THIRD EDITION

Site Analysis

Informing Context-Sensitive and Sustainable Site Planning and Design

James A. LaGro, Jr.

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WILEY

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For David and Kyle

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Preface

Designing with nature—and with sensitivity to pertinent cultural, historic, and legal factors—is the land use ethic that has guided the writing of this book. This third edition of *Site Analysis* retains the basic structure of earlier editions by devoting one or more chapters to individual phases of the site planning process and by arranging these chapters in the sequence in which they typically occur.

This edition's nine chapters examine the linkages between contextual conditions and the design and development—and redevelopment—of the built environment. A variety of project types, scales, and geographic settings are considered, although greater attention is given in this extensively revised edition to urban sites.

This book is written primarily for a multidisciplinary audience of university students and early-career practitioners. Like previous editions, this book can be a resource for landscape architecture students taking introductory design studios and site analysis courses, and for architecture, urban planning, and civil engineering students taking site planning courses.

Working effectively across disciplines has never been more important. Advances in urban sustainability will require more effective and synergistic collaborations among the planning and design professions, especially architecture, engineering, landscape architecture, and urban planning. Meaningful collaboration among these professions' educational programs can also strengthen relationships between universities and their broader communities.

More than two decades ago, Boyer (1990) argued that universities should place greater value on engaged scholarship (i.e., applying one's academic expertise to solve consequential societal problems). Problem-based learning, characterized by small teams of students focusing on solving real-world problems, is particularly relevant in professional planning and design programs, where students strive to develop their problem-solving knowledge and skills (Barrows, 1996).

Within a few years after graduation, many design and planning practitioners study for professional competency exams. This edition, therefore, can serve as a resource for early-career practitioners studying for licensing exams in landscape architecture or architecture and for certification exams in urban planning. My hope is that this book is also useful to public sector planning staff, elected officials, and appointed citizens who serve on local boards or commissions that formally review land development proposals.

Acknowledgments

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Several educators provided constructive critiques at various stages and editions of this book. They are Jack Ahern (University of Massachusetts), Gary Clay (California Polytechnic State University–San Luis Obispo), Randy Gimblett (Arizona State University), Paul Hsu (Oklahoma State University), David Hulse (University of Oregon), Nate Perkins (University of Guelph), Rob Ribe (University of Oregon), and Peter Trowbridge (Cornell University). The book also benefited from three anonymous reviews of this edition's proposal to the publisher.

Margaret Cummins, executive editor at John Wiley & Sons, oversaw the production of all three editions. On this third edition, additional editorial assistance was provided by Lauren Poplawski and Michael New, and the production process was led by Donna Conte.

Bridget and David LaGro provided unstinting support and encouragement.

Site Analysis

part I

Context and Approach

Part I of this book presents the rationale for a context-sensitive approach to site planning and design. Chapter 1, "Shaping the Built Environment," addresses the sustainability imperative and design strategies to create healthier, resilient, and more livable built environments. The chapter also presents a systematic, multiphased approach to place-making at the site scale.

chapter 1

Shaping the Built Environment

Sustainable design balances human needs (rather than human wants) with the carrying capacity of the natural and cultural environments. It minimizes environmental impacts, and it minimizes importation of goods and energy as well as the generation of waste.

—United States. National Park Service (1993, p. 55)

1.1 INTRODUCTION

About 82 percent of the 312 million U.S. residents—and 50 percent of the planet's 7 billion inhabitants—now live in urbanized areas (United Nations, 2010). Cities and their suburbs today import vast quantities of both raw and processed resources (for example, energy, water, food) and they export—often to rural areas—massive quantities of wastes (for example, plastics, paper, metals).

Yet, the global economy—with its 12,000-mile supply chains—increases international dependencies and, potentially, reduces the resilience of communities to distant political disturbances and natural disasters (for example, Japan's 2011 earthquake and tsunami). Sustainability is a global challenge requiring context-specific changes in the structure and function of our built environments. Urban population growth heightens the need for comprehensive interdisciplinary solutions to this contemporary challenge.

1.2 ECOSYSTEM SERVICES

Advances in telecommunications technologies, combined with extensive highway networks and sprawl-inducing land use regulations and subsidies, have greatly loosened the geographic constraints on population distribution and land development spatial patterns.

