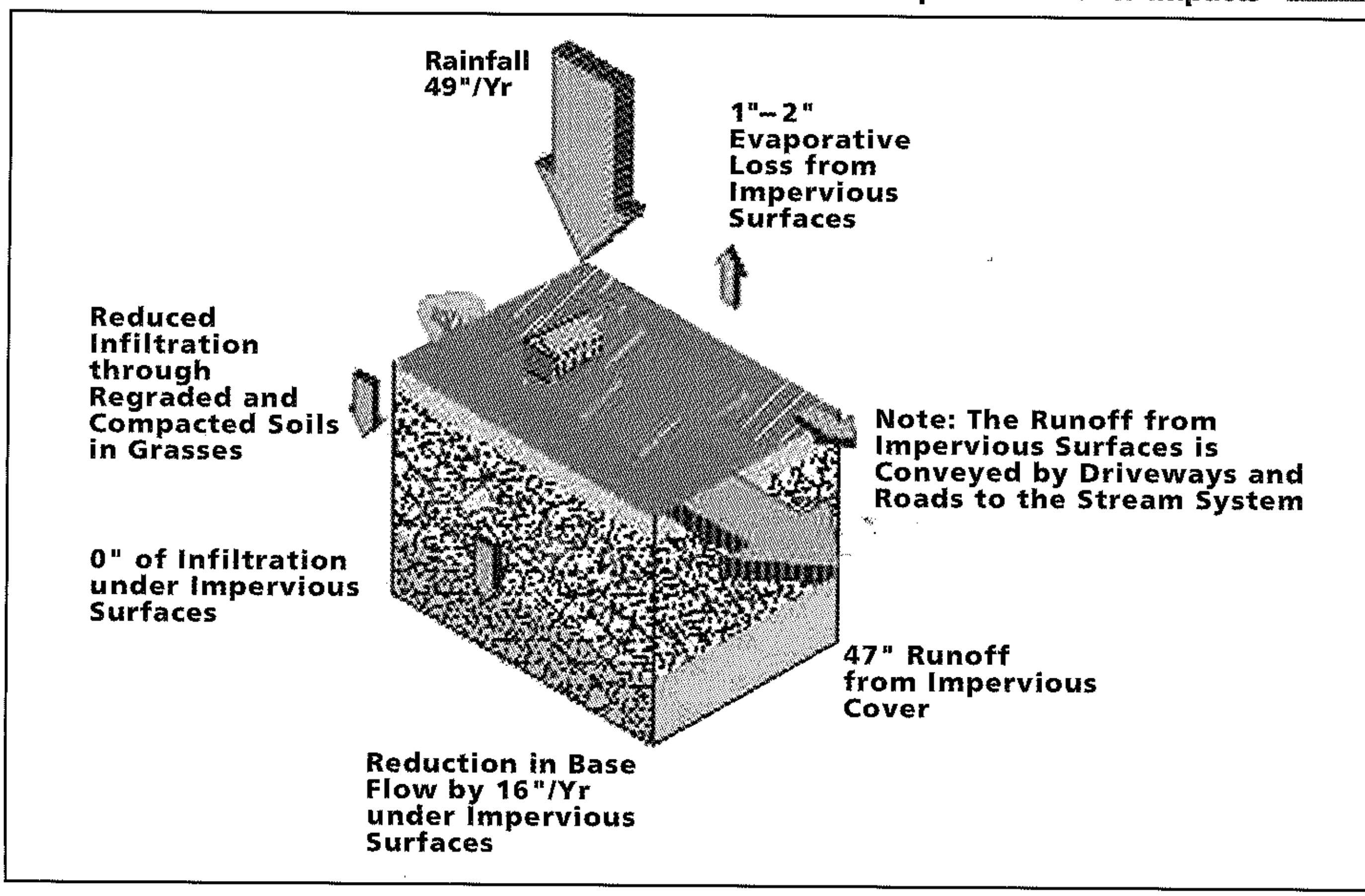
natural stream flows and, in most regions, accounts for the entire flow for much of the year. (In the Piedmont region, estimated base flows are about 15 inches per year, or about one-third of typical annual rainfall.) A single raindrop may take weeks or months to reach a stream, but the displacement of groundwater is a constant process. If we disrupt the flow by reducing the amount of water that enters the soil mantle in the upland, we threaten the entire stream system, particularly the stream water quality and the ability of aquatic life to sustain itself.

On developed land, rainfall continues to initiate the hydrologic cycle, but disruption of the natural landscape substantially alters water pathways through the site. Figure 6-5 is based on the annual average rainfall for the Piedmont Physiographic Region of the Eastern United States, but the net impact of impervious surfaces is the same anywhere on the planet. With the soil mantle largely covered with rooftops and impermeable pavement, rainfall on a unit of land surface is transformed into direct runoff. Whereas rainfall on a naturally vegetated soil surface would generate eight to ten inches of direct runoff in a given year (a relatively small fraction of an annual total rainfall of 45 inches), impervious surfaces transform almost all rainfall into runoff, dramatically increasing the volume of stormwater runoff and decreasing percolation into the soil mantle and thus recharge of the groundwater system. To handle the runoff, we build elaborate and costly systems of inlets, storm sewers, and swales to channel the water to the nearest stream as quickly as possible.

The tremendous increase in runoff volume and loss of groundwater recharge from developed lands can significantly affect the hydrology of an entire watershed. The net result of numerous impervious surfaces is alteration of the water balance to the point where the water resource is reduced in both quantitative and qualitative value. Clearly, the potential impacts of development on the hydrology of a site, and ultimately an entire watershed, have significant implications for achieving sustainable development.

Stormwater Management. Normally, the development of new impervious surfaces affects water resources in three ways.

Impervious Cover Impacts 6-5



First, pavements and structures produce a dramatic increase in the volume of stormwater runoff. Second, impervious surfaces lead to a loss of groundwater recharge and a subsequent reduction in the base flow of local streams. Third, land pollutants scoured from the surface during runoff, known as nonpoint source (NPS) pollution, adversely affect water quality. Such runoff contains nutrients, sediment, petroleum compounds, and a turbid soup of other pollutants. The effects of pollutants on water resources provide one of the strongest arguments against urban development as we know it.

An impacted stream bed. Runoff, increased by upstream impervious surfaces and the mowed-grass floodplain, erodes the streambed and degrades water quality.

Since the 1970s, experts have recognized the problems posed by runoff of sediments from developed land. Largely under the leadership of the U.S. Soil Conservation Service (now the Natural Resources Conservation Service, or NRCS), the conventional farm pond of the 1950s has been adapted for use in suburban development. Situated downstream of areas disturbed by site clearing and grading, earthen ponds are designed to capture runoff and release it slowly to waterways at a peak rate no greater than before development. Combined with a series of on-site erosion control strategies and the use of geotextiles and other innovative materials, detention basins significantly reduce sediment loss and associated stream pollution.

Over the past two decades, use of detention basins, though more practical for large rather than small sites, became the basic means of controlling stormwater runoff. The technique has been incorporated into virtually every municipal land development ordinance and is described in elaborate detail in design manuals used by practicing civil engineers. Increasing recognition of water quality impacts and the decline in groundwater recharge has led to numerous modifications to the design of the basic detention basin along with the emergence of other stormwater management techniques—all grouped under the heading of Best Management Practices. None of these approaches, however, significantly lessens the increased volume of stormwater runoff from new impervious surfaces. Nor do detention basins significantly reduce the nonpoint source pollution generated from new development. Moreover, for small sites with a high proportion of impervious surfaces, detention basins may be infeasible and runoff therefore more problematic.

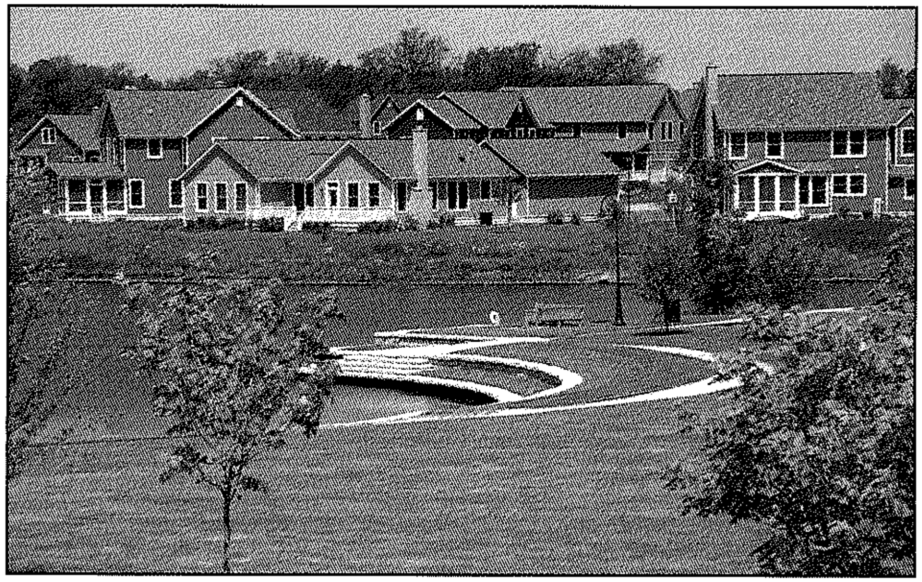
As an alternative, it is possible though challenging to develop a parcel of land while still maintaining the natural hydrologic cycle. The evolving solution calls for systems and materials that mimic natural processes. Thus, for a given site, the design process begins with an examination of how the hydrologic cycle works—how various land and water features control the volume and quality of runoff, infiltration, and recharge—and how these factors will be altered by the proposed introduction of new impermeable surfaces. The process then considers how—short of diverting runoff to a nearby mitigation site—the water balance can be maintained.

The guiding principle for sustainable stormwater management is to design for stormwater recharge rather than for detention. There are a variety of techniques, including temporary storage of runoff in large pipes, drainage swales, and woodland berms, that slow runoff to permit its infiltration into aquifers. Some projects have used constructed wetlands to collect, clean, and allow recharge of runoff. Studies of such wetlands demonstrate that they can effectively remove pollutants from runoff, although factors such as the size and volume of the wetlands system, rates of runoff and sedimentation, and flow volumes generate highly variable results in removal efficiency.[26] Detention ponds in series that discharge slowly into wetlands also work well. Generally, environmentalists frown on the use of natural wetlands for pollution control; the pollution removal efficiency of natural wetlands is less predictable than that of wetlands engineered for such a function.

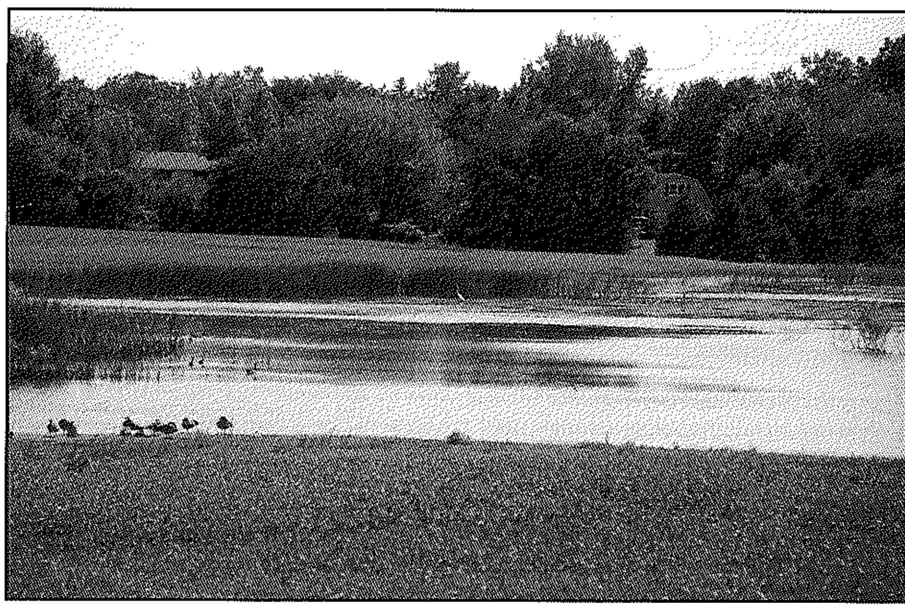
The use of wetlands for stormwater management is demonstrated at Prairie Crossing, a 667-acre conservation community in Grayslake, Illinois, 45 miles northwest of Chicago. Stormwater is managed through a natural, sequential system of stormwater swales, restored upland prairies, created wetlands, and lakes. This treatment train reduces the rate and volume of runoff and increases lag time to allow greater water infiltration and evaporation. Swales and prairies remove 60 to 90 percent of suspended solids, phosphorus, and metals. Wetlands play the principal role in denitrification of the runoff, thus preventing surplus nitrogen from reaching the lake and nearby creeks and marshes. In addition to improved water quality, Prairie Crossing's natural system of stormwater management reduced infrastructure costs by more than $1 million compared with a conventional curb, gutter, and storm sewer system.

The stormwater management plan for Playa Vista, a 1,087-acre, mixed-use infill development in Los Angeles, was required to demonstrate no net increase in stormwater pollutant loads to Santa Monica Bay. To that end, as depicted in figure 6-6, the program called for significant expansion and restoration of the saltwater marsh near the ocean as well as for the redesign and restoration of the freshwater marsh and riparian corridor along the southern edge of the site. The freshwater wetlands system is designed to control periodic flooding; filter runoff pollutants, including those from off-site flows; and provide for rehabilitation of the natural aquatic habitat. The design also allows for occasional flushing of the saltwater marsh. Finally, the plan included a pollution prevention program of street sweeping, car-washing facilities, a survey of off-site illicit connections and dumping, and use of native landscaping requiring little irrigation and chemical treatment.

Despite demonstrated successes with mitigating the hydrologic impacts of impervious surfaces in conventional developments, designers are increasingly turning to the reduction of impermeable surfaces as a means of expanding a site's capacity for infiltration, thereby reducing the volume of runoff. (A recent study estimates that proportions of impermeable surfaces greater than 10 percent throughout a watershed

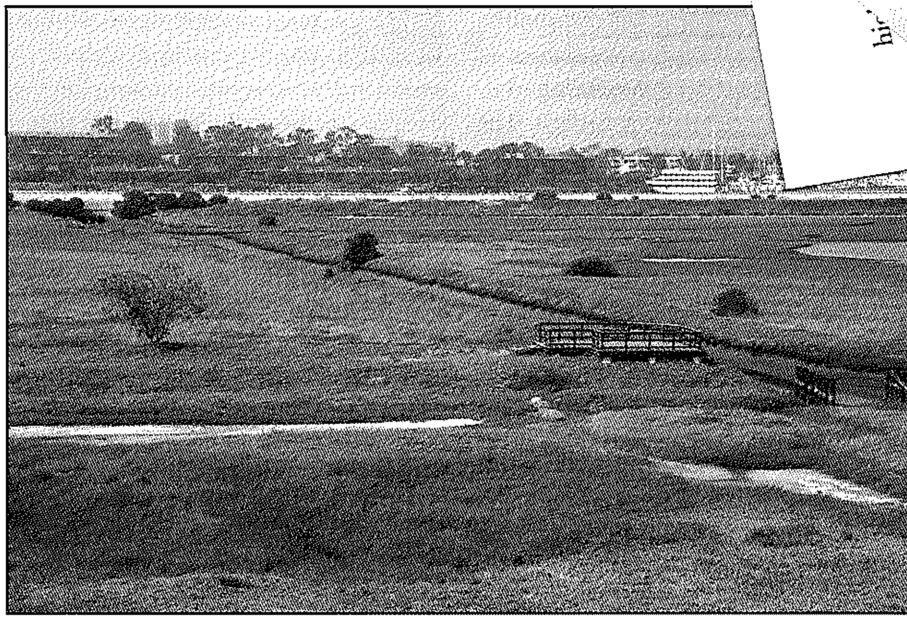


Constructed wetlands at Prairie Crossing, Grayslake, Illinois. Wetlands filter stormwater and recharge aquifers while providing attractive views for nearby homes.



Restored wetlands at Prairie Crossing. Prairie Crossing's designer retained and restored large natural areas to provide a sustainable environment.

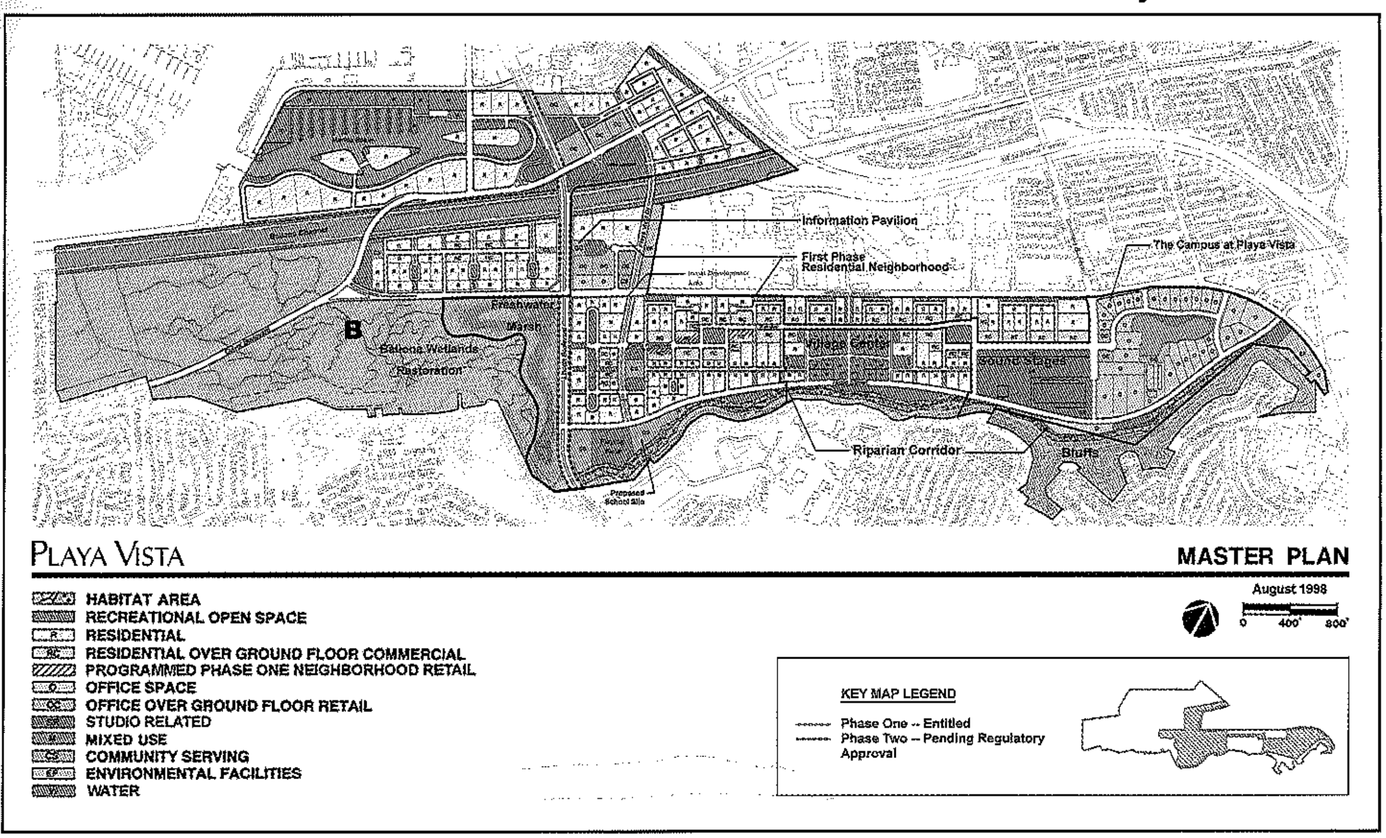
induce more runoff than can be handled on site.[27]) However, two of the three solutions for reducing the proportion of impermeable surface in developments illustrate the tug-of-war between the goals of on-site conservation of natural resources and the development of more compact communities. The first strategy calls for limiting the proportion of impervious surface by spreading development over larger land areas, such as single-family homes on three-acre lots—a development pattern that hardly fosters sustainability. A second approach reduces impervious surfaces by shrinking building footprints and downsizing roads and other paved areas. Certainly, constructing more multistory structures (such as two-level rather than one-level homes) shrinks the footprint per individual dwelling, but it usually results in



Wetlands under restoration at Playa Vista, Los Angeles, California. Degraded saltwater and freshwater wetlands and a riparian corridor are being restored as part of the major infill development taking place at Playa Vista.

The Plan for Playa Vista

6-6



Tight clusters of housing and commercial uses allow conservation of large natural areas on the Playa Vista site.

larger-density development that itself increases rather than decreases the percent of impermeable surface owing to the addition of sidewalks and alleys. The third approach, recognizing that only habitations are required to be impermeable, is to make pavement areas more permeable either by using new materials in the pavement or underlying paved areas with infiltration beds.

Making pavements more permeable raises several problems that have been addressed in experimental projects over several decades. A major technical breakthrough in materials that occurred during the mid-1970s allowed the Franklin Institute in Philadelphia to develop porous asphalt concrete. The material is the basic asphalt concrete mix but omits the two smallest aggregate sizes, producing a strong wearing surface that permits water to pass through rapidly into a deep stone bed for storage. The stormwater then soaks slowly into the soil mantle beneath the bed. After installation of several prototype designs, the surrounding soil filled the stone beds, greatly reducing the beds' storage capacity; thereafter, the material found little application in new development.

In the late 1970s, as geotextiles became available, engineers discovered that a fabric liner beneath the stone bed prevented the bed from filling with soil and preserved the integrity of the recharge system. The addition of several other design features, including open edges and trench drains of various types, ensured operation of the bed in the event of pavement sealing. One design team of landscape architects and environmental engineers produced 40 designs, largely in the eastern mid-Atlantic region, that use porous asphalt concrete pavement and groundwater recharge beds. Subsequently, several designs constructed in Maryland were inundated by sediment-laden runoff and became clogged, giving rise to the local perception that the design was flawed. Nonetheless, experience with several parking lot designs (see figure 6-7) indicates that the combination of porous asphalt concrete and recharge beds is a feasible alternative stormwater management system. A recent study of four types of permeable pavements concluded that the alternative systems dramatically decreased runoff compared with impervious surfaces. Nevertheless, their appearance and ability to handle high traffic volumes differ from conventional systems and therefore should be evaluated by designers for specific project use. In addition, their long-term performance in terms of durability, infiltrability, and water quality has yet to be fully determined.[28]

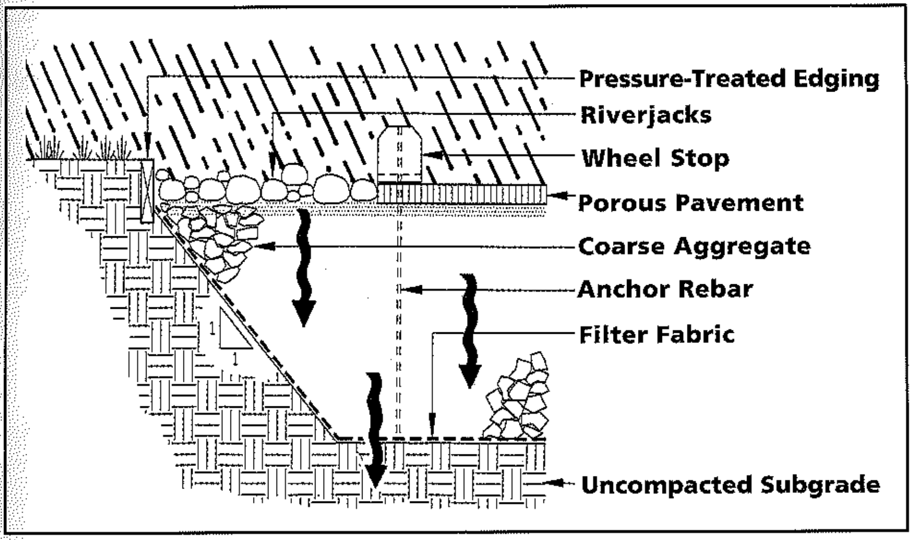
Despite assertions to the contrary, the study noted above concluded that costs for permeable pavements are substantially higher than for traditional asphalt. Typical asphalt paving for parking lots over a prepared base runs from $0.50 to $1 per square foot (1997 estimates); equivalent costs for permeable pavements range from 25 percent to over 300 percent more depending on material and assumptions about volume decreases. However, total costs for permeable pavement actually may be *lower* than for conventional asphalt pavement if costs are discounted for the drainage facilities needed to handle runoff from impervious surfaces. Permitting jurisdictions too often fail to accord full credit to the runoff reduction capabilities of permeable pavements. Therefore, in many jurisdictions, developers interested in using such pavements will have to argue their case for not constructing expensive drainage facilities.[29]

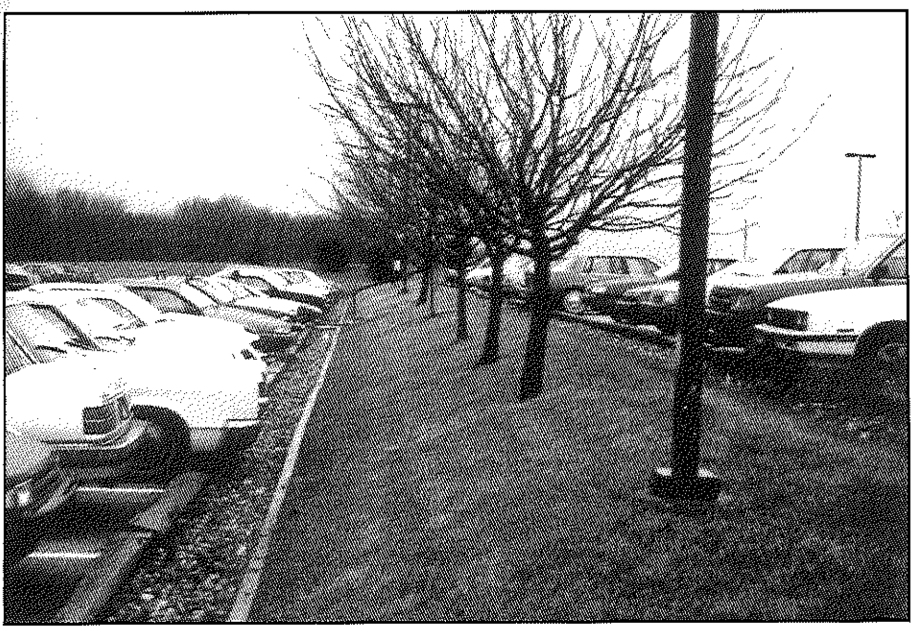
One alternative to permeable pavement materials is to design runoff and filtration to underlay large paved areas such as parking lots. Given that most Americans are unlikely to abandon the automobile any time soon, parking areas will continue to consume sizable proportions of development sites. A series of distribution pipes can drain stormwater from inlets and roof drains to recharge beds beneath paved parking areas.

Systems that promote infiltration in these ways are designed to different standards than detention basins. Historically, the 100-year storm has been the standard for the engineering design of bridges, culverts, and detention basins. Detention basins are usually sized to attenuate the peak rate of runoff flow from a 100-year event; they are designed for a storage volume of about 63 percent of the increased runoff volume and thus require an enormous hole in the ground. The design standard for infiltration, by contrast, is a rainfall of two-year frequency, which represents 95 percent of the total rainfall experienced in a given region. Storage volume in a recharge system's stone beds is designed to be equal to the two-year storm increase, with outlet controls for major storms. A recharge system based on the two-year standard also mitigates the peak rate of flow for large storms, usually satisfying most jurisdictions' regulatory standards.

Irrespective of stormwater management method, preserving the integrity of the soil mantle during site development is important not only for maintaining water quantity but also for maintaining the quality of stormwater runoff. The soil should be sufficiently thick to allow construction of the recharge bed several feet above any seasonal water table or bedrock. Preferably, the soil should fall into Hydrologic Group B, although many Group C soils can be used with care. In any event, the soil mantle plays a critical role in the hydrologic cycle; it is responsible for the operation of a significant pollutant removal and reduction process whereby a community of microbes and physical-chemical

Groundwater Recharge by Use of Porous Pavement in Parking Lots 6-7





Porous-pavement parking lot aids stormwater management.

processes treat the NPS pollutants applied on the land surface.

To summarize the several approaches discussed above, all emphasize capturing and allowing infiltration of stormwater on the site through the use of swales, protected open lands, constructed wetlands, ponds and lakes, surface and subsurface infiltration beds, reduction of impervious surfaces such as rooftops and paving, and permeable paving. These techniques are most effectively applied in low- to moderate-density developments on substantially sized lots where natural systems can be retained, restored, or constructed at costs at or below those for conventional piping and detention ponds. Moderate- to higher-density projects with smaller sites may not be able to incorporate open spaces and wetlands of sufficient size to filter runoff; if so, such projects may need to increase the use of permeable paving and subsurface infiltration beds. At some level of density, it may be necessary to resort to piped removal to adjoining or, as in conventional development, distant streams and water bodies. However, current studies are underway to develop "low-impact development" or microscale methods of stormwater management intended for small, intensively developed sites. The newer methods emphasize integration of stormwater retention into many components of the built environment, including streetscapes, buildings, sidewalks, parking lots, alleys, green spaces, tree boxes, and pipes—all of which compensate for the loss of hydrologic function due to development.[30]

Wastewater Management. For the past 80 years, wastewater has been handled in an increasingly elaborate fashion. Engineers long argued that natural streams and rivers had a natural "assimilative capacity" for treating wastewaters discharged to them in reasonable amounts. This operating rule broke down during the middle of the 20th century when hydrologists finally recognized that most surface waters had long ago lost the natural capacity to complete the treatment process. In effect, many rivers had become all but open sewers. Subsequently, to avoid discharging sewage effluent to small streams, public authorities in many regions have invested heavily in regional wastewater collection and conveyance systems that pipe wastes to large treatment plants on major rivers or water bodies. Such systems gained popularity during the 1960s and 1970s when substantial federal funding encouraged their development, the increasing cost of which has led communities to seek local solutions for wastewater treatment.

The emergence of the concept of sustainability has spurred a reconsideration of the "interceptor sewer" approach not only because of its enormous costs but also because the long-distance conveyance of wastewater makes little sense when the same result can be achieved on the development site. On-site wastewater systems are designed to serve a limited number of residences or other uses. Small-scale systems rely on applications of the effluent to the soil mantle to complete the treatment process and, in so doing, return the effluent to the groundwater.