> Transportation costs, markets, and raw materials no longer determine the location of economic activities. We have developed an information-based economy in which dominant economic activities and the people engaged in them enjoy unparalleled locational flexibility. In this spatial context, amenity and ecological considerations are more important locational factors than in the past. Cities located in amenity regions of North America are growing more rapidly than others and such trends will intensify as society becomes more footloose.
>
> (Abler et al., 1975, p. 301)

The earth's ecosystems perform functions that are essential to human health and welfare. In *Functions of Nature,* deGroot (1992) classified nature's functions into four life-supporting categories: production, regulation, carrier, and information services (Table 1-1). Nature's "infrastructure" helps protect the quality of the air we breathe and the water we drink, and it provides an abundance of other "goods and services." These include food, fiber, water, biodiversity, and energy production as well as the provision of cultural, recreational, and spiritual experiences (Daily et al., 1999; Reid et al., 2005).

The value of nature's services to human well-being, and the implications of different management approaches over space and time, are not widely appreciated or even well understood. Consequently, environmental management practice has suffered from an incorrect assumption (Folke et al., 2002, p. 437): that *"human and natural systems can be treated independently"* [emphasis added]. Many human activities, however, impose detrimental impacts on the earth's capacity to sustain life. The World Resources Institute (WRI) tracks global environmental trends, and the following findings—among many others—reinforce the global sustainability imperative:

TABLE 1-1 Ecosystem services support human civilization by providing a broad range of "goods and services."

Function	***Goods or Services***
Production	Oxygen
	Water
	Food and fiber
	Fuel and energy
	Medicinal resources
Regulation	Storage and recycling of organic matter
	Decomposition and recycling of human waste
	Regulation of local and global climate
Carrier	Space for settlements
	Space for agriculture
	Space for recreation
Information	Aesthetic resources
	Historic (heritage) information
	Scientific and educational information

Source: Adapted, in part, from deGroot (1992, Table 2.0–1).

- Tropical forests are shrinking, and the rates of plant and animal species extinction are increasing.
- Groundwater tables are falling as water demand exceeds aquifer recharge rates, and groundwater continues to be contaminated with pesticides and other contaminants.
- Global climate change and warming are occurring, and the sea level is projected to rise by as much as 3 feet (0.91 meter) by 2100.
  Source: http://earthtrends.wri.org/

Hurricanes, floods, and other natural hazards continually threaten human health, safety, and welfare. Yet, many disasters causing the loss of life and property can be prevented, or at least mitigated, by better land use decisions that reduce these risks (H. John Heinz Center for Science, Economics, and the Environment, 2000; Mileti, 1999). Dennis Mileti, who led the Heinz Center's natural hazards risk analysis, concludes in a press release from the National Science Foundation (1999, p.1):

> The really big catastrophes are getting large and will continue to get larger, partly because of things we've done in the past to reduce risk. . . . Many of the accepted methods for coping with hazards have been based on the idea that people can use technology to control nature to make them safe.

In the United States, hurricanes, flooding, and severe storms contribute about three quarters of the total damages from natural hazards. Per capita losses from natural hazards are outpacing population growth, and if the trend of the past two decades continues, direct losses of $300 to $400 billion are probable within the current decade (Gall et al., 2011).

1.3 PLACE-BASED STEWARDSHIP

The World Commission on Environment and Development (1987, p. 40) suggests that "sustainable development seeks to meet the needs and aspirations of the present without compromising the ability of those to meet those of the future." Concern over climate change, in particular, has precipitated advances in "sustainability science"—which seeks to understand the complex dynamics of interconnected human and environmental systems. Actions to reduce greenhouse gas emissions (climate mitigation) and increase cities' resilience to extreme weather events (climate adaptation) are applications of sustainability science. Yet, the most ambitious application of sustainability science, is *"the integrative task of managing particular places where multiple efforts to meet multiple human needs interact with multiple life-support systems in highly complex and often unexpected ways"* [emphasis added] (Clark, 2007, p. 1737).