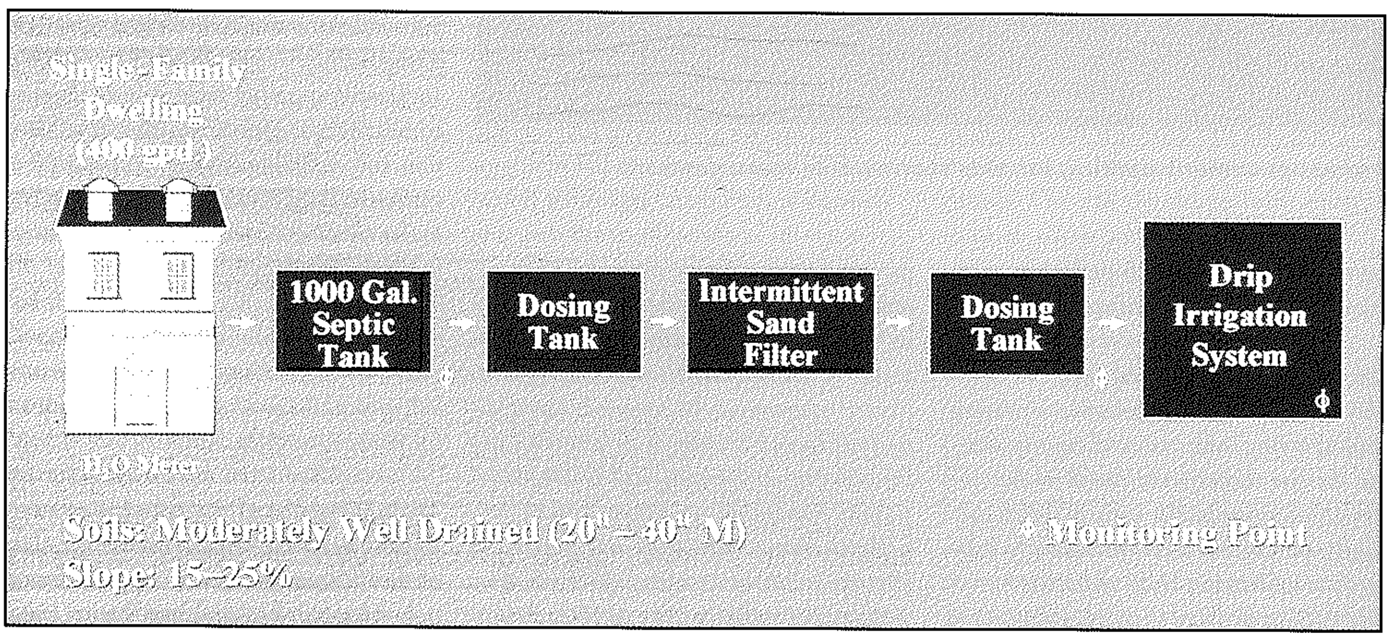
Various types of on-site wastewater treatment systems, including the ubiquitous individual septic tank, have been installed in existing and new developments of all types. Most systems substantially reduce key pollutants—as much as 95 percent of solids and organics—but none removes all pollutants. The final treatment is provided by the physical and biochemical processes that occur in the soil mantle and by the community of microbes that thrives in moist soil.

Regrettably, on-site systems are not without other limitations. As septic fields age and maintenance becomes a sometime thing, systems can begin to have a major impact on subsurface water quality. According to one estimate, the 22 million septic systems in the United States introduce over 1 trillion gallons of waste per year into subsurface aquifers (see chapter 2). That waste includes nitrogen, phosphorous, bacteria, viruses, detergents, solvents, and other chemicals that, at too high a density, can contaminate groundwater and affect water quality in freshwater and saline lakes, rivers, and ponds. Nitrogen transported in high concentrations to groundwater supplies of drinking water can cause serious health hazards for newborns.

Most current wastewater treatment technologies emphasize effluent application either to the land surface or in a shallow system of lines. Application takes many forms, from spray and drip irrigation systems (see figure 6-8) to variations on the concept of a recharge bed. Again, the dual goals of recharge and pollutant removal are achieved in the soil mantle while any woodlands on the parcel benefit from the process as well. The treatment systems tend to be biological in process but unconventional in form. For example, the use of wetlands plantings in containers and beds of greenhouses known as Living Technologies has found appeal in some installations. In another approach, conventional septic systems are outfitted with recirculating filter units used in combination with outdoor wetlands treatment systems (see figure 6-9). Whatever the basic treatment system, the common factor with respect to sustainability is the return of water to the land.

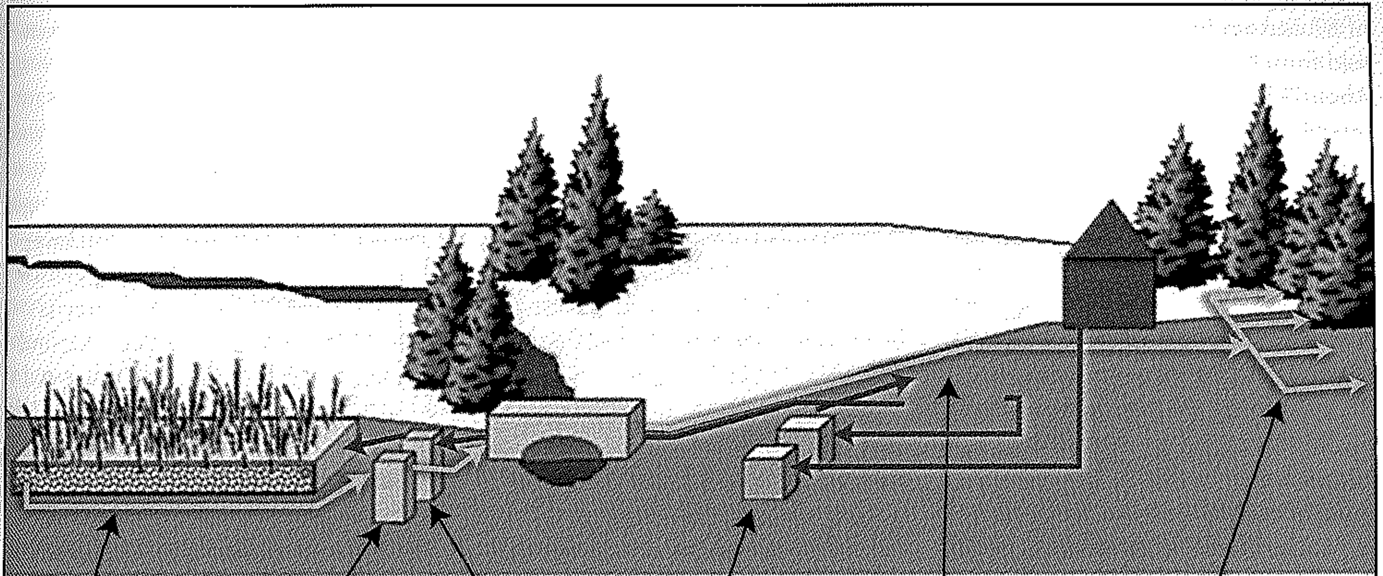
Technologies increasingly favored for sustainable development include freewater and subsurface-flow constructed wetlands and solar aquatic systems. Constructed wetlands—artificial marshes—purify water by breaking down pollutants through a combination of physical, biological, and chemical processes before returning the water to the ground. Such systems can save as much as 30 to 50 percent of construction and operating costs compared with conventional systems, and they offer the added benefit of detaining and purifying stormwater runoff (as discussed in the stormwater

Wastewater Treatment by Drip Irrigation 6-8

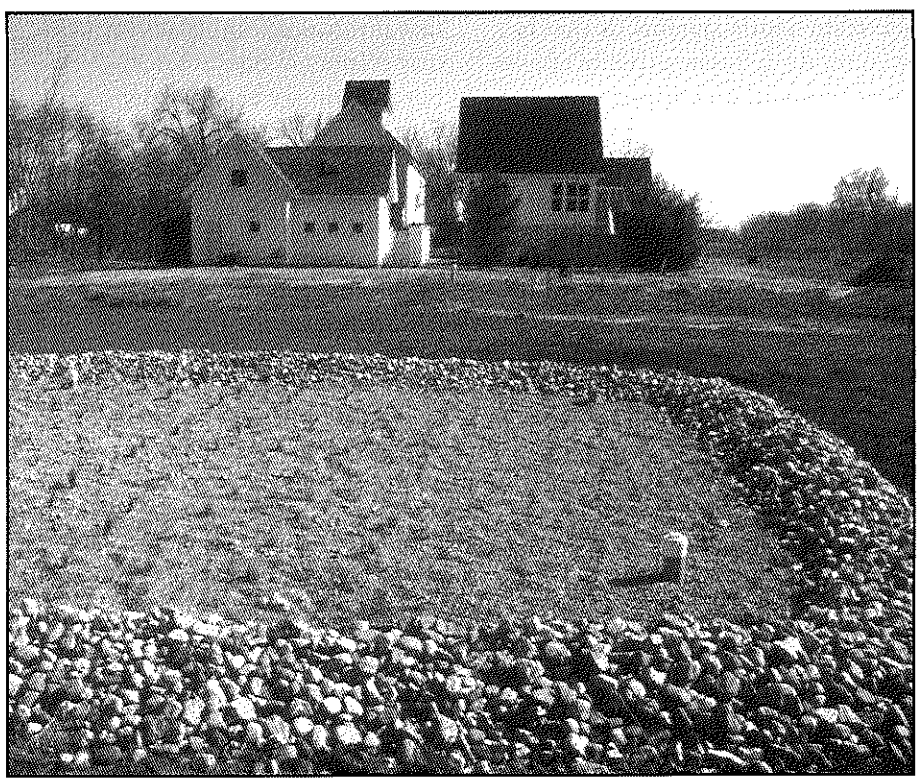


Wastewater Treatment in Constructed Wetlands

6-9



section). The Tryon Farm development discussed in the landscape section uses a series of small constructed wetlands to process wastewater, with each wetlands serving nine to 12 houses. The wetlands clean wastewater in seven days as oxygen seeks the roots of tuber plants and nutrients feed the plants. The cleaned water is pumped onto on-site hay fields for irrigation and return to the aquifer. The first wetlands cost $30,000 to restore, a figure about equal to sewer service. The second wetlands, designed to serve houses in a woodland, cost a similar amount; however, sewer service would have cost as much as $100,000. Developer Tom Forman believes that he has achieved significant cost savings in installing innovative wastewater collection and treatment systems while enhancing natural assets.



Tryon Farm. A wetlands constructed to treat wastewater.

A smaller development in Long Grove, Illinois, a suburb of Chicago, provides another example of on-site wastewater treatment. The 160-acre Fields of Long Grove is a community of 87 custom homes that originally sold from $425,000 to over $700,000. About 75 percent of the site is preserved as open space that includes wetlands, 45 acres of restored prairie, water retention ponds, a wastewater treatment lagoon, and agricultural land. Sewage is pumped to a central comminutor where it is pulverized and sent to the bottom of a storage lagoon covered with 13 feet of aerated water. Aeration keeps the lagoon from freezing in winter and permits aerobic biological action to oxidize organic materials. In summer, treated wastewater is pumped from near the top of the lagoon and disposed of by a circular spray irrigation system on an adjacent alfalfa field. Chlorination of the pumped water is possible but has been unnecessary. Sludge from the bottom of the lagoon will need to be removed about every 20 years. One drawback to the system, which allowed cluster development on smaller lots than could be served by septic systems, is that it requires the full-time presence of operating personnel experienced in managing wastewater systems.

The suspicion with which some public works departments greet innovative systems is best demonstrated by the experience in Hidden Springs, a developing community near Boise, Idaho. Its designers developed a system to carry wastewater from each development cluster to a series of ponds (or "cells") where it would undergo intensive aeration and natural filtration before it was pumped out to irrigate farm fields and common areas and returned to the aquifer. The designers intended the ponds to function as a visual amenity for surrounding homes. The local public works department, however, required a high fence, black liners, and setbacks around the ponds, thus negating their amenity value. The experience at Hidden Springs illustrates the problems that developers may encounter in attempting to apply innovative techniques.

Another technique, solar aquatic systems, uses sunlight, water hyacinths, fish, algae, and snails in a series of indoor tanks to purify sewage through natural processes. The purified water meets effluent standards without the use of chlorine or other toxics and is safe to drink. Aquatic systems have been used successfully in office projects since 1990.[31]

Water Supply. Every development must have access to an adequate supply of potable water. For the most part, it is taken for granted that a public or private local water purveyor exists and can deliver the required service at a reasonable rate. As development extends farther beyond the suburban fringe, however, public delivery of water may not be feasible. In such event, the development must tap an independent supply, usually a groundwater source, from within or near the development. Surface diversions from impoundments may offer an option in some locations, but the primary on-site water source is generally the subsurface aquifer.

Sustainable design principles suggest that water extracted from a subsurface aquifer should be returned to the aquifer within the same watershed or, even better, within the extraction site itself. As discussed in the previous sections, a net extraction of groundwater directly affects the capacity of an aquifer to feed small streams during a dry period. Even when water is recycled by means of soil filtration of wastewater effluent, some net loss of water still occurs, particularly when water is used in manufacturing processes. This so-called consumptive loss, usually in the range of 10 to 20 percent of the extracted water, must be weighed in achieving a sustainable hydrologic system. Some recent studies set the allowable consumptive loss for a given parcel at a percent of the local base flow in accordance with the size of the tract. Whatever the design criterion, a given development's net impact on local water sources determines the upper limits of that development.

Of equal importance to the hydrologic balance on a given parcel is the location of the water supply source. On the one hand, if the water source is derived from the site through groundwater extraction and then discharged to surface waters as treated effluent, a substantial loss of base flow will occur. A more serious concern arises if wastewater derived from water extracted from the site is discharged far downstream or into another watershed. In this case, which occurs more frequently than generally recognized, extraction can significantly deplete the base flow in the stream system. Such depletion is one of the factors contributing to degradation of surface streams in urbanizing watersheds. In fact, the combination of water depletion and an increasing proportion of impervious surfaces produces the well-recognized phenomenon of streams that function primarily as open sewers. On the other hand, if the water supply is imported from off site, then land application of wastewater adds to the water balance. In either case, the hydrologic balance can be significantly altered.

In the absence of standards, effluent returned to the aquifer by filtration can lead to serious deterioration of groundwater quality. Well-recognized water quality criteria are available to guide system design to ensure that water quality is sustained over time. The best indicator of wastewater pollution is the level of nitrate (NO_3), a soluble pollutant that does not respond to treatment by conventional septic systems. In response, federal and state health officials have set the water quality standard for allowable nitrate concentrations at 10 mg/l for water supply sources. In designing a site's hydrology system, design engineers can estimate the potential increase in groundwater nitrate levels under different treatment technologies and formulate designs to ensure that groundwater supplies remain adequate and potable for long-term use.

Taking a cue from the principle of conserving and recycling resources, developers can reduce water supply requirements—and therefore wastewater volumes—by adopting water conservation measures and reusing water on site. In addition, water shortages and declining groundwater reserves have motivated many public water agencies and authorities, especially in the arid Southwest, to initiate water conservation programs, some voluntary and others that involve regulatory and pricing mechanisms.

A typical American home consumes more than 90,000 gallons of water each year. The use of high-efficiency faucets, fixtures, and appliances can reduce that rate of consumption to less than 52,000 gallons a year with no perceptible effect on quality of life or convenience. Low-flow showerheads alone can save 14,000 gallons a year, front-loading (horizontal-axis) washing machines reduce washwater consumption from 24,000 to less than 9,000 gallons a year, and water-efficient toilets cut annual water consumption from 20,000 to 9,000 gallons a year. Education of residents and workers about water consumption can also significantly lower water use.

In many suburban communities, as much as one-third to one-half of water consumption goes for irrigating landscapes, including the lawns so beloved by Americans. Greater use of drought-resistant vegetation, soil treatment, and mulches combined with water-efficient irrigation systems can sharply cut water demands. "Graywater" systems that reclaim water from household sinks and showers for landscape irrigation have been used successfully since the 1970s. A four-person household typically generates enough graywater to irrigate 900 square feet of turf, plus shrubs and trees. Graywater systems offer the additional advantage of increasing local groundwater recharge and reducing drainage needs. Another technique is to collect rainwater from roofs in cisterns for irrigation; in many cases, this old method supplies nearly all irrigation needs at little or no cost. Anyone who has used rainwater for bathing, drinking, and cooking is familiar with its softness, cleaning ability, and friendliness to plants and water-using equipment. Of course, designing smaller lawns, especially in combination with smaller lots, and retaining natural woodlands and meadows as part of the community landscape, will also save substantial amounts of water.

Clearly, sustaining the water balance on a parcel of land, both quantitatively and qualitatively, requires careful consideration of all three water-related aspects of land development—water supply, wastewater, and stormwater management. While no formula covers all the possible situations faced in land development across the country, a set of general guidelines, shown in figure 6-10, identifies applicable management practices.