The built environment—the three-dimensional arrangement of buildings, transportation and utility networks, and green spaces—influences community health and sustainability across the urban-to-rural continuum. As the theoretical concepts guiding sustainability science are translated into actions, the built environment's transformation will require closer collaboration of architects, landscape architects, urban planners, engineers, and other allied professionals. There is a critical need for planning and design professionals who can bridge

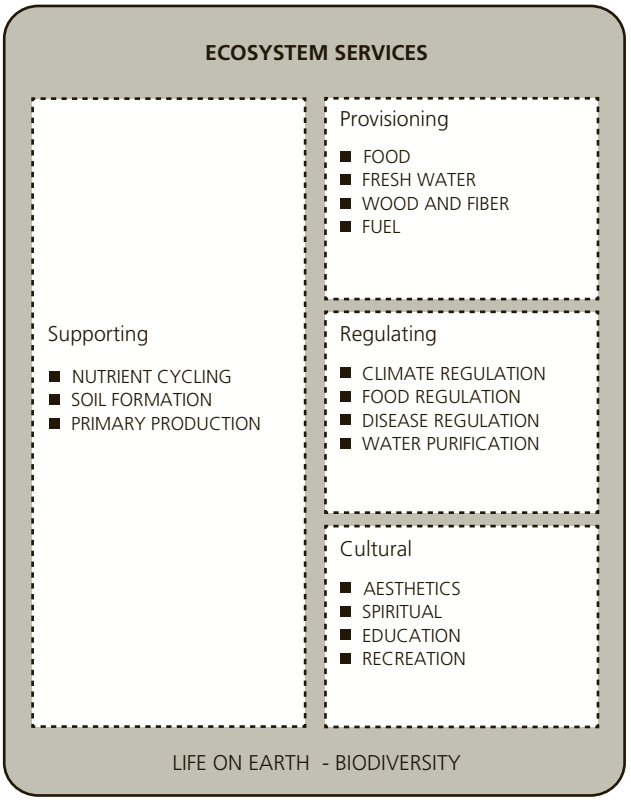

Figure 1-1 Ecosystem services support a hierarchy of human needs. Source: Adapted, in part, from Millennium Ecosystem Assessment (2005).

professional "silos" and lead multidisciplinary teams in creating policy, design, and technology solutions to local, regional, and global sustainability challenges.

Sustainability initiatives at the federal level currently include the *Partnership for Sustainable Communities*—an interagency initiative of the U.S. Environmental Protection Agency (EPA), the U.S. Department of Transportation (DOT), and the Department of Housing and Urban Development (HUD). This collaboration has been a catalyst for integrated sustainability planning at the local and regional scale (www.sustainablecommunities.gov/). Along with efforts by the U.S. Centers for Disease Control and Prevention (CDC), this partnership explicitly recognizes that the spatial structure of the built environment—the location and design of buildings, transportation systems, and green spaces—influences not only economic prosperity and environmental quality, but also public health (Figure 1-1).

Our quality of life is dependent on many factors, including our safety and sense of security, our individual freedom and physical and mental health, and our opportunities for self-expression as individuals (Kaplan and Kivy-Rosenberg, 1973). Most, if not all, of these factors are affected by the design of the built environment. Sprawling development patterns, for example, tend to reduce people's housing choices and limit their opportunities for healthy, active living (Frumkin et al., 2004).

Over the past six decades, suburban sprawl in the United States has been planned, financed, and constructed while largely ignoring the associated social, economic, and environmental externalities (Soule, 2006). Since World War II, the interplay of local land use planning and federal and state policies has produced abundant "driveable suburban" landscapes but far fewer "walkable urban" neighborhoods (Leinberger, 2008). Besides diminishing the nation's energy security, the consequences of this land development paradigm include a litany of public health impacts (Frumkin and Jackson, 2004), economic impacts (Burchell et al., 2005), and environmental impacts (Johnson, 2001).

Public policy plays a significant role in shaping the built environment (Ben-Joseph and Szold, 2005). In the United States, local development regulations have not only encouraged low-density sprawl but also have inhibited other, more sustainable forms of development. Zoning codes, for example, emerged in the early twentieth century to protect public health, safety, and welfare (Platt, 2004). These land use controls were effective in separating new residential areas from polluting industries and ensuring that new housing construction met basic health and safety standards. But zoning codes also routinely separated residential development from shops, restaurants, and other commercial uses, often with detrimental consequences for community health and well-being. There is an urgent need in the United States for land use planning and regulatory reforms (Schilling and Linton, 2005).

Because public policies play significant, yet often hidden, roles in shaping the built environment, planning and design professionals should be leaders in formulating better

public policy. Professional associations are, in fact, taking a greater advocacy role. These changes are reflected in recently launched sustainability initiatives by the American Society of Landscape Architects (ASLA) *Sustainable Sites Initiative™*, the American Institute of Architects (AIA) *SustAIAnability 2030 Toolkit*, the American Planning Association (APA) *Sustaining Places Initiative*, and the American Society of Civil Engineers (ASCE) *Institute for Sustainable Infrastructure*. These sustainability initiatives express strong values and advocacy positions—concerning social equity, for example—that are reflected in each profession's continuing professional education programs and competency exams.

The ASCE, for example, defines "sustainability" as follows:

> A set of environmental, economic and social conditions in which all of society has the capacity and opportunity to maintain and improve its quality of life indefinitely without degrading the quantity, quality or availability of natural, economic, and social resources. (http://www.asce.org/Sustainability/ASCE-and-Sustainability/ASCE---Sustainability/)

The ASLA's Sustainable Sites Initiative defines "site sustainability" as

> design, construction, operations and maintenance practices that meet the needs of the present without compromising the ability of future generations to meet their own needs. http://www.sustainablesites.org/

Suburban sprawl has not only degraded environmental quality in the United States, but has also produced low-density, auto-oriented communities that contribute to sedentary lifestyles and diminished public health (Frumkin et al., 2004). Communities aspiring to become more prosperous, livable—and sustainable—are taking steps to retrofit their built environments in several important ways (Dunham-Jones and Williamson, 2011). "Smart Growth," "New Urbanism," and "sustainable design" are three related development paradigms that focus attention on the physical configuration, or design, of the built environment. Key attributes are the following:

- Mixed and integrated uses (i.e., diverse housing, shops, workplaces, schools, parks, and civic facilities encompassing interconnected indoor and outdoor environments)
- Clustered, compact buildings (i.e., architecture that enriches public open spaces, especially streetscapes, and creates neighborhoods and urban districts with a strong sense of place)
- Open space systems (i.e., connected natural areas and other outdoor places that provide linear recreational opportunities)
- Transportation networks (i.e., integrated systems safely serving pedestrians, bicycle riders, public transit, and automobiles)

Achieving these objectives involves coordination on a community-wide, and even regional, scale. Yet, these efforts must also be coupled with good design at the site, or parcel, level. Site-scale development—usually on privately owned property—is the primary way in which most communities change, for better or worse. And there are significant consequences of poor site planning. Detrimental impacts range from exposing people to safety and property risks to making people endure an unhealthy—even ugly—public realm. For

these reasons, protecting public health, safety, and welfare is the primary reason for licensing professional landscape architects, architects, and engineers.

In the past decade, the number of local sustainability efforts has accelerated, focusing increasingly on integrated approaches to achieving multiple social, economic, and environmental goals. In Ottawa, Canada, for example, in the process of developing the city's Official Plan ("A Vision for Ottawa"), citizens agreed to a set of community sustainability principles that addressed both the natural and cultural environments. These include:

- Minimize harm to the natural environment by recognizing that growth is ultimately limited by the environment's carrying capacity.
- Respect other life forms and support biodiversity.
- Use renewable and reliable sources of energy and foster activities that use materials in continuous cycles.
- Do not compromise the sustainability of other communities (a geographic perspective) or the sustainability of future generations (a temporal perspective).
- Value cultural diversity,
  Source: www.web.net/ortee/scrp/20/23vision.html

Sustainability is a complex technical, scientific, political, and social challenge, however, and efforts to advance this new paradigm must address this complexity systematically and holistically (Graffy, 2008). New policies, institutional structures, and professional cultures are needed to respond to sustainability challenges in ways that protect environmental quality, increase community resilience, and improve the quality of life for both current and future generations.

Sustainability initiatives can benefit from an in-depth understanding of natural and cultural assets. Diamond and Noonan (1996, p. xix) call for recognition of a broad set of community resources.

> A constituency for better land use is needed based on new partnerships that reach beyond traditional alliances to bring together conservationists, social justice advocates, and economic development interests. These partnerships can be mobilized around natural and cultural resources that people value.