Designing a Sustainable Built Environment

An evaluation of a site's landscape features and hydrologic functions as described in the foregoing sections

Sustainable Design Guidelines for Water Resources Management — 6-10

Stormwater

Prevent any increase in stormwater runoff volume for the two-year frequency storm

Recharge all stormwater generated by impervious surfaces

Avoid/minimize new impervious surfaces through footprint reduction

Design permeable surfaces for site needs

Avoid detention basins unless recharge is not feasible

If detention is used, provide additional NPS pollutant removal treatment processes

Minimize stormwater conveyance and use perforated piping in beds

Water Supply

Limit consumptive aquifer withdrawals to preserve base flow in streams

Protect aquifer quality by limiting surface chemical applications

Minimize water use and prevent consumptive use

Avoid irrigation systems except with wastewater effluent

Wastewater

Recycle effluent for flushing use

Avoid direct stream discharge of wastewater effluent

Use land application systems for effluent

Use nitrate reduction technologies where required to protect aquifer

Avoid export of wastewater from drainage area

Use nonchlorine disinfectant systems

helps establish a menu of opportunities and objectives for on-site conservation and restoration of natural resources. The menu defines options for providing basic water supply, wastewater disposal, and stormwater infrastructure and identifies a variety of natural areas that may protect resources while benefiting future site residents. Still to be considered, however, are other important components of the infrastructure system, particularly transportation and community facilities and the desired pattern of buildings on the landscape. The choices that developers make regarding the latter components of development can, in combination with the use of a site's natural resource systems, contribute to a project's overall sustainability.

Broadening Travel Options to Promote Sustainable Development. Achieving more sustainable development by improving the interplay between land use and transportation is a central theme of sustainability as well as of the smart growth and new urbanism movements. Many of the ills blamed on current forms of development stem from the perceived overdependence on the automobile for meeting daily travel needs. Transportation experts Newman and Kenworthy have long studied the interaction between transportation and land use and cite overdependence on the automobile as "a fundamental cause of unsustainability in cities." Such dependence, they assert, comes at a great cost and involves "an almost open-ended supply of transportation infrastructure that caters to exponential growth in demand for travel," with consequent impacts on global resources and city environments "and a whole array of unforeseen social costs such as isolation, destruction of community, and degradation of the public realm."[32]

Reducing dependence on the automobile will necessitate long-term modifications to urban development patterns and people's travel behavior as well as significant shifts in both public policies and private development practices. But the starting point is obvious: an expanded range of opportunities and incentives that encourages residents and workers to choose alternative means of travel. For example, sustainable development principles and those of smart growth speak of increasing residents' and employees' access to public transit, walkways, and bikeways and encouraging more efficient use of the automobile through carpools and other arrangements. Broadening access to travel options means, first, making alternatives physically available and, second, shaping development to make the alternatives accessible to more people.

To be most successful, transportation alternatives require actions at the community and even regional levels; developers, however, can design developments in ways that expand travel options without adding significant costs to a project. Developers can measurably enhance project sustainability by planning an attractive network of pathways, assuring residents and workers of convenient access to existing or future transit ways, and designing the built environment to encourage use of these travel modes.

In many ways, the simplest means of expanding travel options is to make it easier for people to walk or cycle to their destinations—designing walkable communities at a human scale. Designing at a human scale means, among other things, reordering priorities in the automobile/pedestrian relationship to give pedestrians an even break. One of the earliest community designs that responded to problems created by increasing dependence on the automobile was Henry Wright and Clarence Stein's 1929 new town, Radburn, New Jersey. Radburn's organizing principle is complete separation of pedestrian and automobile traffic. The automobile is kept in its place with the use of short culs-de-sac that provide access to clusters of homes; the homes in turn face open spaces in the interior of large blocks. Pathways lead from the homes through interior green spaces to schools, playgrounds, and shopping. Some aspects of Radburn's plan, the cul-de-sac in particular, came into extensive use in the 1960s, 1970s, and even the 1980s, but without many of the other design elements that made Radburn a success.

In 1973, designers/developers Michael and Judy Corbett revitalized and improved on the Radburn concept when they developed Village Homes in the university community of Davis, California. At Village Homes, the houses are likewise oriented away from the street and toward green spaces that incorporate natural drainage areas, parks, community gardens, and orchards. Pedestrian traffic is completely separated from automobile traffic, and the pedestrian/cycle path is the primary circulation grid. Village Homes is designed to take advantage of passive solar energy and makes efficient use of natural resources. Today, homes in the community sell for $10 to $25 per square foot more than nearby comparable homes, turnover is low, and houses resell quickly.[33] Although Village Homes, like Radburn, was ahead of its time, its success in the market demonstrates the benefits of pedestrian-oriented and ecologically sensitive development.

Radburn's designers tended to treat the automobile as a dangerous machine to be relegated to a domain beyond the community's living areas. By contrast, today's advocates of livable communities have embraced the automobile as a vehicle that is here to stay but that can be put in its place. Instead of turning development away from the street and its traffic, proponents of livable communities view streets as valuable public spaces that can be made attractive for pedestrian as well as vehicular travel. Their designs emphasize interconnected street and pathway systems that knit the neighborhood together both functionally and visually. While leaders of the new urbanism movement proclaim the benefits of grid street systems as a unifying element, most land designers prefer street designs that respond to a site's terrain, even including curved streets and culs-de-sac. The essential quality for land designers is the interconnection of streets and pathways to maximize convenience and travel options. The importance of interconnections also carries across site boundaries to the street and walkway systems of adjacent developments.

Walkable (and bikeable) communities require just a few—albeit fundamental—changes to conventional development design, including the following:

- the provision of sidewalks or pathways linking residences to common destinations such as schools and parks, shopping and services, public transit stops, other residential areas, and even employment locations;
- pathways designed to be attractive, convenient, and safe;
- clustering several often-used destinations; and
- shortening overall walking distances by increasing the overall density of development.

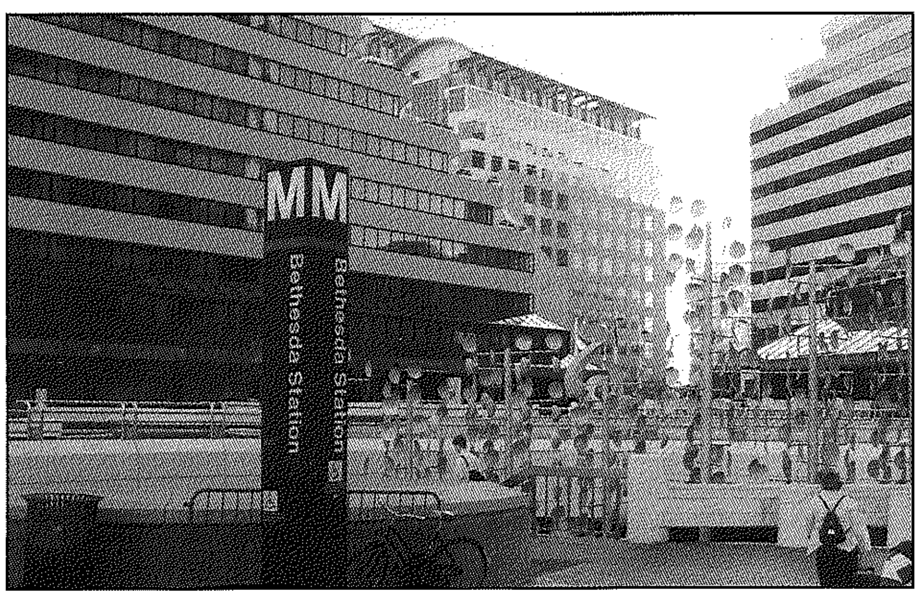
In addition to sidewalks along streets, a common design treatment favored by developers of many planned communities is pathways through neighborhood and community open-space systems such as greenways. By far the most important stimulus to walking and cycling, however, is reducing distances between important destinations, a function of compact and interconnected development.

Developers can also widen travel choices by making their developments transit-friendly. Ideally, they can develop sites along existing or planned rail and bus lines and concentrate a mix of housing, jobs, retail shops and services, and public facilities at stations or stops. If well designed with attractive pathways connecting to transit lines, such development can spur transit ridership and reduce dependence on the automobile. Developments most supportive of transit service generally demonstrate the following characteristics:

- locations within ten minutes' walking distance of transit lines;
- a mix of uses, including a compact urban core of public, commercial, and residential uses;
- a mix of housing densities, types, prices, and ownership forms;
- a street and pathway system easily understood and interconnected, converging on core areas; and
- building orientation toward the streets.

Many transit agencies are working with developers to generate transit-friendly forms of development by publishing guidelines for transit-friendly development and sponsoring public/private ventures on transit properties.[34]

In the San Francisco Bay region, communities and the transit agency are using a combination of powers and incentives to promote transit-oriented development. Redevelopment powers expedite land assembly; assessment districts provide infrastructure financing and density bonuses; and reduced parking requirements help make development feasible. Proximity to Bay Area Rapid Transit (BART) stations is becoming a primary factor in attracting tenants to downtown office buildings. Employers have discovered that it is easier to recruit workers when convenient transit service is available.



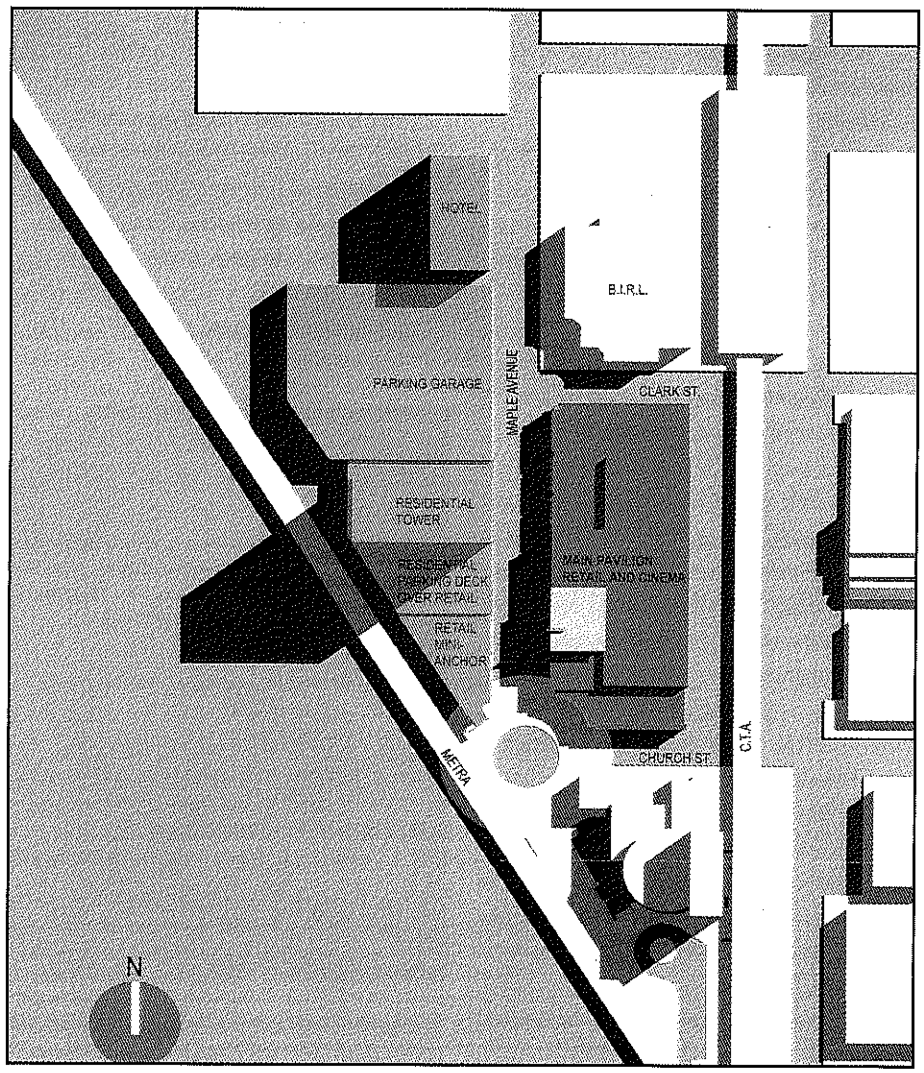
Transit-focused development in Bethesda, Maryland. At the Bethesda Metrorail stop in Bethesda, collaborative planning by the transit authority, Montgomery County, and developers spurred a mixed-use development above the rail and bus stations. The central public plaza is enlivened by a kinetic sculpture and fountain. Bethesda Metro Center is flanked by almost a dozen other office, mixed-use, and residential projects built over the last 12 years.

Similarly, the Washington Metropolitan Area Transit Authority (WMATA) has worked with developers and local jurisdictions to promote over 30 public/private ventures at or near Metrorail stations. In Bethesda, Maryland, for example, WMATA cooperated with the Montgomery County Planning Board to promote development at the station, which is located in the heart of the Bethesda business district. The board drafted design guidelines for WMATA's use in reviewing development proposals for the site. WMATA selected a local firm to develop a mixed-use development over the station, along with a related bus terminal. Access to rail service permitted a reduction in on-site parking requirements. At many other Metrorail station areas, developers have negotiated deals with WMATA to gain direct access to the stations for development.

Another example of a suburban city taking advantage of rail station–related development opportunities is Evanston, Illinois, south of Chicago. The Arthur Hill company negotiated an agreement with the city and Northwestern University to develop long-vacant properties located between rail stations on the Metra commuter and Chicago Transit Authority rail lines, near the university and in the heart of downtown Evanston. In fall 1999, ground was broken for Church Street Plaza on a seven-acre site, shown in figure 6-11. Under construction is the Pavilion, which will house a cineplex with retail and restaurant uses. In addition, a 160- to 180-room Hilton Garden Inn has been announced, and construction drawings are in preparation for a high-rise residential building with about 250 rental units. A 1,400-car municipal parking garage will serve both the project and downtown stores and offices. With all these uses within a few steps of both rail stations, the development is expected to increase transit ridership and benefit from multimodal travel access.

Development sites in the path of planned extensions of transit lines can be designed to respond to eventual opportunities for transit service. In the case of rail transit, projects can take the form of higher-density, mixed-use development focused around a proposed station site and even reserve land for a future station. In addition, development can be designed along a proposed line with future train movements in mind. The cost of planning for potential rail connections is likely to be more than offset by the escalation in development value that follows the introduction of transit service. In any case, a well-designed, mixed-use development can deliver satisfactory profits on its own, as demonstrated by recent experience in Pasadena. The Janss Company, active in southern California for many years, developed Holly Street Village in downtown Pasadena, a $56 million mixed-use project with 384 apartments and 11,000 square feet of retail space. An internal pathway network links housing

Another Transit-Oriented Development: Church Street Plaza, Evanston, Illinois 6-11



Located between two rail transit lines, the mixed-use Church Street Plaza will strengthen downtown Evanston and serve the Northwestern University campus while boosting transit ridership.

to retail shops and the village square. With the expectation that the Metropolitan Transit Authority of Los Angeles (MTA) will extend the light-rail Blue Line to a station within the development over the next few years, the project was built in cooperation with and with financial assistance from the Pasadena Redevelopment Agency and a light-rail line MTA. Upon the introduction of rail service, the city will benefit from higher property tax receipts and the transit agency from greater ridership; the developer will benefit as well from the rail access, although the project is successful as it now stands.[35]

Designing development for eventual bus service is somewhat less complicated and simply calls for the provision of adequate street widths, turning radii, and stopping points along arterial streets designated as likely bus routes. Projects designed for planned bus service should also consider the possibility of incorporating a multimodal center (for buses, taxis, and kiss-and-ride and park-and-ride facilities) in or adjoining a mixed-use community center and providing convenient pathway connections to future stops.

Development sites not in proximity to rail or bus routes can still encourage access to transit by establishing shuttle bus service in association with park-and-ride facilities.

In addition to shaping development to promote a variety of travel options, many developers have established or participated in traffic management programs intended to reduce peak-hour congestion. They work with employers to schedule a range of arrival and departure times, to promote telecommuting (home-based work) for a given proportion of the labor force, and to encourage workplace-based employees to use forms of travel other than single-occupant automobiles. The last approach can include arrangements such as vanpool and carpool programs and paying for part or all of employees' use of transit.