Natural and cultural resources that should be assessed at the community level include (Arendt, 1999):

- Wetlands and wetland buffers
- Floodways and floodplains
- Groundwater resources and aquifer recharge areas
- Woodlands
- Moderate and steep slopes
- Significant wildlife habitats
- Historic, archaeological, and cultural features
- Productive farmland
- Scenic viewsheds from public roads

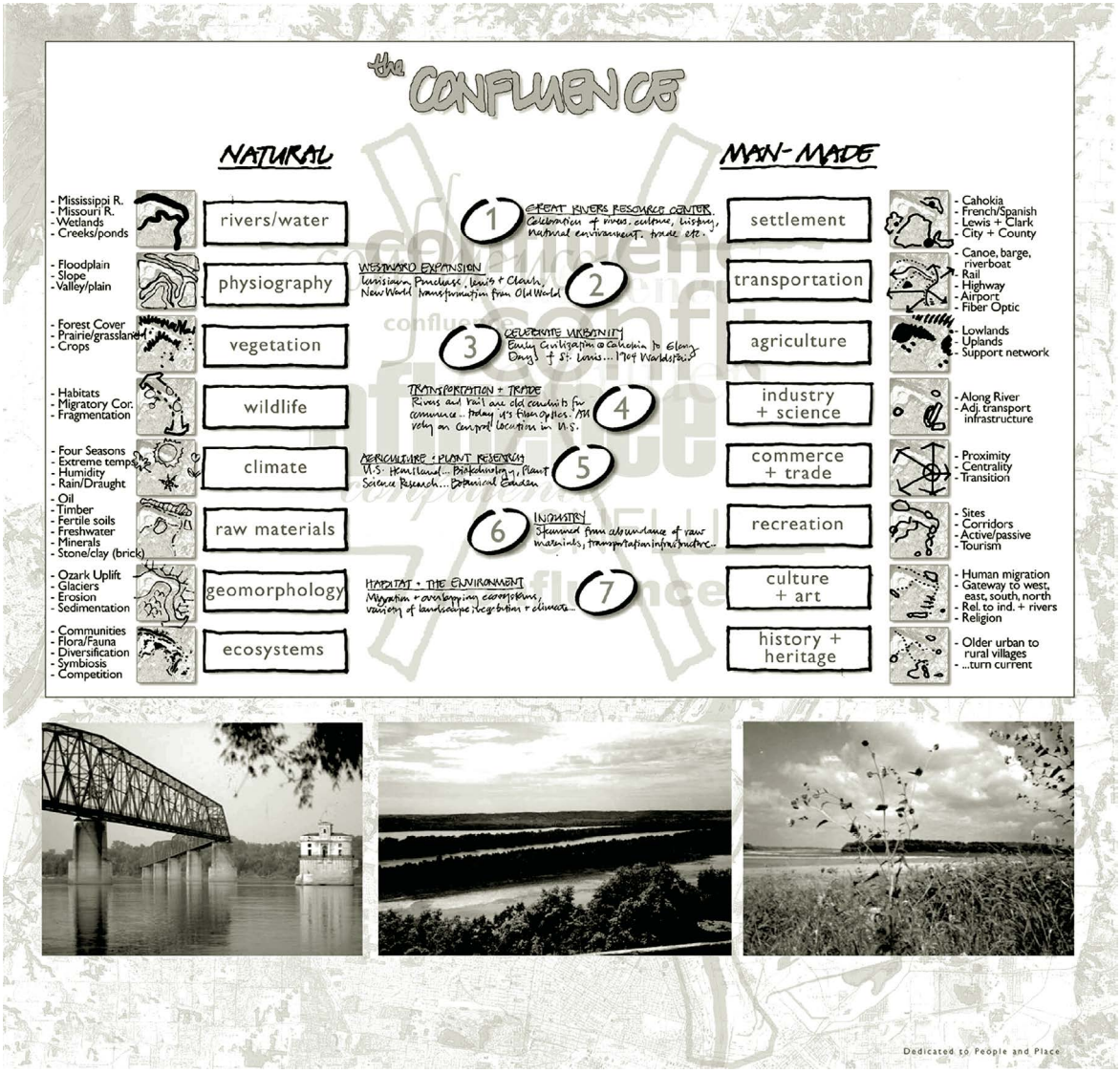

Figure 1-2 Natural and human-made factors influencing a greenway planning project along the Mississippi River in St. Louis, Missouri. Source: The HOK Planning Group. Used with permission of The HOK Planning Group.