Developers can organize such efforts themselves or in partnership with other developers or public agencies, or they can even contract with a firm that specializes in providing those services. Grossman Family Properties, developing Hidden Springs near Boise, Idaho, for example, commissioned a traffic management plan to reduce potential traffic impacts on highway links to the city. The plan set forth a goal of reducing vehicle trips associated with Hidden Springs from an estimated 12 per household as in a conventional development to eight per household. The plan proposed several elements to achieve that reduction, including the following:

- development of commercial and community features that contribute to a relatively high degree of self-sufficiency on the site, including retail services, a post office, parks, play areas, cycle trails for recreation, a community school, and a working farm that operates a produce stand to serve the community;
- an information center providing a rideshare matching service, information on cycle and pedestrian routes, and delivery and shuttle services available from vendors;
- a "partial grid" street pattern that provides direct pedestrian routes to the commercial and community center;
- pedestrian and cycle pathways that offer convenient routes through the development;
- a park-and-ride lot for both work and nonwork trips to encourage carpooling;
- advanced wiring in all dwellings to support telecommuting and home-based work; and
- appointment of an on-site transportation coordinator, issuance to all new residents of an orientation package describing transportation options, participation in any future areawide transportation management association, and periodic promotional events and mailings.[36]

Traffic management programs are not new. The developers of Hacienda Business Park in Pleasanton, California, strongly supported the drafting of a trip reduction ordinance to deal with the area's growing traffic congestion. In 1984, the developers formed an association of property owners and lessors to implement a trip reduction program. The program's design guidelines for the business park specified that new developments must provide preferential carpool parking, install bicycle racks, and appoint transportation coordinators to help workers find new ways of commuting to the site. In addition, the developers began to balance the jobs/housing mix by rezoning some parcels and developing them for high-density residential use.[37]

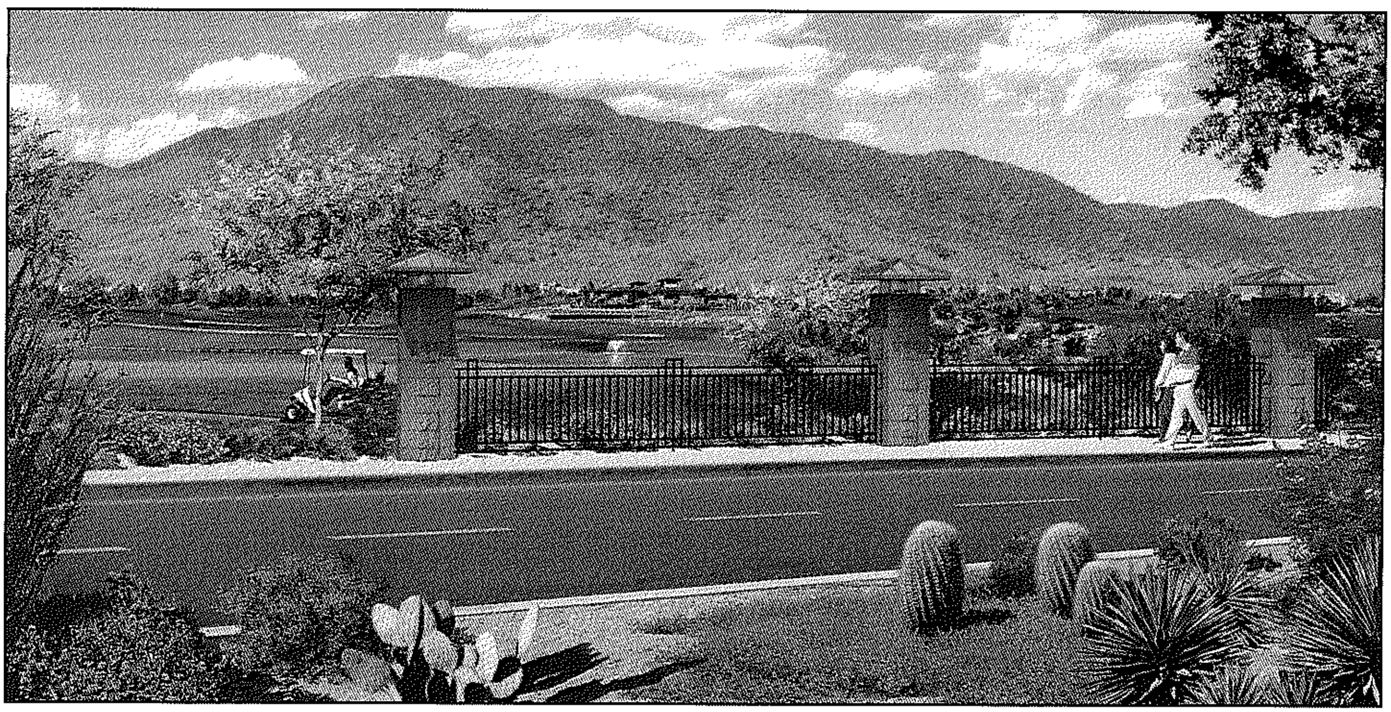
These and many other developments demonstrate the value of designing projects that offer a range of transportation options. Not only do such options attract occupants, but they also help mitigate traffic congestion that might otherwise further degrade air quality and lead to public limits on development.

Community Facilities and Open Space. Sustainable development incorporates the public services and open space essential to creating livable, interactive, and healthy communities. Developers of large-scale planned communities have decades of experience in planning and constructing community facilities and open space as necessary and attractive components of new neighborhoods and communities. They go to great pains to determine appropriate sites for schools, libraries, fire stations, and the like and occasionally design and build them as well. They also lay out elaborate open-space systems of small parks and playgrounds, larger sports facilities, greenways, and conserved woodlands and wetlands. Even in smaller residential and business park developments, developers frequently provide a well-designed amenity package—usually a central park or a recreation center in an attractively landscaped setting—that establishes the identity and tone of the development. In addition, developers of smaller projects are careful to identify and provide access to major community facilities in the surrounding neighborhood that can benefit project residents. Not only do these facilities enhance a development's living and working environment, thereby encouraging sustainability, but they also become an essential aspect of project marketability.

Site designers frequently use open-space systems as "organizers" of the built environment and as the setting for commonly used facilities. Working from the type of landscape analysis described earlier, designers identify site features—terrain, meadows, woodlands, and other natural assets—that can be conserved, restored, or enhanced to create a special character or identity for the development. At the same time, landscape features provide passive and active recreation opportunities for site residents.

The Del Webb Company designed its 5,856-acre, mixed-use development north of Phoenix to fit within the site's ridges and washes in the foothills of Daisy Mountain. Called Anthem, the development retains over a third of the site in open space and for recreational use. About 290 acres of hillsides above the 15 percent slope line remain untouched, offering a wonderfully scenic backdrop for residential areas. Walking and riding trails extend along the washes and a 63-acre central park adjoins a multiuse community center. Together with three golf courses (designed within the state's acreage limits on irrigated fairways), the open spaces provide both recreation opportunities and a pleasant setting for Webb's traditional active-adult market and the extended market of families and individuals targeted by the development. Although some opposed the development of Anthem as a leap-frogging form of sprawl, the community's mix of uses, overall density, and conservation of open space are far more sustainable than the scattered one- and two-acre lots preferred by project opponents.

Smaller developments also benefit from preservation of open space. Developer Robert Engstrom set out to design an environmentally sensitive alternative to the large-lot subdivisions so common in the Twin Cities area of Minnesota. The Fields of St. Croix (see figure 6-12) in the city of Lake Elmo allocates more than 60 percent of the 226-acre site to permanent open space, which comprises farmland, horticultural gardens and a



Anthem master-planned community, Phoenix, Arizona. Anthem clusters homes to retain views of the hills and provide recreational open spaces throughout the community.

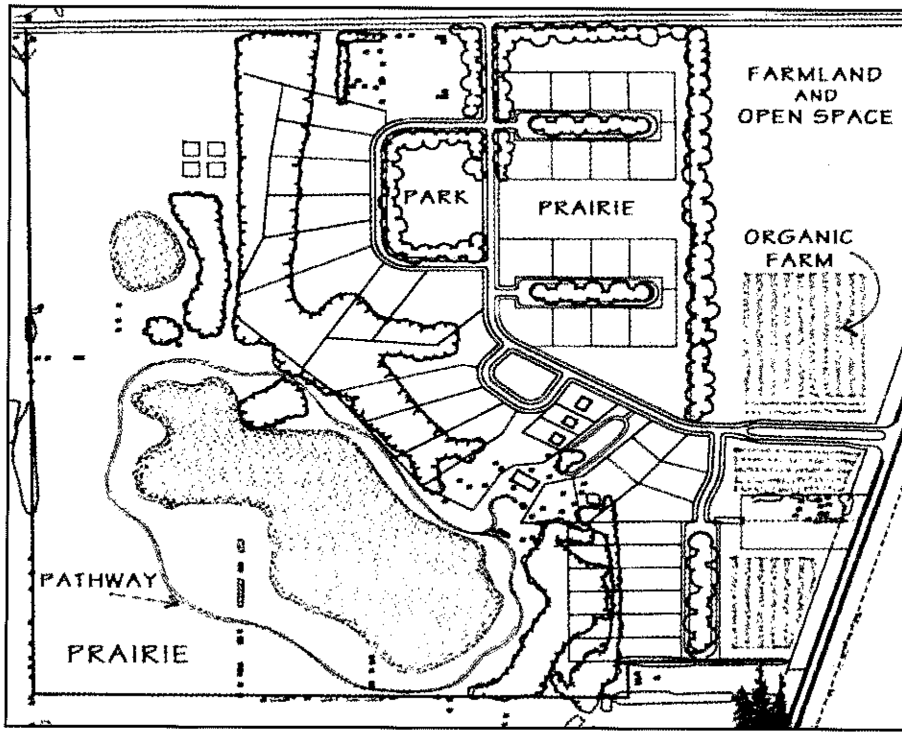
tree nursery, wooded slopes, two ponds, and restored native prairie. Over three-quarters of the 45 homesites in the first phase sold in six weeks after sales began in 1997; a second phase is now complete. Lots were priced in the affordable range of $44,500 to $150,000.

The farmland conservation allowed by clustered homesites in Engstrom's development is echoed in a number of large and small projects in other parts of the nation. The Qroe Companies, based in Nashua, New Hampshire, has developed several New England properties that blend development with working farms. One example, shown in figure 6-13, is Pardon Hill, a 177-acre site on which 22 homes have been developed on one- and two-acre lots, leaving 83 percent of the site—including 60 acres of dedicated farmland—in open space. Hidden Springs near Boise, Idaho, has set aside 85 acres to continue operation of a working farm. Over 60 varieties of fruits and vegetables produced by the farm are sold at the adjoining farmers' market and in the development's general store. The developer, taking every opportunity to remind residents of the site's farmland past, planted a large field of pumpkins and corn in the village center on a vacant parcel planned for future retail use. These deliberate touches and the location of a working farm in proximity to consumers reflect sustainability principles and, not incidentally, provide residents with a distinctive and valued amenity.

Smaller developments can promote sustainability by designing preserved open spaces linked to adjoining natural systems. The on-site inventory of landscape resources should identify connections to the natural systems of the larger watershed or ecosystem so that open space in individual developments functions as part of the whole system, not just as an isolated fragment. Developers can identi-

A Variety of Open Spaces in the Fields of St. Croix, Lake Elmo, Minnesota

6-12



Almost two-thirds of the 226-acre site is retained in permanent open space, including restored native prairie lands, farmland, ponds, horticultural gardens, and wooded areas.

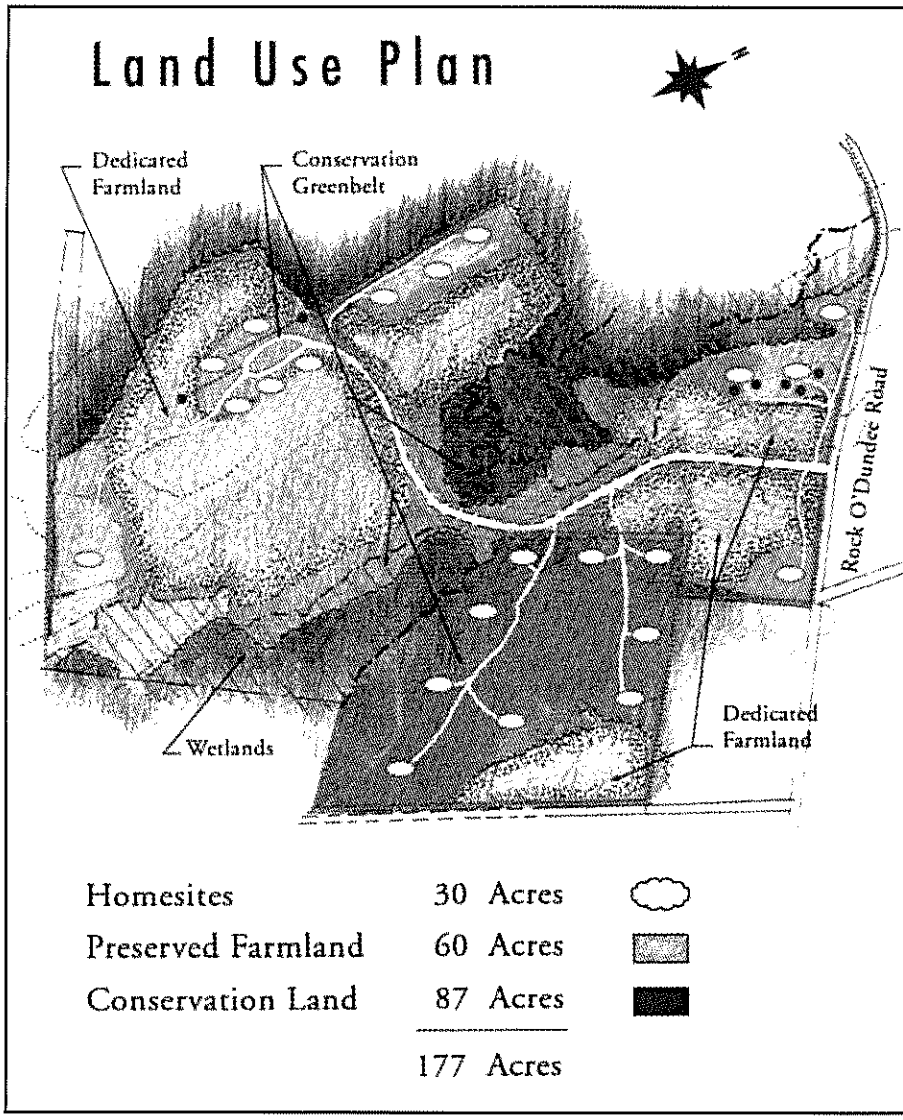
The Fields of St. Croix, St. Elmo, Minnesota. The development preserved farm fields that continue to be cultivated for crops and also function as valued open space for residents.

fy opportunities for linked systems by consulting community conservation plans that might have been developed by local planning offices. Coordination avoids scattershot patterns of open-space conservation that sometimes evolve from conservation efforts on individual properties and thus are far less effective in maintaining natural resource lands than large connected systems. In Lincoln, Massachusetts, for example, the town's program for promoting cluster development in concert with related open-space conservation was greatly enhanced by the adoption of a long-range conservation plan that demonstrated how developers' incremental conservation efforts could link into greenway and other open-space networks.