Collectively, these resources form a unique spatial pattern or "signature" that helps to define a community's sense of place (Figure 1-2). Given their ecological, economic, and psychological importance to human well-being, these patterns must be carefully considered in designing the built environment, from the regional to the site scale (Figure 1-3).

In the context of the built environment, real-world problem solving involves the "stewardship of place" (Beatley and Manning, 1997; Stewart, 2010). The arrangement of streets and buildings involves "design decisions" that—for better or worse—shape the built

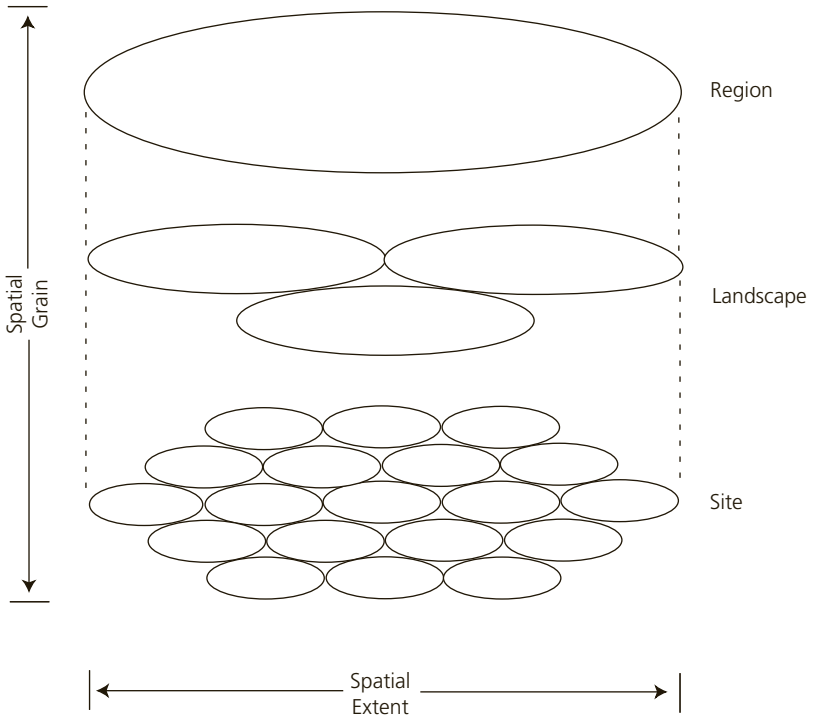

Figure 1-3 Spatial hierarchy—regions, landscapes, sites.

environment. Some designs, however, are far better than others, and the solution to contemporary placelessness is often simply better design. Stewardship depends not only on analyzing what is or has been, but also on imagining what could be, i.e., futures scenarios (Duderstadt, 2000). Net-zero energy buildings—and other aspirational goals for buildings as well as sites, communities, and regions—can lead to important policy, design, and technological breakthroughs.

The average citizen may think that design excellence is a frill or that it simply costs too much. But there are many reasons to justify the expense of investing in skilled planning and design. In *Designing the City: A Guide for Advocates and Public Officials,* mayors, real estate developers, and others who were interviewed expressed the following opinions about the quality of design in the built environment (Bacow, 1995):

> "Good design promotes public health, safety, and welfare."
> "Good design makes a city work better, not just look better."
> "Good design attracts people to a city, and those people help pay for essentials that help instill pride and satisfaction in what citizens get for their taxes."
> "Well-designed [real estate] products will succeed in tight markets where poorly designed products will not."

Good design also reduces the long-term life-cycle costs of operating and maintaining buildings' infrastructure. For example, up-front building design costs may represent only a

TABLE 1-2 Benefits of context-sensitive site planning and design.

Society	Enhances pedestrian/bicyclist mobility and safety
	Creates opportunities for active living
	Promotes a sense of community
	Creates attractive surroundings
	Increases neighborhood safety
	Improves access to public services
	Minimizes negative impacts on surrounding properties
	Protects cultural and historic resources
Economy	Attracts visitors, tourists, and investment
	Increases property value
	Creates marketable "experiences"
	Speeds real estate sales and rentals in tight markets
	Attracts high-skilled employees and employers
	Reduces commuting times
	Uses land efficiently
Environment	Conserves energy
	Protects biodiversity
	Reduces air and water pollution
	Protects ecosystem processes and reduces urban heat islands

fraction of the building's life-cycle costs. Yet, when just 1 percent of a project's up-front costs are spent, up to 70 percent of its life-cycle costs may already be committed; when 7 percent of project costs are spent, up to 85 percent of life-cycle costs have been committed (Romm, 1995). Consequently, design excellence enhances community livability and sustainability, which benefits society, the economy, and the environment (Table 1-2).