Trees and woodlands are an important part of every sustainable development, offering cooling shade in summer, absorbing stormwater, filtering harmful air pollutants, furnishing mini-habitats for birds and other creatures, and providing value-increasing landscape greenery. Trees, either along a street or clustered around homes and businesses, use solar radiation to transpire 100 gallons of water per day, the equivalent of five air conditioners running for 20 hours.[38] A comparative study of air quality along two streets found that the street with trees had less than 3,000 dust particles per liter of air while the street without trees had from 10,000 to 12,000 dust particles per liter.[39] Trees not only take up water as it seeps into the ground, but the foliage shields erodable ground from heavy rains and acts much like a drip irrigation system after rains. The stormwater management capabilities of existing tree cover are estimated to be worth $305 million in Milwaukee and $883 million in Atlanta, according to the American Forests organization. That organization has established desired goals for tree canopy (tree coverage) of 15 percent for business districts, 25 percent for urban residential areas, and 50 percent in suburban areas.[40]

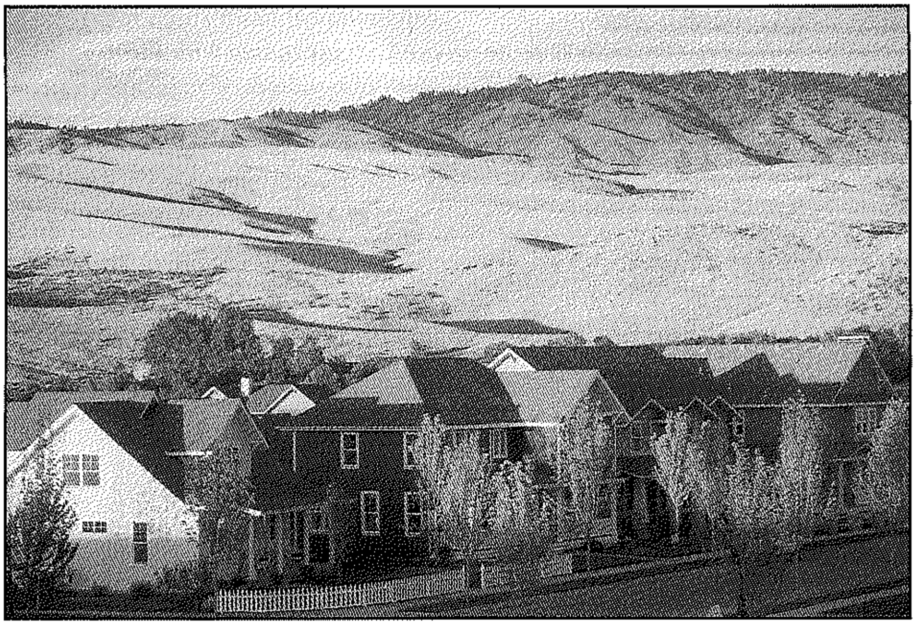
Homes among Farmland in Pardon Hill, South Dartmouth, Massachusetts

6-13



The Qroe Company specializes in developing homes in a natural or farmland environment. Pardon Hill includes 22 homesites and maintains 83 percent of the site in open space.

One issue that often arises in restoring or capitalizing on landscape features is reconciling the potentially conflicting goals of conserving natural qualities and allowing human use. Preserved wildlife habitats and wetlands often may lure site residents who wish to enjoy a walk through nature's wonders. These visits, however, may damage vegetation, habitats, and erodable terrain, gradually diminishing an asset's viability as an environmental resource. Thus, in the case of Playa Vista in Los Angeles, for example, plans for the restored saltwater wetlands will deliberately exclude walkways or other facilities that could attract visitors, although the wetlands will be visible from developed parts of the site. In some developments, walls and fences have been required to protect habitats and wetlands; in others, occasional visits by hikers, bird watchers, or school classes are expected and welcomed.



Hidden Springs, near Boise, Idaho. Homes in Hidden Springs were clustered to retain the hilly landscape as a visual and environmental asset.

The effectiveness of such conservation measures depends on the specific character of the resource, its location in relation to nearby development, and the effectiveness of the management program established for resource conservation. Naturalists have discovered, for example, that the Least Bell's vireo, an endangered bird, thrives in the vegetation bordering golf fairways. In at least one habitat area, coyotes were introduced to discourage cats from nearby homes from preying on native birds. (After losing a few pets, residents now keep their cats indoors.) In any case, on-site conservation in proximity to development calls for a well-designed resource management program, including educational programs for site residents (discussed later).

Although most infield developments contribute to sustainability primarily by taking advantage of existing systems of community facilities and open space, they too can incorporate elements that add to the mix of amenities available to the neighborhood and community. For example, mixed-use projects and regional shopping centers sometimes incorporate community meeting or event rooms as well as outdoor spaces that function much like community parks. Even attractive landscaping adds value to and helps create an identity for the neighborhood.

Many studies have established the value-added quality of open space for development. Other studies have shown that lots with trees can be sold for 5 to 18 percent more than lots without trees. A 1986 Gallup survey determined that across the nation landscaping adds almost 15 percent to the value of a home.[41]

Community facilities and open space, then, provide essential community-making elements for any development. If linked to larger facility and natural systems, these elements become even more important in providing regional settings for sustainable development. Ultimately, they help establish the livability of places that contributes to long-term sustainability.

Buildings on the Site: Patterns and Relationships. Landscape resources and open space, hydrologic systems, and transportation and community facilities establish the broad parameters of a development's design; for developers, though, the ultimate goal is to provide building construction sites. (The next chapter discusses how individual buildings and linked groups of buildings can incorporate "green" elements that promote sustainability.) In considering overall design approaches to site development, developers need to recognize that the patterns and relationships between buildings and the land and among buildings themselves play a significant role in achieving sustainable development. In particular, development designers can site buildings in ways that minimize disruption of the natural landscape, reduce energy requirements, and create a sense of place for the development and larger neighborhood.

The landscape analysis described earlier will identify areas most suitable for building and the landforms that should be preserved. To conserve a property's natural systems and features to the extent possible, developers should site buildings in patterns that minimize earth cuts and fills. Accordingly, buildings should be grouped on parts of the site least susceptible to erosion or already disturbed by clearing and cultivation or previous development. Buildings can be designed in clusters that use less land than typical subdivision lots, leaving more of a site in its natural condition and reducing transportation and utility costs. Building more densely—up rather than out—can reduce impervious surface and thus stormwater runoff.

Forms of development that make efficient use of land have long been espoused by leading development and environmental organizations. The Urban Land Institute, the American Planning Association, and the National

Association of Home Builders, for example, in addition to the U.S. Department of Housing and Urban Development, have promoted clustered, land-saving development since the 1930s. Over the decades, their publications have, first, demonstrated the cost and conservation economies that can be achieved through more efficient use of land and, second, described several projects that achieve those goals successfully.[42] The Coffee Creek Center, Pardon Hill, and Tryon Farm developments described earlier indicate that developers know well the techniques of land-saving clustering; too often, though, they have to "fight city hall" and neighboring residents to obtain approvals for building such projects.

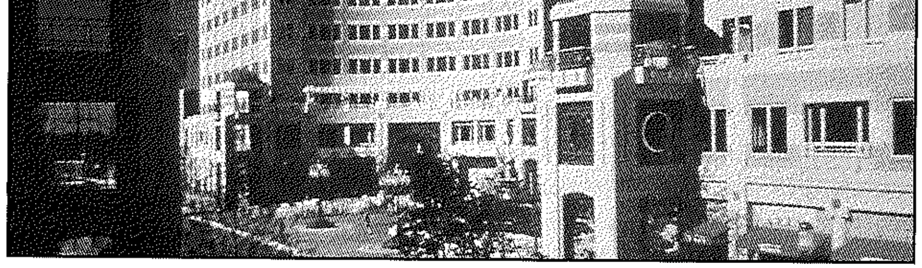
Building patterns (along with individual buildings as discussed in the next chapter) can also be planned to conserve energy. To optimize energy efficiency across a site, developers must integrate a project's land planning, building design, and building components during formulation of the initial project plan. Streets and lots can be laid out to maximize access to solar energy but must also respect other landscape and hydrology considerations. A typical cul-de-sac plan, for example, leaves only about 20 percent of lots usable for passive solar energy. Minor revisions to the street layout can increase that figure to up to 80 percent. Laying out streets and buildings to conserve existing trees and allow extensive tree plantings takes advantage of trees' shade-giving cooling power and windproofing and warming properties while reducing energy requirements for heating and air conditioning. Clustering buildings on interconnected streets to encourage walking and cycling and thus shorten distances between uses cuts down on the amount of fuel consumed by automobiles.

Whether a project is large or small, development designers can group buildings to create a special identity and sense of place. Buildings can be arranged to form a perceivable and hospitable public realm, to create recognizable central places, and to preserve and enhance landmarks of all types. A development's architecture can establish a distinctive identity for the community while the themes and variations of building placement and design can mark the community as a welcoming and enjoyable place.

Town centers—in towns, suburbs, and large-scale new developments—are one expression of place-making. At the planned community of Reston, a 7,400-acre development near Dulles International Airport in Northern Virginia, the town center was designed and developed as an urban place to respond to a market that had matured over decades of community development. The 22-acre first phase consists of 220,000 square feet of retail shops, a 514-room hotel, and 530,000 square feet of office space as well as several parking structures. It centers on a "main street" of retail and office buildings grouped closely around pleasant pedestrian spaces. Since opening in 1990, the project has also become an entertainment destination; today, the center is expanding with the development of hundreds of residential units and additional office towers.

At a smaller scale, the Haile Plantation Village Center is part of a 1,700-acre planned golf community in Gainesville, Florida. Developer Robert Kramer decided to create an "authentic" small-town main street. Over the course of eight years, he has built 30 buildings, each about 2,000 to 3,000 square feet, on 15 acres of the 51-acre site. The remaining acreage is under development as a traditional residential village focused around a village green, shown in figure 6-14.

The redevelopment of the town center in Smyrna, a city of 30,000 amid Atlanta's urban sprawl, is a notable case of reestablishing a distinctive identity for a downtown in deep decline. Sizemore Floyd Architects, commissioned to plan and design a new library and community center for the town, recommended that the public buildings be used to leverage the creation of an entirely new downtown center. To that end, the city assembled a 29-acre site



Creating a big-city town center in Reston, Virginia. The new town of Reston, under development since the 1960s, has matured enough to warrant a prominent place-making center.

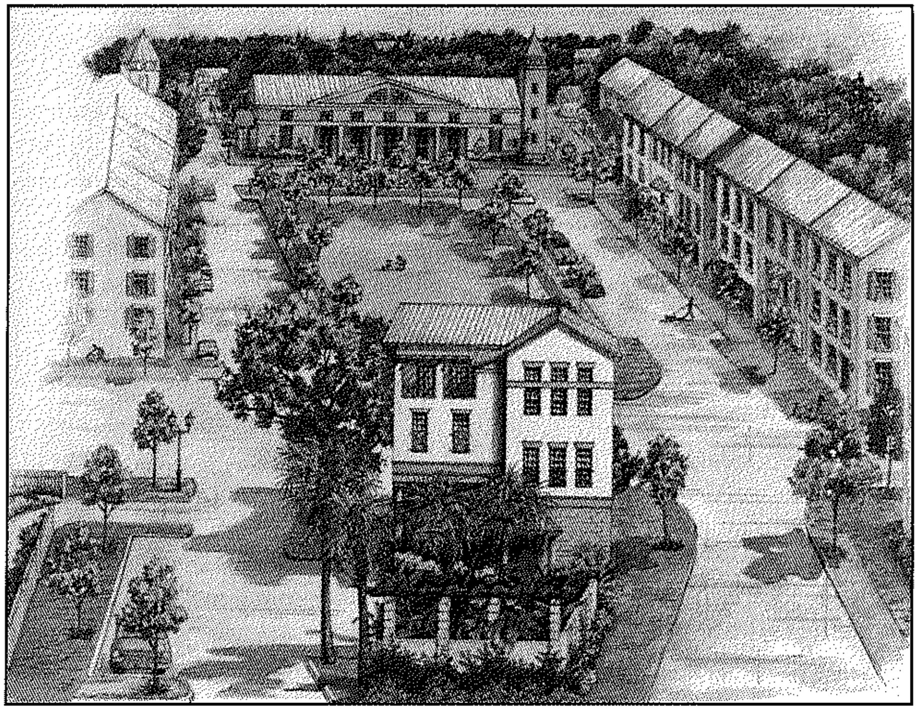
just a block off the main street. The plan incorporated most of the town's civic and community buildings, a town green, a three-acre park, and a site for private high-density commercial and residential development. The public buildings were designed in a distinctive style, and design guidelines were adopted to guide other development. The 1991 completion of the community center and library sparked the development of 22 cottage houses, which sold immediately, and 40,000 square feet of retail and office space. A second phase, including a city hall, public safety facility, and seniors' center, has been completed, followed by private development of space for several shops and services. Plans for additional public and private development were drawn up in 1999.

Another approach to place-making is illustrated in the design of Northpark, a 350-acre village within the enormous expanse of the Irvine, California, development. The design focused on the creation of a strong landscape character to achieve a special identity for the community. To remind residents of the site's natural heritage, the design called for retaining existing windrows of eucalyptus trees and the views of the foothills. A trail system that follows the region's arroyos promotes connectivity within and beyond the village. The street system also provides a continuous walkway system that links to open spaces and community facilities. All of these features contribute to Northpark's sense of place, but that sense is heightened by the design of the buildings along the streets and around the open spaces. The rhythmic interrelationship, individuality, and human scale of the buildings enrich the pedestrian experience.[43]

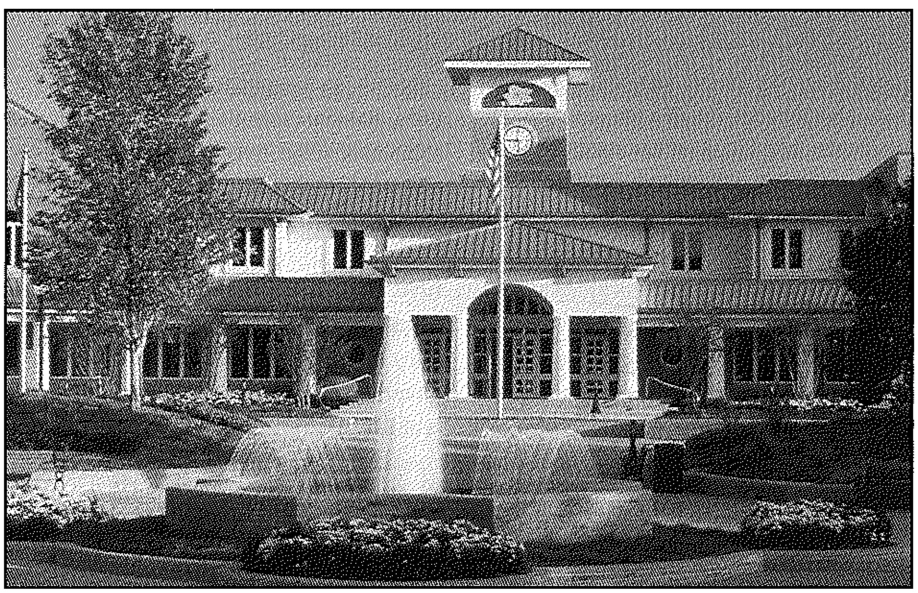
Even small developments can establish a style and distinctiveness in building placement and design that complement rather than compete with adjoining developments. As Edward Blakely points out in chapter 5, too many community designers depend on guarded gateways to mark a development's identity. Careful siting of buildings around central open spaces, in well-designed clusters, or along attractive streets can stimulate a civic consciousness of place that is sustainable without being exclusionary. Preservation of historic or archi-

Haile Plantation Village Center

6-14



The heart of Haile Plantation's Village Center is the green bordered by shops, offices, townhouses, and community buildings, as depicted in this drawing.



Recreating a suburban center: Smyrna, Georgia. Smyrna stimulated private redevelopment in its town center by the artful design of new community buildings.

tecturally interesting buildings can also provide a distinctive identity for a development. The Victorian farmhouse preserved in the Tryon Farm development in Michigan City, Indiana, and the old barns retained in the Hidden Springs development near Boise, Idaho, add place-making character to their respective developments.

Infield Development: Profitable Place-Making. Many infill (or infield) projects capitalize on the sense of place and distinctive architecture of existing buildings and neighborhood surroundings to create a unique identity, as in a sensitively designed project in Charlottesville, Virginia, shown in figure 6-15. Charlottesville is the home of the University of Virginia, whose expanding student body adds to a growing demand for housing. Kellytown, a neighborhood established by freed slaves after the Civil War, is a single-family area near the university with some large undeveloped parcels and many old trees. After a developer purchased two parcels in Kellytown, he participated in a 16-month collaborative planning process to prepare a place-sensitive site plan. Following many meetings and the consideration of several design concepts, the developer agreed to honor the neighborhood's heritage by retaining the original structures still standing; preserving a large forested area as a wildlife habitat that would also mitigate the possible flooding of Kelly's Creek, which runs through the neighborhood; integrating new development into the existing community; and designing small lots and narrow streets in order to retain open space. On the first parcel, 32 houses and ten accessory uses were planned on 40-by-50-foot lots. As of late 1998, 12 houses had been constructed at prices ranging from $120,000 to $170,000.[44]

Many communities view infill development as an essential tool for revitalizing aging neighborhoods and business centers and curbing sprawling fringe-area development. Development of infield sites can reduce the need for investment in new infrastructure, restore declining areas, and improve tax bases and local economies. Infill sites may include vacant lots and tracts, abandoned properties, and underused parcels whose potential value outweighs the value of existing uses. (Chapter 7 discusses infill by reuse of vacant buildings.) In many cases, infill development can be combined with renovation of adjoining properties to stimulate broader neighborhood redevelopment.

By their very nature, infield sites have problematic qualities that sometimes offset any locational advantages. Zoning restrictions or parcel size and shape may restrict development opportunities. Terrain conditions such as steep slopes, poor drainage, and questionable subsoil may increase potential development costs. Removing obsolete structures may add to development costs while ownership conflicts or tax problems may cloud use of the properties. The condition of surrounding land uses and local infrastructure systems may dissuade potential developers. Outdated or overly restrictive local codes and regulations may drive up development costs. Any or all of these possibilities can increase the costs and risks attendant to infill development and thereby reduce the marketability of an infill site.

From a financial standpoint, infill developments pose issues of risk and nonroutine deals. Site prices per unit or square foot are frequently higher than those in urbanizing fringe locations, and the customized design required for virtually every product typically adds to development costs. Moreover, market responses to proposed products are less certain and project approval processes often more tortuous than in the case of suburban greenfield development.

One of the most significant obstacles to many infield projects is neighborhood opposition. Infill development necessarily affects adjoining property owners and residents. Sometimes, neighbors welcome new investments that may shore up their property values or even improve the neighborhood. Sometimes, however, they react fearfully to infill proposals that may "change the character" of the area or bring new residents to old neighborhood. As ULI's book on infill housing put it,

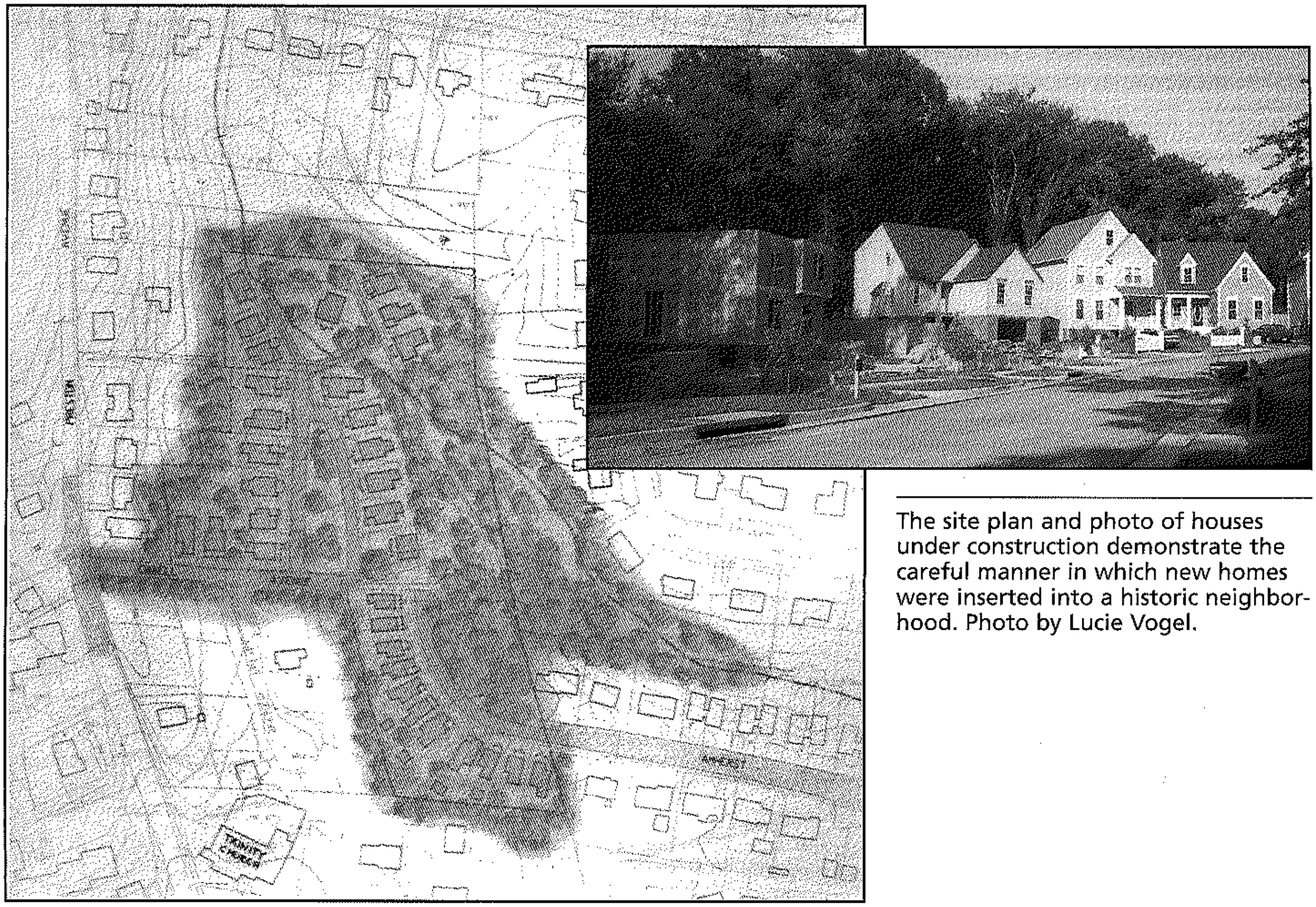
> [E]xisting residents may object even if the development will improve the neighborhood. [They] may fear gentrification, displacement, and change; they may want to preserve vacant property as open space; they may be concerned that community facilities will be overloaded by the influx of newcomers . . . .[45]

Indeed, most cities that have initiated effective infill policies and programs (including, for example, Portland, Oregon, and San Diego) have experienced resistance from neighbors who dislike the appearance, higher density, or other impacts of new development.

Overcoming these obstacles to infill housing typically requires extraordinary efforts by developers and local governments as well as a supportive real estate market. Infill succeeds in communities with strong growth rates and economies, where developers are actively looking for opportunities, and where potential returns on investments can absorb higher risks. Particularly in areas of need, infield development succeeds where the financial resources and project management skills of committed organizations can be brought together to focus on stimulating development. To spur infield development, many local governments and nonprofit organizations have initiated or partici-

New Development in an Old Neighborhood in Charlottesville, Virginia: New Homes Designed to Be Compatible with Existing Residences

6-15



The site plan and photo of houses under construction demonstrate the careful manner in which new homes were inserted into a historic neighborhood. Photo by Lucie Vogel.

pated in redevelopment projects and rehabilitation programs, including land assembly, financial assistance, and infrastructure development. Nonprofit groups such as community development corporations have organized fix-up campaigns and provided channels for financial assistance.

Developers must expect to customize infield projects to the particular conditions and limitations of the site, neighborhood, market, and local regulations. Compared with typical greenfield development at the urbanizing fringe, infield development demands close attention to individual site conditions and requires the design of products highly tailored to niche markets. In fact, developers of infield developments have learned to shape their products carefully to ensure compatibility with neighborhood needs while meeting the demands of the marketplace. They expect (and usually enjoy) the challenge of finding the right design for the right product for the right site versus developing yet another suburban subdivision.

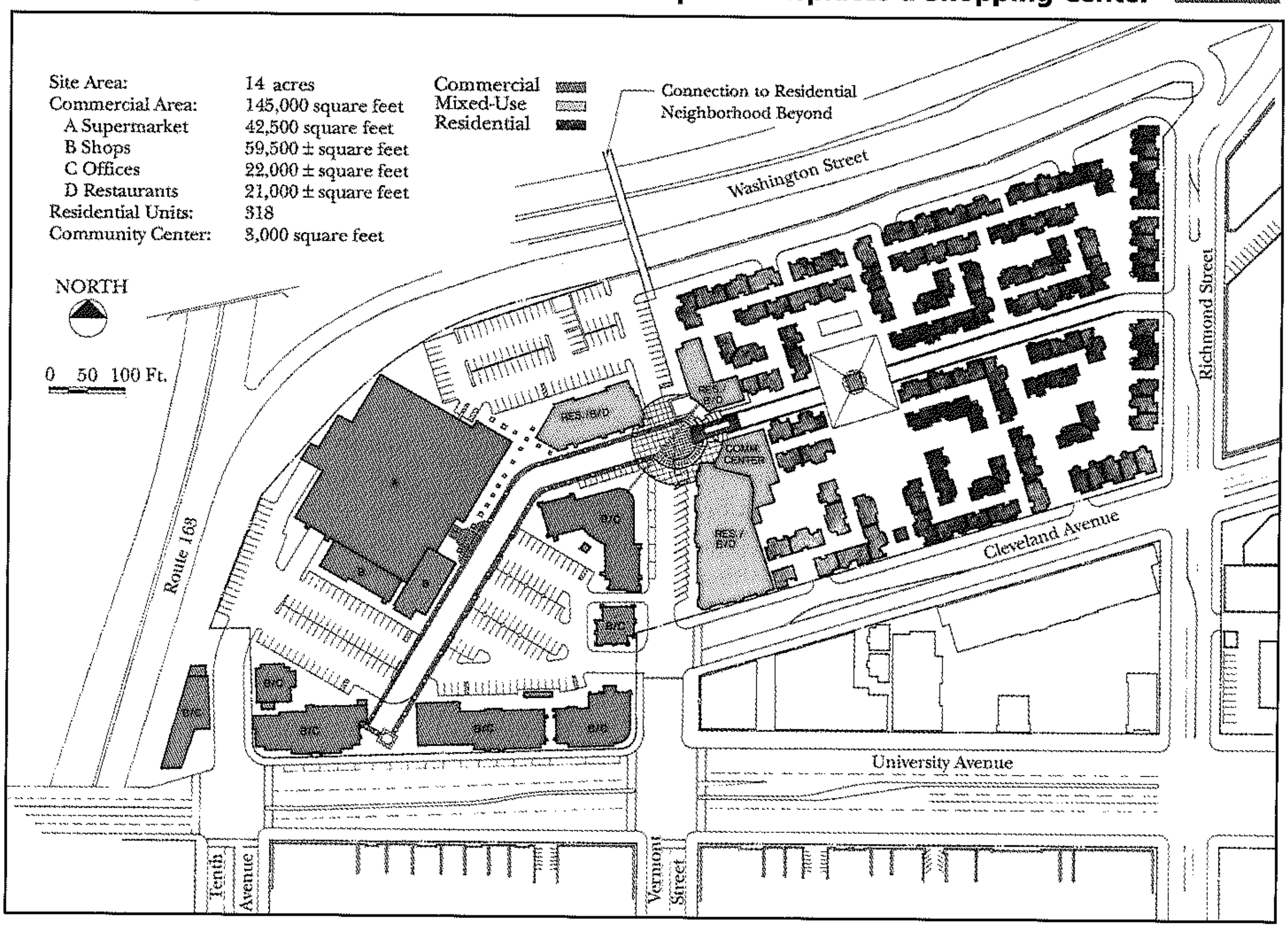
The gestation of the Uptown District mixed-use development in San Diego exemplifies the collaborative and creative challenges of infield development. In 1986, the city acquired the 12.5-acre site of a defunct Sears shopping center in the Hillcrest neighborhood north of downtown. Business and civic groups worked together to craft an overall plan for the site; the plan called for a reduction in retail space but development of a supermarket much needed by area residents. Meanwhile, a development and design group assembled by the development partnership of Oliver McMillan/Odmark & Thelan initiated a strategy of land acquisition and community involvement to formulate a community- and market-responsive plan for redevelopment of what was by then an expanded 14-acre site. Ultimately, the city accepted the plan through a competitive selection process. The plan called for 144,000 square feet of retail space, a 3,000-square-foot community center, 318 residential units, and 1,200 parking spaces. A central feature is a supermarket sited behind smaller stores to provide a continuous street facade along University Avenue. A boulevard through the residential portion of the site is part of the pedestrian-scale street grid, and a central courtyard adjacent to the community center is the focal point of the entire development. The three-story residential buildings are clustered around courtyards built over underground parking and street-level stores. Michael Stepner, then city architect, observed, "Uptown District has broken new ground, placing dense development on an infill site in a way that is acceptable and maintains community character. This project takes a giant step toward making Hillcrest an urban village that works."[46]

A smaller but still complex residential development in an already developed area likewise employs courtyards and underground parking. Developed entirely by private interests, Madison Place provides 125 townhomes on a six-acre site in Northern Virginia in a previously declining neighborhood of single-family bungalows just 20 minutes from downtown Washington, D.C., as shown in figure 6-17. Five groups of townhomes are clustered around highly landscaped courtyards. Below the courtyards, driveways lead to the homes' underground garages. Despite the project's infill location, the developer was required to upgrade roads and stormwater systems in the area. The townhomes, priced at $220,000 to $240,000, have sold well.[47]

Brownfields as Infield Development Sites. Sites that encompass brownfields present a special case with respect to the natural landscape. The U.S. Environmental Protection Agency (EPA) defines

6-16

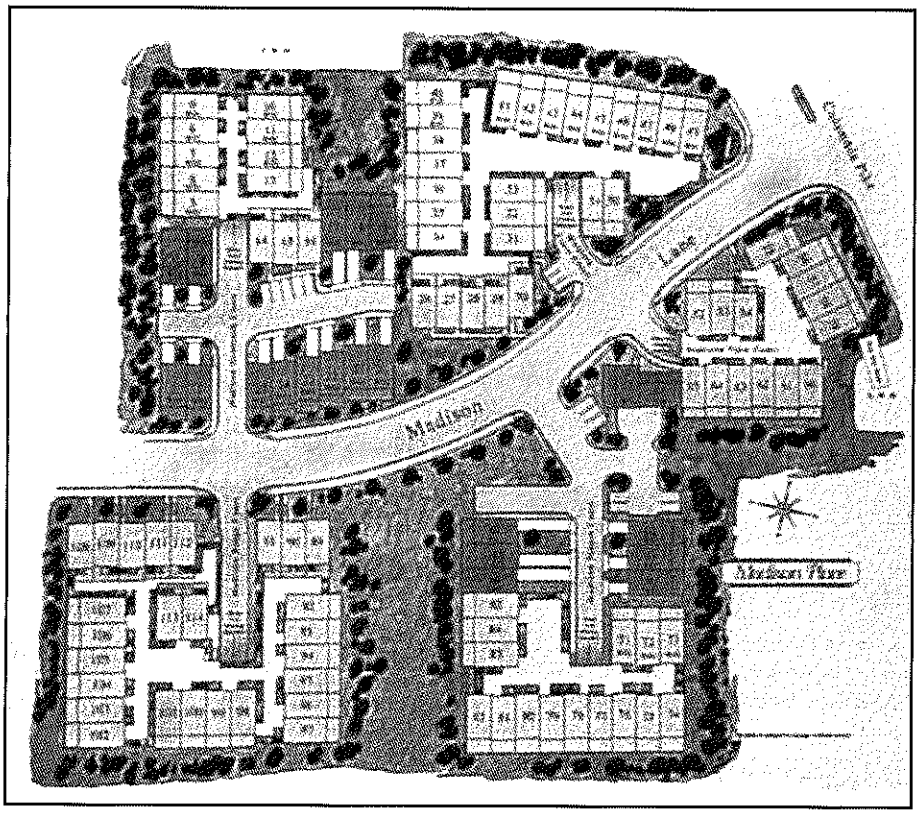
The Uptown District: A Mixed-Use Development Replaces a Shopping Center



A public/private project, the Uptown District exemplifies a development designed to be compatible with and supportive of the surrounding neighborhood.