1.4 EVIDENCE-BASED DESIGN

Communities change incrementally through a continual process of land development and redevelopment, largely through private sector real estate projects at the site scale. The development of unsuitable sites—or poorly designed development on otherwise suitable sites—can negatively affect a broad array of natural and cultural resources (Sanford and Farley, 2004). On-site impacts, for example, may diminish visual quality and reduce native plant and wildlife biodiversity. Off-site impacts may include traffic congestion, flooding, or pollution of local surface waters (Arnold and Gibbons, 1996). Because these externalities degrade the quality of life, local governments must play an active and informed role in guiding the location, intensity, and character of land development and redevelopment.

Each site's carrying capacity is a measure of the type and intensity of development that can be supported without imposing detrimental effects on society, the economy, or the environment (Figure 1-4). A context-sensitive and sustainable approach to site planning pays close attention to development location. Site planning that is responsive to inherent environmental constraints can reduce construction costs, enhance critical ecosystem services,

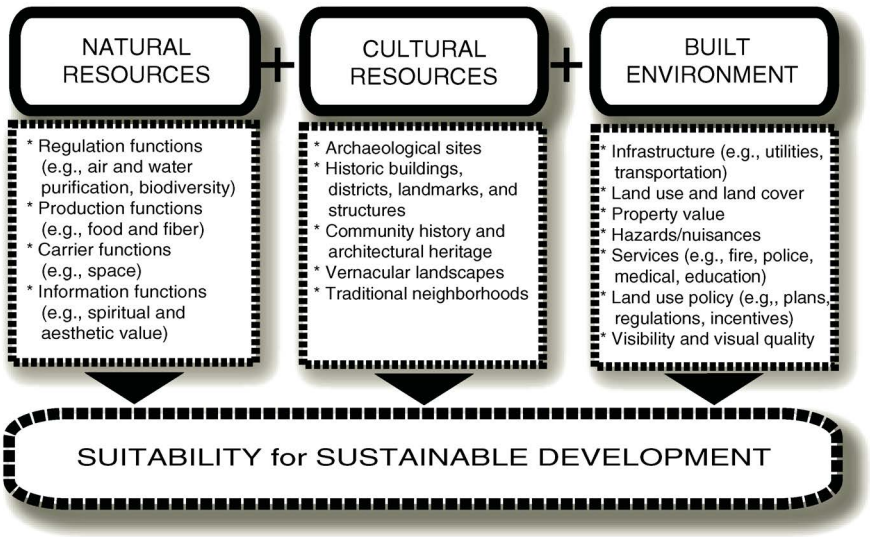

Figure 1-4 Suitability for sustainable development is determined by existing patterns of natural and cultural resources, as well as by the built environment's physical attributes.

and protect intrinsic cultural resources. In *Guiding Principles of Sustainable Design,* the U.S. National Park Service (1993, p. 45) analyzes the potential environmental impacts of new park facility construction by seeking answers to these questions:

> What inputs (energy, material, labor, products, and so on) are necessary to support a development option, and are the required inputs available?
>
> Can waste outputs (solid waste, sewage effluent, exhaust emissions, and so on) be dealt with at acceptable environmental costs?
>
> Can development impacts be minimized?

Sustainable design is inherently context-sensitive, minimizing negative development impacts by respecting the landscape's natural and cultural patterns and processes (Figure 1-5). In "Fostering Living Landscapes" (1997, p. 275), Carol Franklin writes:

> It is the growing realization of the interconnectedness of development and environmental processes worldwide and within our communities that drives the evolution of sustainable design. At every scale, sustainable design is fundamentally about integrating the natural structure of the site with the built environment.

Visual literacy—the capacity to graphically communicate design problems, relevant contextual information, and potential solutions—is an essential skill in the planning and design professions. The ability to integrate ideas from different disciplines into a coherent whole and to communicate that information to others is also an important leadership skill (Gardner, 2006). Decision-support systems, which are commonly deployed in medicine and other applied professions, can help interdisciplinary teams make better decisions in planning