Madison Place, Fairfax County, Virginia: Residential Redevelopment

6-17



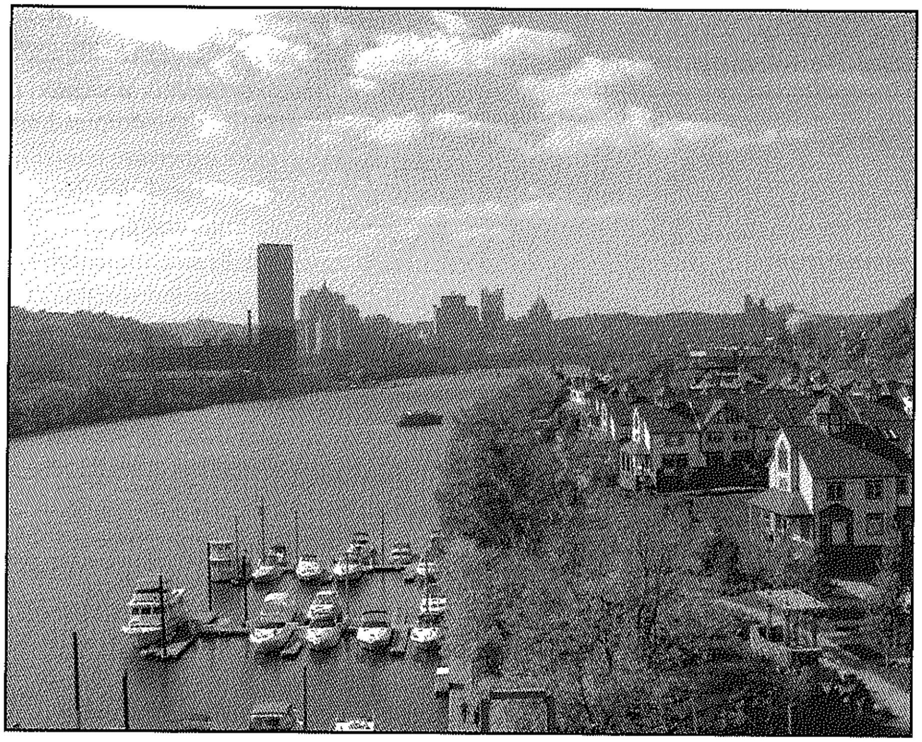
On a six-acre infield site, 125 townhomes replaced a declining low-density residential area.

brownfields as "abandoned, idled, or underused industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination." Even though the EPA has pruned its Superfund list to about 1,200 sites, some estimates claim that 400,000 to 500,000 brownfield sites exist, ranging from closed gasoline stations and dry cleaners to abandoned railyards and steel mills. Many, but not all, are located in urbanized areas and are especially prominent in inner-city areas where large-scale manufacturing occurred for up to a century or more. In many cases, the sites' size and location make them prime candidates for redevelopment; many states and municipalities favor the economic revitalization that can flow from investments in brownfield cleanup.

Developers, however, have learned to approach the development of brownfields with great caution. Not only are many sites located in areas considered commercially undesirable, but federal laws governing cleanup may also require massive and frequently unexpected investments by current and past property owners. Ironically, the liability provisions of the Superfund law—the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, known as CERCLA—discourage redevelopment and even encourage abandonment to avoid cleanup liability. Thus, brownfields or sites incorporating brownfields may prove to be risky investments that drive off lenders.

Nonetheless, several trends are helping to enhance the potential for brownfield development. First, evaluations of site cleanup needs often reveal that contamination, although suspected, is either absent or not sufficiently widespread or dangerous to require expensive remediation. As part of its Brownfields Pilot Program, for example, the city of Chicago conducted environmental audits of several former industrial sites desired as expansion sites by adjoining industries. While the sites had become dumping grounds and eyesores, the city found no significant contamination or only a minor need for remediation, thereby making the parcels available for reuse.[48] Second, Congress amended the Superfund law in 1997 to hold lenders harmless when financing redevelopment of brownfield sites; in addition, at least 35 states have enacted legislation to limit cleanup liability. As a result, insurance companies are now writing policies to limit developer liability and financial institutions are making loans for brownfield development.

Third, state and local agencies have become more knowledgeable about cost-effective cleanup approaches and are frequently willing to provide tax incentives for, and reduce the liability risks associated with, cleanups. Fourth, as changing demographic and economic factors begin to favor central locations, inner-city brownfields are becoming increasingly desirable development sites. The last two trends are exemplified in the development of Washington's Landing, located on Herr's Island two miles from downtown Pittsburgh. The former heavy industrial site required a two-year environmental cleanup financed by state and city agencies. In 1995, builders Montgomery and Rust initiated construction of upscale townhomes and an office park flanked by a rowing club, tennis courts, and a marina. By early 1999, 65 townhomes had been completed and sold at prices ranging from $139,000 to $560,000; by the end of 1999, the project had moved into



Brownfields reused for Washington's Landing, Pittsburgh, Pennsylvania. Townhomes and a mix of commercial and office uses recycled a former industrial site in an attractive center-city location.

its final phase. The Pittsburgh Urban Redevelopment Authority, in addition to managing the predevelopment planning and cleanup efforts, constructed basic infrastructure systems, a public park, and a riverside pathway and helped finance the development.[49]

On sites where contamination is suspected, the landscape analysis should include testing for the presence of toxic wastes. If significant contamination is found, the developer will need to work with state and local agencies to determine cleanup needs and potential financial assistance in meeting remediation requirements. Ideally, testing for toxic wastes should occur before the developer's final acquisition of the site.

Developing for Economic and Social Enhancement

Sustainable developments are not only concerned with a site's natural features and the arrangement of buildings, streets, and open spaces; they are also focused on the people who will live and work in the developments and the adjoining neighborhoods. To be sustainable, physical systems must mesh with and enhance the economic and social fabric of the development and its host community. As stated in the Urban Land Institute's *Trends and Innovations in Master-Planned Communities,* "[P]lanning for the future can no longer simply involve issues of land use and density . . . . For future communities to be truly competitive they must provide quality of life for the community's residents."[50]

Providing opportunities for citizens' economic and social well-being is an essential responsibility of government, but developers can advance the principles of sustainability by attending to such concerns in planning and managing development. In particular, developers can contribute to sustainable social and economic activities by carefully specifying project components that support stimulating activities and by connecting on-site facilities and activities to the broader community. In addition, developers can work to link economic and social activities to the conservation of natural resources.

Broadly stated, initial determinations of the components of a proposed development should consider possibilities for advancing social and economic opportunities. Plans for large residential developments routinely recognize the need for schools, parks, playgrounds, religious buildings, and other community facilities and amenities—all supportive of a sustainable society. In fact, developers are increasingly aware of the competitive edge they may gain from providing top-quality educational opportunities in new developments. Many times, local school districts are unable to finance the timely construction of needed schools. For this reason, developments such as Hidden Springs near Boise, Anthem near Phoenix, and Westin in Broward County, Florida, built schools during the initial phases of development. Some developers have even taken the next step of launching programs to enhance the quality of local education. For example, the Grupe Company's Brookside Community employs a teacher full time on its community association staff and lends the teacher to the middle school to help establish goals and benchmarks for student achievement.

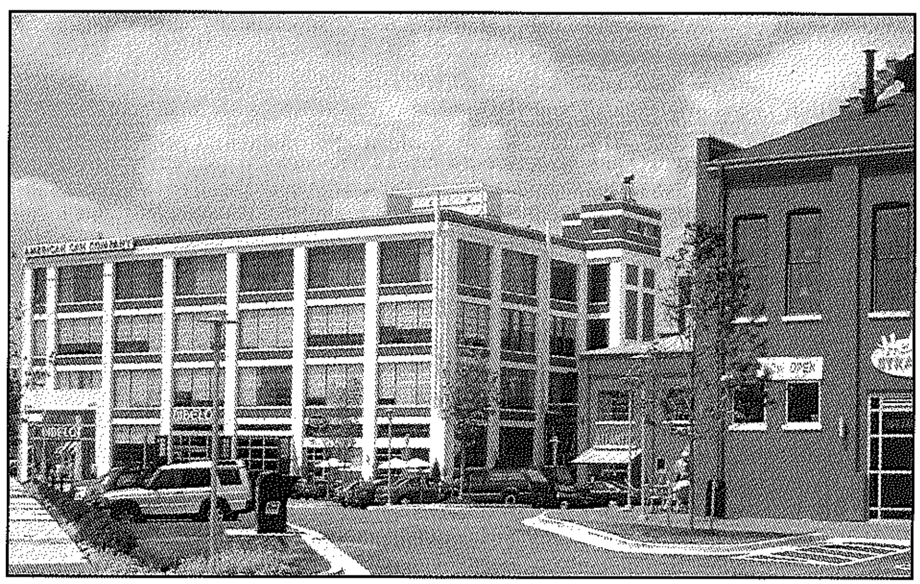
A survey of existing facilities around a proposed development may identify needs and opportunities that can be satisfied on the development site. Even a relatively small development, for example, can host a branch library or child care center or provide space for adult education. Haile Plantation's village center, for example, provides these types of services. Especially if wrapped into a central mixed-use activity center along with shopping, office, and school facilities, space devoted to community services can help create the beneficial sense of place already described. At the same time, a survey of existing facilities may reveal opportunities for meeting the needs of on-site residents by connections to off-site facilities. One of the advantages of the Village Green development (low- to moderate-income housing in Los Angeles) is access to a transit station and an adjoining child care center just across the street from the development.

Developers also look for opportunities to provide retail shops and related services that benefit site and neighborhood residents. Depending on the size of the development, possibilities can range from major shopping malls to small spaces within residential buildings. One of the first buildings completed in Hidden Springs was a general store that offers convenience supplies for new residents; it also accommodates an informal eating space (to be converted later to a fire station), a central mail pickup point, and the sales office for the development, which will eventually be converted to general office space. The 30-unit Knickerbocker Lofts, an adaptive use development in New Rochelle, New York, incorporates 3,000 square feet to be used for neighborhood retail services. A southern California developer, Alexander Hagen, has focused on constructing neighborhood shopping centers, typically anchored by Ralph's supermarkets, aimed at underserved African American and Hispanic neighborhoods in south-central Los Angeles.

Including job-creating businesses in development also helps support the founding and expansion of local firms while widening employment opportunities for local residents near their homes. Business, industrial, and mixed-use developments can include incubator space to nurture new companies and expand local employment. The Can Company development located in a revitalizing neighborhood east of downtown Baltimore, for example, adapted a historic industrial complex to create neighborhood-supporting retail uses, along with jobs for local residents. It also provides incubator space for new businesses that are expected to create new jobs in the area. The project was encouraged by community leaders who saw the need for neighborhood-serving activities to support regeneration of the historic residential area. As for outlying sites, developers can work with large employers to incorporate telecommuting centers that are available to local residents who wish to reduce long-distance commuting a few days each week.

In addition, many developers can work with public agencies and labor unions to offer job opportunities both during and after construction. For infield developments in particular, nearby residents can learn new skills for later use in the employment market. Developers may also help support local business development by working with public agencies to spur "access-to-jobs" programs that provide transportation and related job counseling. These efforts benefit both unemployed workers in central-city labor pools and suburban businesses that need to fill jobs.

Developments may also advance social opportunities by offering a range of housing options, including affordable housing for moderate- to low-income occupants. In many cases, projects are eligible for public financial assistance that makes possible discounted home prices.[51] The Village Green development in Los Angeles, featuring single-family homes targeted to a moderate-income market, has arranged for a partial rebate of construction loan interest, thereby reducing by almost half the income requirements for purchase of some of the development's 186 homes. RiverStation, a multiphase residential development in Minneapolis, offers opportunities for middle-income owners and renters—a market ill-served in the past—to live near downtown. The 360 condominium apartments in



A can-do project: The Can Company in Baltimore, Maryland. Leveraged by city and state funds, the Can Company development transformed a vacant industrial complex in a reviving residential area into a neighborhood-friendly retail and office center.

the first phase and 232 rental units in the second phase are expected to encourage revitalization in the immediate area. The Minneapolis Community Development Authority, which assembled the property and sold it to the developer for $1, is providing below-market mortgages that will allow families with incomes as low as $36,000 (compared to the Minneapolis median of $57,300) to purchase homes in the development. In the initial phase of Rancho Santa Margarita's development, 65 percent of the residential units were priced to meet Orange County's (California) affordable housing standards.

Infield developments that may displace existing residents should not ignore residents' housing needs, especially in the case of low-income occupants who may find alternative housing difficult to obtain. Where displacement will occur, developers should plan ahead by arranging for relocation assistance if necessary and even for affordable rehabilitation rather than demolition of existing homes.

Development of open space and recreational amenities also serves social goals. As discussed earlier, the provision and layout of parks and recreation areas in developments should take account of the different needs of residents and, if possible, should link to open-space systems around the development. Rancho Santa Margarita's 2,500-acre open-space system, for example, connects to O'Neill Regional Park. Such facilities and connections will improve social interaction both within the development and with adjoining neighborhoods.

Social and economic concerns also focus on safety, a continuing worry for many Americans. Developers who plan to do away with gates to maintain connections to the larger community can turn to other measures for ensuring safety. Site and building design is a primary consideration. Techniques such as designing for high levels of activity on streets and in public areas, installing appropriate lighting in those spaces, and carefully designing other open spaces to ensure their visibility from adjacent buildings can stifle opportunities for crime. Laying out small, distinct neighborhoods can encourage residents to watch out for each other. In larger developments, privately hired security patrols have been successful in limiting crime. The Woodlands in Houston reduced crime and increased social interaction by using highly visible horse patrols.

Finally, developers can help educate site occupants to appreciate and maintain the sustainable features of their homes and work environment. Raising residents' awareness of the environmental values of a site's natural qualities helps affect occupant behavior—what Dewees Island developer John Knotts calls "building institutional memory"[52]—and protect those qualities. Some developments sponsor interpretive nature walks or make on-site features available as laboratories for school programs. Dewees Island has gone further, creating partnerships with local schools to sponsor environmental programs that include class instruction as well as field trips to the island throughout the school year. Other projects such as Shenoa Retreat and Learning Center in Mendocino County, California, and Rancho San Carlos in Carmel, California, marketed land stewardship as a primary lure for buyers willing to pay premiums to preserve open space and support sustainable practices in community and building design. Guests at Shenoa, for example, are educated about the food grown in the center's organic garden. The food is then served to the visitors and the surplus donated to a food bank. The ecotourist resort, Harmony at Maho Bay in the Virgin Islands, showcases innovative building technologies. Closer to home, developments can make community gardens available for cultivation by residents and hire local farmers to teach the basics of successful food production, thereby reducing needs for importing food.

Conclusion

This chapter identifies numerous paths and approaches to investing developments with sustainable features. Many are feasible and applicable to a variety of developments; others are most useful in particular locales, climates, terrains, and markets. Developers and their consultant teams can map out paths to sustainable development through their initial decisions on development locations and specific sites; their subsequent determinations of the program of uses and activities to be developed, the green infrastructure to be preserved and restored, and other community facilities and infrastructure to be developed in support of the built environment; and their judgments on the place-making and livability qualities of that built environment and the economic and social factors that can be satisfied and enhanced through the planned development. Developers do not make these decisions in a vacuum; they must be supported by community policies and programs and private market practices that make it at least as easy to apply the principles of sustainability as to produce another conventional project.